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# US DEPARTMENT OF ENERGY OFFICE OF RIVER PROTECTION (ORP) SUBMITTAL OF COMPLETED STACK SAMPLING SYSTEM INSPECTION CHECKLIST AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) N13.1-1999 SAMPLING AND MONITORING RELEASES OF AIRBORNE RADIOACTIVE SUBSTANCES FROM THE STACKS AND DUCTS OF NUCLEAR FACILITIES FOR THE AN AND AW DOUBLE SHELL TANK FARM TANK EXHAUSTERS STACKS 296-A-44 296-A-45 296-A-46 AND 296-A-47 EMISSION UNITS 735 736 855 AND 856 RESPECTIVELY

SECTION 3 OF 4

HNF-EP-0835
Revision 18

# Statement of Work for Services Provided by the Waste Sampling and Characterization Facility for the Effluent Monitoring Program during Calendar Year 2012

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-09RL14728

MSA

**P.O. Box 650**
**Richland, Washington 99352**

HNF-EP-0835
Revision 18

# Statement of Work for Services Provided by the Waste Sampling and Characterization Facility for the Effluent Monitoring Program during Calendar Year 2012

Document Type: DD Program/Project: EM


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Mission Support Alliance



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## APPENDICES



## TABLES

## ACRONYMS

| | |
|---|---|
| ABCASH | Automated Bar Coding of All Samples at Hanford 2 |
| CACN | Cost Account Charge Number |
| CAM | continuous air monitor |
| CFR | Code of Federal Regulations |
| CHPRC | CH2M HILL Plateau Remediation Company |
| CY | calendar year |
| DOE | U.S. Department of Energy |
| EDP code | Electronic Data Processing code |
| EI | Environmental Integration |
| EM | Effluent Monitoring Program |
| EPA | U.S. Environmental Protection Agency |
| ES | Environmental Surveillance [group] |
| GEA | gamma-energy analysis |
| HEPA | high-efficiency particulate air [in relation to a filter] |
| HSER | Hanford Site Environmental Report |
| KBCP | K Basin Closure Project |
| LCS | laboratory control sample |
| MAPEP | (U.S. DOE) Mixed Analyte Performance Evaluation Program |
| MDA | minimum detectable activity |
| MDC | minimum detectable concentration |
| MASF | Maintenance and Storage Facility |
| MSA | Mission Support Alliance, LLC |
| NESHAP | National Emission Standards for Hazardous Air Pollutants |
| PFP | Plutonium Finishing Plant |
| PNNL | Pacific Northwest National Laboratory |
| POC | point of contact |
| QAPP | quality assurance program plan |
| QA | quality assurance |
| QC | quality control |
| SOW | statement of work |
| WAC | Washington Administrative Code |
| WCH | Washington Closure Hanford, LLC |
| WRPS | Washington River Protection Solutions, LLC |
| WSCF | Waste Sampling and Characterization Facility |

## DEFINITION OF TERMS

Accuracy: The degree of agreement of a measurement with a true or known value.

Completeness: A measure of the amount of valid data obtained compared to the amount expected under normal conditions.

Precision: A measure of the agreement among individual measurements of the same parameters under similar conditions.

Turnaround time: Elapsed time, in days, starting at the laboratory with the receipt of samples to be analyzed, along with all sampling information necessary for complete analysis, and ending when the results, generally expressed as a concentration, are electronically accessible.

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# STATEMENT OF WORK PROVIDED BY THE WASTE SAMPLING AND CHARACTERIZATION FACILITY FOR THE EFFLUENT MONITORING PROGRAM DURING CALENDAR YEAR 2012

## 1.0 SCOPE OF SERVICES

This Mission Support Alliance, LLC (MSA) internal document represents a "statement of work" (SOW) in that it defines analytical services the Waste Sampling and Characterization Facility (WSCF) will provide the Effluent Monitoring (EM) Program throughout calendar year (CY) 2012. MSA Environmental Integration (EI) prepares and issues this annual document.

EI is responsible for managing data from the monitoring of radioactive emissions that contain or may contain radioactive and hazardous materials. EI serves numerous projects and facilities, some of which are managed by other contractors such as CH2M HILL Plateau Remediation Company (CHPRC), Washington Closure Hanford, LLC (WCH), and Washington River Protection Solutions, LLC (WRPS). Monitoring data are collected and evaluated to determine their compliance status with applicable federal and state regulations and permits. The data are eventually published in various reports, available to the public.

Appendix A identifies samples and respective analyses that EI, with the assistance of personnel from projects and facilities, has estimated will be collected in CY 2012 for WSCF to analyze. As conditions in the field change, the actual numbers of samples and types of analyses may vary from the estimates. Analysis of effluent samples (i.e., samples of air emissions to the environment) is required using standard laboratory procedures in accordance with requirements cited in Section 3.1. Should significant (as agreed upon by WSCF management and EI) changes to this SOW be necessary, WSCF and/or EI may amend it at any time with a change request notice that is acceptable to EI; otherwise changes and direction EI provides WSCF that are not considered significant may be effected via phone call, e-mail, etc.

## 2.0 REGULATORY REPORTING REQUIREMENTS

For EM to fulfill its data review and regulatory reporting commitments, WSCF must meet the due dates specified in the SOW, and in particular the analysis dates of year-end samples. The analytical data WSCF is to provide by those dates are essential for maintaining compliance with effluent reporting deadlines mandated by federal and state regulatory agencies and the U.S. Department of Energy (DOE). WSCF must inform the EI point of contact (POC) of changes in this document to technical criteria and due dates; depending on the nature of the changes, EI may seek approval authority for them. The key reports in which EM data are published are described in the remainder of this section.

### 2.1 RADIONUCLIDE AIR EMISSIONS REPORT FOR THE CLEAN AIR ACT

This report documents radionuclide air emissions from the Hanford Site and the resulting highest effective dose equivalent to a member of the public. The report complies with the annual air emissions reporting requirements in 40 CFR 61, "National Emissions Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," and in WAC 246-247, "Radiation Protection — Air Emissions."

## 2.2 HANFORD SITE ENVIRONMENTAL REPORT

Starting with the CY 2011 report, to be published in 2012, the Environmental Surveillance (ES) group of MSA's Public Safety & Resource Protection organization will annually compile, edit, and publish the *Hanford Site Environmental Report* (HSER) for DOE in compliance with DOE Manual 231.1-1A, *Environment, Safety and Health Reporting Manual,* and with DOE Order 450.1A, *Environmental Protection Program*. EI authors the effluent chapter of this report.

## 2.3 ENVIRONMENTAL RELEASES REPORT

The annual *Environmental Releases Report* fulfills a deliverable requirement in the Mission Support Contract DE-AC06-09RL14728. Within the contract the report is identified as deliverable CD1029 under Section C, Paragraph C.2.1.7, *Environmental Regulatory Management.* The report summarizes radioactive and nonradioactive airborne and liquid effluent releases to the environment from facilities managed by CHPRC, MSA, WCH, and WRPS. It also provides more detail on releases to the environment than are presented in the HSER, described in Section 2.2.

# 3.0 WASTE SAMPLING AND CHARACTERIZATION FACILITY SERVICES AND DATA QUALITY OBJECTIVES

WSCF shall provide the following analytical services when analyzing low-level emissions samples.

## 3.1 SAMPLING AND ANALYSIS REQUIREMENTS

Analytical services shall be in conformance with the analysis requirements listed in Table 1. Supporting services are defined in Table 2. Analyses shall be performed in accordance with applicable requirements in Appendix B; HNF-SD-CP-QAPP-017, *Waste Sampling and Characterization Facility Quality Assurance Program Plan;* MSC-23333, *Environmental Quality Assurance Program Plan;* and with procedures cited in Section 3.4. As much as is feasible, routine analytical results shall be reported via the Automated Bar Coding of All Samples at Hanford 2 (ABCASH) database system. Results shall be expressed in the same units as for the minimum detectable concentrations (MDCs) shown in Table 1.

The quantity of EM samples projected for WSCF to receive in CY 2012, along with their respective projected analyses, are shown in Table A-1. Table A-1 mainly lists particulate air samples, many of which first require gross alpha and gross beta analysis. Subsequent to gross alpha-beta analysis, many of those samples will be composited for specific isotopic analysis. No analysis shall be conducted on these samples until seven (7) days have elapsed from the time of sample collection in the field, unless otherwise directed by the MSA EI POC. This 7-day delay allows for the decay of short-lived naturally occurring radionuclides, such as radon. Notwithstanding the need for this delay, Project and Facility personnel with responsibility for effluent monitoring (i.e., principally stack emissions monitoring) are strongly encouraged to ensure that collected record samples are delivered to WSCF as soon as practical rather than waiting for the 7-day decay period to elapse; WSCF analytical personnel will ensure that the 7 days have elapsed before performing any analyses.

In Table 1, the term "turn-around time" is found. Turn-around time refers to a discrete period spanning when a sample comes into the custody of WSCF, is analyzed, and the results provided to the customer. More precisely, turnaround time is defined as follows:

> The start of a turn-around time begins exactly when custody of a sample is assumed by WSCF, and the end is when all of the analytical data requested for that sample are loaded into ABCASH and

accessible to the EI POC. Thirty-one (31) days is the turn-around time for gross alpha and gross beta counts of samples requiring such counts as denoted in Table A-1. Ninety (90) days is the turnaround time for isotopic analyses of samples requiring such analyses as denoted in the tables.

In addition, composite sample analyses must be completed by the due dates in Sections 3.2 and 3.7.

## 3.2 DATES BY WHEN ANALYSIS RESULTS MUST BE IN ABCASH

Dates identified in Sections 3.2.1 and 3.2.2 are when analytical results of specified samples need to be available in ABCASH. For "straggler" year-end samples arriving at WSCF after January 15, 2012, WSCF shall attempt to perform the required analyses by the applicable due dates, provided preparation of an associated composite sample has not already begun. WSCF is not responsible should those due dates be missed if a late sample is at fault. Occasionally, a still-missing or late-delivered year-end sample may have to be excluded from a composite sample because fixed annual reporting deadlines could be jeopardized if analyses are further delayed from waiting overly long for overdue samples. WSCF shall inform EI of any samples identified as possibly missing for year-end analyses or perhaps need to be excluded from those analyses before EI makes a final decision to proceed with the analyses.

When selecting samples for compositing, it is the usual practice of WSCF to choose samples with off-dates within the respective compositing period (typically a quarter or half-year in length) and not crossing beyond it. The exception is for "end-of-the-year" stack samples. As an example, for an end-of-the-year composite sample consisting of numerous biweekly or monthly samples, an individual sample with an on-date in, for instance, mid-December and an off-date of January 6 in the following year could be readily included. It's also acceptable not to include in the last composite sample of the year those samples that have on-dates close to the end of December, for instance December 22 or later. Should WSCF have questions regarding the selection of samples to composite, conferring with the EI POC is recommended.

### 3.2.1 Year-End Samples from Calendar Year 2011

**March 15, 2012**, is the date for making available in ABCASH the analytical results for all air emission samples listed in Table A-1 that have sampling on-dates within 2011 and are delivered to WSCF by January 15, 2012. Year-end samples typically have on-dates within the fourth quarter, but some may have earlier on-dates. It's not unusual that a handful of year-end samples from CY 2011 will have off-dates in the first half of January 2012. For purposes of reporting CY 2011 sample results, WSCF should try to count those samples and, if possible and as applicable, incorporate them into respective composite samples; if questions arise on the handling of these types of samples, contact EI for assistance.

### 3.2.2 Due Dates for Results from Semiannual Isotopic Sample Analyses for Calendar Year 2012 Reporting

All analytical results (i.e., gross alpha, gross beta, gamma-energy analysis [GEA], and isotopic) for stack air emission samples listed in Table A-1 collected for CY 2012 reporting need to be available in ABCASH by these dates, if not sooner depending on turnaround times set in Table 1:

**FIRST SEMIANNUAL ISOTOPIC RESULTS ................................September 30, 2012**

**SECOND SEMIANNUAL ISOTOPIC RESULTS ................................ March 15, 2013**

## 3.3 LABORATORY PROCEDURES

WSCF shall use laboratory analytical procedures cited in Appendix B and WSCF analytical procedures, except for newly developed procedures constrained by the criteria cited below, alongside bullet four. These procedures must be and/or are:

- In compliance with U.S. Environmental Protection Agency (EPA) Method 114, Section 4.0, "Quality Assurance Methods," as found in 40 CFR 61, Appendix B, "Test Methods" (specifically, 4.4 and 4.5).
- In conformance with Chapter 6.0 of DOE-EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance.*
- Appropriate to the sample medium and size as well as the analysis criteria listed in Table 1.
- Newly developed for special needs, such as destructive analysis of high-efficiency particulate air (HEPA) filters. Before WSCF uses a new special-needs procedure within the scope of this document, the analysis requirements and methods must be agreed upon by all parties involved, including EI. Note: The organization requiring a new procedure shall be responsible for development costs.

## 3.4 QUALITY CONTROL

WSCF shall assure the integrity and validity of analytical test results through implementation of its own quality control (QC) program, as defined in the current version of HNF-SD-CP-QAPP-017. Standard methods shall be used whenever possible. New methods that are developed or adapted shall be completely and successfully tested and documented.

WSCF shall perform calibration and quality control checks using methods consistent with MSC-SD-CP-QAPP-017. Upon request, WSCF shall provide data to EI to demonstrate adequate quality control, including availability of precision and accuracy reports and the percent of completeness of samples acceptably analyzed. Auditable QC test results shall be provided within two weeks of having received a request for specific records, without additional charges.

WSCF shall participate in the Mixed Analyte Performance Evaluation Program (MAPEP), managed by DOE in Idaho Falls, and provide the results (electronic format [e.g., pdf] is preferred) to EI; interpretation of results shall also be provided when requested by EI. Participation is required by a memorandum from DOE Headquarters ("Participation in the Mixed Analyte Performance Evaluation Program" [Grumbly 1994]).

WSCF agrees to fulfill EI requests for copies of external and internal assessments, audits, and inspections of WSCF analytical activities, management and quality systems, records, etc.

### 3.4.1 Air Sample Analyses

WSCF shall perform QC tests for accuracy and precision, with all test results documented. Analytical problems identified through analysis of QC samples shall be promptly corrected. Upon request from EI, QC test data reports shall be made available for review.

The requirements for precision, accuracy, and completeness are as follows:

- Precision requirements for radioisotopic measurements shall be met when samples fall within a relative percent difference of $\pm 30\%$ for activities $\geq 5$ times the minimum detectable activity (MDA) values in Table 1 or when the analytical uncertainty is $\leq 20\%$.

- Accuracy requirements shall be met when 95% of the results from performance-check standards of the counting instruments fall within ±25%.

- Completeness requirements shall be met when WSCF produces a minimum of 90% reportable data for requested analyses on all submitted EEM samples.

Splitting stack air sample filters is not feasible for making analytical replicates. The extremely low gross alpha and gross beta activities typically found on record stack sample filters result in high counting errors, which for purposes of precision would render large variances in filter recounts. However, split samples can be produced by collecting two essentially identical ambient air sample filters for sampling precision. This is ordinarily done by the near-facility monitoring function within ES providing WSCF sample filters collected from two side-by-side ambient air samplers operating identically throughout a sample collection period, usually two weeks in length for each set of two "matching" samples.

- The requirements of this section also apply to air sample analyses that involve radiochemical separations. The data quality objectives for air samples requiring radiochemical separations shall be met when the objectives specified above in this section, 3.4.1, are met.

## 3.5 RETENTION OF AND ACCESS TO RAW DATA AND RESULTS

WSCF shall retain all raw data and analytical results for a minimum of five years, as specified by 40 CFR 61 Subpart H and in WAC 246-247. EI shall have access to all available raw data and results related to EM samples. Upon request, WSCF shall provide analysis printouts.

Records of samples and analyses identified in this document that are generated and retained at WSCF shall be available for inspection within 24 hours of a request, typically made by a regulatory agency, assessor, or auditor.

## 3.6 ANALYTICAL ERROR AND MINIMUM DETECTABLE CONCENTRATIONS

WSCF shall provide the overall analytical error associated with each analytical result. Total analytical error shall be calculated at the 95%-confidence interval.

For samples of at least nominal volume as specified in Table 1, WSCF will not exceed the corresponding MDC values in that table. However, WSCF will not be accountable for maintaining MDC limits when analyzing samples of less-than-nominal volumes. When sample sizes are less than the prescribed nominal volumes, EI may authorize WSCF to adjust the MDCs for such samples by multiplying the specified MDC by the ratio of the actual sample size and the respective nominal sample size.

## 3.7 ROUTINE ELECTRONIC TRANSFER OF ANALYTICAL DATA

WSCF shall make analytical results available to EI via ABCASH; case-by-case exceptions may be allowed to provide data via means other than ABCASH. As previously stated, all **CY 2011** air emissions data shall be in ABCASH by **March 15, 2012,** and for all **CY 2012** air emissions data, **March 15, 2013.**

## 3.8 ARCHIVING OF SAMPLES

Air emissions samples listed in Table A-1 are identified by an Electronic Data Processing codes (EDP), which are synonymous with "location codes." An EDP code consist of one letter and three numerals as shown in this example: Z810. The EI POC shall select for WSCF air emissions samples on which gross alpha and gross beta counts shall be performed. Following that, the samples shall be either archived or combined with other air emissions samples selected by the EI POC to form composite samples to be further analyzed in accordance with the isotopic analysis requirements in Table A-1.

All **CY 2012** air samples listed in Table A-1 shall be archived by WSCF until **December 31, 2013**, after which WSCF may dispose of them but only after gaining approval from EI. The same archiving schedule applies to **CY 2012** stack continuous air monitor (CAM) samples, which serve as backup samples to stack record samples. Stack CAM samples should arrive at WSCF in envelopes stamped "Archive Only" and identified by EDP codes not listed in Table A-1. All **CY 2011** air samples listed in Tables A-1 and A-3 of HNF-EP-0835, Rev. 17, *Statement of Work for Services Provided by the Waste Sampling and Characterization Facility for the Effluent and Environmental Monitoring Program during Calendar Year 2011,* and stack CAM samples from **CY 2011** shall be archived at WSCF until **December 31, 2012**, after which WSCF may dispose of them but only after receiving approval from the EI POC.

All **CY 2011** samples listed in Tables A-2, A-4, and A-5 of HNF-EP-0835, Rev. 17, that have not been returned to the customer or shipper may be disposed of after **October 1, 2012**, but only after obtaining permission from the EI POC.

### 3.9 ANALYTICAL SERVICE COSTS

WSCF will provide the EI POC access to monthly billing statements that document charges for analytical services provided to EM.

Table 1. Air Emissions Sample Analysis Criteria for the Waste Sampling and Characterization Facility.

| Nominal Sample Volume | Type of Analysis | MDA,[a] µCi | MDC,[b] µCi/ml | Turn-around Time (Days) |
|---|---|---|---|---|
| 20,000 $ft^3$ (5.7 E+02 $m^3$) | gross α[c] | 1.1 E–07 | 2.0 E–16 | 31 |
| | gross ß[c] | 1.1 E–06 | 1.9 E–15 | 31 |
| | Ag zeolite[d] | 1.9 E–05 (as $^{106}$Ru) | 3.4 E–14 (as $^{106}$Ru) | 90 |
| 262,000 $ft^3$ (7.4 E+03 $m^3$) | $^{90}$Sr | 1.4 E–05 | 1.9 E–15 | 90 |
| | gamma-energy analysis[e] | 1.4 E–05 (as $^{137}$Cs) | 1.9 E–15 (as $^{137}$Cs) | 90 |
| | isotopic U (i.e., $^{234}$U, $^{235}$U, $^{238}$U) | 5.3 E–06 | 7.1 E–16 | 90 |
| | isotopic Pu (i.e., $^{238}$Pu, $^{239,240}$Pu) | 1.5 E–06 | 2.0 E–16 | 90 |
| | $^{241}$Pu | 7.4 E–05 | 1.0 E–14 | 90 |
| | $^{241}$Am | 1.4 E–06 | 1.9 E–16 | 90 |
| | gross α composite | 1.5 E–06 | 2.0 E–16 | 90 |
| | gross β composite | 1.4 E–05 | 1.9 E–15 | 90 |
| 22 $ft^3$ (6.2 E–01 $m^3$) | tritium ($^3$H) | 9.3 E–05 | 1.5 E–10 | 90 |

MDA = minimum detectable activity; MDC = minimum detectable concentration.

[a] Actual MDAs derived from sample analyses shall be as low as reasonably achievable and shall not exceed the values specified in Table 1 provided the sample is of nominal volume or greater. The target MDAs in Table 1 are calculated by multiplying the MDCs in Table 1 by the nominal sample volumes, also listed in the table.

[b] Actual MDCs derived from sample analysis shall be as low as reasonably attainable and shall not exceed the values specified in the Table 1 provided the sample is of nominal volume or greater. The target MDCs in Table 1 are 10% of the concentration values in Table 2 of 40 CFR 61, Appendix E.

[c] When appropriate, gross alpha and gross beta emission release data are used in dose calculations to substitute for the presumed presence of the generally most abundant respective alpha- and beta-emitting radionuclides having the highest dose factors, which for alpha-emitters has usually been $^{239/240}$Pu, but occasionally $^{241}$Am, and for beta-emitters, $^{90}$Sr, but occasionally $^{137}$Cs.

[d] Silver-zeolite analysis at a minimum shall be designed to identify $^{106}$Ru, $^{125}$Sb, and $^{129}$I.

[e] All positive gamma-energy analysis (GEA) results shall be reported, with the exception of short-lived progeny of $^{222}$Rn and $^{220}$Rn. At a minimum, GEA shall be designed to identify peaks, if present, of $^{60}$Co, $^{106}$Ru, $^{125}$Sb, $^{134}$Cs, $^{137}$Cs, $^{152}$Eu, $^{154}$Eu, $^{155}$Eu, and $^{231}$Pa.

Table 2. Additional Services the Waste Sampling and Characterization Facility Provides the Effluent Monitoring Program.

| **Sample Category** | **Additional Services Provided** |
|---|---|
| Air Samples | Entering air emissions sample collection data into ABCASH for facilities not equipped with bar-coding equipment. |
| | Sorting air emissions samples into two groups: (1) samples to be analyzed and (2) samples to be archived. |
| | Storing air emissions samples that require composite analyses. |
| | Storing samples from minor emission units that require periodic analysis such as on a quarterly basis. |
| | Archiving for prescribed periods air emissions samples that do not get analyzed. |
| | Notifying the MSA Environmental Integration point of contact (EI POC) of problematic sampling information. |
| | Assembly and preparation of samples for composite analysis. |
| | Preparation and analysis of QC samples (e.g., control standards, blanks, duplicates, matrix spikes, etc.). |
| | Downloading all air sample results into ABCASH. |
| | Disposal of samples and wastes from chemical processing. |
| Miscellaneous | Support the effluent monitoring program when it is audited, assessed, or inspected on areas related to WSCF. |
| | Participate in prescribed laboratory intercomparison programs. |
| | Provide laboratory intercomparison results to MSA EI POC. |
| | Develop and implement new analytical methods or modify existing methods when indicated by circumstances such as regulator concerns or improvements in laboratory techniques or changing environmental and/or operational conditions that affect routine samples. Note: Development costs of new procedures requested by Facilities or Projects are the responsibility of the requestor. |
| | Perform rush and emergency sample analyses. |

## 4.0 REFERENCES

Note: All referenced documents are for the most current revision.

40 CFR 61, "National Emissions Standards for Hazardous Air Pollutants," Title 40, *Code of Federal Regulations,* Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities."

40 CFR 61, "National Emissions Standards for Hazardous Air Pollutants," Title 40, *Code of Federal Regulations,* Part 61, Appendix B, "Test Methods."

DOE Manual 231.1-1A, *Environment, Safety and Health Reporting Manual,* U.S. Department of Energy, Washington, D.C.

DOE Order 435.1, *Radioactive Waste Management,* U.S. Department of Energy, Washington, D.C.

DOE Order 450.1A, *Environmental Protection Program,* U.S. Department of Energy, Washington, D.C.

DOE Order 5400.5, *Radiation Protection of the Public and the Environment,* U.S. Department of Energy, Washington, D.C.

DOE/EH-0173T, 1991, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance,* Assistant Secretary for Environment, Safety and Health, U.S. Department of Energy, Washington D.C.

Grumbly, Thomas P, 1994, Memorandum: "Participation in the Mixed Analyte Performance Evaluation Program," U.S. Department of Energy, Washington, D.C.

HNF-EP-0835, Rev. 17, *Statement of Work for Services Provided by the Waste Sampling and Characterization Facility for the Effluent and Environmental Monitoring Program during Calendar Year 2011,* Mission Support Alliance, LLC, Richland, Washington.

MSC-23333, *Environmental Quality Assurance Program Plan,* Mission Support Alliance, LLC, Richland, Washington.

MSC-SD-CP-QAPP-017, *Waste Sampling and Characterization Facility Quality Assurance Program Plan,* Fluor Hanford, Inc., Richland, Washington.

PNNL-20548, *Hanford Site Environmental Report for Calendar Year 2010,* Pacific Northwest National Laboratory, Richland, Washington.

WAC 246-247, "Radiation Protection – Air Emissions," *Washington Administrative Code,* Olympia, Washington.

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# APPENDIX A

# ANALYTICAL REQUIREMENTS AND PROCESSES FOR EFFLUENT MONITORING PROGRAM AIR EMISSIONS SAMPLES DURING CALENDAR YEAR 2012

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## EXPLANATORY NOTES FOR TABLES A-1

**Air Emissions Collection Period per Sample**

A = annually (generally, this type of annual sampling consists of a single sample collected once a year, the sampling duration is usually one week, and the analysis is for measuring gross-alpha and gross-beta activities)

BW = biweekly

M = monthly

Q = quarterly

V = variable (i.e., the number of samples and duration of collection period cannot be firmly estimated because of the uncertain future needs of the project)

**Table A-1 Notes**

In the column labeled "Time Period per Sample," the time periods listed (e.g., BW, M, A) represent the usual durations of emissions sampling for the listed stacks, with BW meaning biweekly, M meaning monthly, A meaning annually, and V meaning variable. Sampling at a stack associated with an M will almost always result in 12 monthly samples collected during a calendar year. Sampling at stacks marked BW will usually have 4 samples or alternately about 26 samples collected a year, with the difference in total samples contingent on how facility management has chosen to meet its annual monitoring requirements. For Tank Farm minor stacks, 26 samples are generally collected annually but only a few samples analyzed to fulfill the Air Operating Permit monitoring requirement of a 4-week sample per year.

The **boldface characters** in the column labeled "Stack or Emission Point ID" represent "major" stacks, whereas characters not in boldface represent "minor" stacks.

Table A-1. Air Emissions Samples and Analyses for Calendar Year 2012. (3 sheets)

| Facility or Project | Stack or Emission Point ID[a] | EDP Code (aka location code) | Time Period per Sample | Analysis and Number of Samples Projected for Analysis | | | | | | | CACN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Particulate Gross Alpha and Gross Beta | Periodic Isotopic Particulate Composite | | | | | Ag-Zeolite | |
| | | | | | GEA | $^{90}Sr$ | Isotopic Pu | $^{241}Pu$ | $^{241}Am$ | | |
| K Basin Closure Project | 105-KW | Y234 | BW | 4 | 2 | 2 | 2 | 2 | 2 | | 400100 |
| | | Y236 | BW | 4 | 2 | 2 | 2 | 2 | 2 | | |
| | **105-KW Sparger Vent** | Y249[b] | A | 1 | 1 | 1 | 1 | 1 | 1 | | |
| | **296-K-142** | Y201 | M | 12 | 4 | 4 | 4 | 4 | 4 | | |
| PUREX | **291-A-1** | A006 | M | 12 | 2 | 2 | 2 | | 2 | | |
| | | A007 | M | | | | | | | 2 | |
| B Plant | **296-B-1** | B001 | M | 4 | 2 | 2 | | | | | |
| WESF | **296-B-10** | B748 | BW | 12 | 2 | 2 | | | | | |
| East Tanks Farms | 296-A-18 | E060 | BW | 3 | | | | | | | |
| | 296-A-19 | E061 | BW | 3 | | | | | | | |
| | 296-A-20 | E197 | BW | 3 | | | | | | | |
| | 296-A-28 | E272 | BW | 3 | | | | | | | |
| | 296-A-30 | E903 | BW | 3 | | | | | | | |
| | 296-A-40 | E013 | BW | 3 | | | | | | | |
| | 296-A-41 | E015 | BW | 3 | | | | | | | |
| | **296-A-42** | E147 | BW | 12 | 2 | 2 | 2 | | 2 | | |
| | 296-A-43 | E148 | V | 3 | | | | | | | |
| | **296-A-44** | E920 | BW | 12 | 2 | 2 | 2 | 2 | 2 | | |
| | **296-A-45** | E922 | BW | 12 | 2 | 2 | 2 | 2 | 2 | | |
| | **296-A-46** | E924 | BW | 12 | 2 | 2 | 2 | 2 | 2 | | |
| | **296-A-47** | E926 | BW | 12 | 2 | 2 | 2 | 2 | 2 | | |
| | **296-P-45** | E047 | V | 2 | 1 | 1 | 1 | | 1 | | |
| | **296-P-47** | E096 | BW | 3 | 2 | 2 | 2 | | 2 | | |
| | **296-P-48** | E098 | BW | 3 | 2 | 2 | 2 | | 2 | | |
| | **296-P-107** | E104 | BW | 3 | 2 | 2 | 2 | | 2 | | |

Table A-1. Air Emissions Samples and Analyses for Calendar Year 2012. (3 sheets)

| Facility or Project | Stack or Emission Point ID[a] | EDP Code (aka location code) | Time Period per Sample | Analysis and Number of Samples Projected for Analysis | | | | | | | CACN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Particulate Gross Alpha and Gross Beta | Periodic Isotopic Particulate Composite | | | | | Ag-Zeolite | |
| | | | | | GEA | $^{90}$Sr | Isotopic Pu | $^{241}$Pu | $^{241}$Am | | |
| 242-A Evaporator | 296-A-21A | E651 | BW | 4 | | | | | | | 400100 |
| | 296-A-22 | E643 | BW | 12 | 2 | 2 | 2 | | 2 | | |
| ETF | 296-E-1 | E036 | Q | 1 | | | | | | | |
| CSB | **296-H-212** | C601 | M | 12 | 2 | 2 | 2 | 2 | 2 | | |
| 222-S Lab | 296-S-16 | S264 | BW | 3 | | | | | | | |
| | **296-S-21** | S289 | BW | 4 | 2 | 2 | 2 | | 2 | | |
| S Plant | 291-S-1 | S006 | M | 1 | | | | | | | |
| T Plant | **291-T-1** | T785 | BW | 26 | 4 | 4 | 4 | 4 | 4 | | |
| | 296-T-7 | T154[c] | M | 4 | 4 | | | | | | |
| West Tank Farms | 296-P-22 | W191 | BW | 3 | | | | | | | |
| | 296-P-23 | W190 | V | 3 | | | | | | | |
| | 296-P-44 | E046 | V | 3 | 1 | 1 | 1 | | 1 | | |
| | 296-S-18 | W096 | V | 1 | | | | | | | |
| | 296-S-25 | W145 | V | 3 | | | | | | | |
| WRAP | **296-W-4** | W123 | BW | 4 | 2 | 2 | 2 | 2 | 2 | | |
| WSCF | 696-W-1 | W010 | M | 4 | | | | | | | |
| | 696-W-2 | W011 | M | 4 | | | | | | | |
| PFP | **291-Z-1** | Z810 | BW | 12 | | | 4 | 4 | 4 | | |
| | 296-Z-15 | Z915 | A | 1 | | | | | | | |
| 324 Building | **EP-324-01-S** | F025 | M | 12 | 2 | 2 | 2 | | 2 | | |
| MASF | 437-MN&ST | F014 | M | 1 | | | | | | | |
| | 437-1-61 | F019 | M | 1 | | | | | | | |
| | **Totals** | | | **263** | **51** | **47** | **47** | **29** | **47** | **2** | |

The following definitions represent the collection frequency of air emissions samples normally associated with the respective stacks: A = annually; M = monthly; Q = quarterly; V = variable.

[a] A stack or emission point ID in boldface indicates it is a major stack or emission point, meaning the dose potential of its annual emissions exceeds 0.1 mrem/yr effective dose equivalent (EDE); conversely, all stacks or emission points in regular face are minor, meaning the dose potential of each is equal to or less then 0.1 mrem/yr EDE.

[b] This sample is not the standard 47-mm Versapor particulate air filter but a small cube-shaped HEPA filter, about a foot per site, the analysis of which is handled under an active Letter of Instruction between WSCF and K Basin Closure Project.

[c] These monthly samples are not to be analyzed individually for gross alpha and gross beta but instead composited quarterly. WSCF shall then use an appropriate method on these quarterly composite samples to measure gross alpha and gross beta.

# APPENDIX B

# METHOD 114 POINT-BY-POINT COMPARISON WITH ANALYTICAL METHODS USED AT THE WASTE SAMPLING AND CHARACTERIZATION FACILITY

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# APPENDIX B

## METHOD 114 POINT-BY-POINT COMPARISON WITH ANALYTICAL METHODS USED AT THE WASTE SAMPLING AND CHARACTERIZATION FACILITY

In this appendix, emissions monitoring practices and analytical methods at WSCF have been evaluated to determine their state of compliance with the radionuclide emission requirements defined in 40 CFR 61, Subpart H, specifically Method 114 of Appendix B.

Radioactive constituents in air emissions from emission points (e.g., stacks) at the Hanford Site are well characterized. The characterizations are in agreement with the nature of the operations carried out in respective facilities that generate radioactive air emissions. The laboratory ordinarily receives biweekly, monthly, or quarterly stack air filter samples, depending on the respective NESHAP category of stack, which relate to the major or minor category of stacks and their unique mandatory monitoring requirements documented in regulations and permits. The filters used for sampling are usually 47 millimeters in diameter and composed of acrylic copolymer on a nonwoven backing. Before analysis is performed, samples are held for seven days from the date of collection to allow for extensive decay of radon and its daughter products, which can be present on the filters.

After the seven-day decay period, gross alpha and gross beta activities on selected air particulate samples are determined. Those counts are performed to yield the first indication of activity levels in the stack air streams. Soon after the filters are counted, radiological control, effluent monitoring, and facility effluent personnel can access the analysis data via ABCASH. Hard copies of data reports can also be requested.

It is important to note that continuous process control air monitoring systems with alarms are installed at nearly every major stack for real-time response to elevated releases. These alarms allow rapid response from facility personnel if the situation warrants. For retrospective assurance of low emissions and in a few cases for assuring permit compliance, some individual sample filters are measured for gross-alpha and gross-beta activities. For reporting and dose-modeling purposes, these measurements are construed conservatively to be $^{239/240}$Pu for gross alpha and $^{90}$Sr for gross beta.

To ensure compliance with the dose standard is maintained, WSCF, as directed, performs specific radionuclide analyses on composites of multiple filters collected during a prescribed period, such as three months or six months. Those analyses include gamma-energy analysis (GEA), specific analysis for isotopes of Am, Pu, and Sr. Currently, sampling for $^{129}$I is conducted on emissions from the PUREX main stack. Silver-zeolite cartridges are used to collect those samples. The cartridges are sent to WSCF for analysis, which includes gamma-energy analysis.

GEA would be the first analysis performed on a composite sample. GEA determines the activities of the gamma emitters, particularly $^{137}$Cs, $^{60}$Co, $^{154}$Eu, $^{106}$Ru, $^{125}$Sb and any other positive gamma peaks, except radon and thoron daughters. After GEA is complete, the composite of air filters is ashed, dissolved, leached, appropriately treated, and mounted for analysis of individual alpha emitters and beta emitters, depending on the analyses requested.

For compliance purposes, analyses performed at WSCF are compared in a point-by-point fashion with the analytical requirements in Method 114 of Appendix B of Subpart H of 40 CFR 61. The point-by-point comparison of verbatim Method 114 requirements and the WSCF determination of compliance with those requirements, shown as "response" statements, follows from here.

# METHOD 114 — TEST METHODS FOR MEASURING RADIONUCLIDE EMISSIONS FROM STATIONARY SOURCES

1. *Purpose and Background*

This method provides the requirements for: (1) Stack monitoring and sample collection methods appropriate for radionuclides; (2) radiochemical methods which are used in determining the amounts of radionuclides collected by the stack sampling and; (3) quality assurance methods which are conducted in conjunction with these measurements. These methods are appropriate for emissions for stationary sources. A list of references is provided.

Many different types of facilities release radionuclides into air. These radionuclides differ in the chemical and physical forms, half-lives and type of radiation emitted. The appropriate combination of sample extraction, collection and analysis for an individual radionuclide is dependent upon many interrelated factors including the mixture of other radionuclides present. Because of this wide range of conditions, no single method for monitoring or sample collection and analysis of a radionuclide is applicable to all types of facilities. Therefore, a series of methods based on "principles of measurement" is described for monitoring and sample collection and analysis which are applicable to the measurement of radionuclides found in effluent streams at stationary sources. This approach provides the user with the flexibility to choose the most appropriate combination of monitoring and sample collection and analysis methods which are applicable to the effluent stream to be measured.

*Response:* **No response required. [Note: Responses are in boldface text.]**

2. *Stack Monitoring and Sample Collection Methods*

Monitoring and sample collection methods are described based on "principles of monitoring and sample collection" which are applicable to the measurement of radionuclides from effluent streams at stationary sources. Radionuclides of most elements will be in the particulate form in these effluent streams and can be readily collected using a suitable filter media. Radionuclides of hydrogen, oxygen, carbon, nitrogen, the noble gases and in some circumstances iodine will be in the gaseous form. Radionuclides of these elements will require either the use of an in-line or off-line monitor to directly measure the radionuclides, or suitable sorbers, condensers or bubblers to collect the radionuclides.

*Response:* **No response required.**

2.1 Radionuclides as Particulates. The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI N13.1-1999 (section 6.6.2 Filter media) shall be followed in using filter media to collect particulates (incorporated by reference-see §61.18 of this part).

*Response:* **WSCF uses such a filter medium (i.e., a Versapor 3000** [Note: Versapor is a trademark name of the Pall Corporation, Ann Arbor, Michigan]**, or equivalent, filter) to collect samples from its two minor stacks.**

2.2 Radionuclides as Gases

2.2.1 The Radionuclide Tritium (H-3). Tritium in the form of water vapor is collected from the extracted effluent sample by sorption, condensation or dissolution techniques. Appropriate collectors may include silica gel, molecular sieves, and ethylene glycol or water bubblers.

Tritium in the gaseous form may be measured directly in the sample stream using Method B-1, collected as a gas sample or may be oxidized using a metal catalyst to tritiated water and collected as described above.

*Response:* **Not applicable to WSCF.**

2.2.2 Radionuclides of iodine. Iodine is collected from an extracted sample by sorption or dissolution techniques. Appropriate collectors may include charcoal, impregnated charcoal, metal zeolite and caustic solutions.

*Response:* **Not applicable to WSCF.**

2.2.3 Radionuclides of Argon, Krypton and Xenon. Radionuclides of these elements are either measured directly by an in-line or off-line monitor, or are collected from the extracted sample by low temperature sorption techniques. Appropriate sorbers may include charcoal or metal zeolite.

*Response:* **Not applicable to WSCF.**

2.2.4 Radionuclides of Oxygen, Carbon, Nitrogen and Radon. Radionuclides of these elements are measured directly using an in-line or off-line monitor. Radionuclides of carbon in the form of carbon dioxide may be collected by dissolution in caustic solutions.

*Response:* **Not applicable to WSCF.**

2.3 Definition of Terms

*In-line monitor* means a continuous measurement system in which the detector is placed directly in or adjacent to the effluent stream. This may involve either gross radioactivity measurements or specific radionuclide measurements. Gross measurements shall be made in conformance with the conditions specified in Methods A-4, B-2 and G-4.

*Off-line monitor* means a measurement system in which the detector is used to continuously measure an extracted sample of the effluent stream. This may involve either gross radioactivity measurements or specific radionuclide measurements. Gross measurements shall be made in conformance with the conditions specified in Methods A-4, B-2 and G-4.

*Sample collection* means a procedure in which the radionuclides are removed from an extracted sample of the effluent using a collection media. These collection media include filters, absorbers, bubblers and condensers. The collected sample is analyzed using the methods described in Section 3.

*Response:* **No response required.**

3. *Radionuclide Analysis Methods*

A series of methods based on "principles of measurement" are described which are applicable to the analysis of radionuclides collected from airborne effluent streams at stationary sources. These methods are applicable only under the conditions stated and within the limitations described. Some methods specify that only a single radionuclide be present in the sample or the chemically separated sample. This condition should be interpreted to mean that no other radionuclides are present in quantities which would interfere with the measurement.

Also identified (Table 1) are methods for a selected list of radionuclides. The listed radionuclides are those which are most commonly used and which have the greatest potential for causing dose to members of the public. Use of methods based on principles of measurement other than those described in this section must be approved in advance of use by the Administrator. For radionuclides not listed in Table 1, any of the described methods may be used provided the user can demonstrate that the applicability conditions of the method have been met.

The type of method applicable to the analysis of a radionuclide is dependent upon the type of radiation emitted, i.e., alpha, beta or gamma. Therefore, the methods described below are grouped according to principles of measurements for the analysis of alpha, beta and gamma emitting radionuclides.

3.1 Methods for Alpha Emitting Radionuclides

3.1.1 Method A-1, Radiochemistry-Alpha Spectrometry

*Principle:* The element of interest is separated from other elements, and from the sample matrix using radiochemical techniques. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a very thin film by electrodeposition or by coprecipitation on a very small amount of carrier, such as lanthanum fluoride. The deposited element is then counted with an alpha spectrometer. The activity of the nuclide of interest is measured by the number of alpha counts in the appropriate energy region. A correction for chemical yield and counting efficiency is made using a standardized radioactive nuclide (tracer) of the same element. If a radioactive tracer is not available for the element of interest, a predetermined chemical yield factor may be used.

*Applicability:* This method is applicable for determining the activity of any alpha-emitting radionuclide, regardless of what other radionuclides are present in the sample provided the chemical separation step produces a very thin sample and removes all other radionuclides which could interfere in the spectral region of interest. APHA-605(2), ASTM-D-3972(13).

*Response:* **This method involves dissolution, chemical separation, followed by alpha spectrometry. This method meets all the requirements of the EPA-suggested method. This method is used for analyzing $^{241}$Am, $^{238}$Pu, and $^{239,240}$Pu collected on air filter samples. The activities of these isotopes are determined by direct comparison with the recoveries of certified $^{243}$Am and $^{236}$Pu or $^{242}$Pu tracers.**

3.1.2 Method A-2, Radiochemistry-Alpha Counting

*Principle:* The element of interest is separated from other elements, and from the sample matrix using radiochemistry. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a thin film and counted with a alpha counter. A correction for chemical yield (if necessary) is made. The alpha count rate measures the total activity of all emitting radionuclides of the separated element.

*Applicability:* This method is applicable for the measurement of any alpha-emitting radionuclide, provided no other alpha emitting radionuclide is present in the separated sample. It may also be applicable for determining compliance, when other radionuclides of the separated element are present, provided that the calculated emission rate is assigned to the radionuclide which could be present in the sample that has the highest dose conversion factor. IDO-12096(18).

*Response:* **The method (A-2) of determining gross alpha emitter activity of the separated element is not used because more than one alpha might be present.**

3.1.3 Method A-3, Direct Alpha Spectrometry

*Principle:* The sample, collected on a suitable filter, is counted directly on an alpha spectrometer. The sample must be thin enough and collected on the surface of the filter so that any absorption of alpha particle energy in the sample or the filter, which would degrade the spectrum, is minimal.

*Applicability:* This method is applicable to simple mixtures of alpha emitting radionuclides and only when the amount of particulates collected on the filter paper are relatively small and the alpha spectra is adequately resolved. Resolutions should be 50 keV (FWHM ["full width, half max" or better]), ASTM-D-3084(16).

*Response:* **This is not done at WSCF. However, this method is used by the 222-S Laboratory Complex counting room for emergency air samples (i.e., samples in "red-bordered" envelopes, marked as such for special processing and handling). The 222-S Laboratory Complex counting room works to its own procedures for gross alpha counts and for alpha spectrometry. The sample is counted on the alpha counter of known efficiency to obtain the gross alpha counts. In the alpha-energy analysis (AEA), the relative peak fractions of different alpha emitters identified in the sample are determined. The peak fractions are used to correct the gross alpha counts and thus determine the activities of individual alpha nuclides present in the sample.**

3.1.4 Method A-4, Direct Alpha Counting (Gross **Alpha** Determination)

*Principle:* The sample, collected on a suitable filter, is counted with an alpha counter. The sample must be thin enough so that self-absorption is not significant and the filter must be of such a nature that the particles are retained on the surface.

*Applicability:* Gross alpha determinations may be used to measure emissions of specific radionuclides only (1) when it is known that the sample contains only a single radionuclide, or the identity and isotopic ratio of the radionuclides in the sample are well-known, and (2) measurements using either Method A-1, A-2 or A-5 have shown that this method provides a reasonably accurate measurement of the emission rate. Gross alpha measurements are applicable to unidentified mixtures of radionuclides only for the purposes and under the conditions described in section 3.7. APHA-601(3), ASTM-D-1943(10).

*Response:* **The filter samples are counted in a low background thin-window gas-flow proportional counter with a guard detector operated in coincidence mode, which uses pulse-height discriminator to separate alpha and beta activity. The WSCF method meets all of the requirements stated in the EPA-suggested method.**

3.1.5 Method A-5, Chemical Determination of Uranium

*Principle:* Uranium may be measured chemically by either colorimetry or fluorometry. In both procedures, the sample is dissolved, the uranium is oxidized to the hexavalent form and extracted into a suitable solvent. Impurities are removed from the solvent layer. For colorimetry, dibenzoylmethane is added, and the uranium is measured by the absorbance in a colorimeter. For fluorometry, a portion of the solution is fused with a sodium fluoride-lithium fluoride flux and the uranium is determined by the ultraviolet activated fluorescence of the fused disk in a fluorometer.

*Applicability:* This method is applicable to the measurements of emission rates of uranium when the isotopic ratio of the uranium radionuclides is well known. ASTM-E-318(15), ASTM-D-2907(14).

*Response:* **Chemical determination of total U is not performed at WSCF. If the determinations of naturally occurring isotopic uranium activities ($^{234}U$, $^{235}U$ and $^{238}U$) are required, the filter sample undergoes dissolution, followed by column separation, and the mount gets counted by AEA.**

3.1.6 Method A-6, Radon-222 -- Continuous Gas Monitor.

*Principle:* Radon-222 is measured directly in a continuously extracted sample stream by passing the air stream through a calibrated scintillation cell. Prior to the scintillation cell, the air stream is treated to remove particulates and excess moisture. The alpha particles from radon-222 and its decay products strike a zinc sulfide coating on the inside of the scintillation cell producing light pulses. The light pulses are detected by a photomultiplier tube which generates electrical pulses. These pulses are processed by the system electronics and the read out is in pCi/l of radon-222.

*Applicability:* This method is applicable to the measurement of radon-222 in effluent streams which do not contain significant quantities of radon-220. Users of this method should calibrate the monitor in a radon calibration chamber at least twice per year. The background of the monitor should also be checked periodically by operating the instrument in a low radon environment. EPA 520/1-89-009(24).

*Response:* **Not applicable at WSCF.**

3.1.7 Method A-7, Radon-222-Alpha Track Detectors

*Principle:* Radon-222 is measured directly in the effluent stream using alpha track detectors (ATD). The alpha particles emitted by radon-222 and its decay products strike a small plastic strip and produce submicron damage tracks. The plastic strip is placed in a caustic solution that accentuates the damage tracks which are counted using a microscope or automatic counting system. The number of tracks per unit area is correlated to the radon concentration in air using a conversion factor derived from data generated in a radon calibration facility.

*Applicability:* Prior approval from EPA is required for use of this method. This method is only applicable to effluent streams which do not contain significant quantities of radon-220, unless special detectors are used to discriminate against radon-220. This method may be used only when ATDs have been demonstrated to produce data comparable to data obtained with Method A-6. Such data should be submitted to EPA when requesting approval for the use of this method. EPA 520/1-89-009(24).

*Response:* **Not applicable; direct monitoring of $^{222}Rn$ is not performed at WSCF.**

3.2 Methods for Gaseous Beta Emitting Radionuclides

3.2.1 Method B-1, Direct Counting in Flow-Through Ionization Chambers.

*Principle:* An ionization chamber containing a specific volume of gas which flows at a given flow rate through the chamber is used. The sample (effluent stream sample) acts as the counting gas for the chamber. The activity of the radionuclide is determined from the current measured in the ionization chamber.

*Applicability:* This method is applicable for measuring the activity of a gaseous beta-emitting radionuclide in an effluent stream that is suitable as a counting gas, when no other beta-emitting nuclides are present. DOE/EP-0096(17), NCRP-58(23).

*Response:* **Not applicable; not performed at WSCF.**

3.2.2 Method B-2, Direct Counting With In-line or Off-line Beta Detectors.

*Principle:* The beta detector is placed directly in the effluent stream (in-line) or an extracted sample of the effluent stream is passed through a chamber containing a beta detector (off-line). The activities of the radionuclides present in the effluent stream are determined from the beta count rate, and a knowledge of the radionuclides present and the relationship of the gross beta count rate and the specific radionuclide concentration.

*Applicability:* This method is applicable only to radionuclides with maximum beta particle energies greater then 0.2 MeV. This method may be used to measure emissions of specific radionuclides only when it is known that the sample contains only a single radionuclide or the identity and isotopic ratio of the radionuclides in the effluent stream are well known. Specific radionuclide analysis of periodic grab samples may be used to identify the types and quantities of radionuclides present and to establish the relationship between specific radionuclide analyses and gross beta count rates.

This method is applicable to unidentified mixtures of gaseous radionuclides only for the purposes and under the conditions described in section 3.7.

*Response:* **Not applicable; not performed at WSCF.**

3.3 Methods for Non-Gaseous Beta Emitting Radionuclides

3.3.1 Method B-3, Radiochemistry-Beta Counting.

*Principle:* The element of interest is separated from other elements, and from the sample matrix by radiochemistry. This may involve precipitation, distillation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet, and counted with a beta counter. Corrections for chemical yield, and decay (if necessary) are made. The beta count rate determines the total activity of all radionuclides of the separated element. This method may also involve the radiochemical separation and counting of a daughter element, after a suitable period of ingrowth, in which case it is specific for the parent nuclide.

*Applicability:* This method is applicable for measuring the activity of any beta-emitting radionuclide, with a maximum energy greater than 0.2 MeV, provided no other radionuclide is present in the separated sample. APHA-608(5).

*Response:* **WSCF method for determining $^{90}Sr/^{90}Y$ in air filter samples meets the requirements for dissolution of filters of the Versapor type, chemical separation by Sr-spec resins, and gross beta counting.**

3.3.2 Method B-4, Direct Beta Counting (Gross beta determination).

*Principle:* The sample, collected on a suitable filter, is counted with a beta counter. The sample must be thin enough so that self-absorption corrections can be made.

*Applicability:* Gross beta measurements are applicable only to radionuclides with maximum beta particle energies greater than 0.2 MeV. Gross beta measurements may be used to measure emissions of specific radionuclides only (1) when it is known that the sample contains only a single radionuclide, and (2) measurements made using Method B-3 show reasonable agreement with the gross beta measurement. Gross beta measurements are applicable to mixtures of radionuclides only for the purposes and under the conditions described in section 3.7. APHA-602(4), ASTM-D-1890(11).

*Response:* **The filter samples are counted in a low-background, thin-window gas-flow proportional counter with a guard detector in coincidence mode that uses a pulse-height discriminator to separate alpha and beta activity. Gross-beta determination by the laboratory satisfies the method requirements.**

3.3.3 Method B-5, Liquid Scintillation Spectrometry.

*Principle:* An aliquot of a collected sample or the result of some other chemical separation or processing technique is added to a liquid scintillation "cocktail" which is viewed by photomultiplier tubes in a liquid scintillation spectrometer. The spectrometer is adjusted to establish a channel or "window" for the pulse energy appropriate to the nuclide of interest. The activity of the nuclide of interest is measured by the counting rate in the appropriate energy channel. Corrections are made for chemical yield where separations are made.

*Applicability:* This method is applicable to any beta-emitting nuclide when no other radionuclide is present in the sample or the separated sample provided that it can be incorporated in the scintillation cocktail. This method is also applicable for samples which contain more than one radionuclide but only when the energies of the beta particles are sufficiently separated so that they can be resolved by the spectrometer. This method is most applicable to the measurement of low-energy beta emitters such as tritium and carbon-14. APHA-609(6), EML-LV-539-17(19).

*Response:* **Not applicable. Record samples are not analyzed for $^{147}$Pm or $^{3}$H.**

3.4 Gamma Emitting Radionuclides

3.4.1 Method G-1, High Resolution Gamma Spectrometry.

*Principle:* The sample is counted with a high resolution gamma detector, usually either a Ge(Li) or a high purity Ge detector, connected to a multi-channel analyzer or computer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclide. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separations may be made prior to counting but are usually not necessary.

*Applicability:* This method is applicable to the measurement of any gamma emitting radionuclide with gamma energies greater than 20 keV. It can be applied to complex mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gases. The method may also be applied to the analysis of gaseous gamma emitting radionuclides directly in an effluent stream by passing the stream through a chamber or cell containing the detector. ASTM-3649(9), IDO-12096(18).

*Response:* **An air filter or a composite of air filters can as needed be counted on a high-purity Ge (HPGe) detector connected to a computer controlled multi-channel analyzer (MCA). Samples collected in silver-zeolite cartridges are counted on a n-type high-purity Ge detector (very useful for**

**low-energy gamma rays and x-rays). The WSCF method uses gamma-ray spectroscopy with high-resolution germanium detectors that meet all the requirements of the EPA method.**

3.4.2 Method G-2, Low Resolution Gamma Spectrometry.

*Principle:* The sample is counted with a low resolution gamma detector, a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube and connected to a multi-channel analyzer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclides. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separation may be used prior to counting to obtain less complex gamma spectra if needed.

*Applicability:* This method is applicable to the measurement of gamma emitting radionuclides with energies greater than 100 KeV. It can be applied only to relatively simple mixtures of gamma emitting radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream by passing the gas stream through a chamber or cell containing the detector. ASTM-D-2459(12), EMSL-LV-0539-17(19).

*Response:* **Not applicable because this method is not used in air filter analysis at WSCF.**

3.4.3 Method G-3, Single Channel Gamma Spectrometry.

*Principle:* The sample is counted with a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube connected to a single channel analyzer. The activity of a gamma emitting radionuclide is determined from the gamma counts in the energy range for which the counter is set.

*Applicability:* This method is applicable to the measurement of a single gamma emitting radionuclide. It is not applicable to mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream by passing the gas stream through a chamber or cell containing the detector.

*Response:* **Not applicable because this technique is not used in air filter analysis at WSCF.**

3.4.4 Method G-4, Gross Gamma Counting.

*Principle:* The sample is counted with a gamma detector usually a thallium activated sodium iodine crystal. The detector is coupled to a photomultiplier tube and gamma rays above a specific threshold energy level are counted.

*Applicability:* Gross gamma measurements may be used to measure emissions of specific radionuclides only when it is known that the sample contains a single radionuclide or the identity and isotopic ratio of the radionuclides in the effluent stream are well known. When gross gamma measurements are used to determine emissions of specific radionuclides periodic measurements using Methods G-1 or G-2 should be made to demonstrate that the gross gamma measurements provide reliable emission data. This method may be applied to analysis of gaseous radionuclides directly in an effluent stream by placing the detector directly in or adjacent to the effluent stream or passing an extracted sample of the effluent stream through a chamber or cell containing the detector.

*Response:* **Not applicable.**

3.5 Counting Methods. All of the above methods with the exception of Method A-5 involve counting the radiation emitted by the radionuclide. Counting methods applicable to the measurement of alpha, beta and gamma radiations are listed below. The equipment needed and the counting principles involved are described in detail in ASTM-3648(8).

3.5.1 Alpha Counting:

*Gas Flow Proportional Counters.* The alpha particles cause ionization in the counting gas and the resulting electrical pulses are counted. These counters may be windowless or have very thin windows.

*Scintillation Counters.* The alpha particles transfer energy to a scintillator resulting in a production of light photons which strike a photomultiplier tube converting the light photons to electrical pulses which are counted. The counters may involve the use of solid scintillation materials such as zinc sulfide or liquid scintillation solutions.

*Solid-State Counters.* Semiconductor materials, such as silicon surface-barrier p-n junctions, act as solid ionization chambers. The alpha particles interact which the detector producing electron hole pairs. The charged pair is collected by an applied electrical field and the resulting electrical pulses are counted.

*Alpha Spectrometers.* Semiconductor detectors used in conjunction with multi-channel analyzers for energy discrimination.

*Response:* **Thin-window-type gas-flow proportional counters with automatic sample changers used for gross alpha measurements. Ion-implanted solid-state detectors connected to an MCA are used for alpha spectroscopy at WSCF. WSCF equipment meets EPA specifications.**

3.5.2 Beta Counting:

*Ionization Chambers.* These chambers contain the beta-emitting nuclide in gaseous form. The ionization current produced is measured.

*Geiger-Muller (GM) Counters-or Gas Flow Proportional Counters.* The beta particles cause ionization in the counting gas and the resulting electrical pulses are counted. Proportional gas flow counters which are heavily shielded by lead or other metal, and provided with an anti-coincidence shield to reject cosmic rays, are called low background beta counters.

*Scintillation Counters.* The beta particles transfer energy to a scintillator resulting in a production of light photons, which strike a photomultiplier tube converting the light photon to electrical pulses which are counted. This may involve the use of anthracene crystals, plastic scintillator, or liquid scintillation solutions with organic phosphors.

*Liquid Scintillation Spectrometers.* Liquid scintillation counters which use two photomultiplier tubes in coincidence to reduce background counts. This counter may also electronically discriminate among pulses of a given range of energy.

*Response:* **Thin-window-type gas-flow proportional counters with automatic sample changers and liquid scintillation spectrometers are used for beta counting. WSCF counting equipment meets requirements.**

3.5.3 Gamma Counting:

*Low-Resolution Gamma Spectrometers.* The gamma rays interact with thallium activated sodium iodide or cesium iodide crystal resulting in the release of light photons which strike a photomultiplier tube converting the light pulses to electrical pulses proportional to the energy of the gamma ray. Multi-channel analyzers are used to separate and store the pulses according to the energy absorbed in the crystal.

*High-Resolution gamma Spectrometers.* Gamma rays interact with a lithium-drifted (Ge(Li)) or high-purity germanium (HPGe) semiconductor detectors resulting in a production of electron-hole pairs. The charged pair is collected by an applied electrical field. A very stable low noise preamplifier amplifies the pulses of electrical charge resulting from the gamma photon interactions. Multi-channel analyzers or computers are used to separate and store the pulses according to the energy absorbed in the crystal.

*Single Channel Analyzers.* Thallium activated sodium iodide crystals used with a single window analyzer. Pulses from the photomultiplier tubes are separated in a single predetermined energy range.

*Response:* **High-resolution gamma (aka closed-end HPGe coaxial) detectors connected to computer controlled MCAs are used for air filter analysis. WSCF equipment exceeds EPA requirements.**

3.5.4 Calibration of Counters. Counters are calibrated for specific radionuclide measurements using a standard of the radionuclide under either identical or very similar conditions as the sample to be counted. For gamma spectrometers a series of standards covering the energy range of interest may be used to construct a calibration curve relating gamma energy to counting efficiency.

In those cases where a standard is not available for a radionuclide, counters may be calibrated using a standard with energy characteristics as similar as possible to the radionuclide to be measured. For gross alpha and beta measurements of the unidentified mixtures of radionuclides, alpha counters are calibrated with a natural uranium standard and beta counters with a cesium-137 standard. The standard must contain the same weight and distribution of solids as the samples, and be mounted in an identical manner. If the samples contain variable amounts of solids, calibration curves relating weight of solids present to counting efficiency are prepared. Standards other than those prescribed may be used provided it can be shown that such standards are more applicable to the radionuclide mixture measured.

*Response:* **A mixed-gamma standard that emits various gamma rays ranging from 59 to 1,850 keV is used, employing vendor-supplied calibration software to construct efficiency-versus-energy calibration curves for different geometrical configurations used in gamma analysis. The calibration procedure for gamma-ray spectrometer meets EPA criteria for gamma-ray spectroscopic analysis.**

**For calibration of beta detectors for $^{90}Sr/^{90}Y$ analysis, a procedure is used that meets the requirements of the EPA-suggested method. A method standard also is used to check the performance and calibration of the detector.**

**For calibration of alpha-beta proportional counters, the calibration follows laboratory procedures. For gross alpha and gross beta measurements, WSCF instruments are calibrated separately with vendor-supplied certified filter standards made with NIST-traceable alpha-emitting $^{241}Am$ and beta-emitting $^{137}Cs$ standards, respectively, fabricated into the filter sample counting geometry.**

**The gross-alpha result, based on $^{241}Am$ efficiency, is essentially the same as that based on $^{239/240}Pu$ efficiency, because the alpha energies of both are high and very similar.**

**The reasons for choosing the $^{241}$Am standard for alpha calibration are as follows:**

- **$^{241}$Am is one of the alpha emitters commonly found in stack air samples.**
- **Alpha counting efficiency for $^{241}$Am is usually the same for other alpha emitters also found in the air stack samples.**
- **The $^{241}$Am standard can be checked independently by gamma analysis.**

**Because of technical difficulties, the calibration curves relating weight of solids present to counting efficiencies were not established in direct alpha-beta counting of air filter samples. However, the self-absorption factor is applied if gross alpha-beta analysis is performed on the acid leachate of the filter samples.**

3.6 Radiochemical Methods for Selected Radionuclides. Methods for a selected list of radionuclides are listed in Table 1. The radionuclides listed are those which are most commonly used and which have the greatest potential for causing doses to members of the public. For radionuclides not listed in Table 1, methods based on any of the applicable "principles of measurement" described in section 3.1 through 3.4 may be used.

*Response:* **Air samples from stacks are well characterized. Some of the radionuclides identified (e.g., $^{241}$Am, $^{238}$Pu, $^{239,240}$Pu, $^{90}$Sr, and $^{137}$Cs) are listed in Table 1 of Method 114 and are analyzed according to the approved methods given in Table 1. Other radionuclides ($^{129}$I, $^{106}$Ru, $^{125}$Sb) not listed in Table 1 are analyzed depending on the type of radiation, as outlined in Method 114.**

3.7 Applicability of Gross Alpha and Beta Measurements to Unidentified Mixtures of Radionuclides. Gross alpha and beta measurements may be used as a screening measurement as a part of an emission measurement program to identify the need to do specific radionuclide analyses or to confirm or verify that unexpected radionuclides are not being released in significant quantities.

Gross alpha (Method A-4) or gross beta (Methods B-2 or B-4) measurements may also be used for the purpose of comparing the measured concentrations in the effluent stream with the limiting "Concentration Levels for Environmental Compliance" in table 2 of appendix E [from 40 CFR 61]. For unidentified mixtures, the measured concentration value shall be compared with the lowest environmental concentration limit for any radionuclide which is not known to be absent from the effluent stream.

Table 1_List of Approved Methods for Specific Radionuclides

| Radionuclide | Approved methods of analysis |
|---|---|
| Am-241 | A-1, A-2, A-3, A-4 |
| Ar-41 | B-1, B-2, G-1, G-2, G-3, G-4 |
| Ba-140 | G-1, G-2, G-3, G-4 |
| Br-82 | G-1, G-2, G-3, G-4 |
| C-11 | B-1, B-2, G-1, G-2, G-3, G-4 |
| Ca-45 | B-3, B-4, B-5 |
| Ce-144 | G-1, G-2, G-3, G-4 |
| Cm-244 | A-1, A-2, A-3, A-4 |
| Co-60 | G-1, G-2, G-3, G-4 |
| Cr-51 | G-1, G-2, G-3, G-4 |
| Cs-134 | G-1, G-2, G-3, G-4 |
| Cs-137 | G-1, G-2, G-3, G-4 |
| Fe-55 | B-5, G-1 |
| Fe-59 | G-1, G-2, G-3, G-4 |

Ga-67 ........ G-1, G-2, G-3, G-4
H-3 (H[INF]2[INF]0) ........ B-5
H-3 (gas) ........ B-1
I-123 ........ G-1, G-2, G-3, G-4
I-125 ........ G-1
I-131 ........ G-1, G-2, G-3, G-4
In-113m ........ G-1, G-2, G-3, G-4
Ir-192 ........ G-1, G-2, G-3, G-4
Kr-85 ........ B-1, B-2, B-5, G-1, G-2, G-3, G-4
Kr-87 ........ B-1, B-2, G-1, G-2, G-3, G-4
Kr-88 ........ B-1, B-2, G-1, G-2, G-3, G-4
Mn-54 ........ G-1, G-2, G-3, G-4
Mo-99 ........ G-1, G-2, G-3, G-4
N-13 ........ B-1, B-2, G-1, G-2, G-3, G-4
O-15 ........ B-1, B-2, G-1, G-2, G-3, G-4
P-32 ........ B-3, B-4, B-5
Pm-147 ........ B-3, B-4, B-5
Po-210 ........ A-1, A-2, A-3, A-4
Pu-238 ........ A-1, A-2, A-3, A-4
Pu-239 ........ A-1, A-2, A-3, A-4
Pu-240 ........ A-1, A-2, A-3, A-4
Ra-226 ........ A-1, A-2, G-1, G-2
S-35 ........ B-5
Se-75 ........ G-1, G-2, G-3, G-4
Sr-90 ........ B-3, B-4, B-5
Tc-99 ........ B-3, B-4, B-5
Te-201 ........ G-1, G-2, G-3, G-4
Uranium (total alpha) ........ A-1, A-2, A-3, A-4
Uranium (Isotopic) ........ A-1, A-3
Uranium (Natural) ........ A-5
Xe-133 ........ G-1
Yb-169 ........ G-1, G-2, G3, G-4
Zn-65 ........ G-1, G-2, G3, G-4

---------------------------------------------------------------------------------------------

*Response:* **This is not applicable because the air effluents from the main stacks are well characterized. However, gross alpha and gross beta analyses of air samples are routinely performed at WSCF before starting specific radionuclide analyses. Prompt and careful review of screening results would let facility personnel verify a significant release of a radionuclide into the air and quickly initiate corrective actions to minimize radionuclide emission into the environment. The gross alpha and gross beta analysis results are compared for compliance to those listed in the appendix of DOE Order 5400.5.**

4. *Quality Assurance Methods*

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.1 The organizational structure, functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program shall be identified and documented.

*Response:* **Not applicable to this point-by-point comparison focused on WSCF analytical methods.**

4.2 Administrative controls shall be prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.

*Response:* **Not applicable to this point-by-point comparison focused on WSCF analytical methods.**

4.3 The sample collection and analysis procedures used in measuring the emissions shall be described including where applicable:

4.3.1 Identification of sampling sites and number of sampling points, including the rationale for site selections.

*Response:* **Not applicable to this point-by-point comparison focused on WSCF analytical methods.**

4.3.2 A description of sampling probes and representativeness of the samples.

*Response:* **Not applicable to this point-by-point comparison focused on WSCF analytical methods.**

4.3.3 A description of any continuous monitoring system used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

*Response:* **Not applicable to this point-by-point comparison focused on WSCF analytical methods.**

4.3.4 A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

*Response:* **Not applicable to this point-by-point comparison focused on WSCF analytical methods.**

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured. including frequency of analysis calibration procedures and frequency of calibration.

*Response:*

- **Gross alpha and gross beta activities are determined on generally biweekly samples. The calibration procedure is documented. The counting system is recalibrated only in the case of (1) major repairs or adjustments to the power supply or detector or (2) major calibration shift as indicated by the instrument control standards. The performance of the counting systems is checked by running the instrument control standards separately ($^{147}$Pm for low-energy beta, $^{60}$Co for mid-energy beta, $^{137}$Cs for high-energy beta, and $^{241}$Am for alpha activity). When a batch of air filter samples is run, all the performance standards are also run with the sample. To verify that the counting system is working properly, the standard values from analysis should fall within the administrative limits set according to the statement of work and WSCF procedures.** ***Note that the results for $^{147}$Pm and $^{60}$Co are used for informational purposes only.***

- **The WSCF method for analyzing alpha emitters ($^{241}$Am, $^{238}$Pu, and $^{239/240}$Pu) involves various steps for dissolution, chemical separation, and final alpha spectrometry. The analysis of specific alpha emitters is usually done on only composites consistently typically of multiple biweekly air filters. A pulser check is performed daily at a specified energy level within the range of 4 to 6 MeV on each alpha chamber of the AEA system. This check is intended to get a quick evaluation of the energy calibration and resolution of the alpha detector. Efficiency calibration of the AEA is performed according to WSCF procedure. The chemical yield used to correct the analyte activity is determined by using radioactive tracers ($^{243}$Am and $^{242}$ Pu or**

**$^{236}$Pu). Also, direct comparison of the sample response with the tracer response ($^{243}$Am and $^{236}$Pu or $^{242}$Pu) can be made to determine the activities of the radionuclides $^{241}$ Am and $^{238,239/240}$Pu present in the sample. For routine operation, AEA system performance is checked once every week using a mixed alpha source standard. The FWHM, peak centroid, and activity are monitored using statistical or fixed limits. Counting frequency of performance check standards is performed according to WSCF procedure. The recovery of the radionuclides and the calibration of the system are checked on a batch basis by running a method standard under the identical conditions as the sample.**

- **The laboratory method for determining $^{90}$Sr/$^{90}$Y-beta activity consists of a dissolution step and chemical separation, followed by total-beta counting. Analysis is usually done on only composite samples consisting typically of multiple biweekly air filters. A calibration procedure for window-type gas-flow proportional counters is used in conjunction with a procedure for mother/daughter cases (e.g., $^{90}$Sr/$^{90}$Y in-growth calibration). Recalibration of the system is performed only when the responsible scientist finds it necessary based on QC performance. The performance of the beta-counting system is checked by running instrument control standards ($^{60}$Co and $^{137}$Cs for beta activity) with each batch of samples. The complete procedure for the $^{90}$Sr/$^{90}$Y analysis in the sample is carried out with a method standard (several filter papers spiked with $^{90}$Sr, $^{241}$Am, $^{239}$Pu) and preparation blank on a batch basis. This checks the overall method performance. The chemical yield is determined by using the appropriate radioactive tracers ($^{85}$Sr) or stable Sr carrier.**

- **For analysis of gamma emitters $^{134}$Cs, $^{137}$Cs, $^{106}$Ru, $^{60}$Co, $^{152}$Eu, $^{154}$Eu, $^{155}$Eu, $^{125}$Sb, and any other positive gamma peak except radon and thoron daughters, a WSCF procedure is followed. Analysis is done on composite samples consisting typically of multiple biweekly air filter samples. Analysis of volatile radionuclides (e.g., $^{129}$I, $^{106}$Ru, $^{125}$Sb) collected monthly on silver zeolite cartridges are performed to procedure. Calibration of the gamma ray spectrometer is done with the procedure documented using a NIST-traceable certified mixed gamma ray standard. Recalibration is carried out only when it is deemed necessary by a responsible scientist based on QC performance. The performance of each detector of the GEA system over the specified energy range is checked for energy and efficiency calibration once a day by running a mixed gamma check standard consisting of $^{241}$Am for low energy, $^{137}$Cs for mid energy, and $^{60}$Co for high energy. The analytical results on each of these radionuclides should fall within the administratively limits set according to the laboratory QA plan or appropriate description-of-services document. The daily performance results of the detectors are documented. Minor adjustments of the electronics (i.e., fine gain, pole zero of the amplifiers, lower level discriminator of analog-to-digital converter, etc.) are done from time to time when necessary for correcting small energy calibration shift. Whenever a minor electronic adjustment is done on a detector, the adjustment is followed by analysis of a performance check standard at a scientist's discretion. For a major shift in the calibration, the system is thoroughly calibrated for both energy and efficiency.**

- **The content of the WSCF procedures, test plans, supporting documents, and drawings provides a sufficient level of detail to allow trained personnel to safely produce quality results. Laboratory procedures are controlled as required. The specific content of laboratory procedures is defined by its author, based on accepted methods such as 40 CFR 61, Appendix B, Method 114. The content must be agreed to by peer and technical reviewers. While authors are responsible for the specific content of their procedures, authors address the following:**

**<u>Summary</u> - MANDATORY. A short description or abstract of the procedure is provided containing enough information to distinguish this procedure from other procedures.**

**Applications - MANDATORY. The scope and purpose of the specific procedure is defined. This section could be combined with the following element under the title "Applications and Limitations."**

**Limitations - MANDATORY. A brief description of those areas in which the procedure is not applicable. A statement of accuracy and precision is given where appropriate.**

**Quality Control Protocol - Procedures used to support environmental projects are identified that have specific QC requirements. For these procedures, the source of the QC requirements is identified. The samples or project that this element applies to are identified. The following information is typical of QC requirements: frequency and type of calibration, reagent blank analysis, spike sample analysis, and duplicate sample analysis.**

**Approval Designator - MANDATORY. Approval designators are identified for each procedure with a brief basis of determination statement.**

**The procedures usually are specific to one activity. These activities are well defined using common scientific instrumentation and equipment operated in an acceptable manner. The chemicals and materials used are normally small quantities with limited potential for environmental or personnel safety impact. In general, the equipment used in the laboratory is not classified as Safety Class 3 or higher.**

**Safety - MANDATORY. The procedure must identify applicable safety hazards.**

**Reagents - If the procedure requires analytical reagents, a list of reagents is provided. Material safety data sheets (MSDS) are available. Reagent makeup, storage container requirements, unique storage needs, shelf-life requirements, special labeling, and special preparation steps are included when applicable. Reagent preparation described fully in other current documentation could be included by reference.**

**Equipment - Special equipment needs are listed. Standard hood or glovebox equipment is assumed to be available at the work station and does not need to be listed. The fabrication of off-standard equipment is referenced or described in this section.**

**Procedure Steps - MANDATORY. A step-by-step description of operations necessary to perform the task is presented in a logical and sequentially numbered order or an assignment of responsibilities. CAUTIONS and WARNINGS notations are included for the applicable safety hazard before the action is described. Steps with potential for criticality specification violation are identified. Explanatory 'Notes' could be included for clarification of process.**

**Calculations - Calculations required to complete the work are described. Examples with sample values can be included. All combined factors are described fully and units noted.**

**Calibrations - When calibrations are required, a description of how to carry out required calibrations is given.**

**Discussion - A discussion is provided of the theoretical aspects of the procedure. Brief identification of unique characteristics and interfaces to aid in troubleshooting could be included.**

**References - A reference list of published information to provide a technical basis for the procedure could be included.**

**The mandatory topics are addressed WSCF analytical procedures. However, the laboratories have operational, analytical, and administrative procedures. Non-mandatory topics are included if appropriate to the activity covered by the procedure.**

4.3.6 A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

*Response:* **Not applicable to this point-by-point comparison focused on WSCF analytical methods.**

4.3.7 A description of the effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

*Response:* **Not applicable to this point-by-point comparison focused on WSCF analytical methods.**

4.4 The objectives of the quality assurance program shall be documented and state the required precision, accuracy and completeness of the emission measurement data including a description of the procedures used to assess these parameters. Accuracy is the degree of agreement of a measurement with a true or known value. Precision is a measure of the agreement among individual measurements of the same parameters under similar conditions. Completeness is a measure of the amount of data obtained compared to the amount expected under normal conditions.

*Response:* **Refer to Section 3.4 of the main body of this document, HNF-EP-0835, Rev. 18.**

**Precision is a measure of the agreement among individual measurements of the same parameter under similar conditions and is estimated by means of duplicate/replicate analyses. Analytical method precision is estimated using laboratory control standards (method) over time and does not reflect the measure of precision in sample matrices.**

**Precision can be determined by the relative standard deviation (RSD) or relative percent difference (RPD). The RSD is used when at least three replicate measurements are performed on a given technique. The RSD is computed using the following equation:**

**RSD = 100*s/x, where s is standard deviation with n-1 degrees of freedom, n total number of observed values, and x mean of observed values.**

**The RPD is used when two measurements exist. The RPD is computed using the following equation:**

**RPD = (x1 - x2)*100/x, where x1, x2 are observed values and x mean of observed values.**

**Accuracy is defined as the closeness of agreement between an observed value and an accepted reference value. The accuracy of analytical methods is determined using percent recovery. As a basic QC protocol, the evaluation of blind, laboratory control (method standards) appropriate performance evaluation samples (U.S. DOE Mixed Analyte Performance Evaluation Program) might be used to provide the percent recovery (P). However, this can be superseded by the customer's requirements as stated in a description-of-services document or statement of work.**

**P = 100 * R/K, where R is the measured activity of the standard and K is the known value of the standard.**

**Completeness is a measure of the amount of reported data compared to the amount of data requested, as defined in a description-of-services document or a statement of work (i.e., HNF-PRO-0835).**

4.5 A quality control program shall be established to evaluate and track the quality of the emissions measurement data against preset criteria. The program should include where applicable a system of replicates, spiked samples, split samples, blanks and control charts. The number and frequency of such quality control checks shall be identified.

*Response:* **Quality performance within each analytical measurement system (AMS) is maintained by the ability to detect when an AMS is not performing to specifications and to document the deviation as well as the corrective action. The following QC options are used to evaluate the listed components that could affect the quality of the AMS. Where possible, the QC options presented are used. Each analytical batch has at least a blank, laboratory control standard (method), and samples.**

| Option | Component |
|---|---|
| Laboratory control sample or QC standard (method standard) | Accuracy, and gross operation of instrument, reagents, dilution, and technique |
| Replicate analysis ( for composite only)* | Precision |
| Tracer | Matrix interference and chemical yield |
| Preparation blank | Contamination |
| Instrument control standards | Instrument stability |

*** Each stack sample collection point produces only one record sample filter that is sent to the laboratory for analysis; no replicate samples are available, although ambient air samples can be "duplicated" to yield essentially a replicate or split sample. Repeat counting of the sample mounts, if needed, can be performed using other detectors at the discretion of the scientist in charge.**

**Radioanalyte matrix spikes are not used. However, tracer isotopes $^{243}$Am, $^{242}$Pu ( or $^{236}$Pu) and $^{85}$Sr are used in the analysis of $^{241}$Am, $^{238}$Pu, $^{239,240}$Pu, and $^{90}$Sr, respectively, in composites of typically multiple biweekly filter samples to determine matrix interference and the yield.**

**The laboratory does not split samples. There is no guarantee that the distribution of material on the filter would be homogeneous. Because of this, no sampling procedure, such as splitting, can be assured of producing two representative portions. Splitting the sample in effect dilutes the sample, which would adversely affect the method detection limits.**

**Blank filters from the same manufacturer and type are used in analysis of a batch of air filter composite samples. Blank filter holders (i.e., planchets) are used to check the background of the counting instrument.**

**The parameters used in a QC program to monitor and evaluate AMS performance on standards are warning and control limits. These usually are obtained by the statistical evaluation of the laboratory control standard data over time and set to two sigma (warning) and three sigma (control limit). However, the customer and the chemist might require setting the limit for accepting the accuracy or the recovery of a laboratory standard, such as 25 percent at the 95-percent confidence interval as stated in the annual statement of work the Effluent and Environmental Monitoring Program has with WSCF.**

**The counting room instruments software can generate instrument control charts based on instrument control standard, background, efficiency data, etc. The method control chart can be generated from the Laboratory Information Management System (LIMS) such as Omni-LIMS or an equivalent. These charts are updated and evaluated regularly.**

**The WSCF Radiochemistry Laboratory Quality Control Program also includes participation in the U.S. DOE Mixed Analyte Performance Evaluation Program.**

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sample collection, analysis and reporting system. Sample handling and preservation procedures shall be established to maintain the integrity of samples during collection, storage and analysis.

*Response:* **These samples come from fixed sample points and are analyzed according to an established description-of-services document that is reviewed and revised annually.**

**When barcoding of samples is performed, traceability begins with the ABCASH database issuance of a unique sample identifier (in this format: Sxxxxxx) for the customer. With this number, the database references the sample point and the date and time the sample was in service, the date and time the sample was removed, and the total flow. ABCASH also generates chain-of-custody paperwork from the moment of sampling, through shipping, and receipt at the laboratory.**

**When the samples are brought to the laboratory, the sample custodian or chemical technician uses ABCASH to generate a laboratory receipt chain of custody by scanning the sample barcodes. The samples are entered into the laboratory database, such as Omni-LIMS or equivalent, where another unique identifier is issued (WYYFxxxxxxx). For each sample covered by the description-of-services document, the Omni-LIMS or equivalent has the associated required analysis protocols and analytes. The database generates a worklist that lists each sample by both laboratory and customer identification, and the required analyses. The results of the initial analyses are transferred electronically from the instrument to the Omni-LIMS or equivalent database. After validation, the results are uploaded electronically to ABCASH. The samples are archived for periodic compositing and eventual nondestructive and subsequent destructive analyses. The results of these analyses are input to Omni-LIMS or equivalent, and again, after validation, the results are sent electronically to the customer's database (i.e., Environmental Release Summary [ERS]) database via ABCASH.**

4.7 Regular maintenance, calibrations and field checks shall be performed for each sampling system in use by satisfying the requirements found in Table 2: Maintenance, Calibration and Field Check Requirements.

Table 2 – Maintenance, Calibration, and Field Check Requirements

| Sampling System Components | Frequency of Activity |
|---|---|
| Cleaning of thermal anemometer. | As required by application |
| Inspect pitot tubes for contaminant deposits. | At least annually. |
| Inspect pitot tube systems for leaks. | At least annually. |
| Inspect sharp-edged nozzles for damage. | At least annually or after maintenance that could cause damage. |
| Check nozzles for alignment, presence of deposits, or other potentially degrading factors. | Annually. |
| Check transport lines of HEPA-filtered applications to determine if cleaning is required. | Annually. |
| Clean transport lines. | Visible deposits for HEPA-filtered |

| | |
|---|---|
| | applications. Surface density of 1 $g/cm^2$ for other applications. |
| Inspect or test the sample system for leaks. | At least annually. |
| Check mass flow meters of sampling systems with a secondary or transfer standard. | At least quarterly. |
| Check sampling flow rate through critical flow venturis. | At the start of each sampling period. |
| Inspect rotameters of sampling systems for presence of foreign matter. | At the start of each sampling period. |
| Check response of stack flow rate systems. | At least quarterly. |
| Calibration of flow meters of sampling systems. | At least annually. |
| Calibration of effluent flow measurement devices. | At least annually. |
| Calibration of timing devices. | At least annually. |

*Response:* **Not applicable.**

4.8 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

*Response:* **Laboratory and data quality personnel perform internal audits on laboratory analytical activities. Those internal audits do not supplant the activities of the organizations directed by policy to perform company-wide audits and surveillances, nor does the laboratory QAPP cover personnel.**

4.9 A corrective action program shall be established including criteria for when corrective action is needed, what corrective action will be taken and who is responsible for taking the corrective action.

*Response:* **WSCF follows the corrective action system defined in MSC-SD-CP-QAPP-017 and in MSC-PRO-052, *Corrective Action Management.***

4.10 Periodic reports to responsible management shall be prepared on the performance of the emissions measurements program. These reports should include assessment of the quality of the data, results of audits and description of corrective actions.

*Response:* **Not applicable to this point-by-point comparison focused on WSCF analytical methods.**

4.11 The quality assurance program should be documented in a quality assurance project plan which should address each of the above requirements.

*Response:* **Refer to MSC-SD-CP-QAPP-017, MSC-23333, and to Section 3.4 of this document, HNF-EP-0835, Rev. 18.**

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| B. S. Parsons | |
| K. A. Peterson | |
| C. J. Perkins | |
| J. A. Querin | S3-28 |
| C. R. Ramos | |
| D. J. Rokkan (5) | H7-28 |
| R. A. Westberg | |
| N. L. Wilson | |

| | |
|---|---|
| Washington Closure Hanford, LLC | |
| D. L. Johnson | L7-10 |
| J. H. Kessner | |
| R. J. Landon | |
| M. L. Rau | |
| J. G. Woolard | H4-21 |
| D. M. Yasek | |
| | |
| Washington River Protection Solutions, LLC | |
| L. E. Borneman | |
| R. J. Calderon (2) | S5-02 |
| G. M. Crummel | |
| D. L. Dyekman | |
| J. D. Guberski | |
| S. E. Killoy | |
| J. A. Voogd | |

*Those people listed without an MSIN will receive the document in electronic form only. A limited number of hardcopies are available upon request.

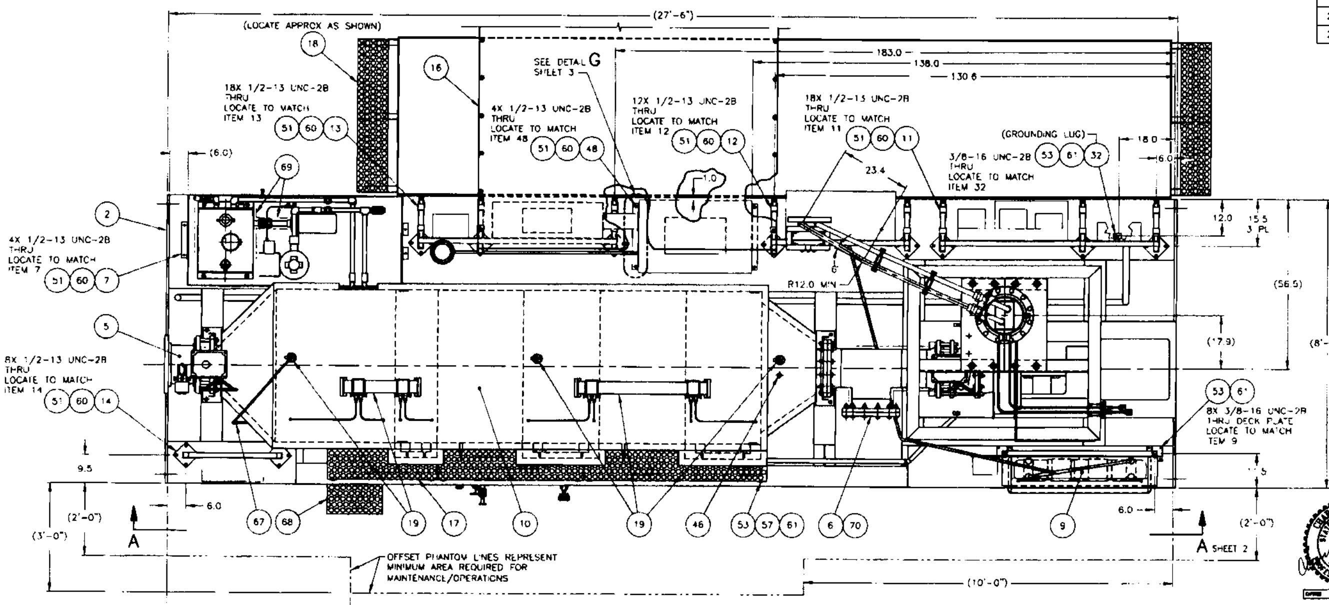
| QTY -010 | PARTS / DASH NUMBER | NOMENCLATURE/DESCRIPTION | MATERIAL/REFERENCE | SHEET | ITEM NO |
|---|---|---|---|---|---|
| 22 | | PLAIN WASHER, 3/8 (SERIES AND TYPE OPTIONAL) | 18-8 SST | | 57 |
| 16 | | PLAIN WASHER, 7/8 (SERIES AND TYPE OPTIONAL) | 18-8 SST | | 58 |
| 1 | SS-1210-R-8 | REDUCER, 3/4" X 1/2" | SWAGELOK | | 59 |
| 81 | | LOCK WASHER, HELICAL SPRING, 1/2 RGLR | 18-8 SST | | 60 |
| 31 | | LOCK WASHER, HELICAL SPRING, 3/8 RGLR | 18-8 SST | | 61 |
| 8 | | LOCK WASHER, HELICAL SPRING, 7/8 RGLR | 18-8 SST | | 62 |
| 1 | 9889T43 | U BOLT, 1/4-20 FOR 1" PIPE, TYPE 304 SST | McMASTER-CARR | | 63 |
| 17 | | HEX NUT, 1/2-13 UNC-2B | ASTM A194 GR 8F | | 64 |
| 4 | | HEX NUT, 3/8-16 UNC-2B | ASTM A194 GR 8F | | 65 |
| 8 | | HEX NUT, 7/8-9 UNC-2B | ASTM A194 GR 8F | | 66 |
| 2 | SS-810-9 | UNION ELBOW, 1/2 TUBE FITTING X 1/2 TUBE FITTING | SWAGELOK | | 67 |
| 1 | H-14-105539-100 | REMOVABLE STEP ASSEMBLY | | | 68 |
| 1 | H-14-105542-010 | HEATER INSULATION ASSEMBLY | | | 69 |
| 1 | H-14-105542-020 | OUTLET SPOOL INSULATION ASSEMBLY | | | 70 |
| 1 | H-14-105542-030 | STACK INSULATION ASSEMBLY | | | 71 |
| 1 | H-14-105542-040 | SEAL POT INSULATION ASSEMBLY | | | 72 |
| 1 | H-14-105542-050 | DRAIN PIPE INSULATION ASSEMBLY | | | 73 |
| 1 | H-14-105542-060 | EMS TUBING INSULATION ASSEMBLY | | | 74 |
| 1 | H-14-105542-070 | EMS RETURN LINE INSULATION ASSEMBLY | | | 75 |
| 2 | SS-810-7-8 | FEMALE CONNECTOR, 1/2 FEMALE NPT X 1/2 TUBE FITTING | SWAGELOK | | 76 |
| AR | | TUBING, 1/2 OD X .049 WALL, SMLS | ASTM A269 TYPE 304L OR 316L | | 77 |
| 1 | BEN 664-12CHC | 6" X 6" ENCLOSURE | HOFFMAN OR EQUIVALENT | | 78 |
| 1 | NO. 5305 | SEALING RING | T & B OR EQUIVALENT | | 79 |
| 1 | NO. 5306 | SEALING RING | T & B OR EQUIVALENT | | 80 |
| 2 | | HEX BOLT, 1/4-20 UNC-2A X 1" LONG | ASTM A193 GR B8 | | 81 |
| 2 | | LOCK WASHER, HELICAL SPRING, 1/4 RGLR | 18-8 SST | | 82 |
| 8 | P1010EG | CHANNEL NUT W/ SPRING | UNISTRUT | | 84 |
| 8 | H-HCS050150EG | HEX HD CAP SCREW, 1/2-13 UNC-2A X 1 1/2 LONG | UNISTRUT | | 85 |

14 (flag note, item 85)

| QTY -010 | PARTS / DASH NUMBER | NOMENCLATURE/DESCRIPTION | MATERIAL/REFERENCE | SHEET | ITEM NO |
|---|---|---|---|---|---|
| 10 | P2034 HG | GALVANIZED TUBING CLAMP | UNISTRUT | | 30 |
| 1 | C-SD20208LG | INSTRUMENT CONNECTION ENCLOSURE | HOFFMAN | | 31 |
| 1 | 2-250T | GROUNDING LUG, TWO CONNECTOR | SOUTHPORT INDUSTRIES | | 32 |
| 1 | SEE NOTE 10 | EXHAUST FAN AND MOTOR ASSEMBLY | AIR TECH | | 33 |
| 1 | SS-65TW16P40-LLK | BALL VALVE, 1" | WHITEY | | 34 |
| 2 | 3434-7-V-304L | TUBE UNION, O-RING, 1 1/2 SOCKETWELD, D TO MATCH .065 WALL TUBE | HART INDUSTRIES | | 35 |
| 1 | F-66W12SS | WIRE WAY, 6 X 6 X 12 LONG TYPE 4X | HOFFMAN | | 36 |
| 1 | SS-45S8 | INSTRUMENT BALL VALVE, 1/2" TUBE FITTINGS | SWAGELOK | | 37 |
| 1 | SS-810-P | PLUG, 1/2" | SWAGELOK | | 38 |
| 1 | SS-1210-3 | UNION TEE, 3/4" | SWAGELOK | | 39 |
| AR | | TUBING, 1 1/2 OD X .065 WALL, SMLS | ASTM A269 TYPE 304L | | 40 |
| 1 | | TUBING, 1 1/4 OD X .065 WALL X 3.0 LONG, SMLS | ASTM A269 TYPE 304L | | 41 |
| 1 | | TUBING REDUCER, CONCENTRIC BUTT WELD, 1 1/2 OD X 1 1/4 OD X .065 WALL | ASTM A269 TYPE 304L | | 42 |
| AR | | PIPE, 1" SCHED 40S | ASTM A312 GR TP 304L | | 43 |
| 20 | | ELBOW, 90°, 1" LR, SCHED 40S, BW | ASTM A403 WP 304L | | 44 |
| 1 | | ELBOW, 45°, 1" LR, SCHED 40S, BW | ASTM A403 WP 304L | | 45 |
| 1 | | PIPE CAP, 1" NPT, CLASS 150 | ASTM A182 GR F 304L | | 46 |
| AR | | TUBING, 3/4 OD X .065 WALL, SMLS | ASTM A269 TYPE 304L OR 316L | | 47 |
| 2 | | ANGLE, 2 X 2 X 1/4 THK X 22.0 LONG | ASTM A276 TYPE 304L | | 48 |
| 2 | 8896T105 | U-BOLT, 1/4-20 FOR 1" PIPE, TYPE 304 SST | McMASTER-CARR | | 49 |
| 16 | | HEX BOLT, 1/2-13 UNC-2A X 1 1/2 LONG | ASTM A193 GR B8 | | 50 |
| 64 | | HEX BOLT, 1/2-13 UNC-2A X 1" LONG | ASTM A193 GR B8 | | 51 |
| 4 | | HEX BOLT, 3/8-16 UNC-2A X 1 1/2 LONG | ASTM A193 GR B8 | | 52 |
| 37 | | HEX BOLT, 3/8-16 UNC-2A X 1" LONG | ASTM A193 GR B8 | | 53 |
| 8 | | HEX BOLT, 7/8-9 UNC-2A X 3" LONG | ASTM A193 GR B8 | | 54 |
| 1 | F-66WGSS | WIRE WAY GASKET & SCREW SET | HOFFMAN | | 55 |
| 36 | | PLAIN WASHER, 1/2 (SERIES AND TYPE OPTIONAL) | 18-8 SST | | 56 |

## PARTS LIST/MATERIAL LIST

| QTY -010 | PARTS / DASH NUMBER | NOMENCLATURE/DESCRIPTION | MATERIAL/REFERENCE | SHEET | ITEM NO |
|---|---|---|---|---|---|
| X | -010 | ASSEMBLY, VENTILATION EXHAUSTER "A" | | 1 | 1 |
| 1 | H-14-105530-010 | SKID WELDMENT | | | 2 |
| 1 | H-14-105531-010 | UPPER STACK ASSEMBLY | | | 3 |
| 1 | H-14-105531-020 | LOWER STACK ASSEMBLY | | | 4 |
| 1 | H-14-105532-010 | INLET SPOOL ASSEMBLY | | | 5 |
| 1 | H-14-105533-010 | OUTLET SPOOL ASSEMBLY | | | 6 |
| 1 | H-14-105534-010 | HEATER ASSEMBLY | | | 7 |
| 1 | H-14-105535-010 | SEAL POT ASSEMBLY | | | 8 |
| 1 | H-14-105536-010 | EFFLUENT MONITORING PUMP ASSEMBLY | | | 9 |
| 1 | 02 HD 295 | FILTER SYSTEM (RIGHT HAND) | FLANDERS/CSC | | 10 |
| 1 | H-14-105538-010 | UNISTRUT ASSEMBLY | | | 11 |
| 1 | H-14-105538-020 | UNISTRUT ASSEMBLY | | | 12 |
| 1 | H-14-105538-030 | UNISTRUT ASSEMBLY | | | 13 |
| 1 | H-14-105538-040 | UNISTRUT ASSEMBLY | | | 14 |
| 1 | H-14-105539-010 | STACK SUPPORT PLATE | | | 15 |
| 1 | H-14-105551-010 | SUN SHIELD ASSEMBLY | | | 16 |
| 1 | H-14-105539-030 | OPEN GRIP PLANK ASSEMBLY | | | 17 |
| 1 | H-14-105537-010 | PLATFORM ASSEMBLY | | | 18 |
| 1 | H-14-105540-010 | INSTRUMENT ASSEMBLY | | | 19 |
| 1 | H-14-105541-010 | LIFTING FIXTURE ASSEMBLY | | | 20 |
| 1 | H-14-105563-010 | FIELD TERMINAL ENCLOSURE ASSEMBLY | | | 21 |
| 1 | H-14-105564-010 | PLC CABINET ASSEMBLY | | | 22 |
| 1 | H-14-105565-010 | POWER ASSEMBLY | | | 23 |
| 1 | H-14-105565-020 | HEAT TRACE CABINET | | | 24 |
| 1 | H-14-105565-030 | VACUUM PUMP RELAY CABINET | | | 25 |
| 1 | H-14-105565-050 | MINI POWER ZONE | | | 26 |
| 1 | H-14-105566-010 | SAMPLE CABINET ASSEMBLY | | | 27 |
| 2 | P1000 HG | GALVANIZED CHANNNEL, 8.0 LONG | UNISTRUT | | 28 |
| 2 | P1000 HG | GALVANIZED CHANNNEL, 14.0 LONG | UNISTRUT | | 29 |




(1) **ASSEMBLY, VENTILATION EXHAUSTER "A" (TOP VIEW)**
SCALE: 3/4" = 1'-0"

DIMENSIONING AND TOLERANCING SHALL BE INTERPRETED PER ANSI Y14.5M-1994
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED

UNSPECIFIED TOLERANCES SHALL BE:
DECIMAL .X ± .1 .XX ± .06 .XXX ± .030
ANGULAR ± 2°

ALL IMPLIED 90° ANGLES SHALL BE PERPENDICULAR WITHIN THE GREATEST TOLERANCE OF THE LINEAR DIMENSIONS

ALL COAXIAL FEATURES SHALL BE CONCENTRIC WITHIN .031 INCH UNLESS OTHERWISE SPECIFIED

## GENERAL NOTES:

1. FABRICATION AND WELDING SHALL BE IN ACCORDANCE WITH THIS DRAWING AND SPECIFICATION PTI-W314-TS-001.
2. APPROXIMATE WEIGHT OF ASSEMBLY:
   - LESS LIFTING FIXTURE = 22,200 POUNDS
   - LESS LIFTING FIXTURE AND UPPER STACK = 21,320 POUNDS
3. ABBREVIATIONS ARE IN ACCORDANCE WITH ANSI Y1.1.
4. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
5. VACUUM PUMP RELAY CABINET (ITEM 25) SHALL BE LOCATED APPROX WHERE SHOWN AND ATTACHED WITH SST FASTENERS SIZED AS REQUIRED TO MATCH CABINET.
6. DISASSEMBLE BALL VALVE (ITEM 34) PRIOR TO WELDING.
7. FOR SAMPLE TUBING RUNS (FROM PROBES TO CAM AND RECORD SAMPLER):
   - THERE SHALL BE NO INWARD FACING STEPS AT THE TUBING CONNECTIONS THAT CAUSE MORE THAN A 1% REDUCTION IN TUBE DIAMETER.
   - THE TUBING ENDS SHALL BE FREE OF BURRS AND CRIMPING.
   - BENDS SHALL HAVE A CURVATURE RATIO (RADIUS OF CURVATURE OF THE BEND DIVIDED BY THE TUBE DIAMETER) OF AT LEAST 3.0
   - FLATTENING OF THE BEND CAUSED BY A BENDING PROCESS SHALL NOT EXCEED 15%, WHERE FLATTENING IS DEFINED IN TERMS OF THE ORIGINAL AND MINOR AXES OF THE TUBE CROSS SECTION AT THE ANGULAR MIDPOINT OF THE BEND.

