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WTP Cost Benefit Analysis for C2 and C3 HVAC Systems
(24590-WTP-R-T-HV-02-001, Revision 0)

Contents

Tables

Acronyms and Abbreviations

AABC	Associated Air Balance Council
ACGIH	American Conference of Government Industrial Hygienists
AFBMA	Anti-Friction Bearing Manufacturers Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ALARA	as low as reasonably achievable
AMBA	American Bearing Manufacturers Association
AMCA	Air Movement and Control Association
ANS	American Nuclear Society
ANSI	American National Standards Institute
API	American Petroleum Institute
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
AWS	American Welding Society
BARCT	best available radionuclide control technology
DCSMF	Duct Construction Standards, Metal and Flexible (SMACNA Standard)
HADLTM	HVAC Air Duct Leakage Test Manual (SMACNA Standard)
HEPA	high efficiency particulate air
HDSIG	HVAC Duct Systems Inspection Guide (SMACNA Standard)
HLW	high-level waste
HSDD	HVAC Systems Duct Design (SMACNA Standard)
HVAC	heating, ventilation and air-conditioning
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
LAW	low-activity waste
MCC	Material Certificate of Compliance
M&TE	maintenance and test equipment
MEI	maximally exposed individual
NEBB	National Environmental Balancing Bureau

NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
OSHA	Occupational Safety and Health Administration
PT	pretreatment
RIDCS	Round Industrial Duct Construction Standards (SMACNA Standard)
TEDE	total effective dose equivalent
SMACNA	Sheet Metal and Air-Conditioning Contractors National Association
WAC	Washington Administrative Code
WC	water column
WDOH	Washington Department of Health
WTP	Waste Treatment Plant

1 Scope

This document performs a cost-benefit analysis for the application of technology standards during the design, fabrication, installation, and testing of HVAC systems at the Tank Waste Treatment and Immobilization Plant (WTP) facility located at the Department of Energy Hanford Site. The analysis specifically covers the exhaust portion of the C2 and C3 HVAC systems of the high-level waste (HLW) facility, the low-activity waste facility (LAW), the pretreatment facility (PT), and the laboratory facility of the WTP. The stack monitoring subsystems and evaluation for selection of components are not within the scope of this analysis.

2 Purpose

This document provides cost-benefit justification for the application of technology standards during the design, fabrication, installation, and testing of the exhaust portion of the C2 and C3 HVAC systems of the WTP.

The Washington Administrative Code (WAC) establishes requirements and procedures for the issuance of a radioactive air emissions license and for regulation of those emissions. These requirements ensure compliance with the standards for radioactive emissions set by the Washington Department of Health (WDOH). New emission units must utilize best available radionuclide control technology (BARCT) as defined in the WAC. The BARCT technology standards identified in WAC 246-247-120 must be met if the emission unit potential-to-emit exceeds 0.1 millirem per year total effective dose equivalent (TEDE) to the maximally exposed individual (MEI). If the potential-to-emit is below this value, the standards must be met only to the extent justified by a cost-benefit evaluation. The subject HVAC systems have been identified by Reference 16 for the WTP to have a potential-to-emit below the 0.1 millirem per year TEDE limit.

This document provides the cost-benefit justification for application of industry standards other than the BARCT technology standards. Application of these alternative technology standards will be recommended where these standards:

- Provide significant cost advantage
- Continue to provide sufficient control of radioactive contamination
- Will not increase the radiation exposure of site workers, the public, or the environment beyond an amount justified by the cost savings

Determination of the cost effectiveness of other technology standards is performed according to the guidance of Reference 18.

3 Introduction

3.1 WTP Facility Description

The WTP will process mixed wastes currently contained in underground waste storage tanks at the Hanford Site. The WTP will vitrify the waste to immobilize the mixed wastes for disposal.

3.2 C2 and C3 HVAC Systems Description

The designations C2 and C3 refer to facility contamination zones. The primary confinement zone consists of plant areas in direct contact with radioactive material and is designated C5. A C3 area is defined as an area that is normally unoccupied, but allows operator access under administrative controls as required for scheduled maintenance. The C3 areas have, by virtue of their location and the activities performed within them, an increased potential for the release of contamination; C3 areas are also classified as secondary confinement zones. C2 areas are defined as routinely occupied operating areas of the process building that have direct interfaces with C3 or C5 areas. The C2 areas have the potential to be contaminated, but are expected to remain free from contamination at all times. The C2 areas are classified as tertiary confinement zones. Emissions from the C2 and C3 systems are expected to result in a TEDE of less than 0.1 millirem per year to the MEI. The estimated unabated dose from each facility is identified in Table 1.

The exhaust portions of the C2 and C3 HVAC systems perform the following functions for the HLW, LAW, PT, and laboratory facilities at the WTP.

- Provide confinement ventilation by maintaining vacuum conditions within the facilities' buildings to prevent release of radioactive contamination to workers or the environment.
- Remove radioactive and non-radioactive particulates by filtration of the exhaust air.

3.3 General HVAC System Components

The HVAC system components as identified in ASME AG-1 are listed below.

fans
dampers
ductwork
housings
refrigeration equipment
conditioning equipment
moisture separators
medium efficiency filters
HEPA filters
type II adsorber cells
type III adsorber cells
adsorbent media
frames

instrumentation and controls
field testing

These components are subject to the analysis of Section 5. Some of these components will not be installed in the C2 and C3 exhaust systems and will be identified as not applicable when discussed in Section 5.

3.4 BARCT Technology Standards

WAC 246-247 sets emission standards based on limiting radiation exposure to the public; BARCT is required to ensure these emissions standards are met. BARCT is defined as "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." The BARCT technology standards ensure that selected abatement controls are designed and constructed to accepted nuclear industry standards, such that compliance with emission standards is ensured to the greatest degree practical.

Following are BARCT technology standards required by WAC 246-247-120 that are subject to evaluation in this document:

- ASME AG-1, *Code on Nuclear-air and Gas-treatment*
- ASME N509, *Nuclear Power Plant Air-Cleaning Units and Components*
- ASME N510, *Testing of Nuclear-Air Treatment Systems*
- ASME NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities*

4 Conclusion

Based on the evaluation and technical justification provided in Section 5 of this document, the cost savings realized through the application of industry standards and design specifications (other than the BARCT Technology Standards of WAC-246-247-120) are justified, for the exhaust portions of the C2 and C3 HVAC systems at the WTP.

5 Analysis

The analysis process uses ASME AG-1 as a benchmark to perform a comparison with the other standards or specifications identified in Table 2. ASME AG-1 is the highest level of standard for nuclear-air treatment systems. It encompasses most requirements from (or requires the implementation of) some of the other BARCT technology standards, such as ASME N509, ASME N510, and ASME NQA-1, as well as other industry standards. Also, WAC 246-247-120 requires that where conflicts in BARCT standards arise, ASME AG-1 shall take precedence.

Each HVAC system is divided into components. Each HVAC component classification mirrors the component classification in ASME AG-1. Industry standards or WTP specifications that apply to each component are identified in combination with the component design specifications, and are then evaluated against ASME AG-1. If it is determined that ASME AG-1 contains additional and more stringent requirements, technical justification for implementing the other industry standards or specifications is provided, if feasible. The cost savings of designing, fabricating, and installing the components to the other industry standards is then determined. Compliance with ASME AG-1 is then evaluated for cost versus benefit, using the guidance of Reference 18. If significant cost savings would be realized by implementing the other industry standards or WTP specification and this cost savings is justified based on evaluation according to Reference 18, these standards or specifications will be implemented.

Additional requirements from the other BARCT technology standards, which were not covered in the ASME AG-1 comparison, are then evaluated using the same methodology, as needed.

5.1 High-Level Waste Facility

5.1.1 High-Level Waste Facility Description

The HLW facility will immobilize high-level mixed waste into a stable glass form.

5.1.2 High-Level Waste HVAC Systems Description

The HLW C2 exhaust system consists of 7 parallel banks of HEPA filters with associated manual-inlet and outlet isolation dampers, safe-change HEPA filter housings, and ductwork. Of the filter banks, 6 are normally active with 1 in standby. Each bank consists of 6 individual, radial-flow HEPA filters rated at 2000 cfm with a clean pressure drop of 1.3 inches water column (WC). A total preliminary nominal flow rate of 60,000 cfm, with manual-inlet isolation dampers and air-operated outlet isolation dampers is provided by 2 centrifugal exhaust fans with 50 % capacity and variable-speed. The reagent tank room has a separate C2 exhaust system consisting of 2 HEPA filters with associated manual-inlet and outlet isolation dampers, safe-change filter housings, and ductwork; 1 of the filters is normally active with 1 in standby. Each HEPA filter is rated at 2000 cfm with a clean pressure drop of 1.3 inches WC. A preliminary, nominal-flow rate of 1700 cfm, with a manual-inlet isolation damper and an air-operated outlet isolation damper is provided by 1 constant-speed centrifugal exhaust fan.

The HLW C3 exhaust system consists of 7 parallel banks of HEPA filters with associated manual-inlet and outlet isolation dampers, safe-change HEPA filter housings, and ductwork. Of the filter banks, 6 are normally active with 1 in standby. Each bank consists of 6 individual, radial-flow HEPA filters rated at 2000 cfm with a clean pressure drop of 1.3 inches WC. A total preliminary nominal-flow rate of 54,830 cfm, with manual-inlet isolation dampers, air-operated outlet isolation dampers, and backdraft dampers is provided by 2 centrifugal exhaust fans with 100 % capacity, redundancy, and variable-speed. The canister storage areas have a separate C3 exhaust system consisting of 3 parallel banks of HEPA filters with associated manual-inlet and outlet isolation dampers, safe-change filter housings, and ductwork. Of the filter banks, 2 are normally active with 1 in standby. Each bank consists of 4 individual, radial-flow HEPA filters rated at 2000 cfm with a clean pressure drop of 1.3 inches WC. A total preliminary nominal-flow rate of 11,740 cfm, with manual-inlet isolation dampers, air-operated outlet isolation dampers, and backdraft dampers is provided by 2 centrifugal exhaust fans with 100 % capacity, redundancy, and variable speed.

5.1.3 High-Level Waste HVAC System Components Evaluation

Table 2 identifies the industry standards that may be applied to the HVAC system components. The industry standards and applicable WTP design specifications that have been chosen for evaluation against the BARCT technology standards are also identified.

5.1.3.1 Fans

ASME AG-1, Section BA, *Fans and Blowers*, provides requirements to ensure that fan equipment used in nuclear facilities is acceptable in all aspects of performance, design, and construction. Evaluation of ASME AG-1, Section BA, is performed by comparison against the requirements of the WTP design specification for commercial-grade centrifugal fans as identified in Table 2. Other industry standards cited in ASME AG-1, Section BA, that are also required by the design specification, are identified in Table 2. Detailed evaluation of Section BA is presented in Table 3.

The fans and motors selected for this application will be standard commercial-grade equipment of a size, type, and arrangement that have an extensive operating history in the industry; this operating history demonstrates the reliability of these fans. Custom fans, motors, or arrangements will not be selected. The fan manufacturer's in-house requirements and procedures for materials, design, fabrication, and construction of commercial-grade fans have demonstrated acceptable assurance that these fans will remain available to perform their functions, under reasonable maintenance and repair schedules. Accessibility for maintenance activities is provided and contamination levels will be minimal or non-existent to allow for routine access.

The increased reliability in and assurance of fan performance that is gained through implementation of ASME AG-1 is highly important to emission units that require removal of high levels of radioactive material, especially if the equipment is inaccessible due to radiation exposure. The C2 and C3 exhaust fans will handle minimal or no radioactive contamination as shown in Table 1. In addition, the C2 and C3 exhaust fans will be accessible for routine maintenance and monitoring. Therefore, the rigor associated with ASME AG-1 standards is not necessary to ensure reliable operation and performance of the design function.

5.1.3.2 Dampers

ASME AG-1, Section DA, *Dampers and Louvers*, provides requirements for the design, manufacture, shop test, and installation of dampers and louvers in nuclear-air and gas-treatment systems. Evaluation of Section DA is performed by comparison against the intended requirements of a future WTP design specification for commercial grade HVAC dampers, as identified in Table 2. Other industry standards called out in Section DA (that are also intended to be required by the design specification) are identified in Table 2. Detailed evaluation of Section DA is presented in Table 4.

The dampers selected for this application and the associated actuators and accessories will be standard commercial-grade equipment that has a past operating history in the industry; this operating history demonstrates the reliability of these dampers. Custom dampers or actuators will not be selected. The damper manufacturer's in-house requirements and procedures for materials, design, fabrication, and construction of commercial-grade dampers have demonstrated acceptable assurance that these dampers will remain available to perform their functions, under reasonable maintenance and repair schedules. Accessibility for maintenance activities is provided and contamination levels will be minimal or non-existent to allow for routine access.

The increased reliability in and assurance of damper performance that is gained through implementation of ASME AG-1 is highly important to emission units that require removal of high levels of radioactive material, especially if the equipment is inaccessible due to radiation exposure. The C2 and C3 HVAC dampers will be exposed to minimal or no radioactive contamination, as shown in Table 1, and will be accessible for routine maintenance and monitoring. Therefore, the rigor associated with ASME AG-1 standards is not necessary to ensure reliable operation and performance of the design function.

5.1.3.3 Ductwork

ASME AG-1, Section SA, *Ductwork*, provides requirements for the performance, design, construction, inspection, shop and field fabrication acceptance testing, and quality assurance for ductwork and accessories used in nuclear-air and gas-treatment systems. Evaluation of Section SA is performed by comparison against the requirements of SMACNA duct construction and installation standards and the *WTP HVAC Installation Specification* as identified in Table 2. The *WTP HVAC Installation Specification* is applicable to both ASME AG-1 and non-ASME AG-1 ductwork. A detailed evaluation of Section SA is presented in Table 5.

The ductwork construction standards for the C2 and C3 ductwork systems are largely based on SMACNA ductwork construction methods. The ductwork materials identified in SMACNA and the project design specifications list ASME AG-1 acceptable materials. Loading and allowable stress criteria in SMACNA and the project design specifications are similar to ASME AG-1 requirements and provide acceptable assurance that the C2 and C3 ductwork systems will perform their function over the life of the plant.

ASME AG-1, Article SA-4000, provides ductwork and ductwork support requirements. ASME AG-1 specifies design load combinations based on service levels (A, B, C, and D), but does not determine the required service level. The ASME AG-1 design load combinations for Service Level A ductwork systems are compared to SMACNA requirements in the table below:

ASME AG-1 (Service Level A) Ductwork Load Combination	**SMACNA**
dead weight (DW)	sections between hangers carry own load
normal operating delta-P (NODP)	pressurized test with maximum deflection and leakage
fluid momentum load (FML)	noise and vibration considerations
external loads (EL)	All in-line equipment shall be braced independently of the duct in conformance with all applicable building codes.
live load (L) – 250 pound load	Construction and maintenance loads must be taken into consideration.
thermal (T)	Temperature extremes, chemical, corrosion. Forces due to thermal expansion must be taken into consideration.
wind (W)	weather, earthquake

The design loads referenced by ASME AG-1 and SMACNA may differ, but the SMACNA design loads still provide a complete and operable system under all anticipated operating conditions. Furthermore, the project design specifications require that the duct systems be designed for a 40-year life upon the commencement of operation.

ASME AG-1 spells out the sheet metal cutting, forming, and bending requirements to be followed; SMACNA addresses these details as well. Similar guidelines exist between ASME AG-1 and SMACNA for construction and assembly of ductwork. Both standards allow the same type of longitudinal seams to be used during fabrication. Transverse joint types identified in SMACNA are acceptable per ASME AG-1 guidelines. Validation of the design for non-safety C2 and C3 systems lies in the ability of the ductwork to not exceed the allowable leakage indicated on the design drawings and specifications. The project-specified allowable ductwork leakage is based on ASME AG-1 requirements.

Some key similarities between ASME AG-1 and SMACNA are shown in the table below.

Item	ASME AG-1	SMACNA	Notes
galvanized duct material	ASTM A525	ASTM A525	ASME AG-1 and SMACNA requirements are equal.
stainless steel duct material	ASTM A167 and A240	ASTM A167 and A240	ASME AG-1 and SMACNA requirements are equal.
welding	AWS D1.1, 1.3 and 9.1	AWS D1.1, 1.3 and 9.1	ASME AG-1 and SMACNA requirements are equal.
construction	similar joints	similar joints	ASME AG-1 and SMACNA requirements are equal.
installation	NFPA 90A	NFPA 90A	ASME AG-1 and SMACNA requirements are equal.
leak test	5 % flow	Based on duct surface area	The project specification requires leak testing to ASME AG-1 requirements.

Other similarities between ASME AG-1 and SMACNA can be found in ASME AG-1. The following ASME AG-1 articles show how SMACNA is an acceptable equivalent to ASME AG-1:

- ASME AG-1, Section AA, Non-mandatory Appendix AA-D, *Design of Ductwork by Analysis (Suggested Approach), Article D-1000, Introduction*: "Other methods may be used to determine the adequacy of ductwork for design loading. These include the techniques presented in the *Sheet Metal and Air-Conditioning Contractor's National Association (SMACNA) Rectangular Industrial Duct Construction Standards*."
- ASME AG-1, Section AA, Non-mandatory Appendix AA-D, *Design of Ductwork by Analysis (Suggested Approach), Article D-2400, Stiffener Design*: "The stiffener may be designed in accordance with the recommendations of SMACNA…"
- ASME AG-1, Section AA, Non-mandatory Appendix AA-D, *Design of Ductwork by Analysis (Suggested Approach), Article D-2410, Stiffener Spacing*: "As an alternative, the spacing recommendation contained in SMACNA may be used as an initial spacing value."
- ASME AG-1, Section AA, Non-mandatory Appendix AA-D, *Design of Ductwork by Analysis (Suggested Approach), Article D-3200, Rectangular Duct Analysis*: "Tests performed have

demonstrated that ducts constructed to SMACNA specifications can adequately withstand specified dynamic loads".