   SPECIAL FABRICATION TECHNIQUES MAY BE REQUIRED TO MEET THESE SPECIFICATIONS (ANSI/HPS N13.1-1999).
8. PROVIDE HOLD DOWN CLIPS AS REQUIRED ON ALL FIELD RUN TUBING. SPACING BETWEEN CLIPS SHALL NOT EXCEED 6'-0"
9. NAME TAGS DENOTING EQUIPMENT IDENTIFICATION NUMBERS WILL BE PROVIDED BY CUSTOMER. TAGS SHALL BE LOCATED ON THE IDENTIFIED ASSEMBLY COMPONENTS IN LOCATIONS THAT ARE CLEARLY VISIBLE AFTER FINAL ASSEMBLY. SEE EQUIPMENT IDENTIFICATION SCHEDULE ON SHEET 2 (ZONE 8-E).
10. ITEM 33 SHALL BE AIR TECH MODEL TROH 24A, CLASS 100 SWSI, ARRANGEMENT 8 (CCW ROTATION FROM DRIVE END) RATED FOR 2851 ACFM @ 24" SP AT 3545 RPM @ 20.07 BHP AT .052#/FT3 WITH FACTORY MOUNTED 20 HP, 3600 RPM, 3/60/230/460V, VFD READY TEFC MOTOR.
11. APPLY LOCTITE THREAD LOCKER 262 PER MANUFACTURER'S INSTRUCTIONS
12. ATTACH HOFFMAN WIRE WAY (ITEM 36) TO ITEMS 21 AND 22 USING GASKET AND SCREW SET (ITEM 55) PER MANUFACTURER'S INSTRUCTIONS. LOCATE ITEM 36 AS REQD TO MATCH CUT OUTS IN ITEMS 21 AND 22.
13. FIELD ROUTE 1/2" TUBING FROM SEAL POT TO RTD COUPLING. ENSURE THAT THE TUBING SLOPES DOWNWARD CONTINUOUSLY FROM THE RTD COUPLING TO THE SEAL POT SUCH THAT ANY FLUIDS IN THE TUBE DRAIN INTO THE SEAL POT
14. MINIMUM (4) 1/2-13 UNC-2A BOLTS ANCHORING EACH LEG OF THE SUN SHIELD ASSEMBLY (ITEM 16) TO THE UNISTRUT FRAMING. LOCATION OF THE 9/16 THRU HOLES IN THE UNISTRUT FRAMING (ITEMS 12 & 13) AS REQD.

| DWG NO | TITLE | REF NUMBER | TITLE |
|---|---|---|---|
| DRAWING TRACEABILITY LIST | | REFERENCES | |
| | | NEXT USED ON H-14-105525 | |

| REV NO | DESCRIPTION | |
|---|---|---|
| 5 | INCORPORATED DCN-408 & AS-BUILT | |
| 4 | INCORPORATED DCN-395 & AS-BUILT | SIGNATURES ON FILE |
| 3 | INCORPORATED DCN-351 & AS-BUILT | SIGNATURES ON FILE |
| 2 | -320 & AS-BUILT INCORPORATED DCN-272, -286, | SIGNATURES ON FILE |
| 1 | -149, -157, -190, -266 & AS-BUILT INCORPORATED DCN-022, -065, | SIGNATURES ON FILE |

REVISIONS

MAR 31 2004

PREMIER Technology, Inc.
GForce engineering & technology

NAME: RK FISHER
SIGNATURES ON FILE
D. Bowers

U.S. DEPARTMENT OF ENERGY
Office of River Protection

**AN241 EXHAUSTER TRAIN "A" ASSEMBLY**

| SIZE | BLDG NO | INDEX NO | DWG NO | REV |
|---|---|---|---|---|
| F | 241AN | 8900 | H-14-105529 | 5 |

SCALE: SHOWN | 820447 | SHEET 1 OF 4

BLDG. NO | INDEX NO. | H-14-105529

S

# ENGINEERING CHANGE NOTICE

Page 1 of 5

1. ECN 664102

Proj. ECN W314-SAZ-004

| 2. ECN Category (mark one) | 3. Originator's Name, Organization, MSIN, and Telephone No. | 4. USQ Required? | 5. Date |
|---|---|---|---|
| Supplemental ○<br>Direct Revision ◉<br>Change ECN ○<br>Temporary ○<br>Standby ○<br>Supersedure ○<br>Cancel/Void ○ | BD Andres, Vista Eng., R3-25, 372-1983 | ◉ Yes ○ No<br>A-03-2685-AA | 5/29/03 |
| | 6. Project Title/No./Work Order No.<br>Project W314, Tank Farm Restoration and Safe Operations | 7. Bldg./Sys./Fac. No.<br>241-AN/AW | 8. Approval Designator<br>QE |
| | 9. Document Numbers Changed by this ECN (includes sheet no. and rev.)<br>RPP-7881, Rev 0-A | 10. Related ECN No(s).<br>N/A | 11. Related PO No.<br>N/A |

| 12a. Modification Work | 12b. Work Package No. | 12c. Modification Work Completed | 12d. Restored to Original Condition (Temp. or Standby ECNs only) |
|---|---|---|---|
| ○ Yes (fill out Blk. 12b)<br>◉ No (NA Blks. 12b, 12c, 12d) | N/A | N/A<br>Design Authority/Cog. Engineer Signature & Date | N/A<br>Design Authority/Cog. Engineer Signature & Date |

13a. Description of Change

13b. Design Baseline Document? ◉ Yes ○ No

Make changes to procurement specification RPP-7881 Rev 0-A as shown with redline changes. See pages 3-4 of this ecn for a detailed description of changes.

| 14a. Justification (mark one) | 14b. Justification Details |
|---|---|
| Criteria Change ○<br>Design Improvement ◉<br>Environmental ○<br>Facility Deactivation ○<br>As-Found ○<br>Facilitate Const. ○<br>Const. Error/Omission ○<br>Design Error/Omission ○ | This change is required to facilitate purchase of a replacement Primary Exhaust System for waste tank ventilation.<br><br>Design verification performed by individual review per TFC-ENG-DESIGN-P-17, Rev A-1. The review documentation is accomplished by approval signature on the Design Verification Record. |

15. Distribution (include name, MSIN, and no. of copies)

| | | | |
|---|---|---|---|
| JW Bailey | R3-25 | RD Gustavson | R3-83 |
| TL Bennington | R3-25 | DE Bowers | S5-08 |
| BD Andres | R3-25 | OD Nelson | R3-25 |
| DP Garguilo | R3-25 | S Schrank | R3-25(H) |
| JD Guberski | R1-51 | | |

RELEASE STAMP

JUN 5 2003

DATE:

STA: 4

ID: 58

# ENGINEERING CHANGE NOTICE



1. ECN (use no. from pg. 1): W314-5AZ-004

16. Design Verification Required: ◉ Yes ○ No

17. Cost Impact

| | ENGINEERING | CONSTRUCTION |
|---|---|---|
| Additional | $ N/A | $ N/A |
| Savings | $ N/A | $ N/A |

18. Schedule Impact (days)
- Improvement: N/A
- Delay: N/A

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

| | | | | | |
|---|---|---|---|---|---|
| SDD/DD | ☐ | Seismic/Stress Analysis | ☐ | Tank Calibration Manual | ☐ |
| Functional Design Criteria | ☐ | Stress/Design Report | ☐ | Health Physics Procedure | ☐ |
| Operating Specification | ☐ | Interface Control Drawing | ☐ | Spares Multiple Unit Listing | ☐ |
| Criticality Specification | ☐ | Calibration Procedure | ☐ | Test Procedures/Specification | ☐ |
| Conceptual Design Report | ☐ | Installation Procedure | ☐ | Component Index | ☐ |
| Equipment Spec. | ☐ | Maintenance Procedure | ☐ | ASME Coded Item | ☐ |
| Const. Spec. | ☐ | Engineering Procedure | ☐ | Human Factor Consideration | ☐ |
| Procurement Spec. | ☐ | Operating Instruction | ☐ | Computer Software | ☐ |
| Vendor Information | ☐ | Operating Procedure | ☐ | Electric Circuit Schedule | ☐ |
| OM Manual | ☐ | Operational Safety Requirement | ☐ | ICRS Procedure | ☐ |
| FSAR/SAR | ☐ | IEFD Drawing | ☐ | Process Control Manual/Plan | ☐ |
| Safety Equipment List | ☐ | Cell Arrangement Drawing | ☐ | Process Flow Chart | ☐ |
| Radiation Work Permit | ☐ | Essential Material Specification | ☐ | Purchase Requisition | ☐ |
| Environmental Impact Statement | ☐ | Fac. Proc. Samp. Schedule | ☐ | Tickler File | ☐ |
| Environmental Report | ☐ | Inspection Plan | ☐ | None | ☒ |
| Environmental Permit | ☐ | Inventory Adjustment Request | ☐ | | ☐ |

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

| Document Number/Revision | Document Number/Revision | Document Number/Revision |
|---|---|---|
| None | | |

21. Approvals

| | Signature | Date |
|---|---|---|
| Design Authority | DE Bowers [signature] | 5/29/03 |
| Cog. Eng. | JW Bailey [signature] | 5/29/03 |
| Cog. Mgr. | B Thacker [signature] | 06-04-03 |
| QA | TL Bennington [signature] | 5-30-03 |
| Safety | | |
| Environ. | JD Guberski [signature] | 5/30/03 |
| Other | [signature] NSHL | 5/29/03 |

| | Signature | Date |
|---|---|---|
| Design Agent | | |
| PE | | |
| QA | | |
| Safety | | |
| Design | | |
| Environ. | | |
| Other | | |

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

SUMMARY OF CHANGES BY PAGE #

Page 1 - Added 241-AW Tank Farm to scope section of specification.

Page 8 - Added requirement for a 2" power conduit that will be used for electical installation at the Hanford site.
- Added requirement for skid mounting holes to be used for installation at the Hanford site.

Page 31 - Deleted requirement for bonding strap over each isolation valve. Valves use metal fasteners which will ensure electrical continuity. Specification still includes a requirement that the skid be designed to ensure that the requirements of NFPA 77 are met to prevent the build-up of static electricity.

Page 33 - Added pneumatic as an option for leak testing heater system.

Page 36 - Added requirement for a vent on the seal pot to allow filling and level measurement.
- Deleted heat trace connection point requirement for condensate line routing to tank. This heat trace is covered on farm installation design.

Page 38 - Clarified NEMA rating for each individual enclosure.

Page 39 - Clarified NEMA rating for individual enclosures.
- Added an option to use MTW insulation on control circuit wiring. THHN/THWN #16 wire is not available.

Page 41 - Added requirement for a pressure transmitter on the discharge of the glycol pump.

Page 42 - Deleted requirement that the record sample line flex hose be stainless. This hose is under vacuum, protected in the sample cabinet and must be compatible with the airstream conditions in 3.1.2.1.
- Added requirement for a vacuum gauge on the record sample line.

Page 43 - Deleted requirement that the CAM sample line flex hose be stainless. This hose is under vacuum, protected in the sample cabinet and must be compatible with the airstream conditions in 3.1.2.1.
- Modified the requirement on the sample flow control valves to allow for buyer approved equals to the specified Hastings model.
- Changed the range of the mass flow controllers to 0 - 4 SCFM.
- Deleted requirement that the sample flow rates be displayed locally in the sample cabinet. Sample flow rates displayed on the HMI in control cabinet.

Page 44 - Delete requirement that the CAM electronics enclosure be located in sample cabinet. CAM electronics enclosure located in Control cabinet due to temp issues.

Page 47 - Deleted requirement that heat trace be divided on each drain line. This would have made the junction boxes inaccessible and very difficult to install. Heat trace will be divided into two sections for the condensate drain system.

Page 56 - Deleted requirement for a 24 hr run-in period prior to testing. 168 hr test will accomplish the same goal of detecting problems after running for a extended period of time.

Page 57 - Deleted requirement for dynamically balancing the glycol pump and sample system vacuum pumps to ISO 1940 requirements.

Page 58-61 - Modified fan flow (vibration) testing requirements.

Page 63 - Added new section for mounting holes to the verification matrix.

# DESIGN VERIFICATION RECORD



**SECTION 1:** (TO BE COMPLETED BY DESIGN ORIGINATOR)

DOCUMENT/PACKAGE TO BE VERIFIED: ECN-W314-SAZ-004

☒ SAFETY CLASS ○ SAFETY SIGNIFICANT ○ GENERAL SERVICE

SUPPORTING/REFERENCE DOCUMENTS ATTACHED

TYPE OF DESIGN VERIFICATION TO BE CONDUCTED: ☒ INDIVIDUAL DESIGN REVIEW ☐ ALTERNATE CALCULATION ☐ TEAM DESIGN REVIEW ☐ QUALIFICATION TESTING

DESIGN VERIFIER ASSIGNED: DP Garguilo

DESIGN ORIGINATOR: (SIGNATURE AND DATE)

**SECTION 2:** (TO BE COMPLETED BY DESIGN VERIFIER)

RESULTS OF VERIFICATION:

| YES | NO | |
|---|---|---|
| ☑ | ☐ | Were the design inputs correctly selected? |
| ☑ | ☐ | Are assumptions necessary to perform the design activity adequately described and reasonable? |
| ☑ | ☐ | Where necessary, are the assumptions identified for subsequent reverifications when the detailed design activities are completed? |
| ☑ | ☐ | Was an appropriate design method used? |
| ☑ | ☐ | Were the design inputs correctly incorporated into the design? |
| ☑ | ☐ | Is the design output reasonable compared to design inputs? |
| ☐ | ☐ | Are the necessary design input and verification requirements for interfacing organizations specified in the design documents or in supporting procedures or instructions? |
| ☑ | ☐ | Have suitable materials, parts, processes, and inspection and testing criteria been specified? |

COMMENTS:

COMMENTS, ERRORS, OR DEFICIENCIES IDENTIFIED: ☐ YES ☒ NO

VERIFICATION PERFORMED BY: (PRINTED NAME, SIGNATURE AND DATE OF ALL PARTICIPANTS)

DP Garguilo [signature] 5/29/03

**SECTION 3: RESOLUTION AND APPROVAL**

RESOLUTION OF COMMENTS, ERRORS, OR DEFICIENCIES:

RESOLUTION PROVIDED BY: (SIGNATURE AND DATE)

RESOLUTION ACCEPTED BY: (DESIGN VERIFIER SIGNATURE AND DATE)

DESIGN VERIFICATION APPROVED: (DESIGN VERIFIER SIGNATURE AND DATE)

RPP-7881 Rev. 0B
Total pgs. 22

# SPECIFICATION FOR A PRIMARY EXHAUSTER SYSTEM FOR WASTE TANK VENTILATION

**Building:** 241-AN/AW Farm

**Project:** W-314

JUN 5 2003
DATE
STA: 4
ID: 58

**Prepared By:**

BD Andres

CH2M Hill Hanford Group

| **Approved By:** | **Date** |
|---|---|
| OD Nelson | |
| JW Bailey | 5/29/03 |
| DE Bowers | 5/29/03 |
| | |
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# SPECIFICATION FOR A PRIMARY EXHAUSTER SYSTEM FOR WASTE TANK VENTILATION

## 1.0 INTRODUCTION

### 1.1 SCOPE

This specification covers the technical requirements for the design, fabrication, testing, delivery and supporting documentation of skid mounted exhauster systems. Two redundant exhauster skids will be used to ventilate the primary vapor space of Hanford's 241-AN and 241-AW Double Shell Tank Farms (a primary and backup for each farm). This document also contains the project management and deliverable data requirements of these exhauster systems.

### 1.2 BACKGROUND

Since 1943, large underground steel-lined concrete storage tanks have been used on the Hanford Site in Richland, Washington, to store byproducts of plutonium production. The tank ventilation systems play a key role in being able to store this waste safely. These exhauster systems will be used to ventilate waste tanks in order to contain and control radioactive emissions to the environment, maintain flammable gas levels within applicable limits, and support retrieval activities during waste feed delivery and treatment.

These exhausters will be connected to each tank utilizing existing tank farm ductwork. Before the tank vapor space air can be discharged to the atmosphere, it must be filtered through two stages of high efficiency particulate air (HEPA) filters. These HEPA filters and their housings, together with a suitable exhaust fan and stack, form the major components of the exhauster. The HEPA filters must be protected from entrained moisture, high humidity and from loading by dust. Therefore, the air entering the system must be heated (and monitored) to lower the relative humidity, and then pre-filtered before entering the first stage of HEPA filtration. Both stages of HEPA filters must be capable of being tested-in-place per ASME N509/510, and ASME AG-1a, to ensure that the desired efficiency is maintained. The pressure drop across each component in the air stream must also be monitored. The flow of air leaving the exhauster must be monitored and the system must be designed to maintain nearly constant flow as the HEPA filters load with particulate and/or as the pressure in the tank vapor space fluctuates. Instrumentation will be installed for monitoring and sampling the exhaust gas for radionuclides.

#### 3.1.2.2 Electrical Connection

The exhauster power connection design shall be capable of operating the exhauster from either a 480V, AC terminal buss connection (3-phase, 4-wire) or a standard weld receptacle (480V, 3-phase, 4-wire). A grounding lug shall be incorporated onto the skid (for equipment ground - not the power system ground). The buyer shall provide location of this lug on the skid. A 2" power conduit routed from the transfer switch enclosure to the duct inlet end of exhaust skid shall be included. This conduit will be used by the buyer to install power at the Hanford site.

#### 3.1.2.3 Seal Pot Condensate Drain

The condensate shall be returned to the buyer's waste tanks by use of a gravity drain (provided by the buyer). A 1" flanged connection shall be provided on the gravity drain lines. A 1/2" flanged connection shall also be provided on the seal pot drain line.

#### 3.1.2.4 Exhauster Inlet Flange Connection

The inlet to the exhauster shall be a 12-inch, Class 150, flanged connection. This flange constitutes the primary interface with the farm ductwork.

#### 3.1.2.5 Exhaust Skid Structural Installation

The design of the exhaust skid shall include mounting holes through base framework to accommodate fastening the skid to a concrete pad during installation at the Hanford site. The buyer shall provide location and size of mounting holes.

## 3.2 CHARACTERISTICS

### 3.2.1 PERFORMANCE

The exhauster shall be capable of producing up to 2000 SCFM or equivalent total mass flow of saturated air (150 lbs/minute) over its entire range of operating conditions. The maximum expected upstream static pressure, as seen at the exhauster inlet flange, shall be no greater than 12 in WG vacuum. This value shall be used to determine system design pressures as described in ASME N509, section 4.6.

steel Grade L. The port length shall be long enough to allow for insulation to be added to the inlet spool section at time of exhauster installation and be threaded to accept a ¼" FNPT fitting.

### 3.3.2.8 Flexible Ductwork

a) To minimize fan induced vibration a flexible duct joint shall be installed on both sides of the fan. The flex joint shall be flanged at both ends and be constructed of Type 300 series stainless steel Grade L. Flanges shall be flat faced and conform to 150# class. One flange shall be welded in place and the other flange to be floating lap type (Vanstone flange). [Hyspan]

b) The flex joints shall be leak tight and be able to withstand the system structural capability pressure as defined in ASME N509, section 4.6.6.1. Both fan inlet and outlet flex joints shall be able to accommodate a minimum lateral flange offset and extension of ½" in each direction, a compression of 1 ½", and a temperature range of -32°F to 170°F. A Type 300 series stainless steel Grade L flow liner shall be provided for each flex joint to accommodate the 2000 SCFM airflow rate.

### 3.3.2.9 Isolation Valves

a) Butterfly valves shall be used to isolate the filter train assembly from the storage tanks and the exhaust fan. Isolation valves shall meet the design requirements of ASME B31.3. Isolation valves shall be Keystone KLOK BFV 360-173, or approved equivalent, with 316 stainless steel body, disc, and stem. Stem packing shall be Teflon and the resilient seat shall be Buna-N. The stem bushing shall be RFTF/Fiberglass Epoxy. The valves shall be furnished with electric actuators and position switches. The electric actuators shall include a standard manual override. Valves shall meet the requirements of ASME N509 for leakage Class I (as defined in paragraph 5.9.1.4.) and shall be individually tested in accordance with ASME N509 section 5.9.7.

b) A 12-inch valve shall be located at the inlet to the heater housing transition section and a TBD-inch valve (sized by the seller) shall be located at the outlet of the filter train assembly transition section. Reach handles shall be provided if easy access to the valves is not attainable. ~~In order to ensure electrical continuity, bonding straps shall extend across each isolation valve.~~

i) All piping shall be pressure tested as an assembly. Hydrostatic or pneumatic leak test heater reservoir and heater system piping per ASME/ANSI B31.3.

### 3.3.2.11 Exhaust Fan and Motor

a) The fan and fan drive shall be designed and tested to ASME N509 and ASME AG-1. The fan shall be tested and rated per AMCA 210 and AMCA 211A.

b) The fan shall meet AMCA Standard 99-0401-86, Type A construction with a CCW or CW (one exhauster will require a CCW and the other will require CW) up blast, AMCA arrangement eight, and be constructed of buyer approved spark-arresting materials. The fan shall be equipped with a factory installed shaft drive and all drive components shall be covered with guards. The fan shall have a 1" IPS drain connection at the low point on the fan housing to allow for attachment of condensate drain piping. The minimum housing thickness shall be no less than ¼". The fan shall be equipped with inlet and outlet flanges with standard bolt patterns. Flange thickness shall be no less than 3/8" and flange faces shall be flat to within a tolerance of ± 1/32". All seams and flanges shall be seal welded. The fan shall be equipped with a bolted access door with 40 – 45 durometer neoprene gasketing (or buyer approved replacement) that is flush with the housing surface. The access door shall be sized to accommodate balancing the fan wheel in place. The bolted inlet collar for access to the fan wheel shall have neoprene gasket 40 – 45 durometer (or buyer approved replacement) between the inlet collar and the fan housing to assure water tightness.

c) The fan shall be selected to operate on the stable portion of its performance curve at a nominal flow range of 1000 to 2000 SCFM. The fan shall be sized to move 2000 SCFM of air at the system maximum operating pressure, as defined in ASME N509 section 4.6.3. Pressure losses through exhaust train shall account for, as a minimum, 5.9 in WG for dirty HEPA filters and 1 in WG across the pre-filter and heater section. Fan sizing shall also include pressure losses through the stack. The fan shall operate at the airstream conditions described in section 3.1.2.1.

d) The fan shall be statically and dynamically balanced per ASME N509 and ASME AG-1 as an assembly. Amplitudes over the motor rpm range of operation shall not exceed those presented in section 5.7.3 of ASME N509 (or Table BA-4162-1 of ASME AG-1).

h) The upper stack section (removable) shall be equipped with lift points provided for lifting and handling, and shall be analyzed by calculation for adequacy. The lifting points and the gross weight of the stack section shall be identified on the drawing and on the stack.

#### 3.3.2.13 Condensate Drain and Seal Pot System

a) The system shall be designed to drain and capture any condensate located in the heater housing, the filter train assembly, or the fan housing to the buyer's waste tanks located at the Hanford site. The condensate shall be returned to the tank by use of a gravity drain. The drain system will need to operate effectively at the maximum negative pressure capacity of the fan. Individual lines from each drainage point in the system shall be sloped a minimum of 1/8" per foot to the seal pot.

b) The seal pot system details are shown on EXHSTR-MECH-15.

c) The seal pot shall have penetrations for a 1" IPS valved fill port, 1" IPS valved drain to the tank, and ½" IPS drain to atmosphere (total drainage). The seal pot design shall include a vent to release air pressure from the headspace to accommodate filling and level measurement of the seal pot. The vent shall be routed from the top of the seal pot back to the airstream before the HEPA filters. The seal pot shall be fabricated from ASTM A 240, Type 304L, using all welded and flanged end construction. (See Level Indication 3.3.4.4)

d) The seal pot piping materials and construction shall conform to the requirements of ASME B31.3, Chapter III. The piping shall be ASTM A 312, Grade TP 304L and fittings shall be ASTM A 403, Class WP 304L. All piping shall be pressure tested in accordance with ASME B31.3 as an assembly with the filter housing.

e) The drain lines and seal pot shall be heat traced, insulated per 3.3.2.14, and weather protected to assure freezing cannot occur under the design conditions of Section 3.2.5.1. ~~A connection point for heat tracing of the drain line (25 foot minimum length) from the seal pot to the tank of origin shall be provided.~~ The inspection of heat tracing shall be performed before insulation is applied.

f) The drain lines shall be protected by grating, or similar, from personnel standing on the drain lines and damaging the piping, heat trace or insulation.

#### 3.3.2.14 Thermal Insulation Material Requirements

A 480-120/240 VAC single-phase transformer with service disconnect and distribution panel board shall be provided with feeder and branch circuit breakers ampere rating sized for the electrical equipment loads shown on EXHSTR-ELECDIAGRAMS-1 in Appendix C.

### 3.3.3.2 Mini-Power Zone

A 480-120/240 VAC single phase 10 KVA transformer and panel board with at least 10 single-pole 20 A breaker, and a minimum NEMA ~~4X~~3R rating, shall be provided.

Two duplex convenience receptacles with GFCI shall be mounted to the exterior of the mini-power zone. The convenience receptacle shall be provided with weather caps.

### 3.3.3.3 Electrical-Non Specified

Electrical materials and equipment shall be UL or FM tested, with label attached, for the purpose intended, whenever such products are available. When there are no UL or FM listed products of the type, testing and certification by another nationally recognized testing agency may be acceptable. Deviations to this requirement shall be evaluated and approved by the buyer on a case-by-case basis.

Butt splicing of wires is not allowed. All wires shall be terminated on terminal strips. All wires shall be labeled with initial and final terminal boards. Passing a NEC inspection is required prior to shipping. The NEC inspection shall be provided by the buyer.

Provisions shall be made for isolating instruments and equipment from hazardous energy sources during maintenance and repair. Electrical enclosures shall provide means for lock and tag application.

### 3.3.3.4 Specific Electrical/Controls Equipment

The exhauster electrical enclosures shall have a Equipment Identification Number (EIN) as shown on EXHSTR-MECH1 in Appendix B.

The various electrical enclosures required are listed below including minimum required NEMA rating:

1. Main 480-Volt Disconnect Switch (NEMA 4)
2. Exhaust Fan Disconnect Switch (NEMA 3R)
3. Glycol Heater Disconnect Switch (NEMA 3R)

4. Instrument Enclosure (NEMA 4)
5. Control Cabinet (NEMA 4X)
6. Heat Trace Cabinet (NEMA 4X)
7. Mini-Power Zone Cabinet (NEMA 3R)
8. Sample Cabinet (NEMA 4)
9. Field Terminal Enclosure (NEMA 4X)
10. Glycol Heater Controller (NEMA 4)
11. Vacuum Pump Terminal Enclosure (NEMA 4)
12. VFD Enclosure (NEMA 4)
13. Transfer Switch (NEMA 3R)

The general arrangement of the electrical enclosures is shown in EXHSTR-MECH3. Items 1, 2, and 3 shall be connected by a wire way. All enclosures shall be weatherproof and suitable for outdoor use. The control cabinet shall be a Hoffman model A-72H3724SSFS custom type with PLC access window as shown on EXHSTR-ENCLOSURE-3.

### 3.3.3.5 Cabinet Temperature Control

The cabinets shall be controlled to maintain the interior cabinet temperature within the operating limits of installed equipment. ~~The cabinets shall be rated NEMA 4 as a minimum.~~ The control cabinet temperature and humidity shall be monitored to prevent the system from exceeding operating limits.

### 3.3.3.6 Wiring Practices and Electrical Safety Requirements

All cabinets shall be fabricated to comply with UL-508, NFPA 70, and NFPA 79. A clear insulating cover shall be placed over energized parts (e.g. terminal blocks, motor starters, and/or relay blocks) if the voltage is above 50 Volts to ground. The purpose of insulating cover is to prevent contact with energized parts. All electrical heaters shall be installed in accordance with the manufacturer's instructions and with proper clearances. All other components are to be installed in accordance with the manufacturer's instructions. Applicable cabinets shall be labeled to indicate UL-508 compliance.

The minimum conductor size shall be as shown in Table 310-16 in NFPA 70, with the exception that the minimum conductor size shall be 14 AWG for power conductors and 16 AWG for control circuits. Lead wires for manufactured components are permitted to be 18 AWG or larger. 16 AWG control circuit wiring shall have either MTW or THHN/THWN insulation. All other wiring shall have THHN/THWN insulation with the exception of the lead wires of an UL or NRTL listed or recognized component. All wires shall be labeled with either a numeric or an alphanumeric labeling scheme. A wire run list or schedule shall be provided if required. Copper conductors shall be used.

Where possible all electrical penetrations into the cabinets shall be from the bottom of the cabinet. Wire ways or equivalent methods shall be used to separate power and control wiring from instrumentation wiring. Instrumentation wire pairs shall be terminated side by side (high next to low) and the shield wire shall be terminated next to the low wire.

Electronic modules or relays installed in sockets shall be secured with a spring clip or other restraining device.

The door of the cabinet shall be bonded to the cabinet ground. The grounding conductor coming from the AC power source shall be bonded to the cabinet grounding point as designated by cabinet manufacturer.

#### 3.3.3.7 NEC Inspection

An NEC electrical inspector, provided by the buyer, shall inspect exhaust skids fabricated under this contract. All deficiencies found shall be corrected or dispositioned prior to shipment.

### 3.3.4 EXHAUSTER INSTRUMENTATION AND CONTOL

Appendix C contains detailed design sketches of the exhaust skid electrical and instrumentation components and Appendix D contains sketches of the stack monitoring system. The sketches in Appendices C and D are intended to supplement this section of the specification. The sketches will not be updated with changes made during design of exhauster.

All of the exhauster instrumentation shall comply with the NEC.

All transmitters, temperature sensors, and velocity probes shall be capable of 2% accuracy (of full scale) or better.

#### 3.3.4.1 Pressure Monitoring

The exhaust system shall be equipped with a differential pressure (DP) system that measures filter performance. The DP indicating transmitters shall measure the DP across the prefilter, first HEPA filter, and the second HEPA filter. The exhaust system shall also be equipped with DP indicating transmitters that measure the DP from the inlet plenum to atmosphere and across the heater plenum. A stable atmospheric reference shall be provided for measuring the DP at the inlet plenum.

The DP transmitter signals shall be input to the PLC and shall be indicated on the control panel with digital indicators. The system shall also have interlocks to shutdown the exhaust fan on certain abnormal alarm situations and prevent start up on some of those conditions. Alarms shall be indicated on a data message display and illuminate a clear strobe light for abnormal situations.

The heater system shall include a pressure indicating transmitter at the discharge of the circulating pump. The system shall also have interlocks to shutdown the heater system on certain abnormal pump discharge pressure situations.

The exhaust system shall also be capable of monitoring the pressure within the storage tanks in which the system is ventilating. The exhaust system shall communicate with existing pressure instrumentation on the storage tanks. The system shall also have interlocks to shutdown the exhaust fan on certain abnormal tank pressure situations.

#### 3.3.4.2 Temperature Monitoring

Exhaust temperature monitoring system shall consist of three 100Ω platinum resistance temperature detector (RTD) probes, one before the heater, one before the first HEPA filter, and one after the second HEPA filter. The RTDs shall be installed in 12" deep thermowells. The RTD signals shall be input to the PLC and shall be indicated on the control panel with digital indicators. The RTD before the first HEPA filter shall have an interlock. Upon detection of a high temperature, and a low temperature differential, alarms shall be indicated on a data message display and illuminate a clear strobe light.

A RTD shall also be provided with the stack flow measurement instrument. This device shall be used to provide temperature compensation for volumetric and mass flow rates.

#### 3.3.4.3 Stack Monitoring

The exhaust stack shall be equipped with flow instrumentation, sample and measuring ports, and a particulate effluent monitoring system as shown on the attached sketches in Appendix D. This portion of the design is *required* to utilize the buyer specified components unless specific written exemption is provided to the seller by the authorized representative of the buyer. The descriptions provided below are intended to supplement the sketch requirements. Any discrepancy between the two sources shall be addressed to the buyers' representative.

The exhaust stack monitoring system in compliance with 40 CFR 61.93 (b)(1)(i), 40 CFR 61.93 (b)(1)(ii), 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities" and 40 CFR 52 Appendix E, "Protection of Environment". The monitoring system shall include the following functions:

a) Sample collection system – including probes and transport system shall comply with the requirements of ANSI N13.1-1999. Two sample probes are required. One loop shall be dedicated to the record sample and the other shall supply the sample to the continuous air monitor (CAM). The sample collection probes shall employ shrouded probe technology. The transport lines shall be insulated and heated to preclude the condensation of moisture between the sample point and the entry into the EMS Sample Cabinet, between the EMS Sample Cabinet and the vacuum pumps, and on the return line of the sample pumps to the exhaust stack. The sample collection system shall be designed to operate in a pH range of 10-14, RH of 85%, and a temperature range of 27 to 75 °C (80 to 167 °F).

   The sample collection system shall be designed (per ANSI N13.1) to minimize depositional losses. The system layout shown in Appendix B is intended only as a guide. The seller's design shall optimize particulate penetration, and provide justification for each percentage increase in depositional loss. The configuration of the seller's sample transport system design shall be approved by the buyer.

   The sample transport lines shall be provided with fittings that provide a near-seamless connection at all tubing joints. The fittings shall enable a smooth transition of sample flow from the probe assembly to the sample transport line. Most compression-type fittings have step transitions. The above restrictions do not apply to the vacuum return lines which are connected downstream from the CAM heads or the record sample filter holder.

b) Particulate Record Sampler – The Record Sample loop shall consist of the sample probe, delivery tubing, a modified Gelman Sciences 47mm filter holder, flexible ~~stainless~~ hose/tubing, mass flow controller, vacuum gauge, isolation valves and manifolding into the redundant vacuum pumps. The mass flow controller will provide a flow signal to the PLC and control sample flow rate based upon input from the PLC. The buyer will be using 47-mm diameter Gelman Sciences Versapor® 3000 collection filter paper, which is 0.0025-inches thick.

c) Particulate Beta Continuous Air Monitor (CAM) – The CAM loop shall consist of a sample probe, delivery tubing, the CAM, flexible ~~stainless/vacuum like~~ hose/tubing, mass flow controller, ~~pressure~~vacuum gauge, isolation valves, and manifolding into the redundant vacuum pumps. The CAM shall be an Eberline model AMS-4 with remote in-line head. The AMS-4 shall be procured with fail-safe alarm logic (fail alarm shall initiate upon loss of power), output relays, and RS-485 host communications port. The seller shall ensure the AMS-4 is qualified by the manufacturer to function at maximum expected sample air stream temperatures, while still meeting detection, accuracy, and response tolerances as described in ANSI N42.18 (NOTE: This may require factory modifications to the in-line sample head). The vendor shall perform calculations to determine the maximum air sample temperature at the CAM given the design conditions in section 3.1.2.1.

d) Stack Flow Instrumentation – The stack shall be equipped with a Veris Verabar type multi-port flow element with integral RTD (for temperature compensation) and remote mount flow transmitter. The transmitter shall have an integral square root function and transmit a flow proportional 4 to 20mA signal to the skid PLC. The buyer will provide the operational logic and PLC program.

e) Sample Flow Instrumentation – Both sample loops (record and CAM) shall be provided with Hastings model HFC-303, or buyer approved equal, mass flow controllers capable of providing a flow rate signal to the PLC and controlling the flow in proportion to a control signal from the PLC. The mass flow controllers shall operate over a range of 0 to ~~2~~4 SCFM.

f) Data Collection/Storage Capability - The stack monitoring equipment shall interface with the PLC. The PLC logic shall include the following control functions:

1. Vacuum pump start, stop, and alternating commands
2. Control function for sample/monitor mass flow controllers
3. Shutdown of exhauster based on High Radiation or system failures
4. CAM bypass to allow functional testing and filter paper change out while maintaining continuous exhauster operation

Stack flow and sample flow rates shall be input to the PLC. The PLC will compute the total flow volume for each loop and display both rates and totals. The PLC will interface with the LAN system to store the rates and totals for historical reference. ~~Flow rates and totals shall also be displayed locally at the Sample Cabinet during sample filter changes.~~ The CAM alarm will have a method to by-pass the High Beta and CAM failure alarms for testing of the CAM. The following

~~message~~ data will be displayed on the ~~alarm panel~~ HMI during by-pass testing of the CAM: Stack Flow (SCFM), Stack Total (SCF), Record Sample Flow (SCFM), Record Sample Total (SCF), CAM Sample Flow Rate (SCFM), and CAM total flow (SCF). All system interlocks will remain in operation and override the by-pass on an alarm condition.

g) Vacuum System – Two sample vacuum pumps shall be provided, each capable of drawing a minimum of 1.42 L/s (3 SCFM) at system static pressure through the sample/monitor loops. The vacuum pumps shall be provided with appropriate motor starters. The discharge from the vacuum pumps shall be routed back to the stack to a point above the sample extraction point. The PLC will control the operation of the vacuum pumps and will alternate lead-lag positions for the pumps in addition to providing an automatic switch from lead to lag upon failure of the lead unit. Valving shall be provided in the delivery systems from the record and CAM loops to individually control the vacuum to each loop for maintenance and filter changing operations. Hour meters shall be provided for both the primary and the secondary vacuum pumps. The hour meters may be mounted in the control cabinet. The hour meter housing shall be rated for the environment where it is mounted.

h) Environmentally Controlled Sample Cabinet – The seller shall provide an enclosure for the effluent monitoring system. The cabinet shall include the record sample filter holder, the CAM detector head, ~~the CAM electronics enclosure,~~ the mass flow controllers for each loop, valving for the loops, and necessary wiring and terminal blocks. The cabinet shall be equipped with environmental controls compatible with the requirements of the equipment contained in the enclosure. The seller shall provide analysis that the maximum and minimum temperatures expected in the cabinets do not fall outside the published operating limits for the included equipment.

i) Condensation Collection System – The seller shall provide a condensate collection system, as required, to ensure reliable operation of the flow control valves, stack flow instrumentation, and other sampling components. The condensate collection system shall be designed for ease of operation and removal of collected condensate. The seller shall determine the requirements for the condensate collection, including the collection location(s) and required capacity and type of collection bottle. Condensate collection requirements and supporting calculations shall be documented in the definitive design report.

See EXHSTR-P&ID-1, in Appendix C, for a preliminary listing of set points for each of the operating modes.

#### 3.3.4.8 Freeze Protection

Freeze protection shall be installed on each of the condensate lines and on the seal pot reservoir. Heat trace ~~circuits~~ shall be separated in at least two separate sections ~~for each of the condensate lines~~ and provide indication that the heat trace is operating correctly. The heat trace system shall be thermostatically controlled to energize when the temperature drops below freezing. Heat trace inspection and testing shall be performed before addition of the insulation.

### 3.3.5 WELDING

Welding, welding procedures, welder qualifications, and inspections shall be in accordance with ASME N509 and ASME AG-1. All welding performed by the filter housing manufacturer and/or the filter train fabricator/manufacturer shall be based on published consensus standards such as AWS D1.1, AWS D1.3, AWS D9.1, ASME B31.3.

Weld size and type shall be selected by the filter housing manufacturer and/or the filter train fabricator/manufacturer based on applicable seismic, wind loading and system pressure requirements established within this specification.

Special care shall be taken to limit contamination of stainless steel components with halides, which are common to adhesive products. If necessary, stainless steel components shall be cleaned with neutral detergent and water.

#### 3.3.5.1 Carbon Steel Structural Welding

a) All welders, welder operators and welding procedures shall be qualified in accordance with the requirements of the AWS D1.1, AWS D1.3 and/or AWS D9.1 to the extent that these standards apply to the fabrication and production welding of the vent train base and stack support.

b) All welds shall be visually inspected and documented by a certified welding inspector (CWI) who has received formal certification in accordance with the requirements of AWS QC-1.

c) Welds for these components shall meet the visual acceptance criteria of ASME AG-1, Article AA-6330. As an option the weld acceptance

Minimizing the loads required by operators (operator effort of less than 35-50 lbs) while operating the equipment.

**3.3.9.1 Noise Levels**

The stack and mechanical equipment noise emissions at the maximum flow rate condition (2000-SCFM) shall not create noise levels equal to or greater than 85 dBA 8-hour time weighted average, or equivalent noise dose. This shall be measured by a calibrated noise meter at 1 meter.

### 3.3.10 DRAWINGS

All design drawings produced for the Exhauster and associated equipment shall utilize AutoCAD[1] Release 2000 or higher for all drawings produced for this specification. All equipment designs shall comply with ANSI Y14.5M, "Dimensioning and Tolerancing." Drawings shall meet all the requirements of buyer-supplied procedures as well as the following:

- ISA 5.1 Instrumentation Symbols and Identifications
- ISA 5.4 Instrument Loop diagrams

## 4.0 QUALIFICATION AND VERIFICATION

The objective of the qualification and verification matrix is to define a method for ensuring that all requirements have been included and that the engineering development of the exhauster system is complete. The seller shall functionally test all indicators, alarms, and interlocks via a Acceptance Test Procedure (ATP).

### 4.1 TESTING

The seller shall be responsible for the completion of all tests, identified in Table 4-1, "Verification Matrix," (Section 4.3). The testing shall include acceptance test, feature tests, analysis, engineering evaluations, and inspections. The seller shall submit an acceptance test procedure that covers all identified tests to the buyer for approval. Analyses, engineering evaluations, and inspections shall be reviewed with the buyer prior to initiation of the tests as applicable.

~~Prior to performing any test described in this section, a minimum 24-hour run in period of continuous exhauster operation shall be completed. The exhauster shall be fully configured in so far as balance and noise are affected.~~

[1]AutoCAD is a trademark of Autodesk, Inc.

### 4.1.1 POWER SYSTEM TEST

This test will verify that electrical power is properly distributed to all exhauster systems, and that applicable codes and standards were adhered to during assembly.

### 4.1.2 ROTATING EQUIPMENT BALANCING AND VIBRATION CRITERIA

The following rotating components are applicable to this section:

1) The drive motor rotating element
2) The fan wheel and shaft assembly
3) ~~Heating system glycol pump~~
4) ~~Sampling system vacuum pumps~~

The components shall be dynamically balanced as a minimum to the requirements of ISO 1940, G 2.5. All attempts by the balancing service provider to balance the components to as close to the requirements of ISO 1940 G 1.0 as attainable shall be made. Balancing services may be performed by component O.E.M. or by a seller selected balancing company. When vibration readings are taken, the exhauster shall be bolted to a level/flat concrete pad free of major cracks in order to simulate installation conditions at the Hanford site.

### 4.1.3 FILTER HOUSING TESTING

a) The filter housing assembly, including inlet/outlet transitions, shall be visually inspected in accordance with the requirements of ASME N510, Section 5. Observed deficiencies shall be documented on the inspection checklist and as a non-conformance report (NCR) if needed. A corrective action shall be noted and re-inspection results documented on the inspection checklist and on the NCR disposition.

b) The filter housings/test sections shall be tested for airflow distribution in accordance with the requirements of ASME N510, section 8. If similar equipment (duplicate in design, layout and fabrication) has previously been qualified by this test, the results of this testing may be used to demonstrate airflow distribution qualification. Acceptance criteria shall be as given in ASME N510, section 8.

c) The filter housings/test sections shall be tested for air-aerosol mixing uniformity in accordance with the requirements of ASME N510, section 9. Qualification testing of sampling manifolds shall be conducted in accordance with ASME N509, Appendix D. Qualification testing of challenge aerosol injection manifolds shall be performed in accordance with ASME N510, section 9. If similar equipment (duplicate in design, layout and fabrication) has previously been qualified by these tests, the results of this testing may be used to demonstrate manifold and air-aerosol mixing uniformity qualification. Acceptance criteria shall be as given in ASME N510, section 9.

d) The filter housing/test sections (including heater housing and transition section) shall undergo a structural capability test in accordance with ASME N510, section 6. The structural capability pressure shall be as defined in ASME N509, section 4.6.6.1.

e) HEPA filter element holding frames at each filter position shall be pressure decay leak tested in accordance with the requirements of ASME N510, section 7 and the Nuclear Air Cleaning Handbook, ERDA 76-21, table 4-5. The leak rate shall not exceed 0.1% of the housing volume per hour at the system leak test pressure as defined in ASME N509, section 4.6.4.

f) The filter train, drain piping, and seal pot shall be pressure decay leak tested before pre-filter and HEPA filters are installed. Test shall be conducted to meet the requirements of ASME N510, section 6 and the Nuclear Air Cleaning Handbook, ERDA 76-21, table 4-5. The leak rate shall not exceed 0.1% of the housing volume per hour at the system leak test pressure as defined in ASME N509, section 4.6.4.

g) A buyer's representative shall be present to witness the decay leak test of the assembly. The seller shall give a minimum of five (5) days advance notice prior to performing the test(s).

### 4.1.4 EXHAUST FAN AND EXHAUST TRAIN FLOW TESTING

This test will verify that the exhauster fan and drive motor operate freely, rotate in the correct direction, and operate within defined vibration limits. Filters shall be installed to perform the following tests. ~~The following tests shall be performed over the entire fan operating speed in 10 RPM increments, thus ensuring the fan does not pass through a resonance frequency at a lower operating speed.~~ The three tests (a, b, and c) may be performed concurrently as a single test.

a) **Clean System Airflow**

The following test shall be performed over the entire fan operating speed in a maximum of 30-RPM increments, thus ensuring the fan does not pass through a resonance frequency at a lower operating speed. In instances where vibration readings approach the acceptance criteria the increments shall be lowered to 10-RPM.

1) Install a device (orifice plate, valve, etc.) to generate a 12 ±0.5 in WG pressure loss to simulate the permanent system pressure losses.

2) Start the system fan and verify stable (no surging) fan operation for a minimum 15 minutes. Adjust fan speed and pressure device to create 12 ±0.5 inWG pressure loss at the lower fan operating speed.

3) Record system airflow, housing differential pressure, HEPA filter differential pressure, fan drive motor current, and fan shaft and motor shaft rpm.

4) Record vibration data on the fan shaft bearings in all three planes (horizontal, vertical and axial) – acceptance criteria, less than 0.1 IPS peak velocity filtered to the fans fundamental frequency (x1 rpm) and less than 0.25 IPS peak velocity unfiltered (overall).

5) Record vibration data on the motor bearings in all three planes (horizontal, vertical and axial) – information only, peak velocity (IPS) filtered to the motors fundamental frequency (x1 rpm) and peak velocity unfiltered (overall).

6) Increase fan speed while maintaining 12 ±0.5inWG pressure loss and record all required information.

b) **Maximum Housing Component Pressure Drop Airflow**

The following test shall be performed at the fan system nominal flowrate of 2000 ACFM.

1) Install a device (orifice plate, valve, etc.) that can generate a sequential pressure from 12 ±0.5 in WG (to simulate the permanent system pressure loss) up to 19 ±0.5 in WG to simulate fully loaded HEPA and pre-filters.

2) Start the system fan and verify stable (no surging) fan operation for a minimum of 15 minutes.

3) Manipulate the device that is generating the artificial pressure loss

on the exhauster system such that initially, only the system pressure loss is applied. Record system airflow, housing differential pressure, HEPA filter differential pressure, fan drive motor current, and fan shaft and motor shaft rpm.

4) Record vibration data on the fan shaft bearings in all three planes (horizontal, vertical and axial) – acceptance criteria, less than 0.1 IPS peak velocity filtered to the fans fundamental frequency (x1 rpm) and less than 0.25 IPS peak velocity unfiltered (overall).

5) Record vibration data on the motor bearings in all three planes (horizontal, vertical and axial) – information only, peak velocity (IPS) filtered to the motors fundamental frequency (x1 rpm) and peak velocity unfiltered (overall).

6) Increase pressure loss in 1 in WG increments and record all required information until 19 in WG (corresponding to loaded HEPA and pre-filters) is applied.

c) **Zero Airflow Test**

1) Install an isolation valve on the inlet

2) Start the system fan and verify stable (no surging) fan operation for a minimum of 15 minutes.

3) Slowly adjust isolation valve to the fully closed position. **Caution: At no time shall the pressure developed within the filter housing exceed the structural capability pressure as defined in ASME N509, section 4.6.6.1.**

~~3)~~4) Record system airflow, housing differential pressure, HEPA filter differential pressure, fan drive motor current, and fan shaft and motor shaft rpm.

~~4)~~5) Record vibration data on the fan shaft bearings in all three planes (horizontal, vertical and axial) – acceptance criteria, less than 0.1 IPS peak velocity filtered to the fans fundamental frequency (x1 rpm) and less than 0.25 IPS peak velocity unfiltered (overall).

~~5)~~6) Record vibration data on the motor bearings in all three planes (horizontal, vertical and axial) – information only, peak velocity (IPS) filtered to the motors fundamental frequency (x1 rpm) and peak velocity unfiltered (overall).

~~6)~~7) ~~Slowly close the inlet valve such that increments of 1.0 in WG pressure is developed and record all required information until the valve is fully closed.~~ ~~**Caution: At no time shall the pressure developed within the filter housing exceed the structural capability pressure as defined in ASME N509, section 4.6.6.1.**~~

### 4.1.5 HEAT TRACE CHECK

This check will verify that the Heat Trace functions properly and in a safe manor.

### 4.1.6 INTERLOCK ALARM CHECK

This check will verify that interlocks perform as required to specific alarm conditions.

### 4.1.7 GLYCOL HEATER CHECK

This check will verify that the Heater and Glycol Circulation Pump function properly. This will also perform a capacity check of glycol pump to verify the pump is operating within the limits of its pump curve.

### 4.1.8 STACK PRESSURE DECAY TEST

This test will verify the integrity of the exhaust stack assembly air boundary (including the flex duct) in accordance with ASME N509/N510.

### 4.1.9 SAMPLING SYSTEM LEAK TEST

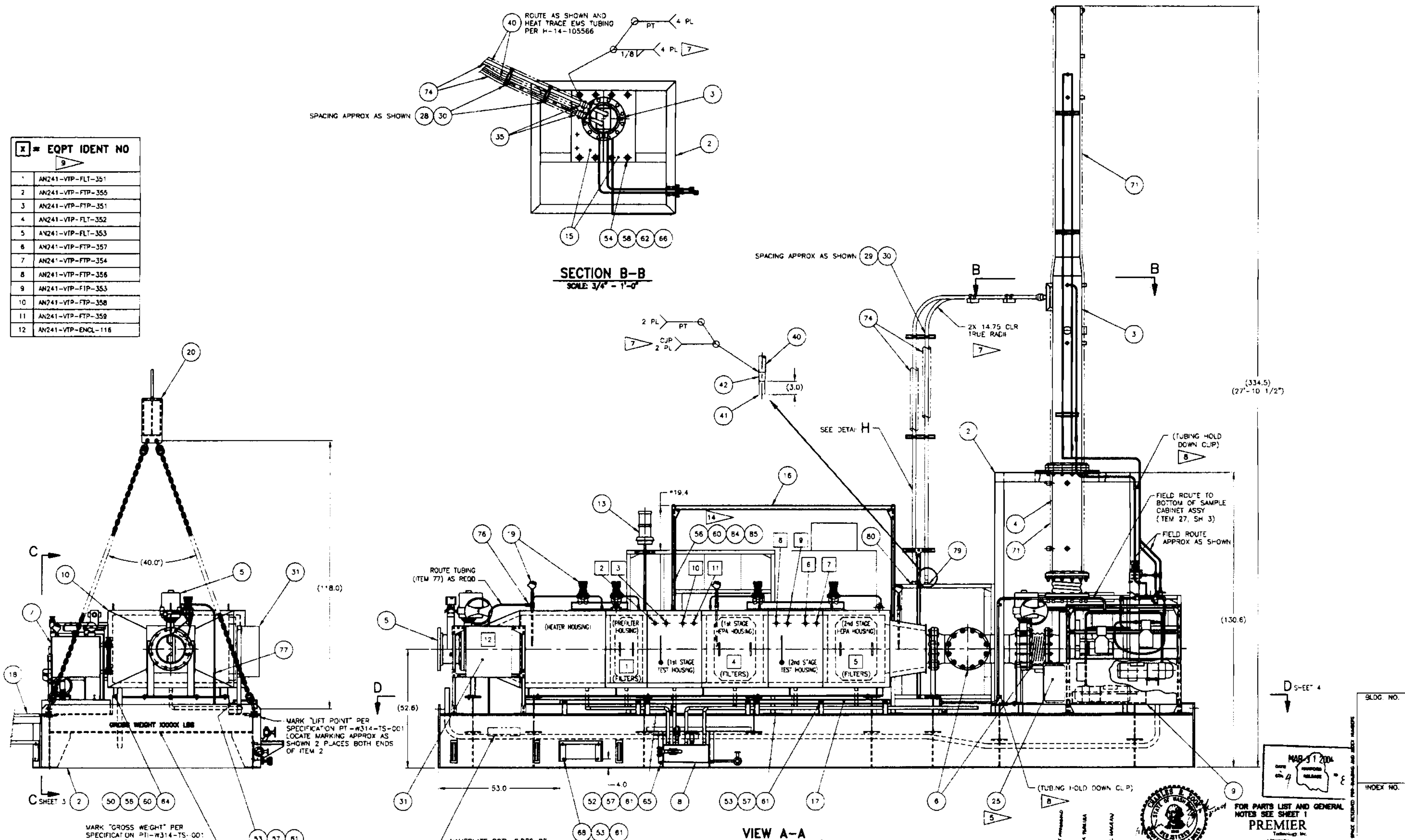
The stack sampling system shall be inspected for leaks at the time on installation in accordance with ANSI N13.1, section 6.9.

## 4.2 VERIFICATION METHODS

### 4.2.1 INSPECTION

The inspection method shall be defined as visual or other means of determining that the requirement was achieved. It can include standard measurement or laboratory instruments to achieve the required accuracy of the inspection.

| SPECIFICATION PARAGRAPH | REQUIREMENT DESCRIPTION | INSPECTION | ANALYSIS | ENGINEERING EVALUATION | FEATURE TEST | ACCEPTANCE OR SYSTEM TEST |
|---|---|---|---|---|---|---|
| 3.1.2.5 | Exhaust Skid Structural Installation | X | | | | |
| 3.2.1 | Performance | | X or | | | X |
| 3.2.2 | Design Life | | | X | | |
| 3.2.3 | Space Envelope | X | | | | |
| 3.2.4.1 | Accessibility | X or | | X | | |
| 3.2.4.2 | Decontamination | X or | | X | | |
| 3.2.4.3 | Special Tools | X | | | | |
| 3.2.5.1 | Climate | | X or | X or | X | |
| 3.2.5.2 | Electromagnetic Noise/Radiation | | | X or | X or | X |
| 3.2.6.1 | Seismic | | X or | | X | |
| 3.2.6.2 | Wind Loads | | X | | | |
| 3.2.6.3 | Snow Loads | | X | | | |
| 3.2.6.4 | Ashfall Events | | X | | | |
| 3.2.6.5 | Dead Loads | | X | | | |
| 3.2.6.6 | Thermal Forces | | X | | | |
| 3.2.6.7 | Load Combinations and Allowable Stresses | | X | | | |
| 3.2.7 | Storage | X and | X | | | |
| 3.2.8 | Transportation Accelerations | | X | | | |
| 3.2.9 | Electrical Grounding | X | | | | |
| 3.3.1.1 | Quality | X | | | | |
| 3.3.1.2 | High-strength and Heat Treatments | X | | | | |
| 3.3.1.3 | Structural | X or | | X | | |
| 3.3.1.4 | Metallic | X or | | X | | |
| 3.3.1.5 | Deterioration and Protection | X or | | X | | |




| X = EQPT IDENT NO (9) | |
|---|---|
| 1 | AN241-VTP-FLT-351 |
| 2 | AN241-VTP-FTP-355 |
| 3 | AN241-VTP-FTP-351 |
| 4 | AN241-VTP-FLT-352 |
| 5 | AN241-VTP-FLT-353 |
| 6 | AN241-VTP-FTP-357 |
| 7 | AN241-VTP-FTP-354 |
| 8 | AN241-VTP-FTP-356 |
| 9 | AN241-VTP-F1P-353 |
| 10 | AN241-VTP-FTP-358 |
| 11 | AN241-VTP-FTP-359 |
| 12 | AN241-VTP-ENCL-116 |

DIMENSIONING AND TOLERANCING SHALL BE INTERPRETED PER ANSI Y14.5M-1994
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED
UNSPECIFIED TOLERANCES SHALL BE:
DECIMAL X ± .1 .XX ± .06 .XXX ± .030
ANGULAR ± 2°
ALL IMPLIED 90° ANGLES SHALL BE PERPENDICULAR WITHIN THE GREATEST TOLERANCE OF THE LINEAR DIMENSIONS
ALL COAXIAL FEATURES SHALL BE CONCENTRIC WITHIN .031 INCH UNLESS OTHERWISE SPECIFIED

| DWG NO | TITLE |
|---|---|
| DRAWING TRACEABILITY LIST | |

| REF NUMBER | TITLE |
|---|---|
| REFERENCES | |
| NEXT USED ON SHEET 1 | |

| REV | DESCRIPTION | | |
|---|---|---|---|
| 5 | INCORPORATED AS-BUILT | JWL | |
| 4 | INCORPORATED DCN-395 & AS-BUILT | JWL | SIGNATURES ON FILE |
| 3 | INCORPORATED DCN-351 & AS-BUILT | JWL | SIGNATURES ON FILE |
| 2 | INCORPORATED DCN-272, -286, -320 & AS-BUILT | ZJF | SIGNATURES ON FILE |
| 1 | INCORPORATED DCN-022, -065, -148, -157, -190, -229 & AS-BUILT | ZJF | SIGNATURES ON FILE |

REVISIONS

FOR PARTS LIST AND GENERAL NOTES SEE SHEET 1

PREMIER Technology, Inc.

GForces

NAME
RK FISHER
SIGNATURES ON FILE
D. Bowers

U.S. DEPARTMENT OF ENERGY
Office of River Protection

# AN241 EXHAUSTER TRAIN "A" ASSEMBLY

F | 241AN | 8900 | H-14-105529 | 5
SCALE SHOWN | 820447 | SHEET 2

INDEX NO. H-14-105529
BLDG NO.

Sta. 4 (5)

MAR 30 2004

# ENGINEERING DATA TRANSMITTAL

1. EDT 820160

1A. Page 1 of 1

2. To: (Receiving Organization)
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3. From: (Originating Organization)
Project W-314, Tank Farm Restoration and Safe Operations

4. Related EDT No.:
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5. Proj./Prog./Dept./Div.:
W-314

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D. E. Bowers

7. Purchase Order No.:
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8. Originator Remarks:
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9. Equip./Component No.:
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10. System/Bldg./Facility:
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11. Receiver Remarks:

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14. Required Response Date:
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| (A) Item No. | (B) Document/Drawing No. | (C) Sheet No. | (D) Rev. No. | (E) Title or Description of Data Transmitted | (F) Approval Desig-nator | (G) Reason for Trans-mittal | (H) Origi-nator Dispo-sition | (I) Receiv-er Dispo-sition |
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| 1 | RPP-15034 | — | 0 | Project W-314 Primary Ventilation System Setpoint Determination | ESQ | | | |

16. KEY

| Approval Designator (F) | Reason for Transmittal (G) | Disposition (H) & (I) |
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17. SIGNATURE/DISTRIBUTION

| (G) Reason | (H) Disp. | (J) Name | (K) Signature | (L) Date | (M) MSIN | (G) Reason | (H) Disp. | (J) Name | (K) Signature | (L) Date | (M) MSIN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | Design Auth. D. E. Bowers | DE Bowers (W-314) DEB | 2/26/04 3/10/04 | S5-07 | 1 | 1 | HVAC Sys Engr: J. Lohrasbi | [signature] | 3-15-04 | 3-15-04 |
| 1 | 1 | Resp. Engr. R.D. Gustavson, HVAC DA | R.D. Gustavson RDG | 2/25/04 3/10/04 | S5-07 | 1 | 1 | MCS Sys Engr: W. D. Winkelman | Wayne Winkelman | 3-15-04 | |
| 1 | 1 | Resp. Mgr. C. W. Jorgensen | [signature] | 3/30/04 | S5-07 | 1 | 1 | NS&L: Thomas G Goetz | TG Goetz | 2/26/04 | S4-44 |
| 1 | 1 | QA T. L. Bennington | [signature] | 3/2/04 | | — | — | USQ TF-04-0322-S | [signature] | 3/04/04 | |
| 1 | 1 | Safety P. J. Vopalensky | [signature] | 2/26/04 3-15-04 | S5-12 | | | | | | |
| 1 | 1 | Env. J. D. Guberski | JD Guberski | 3/1/2004 | R1-51 | | | | | | |
| 1 | 1 | Design Agent B. D. Andres | Brian Andres | 2/26/04 | | | | | | | |
| 1 | 1 | Ops: M. S. Garrett | M Garrett | 2/25/04 | S5-07 | | | | | | |
| ~~1~~ | ~~—~~ | ~~HVAC DA~~ | JT | 26 Feb 2004 | | | | | | | |

18. Signature of EDT Originator: [signature] Date: 26 Feb 2004

19. DOE APPROVAL (if required)
Ctrl. No.

20. Craig Groenen [signature] 3/30/04
Design Auth./Resp. Engr./Resp. Mgr. Date

BD-7400-172.2 (08/03)

# DISTRIBUTION SHEET

| | | |
|---|---|---|
| To<br>Distribution | From<br>DP Garguilo | Page 1 of 1 |
| Project Title/Work Order<br>Project W-314, Tank Farm Restoration and Safe Operations | | Date 8/16/2003 |
| | | EDT No. 820160 |
| | | ECN No. |

| Name | MSIN | Text With All Attach. | Text Only | Attach./ Appendix Only | EDT/ECN Only |
|---|---|---|---|---|---|
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# Project W-314 Primary Ventilation System Setpoint Determination

**DP Gargulio**
Vista Engineering for CH2M Hill Hanford Group
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-99RL14047

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Key Words: Project W-314, Setpoint, Basis, Primary Ventilation System

Abstract: This document provides the basis analysis and calculations for determining setpoints for alarms and interlocks on the W-314 Primary Ventilation Systems.



3/30/04

Release Approval Date

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**Approved For Public Release**

**CONTENTS**

## ACRONYMS AND TERMS

| | |
|---|---|
| ACFM | actual cubic feet per minute |
| AL | *Analytical Limit*: the limit of a measured or calculated variable established by the safety analysis to ensure that a safety limit is not exceeded (ISA-RP67.04.02-2000) |
| CAM | continuous air monitor |
| cpm | counts per minute |
| CU | *Channel Uncertainty*: the allowance made for the amount to which an instrument channel's output is in doubt due to possible errors, random or systematic, that have not been corrected for. The uncertainty is generally identified within a probability and confidence level (ISA-RP67.04.02-2000) |
| dP | differential pressure |
| dpm | disintegrations per minute |
| DST | Double Shell Tank |
| EIN | Equipment Identification Number |
| HEPA | high efficiency particulate air [filter] |
| in. $H_2O$ | inches of water column |
| P&ID | piping & instrumentation diagram |
| PLC | programmable logic controller |
| psig | pounds per square inch (gage) |
| RH | relative humidity |
| RTD | resistance temperature detector |
| SCFM | standard cubic feet per minute |
| SQRT | square root |
| TS | *Trip Setpoint*: a predetermined value for actuation of the final setpoint device to initiate protective action (ISA-RP67.04.02-2000) |

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# 1.0 INTRODUCTION

## 1.1 Purpose

Project W-314 constructed Primary Ventilation Systems for the 241-AN and 241-AW Tank Farms, which are part of the Hanford Double Shell Tank (DST) waste storage system. Identical systems were provided for both of the farms, consisting of ducting connected to the existing tank headspaces, redundant moisture separators (deentrainers), and redundant exhausters. The DST Primary Ventilation System maintains the tank vapor space vacuum, removes heat from the tank vapor space during mixer pump operation, and performs the Safety-Significant function of maintaining the concentration of flammable gases from steady-state releases below the lower flammability limit (RPP-13033, Sec. 4.4.1).

This document is intended to describe the methodology used to determine instrument alarm and interlock setpoints for the Primary Ventilation System. This document will serve as the basis for the alarm and interlock setpoints provided on the P&IDs for the Primary Ventilation System on each farm. Rationale is provided for selecting each alarm, as well as why the alarm limits are as chosen. In some cases, where warranted a setpoint calculation was performed to account for instrument inaccuracy when determining setpoints for the instrument.

## 1.2 Scope

This document covers instruments installed by Project W-314 on the new Primary Ventilation Systems in 241-AN and 241-AW Tank Farms, and pressure instruments installed on the tanks, as listed in the following summary table. The table also includes setpoint evaluation results, with the "Trip Setpoint" values for the instruments covered. Interlocks, calibrated spans, and Equipment Identification Numbers (EIN), which are similar for both farms, are identified as well. This setpoint determination document also covers DST pressure instruments installed (or to be installed) by Project W-314 in 241-AP and 241-SY Tank Farms.

Sec. 1.3, below, describes the methodology used for the setpoint determinations, and Sec. 1.4 discusses assumptions. References listed in Sec. 1.5 include input and basis documents, as well as plant maintenance procedures (mostly indicated as draft at the time of this revision) that will be used to calibrate or functionally test the subject instruments.

The configuration, alarm or interlock descriptions, and setpoint determinations for the subject instruments are documented in Sec. 2.0 through 6.0, covering flow, pressure, temperature, humidity, liquid level, and radiation monitoring functions. Depending on complexity, uncertainty calculations for specific instrument loops or channels are documented in App. A through D and, in some cases, in referenced calculations. These are cited in Sec. 2.0 through 6.0, as needed, to support the setpoint determinations.

## Scope and Summary of Results

| Alarm Label | Trip Setpoint (TS) | Interlock | Instrument EIN | Calibrated Span |
|---|---|---|---|---|
| Stack Hi-Hi Flow | 2950 ACFM | Ventilation Shutdown | FE-551, -651 | N/A |
| | | | TE-551, -651 | N/A |
| Stack Lo-Lo Flow | 650 ACFM | Ventilation Shutdown | PDIT-551, -651 | 0 to 4 in. $H_2O$ |
| Record Sample High Flow | 115% of proportional flow | N/A | FCV-555, -655 | 0 to 4 SCFM |
| Record Sample Low Flow | 90% of proportional flow | N/A | | |
| Record Sample Lo-Lo Flow | 80% of proportional flow | Swap Vacuum Pumps[1] | | |
| CAM Sample High Flow | 2.2 SCFM | N/A | FCV-556, -656 | 0 to 4 SCFM |
| CAM Sample Low Flow | 1.8 SCFM | N/A | | |
| CAM Sample Lo-Lo Flow | 1.6 SCFM | Swap Vacuum Pumps[1] | | |
| Tank High Pressure | -0.7 in. $H_2O$ | N/A | PDIT-25*A/B | -20 to 10 in. $H_2O$ |
| Tank Hi-Hi Pressure | -0.3 in. $H_2O$ | N/A | | |
| Tank Low Pressure | -3.5 in. $H_2O$ | N/A | [2]PDIT-210, -211, -220, -221, -230, -231 | |
| Tank Lo-Lo Pressure | -5.5 in. $H_2O$ | Ventilation Shutdown | | |
| Pre-Filter High dP | 1 in. $H_2O$ | N/A | PDIT-356, -456 | 0 to 4 in. $H_2O$ |
| HEPA #1 Lo-Lo dP | 0.2 in. $H_2O$ | Ventilation Shutdown | PDIT-357, -457 | 0 to 10 in. $H_2O$ |
| HEPA #1 High dP | 4.0 in. $H_2O$ | N/A | | |
| HEPA #1 Hi-Hi dP | 5.8 in. $H_2O$ | Ventilation Shutdown | | |
| HEPA #2 Lo-Lo dP | 0.2 in. $H_2O$ | Ventilation Shutdown | PDIT-358, -458 | 0 to 10 in. $H_2O$ |
| HEPA #2 High dP | 2.8 in. $H_2O$ | N/A | | |
| HEPA #2 Hi-Hi dP | 3.9 in. $H_2O$ | Ventilation Shutdown | | |
| HEPA Bank High dP | 4.7 in. $H_2O$ | N/A | PDIT-357, -457, PDIT-358, -458 | 0 to 10 in. $H_2O$ |
| HEPA Bank Hi-Hi dP | 5.8 in. $H_2O$ | Ventilation Shutdown | | |
| Glycol System Lo-Lo Pressure | 3 psig | Glycol System Shutdown | PIT-371, -471 | 0 to 35 psig |
| Glycol System Low Pressure | 5 psig | N/A | | |
| Glycol System High Pressure | 25 psig | N/A | | |
| Glycol System Hi-Hi Pressure | 28 psig | Glycol System Shutdown | | |
| Heater Low Diff Temp | 16 °F | N/A | TE-353, -453, TE-355, -455 | -150 to 500 °F |

| Alarm Label | Trip Setpoint (TS) | Interlock | Instrument EIN | Calibrated Span |
|---|---|---|---|---|
| Heater Hi-Hi Outlet Temp | 165 °F | Heater Shutdown | TE-355, -455 | -150 to 500 °F |
| Cabinet Temp Lo-Lo | 35 °F | Ventilation Shutdown | MI-110, -111 | -32 to 140 °F (0 to 100% RH) |
| Cabinet Temp Low | 45 °F | N/A | | |
| Cabinet Temp High | 118 °F | N/A | | |
| Cabinet Temp Hi-Hi | 128 °F | Ventilation Shutdown | | |
| Encl Moisture High | 80% RH | N/A | | |
| Encl Moisture Hi-Hi | 88% RH | Ventilation Shutdown | | |
| Glycol Tank Hi-Hi Temp | 209 °F | Heater Shutdown | TE-373, -473 | -150 to 500 °F |
| Deentrainer Seal Pot Lo-Lo Level | 30% Level | N/A | LIT-170 | 0 to 100% Level |
| Deentrainer Seal Pot Lo Level | 40% Level | N/A | | |
| Deentrainer Seal Pot Hi-Hi Level | 95% Level | N/A | | |
| Deentrainer Seal Pot Hi Level | 85% Level | N/A | | |
| Exhauster Seal Pot Lo-Lo Level | 20% Level | Ventilation Shutdown | LT-380, -480 | 0 to 100% Level |
| Exhauster Seal Pot Lo Level | 30% Level | N/A | | |
| Exhauster Seal Pot Hi-Hi Level | 90% Level | Ventilation Shutdown | | |
| Exhauster Seal Pot Hi Level | 80% Level | N/A | | |
| Exhauster Glycol Tank Lo-Lo Level | 20% Level | Glycol System Shutdown | LT-370, -470 | 0 to 100% Level |
| Exhauster Glycol Tank Low Level | 40% Level | N/A | | |
| Exhauster Glycol Tank High Level | 80% Level | N/A | | |
| CAM Radiation | 300 dpm/ft$^3$ (Slow) 7,000 dpm/ft$^3$ (Fast) 3,000 cpm (Nominal) | Ventilation Shutdown | RE-554, -654 | N/A |

[1]A swap from the primary to standby vacuum pump only occurs if both Record Sample Lo-Lo and CAM Sample Lo-Lo flow alarms annunciate.

[2]The tank pressure transmitters in AP-Farm and SY-Farm do not have a Lo-Lo Pressure Interlock, as they are not tied in to the existing ventilation system. In addition, in the case of AP-Farm, the tank pressure instrumentation has not yet been installed by the project.

## 1.3 Methodology

The alarm setpoint determination analysis follows the basic methodology described in ISA-RP67.04.02-2000, *Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation*, in compliance with TFC-ENG-STD-14 (the tank farms setpoint standard). This methodology defines an Analytical Limit (AL) as a value established by a safety analysis, calculation, or other basis. A Trip Setpoint (TS) is then calculated based upon a channel uncertainty (CU) of the instrument to ensure the AL is never exceeded.

## 1.4 Assumptions

Assumptions are documented where appropriate in the text, including specific assumptions to support the uncertainty calculations in Appendices A through D to this report. Common industry-standard practices and assumptions described in ISA-RP67.04.02-2000 were utilized as applicable. In general, the reference accuracy values stated in manufacturer's published specifications were utilized, and were assumed to incorporate repeatability, hysteresis, linearity, and conversion errors unless specifically stated otherwise. By design, the instrumentation is maintained and operated within the manufacturers' specified environmental limits for temperature, pressure, and humidity. Errors associated with power supply frequency variations and dynamic effects, as well as PLC error figures for repeatability and drift, were generally assumed negligible with respect to other terms and were not treated separately.

The uncertainty calculations in the appendices included a total calibration uncertainty term of 0.5% of calibrated span (denoted as "MTE") for the instruments in question. This value was intended to bound both M&TE uncertainty as well as calibration tolerance, as discussed in ISA-RP67.04.02-2000, Sec. 6.2.6. It was further assumed that the tolerance of the M&TE instruments would be low compared with calibration tolerance, and therefore the latter source of uncertainty would dominate this term. This assumption is born-out in the case of the pressure transmitters (App. A, C, and D). Similar instruments have been used onsite for years with existing calibration procedures (e. g., 6-PCD-373) and data sheets. Using an available reference pressure source with a tolerance of ±0.1% or less, it is reasonable to calibrate these instruments to less than ±0.5% of span. Therefore, the assumption of ±0.5% is a reasonable estimate of calibration uncertainty for the pressure instruments.

In the case of the record sampler flow instruments (App. B) the calibration procedure is still in draft, and details of the reference instrument and the calibration process are not established. A calibration uncertainty term of 0.5% of span is still assumed as a reasonable value for the calculation. However, using engineering judgment to account for possible additional uncertainty, an allowance beyond the calculated uncertainty was applied in the record sampler high and low flow alarm setpoint determinations (Sec. 2.2.1 and 2.2.2). The added allowance was not applied to the record sample low-low alarm setpoint, which is an operational feature, and was not applied in the case of the CAM sample flow alarms. These setpoints may be further refined later on, based on experience calibrating and operating the instruments.

## 1.5 References

ANSI/HPS N13.1-1999, *Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities*, America National Standards Society, and Health Physics Society, McLean, Virginia.

HNF-EP-0479-4, 2000, *Facility Effluent Monitoring Plan for the Tank Farm Facility*, U. S. Department of Energy, Office of River Protection, Richland, Washington.

HNF-5196, Rev. 1-A, *Operating Specifications for the Double-Shell Storage Tanks*, U. S. Department of Energy, Office of River Protection, Richland, Washington.

ISA-RP67.04.02-2000, *Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation*, Instrument Society of America, Research Triangle Park, North Carolina.

OSD-T-151-00007, Rev. I-7, *Operating Specifications for the Double-Shell Storage Tanks*, U. S. Department of Energy, Office of River Protection, Richland, Washington.

RPP-13033, Rev. 0-A, *Tank Farms Documented Safety Analysis*, U. S. Department of Energy, Office of River Protection, Richland, Washington.

TFC-ENG-STD-14, Rev. A-1, *Setpoint Standard*, CH2M-Hill Hanford Group, Inc., Richland, Washington.

Vendor Information (VI) Files 50315 & 50316 for the 241-AN and 241-AW Exhausters, including:

- Owner's Manuals and Catalog Cuts from Drexelbrook, Eberline, Endress & Hauser, Flanders, General Eastern, Teledyne-Hastings, Weed Instruments, and Yokogawa.
- Calculation PTI-W314-CALC-003, *Heater Capacity and Sizing Calculations* (also included in RPP-16977, *W314 DST Primary Exhauster Supporting Calculations*).
- Calculation PTI-W314-CALC-004, *Seal Pot Location and Sizing Calculations* (also included in RPP-16977, *W314 DST Primary Exhauster Supporting Calculations*).
- Calculation PTI-W314-CALC-008, *Vacuum Pump Sizing Calculations* (also included in RPP-16977, *W314 DST Primary Exhauster Supporting Calculations*).

W314-I-218, Rev. 0 (W-314 Project Files), *Alarm Setpoint (Temperature & Humidity) Accuracy Calculation for the HVAC PLC Enclosures.*

H-14-104459, *P&ID 241-AN HVAC.*

H-14-105527, *AN241 Exhauster Train "A" P&ID* (Vendor Information [VI] File 50315).

H-14-105528, *AN241 Exhauster Train "B" P&ID* (Vendor Information [VI] File 50315).

H-14-105676, *AW241 Exhauster Train "A" P&ID* (Vendor Information [VI] File 50316).

H-14-105677, *AW241 Exhauster Train "B" P&ID* (Vendor Information [VI] File 50316).

3-FCD-647, *ANSI N13.1 Compliance Procedure* (DRAFT).

3-VB-155ZA, Rev. A-0, *Appendix ZA 241-AN A-Train Exhauster Stack 296-A-44 Air Flow Test Data Sheets.*

3-VB-155ZB, Rev. A-0, *Appendix ZB 241-AN B-Train Exhauster Stack 296-A-45 Air Flow Test Data Sheets.*

3-VB-155ZC, Rev. A-0, *Appendix ZC 241-AW A-Train Exhauster Stack 296-A-46 Air Flow Test Data Sheets.*

3-VB-155ZD, Rev. A-0, *Appendix ZD 241-AW B-Train Exhauster Stack 296-A-47 Air Flow Test Data Sheets.*

6-LCD-612, *Calibrate Drexelbrook 509-75 Exhauster Glycol and Seal Pot Level Monitor* (DRAFT).

6-PCD-373, Rev. A-9, *Yokogawa Instruments EJA 110 & 120 Differential Pressure Transmitter.*

6-PCD-613, *AW and AN HVAC Foundation Field Bus Pressure Transmitters* (DRAFT).

6-PCD-648, *Calibrate Hastings HFC-303 Flow Controller on AN and AW Primary Exhaust Skids* (DRAFT).

6-RM-650, *AW Tank Farm VTP Stack CAM Interlock Functional Check* (DRAFT).

6-RM-655, *AN Tank Farm VTP Stack CAM Interlock Functional Check* (DRAFT).

# 2.0 FLOW MONITORING INSTRUMENTATION

## 2.1 Exhaust Stack Flow Instruments

EIN: FE/TE-551; FE/TE-651
Name: Verabar Flow Sensor with Integral RTD
Manufacturer: Veris, Inc.
Model Number: V100-10-V-D-WNS-C2GC

EIN: PDIT-551; PDIT-651
Name: Differential Pressure Transmitter
Manufacturer: Yokogawa
Model Number: EJA-120A-EES4B-92EC/FS1-D1-HAC-F1

### 2.1.1 Alarm Label: Stack Hi-Hi Flow Alarm

**2.1.1.1 Alarm Description:** Annunciates when the gas flow rate out the exhaust stack exceeds the trip setpoint.
**2.1.1.2 Alarm Interlock:** Primary Ventilation System Shutdown
**2.1.1.3 Alarm Basis:** Ensure the flow rate through the ventilation system does not exceed qualified operating range of system components per ASME N509.
**2.1.1.4 Analytical Limit (AL):** 3,000 ACFM
**2.1.1.5 Basis for AL:** The ventilation system fan has the capacity to produce over 5,000 ACFM of flow at zero static pressure, however not all components in the exhaust stream are designed to function at this high of flow. Most limiting is the HEPA filter housing, which holds two banks, two deep, of Flanders® type GG-F, 24 x 24 x 11½ in. filters rated at 1500 ACFM each.
**2.1.1.6 Trip Setpoint (TS):** 2,950 ACFM
**2.1.1.7 Basis for TS:** The total channel uncertainty of the differential pressure measurement was calculated to be ± 0.049 in. $H_2O$ (see App. A). The calibrated span of the differential pressure transmitter is from 0 to 4 in. $H_2O$, therefore this results in a ± 1.2% uncertainty in the dP reading. From the Verabar vendor flow calculation worksheet, 4 in. $H_2O$ corresponds to a flowrate of 3583 ACFM (at 170 °F). This is the upper bound of the calibrated span in ACFM, therefore the uncertainty in this reading is 1.2% x 3583 ACFM = 43 ACFM.

$$TS = AL - CU = 3000 - 43 = 2957 > 2950 \text{ ACFM}$$

### 2.1.2 Alarm Label: Stack Lo-Lo Flow Alarm

**2.1.2.1 Alarm Description:** Annunciates when the gas flow rate out the exhaust stack drops below the trip setpoint.
**2.1.2.2 Alarm Interlock:** Primary Ventilation System Shutdown
**2.1.2.3 Alarm Basis:** Ensure the flow rate through the ventilation system does not drop below qualified operating range of the system.

**2.1.2.4 Analytical Limit (AL):** 600 ACFM

**2.1.2.5 Basis for AL:** Limiting system component are the HEPA filters, which are qualified to only 20% of rated flow. Filter efficiency cannot be validated below this limit.

**2.1.2.6 Trip Setpoint (TS):** 650 ACFM

**2.1.2.7 Basis for TS:** The total channel uncertainty of the differential pressure measurement was calculated to be ± 0.049 in. $H_2O$ (App. A). The calibrated span of the differential pressure transmitter is from 0 to 4 in. $H_2O$, therefore this results in a ± 1.2% uncertainty in the dP reading. From the Verabar vendor flow calculation worksheet, 4 in. $H_2O$ corresponds to a flowrate of 3583 ACFM (at 170 °F). This is the upper bound of the calibrated span in ACFM, therefore the uncertainty in this reading is 1.2% x 3583 ACFM = 43 ACFM.

$$TS = AL + CU = 600 + 43 = 643 < 650 \text{ ACFM}$$

## 2.2 Stack Monitoring System Sample Flow Instruments

EIN: FCV-555, FCV-556; FCV-655, FCV-656
Name: Mass Flow Controller
Manufacturer: Teledyne-Hastings Instruments
Model Number: HFC-303

### 2.2.1 Alarm Label: Record Sample High Flow Alarm

**2.2.1.1 Alarm Description:** Annunciates when the gas flow rate through the record sampler system exceeds the trip setpoint.

**2.2.1.2 Alarm Interlock:** N/A

**2.2.1.3 Alarm Basis:** Since the record sampler flow controller and flow transmitter are the same unit, this alarm is needed to ensure the flow controller is functional. The flow rate through the record sampler system must be known for state emissions reporting.

**2.2.1.4 Analytical Limit (AL):** 120% of proportional flow

**2.2.1.5 Basis for AL:** The record sampler flow rate varies in proportion to the exhaust stack flow rate as mandated by ANSI/HPS N13.1, Sec. 6.3.4.4. Therefore, the Primary Ventilation System is designed to adjust record sample flow rate automatically, based upon a predetermined ratio, as exhaust stack flow rate is varied. Furthermore, ANSI/HPS N13.1, Sec. 6.8.3, requires that the controller maintains the ratio between the record sampler flow rate and the exhaust stack flow rate within ± 20%.

**2.2.1.6 Trip Setpoint (TS):** 115% of flow

**2.2.1.7 Basis for TS:** Calculated instrument uncertainty for the record sample mass flow controller over the calibrated span of 0 to 4 SCFM was determined to be ± 0.10 SCFM (see App. B), which translates to an uncertainty of 2.5% of span. An added allowance is included in the TS of 115% (see Sec. 1.4, Assumptions).

$$TS = AL - CU = 120\% - 2.5\% = 117.5\% > 115\% \text{ of flow}$$

**2.2.2 Alarm Label:** Record Sample Low Flow Alarm

**2.2.2.1 Alarm Description:** Annunciates when the gas flow rate through the record sampler system drops below the trip setpoint.

**2.2.2.2 Alarm Interlock:** N/A

**2.2.2.3 Alarm Basis:** Since the record sampler flow controller and flow transmitter are the same unit, this alarm is needed to ensure the flow controller is functional. The flow rate through the record sampler system must be known for state emissions reporting.

**2.2.2.4 Analytical Limit (AL):** 80% of flow

**2.2.2.5 Basis for AL:** The record sampler flow rate varies in proportion to the ventilation system exhaust stack flow rate as mandated by ANSI/HPS N13.1, Sec. 6.3.4.4. Therefore, the Primary Ventilation System is designed to adjust record sample flow rate automatically, based upon a predetermined ratio, as exhaust stack flow rate is varied. Furthermore, ANSI/HPS N13.1, Sec. 6.8.3, requires that the controller ensures the ratio between the record sampler flow rate and the exhaust stack flow rate be maintained within ± 20%.

**2.2.2.6 Trip Setpoint (TS):** 90% of flow

**2.2.2.7 Basis for TS:** Calculated instrument uncertainty for the record sample mass flow controller over the calibrated span of 0 to 4 SCFM was determined to be ± 0.10 SCFM (App. B), which translates to an uncertainty of 2.5% of span. An added allowance is included in the TS of 90% (see Sec. 1.4).

$$TS = AL + CU = 80\% + 2.5\% = 82.5\% < 90\% \text{ of flow}$$

**2.2.3 Alarm Label:** Record Sample Lo-Lo Flow Alarm

**2.2.3.1 Alarm Description:** Annunciates when the gas flow rate through the record sampler system drops below the trip setpoint.

**2.2.3.2 Alarm Interlock:** Swap Vacuum Pumps

**2.2.3.3 Alarm Basis:** When triggered in conjunction with the CAM Sample Lo-Lo Flow this interlock will swap from primary to standby vacuum pumps.

**2.2.3.4 Analytical Limit (AL):** N/A

**2.2.3.5 Basis for AL:** The record sample flow "Lo-Lo" setpoint enables the vacuum pumps to switch automatically if the online pump is not functioning, supporting compliance with a requirement for continuous stack effluent sampling.

**2.2.3.6 Trip Setpoint (TS):** 80% of flow

**2.2.3.7 Basis for TS:** When the system is operating correctly, significant deviation from the sample flow setpoint should be negligible. Therefore, a 20% drop in indicated flow through the record sample line would most likely result from the vacuum pump not functioning properly. Switching the vacuum pumps will allow the sampling system to continue operating.

**2.2.4 Alarm Label:** CAM Sample High Flow Alarm

**2.2.4.1 Alarm Description:** Annunciates when the gas flow rate through the CAM system exceeds the trip setpoint.
**2.2.4.2 Alarm Interlock:** N/A
**2.2.4.3 Alarm Basis:** Since the CAM flow controller and flow transmitter are the same unit, this alarm is needed to ensure the flow controller is functional. This ensures the CAM is receiving the flow rate it is expecting, which is used in the Fast and Slow Response CAM alarms.
**2.2.4.4 Analytical Limit (AL):** 2.3 SCFM
**2.2.4.5 Basis for AL:** The CAM is operated at a fixed sample flowrate of 2.0 SCFM, consistent with ANSI/HPS N13.1, Sec. 6.3.4.4. Furthermore, ANSI/HPS N13.1, Sec. 6.8.3, requires that the controller ensures the flow rate be maintained within ± 15% over a range of sample filter loading (i. e., pressure drop) conditions. When the system is operating correctly, deviation from the flow setpoint of 2.0 SCFM is expected to be negligible.
**2.2.4.6 Trip Setpoint (TS):** 2.2 SCFM
**2.2.4.7 Basis for TS:** Calculated instrument uncertainty for the CAM sample mass flow controller over the calibrated span of 0 to 4 SCFM was determined to be ± 0.10 SCFM (App. B).

TS = AL – CU = 2.3 – 0.1 = 2.2 SCFM

**2.2.5 Alarm Label:** CAM Sample Low Flow Alarm

**2.2.5.1 Alarm Description:** Annunciates when the gas flow rate through the CAM drops below the trip setpoint.
**2.2.5.2 Alarm Interlock:** N/A
**2.2.5.3 Alarm Basis:** Since the CAM flow controller and flow transmitter are the same unit, this alarm is needed to ensure the flow controller is functional. This ensures the CAM is receiving the flow rate it is expecting, which is used in the Fast and Slow Response CAM alarms. The low flow alarm also provides indication the stack monitoring vacuum pumps are not providing sufficient airflow.
**2.2.5.4 Analytical Limit (AL):** 1.7 SCFM
**2.2.5.5 Basis for AL:** The CAM is operated at a fixed sample flowrate of 2.0 SCFM, consistent with ANSI/HPS N13.1, Sec. 6.3.4.4. Furthermore, ANSI/HPS N13.1, Sec. 6.8.3, requires that the controller ensures the flow rate be maintained within ± 15% over a range of sample filter loading (i. e., pressure drop) conditions. When the system is operating correctly, deviation from the flow setpoint of 2.0 SCFM is expected to be negligible.
**2.2.5.6 Trip Setpoint (TS):** 1.8 SCFM
**2.2.5.7 Basis for TS:** Calculated instrument uncertainty for the CAM sample mass flow controller over the calibrated span of 0 to 4 SCFM was determined to be ± 0.10 SCFM (App. B).

TS = AL + CU = 1.7 + 0.1 = 1.8 SCFM

### 2.2.6 Alarm Label: CAM Sample Lo-Lo Flow Alarm

**2.2.6.1 Alarm Description:** Annunciates when the gas flow rate through the CAM drops below the trip setpoint.
**2.2.6.2 Alarm Interlock:** Swap Vacuum Pumps
**2.2.6.3 Alarm Basis:** When triggered in conjunction with the Record Sample Lo-Lo Flow this interlock will swap from primary to standby vacuum pumps.
**2.2.6.4 Analytical Limit (AL):** N/A
**2.2.6.5 Basis for AL:** The CAM alarm function is supported by the Low Flow Alarm (previous section). The CAM Sample "Lo-Lo Flow" alarm and interlock function is an operational feature in conjunction with the record sampler "Lo-Lo Flow" trip setpoint.
**2.2.6.6 Trip Setpoint (TS):** 1.6 SCFM
**2.2.6.7 Basis for TS:** When the system is operating correctly, deviation from the flow setpoint of 2.0 SCFM should be negligible, and a 0.4 SCFM (or 20%) drop in flow through the CAM sample line would most likely indicate the vacuum pump is not functioning properly. This is consistent with the record sampler "Lo-Lo Flow" trip setpoint. By facilitating switching of the vacuum pumps, this alarm and interlock allows the sampling system to continue operating until the problem can be diagnosed and corrected, and helps ensure continuity of operation.

## 3.0 PRESSURE MONITORING INSTRUMENTATION

### 3.1 Tank Pressure Instruments

EIN (AN, AW, AP): PDIT-251A/B, PDIT-252A/B, PDIT-253A/B, PDIT-254A/B, PDIT-255/A/B, PDIT-256A/B, PDIT-257A/B (AN and AP Farms only), PDIT-258/A/B (AP Farm only)
EIN (SY): PDIT-210, PDIT-211, PDIT-220, PDIT-221, PDIT-230, PDIT-231
Name: Differential Pressure Transmitter
Manufacturer: Yokogawa
Model Number: EJA-110A-FLS4B-92ED/FS1/AT01 (AN and AW farms) and EJA-110A-ELS4B-92ED/FS1/A/D1/T01 (AP and SY farms)

### 3.1.1 Alarm Label: Tank High Pressure Alarm

**3.1.1.1 Alarm Description:** Annunciates when the DST differential pressure exceeds the high-pressure (i. e., loss of vacuum) trip setpoint.
**3.1.1.2 Alarm Interlock:** N/A
**3.1.1.3 Alarm Basis:** Ensure the exhaust system provides ventilation by maintaining a negative pressure in the DST headspace with respect to outside atmosphere, thus maintaining a controlled airflow from the environment into the tank and then out through the exhaust system, as required per RPP-13033, Sec. 4.4.1.
**3.1.1.4 Analytical Limit (AL):** -0.3 in. $H_2O$

**3.1.1.5 Basis for AL:** The Level 2 specification HNF-5196, Sec. 3.2.1.1.1.
**3.1.1.6 Trip Setpoint (TS):** -0.7 in. $H_2O$
**3.1.1.7 Basis for TS:** Pressure transmitter uncertainty was calculated to be ± 0.25 in. $H_2O$ (App. C).

TS = AL – CU = -0.3 - 0.25 = -0.55 ~ -0.6 in. $H_2O$

To provide extra notification margin, this setpoint is decreased to -0.7 in. $H_2O$. The high-pressure (low vacuum) alarm setpoint per OSD-T-151-00007 is -0.5 in. $H_2O$.

**3.1.2 Alarm Label:** Tank Hi-Hi Pressure Alarm

**3.1.2.1 Alarm Description:** Annunciates when the DST differential pressure exceeds the hi-hi pressure (i. e., loss of vacuum) trip setpoint.
**3.1.2.2 Alarm Interlock:** N/A
**3.1.2.3 Alarm Basis:** Ensure the exhaust system provides ventilation by maintaining a negative pressure in the DST headspace with respect to outside atmosphere, thus maintaining a controlled airflow from the environment into the tank and then out through the exhaust system, as required per RPP-13033, Sec. 4.4.1.
**3.1.2.4 Analytical Limit (AL):** 0 in. $H_2O$
**3.1.2.5 Basis for AL:** Required per the safety basis, RPP-13033, Sec. 4.4.1, and maximum pressure (minimum vacuum) per OSD-T-151-00007.
**3.1.2.6 Trip Setpoint (TS):** -0.3 in. $H_2O$
**3.1.2.7 Basis for TS:** Pressure transmitter uncertainty was calculated to be ± 0.25 in. $H_2O$ (App. C).

TS = AL – CU = 0 – 0.25 = -0.25 ~ -0.3 in. $H_2O$

**3.1.3 Alarm Label:** Tank Low Pressure Alarm

**3.1.3.1 Alarm Description:** Annunciates when the DST differential pressure drops below the low-pressure (i. e., excessive vacuum) trip setpoint.
**3.1.3.2 Alarm Interlock:** N/A
**3.1.3.3 Alarm Basis:** Provide warning that tank vacuum level is approaching the DST structural integrity limit of -6.0 in. $H_2O$ (-9.5 in. $H_2O$ for 241-AP) as defined in interoffice memo 74700-00LJJ-022, *Clarification of Double-Shell Tank Normal Operating Limits*, from L. J. Julyk, dated July 31, 2000. This limit is implemented by the Level 2 specification HNF-5196, Sec. 3.2.1.1.1.
**3.1.3.4 Analytical Limit (AL):** > Tank Lo-Lo Pressure Limit
**3.1.3.5 Basis for AL:** This alarm exists to provide adequate warning before reaching the Lo-Lo Pressure analytical limit defined in Sec. 3.1.4, below.
**3.1.3.6 Trip Setpoint (TS):** -3.5 in. $H_2O$
**3.1.3.7 Basis for TS:** This is the current operating practice corresponding to the low-pressure (high vacuum) alarm setpoint specified in OSD-T-151-00007, Sec. 2.3.

### 3.1.4 Alarm Label: Tank Lo-Lo Pressure Alarm

**3.1.4.1 Alarm Description:** Annunciates when the DST differential pressure drops below the lo-lo pressure (i. e., excessive vacuum) trip setpoint.
**3.1.4.2 Alarm Interlock:** Primary Vent System Shutdown (AN & AW Farms only)
**3.1.4.3 Alarm Basis:** Warning that tank vacuum level has reached the DST structural integrity limit as defined in memo 74700-00LJJ-022, *Clarification of Double-Shell Tank Normal Operating Limits*, from L. J. Julyk, dated July 31, 2000. This requirement is mandated by the Level 2 specification HNF-5196, Sec. 3.2.1.1.1.
**3.1.4.4 Analytical Limit (AL):** -6 in. $H_2O$
**3.1.4.5 Basis for AL:** Interoffice memorandum 74700-00LJJ-022 provides this value based upon design load specifications and supporting structural analysis for the double-shell tanks in AN, AW, AY, AZ, and SY farms. This requirement is mandated by the Level 2 specification HNF-5196, Sec. 3.2.1.1.1, and in the minimum allowable pressure (maximum vacuum) per OSD-T-151-00007, Sec. 2.3.
**3.1.4.6 Trip Setpoint (TS):** -5.5 in. $H_2O$
**3.1.4.7 Basis for TS:** Pressure transmitter uncertainty was calculated to be ± 0.25 in. $H_2O$ (App. C).

$$TS = AL + CU + Error\ Margin = -6 + 0.25 + 0.25 = -5.5 \text{ in. } H_2O$$

## 3.2 Deentrainment and Filtration Differential Pressure Instruments

EIN: PDIT-152, PDIT-162; PDIT-356, PDIT-456;
PDIT-357, PDIT-457; PDIT-358, PDIT-458
Name: Differential Pressure Transmitter
Manufacturer: Yokogawa
Model Number: EJA-110A (-120A)

### 3.2.1 Administrative Limit: Deentrainer High dP

**3.2.1.1 Limit Description:** This is the administratively controlled differential pressure limit where the deentrainer pad should be flushed to remove particulate build-up.
**3.2.1.2 Limit Basis:** Indication of a dirty separator pad. Pad will require cleaning to minimize its impact on fan performance.
**3.2.1.3 Recommended Limit:** 2 in. $H_2O$
**3.2.1.4 Basis for Recommendation:** The clean pressure drop across the deentrainer pad provided by the vendor is less than 1 in. $H_2O$ for the range of operating flow rates for the exhausters. 2 in. $H_2O$ was that design value used to size the exhaust fan.

### 3.2.2 Alarm Label: Pre-Filter High dP Alarm

**3.2.2.1 Alarm Description:** Annunciates when the differential pressure across the pre-filter exceeds the trip setpoint.

**3.2.2.2 Alarm Interlock:** N/A

**3.2.2.3 Alarm Basis:** Indication of a dirty pre-filter. Pre-filter will require periodic replacement to minimize its impact on fan performance and maximize HEPA filter life.

**3.2.2.4 Analytical Limit (AL):** 1 in. $H_2O$

**3.2.2.5 Basis for AL:** Manufacturer's recommendation for optimum performance.

**3.2.2.6 Trip Setpoint (TS):** 1 in. $H_2O$

**3.2.2.7 Basis for TS:** Reaching the analytical limit has no impact on the operability of the Primary Ventilation System; therefore, the trip setpoint need not be any lower than the analytical limit.

**3.2.3 Alarm Label:** HEPA #1 Lo-Lo dP Alarm

**3.2.3.1 Alarm Description:** Annunciates when the differential pressure across the HEPA filter drops below the trip setpoint.

**3.2.3.2 Alarm Interlock:** Primary Ventilation Shutdown

**3.2.3.3 Alarm Basis:** Indication of a potential HEPA filter blowout.

**3.2.3.4 Analytical Limit (AL):** 0.1 in. $H_2O$

**3.2.3.5 Basis for AL:** OSD-T-151-00007, Sec. 3.1.

**3.2.3.6 Trip Setpoint (TS):** 0.2 in. $H_2O$

**3.2.3.7 Basis for TS:** Pressure transmitter uncertainty was calculated to be ± 0.096 in. $H_2O$ (App. D).

$$TS = AL + CU = 0.1 + 0.096 = 0.196 \sim 0.2 \text{ in. } H_2O$$

**3.2.4 Alarm Label:** HEPA #1 High dP Alarm

**3.2.4.1 Alarm Description:** Annunciates when the differential pressure across the HEPA filter exceeds the trip setpoint.

**3.2.4.2 Alarm Interlock:** N/A

**3.2.4.3 Alarm Basis:** Provide early warning of a dirty HEPA filter.

**3.2.4.4 Analytical Limit (AL):** < High-High Trip Setpoint

**3.2.4.5 Basis for AL:** Ensure sufficient time is provided to change-out HEPA filter before the High-High dP alarm shuts down the ventilation system.

**3.2.4.6 Trip Setpoint (TS):** 4.0 in. $H_2O$

**3.2.4.7 Basis for TS:** Pressure transmitter uncertainty was calculated to be ± 0.096 in. $H_2O$ (App. D). Include a 1.7 in. $H_2O$ margin to allow time to change out filter.

$$TS = AL - CU - Margin = 5.8 - 0.096 - 1.7 = 4.004 \sim 4.0 \text{ in. } H_2O$$

**3.2.5 Alarm Label:** HEPA #1 Hi-Hi dP Alarm

**3.2.5.1 Alarm Description:** Annunciates when the differential pressure across the HEPA filter exceeds the trip setpoint.

**3.2.5.2 Alarm Interlock:** Primary Ventilation System Shutdown

**3.2.5.3 Alarm Basis:** Indication of a dirty HEPA filter, based upon manufacturer's recommendation.

**3.2.5.4 Analytical Limit (AL):** 5.9 in. $H_2O$

**3.2.5.5 Basis for AL:** OSD-T-151-00007, Sec. 3.1, limit for a dirty 1st-stage HEPA filter (40% below 10 in. $H_2O$ limit set by manufacturer).
**3.2.5.6 Trip Setpoint (TS):** 5.8 in. $H_2O$
**3.2.5.7 Basis for TS:** Pressure transmitter uncertainty was calculated to be ± 0.096 in. $H_2O$ (App. D).

$$TS = AL - CU = 5.9 - 0.096 = 5.804 \sim 5.8 \text{ in. } H_2O$$

**3.2.6 Alarm Label:** <u>HEPA #2 Lo-Lo dP Alarm</u>

**3.2.6.1 Alarm Description:** Annunciates when the differential pressure across the HEPA filter exceeds the trip setpoint.
**3.2.6.2 Alarm Interlock:** Primary Ventilation System Shutdown
**3.2.6.3 Alarm Basis:** Indication of a potential HEPA filter blowout.
**3.2.6.4 Analytical Limit (AL):** 0.1 in. $H_2O$
**3.2.6.5 Basis for AL:** OSD-T-151-00007, Sec. 3.1.
**3.2.6.6 Trip Setpoint (TS):** 0.2 in. $H_2O$
**3.2.6.7 Basis for TS:** Pressure transmitter uncertainty was calculated to be ± 0.096 in. $H_2O$ (App. D).

$$TS = AL + CU = 0.1 + 0.096 = 0.196 \sim 0.2 \text{ in. } H_2O$$

**3.2.7 Alarm Label:** <u>HEPA #2 High dP Alarm</u>

**3.2.7.1 Alarm Description:** Annunciates when the differential pressure across the HEPA filter exceeds the trip setpoint.
**3.2.7.2 Alarm Interlock:** N/A
**3.2.7.3 Alarm Basis:** Provide early warning of a dirty HEPA filter.
**3.2.7.4 Analytical Limit (AL):** < High-High Trip Setpoint
**3.2.7.5 Basis for AL:** Ensure sufficient time is provided to change-out HEPA filter before the High-High dP alarm shuts down the ventilation system.
**3.2.7.6 Trip Setpoint (TS):** 2.8 in. $H_2O$
**3.2.7.7 Basis for TS:** Pressure transmitter uncertainty was calculated to be ± 0.096 in. $H_2O$ (App. D). Include a 1.0 in. $H_2O$ margin to allow time to change out filter.

$$TS = AL - CU - Margin = 3.9 - 0.096 - 1.0 = 2.804 \sim 2.8 \text{ in. } H_2O$$

**3.2.8 Alarm Label:** <u>HEPA #2 Hi-Hi dP Alarm</u>

**3.2.8.1 Alarm Description:** Annunciates when the differential pressure across the HEPA filter exceeds the trip setpoint.
**3.2.8.2 Alarm Interlock:** Primary Ventilation System Shutdown
**3.2.8.3 Alarm Basis:** Indication of a dirty HEPA filter, based upon manufacturer's recommendation.
**3.2.8.4 Analytical Limit (AL):** 4 in. $H_2O$
**3.2.8.5 Basis for AL:** OSD-T-151-00007, Sec. 3.1, limit for a dirty 2nd-stage HEPA filter (60% below 10 in. $H_2O$ limit set by manufacturer).
**3.2.8.6 Trip Setpoint (TS):** 3.9 in. $H_2O$

**3.2.8.7 Basis for TS:** Pressure transmitter uncertainty was calculated to be ± 0.096 in. $H_2O$ (App. D).

TS = AL - CU = 4 - 0.096 = 3.904 ~ 3.9 in. $H_2O$

**3.2.9 Alarm Label:** HEPA Bank High dP Alarm

**3.2.9.1 Alarm Description:** Annunciates when the differential pressure across the HEPA filter bank exceeds the trip setpoint.
**3.2.9.2 Alarm Interlock:** N/A
**3.2.9.3 Alarm Basis:** Provide early warning of a dirty HEPA filter bank.
**3.2.9.4 Analytical Limit (AL):** < High-High Trip Setpoint
**3.2.9.5 Basis for AL:** Ensure sufficient time is provided to change-out HEPA filters before the High-High dP alarm shuts down the ventilation system.
**3.2.9.6 Trip Setpoint (TS):** 4.7 in. $H_2O$
**3.2.9.7 Basis for TS:** Pressure transmitter uncertainty was calculated to be ± 0.096 in. $H_2O$ (App. D). Include a 1.0 in. $H_2O$ margin to allow time to change-out the filters.

TS = AL – CU – Margin = 5.8 - 0.096 – 1.0 = 4.704 ~ 4.7 in. $H_2O$

**3.2.10 Alarm Label:** HEPA Bank Hi-Hi dP Alarm

**3.2.10.1 Alarm Description:** Annunciates when the differential pressure across the HEPA filter bank exceeds the trip setpoint.
**3.2.10.2 Alarm Interlock:** Primary Ventilation System Shutdown
**3.2.10.3 Alarm Basis:** Indication of dirty HEPA filters, based upon manufacturer's recommendation.
**3.2.10.4 Analytical Limit (AL):** 5.9 in. $H_2O$
**3.2.10.5 Basis for AL:** OSD-T-151-00007, Sec. 3.1, limit for multiple stages of HEPA filters in series.
**3.2.10.6 Trip Setpoint (TS):** 5.8 in. $H_2O$
**3.2.10.7 Basis for TS:** Transmitter uncertainty is ± 0.096 in. $H_2O$ (App. D).

TS = AL - CU = 5.9 - 0.096 = 5.804 ~ 5.8 in. $H_2O$

## 3.3 Glycol System Pressure Instruments

EIN: PIT-371, PIT-471
Name: Pressure Indicating Transmitter
Manufacturer: Yokogawa
Model Number: EJA430A-EAS4B-92EN/FF1/D1

**3.3.1 Alarm Label:** Glycol System Lo-Lo Pressure Alarm

**3.3.1.1 Alarm Description:** Annunciates when the glycol pump discharge pressure drops below the trip setpoint.
**3.3.1.2 Alarm Interlock:** Glycol System Shutdown

3.3.1.3 **Alarm Basis:** Indicates catastrophic failure of glycol pump or substantial leak in glycol system resulting in insufficient flow through the glycol heat exchanger. Continuous operation of the heating element could result in over heating without needed fluid flow, therefore necessitating a complete system shutdown upon alarm.

3.3.1.4 **Analytical Limit (AL):** 0 psig

3.3.1.5 **Basis for AL:** Vendor information and system testing for glycol pump indicate nominal discharge pressure in the range of 16-19 psig. Zero pressure at the pump discharge would indicate pump is not operating in an open system.

3.3.1.6 **Trip Setpoint (TS):** 3 psig

3.3.1.7 **Basis for TS:** Accounts for instrument inaccuracies and residual system pressure.

### 3.3.2 Alarm Label: Glycol System Low Pressure Alarm

3.3.2.1 **Alarm Description:** Annunciates when the glycol pump discharge pressure drops below the trip setpoint.

3.3.2.2 **Alarm Interlock:** N/A

3.3.2.3 **Alarm Basis:** Indicates catastrophic failure of glycol pump or substantial leak in glycol system resulting in insufficient flow through the glycol heat exchanger. Continuous operation of the heating element could result in over heating without needed fluid flow, therefore necessitating a complete system shutdown upon alarm.

3.3.2.4 **Analytical Limit (AL):** > Lo-Lo Alarm Trip Setpoint

3.3.2.5 **Basis for AL:** Provide warning that system is losing pressure and a glycol heater shutdown interlock is approaching.

3.3.2.6 **Trip Setpoint (TS):** 5 psig

3.3.2.7 **Basis for TS:** Ensure spurious alarms do not occur due to system pressure fluctuations, but still provide adequate warning that a heater shutdown is imminent.

### 3.3.3 Alarm Label: Glycol System High Pressure Alarm

3.3.3.1 **Alarm Description:** Annunciates when the glycol pump discharge pressure exceeds the trip setpoint.

3.3.3.2 **Alarm Interlock:** N/A

3.3.3.3 **Alarm Basis:** Indicates a closed valve in the system or other blockage downstream of the glycol pump. Continuous operation could damage pump or result in overheating the heater coil due to lack of fluid flow.

3.3.3.4 **Analytical Limit (AL):** < Hi-Hi Alarm Trip Setpoint

3.3.3.5 **Basis for AL:** Provide warning that a system shutdown is imminent due to a valve misalignment or other blockage.

3.3.3.6 **Trip Setpoint (TS):** 25 psig

3.3.3.7 **Basis for TS:** Normal discharge pressure is 16-19 psig. The alarm is high enough to preclude spurious trips, yet will still provide warning prior to a system shutdown.

### 3.3.4 Alarm Label: Glycol System Hi-Hi Pressure Alarm

**3.3.4.1 Alarm Description:** Annunciates when the glycol pump discharge pressure exceeds the trip setpoint.
**3.3.4.2 Alarm Interlock:** Glycol System Shutdown
**3.3.4.3 Alarm Basis:** Indicates a closed valve in the system or other blockage downstream of the glycol pump. Continuous operation could damage pump or result in overheating the heater coil due to lack of fluid flow.
**3.3.4.4 Analytical Limit (AL):** 33 psig
**3.3.4.5 Basis for AL:** This is the approximate dead head pressure for the pump from vendor information.
**3.3.4.6 Trip Setpoint (TS):** 28 psig
**3.3.4.7 Basis for TS:** Ensure the pump dead head pressure is not reached, while providing sufficient margin for system pressure fluctuations.

# 4.0 TEMPERATURE MONITORING INSTRUMENTATION

## 4.1 Exhauster Temperature Monitoring Instruments

Heater Inlet: TE-353, TE-453
Heater Outlet: TE-355, TE-455

Name: Platinum Resistance Temperature Detector (RTD)
Manufacturer: Weed Instruments
Model Number: 305-01B-A-3-C-018.0-00-Z006

### 4.1.1 Alarm Label: Heater Low Differential Temperature Alarm

**4.1.1.1 Alarm Description:** Annunciates when the temperature rise across the heater drops below the trip setpoint.
**4.1.1.2 Alarm Interlock:** N/A
**4.1.1.3 Alarm Basis:** The relative humidity of the air stream must be reduced to at least 70% RH before entering the HEPA filters. This requirement is in ASME N509, Sec. 5.5.1.
**4.1.1.4 Analytical Limit (AL):** 14.8 °F
**4.1.1.5 Basis for AL:** From vendor calculation PTI-W314-CALC-003, a 14.8 °F temperature rise is required based upon worst-case air stream conditions entering the exhauster. An operating setpoint value of 20 °F will be used to regulate heater operation.
**4.1.1.6 Trip Setpoint (TS):** 16 °F
**4.1.1.7 Basis for TS:** Temperature sensors are 100-Ω Platinum RTDs, rated at a maximum of 500 °F. Accuracy of the instrument is linear over the expected operating range (80 °F to 170 °F), varying no more than ± 1.25 °F.

### 4.1.2 Alarm Label: Heater Hi-Hi Outlet Temperature Alarm

**4.1.2.1 Alarm Description:** Annunciates when the exhaust stream temperature entering the first HEPA exceeds the trip setpoint.

**4.1.2.2 Alarm Interlock:** Heater Shutdown

**4.1.2.3 Alarm Basis:** Protect upper temperature operating limit of exhaust stream components.

**4.1.2.4 Analytical Limit (AL):** 167 °F

**4.1.2.5 Basis for AL:** While heater output is limited to 225 °F per ASME N509, Sec. 5.5.1, to protect HEPA filters, the limiting air stream component for the exhaust skids is the Continuous Air Monitor (CAM) in-line sample head located in the Sample Cabinet. Vendor literature limits the internal gas temperature to 75 °C (167 °F). This is also a limit provided in the Radioactive Air Emissions Notice of Construction (NOC), Project W-314—Operation of a New Ventilation System in 241-AN Tank Farm.

**4.1.2.6 Trip Setpoint (TS):** 165 °F

**4.1.2.7 Basis for TS:** Heat loss from the point of measurement (prior to first HEPA) to the CAM is assumed to exceed any inaccuracies in the RTD probe measurement (ref: PTI-W314-CALC-003).

## 4.2 PLC Control Cabinet Temperature and Humidity Monitoring Instruments

EIN: MI-110, MI-111
Name: Industrial Humidity-Temperature Transmitter
Manufacturer: General Eastern
Model Number: HU-GD-S-S24-S2-OD-OC-SP-NP

### 4.2.1 Alarm Label: Cabinet Temperature Lo-Lo Alarm

**4.2.1.1 Alarm Description:** Annunciates when the temperature inside the exhauster control cabinet drops below the trip setpoint. (Note: This is not a PLC alarm, and therefore is not displayed on the HMI.)

**4.2.1.2 Alarm Interlock:** Primary Ventilation System Shutdown

**4.2.1.3 Alarm Basis:** The operating range of the safety-class programmable logic controller (PLC) is from 0 to 55 °C (32 to 131 °F). Outside this temperature range the operability of the PLC, and consequently the Primary Ventilation System, is compromised.

**4.2.1.4 Analytical Limit (AL):** 32 °F

**4.2.1.5 Basis for AL:** The operating range of the safety-class programmable logic controller (PLC) is from 0 to 55 °C (32 to 131 °F).

**4.2.1.6 Trip Setpoint (TS):** 35 °F

**4.2.1.7 Basis for TS:** Temperature sensor element is a 1000-Ω Platinum RTD. Published accuracy of the instrument over its operating range (-40 °F to 176 °F) is ± 0.36 °F. There is no additional information regarding instrument stability, repeatability, or ambient effects on the sensor uncertainty. To account for these and calibration uncertainties, total channel uncertainty is increased to ± 3 °F (see calculation W314-I-218).

### 4.2.2 Alarm Label: Cabinet Temperature Low Alarm

**4.2.2.1 Alarm Description:** Annunciates when the temperature inside the exhauster control cabinet drops below the trip setpoint.

**4.2.2.2 Alarm Interlock:** N/A

**4.2.2.3 Alarm Basis:** The operating range of the safety-class programmable logic controller (PLC) is from 0 to 55 °C (32 to 131 °F). Outside this temperature range the operability of the PLC, and consequently the Primary Ventilation System, is compromised.

**4.2.2.4 Analytical Limit (AL):** > Low-Low Trip Setpoint

**4.2.2.5 Basis for AL:** Provide warning that the climate control in the control cabinet either has failed or cannot keep up with demand. PLC shutdown is imminent if not rectified.

**4.2.2.6 Trip Setpoint (TS):** 45 °F

**4.2.2.7 Basis for TS:** Provide 10 °F of warning before a Low-Low shutdown occurs on temperature.

### 4.2.3 Alarm Label: Cabinet Temperature High Alarm

**4.2.3.1 Alarm Description:** Annunciates when the temperature inside the exhauster control cabinet exceeds the trip setpoint.

**4.2.3.2 Alarm Interlock:** N/A

**4.2.3.3 Alarm Basis:** The operating range of the safety-class programmable logic controller (PLC) is from 0 to 55 °C (32 to 131 °F). Outside this temperature range the operability of the PLC, and consequently the Primary Ventilation System, is compromised.

**4.2.3.4 Analytical Limit (AL):** < High-High Trip Setpoint

**4.2.3.5 Basis for AL:** Provide warning that the climate control in the control cabinet either has failed or cannot keep up with demand. PLC shutdown is immanent if not rectified.

**4.2.3.6 Trip Setpoint (TS):** 118 °F

**4.2.3.7 Basis for TS:** Provide 10 °F of warning before a High-High shutdown occurs on temperature.

### 4.2.4 Alarm Label: Cabinet Temperature Hi-Hi Alarm

**4.2.4.1 Alarm Description:** Annunciates when the temperature inside the exhauster control cabinet exceeds the trip setpoint. (Note: This is not a PLC alarm, and therefore is not displayed on the HMI.)

**4.2.4.2 Alarm Interlock:** Primary Ventilation System Shutdown

**4.2.4.3 Alarm Basis:** The operating range of the safety-class programmable logic controller (PLC) is from 0 to 55 °C (32 to 131 °F). Outside this temperature range the operability of the PLC, and consequently the Primary Ventilation System, is compromised.

**4.2.4.4 Analytical Limit (AL):** 131 °F

**4.2.4.5 Basis for AL:** The operating range of the safety-class programmable logic controller (PLC) is from 0 to 55 °C (32 to 131 °F).

**4.2.4.6 Trip Setpoint (TS):** 128 °F

**4.2.4.7 Basis for TS:** Temperature sensor element is a 1000-Ω Platinum RTD. Published accuracy of the instrument over its operating range (-40 °F to 176 °F) is ± 0.36 °F. There is no additional information regarding instrument stability, repeatability, or ambient effects on the sensor uncertainty. To account for these and calibration uncertainties, total channel uncertainty is increased to ± 3 °F (see calculation W314-I-218).

**4.2.5 Alarm Label:** Enclosure Moisture High Alarm

**4.2.5.1 Alarm Description:** Annunciates when the relative humidity inside the exhauster control cabinet exceeds the trip setpoint.

**4.2.5.2 Alarm Interlock:** N/A

**4.2.5.3 Alarm Basis:** The operating range of the safety-class programmable logic controller (PLC) is from 0 to 90% RH. Outside this temperature range the operability of the PLC, and consequently the Primary Ventilation System, is compromised.

**4.2.5.4 Analytical Limit (AL):** < High-High Trip Setpoint

**4.2.5.5 Basis for AL:** Provide warning that the climate control in the control cabinet either has failed or cannot keep up with demand. PLC shutdown is imminent if not rectified.

**4.2.5.6 Trip Setpoint (TS):** 80% RH

**4.2.5.7 Basis for TS:** Provide 8% RH of warning before the High-High shutdown occurs on humidity.

**4.2.6 Alarm Label:** Enclosure Moisture Hi-Hi Alarm

**4.2.6.1 Alarm Description:** Annunciates when the relative humidity inside the exhauster control cabinet exceeds the trip setpoint. (Note: This is not a PLC alarm, and therefore is not displayed on the HMI.)

**4.2.6.2 Alarm Interlock:** Primary Ventilation System Shutdown

**4.2.6.3 Alarm Basis:** The operating range of the safety-class programmable logic controller (PLC) is from 0 to 90% RH. Outside this temperature range the operability of the PLC, and consequently the Primary Ventilation System, is compromised.

**4.2.6.4 Analytical Limit (AL):** 90% RH

**4.2.6.5 Basis for AL:** The operating range of the safety-class programmable logic controller (PLC) is from 0 to 90% RH.

**4.2.6.6 Trip Setpoint (TS):** 88% RH

**4.2.6.7 Basis for TS:** Total channel uncertainty was calculated to be 1.9% RH (see calculation W314-I-218).

### 4.3 Glycol Tank Temperature Instruments

EIN: TE-373, TE-473
Name: Platinum Resistance Temperature Detector (RTD)
Manufacturer: Weed Instruments
Model Number: 203-01B-A-3-C/B-013.5-A2-Z006

#### 4.3.1 Alarm Label: Glycol Tank Hi-Hi Temperature Alarm

**4.3.1.1 Alarm Description:** Annunciates when the glycol tank temperature exceeds the trip setpoint.
**4.3.1.2 Alarm Interlock:** Heater Shutdown
**4.3.1.3 Alarm Basis:** Protect glycol heater system components from exceeding operating temperature range due to a heating element malfunction.
**4.3.1.4 Analytical Limit (AL):** 212 °F
**4.3.1.5 Basis for AL:** The glycol pump represents the most limiting component in terms of operating temperature in the glycol heating system. Its maximum operating temperature is 212 °F.
**4.3.1.6 Trip Setpoint (TS):** 209 °F
**4.3.1.7 Basis for TS:** Temperature sensors are 100-Ω Platinum RTDs, rated at a maximum of 500 °F. Accuracy of the instrument is linear over the expected operating range (80 °F to 210 °F), varying no more than ± 2.5 °F.

## 5.0 LIQUID LEVEL MONITORING INSTRUMENTATION

### 5.1 Deentrainer Seal Pot Level Monitoring Instruments

EIN: LIT-170
Name: Level Transmitter
Manufacturer: Endress & Hauser
Model Number: FMR 240-S3V1AEJEA4A

#### 5.1.1 Alarm Label: Deentrainer Seal Pot Lo-Lo Level Alarm

**5.1.1.1 Alarm Description:** Annunciates when the deentrainer seal pot level drops below the trip setpoint.
**5.1.1.2 Alarm Interlock:** N/A
**5.1.1.3 Alarm Basis:** Prevent seal pot level from approaching the bottom of the deentrainer drainpipe, thus creating an airflow pathway to the DST vapor space.
**5.1.1.4 Analytical Limit (AL):** 22% level
**5.1.1.5 Basis for AL:** From H-14-104390 Sh. 1 & 2, drainpipe leg extends down 14.5 in. from top 18.5 in. internal height of seal pot. 4/18.5 = 0.216 = 22% of level.
**5.1.1.6 Trip Setpoint (TS):** 30% level

**5.1.1.7 Basis for TS:** Level transmitter uses a radar wave-guide antenna to obtain very accurate measurements of liquid level. Accuracy is ± 3 mm (± 0.12 inches). For a seal pot height of 18.5 in., this results in an uncertainty of 0.12/18.5 = ± 0.65% level. To account for calibration uncertainties and add an additional margin of error, round up to 30% level.

**5.1.2 Alarm Label:** Deentrainer Seal Pot Lo Level Alarm

**5.1.2.1 Alarm Description:** Annunciates when the deentrainer seal pot level drops below the trip setpoint.
**5.1.2.2 Alarm Interlock:** N/A
**5.1.2.3 Alarm Basis:** Provide warning that the seal pot level is approaching the bottom of the deentrainer drainpipe, thus creating an airflow pathway to the DST vapor space.
**5.1.2.4 Analytical Limit (AL):** > Low-Low Trip Setpoint
**5.1.2.5 Basis for AL:** Provide adequate warning to fill the deentrainer seal pot before the low-low setpoint is reached.
**5.1.2.6 Trip Setpoint (TS):** 40% level
**5.1.2.7 Basis for TS:** Level transmitter uses a radar wave-guide antenna to obtain very accurate measurements of liquid level. Accuracy is ± 3 mm (± 0.12 inches). For a seal pot height of 18.5 in., this results in an uncertainty of 0.12/18.5 = ± 0.65% level. To account for calibration uncertainties and add an additional margin of error, round up to 40% level.

**5.1.3 Alarm Label:** Deentrainer Seal Pot Hi-Hi Level Alarm

**5.1.3.1 Alarm Description:** Annunciates when the deentrainer seal pot level exceeds the trip setpoint.
**5.1.3.2 Alarm Interlock:** N/A
**5.1.3.3 Alarm Basis:** Indicates either that the seal pot has plugged and is no longer draining, or that the entrained liquid content in the exhaust air stream is so great that it exceeds the drain capacity of the seal pot. Either of which could result in a liquid back up into the deentrainer housing or exhauster seal pot.
**5.1.3.4 Analytical Limit (AL):** 100% level
**5.1.3.5 Basis for AL:** Once the seal pot fills completely the drain lines will begin backing up into the exhauster seal pot and the deentrainer housings.
**5.1.3.6 Trip Setpoint (TS):** 95% level
**5.1.3.7 Basis for TS:** Level transmitter uses a radar wave-guide antenna to obtain very accurate measurements of liquid level. Accuracy is ± 3 mm (± 0.12 inches). For a seal pot height of 18.5 in., this results in an uncertainty of 0.12/18.5 = ± 0.65% level. To account for calibration uncertainties and add an additional margin of error, round down to 95% level.

**5.1.4 Alarm Label:** Deentrainer Seal Pot High Level Alarm

**5.1.4.1 Alarm Description:** Annunciates when the deentrainer seal pot level exceeds the trip setpoint.
**5.1.4.2 Alarm Interlock:** N/A
**5.1.4.3 Alarm Basis:** Provide warning that either the seal pot may be plugging and is no longer draining, or that the entrained liquid content in the exhaust air stream is so great that it be exceeding the drain capacity of the seal pot. Either of which could result in a liquid back up into the deentrainer housing or exhauster seal pot.
**5.1.4.4 Analytical Limit (AL):** < High-High Trip Setpoint
**5.1.4.5 Basis for AL:** Provide adequate warning to unplug the deentrainer seal pot drain lines before the high-high trip setpoint is reached.
**5.1.4.6 Trip Setpoint (TS):** 85% level
**5.1.4.7 Basis for TS:** Level transmitter uses a radar wave-guide antenna to obtain very accurate measurements of liquid level. Accuracy is ± 3 mm (± 0.12 inches). For a seal pot height of 18.5 in., this results in an uncertainty of 0.12/18.5 = ± 0.65% level. To account for calibration uncertainties and add an additional margin of error, round down to 85% level.

**5.2 Exhauster Seal Pot Level Monitoring Instruments**

EIN: LT-380, LT-480
Name: Level Transmitter
Manufacturer: Drexelbrook
Model Number: 509-75

**5.2.1 Alarm Label:** Exhauster Seal Pot Lo-Lo Level Alarm

**5.2.1.1 Alarm Description:** Annunciates when the exhauster seal pot level drops below the trip setpoint.
**5.2.1.2 Alarm Interlock:** Primary Ventilation Shutdown
**5.2.1.3 Alarm Basis:** Prevent liquid level from reaching the bottom of the seal pot drain legs, thus creating an airflow pathway bypassing the HEPA filters.
**5.2.1.4 Analytical Limit (AL):** 8% level
**5.2.1.5 Basis for AL:** From calculation PTI-W314-CALC-004, the maximum height from the inside of the seal pot to the highest dip leg opening is 0.62 in. Inside max height of the seal pot is 7.62 in., therefore 0.62/7.62 = 0.081 ~ 8% level.
**5.2.1.6 Trip Setpoint (TS):** 20% level
**5.2.1.7 Basis for TS:** The level transmitter has an accuracy of 0.25% of range (this includes combined effects of linearity, hysteresis, and repeatability). Including 0.1% of range per 50 °F of temperature change, increases instrument uncertainty as follows:
Uncertainty = SQRT $(0.25^2 + 0.1^2)$ = 0.27% = ± 0.02 inches

An additional margin is added to account for calibration uncertainties and other system biases.

**5.2.2 Alarm Label:** Exhauster Seal Pot Low Level Alarm

**5.2.2.1 Alarm Description:** Annunciates when the exhauster seal pot level drops below the trip setpoint.
**5.2.2.2 Alarm Interlock:** N/A
**5.2.2.3 Alarm Basis:** Provide warning that the liquid level is approaching the bottom of the seal pot drain legs, thus creating an airflow pathway bypassing the HEPA filters.
**5.2.2.4 Analytical Limit (AL):** > Low-Low Trip Setpoint
**5.2.2.5 Basis for AL:** Provide adequate warning to fill the exhauster seal pot before the low-low trip setpoint is reached and the Primary Ventilation System shuts down.
**5.2.2.6 Trip Setpoint (TS):** 30% level
**5.2.2.7 Basis for TS:** Vendor calculation PTI-W314-CALC-004 has analyzed the potential of the fan to draw the liquid level of the seal pot down during a fan dead-head event, and has shown that liquid level will not drop below 30% level.

**5.2.3 Alarm Label:** Exhauster Seal Pot Hi-Hi Level Alarm

**5.2.3.1 Alarm Description:** Annunciates when the exhauster seal pot level exceeds the trip setpoint.
**5.2.3.2 Alarm Interlock:** Primary Ventilation Shutdown
**5.2.3.3 Alarm Basis:** Indicates either that the seal pot has plugged and is no longer draining, or that the entrained liquid content in the exhaust air stream is so great that it exceeds the drain capacity of the seal pot. Either of which could result in a liquid back up into the exhauster filter housing.
**5.2.3.4 Analytical Limit (AL):** 100% level
**5.2.3.5 Basis for AL:** Once the seal pot fills completely the drain lines will begin backing up into the exhauster filter housing.
**5.2.3.6 Trip Setpoint (TS):** 90% level
**5.2.3.7 Basis for TS:** The level transmitter has an accuracy of 0.25% of range (this includes combined effects of linearity, hysteresis, and repeatability). Including 0.1% of range per 50 °F of temperature change, increases instrument uncertainty as follows:

Uncertainty = SQRT $(0.25^2 + 0.1^2)$ = 0.27% = ± 0.02 inches
An additional margin is added to account for calibration uncertainties and other system biases.

**5.2.4 Alarm Label:** Exhauster Seal Pot High Level Alarm

**5.2.4.1 Alarm Description:** Annunciates when the exhauster seal pot level exceeds the trip setpoint.

**5.2.4.2 Alarm Interlock:** N/A

**5.2.4.3 Alarm Basis:** Provide warning either that the seal pot is plugging and is no longer draining, or that the entrained liquid content in the exhaust air stream is so great that it exceeds the drain capacity of the seal pot. Either of which could result in a liquid back up into the exhauster filter housing.

**5.2.4.4 Analytical Limit (AL):** < High-High Trip Setpoint

**5.2.4.5 Basis for AL:** Provide adequate warning to unplug the exhauster seal pot before the high-high trip setpoint is reached and the Primary Ventilation System shuts down.

**5.2.4.6 Trip Setpoint (TS):** 80% level

**5.2.4.7 Basis for TS:** The level transmitter has an accuracy of 0.25% of range (this includes combined effects of linearity, hysteresis, and repeatability). Including 0.1% of range per 50 °F of temperature change, increases instrument uncertainty as follows:

Uncertainty = SQRT $(0.25^2 + 0.1^2)$ = 0.27% = ± 0.02 inches
An additional margin is added to account for calibration uncertainties and other system biases.

## 5.3 Exhauster Glycol Tank Level Monitoring Instruments

EIN: LT-370, LT-470
Name: Level Transmitter
Manufacturer: Drexelbrook
Model Number: 509-75

### 5.3.1 Alarm Label: Exhauster Glycol Tank Lo-Lo Level Alarm

**5.3.1.1 Alarm Description:** Annunciates when the exhauster glycol tank level drops below the trip setpoint.

**5.3.1.2 Alarm Interlock:** Glycol System Shutdown

**5.3.1.3 Alarm Basis:** Ensure there is sufficient heating fluid to supply the glycol pump and heater coil. Possible indication of a leak in the glycol system.

**5.3.1.4 Analytical Limit (AL):** 0% level

**5.3.1.5 Basis for AL:** Prevent glycol heater system from running without sufficient heating fluid, resulting in possible pump cavitation.

**5.3.1.6 Trip Setpoint (TS):** 20% level

**5.3.1.7 Basis for TS:** The level transmitter has an accuracy of 0.25% of range (this includes combined effects of linearity, hysteresis, and repeatability). Including 0.1% of range per 50 °F of temperature change, increases instrument uncertainty as follows:

Uncertainty = SQRT $(0.25^2 + 0.1^2)$ = 0.27% = ± 0.02 inches
An additional margin is added to account for calibration uncertainties and other system biases.

**5.3.2 Alarm Label:** Exhauster Glycol Tank Low Level Alarm

**5.3.2.1 Alarm Description:** Annunciates when the exhauster glycol tank level drops below the trip setpoint.

**5.3.2.2 Alarm Interlock:** N/A

**5.3.2.3 Alarm Basis:** Ensure there is sufficient heating fluid to supply the glycol pump and heater coil. Possible indication of a leak in the glycol system.

**5.3.2.4 Analytical Limit (AL):** > Low-Low Trip Setpoint

**5.3.2.5 Basis for AL:** Provide adequate warning to fill the exhauster glycol tank reservoir before the low liquid level impacts performance of the heater system.

**5.3.2.6 Trip Setpoint (TS):** 40% level

**5.3.2.7 Basis for TS:** The level transmitter has an accuracy of 0.25% of range (this includes combined effects of linearity, hysteresis, and repeatability). Including 0.1% of range per 50 °F of temperature change, increases instrument uncertainty as follows:

Uncertainty = SQRT $(0.25^2 + 0.1^2)$ = 0.27% = ± 0.02 inches
An additional margin is added to account for calibration uncertainties and other system biases, as well as to allow time to refill system before reaching the Low-Low interlock.

**5.3.3 Alarm Label:** Exhauster Glycol Tank High Level Alarm

**5.3.3.1 Alarm Description:** Annunciates when the exhauster glycol tank level exceeds the trip setpoint.

**5.3.3.2 Alarm Interlock:** N/A

**5.3.3.3 Alarm Basis:** Ensure the glycol tank has not been overfilled, which could result in a spill once the glycol pump is started.

**5.3.3.4 Analytical Limit (AL):** 100% level

**5.3.3.5 Basis for AL:** Since the glycol tank has vent-fill cap, once the level in the tank exceeds 100% the tank will overflow.

**5.3.3.6 Trip Setpoint (TS):** 80% level

**5.3.3.7 Basis for TS:** Factory testing showed that pressure added to the system during glycol pump operation did not result in a noticeable level change in the glycol tank.

# 6.0 RADIATION MONITORING INSTRUMENTATION

## 6.1 Continuous Air Monitor (CAM) Instruments

EIN: RE-554, RE-654
Name: Continuous Air Monitor
Manufacturer: Eberline
Model Number: AMS-4 with In-Line Sampling Head

### 6.1.1 Alarm Label: CAM Radiation Alarm

**6.1.1.1 Alarm Description:** Annunciates when the CAM radiation level exceeds the high trip setpoint.

**6.1.1.2 Alarm Interlock:** Primary Ventilation System Shutdown

**6.1.1.3 Alarm Basis:** Ensure the radiation limit is ALARA and below allowable emission limits as defined in the air operating permit and the facility effluent monitoring plan, HNF-EP-0479-4. Credited as a "defense-in-depth" feature per the Tank Farms Safety Basis (DSA), RPP-13033, Ch. 3.

**6.1.1.4 Analytical Limit (AL):** 10,000 cpm.

**6.1.1.5 Basis for AL:** Basis for commonly-accepted 10,000-cpm limit is discussed in HNF-EP-0479-4. In general, CAMs need to be set based on meaningful emission increases and rates of increase, but as low as practical without resulting in an excessive number of alarms due to normal fluctuations in background or emissions.

**6.1.1.6 Trip Setpoint (TS):** 300 dpm/ft$^3$ (Slow); 7,000 dpm/ft$^3$ (Fast); 3,000 cpm (Nominal).

**6.1.1.7 Basis for TS:** These values have been determined to be the lowest possible setpoint values without resulting in spurious alarms, per facility effluent monitoring plan HNF-EP-0479-4. The values are based upon historical operation in similar tank farms exhauster systems.

# Appendix A: Exhaust Stack Flow Transmitter Uncertainty Calculation

Title: **Exhaust Stack Flow Transmitter Uncertainty Calculation** Identifier: I-01-01/02/03 RPP-15034 Rev: 0

Originator: DP Gargiulo Date: 7/22/03

Checker: BD Andres Date: 7/22/03

Objective

Determine the uncertainty in the flow measurement for the exhaust stack flow transmitter.

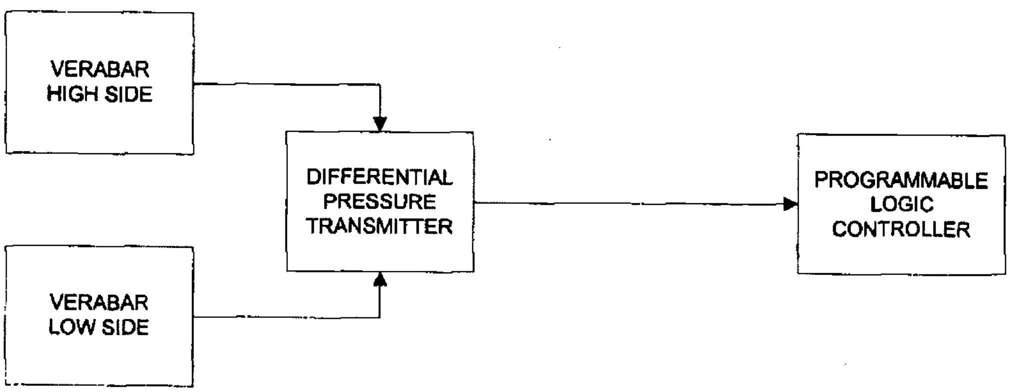
Pressure Transmitter Vendor Specifications

EIN: PDIT-551; PDIT-651
Name: Differential Pressure Transmitter
Manufacturer: Yokogawa
Model Number: EJA-120A-EES4B-92EC/FS1-D1-HAC-F1
Range: -4 to 4 in$H_2O$
Calibrated Span: 0 to 4 in$H_2O$
Accuracy: ±0.1% of Span
Stability: ±0.1% of URL for 60 months (5 years)
Ambient Temperature Effect: ±[0.15% of Span + 0.20% URL] per 28 °C (50 °F) change
Power Supply Effect: ±0.005% per Volt (from 21.6 to 32 VDC, 350Ω)
Ambient Temperature Limits: -40 to 60 °C (-40 to 140 °F)
Process Temperature Limits: -25 to 80 °C (-13 to 176 °F)
Ambient Humidity Limits: 5 to 100 %RH @ 40 °C (104°F)
Working Pressure Limits: -50 to 50 kPa (-7.25 to 7.25 psi)

Assumptions

1. Uncertainty terms are assumed to be both +/- the calculated value
2. Calibration interval is on an annual basis
3. Maximum voltage variation is +/- 1 volt
4. Ambient temperature ranges from -32 F to 115 F
5. Ambient temperature effect is per 50°F change, therefore assume a 2X multiplier for temperature uncertainty effect
6. Radiation effects are minimal, therefore neglected
7. Measurement and Test Equipment (MTE) uncertainty effect is 0.5% of Span
8. Uncertainty of PLC and associated I/O cards is neglibible compared to that of the sensor, therefore it will be neglected

Block Diagram



Originator: DP Gargiulo [signature] Date: 7/22/03

Checker: BO Andres [signature] Date: 7/22/03

Uncertainty Terms for Pressure Transmitter

| | |
|---|---|
| $Span := 4$ | Difference between upper and lower limits of calibrated range |
| $URL := 8$ | Upper Range Limit |
| $RA := 0.1\% \cdot Span$ | Sensor reference accuracy specified by the manufacturer |
| $DR := 0.1\% \cdot \frac{URL}{5}$ | Drift of the module over a 1 year period |
| $TE := 0.15\% \cdot Span + 0.20\% \cdot URL$ | Temperature effect for the module per 50 F change |
| $MTE := 0.5\% \cdot Span$ | Maintenance and Test Equipment effect on the module |
| $PS := 0.005\% \cdot URL$ | Power supply variation effect for the module per volt |
| $MVV := 1$ | Maximum voltage variation |

Uncertainty Equation

$$CU := \sqrt{(RA)^2 + (DR)^2 + (2 \cdot TE)^2 + (MTE)^2 + (PS \cdot MVV)^2}$$ Uncertainty of pressure transmitter

$CU = 0.049$ Inches of Water (+/-)

$Error_{\%} := \frac{CU}{Span}$ $Error_{\%} = 0.012$ (= 1.2%) Percent error in terms of calibrated span

Flow Rate Uncertainty

Verabar Flow Equation (from vendor cut sheets):

| | | | |
|---|---|---|---|
| $N := 103.1953543$ | Numeric Constant | $Y_v := 0.9986$ | Expansion Factor |
| $K := 0.7516$ | Flow Coefficient | $M_w := 28.9644$ | Ideal Gas Specific Gravity |
| $D := 10.02$ | Pipe ID | $T_f := 629.67$ | Flowing temperature |
| $Z_f := 0.999869$ | Flowing Compressability | | |
| $P_f := 409.52$ | Flowing pressure | | |

Originator: DP Gargiulo [signature] Date: 7/22/03

Checker: BD Andres Brian Andres Date: 7/22/03

$$C := \frac{N \cdot K \cdot Y_v \cdot D^2}{\sqrt{M_w}}$$ Flow Constant

$$Q_v := C \cdot \sqrt{\frac{Span \cdot T_f \cdot Z_f}{P_f}}$$

$$Q_v = 3.583 \times 10^3$$

This the maximum flow rate based upon the maximum pressure output from the Yokogawa (4 inches water column) using the flow conversion formula provided by the flow sensor vendor, Veris Inc.

$$CU_{Flow} := Error_{\%} \cdot Q_v$$

$$CU_{Flow} = 43.468 \, CFM$$

This is the uncertainty in the flow measurement loop, in terms of CFM.

<u>Conclusion</u>

The uncertainty in the flow measurement loop is +/- 43 CFM.

# Appendix B: Mass Flow Controller Uncertainty Calculation

Title: **Mass Flow Controller Uncertainty Calculation** Identifier: I-01-01/02/03 RPP-15034 Rev: 0

Originator: JAMES A. TUCK James A. Tuck Date: 11 MAR. 2004

Checker: Brian P. Andres Brian Andres Date: 3/11/04

Objective

Determine the uncertainty in the flow measurement for the stack monitoring system mass flow controllers.

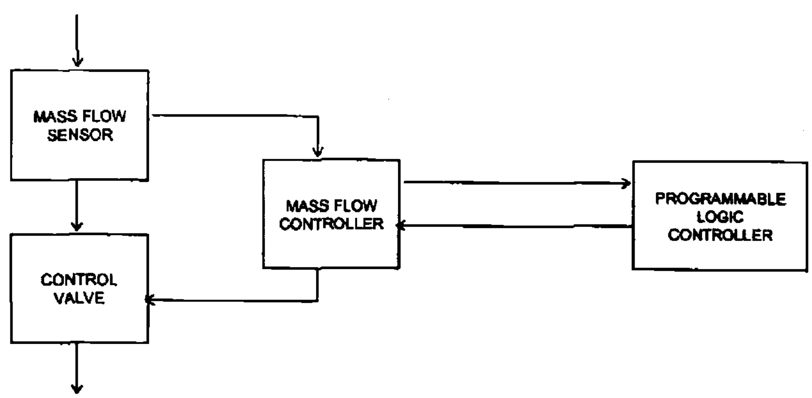
Mass Flow Controller Vendor Specifications

EIN: FCV-555, FCV-556; FCV-655, FCV-656
Name: Mass Flow Controller
Manufacturer: Teledyne Hastings Instruments
Model Number: HFC-303
Range at Full Scale: 0 to 1000 SLM (0 to 35.32 SCFM)
Range of Calibrated Span: 0 to 4 SCFM
Accuracy: ±1% of Span
Repeatability: ±0.07% of Full Scale
Temperature Effect: ±2.067% of Span at 75°C (max temperature)
Static Pressure Effect: ±0.026% of readings/psi
Ambient/Process Temperature Limits: 0 to 75°C (0 to 167°F) in a non-condensing environment
Maximum Pressure Limits: 500 psi

Assumptions

1. Uncertainty terms are assumed to be both +/- the calculated value.
2. Maximum system operating pressure is 11 psig (from calculation PTI-W314-CALC-008).
3. Ambient temperature and process temperature combined effect varies by no more than 30°C (86°F) from calibration temperature.
4. Radiation effects are minimal, therefore neglected.
5. Measurement and Test Equipment (MTE) uncertainty effect is 0.5% of Span.
6. Mass flow controllers are adjusted to read zero volts at zero flow conditions, eliminating zero offset.
7. Uncertainty of PLC and associated I/O cards is negligible compared to that of the sensor, therefore it will be neglected.

Block Diagram



Title: **Mass Flow Controller Uncertainty Calculation** Identifier: I-01-01/02/03 RPP-15034 Rev: 0

Originator: JAMES A. TUCK *James A. Tuck* Date: 11 MAR. 2004

Checker: Brian D. Andres *Brian Andres* Date: 3/11/04

Uncertainty Terms for Mass Flow Controller

| | |
|---|---|
| FS: = 35.32 | Full Scale of instrument in SCFM |
| Span: = 4 | Difference between upper and lower limits of calibrated range |
| RA: = 1.0% Span | Sensor reference accuracy specified by the manufacturer |
| TE: = 2.067% Span | Temperature effect for the module at max temp of 75 deg C |
| SP: = 0.026% Span | Static pressure effect for the module per psi |
| MTE: =0.5% Span | Maintenance and Test Equipment (calibration uncertainty) effect |
| RP: = 0.07% FS | Repeatability of reading |

Uncertainty Equation

$$CU: = \sqrt{RA^2 + TE^2 + (11\ SP)^2 + MTE^2 + RP^2}$$ Channel Uncertainly for mass flow controller

$$= \sqrt{(0.04)^2 + (0.08268)^2 + (0.01144)^2 + (0.02)^2 + (0.0247)^2}$$

CU = 0.098 SCFM (+/-)

Conclusion

The uncertainty in the flow measurement loop is approximately ± 0.1 SCFM.

# Appendix C: DST Pressure Transmitter Uncertainty Calculation

Originator: DP Gargiulo Date: 7/22/03

Checker: BD Andres Date: 7/22/03

## Objective

Determine the uncertainty in the pressure measurement for the DST vacuum pressure transmitters.

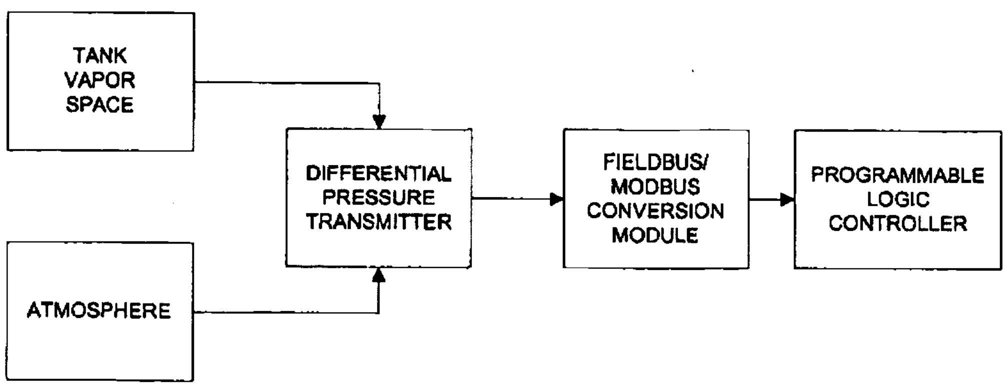
## Pressure Transmitter Vendor Specifications

EIN (AN/AW/AP): PDIT-251A/B, PDIT-252A/B, PDIT-253A/B, PDIT-254A/B, PDIT-255A/B, PDIT-256A/B, PDIT-257A/B, PDIT-258A/B
EIN (SY): PDIT-211, PDIT-212, PDIT-221, PDIT-222, PDIT-231, PDIT-232
Name: Differential Pressure Transmitter
Manufacturer: Yokogawa
Model Number: EJA-110A-FLS4B-92ED/FS1/A/T01
Range: -40 to 40 $inH_2O$
Calibrated Span: -20 to 10 $inH_2O$
Accuracy: ±0.075% of Span
Stability: ±0.1% of URL for 60 months (5 years)
Ambient Temperature Effect: ±[0.08% of Span + 0.09% URL] per 28 °C (50 °F) change
Static Pressure Effect: ±[0.07% of Span + 0.052% URL] per 3.4 Mpa (500 psi) change
Power Supply Effect: ±0.005% per Volt (from 21.6 to 32 VDC, 350Ω)
Ambient Temperature Limits: -40 to 60 °C (-40 to 140 °F)
Process Temperature Limits: -40 to 120 °C (-40 to 248 °F)
Ambient Humidity Limits: 5 to 100 %RH @ 40 °C (104°F)
Working Pressure Limits: 3.5 MPa (500 psig)

## Assumptions

1. Uncertainty terms are assumed to be both +/- the calculated value
2. Calibration interval is on an annual basis
3. Maximum voltage variation is +/- 1 volt
4. Ambient temperature ranges from -32 F to 115 F
5. Ambient temperature effect is per 50 F change, therefore assume a 2X multiplier for temperature uncertainty effect
6. Assume static pressure never varies more than 1 psi (28 inches water)
7. Radiation effects are minimal, therefore neglected
8. Measurement and Test Equipment (MTE) uncertainty effect is 0.5% of Span
9. Uncertainty of fieldbus/modbus conversion module and PLC is neglibible compared to that of the sensor, therefore it will be neglected

## Block Diagram



Title: **DST Pressure Transmitter Uncertainty Calculation** Identifier: I-01-01/02/03 RPP-15034 Rev: 0

Originator: DP Gargurilo [signature] Date: 7/22/03

Checker: BD Andres [signature] Date: 7/22/03

Uncertainty Terms for Pressure Transmitter

| | |
|---|---|
| $Span := 30$ | Difference between upper and lower limits of calibrated range |
| $URL := 80$ | Upper Range Limit |
| $RA := 0.075\% \cdot Span$ | Sensor reference accuracy specified by the manufacturer |
| $DR := 0.1\% \cdot \frac{URL}{5}$ | Drift of the module over a 1 year period |
| $TE := 0.08\% \cdot Span + 0.09\% \cdot URL$ | Temperature effect for the module per 50 F change |
| $HE := 0$ | Humidity effect for the module |
| $SP := 0.07\% \cdot Span + 0.052\% \cdot URL$ | Static pressure effect for the module per 500 psi change |
| $MTE := 0.5\% \cdot Span$ | Maintenance and Test Equipment effect on the module |
| $PS := 0.005\% \cdot URL$ | Power supply variation effect for the module per volt |
| $MVV := 1$ | Maximum voltage variation |

Uncertainty Equation

$$e := \sqrt{(RA)^2 + (DR)^2 + (2 \cdot TE)^2 + (0.002 \cdot SP)^2 \ldots + (MTE)^2 + (PS \cdot MVV)^2}$$

Uncertainty of pressure transmitter

$e = 0.245$ Inches of Water (+/-)

Conclusion

The uncertainty in the pressure measurement loop is +/- 0.25 inches of water.

# Appendix D: HEPA Filter dP Transmitter Uncertainty Calculation

Title: **HEPA Filter DP Transmitter Uncertainty Calculation** Identifier: I-01-01/02/03 RPP-15034 Rev: 0

Originator: DP Garquila [signature] Date: 7/22/03

Checker: BD Andres Brian Andres Date: 7/22/03

Objective

Determine the uncertainty in the differential pressure measurements for the HEPA filter DP transmitters.

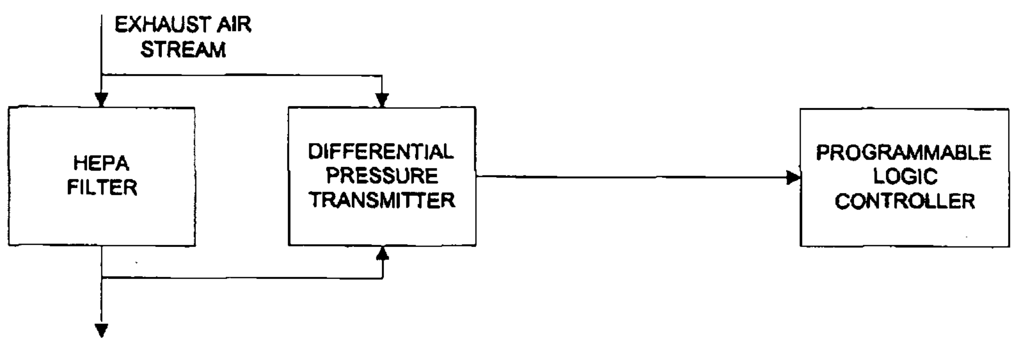
Pressure Transmitter Vendor Specifications

EIN: PDIT-357, PDIT-457; PDIT-358, PDIT-458
Name: Differential Pressure Transmitter
Manufacturer: Yokogawa
Model Number: EJA-110A-FLS4B-92ED/FS1/A/T01
Range: -40 to 40 $inH_2O$
Calibrated Span: 0 to 10 $inH_2O$
Accuracy: ±0.075% of Span
Stability: ±0.1% of URL for 60 months (5 years)
Ambient Temperature Effect: ±[0.08% of Span + 0.09% URL] per 28 °C (50 °F) change
Static Pressure Effect: ±[0.07% of Span + 0.052% URL] per 3.4 Mpa (500 psi) change
Power Supply Effect: ±0.005% per Volt (from 21.6 to 32 VDC, 350Ω)
Ambient Temperature Limits: -40 to 60 °C (-40 to 140 °F)
Process Temperature Limits: -40 to 120 °C (-40 to 248 °F)
Ambient Humidity Limits: 5 to 100 %RH @ 40 °C (104°F)
Working Pressure Limits: 3.5 MPa (500 psig)

Assumptions

1. Uncertainty terms are assumed to be both +/- the calculated value
2. Calibration interval is on an annual basis
3. Maximum voltage variation is +/- 1 volt
4. Ambient temperature ranges from -32 F to 115 F
5. Transmitters calibrated at standard conditions (approx 70 F), therefore ambient temperature effect is no more than +/-50 F
6. Assume static pressure never varies more than 1 psi (28 inches water)
7. Radiation effects are minimal, therefore neglected
8. Measurement and Test Equipment (MTE) uncertainty effect is 0.5% of Span
9. Uncertainty of PLC and associated I/O cards is neglibible compared to that of the sensor, therefore it will be neglected

Block Diagram



Title: **HEPA Filter DP Transmitter Uncertainty Calculation** Identifier: I-01-01/02/03 RPP-15034 Rev: 0

Originator: DP Garguilo [signature] Date: 7/22/03

Checker: BD Andres [signature] Date: 7/22/03

Uncertainty Terms for Differential Pressure Transmitter

| | |
|---|---|
| $Span := 10$ | Difference between upper and lower limits of calibrated range |
| $URL := 80$ | Upper Range Limit |
| $RA := 0.075\% \cdot Span$ | Sensor reference accuracy specified by the manufacturer |
| $DR := 0.1\% \cdot \frac{URL}{5}$ | Drift of the module over a 1 year period |
| $TE := 0.08\% \cdot Span + 0.09\% \cdot URL$ | Temperature effect for the module per 50 F change |
| $SP := 0.07\% \cdot Span + 0.052\% \cdot URL$ | Static pressure effect for the module per 500 psi change |
| $MTE := 0.5\% \cdot Span$ | Maintenance and Test Equipment effect on the module |
| $PS := 0.005\% \cdot URL$ | Power supply variation effect for the module per volt |
| $MVV := 1$ | Maximum voltage variation |

Uncertainty Equation

$$CU := \sqrt{(RA)^2 + (DR)^2 + (TE)^2 + (0.002 \cdot SP)^2 \ldots + (MTE)^2 + (PS \cdot MVV)^2}$$

Channel Uncertainty of pressure transmitter

$CU = 0.096$ Inches of Water (+/-)

Conclusion

The uncertainty in the differential pressure measurement loop is +/- 0.1 inches of water.

# Appendix E: Vendor Specifications (Yokogawa and Teledyne-Hastings)

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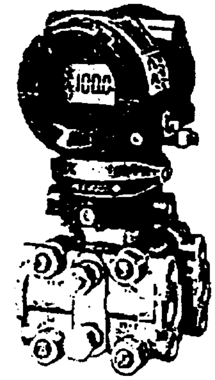
# General Specifications

## Model EJA110A Differential Pressure Transmitter

DPharp

GS 1C21B1-E

The high performance differential pressure transmitter model EJA110A can be used to measure liquid, gas, or steam flow as well as liquid level, density and pressure. It outputs a 4 to 20 mA DC signal corresponding to the measured differential pressure. Model EJA110A also features remote setup and monitoring through communications with the BRAIN™ terminal and CENTUM CS™ or μXL™ or HART® 275 host.




## ■ STANDARD SPECIFICATIONS

Refer to GS 1C22T2-E for Fieldbus communication type marked with "◇."

### □ PERFORMANCE SPECIFICATIONS

Zero-based calibrated span, linear output, wetted parts material code 'S' and silicone oil.

**Reference Accuracy of Calibrated Span**
(including the effects of zero-based linearity, hysteresis, and repeatability)

±0.075 % of Span

For spans below X

$\pm[0.025 + 0.05 \frac{X}{Span}]$ % of Span

where X equals:

| Capsule | X kPa {inH$_2$O} |
|---|---|
| L | 3 {12} |
| M | 10 {40} |
| H | 100 {400} |
| V | 1.4 MPa {200 psi} |

**Square Root Output Accuracy**
The square root accuracy is a percent of flow span.

| Output | Accuracy |
|---|---|
| 50 % or Greater | same as reference accuracy |
| 50 % to Dropout point | reference accuracy×50 / square root output (%) |

T00E.EPS

**Ambient Temperature Effects**
**Total Effects per 28 °C (50 °F) Change**

| Capsule | Effect |
|---|---|
| L | ±[0.08 % Span + 0.09 % URL] |
| M | ±[0.07 % Span + 0.02 % URL] |
| H | ±[0.07 % Span + 0.015 % URL] |
| V | ±[0.07 % Span + 0.03 % URL] |

**Static Pressure Effects**

**Total Effects per Change**
L capsule
±[0.07 % Span+0.052 % URL] per 3.4 MPa {500 psi}
M, H and V capsules
±[0.1% Span+0.028 % URL] per 6.9 MPa {1000 psi}

**Effect on Zero (can be corrected at line pressure)**
L capsule
±[0.02 % Span+0.052 % URL] per 3.4 MPa {500 psi}

M, H and V capsules
±0.028 % of URL per 6.9 MPa {1000 psi}

**Overpressure Effects (M, H and V capsules)**
±0.03 % of URL per 14 MPa {2000 psi}

**Stability (M, H and V capsules)**
±0.1 % of URL per 60 months

**Power Supply Effects "◇"**
±0.005 % per Volt (from 21.6 to 32 V DC, 350 Ω for Output signal code D and E.)

### □ FUNCTIONAL SPECIFICATIONS

**Span & Range Limits**

| Measurement Span/Range | | kPa | inH$_2$O(/D1) | mbar(/D3) | mmH$_2$O(/D4) |
|---|---|---|---|---|---|
| L | Span | 0.5 to 10 | 2 to 40 | 5 to 100 | 50 to 1000 |
| | Range | -10 to 10 | -40 to 40 | -100 to 100 | -1000 to 1000 |
| M | Span | 1 to 100 | 4 to 400 | 10 to 1000 | 100 to 10000 |
| | Range | -100 to 100 | -400 to 400 | -1000 to 1000 | -10000 to 10000 |
| H | Span | 5 to 500 | 20 to 2000 | 50 to 5000 | 0.05 to 5 kgf/cm$^2$ |
| | Range | -500 to 500 | -2000 to 2000 | -5000 to 5000 | -5 to 5 kgf/cm$^2$ |
| V*1 | Span | 0.14 to 14 MPa | 20 to 2000 psi | 1.4 to 140 bar | 1.4 to 140 kgf/cm$^2$ |
| | Range | -0.5 to 14 MPa | -71 to 2000 psi | -5 to 140 bar | -5 to 140 kgf/cm$^2$ |

T01E.EPS

*1: For Wetted parts material code other than S, the ranges are 0 to 14 MPa, 0 to 2000 psi, 0 to 140 bar, and 0 to 140 kgf/cm$^2$.

URL is defined as the Upper Range Limit from the table above.

**Zero Adjustment Limits**
Zero can be fully elevated or suppressed, within the Lower and Upper Range Limits of the capsule.

**External Zero Adjustment "◇"**
External zero is continuously adjustable with 0.01 % incremental resolution of span. Span may be adjusted locally using the digital indicator with range switch.



Yokogawa Electric Corporation
2-9-32 Nakacho, Musashino-shi, Tokyo, 180-8750 Japan
Phone: 81-422-52-5690 Fax.: 81-422-52-2018

**Mounting Position Effect**
Rotation in diaphragm plane has no effect. Tilting up to 90° will cause zero shift up to 0.4 kPa (1.6 inH$_2$O) which can be corrected by the zero adjustment.

**Output "◇"**
Two wire 4 to 20 mA DC output with digital communications, linear or square root programmable. BRAIN or HART FSK protocol are superimposed on the 4 to 20 mA signal.

**Failure Alarm:**
Output status at CPU failure and hardware error;
Up-scale: 110%, 21.6 mA DC or more(standard)
Down-scale: -5%, 3.2 mA DC
Note: Applicable for Output signal code D and E

**Damping Time Constant (1st order)**
The sum of the amplifier and capsule damping time constant must be used for the overall time constant. Amp damping time constant is adjustable from 0.2 to 64 seconds.

| Capsule (Silicone Oil) | L | M | H and V |
|---|---|---|---|
| Time Constant (approx. sec) | 0.4 | 0.3 | 0.3 |

**Ambient Temperature Limits**
**(approval codes may affect limits)**
-40 to 85 °C (-40 to 185 °F)
-30 to 80 °C (-22 to 176 °F) with LCD Display

**Process Temperature Limits**
**(approval codes may affect limits)**
-40 to 120 °C (-40 to 248 °F)

**Ambient Humidity Limits**
5 to 100 % RH @ 40 °C (104 °F)

**Working Pressure Limits (Silicone Oil)**

**Maximum Pressure Limit**

| Capsule | Pressure |
|---|---|
| L | 3.5 MPa (500 psig) |
| M, H, and V | 14 MPa (2000 psig) |

**Minimum Pressure Limit**
See graph below

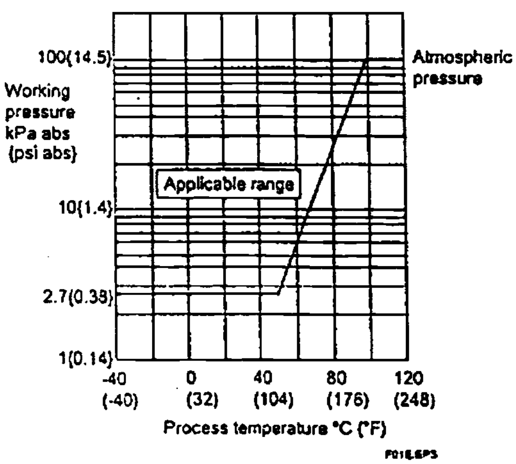



**Figure 1. Working Pressure and Process Temperature**

**Supply & Load Requirements**
(Safety approvals may affect electrical requirements)
With 24 V DC supply, up to a 570 Ω load can be used. See graph below.

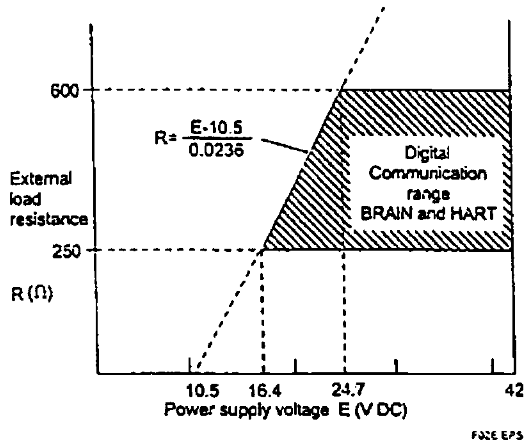



**Figure 2. Relationship Between Power Supply Voltage and External Load Resistance**

**Supply Voltage "◇"**
10.5 to 42 V DC for operation(10.5 to 30 V DC for Intrinsically safe type)
16.4 to 42 V DC for digital communications, BRAIN and HART protocols(16.4 to 30 V DC for Intrinsically safe type)

**Load(Output signal code D and E)**
0 to 1335 Ω for operation
250 to 600 Ω for digital communication

**EMC Conformity Standards** CE , N200
For EMI (Emission): EN55011, AS/NZS 2064 1/2
For EMS (Immunity): EN50082-2

**Communication Requirements "◇"**

**BRAIN**

**Communication Distance**
Up to 2 km (1.25 miles) when using CEV polyethylene-insulated PVC-sheathed cables. Communication distance varies depending on type of cable used.

**Load Capacitance**
0.22 µF or less (see note)

**Load Inductance**
3.3 mH or less (see note)

**Input Impedance of communicating device**
10 kΩ or more at 2.4 kHz.

Note : For general-use and Flameproof type.
For Intrinsically safe type, please refer to 'OPTIONAL SPECIFICATIONS.'

**HART**

**Communication Distance**

Up to 1.5 km (1 mile) when using multiple twisted pair cables. Communication distance varies depending on type of cable used.

Use the following formula to determine cable length for specific applications:

$$L = \frac{65 \times 10^6}{(R \times C)} - \frac{(C_f + 10{,}000)}{C}$$

Where:
L = length in meters or feet
R = resistance in Ω (including barrier resistance)
C = cable capacitance in pF/m or pF/ft
$C_f$ = maximum shunt capacitance of receiving devices in pF/m or pF/ft

## ☐ PHYSICAL SPECIFICATIONS

**Wetted Parts Materials**

**Diaphragm, Cover flange, Process connector, and Vent/Drain Plug**
Refer to 'MODEL AND SUFFIX CODE.'

**Capsule Gasket**
For wetted parts material code S, Teflon-coated SUS316L.
For wetted parts material code other than S, PTFE(Teflon).

**Process Connector Gasket**
PTFE Teflon
Fluorinated rubber for Optional code /N2 and /N3

**Non-wetted Parts Materials**

**Bolting**
SCM435 or SUS630

**Housing**
Low copper cast-aluminum alloy with polyurethane paint (Munsell 0.6GY3.1/2.0)

**Enclosure Classification**
JIS C0920 immersion proof
(equivalent to NEMA 4X and IEC IP67)

**Cover O-rings**
Buna-N

**Name plate and tag**
SUS304

**Fill Fluid**
Silicone, Fluorinated oil (option)

**Weight**
3.9 kg (8.6 lb) without integral indicator, mounting bracket, and process connector.

**Connections**
Refer to the model code to specify the process and electrical connection type.

**< Settings When Shipped > "◇"**

| | |
|---|---|
| Tag Number | As specified in order *1 |
| Output Mode | 'Linear' unless otherwise specified in order |
| Display Mode | 'Linear' unless otherwise specified in order |
| Operation Mode | 'Normal' unless otherwise specified in order |
| Damping Time Constant *2 | '2 sec.' |
| Calibration Range Lower Range Value | As specified in order |
| Calibration Range Higher Range Value | As specified in order |
| Calibration Range Units | Selected from mm$H_2O$, mmAq, mmWG, mmHg, Pa, hPa, kPa, MPa, mbar, bar, gf/cm², kgf/cm², in$H_2O$, inHg, ft$H_2O$, or psi (Only one unit can be specified) |

T07E.EPS

*1: Up to 16 alphanumeric characters (including - and · ) will be entered in the amplifier memory.
*2: If using square root output, set damping time constant to 2 sec. or more.

**< Related Instruments > "◇"**

Power Distributor: Refer to GS 1B4T1-E, 1B4T2-E.
3-Value Manifold: Refer to GS 22B1C1-E
BRAIN TERMINAL: Refer to GS 1C0A11-E

**< Reference >**

1. Teflon; Trademark of E.I. DuPont de Nemours & Co.
2. Hastelloy; Trademark of Haynes International Inc.
3. Monel; Trademark of Inco Alloys International, Inc.
4. HART; Trademark of the HART Communication Foundation.
5. FOUNDATION; Trademark of Fieldbus Foundation.

**Material Cross Reference Table**

| | |
|---|---|
| SUS316L | AISI 316L |
| SUS316 | AISI 316 |
| SUS304 | AISI 304 |
| S25C | AISI 1025 |
| SCM435 | AISI 4137 |
| SUS630 | ASTM630 |
| SCS14A | ASTM CF-8M |

T09E.EPS

**< Specification Conformance >**

The model EJA110A maintains a specification conformance to at least 3 σ.

<<Contents>> <<Index>>

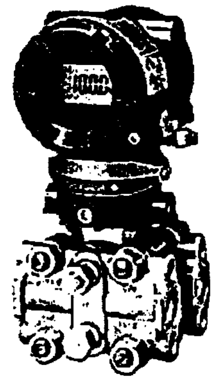
# General Specifications

## Model EJA120A
## Differential Pressure Transmitter

DPharp

GS 1C21B3-E

The high performance draft range differential pressure transmitter model EJA120A outputs a 4 to 20 mA DC signal corresponding to the measured differential pressure. Model EJA120A also features remote setup and monitoring through communications with the BRAIN™ terminal and CENTUM CS™ or μXL™ or HART® 275 host.



## ■ STANDARD SPECIFICATIONS

Refer to GS 1C22T2-E for Fieldbus communication type marked with "◇."

### □ PERFORMANCE SPECIFICATIONS

Zero-based calibrated span, linear output, wetted parts material code 'S' and silicone oil.

**Reference Accuracy of Calibrated Span**

(including the effects of zero-based linearity, hysteresis, and repeatability)

±0.2 % of Span
±0.1 % of Span when /HAC is specified

For spans below X,

$\pm[0.15 + 0.02\frac{URL}{Span}]$ % of Span

$\pm[0.05 + 0.05\frac{X}{Span}]$ % of Span, when /HAC is specified

where X equals:

| Capsule | X kPa {$inH_2O$} |
|---|---|
| E | 0.4 {1.6} |

**Square Root Output Accuracy**

The square root accuracy is a percent of flow span.

| Output | Accuracy |
|---|---|
| 50 % or Greater | same as reference accuracy |
| 50 % to Dropout point | $\frac{\text{reference accuracy} \times 50}{\text{square root output (\%)}}$ |

T00E.EPS

**Ambient Temperature Effects**

**Total Effects per 28 °C (50 °F) Change**

±[0.15 % Span + 0.20 % URL]

**Power Supply Effect "◇"**

±0.005 % per Volt (from 21.6 to 32 VDC, 350 Ω)

### □ FUNCTIONAL SPECIFICATIONS

**Span & Range Limits**

| Measurement Span and Range | | kPa | $inH_2O$(/D1) | mbar(/D3) | $mmH_2O$(/D4) |
|---|---|---|---|---|---|
| E | Span | 0.1 to 1 | 0.4 to 4 | 1 to 10 | 10 to 100 |
| | Range | -1 to 1 | -4 to 4 | -10 to 10 | -100 to 100 |

T01E.EPS

URL is defined as the Upper Range Limit from the table.

**Zero Adjustment Limits**

Zero can be fully elevated or suppressed, within the Lower and Upper Range Limits of the capsule.

**External Zero Adjustment "◇"**

External zero is continuously adjustable with 0.01 % incremental resolution of span. Span may be adjusted locally using the digital indicator with range switch.

**Mounting Position Effect**

Rotation in diaphragm plane has no effect. Tilting up to 90 ° will cause zero shift up to 0.4 kPa {1.6 $inH_2O$} which can be corrected by the zero adjustment.

**Output "◇"**

Two wire 4 to 20 mA DC output with digital communications, linear or square root programmable. BRAIN or HART FSK protocol are superimposed on the 4 to 20 mA signal.

**Failure Alarm:**

Output status at CPU failure and hardware error;
Up-scale: 110%, 21.6 mA DC or more(standard)
Down-scale: -5%, 3.2 mA DC
Note: Applicable for Output signal code D and E

**Damping Time Constant (1st order)**

The sum of the amplifier and capsule damping time constant must be used for the overall time constant. Amp damping time constant is adjustable from 0.2 to 64 seconds.

| Capsule (Silicone Oil) | E |
|---|---|
| Time Constant (approx. sec) | 0.2 |



Yokogawa Electric Corporation
2-9-32 Nakacho, Musashino-shi, Tokyo, 180-8750 Japan
Phone: 81-422-52-5690 Fax : 81-422-52-2018

**Ambient Temperature Limits**
(approval codes may affect limits)
-25 to 80 °C (-13 to 176 °F)

**Process Temperature Limits**
(approval codes may affect limits)
-25 to 80 °C (-13 to 176 °F)

**Ambient Humidity Limits**
5 to 100 % RH @ 40 °C (104 °F)

**Working Pressure Limits**
-50 to 50 kPa (-7.25 to 7.25 psi)

**Supply & Load Requirements**
(Safety approvals can affect electrical requirements (see graph below))
With 24 V DC supply, up to a 570 Ω load can be used.

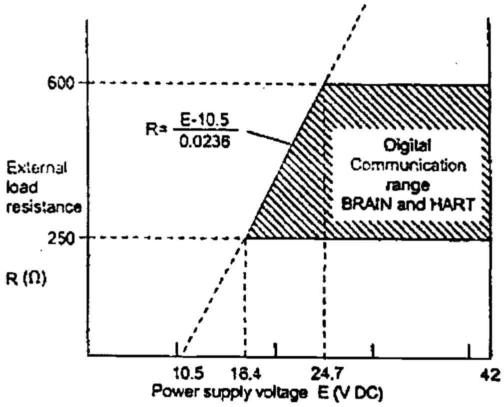



**Figure 1. Relationship Between Power Supply Voltage and External Load Resistance**

**Supply Voltage "◇"**
10.5 to 42 V DC for operation(10.5 to 30 V DC for Intrinsically safe type)
16.4 to 42 V DC for digital communications(16.4 to 30 V DC for Intrinsically safe type)

**Load (Output signal code D and E)**
0 to 1335 Ω for operation
250 to 600 Ω for digital communication

**EMC Conformity Standards** CE , N200
For EMI (Emission): EN55011, AS/NZS 2064 1/2
For EMS (Immunity): EN50082-2

**Communication Requirements "◇"**

**BRAIN**

**Communication Distance**
Up to 2 km (1.25 miles) when using CEV polyethylene-insulated PVC-sheathed cables. Communication distance varies depending on type of cable used.

**Load Capacitance**
0.22 µF or less (see note)

**Load Inductance**
3.3 mH or less (see note)

**Input Impedance of communicating device**
10 kΩ or more at 2.4 kHz.

Note : For general-use and Flameproof type.
For Intrinsically safe type, please refer to 'OPTIONAL SPECIFICATIONS.'

**HART**

**Communication Distance**
Up to 1.5 km (1 mile) when using multiple twisted pair cables. Communication distance varies depending on type of cable used.

Use the following formula to determine cable length for specific applications:

$$L=\frac{65 \times 10^6}{(R \times C)}-\frac{(C_f + 10{,}000)}{C}$$

Where:
L = length in meters or feet
R = resistance in Ω (including barrier resistance)
C = cable capacitance in pF/m or pF/ft
$C_f$ = maximum shunt capacitance of receiving devices in pF/m or pF/ft

## □ PHYSICAL SPECIFICATIONS

**Wetted Parts Materials**

**Diaphragm**
Hastelloy C-276

**Cover flange**
SCS14A

**Process connector**
SCS14A

**Capsule Gasket**
PTFE Teflon

**Vent and Drain Plug**
SUS316

**Process Connector Gasket**
PTFE Teflon
Fluorinated rubber for Optional code /N2 and /N3

**Non-wetted Parts Materials**

**Bolting**
SCM435 or SUS630

**Housing**
Low copper cast-aluminum alloy with polyurethane paint (Munsell 0.6GY3.1/2.0)

**Enclosure Classifications**
JIS C0920 immersion proof
(equivalent to NEMA 4X and IEC IP67)

**Cover O-rings**
Buna-N

**Name plate and tag**
SUS304

**Fill Fluid**
Silicone, Fluorinated oil (option)

**Weight**
3.9 kg (8.6 lb) without integral indicator, mounting bracket, and process connector.

**Connections**
Refer to the model code to specify the process and electrical connection type.

# HASTINGS INSTRUMENTS

## HFM 301/HFC 303

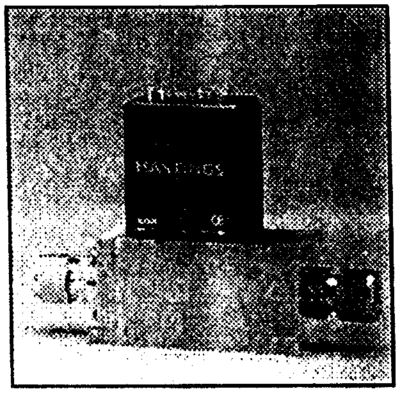
## Models HFM-301, HFC-303

### FEATURES

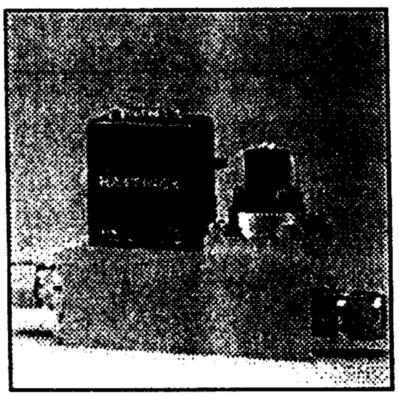
- ±1.0% of Full-Scale Accuracy
- Rapid Settling Times
  HFM-301 ≤ 0.4 sec
  HFC-303 ≤ 2.0 sec
- Range — 25 to 1000 slm (Air Equivalent)
- Operating Pressures to 500 PSI or Higher
- NIST Traceable Calibration

### APPLICATIONS

- Leak Testing
- Research
- Vapor Deposition
- R&D and Process Flows
- Semiconductor Processes
- Pollution Monitoring
- Gas Blending
- Chromatography



HFM-301



HFC-303

### DESIGN FEATURES

Hastings Instruments products represent over 50 years of experience in the design and manufacture of mass flow products. The 300 Series is a culmination of this experience with patented technologies that make these the finest flowmeters and controllers available today

The Hastings Mass Flow 300 Series meters and controllers are designed to accurately measure mass flow without corrections or compensations for gas pressure and temperature. They are accurate to better than ±1.0%. Hastings mass flow instruments do not require any periodic maintenance under normal operating conditions with clean gases. No damage will occur from the use of moderate overpressures (~500 psi) or overflows. Instruments are normally calibrated with the appropriate standard calibration gas (air), then a correction factor is used to adjust the output for the intended gas. Special calibrations for other gases, such as oxygen, helium and argon, are available upon special order.

These products contain a number of features that set them apart from other available instruments: (1) They are inherently linear; no linearization circuitry is employed. Should recalibration in the field be desired (a calibration standard is required), the customer needs to simply set the zero and span points. (2) The output signal is linear for very large overflows and will not come back on scale when a flow an order of magnitude over the full scale flow rate is measured. (3) The instrument incorporates a removable/replaceable sensor module. (4) The unit has very fast settling times.

TELEDYNE ELECTRONIC TECHNOLOGIES
*Hastings Instruments*
A Teledyne Technologies Company

# MODELS HFM-301, HFC-303

**Optional Features**
Fittings–VCR, VCO and Swagelok®
High pressure rating (1000 psig)
Cleaned for oxygen service

**Accessories**
Power supplies/readouts
Flow totalizers
Alarm set points
Interconnecting cables

*Note: After changing components, instruments require recalibration to meet accuracy specifications.

## COMMON SPECIFICATIONS HFM-301/HFC-303

| | |
|---|---|
| Accuracy | ± 1.0% of F.S. |
| Repeatability | ± 0.07% of F.S. |
| Maximum Operating Pressure | 500 psi |
| High-Pressure Option | 1000 psi (proof tested to 1500 psi) |
| Pressure Coefficient | 0.026%/psi ($N_2$) (0-1000 psig) |
| Leak Integrity | < 1x10⁻⁹ sccs He |
| Temperature Coefficient (zero)<br>Temperature Coefficient (span) | < 0.085%/°C of F.S. (0-60°C)<br>< 0.092%/°C of reading (15-50°C) |
| Standard Output | 0-5 VDC |
| Optional Output | 4-20 mA |
| Connector | 15-pin subminiature D |
| *Attitude Sensitivity of Zero | < 0.25% of F.S. |
| *Attitude Sensitivity of Span | < 0.06% of reading |

*$N_2$ @ 19.7 psia

## SPECIFICATIONS HFM-301

| | |
|---|---|
| Settling Time | ≤ 0.4 sec (0% to 100% F.S.) |
| Power Requirement | +15 VDC @ 55 mA to -15 VDC @ 50 mA |
| Wetted Materials | Viton, 316 SS, Nickel 200, Au/Ni Braze |
| Weight (approx.) | 3.5 lb (1.6 kg) (0-300 slm)<br>3.4 lb (1.5 kg) (300-1000 slm) |

## SPECIFICATIONS HFC-303

| | |
|---|---|
| Settling Time | ≤ 2.0 sec (10% to 100% F.S.) |
| Power Requirement | ± 15 VDC @ 150 mA |
| Wetted Materials | 302SS, 316L SS, Nickel 200, Viton, Au/Ni Braze, Kalrez® (valve seat) |
| Setpoint Input | 0-5 VDC (standard)/4-20 mA (optional) |
| Weight (approx.) | 5.3 lb (2.4 kg) (0-300 slm)<br>5.2 lb (2.3 kg) (300-1000 slm) |

*Hastings Instruments reserves the right to change or modify the design of its equipment without any obligation to provide notification of change or intent to change.*

*NOTE: The following page is from "Hastings 303 Series Controller Instruction Manual", in project vendor information submittals. Information was used for App. B, Mass Flow Controller Uncertainty Calculation.*

## 2.13 Temperature Coefficients

As the temperature of the instrument changes from the calibration temperature, errors will be introduced into the output of the instrument. The Temperature Coefficient of Zero describes the change in the output that is seen at zero flow. This error is added in to the overall output signal regardless of flow, but can be eliminated by merely adjusting the zero potentiometer to read zero volts at zero flow conditions. The Temperature Coefficient of Span describes the change in output after the zero error is eliminated. This error cannot be eliminated, but can be compensated for mathematically if necessary. The curve pictured in Figure2.8 shows the span error in percent of point as a function of temperature assuming 23°C is the calibration temperature.