- ASME AG-1, Section AA, Non-mandatory Appendix AA-D, *Design of Ductwork by Analysis (Suggested Approach), Article D-3520, Stiffener Size and Spacing*: "It is recommended that as a starting point, the stiffener size and spacing given by SMACNA, which are primarily based on operational requirements, be used."
- ASME AG-1, Section SA-5000, *Inspection and Testing, Article SA-5410, Ductwork Pressure Test*: "This test is not required if duct construction specified is equal to or greater than the duct construction allowed in the SMACNA standards listed in Article SA-2000 for the system operational pressure transient (SOFT)."
- ASME AG-1, Section SA, Non-mandatory Appendix SA-C, *Additional Guidelines for Duct Design and Construction, Article C-1300, Duct Construction Standards*: "Table C-1300-1 lists standards that may be used in the mechanical design of ductwork." All listed standards are SMACNA standards.

The installation of an ASME AG-1 ductwork system is highly important for nuclear power plant emission units that require removal of high levels of radioactive material, especially if the equipment is inaccessible due to radiation exposure. The C2 and C3 ductwork will be exposed to very low levels of radioactive contamination as shown in Table 1. The C2 and C3 ductwork systems will be designed with regard to accessibility for routine maintenance and monitoring. Furthermore, these systems will be installed by a ductwork subcontractor who has over 27 years of experience. The subcontractor has built similar ductwork systems at the following facilities: nuclear power plants in New York, Texas, Tennessee, Georgia, and at chemical demineralization projects in Hermiston, Oregon, Pine Bluff, Arkansas, and Aberdeen, Maryland.

The above similarities between ASME AG-1 and SMACNA (and the fact that ASME AG-1 recognizes SMACNA methods as an acceptable approach for determining the adequacy of ductwork for design loading), suggest that approving the use of SMACNA standards will result in robust C2 and C3 ductwork systems that will ensure reliable operation and performance while meeting the intent of ASME AG-1.

5.1.3.4 HEPA Filter Housings

Housings for HEPA filters will be designed and constructed to meet the standards of ASME AG-1 to the extent possible and, therefore, will not be evaluated. The radial-flow HEPA filters and filter housings are not specifically covered in ASME AG-1. A deviation request with justification is included in the compliance matrices.

5.1.3.5 Refrigeration Equipment

No refrigeration equipment is installed in the C2 and C3 HVAC exhaust systems at the HLW facility and, therefore, is not subject to this analysis.

5.1.3.6 Conditioning Equipment

Hot-water heating coils and chilled-water cooling coils will be installed in the supply air equipment. However, no conditioning equipment is installed in the C2 and C3 HVAC exhaust systems in the HLW facility and, therefore, is not subject to this analysis.

5.1.3.7 Moisture Separators

No moisture separators are installed in the C2 and C3 HVAC systems at the HLW facility and, therefore, are not subject to this analysis.

5.1.3.8 Medium Efficiency Filters

Medium efficiency filters will be installed in the supply air equipment, however, no medium efficiency filters are installed in the C2 and C3 HVAC exhaust systems at the HLW facility and, therefore, are not subject to this analysis.

5.1.3.9 HEPA Filters

HEPA filters will be designed and constructed to meet the standards of ASME AG-1 to the extent possible and, therefore, will not be evaluated. The radial-flow HEPA filters and filter housings are not specifically covered in ASME AG-1. A deviation request with justification is included in the compliance matrices.

5.1.3.10 Type II Adsorber Cells

No Type II Adsorber cells are installed in the C2 and C3 HVAC systems at the HLW facility and, therefore, are not subject to this analysis.

5.1.3.11 Type III Adsorber Cells

No Type III Adsorber cells are installed in the C2 and C3 HVAC systems at the HLW facility and, therefore, are not subject to this analysis.

5.1.3.12 Adsorbent Media

No adsorbent media is installed in the C2 and C3 HVAC systems at the HLW facility and, therefore, is not subject to this analysis.

5.1.3.13 Frames

Filter frames will be designed and constructed to meet the standards of ASME AG-1 to the extent possible and, therefore, will not be evaluated. The radial-flow HEPA filters and filter housings are not specifically covered in ASME AG-1, however, and a deviation request with justification is included in the compliance matrices.

5.1.3.14 Instrumentation and Controls

ASME AG-1, Section IA, *Instrumentation and Controls*, establishes requirements for the design, manufacture, installation, testing, and documentation for instrumentation, control components, and control panels used in nuclear-air and gas-treatment systems. Evaluation of Section IA was performed by comparison against the requirements of the WTP design specifications for instrumentation as identified in Table 2. Detailed evaluation of Section IA is presented in Table 6.

Some of the components of the HLW C3 ventilation systems are classified as important-to-safety (ITS). ASME AG-1 uses the term *safety related components*. ITS components will comply with the applicable

requirements of ASME AG-1. The evaluation in Table 6 does not include ITS components since ASME AG-1 is an implementing standard in the project's *Safety Requirements Document*. This means that the project intends to comply with applicable portions of ASME AG-1 on these items, in accordance with guidelines developed jointly with the Department of Energy. In Table 6, sections of ASME AG-1 that are specific to safety related components are identified with the words: *does not apply*.

A review of Table 6 reveals that WTP project specifications and procedures are equivalent to Section IA in many cases, and in all cases address the same areas of concern. Project specifications and procedures ensure that:

- All aspects of environmental and functional requirements are addressed during design
- The requirements are incorporated into procurement and construction documents
- Compliance by vendors and the construction forces is achieved and verified
- Nonconformance is detected, tracked, and corrected.

Written documentation of the entire process is included in project records. An extensive commissioning and testing period is planned to provide final verification of compliance.

The instrumentation and control components selected for this application will be standard industrial-grade equipment that has an extensive operating history in the industry and in similar environments. This operating history demonstrates the reliability of this equipment. The instrumentation manufacturer's in-house requirements and procedures for materials, design, fabrication, and construction of industrial grade instrumentation and control components have demonstrated acceptable assurance that this equipment will remain available to perform its function, under reasonable maintenance and repair schedules.

The increased reliability in and assurance of instrument performance that is gained through implementation of ASME AG-1 is highly important to emission units that require removal of high levels of radioactive material, especially if the equipment is inaccessible due to radiation exposure. The instrumentation and control components for the C2 and C3 systems will be exposed to minimal or no radioactive contamination as shown in Table 1, and will be accessible for routine maintenance and monitoring. Therefore, the rigor associated with ASME AG-1 standards is not necessary to ensure reliable operation and performance of the design function.

5.1.3.15 Field Testing

ASME AG-1, Section TA, *Field Testing of Air Treatment Systems*, provides requirements for field acceptance testing to verify that nuclear-air treatment HVAC systems are capable of performing their intended function after installation in the facility. Field testing of the C2 and C3 systems will be performed according to the applicable standards identified in the detailed component evaluations in this cost-benefit analysis. For example, field testing of ductwork will be according to SMACNA standards. All components are also required to be factory tested to applicable industry standards as described in the detailed evaluation sections of this document.

Field testing of the C2 and C3 systems to the detailed field testing requirements of ASME AG-1 is too restrictive for this application for the following reasons. The leak test procedure of the *SMACNA HVAC Air Duct Leak Test Manual* is similar to the constant pressure method of Section TA, Mandatory Appendix TA-III. Although ASME AG-1 has more specific requirements for test personnel qualification, test documentation, and test instrumentation and also requires structural capability testing. SMACNA

provides specific acceptance criteria for leakage, while ASME AG-1 provides very specific guidance for the designer to establish leakage criteria. Duct inspection, in accordance with the *SMACNA HVAC Duct Systems Inspection Guide*, will identify any deficiencies in installation while the duct is accessible during construction and while correction of such deficiencies does not cause unreasonable costs and delay.

The remainder of the C2 and C3 systems are accessible for monitoring and maintenance. Contamination after plant startup will be minimal or non-existent. The C3 exhaust system components and associated ductwork are redundant, which allows repair or replacement without interruption of system operation. The C2 exhaust system, as indicated in section 5.1.2, is equipped with two 50 % centrifugal exhaust fans. When one of the C2 exhaust fans is repaired or replaced the HVAC control system will automatically adjust the interlocked systems to maintain system negative pressure and the entire HVAC system will continue to operate without interruption.

The installation of ductwork and in-line components (including dampers) will include a visual inspection for materials and workmanship. Field testing of the installed ductwork and in-line components (including dampers) will be pressure tested as a system. ASME AG-1, Article TA, offers the following 2 procedural methodologies: Constant Pressure Test, and the Pressure Decay Test. Both tests yield a flow rate equal to air lost from the ductwork pressure boundary. Acceptance criterion is to be provided by the Owner. ASME AG-1, Section SA, indicates a maximum allowable leakage of 5 % rated flow for non-safety related system and components. The HVAC design specification also requires a maximum leakage rate of 5 % using SMACNA guidelines. ASME AG-1 recognizes maximum operating pressure (constant pressure method) and 1.25 times the maximum operating pressure (pressure decay) as acceptable methods to assess duct leakage. SMACNA uses the maximum operating pressure approach, which is consistent with ASME AG-1.

SMACNA standards identify ductwork gauge thickness and corresponding operating pressure. SMACNA fabrication methods are based on laboratory testing where maximum allowable deformation may not be exceeded when pressure tested. SMACNA tables are based on structural-capability test pressures. The tables provide a predetermined gauge thickness based on structural test pressures for various duct sizes. The C2 and C3 systems operate at pressures far below 10-inches WC, and their material thickness is selected from these tables based on system test pressure of 1.25 times the system design pressure. The HVAC subcontractor will submit shop drawings and pressure test reports to ensure that design requirements have been met. Since the material thickness is based on a laboratory test, performed under prescribed operating parameters to ensure structural integrity, a structural examination test is not considered upon field installation of the ductwork. The field pressure test results ensure duct leakage is within allowable limits.

The C2 and C3 HVAC systems are designed to perform their intended function during normal plant operations. During construction, pre-commissioning, or commissioning phases, if any component fails to meet engineering acceptance criteria, then the component will be considered for replacement, repair, or used "as is" with proper technical justification. For example, ASME AG-1 requires that the variation in velocity measurement across a HEPA filter bank be +/-20% of the average velocity. If, for example, during commissioning a remote HEPA filter bank with 5 filters has one HEPA filter that does not meet the ASME AG-1 acceptance criteria, then the above options may be exercised. C2 and C3 ductwork and in-line components and devices are designed for in-place removal should contamination accumulation warrant their replacement.

ASME AG-1, Section TA, *Field Testing of Air Treatment Systems*, provides requirements for field acceptance testing to verify that nuclear-air treatment HVAC systems are capable of performing their intended function after installation in the facility.

On the WTP project, field-testing is comprised of pre-commissioning and commissioning tests. The pre-commissioning test includes visual inspection and pressure boundary tests. The commissioning test includes system functional tests. As detailed in Table 2, ASME AG-1 is the chosen standard for performing the commissioning tests on applicable C2 and C3 exhaust components.

For centrifugal exhaust fans, the selected sections of ASME AG-1 ensure that fan power circuits and controls are verified, and that specific functional tests are performed including: flow balance, mechanical run, flow rate, static pressure, electrical, rotational speed, vibration, bearing temperature, fan performance, and air flow capacity.

For dampers, the selected sections of ASME AG-1 ensure that damper power circuits, pneumatic circuits, and controls are verified, and that specific functional tests are performed including position indication, exercise, static timing, flow control, fire damper, dynamic timing, and interlock tests, as applicable.

For HEPA filter banks, the selected sections of ASME AG-1 ensure that specific functional tests are performed for differential pressure, airflow distribution, air-aerosol mixing, and in-place challenge aerosol leakage, and further that the tests for airflow distribution, air-aerosol mixing, and in-place challenge aerosol leakage will be performed using prescribed test methodology.

As detailed in Table 2, SMACNA standards and engineering specifications are the chosen standards for performing the pre-commissioning tests on applicable C2 and C3 exhaust components.

Table 2 identifies the industry standards that may be applied to the HVAC system components. The industry standards and applicable WTP design specifications that have been chosen for evaluation against the BARCT technology standards are also identified.

5.2 Low-Activity Waste Facility

5.2.1 Low-Activity Waste Facility Description

The LAW facility will immobilize low-activity mixed waste into a stable glass form.

5.2.2 Low-Activity Waste HVAC Systems Description

The C2 exhaust system at the LAW facility consists of 10 parallel banks of HEPA filters with associated manual-inlet and outlet isolation dampers, safe-change filter housings, and ductwork. Of the filter banks, 9 are normally active with 1 in standby. A total nominal flow rate of approximately 38,820 cfm (flow rate is still to be finalized) is provided by 2 centrifugal exhaust fans, with 50 % capacity, variable speed, and manual-inlet isolation dampers and air-operated outlet isolation dampers.

The C3 exhaust system at the LAW facility consists of 10 parallel banks of HEPA filters with associated manual-inlet and outlet isolation dampers, safe-change filter housings, and ductwork. Of the filter banks, 9 are normally active with 1 in standby. Two 100 % capacity, redundant, variable speed, centrifugal exhaust fans provide a total nominal flow rate of 44,680 cfm, with manual-inlet isolation dampers and air-operated outlet isolation dampers.

5.2.3 Low-Activity Waste HVAC System Components Evaluation

The C2 and C3 systems of the LAW facility will be designed, procured, and installed to the same standards and specifications as the C2 and C3 systems of the HLW facility. They will operate under similar design conditions and the same functional requirements. The evaluation of Section 5.1.3 applicable to the HLW facility also applies to the LAW facility in its entirety. A separate evaluation is not included.

5.3 Pretreatment Facility

5.3.1 Pretreatment Facility Description

The PT facility receives and concentrates the waste feed from the Hanford tank farms, separates the waste into high-level waste and low-activity waste, and stores the waste for feed to the HLW and LAW facilities.

5.3.2 Pretreatment HVAC Systems Description

The C2 exhaust system at the PT facility consists of 10 parallel banks of HEPA filters with associated manual-inlet and outlet isolation dampers, safe-change filter housings, and ductwork. Of the filter banks, 8 are normally active with 2 in standby. Each bank consists of 6 individual, radial-flow HEPA filters rated at 2000 cfm with a clean pressure drop of 1.3 inches WC. Two 50 % capacity, variable speed, centrifugal exhaust fans provide a total preliminary nominal flow rate of 81,170 cfm with manual-inlet isolation dampers and air-operated outlet isolation dampers.

The C3 exhaust system at the PT facility consists of 8 parallel banks of HEPA filters with associated manual-inlet and outlet isolation dampers, safe-change filter housings, and ductwork. Of the filter banks, 6 are normally active with 2 in standby. Each bank consists of 6 individual, radial-flow HEPA filters rated at 2000 cfm with a clean pressure drop of 1.3 inches WC. Three 50 % capacity, variable speed, centrifugal exhaust fans provide a total preliminary nominal-flow rate of 67,700 cfm with manual-inlet isolation dampers and air-operated outlet isolation dampers. Two of the exhaust fans are normally operating with 1 in standby.

5.3.3 Pretreatment HVAC System Components Evaluation

The C2 and C3 systems of the PT facility will be designed, procured, and installed to the same standards and specifications as the C2 and C3 systems of the HLW facility. They will operate under similar design conditions and the same functional requirements. The evaluation of Section 5.1.3 applicable to the HLW facility also applies to the PT facility in its entirety. A separate evaluation is not included.

5.4 Laboratory Facility

5.4.1 Laboratory Facility Description

The lab facility contains equipment for performance of analytical functions to support receipt and handling of samples from Hanford tank farms, WTP process control, waste form qualification testing, environmental (effluent) analyses, and limited technology testing. The lab will be housed in a stand-alone structure, separate from other WTP facilities.

5.4.2 Laboratory HVAC Systems Description

The C2 exhaust system at the lab facility consists of 10 parallel banks of HEPA filters with associated manual-inlet and outlet isolation dampers, safe-change filter housings, and ductwork. Of the filter banks, 9 are normally active with 1 in standby. Each bank consists of 3 individual, radial-flow HEPA filters rated at 2000 cfm with a clean pressure drop of 1.3 inches WC. Two 50 % capacity, variable speed, centrifugal exhaust fans provide a total preliminary nominal-flow rate of 50,000 cfm, with manual-inlet isolation dampers and air-operated outlet isolation dampers.

The C3 exhaust system at the lab facility consists of 16 parallel banks of HEPA filters with associated manual-inlet and outlet isolation dampers, safe-change filter housings, and ductwork. Of the filter banks, 14 are normally active with 2 in standby. Each bank consists of 3 individual, radial-flow HEPA filters rated at 2000 cfm with a clean pressure drop of 1.3 inches WC. Three 50 % capacity, variable speed, centrifugal exhaust fans provide a total preliminary nominal-flow rate of 81,000 cfm, with manual-inlet isolation dampers and air-operated outlet isolation dampers. Two of the exhaust fans are normally operating with 1 in standby.

5.4.3 Laboratory HVAC System Components Evaluation

The C2 and C3 systems of the lab facility will be designed, procured, and installed to the same standards and specifications as the C2 and C3 systems of the HLW facility. They will operate under similar design conditions and the same functional requirements. The evaluation of Section 5.1.3 applicable to the HLW facility also applies to the PT facility in its entirety. A separate evaluation is not included.

5.5 Evaluation of BARCT Technology Standards Other than ASME AG-1

The detailed evaluation comparing ASME AG-1 with other industry standards or the design specifications encompasses most of the requirements from the other BARCT technology standards. The remaining requirements from these standards are discussed in this section.

5.5.1 ASME N509

ASME N509 is a system-based standard, but it identifies requirements both at the system level and the component level. The ASME N509 component sections are not evaluated for the C2 and C3 HVAC systems because ASME AG-1 now includes the requirements for each of those components. The evaluation for ASME AG-1 encompasses the component requirements for ASME N509. Therefore, the discussion in this section will only focus on the system general design requirements of ASME N509, Section 4, *Functional Design.*

ASME N509, Section 4.1, *General,* includes a list of components to be considered in the system. All these components have been considered and some of the components are included in the systems. For those components not included, it has been determined that they are not needed to perform the design functions of the system or to meet emission guidelines.

ASME N509, Section 4.2, *Design Parameters,* identifies design parameters that must be specified to ensure proper design and operation of the system. Most of these parameters are identified in project design documentation such as facility drawings, specifications, data sheets, or the Notice of Construction (Reference 16). The required design parameters that are not specified are maximum and minimum flow rate. This is acceptable because the fans of these systems are controlled by variable frequency drives, which vary the fan speed to maintain either a constant flow rate or constant pressure.