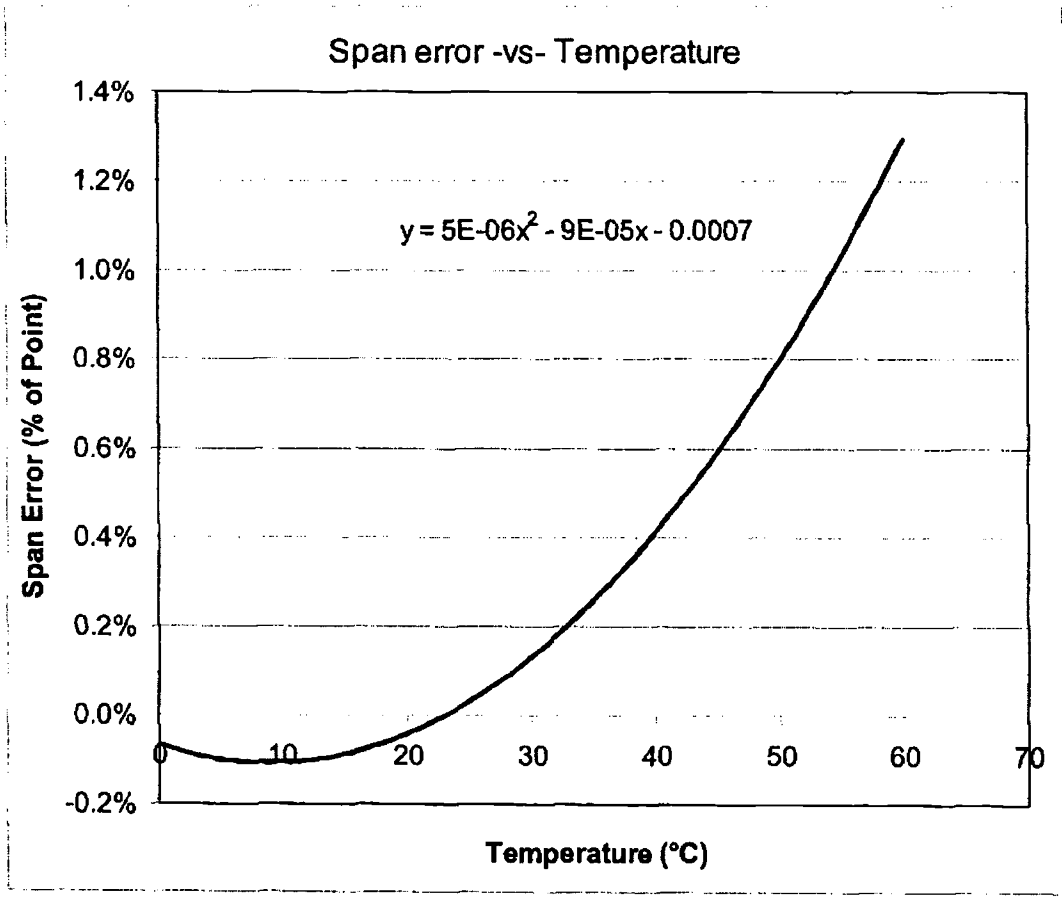



**Figure 2.8**

# Appendix F: Communication from Teledyne-Hastings Regarding Application of Reference Accuracy to "Full Scale" of Mass Flow Controller

## Tuck, James A

**From:** joshua_oliver@teledyne.com
**Sent:** Friday, March 19, 2004 6:30 AM
**To:** Tuck, James A
**Subject:** Re: Need Written Basis for 1% Reference Accuracy -- Hastings HFM-303 Flow Controllers

James,

There are no documents that we possess that equates "F.S." to "RANGE". I have passed your message on to our flow engineer and this is what he replied (in red text). I hope this will help you clarify the accuracy of our instruments. It is a written form of what we spoke about on the phone. Please feel free to contact me if more assistance is required.

Regards,

Joshua Oliver
Flow Technician

1% of Full Scale accuracy is defined by Teledyne Hastings Instruments to mean that the error in the indicated value shall not exceed 1% of the rated full scale output signal for the particular instrument being calibrated. The flow value for this full scale output is typically printed on the label and specifies the range over which the calibration is valid.

The full scale is NOT the maximum range that an instrument model could be set up to measure.

For an HFC303 calibrated for a full scale range of 100 SLM, 1% of Full Scale is 1 SLM. The actual flow for this instrument would always be within 1 SLM of the indicated flow.

The maximum range for the HFC303 model is 1000 slm but the instrument in this example was calibrated to have a full scale value of 100 slm.

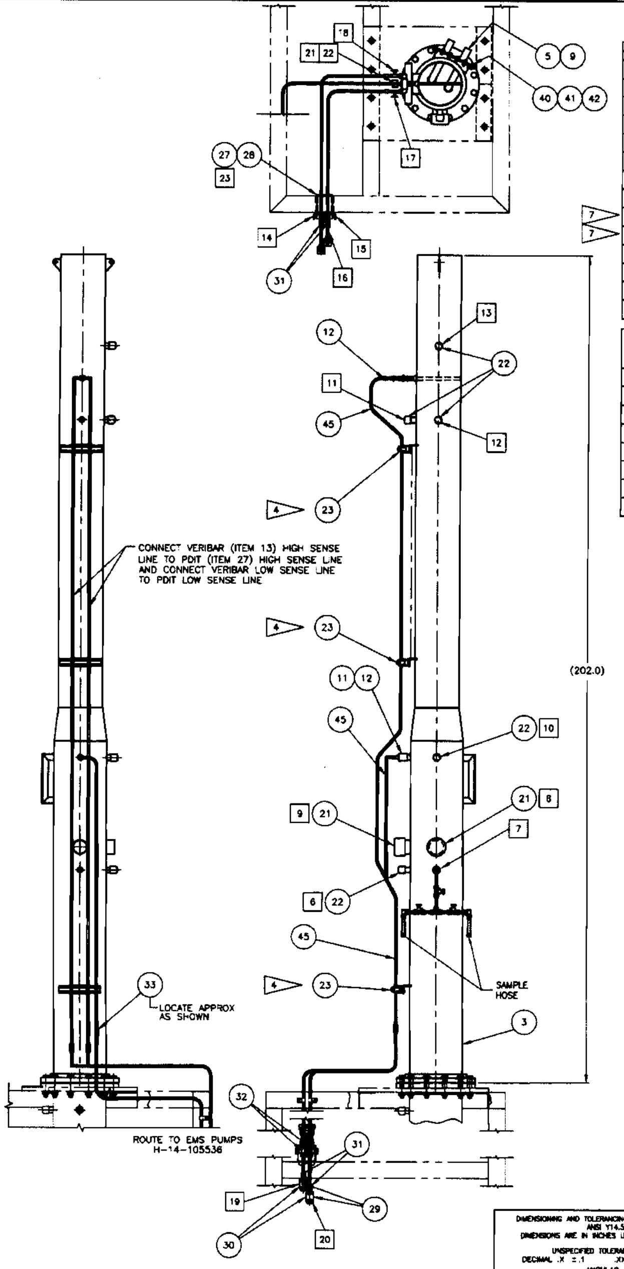
Bill Alvesteffer
Product Engineering Manager

Teledyne Hastings Instruments

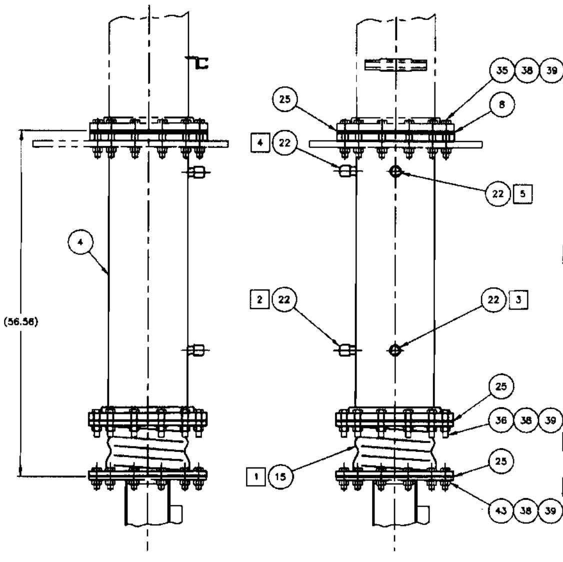
"Tuck, James A" <James_A_Tuck@RL.gov>

03/18/2004 08:59 PM

To "joshua_oliver@teledyne.com" <joshua_oliver@teledyne.com>
cc "Andres, Brian D" <Brian_D_Andres@rl.gov>, "Tuck, James A" <James_A_Tuck@rl.gov>
Subject Need Written Basis for 1% Reference Accuracy – Hastings HFM-303 Flow Controllers




① UPPER STACK ASSEMBLY
SCALE: 1" = 1'-0"




② LOWER STACK ASSEMBLY
SCALE: 1/8

## PARTS LIST/MATERIAL LIST

| QTY -050 | QTY -040 | QTY -030 | QTY -020 | QTY -010 | PARTS / DASH NUMBER | NOMENCLATURE/DESCRIPTION | MATERIAL/REFERENCE | SHEET | ITEM NO |
|---|---|---|---|---|---|---|---|---|---|
| | | | | X | -010 | UPPER STACK ASSEMBLY | | 1 | 1 |
| | | | X | | -020 | LOWER STACK ASSEMBLY | | 1 | 2 |
| | | X | | 1 | -030 | UPPER STACK WELDMENT | | 2 | 3 |
| | X | | 1 | | -040 | LOWER STACK WELDMENT | | 3 | 4 |
| X | | | | 1 | -050 | PROBE WELDMENT | | 3 | 5 |
| | | | | | | | | | 6 |
| | | | | | | | | | 7 |
| | | | 1 | | -001 | FLANGE, PLATE, 7 GA OR 3/16 THK | ASTM A240 TYPE 304L | 3 | 8 |
| | | | | 1 | -002 | GASKET, 1/4" THK 40-45 DURO | NEOPRENE ASTM D2000 | 2 | 9 |
| | | | | | | | | | 10 |
| | | | | 1 | | REDUCER, 1" X 1/2" NPT CLASS 3000 | ASTM A182 GR F 304L | | 11 |
| | | | | 3 | SS-810-1-8 | MALE CONNECTOR, 1/2" TUBE X 1/2" NPT | SWAGELOK | | 12 |
| | | 1 | | | V100-10-V-D-WNS-C20C | VERABAR FLOW SENSOR WITH INTEGRAL RTD | VERIS, INC. | | 13 |
| | | | | | | | | | 14 |
| | | | 1 | | SEE NOTE 10 | 12" NOM BY 9" OAL EXPANSION JOINT | HYSPAN | | 15 |
| | 2 | 1 | | | | PIPE FLANGE, SLIP-ON, 12" CLASS 150, FF | ASTM A182 GR F 304L | | 16 |
| | | | | | | | | | 17 |
| | | | | | | | | | 18 |
| | | 1 | | | | PIPE, REDUCER, 12-10 CLASS 150, BW | ASTM A403 WP 304L | | 19 |
| | | | | | | | | | 20 |
| | | | | 2 | | CAP, 3" NPT, CLASS 3000 | ASTM A182 GR F 304L | | 21 |
| | | | 4 | 6 | | CAP, 1" NPT, CLASS 3000 | ASTM A182 GR F 304L | | 22 |
| | | | | 6 | P2026 | TUBING CLAMPS | UNISTRUT | | 23 |
| | | 3 | | | P1000 | CHANNEL, 1 5/8" X 1 5/8" X 10.0 L | UNISTRUT | | 24 |
| | | | 4 | | | GASKET, 12" 150#, FULL FACE 1/8" STYLE 3000 | GARLOCK | | 25 |
| 2 | | | | | 35-712-111 | SHROUDED SAMPLE PROBE TIP, 2CFM | THERMO ANDERSON | | 26 |
| | | | | 1 | EJA120A-EES4B-92EC/FS1-D1-HAC-F1 | DIFFERENTIAL PRESSURE SMART TRANSMITTER, DP HART, 4-20mA | YOKOGAWA | | 27 |
| | | | | 1 | GP3TC-T-LSS-MB | VALVE, 3-WAY MANIFOLD | D/A MFG CO. | | 28 |
| | | | | 2 | SS-63TF8 | 3-PIECE BALL VALVE, 1/2 FNPT | SWAGELOK | | 29 |
| | | | | 2 | SS-8-P | PIPE PLUG, 1/2 MNPT | SWAGELOK | | 30 |
| | | | | 4 | SS-810-11-8 | BULKHEAD MALE CONNECTOR | SWAGELOK | | 31 |
| | | | | 2 | SS-810-3 | UNION TEE, 1/2 | SWAGELOK | | 32 |
| | | | | 3 | SS-810-6 | UNION, 1/2 | SWAGELOK | | 33 |
| | | | | | | | | | 34 |
| | | | 12 | | | HEX BOLT, HVY, 7/8-9 UNC-2A 5-1/2 LONG | ASTM A193 GR B8 | | 35 |
| | | | 12 | | | HEX BOLT, HVY, 7/8-9 UNC-2A 4 LONG | ASTM A193 GR B8 | | 36 |
| | | | | | | | | | 37 |
| | | | 36 | | | HEX NUT, HVY, 7/8-9 UNC-2B | ASTM A194 GR 8F | | 38 |
| | | | 36 | | | LOCK WASHER, 7/8, (SERIES AND TYPE OPTIONAL) | 18-8 SST | | 39 |
| | | | | 16 | | HEX BOLT, 3/8-16 UNC-2A X 1" LONG | ASTM A193 GR B8 | | 40 |
| | | | | 16 | | HEX NUT, 3/8-16 UNC-2B | ASTM A194 GR 8F | | 41 |
| | | | | 16 | | PLAIN WASHER, 3/8, (SERIES AND TYPE OPTIONAL) | 18-8 SST | | 42 |
| | | | 12 | | | HEX BOLT, HVY, 7/8-9 UNC-2A 3 LONG | ASTM A193 GR B8 | | 43 |
| AR | | | | | | TUBE, 1 1/2 OD X .065 WALL, SMLS | ASTM A269 TYPE 304L | | 44 |
| | | | | AR | | TUBE, 1/2 OD X .049 WALL, SMLS | ASTM A269 TYPE 304L | | 45 |
| | AR | AR | | | | PIPE, 12" SCHED 40S | ASTM A312 GR TP 304L | | 46 |
| | | AR | | | | PIPE, 10" SCHED 40S | ASTM A312 GR TP 304L | | 47 |
| | | 2 | | | | PIPE, 3" SCHED 40S X 2.0 LONG TOE | ASTM A312 GR TP 304L | | 48 |
| | 4 | 7 | | | | PIPE, 1" SCHED 40S X 2.0 LONG TOE | ASTM A312 GR TP 304L | | 49 |
| | | AR | | | | PLATE, 1/2 THK | ASTM A240 TYPE 304L | | 50 |
| | | AR | | | | ANGLE, 2 1/2 X 1 1/2 X 1/4 THK | ASTM A276 TYPE 304L | | 51 |
| | | 3 | | | | ANGLE, 2 X 2 X 1/4 THK X 5.0 L | ASTM A276 TYPE 304L | | 52 |
| AR | | | | | | PLATE, 11 GA | ASTM A240 TYPE 304L | | 53 |

### [X] = EQUIP IDENT NO.
(SEE NOTE 5)

| | |
|---|---|
| 1 | AN241-VTP-EJ-551 |
| 2 | AN241-VTP-FTP-551 |
| 3 | AN241-VTP-FTP-552 |
| 4 | AN241-VTP-FTP-553 |
| 5 | AN241-VTP-FTP-562 |
| 6 | AN241-VTP-FTP-563 |
| 7 | AN241-VTP-FTP-554 |
| 8 | AN241-VTP-FTP-556 |
| 9 | AN241-VTP-FTP-557 |
| 10 | AN241-VTP-FTP-558 |
| 11 | AN241-VTP-FTP-559 |
| 12 | AN241-VTP-FTP-560 |
| 13 | AN241-VTP-FTP-561 |
| 14 | AN241-VTP-V-580 |
| 15 | AN241-VTP-V-581 |
| 16 | AN241-VTP-V-582 |
| 17 | AN241-VTP-V-583 |
| 18 | AN241-VTP-V-584 |
| 19 | AN241-VTP-V-585 |
| 20 | AN241-VTP-V-586 |
| 21 | AN241-VTP-TE-551 |
| 22 | AN241-VTP-FE-551 |
| 23 | AN241-VTP-PDIT-551 |

6. FOR SAMPLE TUBING RUNS (FROM PROBES TO CAM AND RECORD SAMPLER):
   - THERE SHALL BE NO INWARD FACING STEPS AT THE TUBING CONNECTIONS THAT CAUSE MORE THAN A 1% REDUCTION IN TUBE DIAMETER.
   - THE TUBING ENDS SHALL BE FREE OF BURRS AND CRIMPING.
   - BENDS SHALL HAVE A CURVATURE RATIO (RADIUS OF CURVATURE OF THE BEND DIVIDED BY THE TUBE DIAMETER) OF AT LEAST 3.0.
   - FLATTENING OF THE BEND CAUSED BY A BENDING PROCESS SHALL NOT EXCEED 15%, WHERE FLATTENING IS DEFINED IN TERMS OF THE ORIGINAL AND MINOR AXES OF THE TUBE CROSS SECTION AT THE ANGULAR MIDPOINT OF THE BEND.

   SPECIAL FABRICATION TECHNIQUES MAY BE REQUIRED TO MEET THESE SPECIFICATIONS (ANSI/HPS N13.1-1999).
7. ITEMS 48 AND 49 MAY BE PURCHASED AS PIPE NIPPLES PER ASTM A733 GR TP 304L AND TRIMMED TO LENGTH AS SPECIFIED. THREADED PORTION ON ONE END OF PIPE NIPPLES MUST BE COMPLETELY REMOVED.
8. UNISTRUT MAY BE TYPE HG (HOT DIPPED GALVANIZED), PG (PRE-GALVANIZED), OR EG (ELECTRO-GALVANIZED). APPEND TO THE END OF UNISTRUT PART NUMBERS AS REQUIRED.
9. 7/8 HEX BOLTS (ITEMS 35, 36, & 43) MAY BE REPLACED WITH THREADED ROD, 7/8-9 UNC-2A LENGTH AS REQD, ASTM A193 GR B8 OR GR B8M WITH ADDITIONAL HEX NUTS AND LOCK WASHERS IF REQD TO ACCOMMODATE SPACE RESTRAINTS.
10. EXPANSION JOINT MAY BE EITHER PART NUMBER 2509/10L-080-7.0 OR 57194.
11. REVISION 4 OF THIS DRAWING WAS FIELD WALKED DOWN IN OCTOBER 2010. FOR CHANGES MADE AND FOR ITEMS NOT VERIFIED IN FIELD, SEE ECN-10-001455.

## GENERAL NOTES:

1. FABRICATION AND WELDING SHALL BE IN ACCORDANCE WITH THIS DRAWING AND SPECIFICATION PTI-W314-TS-001.
2. ABBREVIATIONS ARE IN ACCORDANCE WITH ANSI Y1.1.
3. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
4. SPACE THE TUBING CLAMPS (ITEM 23) AS NECESSARY TO FIT TUBING (ITEM 45).
5. NAME TAGS DENOTING EQUIPMENT IDENTIFICATION NUMBERS WILL BE PROVIDED BY CUSTOMER. TAGS SHALL BE LOCATED ON THE IDENTIFIED ASSEMBLY COMPONENTS IN LOCATIONS THAT ARE CLEARLY VISIBLE AFTER FINAL ASSEMBLY.

DIMENSIONING AND TOLERANCING SHALL BE INTERPRETED PER ANSI Y14.5M-1994
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED

UNSPECIFIED TOLERANCES SHALL BE:
DECIMAL .X ± .1 .XX ± .06 .XXX ± .030
ANGULAR ± 1°

ALL IMPLIED 90° ANGLES SHALL BE PERPENDICULAR WITHIN THE GREATEST TOLERANCE OF THE LINEAR DIMENSIONS

ALL COAXIAL FEATURES SHALL BE CONCENTRIC WITHIN .031 INCH UNLESS OTHERWISE SPECIFIED

| DWG NO | TITLE | REF NUMBER | TITLE |
|---|---|---|---|
| DRAWING TRACEABILITY LIST | | REFERENCES | |
| | | NEXT USED ON H-14-105529 | |

REVISIONS

| REV | DESCRIPTION |
|---|---|
| 5 | DIRECT REV PER ECN-10-001455 |

SEE REVISION 0

FEB 16 2011
RELEASE

U.S. DEPARTMENT OF ENERGY
Office of River Protection

AN241-VTP (W-314)
EXHAUSTER TRAIN "A" UPPER & LOWER STACK ASSEMBLIES

F | 241AN | 8900 | H-14-105531 | 5
SCALE SHOWN | 820447 | SHEET 1 OF 3

H-14-105531

# Technical Justification for Applicability of General WAC 246-247 Technology Standards for Tank Farm Facility Waste Tank Ventilation Systems

**Lois L. Payne**
Washington River Protection Solutions, LLC
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-08RV14800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Abstract: The purpose of this document is to provide the technical justification for applicability of specific requirements from technology standards and regulations identified in Washington Administrative Code (WAC) 246 247, "Radiation Protection Air Emissions." They include specific design, fabrication, installation, and testing requirements of air cleaning systems that are applicable to ventilation systems used at Hanford Site Waste Tank Farm facilities. Approval of these exemptions by the Washington Department of Health (WDOH) will be documented elsewhere, and this document will provide the basis for such approval.



DATE: HANFORD RELEASE
STA: 4
ID: 2
JAN 1 1 2011

[signature] Release Approval

1-11-11 Date

Release Stamp

**Approved For Public Release**

| Tank Operations Contractor (TOC) RECORD OF REVISION | (1) Document Number: RPP-19233 | Page 1 |
|---|---|---|

(2) Title:

**Technical Justification for Applicability of General WAC 246-247 Technology Standards for Tank Farm Facility Waste Tank Ventilation Systems**

**Change Control Record**

| (3) Revision | (4) Description of Change – Replace, Add, and Delete Pages | Authorized for Release | |
|---|---|---|---|
| | | (5) Resp. Engr. (print/sign/date) | (6) Resp. Mgr. (print/sign/date) |
| 0 | EDT-820491, 2/12/04 | R.D. Gustavson 2/5/04 | P.C. Miller 2/5/04 |
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| 3 | ECN-722306, Rev. 2. Full revision to incorporate ORP comments, update Appendix D, delete requirement exemptions for the 702-AZ adsorbent media, change "TFC" to "TOC", replace "exemption" with "technical justification," replace "CH2M Hill" with "Washington River Protection Solutions." and revise references. | L.L. Payne 4/7/10 | E.A. Nelson 4/7/10 |
| 4 RS | ECN-10-001872, Rev. 0, Full revision to add Portable Exhauster POR-107 to the portable exhausters included in the scope of this document. | [signature] L.L. Payne 12/29/10 | [signature] E.A. NELSON ~~L. Curtis~~ ~~12/30/10~~ 1/10/11 |

A-6003-835 (REV 2)

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**Abbreviations and Acronyms**

| | |
|---|---|
| ALARA | As low as reasonably achievable |
| AMCA | Air Movement and Control Association |
| ANSI | American National Standards Institute |
| ASNT | American Society for Nondestructive Testing |
| ASCE | American Society of Civil Engineers |
| ASHRAE | American Society of Heating, Refrigerating, and Air-Conditioning Engineers |
| ASME | American Society of Mechanical Engineers |
| ASME Code | ASME Boiler and Pressure Vessel Code |
| ASTM | American Society for Testing and Materials |
| AWS | American Welding Society |
| BARCT | Best Available Radionuclide Control Technology |
| BPVC | Boiler and Pressure Vessel Code |
| CAM | Continuous Air Monitor |
| CFR | Code of Federal Regulations |
| DOE | U.S. Department of Energy |
| DST | Double-Shell Tank |
| DVR | Design Verification Report |
| ERDA | Energy Research and Development Administration |
| ESS | Exhaust System Stack |
| HDPE | High Density Polyethylene |
| HEGA | High-Efficiency Gas Adsorber |
| HEPA | High-Efficiency Particulate Air |
| HPS | Health Physics Society |
| IBC | International Building Code |
| ICBO | International Conference of Building Officials |
| IEEE | Institute of Electrical and Electronics Engineers |
| M&TE | Measuring and Test Equipment |
| NDT | Non-Destructive Testing |
| NFPA | National Fire Protection Association |
| ORP | U.S. Department of Energy, Office of River Protection |
| SMACNA | Sheet Metal and Air Conditioning Contractors National Association, Inc. |
| SST | Single-Shell Tank |
| UBC | Uniform Building Code |
| UL | Underwriters Laboratory |
| WAC | Washington Administrative Code |
| WDOH | Washington Department of Health |

**Units**

| | | | |
|---|---|---|---|
| cfm | cubic feet per minute | mm/s | millimeters per second |
| ft | Feet | µg/L | micrograms per liter |
| M | Meters | µm | micrometer |
| Mm | Millimeters | psi | pounds per square inch |

# 1.0 PURPOSE

The purpose of this document is to provide the technical justification for applicability of specific requirements from technology standards and regulations identified in *Washington Administrative Code* (WAC) 246-247, "Radiation Protection - Air Emissions." They include specific design, fabrication, installation, and testing requirements of air cleaning systems that are applicable to ventilation systems used at Hanford Site Waste Tank Farm facilities. Approval of these technical justifications by the Washington Department of Health (WDOH) will be documented elsewhere, and this document will provide the basis for such approval.

# 2.0 SCOPE

This document is applicable to all new Tank Farm facility waste tank ventilation systems and significant modifications to existing Tank Farm facility waste tank ventilation systems installed as radioactive air emission units regulated under WAC 246-247. These technical justifications are not applicable to ventilation systems serving Hanford Site facilities other than radioactive waste tanks at Tank Farm facilities.

Only the specific items identified in Section 4.0 and Appendix C are subject to these technical justifications. Compliance with other provisions of the technology standards identified in Section 4.0 or with other technology standards required by WAC 246-247 is outside the scope of this document.

# 3.0 INTRODUCTION

WAC 246-247 establishes emission standards, requirements, and procedures for the regulation of radioactive air emissions. WAC-246-247-040, "Standards," establishes emission standards by reference to other regulations and requires new emission units and significant modifications to existing emission units to utilize best available radionuclide control technology (BARCT) as defined in WAC 246-247. As part of compliance with the BARCT requirement, design and construction of emission units must meet certain technology standards. WAC-246-247-075, "Monitoring, Testing and Quality Assurance," establishes monitoring requirements in accordance with certain additional technology standards and regulations.

The process of demonstrating compliance with these technology standards and regulations during installation of new emission units at tank farms has revealed some specific requirements that provide no benefit for protecting health and safety when applied to waste tank ventilation systems at the Hanford Site. Some of the requirements and methods specified in the technology standards are recognized as dated and archaic from a technical standpoint, having been promulgated as long as 30 years ago or more. Other requirements from the technology standards are intended, by the respective authoring code committees, specifically for use at nuclear power plants or nuclear fuel reprocessing facilities. Protection of the worker, the public, and the environment at those facilities generally requires a more rigorous approach than that necessary at a radioactive waste storage facility such as the Hanford Site Tank Farms. Technical justifications from selected requirements in the technology standards or regulations are documented to support the adequacy of the design and operation of the emission units as required by WAC 246-247, to facilitate completion of tank farm mission objectives and to control emissions within regulatory standards.

The technical justifications in this document do not preclude the specification of these requirements by the Tank Operations Contractor (TOC) if technically necessary for specific applications.

This document was originated using the 2003 edition of ASME AG-1, *Code on Nuclear Air and Gas Treatment,* including the 2004 Addenda. The second revision incorporated the changes to the Code from ASME AG-1-2009, issued September 30, 2009, including the 2007 addenda. The changes to the code are documented in Appendix E. The impact of the code changes are documented in Appendix F which includes updates to the conclusions and technical justifications for applicability.

## 3.1 TYPICAL TANK FARM VENTILATION SYSTEM DESCRIPTION

This description is intended to generally include all components that are typically installed in waste tank ventilation systems. It does not detail a specific system, but provides a general description of the systems, components, and their functions.

Tank Farm ventilation systems include permanently installed and temporary, portable units. These systems are typically installed to perform some or all of the following functions.

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

Air typically enters the tank through various air infiltration pathways; a high-efficiency particulate air (HEPA) filtered inlet station, or a combination of both. The exhaust air leaves the tank through ductwork connected to a tank riser. If more than one tank is being ventilated, the exhaust ductwork from each tank will join in a header that will direct the exhaust air to the exhaust filter train. The exhaust air is then directed through an emission unit that includes multiple stages of HEPA filtration in series. Multiple parallel filter trains and fans may be installed for redundancy and to facilitate maintenance activities. A deentrainer or moisture separator may be installed prior to or as part of the exhaust filter train to remove any entrained moisture particles for protection of downstream components. A heater reduces the relative humidity of the exhaust air stream to limit condensation on the HEPA filters and high-efficiency gas adsorbers (HEGA), if installed. A prefilter protects the downstream HEPA filters from premature loading by large particulate. HEPA filters are typically the primary abatement control for radioactive particulate to maintain emissions below regulatory standards. Air leaves the filter train and enters the exhaust fan, which discharges the air out the stack. A record sampler draws a sample of the exhaust air from the stack through a sample collection filter to provide measurement of stack particulate emissions. A continuous air monitor (CAM) may also be installed to provide real-time monitoring and alarm functions for radioactivity in the stack emissions. Isolation valves or dampers are installed throughout the system, typically at the tank inlet, tank outlet, filter train inlet, and filter train outlet. See Figure 1 for a schematic of a typical waste tank ventilation system.

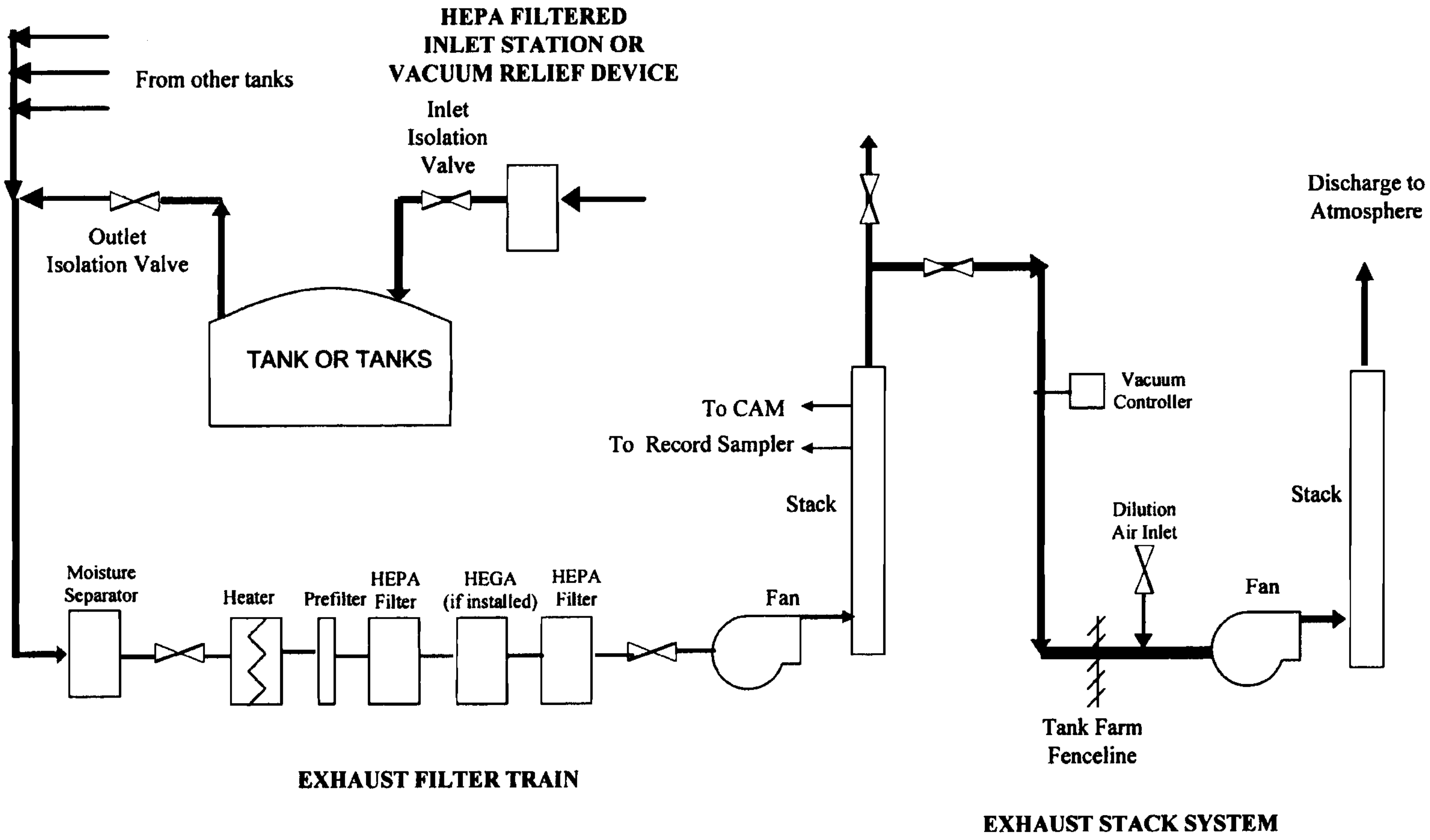
## 3.2 PORTABLE EXHAUSTERS

Several portable exhausters were originally constructed to support sampling and salt-well pumping of liquids from single-shell tanks (SST). They consist of an exhaust filter train, fan, stack, and stack sampling system similar to the configuration shown on Figure 1. All components are mounted on a skid that can be transported to various locations for installation and use. These portable exhausters are currently being utilized at tank farms to support additional DST and SST waste retrieval projects. The portable exhausters referred to in this document are listed below.

Portable exhausters:

- POR-03, 500 cfm (Stack 296-P-48)
- POR-04, 500 cfm (Stack 296-P-43)
- POR-05, 500 cfm (Stack 296-P-44)
- POR-06, 500 cfm (Stack 296-P-45)
- POR-007, 1000 cfm (Stack 296-P-23)
- POR-008, 1000 cfm (Stack 296-P-47)
- POR-107, 3000 cfm (Stack 296-P-107)
- POR-126, 3000 cfm (Stack 296-P-49)
- POR-127, 3000 cfm (Stack 296-P-50)

**Figure 1 - Typical Tank Farm Ventilation System**



### 3.3 EXHAUST STACK SYSTEM

The Exhaust System Stack (ESS) is designed to reduce odor exposures to workers in and around the tank farms and to ensure tank farm workers and other on-site personnel are not exposed to emissions above odor criteria. The ESS is designed to individually intercept the exhaust emissions from each existing tank farm emission system stack, mix it with ambient dilution air, and discharge the diluted air to the atmosphere. This system does not provide any radiological abatement or control. Radiological abatement or control is provided on tank farm radiological air emission units upstream of the tank exhaust system interface with the ESS

The ESS is designed to direct the exhaust to the remote stack location or to the existing in-farm location in the event of equipment failures in the ESS. The major components of the ESS are ductwork, a booster fan, and a stack. The booster fan will operate in series with the existing ventilation system fan. Isolation capability will be provided at the point of connection to enable the tank farm ventilation system to operate independently.

### 3.4 TEMPORARY WASTE TANK VENTILATION SYSTEMS

Temporary waste tank ventilation systems, as identified in this document, are those ventilation systems installed to provide confinement ventilation and other functions in support of short-term, finite life projects, which include waste retrieval and closure projects. These systems typically consist of a tank air inlet station and a tank exhaust ductwork system connected to one or more of the portable exhausters.

### 3.5 VENTILATION SYSTEM COMPONENTS

American Society of Mechanical Engineers (ASME) AG-1, *Code on Nuclear Air and Gas Treatment*, separates the ventilation systems into the following components:

- 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 4.0. Some of these components are not typically installed in waste tank ventilation systems or have no requirements that have documented technical justifications. These components are identified as such when discussed in Section 4.0.

# 4.0 ANALYSIS

This section identifies requirements from technology standards and regulations for which proposed alternatives with technical justification is documented for waste tank ventilation systems.

## 4.1 40 CFR 52, APPENDIX E

Compliance with 40 Code of Federal Regulations (CFR) 52, Appendix E, "Performance Specifications and Specification Test Procedures for Monitoring Systems for Effluent Stream Gas Volumetric Flow Rate," is required by WAC 246-247-075, "Monitoring, Testing and Quality Assurance," when a permanently installed flow rate measurement system is used for emission reporting purposes on radioactive air emission units. The code appendix defines a test procedure used to determine the accuracy of the installed flow rate measurement system compared to manual flow rate measurements, and criteria are established to evaluate its acceptability. This section provides the technical justification from this test procedure for waste tank ventilation systems with a stack flow measurement system component design that is identical to previously successfully tested ventilation systems.

The test involves an initial 168-hour conditioning period followed by a 168-hour performance and operational test period. During the operational test period, 14 volumetric flow rate measurements are taken simultaneously using both the installed flow rate measurement system and the applicable manual reference method of Appendix A of 40 CFR 60, "Standards of Performance for New Stationary Sources." The manual flow measurements are used to determine the relative accuracy of the installed flow measurement system. The zero drift and calibration drift of the installed flow measurement system is determined to ensure measurements remain consistently accurate over time. The orientation sensitivity of the measurement probe is obtained by taking flow measurements at different probe angular displacements. The installed flow rate measurement system is considered acceptable for use in emissions reporting if the results of all these tests are within the acceptance criteria defined in 40 CFR 52, Appendix E.

Repetition of this extensive testing should not be necessary for installed flow measurement systems with identical component design. The test only involves flow measurement at the stack, and, therefore, is independent of the system where the exhauster is installed. From a technical

standpoint, qualification testing of the installed flow measurement system for one exhauster qualifies all exhausters with identical stack configuration and flow measurement system component design. This applies to both existing and future systems.
The stack configuration, flow measurement devices, and flow instrumentation is identical in all the portable exhausters. The 168-hour test has been performed on portable exhausters POR-04, POR-05, and POR-06 (documented in RPP-14759, *Portable Exhauster (POR-05) 168 Hour Air Flow Test Data Sheets and Results*, and in work packages WS-99-00132, WS-99-00605, and 2E-01-00650). The 168-hour test has been performed on the new W314 exhausters that are identical to POR-107, POR-126 and POR-127 (documented in Vendor Information files 50315 & 50316 and in RPP-20278, *Project W-314, 241-AN and 241-AW Primary Ventilation Systems ASME AG-1 Code and WAC 246-247 Technology Standards Compliance Matrix)*. Subsequent testing of the other portable exhausters should not be necessary. Design drawings that show the identical configuration and component design for the portable exhauster stacks include:

- H-14-100737, *500 CFM Portable Exhauster*, (POR-03)
- H-14-100867, *500 CFM Portable Exhausters B, C, & D,* (POR-04, POR-05, POR-06)
- H-14-102578, *1000 CFM Port Exhauster Final Assembly*, (POR-007, POR-008)
- H-14-105529, *AN241-VTP (W-314) Exhauster Train "A" Assembly*
- H-14-105543, *AN241-VTP (W-314) Exhauster Train "B" Assembly*
- H-14-106702, *Exhauster Train POR126 Assembly*, (POR-126)
- H-14-106727, *Exhauster Train POR127 Assembly*, (POR-127)
- H-14-108900, *Exhauster Train POR107 Assembly*, (POR-107)

A similar approach was accepted by WDOH for qualification of the shrouded probe used for particulate sampling of the exhaust stack emissions on the portable exhausters. The installed sampling probes on all the portable exhausters are identical in design. One probe was qualified in accordance with ANSI/HPS N13.1-1999, *Sampling and Monitoring Releases of Airborne Radioactive Substances From the Stacks and Ducts of Nuclear Facilities*, and this served as the basis for qualification of all the other identical probes and stack configurations, with no further qualification testing required. This qualification is documented in PNNL-11701, *Generic Effluent Monitoring System Certification for Saltwell Portable Exhauster.*

The shrouded sampling probes for the W-314 exhaust skids and the POR-126 and POR-127 exhausters are also of identical design with each other. The W-314 exhaust skid sampling probe qualification testing is discussed in RPP-20278, *Project W-314, 241-AN and 241-AW Primary Ventilation Systems ASME AG-1 Code and WAC 246-247 Technology Standards Compliance Matrix*, and documented in a vendor test report in Vendor Information File #50315.

Accuracies of current flow measurement systems have improved substantially since the testing of 40 CFR 52, Appendix E, was developed and codified. The latest revision of the code is dated 1975. The manufacturer's published accuracy and reliability for the subject flow rate measurement systems can be taken with a high degree of confidence based on their quality assurance program, verification testing of critical characteristics, and improved technology. The zero drift and calibration drift tests are also not necessary based on this accuracy and reliability of modern instrumentation. These drift tests are also impractical because they must be performed with the exhauster operating; however, the resultant zero flow indication during the test would activate exhauster low flow interlocks that cannot be bypassed, thus shutting down the exhauster. Loop accuracies for the installed flow measurement systems on the portable exhausters are calculated in RPP-15253, *Portable Exhauster Set Point Justification and Set Points (POR-03, POR-04, POR-05, POR-06, and POR-*008). Loop accuracies for the installed flow measurement systems on the W-314 exhausters, which are identical in design with POR-126 and POR-127, are calculated in RPP-15034, *Project W-314 Primary Ventilation System Setpoint Determinations*. Loop accuracy includes errors induced from inaccuracies in all components of the flow rate measurement system including the probe and all electrical components. The calculated values of 2.51% for the 500-cfm portable exhausters and 1.08% for the 1000-cfm portable exhausters and 1.2 % for the W-314 exhausters are well within the acceptance criteria of 10% of the mean reference value established in Table E-1, 40 CFR 52, Appendix E. In accordance with ANSI/HPS N13.1, manual flow measurements are taken annually to verify that the accuracy of the installed flow rate measurement system is still within the 10% acceptance criteria.

Repetition of the probe orientation sensitivity test should not be necessary for the installed flow measurement systems on the portable exhausters. With a maximum calculated loop accuracy of 2.51%, inaccuracies caused by probe misalignment of up to 7.5% would still result in flow measurement accuracies within the 168-hour test acceptance criteria of 10% of the mean reference value. This value of 7.5% is much greater than the probe orientation sensitivity acceptance criteria of 4%. Probe orientation sensitivity testing was conducted for W-314 exhausters (identical to POR-126 and POR-127) to demonstrate compliance with 40 CFR-52, Appendix E. The testing is documented in Vendor Information Files #50315 and #50316.

Rotational tests performed by the manufacturer of the Verabar®[1] V100 probe used in the portable exhausters demonstrate probe accuracies well within the 10% acceptance criteria at rotations up to 10°. The report for these tests is presented in Appendix A. The annual accuracy verification in accordance with ANSI/HPS N13.1 will ensure that any inaccuracies caused by probe misalignments will be detected and corrected. During installation, leveling the probe valve body to give a parallel orientation with the stack ensures correct orientation of the probe to within the manufacturer's recommended tolerance of ±3°. This value was determined by the manufacturer based on rotation tests that resulted in insignificant deviations from flow indication at the correct probe alignment. In summary, the probe orientation sensitivity test for the portable exhausters does not add significant value based on the following:

- The high degree of accuracy inherent in the installed flow rate measurement system,
- Annual accuracy verification of the installed flow rate measurement system in accordance with ANSI/HPS N13.1, and
- Reliable installation procedures that ensure that the probe is installed to the manufacturer's recommended tolerance of ±3°.

In lieu of repeating the extensive tests of 40 CFR 52, Appendix E, on installed stack flow measurement systems with stack configuration and component design identical to previously

[1] Verabar is a registered trademark of Veris, Inc., Niwot, Colorado.

tested systems, it has been proposed by the U.S. Department of Energy, Office of River Protection (ORP) to WDOH that the stack flow for the existing portable exhausters shall initially be measured manually using pre-existing stack flow measurement procedures while simultaneously recording the reading from the installed stack flow measurement system indicator. A comparison shall be made to ensure the two results agree within 10 percent of each other. The test shall be repeated annually in accordance with ANSI/HPS N13.1. This proposal is documented in ORP letter 03-ED-175, "Request for Exemption for the 168-Hour Test Required Under 40 Code of Federal Regulations (CFR) 52, Appendix E, for Stacks 296-P-48, 296-P-23, and 296-P-47." As of the release of this document revision, approval for these technical justifications has been received from WDOH on the portable exhauster systems only; the technical justifications for the ESS system are pending approval. If applicable, technical justifications from the requirements of 40 CFR 52, Appendix E, for other systems may use this information as justification; however, approval from WDOH will need to be sought separately. Where the ESS system is installed to interface with the portable exhausters, compliance with 40 CFR 52 Appendix E, will need to be re-evaluated.

## 4.2 40 CFR 61, SUBPART H

Compliance with 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities," is required by several sections of WAC 246-247. In September 2002, 40 CFR 61, Subpart H, was amended to require compliance with the 1999 edition of ANSI/HPS N13.1 for new major emission units. This amendment also incorporated inspection criteria from Table 5 of ANSI/HPS N13.1 and required these inspection criteria for all existing major emission units. Technical discussions were held in 2003 between representatives of the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency, WDOH, and Hanford Site contractors. These discussions resulted in some exemptions and clarifications of the requirements of the amendment to 40 CFR 61, Subpart H, for emission units on the Hanford Site. These exemptions and clarifications are documented in an attachment to ORP letter 03-ED-141, "Title 40, Code of Federal Regulations (CFR), Part 61, Subpart H, and Amendment Implementation on the Hanford Site." The referenced letter is presented in Appendix B.

## 4.3 ANSI/HPS N13.1

ANSI/HPS N13.1 is a BARCT technology standard required by WAC-246-247-120. WAC 246-247-075 also requires this standard for equipment and procedures used for the continuous monitoring of radioactive air emissions. The amendment to 40 CFR 61, Subpart H, discussed in Section 4.3 incorporated Table 5 of ANSI/HPS N13.1 as Table 2 of that amendment. Therefore, the technical justifications for Table 2 identified in Appendix B are also applicable to Table 5 of ANSI/HPS N13.1.

## 4.4 ASME AG-1

ASME AG-1, is a BARCT technology standard required by WAC 246-247. It is a comprehensive and detailed code covering all aspects of design, fabrication, delivery, installation, and testing of nuclear ventilation components. This section and Appendix C provide the technical justifications and basis for specific requirements of ASME AG-1.

Although ASME AG-1 is written for nuclear power plants and nuclear fuel cycle facilities, WAC-246-247 imposes it on other nuclear facilities that operate radioactive air emission units in Washington State because no other design code exists that is strictly related to air and gas treatment systems at nuclear facilities. These code requirements for nuclear power plants and nuclear fuel cycle facilities are necessarily quite stringent, but may not be fully applicable to radioactive waste storage facilities, where a graded approach to their use is appropriate in consideration of the technical requirements and relative risk associated with these facilities. The forward to ASME AG-1 specifically states that, "the user is cautioned to carefully review these Code requirements for applicability to specific applications other than nuclear power and nuclear fuel cycle facilities." Nonetheless, the ASME committee recognizes that this Code is used in other nuclear facilities, including DOE facilities, and sections of the Code are under revision or are to be added that will help in the application of the Code at those other nuclear facilities. This includes the revision of the definitions to include other nuclear facilities.

The ventilation systems at nuclear power plants for which ASME AG-1 is written must operate under the most demanding conditions. These systems are relied upon to mitigate the consequences of an accident or maintain control room habitability following an accident and must continue to operate even when inaccessible due to post-accident radiological conditions. This requires a high degree of certainty that the system and components will maintain structural and functional integrity while subjected to severe loading caused by seismic forces and the very high-energy releases expected in nuclear power plant accidents. Waste tank ventilation systems do not need to meet these post-accident operability requirements. The safety analysis for tank farm facilities at the Hanford Site, RPP-13033, *Tank Farms Documented Safety Analysis,* demonstrates that waste tank ventilation systems are not required to operate continuously or to operate during or after a seismic event to ensure performance of any nuclear safety function. Also, waste tank ventilation systems are not required to operate during or after a design basis seismic event to maintain emissions within regulatory emission standards. Therefore, waste tank ventilation systems do not need to meet some of the stringent requirements of ASME AG-1, which are established to ensure operability of safety systems at nuclear power plants during and following any postulated accident. Other industry consensus standards or common practices are acceptable alternatives to certain requirements in ASME AG-1 to ensure satisfactory functional performance.

This section and Appendix C identifies and provides justification for the implementation of ASME AG-1 2009 for the upgrade of all ventilation systems at the Hanford Site Tank Farms. Comparison between ASME AG-1b 2007 and ASME AG-1 2009 were evaluated to assess the impacts/changes of the current design and associated specifications for which alternative measures are deemed acceptable from a technical and/or risk-based perspective to ensure that emissions from radioactive waste storage facilities at the Hanford Site tank farms are maintained within regulatory emission standards.

### 4.4.1 Section AA, Common Articles

This section of ASME AG-1 includes requirements that may be required for any of the components of nuclear air and gas treatment systems. These general requirements are only applicable to specific components if invoked by the component sections of ASME AG-1.

See Table C-1 for the technical justifications of specific requirements of ASME AG-1, Section AA. Unless applicability is specifically addressed in Table C-1, these technical justifications are applicable to specific components only if invoked by the respective component section of ASME AG-1.

### 4.4.2 Section BA, Fans and Blowers

This section of ASME AG-1 includes requirements for fans, fan motors, and drives. The fans provide the air movement in the ventilation system. These fans are typically centrifugal fans with a belt drive, a direct drive, or a variable frequency drive. Approximate capacities for currently installed systems range from 200 cfm to 9,000 cfm.

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

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

See Table C-2 for the technical justifications of specific requirements of ASME AG-1, Section BA.

#### 4.4.2.1 BA-4142, Fan Leakage

> "Fans are subject to the leakage criteria when the location of the fan and direction of leakage impose a contamination burden in the space housing the fan or the space supplied with air by the fan. Leakage testing shall be as given in BA-5142."

No contamination burden exists because the HEPA filters remove radioactive particulates upstream of the fan. Therefore, the leakage criteria and testing are not required for exhaust fans downstream of HEPA filters. In-leakage could, however, affect sampling of stack emissions or HEPA filter in-place leak testing for those systems where downstream aerosol concentration is measured after the fan. This in-leakage should be minimized. Continuous welding of seams in the fan housing will ensure leak tightness of the housing and high-quality industrial shaft seals can be expected to allow in-leakage around the shaft on the order of 1% to 2% of system flow for typical waste tank ventilation system conditions.

Fan shaft in-leakage will slightly dilute the air stream that is sampled in the stack; however, the sample is still representative of the emissions at the stack outlet and, therefore, is not a concern regarding emission measurement.

The photometer used for aerosol concentration measurement is the Model TDA-2EN manufactured by Air Techniques International. The accuracy of this photometer is 1% of full-scale for the decade in use. For example, the accuracy would be 1 µg/L if the decade in use has a full-scale reading of 100 µg/L. The acceptance criterion for aerosol penetration during the in-place leak test is 0.03% penetration. The upstream concentration of challenge aerosol is typically established at the upper limit of the measurement range of the photometer, which is 100 µg/L. Given an upstream concentration of 100 µg/L, the limit for downstream concentration would be 0.05 µg/L. The photometer would be set at the 0.1 µg/L decade to measure this downstream concentration, resulting in a corresponding accuracy of 0.001 µg/L. A 2% dilution of the downstream concentration caused by fan shaft in-leakage would affect the downstream concentration by 0.001 µg/L (2% of 0.05 µg/L). Therefore, when considered by itself, the fan shaft in-leakage expected with the use of standard high-quality industrial shaft seals is insignificant because it results in a variation in the downstream aerosol concentration that is within the accuracy of the photometer.

Other variables in the in-place leak testing apparatus cause the dilution due to fan shaft in leakage to be insignificant. The aerosol generator concentration can drift by as much as ±10% and is affected by injection pressure, aerosol liquid level, and system conditions such as turbulence. While it is unlikely that this amount of drift would be seen in the course of one HEPA filter in-place leak test, it does represent a variable in the testing that is potentially greater than the dilution effect of fan shaft in-leakage.

This minimal fan shaft in-leakage does not introduce error in emission sampling or aerosol testing that is significant enough to justify the added expense of fan leak testing and fan shaft seals that are capable of meeting the leakage criteria of ASME AG-1.

#### 4.4.3 Section DA, Dampers and Louvers

This section of ASME AG-1 includes requirements for dampers, actuators, and accessories. Dampers are used in waste tank ventilation systems for isolation, flow or pressure control, and pressure relief. Butterfly valves are commonly used on Tank Farm facility ventilation systems for isolation and control dampers. Multiple blade-type dampers are typically not used. Actuators may be manual, automatic modulating, or automatic two-position. Air intakes usually point downward for weather protection with metal mesh grates for protection against large debris, so louvers are typically not necessary.

Butterfly valves used in waste tank ventilation systems are common industrial equipment. No custom designs are used, and no complex and unusual performance or operational requirements are necessary. The performance, reliability, and structural integrity of these standard industrial valves have been demonstrated in industries with far more demanding process conditions than waste tank ventilation systems. These industries include chemical processing, mining, water treatment, and power production utilizing piping systems and valves that handle liquids at high pressures, temperatures, and toxicities relative to waste tank ventilation systems. This successful operating history provides generic field qualification of these standard industrial components at more demanding process conditions and demonstrates the adequacy, reliability, and structural integrity of these valves for use in waste tank ventilation systems.

ASME AG-1, Section DA-1210, states that, "valves whose design, manufacture, test, and installation are covered by the ASME Code, Section III, or ASME B31.1, are excluded from this Section even though they may be used to perform the function of a damper." The preferred course in some cases may be to specify valve construction in accordance with one of these standards rather than with the detailed requirements of ASME AG-1, Section DA. The technical justifications of this document are not applicable for valves that comply with the ASME Boiler and Pressure Vessel Code (ASME Code or BPVC), Section III, "Nuclear Components," ASME B31.1, *Power Piping*; or that are shown to comply with these standards. Justifications or demonstrations of compliance to these standards that are specific to individual valve manufacturers and models will be provided, as required. For example, RPP-12517, *Justification for Keystone Butterfly Valve Usage With the 244-AR Ventilation System per ASME B31.1*, demonstrates compliance to ASME B31.1 for Keystone Model 920 butterfly valves. ASME B31.1, Section 126.3, allows piping components to be designed and fabricated to other industry consensus standards, and it is likely that most butterfly valves currently used in waste tank ventilation systems are in compliance with one or more of these referenced standards.

See Table C-3 for the technical justifications of specific ASME AG-1, Section DA requirements.

#### 4.4.4 Section SA, Ductwork

This section of ASME AG-1 includes requirements for ductwork, accessories, supports, and duct mounted equipment supports. Ductwork used in waste tank ventilation systems may be fabricated from steel pipe, flexible pipe or ductwork, and sheet metal ductwork.

The rigor of some requirements in ASME AG-1 for ductwork in waste tank ventilation systems is often not necessary for the ductwork to perform its design function and to adequately control emissions. From a nuclear safety and emission control standpoint, the ductwork is not required to maintain structural integrity during a seismic event or a design basis accident. Many requirements from ASME AG-1 are intended for systems that must remain operational during and after seismic events or design basis accidents or that may be required to handle high pressures and/or highly corrosive air streams. Some of these requirements are overly stringent for waste tank ventilation systems.

All contaminated ductwork in waste tank ventilation systems is maintained at a negative pressure with respect to atmosphere during ventilation system operation, thereby eliminating out-leakage from pressurized ducts. Leak testing to ASME AG-1 allowable leakage criteria further minimizes the benefit gained from some of the rigorous design and construction requirements of ASME AG-1.

Ductwork for waste tank ventilation systems that is made from steel pipe is typically designed, manufactured, and tested in accordance with ASME B31.3, *Process Piping*. This code is established for fluid piping systems operating at high pressures and temperatures and, therefore, is quite adequate for piping systems used as ductwork in waste tank ventilation systems. Many requirements of ASME B31.3 are technically equivalent or exceed the requirements of ASME AG-1. Other requirements are similar and are technically acceptable for assurance of design function, structural integrity, and reliability of waste tank ventilation systems. The remaining requirements from ASME AG-1 do not have corresponding equivalent or similar ASME B31.3 requirements. Table D-1 in Appendix D provides technical justifications for the acceptability of ASME B31.3 as an alternative to ASME AG-1. Ductwork designed, manufactured, and tested in accordance with ASME B31.3 should be considered exempt from the ASME AG-1 requirements of Sections SA-4000, SA-5000, SA-6000, and referenced articles of Section AA, with the exception of pressure boundary leak testing. This leak testing shall be performed in accordance with Section SA-5000 and Section TA, subject to the technical justifications identified in this document for those sections. This is to properly quantify the leakage by using test pressures based on the normal operating pressure of the systems and in the proper direction with respect to atmospheric pressure. Using higher test pressures or test pressures acting in the opposite direction of the normal operating pressures, as specified in ASME B31.3, can cause deflections and compression of joints that cause leakage under test conditions that does not represent the leakage expected under normal operation.

The ESS ductwork material will be high density polyethylene (HDPE), a high molecular weight polymer known for its flexibility, toughness, and chemical resistance. This material meets the requirements of ASME B31.3. The pressure boundary leak test will not be performed on ESS ductwork; however, welding inspections will be performed on all joints during construction and air system balancing will be performed with acceptance testing that meets the requirements of Appendix SA-B. This system is an open loop system that is subject to significantly lower pressures than the pipe is designed for; therefore, air system balancing will be performed to confirm air flow requirements are met and that leakage is within the requirements of Appendix SA-B.

See Table C-4 for the technical justifications of specific ASME AG-1, Section SA requirements.

### 4.4.5 Section HA, Housings

This section of ASME AG-1 includes requirements for housings and housing supports. A housing encloses and provides access to the components of the ventilation system. In waste tank ventilation systems, these components include HEPA filters, prefilters, moisture separators, and heaters.

The rigor of some requirements in ASME AG-1 for housings in waste tank ventilation systems is often not necessary for the housings to perform their design function and to adequately control emissions. From a nuclear safety and emission control standpoint, the housings are not required to maintain structural integrity during a seismic event or a design basis accident. Many requirements from ASME AG-1 are intended for systems that must remain operational during and after seismic events or design basis accidents or that may be required to handle high pressures and/or highly corrosive air streams. Some of these requirements are overly stringent for waste tank ventilation systems.
All contaminated housings are maintained at a negative pressure with respect to atmosphere, eliminating out-leakage from pressurized housings. Leak testing to ASME AG-1 allowable leakage criteria further minimizes the benefit gained from some of the rigorous design and construction requirements of ASME AG-1.

See Table C-5 for the technical justifications of specific ASME AG-1, Section HA requirements.

### 4.4.6 Section RA, Refrigeration Equipment

Refrigeration equipment is typically not installed in waste tank ventilation systems. The requirements of ASME AG-1, Section RA are applicable for refrigerant equipment that may be included in future waste tank ventilation systems.

### 4.4.7 Section CA, Conditioning Equipment

This section of ASME AG-1 includes requirements for forced circulation air cooling and heating coils, air washers, evaporative coolers, and electric heating coils. Conditioning equipment currently in use in waste tank ventilation systems includes heating coils and condenser coils using a water/glycol mixture and electric heating coils. Electric heating coils will probably not be used in new systems or modifications to existing systems because they may present an ignition source in a potential flammable gas environment. The technical justifications identified in this document are, therefore, only applicable to water/glycol coils used for air stream heating and condenser cooling. No technical justifications are identified for other types of conditioning equipment that are typically not used, but future revisions of this document may address the requirements applicable to other types of conditioning equipment, as necessary.

Water/glycol heating and condenser coils used in waste tank ventilation systems are common industrial equipment. No custom designs are used, and no complex or unusual performance or operational requirements are necessary. The performance, reliability, and structural integrity of these standard industrial coils have been demonstrated in industries with far more demanding process conditions than waste tank ventilation systems. These include industrial processes such as solvent recovery, process fluid cooling, and exhaust gas cooling. This successful operating history provides field qualification of these standard industrial components at more demanding process conditions and demonstrates the adequacy, reliability, and structural integrity of these coils for use in waste tank ventilation systems.

Many of the requirements of Section CA of ASME AG-1 reference ASME Code, Section III, "Rules for Construction of Nuclear Facility Components," which is established for nuclear power plant components including reactor vessel and cooling systems. The requirements of Section III are overly stringent and impractical for heating coils used in waste tank ventilation systems. It is costly and difficult to locate a manufacturer that has experience constructing a heating coil to meet Section III. The heating coils in waste tank ventilation systems do not perform any direct emissions control function or any nuclear safety function and, therefore, do not need to meet the rigorous requirements imposed on nuclear power plants. The heating coils help to extend the life of the HEPA filters and, therefore, should be constructed to a high-quality industry consensus standard. ASME Code, Section VIII, "Rules for Construction of Pressure Vessels," may be used for design, fabrication, and testing requirements in lieu of ASME Code, Section III. This will ensure acceptable structural design, construction, and reliability of these coils.

See Table C-6 for the technical justifications of specific ASME AG-1, Section CA requirements.

#### 4.4.8 Section FA, Moisture Separators

A moisture separator, as described in ASME AG-1, consists of a pad of fiber mesh within a supporting frame and installed in a housing or duct to direct the exhaust air stream through the pad. Moisture particles are removed by impingement on the fibers and allowed to drain out of the housing. Moisture separators are also referred to as deentrainers, demisters, or mist eliminators.

The performance and reliability of moisture separators of comparable design and construction have been demonstrated in industries with much more demanding process conditions. The typical process conditions of the waste tank exhaust air stream are close to ambient temperature and pressure, with little corrosiveness. Exposure to radiation could be an issue in these ventilation systems, but is typically a specification requirement, along with the performance requirements of ASME AG-1. Standard industrial moisture separators of similar design are installed in industries with much more demanding process conditions, such as electrical power plants, refineries, sulfuric acid plants, caustic evaporators, and brine concentrators, and have demonstrated successful, reliable operation and structural integrity in these environments. This successful operating history provides field qualification of these standard industrial components at more demanding process conditions and demonstrates the adequacy, reliability, and structural integrity of these moisture separators for use in waste tank ventilation systems. The rigor associated with ASME AG-1 adds little benefit for waste tank ventilation systems with far less severe operating conditions than those in other industries.

The potential increased risk from not meeting some of the rigorous standards of ASME AG-1 is minimal. The probability that a standard industrial moisture separator will not meet the specified performance requirements or fail structurally is qualitatively judged to be extremely low. Waste tank ventilation systems have additional moisture protection features that can mitigate any minor reduction in performance of the moisture separators. Impingement on the heater will vaporize some entrained moisture particles. Washington Department of Health mandated monitoring and trending of operational parameters (such as moisture separator and HEPA filter differential pressure), and differential pressure alarm functions provide timely warning of reduced moisture separator performance. Technical justification from the rigorous requirements of ASME AG-1 identified in this document, therefore, does not cause significant increase in risk.

See Table C-7 for the technical justifications of specific ASME AG-1, Section FA requirements.

### 4.4.9 Section FB, Medium Efficiency Filters

This section of ASME AG-1 includes requirements for filters with an average efficiency of between 40% and 99%. These types of filters may be installed in nuclear air and gas treatment systems upstream of HEPA filters to prevent larger particulates from prematurely loading the HEPA filters.

Prefilters, as defined by ASME AG-1, are not required in waste tank ventilation systems. ASME N509, *Nuclear Power Plant Air Cleaning Units and Components*, Section 4.1(a), establishes that a prefilter is required "when design inlet particulate concentrations and particle size are such that the HEPA filter may be rendered ineffective prematurely. On other air-cleaning units, prefilters are recommended only when it is desired to increase HEPA filter life." The particulate conditions in the air stream of waste tank ventilation systems would not render the HEPA filter ineffective prematurely. Prefilters are installed in these systems to prevent excessive loading of the HEPA filters by larger particulates, which would cause the HEPA filter differential pressure to increase to the point where changing of the HEPA filter is required. Therefore, prefilters are not required, but are recommended by ASME N509.

The prefilters used in waste tank ventilation systems typically have efficiencies less than the minimum of 40% identified in ASME AG-1 for medium efficiency filters. Therefore, this section of ASME AG-1 is not applicable to these prefilters. This is acceptable because prefilters are recommended, but not required, in accordance with ASME N509. A new section of ASME AG-1, Section FJ, "Low Efficiency Filters," is in the course of preparation and will be applied, where applicable, when it is issued. If prefilters meeting the efficiency definition of medium efficiency filters in ASME AG-1 are installed, they will meet the requirements of Section FB, subject to the technical justifications identified in Table C-8.

See Table C-8 for the technical justifications of specific ASME AG-1, Section FB requirements.

### 4.4.10 Section FC, HEPA Filters

A HEPA filter is defined in ASME AG-1 as "a throwaway, extended-media dry-type filter with a rigid casing enclosing the full depth of the pleats. The filter shall exhibit a minimum efficiency of 99.97% when tested with an aerosol of essentially monodispersed 0.3-μm diameter test aerosol particles."

HEPA filters are considered BARCT for control of radioactive particulate emissions in waste tank ventilation systems. They are the primary abatement control to maintain emissions within regulatory standards. Some clarifications of ASME AG-1 requirements are identified in Table C-9 including code deviations that have been accepted separately by WDOH.

See Table C-9 for the detailed clarifications and deviations of specific selected requirements from ASME AG-1, Section FC.

### 4.4.11 Section FD, Type II Adsorber Cells

Adsorbers are typically not installed in waste tank ventilation systems and, therefore, are not subject to this analysis. However, adsorbers are installed in the 702-AZ ventilation system, and other waste tanks have the potential to require adsorbers during waste retrieval and closure projects. Future revisions to this document may address the requirements of this section, as necessary.

### 4.4.12 Section FE, Type III Adsorbers

Adsorbers are typically not installed in waste tank ventilation systems and, therefore, are not subject to this analysis. However, adsorbers are installed in the 702-AZ ventilation system, and other waste tanks have the potential to require adsorbers during waste retrieval and closure projects. Future revisions to this document may address the requirements of this section, as necessary.

### 4.4.13 Section FF, Adsorbent Media

Adsorbers are typically not installed in waste tank ventilation systems and, therefore, are not subject to this analysis. However, adsorbers are installed in the 702-AZ ventilation system, and some waste tanks have the potential to require adsorbers during waste retrieval and closure projects. Future revisions to this document may address the requirements of this section, as necessary.

### 4.4.14 Section FG, Mounting Frames, Conagt Air-Cleaning Equipment, Nuclear Safety-Related Equipment

This section of ASME AG-1 includes requirements for HEPA filter and adsorber cell mounting frames.

Interpretation 03-12 of the 2007 Addenda to ASME AG-1 confirms that all of Section FG applies to walk-in filter housings. This type of filter housing is typically not used in the ventilation systems installed in Hanford Site Tank Farms. However, frames are important to the structural integrity and maintenance of HEPA filter performance; therefore, some clarifications of the applicability of ASME AG-1 requirements identified in Table C-10.

See Table C-10 for clarifications of specific ASME-AG-1, Section FG requirements.

### 4.4.15 Section FH, Other Adsorbers

Adsorbers are typically not installed in waste tank ventilation systems and, therefore, are not subject to this analysis. However, adsorbers are installed in the 702-AZ ventilation system, and some waste tanks have the potential to require adsorbers during waste retrieval and closure projects. Future revisions to this document may address the requirements of this section, as necessary.

### 4.4.16 Section FI, Metal Media Filters and FJ, Low Efficiency Filters

These sections are under construction by ASME Code Committee and will not be evaluated in this report.

### 4.4.17 Section FK, Special Round and Duct-Connected HEPA Filters

A HEPA filter is defined in ASME AG-1 as "A throwaway, extended-media dry-type filter in a rigid casing enclosing the full depth of the pleats, having a minimum efficiency of 99.97% (that is, a maximum particulate penetration of 0.03%) for 0.3 μm diameter test aerosol particles."

HEPA filters are considered BARCT for control of radioactive particulate emissions in waste tank ventilation systems. They are the primary abatement control to maintain emissions within regulatory standards. Some clarifications of HEPA filter requirements are documented in Table C-9, including code deviations that have been accepted separately by WDOH.

See Table C-9 for the detailed clarifications and deviations of specific ASME AG-1, Section FC requirements.

### 4.4.18 Section FL, Sand Filters and Section FM, High Strength HEPA Filters

These sections are under construction by ASME Code Committee and will not be evaluated in this report.

### 4.4.19 Section IA, Instrumentation and Controls

This section of ASME AG-1 includes requirements for permanently installed instrumentation, control components, and control panels. Instrumentation in waste tank ventilation systems monitors operating parameters such as temperature, flow, component differential pressure, and radioactivity in stack emissions. Control functions may include fan speed control and interlocks.

Many of the requirements in this section are specifically applicable to "nuclear safety-related" components or "redundant safety channels." When this applicability is explicitly stated in an individual requirement, instrumentation and control components in waste tank ventilation systems are considered exempt from the requirement. Also, any referenced Institute of Electrical and Electronic Engineers (IEEE) standards that are explicitly applicable to Class 1E electrical components are also not applicable and are considered exempted. Nuclear safety related is defined in ASME AG-1 as related to ensuring the integrity of the reactor coolant pressure boundary or primary coolant boundary, the capability for safe reactor shutdown, or the capability to prevent or mitigate significant offsite exposures comparable to the guideline exposures of 10 CFR 100, "Reactor Site Criteria"[2]. ANSI/IEEE 308, *Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations,* defines Class 1E as, "The safety classification of the electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or are otherwise essential in preventing significant release of radioactive material to the environment." The consequences of failure of these "nuclear safety related" components are severe, and requirements imposed on these components are necessarily very stringent to ensure functionality under accident and post-accident conditions. Consequences from failure of instrumentation and control components in waste tank ventilation systems are far less severe and have negligible effect on radioactive air emissions. Therefore, the requirements for nuclear safety related components add little benefit in terms of maintaining emissions within regulatory standards. This is not intended to document technical justifications from all requirements of this section because the instrumentation is not nuclear safety related, but only the requirements in Section IA where applicability to "nuclear safety related" components, Class 1E components, or "redundant safety channels" is stated.

See Table C-11 for the technical justifications of specific ASME AG-1, Section IA requirements.

### 4.4.20 Section GA, Pressure Vessels, Piping, Heat Exchangers, and Valves; Section GB, Noble Gas Hold-Up Equipment; Section GC, Compressors; Section GD, Other

[2] The guideline exposures from 10 CFR 100 are a whole body radiation dose of 25 rem or a thyroid radiation dose from iodine exposure of 300 rem. These values are much greater than the applicable regulatory emission standard of 10 mrem/year from 40 CFR 61, Subpart H.

**Radionuclide Equipment; Section GE, Hydrogen Recombiners; Section GF, Gas Sampling**

These sections are under construction by ASME Code Committee and will not be evaluated in this report.

### 4.4.21 Section TA, Field Testing of Air Treatment Systems

This section of ASME AG-1 includes requirements for field acceptance testing of nuclear ventilation systems. Acceptance testing verifies that the system and components are installed in accordance with the design and that they perform their intended function. This testing is performed after assembly and installation, but prior to operation, and typically involves initial start-up of system components.

See Table C-12 for the technical justifications of specific ASME AG-1, Section TA requirements.

### 4.4.22 Section TB, Field Testing of Gas-Processing Systems

This section is under construction by ASME Code Committee and will not be evaluated in this report.

## 4.5 ASME N509

ASME N509, *Nuclear Power Plant Air-Cleaning Units and Components*, is a BARCT technology standard required by WAC 246-247. It is a system based standard covering functional design, construction, and qualification and acceptance testing of nuclear ventilation systems. Many of the detailed component requirements of this standard are implemented through reference to ASME AG-1. This section provides the technical justifications for specific ASME N509 requirements.

### 4.5.1 ASME AG-1 References

All requirements from ASME N509 that refer to sections of ASME AG-1 are included in the technical justifications documented in Section 4.4 and Appendix C.

### 4.5.2 Section 4.4, Environmental Design Condition

> "All parts and components of the air-cleaning unit shall be selected or designed to operate under the environmental conditions (temperature, relative humidity, pressure, radiation, etc.) specified in para. 4.2. Materials of construction and components shall be

> selected or treated to limit generation of combustibles and contaminants and to resist corrosion and degradation that would result in loss of function when exposed to the specified environmental conditions for the design life of the component.
> Environmental qualification requirements are contained in 10 CFR 50.49, IEEE 323 and ASME AG-1, Section AA and various specific ASME AG-1 Code sections."

This section shall be required except that the environmental qualification requirements of 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants," and ANSI/IEEE 323, *Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations*, are not applicable to waste tank ventilation systems. ANSI/IEEE 308, *Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations*, defines Class 1E as, "The safety classification of the electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or are otherwise essential in preventing significant release of radioactive material to the environment." No electric equipment in waste tank ventilation systems performs a safety function or emission control function comparable to that defined by Class 1E. Environmental qualification of this equipment is important and shall follow requirements of ASME AG-1, the manufacturer's qualification process, and the design specification. However, Class 1E standards are not applicable to waste tank ventilation systems and the cost and rigor associated with compliance with stringent Class 1E standards adds little value for control of emissions. 10 CFR 50.49 covers equipment that is comparable to Class 1E, that supports safety functions of Class 1E equipment, and that performs a post-accident monitoring function. This is also not applicable to waste tank ventilation systems.

### 4.5.3 Section 4.8.2, Internal Space for Maintenance

> "For ease of maintenance, air-cleaning unit design should provide for a minimum of 3 ft (0.92 m) from mounting frame to mounting frame between banks of components. If components are to be replaced between mounting frames, the bank-to-bank dimension should be the maximum deflated length of component plus a minimum of 3 ft (0.92 m). The designer should consider susceptibility of permanently installed testing manifolds to damage in determination of maintenance space. An extra 3 ft (0.92 m) bank-to-bank spacing should be considered for testing manifold clearance when manifolds are permanently installed."

This section is interpreted to be applicable to walk-in type housings only. The 3-ft. spacing requirement is necessary only when physical, full-body, access for maintenance is necessary. Access between components and test manifolds for maintenance is unnecessary for smaller housings because filter banks with only one or two small filters are typically designed for access from the side of the housing for replacement. Space for access is also unnecessary for in-place leak testing because permanent aerosol testing, injection, and sampling manifolds and/or ports are typically installed in housings used in waste tank ventilation systems.

### 4.5.4 Section 4.13(c), Testability – Access for Inspections

> "Access shall be provided between banks of components in the housing to permit physical inspection of both sides of each bank; components shall not be installed back-to-

back on the same or opposite sides of the same mounting frame, or on adjacent mounting frames which are so close as to not permit adequate access space between banks."

This requirement is intended for banks with multiple filters that cannot be tested separately in order to facilitate inspection to investigate which filter(s) to replace if the bank fails to meet the in-place leak test acceptance criteria. Access for physical inspection of both sides of each filter bank shall not be required for housings containing only one filter in a bank, which is typical for most tank farm facility ventilation systems. Also, access for physical inspection of both sides of each filter bank shall not be required for housings containing more than one filter in a bank, where the housing design allows individual testing of each filter in the bank or stage. In-place leak testing verifies performance with no further inspection required. Failure of the test will require replacement of the filter.

## 4.6 ASME N510

ASME N510, *Testing of Nuclear Air Treatment Systems*, is a BARCT technology standard required by WAC 246-247. It covers in-service (operational) testing of installed ASME N509 high-efficiency air treatment systems for nuclear power plants. This Standard provides a basis for the development of test programs and ASME AG-1, Section TA covers the acceptance testing program. This section provides the technical justifications for specific ASME N510 requirements.

### 4.6.1 Requirements Similar to ASME AG-1, Section TA

Many of the tests required by ASME N510 are similar, but not necessarily identical, to the tests in ASME AG-1, Section TA. The requirements of ASME N510 are included in the technical justifications for Section TA identified in Section 4.4 and Appendix C of this document to the extent that they are applicable.

### 4.6.2 Table 1, Tests and Inspections with Recommended Frequencies

The recommended frequency for the housing leak test is "Acceptance and at least once each 10 years."

Repetition of the housing leak test every 10 years shall not be required for systems installed prior to the 1989 edition of ASME N510. The frequency of every 10 years is only recommended and should be modified based on the technical requirements of individual ventilation systems. These older systems were designed without consideration of installed housing leak testing because it was not a requirement at that time and may not have features to easily allow this testing. Some systems may have isolation valves both upstream and downstream of housings, but these old valves may not seal well enough to provide a sufficiently leak tight boundary to provide a meaningful leak test. Breaking the pressure boundary to install blanks for leak testing would violate ALARA principles. Workers could be exposed to unacceptable levels of radiation during the leak testing. The housings are installed upstream of the exhaust fan and are at a negative pressure with respect to the environment. All leakage during system operation, therefore, is from the environment into the housing. Leak testing in addition to acceptance testing is, therefore, of limited value. The cost and potential worker exposure is not justified from an emission control standpoint.

## 5.0 ASME AG-1 COMPARISON ANALYSIS

This section identifies the comparison between the articles of ASME AG-1 revised by the 2009 addenda and ASME AG-1b revised by the 2007 addenda. The articles were identified and evaluated in Appendix E and Appendix F of this document to assess the impacts/changes of the current design and associated specifications for the upgrade of all ventilation systems at the Hanford Site Tank Farms. This justification will also provide compliance with *Washington Administrative Code* (WAC) 246-247, "Radiation Protection - Air Emissions.

## 5.1 ASME AG-1 ARTICLES

Appendix E identifies the changes between ASME AG-1-2003 and ASME AG-1-2009. Appendix F identifies the sections of this document that are impacted as a result of the Code revision and Appendix C was revised to incorporate the changes to ASME AG-1.

## 6.0 REFERENCES

03-ED-141, 2003, "Title 40, Code of Federal Regulations (CFR), Part 61, Subpart H, Amendment Implementation on the Hanford Site," (external letter from R. J. Schepens to J. Ken Knight, September 3), U.S. Department of Energy, Office of River Protection, Richland, Washington.

03-ED-175, 2003, "Request for Exemption for the 168-Hour Test Required Under 40 Code of Federal Regulations (CFR) 52, Appendix E, for Stacks 296-P-48, 296-P-23, and 296-P-47," (external letter from R. J. Schepens to A.W. Conklin, December 15), U.S. Department of Energy, Office of River Protection, Richland, Washington.

10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants," *Code of Federal Regulations*, as amended.

10 CFR 100, "Reactor Site Criteria," *Code of Federal Regulations*, as amended.

40 CFR 52, Appendix E, "Performance Specifications and Specification Test Procedures for Monitoring Systems for Effluent Stream Gas Volumetric Flow Rate," *Code of Federal Regulations*, as amended.

40 CFR 60, "Standards of Performance for New Stationary Sources," Appendix A, *Code of Federal Regulations*, as amended.

40 CFR 61, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities," *Code of Federal Regulations*, as amended.

ANSI/HPS N13.1-1999, *Sampling and Monitoring Releases of Airborne Radioactive Substances From the Stacks and Ducts of Nuclear Facilities*, American National Standards Institute, New York, New York.

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

ASME AG-1a, 2004, *Code on Nuclear-Air and Gas-Treatment*, American Society of Mechanical Engineers, New York, New York.

ASME AG-1b, 2007, *Code on Nuclear-Air and Gas-Treatment*, American Society of Mechanical Engineers, New York, New York.

ASME AG-1, 2009, *Code on Nuclear-Air and Gas-Treatment*, American Society of Mechanical Engineers, New York, New York.

*ASME Boiler and Pressure Vessel Code*, 2007, American Society of Mechanical Engineers, New York, New York.

ASME B31.1, 2009, *Power Piping*, American Society of Mechanical Engineers, New York, New York.

ASME B31.3, 2008, *Process Piping,* American Society of Mechanical Engineers, New York, New York.

ASME N509, 2002, *Nuclear Power Plant Air-Cleaning Units and Components*, American Society of Mechanical Engineers, New York, New York.

ASME N510, 1989, *Testing of Nuclear Air Treatment Systems*, American Society of Mechanical Engineers, New York, New York.

ASME N510, 2007, *Testing of Nuclear Air Treatment Systems*, American Society of Mechanical Engineers, New York, New York.

H-14-100737, 2009, *500 CFM Portable Exhauster POR-03*, Sheets 1 – 19, latest revision, Washington River Protection Solutions, Richland, Washington.

H-14-100867, 2006, *500 CFM Portable Exhausters B, C, & D*, Sheets 1 – 25, latest revision, Washington River Protection Solutions, Richland, Washington.

H-14-102578, 2007, *1000 CFM Port Exhauster Final Assembly*, Sheets 1 – 8, latest revision, Washington River Protection Solutions, Richland, Washington.

H-14-105529, 2004, *AN241-VTP (W-314)Exhauster Train "A" Assembly*, Sheets 1-4, latest revision, Washington River Protection Solutions, Richland, Washington.

H-14-105543, 2004, *AN241-VTP (W-314) Exhauster Train "B" Assembly*, Sheets 1-4, latest revision, Washington River Protection Solutions, Richland, Washington.

H-14-106702, 2005, *Exhauster Train POR126 Assembly*, Sheets 1 – 4, latest revision, Washington River Protection Solutions, Richland, Washington.

H-14-106727, 2005, *Exhauster Train POR127 Assembly*, Sheets 1 – 4, latest revision, Washington River Protection Solutions, Richland, Washington.

H-14-108900, 2010, *Exhauster Train POR107 Assembly*, Sheets 1 – 4, latest revision, Washington River Protection Solutions, Richland, Washington.

IEEE 308-2001, *Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations*, Institute of Electrical and Electronics Engineers, Inc., New York, New York.

IEEE 323-2003, *Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations*, Institute of Electrical and Electronics Engineers, Inc., New York, New York.

PNNL-11701, 1997, *Generic Effluent Monitoring System Certification for Saltwell Portable Exhauster*, Pacific Northwest National Laboratory, Richland, Washington.

RPP-12517, 2002, *Justification for Keystone Butterfly Valve Usage With the 244-AR Ventilation System per ASME B31.1*, Rev. 0, Washington River Protection Solutions, Richland, Washington.

RPP-13033, 2009, *Tank Farms Documented Safety Analysis*, Rev. 3-G, Washington River Protection Solutions, Richland, Washington.

RPP-14759, 2003, *Portable Exhauster (POR-05) 168 Hour Air Flow Test Data Sheets and Results*, Rev. 0, Washington River Protection Solutions, Richland, Washington.

RPP-15034, 2004, *Project W-314 Primary Ventilation System Setpoint Determination*, Rev. 0, Washington River Protection Solutions, Richland, Washington.

RPP-15253, 2003, *Portable Exhauster Set Point Justification and Set Points (POR-03, POR-04, POR-05, POR-06, POR-008)*, Rev. 3, Washington River Protection Solutions, Richland, Washington.

RPP-20278, 2004, *Project W-314, 241-AN and 241-AW Primary Ventilation Systems ASME AG-1 Code and WAC 246-247 Technology Standards Compliance Matrix,* Rev. 0, Washington River Protection Solutions, Richland, Washington.

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

# APPENDIX A

# ROTATIONAL TEST REPORT FOR PORTABLE EXHAUSTER STACK FLOW MEASUREMENT PROBE

**VERIS, inc.**

12/12/2003

## Verabar Rotational Test:

**Abstract:**
Customers frequently request more information about the rotational sensitivity of the Verabar when installed in the flow stream of any given application. Installation instructions supplied with each Verabar state that the sensor may be installed with a 3-degree deviation from the centerline of the pipe. Previously, only limited quantitative analysis regarding the rotational sensitivity of the Verabar to misalignment was available. To better understand the Verabars' performance when rotated, Veris incrementally misaligned the Verabar in an air flow test and noted the differential pressure produced by the Verabar at each increment. The performance of the Verabar during extreme rotation showed relatively little sensitivity during the flow test performed at Veris.

**Test:**
Testing performed at Veris utilized 4 and 6 inch SCH 40 PVC pipe and V100-05 and V100-10 sensors, respectively. The rotated sensor was located a minimum of 19 pipe diameters downstream from the inlet where a flow straightener additionally conditioned the entering flow stream. The Verabar mounted in the pipe via a pipe saddle and plumbed to a differential pressure transmitter using brass fittings and Tygon semi-flexible tubing. All connections were leak checked by internally pressurizing the system, applying soap bubble solution to the connections and correcting any leaks. A high pressure blower created flow in the pipe.

With the blower on, the Verabar was rotated in 2.5 degree increments to ±30 degrees from the centerline of the pipe. The differential pressure at the transmitter was allowed ample settling time before each data point was taken.

Two tests performed on the 4 and 6 inch pipes used different sensors for each test, a total of four sensors.

**Results:**
The data were tabulated, normalized, averaged and plotted using Excel. The analysis extrapolates the percent shift in the Verabar's flow coefficient from the published flow coefficient as the sensor is rotated from the centerline of the pipe. (See attached graphs.)

The results are as follows:
- ±1% K shift to ±9 degrees of rotation from centerline of the pipe.
- ±2% K shift to ±10.5 degrees of rotation from centerline of the pipe.
- ±3% K shift to ±21 degrees of rotation from centerline of the pipe.

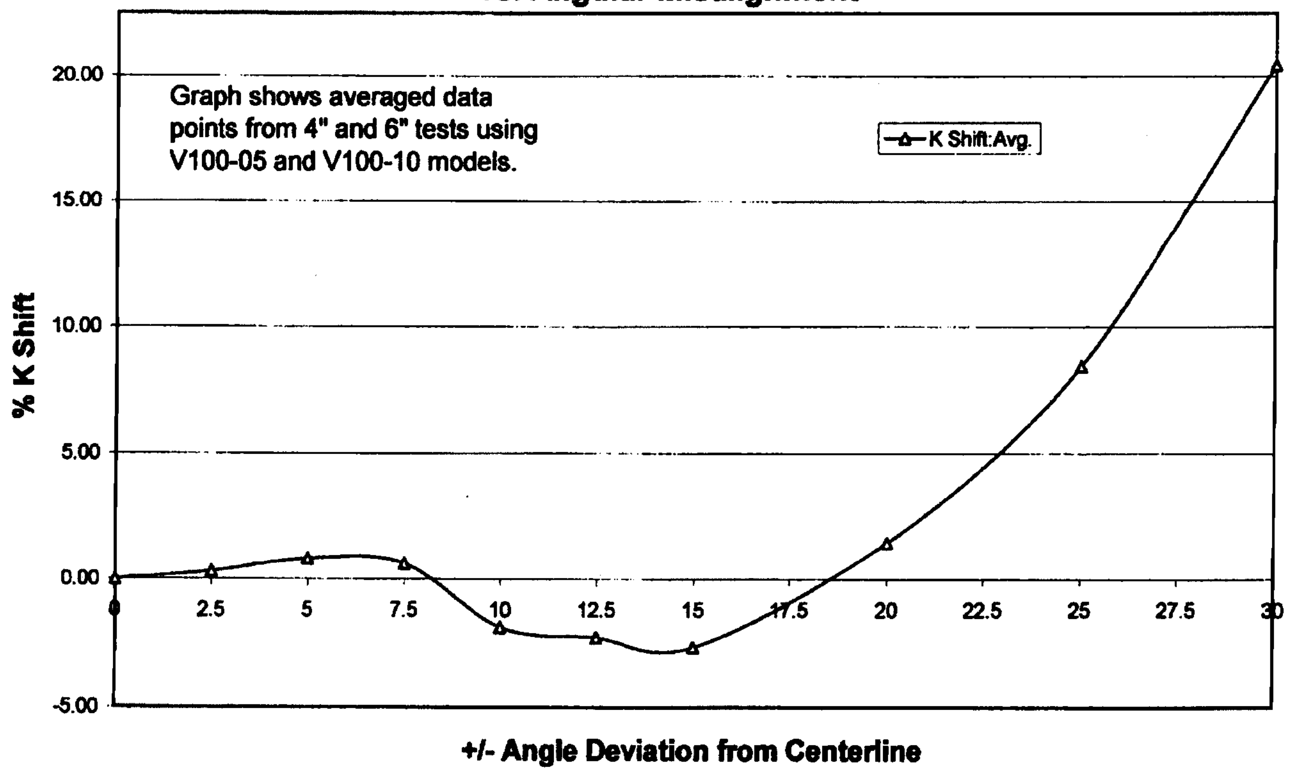
Therefore, the Verabar could be installed at an angle of 21 degrees from the centerline of the pipe and only exhibit ±3% induced inaccuracy.

**Conclusion:**
Testing shows that the Verabar is extremely resilient to misalignment. While the Verabar should always be installed carefully and in accordance with Veris Installation and Operation Instructions, the robust nature of the bullet shape prevents poor flow measurement on all but the most carelessly installed sensors.

6315 Monarch Park Place • Niwot, CO 80503 • Phone: (303) 652-8550 • FAX: (303) 652-8552

**Verabar Rotational Sensitivity Test:**
**Percent Shift In Verabar Flow Coefficient vs. Angular Misalignment**

Test Conducted on 11/27/03.



# APPENDIX B

# ANSI/HPS N13.1 TECHNICAL JUSTIFICATIONS BASED ON 40 CFR 61 SUBPART H AMENDMENT IMPLEMENTATION ON THE HANFORD SITE

**U.S. Department of Energy**
**Hanford Site**

SEP 0 3 2003

Pam

03-ED-141

Mr. Jeff KenKnight, Unit Manager
Office of Air Quality
U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue, OAQ-107
Seattle, Washington 98081

Dear Mr. KenKnight:

TITLE 40, CODE OF FEDERAL REGULATIONS (CFR), PART 61, SUBPART H AMENDMENT IMPLEMENTATION ON THE HANFORD SITE

Attached please find a summary of technical discussions held between the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA), Region 10, regarding implementation of the recent 40 CFR Part 61, Subpart H. These discussions between DOE and EPA were started February 19, 2003, and concluded August 6, 2003. All EPA comments from both meetings have been incorporated into this summary. DOE requests your concurrence with the attached summary.

If you have any questions, please contact Dennis Bowser, Environmental Division, Office of River Protection, (509) 373-2566, or Mary Jarvis, Regulatory Compliance and Analysis Division, Richland Operations Office, (509) 376-2256.

Roy J. Schepens, Manager
Office of River Protection

Keith A. Klein, Manager
Richland Operations Office

ED:DWB

Attachment

cc: See page 2

*Office of River Protection*
*P.O. Box 450*
*Richland, Washington 99352*

*Richland Operations Office*
*P.O. Box 550*
*Richland, Washington 99352*

Mr. Jeff KenKnight
03-ED-141

-2-

SEP 0 3 2003

cc w/attach:
J. G. Woolard, BHI
D. Carrell, CH2M HILL
C. J. Kemp, CH2M HILL
N. Ceto, EPA
D. L. Dyekman, FHI
R. H. Engelmann, FHI
R. H. Gurske, FHI
J. L. Hanson, INNOV
M. Barnett, PNNL
D. L. Edwards, PNNL
J. B. Hebdon, RL
M. F. Jarvis, RL
A. W. Conklin, WDOH
E. W. Fordham, WDOH, MSIN B1-42
J. W. Schmidt, WDOH, MSIN B1-42
Administrative Record
Environmental Portal, LMSI

Attachment
03-ED-141

Title 40 Code of Federal Regulations (CFR) Part 61, Subpart H
Amendment Implementation on the Hanford Site

Attachment
03-ED-141

# TITLE 40 CODE OF FEDERAL REGULATIONS (CFR) PART 61 SUBPART H AMENDMENT IMPLEMENTATION ON THE HANFORD SITE

The following summarizes the technical discussion between the U.S. Department of Energy (DOE) and the Environmental Protection Agency, Region 10 (EPA) regarding implementation of new requirements promulgated by EPA in the Federal Register, Volume 67, Number 174 as published September 9, 2002, which amends the National Emissions Standards for Hazardous Air Pollutants (NESHAP) 40 CFR 61, Subpart H, - "National Emissions Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities."

## A. FREQUENTLY USED DEFINITIONS:

**ANSI 1999 Standard** – ANSI/HPS N13.1 – 1999 "Sampling and Monitoring Releases of Airborne Radioactive Substances From the Stacks and Ducts of Nuclear Facilities," published by the Health Physics Society and approved by the American National Standards Institute, Inc., January 12, 1999.

**DOE** – the U.S. Department of Energy, including its Richland Operations Office (RL) and the Office of River Protection (ORP).

**EPA** – the U.S. Environmental Protection Agency and its authorized representatives.

**Major Stack** – a stationary point source which has a potential to discharge radionuclides into the air in quantities which could cause an effective dose equivalent in excess of 0.1 mrem/yr to members of the public. The potential to discharge radionuclides is based on the discharge of the effluent stream that would result if all pollution control equipment did not exist, but the facilities operations were otherwise normal. Major stacks are sometimes referred to as major sources or designated stacks.

**Minor Stack** – a stationary point source which has a potential to discharge radionuclides into the air in quantities which could cause an effective dose equivalent less than 0.1 mrem/yr to members of the public. Minor stacks are sometimes called minor sources or non-designated stacks.

**NESHAP Amendment** – the EPA final amendment to 40 CFR Part 61 as promulgated in the Federal Register, Volume 67, Number 174, published Monday, September 9, 2002.

**Table 2 Requirements** – 40 CFR 61, "National Emissions Standards for Hazardous Air Pollutants," Subpart H, National Emissions Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities, Appendix B Test Methods, Method 114 Test Methods for Measuring Radionuclide Emissions from Stationary Sources, 4. Quality Assurance Methods, Table 2. – Maintenance, Calibration, and Field Check Requirements.

Attachment
03-ED-141

**B. BACKGROUND INFORMATION:**

The EPA amended 40 CFR 61 Subpart H in the **Federal Register**, Volume 67, Number 174, as published Monday, September 9, 2002. The amended rule became effective October 9, 2002. The Table 2 – Maintenance, Calibration, and Field Check Requirements apply to existing major stacks as well as newly constructed major sources.

A meeting was held on February 19, 2003, between the EPA, State of Washington Department of Health, Air Emissions, and Defense Waste Section, (WDOH), DOE and Hanford contractors to discuss important concepts and details that may be useful when interpreting and implementing the NESHAPs amendment requirements. Representatives from the EPA, WDOH, RL, ORP, Fluor Hanford, Inc., CH2M HILL Hanford Group, Inc., Pacific Northwest National Laboratory, and Bechtel Hanford, Inc. attended the meeting.

**C. COMPLIANCE:**

1. The regulatory agencies expect a compliance plan to be developed and submitted by December 31, 2003, for those stacks and facilities not in full compliance with the NESHAP amendment requirements by December 31, 2003.

2. DOE will pursue good faith efforts to comply with the NESHAP Table 2 maintenance requirements before December 31, 2003. EPA will exercise its enforcement discretion as appropriate during that time.

3. Notice of Construction permit applications and associated regulatory agency approvals are not needed to accomplish the tasks associated with Table 2 requirements because these actions will not result in increased emissions.

4. With respect to Federal enforcement of the NESHAP, Table 2 requirements do not apply to minor stacks.

**D. CLARIFICATIONS:**

1. Where applicable, the ANSI 1999 Table 2, "Graded approach to sampling and monitoring," could be used. The ANSI 1999 Table 2, "Potential fraction of allowable limit," refers to an emission unit's potential to discharge radionuclides and the allowable limit is the 40 CFR 61.92, 10 mrem per year effective dose equivalent to any member of the public. Note: The ANSI 1999 Table 2 is not the same as the NESHAP Amendment Table 2.

2. The ANSI 1999 Table 2, "Graded approach to sampling and monitoring," can be applied to the sample transport system leak testing – leak inspection requirement as discussed in ANSI 1999, Paragraph 6.9.

3. Although the NESHAP Amendment uses ANSI 1999 Table 5 as the basis for the new Table 2 requirements, the EPA did not adopt, reference, or otherwise make use of the

related ANSI 1999 text. The ANSI 1999 text provides useful information that can be used for guidance and clarification, where appropriate.

4. For stack flow instruments certified as accurate per the requirements of 40 CFR 52 Appendix E, Table 2 inspection of the pitot tube for deposits and leaks can be substituted with an evaluation that the instrument is still producing measurements within 10 percent of a manual flow measurement recorded per 40 CFR 60, Appendix A, Method 2 or 2C.

5. The Table 2 quarterly response check of stack flow rate systems can be done simply by changing the exhaust fan rate (e.g., by valve alignment) or producing a pressure pulse by some other means and checking that the corresponding instrument reading changed.

6. The Table 2 sharp edged nozzle inspection is <u>not</u> for shrouded probes.

7. The Table 2 transport line cleaning is not required if visible deposits are not seen inside the sample probe nozzle(s).

8. The Table 2 timing device calibration applies to electronic controllers or computer timing devices. All timing items must be checked and traceable to a national standard.

9. The Table 2 requirement to clean transport lines must be accomplished within the annual inspection cycle.

## E. OTHER

1. The NESHAP Amendment copied Table 2 from ANSI – 1999 Table 5, which included a typographical error. The ANSI 1999 Table 5 and NESHAP Amendment Table 2 frequency to clean transport lines requirement states, "Visible deposits for HEPA-filtered applications. Surface density of 1 $g/cm^3$ for other applications." The surface density value as published is incorrect and should be 1 $g/m^2$.

2. EPA will consider written proposals requesting approval for alternate methods of Table 2 compliance for individual facilities/stacks. ANSI 1999 Paragraph 6.4.6 states a cleaning schedule can be based on the actual performance of the sampling transport system. FHI plans to develop and submit a proposal for a stack sampling system aerosol test that will accomplish several Table 2 requirements in a single performance based test.

# APPENDIX C

# ASME AG-1 REQUIREMENT TECHNICAL JUSTIFICATIONS

Table C-1. Section AA, "Common Articles," Technical Justifications (12 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| AA-4200, Design Criteria (entire section): This subarticle contains the load, stress, deflection, and other criteria for the design of equipment. Verification of equipment design shall be based on calculations or tests, or a combination of both. | Manufacturers' or TOC's design criteria shall be used. Additional alternative criteria shall be identified in the design specification for specific applications. Design verification shall be in accordance with manufacturers' or TOC's procedures. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | The loading criteria, load combinations, and service levels defined in ASME AG-1 that are associated with nuclear power plant accident scenarios are not applicable to waste tank ventilation systems. No credible mechanism exists to create loading comparable to accident conditions at a nuclear reactor. Only Service Level A loads and stress criteria are applicable and are comparable to criteria used in most engineering design processes. Reevaluation to the specific criteria of ASME AG-1 adds little value. Manufacturers' consideration of deflection criteria as it affects normal component function is adequate for these ventilation systems. For components constructed on the Hanford Site, TFC-ENG-STD-06, *Design Loads for Tank Farm Facilities*, is adequate for defining structural design criteria and includes references to requirements in such industry standards as ASCE-7, *Minimum Design Loads for Buildings and Other Structures*, the International Conference of Building Officials (ICBO) *Uniform Building Code* (UBC) for portable exhausters and the *International Building Code* (IBC) for the ESS and new ventilation systems. |

Table C-1. Section AA, "Common Articles," Technical Justifications (12 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| AA-4300, Design of Equipment Systems and Their Supporting Elements (entire section):<br><br>AA-4310, General Requirements:<br>(Defines allowable stresses, type of analysis, and terms related to design by analysis.)<br>AA-4320, Design Verification Of Plate- And Shell-Type Components And Their Supporting Elements:<br>(Defines stress analysis, stress limits, and buckling stress criteria)<br>AA- 4330, Design Verification Of Linear-Type Systems By Analysis:<br>(Defines stress analysis and stress limits.) | Manufacturers' or TOC's design processes shall be used. Additional alternative processes shall be identified in the design specification, as necessary, for specific applications. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | Waste tank ventilation systems have no unusual loading or design geometry that requires application of the rigorous structural analysis of ASME AG-1. Manufacturers' analysis procedures are acceptable for the typical industrial components that are selected for these ventilation systems. Additional design analysis to the requirements of ASME AG-1 adds substantial cost with little benefit. The extensive operating history of these industrial components essentially provides field design qualification testing for components of similar design and demonstrates the adequacy of the manufacturers' design processes. |
| AA-4340, Functionability Requirements (entire section):<br>The stress limits specified by this Code do not assure that the equipment will be able to perform their required safety function. Functionability is assured by following the rules stipulated below. | Additional functionability verification shall not be required. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | The stress limits applied to these components ensure that the waste tank ventilation systems will be able to perform their required emission control function by maintaining structural integrity under normal operating conditions. No additional functionability verification is required. |
| AA-4350, Design Verification by Testing (entire section):<br>Design verification by testing shall be in accordance with the rules of this subarticle. Seismic tests are to be performed by subjecting the equipment to vibratory motion that conservatively simulates that postulated at the equipment mounting during the operating basis earthquake (OBE) and a safe-shutdown earthquake (SSE). In addition, other loads that may occur concurrently with the seismic event shall be accounted for (see AA-4212). The rules of this subarticle are consistent with and complementary to ANSI/IEEE 344. | Seismic testing shall not be required. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | The seismic testing of this section is intended to verify satisfactory operability of safety systems at nuclear power plants during design basis seismic events. Neither nuclear safety requirements nor the control of emissions within regulatory standards require waste tank ventilation systems to operate during or after a seismic event. Therefore, the testing of this section is not applicable. |

Table C-1. Section AA, "Common Articles," Technical Justifications (12 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| AA-4360, Design of Bolts:<br>The number and cross-sectional area of bolts required for the load combinations of AA-4212 shall be determined in accordance with the ASME Code, Section III, Division 1 Subsection NF-3324 | Bolting requirements shall be based on American Society for Testing and Materials (ASTM) standards for flanges, manufacturers' requirements for housings, or other industrial standards. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | Other industrial standards or manufacturers' requirements define dimensions and material strength properties based on analysis, testing, or operational experience that demonstrate the required leak tightness and structural integrity for the expected loads for which the bolted connection is designed. This is acceptable for waste tank ventilation systems. The requirements for nuclear power plant components from the ASME Code, Section III, are overly stringent and add little benefit from an emission control standpoint for systems that are not required to withstand the demanding loading from seismic events or nuclear reactor accidents. Also see AA-4200 in this table. |
| AA-4400, Documentation Requirements (entire section):<br>The equipment design verification shall be documented by a certified design verification report, in accordance with the rules given in this section. This document may be based on one of three types of verification, or a combination of these:<br>(a) design verification stress report;<br>(b) design verification test report; or<br>(c) design verification by comparative evaluation.<br>Factors considered in choosing a particular type of design verification shall be included in the DVR. | Design verification shall be in accordance with the manufacturers' or TOC's procedures and quality assurance program. Additional design verification requirements may be included in the design specification. A certified DVR is not required. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | A design verification process is important for these ventilation systems. The detail in ASME AG-1 and cost of compliance, however, do not add significant benefit. A quality assurance program in accordance with ASME AG-1 subject to the technical justifications of this document ensures adequate design verification for these ventilation systems. The extensive past operating history of these industrial components essentially provides field design qualification testing for components of similar design and demonstrates the adequacy of the manufacturers' design verification processes. The certification required by ASME AG-1 is a statement of compliance with AA-4000 and is not applicable as specified in the technical justifications in this table. |

Table C-1. Section AA, "Common Articles," Technical Justifications (12 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| AA-5120, Responsibility for Procedures:<br>When an inspection or test is required by Article AA-5000 or by any other section, written inspection or testing procedures shall be developed by the parties performing the test or inspection subject to the specific requirements of this Code. The inspection or testing shall be performed by personnel qualified in accordance with Article AA-8000 and with applicable portions of the other sections. | This section shall be required except that inspection and testing personnel qualification shall be in accordance with TFC-PLN-02, *Quality Assurance Program Description (QAPD)*, and implementing procedures MSC-PRO-263 and TFC-ESHQ-Q_INSP-C-01, *Control of Inspections*. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | NQA-1 requirements are implemented through the TOC QAPD program and implementing procedures regarding qualified personnel performing inspections and testing, as well as other requirements. The TOC has experience in evaluating quality assurance programs from manufacturers to ensure tests and inspections are performed by qualified personnel. |
| AA-5130, Measuring and Test Equipment:<br>Control and calibration of measuring and test equipment (M&TE) shall be in accordance with ASME NQA-1, Part I, Requirement 12. | Other industry accepted quality assurance standards for control of M&TE shall be allowed, subject to evaluation by the TOC. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | See the justification in AA-8110 in this table. |
| AA-5200, Visual Inspection (entire section):<br>This article contains methods and requirements for visual inspection. The criteria for interpretation of visual inspection are not included in this article, since such criteria are included in the other Code sections. | For components that are not built to other industry codes or standards with similar inspection requirements, visual inspections shall be performed in accordance with the manufacturers' procedures or the TOC QA inspection plan for the item. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | The stringent visual inspection requirements of ASME AG-1 do not add significant value. TOC procedures (including the Ventilation System Design Standard) are relied on to ensure manufacturer visual inspection requirements are included; also all design requirements are verified upon completion of design: TFC-PLN-02; TFC-BSM-CP_CPR-C-06, *Procurement of Items (Materials)*; TFC-ENG-DESIGN-C-34, *Technical Requirements for Procurement*; TFC-ENG-DESIGN-C-01, *Development of System and Subsystem Specifications*; and TFC-ENG-DESIGN-P-17, *Design Verification*. |
| AA-5300, Welded Connections:<br>Examination, inspection, and testing of welds shall be in accordance with Article AA-6000 and other sections of this Code. | This section shall be required, subject to the alternatives for article AA-6000 identified in this table. This alternative is applicable to all components except HEPA filters, HEPA filter housings, HEPA filter frames, and permanent ductwork. | See the justifications for article AA-6000 in this table. |

Table C-1. Section AA, "Common Articles," Technical Justifications (12 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| AA-5410, Before Bolting:<br>Flange seating surfaces shall be visually examined for cleanliness and acceptable surface finish. Flange faces shall be examined for compliance with tolerances for mutual parallelism and axial alignment, as well as for planarity of each flange. Gaskets shall be visually examined to assure conformance with specified dimensional tolerances and freedom from tears, breaks, or other defects. | Inspection and testing requirements for bolted connections shall be determined by the responsible engineer in accordance with the manufacturers' standard practices and considering the technical requirements of the specific bolted connection. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | These inspection requirements should be applied with a graded approach considering the importance of the bolted connection to control and monitoring of emissions. This level of inspection for every bolted connection may be impractical and adds little value from an emission control standpoint. |
| AA-5420, After Bolting:<br>Bolts in all bolted connections shall be examined to ensure bolts are in place. A uniform sampling of 25% of all bolts in a bolted connection shall be tested with a calibrated torque wrench. Torquing requirements shall be established for each bolted connection. If any bolt in the sample fails to meet torque requirements, all bolts in the connection shall be re-torqued. Gaskets in bolted connections shall be visually examined for uniform compression. | Inspection and testing requirements for bolted connections shall be determined by the responsible engineer in accordance with the manufacturers' standard practices and considering the technical requirements of the specific bolted connection. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | See the justification for AA-5410 in this table. Torque requirements are typically unnecessary in these low-pressure systems. Waste tank ventilation systems are not subjected to forces that typically necessitate torquing of bolts nor are they required to operate during or after a seismic event or accident. |
| AA-5800, Seismic Testing:<br>Refer to AA-4350 for the requirements of structural design verification by testing. | Seismic testing shall not be required. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | See the justification for AA-4350 in this table. |
| AA-6122, Material Identification:<br>Materials to be used in the fabrication and installation of components, parts, and appurtenances shall be identified on fabrication and installation plans and specifications as required in Article AA-8000. | This section shall be required, subject to the alternatives identified in article AA-8000. This alternative is applicable to all components except HEPA filters, HEPA filter housings, HEPA filter frames, and permanent ductwork. | See the justification for AA-8110 in this table. |
| AA-6123, Repair of Material with Defects:<br>Material with defects that are discovered or produced during the fabrication and installation processes may be used, provided the defects are repaired in accordance with the requirements of Article AA-8000, and for weld repairs, in accordance with AA-6300. | This section shall be required, subject to the alternatives identified for article AA-8000. This alternative is applicable to all components except HEPA filters, HEPA filter housings, HEPA filter frames, and permanent ductwork. | See the justification for AA-8110 in this table. |

Table C-1. Section AA, "Common Articles," Technical Justifications (12 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| AA-6130, Control of Fabrication and Installation Processes:<br>Quality control procedures shall be prepared and maintained current for all fabrication and installation processes in accordance with the requirements of Article AA-8000. | The manufacturer's quality control procedures shall meet the basic requirements of ASME NQA-1 or shall be based on other accepted industry standards. The TOC shall evaluate them for acceptability. This alternative is applicable to all components except HEPA filters, HEPA filter housings, HEPA filter frames, and permanent ductwork. | See the justification for AA-8110 in this table. |
| AA-6230, Fitting and Aligning:<br>Parts that are to be assembled or joined by mechanical means (e.g., bolts) or welding shall be fitted, aligned, and when necessary, retained in position during assembly. Attachments that are welded to the component during construction, but are not incorporated into the final component, such as alignment lugs or straps, tie straps, braces, preheat equipment, and post-weld heat treatment equipment, are permitted provided the following requirements are met:<br>(c) the welder and welding procedure shall be in accordance with AA-6300;<br>(d) the immediate area around the temporary attachment shall be marked in an acceptable manner so that, after attachment removal, the area can be examined in accordance with the requirements of Article AA-5000; | This section shall be required, subject to the alternatives to AA-6300 and AA-5000. This alternative is applicable to all components except HEPA filters, HEPA filter housings, HEPA filter frames, and permanent ductwork. | See the justifications for AA-6300 and AA-5000 in this table. |

Table C-1. Section AA, "Common Articles," Technical Justifications (12 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| AA-6240, Welded joints: Manufacturer's fabrication drawings shall provide complete information regarding location, type, size, and extent of all welds. Field and shop welds shall be clearly identified. Members to be joined by welding shall be brought into correct alignment when necessary and held in position by bolts, clamps, or temporary weld attachments meeting the requirements of AA-6230, until the welding is completed. Welding shall conform to the requirements of AA-6300. | Documentation of welds on fabrication drawings shall not be required. Welding shall be performed in accordance the manufacturers' welding procedures based on standard industrial welding processes. This alternative is applicable to all components except HEPA filters, HEPA filter housings, HEPA filter frames, and permanent ductwork. | It is unlikely that drawings of components fabricated in accordance with general commercial practice will contain such detailed weld information. The successful operating history of these standard industrial components demonstrates the adequacy of the standard industrial welding processes used by the manufacturers, without the rigorous weld documentation required by ASME AG-1. See the justifications for AA-6300 in this table. TOC procedures are relied on to ensure this requirement is included: TFC-ENG-STD-07, *Ventilation System Design Standard*, identifies the applicable welding codes and standards for ventilation systems; also TFC-ESHQ-Q_INSP-C-01. |
| AA-6252, Structural and Pressure Boundary Fasteners: Type, size, and spacing of structural and pressure boundary fasteners shall be selected to meet the maximum stresses anticipated for the worst load combination and shall be documented by calculations. | Accepted manufacturers' engineering practices or industry standards shall be allowed to determine the specified fastener requirements. Calculations shall not be required. This alternative is applicable to all components. | Calculations that document the specified requirements may be difficult and costly to create for certain components and do not add significant value. Industry standards and specifications for flanged connections establish the necessary requirements through undocumented analysis, testing, or operational experience. The successful operating history of standard industrial components demonstrates the reliability and structural integrity of pressure boundary fastener design. |
| AA-6258, Locking Devices: Threaded fasteners, except high strength bolts, shall be provided with locking devices to prevent loosening during service. Elastic stop nuts (when compatible with service temperature), lock nuts, jam nuts, and drilled and wired nuts are all acceptable locking devices. Upset threads may serve as locking devices. | Locking devices shall be required as determined by the responsible engineer and based on the vibratory loads expected during system operation. This alternative is applicable to all components except HEPA filters, HEPA filter housings, HEPA filter frames, and permanent ductwork. | Locking devices are not necessary for all threaded fasteners and should be required only if necessary based on the service loads on the connection. AA-6251 requires "locking devices or other means to prevent loosening under the vibratory loads expected during system operation." AA-6251 should be required in lieu of the mandatory requirement for locking devices of AA-6258. |

Table C-1. Section AA, "Common Articles," Technical Justifications (12 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| AA-6300, Welding Requirements (entire section):<br><br>AA-6310, General:<br>(This section establishes requirements for qualification records, welding materials, welding processes, terms and definitions, welding symbols, and safety precautions. Qualification of welding procedures, welders, and welding operators is required to be in accordance with ASME Code, Section IX, and American Welding Society (AWS) standards.)<br><br>AA-6320, Workmanship:<br>(This section establishes requirements for preparation of base metal, joint fit-up, weld cleaning, and weld quality.)<br><br>AA-6330, Inspection And Testing Of Welds:<br>(This section establishes requirements and acceptance criteria for inspection and testing of welds, nondestructive testing, inspector qualifications to ASME NQA-1 and SNT-TC-1A, and weld repairs.) | Welding shall be performed in accordance the manufacturers' welding procedures based on standard industrial welding processes. This alternative is applicable to all components except HEPA filters, HEPA filter housings, HEPA filter frames, and permanent ductwork. | It is unlikely that components fabricated in accordance with general commercial practice will meet or be documented to meet ASME Code, Section IX, or AWS standards for qualification or ASME Code, Section II, for filler metal. It is unlikely that the acceptable weld profiles and maximum reinforcement criteria of AA-6320 will be met. It is unlikely that the weld inspection criteria for fillet and butt welds, the personnel qualification requirements, and the qualification requirements for weld repairs of AA-6330 will be met.<br><br>The stringent requirements of this section of ASME AG-1 are often not cost effective and add little value from an emission control standpoint. The successful operating history of these standard industrial components demonstrates the adequacy of the standard industrial welding processes used by the manufacturers.<br><br>Manufacturer's compliance with many of the other requirements of this section is likely, however documented verification of compliance is unlikely. |
| AA-7200, General Requirements (entire section):<br>…<br>This article is intended to supplement ASME NQA-1, Part II, Subpart 2.2. The provisions of this article shall replace these respective sections and subsections of ASME NQA-1, Part II, Subpart 2.2. The balance of ASME NQA-1, Part II, Subpart 2.2, shall apply and be part of this Code. | Packaging, shipping, receiving, storage, and handling requirements shall comply with the manufacturer's recommended practices. The responsible engineer shall determine additional requirements. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | These requirements may be reasonably achievable for the levels of packaging defined in ASME NQA-1 that are applicable to components of waste tank ventilation systems. These requirements may be necessary, but documentation verifying compliance with ASME NQA-1 is impractical, costly, and adds little benefit for components that are not primary abatement controls. ASME NQA-1 should be used as a guide for requirements in addition to the manufacturer's recommended practices. |

Table C-1. Section AA, "Common Articles," Technical Justifications (12 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| AA-8110, Scope and Applicability:<br>This article contains general requirements for the quality assurance of components, parts, and equipment. The requirements of ASME NQA-1 apply to the components, parts, and equipment covered by this Code. The requirements of Article AA-8000 are applicable to the extent they are specifically invoked by each Code section. Additional or supplemental requirements may also be given in each Code section. | The TOC implements the requirements of NQA-1 through TFC-PLN-02, and subsequent procedures. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | As the requirement is stated, the quality assurance program does not have to be certified in accordance with ASME NQA-1. A quality assurance program certified in accordance with ASME NQA-1 is costly, and it is often impractical to find manufacturers with this level of quality assurance for many of the standard industrial components used in waste tank ventilation systems. The TOC has a quality assurance program compliant with ASME NQA-1 and has experience in evaluating quality assurance programs. The TOC's procedures will be relied on for quality assurance requirements. |

Table C-1. Section AA, "Common Articles," Technical Justifications (12 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| AA-8130, Responsibilities of Fabricators, Material Suppliers, and Material Manufacturers<br>*(b)* In addition to the specific responsibilities delegated to the Fabricator, Material Supplier, and Material Manufacturer by the Owner or designee, the following shall apply:<br>(1) each member of the chain depicted in Fig. AA-8130 shall be responsible for evaluating and qualifying the suppliers of contracted services or material from the next level down, i.e., the Fabricator shall be responsible for evaluating and qualifying the Material Supplier's quality assurance program, and so forth;<br>(2) each member of the chain depicted in Fig. AA-8130 shall be responsible for notifying the party that qualified their program of planned modifications that might affect the quality of the delivered product;<br>(3) the Fabricator, Material Supplier, and Material Manufacturer shall be responsible for establishing and maintaining an identification and verification program for the traceability of material while under his control;<br>(4) the Fabricator, Material Supplier, and Material Manufacturer shall be responsible for controlling quality during manufacture and fabrication, including control of manufacturing processes, testing, examination, repair, and treatment of the material, including subcontracted services. | These responsibilities shall be determined in accordance with the manufacturer's and TOC's procedures. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | See the justification for AA-8110. |

Table C-1. Section AA, "Common Articles," Technical Justifications (12 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| AA-8210, Documentation:<br>Documents for procurement of material and subcontracted services shall include requirements to the extent necessary to assure their compliance with ASME NQA-1 and the additional requirements of this paragraph. Measures shall be established to assure that all purchased and fabricated material and services conform to the requirements of this paragraph. Measures shall be established for identification and control of material, including partially processed material, throughout the manufacturing and fabrication process and during shipment. These measures shall ensure that identification is maintained either on the material or on records traceable to the material through manufacture and fabrication. Welding filler metal for use in repair of the material shall also be controlled in accordance with this paragraph. | Documentation shall be required as specified in design or procurement specifications and kept in vendor files as permanent records in accordance with the TOC's quality assurance program. A graded approach will be used by assigning quality levels to procured items and services. Procurement quality levels shall be assigned to structures, systems, and components (SSCs) utilizing a risk-based (graded) approach. The level of quality control and assurance required shall be directly related to the magnitude of hazards and shall incorporate considerations of risk. This documentation shall assure compliance with a quality assurance program subject to the technical justification for AA-8110 in this table. Control of welding filler metal shall be in accordance with the manufacturers welding processes. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | See the justification for quality assurance requirements in AA-8110 and the welding requirements in AA-6300 in this table. |
| AA-8230, Marking Requirements for Small Products:<br>(b) Welding and brazing materials shall be clearly identified by marking on the package or container to ensure positive identification of the material. The package or container marking shall include the heat or lot number, as applicable, a control marking code that identifies the materials with the Certified Material Test Report, and other information such as specification, grade, classification number, supplier's name, and trade designation. | This section shall be required except that identification of materials with a Certified Material Test Report shall not be required. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | Certified test reports do not add significant benefit because this application does not require such rigorous material testing. The ventilation systems identified in Section 3.2 are not subjected to excessively corrosive or damaging process conditions that would warrant such rigorous verification of physical and chemical properties. |
| AA-8300, Quality Assurance Records:<br>Documentation required by this section and each of the other sections shall be prepared, maintained, and submitted to the Owner for recording as required by the applicable section and ASME NQA-1. | This section shall be required, subject to the alternative in AA-8110 for ASME NQA-1. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames. | See the justification for AA-8110 in this table. |

Table C-1. Section AA, "Common Articles," Technical Justifications (12 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| AA-9120, Requirements:<br>Each item shall have a nameplate, except as otherwise permitted by this Code. Nameplate information shall be as required by (a) through (e) below:<br>(a) Manufacturer's name;<br>(b) Manufacturer's serial number and, if applicable, model number;<br>(c) Capacity in appropriate units;<br>(d) Operating temperature and pressure;<br>(e) Other data prescribed by the specific equipment section of this Code.<br>The data shall be in characters not less than 3/32 in. (2.4 mm) high. All nameplate marking shall be stamped, etched, cast, or impressed on the nameplate. Nameplates shall be of a non-corrosive material. Stamping directly on items, where permitted by the respective equipment section of this Code and used in lieu of a nameplate, shall be done with blunt nose continuous or blunt nosed interrupted dot die stamps. The selected marking method shall not result in any harmful contamination or sharp discontinuities. | Manufacturer's standard nameplates shall be required. This alternative is applicable to all components. | Information required by ASME AG-1, such as capacity and operating temperature and pressure may be impractical for manufacturers to include on component nameplates and adds little value. Standard nameplates include adequate information necessary to verify correct installation, such as make, model number, and serial number. This information also allows traceability to additional technical information, if required, during system operation. |
| AA-9140, Location of Nameplates:<br>The location of the nameplate shall be shown on the as-constructed drawing. It should be readily visible when the component is installed. Nameplates shall be located so insulation does not obscure nameplate data. | This section shall be required except nameplate location shall not be required to be shown on drawings. This alternative is applicable to all components. | Showing the nameplate location on manufacturer's drawings may be impractical and adds little value. Compliance with the other provisions of this section ensures adequate accessibility to the nameplate. |

Table C-2. Section BA, "Fans and Blowers," Technical Justifications (7 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| BA-3110, Material Stress Values:<br>The ASME or ASTM designation in Table BA-3100 specifies a chemical composition and a material thickness limit. A grade designation is usually required to determine the minimum strength of the material. If the specific grade material has an assigned minimum yield and tensile strength, these values shall be used for design purposes. If values have not been established and assigned, then tests in accordance with the procedures outlined in ASTM A 370 and Article AA-5000 shall be performed to obtain these values. Results of mill certified tests performed as above designating these values may be used. Maximum allowable design stress values shall be calculated by the procedures in Article AA-4000. These procedures require the use of an allowable stress for normal structural requirements, and correction of allowable stress for conditions where buckling can take place and for the several service levels. When the minimum yield values have been established by test or by ASTM minimums, then the allowable stress S or *Sa* used in Article AA-4000 shall be 60% of yield. | This section shall be required, subject to the alternatives in articles AA-4000 and AA-5000 in Table C-1. | See the justifications in AA-4000 and AA-5000 in Table C-1. |

Table C-2. Section BA, "Fans and Blowers," Technical Justifications (7 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| BA-4122, Aging:<br>The aging mechanisms listed in BA-4123 shall be applied to the equipment and components, Design qualification shall be specified in accordance with ANSI/IEEE 627. A list of recommended spare parts and their expected life shall be provided for the equipment and components that are not expected to last for the life of the plant under specific environmental conditions. | This section shall be required except that design qualification in accordance with ANSI/IEEE 627 shall not be required. Design qualification shall be in accordance with the manufacturers and TOC's procedures. | ANSI/IEEE 627, *Standard for Design Qualification of Safety Systems Equipment Used in Nuclear Power Generating Stations*, contains extensive qualification processes that are intended to ensure adequate functional performance of safety systems at nuclear power plants. The stated purpose of this standard is "to confirm the adequacy of the equipment design to perform its safety functions over the expected range of normal, abnormal, design-basis event, post design-basis event, and in-service test conditions." The rigor associated with this standard is not necessary for fans in waste tank ventilation systems, because continuous operation of these fans during normal, abnormal, or design-basis events is not necessary to perform its safety function or to meet regulatory emission standards. Manufacturer's and TOC's procedures for design qualification are acceptable. The successful operating history of these standard industrial fans provides significant field qualification of the design. |
| BA-4131, Load Definition (entire section):<br>Loads applicable to fan design are described in AA-4211 and AA-4212. The specific conditions listed in BA-4131.1 through BA-4131.4 shall be considered. | This section shall be required, subject to the technical justification in AA-4200 in Table C-1. | See the justification in AA-4200 in Table C-1. |
| BA-4133, Construction:<br>As a minimum, the fan construction shall be capable of meeting the maximum conditions in which fan pressure and outlet velocity are specified. Fans shall be designed in accordance with the structural requirements given in Article AA-4000. Structural requirements, load definitions, and structural design verification specific to fans are given in BA-4131, BA-4431, BA-4432, and BA-4433. Additionally, construction shall comply with the stress and deflection criteria associated with the loads given by BA-4433. | This section shall be required, subject to the alternatives in AA-4000 in Table C-1 and the referenced subsections of Section BA. | See the justifications in AA-4000 in Table C-1 and from the referenced subsections of Section BA in this table. |

Table C-2. Section BA, "Fans and Blowers," Technical Justifications (7 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| BA-4141, General<br>Fans are subject to the leakage criteria when the location of the fan and direction of leakage impose a contamination burden in the space housing the fan or the space supplied with air by the fan. Leakage testing shall be as given in BA-5142. | Fans installed downstream of HEPA filters in waste tank ventilation systems are not subject to the leakage criteria or testing of ASME AG-1. Seal welded fan housings and standard high-quality industrial shaft seals shall be used. | No contamination burden exists because the HEPA filters remove radioactive particulates upstream of the fan. Therefore, the leakage criteria and testing are not required for exhaust fans downstream of HEPA filters. See Section 4.4.2.1 for a discussion of the effect of fan shaft in-leakage on stack sampling and HEPA filter in-place leak testing. |
| BA-4160, Vibration:<br><br>BA-4161, General:<br>Fan wheels shall be dynamically balanced prior to fan assembly. Final balancing shall be performed on the completed assembly. All test results shall be documented. After installation, fans shall be checked and rebalanced, if necessary, to correct changes due to handling, shipping, and final support structure conditions.<br><br>BA-4162, Centrifugal Fans:<br>The double amplitude radial displacement measured on the bearing caps at the designated fan speed shall not exceed the values listed in Table BA-4162, measured with a meter filtered to the fan rotational speed.<br><br>BA-4163, Axial Fans:<br>The double amplitude radial displacement measured on the fan housing at both the inlet and discharge locations at the designated speed shall not exceed 1.0 mil (0.025 mm), measured with a meter filtered to the fan rotational speed. | "After installation" for skid-mounted portable exhausters is interpreted to mean after mounting of the fan on the support skid, but before field installation of the entire exhauster. The vibration testing procedures and criteria of AMCA 204 shall be used for in-situ vibration testing for fans on skid-mounted portable exhausters after field installation. | The portable exhausters are not firmly mounted to a concrete base, but simply rest on the ground. The ASME AG-1 vibration criteria are impractical to meet for this type of field application. The more stringent ASME AG-1 vibration criteria is intended to minimize maintenance and increase reliability, but adds no benefit for abatement of radioactive air emissions when these fans are accessible for routine maintenance and are not required to operate under post-accident conditions. The accepted industry vibration standard of AMCA 204, *Balance Quality and Vibration Levels for Fans*, establishes criteria that are adequate to ensure the required reliability of waste tank ventilation systems. The ASME AG-1 criteria are equivalent to the most stringent criteria of AMCA 204 (2.5 mm/s peak velocity), which is intended for computer chip manufacturer clean room applications. The less stringent criteria for low horsepower, industrial process or petrochemical applications (6.4 mm/s peak velocity) are more appropriate for waste tank ventilation systems. |

Table C-2. Section BA, "Fans and Blowers," Technical Justifications (7 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| BA-4222.1, Special Limitations – Centrifugal Fans:<br>Belt drives shall be permitted only in areas that are accessible for maintenance during normal or accident conditions. The number of belts selected shall allow for a single belt failure without loss of function. In use of either direct or belt drives, the equipment shall be capable of operating under the specified conditions while performing its intended safety-related function. Drives in which gear reducers are used shall not be allowed. Systems that are air balanced using variable pitch diameter sheaves shall be provided with fixed diameter sheaves for long-term operation. | This section shall be required except that a single belt failure is allowed that would cause loss of function. | Waste tank ventilation systems are not required to operate continuously or after a design basis accident, so temporary fan shutdown caused by belt failure is acceptable from a nuclear safety and emission control standpoint. Belt failure would immediately activate alarms that would trigger operational cessation of any waste disturbing activities to limit waste particles in the tank from escaping through leakage paths. Replacement belts are maintained in spare parts inventory, so operational downtime would be minimal. |
| BA-4430, Structural Verification Considerations:<br><br>BA-4431, Structural Verification by Analysis:<br>When verification of design by analysis is selected, the results of the analysis shall be in the form of a design verification report (DVR). The DVR shall comply with AA-4441. Equipment shall be deemed to be designed verified if the stress conditions and deflections identified in BA-4131 and AA-4341.2 are not exceeded under the applicable load combinations.<br>The DVR shall address, as a minimum the stress and deflection of the following fan components in both the normal and accident conditions:<br>(a) housings, including flanges and mounting supports<br>(b) wheel blades<br>(c) wheel hub<br>(d) shaft<br>(e) bearing supports<br>(f) driver supports<br>(g) weld filler material<br>(h) driver<br>Maximum shaft deflection shall not exceed 90% of the radial clearance between blade and housing. No deflection shall be allowed to exceed the limits of AA-4341.2. | Manufacturers' design verification procedures and load and deflection criteria shall be used. Additional design verification requirements may be included in the design specification. A certified DVR is not required. This section shall be subject to the alternatives in all subsections of AA-4000 identified in Table C-1. | The successful operating history of these standard industrial fans demonstrates the acceptability of the structural design and of the manufacturers' design verification process for the application of waste tank ventilation systems. Also, see the justifications in all subsections of AA-4000 in Table C-1. |

Table C-2. Section BA, "Fans and Blowers," Technical Justifications (7 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| BA-4432, Structural Verification by Testing:<br>When verification by testing is selected, a design verification test procedure (DVTP) shall be established. The test procedure, as a minimum, shall identify the specific components to be tested and the respective test methods and acceptance values. Upon completion of the tests, a DVR shall be prepared. The DVR shall comply with AA-4442. Equipment shall be deemed to have successfully passed the tests if the equipment meets the acceptance requirements identified in AA-4442 when subjected to the selected load combinations. | Manufacturers' design verification procedures and load and deflection criteria shall be used. Additional design verification requirements may be included in the design specification. A certified DVR is not required. This section shall be subject to the alternatives in AA-4400 of Table C-1. | See the justifications for BA-4430 in this table and AA-4400 in Table C-1. |
| BA-4433, Special Considerations:<br>(a) The maximum deflection that may be sustained without loss of equipment function during normal or accident conditions shall be determined by analysis or test. The allowable deflections in any plane for the load combinations of BA-4131 shall not exceed the limits expressed by and measured according to BA-4162 and BA-4163.<br>(b) Fan supports shall be designed to withstand the loads described in BA-4131. Foundation and supports shall be designed so that the natural frequency of vibration of the overall supporting structure is at least 25% lower or 25% higher than the rotational frequency of the fan or driver. | Manufacturers' design load and deflection criteria shall be used. The natural frequency requirement for foundation and supports of item (b) shall be required. | See the justification for BA-4430 in this table. |
| BA-5000, Inspection and Testing – General:<br>Inspection and testing of fans shall be in accordance with the requirements of Section BA and of AA-5100, AA-5200, AA-5400, and AA-6430. | This section shall be required, subject to the alternatives in all subsections of AA-5000 of Table C-1. | See the justifications for all subsections of AA-5000 in Table C-1. |

Table C-2. Section BA, "Fans and Blowers," Technical Justifications (7 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| BA-5142, Leakage Tests:<br><br>BA-5142.1, Housing:<br>Housing leakage tests required by BA-4141 shall be conducted on the fan housing, pressurized to a level at least 1.25 times the fan operating pressure, using a soap solution at all welds and joints. The acceptance criteria shall call for the absence of any visible bubble formation.<br><br>BA-5142.2, Shaft:<br>Shaft leakage tests required by BA-4141 shall be conducted on the fan with the shaft and seal assembled, the shaft rotating at the normal fan operating speed, the fan openings sealed closed, and the fan subjected to the normal fan operating pressure. The fan wheel shall be removed prior to the shaft leakage test, or provision shall be made to account for the increase in air temperature if the fan wheel is left in place. | Fans installed downstream of HEPA filters in waste tank ventilation systems are not subject to the leakage criteria or testing of ASME AG-1 as described in the alternatives for BA-4141 in this table. | See the justification for BA-4141 in this table. |
| BA-5143, Fan Vibration Test:<br>Fans shall be given a vibration test as required by BA-4160. Prior to taking the vibration measurements, the fans shall be operated at the normal operating speed for a run in period of time until the bearings reach a stable equilibrium temperature, at which point the temperature no longer rises. Vibration readings taken on the bearing caps on centrifugal fans, and on the fan housing on axial fans, shall be no greater than those given in BA-4162 and BA-4163, respectively. | This section shall be required, subject to the alternative for BA-4160 identified in this table. | See the justification for BA-4160 in this table. |
| BA-6000, Fabrication and Installation of Centrifugal and Axial Fans:<br>Fabrication shall be in accordance with the requirements of Section BA and of Article AA-6000. | This section shall be required, subject to the alternatives in all subsections of AA-6000 in Table C-1. | See the justifications for all subsections of AA-6000 in Table C-1. |
| BA-7100, General:<br>Packaging, shipping, receiving, storage and handling of fans shall be in accordance with the requirements of Section BA and of Article AA-7000 unless otherwise required by the Design Specification... | This section shall be required, subject to the alternatives in all subsections of AA-7000 in Table C-1. | See the justifications for all subsections of AA-7000 in Table C-1. |

Table C-2. Section BA, "Fans and Blowers," Technical Justifications (7 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| BA-8100, General:<br>Fans, fan drivers, drives, and related fan accessories covered under this section shall be manufactured, fabricated, installed, inspected, and tested in accordance with the provisions of a quality assurance program meeting the requirements of Article AA-8000. | This section shall be required, subject to the alternatives in all subsections of AA-8000 in Table C-1. | See the justifications for all subsections of AA-8000 in Table C-1. |
| BA-8220, Material Certification:<br>Material test reports are required in accordance with BA-3400. Permanent documentation shall be established and shall include as a minimum: procurement records, receiving records, manufacturing records, inspection reports, material control records, and Certified Material Test Reports for which certification is required. Permanent documentation shall be maintained for the life of the plant. | The materials documentation of this section shall be required except for the material test reports of BA-3400. Tank farm procedures will be followed to develop the quality assurance inspection plan for all fans; a Certificate of Conformance will be required which will include material identification. The ESS equipment procurement specifications shall require a hold point on the submittal for review and approval prior to acceptance for shipment in lieu of a Certificate of Conformance. | See the justification for BA-3400 in this table. See the justifications for all subsections of AA-8000 in Table C-1. |
| BA-9210, Required Nameplate Data:<br>Each fan assembly shall be provided with a legibly marked nameplate giving the identifying name, normal fan capacity, manufacturer, fan type, size, rotation, rating, maximum speed, and mark numbers, as applicable to Section BA and Article AA-9000. | This section shall be required, subject to the alternatives in all subsections of AA-9000 in Table C-1. | See the justifications for all subsections of AA-9000 in Table C-1. |

Table C-3. Section DA, "Dampers and Louvers," Technical Justifications (4 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| DA-3120, Allowable Stress:<br>Allowable stress values for the design of frames, blades, shafts, and linkages are specified in Article AA-4000. At temperatures above 650 °F (343 °C) for ferrous material or 200 °F (93 °C) for nonferrous material, the special limitations cited in DA-3211 shall apply. | This section shall be required except that allowable stress values shall be specified in manufacturers' design procedures. | See the justifications for all subsections of AA-4000 in Table C-1. |
| DA-3300, Certification of Materials:<br>The Manufacturer shall make available, as a minimum, certified test reports of chemical and physical properties of material and hardware for stress components such as related accessories including frames, blades, shafts, and linkages. For those ASTM materials which do not have physical testing required by the ASTM specification, testing should be performed per ASTM A 370.<br>All other components used in the construction of the damper shall be provided with a manufacturer's certificate of compliance covering the ASME or ASTM material specification, grade, and class, if applicable. | Damper materials shall be in conformance with the allowable materials of ASME AG-1, Table DA-3100. Manufacturer's Certificates of Conformance with the ASME or ASTM designations of Table DA-3100 shall be provided. Certified test reports shall not be required. The ESS equipment procurement specifications shall require a hold point on the submittal for review and approval prior to acceptance for shipment in lieu of a Certificate of Conformance. | Certified test reports are documented verification of compliance of material properties with ASTM or ASME standards. They do not add significant benefit because this application does not require such rigorous material testing. These ventilation systems are not subjected to excessively corrosive or damaging process conditions that would warrant such rigorous verification of physical and chemical properties. Compliance with the allowable materials of ASME AG-1 and manufacturer's Certificates of Conformance with ASME or ASTM standards provide adequate verification of the physical properties of materials. The extensive successful operating history of these standard industrial dampers demonstrates the acceptability of the materials used. |
| DA-4110, Requirements of Design Specification:<br>Design specifications prepared by the Owner or his designee in sufficient detail to provide a complete basis for design and manufacture in accordance with this Code shall include, as applicable:<br>(w) combination of loading conditions, seismic requirements, and the design transients applicable to the appropriate service level per Article AA-4000; | This section shall be required, subject to the alternatives in all subsections of AA-4000 identified in Table C-1. | See the justifications for all subsections of AA-4000 in Table C-1. |

Table C-3. Section DA, "Dampers and Louvers," Technical Justifications (4 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| DA-4120, Requirements of the Manufacturer:<br>When required by the design specifications, documentation provided by the Manufacturer to the Owner or his designee shall include the following, as applicable:<br>(m) verification of structural integrity, performance, and qualification in accordance with Article AA-4000; | This section shall be required, subject to the alternatives in all subsections of AA-4000 identified in Table C-1. | See the justifications for all subsections of AA-4000 in Table C-1. |
| DA-4211, General:<br>Dampers or louvers shall be designed in accordance with the structural requirements given in AA-4000. Structural requirements and load definitions are given in DA-4212 through DA-4214. | This section shall be required, subject to the alternatives in all subsections of AA-4000 identified in Table C-1. | See the justifications for all subsections of AA-4000 in Table C-1. |
| DA-4212.2, Support Boundary – Documentation:<br>The damper or louver Manufacturer shall be responsible for providing all information necessary to define the support boundary interfaces. The interface control information to be specified shall include but not necessarily be limited to the following:<br>(b) magnitudes and directions of all loads imposed on the anchorage points, including ail static, dynamic, and operational loads resulting from the installed assembly. Load data shall be provided in a form which shall allow combinations to be considered as required in Article AA-4000. | This section shall be required, subject to the alternatives in all subsections of AA-4000 identified in Table C-1. | See the justifications for all subsections of AA-4000 in Table C-1. |
| DA-4213, Loads (entire section):<br>Loads to be considered are as given in AA-4211 and AA-4212 with the following clarifications. | The specific loads identified in this section shall be required. References to AA-4000 are subject to the alternatives in all subsections of AA-4000 identified in Table C-1. | See the justifications for all subsections of AA-4000 in Table C-1. |
| DA-4214, Structural Verification:<br>The technical and documentation requirements of AA-4000 shall apply to verification of design by analysis, test, or comparison. | This section shall be required, subject to the alternatives in all subsections of AA-4000 identified in Table C-1. | See the justifications for all subsections of AA-4000 in Table C-1. |
| DA-4283, Mounting Structure Material:<br>The structure for mounting actuators and accessories shall be fabricated of material listed in Table DA-3 I 10. Structures shall be designed as required by Article AA-4000. | This section shall be required, subject to the alternatives in all subsections of AA-4000 identified in Table C-1. | See the justifications for all subsections of AA-4000 in Table C-1. |

Table C-3. Section DA, "Dampers and Louvers," Technical Justifications (4 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| DA-4284, Attachment of Actuators and Accessories: Actuators and accessories shall be attached to the mounting structure with removable fasteners, of materials listed in Table DA-3 110, sized to conform to the stress limitations stated in Article AA-4000. | This section shall be required, subject to the alternatives in all subsections of AA-4000 identified in Table C-1. | See the justifications for all subsections of AA-4000 in Table C-1. |
| DA-4321, Manual Actuator - Torque Requirements: Manual actuators shall be capable of delivering the torque required by DA-4232. Manual actuator components shall be sized as required by Article AA-4000. | This section shall be required, subject to the alternatives in all subsections of AA-4000 identified in Table C-1. | See the justifications for all subsections of AA-4000 in Table C-1. |
| DA-5000, Inspection and Testing – General: Inspection and testing of louvers and dampers shall be in accordance with the requirements of this Article and of AA-5100, AA-5200, AA-5300, AA-5410, AA-5500, and AA-5800. The Manufacturer shall be responsible for establishing the written visual examination procedures and necessary tolerances to ensure that the products are built to the Manufacturer's drawings. Examination procedures shall include appropriate checklists to verify that the required observations were performed. Written reports of visual inspection shall contain, as a minimum, the requirements of AA-5200. | This section shall be required, subject to the alternatives in all subsections of AA-5000 identified in Table C-1. | See the justifications for all subsections of AA-5000 in Table C-1. |
| DA-6000, Fabrication, Finishing, and Installation – General: Article AA-6000 shall apply for fabrication, finishing, and installation, except that the design and seismic qualifications of the damper assembly are based on the damper assembly being adequately supported for the appropriate loads. The Owner or his designee shall provide supports for the damper assembly to ensure that the damper is adequately supported as required by the Manufacturer's requirements and DA-4212. All of the welding codes or standards listed are allowed. In addition, installation of Underwriters Laboratory (UL) fire dampers shall be in accordance with the Manufacturer's UL installation instructions. | This section shall be required, subject to the alternatives in all subsections of AA-6000 identified in Table C-1. | See the justifications for all subsections of AA-6000 in Table C-1. |
| DA-6100, Welding and Brazing: Specific welding and brazing parameters shall conform to the requirements of Article AA-6000. | This section shall be required, subject to the alternatives in all applicable subsections of AA-6000 identified in Table C-1. | See the justifications for all applicable subsections of AA-6000 in Table C-1. |

Table C-3. Section DA, "Dampers and Louvers," Technical Justifications (4 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| DA-7000, Packaging, Shipping, and Storage:<br>Packaging, shipping, and storage of damper and louver assemblies shall be in accordance with the requirements of Article AA-7000. Implementation requires an ANSI /ASME NQA-1 classification level for packaging, shipping, receiving, storage, and handling of all items. | This section shall be required, subject to the alternatives in all subsections of AA-7000 identified in Table C-1. | See the justifications for all subsections of AA-7000 in Table C-1. |
| DA-8000, Quality Assurance:<br>Quality assurance of dampers and louvers shall be in accordance with the requirements of Section DA and AA-8000. | This section shall be required, subject to the alternatives in all subsections of AA-8000 identified in Table C-1. | See the justifications for all subsections of AA-8000 in Table C-1. |
| DA-9000, Nameplates, Stampings, and Manuals:<br>Article AA-9000 requirements for nameplates, stampings, and manuals shall apply, except that the nameplate shall require only the following information:<br>(a) Manufacturer's name<br>(b) Equipment, tag, or mark number information as supplied by the purchaser<br>(c) Size | This section shall be required, subject to the alternatives in all subsections of AA-9000 identified in Table C-1. | See the justifications for all subsections of AA-9000 in Table C-1. |

Table C-4. Section SA, "Ductwork," Technical Justifications (7 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| SA-3100, General:<br>For components of ductwork and ductwork supports, the supplier shall make available, as a minimum, certified test reports of chemical and physical properties. For those ASTM materials which do not have physical testing required by the ASTM specification, tensile testing shall be performed per ASTM A 370. All other components used in the construction of ductwork shall be provided with a manufacturer's Certificate of Compliance covering the ASME, ASTM, or other material specification, grade, and class, if applicable. | Ductwork materials shall be in conformance with the allowable materials of ASME AG-1, Table SA-3400-1. Substitute materials shall be allowed as identified in SA-3400. Manufacturer's Certificates of Compliance with the ASME or ASTM designations of Table SA-3400-1 shall be provided. Certified test reports shall not be required. The ESS equipment procurement specifications shall require a hold point on the submittal for review and approval prior to acceptance for shipment in lieu of a Certificate of Conformance. | Certified test reports are documented verification of compliance of material properties with ASTM or ASME standards. They do not add significant benefit for waste tank ventilation systems because this application does not require such rigorous material testing. These ventilation systems are not subjected to excessively corrosive or damaging process conditions that would warrant such rigorous verification of physical and chemical properties. Compliance with the allowable or substitute materials of ASME AG-1 and manufacturer's Certificates of Compliance with ASME or ASTM standards provide adequate verification of the physical properties of materials. Justification for not requiring a certified material test reports (CMTR) for specific temporary ductwork support systems is documented in RPP-16797, *Justification for the Use of Non-CMTR Materials in the Construction of ASME AG-1 Code Compliant Ductwork Supports.* |
| SA-4100, General - Design:<br>Ductwork and ductwork supports shall be designed in accordance with the requirements of Article AA-4000 and this Section.<br><br>SA-4200, Design Criteria (entire section): | The TOCs' procedure, TFC-ENG-STD-06, shall be used for design criteria. This section shall be subject to the alternatives in all subsections of AA-4000 in Table C-1. The ESS ductwork shall be designed in accordance with ASME B31.3 and the ESS stack shall be designed in accordance with ASME STS-1. | TFC-ENG-STD-06 requires consideration of all applicable loads and allowable stresses. Other industry standards are referenced for methods of analysis, such as ASCE 7 and IMC. Also, see the justifications for all subsections of AA-4000 in Table C-1. |

Table C-4. Section SA, "Ductwork," Technical Justifications (7 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| SA-4410, Flexible Connections:<br>(a) Flexible connections shall be designed to meet the requirements for design given by SA-4212, SA-4500, and NFPA 90A. Allowable leakage (fabric leakage and joint leakage) shall be determined in accordance with SA-4500. | Flexible connections shall meet these requirements from ASME AG-1 except for SA-4212 and except for NFPA 90A on systems installed outdoors. | SA-4212 defines the design load combinations which are similar to AA-4212. The defined scope of NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*, is limited to ventilation systems that serve spaces within buildings and, therefore, is not applicable to waste tank ventilation systems installed outdoors. Also, the stated purpose is to limit the spread of smoke and fire within a building. See the justification for SA-4100 and SA-4200 and AA-4200. |
| SA-4452, Insulation:<br>(d) The fire hazard classification of applied insulation, adhesive, and sealer shall not exceed a flame spread of 25 and smoke developed of 50 in accordance with NFPA-90A. | Insulation shall not be required to meet NFPA 90A on systems installed outdoors. | See the justification for SA-4410 in this table. |
| SA-4453, Air Distribution Devices:<br>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 Article SA-2000. | This section shall be required, subject to the alternatives for SA-4200 in this table and from AA-4300 in Table C-1. | See the justifications for SA-4200 in this table and AA-4300 in Table C-1. |
| SA-4533, Exceptions to Leakage Requirements:<br>Portions of air cleaning, air cooling, and ventilation systems exhibiting one of the following conditions need not be subjected to quantitative measurement of leakage unless otherwise required by the design specification (however, the system shall be pressurized to normal operating pressure differential (NOPD) to locate and seal all audible leaks):<br>(d) other exceptions to quantitative measurement of leakage requirements shall be technically justified and specifically documented with basis by the Owner or his agent | Quantitative measurement of leakage shall not be required for maintenance activities and minor alterations defined in RPP-18927 that affect the pressure boundary. | See RPP-18927, *Testing & Inspection Requirements Relative to the Maintenance and Minor Alteration of Ventilation System Pressure Boundaries,* for the technical justification. |

Table C-4. Section SA, "Ductwork," Technical Justifications (7 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| SA-4600 Design Specification:<br>A design specification shall be prepared which consists, as a minimum, of the following information regarding the ductwork and ductwork supports covered by this section:<br>(e) service conditions as defined by AA-4213.<br>(d) design and service limits as defined by AA-4214.<br>(f) system safety-related function: Identify the function of the ductwork system for each plant condition. The function shall consist of purpose and operational parameters (i.e., flow, leakage, pressure, temperature). Plant conditions and service limits are defined by AA-4213 and AA-4214. | This section shall be required, subject to the alternative in AA-4200 identified in Table C-1. | See the justification for AA-4200 in Table C-1. |
| SA-5100, Inspection and Testing - General:<br>Inspection and testing shall be in accordance with the requirements of AA-5 100, AA-5200, AA-5300, TA-3300, and the additional requirements of this section. | This section shall be required, subject to the alternatives in all subsections of AA-5000 identified in Table C-1. | See the justifications for all subsections of AA-5000 in Table C-1. |
| SA-5210, General Requirements:<br>Visual inspections shall be performed in accordance with AA-5200 and TA-3510. | This section shall be required, subject to the alternative in AA-5200 identified in Table C-1. | See the justification for AA-5200 in Table C-1. |
| SA-5220, Welded Connections:<br>Inspection and testing of welds shall be performed in accordance with AA-5300 and Article AA-6000. | This section shall be required, subject to the alternatives in AA-5300 and all subsections of AA-6000 identified in Table C-1. | See the justifications for AA-5300 and all subsections of AA-6000 in Table C-1. |
| SA-5231, Joints and Seams:<br>Joints and seams shall be visually inspected. Acceptance criteria shall be as follows:<br>(e) Threaded fasteners shall be provided with locking devices in accordance with AA-6258.<br><br>SA-5232, Stiffeners:<br>Stiffeners shall be visually inspected to ensure compliance with the following acceptance criteria:<br>(c) Threaded fasteners shall be provided with locking devices in accordance with AA-6258. | These sections shall be required, subject to the alternatives in AA-6258 identified in Table C-1. | See the justification for AA-6258 in Table C-1. |

Table C-4. Section SA, "Ductwork," Technical Justifications (7 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| SA-5240, Ductwork Supports:<br>Supports shall be visually inspected during installation, after installation, or both in accordance with the following acceptance criteria:<br>(a) Supports shall comply with the fabrication and installation requirements of SA-6400 and SA-6500.<br>(b) Welded joints shall comply with the requirements of SA-5220.<br>(c) Threaded fasteners shall be provided with locking devices in accordance with AA-6258.<br>(d) Removal of temporary attachments shall be confirmed. | This section shall be required except that threaded fasteners on ductwork supports on temporary waste tank ventilation systems shall be installed to the manufacturers' recommended torque without locking devices. Locking devices on other ductwork and supports shall be subject to the alternative in AA-6258 in Table C-1. | Locking devices on temporary ductwork supports manufactured by Unistrut Corporation and Cooper B-Line, Inc. are not required because the manufacturers do not specify locking devices as necessary and do not perform load testing with locking devices in place. The specially designed nuts for these supports have teeth that grip the edge of the support channel when tightened to the recommended torque. Also, the service life of temporary systems is short enough that loosening of threaded fasteners is not a concern. See the justification for AA-6258 in Table C-1. |
| SA-5300, Pressure Boundary Leakage Testing—General:<br>The ductwork system shall be tested to demonstrate compliance with the design leakage requirements identified in SA-4500, unless exempted by SA-4533. | Additional pressure boundary leakage testing shall not be performed on portable exhauster stacks or on the ESS exhaust distribution system. | Portable exhauster stack leak testing in addition to the leak tests performed during fabrication is not necessary. Stack leak testing at each installation is impractical due to the sampling and monitoring penetrations that must be sealed. The stacks may have been disassembled at a flanged connection for transportation and reassembled at different locations. The gasketed flange connections ensure leak tightness and do not require additional testing even though they may have been disassembled. Leak testing would require a blank to be installed at this flange, so the flange connection could not be tested. Visual inspections in accordance with SA-5231 verify acceptable installation of the gasket and flange to prevent any bypass of the stack sampling system. The ESS system is located downstream of the HEPA filter train and outside the tank farm boundary; therefore high-level or mixed mode release credit is not required to meet off-site dose limits. |

Table C-4. Section SA, "Ductwork," Technical Justifications (7 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| SA-5400, Structural Capability Tests (entire section):<br><br>SA-5410, Ductwork Pressure Test:<br><br>SA-5420, Longitudinal Seam Qualification Test: | These tests shall not be required. | See the justification for the structural capability tests of TA-3522 in Table C-12. |
| SA-6100, General:<br>Ductwork and supports shall be fabricated and installed in accordance with this section and Article AA-6000. | This section shall be required, subject to the alternatives in all subsections of AA-6000 identified in Table C-1. | See the justifications for all subsections of AA-6000 in Table C-1. |
| SA-6122, Material Identification:<br>Materials to be utilized in the fabrication and installation of components, parts, and appurtenances shall be identified on fabrication or installation plans, or both and in the specifications, as required in Article AA-8000. | This section shall be required, subject to the alternatives in AA-8000 identified in Table C-1. | See the justifications for all subsections of AA-8000 in Table C-1. |
| SA-6123, Repair of Material With Defects:<br>Material with defects that are discovered or produced during the fabrication and installation process may be used, provided the defects are repaired in accordance with the requirements of Article AA-8000, and for weld repairs, in accordance with AA-6300. | This section shall be required, subject to the alternatives in all subsections of AA-8000 and AA-6300 identified in Table C-1. | See the justifications for all subsections of AA-8000 and AA-6300 in Table C-1. |
| SA-6130, Control of Installation and Fabrication Process:<br>Quality control procedures shall be prepared and kept current for all fabrication and installation processes in accordance with the requirements of Article AA-8000. | This section shall be required, subject to the alternatives in all subsections of AA-8000 identified in Table C-1. | See the justifications for all subsections of AA-8000 in Table C-1. |
| SA-6140, Welding:<br>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.<br>Welding and brazing performed in accordance with this section shall meet the requirements of AA-6300 and AA-6400. | This section shall be required, subject to the alternatives in AA-6300 identified in Table C-1. | See the justifications for AA-6300 in Table C-1. |

Table C-4. Section SA, "Ductwork," Technical Justifications (7 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| SA-6410, Fabrication Tolerances—General:<br>The fabrication of ductwork shall be accomplished within tolerances detailed in the following tables. These fabrication tolerances provide a method of quality control. Installation tolerances shall take precedence over fabrication tolerances. Tolerances listed below are maximum deviations permitted from design dimensions. Greater deviations, due to rolling mill tolerances, are not permitted.<br>(b) Circular ducts, measured by outside circumference or two interior diameters at 90 deg. (± 5) to each other, shall conform to Table SA-6410-2. | The specified tolerances shall not be applicable for flexible pipe used as ductwork. | Flexible pipe may be used as ductwork in temporary waste tank ventilation systems and complies with the requirements of SA-4410. The specified tolerances cannot be applied to flexible ductwork because it is not rigid. The quality of installation is not affected because the ductwork can deform slightly to ensure secure joints and connections. |
| SA-6600, Cleaning, Finishing, and Coating:<br>Galvanized surfaces shall be free of damage which impairs the effectiveness of the coating. Surfaces shall be repaired in accordance with AA-6540. Painted surfaces shall be prepared and finished as described in Article AA-6000. Painted surfaces shall be free of scratches and welding damage. Surfaces shall be repaired and repainted in accordance with Article AA-6000. Required marking, for identification, shall be on the exterior of each section. | This section shall be required except marking is not required for temporary waste tank ventilation systems. | See the justifications for marking requirements in SA-9111 and SA-9112 in this table. |
| SA-7000, Packaging, Shipping, Receiving, Storage, and Handling (entire section):<br><br>SA-7100, General:<br>Packaging, shipping, receiving, storage, and handling requirements shall be in accordance with Article AA-7000 and this section. | Packaging, shipping, receiving, storage, and handling of ductwork and ductwork supports for temporary waste tank ventilation systems shall be in accordance with manufacturers' procedures and Hanford Site contractor procedures. This section shall be subject to the alternatives in all subsections of AA-7000 identified in Table C-1. | The rigor associated with the protective measures of SA-7000, AA-7000, and the referenced sections of ASME NQA-1 are not necessary for temporary waste tank ventilation systems because the service life of ductwork in these systems is short so that pre-installation deterioration is not a significant factor in long term emission control performance. Manufacturers' procedures and Hanford Site contractor procedures provide adequate protection from damage. Also, see the justification for AA-7200 in Table C-1. |

Table C-4. Section SA, "Ductwork," Technical Justifications (7 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| SA-8100, General:<br>Equipment and material covered under this section shall be manufactured, fabricated, installed, inspected, and tested in accordance with the provisions of a quality assurance program meeting the requirements of Article AA-8000.<br><br>SA-8200, Material Identification:<br>Measures shall be established for controlling and identifying material throughout the manufacturing process and during shipment in accordance with Article AA-8000. | These sections shall be required, subject to the alternatives in all subsections of AA-8000 identified in Table C-1. | See the justifications for all subsections of AA-8000 in Table C-1. |
| SA-9100, General:<br>All items manufactured under the requirements of this section shall be identified to ensure compliance with the requirements of AA-8200, AA-9130, and AA-9140. Records, as necessary to assure compliance with AA-8200, shall be maintained by the responsible organization in accordance with the approved quality assurance program. | This section shall be required, subject to the alternatives in all subsections of AA-8200 and AA-9140 identified in Table C-1. | See the justifications for all subsections of AA-8200 and AA-9140 in Table C-1. |
| SA-9111, Ducts – Stamping/Marking:<br>Each duct section shall have noncorrosive, permanent identification markings. Identification markings shall relate each duct section to the applicable design and fabrication documents. Markings shall be located on the exterior of the duct. Markings need not be visible after installation is complete; however, markings shall be retrievable. It is recommended that the identification markings be placed on the "incoming air" end of the duct joint, as close to the end of the joint as possible, and not in such position as to be hidden or nonreadable. | The specified marking is not required for round metal or flexible ductwork in temporary waste tank ventilation systems with same size duct sections. | Duct sections in temporary waste tank ventilation systems cannot be incorrectly installed when they are all the same size and construction and, therefore, do not need specific referencing to design and fabrication documents for each duct section. Installation procedures ensure correct field installation of individual duct sections. |
| SA-9112, Ductwork Supports – Stamping/Marking:<br>Each ductwork support shall have noncorrosive, permanent identification markings. Identification markings shall relate each ductwork support to the applicable design and fabrication documents. | The specified marking is not required for ductwork supports in temporary waste tank ventilation systems. | Duct supports for temporary waste tank ventilation systems are typically sized and fabricated in the field to meet design requirements for duct slope. Specific design dimensions are not identified on design documents prior to fabrication. Unique identification markings are impractical for these modular type duct supports typically used in these temporary systems. |

Table C-5. Section HA, "Housings," Technical Justifications (1 Sheet)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| HA-4200, Design Criteria (entire section)<br>(This section establishes requirements for loads, load combinations, stress criteria, deflection criteria, and other criteria for the design of housings.) | Structural design of housings shall be in accordance with the manufacturers' design procedures, except HEPA filter and adsorber housings shall meet ASME AG-1, Section HA design criteria. | Standard industrial housings built to manufacturers' design procedures have demonstrated reliable structural integrity and a successful operating history. Specifying compliance with the additional analysis of ASME AG-1, Section HA-4200 is an extra expense that adds little value in terms of emissions control. Also, see the justification for AA-4200 in Table C-1. |
| HA-4442, Insulation:<br>(d) The fire hazard classification of applied insulation, adhesive, and sealer shall not exceed a flame spread of 25 and smoke developed of 50 in accordance with NFPA-90A. | Insulation shall not be required to meet NFPA 90A on systems where it is not applicable. | See the justification for SA-4410 in Table C-4. |
| HA-4443, Clamping Mechanism:<br>Side-access housings shall have a clamping mechanism, filter retrieval features, and filter indexing mechanisms. The clamping mechanism shall be individually adjustable for each HEPA filter or adsorber. For side-access housings with fluid seals, the filter clamping mechanism shall be capable of moving the filter on and off through adequate travel to ensure the knife edge is embedded into the pliable sealant and provides seal for the complete perimeter of each filter or adsorber. The clamping mechanism shall provide for uniform gasket compression. The clamping mechanism for walk-in housings shall be designed per Section FG. | The requirement that the clamping mechanism be individually adjustable shall apply to gasket seals only and not to fluid seals. | Individual and precise adjustment of the clamping mechanism is not required when used with fluid or gel seals because seal integrity is maintained by adequate embedment, which does not require fine adjustment. A larger margin for misalignment and distance of travel is available with fluid seals than with gasket seals, which require more precise control of gasket compression. |
| HA-5500, Structural Capability Tests (Housing Pressure Test):<br>A pressure test shall be performed at the structural capability pressure per TA-3422. This test shall be maintained for the duration of the inspection. Upon completion of this pressure test, housings exhibiting permanent distortion or breach of integrity shall be repaired or replaced. The pressure test shall be repeated after repair or replacement until no permanent distortion or breach of integrity is observed. | These tests shall not be required. | See the justification for structural capability tests in TA-3522 of Table C-12. HEPA filter housings are typically rated for pressures greater than the typical operating pressures of waste tank ventilation systems making structural capability tests unnecessary. |

Table C-6. Section CA, "Conditioning Equipment," Technical Justifications (7 sheets)

Note: This table is only applicable to water or water/glycol coils used for air stream heating or condenser cooling.

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| CA-All Sections:<br>Any requirements referencing ASME Code, Section III. | Pressure retaining parts of water coils that are designed, fabricated, and tested in accordance with ASME Code, Section VIII, shall be exempt from all referenced requirements of ASME Code, Section III. Comparable requirements from Section VIII shall be used. | See Section 4.4.7 for the technical justification for ASME Code, Section III. |
| CA-3110, Material Specifications:<br>The ASME and ASTM specifications listed in Tables CA-3230, CA-3310, and CA-3410 contain requirements for the chemical composition, material thickness limits, minimum yield strength, and tensile strength for each grade designation covered. Where a grade designation is not assigned a minimum yield strength and a tensile strength, tests in accordance with ASTM A 370 shall be conducted in order to obtain these values. Maximum allowable design stress values shall be calculated by the procedures in Article AA-4000. | This section shall be required, subject to the alternatives in all subsections of AA-4000 identified in Table C-1. | See the justifications for design requirements of all subsections of AA-4000 in Table C-1. |
| CA-3210, Pressure Retaining Materials for Water and Steam Coils:<br>(a) Allowable stresses and yield strengths of materials for all pressure-retaining items shall conform to the requirements given in the ASME Code for the appropriate class of service. For Codes of Record prior to the 1992 Edition, use Section III Appendices, Tables 1-7.0, 1-8.0, or 1-13.3, as applicable. For Codes of Record beginning with the 1992 Edition, use Section II, Part D, Subpart 1, Tables lA, lB, and Y-1, as applicable. | This section shall be required and materials identified in ASME Code, Section II shall be considered allowable materials. | This section is interpreted to allow all materials identified in ASME Code, Section II. A technical inquiry to the ASME Committee on Nuclear Air and Gas Treatment has been submitted to clarify what materials are allowable for water and steam coils. It is expected that the ASME Code, Section II will define the allowable materials for conditioning equipment. |

Table C-6. Section CA, "Conditioning Equipment," Technical Justifications (7 sheets)

Note: This table is only applicable to water or water/glycol coils used for air stream heating or condenser cooling.

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| CA-3500, Certification of Materials:<br>Certification of materials shall be in accordance with Articles AA-3000 and AA-8000, and the specific requirements of the following subparagraphs.<br>(b) The coil Manufacturer shall supply to the Purchaser, as a minimum, certified material test reports (CMTR) of chemical and physical properties of all materials that form pressure boundaries. The pressure boundary includes the coil tubing, headers, return bends, nozzles, and flanges. A Material Manufacturer's Certificate of Compliance with the material specification, grade, class, and heat-treated condition, as applicable, may be provided in lieu of a CMTR for the coil material defined below:<br>(1) pipe, fittings, flanges, material for valves and tubes (except heat exchanger tubes) NPS ¾ and less;<br>(2) bolting of 1 in. nominal diameter and less.<br>(c) ASME Code, Section III, Subsection NF, materials shall be supplied with CMTRs except as designated in NF-2600. | Manufacturer's Certificates of Conformance with the ASME or ASTM designations of the ASME Code, Section II shall be provided. Certified material test reports shall not be required. This section shall be subject to the alternatives in all subsections of AA-8000 identified in Table C-1. | Certified test reports are documented verification of compliance of material properties with ASTM or ASME standards. They do not add significant benefit for waste tank ventilation systems because this application does not require such rigorous material testing. These ventilation systems are not subjected to excessively corrosive or damaging process conditions that would warrant such rigorous verification of physical and chemical properties. Compliance with the allowable materials of ASME Code, Section II, and manufacturer's Certificates of Compliance with ASME or ASTM standards provide adequate verification of the physical properties of materials. The extensive successful operating history of these industrial coils demonstrates the acceptability of the materials used. Also, see the justifications for all subsections of AA-8000 in Table C-1. For future system designs, TOC procedures (including the Ventilation System Design Standard) are relied on to ensure this requirement is included. |

Table C-6. Section CA, "Conditioning Equipment," Technical Justifications (7 sheets)

Note: This table is only applicable to water or water/glycol coils used for air stream heating or condenser cooling.

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| CA-4110, Design Specification for Water and Steam Coils:<br>A design specification shall be prepared and certified by the Owner or his designee in accordance with NCA-3255 of the ASME Code, in sufficient detail to provide a complete basis for coil design in accordance with this Code. The design specification shall include, as a minimum, the following data:<br>(a) ASME Code edition, addenda, class, and applicable Code Cases<br>(b) Coil type<br>(c) Corrosion allowance per ASME Code, Section III, NX-3121.<br>(d) Fouling factor – fluid side<br>(e) Safety classification per ASME Code, Section III, NCA-2110(d)<br>(f) Boundaries of jurisdiction per NCA-3254<br>(g) Tube, fin, minimum material thickness<br>(h) Maximum allowable fin spacing<br>(i) Materials of construction<br>(j) Conditions of operation – normal, accident, containment pressurization (leak) test<br>(k) design and service loading per ASME Code, Section III, NCA-2140<br>(l) radiation, total integrated dosage, rads<br>(m) coating system requirements | This section shall be required except items (d), (g), (h), and references to ASME Code, Section III. These items may be in the design specification, as applicable. | The items selected are defined by the required heat transfer capacity of the coil. For example, the fin spacing would be determined by designing the coil to achieve the required heating capacity. These items do not need to be specified for coils used in waste tank ventilation systems, but would be established based on the required performance of the coil. See Section 4.4.7 for the justification for ASME Code, Section III. |
| CA-4126, Casing and Tube Support:<br>(a) The casing and tube supports shall be designed to withstand, without causing permanent distortion or breach of integrity, stresses, and external overpressure as defined in Article AA-4000. Structural requirements for coils are given in CA-4130.<br>(b) Casings and tube supports shall be of approved material from Table CA-3230 | This section shall be required, subject to the alternatives in all subsections of AA-4000 identified in Table C-1 and from all subsections of CA-4130 in this table. | See the justifications for all subsections of AA-4000 in Table C-1 and all subsections of CA-4130 in this table. |

Table C-6. Section CA, "Conditioning Equipment," Technical Justifications (7 sheets)

Note: This table is only applicable to water or water/glycol coils used for air stream heating or condenser cooling.

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| CA-4130, Structural Requirements for Water, Steam, and Volatile Refrigerant Coils:<br><br>CA-4131, General:<br>Coils shall be designed in accordance with the structural requirements given in Article AA-4000. Structural requirements and load definitions specific to water and steam coils are given in CA-4132 through CA-4134. | Structural requirements shall be determined by the manufacturer's design process. | See the justifications for the design requirements of all subsections of AA-4000 in Table C-1, and CA-4132 through CA-4134 of this table. |
| CA-4132, Support Boundaries for Coils:<br>(c) The coil supplier shall be responsible for specifying all information necessary to define the support boundary interfaces. This information shall include, but not necessarily be limited to<br>(2) magnitudes and directions of all loads imposed on the anchorage points, including all static, dynamic, and operating loads resulting from the installed coil assembly. Loads shall be provided in a form that shall allow combinations to be considered as required in AA-4212. | Loads and load combinations shall be determined in accordance with the manufacturer's design process. | See the justification for the design requirements of AA-4200 in Table C-1. |
| CA-4133, Load Definition:<br>Loads to be considered in the structural design of equipment are given in AA-4211 and AA-4212 with the following additions.<br>(a) Normal loads *N* shall include:<br>(1) deadweight load …<br>(2) operating pressure load …<br>(3) nozzle loads …<br>(4) normal equipment interface load …<br>(b) Thermal loads *T* shall include temperature induced loads resulting from constraint of force and displacements.<br>(c) Design and service limits shall be as follows.<br>(1) Pressure boundary limits shall conform to the ASME Code, Section III, NCA-2142.2, and Tables NC/ND-3321-1.<br>(2) For subsection NF casings, limits shall be in accordance with NCA-2142.2, NF-3321, NF-3350, NF-3360, and Table NF-3523.2-1. | Manufacturers' or TOC's design loads and load combinations shall be used. Design and service limits shall be in accordance with ASME Code, Section VIII allowable stress criteria. | See the justification for the design requirements of AA-4200 in Table C-1. See Section 4.4.7 for the justification of ASME Code, Section III. |

Table C-6. Section CA, "Conditioning Equipment," Technical Justifications (7 sheets)

Note: This table is only applicable to water or water/glycol coils used for air stream heating or condenser cooling.

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| CA-4134, Structural Verification<br><br>CA-4134.1, Structural Verification by Analysis:<br><br>CA-4134.2, Structural Verification by Testing:<br><br>CA-4134.3, Structural Verification by Comparison:<br><br>CA-4134.4, Design Reports:<br><br>CA-4134.5, Design Verification Acceptance Criteria: | Manufacturers' or TOC's design verification processes shall be used. Acceptance criteria for structural design verification shall be based on allowable stresses from ASME Code, Section VIII in lieu of ASME Code, Section III. | See the justification for the design requirements of AA-4200 in Table C-1. See Section 4.4.7 for the justification of ASME Code, Section III. |
| CA-5000, Inspection and Testing - Introduction:<br>Examination, testing, and inspection shall be in accordance with Article AA-5000 and the requirements of this section. | This section shall be required, subject to the alternatives in all subsections of AA-5000 identified in Table C-1. | See the justifications for all subsections of AA-5000 in Table C-1. |
| CA-5500, Test Reports:<br>Sufficient records shall be provided to show documentary evidence of all testing. Records shall include inspections and test reports, and shall show the date of inspection or test, the inspector or data recorder, the type of observation, and the results and their acceptability. Requirements and responsibilities for record transmittal, retention, and maintenance shall conform to those established by the design specification and CA-8120. | Manufacturer's standard test reports documenting performance and pressure testing shall be required in accordance with the TOC's quality assurance procedures. | Coil manufacturer's test reports provided as standard submittals provide adequate documentation of the performance and pressure testing of these common industrial coils. These standard test reports document that the coil is capable of achieving its designed heat transfer capability. Information provided on these standard test reports are similar to that required by ASME AG-1, but the additional cost of compliance with the specific requirements of ASME AG-1 does not add significant benefit. Also, see the justification for CA-8120 in this table. |
| CA-6000, Fabrication and Installation (entire section):<br>CA-6110, Introduction<br><br>CA-6120, Welding<br><br>CA-6130, Brazing<br><br>CA-6140, Mechanical Joining | This section shall be required, subject to the justification for ASME Code, Section III, in Section 4.4.7 and alternatives in all subsections of AA-6000 in Table C-1. | See Section 4.4.7 for the justification for ASME Code, Section III. See Table C-1 for the justification for all subsections of AA-6000. |

Table C-6. Section CA, "Conditioning Equipment," Technical Justifications (7 sheets)

Note: This table is only applicable to water or water/glycol coils used for air stream heating or condenser cooling.

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| CA-7000, Packaging, Shipping, Storage, and Handling:<br>(a) Packaging, shipping, and storage requirements shall be in accordance with Article AA-7000, ASME NQA-1 Requirement 13 and the specific requirements of this article. | This section shall be required, subject to the alternatives in all subsections of AA-7000 identified in Table C-1 and from ASME NQA-1 as described in AA-8110 in Table C-1. | See the justifications for all subsections of AA-7000 and AA-8110 in Table C-1. |
| CA-8110, Introduction:<br>(b) The organizations responsible for a project shall establish documented quality assurance programs in accordance with the requirements of Article AA-8000. A project includes design, fabrication, assembly, shipping, packaging, and storage; and the various organizations that will be involved in the steps of the project. The quality assurance program shall define the organizational structure within which the program is to be implemented. The program shall delineate the authority and responsibility of the persons and organizations involved in various activities affecting quality. Provision shall be made in the program for review and evaluation of its effectiveness. Correction of deficiencies shall be an integral part of the program. | The manufacturer's quality assurance program shall meet the basic requirements of ASME NQA-1 or shall be based on other accepted industry standards. The TOC shall evaluate it for acceptability. | See the justifications for all subsections of AA-8000 in Table C-1. |
| CA-8000, Quality Assurance -Introduction<br>(b) The organizations responsible for a project shall establish documented quality assurance programs in accordance with the requirements of Article AA-8000. A project includes design, fabrication, assembly, shipping, packaging, and storage; and the various organizations that will be involved in the steps of the project. The quality assurance program shall define the organizational structure within which the program is to be implemented. The program shall delineate the authority and responsibility of the persons and organizations involved in various activities affecting quality. Provision shall be made in the program for review and evaluation of its effectiveness. Correction of deficiencies shall be an integral part of the program. | This section shall be required, subject to the alternatives in all subsections of AA-8000 identified in Table C-1. | See the justifications for all subsections of AA-8000 in Table C-1. |

Table C-6. Section CA, "Conditioning Equipment," Technical Justifications (7 sheets)

Note: This table is only applicable to water or water/glycol coils used for air stream heating or condenser cooling.

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| CA-8120, Documentation and Retention:<br>The lifetime and nonpermanent quality assurance records shall be in accordance with Tables CA-8120-1 and CA-8120-2.<br>(a) *Water coils:* For coils designed and fabricated in accordance with the ASME Code, Section III, permanent and nonpermanent records shall be in conformance with ASME NQA-1 as amended by NCA-4134.17, and Tables NCA-4134.17-1 and NCA-4134.17-2. Documentation package requirements shall be as listed in the certified Design Specification.<br>(b) *Steam and Volatile Refrigerant Coils, Evaporative Coolers, Air Washers, and Electric Heating Coils…* | Documentation shall be required as specified in design or procurement specifications and kept in vendor files as permanent records in accordance with the TOC's quality assurance program. | Obtaining and maintaining all the records for water coils required by ASME AG-1 does not add significant benefit for the assurance of compliance with regulatory emission standards. The graded approach based on importance to safety and emission control that is used by TOC quality assurance procedures should be acceptable for quality assurance documentation for components in waste tank ventilation systems that are not the primary abatement controls. The TOC's quality assurance program is certified to be compliant with ASME NQA-1. |
| CA-9000, Nameplates and Records – Introduction:<br>Nameplates and stamping requirements shall meet the requirements of Article AA-9000, except as provided in this article. | This section shall be required, subject to the alternatives in all subsections of AA-9000 identified in Table C-1. | See the justifications for all subsections of AA-9000 in Table C-1. |
| CA-9500, Data Reports/CA-9510 Water and Steam Coils:<br>(a) Coils designed, fabricated, and stamped in accordance with the ASME Code, Section III shall have an N-1 Code Data Report completed for each coil.<br>(b) For coils not stamped in accordance with the ASME Code, Section III, a Manufacturer's Data Report shall be provided in accordance with Mandatory Appendix CA-I, Form CA-IA. | The Data Report shall be in accordance with Mandatory Appendix CA-1A, Form CA-1A, except the Certificate of Shop Compliance and Certificate of Shop Inspection shall not be required. A Manufacturers Data Report required by an alternative code or standard (ARI-410) is acceptable. | Form CA-IA, Certificate of Shop Compliance, is to certify the nuclear vessel conforms to the rules of construction in accordance with ASME AG-1. This alternative to exclude the certifications is acceptable because:<br>1) The Manufacturers Data Report Items 1-11 provides all data required, and<br>2) The technical justifications for specific construction requirements herein exclude the manufacturer from certifying that the vessel conforms to ASME AG-1. |

Table C-7. Section FA, "Moisture Separators," Technical Justifications (6 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| FA-3100, Allowable Materials:<br>*adhesive:* adhesive used to splice gaskets or to fasten gasket to cell shall be compatible with gasket material and appropriate to intended application.<br>*frames, cross-grids, and supports:* material shall meet the requirements of ASTM A 240, Type 304, stainless steel or as required to meet design conditions.<br>*gaskets:* the material for these parts shall be closed cell silicone rubber sponge, Grade SCE-43-1 or SCE-44-1, in accordance with ASTM D 1056.<br>*pads:* the pad is usually constructed of glass fiber and/or corrosion resistant (stainless steel) wire. Other materials that have demonstrated equal or better corrosion resistance are allowable if they meet the requirements of UL 900, Class 1 filters and the design conditions.<br>*rivets:* when rivets are used for fabrication or attachment they shall be 300 series austenitic steel meeting the minimum requirements of ASTM A 581, Type 303. | The allowable materials of ASME AG-1 shall be complied with, except alternative pad materials for waste tank ventilation systems shall not be required to meet UL 900, Class 1 requirements. | UL 900, *Standard for Test Performance of Air Filter Units*, is not applicable for waste tank ventilation systems. UL 900 establishes combustibility and smoke generation requirements, which are not a concern with outdoor ventilation systems. No mechanism for accumulation of combustible materials exists in these ventilation systems. Nuclear safety requirements effectively manage ignition sources because of the potential flammable gas environment. The scope of UL 900 states that it is applicable to systems and equipment installed in accordance with NFPA 90A, which is not applicable to waste tank ventilation systems as discussed in the justification for SA-4410 in Table C-4. |
| FA-3200, Limitations:<br>Alternative materials are acceptable as long as they meet the requirements of Article FA-4000, Class 1 filter requirements of UL 900, and pass the qualification test of Article FA-5100. | ASME AG-1 specified materials shall be used to the maximum extent practical. Alternative materials shall not be required to meet UL 900, Class 1 filter requirements for waste tank ventilation systems. This section shall be subject to the alternatives in all subsections of FA-5000 in this table. | UL 900, *Standard for Test Performance of Air Filter Units*, is not applicable for waste tank ventilation systems. UL 900 establishes combustibility and smoke generation requirements, which are not a concern with outdoor ventilation systems. No mechanism for accumulation of combustible materials exists in these ventilation systems. Nuclear safety requirements effectively manage ignition sources because of the potential flammable gas environment. The scope of UL 900 states that it is applicable to systems and equipment installed in accordance with NFPA 90A, which is not applicable to waste tank ventilation systems as discussed in the justification for SA-4410 in Table C-4. See the justifications for qualification tests in all subsections of FA-5000 in this table. |

Table C-7. Section FA, "Moisture Separators," Technical Justifications (6 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| FA-4230, Moisture Separator Assembly:<br>The case shall be formed and assembled in a manner to meet the requirements of Table FA-4200-1. Drain holes shall be provided in the bottom of the case. The design shall include provisions to ensure that the pad is maintained in its operating position and that the pad does not settle, pack down, or pull away from the case when installed. | The requirement shall be met, except drain holes are not required for horizontal pad/vertical flow moisture separators. | The requirement for drain holes is not applicable to horizontal pad/vertical flow moisture separators because the accumulated moisture will drain directly from the pad surface, precluding collection in the frame. |
| FA-4310, Structural Requirements, General:<br>The moisture separators shall be designed in accordance with the structural requirements given in Article AA-4000 or qualified by test in accordance with subarticle AA-4350. | Structural design of the moisture separator pad and frame shall be in accordance with the manufacturers' design procedures. This section shall be subject to the alternatives in all subsections of AA-4000 identified in Table C-1. | Standard industrial moisture separators built to manufacturers' design procedures have demonstrated reliable structural integrity as described in Section 4.4.8. Specifying compliance with the additional analysis of ASME AG-1, Section AA-4000 is an extra expense that adds little value in terms of emissions control. See the justifications for all subsections of AA-4000 in Table C-1. |
| FA-4320, Load Definition:<br>Loads to be considered in the structural design of the moisture separator are defined in AA-4211.<br><br>FA-4330, Load Combinations:<br>Load combinations for Service Levels A, B, and C, applicable to moisture separators, are defined in Table AA-4212.<br><br>FA-4340, Acceptance Criteria:<br>The acceptance criteria are listed in Table AA-4321. The design stress allowable values, *S*, shall be 0.6 $S_y$. | Loading and stress criteria shall be in accordance with the manufacturers' design standards. | The specified Service Level A loads, load combinations, and stress criteria are comparable to typical engineering design standards. Specifying strict compliance to the ASME AG-1 defined criteria is an extra expense that adds little value in terms of emissions control. The successful operating history of these moisture separators in industries with more demanding service conditions demonstrates the adequacy of the manufacturers' design standards. The additional moisture protection systems, described in Section 4.4.8, that are installed in these ventilation systems can successfully mitigate the very low probability that performance would be compromised by minor structural deformation due to inadequate structural analysis of the moisture separator. See the justifications for AA-4200 and AA-4300 in Table C-1. |

Table C-7. Section FA, "Moisture Separators," Technical Justifications (6 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| FA-5000, Inspection and Testing: Inspection and testing of the moisture separator shall conform to requirements of this Section and to specific requirements set forth in Article AA-5000. | This section shall be required, subject to the alternatives in all subsections of FA-5000 in this table and AA-5000 in Table C-1. | The successful operating history of these types of moisture separators at the Hanford Site and in other industries is equivalent to satisfactory field qualification testing. See the justifications for all subsections of FA-5000 in this table and AA-5000 in Table C-1. |
| FA-5100, Qualification Tests: New or revised moisture separator designs shall require qualification testing prior to acceptance and production. A design qualification test shall be performed on each specific moisture separator design. Four units of each design shall be tested to all requirements of FA-5200. Tests shall be performed and certified by an independent test facility. | Previous manufacturers' testing of one unit of a design, subject to the alternatives in all subsections of FA-5200, shall qualify similar designs with similar critical operating parameters. Tests will not be required to be performed and certified by an independent test facility. | Previous design qualification tests are acceptable for designs with the same fiber pad media, but different geometries, as long as critical operating parameters are similar. It is not necessary to qualify each unique design or for the test to be performed and certified by an independent test facility for these ventilation systems. See FA-5230 through FA-5260 of this table for further justification. |
| FA-5110, Moisture Separator Rough Handling Qualifications: In its service orientation, each of the four moisture separators shall be hard-mounted to a rough-handling machine equipped with sharp cutoff cams and vibrated individually for 10 min at a frequency of 200 cycles per min at an amplitude of 0.75 in. (19 mm). As determined by visual inspection, there shall be no settling of the mesh pad, no broken welds or other physical damage as a result of the rough handling. | Rough handling testing shall not be required. | The intent of the rough handling test is to simulate a design basis accident or seismic event at a nuclear power plant. No credible mechanism exists during shipping or operation in these ventilation systems that would produce vibrations comparable to those required by the rough handling test. These ventilation systems are not required to operate during or after a seismic event. Therefore, this test and the subsequent air flow resistance and performance tests do not add significant benefit to these ventilation systems. |
| FA-5120, Moisture Separator Air Flow Resistance Test: After the rough handling test of FA-5110, each of the four separators shall be individually mounted in its service orientation within a test tunnel, and operated at its rated airflow. The pressure differential across the separator shall not exceed the ratings in Table FA-4200-1 for the clean, dry condition and the clean, wet condition. The separator shall also demonstrate that it can withstand the minimum burst pressure differential given in Table FA-4200-1 without any visible physical damage or change in pressure drop (clean, wet) at rated flow. | The rated airflow resistance shall meet the requirements of Table FA-4200-1 and shall be based on the manufacturer's tests. Previous testing of similar designs and/or calculated evaluations is acceptable. | See the justification for FA-5110 in this table. |

Table C-7. Section FA, "Moisture Separators," Technical Justifications (6 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| FA-5130, Moisture Separator Performance Test:<br>After successfully meeting the requirements of FA-5120, the four separators subjected to the rough handling test shall be tested to demonstrate compliance with the moisture removal and efficiency requirements of Table FA-4200-1. | The rated performance shall meet the requirements of Table FA-4200-1 and shall be based on the manufacturer's tests. Previous testing of similar designs with the same critical operating parameters and/or calculated evaluations is acceptable. | The performance requirements of ASME AG-1 are comparable to those specified in DOE-HDBK-1169-2003, *Nuclear Air Cleaning Handbook*, which are based on post-accident conditions at nuclear power plants caused by pressurized water release and condensing steam. These performance requirements are, therefore, conservative for waste tank ventilation systems. No data or analyses to determine the entrained moisture content of tank farm exhaust air streams is available for the basis of performance standards specific to waste tank ventilation systems, so the performance requirements of ASME AG-1 shall be used. Previous performance testing of moisture separator designs with the same fiber pad media and critical design parameters are acceptable given the conservative nature of the performance requirements. An example of moisture separator performance testing is documented in Tassios and Major (2001). See Section 4.4.8 for additional justification. |
| FA-5200, Production Inspection and Testing:<br>Each moisture separator to be delivered to the purchaser shall be inspected and tested in accordance with FA-5200. | Only FA-5210 and FA-5220 shall be applicable to each moisture separator to be delivered. | This section of ASME AG-1 is interpreted such that only FA-5210 and FA-5220 are intended for each moisture separator. FA-5230, FA-5240, FA-5250, and FA-5260 apply to design qualification testing only. |

Table C-7. Section FA, "Moisture Separators," Technical Justifications (6 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| FA-5220, Welding Inspection:<br><br>FA-5221, Spot Welds:<br>Spot welds shall be inspected visually in accordance with AA-6332.<br><br>FA-5222, Seal Welds:<br>Seal welds shall be inspected visually in accordance with AA-6331.<br><br>FA-5223, Fillet Welds:<br>Fillet welds shall be inspected visually in accordance with AA-6331. | This section shall be required, subject to the alternatives in AA-6300 identified in Table C-1. | See the justification for AA-6300 in Table C-1. |
| FA-5230, Moisture Separator Air Flow Resistance Test:<br>With the moisture separator oriented in its service orientation within a test tunnel and operating at its rated airflow, the pressure differential across the separator shall not exceed the maximum pressure drop in Table FA-4200-A for the clean, dry condition. | The rated airflow resistance shall meet the requirements of Table FA-4200-1 and shall be based on the manufacturer's tests. Previous testing of similar designs and/or calculated evaluations is acceptable. | Airflow resistance is an important parameter for its affect of fan performance, but it does not affect moisture removal performance in waste tank ventilation systems. Previous tests or calculations provide adequate estimation of airflow resistance for fan sizing determination. The airflow resistance testing of each moisture separator design adds no benefit for emission control and the added cost is not justified. |
| FA-6000, Fabrication:<br>The general requirements for fabrication are contained in subarticles AA-6200 and AA-6300. | Fabrication shall meet the requirements of this section except as exempted by this document. | See the justifications for AA-6200 and AA-6300 in Table C-1. |
| FA-6100, Repairs:<br>All welds shall be repaired in accordance with Article AA-6000. Damaged materials shall be replaced. | This section shall be required, subject to the alternatives in all subsections of AA-6000 identified in Table C-1. | See the justifications for all subsections of AA-6000 in Table C-1. |

Table C-7. Section FA, "Moisture Separators," Technical Justifications (6 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| FA-6300, Tolerances:<br><br>FC-6310, Flatness and Squareness<br>The faces of the case shall be flat and parallel within 5 8 in. (16 mm). The case shall be square within 1 8 in. (3 mm) when measured diagonally across the corners of both faces.<br><br>FC-6320, Overall Dimensions<br>Moisture separators 24 in. × 24 in. × 5 1 2 in. (600mm × 600 mm × 140 mm) and larger shall be of +0 in., 1 8 in. (+0 mm, −3 mm) outside dimensions. All moisture separators smaller than the above shall be of +0 in., −1 16 in., − (+0 mm, −1.5 mm) outside dimensions. The above dimensions exclude gaskets | Structural design of the moisture separators and cases shall be in accordance with the manufacturers' design procedures. | Standard industrial moisture separators built to manufacturers' design procedures have proven to be reliable as described in Section 4.4.8. Specifying compliance with this requirement adds no emissions control benefit in this application. |
| FA-8000, Quality Assurance (General):<br>The moisture separator manufacturer shall establish and comply with a quality assurance program and quality assurance plan in accordance with Article AA-8000. | This section shall be required, subject to the alternatives in all subsections of AA-8000 identified in Table C-1. | See the justifications for all subsections of AA-8000 in Table C-1. |
| FA-8300, Certificate of Conformance:<br>The Certificate of Conformance shall state that the moisture separator conforms to AG-1, Section FA. | The Certificate of Conformance shall state that the moisture separator conforms to the procurement specification. | Standard industrial moisture separators built to manufacturers' design procedures and specifications have proven to be reliable as described in Section 4.4.8. |
| FA-9100, Moisture Separator Marking:<br>Each separator shall have a nameplate permanently attached to the top or side of the case with the following information:<br>(a) moisture separator<br>(b) manufacturer's name or symbol<br>(c) weight of separator<br>(d) pressure drop across the separator (clean) at airflow velocity specified<br>(e) serial number (each separator shall be identified by a nonrecurring alpha-numeric symbol, which shall also identify all documentation for the separator)<br>(f) direction of airflow<br>(g) mounting orientation<br>(h) UL label indicating successful testing per UL 900<br>(i) date of manufacture | The nameplate information shall be complied with except the moisture separator shall not be required to meet UL 900 requirements. | UL 900, *Standard for Test Performance of Air Filter Units*, is not applicable for waste tank ventilation systems. See the justifications for subarticle FA-3100. |