ASME N509, Section 4.3, *Size (Installed Capacity) of Air Cleaning Unit,* requires that the installed capacity of the air cleaning unit be no greater than the capacity of any of the individual components. This requirement is being met and the system flow rate will not exceed the rated flow capacity of any of the components.

ASME N509, Section 4.4, *Environmental Design Conditions*, requires selection or design of components to operate under the expected environmental conditions. The evaluation of ASME AG-1 encompasses these requirements.

ASME N509, Section 4.5, *Structural Load Requirements,* requires that systems and all components be shown, through testing or analysis, to remain functional under specified structural loading. The evaluation of ASME AG-1 encompasses these requirements.

ASME N509, Section 4.6, *Design Pressures*, requires that the system be designed to withstand expected normal and transient pressures. These pressures are defined in this section of ASME N509 and include the operating pressure, leak test pressure, maximum design pressure, and structural capability pressure. The procurement specifications and design requirement documents identify the operating pressure of the system, the leak test pressure for each system, the maximum design pressure and the structural capability pressure. Therefore, this requirement is met. The evaluation of ASME AG-1 regarding structural loading encompasses these requirements.

ASME N509, Section 4.7, *Nuclear-air Treatment System Configuration and Location*, provides guidance on the configuration of the system and the location and sequence of components in the system to ensure cross contamination does not occur. This guidance has been taken into account during the system design.

ASME N509, Section 4.8, *Maintainability Criteria*, requires that the system be designed for maintenance, testing, and inspection activities to be performed while maintaining radiation exposure ALARA. Some general accessibility guidelines that can be used to accomplish this requirement are identified. The design incorporates this philosophy by relying upon bags during HEPA filter removal and by ensuring accessibility for maintenance, as well as using remote instrumentation for monitoring.

ASME N509, Section 4.9, *Monitoring of Operational Variables*, provides guidance for consideration of external effects in the design of instrumentation, identifies the minimum instrumentation required to be included in the system, and the establishes the qualification requirements for that instrumentation. The design of the systems includes monitoring instrumentation of key parameters such as flow rate, temperature and pressure. This instrumentation exceeds the required instrumentation of ASME N509, except for inlet temperature indication. Temperature monitoring at this location is not required because no conditioning equipment is included in the systems that could be affected by inlet temperature. The design of the instrumentation has considered the applicable external effects. The evaluation of ASME AG-1, Section IA, encompasses the qualification requirements.

ASME N509, Section 4.10, *Adsorbent Cooling* is not applicable because no adsorbers are installed.

ASME N509, Section 4.11, *Fire Protection*, establishes requirements for fire protection systems. Fire protection has been considered for these systems and was determined to be not necessary.

ASME N509, Section 4.12, *Insulation*, establishes requirements for insulation, when installed. This section is not applicable because these systems are located inside and insulation is not being used.

ASME N509, Section 4.13, *Testability*, requires sufficient injection and sampling ports or manifolds to be installed to permit accurate testing in accordance with ASME N510 and requires access for inspection of both sides of system components. Although the systems are not being designed to ASME N509 criteria, the systems will be routinely aerosol tested using the guidance provided in ASME N510. The design includes adequate ports for proper mixing of the aerosol to challenge the filters, as well as determining the leakage after the filter. Field testing will be in accordance with ASME AG-1, to the extent possible, with any deviations documented in the compliance matrices. Access is provided for inspection of both sides of the HEPA filter banks.

ASME N509, Section 4.14, *Pressure Boundary Leakage*, establishes requirements for determining allowable leakage criteria and leak test parameters. The only portion of this section that applies is the leak testing that will be performed at the manufacturer's shop for the HEPA filter housings. The specification identifies the testing parameters, the test method, and the acceptance criteria. The field acceptance testing criteria was discussed above.

5.5.2 ASME N510

ASME N510 defines the technical requirements for testing of nuclear ventilation systems. This standard applies to both factory acceptance testing and routine in-place leak testing.

The only component that falls under the factory testing identified in ASME N510 is the HEPA filter housing. This includes pressure leak testing, airflow capacity and distribution testing, air-aerosol mixing uniformity testing, and in-place leak testing. The filter housings are not designed to the requirements of ASME N509 and, therefore, the testing requirements identified in ASME N510 can only be applied as guidance. The filter housings are being designed and constructed to ASME AG-1 requirements, however, as described above and will be tested to the extent possible to the ASME N510 requirements. The routine in-place leak testing of the filter housings, after installation, will be performed in accordance with ASME N510.

5.5.3 ANSI/ASME NQA-1

The evaluation for ASME AG-1 encompasses the requirements of ASME NQA-1.

5.6 Cost Summary

The estimated additional cost to meet all the requirements of the BARCT technology standards is summarized below. Cost is an average per emission unit with a total of 8 emission units from the 4 facilities. The estimates include capital costs only. Acceptance test specifications and procedures have not been developed yet, so operational costs associated with acceptance testing cannot be established and are not included. Ductwork costs include both labor and materials for all aspects of purchase and installation. Ductwork support costs are expected to remain the same and are not included.

Fans	$50,000
Dampers	$100,000
Ductwork	$450,000
Instrumentation and Control	$8,000
Field Testing	Not available
Total (per emission unit)	$608,000

5.7 Evaluation of Cost Versus Benefit

WAC 246-247 recommends the use of Reference 18 as guidance for performing a cost-benefit analysis for radiation protective measures. This method has established decision gates based on person-rem dollar figures. Non-quantitative parameters, such as reliability and risk reduction, are evaluated using an ALARA factor analysis. The outline of this section follows the procedural steps of Reference 18.

5.7.1 Protective Measure

The protective measure for the C2 and C3 HVAC systems is compliance with ASME AG-1 and the other BARCT technology standards identified in Section 3.4. The protective measure is further subdivided into applying ASME AG-1 to each of the specific components of the HVAC systems identified in Section 3.3. This allows evaluating ASME AG-1 for each of the components, individually and separately from the others. The detailed description of the protective measures provided by ASME AG-1 and the other BARCT technology standards is given in Sections 5.1 through 5.5.

5.7.2 Relevant Activity

The relevant activity is the design, fabrication, installation, and testing of the C2 and C3 HVAC exhaust systems at the WTP.

5.7.3 Relevant Time Frame

The relevant time frame is the time period required for design, fabrication, installation, and testing of the C2 and C3 HVAC exhaust systems at the WTP. The cost savings will be realized during this time frame, although the benefits will continue through the lifetime of the plant.

5.7.4 Collective Dose Saved

The collective dose saved is indeterminate because implementation of ASME AG-1, and the other BARCT technology standards, as a protective measure results in greater assurance of high standards of manufacture, greater reliability, and, therefore, reduced risk. Quantitative estimation of collective dose saved is, therefore, not practical. The ALARA factor analysis of Reference 18 will then be used to evaluate the protective measure.

It is reasonable to expect that the collective dose saved will be zero because the chosen abatement technology (HEPA filters) will be equivalent and will comply with ASME AG-1 to the extent possible regardless of the standards to which other components of the system are built. Ductwork compliance with ASME AG-1 may result in less leakage due to lower leakage criteria and tighter fabrication tolerances, but the system will operate continuously at a negative pressure, which will provide containment of the minimal contamination expected within the ductwork. Therefore, it is reasonable to expect that no decrease in occupational or environmental exposure would result from ductwork compliance with ASME AG-1.

5.7.5 Cost of Protective Measure

The total additional cost for complying with ASME AG-1 and the other BARCT technology standards evaluated in this document is expected to be $608,000 per emission unit as identified in Section 5.6.

5.7.6 Activity Cost

The total expected cost for all the HVAC systems at the HLW, LAW, PT, and lab facilities is approximately $72 million, if all systems comply with ASME AG-1.

5.7.7 Cost Effectiveness

The flow charts of Reference 18 lead to the use of the ALARA factor analysis method, performed in the next section, for determination of cost effectiveness, assuming the collective dose saved is zero or indeterminate.

5.7.8 ALARA Factor Analysis

The ALARA factor analysis weighs the intangible or non-quantitative aspects of the protective measure. The answers to the 14 questions help determine if the protective measure is reasonable and can be recommended. Analysis for each component resulted in the same answers so the analysis is presented only once, in Table 7. The results of the ALARA factor analysis indicate that the protective measure is not recommended for all components identified in Table 2 that are subject to this cost-benefit analysis.

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Table 1 Unabated Dose Rates from WTP HVAC Systems

Facility System	Unabated Dose (millirem/year)	Abated Dose (millirem/year)
Pretreatment C2	5.26E-08	2.63E-11
Pretreatment C3	3.67E-07	1.83E-10
LAW C2	2.93E-08	1.47E-11
LAW C3	1.50E-04	7.49E-08
HLW C2	4.18E-08	2.09E-11
HLW C3	1.44E-05	7.21E-09
HLW Canister Storage	1.73E-06	1.73E-06
Analytical Lab C2	1.50E-02	7.48E-06
Analytical Lab C3	1.41E-02	7.06E-06

Source: 24590-WTP-RPT-ENV-01-008, Rev 1, *Radioactive Air Emissions Notice Of Construction (NOC) Application for the RPP-WTP.*

Table 2 C2 and C3 Components for Code and Standard Evaluation

Component		Applicable Industry Standards	Chosen Industry Standards and WTP Specifications
1	fans	AMCA-201, -210, -300 NEMA MG-1 API-673	AMCA-201, -210, -300 NEMA MG-1 24590-WTP-3PS-MACS-T0001, *Engineering Specification for High Integrity Fans.* 24590-WTP-3PS-MUMI-T0002, *Engineering Specification for Low Voltage Induction Motors.* 24590-WTP-3PS-EVV1-T0001, *Engineering Specification for Low Induction Variable Speed Drives.*
2	dampers	SMACNA ASME-B31.1, -B31.3, -B16.34 API-609 AMCA 500	*WTP Design Specifications for Backdraft Dampers*, Document Number TBD. 24590-WTP-3PS-MDD0-T00001, *Engineering Specification for HVAC Dampers.* 24590-WTP-3PS-MD00-T0001, *Engineering Specification for HVAC Systems Installation.* AMCA 500
3	ductwork	SMACNA HVAC Duct Construction Standards, Metal and Flex (DCSMF) SMACNA Round Industrial Duct Construction Standards (RIDCS) SMACNA HVAC Systems Duct Design (HSDD) SMACNA HVAC Air Duct Leakage Test Manual (HADLTM) SMACNA HVAC Duct Systems Inspection Guide (HDSIG)	SMACNA DCSMF SMACNA RIDCS SMACNA HSDD SMACNA HADLTM SMACNA HDSIG 24590-WTP-3PS-MD00-T0001, *Engineering Specification for HVAC Systems Installation.* 24590-WTP-3PS-G000-T0003, Rev 0. 24590-WTP-3PS-MDH0-T0001, *Engineering Specification for HVAC Seismic Category III and IV Ductwork.*
4	housings	ASME AG-1	ASME AG-1 (See Note 1)
5	refrigeration equipment	N/A	N/A
6	conditioning equipment	N/A	N/A
7	moisture separators	N/A	N/A
8	medium efficiency filters	N/A	N/A
9	HEPA filters	ASME AG-1	ASME AG-1 (See Note 1)

Table 2 C2 and C3 Components for Code and Standard Evaluation

Component		Applicable Industry Standards	Chosen Industry Standards and WTP Specifications
10	type II adsorber cells	N/A	N/A
11	type III adsorber cells	N/A	N/A
12	adsorbent media	N/A	N/A
13	frames	ASME AG-1	ASME AG-1 (See Note 1)
14	instrumentation and controls	NFPA 70, National Electric Code NEMA ICS 6, Industrial Control and System Enclosures.	NFPA 70 NEMA ICS 6 24590-WTP-3PS-G000-T0001, Rev 0 24590-WTP-3PS-G000-T0003, Rev 0 24590-WTP-3PS-JXF0-T0001, Rev A 24590-WTP-3PS-JXXE-T0002, Rev 0 24590-WTP-GPG-J-014, Rev B 24590-WTP-DB-ENG-01-001, Rev 0 24590-WTP-GPP-CON-7101, Rev 1 24590-WTP-GPP-CON-7102C, Rev 0 24590-WTP-GPP-CON-3504, Rev 0
15	field testing pre-commissioning tests (See Note 2)	SMACNA HVAC Air Duct Leakage Test Manual (HADLTM). SMACNA HVAC Duct Systems Inspection Guide (HDSIG). ASHRAE 126, Method of Testing Air Ducts.	SMACNA HVAC Air Duct Leakage Test Manual (HADLTM) SMACNA HVAC Duct Systems Inspection Guide (HDSIG) 24590-WTP-3PS-MD00-T0001, *Engineering Specification for HVAC Systems Installation.* 24590-WTP-3PS-MDH0-T0001, *Engineering Specification for HVAC System Seismic Category III and IV Ductwork.*

Table 2 C2 and C3 Components for Code and Standard Evaluation

Component		Applicable Industry Standards	Chosen Industry Standards and WTP Specifications
16	field testing commissioning tests (See Note 2)	SMACNA Testing Adjusting and Balancing. NEBB Testing, Adjusting and Balancing. AABC Total System Balance. ACGIH Industrial Ventilation A Manual of Recommended Practice. ASHRAE 87.1, Method of Testing Fan Vibration. ASHRAE 111, Practices for Measurement, Testing, Adjusting and Balancing of HVAC and Refrigeration Systems.	Fan and Flow Balance: ASME AG-1, Sections TA-4140 through TA-4159 Dampers: ASME AG-1, Sections TA-4240 through TA-4254, HEPA Filter Banks: ASME AG-1, Section TA-4630 through TA-4642, Appendix TA-IV, Appendix TA-V, and Appendix TA-VI, with deviations to TA-4632, Appendix TA-IV, and Appendix TA-V as approved in the HVAC compliance matrices.

Notes:

1 HEPA filters, housings, and frames will be designed and constructed to ASME AG-1 to the extent possible and, therefore, will not be evaluated. The radial-flow HEPA filters and filter housings are not specifically covered in ASME AG-1. However, a deviation request with justification is included in the compliance matrices.

2 The pre-commissioning tests will include visual inspections and pressure boundary tests. The commissioning tests will include component and system functional tests.

Table 3 Section BA, Exhaust Fans Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
BA-1000, Introduction			
BA-1000, *Introduction*	Identifies the scope, purpose, and applicability of this section and defines terms used.	Not applicable to this evaluation.	Not applicable to this evaluation. Introductory information only.
BA-2000, Referenced Documents			
BA-2000, *Referenced Documents*	Identifies codes and standards referenced in this section.	Not applicable to this evaluation.	Not applicable to this evaluation. Reference information only.
BA-3000, Materials			
BA-3100, *General*	Defines allowable materials and material stress limits, primarily by requiring specific ASTM and ASME designated materials.	The design specification specifies the use of structural steel shapes and plates. It is intended that the design specification will require that materials used be ASTM or ASME designated materials.	The chosen specification is equivalent to ASME AG-1, except that specific ASTM or ASME designations are not specified. This is acceptable because requiring materials that are ASTM or ASME designated, without identifying any specific designations, provides adequate assurance of material properties for this application.
BA-3200, *Special Limitations on Materials*	Does not allow aluminum or zinc to be used in a corrosive environment and requires that all materials be compatible with operating environmental conditions.	The design specification prohibits certain materials and specifies that all materials shall be compatible with the air stream.	The chosen specification is equivalent to or exceeds ASME AG-1. No corrosive vapors are present in the C2 and C3 systems and the design specification prohibits other materials in addition to those prohibited by ASME AG-1.
BA-3300, *Designation of Materials*	Requires identification of ASME or ASTM material numbers and grades.	The design specification requires identification of ASTM or equivalent designations on drawings.	The chosen specification is equivalent to ASME AG-1.

Table 3 Section BA, Exhaust Fans Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
BA-3400, *Certification of Materials*	Requires certified test reports and Manufacturer's Certificate of Compliance with ASME or ASTM specifications for certain fan stress components and accessories.	The design specification requires Certificates of Conformance demonstrating compliance with ASME or ASTM standards.	Certified test reports are not required because this application does not require such rigorous material testing. Certificates of Conformance with standards provide adequate verification of the physical properties of materials. Furthermore, based on the extensive past successful operating history of these industrial fans, there is no benefit in obtaining certified test reports.
BA-3500, *Purchased Materials*	Requires purchased materials to meet the requirements of BA-3100, BA-3200, BA-3300, and BA-3400.	Requirements identified in the previous sections apply.	See discussions above for material identification and compliance with standards.
BA-3600, *Driver Materials*	Requires driver materials to meet ANSI/IEEE 323, ANSI/IEEE 334, ANSI/IEEE 344, and NEMA MG-1, as required by the design specification.	The design specification requires driver conformance with NEMA MG-1.	The chosen specification is equivalent to ASME AG-1. The standards identified in ASME AG-1 are "as required by the design specification".
BA-4000, Design			
BA-4100, *Design Conditions*	BA-4110, *Performance*, requires fan selection to meet volume and pressure requirements while operating in the stable region of the fan curve. Fan sizing shall consider inlet and discharge conditions and dynamic losses. System characteristics shall be considered using AMCA 201. Fan data to support fan selection is identified.	The design specification specifies flow and pressure requirements and requires stable operation. AMCA 201 was used during design for consideration of system characteristics, as referenced by the Bechtel HVAC design guide (Reference 18).	ASME AG-1 has more detailed requirements. The flow and pressure requirements of the chosen specification are equivalent to ASME AG-1. The additional requirements in ASME AG-1 of maximum discharge velocity, maximum air density, and peak design temperature are important only when the process gas is high temperature, contains high moisture, or contains other gases, conditions that are not found in this application.

Table 3 Section BA, Exhaust Fans Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	BA-4120, *Environmental Conditions*, requires continuous operation for at least 30 days under environmental conditions caused by a postulated accident. Identifies environmental aging mechanisms affecting life expectancy that are to be considered. Design qualification shall be specified in accordance with ANSI/IEEE 627.	The design specification specifies the temperature range and housing design pressure criteria.	ASME AG-1 has more detailed and specific requirements. Aging is not a concern because the fans will be accessible for maintenance and repair. The 30-day operation criteria is for operation under postulated accident conditions and does not affect continuous emissions or confinement ventilation under normal operation. ANSI/IEEE 627 is primarily for safety related electrical equipment and the associated rigor is not necessary for this application.
	BA-4130, *Loading*, provides specific and detailed structural loading criteria such as pressure transients, external forces, free end constraint loads, starting loads, and missile protection. Also, the reference to AA-4000 includes detailed load, stress, and deflection criteria, design verification, and documentation requirements.	The design specification has a general requirement for fans to meet shipping, installation, and operational loads. Criteria for internally propelled missiles and housing pressure design limits are also included.	ASME AG-1 requires more detailed and rigorous design analysis. This analysis is required to ensure the fans can perform their safety function under all foreseeable conditions. The C2 and C3 fans are not required to withstand all natural phenomena since the failure of the fan will not result in an increase of the potential-to-emit. See Section 5.1.3.1 for further justification.
	BA-4140, *Leakage*, provides fan housing and shaft leakage criteria to be implemented if the direction of leakage would impose a contamination burden on the space housing the fan or the space supplied with air by the fan.	The design specification specifies leakage criteria that is equal to ASME AG-1 criteria.	The C2 and C3 exhaust fans are located downstream of their system HEPA Filter housings and exclusive of the boundary required for aerosol testing. Aerosol injection takes place upstream of the filter housing. In addition, the C2 and C3 exhaust fans are located in a C2 or C3 space where the source of a potential release would be a ruptured contaminated filter resulting from maintenance activities. This is considered a transient occurrence in lieu of a continuous release and since the HEPA filters are expected to be changed out at their shelf life (5-years), a less stringent shaft leakage is considered acceptable.

Table 3 Section BA, Exhaust Fans Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	BA-4150, *Support Boundary*, requires identification of size and type of anchorage points and anchorage loads.	The design specification requires mounting dimensions and information for the design of supports and foundations to be provided after fan selection.	The chosen specification is equivalent to ASME AG-1.
	BA-4160, *Vibration,* identifies fan balancing requirements and bearing displacement limits.	The design specification requires static and dynamic balancing and specifies the same bearing displacement limits.	The chosen specification is equivalent to ASME AG-1, except that ASME AG-1 is more specific by requiring balancing before assembly, after assembly and after installation. This is acceptable because initial fan balancing ensures acceptable fan vibration. Acceptance testing should perform vibration testing to ensure balancing was not compromised during shipping and installation. Acceptance testing shall include vibration testing both prior to shipment and following installation.
BA-4200, *Selection*	BA-4210, Fans		
	BA-4211, *General,* specifies descriptive fan information to be used for fan selection, such as unique identifier, duty, fan location, fan environment, drive arrangement, and special limitations.	The design specification provides similar information.	The chosen specification is equivalent to ASME AG-1, except that the type of foundation and means of support are not included in the design specification. The chosen specification is acceptable, however, because it requires the fan manufacturer to provide mounting dimensions and information required for the design of supports and foundations. (10.2.1.2). Duty information for motors is specified, and the design specification should specify continuous duty for fans (3.6.6).

Table 3 Section BA, Exhaust Fans Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	BA-4212, *Performance Rating*, identifies minimum information to be used to specify the fan performance rating.	The design specification provides or requires similar fan performance rating information. The performance rating is required to be based on AMCA 210 standard air conditions.	ASME AG-1has more specific requirements for actual air stream, air density, and fan total pressure to be used to specify fan performance rating. This is acceptable because actual air density will not deviate significantly from air density at standard conditions and total pressure is not necessary to define fan performance for this application.
	BA-4213, *Pressure Relationships*, requires fan ratings to use both total and static pressure, as illustrated in AMCA 201.	The design specification identifies static pressure to be used for the fan performance rating.	ASME AG-1has the more specific requirement of using both pressures for fan performance rating. Total pressure is the summation of static pressure and velocity pressure (Pt = Pu = Ps). Static pressure is the force required to deliver the airstream through the system's frictional losses such as ductwork, dampers, coils, turning vanes, and the like. The velocity pressure is that force corresponding to the fan's discharge velocity, and is inherent to the manufacture's house-power selection when static pressure is provided by the buyer. The velocity pressure varies with airflow and fan arrangement; so, manufacturer's performance selection curves are based on static pressure. The wording that total pressure is not necessary for this application will be replaced with verbiage that indicates that total pressure is provided by the supplier whereas static pressure is provided by the buyer. Total pressure will be an integral part of the equipment selection for fans and blowers.
	BA-4214, *Operation at Reduced Flow*, requires evaluation of operation at reduced flow to ensure stable operation over the entire range of expected fan operation.	The design specification requires stable operation at ± 10 % of airflow and ± 20 % of total pressure from design conditions.	The chosen specification is equivalent to ASME AG-1.

Table 3 Section BA, Exhaust Fans Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	BA-4215, *Construction Information* identifies specific construction information for fan selection.	The design specification requires all information required by ASME AG-1.	The chosen specification is equivalent to ASME AG-1.
	BA-4216, *Bases for Fan Rating Data*, requires testing to establish fan rating data and tests to establish performance ratings from reduced size fans are required to comply with AMCA 210.	The design specification requires fan performance to be certified as complying with AMCA 210.	The chosen specification is equivalent to ASME AG-1.
	BA-4217, *Bases for Sound Data Rating*, requires testing of the actual fan or calculations from test data from a similar fan in accordance with AMCA 301.	The design specification requires sound power levels in accordance with AMCA 300 and AMCA 301 with data to be submitted.	The chosen specification is equivalent to ASME AG-1.
	BA-4220, Drivers		
	BA-4221, *Information Required for Driver Selection*, identifies minimum information to be used in driver selection.	The design specification specifies information for motor selection.	The design specification identifies all information required by ASME AG-1, except fan inertia applied to the driver shaft and minimum air velocity over driver, if required. This is acceptable based on past operating history of commercial grade fans matched with motors complying with NEMA MG-1. See Section 5.1.3.1 for further justification.
	BA-4222, *Special Limitations*, limits or does not allow under certain circumstances the use of belt drives, direct drives, drives with gear reducers, and variable pitch diameter sheaves on centrifugal fans.	Not applicable to the C2 and C3 fans.	Not applicable to the C2 and C3 fans. BA-4222 stipulates that belt drive fans are only to be used in areas that are accessible. The C2 and C3 exhaust fans in all cases are of the direct-drive configuration and negates other requirements in this paragraph applicable to belt and gear driven equipment.

Table 3 Section BA, Exhaust Fans Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
BA-4300, *Construction*	BA-4310, Fans		
	BA-4311.1, *General*, requires compliance with BA-4100 and BA-4200 for housing materials and design. Spark resistant construction, where specified, shall meet AMCA 99-401.	See BA-4100 and BA-4200 sections of this table. No spark resistant construction is required.	See BA-4100 and BA-4200 sections of this table.
	BA-4311.2, *Bearings*, provides bearing requirements and the bearing rating life criteria are to be established in accordance with ANSI/AFBMA 9 or 11 (currently ANSI/AMBA 9 or 11).	The design specification provides bearing requirements and the bearing rating life criteria are to be established in accordance with ANSI/ABMA 9 or 11.	The chosen specification is equivalent to ASME AG-1.
	BA-4320, Drivers and Drives		
	BA-4322, *Drive Alignment and Adjustment*, requires metal shims for direct drive alignment and adjustable driver base for belt tension adjustments.	The design specification requires disc type, forged steel, flexible shaft coupling for direct drives but does not specify alignment requirements.	Drive alignment will be performed in accordance with the fan manufacturer's installation instructions. See Section 5.1.3.1 for further justification. All C2 and C3 fans have direct drives so the belt tension requirements are not applicable.
	BA-4323, *Mechanical Design Requirements for Drivers*, requires specific bearing life-expectancy, sheave arrangement limitations according to NEMA MG-1, and driver conformance with NEMA MG-1.	The design specification establishes bearing requirements in accordance with the motor manufacturer's standard design and driver conformance with NEMA MG-1.	The chosen specification is equivalent to ASME AG-1, except that bearing life expectancy is not specifically established for drivers. The extensive past operating history of these fan motors demonstrates their reliability. See Section 5.1.3.1 for further justification.

Table 3 Section BA, Exhaust Fans Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	BA-4324, *Electrical Design Requirements*, requires that drivers be designed for single voltage supply, have solid grounding, and conform to NEMA MG-1.	The design specification specifies driver conformance with NEMA MG-1.	The design specifications require single voltage motors and are fed independently by a 480-volt system, which is solidly grounded. Motors are specified to comply with NEMA MG-1 requirements and to perform at their rated load at a service factor of 1.0.
	BA-4325, *Application*, requires drivers to be designed to operate at maximum-load brake horsepower without encroaching on the driver service factor.	The design specification requires that motors have service factors in accordance with NEMA MG-1, and that the motor will not be loaded beyond its design power rating.	The design specifications require single voltage motors and are fed independently by a 480-volt system, which is solidly grounded. Motors are specified to comply with NEMA MG-1 requirements and to perform at their rated load at a service factor of 1.0.
	BA-4330, *Accessories*, identifies requirements and criteria for lifting lugs, inspection panels, direction arrows, gaskets, bearing lubricants, bearing thermocouples, variable inlet vanes, inlet screen guards, vibration isolators, guards, inlet transitions, and shaft seals.	The design specification requires certified lifting lugs, sealed access doors, ASTM designated gaskets, sealed for life and grease lubricated bearings, bearing RTDs, OSHA compliant drive guards, flanged or collared inlets and outlets, and shaft seals meeting the same leakage criteria. No variable-inlet vanes, inlet screen guards or vibration isolators are specified.	The chosen specification is equivalent to ASME AG-1, except that the design specification allows collared connections. This is acceptable because collared connections can provide a seal with acceptable leakage for this application.
BA-4400, *Reports and Calculations*	Establishes requirements for documentation of fan performance rating, sound production, and structural verification.	The design specification requires submittal of performance test reports, fan curves, and sound test data.	ASME AG-1 identifies more specific information to be included on fan curves. Standard industry fan curves, as required by the chosen specification, provide most of the information required by ASME AG-1 and this information is adequate to ensure fan performance meets the design criteria and to meet the intent of ASME AG-1. Structural verification not required for this application. See Section 5.1.3.1 for further justification.

Table 3 Section BA, Exhaust Fans Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
BA-5000, Inspections and Testing			
BA-5100, *Fan Inspection and Testing*	AA-5000 and AA-6430, referenced subsections, establish general requirements for calibration of M&TE, visual inspections, and inspections and testing of bolted and brazed connections.	The design specification has no similar requirements, except as may be included in other referenced codes and standards. AMCA 210 contains instrument (M&TE) calibration requirements for performance testing.	ASME AG-1 has more detailed and specific requirements as described. BA-5100 pertains to requirements governing *Fan Inspection and Testin,g* the scope as defined by AG-1, Section BA, *Fans and Blowers,* is as follows and in parentheses (the SMACNA reference standard). "Provides the minimum requirement for performance (AMCA 201), design (AMCA 201), construction (AMCA 99), noise (AMCA 300) acceptance testing (AMCA 210), and quality assurance (WTP Project QAM which includes NQA-1requirements) for fans, fan drivers, drives, and related fan accessories." The C2 and C3 exhaust functions are limited to normal plan operations where they exhaust air from low contamination areas of the building that is not cascaded through C5. (Refer to Table 1 of the CBA.) The normal C2 and C3 operating environment are judged equivalent to an industrial facility due to lack of low contamination. With the above-identified AMCA standards being included in the project procurement documents, commercial-grade equipment enhanced with operating design and environmental conditions is compliant to ASME AG-1.
	BA-5110, *General Testing Requirements*, establishes requirements for fans requiring performance tests and for test facilities.	The design specification requires testing of all fans, but may allow test data from similar fans. The design specification requires test facilities to comply with AMCA standards.	ASME AG-1 allows test data from other fans, but with more specific requirements. The design specification has no requirements for test facilities other than AMCA standards. Testing to AMCA standards is acceptable for this application. See Section 5.1.3.1 for further justification.

Table 3 Section BA, Exhaust Fans Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	BA-5120, *Performance Acceptance Tests*, requires AMCA 210 for all aspects of performance testing, requires IEEE 112A for driver testing, and identifies specific tests measurements.	The design specification requires AMCA test reports and tests to be performed in AMCA approved facilities. The design specification specifies minimum test requirements, requires certified test results and testing in accordance with IEEE 112A or the manufacturer's standard.	The chosen specification is equivalent to ASME AG-1, except that ASME AG-1and more explicit in defining test requirements including test procedures that define test setups and test methods, and identifying specific measurements including flow rate, pressure, power, and fan speed. Also, The design specification allows driver testing to the manufacturers standards. This is acceptable for this application. See Section 5.1.3.1 for further justification.
	BA-5130, *Sound Tests*, requires AMCA 300 or ASHRAE 68 for sound power level ratings tests.	The design specification requires sound power levels, in accordance with AMCA 300 and AMCA 301 with data to be submitted.	The chosen specification is equivalent to ASME AG-1.
	BA-5140, *Mechanical Tests*, requires and establishes criteria for over-speed tests, leakage tests, fan vibration tests, mechanical running tests, and seismic tests, if required.	The design specification requires leakage and vibration tests with the same acceptance criteria.	ASME AG-1 provides more specific requirements for how shaft leakage and vibration testing will be performed. The design specification does not require over-speed tests and mechanical running tests, although most manufacturers will typically perform mechanical running tests on new production fan models. This is acceptable for this application. See Section 5.1.3.1 for further justification.
	BA-5150, *Test Results and Reports*, requires that all test results be certified and documented.	The design specification requires test reports for all required testing.	The chosen specification is equivalent to ASME AG-1.
BA-5200, *Driver Inspection and Testing*	Requires driver testing according to IEEE 112A and documentation of test data.	The design specification specifies minimum test requirements, requires certified test results and testing in accordance with IEEE 112A or the manufacturer's standard.	The chosen specification is equivalent to ASME AG-1, except that the design specification allows the use of the manufacturer's standards for driver testing. This is acceptable for this application. See Section 5.1.3.1 for further justification.

Table 3 Section BA, Exhaust Fans Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
BA-6000, Fabrication and Installation of Centrifugal and Axial Fans (References Section AA-6000)			
AA-6100, *General*	Identifies materials requirements by reference to BA-3000 and requires quality control procedures for all fabrication, installation, and repair processes by reference to AA-8000 or AA-6300.	See sections BA-3000, BA-8000, and AA-6300 of this table.	See sections BA-3000, BA-8000, and AA-6300 of this table.
AA-6200, *Fabrication Processes*	Establishes requirements for cutting, forming, bending, forming tolerances, fitting and aligning for bolting or welding, welded joints, and mechanical joints.	The design specification establishes welding, weld repair and weld procedure requirements including conformance with applicable AWS standards.	ASME AG-1 provides more detailed fabrication requirements. Typical manufacturers standards and tolerances for fabrication processes are acceptable for this application. See Section 5.1.3.1 for further justification.
AA-6300, *Welding Requirements*	Establishes very detailed and specific requirements for welding including workmanship, inspection, testing, non-destructive testing, inspector qualifications, and repairs. Identifies several ANSI/AWS codes and ASME Code, Section IX to be complied with.	The design specification requires conformance to AWS codes and ASME code, Section IX, as applicable, and weld repair documentation.	The design specification requires codes that are listed in ASME AG-1, but ASME AG-1 includes very specific and detailed additional welding requirements as identified in the ASME AG-1 requirement description. The requirements in ASME AG-1 in addition to the industry standards are unnecessary for this application. See Section 5.1.3.1 for further justification.
AA-6400, *Brazing*	Establishes brazing requirements similar to the welding requirements of AA-6300.	The design specification has no brazing requirements.	The fan material is specified as all steel and, therefore, brazing is not applicable. If brazing is necessary, the requirements in ASME AG-1 that go beyond the fan manufacturer's or other industry standards are unnecessary for this application. See Section 5.1.3.1 for further justification.
AA-6500, *Cleaning and Coating*	Establishes coating requirements using a graded approach using service levels based on the coating's and the equipment's relation to nuclear safety.	The design specification requires painting in accordance with the fan manufacturer's procedures, which are to be submitted along with list of surfaces to be coated and names of coating materials.	The chosen specification is equivalent to ASME AG-1, because Service level III coatings are only required to meet the equipment manufacturer's specifications.

Table 3 Section BA, Exhaust Fans Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
AA-6600, *Installation Requirements*	Establishes requirements for handling, rigging, field assembly, installation procedures, and temporary field attachments.	The design specification requires certified lifting eyes or lugs, allows field assembly, and requires erection and installation manuals.	ASME AG-1has more detailed and specific requirements for handling and rigging and for field assembly. WTP rigging procedures will be complied with and contain adequate rigor for this application. Installation in accordance with the manufacturer's instructions is also acceptable for this application. See Section 5.1.3.1 for further justification.
BA-6100, *Fabrication*	Requires written fabrication procedures to be established and used, and all heat-treating requirements to be indicated on drawings or procedures.	The design specification requires welding procedures and procedures for repairs of rejected items or parts.	Procedures required by ASME AG-1 encompass the whole fabrication process, not just welding. Typical manufacturers standards and tolerances for fabrication processes are acceptable for this application. See Section 5.1.3.1 for further justification.
BA-7000, Packaging, Shipping, and Storage (References Section AA-7000)			
AA-7000	Establishes general requirements and responsibilities for packaging, shipping, receiving, storage and handling, primarily by supplementing the provisions of ANSI/ASME NQA-2, Part 2.2. Personnel qualification requirements of ANSI/ASME NQA-1 are required for inspection, examination, and testing.	The design specification requires cleaning, coating, tagging, documentation, and shipping in accordance with the fan manufacturer's procedures.	ASME AG-1 has more detailed and specific requirements, including compliance with ANSI/ASME NQA-1 and ANSI/ASME NQA-2. Fan manufacturer's quality standards for packaging and shipping are acceptable for this application. See general justification of Section 5.1.3.1.
BA-7100, *Fans*	Defines ANSI/ASME NQA-2 protection levels for fans and drivers during shipment and storage. Requires a storage procedure.	The design specification requires packaging for outdoor storage up to 12 months and instructions for longer storage periods.	ASME AG-1 imposes ANSI/ASME NQA-2 requirements. Fan manufacturer's quality standards for the specified storage period are acceptable for this application. See Section 5.1.3.1 for further justification.