Table C-8. Section FB, "Medium Efficiency Filters," Technical Justifications (1 Sheet)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| All sections that reference requirements from Section AA. | These sections shall be required, subject to the applicable alternatives in Section AA identified in Table C-1. | See the applicable justifications for Section AA in Table C-1. |
| FB-5210, Testing Requirements:<br>To obtain standard ratings, three medium efficiency filters of the design to be qualified shall be tested and test results shall be provided in accordance with ANSI/ASHRAE 52.1. The rated performance may be obtained by averaging the results of the tests on the three filters. The rated performance shall be established at airflow rate(s) selected by the Manufacturer for initial resistance, initial atmospheric dust spot efficiency, average atmospheric dust spot efficiency, average synthetic dust weight arrestance, and dust holding capacity. The various parameters at which the filters are rated are defined in ANSI/ASHRAE 52.1. | This section shall be required except testing of three filters shall not be required. The manufacturer shall determine the number of filters that must be tested to obtain ratings. | Standard industrial practice for the number of filters to test to establish ratings is acceptable. ASHRAE Standards 52.1-1992 and 52.2-1999 were superseded with ASHRAE Standard 52.2-2007. *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.* Specifying testing in accordance with ANSI/ASHRAE 52.2 is sufficient to ensure that a manufacturer has a satisfactory testing program for these filters when used in waste tank ventilation systems. |

Table C-9. Section FC, "HEPA Filters," Technical Justifications (1 Sheet)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| Table FC-4110, Nominal Sizes and Ratings: Minimum Rated Air Flow column. | The column heading of this table should be "Maximum Rated Air Flow" | HEPA filters with flow rates greater than the flow rates specified in this column may not be able to meet the corresponding maximum resistance criteria. |
| FC-5100, Qualification Testing (entire section): New or revised filter designs shall require qualification testing prior to acceptance and production. Filter designs shall be requalified at least every 5 years. Tests must be performed and certified by an independent test facility. | Qualification testing shall be as required in WDOH letter AIR 99-507. | An existing deviation to the qualification testing has been approved by the WDOH and is documented in WDOH letter AIR 99-507, "Approval of Request for Technical Justification for Temporary Deviation to American Society of Mechanical Engineers AG-1, Section FC 5100 High Efficiency Particulate Air Filter Qualification Test Requirements." |

Table C-10. Section FG, "Frames," Technical Justifications (2 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| FG-4111, HEPA Filter Mounting Frame Dimensions: Primary and cross members of face sealed HEPA filter frames shall have a minimum frame width of 4 in. (100 mm). This shall include a 1 in. (25 mm) wide filter-seating surface to compensate for any misalignment of the filter during installation, and a 2 in. (50 mm) space between filters horizontally and vertically, to provide adequate room for clamping, handling, using power tools or torque wrenches during filter change, and for manipulating a test probe between the units. The openings for HEPA filters shall be square within 1 16 in. (1.5 mm) and shall be 2 in. (50 mm) smaller than the filter size. Reference Table FC-4000-1 for filter sizes. | This requirement shall be applicable to frames installed in walk-in housings only. | Flanders Filters, Inc. interprets this requirement as applicable to walk-in housings. It cannot be applied to single filter housings. |
| FG-4112, HEPA Filter Clamping: Major requirements of filter clamping systems toward effecting positive sealing are magnitude and uniformity of clamping. Essential to continuous sealing is minimal relative movement between clamping system components and the frame, due to component deformation under the loads specified for mounting frames in FG-4220 and FG-4300. HEPA filters are to be clamped with at least the equivalent of four (4) pressure points. Each filter is to be independently clamped. The calculated stress within any element of the clamping device shall not exceed 25% of the material yield strength at the required sealing load of FG-4112.1 or FG-4112.2. | This requirement shall be applicable to frames installed in walk-in housings only. | See the justification for FG-4111 in this table. |
| FG-4113, Filter Support: Supports or cradles are required for HEPA filters to facilitate installation. The supports shall permit inspection of the filter-to-frame interface when the filter is installed. Refer to Fig. FG-4110.1. | This requirement shall be applicable to frames installed in walk-in housings only. | See the justification for FG-4111 in this table. |
| FG-4121, Type II Adsorber Cell Mounting Frame Dimensions: Mounting frame openings for installing Type II adsorber cells shall be: 63 8 in. × 241 8 in. (+1 8, 0) [162 mm × 613 mm (+3, −0)]. A minimum frame width (space between openings) of 4 in. (100 mm) is required for vertical members, and 2 in. (50 mm) for horizontal members for Type II adsorber cell mounting frames. | This requirement shall be applicable to frames installed in walk-in housings only. | See the justification for FG-6300 in this table. |

Table C-10. Section FG, "Frames," Technical Justifications (2 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| FG-4122, Type II Adsorber Cell Clamping:<br>Major requirements of adsorber cell clamping systems toward effecting positive sealing are magnitude and uniformity of clamping. Essential to continuous sealing is minimal relative movement between clamping system components and the frame, due to component deformation under the loads specified for mounting frames in FG-4200 and FG-4300. Type II adsorber cells shall be clamped with at least the equivalent of four (4) pressure points. Each cell shall be independently clamped. The calculated stress within any element of the clamping device shall not exceed 25% of the material yield strength at the required gasket compression of FG-4123. Clamping shall be accomplished in the first 31 2 in. (90 mm) of the right and left sides of the adsorber face plate and within 1 in. (25 mm) of the top and bottom edge of the face plate (to avoid interference with handles). | This requirement shall be applicable to frames installed in walk-in housings only. | See the justification for FG-4111 in this table. |
| FG-4151, Galling Prevention:<br>Threaded surfaces in the region of clamping device movement lubricated with a chemically compatible lubricant to prevent galling, as specified in the Design Specification, or the clamping device nuts shall be of a dissimilar metal that is environmentally and structurally compatible with the threaded surface. | This requirement shall not be applicable when the same material is used. | Galling is a phenomenon that takes place only when dissimilar metals come into contact. |
| FG-6300, Clamping Devices:<br>Required bolt or stud size 1/2 - 1/3–UNC or 5/8 - 11-UNC. | This requirement shall be applicable to frames installed in walk-in housings only. | See the justification for FG-4111 in this table. |
| FG-9000 General:<br>The following information, as a minimum, shall be permanently marked on an accessible non-sealing surface of the mounting frame;<br>TYPE OF FRAME BY: (Manufacturer's name or symbol)<br>FRAME SERIAL NUMBER: (or other identification)<br>PURCHASE ORDER NUMBER:<br>YEAR OF MANUFACTURE:<br>This shall not apply to frames installed as integral parts of air handling units or ducts. Any other stampings necessary shall be specified in the design specifications. | This requirement shall be applicable to frames installed in walk-in housings only. | See the justification for FG-4111 in this table. |

Table C-11. Section IA, "Instrumentation and Controls," Technical Justifications (3 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| IA-ALL SECTIONS:<br>Any requirement explicitly applicable to "nuclear safety related" components, Class 1E components, or "redundant safety channels" | These specific sections shall not be required. | See Section 4.4.19, Section IA, for the justification from requirements for nuclear safety related instrumentation and control components. |
| IA-3100, Materials of Construction:<br>All materials used shall have properties and composition suitable for the application as defined by the design specification and the operating environmental conditions as defined in IA-4120.<br>Materials shall be in conformance with the latest revision of the ASME and ASTM materials listed in Table IA-3100. Substitute materials shall be equivalent to or exceed the requirements in Table IA-3100.<br>Materials that are part of the pressure boundary or support equipment shall meet the structural requirements of Article AA-4000. | This section shall be required except that structural requirements for materials shall be in accordance with the manufacturers' or TOC's design criteria. | See the justifications for all subsections of AA-4000 in Table C-1. |
| IA-4120, Design Specification:<br>...The design specification shall provide requirements for the design, fabrication, and selection of instrumentation and control systems in accordance with this Code and shall include, as applicable:<br>(b) Ambient and process operating conditions including the measured variable for each of the applicable operating modes described in IA-4120(a).<br>(7) Structural: structural loads to which the instrumentation and control system components will be subjected. The loads shall include as a minimum the applicable loads listed in AA-4211. | This section shall be required except that structural loads shall be determined in accordance with the manufacturer's and the TOC's design processes. | See the justification for AA-4200 in Table C-1. |

Table C-11. Section IA, "Instrumentation and Controls," Technical Justifications (3 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| IA-4430, Seismic Qualification:<br>Safety-related components and mountings shall be seismically qualified using the guidelines of IEEE Standard 344 to the Owner's required response spectra, plus applicable amplification factors, for the components location and mounting.<br>Components that do not perform a safety-related function but must retain their structural integrity so as not to damage, degrade, or interfere with the performance of safety functions by any safety-related equipment or components shall maintain their structural integrity when subjected to applicable seismic loads. | Seismic qualification shall not be required. | These ventilation systems are not required to operate during or after a seismic event. Any instrument failure due to a seismic event or system shutdown caused by instrument failure will not increase emissions. Therefore, seismic qualification is not necessary for instrumentation in waste tank ventilation systems. |
| IA-4521, Structure and Enclosure Materials:<br>Material for enclosures, stiffeners, braces, supports and frames shall be selected to meet the structural design requirements of Article AA-4000. | Structural design requirements for materials shall be in accordance with the manufacturers' or TOC's design criteria. | See the justifications for all subsections of AA-4000 in Table C-1. |
| IA-4525, Structure and Enclosure Materials:<br>All tubing, wire troughs or raceways used in the panel shall be of the metallic type or shall be manufactured from fire retardant or self-extinguishing material. Nonmetallic components and devices shall be manufactured from self-extinguishing materials, as classified by ASTM D 635, *Standard Method of Test for Flammability of Self-Supportive Plastics*. | Structure and enclosure materials shall not be required to be fire retardant or self-extinguishing. Fire safety of electrical enclosures shall be maintained in accordance with other industry consensus standards, such as the National Electric Code. | A fire within an instrument enclosure will not impact nuclear safety or control of emissions. Interlocks will cause system shutdown due to instrument or stack sampling system failure and will not increase emissions. These systems are not required to operate continuously for nuclear safety or to maintain emissions below regulatory guidelines, so fire propagation in a control panel is not a concern from an emission control standpoint. |
| IA-4534, Panel Wiring:<br>Both ends of each wire shall be marked with color-coded wire markers as required by the design specification. | Both ends of each wire shall be marked as required by the Design Specification. | Equivalent labeling of both ends of a wire with termination points is an acceptable alternative to color-coded wire markers at both ends of a wire. |
| IA-4700, Interconnecting Wiring for Skid Mounted Components:<br>Interconnecting circuits between components mounted on a skid shall meet the requirements of the National Electric Code, Sections 250-59 and 250-95, and paras. IA-4534 and IA-4535. | This section shall be required except for IA-4534 requirements. | See the justification for IA-4534 in this table. |
| IA-4834, Support System:<br>Loads such as thermal expansion and weight of insulation shall be evaluated in accordance with AA-4212 for instrument tubing. | Structural loads shall be evaluated in accordance with the manufacturer's and the TOC's design processes. | See the justification for AA-4200 in Table C-1. |

Table C-11. Section IA, "Instrumentation and Controls," Technical Justifications (3 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| IA-5100, General:<br>Inspection and testing of instrumentation and control components shall be in- accordance with IEEE 336. In addition, the requirements of Article AA-5000 supplemented by the following shall apply. | This section shall be required, subject to the alternatives in all subsections of AA-5000 identified in Table C-1. | See the justifications for AA-5000 of Table C-1. |
| IA-6000, Panel Fabrication and Assembly (entire section):<br>In addition to the requirements of Article AA-6000, the following requirements shall apply. | This section shall be required, subject to the alternatives in all referenced sections of AA-6000 identified in Table C-1. | See the justifications for AA-6000 of Table C-1. |
| IA-7100, General Requirements:<br>Packaging, shipping, receiving, storage, and handling of all control panels, instrumentation, and accessories shall be in accordance with Article AA-7000 and ASME NQA-1, Subpart 2.2.<br>Any control panel made of items requiring different levels of handling shall be classified to the highest level designated for any of the respective items. | This section shall be required, subject to the alternatives in all subsections of AA-7000 identified in Table C-1. | See the justifications for all subsections of AA-7000 of Table C-1. |
| IA-8100, General:<br>Quality assurance for instrumentation and controls shall be in accordance with the requirements of Article AA-8000 and the requirements below. | This section shall be required, subject to the alternatives in all subsections of AA-8000 identified in Table C-1. | See the justifications for AA-8000 of Table C-1. |
| IA-9100, General:<br>Permanent types of nameplates shall be designed, manufactured and installed in accordance with the requirements of Article AA-9000 and the requirements below. | This section shall be required, subject to the alternatives in all subsections of AA-9000 identified in Table C-1. | See the justifications for AA-9000 of Table C-1. |

Table C-12. Section TA, "Field Testing of Air Treatment Systems," Technical Justifications (6 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| TA-3400, Inspections and Test Requirements:<br>Acceptance tests shall be conducted following initial component installation but prior to releasing the system for intended operations. Applicable acceptance tests shall also be used to obtain new reference values and verify design function following component replacement, repair, modification, or maintenance. Equipment shall be evaluated as separate components and as functioning parts of an integrated system. The Owner shall define system test boundaries and evaluate system performance with respect to system functional requirements in accordance with the Owner's design specifications. Field acceptance tests shall be implemented as applicable and in accordance with this section. | This section shall be required. For portable exhausters, the Owner or operator shall determine if specific acceptance tests are to be performed in the shop, in the field, or both. | This is a clarification of the first sentence of this requirement for portable exhausters. Skid mounted components on the portable exhausters underwent acceptance testing following initial component installation on the skid in the fabrication shop, but prior to initial field installation of the portable exhausters. Most, but not all, of these tests can be accepted for compliance with Section TA for future deployment of the portable exhausters. Other tests, however, such as pressure boundary leak testing, that are relied upon to verify operation and structural integrity that could be affected by relocation of the portable exhausters will be performed again for each deployment. |
| TA-3510, Visual Inspections:<br>Visual inspections shall be conducted in accordance with Article AA-5000 and the applicable portions of Mandatory Appendix TA-I. Field acceptance visual inspections, required in Article TA-4000, shall include verification of component installation in accordance with the owner's design specification, the supplier's installation and operating manual, and the applicable sections of this Code. Acceptance inspections shall be conducted prior to releasing the equipment for normal operation. | This section shall be required, subject to the alternatives in AA-5200 for visual inspections in Table C-1. | See the justification for AA-5200 in Table C-1. |

Table C-12. Section TA, "Field Testing of Air Treatment Systems," Technical Justifications (6 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| TA-3522, Structural Capability Test:<br>Structural capability tests shall be conducted at the structural capability pressure defined by the Owner's design specification and shall verify that the component will not rupture or be permanently deformed under design pressure loads. Testing shall be conducted in accordance with Mandatory Appendix TA-II. | Structural capability testing shall not be required for waste tank ventilation systems. If a future ventilated process has mechanisms that could generate pressures greater than the static pressure of the fan, structural capability testing shall be required. | The structural capability test adds no value from an emission control standpoint. The only pressure source in waste tank ventilation systems under normal operation is the fan. Waste tank ventilation systems are not required to operate or maintain structural integrity following upset conditions, during which pressures may exceed the static pressure of the fan. The ventilation system would be shut down and inspected following any upset condition that may cause breach of the pressure boundary.<br>Pressure boundary leak testing is performed in accordance with the pressure decay method of ASME AG-1 at a pressure of 1.25 times the maximum operating pressure, which is typically the static pressure capability of the fan. This leak test pressure is bounding for all expected normal operating conditions. As a clarification of the basis for the structural capability pressure, ASME N509-1989 defines structural capability pressure as 1.25 times the maximum design pressure. Maximum operating pressure is equivalent to maximum design pressure for waste tank ventilation systems; therefore, the leak test pressure would be equivalent to the structural capability pressure making further testing unnecessary. |
| TA-4000, Field Acceptance Tests:<br>Field acceptance tests shall be conducted following initial system installation but prior to releasing the equipment for normal operation. Applicable inspections and tests shall be conducted to verify compliance with the Owner's design specification following equipment replacement, modification, or abnormal incident. Repair or maintenance that has not affected acceptance test reference values does not require repeating acceptance tests. | This section shall be required. For portable exhausters, the Owner or operator shall determine if specific acceptance tests are to be performed in the shop, in the field, or both. | See the justification for TA-3400 in this table. |

Table C-12. Section TA, "Field Testing of Air Treatment Systems," Technical Justifications (6 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| TA-4110, Acceptance Test Requirements (Fans): Acceptance tests shall be conducted with the fan operating at a flow rate within the normal operating range for the system. The tests listed in Table TA-4110 shall be conducted and test results verified to be within the acceptance limits of the Owner's design specification, the applicable portions of Section BA of this Code, and as required in TA-3600 and TA-4160. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison during periodic in-service tests. | The tests identified in Table TA-4110 shall be required except for the bearing temperature test, structural capability test, and leak test for fans installed downstream of HEPA filters. | See the justification for the bearing temperature test of TA-4158 in this table.<br><br>See the justification for the structural capability test of TA-3522 in this table.<br><br>See the justification for the pressure boundary leak test of TA-4130 in this table. |
| TA-4130, Pressure Boundary Tests (Fans): (entire section)<br>TA-4131, Structural Capability Test<br><br>TA-4132, Leak Test for Fan Housing<br><br>TA-4133, Leak Test for Fan Shaft Seal | Pressure boundary tests shall not be required for fans installed downstream of HEPA filters. | See the justification for the structural capability test of TA-3522 in this table.<br><br>See the justification for the fan leakage testing of BA-4142 in Table C-2. |
| TA-4150, System Functional Tests (Fans): (entire section) This section provides the system-level field acceptance test requirements for fan systems.<br><br>TA-4160, Acceptance Criteria (Fans): (entire section) The following acceptance criteria are in addition to the requirements of TA-3600. | The test requirements of this section shall not be required for future deployments of the portable exhausters identified in Section 3.2. For new systems, tests performed by the manufacturer shall be acceptable for compliance with the field acceptance test requirements of these sections. | These tests are determined to be applicable to initial installations of the portable exhausters only and are not necessary for subsequent deployments. Also, see the justification for TA-3400 in this table.<br><br>For new systems, it is acceptable to take credit for manufacturers' testing because they may be impractical to perform in the field. Repeating manufacturers' tests in the field adds little benefit for these fans that are not required to maintain continuous operation during normal or upset conditions. Re-verification of fan performance parameters is not critical for control of emissions. |

Table C-12. Section TA, "Field Testing of Air Treatment Systems," Technical Justifications (6 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| TA-4158, Bearing Temperature Test (Fans):<br>Following bearing temperature stabilization, the fan and motor bearing temperatures shall be measured. Stabilization occurs when temperature changes are less than or equal to ±3 °F (1.5 °C) in a 10 minute period. | This test shall not be required. | The bearing temperature test establishes baseline information for comparison with future measurements to determine preventive maintenance needs of the bearings. This is a maintenance requirement that has no emission control function. Waste tank ventilation systems are not required to operate continuously to perform any nuclear safety or emission control function, so system shutdown due to bearing failure would not increase emissions. |
| TA-4210, Acceptance Test Requirements (Dampers):<br>Acceptance tests shall be conducted with the dampers installed in the system. The tests listed in Table TA-4210 shall be conducted and test results verified to be within the acceptance limits of the owner's design specification, the applicable portions of Section DA of this Code, and as required in TA-3600. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results. | The tests identified in Table TA-4210 shall be required except for the structural capability test. | See the justification for the structural capability test of TA-3522 in this table. |
| TA-4231, Structural Capability Test for Damper Housing:<br>When the damper housing and actuator shaft seal are part of the system pressure boundary, a structural capability test shall be conducted to verify the structural capability of the damper housing, shaft seal, and interfaces in accordance with TA-3522 and Mandatory Appendix TA-II. The damper housing may be tested concurrent with the duct and housing structural capability test specified in TA-4331. | This test shall not be required. | See the justification for the structural capability test of TA-3522 in this table. |
| TA-4232, Structural Capability Test for Damper Blades:<br>Isolation dampers shall be tested to verify the structural capability of the damper blade and seat in accordance with TA-3522 and Mandatory Appendix TA-II. The damper blades and seat may be tested concurrent with the duct and housing structural capability test specified in TA-4331. | This test shall not be required. | See the justification for the structural capability test of TA-3522 in this table. |

Table C-12. Section TA, "Field Testing of Air Treatment Systems," Technical Justifications (6 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
|---|---|---|
| TA-4310, Acceptance Test Requirements (duct, housings, and mounting frames):<br>Acceptance tests shall be conducted with the ducts, housings and mounting frames installed in the system. The tests listed in Table TA-4310 shall be conducted and test results verified to be within the acceptance limits of the Owner's design specification, the applicable portions of Section SA of this Code, and as required in TA-3600. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results. | The tests identified in Table TA-4310 shall be required except for the structural capability test. | See the justification for the structural capability test of TA-3522 in this table. |
| TA-4331, Structural Capability Test for Duct and Housing:<br>A structural capability test shall be conducted to verify structural capability of ducts and housings in accordance with TA-3522 and Mandatory Appendix TA-II. | This test shall not be required. | See the justification for the structural capability test of TA-3522 in this table. |
| TA-4510, Acceptance Test Requirements (Conditioning Equipment):<br>Acceptance tests shall be conducted with the conditioning equipment in service under normal operating conditions for the system. The tests listed in Table TA-4510 shall be conducted and test results verified to be within the acceptance limits of the Owner's design specification, the applicable portions of Section CA of this Code, and as required in TA-3600 and TA-4570. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results. | The tests identified in Table TA-4110 shall be required except for the rotational speed test, the vibration test, and the bearing temperature test. | See the justification for the tests described in TA-4556 through TA-4558 in this table. |
| TA-4550, System Functional Tests (Conditioning Equipment): (entire section)<br>The conditioning equipment shall be tested in conjunction with the system to verify mechanical component integrity and design cooling or heating function. TA-4551 through TA-4556 shall be conducted in the same time frame. | The test requirements of this section shall not be required for future deployments of the portable exhausters identified in Section 3.2. For new systems, tests performed by the manufacturer shall be acceptable for compliance with the field acceptance test requirements of these sections. | See the justifications for the requirements of TA-4150 and TA-4160 in this table. The justification for fans is also applicable for conditioning equipment pumps. |

Table C-12. Section TA, "Field Testing of Air Treatment Systems," Technical Justifications (6 sheets)

| Requirement Text | Chosen Alternative | Technical Justification |
| --- | --- | --- |
| TA-4556, Rotational Speed Test (Conditioning Equipment): The rotational speed of the pump shaft shall be measured.<br><br>TA-4557, Vibration Test (Conditioning Equipment): The vibration of each bearing on the pump and motor shall be measured in accordance with TA-3533.<br><br>TA-4558, Bearing Temperature Test (Conditioning Equipment): Following pump and motor bearing temperature stabilization, the bearing temperature shall be measured. Stabilization occurs when temperature changes are less than or equal to ±3 °F (1.5 °C) in a 10 minute period. | These tests shall not be required. | These tests establish baseline information for comparison with future measurements to determine the need for preventive maintenance activities. The glycol pumps on the heating coils used on waste tank ventilation systems are small and easily replaced. These pumps are typically run to failure because preventive maintenance is not cost effective on such small pumps. |
| TA-6100, Quality Assurance - General: Field testing of nuclear air treatment, heating, ventilating, and air conditioning systems shall be conducted in accordance with the quality assurance requirements of Article AA-8000 and ASME NQA-1. | Quality assurance requirements for testing shall be equivalent or more rigorous than the quality assurance requirements applied during design and fabrication of the component. | Some components are exempt from some of the quality assurance requirements of AA-8000 and testing should be commensurate with the level of quality assurance required for design and fabrication. See the justification for AA-8110 in Table C-1. |

## C1.0 REFERENCES


AIR 99-507, 1999, "Approval of Request for Technical Justification for Temporary Deviation to American Society of Mechanical Engineers AG-1, Section FC 5100 High Efficiency Particulate Air Filter Qualification Test Requirements," (external letter from A. W. Conklin to J.E. Rasmussen, May 19), Washington Department of Health, Division of Radiation Protection, Olympia, Washington.

AMCA 204, 2005, *Balance Quality and Vibration Levels for Fans*, Air Movement and Control Association, Arlington Heights, Illinois.

ANSI/ASHRAE 52.1-1992 (Withdrawn), *Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter*, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Atlanta, Georgia.

ANSI/ASHRAE 52.2-2007, *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Atlanta, Georgia.

ANSI/IEEE 323-2003, *Qualifying Class 1E Equipment for Nuclear Power Generating Stations*, Institute of Electrical and Electronics Engineers, Inc., Piscataway, New Jersey.

ANSI/IEEE 336, 2005, *Guide for Installation, Inspection, and Testing for Class 1E Power, Instrumentation, and Control Equipment at Nuclear Facilities*, Institute of Electrical and Electronics Engineers, Inc., Piscataway, New Jersey.

ANSI/IEEE 344, 2004, *Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*, Institute of Electrical and Electronics Engineers, Inc., Piscataway, New Jersey.

ANSI/IEEE 627-1980 (Withdrawn), *Standard for Design Qualification of Safety Systems Equipment Used in Nuclear Power Generating Stations*, Institute of Electrical and Electronics Engineers, Inc., Piscataway, New Jersey.

ASCE/SEI 7, 2005, *Minimum Design Loads for Buildings and Other Structures*, American Society of Civil Engineers, Reston, Virginia.

ASME AG-1, 2009, *Code on Nuclear-Air and Gas-Treatment*, American Society of Mechanical Engineers, New York, New York.

*ASME Boiler and Pressure Vessel Code*, 2007, American Society of Mechanical Engineers, New York, New York.

ASME B31.3, 2008, *Process Piping,* American Society of Mechanical Engineers, New York, New York.

ASME NQA-1, 2004, *Quality Assurance Requirements for Nuclear Facility Applications*, American National Standards Institute/American Society of Mechanical Engineers, New York, New York.

ASME NQA-1b, 2007, Addenda to ASME NQA-1-2004, *Quality Assurance Requirements for Nuclear Facility Applications*, American National Standards Institute/American Society of Mechanical Engineers, New York, New York.

ASME STS-1-2006, *Steel Stacks*, American Society of Mechanical Engineers, New York, New York.

ASNT SNT-TC-1A, 2006, *Recommended Practice No. SNT-TC-1A and ASNT Standard Topical Outlines for Qualification of Nondestructive Testing Personnel (ANSI/ASNT CP-105-2006)*, American Society for Nondestructive Testing, Columbus, Ohio.

ASTM A 240, 2009, *Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications*, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

ASTM A 370, 2009, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

ASTM A 581, 1995, *Standard Specification for Free-Machining Stainless Steel Wire and Wire Rods*, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

ASTM D 635, 2006, *Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position*, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

ASTM D 1056, 2007, *Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber*, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

AWS D1.1, 2008, *Structural Welding Code – Steel*, American Welding Society, Miami, Florida.

AWS D1.3, 2008, *Structural Welding Code - Sheet Steel*, American Welding Society, Miami, Florida.

AWS-D9.1, 2006, *Sheet Metal Welding Code*, American Welding Society, Miami, Florida.

DOE-HDBK-1169-2003, *Nuclear Air Cleaning Handbook*, U.S. Department of Energy, Washington, D.C.

ICC IBC, *International Building Code*, 2006, International Code Council (ICC), Whittier, California.

ICBO UBC, 1997, *Uniform Building Code*, Volume 2, International Conference of Building Officials, Whittier, California.

MSC-PRO-263, *Qualification and Certification of Inspection and Test Personnel*, Washington River Protection Solutions, Richland, Washington.

NFPA 90A, 2009, *Standard for the Installation of Air Conditioning and Ventilating Systems*, National Fire Protection Association, Quincy, Massachusetts.

RPP-16797, 2003, *Justification for the Use of Non-CMTR Materials in the Construction of ASME AG-1 Code Compliant Ductwork Supports*, Rev. 0, Washington River Protection Solutions, Richland, Washington.

RPP-18927, 2003, *Testing & Inspection Requirements Relative to the Maintenance and Minor Alteration of Ventilation System Pressure Boundaries*, Rev. 0, Washington River Protection Solutions, Richland, Washington.

Tassios, D. and Major, J. H., 2001, *Performance of the York Model 299 Type 3G Demister, Moisture Separator in Removing Droplets in an Air-Stream Dispersion*, York Report No. 80-67459, Koch-Otto York Separations Technology, a Koch-Glitsch, Inc. Business Group, Parsippany, New Jersey.

TFC-BSM-CP_CPR-C-06, *Procurement of Items (Materials)*, Washington River Protection Solutions, Richland, Washington.

TFC-ENG-DESIGN-C-01, *Development of System and Subsystem Specifications*, Washington River Protection Solutions, Richland, Washington.

TFC-ENG-DESIGN-C-34, *Technical Requirements for Procurement*, Washington River Protection Solutions, Richland, Washington.

TFC-ENG-DESIGN-P-17, *Design Verification*, Washington River Protection Solutions, Richland, Washington.

TFC-ENG-STD-06, *Design Loads for Tank Farm Facilities*, Washington River Protection Solutions, Richland, Washington.

TFC-ENG-STD-07, *Ventilation System Design Standard*, Washington River Protection Solutions, Richland, Washington.

TFC-ESHQ-Q_INSP-C-01, *Control of Inspections*, Washington River Protection Solutions, Richland, Washington.

TFC-PLN-02, *Quality Assurance Program Description (QAPD)*, Washington River Protection Solutions, Richland, Washington.

UL 900, 2004, UL *Standard for Safety Air Filter Units*, Underwriters Laboratories, Inc., Northbrook, Illinois.

# APPENDIX D

# CROSSWALK BETWEEN ASME AG-1 AND ASME B31.3

Table D-1 compares the requirements of ASME AG-1-2009, Section SA and referenced articles of ASME AG-1, Section AA with the requirements of ASME B31.3-2008. Justifications of the acceptability of welded pipe used as ductwork are provided when the requirements of ASME AG-1 are different, more stringent, or not addressed.

Table D-1. Crosswalk Between ASME AG-1 and ASME B31.3 (12 sheets)

| ASME AG-1 Requirement | ASME B31.3 Corresponding Requirement | Equivalent[1] | Justification |
|---|---|---|---|
| **SA-3000, Materials** | | | |
| SA-3100, Materials, General | None | No | ASME B31.3 has no equivalent requirement, but see Table C-4 for justifications applicable to all ductwork in waste tank ventilation systems. |
| SA-3200, Material Substitution | None | No | |
| SA-3300, Material Testing: | Section 323.3 and Table 323.2.2 | Yes, 1 | ASME B31.3 establishes more specific requirements for when additional material testing is required. |
| SA-3400, Material Specifications | None | No | |
| SA-3400, Material Specifications | None | No | |
| **SA-4000, Design** | | | |
| SA-4100, General: References AA-4000. | Chapter II | Yes, 2 | See Table C-1 for technical justifications for the requirements of AA-4000. |
| **SA-4200, Design Criteria** | | | |
| SA-4200, Establishes requirements for loading, load combinations, stress criteria, deflection criteria, and other design criteria. | Chapter II | Yes, 2 | ASME B31.3 requires design consideration of similar loads and establishes stress criteria. Specific load combinations and deflection criteria are not established. This is acceptable considering the technical justifications given in Table C-1 for AA-4200. ASME B31.3 can be used for acceptable alternative design criteria and processes as identified in those justifications. Deflection is not a design criterion for waste tank ventilation systems ductwork. |
| **SA-4300, Ductwork Joins and Seams** | | | |
| SA-4310, General: General design basis considerations for ductwork joints and seams. | Section 310 | Yes, 1 | ASME B31.3 is equivalent. |
| SA-4321, Longitudinal Seams: Identifies acceptable types of longitudinal seams. | Sections 311.2.6, 323.1.1, 328.4.3, 328.5.2 and Appendix A | Yes, 1 | Section 328 allows longitudinal groove welds, Section 311.2.6, allows fillet welds to be used as primary welds to attach socket welding components and slip-on flanges; they may also be used to attach reinforcement and structural attachments, to supplement the strength or reduce stress concentration of primary welds and to prevent disassembly of joints. |

Table D-1. Crosswalk Between ASME AG-1 and ASME B31.3 (12 sheets)

| ASME AG-1 Requirement | ASME B31.3 Corresponding Requirement | Equivalent[1] | Justification |
|---|---|---|---|
| SA-4322, Transverse Joints: Identifies acceptable types of transverse joints. | Chapter II, Part 4 | Yes, 2 | ASME B31.3 allows other types of transverse joints, but provides additional requirements specific to those joints. The ASME B31.3 allowable joints and design requirements are acceptable for pressurized fluid systems: therefore, are acceptable for waste tank ventilation systems. |
| SA-4323, Other Types of Connections: Other types acceptable with engineering evaluation and testing. | Section 318.1.2 | Yes, 1 | ASME B31.3 is equivalent. |
| SA-4324, Limitations of Ductwork Joints and Seams | N/A | N/A | This requirement refers to seams with folded or punched metal, sealants or elastomers, and brazing and, therefore, is only applicable to sheet metal ductwork. |
| SA-4325, Bolts and Fasteners: Requires specific bolt spacing, dimensions, or calculations to determine spacing and dimensions. | Sections 309 and 335.2, and Table 326.1. | Yes, 1 | Section 309 describes all bolting requirements and Table 326.1 lists component ASTM specifications, including bolts and flanges. ASME B31.3 design requirements are acceptable for pressurized fluid systems; therefore, are acceptable for waste tank ventilation systems. |
| **SA-4400, Components** | | | |
| SA-4410 (a), Flexible Connections: Identifies design and leakage requirements for flexible connections. | Sections 304.7.2 and 304.7.4(c) | Yes, 2 | ASME B31.3 design requirements for unlisted components apply, which includes pressure design by calculation consistent with the design criteria of ASME B31.3 and with specific additional substantiation requirements. |
| SA-4410(b): Establishes qualified life requirements. | None. | No | Qualified life requirements are not identified in ASME B31.3. The system design life is included in TFC-ENG-STD-07, *Ventilation System Design Standard.* |
| SA-4410(c): Establishes pressure rating requirements based on burst pressure. | None. | No | ASME B31.3 does not require pressure rating based on burst pressure testing. The system pressure is included in the system design specification. |
| SA-4410(d): Establishes adhesive qualification requirements. | None. | No | Adhesive requirements for flexible connections are not identified in ASME B31.3. |
| SA-4420, Gaskets: Establishes requirements for gasket material, dimensions, compression, and service life. | Section 308.4 and Table 326.1, | Yes, 2 | ASME B31.3 is equivalent except for the evaluated acceptance criterion for gasket compression. The use of gaskets and flanges that comply with the specifications listed in ASME B31.3, Table 326.1 are acceptable for pressurized fluid systems; therefore, are acceptable for waste tank ventilation systems. |
| SA-4430, Access Doors and Panels | N/A | N/A | Access doors and panels are not installed in steel piping used as ductwork. |
| SA-4441, Test Ports | None. | No | Test ports requirements are not identified in ASME B31.3. This requirement is identified in TFC-ENG-STD-07. |

Table D-1. Crosswalk Between ASME AG-1 and ASME B31.3 (12 sheets)

| ASME AG-1 Requirement | ASME B31.3 Corresponding Requirement | Equiv-alent[1] | Justification |
|---|---|---|---|
| SA-4451, Drains | None. | No | Drain requirements are not identified in ASME B31.3. This requirement is identified in TFC-ENG-STD-07. |
| SA-4452, Insulation | None. | No | Specific insulation requirements are not identified in ASME B31.3. This requirement is identified in TFC-ENG-STD-07. |
| SA-4453, Air Distribution Devices | None. | No | Air distribution device requirements are not identified in ASME B31.3, and are not utilized in waste tank ventilation systems |
| SA-4454, Security Barriers | N/A | N/A | Security barriers are not necessary for waste tank ventilation systems. |
| **SA-4500, Pressure Boundary Leakage** | | | |
| SA-4510, General: Establishes requirements for allowable leakage determination. | Sections 345.1 and 345.2.2(a) | Yes, 1 | ASME B31.3 exceeds the requirements of ASME AG-1. ASME B31.3 is used for liquid service and, therefore, does not allow leakage. Leak testing is to ensure tightness. Determination of testing requirements is required by TFC-ENG-STD-07 and TFC PRJ SUT-C-01, *Test Plan Preparation*. |
| SA-4520, Applicability | Section 345 | Yes, 1 | ASME B31.3 describes the leak test requirements for the piping system, components may be tested separately or as assembled piping. |
| SA-4531, Evaluation—Responsibility: The engineer shall evaluate for allowable leakage. | Sections 300, 345.1, and 345.2.2(a) | Yes, 1 | ASME B31.3 states that the designer is responsible to the owner for assurance that the engineering design of piping complies with the requirements of this Code. Determination of testing requirements is required by TFC-ENG-STD-07 and TFC PRJ SUT-C-01.ASME B31.3 does not allow leakage. |
| SA-4532, Allowable Leakage Determination: Establishes criteria for allowable leakage. | Section 345.1 and 345.2.2(a) | Yes, 1 | ASME B31.3 exceeds the requirements of ASME AG-1. ASME B31.3 does not allow leakage. |
| SA-4533, Exceptions to Leakage Requirements | None. | No | ASME B31.3 is more conservative by not allowing exceptions to leakage requirements. |
| SA-4534, Documentation: Evaluation for allowable leakage shall be documented. | Sections 345 and 346 | Yes, 1 | Section 345 describes the leakage test requirements, for which no leakage is allowed. Section 346 describes the requirements for records and record retention. |
| SA-4540, Leakage Testing: Leak testing shall be performed in accordance with SA-5300 and Section TA. | Section 345 | No | Section TA of ASME AG-1 has more specific and detailed requirements than ASME B31.3. See Table C-12. |
| SA-4600, Design Specification | None | No | Design specification requirements are not identified in ASME B31.3. TFC-ENG-DESIGN-C-01, *Development of System and Subsystem Specifications*, is required to develop the TOC design specification. |

Table D-1. Crosswalk Between ASME AG-1 and ASME B31.3 (12 sheets)

| ASME AG-1 Requirement | ASME B31.3 Corresponding Requirement | Equivalent[1] | Justification |
|---|---|---|---|
| **SA-5000, Inspections and Testing** | | | |
| SA-5100, General: Inspection and testing shall be in accordance with AA-5000, TA-3300, and this section. | Chapter VI | Other | ASME AG-1 references AA-5100, AA-5200, AA-5300, and TA-3300. See applicable sections of this table for comparison to these referenced sections. |
| SA-5120, Responsibility for Procedures: Requires written procedures and personnel qualification to ASNT SNT-TC-1A as amended by ASME NQA-1 and AA-6433. | Sections 343, 344 and 345. | Yes, 2 | ASME B31.3 is equivalent regarding testing procedures. ASNT SNT-TC-1A, *Recommended Practice for Nondestructive Testing Personnel Qualification and Certification*, is not required, but is recommended as a guide. ASME NQA-1 qualification standards are not required. This is acceptable subject to the quality assurance justification from AA-8000 in Table C-1. |
| **SA-5200, Visual Inspection** | | | |
| SA-5210, General Requirements: Visual inspections shall be performed in accordance with AA-5200 and TA-3510. | Section 344.2 ASME Code, Section V, Article 9 | Yes, 2 | ASME B31.3 requires visual inspections be performed in accordance with the ASME Boiler and Pressure Vessel Code (BPVC), Section V, Article 9, which is equivalent to applicable requirements of AA-5200. See applicable sections of this table. ASME B31.3 is equivalent to TA-3510, except for identification of specific inspection items in Mandatory Appendix TA-I that are applicable to ductwork, although the general discussion of inspection items in ASME B31.3 should include the specific items of ASME AG-1. |
| SA-5220, Welded Connections: Inspection and testing of welds shall be performed in accordance with AA-5300 and AA-6000. | Sections 341, 342, 343 and 344 | Other | ASME AG-1 references AA-5300 and AA-6000. ASME B31.3 includes similar requirements for weld examination, examination personnel and examination procedures. See applicable sections of this table for comparison to AA-6330 requirements. |
| SA-5230, Ductwork: Requires dimensional inspection of ductwork. | Section 341.4.1 | Yes, 1 | Dimensional inspection for tolerances is satisfied by inspection for conformance to the piping and component specifications listed in ASME B31.3. |
| SA-5231(a), Joints and Seams: References SA-6400 and SA-6500 for inspection acceptance criteria. | Section 344.2 | Yes, 1 | ASME B31.3 is equivalent because acceptance criteria for inspections are compliance with ASME B31.3. See applicable sections of this table for specific comparison to SA-6400 and SA-6500. |
| SA-5231(b): Acceptance criteria for compression of gaskets. | Section 335.2.2(a) | Yes, 1 | ASME B31.3 is equivalent. |
| SA-5231(c): Brazed joints shall comply with the requirements of AA-6430. | N/A | N/A | Brazed joints are not used in welded pipe used as ductwork. |

Table D-1. Crosswalk Between ASME AG-1 and ASME B31.3 (12 sheets)

| ASME AG-1 Requirement | ASME B31.3 Corresponding Requirement | Equivalent[1] | Justification |
|---|---|---|---|
| SA-5231(d): Longitudinal or transverse welded joints shall comply with the requirements of SA-5220. | Section 344.2.1 | Yes, 1 | ASME B31.3 is equivalent because acceptance criteria for inspections are compliance with ASME B31.3. See applicable sections of this table for specific comparison to SA-5220. |
| SA-5231(e): Threaded fasteners shall have locking devices in accordance with AA-6258 to prevent loosening during service. | None | No | ASME B31.3 does not require locking devices on threaded fasteners for joints and seams; however, tightening to a predetermined torque is recommended, which prevents loosening during service. |
| SA-5232, Stiffeners | N/A | N/A | Stiffeners are used in sheet metal ductwork and are not applicable to welded pipe used as ductwork in the waste tank ventilation systems. |
| SA-5240(a), Ductwork Supports: References SA-6400 and SA-6500 for inspection acceptance criteria. | Section 344.2.1 | Yes, 1 | ASME B31.3 is equivalent because acceptance criteria for inspections are compliance with ASME B31.3. See applicable sections of this table for specific comparison to SA-6400 and SA-6500. |
| SA-5240(b): Acceptance criteria for welded joints. | Section 344.2.1 | Yes, 1 | ASME B31.3 is equivalent because acceptance criteria for inspections are compliance with ASME B31.3. See applicable sections of this table for specific comparison to SA-5220. |
| SA-5240(c): Threaded fasteners shall have locking devices in accordance with AA-6258 to prevent loosening during service. | None | No | ASME B31.3 does not require locking devices on threaded fasteners for ductwork supports. |
| SA-5240(d): Removal of temporary attachments shall be confirmed. | None | No | ASME B31.3 does not require confirmation of removal of temporary attachments. |
| **SA-5300, Pressure Boundary Leakage Testing** | | | |
| SA-5310, General: Requires leak testing to the allowable leakage criteria of SA-4500. | Section 345 | Yes, 1 | ASME B31.3 is equivalent. Design leakage requirements exceed ASME AG-1 allowable leakage. |
| SA-5320, Systems Completeness | Section 345 | Yes, 1 | ASME B31.3 does not establish specific system completeness requirements; however, there are equivalent requirements. |
| SA-5330, Allowances for Testing System Leakage Rates by Sections | Section 345.2.3(a) | Yes, 1 | ASME B31.3 allows separate testing of piping subassemblies. |
| SA-5330(a): Requires capability of inspection of transverse joints not subjected to leak testing. | None | Yes, 1 | ASME B31.3 does not require flanged joints at which a blank is inserted for isolation to be tested or inspected; however, no leakage is allowed. |
| SA-5330(b): Requires visual inspection of gasket compression. | None | Yes, 1 | ASME B31.3 does not require flanged joints at which a blank is inserted for isolation to be tested or inspected; however, no leakage is allowed. |
| SA-5330(c): Requires visual inspection of joints using mastic or liquid sealant. | None | Yes, 1 | ASME B31.3 does not require flanged joints at which a blank is inserted for isolation to be tested or inspected; however, no leakage is allowed. |

Table D-1. Crosswalk Between ASME AG-1 and ASME B31.3 (12 sheets)

| ASME AG-1 Requirement | ASME B31.3 Corresponding Requirement | Equiv-alent[1] | Justification |
|---|---|---|---|
| SA-5330(d): Reduction to allowable leakage for testing in sections. | N/A | Yes, 1 | Allowable leakage is zero, so reduction of allowable leakage for ductwork tested in sections is not applicable. |
| SA-5340, Testing Procedures | Sections 343 and 345.5 | Yes, 1 | Examination procedures are included in ASME B31.3 and procedures are required to be written as required in the BPVC, Section V, Article 1, T-150. Leak test procedures are included in ASME B31.3. |
| SA-5350, Documentation: Requires a test report with specific required information. | Section 345.2.7 | No | ASME B31.3 requires test records, but does not require the same minimum information. Most of the information is required or not applicable, but it is not unreasonable to fully comply with ASME AG-1. |
| SA-5361, Acceptance criteria - Quantitative Leakage Tests: References SA-4500 and SA-5350(d) for acceptance criteria. | Section 345.1 Section 345.2.2(a) | Yes, 1 | ASME B31.3 is equivalent. Design leakage requirements exceed ASME AG-1 allowable leakage. |
| SA-5362, Non-quantitative Leakage Tests | N/A | N/A | Non-quantitative leak tests are not performed. |
| **SA-5400, Structural Capability Test** | | | |
| SA-5410, Ductwork Pressure Test: Requires a structural capability test in accordance with TA-3522. 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 (SOPT). | Section 345.2.4 | Yes, 2 | ASME B31.3 does not specifically require a structural capability test. However, externally pressurized piping is required to be tested at not less than 15 psi. This is much greater than any structural capability pressure in waste tank ventilation systems. This test pressure will satisfactorily demonstrate the structural capability of the ductwork. Piping that complies with ASME B31.3 exceeds the duct construction allowed in the SMACNA standards. |
| SA-5420, Longitudinal Seam Qualification Test | N/A | N/A | The longitudinal seam qualification test is applicable to sheet metal ductwork only. |
| **SA-6000, Fabrication and Installation** | | | |
| SA-6100, General: References AA-6000. | Chapter V | Other | See applicable sections of this table for comparison to the requirements of AA-6000. |
| SA-6121, Material Selection: References SA-3000. | Chapter III | Other | See applicable sections of this table for comparison to the requirements of AA-3000. |
| SA-6122, Material Identification: Materials shall be identified on plans and specifications. | None | No | ASME B31.3 does not require material identification on plans or specifications. |

Table D-1. Crosswalk Between ASME AG-1 and ASME B31.3 (12 sheets)

| ASME AG-1 Requirement | ASME B31.3 Corresponding Requirement | Equivalent[1] | Justification |
|---|---|---|---|
| SA-6123, Repair of Material With Defects:<br>Allows material repairs in accordance with AA-8000 and AA-6300. | Section 341.3.3<br>Section 328.6 | Yes, 2 | ASME B31.3 allows defect repair and reexamination of the repaired component to the same acceptance criteria as the original examination. This is acceptable subject to the justification for AA-8000 in Table C-1. See applicable sections of this table for comparison to AA-6300. |
| SA-6130, Control of Installation and Fabrication Process | Chapter V | No | ASME B31.3 includes the requirements for how metallic piping materials and components are prepared for assembly and erection by one or more of the fabrication processes covered in paragraphs. 328, 330, 331, 332, and 333. When any of these processes is used in assembly or erection, requirements are the same as for fabrication. |
| SA-6140, Welding:<br>Requires welding compliance with AWS standards;<br>ASME Code, Section IX; and AA-6300 and AA-6400. | Section 328 | Yes, 2 | ASME B31.3 is equivalent because it requires compliance to BPVC, Section IX. See applicable sections of this table for comparison to AA-6300 and AA-6400. |
| **SA-6200, Fabrication Processes** | | | |
| SA-6210(a):<br>Requires that cutting, forming, or bending does not degrade material properties. | Section 331 | Yes, 2 | ASME B31.3 does not specifically require that cutting, forming, and bending processes not degrade material properties. However, ASME B31.3 has specific requirements for heat treatment to restore strength properties after cutting or welding. |
| SA-6210(b):<br>Cutting, forming, and bending requirements for coated metal. | N/A | N/A | Coated metal is not used in piping systems used as ductwork. |
| SA-6210(c):<br>Inside bend radii shall not be less than ASTM standards. | N/A | N/A | This requirement is applicable to rectangular sheet metal ductwork. Tight bend radii are not required for round piping used as ductwork. |
| SA-6210(d):<br>Fitting and aligning requirements. | Section 335.1 | Yes, 1 | ASME B31.3 is equivalent. |
| SA-6210(e):<br>Allows temporary welded attachments. | Section 328.5.1(c) | Yes, 1 | Tack welds at the root of the joint are the only allowable temporary attachment in ASME B31.3. ASME B31.3 meets the requirements of this section of ASME AG-1 for tack welds. |
| SA-6210(f):<br>Access doors and panels requirements. | N/A | N/A | Access doors and panels are not installed in piping systems used as ductwork. |
| SA-6210(g):<br>Grilles, registers, and diffusers requirements. | N/A | N/A | Grilles, registers, and diffusers are not installed in piping systems used as ductwork. |
| **SA-6300, Mechanical Fastening** | | | |
| SA-6310(a):<br>Nut thread engagement. | Section 335.2.3 | Yes, 1 | ASME B31.3 is equivalent. |

Table D-1. Crosswalk Between ASME AG-1 and ASME B31.3 (12 sheets)

| ASME AG-1 Requirement | ASME B31.3 Corresponding Requirement | Equiv-alent[1] | Justification |
|---|---|---|---|
| SA-6310(b): Requires AISC code compliance for bolts. | Section 309 | Yes, 2 | ASME B31.3 does not require compliance with the AISC Code for standard bolts, but includes bolting requirements for pressurized fluid systems; therefore, is acceptable for waste tank ventilation systems. |
| SA-6310(c): Allows self-drilling or self-threading screws. | N/A | N/A | Self-drilling or self-threading screws are not installed in piping systems used as ductwork. |
| SA-6310(d): Rivet qualification requirements. | N/A | N/A | Rivets are not installed in piping systems used as ductwork. |
| SA-6310(e): Insulation attachment requirements. | None | No | ASME B31.3 has no requirements for attachment of insulation. |
| SA-6310(f): Flange faces shall be free of crevices at the corners. | N/A | N/A | Round pipe has no corners on flange faces. |
| SA-6410(a): Rectangular duct tolerances. | N/A | N/A | Applicable to rectangular ducts only, not to round pipe. |
| **SA-6400, Fabrication Tolerances** | | | |
| SA-6410(b): Circular duct tolerances. | Section 335.1(c) | Yes, 1 | ASTM specifications for pipe include tighter tolerances than those specified in ASME AG-1. ASME B31.3 flanged joint alignment is equivalent. |
| SA-6410(c): Flat sheet or plate surfaces tolerances. | N/A | N/A | No flat sheet or plate surfaces in round piping. |
| SA-6410(d): Statement of tolerance applicability | N/A | N/A | Compliance with code applicability statement not required; these apply to sheet metal duct, not piping. |
| SA-6410(e): Flange hole tolerances. | Chapter IV | Yes, 1 | ASME B31.3, Table 326.1, designates ASME B16.5, *Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard,* which establishes more stringent hole and bolting requirements. |
| SA-6410(f): Grilles, registers, and diffusers tolerances. | N/A | N/A | Grilles, registers, and diffusers are not installed in waste tank ventilation piping systems used as ductwork. |
| **SA-6500, Installation Tolerances** | | | |
| Installation tolerances shall be in accordance with construction documents and SA-4000. | Sections 328.4.3 and 335 | Yes, 1 | ASME B31.3 is equivalent. Installation tolerances are required to be in accordance with weld procedure specifications. |
| **SA-6600, Cleaning, Finishing, and Coating** | | | |
| Requirements for galvanized and painted surfaces. | None | No | ASME B31.3 has no coating requirements. |

Table D-1. Crosswalk Between ASME AG-1 and ASME B31.3 (12 sheets)

| ASME AG-1 Requirement | ASME B31.3 Corresponding Requirement | Equivalent[1] | Justification |
|---|---|---|---|
| **SA-7000, Packaging, Shipping, Receiving, Storage, and Handling** | | | |
| SA-7000, Packaging, Shipping, Receiving, Storage, and Handling | None | No | ASME B31.3 has no packaging, shipping, or handling requirements. |
| **SA-8000, Quality Assurance** | | | |
| SA-8000, Quality Assurance | None | No | ASME B31.3 has no specific quality assurance requirements. |
| **SA-9000, Nameplate and Stamping** | | | |
| SA-9000, Nameplate and Stamping | None | No | ASME B31.3 has no nameplate or stamping requirements. |
| **AA-5000, Inspection and Testing** | | | |
| AA-5120, Responsibility for Procedures:<br>Equivalent requirements as SA-5120. | Section 342<br>Section 343 | Yes, 2 | See section SA-5000 of this table for comparison. |
| AA-5130, Measuring and Test Equipment:<br>Control in accordance with ASME NQA-1. | None | No | ASME B31.3 has no requirements for measuring and test equipment. |
| **AA-5200, Visual Inspection** | | | |
| AA-5221, Direct Visual Inspection | Section 344.2 | Yes, 1 | ASME B31.3 references Section V, Article 9 of the BPVC, which is equivalent to ASME AG-1. |
| AA-5222, Remote Visual Inspection | Section 344.2 | Yes, 1 | ASME B31.3 references Section V, Article 9 of the BPVC, which is equivalent to ASME AG-1. |
| AA-5230, Requirements:<br>Requires visual inspections | Section 341.4.1<br>Section 344.2 | Yes, 1 | ASME B31.3 requires visual examination. |
| AA-5240, Inspection Checklist | N/A | N/A | Section SA does not require an inspection checklist. |
| AA-5250, Reports | N/A | N/A | Section SA does not require an inspection report. |
| **AA-5300, Welded Connections** | | | |
| References AA-6000 for weld inspection requirements. | Chapter VI | Other | ASME AG-1 references AA-6000. ASME B31.3 includes similar requirements for weld inspection and testing. See applicable sections of this table for comparison to AA-6300. |
| **AA-5400, Bolted Connections** | | | |
| AA-5410, Before Bolting:<br>Requires gasket and flange inspection for cleanliness and dimensions. | N/A | N/A | Flange and gasket inspections are applicable to sheet metal ductwork only. Use of flanges and gaskets listed in ASME B31.3 provides acceptable dimensional verification. |

Table D-1. Crosswalk Between ASME AG-1 and ASME B31.3 (12 sheets)

| ASME AG-1 Requirement | ASME B31.3 Corresponding Requirement | Equivalent[1] | Justification |
|---|---|---|---|
| AA-5420, After Bolting: Requires inspection to verify installation of all bolts, torque requirements, and gasket compression. | Section 335.2.2 Section 341.4.1(a)(4) | Yes, 2 | ASME B31.3 is equivalent except for torque requirements. This is acceptable due to the low temperatures and pressures in waste tank ventilation systems compared to the high-pressure and temperature fluid systems to which ASME B31.3 is applicable. |
| **AA-5500, Fabrication Tolerances** | | | |
| Requires inspection for compliance to tolerances in other applicable code sections. | Section 341.4.1(a)(1) | Other | ASME B31.3 requires inspection for conformance to specifications, which would include dimensional tolerances. See applicable sections of this table for specific comparison to tolerance requirements of SA-5200. |
| **AA-5600, Pressure and Leak Testing** | | | |
| Requires leak testing in accordance with other applicable code sections. | Section 345 | Other | ASME B31.3 includes similar requirements for pressure and leak testing. See applicable sections of this table for specific comparison to tolerance requirements of SA-5300. |
| **AA-5700, Performance and Functional Testing** | | | |
| Requires performance and functional testing. | N/A | N/A | Performance and functional testing is not applicable to ductwork. |
| **AA-5800, Seismic Testing** | | | |
| Requires structural design verification by testing. | N/A | N/A | Seismic qualification is not required for waste tank ventilation systems. |
| **AA-6300, Welding Requirements** | | | |
| AA-6310(a), Statement of scope | Section 328 | | |
| AA-6310(b), Requires qualification of welding procedures, welders, welding operators, and inspectors. | Section 328.1 | Yes, 1 | ASME B31.3 is equivalent. |
| AA-6310(c), Requires certified records of qualifications. | Section 328.2.4 | Yes, 1 | ASME B31.3 is equivalent. |
| AA-6310(d)(1), Base metals shall be listed in SA-3000. | None | No | ASME AG-1 references SA-3000 for base metal materials. See applicable sections of this table. |
| AA-6310(d)(2), Coatings may remain during welding if procedure is qualified with them present. | Section 328.2.1(a) | N/A | ASME B31.3 requires procedure and welder qualification in accordance with BPVC, Section IX. These coatings, if used, will not be applied prior to welding. |
| AA-6310(e), Filler metals shall be listed in ASME Code, Section II, and compatible with process and base metal. | Section 328.3.1 | Yes, 1 | ASME B31.3 requires filler metal to conform to BPVC, Section IX, which identifies Section II for filler metal. |

Table D-1. Crosswalk Between ASME AG-1 and ASME B31.3 (12 sheets)

| ASME AG-1 Requirement | ASME B31.3 Corresponding Requirement | Equivalent[1] | Justification |
|---|---|---|---|
| AA-6310(f), Identifies allowable welding processes. | Section 328.2 | Yes, 1 | B31.1 requires procedure and welder qualification in accordance with BPVC, Section IX, which includes the joining processes identified in ASME AG-1. |
| AA-6310(g), Terms shall be in accordance with ANSI/AWS A3.0. | Section 300.2 | Yes, 1 | ASME B31.3 is equivalent. |
| AA-6310(h), Symbols shall be in accordance with ANSI/AWS A2.4. | None | No | ASME B31.3 does not require weld symbols from a specific standard. |
| AA-6310(i), Safety precautions shall conform to ANSI/AWS Z49.1. | None | No | ASME B31.3 does not require safety precautions from a specific standard. |
| AA-6310(j), US customary units are standard. SI equivalents are approximate. | N/A | N/A | Discussion of units of measurement. |
| AA-6310(k), Identifies required welding standards and qualification requirements. | Section 328.2.1 | Yes, 1 | ASME B31.3 requires procedure and welder qualification in accordance with BPVC, Section IX. |
| **AA-6320, Workmanship** | | | |
| **AA-6321, Preparation of Base Metal** | | | |
| AA-6321.1, Identifies welding surface quality and cleanliness requirements. | Section 328.4.1 | Yes, 2 | ASME B31.3 requires surfaces are cleaned prior to welding to ensure there are no detrimental affects to either the weld or the base metal when heat is applied. |
| AA-6321.2, Allows welding galvanized with zinc coating surface present if procedure is qualified. | Sections 328.2.1(a), K323.4.2, F323.4 | Yes, 1 | ASME B31.3 requires procedure and welder qualification in accordance with BPVC, Section IX. Pipe used in waste tank ventilation systems is typically stainless steel. |
| **AA-6322, Joint Fit-Up** | | | |
| AA-6322.1, Requires alignment within specified tolerances. | Section 328.4.3 | Yes, 1 | ASME B31.3 is equivalent. |
| AA-6322.2, Tack welds shall be made with qualified electrodes. | Section 328.5.1(c) | Yes, 1 | ASME B31.3 is equivalent. |
| AA-6322.3, Tack welds not incorporated shall be removed. | Section 328.5.1(c) | Yes, 1 | ASME B31.3 is equivalent. |
| **AA-6323, Weld Cleaning** | | | |
| AA-6323.1, Identifies methods of base metal cleaning. | None | No | ASME B31.3 has no requirements for specific methods of base metal cleaning. |

Table D-1. Crosswalk Between ASME AG-1 and ASME B31.3 (12 sheets)

| ASME AG-1 Requirement | ASME B31.3 Corresponding Requirement | Equivalent[1] | Justification |
|---|---|---|---|
| AA-6323.2, Slag shall be removed when welding over previously deposited metal. | Sections 328.4.1, 328.4.2, 344.7 | Yes, 2 | ASME B31.3 does not specifically discuss cleaning of slag before welding over previously deposited metal, but it does require cleaning and end preparation prior to welding, removing of slag between passes and criteria regarding slag is included in weld acceptance criteria. |
| AA-6323.3, Welds shall be cleaned upon completion. | None | No | ASME B31.3 has no specific requirements for methods of cleaning completed welds. |
| **AA-6324, Weld Quality** | | | |
| AA-6324.1, Weld dimensions shall be as specified on design drawings. | Sections 341.3 and Table 341.3.2 | Yes, 2 | ASME B31.3 Acceptance criteria shall be as stated in the engineering design and in Table 341.3.2, which identifies the limits on imperfections for welds. |
| AA-6324.2, Identifies acceptable fillet and butt weld profiles in Figure AA-6324.2. | Sections 328.5.2, 341.3.2, Figures 328.5.2A, 328.5.2B, 328.5.2C, 341.3.2, and Table 341.3.2 | Yes, 2 | ASME B31.3 provides equivalent weld acceptance criteria. ASME AG-1is intended primarily for welding of sheet metal ductwork, which may require more rigorous welding criteria due to the low wall thickness. |
| AA-6324.3, Identifies acceptable and unacceptable fillet weld profiles in Figure AA-6324.2. | Figures 328.5.2A, 328.5.2B, 328.5.2C, 341.3.2 and Table 341.3.2 | Yes, 2 | ASME B31.3 provides equivalent weld acceptance criteria and Table 341.3.2, identifies the limits on imperfections for welds. |
| AA-6324.4, Identifies groove or butt weld requirements. | Section 328.5.4 and Table 341.3.2 | Yes, 2 | Figures 328.5.4A through 328.5.4E show acceptable details of branch connections with and without added reinforcement, and Table 341.3.2, identifies the limits on imperfections for welds. |
| **AA-6330, Inspection and Testing of Welds** | | | |
| **AA-6331, Butt and Fillet Welds** | | | |
| AA-6331.1, Establishes weld inspection acceptance criteria. | Table 341.3.2 Figure 341.3.2 | Yes, 2 | ASME B31.3 provides equivalent weld examination and acceptance criteria and Table 341.3.2, identifies the limits on imperfections for welds. |
| AA-6331.2, Requires inspection for compliance with design dimensions. | Section 341.4.1 Section 341.3.2 | Yes, 2 | ASME B31.3 references the engineering design for acceptance criteria, which would include location, size, and length of welds. |
| AA-6331.3, Allows alternate criteria in accordance with NCIG-03 for structures and supports fabricated to the requirements of the AISC specification and AWS D1.1. | Sections 300.1 and 300.2 | Yes, 2 | Structures such as building frames, bents, foundations, or equipment are excluded from the scope of ASME B31.3 which includes piping and pipe-supporting elements. Waste tank ventilation system ducting is not located inside a structure. |
| **AA-6332, Resistance Spot Welds** | | | |

Table D-1. Crosswalk Between ASME AG-1 and ASME B31.3 (12 sheets)

| ASME AG-1 Requirement | ASME B31.3 Corresponding Requirement | Equivalent[1] | Justification |
|---|---|---|---|
| AA-6332, Establishes spot weld acceptance criteria. | N/A | N/A | Resistance spot welding is not utilized in piping systems used as ductwork. |
| **AA-6333, Stud Welding** | | | |
| AA-6333.1, Identifies stud weld requirements. | None | No | ASME B31.3 has no requirements for welding of studs. |
| AA-6333.2, Identifies stud weld reinforcement requirements. | None | No | ASME B31.3 has no requirements for welding of studs. |
| **AA-6334, Nondestructive Testing Methods and Acceptance Criteria** | | | |
| AA-6334.1, Required nondestructive testing (NDT) shall be stated on drawings and in specifications. | Sections 341.3 and 341.5 | Yes, 1 | ASME B31.3 is equivalent. |
| AA-6334.2, Surface inspection shall be by the dye penetrant method in accordance with ASTM E165. | Section 344.4 | Yes, 2 | ASME B31.3 references BPVC, Section V, Article 6, for liquid penetrant examination and is considered equivalent to the ASME AG-1 requirements. |
| AA-6334.3, establishes requirements for radiographic and ultrasonic inspection in accordance with ASME Code, Section V. | Sections 344.5 Section 344.6 | Yes, 1 | ASME B31.3 has equivalent requirements for radiographic and ultrasonic examination, including reference to BPVC, Section V. |
| **AA-6335, Inspector Qualifications** | | | |
| AA-6335.1 Requires visual inspection personnel qualification to ASME NQA-1. | Section 342.1 | No | ASME B31.3 has inspector qualification requirements, but not to ASME NQA-1; it recommends SNT-TC-1A be used as a guide. |
| AA-6335.2, Requires NDT personnel qualification to SNT-TC-1A, and ASME NQA-1. | Section 342.1 | No | ASME B31.3 has inspector qualification requirements, but not to ASME NQA-1; it recommends SNT-TC-1A be used as a guide. |
| AA-6335.3, Requires personnel qualification to NCIG-03, if used. | N/A | N/A | See AA-6331.3 of this table. |
| **AA-6336, Repairs** | | | |
| AA-6336, Weld repairs shall be made to the requirements for the original weld. | Section 328.6 | Yes, 1 | ASME B31.3 is equivalent. |

[1] Yes, 1 – The ASME B31.3 requirement is equivalent or exceeds the requirements of ASME AG-1.
Yes, 2 – The ASME B31.3 requirement is similar, but is considered technically acceptable for waste tank ventilation systems based on the stated justification. ASME AG-1 may also reference other sections of that code that are equivalent or similar.
No – ASME B31.3 does not address the ASME AG-1 requirement in any form.
N/A – The ASME AG-1 requirement is not applicable to welded pipe used as ductwork.
Other – Equivalency identified in the description of the other code sections referenced.

## D1.0 REFERENCES


ASME AG-1, 2009, *Code on Nuclear-Air and Gas-Treatment*, American Society of Mechanical Engineers, New York, New York.

*ASME Boiler and Pressure Vessel Code (BPVC)*, 2007, American Society of Mechanical Engineers, New York, New York.

ASME B16.5-2009, *Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard*, American Society of Mechanical Engineers, New York, New York.

ASME B31.3, 2008, *Process Piping,* American Society of Mechanical Engineers, New York, New York.

ASME NQA-1, 2004, *Quality Assurance Requirements for Nuclear Facility Applications*, American National Standards Institute/American Society of Mechanical Engineers, New York, New York.

ASME NQA-1b, 2007, Addenda to ASME NQA-1-2004, *Quality Assurance Requirements for Nuclear Facility Applications*, American National Standards Institute/American Society of Mechanical Engineers, New York, New York.

ASNT SNT-TC-1A, 2006, *Recommended Practice No. SNT-TC-1A and ASNT Standard Topical Outlines for Qualification of Nondestructive Testing Personnel (ANSI/ASNT CP-105-2006)*, American Society for Nondestructive Testing, Columbus, Ohio.

ASTM E165, 2009, *Standard Practice for Liquid Penetrant Examination for General Industry*, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

AWS A2.4, 2007, Standard *Symbols for Welding, Brazing, and Nondestructive Testing,* American Welding Society, Miami, Florida.

AWS 3.0, 2010, *Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying - 12th Edition*, American Welding Society, Miami, Florida.

AWS D1.1, 2008, *Structural Welding Code – Steel*, American Welding Society, Miami, Florida.

AWS Z49.1, 1983, *Safety in Welding, Cutting and Allied Processes,* American Welding Society, Miami, Florida.

NCIG-03, *Training Manual for Inspectors of Structural Welds at Nuclear Power Plants Using the Acceptance Criteria of NCIG-01, Revision 1,* Publisher: Nuclear Construction Issues Group (NCIG)

TFC-ENG-DESIGN-C-01, *Development of System and Subsystem Specifications*, Washington River Protection Solutions, Richland, Washington.

TFC-ENG-STD-07, *Ventilation System Design Standard*, Washington River Protection Solutions, Richland, Washington.

TFC PRJ SUT-C-01, *Test Plan Preparation*, Washington River Protection Solutions, Richland, Washington.

# APPENDIX E

# LIST OF CHANGES IN ASME AG-1b 2007 AND AG-1-2009

**DIVISION I General Requirements**

**SECTION AA COMMON ARTICLES**

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| AA-2000 | Referenced Documents | Revised in its entirety; (Note: ASME NQA-2 has been replaced with NQA-1 throughout the revised Code). |
| AA-4323 | Table AA-4323, Linear-Type Systems, Primary Stress Allowables | Note (1) revised |
| AA-4332.1 | Design Level A and Level B Limits | Revised |
| AA-4332.2 | Level C Limits | First sentence revised |
| AA-4332.3(a) | Level D Limits | Revised |
| AA-4360 | Design of Bolts | Revised |
| AA-5130 | Measuring and Test Equipment | Revised |
| AA-5221 | Direct Visual Examination | Third sentence revised |
| AA-5700 | Performance and Functional Testing | Note deleted |
| AA-6310(i) | Welding Requirements, Safety Precautions | Revised |
| AA-6335.1 | Welding, Inspector Qualifications | Revised |
| AA-6410(i) | Brazing, General | Revised |
| AA-6433.1 | Brazing, Inspector Qualifications | Revised |
| AA-6500 | Cleaning and Coating | Revised in its entirety |
| AA-6610(a) | Handling and Rigging | Second sentence revised |
| AA-7200 | Packaging, Shipping, Receiving, Storage, and Handling, General Requirements | Third and fourth paragraphs revised |
| AA-7220 | Personnel Qualifications | Revised |
| AA-7230 | Classification of Items | Second paragraph revised |
| AA-7310 | Packaging, General | Second paragraph revised |
| AA-8000 | Quality Assurance | No additions or changes |
| AA-9000 | Nameplates and Stamping | No additions or changes |
| AA-10000 | Repair and Replacement of Components | Added with 2007 Addenda; no changes in 2009 Rev. |

**DIVISION II Ventilation Air Cleaning and Ventilation Air Conditioning**

**SECTION BA FANS AND BLOWERS**

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| BA-1100 | Scope | Revised |
| BA-1110 | Purpose | Revised to include testing and quality assurance |
| BA-1130 | Definitions and Terms | Revised definitions |

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| BA-2000 | Referenced Documents | Revised in its entirety |
| BA-3000 | Materials | Revised in its entirety |
| BA-4000 | Design | Revised in its entirety |
| BA-5111 | Fans Requiring Tests | Revised first sentence |
| BA-5141 | Overspeed Tests | Revised |
| BA-5142 | Leakage Tests | References to BA-4142 revised to BA-4141 |
| BA-5210 | First Unit Of A Design | Revised |
| BA-6000 | Fabrication and Installation of Centrifugal and Axial Fans | Revised first sentence; added BA-6200 |
| BA-7000 | Packaging, Shipping, Receiving, Storage, and Handling | Revised in its entirety |
| BA-8000 | Quality Assurance | Revised in its entirety |
| BA-9000 | Nameplates and Operating and Maintenance Manuals | New BA-9100 added, and all subsequent paragraphs redesignated |
| BA-A | Fan System Considerations | Parenthetical note below heading deleted; last word in BA-A-1300 revised |
| BA-B | Nonmandatory Appendix, Division of Responsibility | Revised |

**SECTION HA HOUSINGS**

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| HA-3111 | Protective Coatings | Parenthesis removed from "galvanized" |
| HA-3110 | Table HA-3110, Allowable Materials | ASTM A 167 line under "Plate, Sheet, Strip" deleted |

**SECTION RA REFRIGERATION EQUIPMENT**

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| RA-2000 | Referenced Documents | References updated |
| RA-3100(d) | Materials, General | Added |
| RA-3110 | Pressure Retaining Materials | Subparagraph (c) revised and 1 spelling correction |
| RA-3120(b) | Component Support Materials | Revised |
| RA-3151 | Valve, Piping, and Fitting materials, Refrigerant | Revised |
| RA-3152(b) | Valve, Piping, and Fitting materials, Water | Revised |

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| RA-3153 | Valve, Piping, and Fitting materials, Lubrication | Revised |
| RA-3154 | Valve, Piping, and Fitting materials, Control | Revised |
| RA-3160(c) | Welding and Brazing Materials | Revised |
| RA-3160(d) | Welding and Brazing Materials | Revised |
| RA-4200(b) | Design Specification | Revised in its entirety |
| RA-4423 | Refrigerant System Interconnecting Piping, Valves, and Fittings | Revised |
| RA-4431 | Lubrication System, Piping Valves and Fittings | Revised |
| RA-4432 | Lubrication System, Pump | Second sentence editorially revised |
| RA-5214.3(a) | Hermetic Reciprocating Scroll & Screw Compressor Testing | Editorially revised |
| RA-5214.4(a) | Open Reciprocating Scroll & Screw Compressor Testing | Editorially revised |

**SECTION CA CONDITIONING EQUIPMENT**

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| CA-2000 | Referenced Documents | References updated |
| CA-3110 | Material Specifications | First sentence revised |
| CA-4122 | Technical Requirements, Tubes | Revised in its entirety |
| CA-3230 | Table CA-3230, Allowable Materials - Nonpressure-Retaining Components | ASTM A 167 line under "Plate, Sheet, Strip" deleted |
| CA-3310 | Table CA-3310, Allowable Materials - Air Washers and Evaporative Coolers | ASTM A 167 line under "Plate, Sheet, Strip" deleted |
| CA-3410 | Table CA-3410, Allowable Materials - Electric Heating Coils | ASTM A 167 line under "Plate, Sheet, Strip" deleted |

**SECTION FA MOISTURE SEPARATORS**

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| FA-1000 | Introduction | Revised in its entirety |
| FA-2000 | Referenced Documents | Revised in its entirety |
| FA-3000 | Materials | Revised in its entirety |
| FA-4000 | Design | Revised in its entirety |
| FA-5000 | Inspection and Testing | Revised in its entirety |
| FA-6000 | Fabrication | Revised in its entirety |
| FA-7000 | Packaging, Shipping, and Storage | Revised in its entirety |
| FA-8000 | Quality Assurance | Revised in its entirety |

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| FA-9000 | Nameplates | Revised in its entirety |
| FA-A | Nonmandatory Appendix, Division of Responsibility | Designator revised from FA-B (former Non-mandatory Appendix FA-A deleted); Table TA-A-1000 revised |

**SECTION FB MEDIUM EFFICIENCY FILTERS**

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| FB-1100 | Referenced Documents | References updated |
| FB-1110 | Material Specifications | First sentence revised |
| FB-1121(b) | Technical Requirements, Tubes | Revised in its entirety |
| FB-1122 | Table CA-3230, Allowable Materials - Nonpressure-Retaining Components | ASTM A 167 line under "Plate, Sheet, Strip" deleted |
| FB-1130 | Table CA-3310, Allowable Materials - Air Washers and Evaporative Coolers | ASTM A 167 line under "Plate, Sheet, Strip" deleted |
| FB-2000 | Table CA-3410, Allowable Materials - Electric Heating Coils | ASTM A 167 line under "Plate, Sheet, Strip" deleted |
| FB-3000 | Materials | Revised |
| FB-4000 | Design | Revised in its entirety |
| FB-5000 | Inspection and Testing | Revised in its entirety |
| FB-6200 | Fabrication, Manufacture and Assembly | Added with 2007 Addenda; no changes in 2009 Rev. |
| FB-7100 | Packaging, Shipping, Receiving, Storage, and Handling, General | Revised |
| FB-8000 | Quality Assurance | Revised in its entirety |
| FB-9100 | Filter Markings | Subparagraphs revised, one subparagraph added |
| FB-9200 | Package Marking | First paragraph revised, one subparagraph revised |
| FB-A-1000 | Division of Responsibility | Revised |

**SECTION FC HEPA FILTERS**

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| FC-1000 | Introduction | Revised in its entirety |
| FC-2000 | Referenced Documents | Revised in its entirety |
| FC-3000 | Materials | Revised in its entirety |
| FC-4000 | Design | Revised in its entirety |
| FC-5000 | Inspection | Revised in its entirety |
| FC-6000 | Fabrication | Revised in its entirety |
| FC-7000 | Packaging, Shipping, and Storage | Revised |

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| FC-8200 | Quality Assurance | Revised in its entirety |
| FC-9000 | Nameplates | Revised in its entirety |
| FC-I-2000 | Reference Documents | Revised in its entirety |
| FC-I-3000 | Requirements | Revised in its entirety |
| FC-I-4000 | Qualification and Testing Procedures | Revised in its entirety |
| FC-I-5000 | Quality Assurance Provisions | Revised and redesignated as Article FC-I-6000, and new Article FC-I-5000 added |
| FC-A-1000 | Nonmandatory Appendix, Division of Responsibility | Revised |

**SECTION FE    TYPE III ADSORBERS**

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| FE-2000 | Referenced Documents | Listing of ASTM A 167 deleted |
| FE-3140(a) | Other Components, stainless steel plate, sheet, and strip: ASTM A 240 | Listing of ASTM A 167 deleted |

**SECTION FG    MOUNTING FRAMES, CONAGT AIR-CLEANING EQUIPMENT, NUCLEAR SAFETY-RELATED EQUIPMENT**

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| FG-1000 | Introduction | Revised in its entirety |
| FG-2000 | Referenced Documents | References updated |
| FG-3000 | Materials | Revised in its entirety |
| FG-3100 | Table FG-3100, Allowable Materials | Table updated |
| FG-3200 | Material Limitations | Revised |
| FG-4000 | Design | Revised in its entirety |
| FG-5000 | Inspection and Testing | Revised in its entirety |
| FG-6300 | Clamping Devices | Revised |
| FG-7000 | Packaging and Shipping | Revised |
| FG-9000 | Nameplates | Revised |
| FG-I | Mandatory Appendix, HEPA Filter Mounting Frames | These requirements were incorporated into FG.-4000. |
| FG-II | Mandatory Appendix, Type II Adsorber Cell Mounting Frames | These requirements were incorporated into FG.-4000. |
| FG-A-1000 | Table FG-A-1000, Division of Responsibility | Revised |

**SECTION FH    OTHER ADSORBERS**

This is a new section; added with 2007 Addenda

**SECTION FI METAL MEDIA FILTERS**
New section added - in the course of preparation.

**SECTION FJ LOW EFFICIENCY FILTERS**
New section added - in the course of preparation.

**SECTION FK SPECIAL ROUND AND DUCT-CONNECTED HEPA FILTERS**
This is a new section; added with 2007 Addenda

**SECTION FL SAND FILTERS**
New section added - in the course of preparation.

**SECTION FM HIGH STRENGTH HEPA FILTERS**
New section added - in the course of preparation.

**SECTION IA INSTRUMENTATION AND CONTROLS**

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| IA-3100 | Referenced Documents | Listing of ASTM A 167 deleted |

**DIVISION III Process Gas Treatment**
(In the Course of Preparation)

**SECTION GA PRESSURE VESSELS, PIPING, HEAT EXCHANGERS, AND VALVES**
New section added - in the course of preparation.

**SECTION GB NOBLE GAS HOLD-UP EQUIPMENTS**
New section added - in the course of preparation.

**SECTION GC COMPRESSORSS**
New section added - in the course of preparation.

**SECTION GD OTHER RADIONUCLIDE EQUIPMENTS**
New section added - in the course of preparation.

**SECTION GE HYDROGEN RECOMBINERS**
New section added - in the course of preparation.

**SECTION GF GAS SAMPLING**
New section added - in the course of preparation.

**DIVISION IV Testing Procedures**

**SECTION TA FIELD TESTING OF AIR TREATMENT SYSTEMS**

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| TA-1120 | Applicability | Last sentence revised |
| TA-1130 | Definitions and Terms | Revised definitions of: challenge aerosol, in-service test, test canister, habitability envelope, and acceptance test |
| TA-2000 | Referenced Documents | Revised in its entirety |
| TA-3000 | General Inspection and Test Requirements | Revised in its entirety |
| TA-4000 | Field Acceptance Tests | Revised in its entirety |
| TA-5000 | Corrective Action Requirements | First sentence revised |
| TA-6200 | Personnel | Last sentence revised |
| TA-6310 | Procedures | "Written" deleted from first sentence |
| TA-6320 | Reports | Subparagraph (b) inserted, and all subsequent subparagraphs redesignated |
| TA-I | Visual Inspection Checklist | Revised in its entirety |
| TA-II-3000 | Test Equipment | Subparagraph (c) revised |
| TA-II-5000 | Acceptance Criteria | Revised |
| TA-III-1100 | Duct and housing Leak Test Procedural Guidelines, Summary of Method | Value of 80% revised to 75% |
| TA-III-2000 | Prerequisites | Last sentence revised |
| TA-III-3000 | Test Equipment | Subparagraph (c), (d) and (e) revised |
| TA-III-4100 | Procedural Guidelines | Subparagraph (e) and (g) revised |
| TA-III-4200 | Pressure Decay Test | Revised |
| TA-III-4300 | Acceptance Criteria | Revised |
| TA-IV-1100 | Airflow Distribution Test Procedural Guidelines, Summary of Method | Revised |
| TA-IV-2000 | Prerequisites | Revised |
| TA-IV-3000 | Test Equipment | "Pitot" capitalized |
| TA-IV-4000 | Procedural Guidelines | Revised |
| TA-V-1000 | Air-Aerosol mixing Test Procedural Guidelines | Revised |
| TA-V-2000 | Prerequisites | Sentence added |
| TA-V-4000 | Procedural Guidelines | Revised in its entirety |
| TA-VI-1100 | HEPA Filter Bank In-Place Leak Test Procedural Guidelines, Summary of Method | Revised |

| ARTICLE NUMBER | DESCRIPTION | CHANGE |
|---|---|---|
| TA-VI-3000(c) | Test Equipment (challenge aerosol) | Revised in its entirety |
| TA-VI-4000(b) | Procedural Guidelines | Revised in its entirety |
| TA-VII-1100 | Adsorber Bank In-Place Leak Test Procedural Guidelines, Summary of Method | First sentence revised |
| TA-VII-2000 | Prerequisites | Sentence added |
| TA-VII-3000 | Test Equipment | Subparagraph (c) deleted |
| TA-VII-4000 | Procedural Guidelines | Revised in its entirety |
| TA-A-3000(c) | Nonmandatory Appendix, Test Equipment (pressure-indicating device) | Revised |
| TA-A-4000(d) | Procedural Guidelines | Revised |
| TA-C | Challenge Gas and Aerosol Substitute Selection Criteria | Revised |

## E1.0 REFERENCES

ASME AG-1b, 2007, *Code on Nuclear-Air and Gas-Treatment*, American Society of Mechanical Engineers, New York, New York.

ASME AG-1, 2009, *Code on Nuclear-Air and Gas-Treatment*, American Society of Mechanical Engineers, New York, New York.

ASME NQA-1, 2004, *Quality Assurance Program Requirements for Nuclear Facilities*, American National Standards Institute/American Society of Mechanical Engineers, New York, New York.