Table 3 Section BA, Exhaust Fans Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
BA-7200, *Drivers Shipped Separately*	Establishes short term and long term storage requirements for drivers shipped separately from the fan.	The design specification requires packaging for outdoor storage up to 12 months and instructions for longer storage periods.	ASME AG-1 has more detailed and specific requirements. Fan manufacturer's quality standards for the specified storage period are acceptable for this application. See Section 5.1.3.1 for further justification.
BA-8000, Quality Assurance (References Section AA-8000)			
BA-8000, *Quality Assurance*	Establishes general requirements and responsibilities for quality assurance primarily by supplementing the provisions of ANSI/ASME NQA-1.	The design specification establishes requirements for the manufacturer's quality program and provides a process for requests of deviations from procurement documents. The design specification will procure the fans in accordance with the WTP quality assurance program.	ASME AG-1 has more detailed and specific requirements, including compliance with ANSI/ASME NQA-1. Compliance with the quality assurance programs of the WTP and the fan manufacturer is acceptable for this application. See Section 5.1.3.1 for further justification.
BA-8100, *Required Documentation for Fans*	Requires fan performance curves generated in accordance with AMCA 210 and material certification records.	The design specification requires AMCA test reports.	The chosen specification is equivalent to ASME AG-1, except the requirement for material certification records, including material test reports. See description of BA-3400 in this Table.
BA-8200, *Quality Assurance for Drivers*	Requires driver manufacture under a quality assurance program that conforms to ANSI/ASME NQA-2 and qualification of drivers in accordance with ANSI/IEEE 323 Class 1E standards.	The design specification requires that the driver manufacturer have a quality management system and that quality program requirements are the same as for fans.	ASME AG-1 has more detailed and specific requirements, including compliance with ANSI/ASME NQA-2 and ANSI/IEEE 323 Class 1E standards. Compliance with the quality assurance programs of the WTP and the driver manufacture is acceptable for this application. See Section 5.1.3.1 for further justification.

Table 3 Section BA, Exhaust Fans Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
BA-9000, Nameplates and Operating and Maintenance Manuals			
BA-9100, *Fans*	Establishes nameplate requirements for fans and references AA-9000 for more specific nameplate requirements. Driver nameplates are required to comply with NEMA MG-1.	The design specification requires stainless steel fan nameplates and stainless steel motor nameplates in compliance with NEMA MG-1.	ASME AG-1 has more detailed and specific requirements for required information, materials, lettering, attachment and, location. The design specification specifies most, but not all, of the required information. This is acceptable to identify only the fan manufacturer information, rating or capacity information, and unique tag number. Driver nameplate requirements are equivalent.
BA-9200, *Accessories*	The manufacturer must be identified on each accessory.	The design specification has no similar requirement.	Accessories are typically provided with this information.
BA-9300, *Operating and Maintenance Manuals*	Requires the manufacturer to provide an operation and maintenance manual including recommended spare parts list and recommended maintenance procedure.	The design specification requires the manufacturer to provide an operation and maintenance manual for the fan and accessories including maintenance requirements. A list of recommended spare parts is also required.	The chosen specification is equivalent to ASME AG-1.

Table 4 Section DA, Dampers Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
DA-1000, Introduction			
DA-1000, *Introduction*	Identifies the scope, purpose, and applicability of this section and defines terms used.	Not applicable to this evaluation.	Not applicable to this evaluation. Introductory information only.
DA-2000, Referenced Documents			
DA-2000, *Referenced Documents*	Identifies codes and standards referenced in this section.	Not applicable to this evaluation.	Not applicable to this evaluation. Reference information only.
DA-3000, Materials			
DA-3100, *Allowable Materials*	Defines allowable materials and material stress limits for frames, blades, shafts, and linkages, primarily by requiring specific ASTM and ASME designated materials. Bearing and seal allowable materials are defined by reference to DA-4250 and DA-4260.	It is intended that the design specification will specify general type of allowable materials and that these materials be ASTM or ASME designated materials.	The chosen specification will be equivalent to ASME AG-1, except that specific ASTM or ASME designations will not be specified. This is acceptable because requiring materials that are ASTM or ASME designated, without identifying any specific designations, provides adequate assurance of material properties for this application.
DA-3200, *Special Limitations on Materials*	Requires consideration of special conditions such as high temperatures, galvanic corrosion, and corrosive vapors. Additional consideration is required when using non-metallic materials.	It is intended that the design specification will require consideration of galvanic corrosion and non-metallic materials similar to the requirements of ASME AG-1. Consideration of high temperatures and corrosive vapors is not applicable.	The chosen specification will be equivalent to ASME AG-1.

Table 4 Section DA, Dampers Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
DA-3300, *Certification of Materials*	Requires certified test reports for damper stress components, and Manufacturer's Certificate of Compliance with ASME or ASTM specifications for all other components.	It is intended that the design specification will specify Certificates of Compliance with specified codes and standards, including ASTM or ASME designations for materials (11.2.7).	Certified test reports are not required because this application does not require such rigorous material testing. Certificates of Conformance with standards provide adequate verification of the physical properties of materials. Furthermore, based on the extensive past successful operating history of these industrial dampers, there is no benefit in obtaining certified test reports.
DA-4000, Design			
DA-4100, *General Design*	DA-4110, *Requirements of Design Specifications*" require specific design parameters, as applicable, that provide a complete basis for design and manufacture of dampers.	It is intended that the design specification will include information specified in ASME AG-1, as applicable.	The chosen specification will be equivalent to ASME AG-1.
	DA-4120, *Requirements of the Manufacturer,* requires specific documentation, as applicable, to be provided by the manufacturer to the Owner.	It is intended that the design specification will include information specified in ASME AG-1, as applicable.	The chosen specification will be equivalent to ASME AG-1.
	DA-4130, *Performance Requirements,* establishes requirements for seat leakage, frame leakage, pressure drop, fire ratings, fire damper closure, and cycle time.	It is intended that the design specification will specify leakage, pressure drop, and cycle time criteria. Fire ratings and fire damper closure is not applicable to the exhaust portion of the C2 and C3 systems.	The chosen specification may be equivalent to ASME AG-1. ASME AG-1 requires pressure drop and cycle time to be specified in the design specification. Leakage criteria can be specified to meet ASME AG-1 criteria for leakage rates, as required by the design function of the damper.
	DA-4210, *Structural*, provides very specific and very detailed structural loading criteria.	It is intended that the design specification will specify loading criteria, as applicable, such as actuator loads, support requirements, closure under design flow conditions, etc.	The additional rigorous design analysis required by ASME AG-1 is not necessary for this application. The extensive past operating history of these dampers demonstrates adequate structural design for this application. See Section 5.1.3.2 for further justification.

Table 4 Section DA, Dampers Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	DA-4220, *Thermal Expansion*, requires that the design provide for the relative motions that occur between components due to differential expansion.	No requirements for thermal expansion should be included in the design specification.	Thermal expansion need not be a consideration because temperature gradients will not be established. The air stream temperature will not deviate significantly from the temperature of the room housing the equipment.
	DA-4230, *Torque*, establishes requirements for determination of the torque required to actuate the blades and for minimum actuator torque.	It is intended that the design specification will allow the manufacturer to determine torque requirements for commercial grade applications.	ASME AG-1 has more detailed and specific requirements. See Section 5.1.3.2 for further justification.
	DA-4240, *Linkage*, establishes specific requirements for linkage design.	It is intended that the design specification will define linkage requirements to ensure design function, maintainability, and reliability as necessary, but not to the extent of ASME AG-1.	Section DA-4240/4241 identifies damper linkage requirements to produce stable operation over its operating range. The project damper specification calls for dampers to comply with AG-1, Article 4241. For dampers to be installed in non-QL C2/C3 exhaust systems, they will be compliant to AG-1 but without the NQA-1 documentation.
	DA-4250, *Bearings*, establishes specific requirements for bearing selection including bearing types, bearing design, and bearing loading.	It is intended that the design specification will define bearing requirements to ensure design function, maintainability, and reliability as necessary, but not to the extent of ASME AG-1.	ASME AG-1 has more detailed and specific requirements. See Section 5.1.3.2 for further justification.
	DA-4260, *Seals*, establishes requirements for seal design and materials to limit seat and frame leakage.	It is intended that the design specification will define seal requirements to ensure design function, maintainability, and reliability as necessary, but not to the extent of ASME AG-1.	ASME AG-1 has more detailed and specific requirements. See Section 5.1.3.2 for further justification.

Table 4 Section DA, Dampers Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	DA-4270, *Frame Construction*, requires stuffing boxes, gasketed cover plates, or other sealing devices to limit frame leakage on dampers where leakage is a consideration. Also, specifies material requirements for gasket and packing materials.	It is intended that the design specification will identify the ASME AG-1 frame leakage class, as required, and then comply with ASME AG-1 accordingly. Material requirements should also conform to ASME AG-1.	The chosen specification will be equivalent to ASME AG-1.
	DA-4280, *Mounting of Actuators and Accessories*, establishes requirements for the mounting structure, accessibility, mounting structure material, attachment, and linkage adjustability for actuators and accessories.	It is intended that the design specification will comply with ASME AG-1 regarding mounting, accessibility, and linkage adjustability. Materials requirements should be specified according to Section DA-3000 of this table. Stress limitations on attachments should follow manufacturer's recommendations.	The chosen specification will be equivalent to ASME AG-1, except for materials requirements and stress limitations. Rigorous stress loading analysis is not necessary for this application. See Section 5.1.3.2 for further justification.
DA-4300, *Actuators*	DA-4310, *Power-Operated Actuators*, establishes requirements for required torque, actuator loading, voltage or pressure rating, and minimum specified design parameters to establish requirements for actuator performance.	It is intended that the design specification will identify some or all of the design parameters required by ASME AG-1, and then allow the manufacturer to match an appropriate commercial grade actuator to the damper.	It is acceptable to allow the manufacturer to select power-operated actuators for dampers, given design parameters that ensure acceptable actuator performance. See Section 5.1.3.2 for further justification.
	DA-4320, *Manual Actuators*, establishes requirements for locking devices, position indicators, torque requirements, actuator loading, and maximum input forces.	It is intended that the design specification will identify similar requirements, as applicable, and then allow the manufacturer to match an appropriate commercial grade actuator to the damper.	Requirements for locking devices, position indicators, and input forces may be determined by operational requirements. It is acceptable to allow the manufacturer to select manual actuators for dampers. See Section 5.1.3.2 for further justification.
	DA-4330, *Self-Contained Actuators*, references DA-4231 for torque requirements for self-contained actuators.	Not applicable.	Not applicable.

Table 4 Section DA, Dampers Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	DA-4340, *Heat or Temperature Operated Actuators*, requires compliance with NFPA 90A for heat or temperature operated actuators.	Not applicable.	Not applicable.
DA-4400, Accessories	Establishes requirements for accessories to be provided, auxiliary energy source, modulating actuators, position indicators, environmental conditions, piping of pneumatic actuators, and electrical wiring, primarily to be identified in the design specification.	It is intended that the design specification will identify requirements for accessories, as necessary, to ensure acceptable damper function. Piping requirements for pneumatic actuators should comply with ASME AG-1.	The chosen specification will be equivalent to ASME AG-1. Most ASME AG-1 requirements are needed only when required by the design specification.
DA-5000, Inspections and Testing			
Referenced Sections of AA-5000	Establishes general requirements for calibration of M&TE, visual inspections, inspections and testing of welded connections, inspections of bolted connections, examination of fabrication tolerances, and seismic testing.	It is intended that the design specification will make no specific requirements.	ASME AG-1 has more detailed and specific requirements as described. Reliance on the manufacturer's inspection and testing procedures for fabrication of commercial grade dampers is acceptable for this application. The level of detail specified in ASME AG-1 is unnecessary for this application. See Section 5.1.3.2 for further justification.
DA-5700, *Testing*	DA-5710, *Pressure Drop Testing*, requires pressure drop data to be based on tests performed in accordance with AMCA 500.	AMCA 500 is a chosen standard and will be complied with.	The chosen specification will be equivalent to ASME AG-1.
	DA-5720, *Cycle Time and Cycle Repetition*, establishes requirements for valve cycle testing to verify such things as free and smooth operation, proper seating of blades, cycle time, and limit switch operation.	It is intended that the design specification will require cycle testing in accordance with the manufacturer's procedures.	Reliance on the manufacturer's cycle testing provides adequate assurance of damper operation for this application. See Section 5.1.3.2 for further justification.

Table 4 Section DA, Dampers Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	DA-5730, *Frame Leakage Testing for Frame Leakage Classes A and B*, establishes testing requirements for frame leakage on dampers where leakage is a consideration.	It is intended that the design specification will not require rigorous frame leakage testing by the manufacturer and can rely on acceptance testing to verify acceptable leakage rates.	ASME AG-1 requires leakage criteria to be tested by the manufacturer. It is acceptable for the design specification to not require frame leakage testing by the manufacturer for this application and to rely on acceptance testing to verify acceptable leakage rates. See Section 5.1.3.2 for further justification. Following HVAC damper installations, a combination ductwork and in-line devices (such as, dampers, humidifiers, coils, instrumentation taps) will be pressure tested as a system, by the HVAC subcontractor, in which test reports are submitted to BNI for approval. The approval is based on the successful demonstration that the leakage rate is within prescribed limits. This approach is judged acceptable since ASME AG-1, Section SA-4500, *Pressure Boundary Leakage*, allows for an installed system boundary test in lieu of each individual damper. Refer to 5.1.3.15 response for acceptance leakage criteria. The values shown in Appendix DA-I identify leakage values through damper blades under an airflow condition whereas the boundary test pressurizes the ductwork envelope including the inline components.
	DA-5740, *Seat Leakage Testing*, establishes testing requirements for seat leakage specifically or by requiring AMCA 500 test methods. Fire dampers shall be tested in accordance with AMCA 500.	It is intended that the design specification will identify dampers to be leakage class II, III, or IV, and then require testing in accordance with AMCA 500. Fire damper testing is not applicable.	The chosen specification will be equivalent to ASME AG-1.

Table 4 Section DA, Dampers Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
DA-6000, Fabrication, Finishing, and Installation (References Section AA-6000)			
AA-6100, *General*	Identifies materials requirements by reference to DA-3000 and requires quality control procedures for all fabrication and installation processes by reference to AA-8000.	See sections DA-3000 and DA-8000 of this table.	See sections DA-3000 and DA-8000 of this table.
AA-6200, *Fabrication Processes*	Establishes requirements for cutting, forming, bending, forming tolerances, fitting and aligning for bolting or welding, welded joints, and mechanical joints.	It is intended that the design specification will require compliance to AWS standards.	ASME AG-1 provides more detailed fabrication requirements. Typical manufacturers standards and tolerances for fabrication processes are acceptable for this application. See Section 5.1.3.2 for further justification.
AA-6300, *Welding Requirements*	Establishes very detailed and specific requirements for welding including workmanship, inspection, testing, non-destructive testing, inspector qualifications, and repairs. Identifies several ANSI/AWS codes and ASME Code, Section IX to be complied with.	It is intended that the design specification will require compliance to AWS standards.	The design specification requires codes that are listed in ASME AG-1, but ASME AG-1 includes very specific and detailed additional welding requirements as identified in the ASME AG-1 requirement description. The requirements in ASME AG-1 in addition to the industry standards are unnecessary for this application. See Section 5.1.3.2 for further justification.
AA-6400, *Brazing*	Establishes similar requirements as AA-6300.	It is intended that the design specification will require compliance to AWS standards.	The requirements in ASME AG-1 in addition to the industry standards are unnecessary for this application. See Section 5.1.3.2 for further justification.
AA-6500, *Cleaning and Coating*	Establishes coating requirements using a graded approach using service levels based on the coating's and the equipment's relation to nuclear safety.	It is intended that the design specification will require painting in accordance with the damper manufacturer's procedures.	The chosen specification will be equivalent to ASME AG-1, because Service level III coatings are only required to meet the equipment manufacturer's specifications.

Table 4 Section DA, Dampers Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
AA-6600, *Installation Requirement*	Establishes requirements for handling, rigging, field assembly, installation procedures, and temporary field attachments.	It is intended that the design specification will require certified lifting eyes or lugs and require submittal of installation manuals.	ASME AG-1has more detailed and specific requirements for handling and rigging and for field assembly. WTP rigging procedures will be complied with and contain adequate rigor for this application. Installation in accordance with the manufacturer's instructions is also acceptable for this application. See Section 5.1.3.2 for further justification.
DA-7000, Packaging, Shipping, and Storage (References Section AA-7000)			
AA-7000	Establishes general requirements and responsibilities for packaging, shipping, receiving, storage and handling, primarily by supplementing the provisions of ANSI/ASME NQA-2, Part 2.2. Personnel qualification requirements of ANSI/ASME NQA-1 are required for inspection, examination, and testing.	It is intended that the design specification will require packaging and shipping in accordance with the damper manufacturer's procedures.	ASME AG-1 has more detailed and specific requirements, including compliance with ANSI/ASME NQA-1 and ANSI/ASME NQA-2. Damper manufacturer's quality standards for packaging and shipping are acceptable for this application. See Section 5.1.3.2 for further justification.
DA-7000	Identifies ANSI/ASME NQA-2 classification levels for packaging, shipping, storage, and handling of dampers, louvers, actuators, and accessories.	It is intended that the design specification will require packaging and shipping in accordance with the damper manufacturer's procedures.	ANSI/ASME NQA-2 classification levels are not applicable if packaging, shipping, storage, and handling is performed in accordance with the damper manufacturer's procedures. Damper manufacturer's quality standards for packaging and shipping are acceptable for this application. See Section 5.1.3.2 for further justification.

Table 4 Section DA, Dampers Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
DA-8000, Quality Assurance (References Section AA-8000)			
AA-8000, *Quality Assurance*	Establishes general requirements and responsibilities for quality assurance primarily by supplementing the provisions of ANSI/ASME NQA-1.	It is intended that the design specification will provide quality assurance requirements similar to the fan specification and the WTP will procure the dampers in accordance with their quality assurance program plan.	ASME AG-1 has more detailed and specific requirements, including compliance with ANSI/ASME NQA-1. Compliance with the quality assurance programs of the WTP and the fan manufacture is acceptable for this application. See Section 5.1.3.2 for further justification.
DA-8100, *Damper and Louver Performance*	Requires documentation to verify that damper and louver performance comply with the testing criteria of DA-5000.	It is intended that the design specification will require documentation of pressure drop, cycling, and leakage testing, as applicable.	The chosen specification will be equivalent to ASME AG-1 to the extent that it complies with section DA-5000, as identified in this Table.
DA-9000, Nameplates, Stampings, and Manuals			
AA-9000	Establishes specific nameplate requirements for materials, lettering, attachment, and location.	It is intended that the design specification will identify nameplate requirements.	The chosen specification will be equivalent to ASME AG-1.
DA-9100, *Nameplates and Stampings*	Requires part marking of each part of removable frames and the manufacturer must be identified on each actuator and accessory.	It is intended that the design specification will require similar information, if necessary.	The chosen specification will be equivalent to ASME AG-1.
DA-9200, *Manuals*	Requires manuals that shall include a recommended spare parts list and recommended installation, maintenance, and operational procedures.	It is intended that the design specification will comply with ASME AG-1.	The chosen specification will be equivalent to ASME AG-1.

Table 5 Section SA, Ductwork Detailed Evaluation

AG-1 Section	AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
SA-1000, Introduction			
SA-1000, *Introduction*	Identifies the scope, purpose, and applicability of this section and defines terms used.	Not applicable to this evaluation.	Not applicable to this evaluation. Introductory information only.
SA-2000, Referenced Documents			
SA-2000, *Referenced Documents*	Identifies codes and standards referenced in this section.	Not applicable to this evaluation.	Not applicable to this evaluation. Reference information only.
SA-3000, Materials			
SA-3100, *General*	Identifies allowable materials and material stress limits, primarily by requiring ASTM and ASME designated materials with certified test reports.	SMACNA RIDCS identifies ASTM materials to be used in the construction of industrial duct. The HVAC installation specification also identifies allowable materials.	The chosen standard and specification are equivalent to ASME AG-1. Materials identified in SMACNA are also listed in ASME-AG-1.
SA-3200, *Material Substitution*	Measures shall be established for controlling and identifying material substitutions throughout the manufacturing and installation process.	The HVAC installation specification does not allow substitutions without authorization from contractor which includes documenting deviations of the procuring specification	The chosen specification is similar to ASME AG-1. The HVAC installation specification requires the contractor to seek permission for using material substitutions and to document the substitutions.

Table 5 Section SA, Ductwork Detailed Evaluation

AG-1 Section	AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
SA-3300, *Material Testing*	When required by the design specification, material shall be tested in accordance with the applicable material specification.	The HVAC installation specification does not require material testing.	Material testing is specified as an option in ASME AG-1. The chosen specification does not require material testing. In the absence of corrosive material stored in C2 areas, galvanized steel is selected duct material. In C3 areas where the potential exist for corrosive material to vent to the room environment or directly into the ductwork, stainless steel will be considered/used based on the release concentration to the space. Stainless steel is chosen due to its mitigating corrosive properties. Note that impacts of corrosive products on HEPA filters will require evaluation. The HVAC installation specification requires the HVAC subcontractor to procure the ASTM materials as identified in the design specification for both galvanize and stainless steel ductwork. The specification also requires the subcontractor to submit a Material Certificate of Compliance (MCC) for approval. Given the severity level of the C2 and C3 areas, the MCC is considered sufficient for the intended system design.
SA-3400, *Material Specifications*	Material for ductwork and ductwork supports shall be capable of meeting all requirements of Article SA-4000. Materials selected shall be evaluated for suitability with service conditions and compatibility with other materials used in duct construction.	The HVAC installation specification requires that dissimilar metal couples be avoided. SMACNA and the HVAC installation specification require evaluation of the environment that the materials will be used in.	The chosen standard and specification are equivalent to ASME AG-1. Materials specified are common materials used in industrial duct construction.

Table 5 Section SA, Ductwork Detailed Evaluation

AG-1 Section	AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
SA-4000, Design			
SA-4200, *Design Criteria*	SA-4210, *Load Criteria*, identifies the loads and load definitions for duct and duct supports to be considered.	SMACNA RIDCS defines loads and load combinations for ductwork, and requires ductwork support design to consider all loads applied to the ductwork.	The chosen standard is equivalent to ASME-AG-1. ASME-AG-1 defines loads that shall be considered for ductwork loads. These loads are accounted for in SMACNA.
	SA-4220, *Stress Criteria* - The ductwork stress shall be based upon the AISI *Specifications for the Design of Cold Formed Steel Structural Members*. The ductwork support stress shall be based upon the AISC, *Specification for the Design, Fabrication, and erection of Structural Steel for Buildings*.	SMACNA RIDCS defines allowable stress criteria for duct. Supports are required to have the necessary flexibility to allow for thermal expansion and contraction. Hangers and supports must be designed with a factor of safety of 3 and, therefore, must he capable of resisting 3 times the reaction that develop at their point of application.	Stress criteria specified in SMACNA is satisfactory for this application. This is a standard industrial ventilation system utilizing products and construction techniques with proven reliability in industry. See Section 5.1.3.3 for further justification.
	SA-4230, *Deflection Criteria* - The maximum deflection that may be sustained, so that the duct function is not impaired, shall be determined by analysis, testing, or both. The allowable deflections are as defined in AA-4231 for various Service level conditions.	SMACNA RIDCS and the HVAC installation specification use allowable stress as criteria for design loads.	Stress criteria specified in SMACNA is satisfactory for this application. This is a standard industrial ventilation system utilizing products and construction techniques with proven reliability in industry. See Section 5.1.3.3 for further justification.
	SA-4240, *Other Criteria*, establishes requirements for vibration isolation, relative movement, and permanent attachments.	SMACNA HSDD provides extensive analysis to enhance sound and vibration isolation, if required. No requirements for relative movement are established. SMACNA RIDCS addresses construction and installation; the HVAC installation specification addresses welding and bolting criteria for permanent attachments.	The chosen specification is equivalent to ASME AG-1, except for requirements for relative movements. Relative movement is a consideration only in systems where differential thermal expansion is likely. The C2 and C3 exhaust systems handle air at with relatively uniform temperatures and have no heating or cooling components. Therefore, relative movement is not applicable to these systems.

Table 5 Section SA, Ductwork Detailed Evaluation

AG-1 Section	AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
SA-4300, *Ductwork Joints and Seams*	SA-4320, *Duct Joints and Seams,* identifies acceptable longitudinal seams (groove weld, lock type, Pittsburgh lock, and fillet weld) and transverse joints (welded flange, companion angle, Vanstone flange, and welded coupling)	SMACNA RIDCS identifies acceptable longitudinal seams (buttweld, pipe lock grooved, and spiral lock) and transverse joints (buttwelded, draw band, large and small end joint, socket, beaded sleeve, welded flange, and Vanstone). The HVAC installation specification also requires buttwelded seams and welded flange for leakage class I, and companion angle transverse joints for leakage class II.	The chosen standard and specification are equivalent to ASME AG-1. SMACNA leak classes dictate sealing requirements for joints.
	SA-4324, *Limitations of Ductwork Joints and Seams*, requires that longitudinal seams and transverse joints that are folded or punched metal, shall be pressure tested. Also, requires qualification by testing, analysis, or both for longitudinal seams that use sealants or elastomers to meet the leakage requirements.	The HVAC installation specification requires that the seams be buttwelded.	The HVAC installation specification does not allow folded or punched metal transverse joints, so this requirement is not applicable.
	SA-4325, *Bolts and Fasteners*, establishes specific bolt spacing and size requirements for ductwork with a design pressure differential less than 15 in. w.g. and requires calculations or testing for bolted connections for ducts with pressures greater than 15 in. w.g. and for nonbolted, non-welded type fastening devices.	SMACNA RIDCS establishes bolt spacing for flanged joints and addresses bolt diameter based on design loads. The HVAC installation specification requires load calculations and 100 % duct pressure testing	ASME AG-1 has more restrictive requirements. The SMACNA allowable bolt spacing exceeds the 4" spacing of ASME AG-1. Standard industrial bolting practices will provide acceptable sealing and load bearing capability for this application. See Section 5.1.3.3 for further justification.

Table 5 Section SA, Ductwork Detailed Evaluation

AG-1 Section	AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
SA-4400, *Components*	SA-4410, *Flexible Connections*, establishes loading and pressure boundary leakage requirements for flexible connections and requires compliance with NFPA 90A. Also establishes requirements for pressure rating, qualified life, and adhesives.	SMACNA RIDCS identifies factors to be considered in expansion joint design, such as pressure, temperature, motion, corrosion, and erosion. The HVAC installation specification also addresses attachment of dissimilar metals, temperature requirements, pressure requirements, loading, performance, and NFPA 90A requirements.	The chosen standard and specification are equivalent to ASME AG-1.
	SA-4420, *Gaskets*, establishes requirements for gasket materials, dimensions, and compression criteria.	SMACNA RIDCS provides guidance for selecting gasket material and suggests consultation with gasket manufacturers for proper application depending on air stream requirements.	The chosen standard is equivalent to ASME AG-1.
	SA-4430, *Access Doors and Panels*, establishes requirements for allowable leakage, sealing surfaces, compression, adjustment, and spacing of hinges, latches and bolts for access doors and panels.	SMACNA RIDCS requires access doors to be of the same material, and equal to or greater thickness than the duct, gasket all around, continuous hinge, commercial shimmed latch, door oversized at least 1-1/2" all around opening. SMACNA DCSMF requires that construction and air-tightness be suitable for leak class used.	SMACNA includes similar requirements as ASME AG-1, but is not as stringent. SMACNA does not include requirements for adjusting compression forces, gasket compression, and alignment. Maintenance on ductwork is not expected to occur following commissioning unless approved through the configuration management program. Access doors, on the other hand, will be located and sized to allow maintenance personnel access to HVAC in-line components (such as, dampers, humidifiers, instrumentation) requiring periodic inspection or maintenance during normal plant operations.
	SA-4440, *Provisions for Testing and Maintenance* - The engineer shall evaluate the design function of the equipment to determine where test ports (including injection and sampling ports) are required.	Duct test holes with closures or threaded holes with plugs shall be provided in duct and plenums as indicated or where necessary, according to the HVAC installation specification	The chosen specification is equivalent to ASME AG-1.

Table 5 Section SA, Ductwork Detailed Evaluation

AG-1 Section	AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	SA-4451, *Drains* – Consideration shall be given to drains depending on requirements, services, or components within ductwork. Drains are subject to the air leakage requirements established in SA-4500.	SMACNA RIDCS requires installation of drains in accordance with drawings and to provide adequate trap depth for designed static pressure.	The chosen standard is equivalent to ASME AG-1.
	SA-4452, *Insulation*, establishes insulation requirements.	Thermal insulation shall meet the criteria according to the HVAC installation specification	The chosen specification is equivalent to ASME AG-1.
	SA-4453, *Air Distribution Devices* - Design of air distribution devices and their attachments shall comply with SA-4200 and AA-4300. The performance rating of air distribution devices shall be determined by actual tests performed in accordance with the Air Diffusion Council standard listed in SA-2000.	SMACNA RIDCS and HSDD address air diffusion devices, but do not reference ADC standard or design criteria. The HVAC installation specification requires ductwork accessories be designed for proper pressure differential and airflow rate. Ductwork accessories shall comply with seismic categories specified. Performance rating shall be IAW published catalog data.	Requirements for air distribution devices are only applicable to the supply portion of the C2 and C3 systems and are, therefore, not evaluated.
	SA-4454, *Security Barriers*, establishes requirements for internal and bullet resistant barriers.	No security barrier requirements are established.	Security barriers are not applicable to this application.
SA-4500, *Pressure Boundary Leakage*	SA-4510, *General*, identifies considerations for determination of allowable leakage for a system including control of airborne contamination, control of space pressure, control of space temperature, and control of space humidity	SMACNA HADLTM requires that the duct system designer evaluate the leakage potential considering the location, type of service, equipment, dampers and accessories, and balance and performance of the system.	The chosen standard is equivalent to ASME AG-1.

Table 5 Section SA, Ductwork Detailed Evaluation

AG-1 Section	AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	SA-4520, *Applicability* - Pressure boundary leakage shall apply to air cleaning, air cooling, and ventilation systems. Identifies components that make up the systems pressure boundary, as applicable.	SMACNA HADLTM requires that leakage be accounted for in ventilation equipment independent of duct leakage.	The chosen standard is equivalent to ASME AG-1.
	SA-4531, *Responsibility* - The engineer shall evaluate each system to establish the allowable leakage to ensure its design ventilation, temperature, and contamination control function is achievable.	SMACNA HADLTM requires that the duct system designer evaluate the leakage potential to ensure the balance and performance objectives of the system is achievable.	The chosen standard is equivalent to ASME AG-1.
	SA-4532, *Allowable Leakage Determination*, identifies criteria to be utilized in the determination of allowable leakage.	SMACNA HADLTM requires that the duct system designer evaluate the leakage potential for ducts conforming to SMACNA or other standards and supplement the requirements with deletions and additions as may be prudent and economical to achieve design objectives.	The chosen standard is equivalent to ASME AG-1.
	SA-4533, *Exceptions to Leakage Requirements* identifies portions of systems that may not be subject to quantitative measurement of leakage, but will have all audible leaks sealed.	SMACNA HADLTM requires that the duct system designer evaluate the leakage potential for ducts conforming to SMACNA or other standards and supplement the requirements with deletions and additions as may be prudent and economical to achieve design objectives.	The chosen standard is equivalent to ASME AG-1.

Table 5 Section SA, Ductwork Detailed Evaluation

AG-1 Section	AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	SA-4534, *Documentation*, establishes documentation requirements for the evaluation of allowable leakage.	The HVAC installation specification requires calculations to determine maximum allowable leakage rate acceptance criteria for leak testing of the installed ductwork.	ASME AG-1 has more detailed and specific requirements. The HVAC installation specification does not specifically require documentation of the purpose of leakage control, system modes of operation, and method or derivation for allowable leakage. This is acceptable because documentation of the allowable leakage through calculations is the minimum requirement to ensure adequate system performance.
	SA-4540, *Leakage Testing* - When specified for a system, leakage testing shall be performed in accordance with SA-5300 and Section TA of this Code.	Leak testing will be performed in accordance with SMACNA HADLTM.	See SA-5300 of this table and Section 5.1.3.15.
SA-4600, *Design Specification*	Identifies minimum information to be included in a design specification including loads, environmental conditions, service conditions, design and service limits, allowable leakage, and system safety related function.	The HVAC installation specification includes environmental conditions.	ASME AG-1 has more specific and detailed requirements. Standard industry ductwork installed to SMACNA standards will provide adequate structural loading capability and leakage criteria for this application. See Section 5.1.3.3 for further justification. System safety related function is not applicable.
SA-5000, Inspection And Testing			
SA-5120, *Responsibility for Procedures*	Requires written inspection or testing procedures and test personnel qualification in accordance with ASNT SNT-TC-1A as amended by ASME NQA-1 and AA-6433.	The HVAC installation specification requires field leak test procedures and inspection procedures that follow SMACNA standards.	The chosen standard and specification do not require test personnel qualification to the same standards as ASME AG-1. It is acceptable to qualify test personnel to the SMACNA standards to which the system is being tested.

Table 5 Section SA, Ductwork Detailed Evaluation

AG-1 Section	AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
SA-5200, *Visual Inspection*	Establishes requirements for visual inspections of welded connections ductwork, joints, seams, stiffeners, and ductwork supports. References AA-5200 and TA-3510 for general visual inspection requirements and AA-5300 and AA-6000 for weld inspection requirements.	SMACNA requires welding per AWS D9.1, which includes inspection requirements. SMACNA provides general guidelines for visual inspections that can be tailored to comply with documentation for which the inspector is responsible.	ASME AG-1 has more specific and detailed requirements. The additional rigor of ASME AG-1 above the requirements of SMACNA for visual inspection is not necessary for this application. See Section 5.1.3.3 for further justification.
SA-5300, *Pressure Boundary Leakage Testing*	SA-5310, *General* - The ductwork system shall be tested to demonstrate compliance with the design leakage requirements identified in SA-4500, unless exempted by SA-4533.	The HVAC installation specification requires duct leak testing in accordance with SMACNA..	The chosen specification is equivalent to ASME AG-1 to the extent that it is equivalent to section SA-4500.
	SA-5320, *Systems Completeness*, requires the system to be complete prior to testing and allows exclusion of terminal-air distribution devices, pressure boundary items not yet installed, and testing in sections.	The HVAC installation specification requires testing of ductwork to be performed on a section-by-section basis after each section is installed and completed.	The chosen specification is equivalent to ASME AG-1.
	SA-5330, *Allowances for Testing System Leakage Rates by Sections*, establishes requirements for temporary isolation at a transverse joint.	The HVAC installation specification requires testing of ductwork to be performed on a section-by-section basis after each section is installed and completed. It is intended that the HVAC installation specification will include inspection of sealing qualities of joints when the leak test boundary is at a transverse joint.	The chosen specification is equivalent to ASME AG-1.