ASME NQA-2, 1989, *Quality Assurance Requirements for Nuclear Facility Applications*, American Society of Mechanical Engineers, New York, New York. (Inactive)

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

# APPENDIX F

## ASME AG-1 REVISION IMPACT ON APPENDIX C

| Table F-1<br>ASME AG-1 REVISION IMPACT TO APPENDIX C | | |
|---|---|---|
| **Section** | **Analysis** | **Conclusion** |
| **Section AA, COMMON ARTICLES** | | |
| AA-2000 | There is no alternative for this article; it is required. | All sections that contained a reference to NQA-2 were revised to reference NQA-1. |
| AA-4360 | The ASME Section III Code reference was changed to Subsection NF-3324. | Table C-1 has been revised to reflect the wording in ASME AG-1b-2007 and -2009. The justification is not impacted. |
| AA-5130 | The requirement reference to NQA-2 was revised to reference NQA-1. | Table C-1 has been revised to reflect the wording in ASME AG-1b-2007 and -2009. The justification is not impacted. |
| AA-6310(i) | The requirement reference to ANSI/ASC Z49.1 was revised to reference ANSI/AWS Z49.1. | No Impact |
| AA-6500 | There is no alternative for this subarticle; it is required. | No Impact |
| AA-7200 | Reference to ASME NQA-2 has been replaced with NQA-1. The title of this article has been changed to include receiving and handling in addition to packaging, shipping, and storage. | The Tables in Appendix C have been revised to reflect the wording of ASME AG-1-2009 and to delete the first sentence in the justification regarding NQA-2. |
| AA-8110 | Reference to ASME NQA-2 has been replaced with NQA-1. | The driving requirements for the TFC QAPD (10 CFR 830, Subpart A, and DOE Order 414.1C) were deleted as well as the edition of ASME NQA-1 and subsection used to implement the QAPD. |
| **Section BA, FANS AND BLOWERS** | | |
| BA-1100 | There is no alternative for this subarticle; it is required. | No Impact |
| BA-1110 | There is no alternative for this subsubarticle; it is required. | No Impact |
| BA-1130 | There is no alternative for this subsubarticle; it is required. | No Impact |
| BA-2000 | There is no alternative for this article; it is required. | No Impact |
| BA-3000 | There is no alternative for this article; it is required. | The subarticles below are impacted. |

**Table F-1**
**ASME AG-1 REVISION IMPACT TO APPENDIX C**

| Section | Analysis | Conclusion |
|---|---|---|
| BA-3110 | The first sentence was changed from "numbers in Table BA-3100 designate" to "designation in Table BA-3100 specifies" | Table C-2 has been revised to reflect the wording of ASME AG-1-2009. |
| BA-3400 | The 2003 edition required certified test reports; the 2009 edition adds "when required by the Design Specification." The 2003 edition required a Manufacturer's Certificate of Compliance covering the ASME or ASTM material specification, grade and class for components listed in Tables BA-3410 and BA-3420; this requirement was deleted in the 2009 edition. | A justification is no longer required for subarticle BA-3400; it has been deleted from Table C-2. |
| BA-3500 | The 2003 edition required all purchased items meet the requirements of BA-3100, BA-3200, BA-3300, and BA-3400. The 2009 edition added BA—3110. The alternative addressed subarticle BA-3400, which was changed (see BA-3400) | A justification is no longer required for subarticle BA-3500; it has been deleted from Table C-2. |
| BA-4000 | There are alternatives for eleven subarticles/paragraphs in this article. | Impact (see below) |
| BA-4122 | This paragraph was not revised. | No Impact |
| BA-4131 | This paragraph was not revised. | No Impact |
| BA-4133 | This paragraph was not revised. | No Impact |
| BA-4142 | This requirement is now paragraph BA-4141, "General". | Table C-2 has been revised to reflect the paragraph number and heading in ASME AG-1-2009. |
| BA-4161 | This paragraph was not revised. | No Impact |
| BA-4162 | This paragraph was not revised. | No Impact |
| BA-4163 | This paragraph was not revised. | No Impact |
| BA-4222 | This paragraph was not revised. | No Impact |
| BA-4431 | This paragraph was not revised. | No Impact |
| BA-4432 | This paragraph was not revised. | No Impact |
| BA-4433 | The heading was changed from "Structural Special Considerations" to "Special Considerations." | Table C-2 has been revised to reflect the heading in ASME AG-1-2009. |
| BA-5111 | There is no alternative for this paragraph; it is required. | No Impact |
| BA-5141 | There is no alternative for this paragraph; it | No Impact |

**Table F-1**
**ASME AG-1 REVISION IMPACT TO APPENDIX C**

| Section | Analysis | Conclusion |
|---|---|---|
| | is required. | |
| BA-5142 | BA-4142 was changed to BA-4141 and the headings of BA-5142.1 and BA-5142.2 were changed from "Leakage Tests-Housing" and "Leakage Tests- Shaft" to "Housing" and "Shaft", respectively. | Table C-2 has been revised to reflect the paragraph number and headings in ASME AG-1-2009. |
| BA-5210 | There is no alternative for this subsubarticle; it is required. | No Impact |
| BA-6000 | The word "General" was deleted from the end of the title of this article. BA-6200 is a required subarticle. | Table C-2 has been revised to reflect the title in ASME AG-1-2009. |
| BA-7000 | The "General" Section is now subarticle 7100; "Packaging, shipping, and storage" was changed to "Packaging, shipping, receiving, storage and handling"; and "unless otherwise required by the Design Specification" was added at the end of the last sentence. An alternative is taken to all subsections of AA-7000 in Table C-1. | Table C-2 has been revised to reflect the subarticle number. The first and last sentences have been revised to reflect the wording in ASME AG-1-2009. |
| BA-8000 | The "General" Section is now subarticle 8100 and the requirement has been expanded. An alternative is taken to all subsections of AA-8000 in Table C-1. | Table C-2 has been revised to reflect the subarticle number. The requirement has been revised to reflect the wording in ASME AG-1-2009. |
| BA-8120 | The requirement of subsubarticle BA-8120 has been moved to BA-8220; subarticle BA-8120 has been deleted. The title changed from "Material Certifications" to "Material Certification." The alternative is not changed. | Table C-2 has been revised to reflect the subarticle number and title in ASME AG-1-2009. |
| BA-8200 | Subarticle BA-8200 has been deleted. This requirement was not located in ASME AG-1-2009. | BA-8200 has been deleted from Table C-2. |
| BA-9110 | The requirement of subsubarticle BA-9110 has been moved to BA-9210; subarticle BA-9120 has been deleted. The alternative is not changed. | Table C-2 has been revised to reflect the subarticle number in ASME AG-1-2009. |
| BA-A | There is no alternative for this Nonmandatory Appendix. | No Impact |
| BA-B | There is no alternative for this Nonmandatory Appendix. | No Impact |
| **Section HA, HOUSINGS** | | |

**Table F-1**
**ASME AG-1 REVISION IMPACT TO APPENDIX C**

| Section | Analysis | Conclusion |
|---|---|---|
| HA-3111 | There is no alternative for this paragraph; it is required. | No Impact |
| Table HA-3110 | There is no alternative for this table. | No Impact |
| **Section CA, CONDITIONING EQUIPMENT** | | |
| Table CA-3230 | There is no alternative for this table. | No Impact |
| Table CA-3310 | There is no alternative for this table. | No Impact |
| Table CA-3410 | There is no alternative for this table. | No Impact |
| **Section FA, MOISTURE SEPARATORS** | | |
| FA-1000 | There is no alternative for this article; it is required. | No Impact |
| FA-2000 | There is no alternative for this article; it is required. | No Impact |
| FA-3000 | There is no alternative for this article; it is required. | The subarticles below are impacted. |
| FA-3100 | The requirements for the materials listed in this subarticle have been moved to subsubarticles and some of the headings have changed. The requirement for alternative pad materials to meet UL900, Class 1 requirements has been deleted from ASME AG-1-2009. | The justification for BA-3100 has been deleted from Table C-7. |
| FA-3200 | The heading has changed from "Limits" to "Limitations" and the requirement wording has been revised. | Table C-7 has been revised to reflect the wording in ASME AG-1-2009. The justification has been revised to eliminate the reference to FA-3100. |
| FA-4000 | There is no alternative for this article; it is required; however, the subarticles below are impacted. | No impact |
| FA-4230 | The requirement wording has been revised. | Table C-7 has been revised to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| FA-4310 | The requirement wording has been revised. | Table C-7 has been revised to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| FA-4320, FA-4330, and FA-4340 | The requirements wording has been revised and definitions duplicated in paragraphs AA-4211 and AA-4212 have been deleted. | Table C-7 has been revised to reflect the wording in ASME AG-1-2009. The justification is not impacted. |

**Table F-1**
**ASME AG-1 REVISION IMPACT TO APPENDIX C**

| Section | Analysis | Conclusion |
|---|---|---|
| FA-5000 | The requirement of FA-5000 was not revised; however, there are alternatives for seven subarticles/paragraphs in this article (see below). | No Impact |
| FA-5100 | The requirement wording has been revised and a new requirement was added: "Tests shall be performed and certified by an independent test facility." | Table C-7 has been revised to reflect the wording in ASME AG-1-2009. The justification has been revised to include the new requirement. |
| FA-5200 | The requirement wording has been revised. | Table C-7 has been revised to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| FA-5220 | This subsubarticle and associated paragraphs were not revised. | No Impact |
| FA-5230 | The requirement wording has been revised and the maximum pressure drop value has been moved to Table FA-4200-1. | Table C-7 has been revised to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| FA-5240 | This requirement has been moved to FA-5110 and the wording has been revised. | Table C-7 has been revised to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| FA-5250 | This requirement has been moved to FA-5120 and the wording has been revised; also the referenced Table has a revised number (Table FA-4200-1). | Table C-7 has been revised to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| FA-5260 | This requirement has been moved to FA-5130 and the wording has been revised; also the referenced Table has a revised number (Table FA-4200-1). | Table C-7 has been revised to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| FA-6000 | The general requirement of FA-6000 was revised to reference AA-6200 and AA-6300. One subarticle has an alternative (FA-6100) and requirement FA-6300 was added; see below. | Table C-7 has been revised to reflect the wording in ASME AG-1-2009 and reference the appropriate justifications in Table C-1. |
| FA-6100 | The requirement wording has been revised to reference AA-6300 instead of AA-6000. | Table C-7 has been revised to reflect the wording in ASME AG-1-2009 and to reference AA 6300 instead of AA-6000. |
| FA-6300 | An alternative is taken to this subarticle. | Table C-7 has been revised to add this requirement, describe the chosen alternative and |

**Table F-1**
**ASME AG-1 REVISION IMPACT TO APPENDIX C**

| Section | Analysis | Conclusion |
|---|---|---|
| | | justification. |
| FA-7000 | There is no alternative for this article; it is required | No impact |
| FA-8000 | The requirement wording has been revised and the section had been revised. One subarticle has an alternative (FA-8100) and requirement FA-8300 was added; see below. | Table C-7 has been revised to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| FA-8100 | This requirement has been moved to FA-8200 and the documentation requirements have been revised; | A justification is no longer required for subarticle FA-8100; it has been deleted from Table C-2. |
| FA-8300 | An alternative is taken to this subarticle. | Table C-7 has been revised to add this requirement, describe the chosen alternative and justification. |
| FA-9000 | A requirement that the moisture separator have a UL label indicating successful testing per UL900 has been added to subarticle FA-9100. | Table C-7 has been revised to add this requirement, describe the chosen alternative and justification. |
| FA-A | There is no alternative for this Nonmandatory Appendix. | No Impact |
| **Section FB, MEDIUM EFFICIENCY FILTERS** | | |
| FB-5210 | An alternative is taken to this subarticle. | Table C-7 has been revised to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| **Section FC, HEPA FILTERS** | | |
| FC-1000 | There is no alternative for this article; it is required. | No Impact |
| FC-2000 | There is no alternative for this article; it is required. | No Impact |
| FC-3000 | There is no alternative for this article; however, there are alternatives for two subsubarticles in this article (see below). | No Impact |
| FC-3140 | Metallic faceguard materials now include the option to use 304 stainless steel, ASTM A 580; therefore no alternative is needed. | Table C-9 has been revised to delete this justification. |
| FC-3210 | This alternative was written to clarify that HEPA filters may use alternate materials, such as stainless steel. Due to the revision | Table C-9 has been revised to delete justification. |

| Table F-1<br>ASME AG-1 REVISION IMPACT TO APPENDIX C | | |
|---|---|---|
| **Section** | **Analysis** | **Conclusion** |
| | to FC-3140, this alternative is not needed. | |
| FC-4000 | There is no alternative for this article; however, there is an alternative for one Table in this article (see below). | No Impact |
| Table FC-4110 | The requirement wording has not been revised. | No Impact |
| FC-5000 | There is no alternative for this article; however, there is an alternative for one subarticle in this article (see below). | No Impact |
| FC-5100 | The requirement wording has not been revised. | No Impact |
| FC-6000 | There is no alternative for this article; it is required. | No Impact |
| FC-7000 | There is no alternative for this article; it is required. | No Impact |
| FC-8200 | There is no alternative for this subarticle; it is required. | No Impact |
| FC-9000 | There is no alternative for this article; it is required. | No Impact |
| FC-I-2000 | There is no alternative for this article; it is required. | No Impact |
| FC-I-3000 | There is no alternative for this article; it is required. | No Impact |
| FC-I-4000 | There is no alternative for this article; it is required. | No Impact |
| FC-I-5000 | There is no alternative for this article; it is required. | No Impact |
| FC-A-1000 | There is no alternative for this Nonmandatory Table. | No Impact |
| **Section FE, TYPE III ADSORBERS** | | |
| FE-2000 | There is no alternative for this article; it is required. | No Impact |
| FE-3140(a) | There is no alternative for this article; it is required. | No Impact |
| **Section FG, MOUNTING FRAMES** | | |
| FG-I | The requirements of Mandatory Appendix FG-I were incorporated into the body of Section FG. | The heading in Section 4.4.14 has been revised to reflect the wording in AG-1-2009. Mandatory FG-I has been deleted from Table C-10, see below. |
| FG-II | The requirements of Mandatory Appendix | Mandatory FG-II has been |

| Table F-1<br>ASME AG-1 REVISION IMPACT TO APPENDIX C | | |
|---|---|---|
| **Section** | **Analysis** | **Conclusion** |
| | FG-I were incorporated into the body of Section FG. | deleted from Table C-10, see below. |
| FG-4110 | FG-I-1100, HEPA Filter Mounting Frame Dimensions, has been moved to FG-4110 and revised. | Added FG-4110 to Table C-10 and revised the requirement to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| FG-4112 | FG-I-1200, HEPA Filter Clamping, has been moved to FG-4112 and revised. | Added FG-4112 to Table C-10 and revised the requirement to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| FG-4113 | FG-I-1300, HEPA Filter Support, has been moved to FG-4113 and revised. | Added FG-4113 to Table C-10 and revised the requirement to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| FG-4121 | FG-II-1000, Mounting Frame Dimensions, has been moved to FG-4121, Type II Adsorber Cell Mounting Frame Dimensions, and revised. | Added FG-4121 to Table C-10 and revised the requirement to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| FG-4122 | FG-II-1100, Clamping, has been moved to FG-4122, Type II Adsorber Cell Clamping and revised. | Added FG-4122 to Table C-10 and revised the requirement to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| FG-4151 | FG-I-1210 and FG-II-1110, Galling Prevention, have been combined and moved to FG-4151 and revised. | Added FG-4151 to Table C-10 and revised the requirement to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| FG-6300 | An alternative is taken to this subarticle. | No Impact |
| FG-9000 | An alternative is taken to this subarticle. | Table C-10 has been revised to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| **Section IA, INSTRUMENTATION AND CONTROLS** | | |
| IA-3100 | There is no alternative for this article; it is required. | No Impact |
| **Section TA FIELD TESTING OF AIR TREATMENT SYSTEMS** | | |
| TA-1120 | There is no alternative for this article; it is | No Impact |

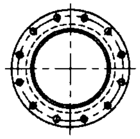
**Table F-1**
**ASME AG-1 REVISION IMPACT TO APPENDIX C**

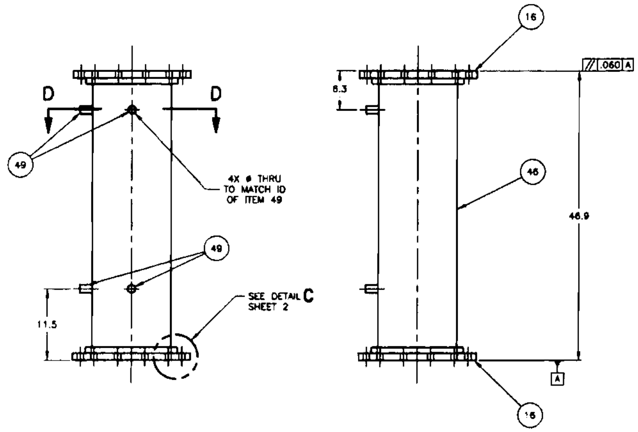
| Section | Analysis | Conclusion |
|---|---|---|
| | required. | |
| TA-1130 | There is no alternative for this article; it is required. | No Impact |
| TA-2000 | There is no alternative for this article; it is required. | No Impact |
| TA-3000 | There is no alternative for this article; it is required; however, there are alternatives for three sections in this article (see below). | No Impact |
| TA-3400 | The requirement wording has been revised. | Table C-12 has been revised to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| TA-3510 | The requirement wording has been revised. | Table C-12 has been revised to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| TA-3522 | The requirement wording has not been revised. | No Impact |
| TA-4000 | The requirement wording has been revised. In addition, there are alternatives for fifteen sections in this article (see below). | Table C-12 has been revised to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| TA-4110 | The requirement wording has not been revised. | No Impact |
| TA-4130 | The requirement wording has not been revised. | No Impact |
| TA-4150 | The requirement wording has not been revised. | No Impact |
| TA-4158 | The requirement wording has not been revised. | No Impact |
| TA-4160 | The requirement wording has not been revised. | No Impact |
| TA-4210 | The requirement wording has been revised. | Table C-12 has been revised to reflect the wording in ASME AG-1-2009. The justification is not impacted. |
| TA-4231 | The requirement wording has not been revised. | No Impact |
| TA-4232 | The requirement wording has not been revised. | No Impact |
| TA-4310 | The requirement wording has not been revised. | No Impact |

**Table F-1**
**ASME AG-1 REVISION IMPACT TO APPENDIX C**

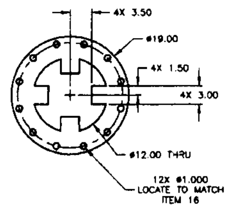
| Section | Analysis | Conclusion |
|---|---|---|
| TA-4331 | The requirement wording has not been revised. | No Impact |
| TA-4510 | The requirement wording has not been revised. | No Impact |
| TA-4550 | The requirement wording has not been revised. | No Impact |
| TA-4556 | The requirement wording has not been revised. | No Impact |
| TA-4557 | The requirement wording has not been revised. | No Impact |
| TA-4558 | The requirement wording has not been revised. | No Impact |
| TA-5000 | There is no alternative for this article; it is required. | No Impact |
| TA-6200 | There is no alternative for this subarticle; it is required. | No Impact |
| TA-6310 | There is no alternative for this subsubarticle; it is required. | No Impact |
| TA-6320 | There is no alternative for this subsubarticle; it is required. | No Impact |
| TA-I | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-II-3000 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-II-5000 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-III-1100 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-III-2000 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-III-3000 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-III-4100 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-III-4200 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-III-4300 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-IV-1100 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-IV-2000 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |

| Table F-1<br>ASME AG-1 REVISION IMPACT TO APPENDIX C | | |
|---|---|---|
| **Section** | **Analysis** | **Conclusion** |
| TA-IV-3000 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-IV-4000 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-V-1000 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-V-2000 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-V-4000 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-VI-1100 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-VI-3000(c) | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-VI-4000(b) | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-VII-1100 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-VII-2000 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-VII-3000 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-VII-4000 | There is no alternative for this Mandatory Appendix; it is required. | No Impact |
| TA-A-3000(c) | There is no alternative for this Nonmandatory Appendix. | No Impact |
| TA-A-4000(d) | There is no alternative for this Nonmandatory Appendix. | No Impact |
| TA-C | There is no alternative for this Nonmandatory Appendix. | No Impact |

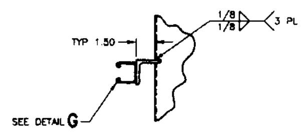




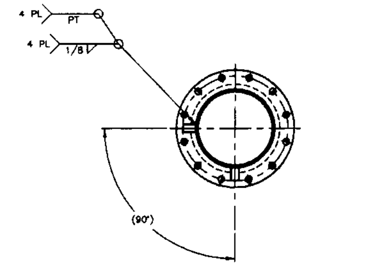

4 LOWER STACK WELDMENT
SCALE: 1/8



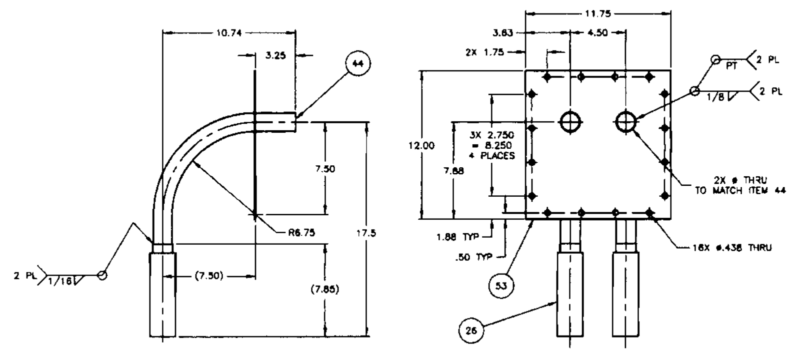

8 FLANGE
SCALE: 1/8



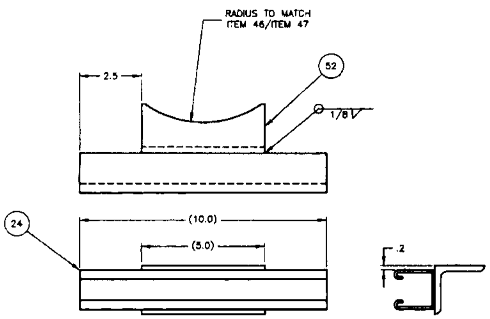

DETAIL F
SCALE: 1/4
FROM SHEET 2



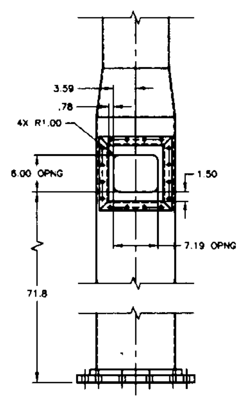

SECTION D–D
SCALE: 1/8




5 PROBE WELDMENT
SCALE: 1/4




DETAIL G
SCALE: 1/2
(3 REQD)




VIEW H–H
SCALE: 1/8
FROM SHEET 2

NOTES:

1. FOR PARTS LIST AND GENERAL NOTES SEE SHEET 1.
2. REVISION 4 OF THIS DRAWING WAS FIELD WALKED DOWN IN OCTOBER 2010. FOR CHANGES MADE AND FOR ITEMS NOT VERIFIED IN FIELD, SEE ECN-10-001455.

DIMENSIONING AND TOLERANCING SHALL BE INTERPRETED PER ANSI Y14.5M-1994
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED
UNSPECIFIED TOLERANCES SHALL BE:
DECIMAL .X ±.1 .XX ±.06 .XXX ±.030
ANGULAR ± 1°
ALL IMPLIED 90° ANGLES SHALL BE PERPENDICULAR WITHIN THE GREATEST TOLERANCE OF THE LINEAR DIMENSIONS
ALL COAXIAL FEATURES SHALL BE CONCENTRIC WITHIN .031 INCH UNLESS OTHERWISE SPECIFIED

| DWG NO | TITLE | REF NUMBER | TITLE |
|---|---|---|---|
| DRAWING TRACEABILITY LIST | | REFERENCES | |
| | | NEXT USED ON SHEET 1 | |

REVISIONS: 5 — DIRECT REV PER ECN-10-001455

SEE REVISION 0

FEB 16 2011 — RELEASE 78

U.S. DEPARTMENT OF ENERGY
Office of River Protection

AN241-VTP (W-314)
EXHAUSTER TRAIN "A" UPPER & LOWER STACK ASSEMBLIES

F | 241AN | 8900 | H-14-105531 | 5

SCALE: SHOWN | 820447 | SHEET 3

H-14-105531

Station 48 S

SEP 08 2004 **ENGINEERING DATA TRANSMITTAL**

1. EDT 821123
1A. Page 1 of 1

| | | |
|---|---|---|
| 2. To: (Receiving Organization) Distribution | 3. From: (Originating Organization) Project W-314, Tank Farm Restoration and Safe Operations | 4. Related EDT No.: N/A<br>7. Purchase Order No.: N/A |
| 5. Proj./Prog./Dept./Div.: W-314 | 6. Design Authority/Resp. Engr./Design Agent: D.E Bowers | 9. Equip./Component No.: 241-AN/AW<br>10. System/Bldg./Facility: VTP |
| 8. Originator Remarks: For approval and release of a supporting calculation | | 12. Major Assembly Dwg. No.: H-14-104459<br>13. Permit/Permit Application No.: N/A |
| 11. Receiver Remarks: | 11A. Design Basis Document? ☒ Yes ☐ No | 14. Required Response Date: |

15. DATA TRANSMITTED

| (A) Item No. | (B) Document/Drawing No. | (C) Sheet No. | (D) Rev. No. | (E) Title or Description of Data Transmitted | (F) Approval Designator | (G) Reason for Transmittal | (H) Originator Disposition | (I) Receiver Disposition |
|---|---|---|---|---|---|---|---|---|
| 1 | RPP-22211 | --- | 0 | 241-AN/AW VTPStack Flow Transmitter | EQ | 1 | 1 | |
| | | | | Maintenance Calculation | | | | |
| | | | | | | | | |

16. KEY

| Approval Designator (F) | Reason for Transmittal (G) | Disposition (H) & (I) |
|---|---|---|
| See TFC-ESHQ-Q-INSP-C-05 | 1. Approval 2. Review 3. Post-Review | 1. Approved 2. Approved w/comment 3. Reviewed no comment 4. Reviewed w/comment 5. Disapproved |

17. SIGNATURE/DISTRIBUTION

| (G) Reason | (H) Disp. | (J) Name | (K) Signature | (L) Date | (M) MSIN | (G) Reason | (H) Disp. | (J) Name | (K) Signature | (L) Date | (M) MSIN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | Design Auth. D.E. Bowers | D E Bowers | 8/24/04 | S5-07 | | | | | | |
| 1 | 1 | Resp. Engr. O.D. Nelson | O. Nelson | 8/19/04 | R3-25 | | | | | | |
| 1 | 1 | Resp. Mgr C JORGENSEN ~~B.H. Thacker~~ | [signature] | 9/7/04 | S5-07 | | | | | | |
| 1 | 1 | QA T.L Bennington | [signature] | | R3 25 | | | | | | |
| | | Safety | | | | | | | | | |
| 1 | 1 | Env. J.D. Guberski | J D Guberski | 8/31/04 | R1-51 | | | | | | |
| | | Design Agent | | | | | | | | | |

| | | |
|---|---|---|
| 18. [signature] 08/17/04<br>Signature of EDT Originator / Date<br>CHRIS J. RAYMOND | 19. DOE APPROVAL (if required)<br>Ctrl. No. N/A | 20. [signature] 9/7/04<br>Design Auth./Resp. Engr./Resp. Mgr. / Date<br>C. Jorgensen |

BD-7400-172.2 (08/03)

# 241-AN/AW VTP Stack Flow Transmitter Maintenance Calculation

**BD Andres**
Vista Engineering for CH2M Hill Hanford Group
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-99RL14047

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Key Words: Project W-314, 241-AN, 241-AW, Primary Ventilation System

Abstract: This document provides the basis for leak testing acceptance criteria for the Project W-314 241-AN and 241-AW Primary Ventilation System stack volumetric flow measurement system for compliance with ANSI/HPS N13.1-1999.



9/7/04
Release Approval    Date

DATE: SEP 08 2004
STA: 4    HANFORD RELEASE    ID: 8
Release Stamp

**Approved For Public Release**

**Calculation Review Checklist.**

Calculation Reviewed: 241-AN/AW STACK FLOW TRANSMITTER MAINTENANCE CALCULATION

Scope of Review: ENTIRE CALCULATION
(e.g., document section or portion of calculation)

Engineer/Analyst: CHRIS J. RAYMOND Date: 8/17/04

Organizational Mgr: B.H. THACKER Date: 8/17/04

This document consists of 14 pages and the following attachments (if applicable):

| Yes | No | NA* | | |
|---|---|---|---|---|
| [X] | [ ] | [ ] | 1. | Analytical and technical approaches and results are reasonable and appropriate. |
| [X] | [ ] | [ ] | 2. | Necessary assumptions are reasonable, explicitly stated, and supported. |
| [ ] | [ ] | [X] | 3. | Ensure calculations that use software include a paper printout, microfiche, CD ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process. |
| [X] | [ ] | [ ] | 4. | Input data were checked for consistency with original source information. |
| [ ] | [ ] | [X] | 5. | For both qualitative and quantitative data, uncertainties are recognized and discussed. |
| [X] | [ ] | [ ] | 6. | Mathematical derivations were checked including dimensional consistency of results. |
| [X] | [ ] | [ ] | 7. | Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information. |
| [ ] | [ ] | [X] | 8. | Software verification and validation are addressed adequately. |
| [X] | [ ] | [ ] | 9. | Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references. |
| [X] | [ ] | [ ] | 10. | Conclusions are consistent with analytical results and applicable limits. |
| [X] | [ ] | [ ] | 11. | Results and conclusions address all points in the purpose. |
| [X] | [ ] | [ ] | 12. | Referenced documents are retrievable or otherwise available. |
| [X] | [ ] | [ ] | 13. | The version or revision of each reference is cited. |
| [X] | [ ] | [ ] | 14. | The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions." |
| [X] | [ ] | [ ] | 15. | All checker comments have been dispositioned and the design media matches the calculations. |

R.D. GUSTAVSON R.D. Gust 8/17/04 RDG 8/24/04
Checker (Printed Name and Signature) Date

* If No or NA is chosen, an explanation must be provided on or attached to this form.

**Title:** **Stack Flow Transmitter Maintenance Calculation** **Rev: 0**

**Originator:** **Raymond, Christopher J** **Date:** 8/16/04

**Checker:** **Gustavson, Robert D** R. D. Gust **Date:** 8/17/04

**Organizational Manager:** C SORGENSEN **Date:** 9/7/04

**Objective/Purpose:** The object of this analysis is to calculate the leak test parameters and acceptance criteria pertaining to the stack flow measurement system on the new Project W-314 Primary Ventilation System for 241-AN/AW tank farms. The purpose of this calculation is to comply with ANSI/HPS N13.1-1999, *Maintenance Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities*, for annual surveillance/inspection requirements on stack volumetric flow measurement systems.

**Introduction:** ANSI N13.1-1999 requires an annual inspection of volumetric flow measurement systems which includes checking the system for leaks. The system being tested consists of a Pitot Tube, two tubes (one for static pressure and one for velocity pressure)that follow a portion of the stack and frame height and connect to a Yokogawa differential pressure transmitter mounted on the frame (See Attachment 2). The differential pressure transmitter communicates with a PLC that converts the measured pressure to a flow rate.

**Discussion:** ANSI N13.1-1999 specifies during the annual inspection, that the system shall be checked for leaks. Leakage at average flow conditions shall not affect the results of differential pressure by more than 1%. Veris Verabar flow calculations show a nominal pressure differential at 0.4 in. WG (Attachment 3), so the total pressure drop through the system must not exceed 0.004 in. WG. This nominal pressure differential corresponds to the exhauster lower design stack flow rate of 1000 scfm.

**Input Data:** See attachment 2 for the physical properties of the stack flow system. Also see attachment 3 for Veris Verabar flow calculations. To comply with equation parameters the leak properties must remain in laminar conditions.

**Assumptions:**

- Tube outside diameter = 0.5 in.
- Tube wall thickness = .049 in.
- Standard Pressure and Temperature
- Differential pressure due to altitude change is negligible
- A conservative number of 13 pipe bends, All bends assumed to be 90 degrees
- Tube length 25 ft that is the static tube only
- Bend ratio conservative with r/d=1, and loss coefficient K=.35 < ref 1 pg.428 >
- Pipe Inlet loss coefficient K = .5 < ref 1 pg.428 >
- Velocity is tangent to streamline "That is, since there is no flow through impervious boundaries, all velocity vectors of the flow adjacent to the boundaries must be parallel to the boundary." < Ref 1 pg 100 >
- Constant density

**Title:** **Stack Flow Transmitter Maintenance Calculation** **Rev: 0**

**Originator:** **Raymond, Christopher J** **Date:** 8/19/04

**Checker:** **Gustavson, Robert D** R.D. Gust **Date:** 8/24/04

**Method of Analysis:** ANSI N13.1 requires periodic verification that stack volumetric flow measurement systems are accurate. Procedure 3-FCD-647 was written to perform this periodic check. If the installed indication deviates from the measured indication, one of the possible causes is due to a leak in one of the flow indication instrument lines. Procedure 3-FCD-647 verifies the integrity of the instrument lines by conducting a pressure leak test. This calculation provides the acceptance criteria for the leak rate.

The instrument tube leakage acceptance criteria based on ANSI N13.1 section 6.2.2.2 requirement, states "During the annual inspection, the system shall be checked for leaks. Leakage at average flow conditions shall not affect the results of differential pressure by more than 1%". < Ref. 4 > The normal operating flow range of the AN and AW exhauster is 1000 - 2000 scfm and corresponds to a differential pressure of approximately 0.4 - 2.0 in WG. To be conservative (lowest leak rate), the differential pressure associated with the lowest flow rate is used. This would be 1% of 0.4 in WG for a stack flow rate of 1000 scfm. The approach of this calculation is to determine the flow rate through one leg of the flow indication instrument tubing that would result in a pressure drop of 0.004 in WG at the differential pressure transmitter.

An iterative process was used to determine the flow rate because velocity is in the range of the input parameters and in the domain of the velocity pressure (steps 1-5 below). Once the flow rate that generated a pressure drop of 0.004 in WG was determined, the calculated leak rate from the instrument tube was applied to the pressure decay formula in ASME AG-1. < Ref. 3 pg. 632 > This formula was used to calculate final pressure (given initial pressure of 10 in. WG and 15 minute test time) and the time to exceed the parameter of the ASME AG-1 test (the acceptable amount of time to drop from 10 in. WG to 0 in. WG).

The summary of the approach used in this calculation is:

1. Assume a flow rate that would result in a 0.004 in. WG pressure drop
2. Calculate velocity, Reynolds number, friction factor and velocity pressure
3. Calculate major and minor losses
4. Calculate total pressure drop
5. If the total pressure drop is equal to 0.004 in. WG then continue to step 6 otherwise start over with step 1 with new assumed flow rate.
6. Calculate final pressure over a 15 minute time period given an initial pressure of 10 in. WG
7. Calculate time required to decay pressure from 10 in. WG to 0 in. WG
8. Specify acceptance criteria for periodic pressure test for result/conclusion

**Title:** **Stack Flow Transmitter Maintenance Calculation** **Rev: 0**

**Originator:** **Raymond, Christopher J** **Date:** 8/16/04

**Checker:** **Gustavson, Robert D** R.D. Gust **Date:** 8/17/04

**Results/Conclusion:** Leak test calculations pertaining to the stack flow system on the new Project W-314 Primary Ventilation System on 241-AN/AW farms have produced a value to comply with ANSI/HPS N13.1-1999 Stack Flow Transmitter surveillance/inspection maintenance calculation annual requirements on volumetric flow measurement systems. The calculation verified a flow rate of 0.0042 scfm would result in a pressure loss of 0.004 in. WG which is equivalent to 1% of the system differential pressure. Calculation step 7 shows that if the system holds a positive pressure after a period of 16 seconds, given a starting pressure of 10 in. WG, the system complies with the leak test requirements of ANSI N13.1-1999.

**Recommendation:** It is recommended that a 15 minute leak test be completed with a starting pressure of 10 in. WG and a final test pressure greater than 5 in. WG.

**References:**

1. Roberson, John A., and Clayton T. Crowe, 1990 *Engineering Fluid Mechanics*, fourth edition, Boston, MA.

2. Crane Co *Flow of Fluids Through Valves, Fittings, and Pipe*, Technical paper No.410, New York, 1976

3. ASME AG-1, 2000, American Society of Mechanical Engineers, *Code on Nuclear Air and Gas Treatment*, Article TA-III-4000, "Procedural Guidelines."

4. Health Physics Society, ANSI/HPS N13.1-1999 *Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities*, Mclean, VA.

5. CHG, 2004, Drawing H-14-105531, sheets 1-3, AN241 Exhauster Train "A" Upper and Lower Stack Assemblies, Richland, WA

6. CHG, 2004, Drawing # H-14-105545, sheet 1-3, AN241 Exhauster Train "B" Upper and Lower Stack Assemblies, Richland, WA

7. CHG, 2004, Drawing H-14-105681, Sheets 1-3, AW241 Exhauster Train "A" Upper and Lower Stack Assemblies, Richland, WA

8. CHG, 2004, Drawing H-14-105695, Sheets 1-3, AW241 Exhauster Train "B" Upper and Lower Stack Assemblies, Richland, WA

9. ASHRAE, 1989, ASHRAE Handbook Fundamentals, American Society of Heating, Refrigeration and Air-Conditioning Engineers, INC., Atlanta Georgia.

**Title:** **Stack Flow Transmitter Maintenance Calculation** **Rev: 0**

**Originator:** **Raymond, Christopher J** **Date:** 8/19/04

**Checker:** **Gustavson, Robert D** **Date:** 8/17/04

ATTACHMENT 1: CALCULATIONS

DETERMINE THE FLOW RATE REQUIRED PRODUCING 0.004 in. WG LOSS

**TRIAL A:** ASSUME Q = .003 scfm

1. CALCULATE VELOCITY INSIDE 0.5 INCH TUBE

ASSUME Q = .003 scfm (value estimated)

$V = Q / A$

WHERE: $Q$ = .003 scfm

A = 0.000881 ft^2 < Ref 5, 6, 7, 8 >

Note: References 5-8 all show the same tube properties

**V = 3.4 ft/min = 0.057 ft/s**

2. CALCULATE REYNOLDS #

$Re = DV / \nu$ < Ref 2 pg 3-2 equation 3-3>

WHERE: D = 0.0335 ft

V = 0.057t/s

$\nu$ = 1.58E-04 ft^2/s < Ref 1 pg. A-22 >

**Re = 12.03**

3. CALCULATE FRICTION FACTOR

Note: "The friction factor for laminar flow (Re<2000) is a function of the Reynolds Number only."

$\lambda$ = 64/Re < Ref 2 pg.1-6 >

WHERE: Re = 12.03

**$\lambda$ = 5.32**

**Title:** **Stack Flow Transmitter Maintenance Calculation** **Rev: 0**

**Originator:** **Raymond, Christopher J** [signature] **Date:** 8/16/04

**Checker:** **Gustavson, Robert D** R.D. Gust[signature] **Date:** 8/17/04

ATTACHMENT 1: CONTINUED

4. CALCULATE VELOCITY PRESSURE

Pv = (V/4005)^2 < Ref 9 pg.32.3 equation 13 >

WHERE: V = 3.4 ft/min

**Pv = 7.23E-07 in. WG**

5. CALCULATE MAJOR LOSSES

$\Delta P_{(major)}$ = λ*(12L/D)*Pv < Ref 9 pg.32.4 equation 24>

WHERE: λ = 3.88

L = 25 feet

D = 0.402 in.

Pv = 7.23E-07 in

**$\Delta P_{(major)}$ = 0.0029 in. WG**

6. CALCULATE MINOR LOSSES

ASSUME: r/d = 1 so K = .35 * 13 bends, at inlet K = .5 < ref 1 pg.428 >

$\Delta P_{(minor)}$= ∑K* Pv < Ref 9 >

WHERE: Pv = 7.23E-07 in. WG

∑K = 5.05

$\Delta P_{(minor)}$= 3.65E-06 in. WG

7. CALCULATE TOTAL PRESSURE DROP:

ΔP (total) = ΔP (major) + $\Delta P_{(minor)}$

**ΔP(total) = 0.0029 in. WG < 0.004 in. WG,** therefore Recalculate

Title: Stack Flow Transmitter Maintenance Calculation — Rev: 0

Originator: Raymond, Christopher J [signature] Date: 8/17/04

Checker: Gustavson, Robert D [signature] Date: 8/17/04

ATTACHMENT 1: CONTINUED

**TRIAL B:** ASSUME Q = 0.005 scfm

1. CALCULATE VELOCITY INSIDE 0.5 INCH TUBE

$V = Q / A$

WHERE: $Q$ = .005 scfm

A = 0.000881 ft^2 < Ref 5, 6, 7, 8 >

Note: References 5-8 all show the same tube properties

**V = 5.7 ft/min = 0.095 ft/s**

2. CALCULATE REYNOLDS #

$Re = DV/\nu$ < Ref 2 pg 3-2 equation 3-3>

WHERE: D = 0.0335 ft

V = 0.095t/s

ν = 1.58E-04 ft^2/s < Ref 1 pg. A-22 >

**Re = 20.06**

3. CALCULATE FRICTION FACTOR

Note: "The friction factor for laminar flow (Re<2000) is a function of the Reynolds Number only."

λ = 64/Re < Ref 2 pg.1-6 >

WHERE: Re = 20.06

**λ = 3.19**

4. CALCULATE VELOCITY PRESSURE

Pv = (V/4005)^2 < Ref 9 pg.32.3 equation 13 >

WHERE: V = 5.7 ft/min

**Pv = 2.01E-06 in. WG**

**Title:** **Stack Flow Transmitter Maintenance Calculation** **Rev: 0**

**Originator:** **Raymond, Christopher J** [signature] **Date:** 8/16/04

**Checker:** **Gustavson, Robert D** R.D. Gust[signature] **Date:** 8/17/04

5. CALCULATE MAJOR LOSSES

$\Delta P_{(major)} = \lambda*(12L/D)*Pv$ < Ref 9 pg.32.4 equation 24>

WHERE: $\lambda = 3.19$

L = 25 feet

D = 0.402 in.

Pv = 2.01-06 in.

**$\Delta P_{(major)}$ = 0.00478 in. WG**

6. CALCULATE MINOR LOSSES

ASSUME: r/d = 1 so K = .35 * 13 bends, at inlet K = .5 < ref 1 pg.428 >

$\Delta P_{(minor)} = \sum K * Pv$ < Ref 9 >

WHERE: Pv = 2.01E-06 in. WG

$\sum K = 5.05$

$\Delta P_{(minor)}$ = 1.01E-05 in. WG

7. CALCULATE TOTAL PRESSURE DROP:

$\Delta P\ (total) = \Delta P_{(major)} + \Delta P_{(minor)}$

**$\Delta P$(total) = 0.0048 in. WG > 0.004 in. WG,** therefore Recalculate

**Title:** **Stack Flow Transmitter Maintenance Calculation** **Rev: 0**

**Originator:** **Raymond, Christopher J** [signature] **Date:** 8/16/04

**Checker:** **Gustavson, Robert D** R.D. Gust [signature] **Date:** 8/17/04

ATTACHMENT 1: CONTINUED

**TRIAL C:** ASSUME Q = 0.0042 scfm

1. CALCULATE VELOCITY INSIDE 0.5 INCH TUBE

$V = Q / A$

WHERE: $Q$ = .0042 scfm

A = 0.000881 ft^2 < Ref 5, 6, 7, 8 >

Note: References 5-8 all show the same tube properties

**V = 4.8 ft/min = 0.079 ft/s**

2. CALCULATE REYNOLDS #

$Re = DV/\nu$ < Ref 2 pg 3-2 equation 3-3>

WHERE: D = 0.0335 ft

V = 0.079 ft/s

ν = 1.58E-04 ft^2/s < Ref 1 pg. A-22 >

**Re = 16.85**

3. CALCULATE FRICTION FACTOR

Note: "The friction factor for laminar flow (Re<2000) is a function of the Reynolds Number only."

$\lambda = 64/Re$ < Ref 2 pg.1-6 >

WHERE: Re = 16.85

**λ = 3.8**

**Title:** **Stack Flow Transmitter Maintenance Calculation** **Rev: 0**

**Originator:** **Raymond, Christopher J** [signature] **Date:** 8/17/04

**Checker:** **Gustavson, Robert D** R.D. Gust[signature] **Date:** 8/17/04

ATTACHMENT 1: CONTINUED

4. CALCULATE VELOCITY PRESSURE

Pv = (V/4005)^2 < Ref 9 pg.32.3 equation 13 >

WHERE: V = 4.8 ft/min

**Pv = 1.42E-06 in. WG**

5. CALCULATE MAJOR LOSSES

ΔP*(major)* = λ*(12L/D)*Pv < Ref 9 pg.32.4 equation 24>

WHERE: λ = 3.8

L = 25 feet

D = 0.402 in.

Pv = 1.42E-06 in

**ΔP*(major)* = 0.00402 in. WG**

6. CALCULATE MINOR LOSSES

ASSUME: r/d = 1 so K = .35 * 13 bends, at inlet K = .5 < ref 1 pg.428 >

ΔP*(minor)*= ∑K* Pv < Ref 9 >

WHERE: Pv = 1.42E-06 in. WG

∑K = 5.05

ΔP*(minor)*= 7.16E-06 in. WG

7. CALCULATE TOTAL PRESSURE DROP:

ΔP (total) = ΔP (major) + ΔP*(minor)*

**ΔP(total) = 0.004 in. WG** (meets criteria, continue to step 8)

THEREFORE THE ALLOWABLE LEAK RATE IS 0.0042 scfm

| **Title:** Stack Flow Transmitter Maintenance Calculation | **Rev:** 0 |
|---|---|
| **Originator:** Raymond, Christopher J [signature] | **Date:** 5/19/04 |
| **Checker:** Gustavson, Robert D R.D. Gust [signature] | **Date:** 8/24/04 |

ATTACHMENT 1: CONTINUED

8. CALCULATE PRESSURE DECAY FROM A 15 MINUTE TEST STARTING WITH AN INITIAL PRESSURE OF 10 in. WG:

Qave = ((Pt)i /Ti –(Pt)*f* /Tf)*(Vol/(R*Δt*0.075)) < ref 3 pg.633 >

(Pt)*f* = T*f* *( (Pt)*i*/ T*i* – (Qave*R*Δt*0.075)/Vol))

ASSUME:

P*i* =10 in. WG = 52.0 psf

T*i* = 527.7 R

T*f* = 527.7 R

Δt = 15 min

*Qave* = .0042 scfm

Vol = A*2*L = .022 ft^3 — note: test volume doubled to accommodate both static and dynamic tubes during actual test

Bp = 2116.224 psf

(Pt)*i* = Bp + P*i*

**(Pt)*f* = -2971.23 psfa**

P*f* = (Bp + (Pt)*f*)*27.7/144 (such that 1 in. WG = 1/27.7 psi, and 1 ft^2 = 144 in^2)

**P*f* = -855.00 in. WG**

9. CALCULATE PRESSURE DECAY TIME GIVEN INITIAL PRESSURE OF 10 in. WG AND FINAL PRESSURE OF 0 in. WG

SOLVING FOR Δt

WERE: P*f* = 0 IN.WG

Δt = ((Pt)*i* /T*i* -(Pt)*f* / T*f*)*Vol/(R*0.075* *Qave*)

**Δt = 0.258 min = 15.5 seconds**

**Title:** **Stack Flow Transmitter Maintenance Calculation** **Rev: 0**

**Originator:** **Raymond, Christopher J** [signature] **Date:** 8/16/04

**Checker:** **Gustavson, Robert D** R.D. Gust [signature] **Date:** 8/17/04

ATTACHMENT 1 CONTINUED: NOMENCLATURE

WG = Water Gage

Re = Reynolds Number, unit less

$Q$ = Flow Rate, scfm

A = Area

D = Inside Diameter of Pipe

V = Velocity

ν = Kinematic Viscosity @ 60 degrees F

A = Area

L = ∑of lengths, in feet

λ = friction factor, unit less

Pv = Velocity Pressure, in. WG

ΔP = Pressure Drop

K = Resistant Coefficient

$Q_{ave}$ = Average Leak Rate, scfm (sm^3/s). [air density = 0.075 lb/ft^3]

P*i* = Initial Pressure With in Test Boundary, lb/ft^2

P*f* = Final Pressure With in Test Boundary, lb/ft^2

T*i* = Absolute Temperature at Start of test, R

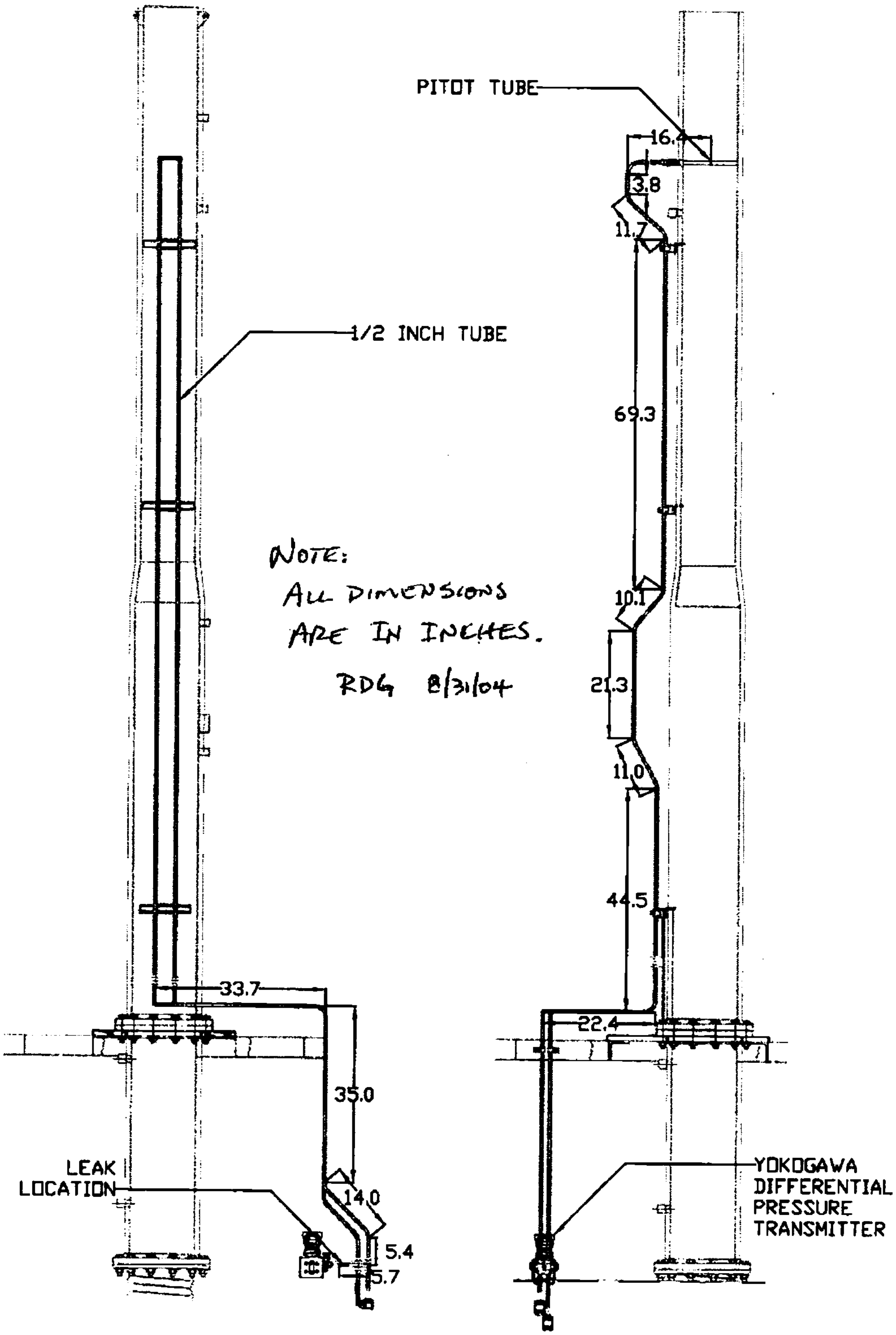
T*f* = Absolute Temperature at end of test, R

Δt = Time Difference

Vol = Volume in ft^3

R = gas constant = 53.35 ft lb/(lb*deg R)

BP = Barometric pressure @ STP in psf = 14.967*144 = 2116.224




NOTE:
ALL DIMENSIONS
ARE IN INCHES.
RDG 8/31/04

VERIS Verabar.

# Flow Calculation

Veracalc
Version Beta 1.3

| | | | |
|---|---|---|---|
| Model No.: | V100 (10 in SCH 40) -10-V-D | Customer: | PREMIER TECHNOLOGIES, INC. |
| Serial No.: | 220747 | Customer PO: | Q220747 |
| Tag No.: | Jeff Schutte | Processed By: | Jerry Cooke |
| | | Veris Ref.: | |
| Pipe Size: | 10 in SCH 40<br>ID = 10.02 Wall = 0.365 | Process Date: | 12-13-2002 10:29:50 |
| | | File Name: | Q220747.vfc |
| Process: | GAS | Fluid Name: | Air |

## I. Flow Equation

Standard Volumetric Flow Rate for Gases

$$Q_v = C' \cdot \sqrt{\frac{h_w \cdot P_{fa}}{T_{fa} \cdot Z_f}} \qquad h_w = \left[\frac{Q_v}{C'}\right]^2 \cdot \left[\frac{T_{fa} \cdot Z_f}{P_{fa}}\right]$$

$$C' = \frac{N \cdot K \cdot Y_v \cdot D^2}{\sqrt{G_i}} \cdot \left[\frac{T_{ba} \cdot Z_b}{P_b}\right]$$

Tfa = Tf + 459.67
Tba = Tb + 459.67
Pfa = Pf + 407.52

## II. Constants

| Term | Description | Value | Units |
|---|---|---|---|
| N | Numeric Constant | 0.6914899 | |
| K | Flow Coefficient | .7505 | |
| D | Pipe ID | 10.02 | in |
| $P_a$ | Atmos Pressure | 14.69595 | psi |
| k | Ratio of Sp Heat | 1.36 | |
| $Z_b$ | Base Compress | 1 | |
| $T_b$ | Base Temperature | 59 | F |
| $P_b$ | Base Pressure | 14.69595 | psi |

## III. Flow Rate and Differential Pressure

| Term | Description | Maximum | Nominal | Minimum | Units |
|---|---|---|---|---|---|
| $Q_v$ | Standard Volumetric Flow Rate | 3000 | 1000 | 400 | SCFM |
| C' | Flow Constant | 1836.67 | 1838.82 | 1839.02 | |
| $P_f$ | Flowing Pressure | 2 | .5 | .5 | in H2O(68F) G |
| $T_f$ | Flowing Temperature | 170 | 95 | 80 | F |
| $G_i$ | Ideal Gas Specific Gravity | 1 | 1 | 1 | S.G. Ideal |
| $Y_v$ | Expansion Factor | .9987 | .9999 | 1.0000 | |
| $Z_f$ | Flowing Compressibility | 0.999869 | 0.999611 | 0.99954 | |
| $h_w$ | Differential Pressure | 4.1 | 0.4 | 0.06 | in H2O(68F) |

## V. Structural Limits

| Term | ANSI Eq | at User's Maximum | Ultimate Maximum | Limiting Factor |
|---|---|---|---|---|
| Max Temp | ANSI 600 | 800 F at 0 PSI G | 800 F at 330 PSI G | Instrument Head |
| Max Press | ANSI 300 | 505 PSI G at 170 F | 720 PSI G at 100 F | Sensor |

Maximum Allowable Flow Rate: 16621.63 SCFM (137.2 in H2O(68F))
Maximum Insert/Retract Flow Rate:

## V. Notes

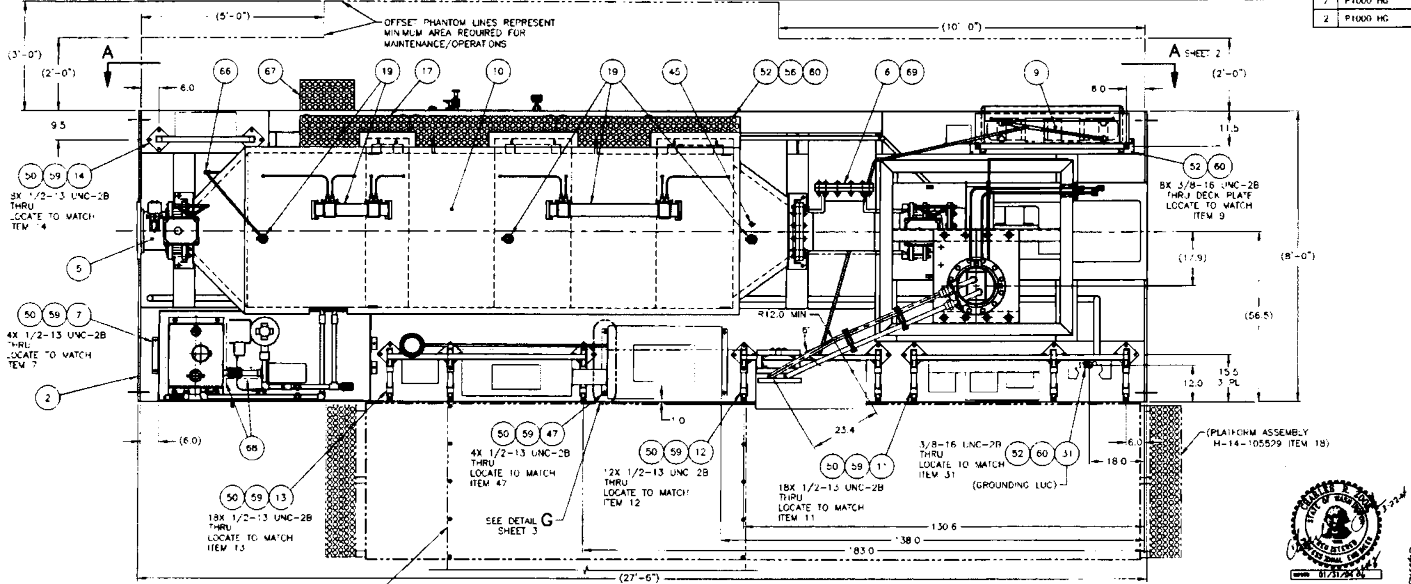
Verified Signature: ____________

## PARTS LIST/MATERIAL LIST

| QTY -010 | PARTS / DASH NUMBER | NOMENCLATURE/DESCRIPTION | MATERIAL/REFERENCE | SHEET | ITEM NO |
|---|---|---|---|---|---|
| X | -010 | ASSEMBLY, VENTILATION EXHAUSTER "B" | | 1 | 1 |
| 1 | H-14-105544-010 | SKID WELDMENT | | | 2 |
| 1 | H-14 105545-010 | UPPER STACK ASSEMBLY | | | 3 |
| 1 | H-14-105545-020 | LOWER STACK ASSEMBLY | | | 4 |
| 1 | H-14-105546-010 | INLET SPOOL ASSEMBLY | | | 5 |
| 1 | H-14-105547-010 | OUTLET SPOOL ASSEMBLY | | | 6 |
| 1 | H-14-105548-010 | HEATER ASSEMBLY | | | 7 |
| 1 | H-14-105549-010 | SEAL POT ASSEMBLY | | | 8 |
| 1 | H-14-105550-010 | EFFLUENT MONITORING PUMP ASSEMBLY | | | 9 |
| 1 | 02 HD 295 | FILTER SYSTEM (LEFT HAND) | FLANDERS/CSC | | 10 |
| 1 | H-14-105552 010 | UNISTRUT ASSEMBLY | | | 11 |
| 1 | H-14-105552-020 | UNISTRUT ASSEMBLY | | | 12 |
| 1 | H-14-105552 030 | UNISTRUT ASSEMBLY | | | 13 |
| 1 | H-14-105552-040 | UNISTRUT ASSEMBLY | | | 14 |
| 1 | H-14 105553-010 | STACK SUPPORT PLATE | | | 15 |
| | | | | | 16 |
| 1 | H-14-105553-030 | OPEN GRIP PLANK ASSEMBLY | | | 17 |
| | | | | | 18 |
| 1 | H-14-105554-010 | INSTRUMENT ASSEMBLY | | | 19 |
| 1 | H-14-105577-010 | FIELD TERMINAL ENCLOSURE ASSEMBLY | | | 20 |
| 1 | H-14 105578-010 | PLC CABINET ASSEMBLY | | | 21 |
| 1 | H-14-105579-010 | POWER ASSEMBLY | | | 22 |
| 1 | H-14-105579-020 | HEAT TRACE CABINET | | | 23 |
| 1 | H-14-105579-030 | VACCUM PUMP RELAY CABINET | | | 24 |
| 1 | H-14-105579-050 | MINI POWER ZONE | | | 25 |
| 1 | H-14-105580 010 | SAMPLE CABINET ASSEMBLY | | | 26 |
| 2 | P1000 HG | GALVANIZED CHANNNEL, 8.0 LONG | UNISTRUT | | 27 |
| 2 | P1000 HG | GALVANIZED CHANNNEL, 14.0 LONG | UNISTRUT | | 28 |

| QTY -010 | PARTS / DASH NUMBER | NOMENCLATURE/DESCRIPTION | MATERIAL/REFERENCE | SHEET | ITEM NO |
|---|---|---|---|---|---|
| 10 | P2034 HG | GALVANIZED TUBING CLAMP | UNISTRUT | | 29 |
| 1 | C-SD2020BLG | INSTRUMENT CONNECTION ENCLOSURE | HOFFMAN | | 30 |
| 1 | 2-250T | GROUNDING LUG, TWO CONNECTOR | SOUTHPORT INDUSTRIES | | 31 |
| 1 | SEE NOTE 10 | EXHAUST FAN AND MOTOR ASSEMBLY | AIR TECH | | 32 |
| 1 | SS-65TW16P40-LLK | BALL VALVE, 1" | WHITEY | | 33 |
| 2 | 3434-7-V-304L | TUBE UNION, O-RING, 1 1/2 SOCKETWELD, ID TO MATCH .065 WALL TUBE | HART INDUSTRIES | | 34 |
| 1 | F-66W12SS | WIRE WAY, 6 X 6 X 12 LONG TYPE 4X | HOFFMAN | | 35 |
| 1 | SS-45S8 | INSTRUMENT BALL VALVE, 1/2" TUBE FITTINGS | SWAGELOK | | 36 |
| 1 | SS-810-P | PLUG, 1/2" | SWAGELOK | | 37 |
| 1 | SS-1210-3 | UNION TEE, 3/4" | SWAGELOK | | 38 |
| AR | | TUBING, 1 1/2 OD X .065 WALL, SMLS | ASTM A269 TYPE 304L | | 39 |
| 1 | | TUBING, 1 1/4 OD X .065 WALL X 3.0 LONG, SMLS | ASTM A269 TYPE 304L | | 40 |
| 1 | | TUBING REDUCER, CONCENTRIC BUTT WELD, 1 1/2 OD X 1 1/4 OD X .065 WALL | ASTM A269 TYPE 304L | | 41 |
| AR | | PIPE, 1" SCHED 40S | ASTM A312 GR TP 304L | | 42 |
| 20 | | ELBOW, 90°, 1" LR, SCHED 40S, BW | ASTM A403 WP 304L | | 43 |
| 1 | | ELBOW, 45°, 1" LR, SCHED 40S, BW | ASTM A403 WP 304L | | 44 |
| 1 | | PIPE CAP, 1" NPT, CLASS 150 | ASTM A182 GR F 304L | | 45 |
| AR | | TUBING, 3/4 OD X .065 WALL, SMLS | ASTM A269 TYPE 304L OR 316L | | 46 |
| 2 | | ANGLE, 2 X 2 X 1/4 THK X 22.0 LONG | ASTM A276 TYPE 304L | | 47 |
| 2 | 8896T105 | U-BOLT, 1/4-20 FOR 1" PIPE, TYPE 304 SST | McMASTER-CARR | | 48 |
| 16 | | HEX BOLT, 1/2-13 UNC-2A X 1 1/2 LONG | ASTM A193 GR B8 | | 49 |
| 64 | | HEX BOLT, 1/2-13 UNC-2A X 1" LONG | ASTM A193 GR B8 | | 50 |
| 4 | | HEX BOLT, 3/8-16 UNC-2A X 1 1/2 LONG | ASTM A193 GR B8 | | 51 |
| 37 | | HEX BOLT, 3/8-16 UNC-2A X 1" LONG | ASTM A193 GR B8 | | 52 |
| 8 | | HEX BOLT, 7/8-9 UNC-2A X 3" LONG | ASTM A193 GR B8 | | 53 |
| 1 | F-66WGSS | WIRE WAY GASKET & SCREW SET | HOFFMAN | | 54 |
| 49 | | PLAIN WASHER, 1/2 (SERIES AND TYPE OPTIONAL) | 18-8 SST | | 55 |

| QTY -010 | PARTS / DASH NUMBER | NOMENCLATURE/DESCRIPTION | MATERIAL/REFERENCE | SHEET | ITEM NO |
|---|---|---|---|---|---|
| 22 | | PLAIN WASHER, 3/8 (SERIES AND TYPE OPTIONAL) | 18-8 SST | | 56 |
| 16 | | PLAIN WASHER, 7/8 (SERIES AND TYPE OPTIONAL) | 18-8 SST | | 57 |
| 1 | SS-1210-R-8 | REDUCER, 3/4" X 1/2" | SWAGELOK | | 58 |
| 81 | | LOCK WASHER, HELICAL SPRING, 1/2 RGLR | 18-8 SST | | 59 |
| 31 | | LOCK WASHER, HELICAL SPRING, 3/8 RGLR | 18-8 SST | | 60 |
| 8 | | LOCK WASHER, HELICAL SPRING, 7/8 RGLR | 18-8 SST | | 61 |
| 1 | 8889T43 | U-BOLT, 1/4-20 FOR 1" PIPE, TYPE 304 SST | McMASTER-CARR | | 62 |
| 25 | | HEX NUT, 1/2-13 UNC-2B | ASTM A194 GR 8F | | 63 |
| 4 | | HEX NUT, 3/8-16 UNC-2B | ASTM A194 GR 8F | | 64 |
| 8 | | HEX NUT, 7/8-9 UNC-2B | ASTM A194 GR 8F | | 65 |
| 2 | SS-810-9 | UNION ELBOW, 1/2 TUBE FITTING X 1/2 TUBE FITTING | SWAGELOK | | 66 |
| 1 | H-14-105553-100 | REMOVABLE STEP ASSEMBLY | | | 67 |
| 1 | H-14-105542-010 | HEATER INSULATION ASSEMBLY | | | 68 |
| 1 | H-14-105542-020 | OUTLET SPOOL INSULATION ASSEMBLY | | | 69 |
| 1 | H-14-105542-030 | STACK INSULATION ASSEMBLY | | | 70 |
| 1 | H-14-105542-040 | SEAL POT INSULATION ASSEMBLY | | | 71 |
| 1 | H-14-105542-050 | DRAIN PIPE INSULATION ASSEMBLY | | | 72 |
| 1 | H-14-105542-060 | EMS TUBING INSULATION ASSEMBLY | | | 73 |
| 1 | H-14-105542-070 | EMS RETURN LINE INSULATION ASSEMBLY | | | 74 |
| 2 | SS-810-7-8 | FEMALE CONNECTOR, 1/2 FEMALE NPT X 1/2 TUBE FITTING | SWAGELOK | | 75 |
| AR | | TUBING, 1/2 OD X .049 WALL, SMLS | ASTM A269 TYPE 304L OR 316L | | 76 |
| 1 | BEN 664-12CHC | 6" X 6" ENCLOSURE | HOFFMAN OR EQUIVALENT | | 77 |
| 1 | NO. 5305 | SEALING RING | T & B OR EQUIVALENT | | 78 |
| 1 | NO. 5306 | SEALING RING | T & B OR EQUIVALENT | | 79 |
| 2 | | HEX BOLT, 1/4-20 UNC-2A X 1" LONG | ASTM A193 GR B8 | | 80 |
| 2 | | LOCK WASHER, HELICAL SPRING, 1/4 RGLR | 18-8 SST | | 81 |
| 8 | P1010EG | CHANNEL NUT W/ SPRING | UNISTRUT | | 83 |
| (15) 8 | HHCS050150EG | HEX HD CAP SCREW, 1/2-13 UNC-2A X 1 1/2 LONG | UNISTRUT | | 84 |




## ① ASSEMBLY, VENTILATION EXHAUSTER "B" (TOP VIEW)

SCALE: 3/4" = 1'-0"

## GENERAL NOTES:

1. FABRICATION AND WELDING SHALL BE IN ACCORDANCE WITH THIS DRAWING AND SPECIFICATION PTI-W314-TS-001
2. APPROXIMATE WEIGHT OF ASSEMBLY IS 22,200 POUNDS. APPROXIMATE WEIGHT OF ASSEMBLY, LESS UPPER STACK, IS 21,320 POUNDS.
3. ABBREVIATIONS ARE IN ACCORDANCE WITH ANSI Y1.1
4. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
5. VACUUM PUMP RELAY CABINET (ITEM 24) SHALL BE LOCATED ARRPOX WHERE SHOWN AND ATTACHED WITH SST FASTENERS SIZED AS REQUIRED TO MATCH CABINET.
6. DISASSEMBLE BALL VALVE (ITEM 33) PRIOR TO WELDING
7. FOR SAMPLE TUBING RUNS (FROM PROBES TO CAM AND RECORD SAMPLER).
   - THERE SHALL BE NO INWARD FACING STEPS AT THE TUBING CONNECTIONS THAT CAUSE MORE THAN A 1% REDUCTION IN TUBE DIAMETER.
   - THE TUBING ENDS SHALL BE FREE OF BURRS AND CRIMPING.
   - BENDS SHALL HAVE A CURVATURE RATIO (RADIUS OF CURVATURE OF THE BEND DIVIDED BY THE TUBE DIAMETER) OF AT LEAST 3.0.
   - FLATTENING OF THE BEND CAUSED BY A BENDING PROCESS SHALL NOT EXCEED 15%. WHERE FLATTENING IS DEFINED IN TERMS OF THE ORIGINAL AND MINOR AXES OF THE TUBE CROSS SECTION AT THE ANGULAR MIDPOINT OF THE BEND.

   SPECIAL FABRICATION TECHNIQUES MAY BE REQUIRED TO MEET THESE SPECIFICATIONS (ANSI/HPS N13.1-1999).
8. PROVIDE HOLD DOWN CLIPS AS REQUIRED ON ALL FIELD RUN TUBING. SPACING BETWEEN CLIPS SHALL NOT EXCEED 6'-0"
9. NAME TAGS DENOTING EQUIPMENT IDENTIFICATION NUMBERS WILL BE PROVIDED BY CUSTOMER. TAGS SHALL BE LOCATED ON THE IDENTIFIED ASSEMBLY COMPONENTS IN LOCATIONS THAT ARE CLEARLY VISIBLE AFTER FINAL ASSEMBLY. SEE EQUIPMENT IDENTIFICATION SCHEDULE ON SHEET 2 (ZONE 1-F)
10. ITEM 32 SHALL BE AIR TECH MODEL TROH 24A, CLASS 100 SWSI, ARRANGEMENT 8 (CW ROTATION FROM DRIVE END) RATED FOR 2851 ACFM @ 24" SP AT 3545 RPM @ 20.07 BHP AT .052#FT3 WITH FACTORY MOUNTED 20 HP, 3600 RPM, 3/60/230/460V, VFD READY TEFC MOTOR.
11. APPLY LOCTITE THREAD LOCKER 262 PER MANUFACTURER'S INSTRUCTIONS
12. ATTACH HOFFMAN WIRE WAY (ITEM 35) TO ITEMS 20 AND 21 USING GASKET AND SCREW SET (ITEM 54) PER MANUFACTURER'S INSTRUCTIONS. LOCATE ITEM 35 AS REQD TO MATCH CUT OUTS IN ITEMS 20 AND 21.
13. ACTUAL ORIENTATION OF KEYSTONE VALVES MAY VARY.
14. FIELD ROUTE 1/2" TUBING FROM SEAL POT TO RTD COUPLING. ENSURE THAT THE TUBING SLOPES DOWNWARD CONTINUOUSLY FROM THE RTD COUPLING TO THE SEAL POT SUCH THAT ANY FLUIDS IN THE TUBE DRAIN INTO THE SEAL POT
15. MINIMUM (4) 1/2-13 UNC-2A BOLTS ANCHORING EACH LEG OF THE SUN SHIELD ASSEMBLY (ITEM 16, H-14-105529) TO THE UNISTRUT FRAMING. LOCATION OF THE 9/16 THRU HOLES IN THE UNISTRUT FRAMING (ITEMS 12 & 13) AS REQD.

DIMENSIONING AND TOLERANCING SHALL BE INTERPRETED PER ANSI Y14.5M-1994
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED
UNSPECIFIED TOLERANCES SHALL BE: DECIMAL .X ± .1 .XX ± .06 .XXX ± .030
ANGULAR ± 2°
ALL IMPLIED 90° ANGLES SHALL BE PERPENDICULAR WITHIN THE GREATEST TOLERANCE OF THE LINEAR DIMENSIONS
ALL COAXIAL FEATURES SHALL BE CONCENTRIC WITHIN .031 INCH UNLESS OTHERWISE SPECIFIED

| DWG NO | TITLE |
|---|---|
| DRAWING TRACEABILITY LIST | |

| REF NUMBER | TITLE |
|---|---|
| H-14-105529 | EXHAUSTER TRAIN "A" ASSY |

REFERENCES
NEXT USED ON H-14-105525

| REV | DESCRIPTION | | | | |
|---|---|---|---|---|---|
| 5 | INCORPORATED DCN-409 & AS-BUILT | JWL | | | |
| 4 | INCORPORATED DCN-398 & AS-BUILT | JWL | SIGNATURES ON FILE | | |
| 3 | INCORPORATED DCN-352 & AS-BUILT | JWL | SIGNATURES ON FILE | | |
| 2 | INCORPORATED DCN-273, -287, -321 & AS-BUILT | | SIGNATURES ON FILE | | |
| 1 | INCORPORATED DCN-025, -071, -150, -158, -214, 267 & AS-BUILT | | SIGNATURES ON FILE | | |

REVISIONS

MAR 31 2004

PREMIER Technology, Inc.

GForce engineering & technology

NAME: RK FISHER; D. Bowers

U.S. DEPARTMENT OF ENERGY
Office of River Protection

AN241 EXHAUSTER TRAIN "B" ASSEMBLY

SIZE F | 241AN | 8900 | H-14-105543 | REV 5
SCALE SHOWN | 820447 | SHEET 1 OF 4

BLDG. NO
INDEX NO
H-14-105543 SH 1 OF 4 REV 5
21373

RPP-46436, Rev. 1

# Generic Effluent Monitoring System Qualification 3000 CFM Exhaust Stack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Abstract: This document provides the technical basis for compliance with ANSI/HPS N13.1-1999, Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities, of the 3,000 cfm ventilation system exhaust stack effluent sampling and monitoring system design. This design was originally used for the AN and AW waste tank farm Primary Ventilation Systems and subsequently on portable exhausters POR107, POR126 and POR127. This document also provides the corrected standard cubic feet per minute conversion of the maximum stack flow for the purpose of establishing the high end of the evaluation domain for the qualification testing.




M. Washington
M. Washington 9/29/2011
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**Approved For Public Release**

| Tank Operations Contractor (TOC) **RECORD OF REVISION** | (1) Document Number: RPP-46436 | Page 1 |
|---|---|---|

(2) Title:

**Generic Effluent Monitoring System Qualification 3000 CFM Exhaust Stack**

**Change Control Record**

| (3) Revision | (4) Description of Change – Replace, Add, and Delete Pages | Authorized for Release | |
|---|---|---|---|
| | | (5) Resp. Engr. (print/sign/date) | (6) Resp. Mgr. (print/sign/date) |
| 0 | EDT-823616, May 18, 2010 | WM Harty, Jr. 5/12/2010 | MJ Sheridan 5/12/2010 |
| 0A | ECN-11-001209 issue Rev 0A to add portable exhauster POR107 to cover page of the W314 Exhauster Stack Qualification Report performed by Richard R. Brey, Ph.D., C.H.P. of Idaho State University dated February 17, 2004. | RE Flye 6/15/2011 | JH Huber 6/23/2011 |
| 1 RS | ECN-11-001769 – Revise Cover Page; Add Executive Summary, page i, Add Table of Contents, page ii, Add cover report, pages 1 thru 6, to provide Purpose, Scope, Background, ANSI/HPS N13.1 Acceptance Criteria, Validation of Calculated Stack Flow Rate, and References ; Add Appendix A, page A-1 thru A-326 to include W314 Exhaust Stack Qualification Report by Richard R. Brey, Ph.D., C.H.P. of Idaho State University. | GM Gaulden 9-27-2011 | JH Huber 9/29/11 |

## EXECUTIVE SUMMARY

This document provides the technical basis for compliance with ANSI/HPS N13.1-1999, *Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities*, of the 3,000 cfm ventilation system exhaust stack effluent sampling and monitoring system design. This design was originally used for the AN and AW waste tank farm Primary Ventilation Systems and subsequently on portable exhausters POR107, POR126 and POR127. This document also provides the corrected standard cubic feet per minute conversion of the maximum stack flow for the purpose of establishing the high end of the evaluation domain for the qualification testing.

# TABLE OF CONTENTS

## 1.0 PURPOSE

The Hanford Site tank farm ventilation systems are governed by a number of standards, regulations, controls, bases, and guidance documents in three key areas – Safety, Environmental, and Engineering. This technical basis document focuses on the Environmental requirements of ANSI/HPS N13.1 relative to the 3,000 cfm ventilation system design. The purpose of this document is to explain the rationale for qualification of all seven installed ventilation skids based on testing results of two skids. Further, this document provides the corrected standard cubic feet per minute conversion of the maximum stack flow for the purpose of establishing the high end of the evaluation domain for the qualification testing.

## 2.0 SCOPE

This document provides the technical basis for ANSI/HPS N13.1 qualification of the exhaust stack Effluent Sampling and Monitoring System on the following systems:

- AN Primary Ventilation System (VTP), A-Train,
- AN VTP, B-Train,
- AW VTP, A-Train,
- AW VTP, B-Train,
- POR107 Portable Ventilation System,
- POR126 Portable Ventilation System,
- POR127 Portable Ventilation System.

## 3.0 BACKGROUND

Qualification of the 3,000 cfm exhaust stack Effluent Sampling and Monitoring System design was originally accepted by the W-314 Project (Accession number D5668942, *ANSI/HPS N13.1-1999 Qualification Project Report Skids A, AW, B, BW*), which is provided in Appendix A. Portable exhauster POR107 was originally procured for the CH-TRU Project with a similar specification (RPP-21568, Rev. 0) and POR126 and POR127 were procured with the same specification as POR107 (RPP-21568, Rev. 1). The W-314 system design drawings were used with both specifications. During factory acceptance testing (FAT) of POR126 and POR127, the W-314 qualification report was released as RPP-46436, Rev. 0, *Generic Effluent Monitoring System Qualification 3000 CFM Exhaust Stack, AN, AW, POR126, POR127*. Following FAT of POR107 in 2011, RPP-46436, Rev. 0A was released to add POR107 to the scope.

All of these W-314 exhauster skids (AN VTPA Train & B-Train, AW VTP A-Train & B-Train, POR107, POR126, and POR127) were designed and manufactured by Premier Technologies. Idaho State University (ISU) in collaboration with Auxier and Associates (A&A) completed qualification of the exhaust stack sampling location and sampling apparatus for the first four

W-314 exhauster skids which were procured for use in the AN and AW waste tank farms. Specifically, they were called AN Farm Skid A (referred to in their report as Skid A), AN Farm Skid B (referred to in their report as Skid B), AW Farm Skid A (referred to in their report as Skid AW) and AW Farm Skid B (referred to in their report as Skid BW). Testing was performed on two of the four exhaust stacks and the other two were qualified based on their similarity. An allowance for similarity, provided in Section 5.2.2.2 of ANSI/HPS N13.1, is also applied to extend qualification of the AN and AW exhaust stacks and Effluent Sampling and Monitoring Systems to include POR107, POR126, and POR127 exhaust stacks and Effluent Sampling and Monitoring Systems, which have identical designs. This conclusion is based on comparison of the as-built drawings with respect to the five criteria in Section 5.2.2.2.

## 4.0 ANSI/ HPS N13.1 ACCEPTANCE CRITERIA

The acceptance criteria and testing methods used for this qualification are prescribed in ANSI/HPS N13.1. Section 5.2.2.2, provides five criteria for qualification of effluent monitoring systems on stacks of similar design. When these five criteria are met, it does not require testing of each sampling location in each stack to verify compliance with the ANSI/HPS N13.1 requirements. These five criteria and the bases for compliance are as follows:

1. *A geometrically similar stack or duct (one with proportional critical dimensions) has been tested and the sampling location has been found to comply with the requirements of clause 5.2.2. Critical dimensions are those associated with the components of the effluent flow system that can influence the degree of contaminant mixing and/or the velocity profile. The prior testing may be conducted either on the stack or duct in the field, or it may be conducted on a scale model.*

   **Basis for Compliance:** POR107, POR126, and POR127 exhaust stacks are of the same critical dimensions as the previously tested and accepted AN VTP and AW VTP exhaust stacks. The previous testing of the W-314 exhaust stacks constitutes a 1:1 scale model.

2. *The product of mean velocity (see equation A-2) times hydraulic diameter of the candidate stack or duct is within a factor of six of that of the tested stack or duct, and the hydraulic diameter of the stack or duct is at least 250 mm at the sampling location. The Reynolds Numbers based on hydraulic diameter of both the candidate stack or duct and the tested stack or duct are greater than 10,000 (see equation B-1 and B-2 for examples of expressions that can be used for calculation of Reynolds Numbers).*

   **Basis for Compliance:** The POR107, POR126, and POR127 exhaust stacks have the same hydraulic diameter (10" at the discharge – 254 mm) and the mean velocities vary only slightly. AN VTP's, AW VTP's, POR107, POR126, and POR127 exhausters are all rated at 3,201 scfm, resulting in the products of mean velocities and hydraulic diameters being well within a factor of six.

3. *The velocity profile of the candidate stack or duct meets the requirements of clause 5.5.5.2.*

   **Basis for Compliance:** Clause 5.2.2.2 addresses the velocity profile in the stack, the acceptable uniformity of contaminant mixing, and air velocity across the stack. This is shown by the performance of the velocity profile across the stack. From these values, a coefficient of variation (COV) is established and is required to be within 20% across the center two thirds area of the stack or duct. The POR107, POR126, and POR127 exhaust stacks are of the exact same design and critical dimensions as the previously tested stacks. This constitutes a 1:1 scale model and creates a very similar velocity profile and COV. Therefore, additional testing has been deemed unnecessary.

4. *The difference between the velocity COV's (coefficient of variation) of the two systems is not more than 5%.*

   **Basis for Compliance:** The POR107, POR126, and POR127 exhaust stacks are of the exact same design and critical dimensions as the previously tested exhaust stacks, constituting a 1:1 scale model. Therefore, additional testing has been deemed unnecessary.

5. *The sampling location in the candidate stack or duct is placed at a geometrically similar location to that in the tested stack.*

   **Basis for Compliance:** Sampling locations on the POR107, POR126, and POR127 exhaust stacks and the previously tested exhaust stacks are at the exact same locations and have the identical configuration.

## 5.0 VALIDATION OF CALCULATED STACK FLOW RATE

The Executive Summary of the Idaho State University Qualification Report (Appendix A) establishes the qualified maximum flow rate of the exhauster systems at 3,615 actual cubic feet per minute (acfm), or an equivalent 2,484 standard cubic feet per minute (scfm). The significant difference between these two values, supposedly based upon the difference between actual conditions during testing and standard atmospheric conditions, raised a concern that the conversion from acfm to scfm, as presented in the report, was inaccurate. Further review confirmed this to be the case. The purpose of this section is to provide the corrected conversion from acfm to scfm for the maximum qualified flow rate of the exhauster systems.

The method of analysis used to convert acfm to scfm is described in Attachment One of the Idaho State University Qualification Report under Standard Operating Procedure PTE-002, Page 60. Equation 11.10, presented below, is derived from the perfect gas equation, $pV=nRT$, and is accepted as the standard for acfm/scfm conversions.

11.10. Convert the average stack gas dry volumetric flow rate from acfm to scfm:

$$Q_{sd} = (1 - B_{ws})Q_s \frac{T_{std}}{T_{s(ave)}} \frac{P_s}{P_{std}} \text{ scfm}$$

where:

$B_{ws}$ = Water vapor in the gas stream, proportional by volume. Use a value of 0% relative humidity for conservatism.

$P_{bar}$ = Barometric pressure at measurement site, inches Hg.

$P_g$ = Stack static pressure, inches Hg.

$P_s$ = Absolute stack pressure, inches Hg.

$$P_s = P_{bar} + P_g$$

$P_{std}$ = Standard absolute pressure, 29.92 inches Hg.

$Q_s$ = Actual exhaust stack flow rate at actual testing conditions, acfm.

$Q_{sd}$ = Dry volumetric stack gas flow rate corrected to standard conditions, scfm.

$t_{s(ave)}$ = Exhaust stack average temperature, °F.

$T_{s(ave)}$ =Exhaust stack average absolute temperature, °R

$$T_{s(ave)} = 460 + t_{s(ave)}$$

$T_{std}$ = Standard absolute temperature, 528°R.

The maximum flow rate test data is provided in Appendix A, Attachment Seven, Table 2.

$B_{ws}$ = 0 (dry air)

$P_s$ = 25.58 inches Hg (averaged over measurement times relative to Pocatello Regional Airport Meteorological Station

$P_{std}$ = 29.92 inches Hg

Qs = 3,615 acfm (results of maximum flow rate test)

$T_{std}$ = 528°R

$T_{s(ave)}$ =509.8°R (49.8°F measured at site during testing)

Solving for scfm at these maximum flow rate conditions:

$$Q_{sd} = (1 - 0)3615 \frac{528}{509.8} \frac{25.58}{29.92} scfm$$

$Q_{sd}$ = 3,201 scfm

The significance of this result is that it establishes the high end of the evaluation domain for the Idaho State University Qualification Report (Appendix A) at maximum volumetric flow rate of 3,201 scfm instead of the inaccurately published 2,484 scfm.

## 6.0 REFERENCES

40 CFR 61, *National Emissions Standard for Hazardous Air Pollutants*, Code of Federal Regulations, as amended.

ANSI/HPS N13.1, 1999, *Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities*, American National Standards Institute, New York, New York.

H-14-105531, Sheet 1, *AN241-VTP (W-314) Exhauster Train "A" Upper & Lower Stack Assemblies,* Washington River Protection Solutions, LLC, Inc., Richland, Washington.

H-14-105531, Sheet 2, *AN241-VTP (W-314) Exhauster Train "A" Upper & Lower Stack Assemblies,* Washington River Protection Solutions, LLC, Inc., Richland, Washington.

H-14-105531, Sheet 3, *AN241-VTP (W-314) Exhauster Train "A" Upper & Lower Stack Assemblies,* Washington River Protection Solutions, LLC, Inc., Richland, Washington.

H-14-105681, Sheet 1, *AW241-VTP (W-314) Exhauster Train "A" Upper & Lower Stack Assemblies,* Washington River Protection Solutions, LLC, Inc., Richland, Washington.

H-14-105681, Sheet 2, *AW241-VTP (W-314) Exhauster Train "A" Upper & Lower Stack Assemblies,* Washington River Protection Solutions, LLC, Inc., Richland, Washington.

H-14-105681, Sheet 3, *AW241-VTP (W-314) Exhauster Train "A" Upper & Lower Stack Assemblies,* Washington River Protection Solutions, LLC, Inc., Richland, Washington.

H-14-106704, Sheet 1, *Exhauster Train POR126 Upper & Lower Stack Assemblies,* Washington River Protection Solutions, LLC, Inc., Richland, Washington.

H-14-106704, Sheet 2, *Exhauster Train POR126 Upper & Lower Stack Details,* Washington River Protection Solutions, LLC, Inc., Richland, Washington.

H-14-106704, Sheet 3, *Exhauster Train POR126 Upper & Lower Stack Details,* Washington River Protection Solutions, LLC, Inc., Richland, Washington.

H-14-106729, Sheet 1, *Exhauster Train POR127 Upper & Lower Stack Assemblies,* Washington River Protection Solutions, LLC, Inc., Richland, Washington.

H-14-106729, Sheet 2, *Exhauster Train POR127 Upper & Lower Stack Details,* Washington River Protection Solutions, LLC, Inc., Richland, Washington.

H-14-106729, Sheet 3, *Exhauster Train POR127 Upper & Lower Stack Details,* Washington River Protection Solutions, LLC, Inc., Richland, Washington.

H-14-108901, Sheet 1, *Exhauster Train POR107 Upper & Lower Stack Assemblies,* Washington River Protection Solutions, LLC, Inc., Richland, Washington.

H-14-108901, Sheet 2, *Exhauster Train POR107 Upper & Lower Stack Details,* Washington River Protection Solutions, LLC, Inc., Richland, Washington.

H-14-108901, Sheet 3, *Exhauster Train POR107 Upper & Lower Stack Details,* Washington River Protection Solutions, LLC, Inc., Richland, Washington.

HNF-S-0400, 2000, *Generic Effluent Monitoring System,* Rev. 2, Washington River Protection Solutions, LLC, Inc., Richland, Washington.

RPP-7881, 2004, *Specification for a Primary Exhauster System for Waste Tank Ventilation*, Rev. 1, Washington River Protection Solutions, LLC, Inc., Richland, Washington.

RPP-21568, 2004, *Specification for a Primary Exhauster System for Waste Tank Ventilation*, Rev. 0, Washington River Protection Solutions, LLC, Inc., Richland, Washington.

RPP-21568, 2005, *Specification for a Primary Exhauster System for Waste Tank Ventilation*, Rev. 1, Washington River Protection Solutions, LLC, Inc., Richland, Washington.

TFC-ENG-STD-07, Rev F-1, 2011, *Ventilation System Design Standard*, Washington River Protection Solutions, LLC, Inc., Richland, Washington.

Glissmeyer, J.A. and A.D. Maughan, 1997, *Generic Effluent Monitoring System Certification for Salt Well Portable Exhauster,* PNNL-11701, UC-702, Pacific Northwest National Laboratory, Richland, Washington.

# APPENDIX A –
# IDAHO STATE UNIVERSITY QUALIFICATION REPORT

W-314-RPP-7881-002

| CH2M HILL Hanford Group, Inc. (CHG) | SUPPLIER SUBMITTAL | 1. Submittal No. |
|---|---|---|
| 2. To: Distibution | 3. From: Sandi Schrank R2-25 | 4. Sheet 1 of 1 |
| 5. Project Title: Primary exhauster system for waste tank ventilation | | 10. Date: 06-03-04 |

| 6. PO No. | 7. Project No. | 8. Tank Farm/Tank No. | 9. Area/Bldg. No. |
|---|---|---|---|
| N/A | W-314 | 241AN | 200E/2752 |

11. Subcontract No. and Release No.: N/A

12. Subcontractor or Supplier: Premier Technology, Inc.

13. ○ Pre-Purchase Evaluation ◉ Approval Data ○ VI ○ Information/Record

| 14. Paragraph | 15. Section | 16. Specification |
|---|---|---|
| Table 5-2 | N/A | RPP-7881 |

17. Description of Item Submitted: ANSI/HPS N13.1-1999 Qualification Project Report Skids A, AW, B, BW

18. Special Instructions: ○ Resubmit ○ Additional Info. ○ Substitution

21. Review Distribution: OD Nelson

22. Final Disposition

23. Construction Document Control Stamps

| 19. Data Furn. | 20. Data Description | 24. Disposition: Not Recvd. | Data Incompl. | Appd. | App./X | Not Appd. | Resub. Reqrd. |
|---|---|---|---|---|---|---|---|
| | Dimensional Drawings | | | | | | |
| | Equipment Weights | | | | | | |
| | Specifications | | | | | | |
| | Material Description | | | | | | |
| | Performance Data | | | | | | |
| | Circ./Control Diagram | | | | | | |
| | Data Sheets | | | | | | |
| | Illustrative Cuts | | | | | | |
| | Install Instructions | | | | | | |
| | Operat. Instructions | | | | | | |
| | Maint. Instructions | | | | | | |
| | Spare Parts Lists | | | | | | |
| | | | | | | | |
| | | | | | | | |

25. Submittal proposes deviations from contract documents? ☐ Yes ☒ No

26. ☒ Approved ☐ Not Approved ☐ Approved with Comments ☐ Resubmit ☐ Information/Record

27. Comments:

28. Changes Required to Contract Documents? ☐ Yes ☒ No

29. Signature: [signature]

30. Date: 7/12/04

| CH2M HILL Hanford Group, Inc. (CHG) | SUPPLIER SUBMITTAL CONTINUATION SHEET | | | 1. Submittal No. |
|---|---|---|---|---|
| 5. Project Title<br>Primary exhauster system for waste tank ventilation | | | | 4. Sheet of 1 |
| 6. PO No.<br>N/A | 7. Project No.<br>W-314 | 8. Tank Farm/Tank No.<br>241AN | 9. Area/Bldg. No.<br>200E/2752 | 10. Date<br>06-03-04 |
| 11. Subcontract No. and Release No.<br>N/A | | 12. Subcontractor or Supplier<br>Premier Technology, Inc. | | |

Comments:

IDAHO STATE UNIVERSITY

Department of Physics
Health Physics
Program

Campus Box 8106
Pocatello, Idaho
83209-8106

17 February, 2004

Jeff Schutte
Project Engineer
Premier Technology, Inc.
170 East Siphon Rd.,
Pocatello, Idaho 83202

Dear Mr. Schutte:

Attached please find seven addendum pages to our report: Premier Technologies Inc., W0314 Exhauster, ANSI/HPS N13.1-1999 Qualification Project now dated 2/26/2004. Some discrepancies were identified between modeled parameters and final design values in this report as appear throughout the enclosed pages. We believe these discrepancies are related to use of an incorrect set of drawings during the modeling phase of this project. The drawings used to make these changes are DWG H-14-105693 Train B, and DWG H-14-105679 Train A.

None of these changes are of significance. **These changes do not change the conclusions on exhauster performance.** A brief review of the aforementioned report indicates that a few changes in figures were necessary and have prompted this addendum. We apologize for the need for this addendum. Should any further questions arise please contact me at your convenience.

Sincerely,

Richard R. Brey

Richard R. Brey, Ph.D., C.H.P.

(208) 282-4308
FAX (208) 282-4649

Table Twelve

| Skid A and AW | Deposition 2001a-Version 1<br>10 um monodisperse particles<br>AMS-4 Sample Line | AMS-4 Sample Line | Sample Flow rate 56.6 LPM<br>Pressure 550.0 mmHg |
|---|---|---|---|
| Exhaust Free Stream Velocity | 16.1 m/s | 2.6 m/s | Temperature: 10.0 'C |
| Element | % Penetration | % Penetration | Element Notes |
| Probe | 109.7 | 92.8 | Thermo-Andersen RF2-111 |
| Tube | 100.0 | 100 | Length: 0.05m at 90.000 degrees from horizontal |
| Bend | 99.4 | 99.4 | Bend angle: 90.000 degrees RC = 5.19 |
| Tube | 81.9 | 81.9 | Length: 1.73 m, at 0.000 degrees from horizontal |
| Bend | 95.9 | 95.9 | Bend Angle: 90.000 degrees RC = 19.67 |
| Tube | 100.0 | 100 | Length 3.200 m, at 90.000 degrees from horizontal |
| Contraction | 99.9 | 99.9 | Half angle of contraction: 4.76 degrees, Area ratio 0.8175 |
| Bend | 97.6 | 97.6 | Bend Angle: 90.000 degrees RC = 8 |
| Total Penetration | 83.4 | 70.6 | |
| Stokes Number | 0.0163 | 0.0163 | |
| Reynolds Number | 2137 | 2137 | |

| Skid A and AW | Deposition 2001a-Version 1<br>10 um monodisperse particles<br>Ancillary Sample Line | Ancillary Sample Line | Sample Flow rate 56.6 LPM<br>Pressure 550.0 mmHg |
|---|---|---|---|
| Exhaust Free Stream Velocity | 16.1 m/s | 2.6 m/s | Temperature: 10.0 'C |
| Component | % Penetration | % Penetration | Element Notes |
| Probe | 109.7 | 92.8 | Thermo-Andersen RF2-111 |
| Tube | 100.0 | 100.0 | Length: 0.05m at 90.000 degrees from horizontal |
| Bend | 99.4 | 99.4 | Bend angle: 90.000 degrees RC = 5.19 |
| Tube | 86.4 | 86.4 | Length: 1.26 m, at 0.000 degrees from horizontal |
| Bend | 100.0 | 100.0 | Bend Angle: 6.000 degrees RC = 17 |
| Tube | 93.4 | 93.4 | Length: 0.590 m, at 0.000 degrees from horizontal |
| Bend | 95.9 | 95.9 | Bend Angle: 90.000 degrees RC = 19.67 |
| Tube | 100.0 | 100.0 | Length 3.250 m, at 90.000 degrees from horizontal |
| Total Penetration | 84.3 | 71.3 | |
| Stokes Number | 0.0089 | 0.0089 | |
| Reynolds Number | 1747 | 1747 | |

Note: This employs the default sampling rate for the Thermo-Andersen sampling probe of 56.6 LPM.

## Table Thirteen

| Skid B and BW | Deposition 2001a-Version 1<br>10 um monodisperse particles<br>AMS-4 Sample Line | AMS-4 Sample Line | Sample Flow rate 56.6 LPM<br>Pressure 550.0 mmHg |
|---|---|---|---|
| Exhaust Free Stream Velocity | 16.1 m/s | 2.6 m/s | Temperature: 10.0 °C |
| Element | % Penetration | % Penetration | Element Notes |
| Probe | 109.7 | 92.8 | Thermo-Andersen RF2-111 |
| Tube | 100.0 | 100.0 | Length: 0.05m at 90.000 degrees from horizontal |
| Bend | 99.4 | 99.4 | Bend angle: 90.000 degrees RC = 5.19 |
| Tube | 93.4 | 93.4 | Length: 0.587 m, at 0.000 degrees from horizontal |
| Bend | 99.7 | 99.7 | Bend Angle: 18.000 degrees RC = 17 |
| Tube | 90.6 | 90.6 | Length: 0.850 m, at 0.000 degrees from horizontal |
| Bend | 95.9 | 95.9 | Bend Angle: 90.000 degrees RC = 19.67 |
| Tube | 100.0 | 100.0 | Length 3.250 m, at 90.000 degrees from horizontal |
| Constriction | 99.9 | 99.9 | Half angle of contraction: 4.76 degrees, Area ratio 0.8175 |
| Bend | 97.6 | 97.6 | Bend Angle: 90.000 degrees RC = 8 |
| Total Penetration | 86.1 | 72.8 | |
| Stokes Number | 0.0163 | 0.0163 | |
| Reynolds Number | 2137 | 2137 | |

| Skid B and BW | Deposition 2001a-Version 1<br>10 um monodisperse particles<br>Ancillary Sample Line | Ancillary Sample Line | Sample Flow rate 56.6 LPM<br>Pressure 550.0 mmHg |
|---|---|---|---|
| Exhaust Free Stream Velocity | 16.1 m/s | 2.6 m/s | Temperature: 10.0 °C |
| Component | % Penetration | % Penetration | Element Notes |
| Probe | 109.7 | 92.8 | Thermo-Andersen RF2-111 |
| Tube | 100.0 | 100.0 | Length: 0.05m at 90.000 degrees from horizontal |
| Bend | 99.4<br>92.8 | 99.4 | Bend angle: 90.000 degrees RC = 5.19 |
| Tube | | 92.8 | Length: 0.643 m, at 0.000 degrees from horizontal |
| Bend | 99.7 | 99.7 | Bend Angle: 18.000 degrees RC = 17 |
| Tube | 92.8 | 92.8 | Length: 0.650 m, at 0.000 degrees from horizontal |
| Bend | 95.9 | 95.9 | Bend Angle: 90.000 degrees RC = 19.67 |
| Tube | 100.0 | 100.0 | Length 3.250 m, at 90.000 degrees from horizontal |
| Total Penetration | 89.7 | 75.8 | |
| Stokes Number | 0.0089 | 0.0089 | |
| Reynolds Number | 1747 | 1747 | |

Note: This employs the default sampling rate for the Thermo-Andersen sampling probe of 56.6 LPM.

## *Combination of Modeled, Measured, and Published Data*

Probe Information

Shrouded probe performance has been well documented in the literature (Chandra and McFarland 1997)[14]. Figure 28 is a plot summarizing the expected performance of Shrouded Probes as Published by Chandra and McFarland as incorporated with limited experimental data generated during this investigation.

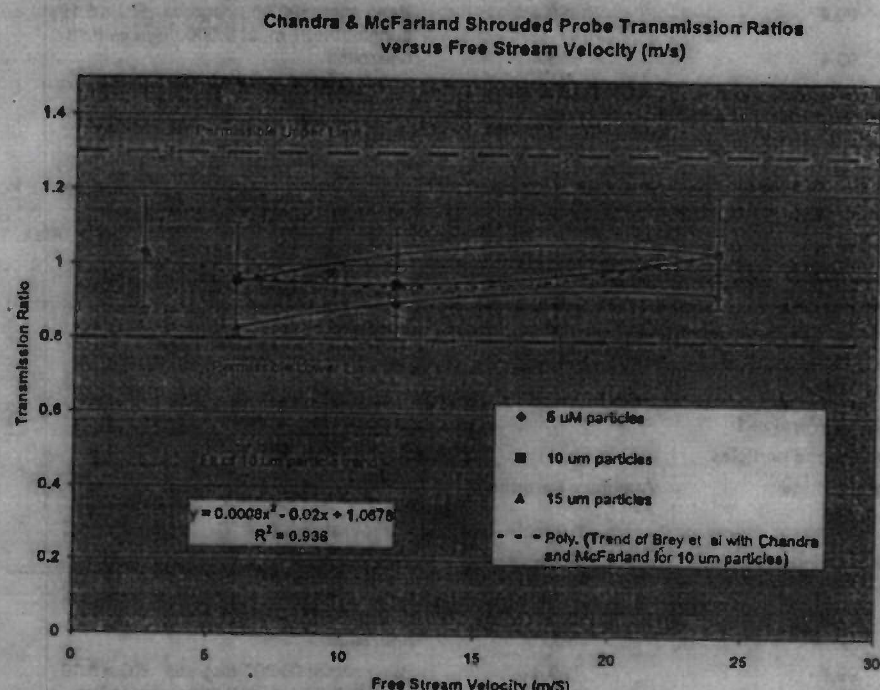


Figure 28 Chandra and McFarland data Summary from: Sumit Chandra and Andrew R. McFarland, Shrouded Probe Performance: Variable Flow Operation and Effect of Free Stream Turbulence, Aerosol Science and Technology 26:111-126 (1997). The 6-m/s free stream velocity corresponded to a sample flow rate of 30 LPM, the 12-m/s free stream velocity corresponded to a sample flow rate of 56.5 LPM and the 24-m/s free stream velocity corresponded to a sample flow rate of 113 LPM. Brey et al. field data as reported above for particles in the size range of 7.1 to 11.19 µm obtained at a free stream velocity of 2.59 m/s with a sampling rate of 20 LPM is superimposed on this plot. A trend line assuming that these 7.1 to 11.19-µm particles can be represented as 10-µm particles and which incorporates the Chandra and McFarland 10-µm particles is also superimposed on this figure. The free stream to sample flow ratio of the Chandra and McFarland data is about 0.2 the measured values in question have a free stream to sample flow of 0.12. Note the lowest probe transmission ratio of 0.943 occurs at a free stream velocity of about 12 m/s.