Table 5 Section SA, Ductwork Detailed Evaluation

AG-1 Section	AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	SA-5340, *Testing Procedures,* requires test procedures in accordance with TA-3400, requires test equipment to be specified with the proper range and required accuracy, and requires acceptance criteria be determined by SA-4500, SA-5320, and SA-5330.	The HVAC installation specification requires duct leak testing according to SMACNA, which uses a positive pressure test procedure. The ductwork specification requires that test instrumentation used to determine ductwork leakage rates be selected to meet the accuracy and calibration requirements of ASME AG-1, Article TA-3000.	The SMACNA leak test procedure is similar to the constant pressure method of ASME AG-1, Section TA; although ASME AG-1 has more specific requirements for test personnel qualification, test procedures, and test instrumentation. This is acceptable for this application. See Section 5.1.3.3 for further justification. The chosen standard for test instrumentation is equivalent to ASME AG-1.
	SA-5350, *Documentation,* identifies minimum information to be included in a test report to document the pressure boundary leakage test.	SMACNA provides procedures for documenting the leakage tests.	The chosen standard is equivalent to ASME AG-1.
	SA-5360, *Acceptance Criteria,* requires that acceptance criteria for quantitative leakage tests comply with SA-4500 and SA-5350(d). For non-quantitative leakage tests allowed by SA-4533, the acceptance criteria shall be that audible leaks have been sealed.	The HVAC installation specification defines acceptance criteria for leakage class and reduction of leakage rates for sectional testing. The HVAC installation specification does not identify any non-quantitative leak testing.	The chosen specification is equivalent to ASME AG-1.
SA-5400, *Structural Capability Tests*	SA-5410, *Ductwork Pressure Test,* requires that a pressure test be performed at the structural capability pressure per TA-3522, with acceptance criteria of not permanent distortion or breach of integrity. This test is not required if duct construction allowed in the SMACNA standards listed in Article SA-2000 for the system operational pressure transient (SOPT).	Neither the HVAC installation specification nor SMACNA require structural capability testing.	ASME AG-1 permits SMACNA ductwork without structural capability testing provided the construction of the ductwork is equal to or exceeds the system operational pressure transient. Therefore, the chosen standard and specification are equivalent to ASME AG-1.

Table 5 Section SA, Ductwork Detailed Evaluation

AG-1 Section	AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	SA-5420, *Longitudinal Seam Qualification Test,* requires structural capability pressure testing of ductwork utilizing folded or punched metal longitudinal seams to qualify the structural design capability of those seams prior to any of these seams being installed.	The HVAC installation specification requires all longitudinal seams to be buttwelded.	The HVAC installation specification does not allow folded or punched metal transverse joints, so this requirement is not applicable.
SA-6000, Fabrication and Installation			
SA-6120, *Materials*	Establishes requirements for materials selection by reference to SA-3000, material identification on fabrication plans, installation plans, and specifications, and use of materials with defects.	The HVAC installation specification requires ASTM designation for all materials be furnished on drawings and describes welding repairs and submittal procedures including repair procedures for rejected parts. Also, see SA-3000 of this table.	The chosen specification is equivalent to ASME AG-1. Materials identified in SMACNA are also listed in ASME AG-1.
SA-6130, *Control of Installation and Fabrication Process*	Quality control procedures shall be prepared and maintained current for all fabrication and installation processes in accordance with the requirements of AA-8000.	The HVAC installation specification requires that a quality assurance program be in place, meeting 24590-WTP-3PS-G000-T0001.	See justification for section AA-8000 of this table.
SA-6140, *Welding*	The welding of ductwork and ductwork supports shall comply with the requirements of AWS D1.1, AWS D1.3, AWS-D9.1, and ASME Code, Section IX, as applicable. Welding and brazing, performed in accordance with this section, shall meet the requirements of AA-6300 and AA-6400.	SMACNA recommends AWS D9.1 and the HVAC installation specification requires compliance with AWS D1.1, AWS D1.3, AWS D1.6, and AWS D9.1.	Compliance with the AWS standards is acceptable for this application. See Section 5.1.3.3 for further justification. ASME AG-1 has more detailed requirements in Section AA-6300 and AA-6400 which is better suited to C5 ductwork applications which is not in the scope of this cost benefit analysis.

Table 5 Section SA, Ductwork Detailed Evaluation

AG-1 Section	AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
SA-6200, *Fabrication Process*	Establishes requirements for cutting, forming, bending, aligning, and fitting.	The HVAC installation specification requires "CM" quality galvanized metal surfaces to be repaired using a zinc rich coating.	ASME AG-1 has more specific requirements. Many of the requirements in ASME-AG-1 are common practices for fabrication processes.. The C2 and C3 systems are operated in non-corrosive environments and, therefore, do not require stringent procedures to repair galvanized coating. Requirements for temporary welded attachments are not described in the HVAC installation specification and, therefore, are not applicable. See Section 5.1.3.3 for further justification.
SA-6300, *Mechanical Fastening*	Establishes requirements for nuts, bolts, screws, rivets, pins, and flange faces. References AISC code for bolts requirements and SA-4000 for qualification of screws, rivets, and attachment of pins.	The HVAC installation specification provides similar requirements for the use of mechanical fasteners on non-ASME AG-1 ductwork and for the attachment of insulation to the ductwork. SMACNA RIDCS provides requirements for joints and minimum spacing for screws and rivets.	The chosen standard and specification are equivalent to ASME AG-1, except for the requirement to eliminate crevices from flange faces. This is acceptable for this application. See Section 5.1.3.3 for further justification.

Table 5 Section SA, Ductwork Detailed Evaluation

AG-1 Section	AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
SA-6400, *Fabrication Tolerances*	Establishes specific ductwork fabrication tolerances for rectangular and circular ducts as a method of quality control. These include twist, joint flange squareness, joint connection maximum offset, and flat plate waviness or bulge for rectangular ducts; out-of-round, joint end squareness, and joint connection offset for circular ducts; and hole tolerances for bolted connections.	The HVAC installation specification establishes installation tolerances for hangers, supports, in-line duct location, out-of-circular plane, and waviness, bulging, or other deformation for sheet panels of rectangular ducts. SMACNA defines requirements for bolt hole spacing and ductwork accessories.	ASME AG-1 has more specific requirements and closer tolerances. This is acceptable because it is unlikely that the less stringent tolerances defined by the HVAC installation specification will impair system function. Most of the ductwork will remain accessible and will contain minimal or no contamination. This will allow for less stringent leakage criteria and will allow ease of repair or replacement of ductwork if tolerances are indeed a factor in system performance. See Section 5.1.3.3 for further justification. Article SA-6400 identifies fabrications tolerances for ductwork. Per ASME AG-1, fabrication tolerance for rectangular ductwork range for 1/16" to 3/16" depending on the duct section or joint being fabricated. For round ductwork, the tolerance range from 1/16" to 1". SMACNA does not identify fabrication tolerances in their design manual. However, the project specification calls for a fabrication tolerance not to exceed 1/4" for both rectangular and round ductwork. Although, the specification appears to be more stringent, it doesn't include a longitudinal tolerance as identified in AG-1. This small difference is judged acceptable since 1) BNI will receive fabrication cut sheets from the HVAC installation subcontractor for approval, and 2) the ductwork system will receive a walk-down visual inspection.
SA-6500, Installation Tolerances	Ductwork and their supports shall be installed within the tolerance specified by approved construction documents. These tolerances shall comply with the design requirements of SA-4000.	The HVAC installation specification establishes installation tolerances.	The chosen specification is equivalent to ASME AG-1, to the extent that it complies with SA-4000.

Table 5 Section SA, Ductwork Detailed Evaluation

AG-1 Section	AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
SA-6600, *Cleaning, Finishing, and Coating*	Establishes requirements for repair of galvanized surfaces, preparation and repair of painted surfaces, and requires marking for identification on the exterior of each section.	The HVAC installation specification establishes requirements for painting of welded galvanized steel surfaces and specifies touch-up paint to be used for repairs.	ASME AG-1 has more detailed requirements. The HVAC installation specification adequately addresses repair of galvanized surfaces to prevent corrosion for this application. Most ductwork will be accessible for future repair, if required, and is housed inside the building so the potential for corrosion is minimal.
SA-7000, Packaging, Shipping and Storage			
AA-7000 and SA-7000	Establishes general requirements and responsibilities for packaging, shipping, receiving, storage and handling, primarily by supplementing the provisions of ANSI/ASME NQA-2, Part 2.2 (now contained in ANSI/ASME NQA-1). Duct components are required to meet Level C or Level D of ANSI/ASME NQA-2, Part 2.2.	The general specification for packaging, shipping, handling, and storage (24590-WTP-3PS-G000-T0003) is modeled after ANSI/ASME NQA-1, Subpart 2.2, Level B classification, with requirements for the same activities identified with the exception of receiving requirements.	The general specification for packaging, shipping, handling, and storage establishes similar requirements as ASME AG-1 and ANSI/ASME NQA-1, Subpart 2.2, often by paraphrasing these codes, but with less detail and no receiving and inspection requirements. Receiving requirements should be implemented through WTP receiving procedures. The level of detail of this specification provides similar protection for the ductwork, but with somewhat less rigor, and is adequate for this application. Specification requirements that are equivalent to Level B provide protection from contamination and condensation that exceed the requirements of ASME AG-1. See Section 5.1.3.1 for further justification.

Table 5 Section SA, Ductwork Detailed Evaluation

AG-1 Section	AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
SA-8000, Quality Assurance (References Section AA-8000)			
AA-8000, *Quality Assurance*	Establishes general requirements and responsibilities for quality assurance primarily by supplementing the provisions of ANSI/ASME NQA-1.	The HVAC installation specification requires that the HVAC installation subcontractor have a quality assurance program meeting the requirements of 24590-WTP-3PS-G000-T0001, *General Specification for Supplier Quality Assurance Program Requirements.*	ASME AG-1 has more detailed and specific requirements, including compliance with ANSI/ASME NQA-1. The quality assurance data sheets lists attributes that are identical to the chapters of ANSI/ASME NQA-1, but does not include detailed requirements associated with each attribute. Compliance with the quality assurance programs of the WTP is acceptable for this application.
SA-8200, *Material Identification*	Measures shall be established for controlling and identifying material throughout the manufacturing process and during shipment in accordance with Article AA-8000.	The HVAC installation specification requires that the HVAC installation subcontractor have a quality assurance program meeting the requirements of 24590-WTP-3PS-G000-T0001. Shipping lists are required to clearly identify the contents of each package.	ASME AG-1 has more detailed and specific requirements. Compliance with the quality assurance programs of the WTP is acceptable for this application.
SA-8300, *Drawings and Documentation*	Identifies minimum drawings and documentation to be provided.	The HVAC installation specification requires that this information be provided.	The chosen specification is equivalent to ASME AG-1.
SA-9000, Nameplates and Stamping			
SA-9000, *General*	Establishes nameplate and stamping/marking requirements for ductwork, supports, and air distribution accessories. Also, references AA-8200, AA-9130, and AA-9140 for additional requirements.	The HVAC installation specification requires stainless steel equipment tags for ductwork and ductwork accessories that meet the requirements of ASME AG-1. It is intended that the HVAC installation specification will include nameplate requirements for non-ASME AG-1 components.	The chosen specification is equivalent to ASME AG-1.

Table 6 Section IA, Instrumentation and Control Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
IA-1000, Introduction			
IA-1000, *Introduction*	Identifies the scope, purpose, and applicability of this section and defines terms used.	Not applicable to this evaluation.	Not applicable to this evaluation. Introductory information only.
IA-2000, Referenced Documents			
IA-2000, *Referenced Documents*	Identifies codes and standards referenced in this section.	Not applicable to this evaluation.	Not applicable to this evaluation. Reference information only.
IA-3000, Materials			
IA-3100, *Materials of Construction*	Defines allowable materials and material properties and composition requirements, primarily by requiring ASTM and ASME designated materials. Also, references AA-4000 for structural requirements for materials that are part of the pressure boundary.	WTP design specifications require that the materials of construction of each component be evaluated for suitability for the application and compatibility with the design environmental conditions.[1] In most cases specific materials are specified. In addition the specifications will list the process and environmental conditions for evaluation by the vendor.[2] Design maximum pressure will be specified for components which are part of the pressure boundary.[3]	The chosen specifications allow some materials that are not ASME AG-1 allowable materials and, in some cases, make no specific requirements other than the manufacturer's standard materials. Reliance on materials used in standard industrial grade instrumentation is acceptable for the environmental conditions of this application, as it is a non-corrosive, non-severe environment. It is also acceptable to rely on the equipment manufacturer to provide adequate structural analysis of instrumentation supports and panels for this application. See Section 5.1.3.14 for further justification.

[1] WTP Project Document 24590-WTP-GPG-K-014, Control System Design Process Guide, Rev B, Section 6.0.
[2] Typical Instrument Data Sheet.
[3] Typical Instrument Data Sheet.

Table 6 Section IA, Instrumentation and Control Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
IA-3200, *Non-permissible Materials*	Does not allow mercury, asbestos, or radiologically unstable fluorinated polymers to be used in the manufacture and installation of instrumentation and controls.	The design specifications prohibit mercury, asbestos, and any material chemically reactive with the gas stream.	The chosen specifications are equivalent to ASME AG-1. It is not expected that radiologically unstable fluorinated polymers will be affected by the low radiation fields produced by these systems.
IA-3300, *Restricted Materials*	Does not allow aluminum and zinc to be used in a corrosive environment, chlorine producing materials (PVC), or adjoining materials that may cause galvanic corrosion. All materials are required to be compatible with the operating environment.	The design specification does not allow metals in combination that may cause galvanic action and requires the materials to be compatible with the operating environment.	The chosen specifications are equivalent to ASME AG-1. No corrosive vapors are present in the C2 and C3 systems and chlorine producing materials are not of concern.
IA-3400, *Certification of Material*	Requires manufacturer's Certificate of Conformance with specified ASTM designations for panel box structural materials and tubing and Certificates of Compliance with the design specification for other materials.	The design specification does not address Certificates of Conformance regarding panel box or tubing materials. The design specifications require specific materials for panels and tubing. WTP Project representative will inspect all panels prior to shipment for compliance with specifications.[4]	ASME AG-1 has more stringent requirements. The design specifications require specific materials for panels and tubing. Assurance of conformance is achieved by inspection rather than by supplying documentation.
IA-4000, Design Requirements			
IA-4100, *General Design*	Establishes design requirements for instrument and control systems and component selection.	See details below.	See details below.

[4]WTP Project Document 24590-WTP-3PS-JXXE-T0002, Engineering Specification for C&I Enclosures, Panels, Cabinets, and Racks, Rev 1, section 6.2.4.2.

Table 6 Section IA, Instrumentation and Control Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	IA-4120, *Design Specification,* establishes minimum requirements for the design specification including design function, safety classification, performance requirements, ambient and process operating conditions, and design, fabrication, and selection requirements.	The design specification provides detailed requirements for instrumentation and control function, performance, ambient, and process operating conditions.	ASME AG-1 has more detailed requirements for electrical power transients and structural loading. It is acceptable to rely on commercial grade components with a proven operating history. These systems do not contain any custom installations that might create unusual structural loading.
	IA-4130, *Manufacturer's Documentation Requirements,* identifies documentation requirements, when required by the design specification.	The design specifications identify document submittals, as applicable to specific components.	The chosen specification is equivalent to ASME AG-1.
	IA-4140, *Clarification of Code Applicability,* establishes code precedence for pressure retaining parts between ASME AG-1 and ASME Section III, if implemented.	The design specifications do not implement ASME Section III.	Not applicable because ASME Section III is not implemented by the design specifications.
IA-4200, *Single Failure Criteria*	Requires redundant safety related components to meet the single failure requirements of ANSI/IEEE 379.	Does not apply.	Does not apply.
IA-4300, *Separation Criteria*	Establishes separation criteria for nuclear safety-related circuits, devices, and instrument sensing lines. Also provides general requirements to protect instrument circuits and sensing lines.	Requirements for safety related components do not apply. Instrument circuits are separated from power circuits.[5]	Requirements for safety related components do not apply. Bechtel standard installation practices for wiring and tubing provide protection from electromagnetic interference and damage from adjoining equipment.

[5] WTP Project Document 24590-WTP-DB-ENG-01-001, Basis of Design, Rev 0, Section 8.13.

Table 6 Section IA, Instrumentation and Control Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
IA-4400, *Qualification of Equipment*	Establishes requirements for qualification of equipment to defined normal operating conditions, harsh environments, and seismic loading. Requires documentation of qualification.	See details below.	See details below.
	IA-4410, *Normal Operating Conditions,* requires component specification, manufacture, and qualification to function under normal operating conditions. Establishes minimum information for definition of normal operating conditions.	The design specifications identify normal operating conditions for which the instrumentation and control components are to be functional, and the required accuracy under those conditions.[6]	Assurance that components will function and maintain their accuracy is ensured by specifying the requirements and review of vendor specifications. No extreme conditions requiring rigorous qualification testing of equipment will exist during normal system operation.
	IA-4420, *Environmental Qualification,* requires safety related components that are operated in a harsh environment to be qualified in accordance with IEEE 323.	Does not apply.	Does not apply.
	IA-4430, *Seismic Qualification,* requires safety related components and mountings to be seismically qualified in accordance with IEEE 344.	Does not apply.	Does not apply. If a seismic event damages components and mountings, process operations with the potential to produce radionuclide emissions shall cease within the associated area until the system is repaired.
	IA-4440, *Qualification Documentation,* requires documentation that demonstrates the qualification of components and the acceptance of qualification testing and results.	The design specifications do not require qualification documentation for non-safety related components.	See justification under section IA-4410.

[6] Typical Instrument Data Sheet.

Table 6 Section IA, Instrumentation and Control Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
IA-4500, *Panels*	IA-4510, *General,* establishes requirements for control panel design to support and protect nuclear safety related instrumentation and controls, and control panel instrumentation arrangement, in accordance with ISA-RP60.3, and control panel temperature limits.	The design specifications establish requirements for temperature control within the panel, accessibility requirements for maintenance, and instrument location for readability. Structural requirements are specified by reference to NEMA ICS 6.[7]	The design specifications do not require the rigor associated with the nuclear safety related control panel instrumentation requirements of ASME AG-1. If a failure occurs, process operations with the potential to produce radionuclide emissions shall cease within the associated area until the system is repaired.
	IA-4520, *Structures and Enclosure Materials*, establishes requirements for structural design of panels and supports, supports for incoming cables, wiring, and piping, lifting eyes, and fire safe materials.	The design specifications state that racks and panel frames shall be constructed and designed to support the weight of installed instruments. It also establishes anchoring requirements, specifies removable lifting eyes. Structural requirements are specified by reference to NEMA ICS 6.	ASME AG-1 has more specific and detailed requirements including structural analysis. It is acceptable for this application to rely on the equipment manufacturer to provide adequate structural analysis, materials, and lifting eyes or lugs for instrumentation supports and panels. WTP design procedures ensure that panels are designed to support and protect instruments, controls, wiring, and tubing.
	IA-4530, *Panel Wiring,* establishes requirements for wiring bundles, insulating grommets, cable marking, wire performance characteristics, terminal blocks, and grounding.	The design specification establishes similar requirements for panel wiring and all associated infrastructure.	The chosen specifications are equivalent to ASME AG-1.
	IA-4540, *Power Supply and Fuses*, requires that power supplies within control panels be provided with branch circuit overload protection and a means to disconnect incoming power. Requirements for fuse location and sizing are also specified.	The design specifications establish similar requirements for power supply circuit breakers and fuses.	The chosen specifications are equivalent to ASME AG-1.