---

[14] Sumit Chandra and Andrew R. McFarland, Shrouded Probe Performance: Variable Flow Operation and Effect of Free Stream Turbulence, Aerosol Science and Technology 26:111-126 (1997)

## Sample Line Information

The Software code Deposition 2001a - version 1 was used to model deposition within the *sampling lines* of the Premier W-314 Exhausters over ranges of sampling flow rate that were not available for the Thermo Andersen Sampling Probe in the code DEPOSITION 2001a. Sampling flow rate using the Thermo Andersen sampling probes is restricted to a flow rate of 56.6 LPM (2 SCFM) while using this code. To model sampling line performance it is necessary to omit probe information and simply consider losses in the sampling lines. Figures 29 and 30 provide estimated sample line particle deposition as generated by the code DEPOSITION 2001a for sample flow rates ranging from 20 LPM (0.7 SCFM) to 70 LPM (2.5 SCFM). The model input parameters were as appropriate the same as those provided in Table Twelve and Thirteen given above.

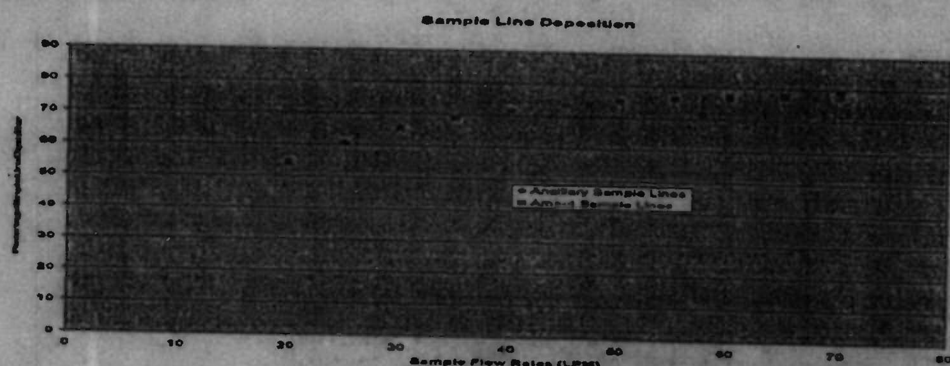


Figure 29: Estimated Line Loss for Exhausters A and AW considering both the AMS-4 Sample line and the Ancillary Sample Line and penetration of 10-µm AD mono-disperse particles.

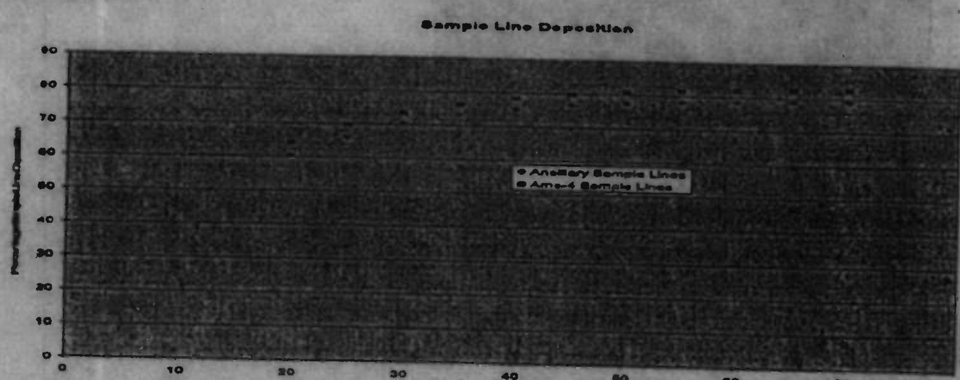


Figure 30: Estimated Line Loss for Exhausters B and BW considering both the AMS-4 Sample line and the Ancillary Sample Line and penetration of 10-µm AD mono-disperse particles.

Combining information from Figures 28, 29, and 30 as the product of probe losses and sample losses can be accomplished as a three dimensional surface plot for all four probes. These are presented below as Figures 31 through 34 for 10-μm AD particles. Just considering the lowest efficiency combinations in the system is an alternate means of describing the performance of the W-314 exhausters. The lowest probe performance for 10-μm particles is observed, as noted previously, at a free stream velocity of about 12 m/s with a transmission ratio of 0.943. The lowest transmission ratio in all four types of samples lines is in the Ancillary line of skids A and AW with a value of 0.537 when a sample rate of 20LPM is employed. The product of these two lowest values, which is the worse case particle penetration, is a percentage penetration of 50.6%. This value is greater than 50% and is, therefore, acceptable according to the criteria of ANSI/HPS N13.1-1999. Most performance is substantially better than this minimum.

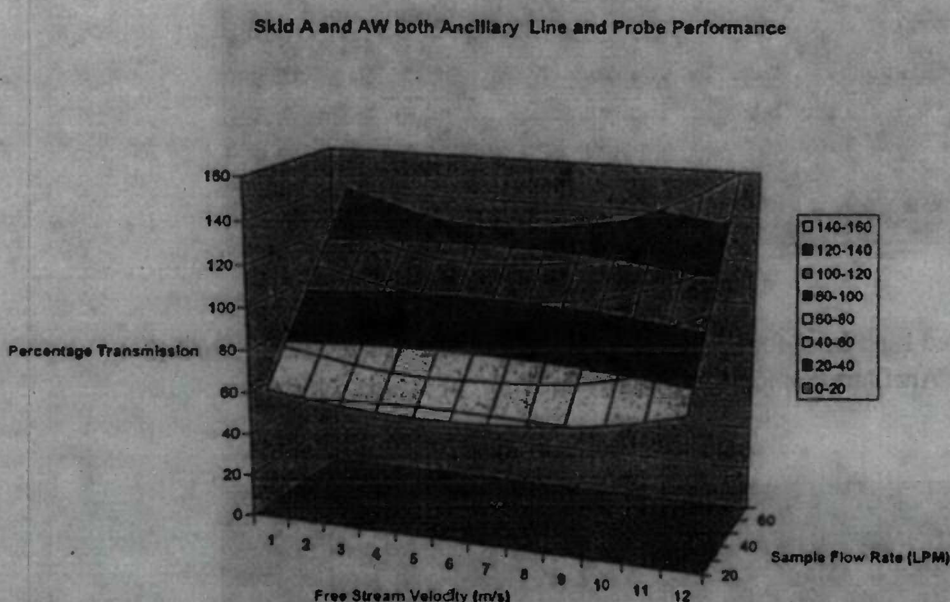


Figure 31 Skid A and AW ancillary line and probe performance.

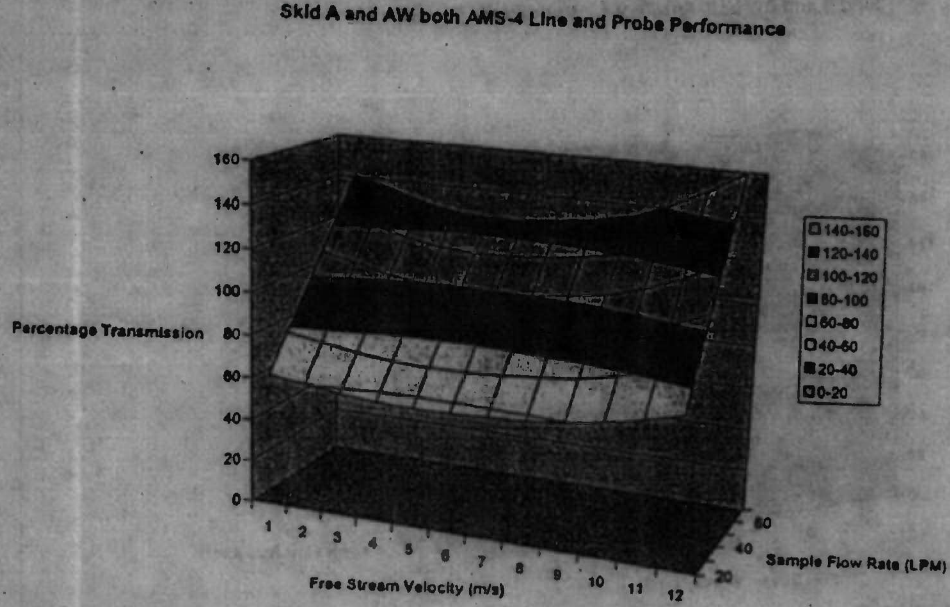


Figure 32 Skid A and AW AMS-4 line and probe performance.

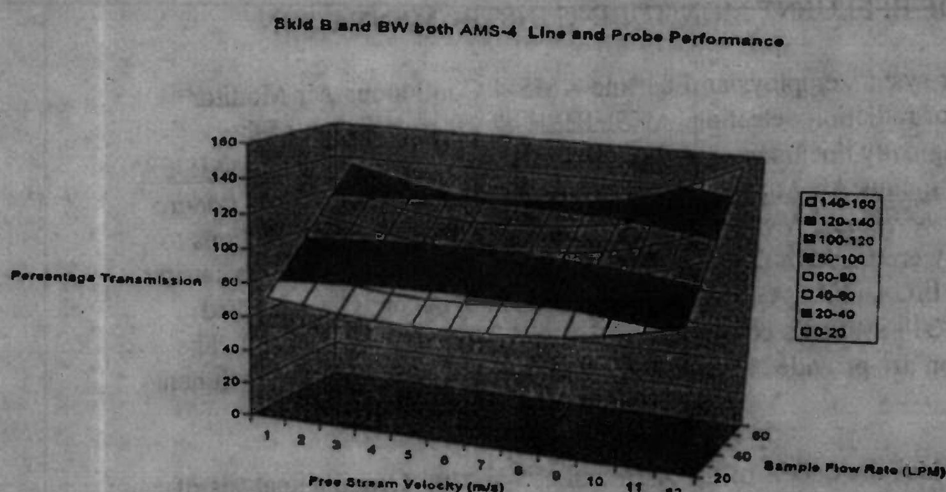


Figure 33 Skid B and BW AMS-4 line and Probe performance

# Premier Technology Inc.
# W-314 Exhauster

## ANSI/HPS N13.1-1999 Qualification Project report
## Skids A, AW, B, BW

Department of Physics/Health Physics

Idaho State University

Auxier and Associates

18 November, 2003

# Premier Technologies Inc. W-314 Exhauster

ANSI/HPS N13.1-1999 Qualification Project

# Premier Technologies Inc. W-314 Exhauster

ANSI/HPS N13.1 Qualification Project

## Executive Summary

Idaho State University (ISU) in collaboration with Auxier and Associates (AA) has completed qualification of the sampling location and the sampling apparatus for Skids A, B, AW, and BW of the Premier Technology Inc., Hanford Tank Farm Project W-314 Exhausters. The acceptance criteria and the testing methods used were prescribed in American National Standards Institute/Health Physics Society ANSI/HPS N13.1-1999, Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities, ANSI/IEEE 42.18-1980, Specification and Performance of On site Instrumentation for Continuously Monitoring Radioactivity in Effluents, and 40 CFR 60, APPENDIX A, METHOD 1. **The four W-314 Exhausters manufactured by Premier Technology Inc. are specifically:**

| | |
|---|---|
| AN Farm Skid A | Referred to as Skid A |
| AN Farm Skid B | Referred to as Skid B |
| AW Farm Skid A | Referred to as Skid AW |
| AW Farm Skid B | Referred to as Skid BW. |

**All four skids performed in an acceptable manner with respect to all qualification criteria.** This following report provides details of the qualification performance of these skids.

Based upon previously published information on probe performance, modeled sampling line performance and measured data obtained during investigations of the W-314 Exhausters manufactured by Premier Technology the qualified operating range of the exhauster systems may span an exhaust stack flow rate range from 401 SCFM (461 ACFM) corresponding to a free stream velocity of 2.6 m/s employing a minimum stack sample flow rate of 0.7 SCFM (20 LPM) to an Exhauster flow rate of 2,484 SCFM (3,615 ACFM) corresponding to a free stream velocity of 16.0 m/s employing a maximum stack sample flow rate of 2.5 SCFM (70 LPM). As an acceptable alternate, a constant sample flow rate of 2.0 SCFM (56.6 LPM) could be maintained over the range of the exhauster stack flow rate of 401 SCFM (461 ACFM) to 2,484 SCFM (3,615 ACFM).

# Premier Technologies Inc. W-314 Exhauster

ANSI/HPS N13.1-1999 Qualification Project -Final Report

## Abstract

Idaho State University (ISU) in collaboration with Auxier and Associates (A&A) has completed qualification of the sampling location and the sampling apparatus for Skids A, AW, B, and BW of the Premier Technology Inc., Hanford Tank Farm Project W-314 Exhausters. The acceptance criteria and the testing methods used were prescribed in American National Standards Institute/Health Physics Society ANSI/HPS N13.1-1999, Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities, ANSI/IEEE N42.18-1980, Specification and Performance of Onsite Instrumentation for Continuously Monitoring Radioactivity in Effluents, and 40 CFR 60, Appendix A, Method 1.

**The W-314 Exhauster A, AW, B and BW Skids manufactured by Premier Technology performed in an acceptable manner with respect to all ANSI/HPS N13.1 qualification criteria.** This report provides details of the qualification performance of Skids A, AW, B and BW.

Based upon previously published information on probe performance, modeled sampling line performance and measured data obtained during investigations of the W-314 Exhausters manufactured by Premier Technology the qualified operating range of the exhauster systems may span an exhaust stack flow rate range from 401 SCFM (461 ACFM) corresponding to a free stream velocity of 2.6 m/s employing a minimum stack sample flow rate of 0.7 SCFM (20 LPM) to an Exhauster flow rate of 2,484 SCFM (3,615 ACFM) corresponding to a free stream velocity of 16.0 m/s employing a maximum stack sample flow rate of 2.5 SCFM (70 LPM). As an acceptable alternate, a constant sample flow rate of 2.0 SCFM (56.6 LPM) could be maintained over the range of the exhauster stack flow rate of 401 SCFM (461 ACFM) to 2,484 SCFM (3,615 ACFM).

This report also includes an expert evaluation of continuous air monitor performance compliance with respect to ANSI/IEEE N42.18-1980 as limited by equipment performance capability and specifically not considering radiation detection ability. The radiation detection ability of the system can only be determined *in situ* as it is a function of the magnitude of background environmental radiation under which the system is operated. Slight modifications to the Eberline AMS-4 continuous air monitor (CAM) have been made to enhance the performance of the W-314 Exhauster over a broad

range of operating conditions. These modifications, due to their subtle nature, are unlikely to have an important effect on system performance relative to the ANSI/IEEE N42.18-1980 performance requirements; however, experimental evidence to validate this speculation is not available.

## OBJECTIVES/ACCOMPLISHMENTS

Idaho State University (ISU) and Auxier and Associates (A&A) were asked to perform Qualification of the Premier Technologies Inc., W-314 Exhauster consistent with ANSI/HPS N13.1-1999. Additionally they were asked to review the qualification of the Continuous Air Monitoring (CAM) systems incorporated into the W-314 Exhausters.

ANSI N13.1-1999 section 5.2.2 states that the sampling location shall be chosen to provide a valid representative sample of the contaminant discharge. Section 5.3 discusses methods for qualifying the sampling location and Table 4 located in that section lists characteristics to be tested, methods of testing, and acceptance criteria. The characteristics are:

- Test for cyclonic flow
- Determine velocity profile
- Determine tracer gas profile
- Determine maximum tracer gas concentration
- Determine aerosol particle profile

Section 6.3.2 provides requirements for evaluating nozzle performance and Section 6.4 for transport tube performance. The characteristics are:

- Nozzle transmission ratio
- Deposition losses in transport tubes

These seven characteristics were tested against the appropriate ANSI/HPS N13.1-1999 criteria using precision measurement techniques, i.e., techniques capable of measuring the characteristic to less than 10% of the allowable variation. The last two characteristics, nozzle transmission ratio and deposition losses in transport tubes were verified using published probe performance data, the transport code DEPOSITION 2001a and experimentally. An evaluation of the qualification of the Effluent Monitoring Instrumentation designated to be employed in the W-314 Exhauster units was also completed.

SCOPE OF EVALUATION AND ALLOWANCES FOR SIMILARITY

Section 5.2.2.2 of ANSI/HPS N13.1-1999 entitled: **Contaminant Concentration and Velocity Profile** makes the following statement:

> *Often nuclear facilities have multiple stacks or ducts that are of similar design. For such situations, it is not necessary to completely test the sampling location in a candidate stack or duct for compliance with the requirements given in clause 5.2.2 provided that:*
>
> 1) *A geometrically similar stack or duct (one with proportional critical dimensions) has been tested and the sampling location has been found to comply with the requirements of clause 5.2.2 Critical dimensions are those associated with components of the effluent flow system that can influence the degree of contaminant mixing and/or the velocity profile. The prior testing may be conducted either on a stack or duct in the field, or it may be conducted on a scale model.*
>
> 2) *The product of mean velocity (see eqn A-2) times hydraulic diameter of the candidate stack or duct is within a factor of six of that of the tested stack or duct, and the hydraulic diameter of the stack or duct is at least 250 mm at the sampling location, The Reynolds numbers based on hydraulic diameter of both the candidate stack or duct and the tested stack or duct are greater than 10,000 (see eqn B-1 and B-2 for examples of expressions that can be used for calculation of Reynolds numbers).*
>
> 3) *The velocity profile in the candidate stack or duct meets the requirements of clause 5.2.2.2.*
>
> 4) *The difference between velocity COVs of the two systems is not more than 5%.*
>
> 5) *The sampling location in the candidate stack or duct is placed at a geometrically similar location to that in the tested stack.*
>
> *If these requirements are fulfilled, the sampling location in the second stack or duct is acceptable.*

The four W-314 Exhausters manufactured by Premier Technology, specifically:

| | |
|---|---|
| AN Farm Skid A | Referred to as Skid A |
| AN Farm Skid B | Referred to as Skid B |
| AW Farm Skid A | Referred to as Skid AW |
| AW Farm Skid B | Referred to as Skid BW |

On the basis of as-built drawings, and data comparisons are identical with respect to the five similarity criteria listed above. This investigation redundantly considered each of the stack qualification criteria in at least two of the four skids and in some instances the stack qualification criteria were redundantly considered in all skids. Based on the ANSI/HPS N13.1-1999 allowance quoted above and the consistency among the skids in passing the criteria tested, it can be concluded that all skids pass all the criteria equally well regardless whether or not a particular criterion was tested on a particular skid.

**Methods and Materials**

QUALITY ASSURANCE PROGRAM PLAN AND STANDARD OPERATING PROCEDURES

Attachment One of this document is the Final Quality Assurance Program Plan (QAPP) and The Final Standard Operating Procedures (SOP) employed to complete Qualification of the Premier Technologies Inc., W-314 Exhauster. Neither the final version of the QAPP nor the final versions of the SOP were modified during the course of this project. These documents were implemented as presented in Attachment One. Attachments Nine is a photocopy of all relevant pages of information recorded in the Activity Specific Laboratory Notebook during performance of this task. Attachment Ten are all completed data forms prepared during performance of this work.

EVALUATION DOMAIN

The operational domains investigated corresponded to the lowest and highest viable stack volumetric flow rates of the W-314 Exhauster units and the corresponding sample flow rates as established by the engineering staff of Premier Technology.

The lowest stack flow rate was established at a power frequency of 25 Hz and a corresponding motor speed of about 1,500 rpm with the inlet valve throttled to a position at which the motor required a constant current of 6.7 amps. This corresponds to a volumetric flow rate of about 461 ACFM (401 SCFM given the barometric pressure and stack temperature measured at the time experimental measurements were made). The highest stack flow rate was established at a power frequency of 40 Hz and a corresponding motor speed of about 2,400 rpm with the inlet valve throttled to a position at which the motor required a constant current of 20.0 amps. Field tests verified that at 40 Hz operation, the maximum volumetric flow was achieved. This corresponds to a volumetric flow rate of about 3,615 ACFM (2,484 SCFM given the barometric pressure and stack temperature measured at the time experimental measurements were made). Higher frequency operation apparently leads to turbulent flow that increases power consumption and noise generation but substantially decreases flow rate. Some data have been generated at 60 Hz operation to demonstrate the decreased volumetric stack flow rate under other than optimal operational conditions. At 60 Hz operation a volumetric flow rate of about 1,357 ACFM (1,190 SCFM) was observed.

The W-314 exhauster units employ shrouded sampling probes manufactured by Thermo Anderson. The nominal sample flow rate for these probes is expected to be 2.0 SCFM (56.6 LPM) while sampling from a stack free stream velocity of 12 m/s. Chandra and McFarland (1997)[1] demonstrated that these shrouded probes could be successfully employed over a range of free stream velocities when sampling flow rates were maintained consistently within the nominal free stream to sample flow rate ratio. The Chandra and McFarland data indicate that these probes may be used at free stream velocities as low as 6 m/s while sampling at 1.1 CFM (30 LPM) and with a free stream velocity as high as 24 m/s while sampling at 3.99 CFM (113 LPM). The W-314 exhauster sampling system was investigated at both the minimum 401 SCFM (461 ACFM) considering sampling flow rates down to 0.7 SCFM (20 LPM) and at the maximum 2,484 (3,615 ACFM) exhauster stack flow rates considering sampling flow rates up to 2.5 SCFM (70 LPM). This approach defines a viable operational envelope for exhauster stack flow and appropriate sampling. Probe and sample line performance was evaluated using published probe performance data, the transport code Deposition 2001a, and experimental evidence.

CYCLONIC FLOW

As prescribed in ANSI/HPS N13.1-1999, the average flow angle at the sample extraction point in a stack shall not exceed 20° relative to the longitudinal axis of the stack. The average flow angle in this situation is determined in accordance with 40 CFR 60, Appendix A, Method 1, Section 2.4 using the pitot-tube method.

Standard Operating Procedure PTE-001; Determination of the Average Cyclonic Flow Angle in the Project W-314 Exhauster as found in Attachment One of this document was employed as the procedure for measurement and analysis of cyclonic flow. This procedure requires the application of two devices: an inclined manometer and an S-type pitot-tube. The inclined manometer employed was a Dwyer[2] No. 424 Stationary Gage inclined oil manometer. This device provides an absolute measure of pressure difference (i.e. Velocity Pressure) in units of inches of water. Since this device provides an absolute measurement it does not require secondary calibration. The S-

[1] Sumit Chandra and Andrew R. McFarland, Shrouded Probe Performance: Variable Flow Operation and Effect of Free Stream Turbulence, Aerosol Science and Technology 26:111-126 (1997)
[2] Dwyer Instruments Inc., Michigan City, Indiana 46360

Type pitot-tube employed was manufactured and calibrated by Apex Instruments[3]. Apex Instruments refers to the S-type pitot-tube (Serial Number 2072) as a type 6PT4 Ekkipsoldal device and that it was tested in accordance with Method 2 of 40 CFR 60 Appendix A. The manufacturer supplied value for the pitot-tube coefficient is Cp = 0.870. Attachment Two is a photocopy of the Apex Instruments S-type pitot-tube calibration sheet. Temperature measurements were made with an HB Instruments[4] Environ-Safe thermometer that was calibrated against NIST standards by the manufacturer and accurate to ± one scale division below 105°C. Tygon tube was used to connect the ports of the pitot-tube to the inlets of the inclined manometer. Leak tests were performed using a Mityvac II model HG3020 hand vacuum pump with vacuum gauge reliability established by the manufacturer. During leak tests the essential parameter is the relative stability of the vacuum gauge, which by changing very little or remaining stable during the tests, demonstrates that the system is leak free.

Pressure and temperature corrections of measured gas flow data were frequently necessary while evaluating W-314 Exhauster performance. Atmospheric pressure values were obtained ultimately from data generated at the National Weather Station facility located at the Pocatello Regional Airport. This data can be obtained online as hourly averages from the site:

http://www.met.utah.edu/cgiin/roman/past.cgi?stn=PIH&day1=30&month1=4&year1=2003.

The most useful information provided by this source is altimeter data which is converted to station surface pressure using the station pressure calculator available online at:

http://www.csgnetwork.com/stationpressurecalc.html.

During the early course of this project ISU developed a special jig to stabilize the S-type pitot-tube relative to the stack. Measurements trended over time reflect the improvements made in stabilization of the pitot-tube during the evolution of this jig. All measurements were valid; however, latter measurements reflect enhanced stability. This jig allowed the pitot-tube to be leveled relative to the horizontal using an oil bubble level, thus verifying the pitot-tube was perpendicular to the vertical stack, which also was verified to be vertical using an oil bubble level. The jig also provided a mechanical means to precisely rotate (adjustments of 0.1 degrees possible without noticeable mechanical hysteresis) the pitot-tube about its long axis while allowing for both adjust and maintenance of the length of pitot-tube insertion into the stack at designated fixed positions. The angle of rotation was measured using a 5-inch common carpenter's angle finder mounted perpendicular to the pitot-tube's long axis and parallel to the generalized direction of air flow through the stack. The two orthogonal ports of the W-314 exhauster units employed during this procedure are designated as ID# 7 and ID# 6

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[3] Apex Instruments 125 Quantum Street, Holly Springs, NC 27540
[4] Collegeville, Pennsylvania -U.S.A. (Country Code: 011)

see AN drawing [H-14-105531]. Data generated during this procedure was recorded in the project's laboratory notebook and later transcribed to the appropriate data pages provided in PTE-001.

VELOCITY PROFILE

Consistent with ANSI/HPS N13.1-1999 the velocity profile within the stack was determined using orthogonal pitot-tube traverses at the sample extraction point. The two orthogonal sample ports of the W-314 exhauster unit employed during this procedure are designated as ID# 7 and ID# 6 see AN drawing [H-14-105531]. The selection of measurement points was accordance with 40 CFR 60, Appendix A, Method 1. The acceptance criteria established within ANSI/HPS N13.1-1999 specifies that the coefficient of variation (COV) of the velocity profile shall not exceed 20% over the center region of the stack that encompasses at least two-thirds of the stack area.

Standard Operating Procedure PTE-002; Determination of the Stack Gas Velocity and Flow Rate in the Project W-314 Exhauster as found in Attachment One of this document was employed as the procedure for measurement and analysis of stack gas velocity and velocity profile. This procedure employed the same inclined manometer, S-type pitot-tube, pitot-tube jig, leak testing device, and thermometers as described above in the **Methods and Materials** section: CYCLONIC FLOW. Barometric pressure information was also obtained in the same way as described in the previous section. Data generated during this procedure was recorded in the project's laboratory notebook and later transcribed to the appropriate data pages provided in PTE-001.

TRACER GAS PROFILE

Either sulfur hexafluoride ($SF_6$) or carbon dioxide ($CO_2$) tracer gas was used to ensure the uniformity of mixing of the exhaust at the point of sample extraction. During the evaluation of Skid A, sulfur hexafluoride ($SF_6$) was employed to examine tracer gas mixing. During the evaluation of Skid B, carbon dioxide ($CO_2$) was employed to examine tracer gas mixing. The selections of measurement points were in accordance with 40 CFR 60, Appendix A, Method 1. A ¼ -inch inside diameter copper sample probe consistent with N13.1 requirements was used to obtain gas samples. Immediately following the probe was a Whatman[5] Inlet 0.45-µm PES, L#Q848 inline filter. The filter was employed to avoid contaminating the samples with any incidental particulate that may be in the stack. The two orthogonal sample ports of the W-314 exhauster unit employed during this procedure for SKID A are designated as ID# 7 and ID# 6 see AN drawing [H-14-105531]. The two orthogonal sample ports of the W-314 exhauster unit employed during this procedure for SKID B are designated as ID# 8 and ID# 9 see AN drawing [H-14-105545]. The sample was pumped with a low flow rate diaphragm

[5] Whatman Inc., 401 West Morgan Road, Ann Arbor, MI 48108-9109

pump. Sample flow rate was controlled at a rotometer indication of 5.0 which corresponds to 1.97 LPM at 70° F and 14.70 psia. The flow rate corrected for pressure and temperature is about 1.48 liters/minute. Sample flow rate was measured using a Dwyer[6] rotometer Model N014-96, SN 89281-2. Attachment Three provides information on the manufacturer's calibration of this rotometer. Sampling time in each instance was 30.0 seconds.

The acceptance criteria established within ANSI/HPS N13.1-1999 specifies that the coefficient of variation (COV) of the gas concentration profile shall not exceed 20% over the center region of the stack that encompasses at least two-thirds of the stack area. The tracer gas was injected into the stack after the exhaust fan at port location ID#2 see AN drawing [H-14-105531]. $SF_6$ gas was injected at the maximum possible tank feed pressure of 43 psi when evaluating Skid A performance. $CO_2$ gas was injected at the optimum tank feed pressure of 80 psi when evaluating skid B performance. If gas pressure was not maintained constant, the recorded pressure of gas delivery was used to correct final measured gas concentration assuming ideal gas relationships applied in a linear fashion. During evaluation of Skid A and Skid B tracer gas samples were obtained and stored for laboratory analysis in tedlar bags of either 1.0 or 1.2 liter volume with built in and lockable closure values. Tracer gas concentration was determined using mass spectroscopy. During the second series of measurements for the minimum exhaust flow of Skid A, tracer gas concentration was determined redundantly using both FTIR and mass spectrometry, both sets of data were averaged for this particular group of samples even though there was not particularly good agreement between both methods.

## MAXIMUM TRACER GAS CONCENTRATION

The results of the tracer gas profile test including additional test points consistent with 40 CFR 60, Appendix A, Method 1, were used to determine the maximum tracer gas concentration. Sampling and analysis of tracer gas was described in the preceding part of the **Methods and Materials** section: TRACER GAS PROFILE. The acceptance criteria established within ANSI/HPS N13.1-1999 for the acceptable maximum tracer gas concentration specifies that the maximum value of tracer gas concentration shall not exceed the mean value by more than 30% at any point along the tracer gas profile.

## AEROSOL PARTICLE PROFILE

According to ANSI/HPS N13.1 test aerosols will be used to ensure the uniformity of mixing of the exhaust at the point of sample extraction. The selection of measurement points will be in accordance with 40 CFR 60, Appendix A, Method 1. The acceptance criteria established within ANSI/HPS N13.1 for the aerosol particle profile is that the coefficient of variation (COV) of the aerosol particle concentration profile shall not

[6] Dwyer Instruments Inc., Michigan City, Indiana 46360

exceed 20% over the center region of the stack that encompasses at least two-thirds of the stack area. The challenge aerosol particles were injected into the stack after the exhaust fan at port location ID#2 see drawing [H-14-105545]. ANSI/HPS N13.1-1999 prescribes that the aerosols will be a low vapor pressure organic liquid. During evaluation of the Premier W-314 Exhauster the organic oil used to generate aerosols was soybean oil distributed by the Albertsons'[7] grocery store chain. A yellow die manufactured and distributed by Florida Soy Solutions[8] Inc., and compatible with soybean oil was added to enhance detectablity of the oil using an ultraviolet/visible (UV/VIS) light spectrophotometer. Aerosols were generated using a particle generator developed by employees of A&A. Attachment Seven's Figures 31 and 32 provide information on the aerosol particle size distribution generated by this device as employed during this project. Patent information for this device is provided in Attachment Four. The aerosol generator was driven by a compressed air line source maintained at a minimum pressure of 15.0 psig regulated from a tank pressure of 120 psi. The 6 HP, 33-gallon, model 919.167346 compressor used was manufactured by Sears Roebuck and Company[9]. No pressure variations greater than ±5psig were observed during the evaluation. The aerosol concentration during this experiment was sampled by collection on stages of a cascade impactor. The impactor plates employed in the cascade were cut using a 3.65-cm bridge die at ISU from commercial grade Aluminum foil distributed by the Albertsons'[10] grocéry store chain. Impactor plates were rinsed with reagent grade hexane prior to use. The eighth stage of the cascade impactor employed a 47-mm diameter cellulose nitrate membrane filter with a 5.0-μm pore size rather than an aluminum impaction plate. A set of In-Tox Products[11] 20-LPM, multi-stage multi-jet, cascade impactors were used to complete this procedure. Attachment Five of this report provides the specification for these impactors. The cascade impactor allowed profiling by particle sizes according to aerodynamic diameter (AD). The evaluation of 10μm-particles was accomplished by impacting this particle size on an impactor plate that trapped all particles from 7.1μm to 11.9μm-AD. The sampling flow rate was constant at about 42±0.8SCFH (19.8±0.4LPM) as corrected for temperature and pressure, as measured using a model RMC-105-SSv rotometer manufactured by Dwyer[12] Instruments. This rotometer has a manufactured specified accuracy of ± 2% of full scale. A ½-inch inside diameter, copper, sample probe consistent with N13.1 requirements was used to obtain aerosol samples. The two orthogonal sample ports of the W-314 exhauster unit employed during this procedure for SKID A are designated as ID# 7 and ID# 6 see drawing [H-14-105531]. The two orthogonal sample ports of the W-314 exhauster unit employed during this procedure for SKID B are designated as ID# 8 and ID# 9 see drawing [H-14-105545]. The aerosol concentration by particle size was determined by dissolving the material off the

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[7] Albertson's Inc., General Office, Boise, Idaho 83726
[8] Florida Soy Solutions, LLC Sanford, Florida 32773
[9] Sears Roebuck and Company, Hoffman Estates, IL 60176
[10] Albertson's Inc., General Office, Boise, Idaho 83726
[11] In-Tox Products, 1712 Virginia NE Albuquerque, New Mexico 87110
[12] Dwyer Instruments Inc., Michigan City, Indiana 46360

impactor stage using 3.00±0.01 mlof reagent grade hexane and then determining the concentration in the solvent using an UV/VIS spectrophotometer. A fitted scatter plot calibration curve developed to determine the mass of soybean oil on each impactor plate is provided as Attachment Six.

NOZZLE TRANSMISSION RATIO AND DEPOSITION LOSSES IN THE TRANSPORT TUBE

ANSI/HPS N13.1-1999 in section **6.3.2 Nozzle Performance** specifies that a sampling nozzle shall have an aerosol transmission ratio within the range of 0.80 to 1.30 over the anticipated range of normal or anticipated accident operational conditions for an aerosol particle size of 10-μm AD or for the range of sizes that could be encountered in normal operating or accident conditions if those sizes are greater than 10 μm AD. Also, the aspiration ratio of a sampling nozzle shall be within the range of 0.80 to 1.50 for the anticipated range of operating conditions and the previously noted particle size or sizes. Compliance shall be demonstrated with liquid aerosol particles, which will provide conservative transmission values in comparison with solid particles because liquid particles adhere to walls, while solid particles may rebound or be re-entrained from a surface.

ANSI/HPS N13.1-1999 in section **6.4.1 Depositional Losses** specifies that the deposition of particles inside the transport tubing shall be evaluated either through experimental techniques, through the use of documented computer codes, or through the use of documented and referenced hand calculations, for either 10 μm AD aerosol particles or the size range expected in the particular application under normal, off-normal, and anticipated accident conditions.

Section **6.4.1 Depositional Losses** later specifies that "In general terms, there will be some losses of aerosols in transport lines, and any design will entail compromises. The design parameters shall be carefully chosen to optimize the utility of the overall system. The penetration of 10 μm AD aerosol particles from the free stream to the collector or analyzer should be known and should not be less than 50%.

Annex B of ANSI/HPS N13.1-1999 describes modeling of particles in transport lines and Annex F discusses Sampling System Performance Verification. Section F.2 of Annex F Approaches to Verification summarizes four methods for verifying sample transmission performance:

- In-place testing
- Laboratory simulations
- Modeling based on deposition and resuspension rates determined in the laboratory
- A combination of the above.

Deposition losses of aerosol particles from the sample extraction point to the point of collection were evaluated using, published information on probe performance, experimental data, and the computer code DEPOSITION 2001a.

The Software code Deposition 2001a - version 1 was used to model deposition within the sampling lines of the Premier exhausters and the probe transmission for the Thermal Andersen probes used in the exhauster units. Sampling flow rate using the Thermo Andersen sampling probes is restricted to a flow rate of 56.6 LPM (2 SCFM) while using this code.

Since shrouded probe performance has already been well documented in the literature (Chandra and McFarland 1997)[13] for a range of free stream velocities and sampling rates, sample line performance was evaluated using the code Deposition 2001a over the range of potential sample flow rates without considering probe performance. The combination of published data on probe performance and modeled sample line performance over the range of free stream velocity and sample flow rates under which the W-314 Exhausters may operate was used to validate system performance.

Field measurements at a low sampling flow rate of 0.7 SCFM (20 LPM) which coincided with the proper operation of the cascade impactors employed for high and low exhauster flow rates were also conducted. Measured samples were obtained from the sample line nozzle through the transport tube to a point just before the AMS-4 CAM where the line could be decoupled and from the ancillary sample line at the point where the line could be decoupled (See drawing H-14-105566 Sheet 3).. Aerosols were generated and samples were obtained and analyzed using the same methods described above. ANSI/HPS N13.1 specifies that aerosol transmission should be evaluated for a particle size of 10-μm aerodynamic diameter and transmission for any size shall not be less than 50%.

The nozzle transmission ratio was tested with soybean oil generated as described in the preceding part of the **Methods and Materials Section**: AEROSOL PARTICLE PROFILE. The aerosol concentration was determined in the aspirated sample and the test stream with the same procedures described in the preceding section. The ratio of the concentration in the aspirated sample to that in test stream was used to determine the aerosol transmission ratio by particle size. ANSI/HPS N13.1 specifies that the aerosol transmission ratio shall not be lower than 0.8 or higher than 1.3. Experimental measurements were restricted to the capabilities of the cascade impactors employed.

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[13] Sumit Chandra and Andrew R. McFarland, Shrouded Probe Performance: Variable Flow Operation and Effect of Free Stream Turbulence, Aerosol Science and Technology 26:111-126 (1997)

# QUALIFICATION OF EFFLUENT MONITORING INSTRUMENTATION

Premier Technology Inc. supplied relevant ANSI/HPS 42.18 test results for the Eberline AMS-4 Continuous Air Monitor (CAM). The test results were evaluated against the expected operating environment at the Hanford site and on the Premier Technology skid. The results of the evaluation are provided as discussion and in tabular format. ANSI/IEEE 42.18-1980 compliance of the AMS-4 CAM was documented in the following report: Evaluation of Eberline AMS-3A and AMS-4 Beta Continuous Air Monitors: M.L. Johnson, D.R. Sisk, Battelle, Pacific Northwest National Laboratory PNNL-10938, 1996. However, slight modifications were made to the AMS-4 CAMs installed in the W-314 Exhauster Units in order to compensate for an expected higher possible operational temperature. There are four major areas of performance described in ANSI/IEEE 42.18-1980: Detection Capability, Physical and Electrical Operating Limits, System Reliability, and Calibration. Attachment Eight provides the details of the Assessment Working Group's analysis of impacts due to changes in the AMS-4 system on the previously reported ANSI/IEEE N42.18-1980 performance and information requirements.

**Results and Discussion**

CYCLONIC FLOW MEASUREMENT AND CRITERIA

The average flow angle at the sample extraction point in a stack, according to ANSI/HPS N13.1-1999, is not to exceed 20° relative to the longitudinal axis of the stack. The average flow angle was determined in accordance with 40 CFR 60, Appendix A, Method 1, Section 2.4 using the pitot-tube method. Summary results of this evaluation are provided in Table One below:

Table One: a summary of cyclonic flow measurements and data evaluation.

| SKID | Qs(ACFM)[1]/ Qs (SCFM) | Frequency (Hz)[2] | Average flow angle[3] (degrees) | Statement of test Performance[4] |
|---|---|---|---|---|
| A | 513/455 | 25 | 0.750 | Pass |
| A | 3,615/2,484 | 40 | 1.375 | Pass |
| A | 2,446/2,171 | 60 | 4.188 | Pass |
| B | 461/401 | 25 | 0.000 | Pass |
| B | 3,285/2,460 | 40 | 4.313 | Pass |
| B | 1,357/1,190 | 60 | 4.500 | Pass |
| AW | 795/655 | 25 | 8.125 | Pass |
| AW | 3,022/2,492 | 40 | 2.406 | Pass |
| BW | 1,027/834 | 25 | 7.125 | Pass |
| BW | 3,033/2,501 | 40 | 2.438 | Pass |

[1] Value of volumetric flow averaged over the center two-thirds of the stack.
[2] Motor Power Frequency applied during evaluation.
[3] The average of the absolute values of the measured flow angles at the level of the proposed sample extraction point considering 8-measured points distributed in accordance with 40 CFR 60, Appendix A, Method 1, along two orthogonal axis.
[4] ANSI/HPS N13.1-1999 acceptable performance criteria requires that the average of the absolute values of the measured flow angles must be less than 20°

Attachment Seven serves as the location for providing all data in this report. Tables 1 through 10 of Attachment Seven provide data on cyclonic flow. These data tables provide evidence of system performance consistent with the criteria established in ANSI/HPS N13.1-1999.

VELOCITY PROFILE MEASUREMENT AND CRITERIA

The velocity profile in accordance with ANSI/HPS N13.1-1999 is determined using two orthogonal pitot-tube traverses at the sample extraction point. The selection of measurement points was in accordance with 40 CFR 60, Appendix A, Method 1. The coefficient of variation (COV) of the velocity profile must not exceed 20% over the center region of the stack that encompasses at least two-thirds of the stack area under the standard criteria of ANSI/HPS N13.1-1999. Results of this evaluation are provided in Table Two below:

Table Two: a summary of velocity profile measurements and data evaluation.

| SKID | Qs(acfm)[1] | Frequency (Hz)[2] | Coefficient of Variation for the dry gas velocity profile[3] | Statement of test Performance[4] |
|---|---|---|---|---|
| A | 513/455 | 25 | 0.06 | Pass |
| A | 3,615/2,484 | 40 | 0.04 | Pass |
| A | 2,446/2,171 | 60 | 0.04 | Pass |
| B | 461/401 | 25 | 0.11 | Pass |
| B | 3,285/2,460 | 40 | 0.04 | Pass |
| B | 1,357/1,190 | 60 | 0.02 | Pass |
| AW | 795/655 | 25 | 0.05 | Pass |
| AW | 3,022/2,492 | 40 | 0.05 | Pass |
| BW | 1,027/834 | 25 | 0.04 | Pass |
| BW | 3,033/2,501 | 40 | 0.04 | Pass |

[1] Value of volumetric flow averaged over the center two-thirds of the stack.
[2] Motor Power Frequency applied during evaluation.
[3] The Coefficient of Variation of measured dry gas velocity values over the center two-thirds of the stack at the level of the proposed sample extraction point considering 8-measured points distributed in accordance with 40 CFR 60, Appendix A, Method 1, along two orthogonal axis.
[4] ANSI/HPS N13.1-1999 acceptable performance criteria requires that the Coefficient of Variation of measured dry gas velocity values over the center two-thirds of the stack must be less than 20% (i.e. fractional COV must be ≤ 0.20).

Attachment Seven serves as the location for providing all data in this report. Tables 1 through 10 of Attachment Seven provide data on flow velocity profiles. These data tables provide evidence of system performance consistent with the criteria established in ANSI/HPS N13.1-1999. Figures 1 through 19 of Attachment Seven are scatter plots for all the data collected and demonstrate the velocity profiles measured under the operating domains described above. Examples of typical velocity profiles from Attachment Seven's Figure 1 and Figure 2 are provided below.

These plots also provide evidence of system performance that is consistent with the criteria established in ANSI/HPS N13.1-1999. One may notice a difference in flow rates measured at identical power frequencies, and motor current in Skids A, AW, B and BW. This difference reflects different positions of inlet valve position, conditions of HEPA filters and other environmental conditions such as humidity, temperature and pressure rather than performance differences in the machines.

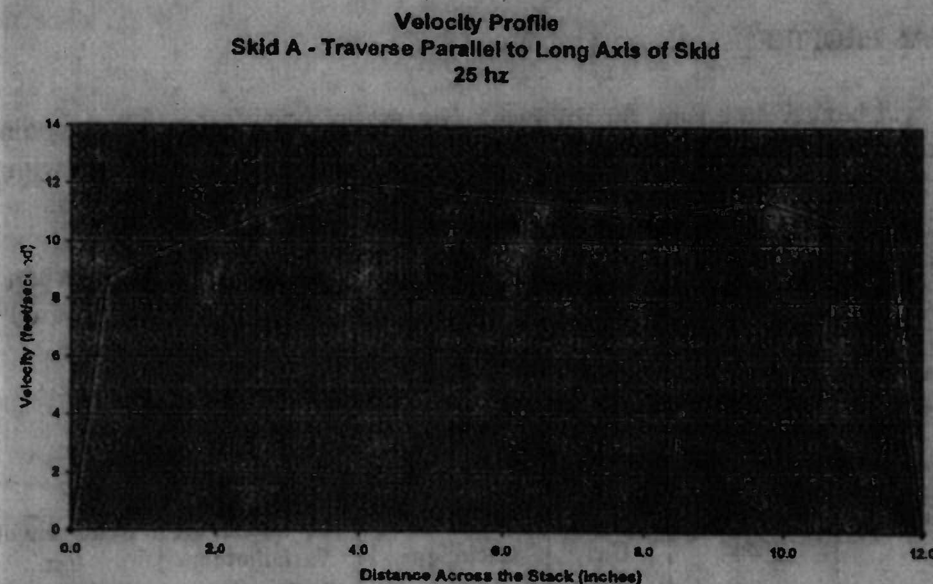


Figure 1: Example of typical velocity profile. This velocity profile is for Skid A during traverse parallel to the long axis of the skid at the minimum viable flow rate. Velocity profile scatter plots for all measurements made may be found in Attachment Seven in Figures 1 through 19.

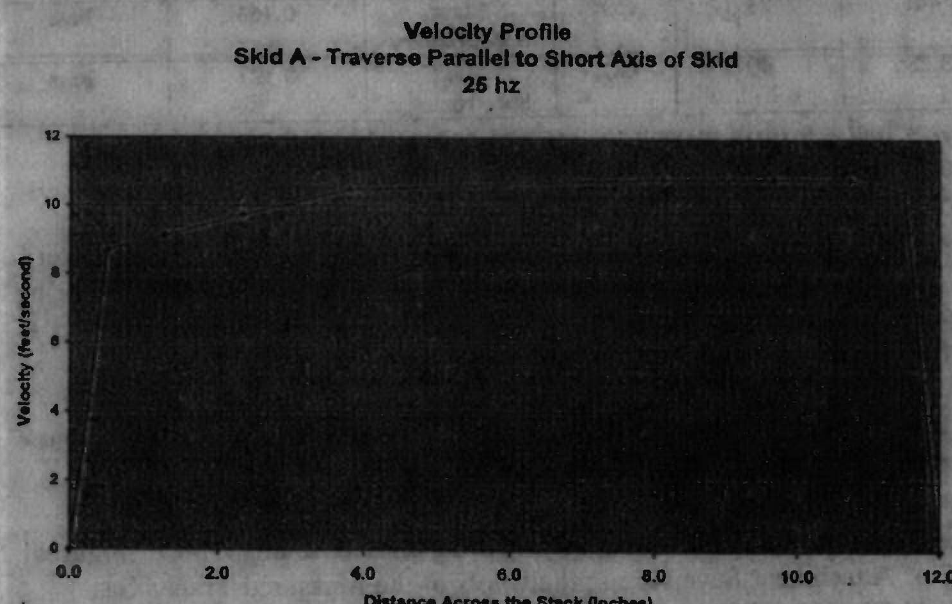


Figure 2: Example of typical velocity profile. This velocity profile is for Skid A during traverse parallel to the short axis of the skid at the minimum viable flow rate. Velocity profile scatter plots for all measurements made may be found in Attachment Seven in Figures 1 through 19.

## TRACER GAS PROFILE

A tracer gas will be used to ensure the uniformity of mixing of the exhaust at the point of sample extraction. The selection of measurement points will be in accordance with 40 CFR 60, Appendix A, Method 1. The coefficient of variation (COV) of the gas concentration profile shall not exceed 20% over the center region of the stack that encompasses at least two-thirds of the stack area. The tracer gas will be either carbon dioxide ($CO_2$) or sulfur hexafloride ($SF_6$). The tracer gas concentration was measured using either mass spectroscopy or FTIR spectroscopy. The gas concentration was measured in the laboratory using samples collected in tedlar bags. Results of this evaluation are provided in Table Three below:

Table Three: a summary of velocity profile measurements and data evaluation.

| SKID | Qs(acfm)[1] | Frequency (Hz)[2] | Tracer Gas Used | Measurement technique | Coefficient of Variation for the tracer gas concentration profile[3] | Statement of test Performance[4] |
|---|---|---|---|---|---|---|
| A | 513 | 25 | $SF_6$ | Mass Spectrometry | 0.111 | Pass |
| A | 3,615 | 40 | $SF_6$ | Mass Spectrometry | 0.069 | Pass |
| B | 461 | 25 | $CO_2$ | Mass Spectrometry | 0.163 | Pass |
| B | 3,285 | 40 | $CO_2$ | Mass Spectrometry | 0.127 | Pass |

a summary of velocity profile measurements and data evaluation.

[1] Value of volumetric flow averaged over the center two-thirds of the stack.

[2] Motor Power Frequency applied during evaluation.

[3] The Coefficient of Variation for the tracer gas concentration profile over the center two-thirds of the stack at the level of the proposed sample extraction point considering 8-measured points distributed in accordance with 40 CFR 60, Appendix A, Method 1, along two orthogonal axis.

[4] ANSI/HPS N13.1 acceptable performance criteria requires that the Coefficient of Variation of the tracer gas concentration profile over the center two-thirds of the stack must be less than 20% (i.e. fractional COV must be ≤ 0.20).

Attachment Seven serves as the location for providing all data in this report. Figures 20 through 27 of Attachment Seven are scatter plots of the Measured Tracer Gas Profiles obtained for evaluation of the W-314 exhausters. These plots provide evidence of system performance that is consistent with the criteria established in ANSI/HPS N13.1. Examples of typical tracer gas concentration profiles from Attachment Seven's Figure 24 and Figure 25 are provided immediately below.

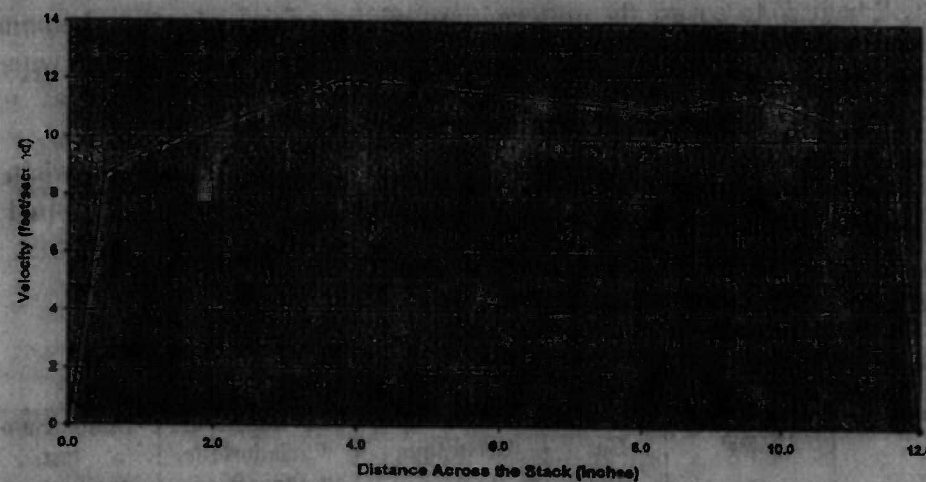


Figure 1: Example of typical velocity profile. This velocity profile is for Skid A during traverse parallel to the long axis of the skid at the minimum viable flow rate. Velocity profile scatter plots for all measurements made may be found in Attachment Seven in Figures 1 through 19.

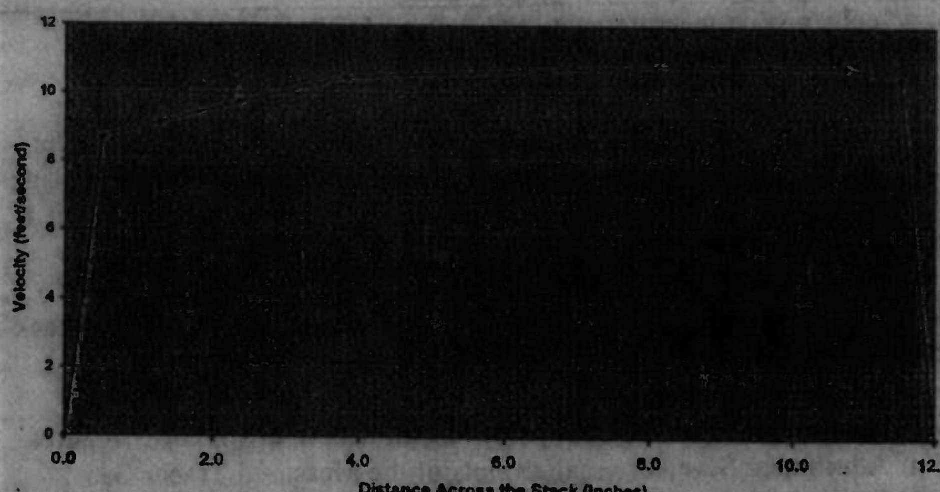


Figure 2: Example of typical velocity profile. This velocity profile is for Skid A during traverse parallel to the short axis of the skid at the minimum viable flow rate. Velocity profile scatter plots for all measurements made may be found in Attachment Seven in Figures 1 through 19.

measurements as gas concentration measurements were made using both mass spectroscopy and FTIR spectroscopy. These two sets of data demonstrated variable agreement among data points. Both sets of data were considered equally valid. These data sets were averaged to provide final results. All other data sets provided information from only mass spectroscopy measurements of gas concentration. Tables 11 through 15 also provide the output from logic comparisons of gas concentrations that lead to conclusions with respect to ANSI/HPS N13.1-1999 criteria compliance.

## MAXIMUM TRACER GAS CONCENTRATION

The results of the tracer gas profile test with additional tests points in accordance with 40 CFR 60, Appendix A, Method 1, for the entire cross sectional area of the duct were used to evaluate the maximum tracer gas concentration. The acceptance criteria established within ANSI/HPS N13.1-1999 for the acceptable maximum tracer gas concentration specifies that the maximum value of tracer gas concentration shall not exceed the mean value by more than 30% at any point along the tracer gas profile. Results of this evaluation are provided in Table Four below:

Table Four: a summary of tracer gas concentration measurements and data evaluation.

| SKID | Qs (acfm)[1] | Frequency (Hz)[2] | Tracer Gas Used | Measurement technique | Maximum Value of Tracer Gas Concentration | Average Value of Tracer Gas Concentration | % Absolute Difference | Test Result[3] |
|---|---|---|---|---|---|---|---|---|
| A | 513 | 25 | $SF_6$ | Mass Spectrometry | $5.48 \times 10^{0} \pm 1.2 \times 10^{-1}$ PPT | $4.41 \times 10^{0} \pm 2.6 \times 10^{-2}$ PPT | 24.3 | Pass |
| A | 3,615 | 40 | $SF_6$ | Mass Spectrometry | $1.53 \times 10^{-1} \pm 5.0 \times 10^{-4}$ PPT | $1.18 \times 10^{-1} \pm 9.0 \times 10^{-4}$ PPT | 29.7 | Pass |
| B | 461 | 25 | $CO_2$ | FTIR and Mass Spectrometry | 7.69±0.3% | 6.85±0.6 % | 12.3 | Pass |
| B | 3,285 | 40 | $CO_2$ | Mass Spectrometry | 1.99±0.6% | 1.55±0.0% | 28.4 | Pass |

[1] Value of volumetric flow averaged over the center two-thirds of the stack.
[2] Motor Power Frequency applied during evaluation.
[3] The ANSI 13.1 acceptance requirement is that the maximum value of tracer gas concentration shall not exceed the average value by more than 30% of the mean value at any point along the tracer gas profile traverses.

Attachment Seven serves as the location for providing all data in this report. Figures 20 through 27 of Attachment Seven are scatter plots of the Measured Tracer Gas Profiles obtained for evaluation of the W-314 exhausters. These plots provide evidence of system performance that is consistent with the criteria established in ANSI/HPS N13.1-1999.

Tables 11 through 15 of Attachment Seven provide the data from which tracer gas profile plots were generated. The raw measurement data from tracer gas concentrations was corrected for machine amplification factors, and variations in challenge feed gas pressure. Some data points were lost from the full set of traverse sampling relative to

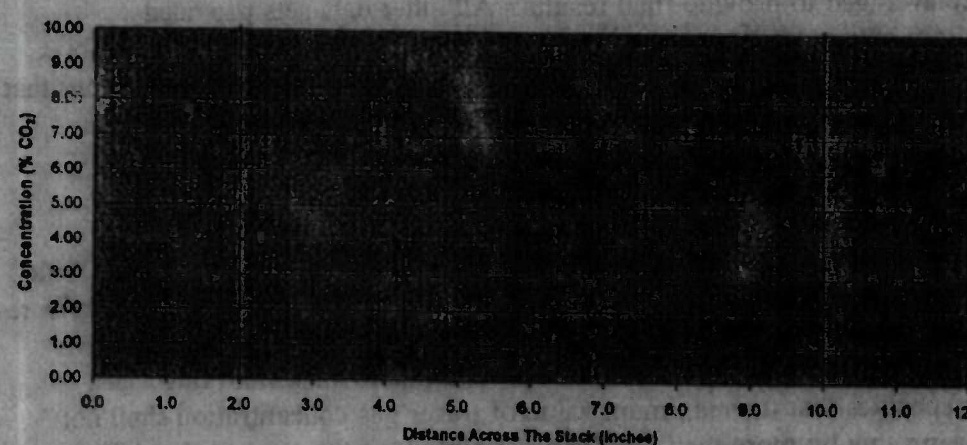


Figure 24: Example of typical tracer gas concentration profile. This tracer gas concentration profile is for Skid B during traverse parallel to the long axis of the skid at the minimum viable flow rate. Tracer gas profile scatter plots for all measurements made may be found in Attachment Seven in Figures 20 through 27.

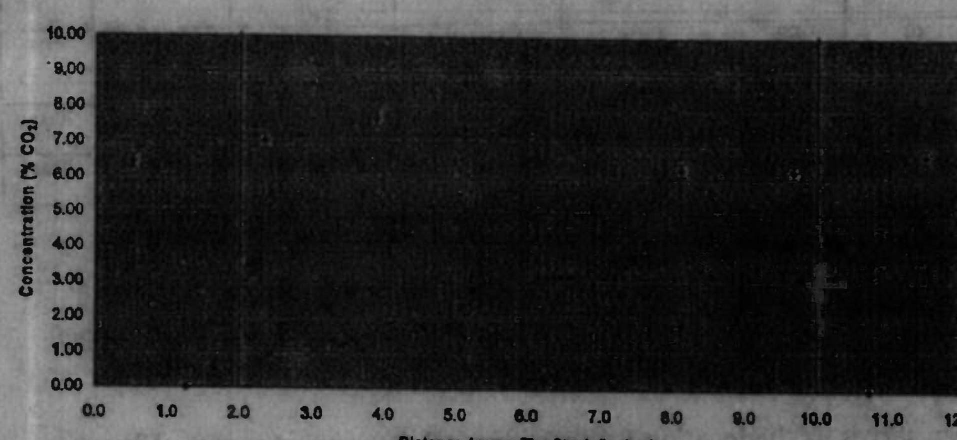


Figure 25: Example of typical tracer gas concentration profile. This tracer gas concentration profile is for Skid B during traverse parallel to the short axis of the skid at the minimum viable flow rate. Tracer gas profile scatter plots for all measurements made may be found in Attachment Seven in Figures 20 through 27.

Tables 11 through 15 of Attachment Seven provide the data from which tracer gas profile plots were generated. The raw measurement data from tracer gas concentrations was corrected for machine amplification factors, and variations in challenge feed gas pressure. Skid A minimum exhauster flow rate data is unique to this series of this portion of the evaluation. There was apparent leakage of the tedlar bags between sampling and analysis. One $SF_6$ concentration measurement point was rejected as it was linked to a blunder during the measurement procedure. Four measurements of the $CO_2$ gas concentrations were rejected as they were associated with apparently leaking tedlar bags which invalidated the results. These data points could not be re-established. None of the lost data had an effect on the Tracer Gas Profile Evaluation. Although a loss of data reduces the range of certainty in the Maximum Tracer Gas Concentration evaluation, the redundancy in the measurements made at maximum and minimum flow rates clearly compensates for this shortfall and provides ample information for the evaluation.

Skid B minimum exhauster flow rate data is unique to this series of measurements as gas concentration measurements were made using both mass spectroscopy and FTIR spectroscopy. These two sets of data demonstrated variable agreement among data points. Both sets of data were considered equally valid. These data sets were averaged to provide final results. All other data sets provided information from only mass spectroscopy measurements of gas concentration.

Tables 11 through 15 also provide the output from logic comparisons of gas concentrations that lead to conclusions with respect to ANSI/HPS N13.1-1999 criteria compliance. One comparison made was a comparison of gas concentration at each sample point to the average gas concentration measured. The percentage difference relative to the average concentration is determined. Spreadsheet columns have logic functions to determine if these percentage differences are greater than the ANSI/HPS N13.1-1999 allowable difference for the maximum concentration of 30%. The maximum concentration in each of the profiles has a percentage difference relative to the average concentration that is less than 30% so the W-314 Exhauster units pass this criterion. However, the logic tests provided are more stringent than the ANSI/HPS N13.1-1999 requirement. The logic tests consider all concentrations not just the highest concentration. There is evidence that in one situation, Skid A's maximum flow rate evaluation, the lowest concentration at the short axis traverse at a point 1.26-inches into the stack varies from the average by about 31.4% so this is flagged as a failure. <u>Low concentration variations from the average are not part of ANSI/HPS N13.1-1999 criteria</u>.

## AEROSOL PARTICLE PROFILE

Aerosols were used to ensure the uniformity of mixing of the exhaust at the point of sample extraction. The selection of measurement points was in accordance with 40 CFR 60, Appendix A, Method 1. The coefficient of variation (COV) of the aerosol particle concentration profile according to ANSI/HPS N13.1 shall not exceed 20% over the center region of the stack that encompasses at least two-thirds of the stack area. The aerosols used were generated from soybean oil mixed with compatible dye. The aerosol concentration was measured by collection on stages of a cascade impactor. All samples were taken at a sampler flow rate of 20 LPM for 10-minute sample duration. The cascade impactor allowed profiling by particle size up to 10-μm aerodynamic diameter. Dissolving the material off the impactor stage by a known volume of solvent, then determining the concentration of oil in the solvent by means of spectrophotometry was the method by which the aerosol concentration by particle size was determined. Tables Five, Six, Seven, and Eight, summarize the results of this investigation. Table Five as an example, is a summary of aerosol profile data for Skid B at the minimum flow rate of 461 ACFM (401 SCFM). Within the first column of Table Five is the designation ECD. ECD is an acronym for Effective Cut-off Diameter. This implies that all particles in the gas stream moving through that particular impactor stage that were greater than the ECD value in question would have been deposited on that particular impact plate of the cascade impactor. ANSI/HPS N13.1 in section 5.2.2.2 specifies that "*If aerosol particles can be present in the flow, the criterion for establishing the acceptable uniformity of contaminant mixing and velocity across a stack or duct is that the coefficient of variation of concentration of 10 ±1-*μm *AMAD tracer aerosol particles and of a tracer gas shall be less than or equal to 20%.*" To pass the ANSI/HPS N13.1 standard for aerosol profile variation, strictly speaking the COV associated with the rows corresponding to the 11.9 and 7.1 ECD values are the key and only parameters that must be less than 20%. Figures 31 to 34 in Attachment Seven are scatter plots of these data.

*This section intentionally left blank.*

Table Five: a summary of aerosol profile data for Skid B at the minimum flow rate of 461 ACFM, (401 SCFM).

| ECD[3] (μm) | S1[1] | S2[1] | S3[1] | S4[1] | L1[1] | L2[1] | L3[1] | L4[1] | COV | < 20%[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| 11.19 | 5.26E-01 | 4.12E-01 | 5.12E-01 | 4.93E-01 | 4.62E-01 | 3.88E-01 | 4.83E-01 | 3.92E-01 | 11.9% | Pass |
| 7.1 | 4.69E-01 | 3.52E-01 | 4.68E-01 | 5.57E-01 | 5.26E-01 | 3.93E-01 | 5.07E-01 | 4.11E-01 | 15.3% | Pass |
| 4.4 | 5.29E-01 | 4.58E-01 | Rejected[4] | 5.40E-01 | 5.40E-01 | 5.57E-01 | 5.16E-01 | 3.77E-01 | 12.7% | Pass |
| 2.8 | 5.36E-01 | 5.65E-01 | 3.92E-01 | 4.25E-01 | 4.56E-01 | 4.91E-01 | 4.12E-01 | 4.18E-01 | 13.6% | Pass |
| 1.76 | 5.46E-01 | 4.72E-01 | 4.52E-01 | 4.74E-01 | 4.98E-01 | 4.00E-01 | 4.12E-01 | 4.31E-01 | 10.4% | Pass |
| 1.11 | 3.75E-01 | 4.43E-01 | 3.59E-01 | 5.73E-01 | 3.94E-01 | 4.28E-01 | 4.25E-01 | 4.11E-01 | 15.4% | Pass |
| 0.7 | 3.65E-01 | 4.25E-01 | 3.41E-01 | 4.34E-01 | 4.45E-01 | 5.16E-01 | 5.02E-01 | 3.76E-01 | 14.8% | Pass |
| 5 CNM | 8.16E-01 | 5.51E-01 | 3.77E-01 | 3.88E-01 | 4.09E-01 | 5.43E-01 | 5.47E-01 | 5.11E-01 | 27.3% | Fail[5] |
| sum | 4.16E+00 | 3.68E+00 | 2.90E+00 | 3.89E+00 | 3.73E+00 | 3.71E+00 | 3.80E+00 | 3.33E+00 | 10.4% | Pass |

[1] These sampling locations along the orthogonal traverses of Skid B were used during the aerosol profile investigation. The "S" designation represents a traverse parallel to the short axis of the skid. The "L" designation represents a traverse parallel to the long axis of the skid. Point 1 was at an insertion of 0.8 inches, point 2 at 3.0 inches, point 3 at 9.0 inches, and point 4 at 11.2 inches. All values are reported as mg of collected oil.

[2] The column headed < 20% indicates the test result for the test that considers if the coefficient of variation was less than 20%.

[3] ECD is an acronym for Effective Cut-off Diameter. This implies that all particles in the test stream entering the impactor stage in question that were greater than the ECD value would have been deposited on the impact plate of the cascade impactor.

[4] The impactor plate corresponding to the 4.4-μm effective cut-off diameter for the B4 insertion point was rejected. This data point was known to be accidentally contaminated during analysis.

[5] The COV for the collection of particles less than 0.5-μm effective cut-off diameter was measured to be greater than 20%. The final stage of the cascade impactor employs a 5.0-μm pore diameter Cellulose Nitrate Membrane (CNM) filter rather than an aluminum impaction plate. Essentially all particles less than 0.7-μm in diameter making it to this stage are likely to be captured; however, the collection efficiency of such particles as a function of effective particle diameter is unclear. Interpretation of the COV for the row of data corresponding to the 5.0-μm CNM filter is left to the reader. This has no impact on the ANSI/HPS N13.1-1999 review criteria.

Table Six: a summary of aerosol profile data for Skid B at the maximum flow rate of 3,285 ACFM (2,460 SCFM).

| ECD[3] (µm) | S1[1] | S2[1] | S3[1] | S4[1] | L1[1] | L2[1] | L3[1] | L4[1] | COV | < 20%[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| 11.19 | 3.80E-01 | 4.33E-01 | 4.28E-01 | 3.95E-01 | 4.74E-01 | 4.58E-01 | 6.40E-01 | 5.60E-01 | 18.6% | Pass |
| 7.1 | 5.13E-01 | 4.11E-01 | 3.52E-01 | 4.11E-01 | 4.57E-01 | 4.46E-01 | 4.06E-01 | 4.83E-01 | 11.7% | Pass |
| 4.4 | 4.64E-01 | 4.04E-01 | 5.07E-01 | 4.36E-01 | 4.08E-01 | 4.27E-01 | 5.53E-01 | 3.42E-01 | 14.8% | Pass |
| 2.8 | 5.57E-01 | 4.78E-01 | 4.70E-01 | 4.19E-01 | 4.63E-01 | 4.06E-01 | 3.60E-01 | 3.71E-01 | 14.7% | Pass |
| 1.76 | 5.11E-01 | 4.98E-01 | 5.64E-01 | 4.58E-01 | 4.79E-01 | 4.81E-01 | 3.46E-01 | 5.12E-01 | 13.1% | Pass |
| 1.11 | 5.60E-01 | 4.59E-01 | 4.34E-01 | 4.77E-01 | 5.42E-01 | 3.66E-01 | 4.89E-01 | 3.88E-01 | 14.6% | Pass |
| 0.7 | 5.41E-01 | 6.48E-01 | 4.26E-01 | 4.85E-01 | 6.11E-01 | 6.48E-01 | 6.36E-01 | 5.04E-01 | 15.2% | Pass |
| 5 CNM | 4.32E-01 | 4.71E-01 | 4.73E-01 | 5.20E-01 | 4.68E-01 | 5.76E-01 | 6.32E-01 | 3.88E-01 | 15.8% | Pass |
| sum | 3.96E+00 | 3.80E+00 | 3.65E+00 | 3.60E+00 | 3.90E+00 | 3.81E+00 | 4.06E+00 | 3.55E+00 | 4.8% | Pass |

[1] These sampling locations along the orthogonal traverses of Skid B were used during the aerosol profile investigation. The "S" designation represents a traverse parallel to the short axis of the skid. The "L" designation represents a traverse parallel to the long axis of the skid. Point 1 was at an insertion of 0.8 inches, point 2 at 3.0 inches, point 3 at 9.0 inches, and point 4 at 11.2 inches. All values are reported as mg of collected oil.

[2] The column headed < 20% indicates the test result for the test that considers if the coefficient of variation was less than 20%.

[3] ECD is an acronym for Effective Cut-off Diameter. This implies that all particles sampled that were greater than the ECD value in question would have been deposited on the impact plate of the cascade impactor.

Table Seven: a summary of aerosol profile data for Skid A at the minimum flow rate of 513 ACFM (455 SCFM).

| ECD[3] (µm) | S1[1] | S2[1] | S3[1] | S4[1] | L1[1] | L2[1] | L3[1] | L4[1] | COV | < 20%[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| 11.19 | 3.88E-01 | 3.83E-01 | 4.59E-01 | 4.54E-01 | 3.96E-01 | 3.51E-01 | 4.10E-01 | 4.36E-01 | 9.2% | Pass |
| 7.1 | 4.03E-01 | 4.92E-01 | 3.98E-01 | 3.58E-01 | 3.87E-01 | 3.85E-01 | 4.13E-01 | 5.47E-01 | 15.0% | Pass |
| 4.4 | 5.07E-01 | 3.42E-01 | 3.78E-01 | 3.63E-01 | 4.12E-01 | 4.30E-01 | 2.99E-01 | 3.97E-01 | 15.9% | Pass |
| 2.8 | 5.18E-01 | 4.58E-01 | 3.52E-01 | 6.10E-01 | 4.21E-01 | 4.13E-01 | 4.34E-01 | 4.88E-01 | 16.9% | Pass |
| 1.76 | 4.27E-01 | 4.05E-01 | 5.48E-01 | 6.07E-01 | 5.22E-01 | 3.86E-01 | 4.54E-01 | 3.56E-01 | 18.9% | Pass |
| 1.11 | 5.30E-01 | 5.06E-01 | 3.66E-01 | 3.53E-01 | 3.54E-01 | 4.80E-01 | 3.58E-01 | 3.92E-01 | 18.0% | Pass |
| 0.7 | 4.92E-01 | 5.44E-01 | 4.79E-01 | 3.66E-01 | 4.22E-01 | 5.10E-01 | 3.59E-01 | 3.89E-01 | 15.8% | Pass |
| 5 CNM | 4.11E-01 | 4.38E-01 | 5.16E-01 | 4.37E-01 | 4.25E-01 | 5.80E-01 | 5.07E-01 | 4.61E-01 | 12.2% | Pass |
| sum | 3.68E+00 | 3.57E+00 | 3.49E+00 | 3.55E+00 | 3.34E+00 | 3.53E+00 | 3.23E+00 | 3.47E+00 | 4.0% | Pass |

[1] These sampling locations along the orthogonal traverses of Skid A were used during the aerosol profile investigation. The "S" designation represents a traverse parallel to the short axis of the skid. The "L" designation represents a traverse parallel to the long axis of the skid. Point 1 was at an insertion of 0.8 inches, point 2 at 3.0 inches, point 3 at 9.0 inches, and point 4 at 11.2 inches. All values are reported as mg of collected oil.

[2] The column headed < 20% indicates the test result for the test that considers if the coefficient of variation was less than 20%.

[3] ECD is an acronym for Effective Cut-off Diameter. This implies that all particles sampled that were greater than the ECD value in question would have been deposited on the impact plate of the cascade impactor.

Table Eight: a summary of aerosol profile data for Skid A at the maximum flow rate of 3,615 ACFM (2,484 SCFM).

| ECD[3] (µm) | S1[1] | S2[1] | S3[1] | S4[1] | L1[1] | L2[1] | L3[1] | L4[1] | COV | < 20%[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| 11.19 | 4.12E-01 | 3.76E-01 | 3.81E-01 | 4.08E-01 | 4.17E-01 | 3.41E-01 | 3.96E-01 | 3.58E-01 | 7.0% | Pass |
| 7.1 | 3.95E-01 | NA[4] | 3.81E-01 | 3.96E-01 | 4.33E-01 | 3.57E-01 | 4.11E-01 | 3.94E-01 | 5.9% | Pass |
| 4.4 | 5.42E-01 | 3.71E-01 | 4.77E-01 | 4.31E-01 | 5.24E-01 | 3.86E-01 | 4.60E-01 | 3.78E-01 | 14.8% | Pass |
| 2.8 | 5.14E-01 | 3.95E-01 | 4.00E-01 | 4.15E-01 | 3.97E-01 | 4.70E-01 | 3.83E-01 | 3.60E-01 | 12.1% | Pass |
| 1.76 | 3.99E-01 | 4.37E-01 | 4.97E-01 | 3.95E-01 | 3.94E-01 | 4.10E-01 | 5.61E-01 | 3.77E-01 | 14.6% | Pass |
| 1.11 | 3.92E-01 | 3.65E-01 | 4.66E-01 | 3.70E-01 | 4.00E-01 | 3.94E-01 | 4.26E-01 | 3.56E-01 | 9.1% | Pass |
| 0.7 | 4.46E-01 | 4.26E-01 | 4.29E-01 | 3.99E-01 | 4.15E-01 | 3.79E-01 | 3.94E-01 | 3.74E-01 | 6.2% | Pass |
| 5 CNM | 3.85E-01 | 4.54E-01 | 5.44E-01 | 3.57E-01 | 3.74E-01 | 4.30E-01 | 4.32E-01 | 5.99E-01 | 19.0% | Pass |
| sum | 3.48E+00 | 2.82E+00 | 3.57E+00 | 3.17E+00 | 3.35E+00 | 3.17E+00 | 3.46E+00 | 3.20E+00 | 7.3% | Pass |

[1] These sampling locations along the orthogonal traverses of Skid B were used during the aerosol profile investigation. The "S" designation represents a traverse parallel to the short axis of the skid. The "L" designation represents a traverse parallel to the long axis of the skid. Point 1 was at an insertion of 0.8 inches, point 2 at 3.0 inches, point 3 at 9.0 inches, and point 4 at 11.2 inches. All values are reported as mg of collected oil.

[2] The column headed < 20% indicates the test result for the test that considers if the coefficient of variation was less than 20%.

[3] ECD is an acronym for Effective Cut-off Diameter. This implies that all particles sampled that were greater than the ECD value in question would have been deposited on the impact plate of the cascade impactor.

[4] The impactor plate corresponding to ECD 7.1 for the Skid A maximum flow rate traverse at position S2 could not be analyzed as the plate was dropped and contaminated upon disassembly of the cascade impactor. Although the data from this particular impactor plate is important to the ANSI/HPS N13.1-1999 evaluation and an unfortunate loss, it is the judgment of the evaluators that the ponderousness of data in all cases would imply that an unexpected deviation in the general observed trends is unlikely.

## NOZZLE TRANSMISSION RATIO AND DEPOSITION LOSSES IN THE TRANSPORT TUBE

The Nozzle Transmission Ratio and Deposition Losses in the transport lines were evaluated experimentally, using documented software codes, and employing published data on shrouded probe performance.

### *Experimental Data*

Measured samples were obtained from the sample line nozzle through the transport tube to a point just before the AMS-4 CAM where the line could be decoupled and from the ancillary sample line at the point where the line could be decoupled. This series of measurements provides experimental evidence of deposition losses in the transport lines at the low sampling flow rate of 0.7 SCFM (20 LPM).

Aerosols were generated and samples were obtained and analyzed using the same methods described above. Field measurements were conducted for low (401 SCFM - 2.6 m/s free stream velocity) and high (2,484 SCFM - 16.0 m/s free stream velocity) exhauster flow rates. The low sampling flow rate of 0.7 SCFM (20 LPM) used coincided with the proper operation of the cascade impactors employed during field measurements. Within a sample line difference between high exhaust flow and low exhaust flow represent variation of isokinetic sampling conditions.

ANSI/HPS N13.1-1999 specifies that aerosol transmission should be evaluated for a particle size of 10-µm aerodynamic diameter and transmission for any size shall not be less than 50%. The performance of the W-314 Exhauster units A, AW, B, and BW based on field measurements and the conditions of similarity outlined in ANSI/HPS N13.1 Section 5.2.2 is acceptable under these conditions.

Table Nine provides information for the measured transport tube deposition for the two sample lines of Skid A. Table Ten provides information for the measured transport tube deposition for the two sample lines of Skid B. Table Nine and Table Ten represent a sampling flow rate of 20 LPM with free stream stack velocities at both 2.6 m/s and 16.0 m/s. Table Eleven provides transmission ratio data averaged over both the AMS-4 and Ancillary Probes for Skids A and B when operated at a free stream velocity of 2.6 m/s and sampling at a flow rate of 20 LPM.

*Modeled Data*

Deposition losses of aerosol particles from the sample extraction point to the point of collection were evaluated using the computer code DEPOSITION 2001a over the range of exhauster flow rate i.e. 401 SCFM (461 ACFM corresponding to a free stream velocity of 2.6 m/s) to 2,484 SCFM (3,615 ACFM corresponding to a free stream velocity of 16.1 m/s) for the Thermo-Andersen Probe's nominal sampling flow rate of 2.0 SCFM (56.6 LPM). As may be observed in Tables Twelve and Thirteen, the performance of the W-314 Exhauster units A, AW, B, and BW was acceptable under these conditions.

## Table Nine

**Deposition Loss in the Transmission Line**

| ECD[1] (µm) | SKID A Maximum Flow Probe (mg) | AMS-4 Line Transmission Line (mg) | Ratio | Must not be less than 50% |
|---|---|---|---|---|
| 11.19 | 4.65E-01 | 3.73E-01 | 80.2% | Pass |
| 7.1 | 4.40E-01 | 3.64E-01 | 82.6% | Pass |
| 4.4 | 4.13E-01 | 3.79E-01 | 91.9% | Pass |
| 2.8 | 5.12E-01 | 4.06E-01 | 79.4% | Pass |
| 1.76 | 4.30E-01 | 3.61E-01 | 83.9% | Pass |
| 1.11 | 4.37E-01 | 3.92E-01 | 89.7% | Pass |
| 0.7 | 3.62E-01 | 3.59E-01 | 99.0% | Pass |
| 5 CNM | 6.36E-01 | 5.28E-01 | 83.0% | Pass |
| sum | 3.70E+00 | 3.16E+00 | 85.6% | Pass |

| ECD[1] (µm) | SKID A Maximum Flow Probe (mg) | Ancillary Line Line (mg) | Transmission Ratio | Must not be less than 50% |
|---|---|---|---|---|
| 11.19 | 3.93E-01 | 3.94E-01 | 100.1% | Pass |
| 7.1 | 4.01E-01 | 4.11E-01 | 102.4% | Pass |
| 4.4 | 3.88E-01 | 3.89E-01 | 100.4% | Pass |
| 2.8 | 4.15E-01 | 3.95E-01 | 95.3% | Pass |
| 1.76 | 4.02E-01 | 4.02E-01 | 100.1% | Pass |
| 1.11 | 4.29E-01 | 4.45E-01 | 103.7% | Pass |
| 0.7 | 4.24E-01 | 4.49E-01 | 105.8% | Pass |
| 5 CNM | 4.53E-01 | 4.85E-01 | 107.1% | Pass |
| sum | 3.30E+00 | 3.37E+00 | 102.0% | Pass |

| ECD[1] (µm) | SKID A Minimum Flow Probe (mg) | AMS-4 Line Transmission Line (mg) | Ratio | Must not be less than 50% |
|---|---|---|---|---|
| 11.19 | 4.00E-01 | 3.74E-01 | 93.6% | Pass |
| 7.1 | 4.52E-01 | 4.19E-01 | 92.6% | Pass |
| 4.4 | 4.08E-01 | 3.96E-01 | 97.0% | Pass |
| 2.8 | 4.27E-01 | 4.37E-01 | 102.3% | Pass |
| 1.76 | 3.71E-01 | 3.52E-01 | 95.0% | Pass |
| 1.11 | 3.86E-01 | 3.67E-01 | 95.2% | Pass |
| 0.7 | 5.45E-01 | 4.02E-01 | 73.8% | Pass |
| 5 CNM | 3.88E-01 | 3.81E-01 | 98.2% | Pass |
| sum | 3.38E+00 | 3.13E+00 | 92.6% | Pass |

| ECD[1] (µm) | SKID A Minimum Flow Probe (mg) | Ancillary Line Line (mg) | Transmission Ratio | Must not be less than 50% |
|---|---|---|---|---|
| 11.19 | 4.18E-01 | 3.59E-01 | 86.0% | Pass |
| 7.1 | 3.94E-01 | 4.18E-01 | 106.1% | Pass |
| 4.4 | 3.88E-01 | 4.03E-01 | 103.8% | Pass |
| 2.8 | 4.24E-01 | 4.01E-01 | 94.5% | Pass |
| 1.76 | 4.02E-01 | 3.65E-01 | 90.8% | Pass |
| 1.11 | 3.54E-01 | 3.70E-01 | 104.7% | Pass |
| 0.7 | 5.64E-01 | 4.07E-01 | 72.1% | Pass |
| 5 CNM | 4.56E-01 | 4.07E-01 | 89.1% | Pass |
| sum | 3.40E+00 | 3.13E+00 | 92.1% | Pass |

[1]ECD is an acronym for Effective Cut-off Diameter. This implies that all particles sampled that were greater than the ECD value in question would have been deposited on the impact plate of the cascade impactor.

## Table Ten

**Deposition Loss in the Transmission Line**

| ECD[1] (µm) | SKID B Maximum Flow Probe (mg) | AMS-4 Line Transmission Line (mg) | Ratio | Must not be less than 50% |
|---|---|---|---|---|
| 11.19 | 3.97E-01 | NA[2] | 0.0% | Not Available |
| 7.1 | 4.75E-01 | 3.99E-01 | 84.1% | Pass |
| 4.4 | 4.22E-01 | 3.95E-01 | 93.6% | Pass |
| 2.8 | 3.76E-01 | 3.98E-01 | 105.8% | Pass |
| 1.76 | 4.66E-01 | 4.12E-01 | 88.3% | Pass |
| 1.11 | 4.38E-01 | 3.80E-01 | 86.7% | Pass |
| 0.7 | 5.53E-01 | 4.67E-01 | 84.5% | Pass |
| 5 CNM | 7.22E-01 | 6.06E-01 | 84.0% | Pass |
| sum | 3.85E+00 | 3.06E+00 | 79.4% | Pass |

| ECD[1] (µm) | SKID B Maximum Flow Probe (mg) | Ancillary Line Line (mg) | Transmission Ratio | Must not be less than 50% |
|---|---|---|---|---|
| 11.19 | 4.78E-01 | 4.70E-01 | 98.5% | Pass |
| 7.1 | 4.93E-01 | 4.02E-01 | 81.5% | Pass |
| 4.4 | 4.35E-01 | 4.03E-01 | 92.7% | Pass |
| 2.8 | 4.96E-01 | 4.78E-01 | 96.4% | Pass |
| 1.76 | 4.31E-01 | 3.56E-01 | 82.6% | Pass |
| 1.11 | 5.76E-01 | 4.40E-01 | 76.4% | Pass |
| 0.7 | 4.16E-01 | 4.38E-01 | 105.2% | Pass |
| 5 CNM | 5.62E-01 | 4.46E-01 | 79.3% | Pass |
| sum | 3.89E+00 | 3.43E+00 | 88.3% | Pass |

| ECD[1] (µm) | SKID B Minimum Flow Probe (mg) | AMS-4 Line Transmission Line (mg) | Ratio | Must not be less than 50% |
|---|---|---|---|---|
| 11.19 | 4.67E-01 | 4.49E-01 | 96.3% | Pass |
| 7.1 | 4.77E-01 | 5.77E-01 | 120.9% | Pass |
| 4.4 | 5.20E-01 | 6.39E-01 | 122.8% | Pass |
| 2.8 | 5.92E-01 | 4.59E-01 | 77.5% | Pass |
| 1.76 | 5.00E-01 | 4.98E-01 | 99.6% | Pass |
| 1.11 | 3.91E-01 | 3.65E-01 | 93.2% | Pass |
| 0.7 | 4.02E-01 | 3.97E-01 | 98.8% | Pass |
| 5 CNM | 4.23E-01 | 4.13E-01 | 97.5% | Pass |
| sum | 3.77E+00 | 3.80E+00 | 100.6% | Pass |

| ECD[1] (µm) | SKID B Minimum Flow Probe (mg) | Ancillary Line Line (mg) | Transmission Ratio | Must not be less than 50% |
|---|---|---|---|---|
| 11.19 | 4.41E-01 | 4.40E-01 | 99.7% | Pass |
| 7.1 | 4.21E-01 | 3.80E-01 | 90.2% | Pass |
| 4.4 | 5.90E-01 | 5.33E-01 | 90.3% | Pass |
| 2.8 | 5.19E-01 | 5.02E-01 | 96.8% | Pass |
| 1.76 | 4.30E-01 | 4.31E-01 | 100.1% | Pass |
| 1.11 | 4.29E-01 | 3.70E-01 | 86.2% | Pass |
| 0.7 | 4.33E-01 | 4.50E-01 | 104.0% | Pass |
| 5 CNM | 4.90E-01 | 3.99E-01 | 81.4% | Pass |
| sum | 3.75E+00 | 3.50E+00 | 93.4% | Pass |

[1]ECD is an acronym for Effective Cut-off Diameter. This implies that all particles sampled that were greater than the ECD value in question would have been deposited on the impact plate of the cascade impactor.
[2] Sample impactor plate was not available for analysis.

Table Eleven

Measured Probe Transmission with 2.59 m/s free stream velocity and 20 LPM sample flow rate.

| | Skid A | | | Skid B | | |
|---|---|---|---|---|---|---|
| ECD (μm) | Transmission ratio | STD | % CV | Transmission ratio | STD | % CV |
| 11.19 | 1.02 | 0.10 | 0.10 | 1.04 | 0.12 | 0.11 |
| 7.1 | 1.03 | 0.10 | 0.10 | 1.03 | 0.15 | 0.15 |
| 4.4 | 1.03 | 0.06 | 0.06 | 0.94 | 0.26 | 0.27 |
| 2.8 | 1.01 | 0.06 | 0.06 | 1.01 | 0.16 | 0.16 |
| 1.76 | 0.98 | 0.06 | 0.06 | 1.02 | 0.11 | 0.11 |
| 1.11 | 0.97 | 0.04 | 0.04 | 1.01 | 0.07 | 0.07 |
| 0.7 | 1.01 | 0.02 | 0.02 | 1.01 | 0.05 | 0.05 |

Because of the properties of similarity as defined in ANSI/HPS N13.1-1999 these data would apply to all skids; A, AW, B, and BW.

Table Twelve

| Skid A and AW | Deposition 2001a-Version 1<br>10 um monodisperse particles<br>AMS-4 Sample Line | AMS-4 Sample Line | Sample Flow rate 56.6 LPM<br>Pressure 550.0 mmHg |
|---|---|---|---|
| Exhaust Free Stream Velocity | 16.1 m/s | 2.6 m/s | Temperature: 10.0 °C |
| Element | % Penetration | % Penetration | Element Notes |
| Probe | 109.7 | 92.8 | Thermo-Andersen RF2-111 |
| Tube | 99.8 | 99.8 | Length: 0.05m at 90.000 degrees from horizontal |
| Bend | 91.1 | 91.1 | Bend angle: 90.000 degrees RC = 5.19 |
| Tube | 76.0 | 76.0 | Length: 1.320 m, at 0.000 degrees from horizontal |
| Bend | 95.3 | 95.3 | Bend Angle: 90.000 degrees RC = 19.67 |
| Tube | 99.9 | 99.9 | Length 3.200 m, at 90.000 degrees from horizontal |
| Contraction | 99.8 | 99.8 | Half angle of contraction: 45 degrees, Area ratio 0.668 |
| Bend | 97.4 | 97.4 | Bend Angle: 90.000 degrees RC = 8 |
| Total Penetration | 70.2 | 76.2 | |
| Stokes Number | 0.0089 | 0.0089 | |
| Reynolds Number | 1747 | 1747 | |

| Skid A and AW | Deposition 2001a-Version 1<br>10 um monodisperse particles<br>Ancillary Sample Line | Ancillary Sample Line | Sample Flow rate 56.6 LPM<br>Pressure 550.0 mmHg |
|---|---|---|---|
| Exhaust Free Stream Velocity | 16.1 m/s | 2.6 m/s | Temperature: 10.0 °C |
| Component | % Penetration | % Penetration | Element Notes |
| Probe | 109.7 | 92.8 | Thermo-Andersen RF2-111 |
| Tube | 100.0 | 100.0 | Length: 0.05m at 90.000 degrees from horizontal |
| Bend | 99.4 | 99.4 | Bend angle: 90.000 degrees RC = 5.19 |
| Tube | 80.3 | 80.3 | Length: 1.90 m, at 0.000 degrees from horizontal |
| Bend | 100.0 | 100.0 | Bend Angle: 6.000 degrees RC = 17 |
| Tube | 93.4 | 93.4 | Length: 0.590 m, at 0.000 degrees from horizontal |
| Bend | 95.9 | 95.9 | Bend Angle: 90.000 degrees RC = 19.67 |
| Tube | 100.0 | 100.0 | Length 3.250 m, at 90.000 degrees from horizontal |
| Total Penetration | 78.3 | 66.2 | |
| Stokes Number | 0.0089 | 0.0089 | |
| Reynolds Number | 1747 | 1747 | |

Note: This employs the default sampling rate for the Thermo-Andersen sampling probe of 56.6 LPM.

## Table Thirteen

| Skid B and BW<br>Exhaust Free Stream Velocity<br>Element | Deposition 2001a-Version 1<br>10 um monodisperse particles<br>AMS-4 Sample Line<br>16.1 m/s<br>% Penetration | AMS-4 Sample Line<br>2.6 m/s<br>% Penetration | Sample Flow rate 56.6 LPM<br>Pressure 550.0 mmHg<br>Temperature: 10.0 °C<br>Element Notes |
|---|---|---|---|
| Probe | 109.7 | 92.8 | Thermo-Andersen RF2-111 |
| Tube | 100.0 | 100.0 | Length: 0.05m at 90.000 degrees from horizontal |
| Bend | 98.5 | 99.4 | Bend angle: 90.000 degrees RC = 5.19 |
| Tube | 95.6 | 95.6 | Length: 0.390 m, at 0.000 degrees from horizontal |
| Bend | 99.7 | 99.7 | Bend Angle: 18.000 degrees RC = 17 |
| Tube | 90.6 | 90.6 | Length: 0.850 m, at 0.000 degrees from horizontal |
| Bend | 95.9 | 95.9 | Bend Angle: 90.000 degrees RC = 19.67 |
| Tube | 100.0 | 100.0 | Length 3.250 m, at 90.000 degrees from horizontal |
| Constriction | 99.8 | 99.8 | Half angle of contraction: 45 degrees, Area ratio 0.668 |
| Bend | 97.4 | 97.4 | Bend Angle: 90.000 degrees RC = 8 |
| Total Penetration | 87.0 | 74.2 | |
| Stokes Number | 0.0089 | 0.0089 | |
| Reynolds Number | 1747 | 1747 | |

| Skid B and BW<br>Exhaust Free Stream Velocity<br>Component | Deposition 2001a-Version 1<br>10 um monodisperse particles<br>Ancillary Sample Line<br>16.1 m/s<br>% Penetration | Ancillary Sample Line<br>2.6 m/s<br>% Penetration | Sample Flow rate 56.6 LPM<br>Pressure 550.0 mmHg<br>Temperature: 10.0 °C<br>Element Notes |
|---|---|---|---|
| Probe | 109.7 | 92.8 | Thermo-Andersen RF2-111 |
| Tube | 100.0 | 100.0 | Length: 0.05m at 90.000 degrees from horizontal |
| Bend | 99.4 | 99.4 | Bend angle: 90.000 degrees RC = 5.19 |
| Tube | 96.1 | 96.1 | Length: 0.390 m, at 0.000 degrees from horizontal |
| Bend | 99.7 | 99.7 | Bend Angle: 18.000 degrees RC = 17 |
| Tube | 92.8 | 92.8 | Length: 0.850 m, at 0.000 degrees from horizontal |
| Bend | 95.9 | 95.9 | Bend Angle: 90.000 degrees RC = 19.67 |
| Tube | 100.0 | 100.0 | Length 3.250 m, at 90.000 degrees from horizontal |
| Total Penetration | 92.9 | 78.6 | |
| Stokes Number | 0.0089 | 0.0089 | |
| Reynolds Number | 1747 | 1747 | |

Note: This employs the default sampling rate for the Thermo-Andersen sampling probe of 56.6 LPM.