[7] WTP Project Document 24590-WTP-3PS-JXXE-T0002, Engineering Specification for C&I Enclosures, Panels, Cabinets, and Racks, Rev 1, Section 2.2.

Table 6 Section IA, Instrumentation and Control Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	IA-4550, *Panel Piping, Tubing, Valves, and Fittings,* establishes requirements for protection from vibration (IA-4600), compliance with ANSI/ASME B31.1, tubing bends, maintenance accessibility, isolation valve support, bulkhead fittings, and instrument line identification tags.	The design specifications establish detailed requirements for tubing, tube fittings, instrument and manifold valves, and tagging, including compliance with B31.3.[8]	The design specification meets some ASME AG-1 requirements, but ASME AG-1 has additional requirements. These additional requirements are common industry practice, which provides adequate assurance that they, or similar requirements, will be implemented. Compliance with ASME B31.1 is excessive for these low pressure systems. See Section 5.1.3.14 for further justification.
	IA-4560, *Instrument Air-Supply Header Assembly,* establishes requirements for the instrument air system	These requirements are standard industry practice.	These requirements are standard industry practice.
	IA-4570, *Instrument Tags,* requires permanent nameplates on control panels to designate instrument function and tag number in accordance with ISA-RP60.6 or the owner's requirements.	The design specifications establish labeling requirements for panel mounted instruments.	The chosen specification is equivalent to ASME AG-1.

[8] WTP Project Document 24590-WTP-3PS-JXF0-T0001, Engineering Specification for Instrument Piping Material Classes, Rev 0, section 2.0.

Table 6 Section IA, Instrumentation and Control Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
IA-600, *Mounted Instruments and Sensors*	Instruments shall not be mounted in locations where their performance will be adversely affected by equipment vibration. Instrument chassis and attached capillary tubing shall be supported to meet the seismic requirements for their particular location.	The design specification for packaged systems requires the placement of instruments in vibration free areas. Seismic requirements are developed for all items and those requirements are implemented.	The chosen specification is equivalent to ASME AG-1.
IA-4700, *Interconnecting Wiring for Skid Mounted Components*	Interconnecting circuits between components mounted on a skid shall meet the requirements of the National Electric Code (NFPA 70), Sections 250-59 and 250-95, and paragraphs IA-4534 and IA-4535.	The WTP Project will comply with the National Electric Code.[9] See above for paragraphs IA-4534 AND 4535.	The chosen specifications are equivalent to ASME AG-1.
IA-4800, *Instrument Sensing Lines and Field-Installed Tubing*	IA-4810, *Pressure Boundary and Mechanical Design Requirements*, Establishes requirements for instrument sensing lines connected to systems designed to ASME Section III. Also, requires sensing lines not connected to ASME Section III systems to meet ANSI/ASME B31.1. Specifies that fittings are to be compatible with tubing and piping.	Materials for instrument sensing lines are required to comply with ANSI/ASME B31.3.[10] Fittings will be same material as tubing and piping, except 316SS fittings will be used with carbon steel piping.[11]	

[9] WTP Project Document 24590-WTP-DB-ENG-01-001, Basis of Design, Rev 0, Section 9.1.2.1.
[10] WTP Project Document 24590-WTP-3PS-JXF0-T0001, Engineering Specification for Instrument Piping Material Classes, Rev 0, Section 2.0.
[11] WTP Project Document 24590-WTP-3PS-JXF0-T0001, Engineering Specification for Instrument Piping Material Classes, Rev 0, Section 3.4.2.1.

Table 6 Section IA, Instrumentation and Control Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	IA-4820, *Tube Pitch and Condensate Trap* requires condensate or oil traps with valved drain legs to be provided at the low points of tubing, where the potential for condensation or oil migration exists.	The design specifications require the installation of drain and vent valves, where required.[12]	The chosen specification is equivalent to ASME AG-1.
	IA-4830, *Support System*, establishes requirements for sensing lines and tubing supports, including loading requirements. Safety-related sensing lines are to meet the requirements of Section AA-4000.	The design specifications require that tubing runs be properly supported in clamps or channels and be protected from mechanical loads.	ASME AG-1 has more specific and detailed requirements. The rigor associated with the requirements for nuclear safety-related circuits is not necessary for this application. Other requirements are common industry practice, which provides adequate assurance that they, or similar requirements, will be implemented. See Section 5.1.3.14 for further justification.
	IA-4840, *Root Valves and Isolation Valves*, establishes requirements for the location of root valves, isolation valves, and test connections.	Root valve location is in accordance with standard industry practice. Isolation and test valves are to be located to allow for in-place calibration.[13]	The chosen specification is equivalent to ASME AG-1.
IA- 4900, *Instrument Setpoints*	Establishes requirements for establishing nuclear-safety related setpoints using ISA S67.04.	Requirements for safety related components do not apply. Non-safety related setpoints are determined by the design team and documented in software functional specifications.	The project has implemented a program to establish and maintain setpoints.

[12] WTP Project Document 24590-WTP-GPG-K-014, Control System Design Process Guide, Rev B, Section 16.5.
[13] WTP Project Document 24590-WTP-GPG-K-014, Control System Design Process Guide, Rev B, Section 16.8.

Table 6 Section IA, Instrumentation and Control Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
IA-5000, Inspection and Testing			
IA-5100, *General*	Requires inspection and testing of instrumentation and control components to be in accordance with ANSI/IEEE 336 and Article AA-5000. AA-5000 establishes general requirements for calibration of M&TE (measuring and test equipment), visual inspections, inspections and testing of welded and bolted connections, conformance to fabrication tolerances, pressure and leak testing, performance and functional testing, and seismic testing. Also, requires written test procedures in accordance with AA-5120 and TA-3000 and test reports.		ASME AG-1 has more specific and detailed requirements, primarily through reference to ANSI/IEEE 336. IEEE-336 states that it is intended for safety systems equipment. Minimum project requirements for all components provide assurance that they are installed in accordance with design documents and are adequate for intended use. Manufacturer's inspection and testing procedures for industrial grade instrumentation provides additional assurance.
IA-5200, *Visual Inspection*	Establishes requirements for visual inspections, checklists, and procedures, primarily by reference to applicable sections of AA-5000.	The Construction Quality Control Program requires visual inspections to verify compliance with the specifications. Features include qualification of personnel, written procedures, and written test reports.	The chosen specification is equivalent to ASME AG-1
IA-5300, *Calibration and Testing*	Requires that the manufacturer's calibration and test instrumentation comply with Article TA-3000 and be traceable to NIST. Article TA-3000 requires establishment of a calibration program and specifies minimum accuracy for calibration and test instrumentation.	Calibration programs with standards traceable to NIST are general industry practice for controls and instrumentation manufacturers. The project's in-house Measuring and Test Equipment procedure provides similar requirements.	The chosen specification is equivalent to ASME AG-1.

Table 6 Section IA, Instrumentation and Control Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
	IA-5310, *Panel-Mounted Instruments*, requires test and calibration procedures in accordance with AA-5120 and TA-3000, Megger tests for control power wiring, continuity tests, and functional tests.	The project's in-house Measuring and Test Equipment procedure provides similar requirements for calibration and testing. The design specifications for panels and racks require burn-in, electrical continuity tests, and functional tests.[14]	The chosen specification is equivalent to ASME AG-1.
	IA-5320, *Local Mounted Instruments*, requires calibration according to the manufacturer's procedures and those procedures developed in accordance with AA-5120 and TA-3000.	The design specifications require that the manufacturer perform instrument inspection and testing.	The chosen specification is equivalent to ASME AG-1, except for the requirements for calibration and test procedures. Manufacturer's inspection and testing procedures for commercial grade instrumentation are adequate for this application. See Section 5.1.3.14 for further justification.
	IA-5330, *Pressure Testing of Tubing and Sensing Lines*, requires pressure testing of sensing lines in accordance with ANSI/ASME B31.1 or ASME Section III, as applicable, and pressure testing of pneumatic control circuits.	A written pressure testing procedure has been developed, with specific tests to be in accordance with design specifications.[15]	ASME AG-1 has more stringent requirements. Pressure testing for sensing lines will generally be identical to that of the associated piping or ductwork. Requirements for pneumatic control circuits are not applicable.

[14] WTP Project Document 24590-WTP-3PS-JXXE-T0002, Engineering Specification for C&I Enclosures, Panels, Cabinets, and Racks, rev 1, section 6.2.
[15] WTP Project Document 24590-WTP-GPP-CON-3504, Pressure Testing, Rev 1, Section 3.3.

Table 6 Section IA, Instrumentation and Control Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
IA-6000, Panel Fabrication and Assembly (References Section AA-6000)			
AA-6100, *General*	Identifies materials requirements by reference to IA-3000 and requires quality control procedures for all fabrication, installation and repair processes by reference to AA-8000 or AA-6300.	See sections IA-3000, IA-8000, and AA-6300 of this table.	See sections IA-3000, IA-8000, and AA-6300 of this table.
AA-6200, *Fabrication Processes*	Establishes requirements for cutting, forming, bending, forming tolerances, fitting and aligning for bolting or welding, welded joints, and mechanical joints.	Panels are to be fabricated to NEMA standards.[16] Panel fabricator is required to submit quality assurance manual and procedures for review and concurrence.[17]	ASME AG-1 provides much more specific and detailed fabrication requirements. NEMA standards plus typical manufacturer's standards and tolerances for fabrication processes for control panels are acceptable for this application and the use thereof will be verified. See Section 5.1.3.14 for further justification.
AA-6300, *Welding Requirements*	Establishes very detailed and specific requirements for welding including workmanship, inspection, testing, non-destructive testing, inspector qualifications, and repairs. Identifies several ANSI/AWS codes and ASME Code, Section IX to be complied with.	Panel fabricator is required to submit quality assurance manual and procedures for review and concurrence.	ASME AG-1 provides much more specific and detailed welding requirements. Typical manufacturers standards and tolerances for welding processes for control panels are acceptable for this application. See Section 5.1.3.14 for further justification.
AA-6400, *Brazing*	Establishes similar requirements as AA-6300.	Panel fabricator is required to submit quality assurance manual and procedures for review and concurrence.	ASME AG-1 provides much more specific and detailed brazing requirements. Typical manufacturers standards and tolerances for brazing processes for control panels are acceptable for this application. See Section 5.1.3.14 for further justification.

[16] WTP Project Document 24590-WTP-3PS-JXXE-T0002, Engineering Specification for C&I Enclosures, Panels, Cabinets, and Racks, Rev 1, section 3.1.1.
[17] WTP Project Document 24590-WTP-3PS-JXXE-T0002, Engineering Specification for C&I Enclosures, Panels, Cabinets, and Racks, Rev 1, section 10.1.2.

Table 6 Section IA, Instrumentation and Control Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
AA-6500, *Cleaning and Coating*	Establishes coating requirements using a graded approach using service levels based on the coating's and the equipment's relation to nuclear safety.	The design specifications require painting in accordance with the instrument and control panel manufacturer's procedures.	The chosen specification is equivalent to ASME AG-1, because Service level III coatings are only required to meet the equipment manufacturer's specifications.
AA-6600, *Installation Requirements*	Establishes requirements for handling, rigging, field assembly, installation procedures, and temporary field attachments.	The design specification requires lifting eyes or lugs for control panels.	ASME AG-1has detailed and specific requirements for handling and rigging and for field assembly. WTP rigging procedures will be complied with and contain adequate rigor for this application. Installation in accordance with the manufacturer's instructions is also acceptable for this application. See Section 5.1.3.1 for further justification.
IA-6110, *Materials*	Requires materials to conform to IA-3000 and plate material to meet the design structural requirements of IA-4000 and the design specification. Repair of materials is required to be in accordance with AA-6123.	See sections IA-3000, IA-4000, and AA-6100 of this table.	See sections IA-3000, IA-4000, and AA-6100 of this table.
IA-6200, *Fabrication Process*	Establishes requirements for cutting, forming, bending, thermal cutting, and welding by reference to the applicable section of AA-6000. Also, establishes additional limits on warping or distortion due to fabrication and panel deflection due to instrument weight.	See sections AA-6200 and AA-6300 of this table.	See sections AA-6200 and AA-6300 of this table. The design specification addresses neither warping nor distortion due to fabrication nor panel deflection due to instrument weight. Reliance on manufacturer's fabrication procedures for commercial grade instrumentation is acceptable for this application. See Section 5.1.3.14 for further justification.

Table 6 Section IA, Instrumentation and Control Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
Remaining subsections of IA-6000.	Establishes requirements for fitting, aligning, mechanical joints, welding, brazing, cleaning, coating, handling, and rigging by reference to applicable sections of AA-6000. Requires materials identification in accordance with IA-3400.	See applicable subsections evaluating AA-6000 and IA-3400 of this table.	See applicable subsections evaluating AA-6000 and IA-3400 of this table.
IA-7000, Packaging, Shipping, Receiving, Storage, and Handling (References Section AA-7000)			
AA-7000 and IA-7000	Establishes general requirements and responsibilities for packaging, shipping, receiving, storage and handling, primarily by supplementing the provisions of ANSI/ASME NQA-2, Part 2.2 (now contained in ANSI/ASME NQA-1).	The general specification for packaging, shipping, handling, and storage (24590-WTP-3PS-G000-T0003) is modeled after ANSI/ASME NQA-1, Subpart 2.2, Level B classification, with requirements for the same activities identified with the exception of receiving requirements. Receiving inspection requirements include intact packaging in accordance with specification.	The general specification for packaging, shipping, handling, and storage establishes similar requirements as ASME AG-1 and ANSI/ASME NQA-1, Subpart 2.2, often by paraphrasing these codes, but with less detail. The level of detail of this specification provides similar protection for the instrumentation, but with somewhat less rigor, and is adequate for this application. See Section 5.1.3.1 for further justification.
IA-8000, Quality Assurance Requirements (References Section AA-8000)			
AA-8000, *Quality Assurance*	Establishes general requirements and responsibilities for quality assurance primarily by supplementing the provisions of ANSI/ASME NQA-1.	The design specifications reference the general specification for supplier quality assurance program requirements (24590-WTP-3PS-G000-T0001), which establishes general contractual requirements and allows for close review by the WTP. The quality assurance data sheets identify specific quality assurance program requirements for each component.	ASME AG-1 has more detailed and specific requirements, including compliance with ANSI/ASME NQA-1. The quality assurance data sheets lists attributes that are identical to the chapters of ANSI/ASME NQA-1, but does not include detailed requirements associated with each attribute. Compliance with the quality assurance programs of the WTP and the instrument manufacturer is acceptable for this application. See Section 5.1.3.14 for further justification.

Table 6 Section IA, Instrumentation and Control Detailed Evaluation

ASME AG-1 Section	ASME AG-1 Requirement	Chosen Standard or Specification Requirement (See Table 2)	Difference Between ASME AG-1 and the Chosen Standard or Specification
IA-8200, *Test Reports and Data*	Identifies test reports and data to be maintained in records, including records and procedures required by ANSI/ASME B31.1and ASME Section III and documentation identified in IA-4130 and IA-4440.	It is intended that records and supplier submittals will be maintained in records.	The chosen specification is equivalent to ASME AG-1 to the extent that the documentation of IA-4130 and IA-4440 is obtained. Compliance with ANSI/ASME B31.1and ASME Section III is not applicable.
IA-9000, Nameplates			
IA-9100, *General*	Permanent types of nameplates shall be designed, manufactured, and installed in accordance with the requirements of Article AA-9000.	The design specifications establish similar requirements for instrument nameplates.	The chosen specifications are equivalent to ASME AG-1.
IA-9200, *Requirements*	Each instrument and control device shall be provided with a permanent type of Manufacturer's nameplate.	The design specification requires nameplates for each instrument.	The chosen specifications are equivalent to ASME AG-1.
IA-9300, *Nameplates*	Requires nameplates to be made of a non-corrosive material and sized to accommodate all pertinent information. Identifies information to be included on nameplates.	The design specifications establish similar requirements for instrument nameplates.	The chosen specifications are equivalent to ASME AG-1.

Table 7 ALARA Factor Analysis

		Negative Factor for Protective Measure?		Positive Factor for Protective Measure?	
1	Does the cost of the protective measure exceed the cost of the activity?	Yes		No	X
2	Will individual doses for the activity be maintained below 10 millirem (occupational) or 1 millirem (public) even without the protective measure?	Yes	X	No	
3	Does the protective measure increase the risk of occupational incidents or accidents?	Yes		No	X
4	Does the protective measure decrease the risk of environmental incidents or accidents?	No	X	Yes	
5	Does the protective measure ultimately result in collective dose savings during the post operational phase of operations?	No	X	Yes	
6	Does the protective measure ultimately result in cost savings during the post operational phase of operations?	No	X	Yes	
7	Could the protective measure increase future occupational or public dose (other than via decontamination and decommissioning)?	Yes		No	X
8	Does the protective measure increase the flexibility of personnel or other resources?	No	X	Yes	
9	Does the protective measure optimize the balance between occupational and public exposures?	No	X	Yes	
10	Does the protective measure result in improved relations with outside organizations?	No	X	Yes	
11	Does the protective measure have adverse effects on employees (such as discomfort or strain)?	Yes		No	X
12	Does the protective measure have adverse effects on other activities?	Yes	X	No	
13	Does the protective measure have an extreme adverse effect on the activity schedule?	Yes		No	X
14	Does the protective measure have any favorable environmental impacts other than public dose reduction?	No	X	Yes	

A predominance of checks in the left-hand column above indicates the protective measure is not reasonable and not recommended. Conversely, a predominance of checks in the right-hand column indicates that the protective measure is reasonable and recommended.