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Section 1 of 2

Document Information			
Document #	HNF-4245	Revision	0
Title	ALTERANTIVES GENERATION & ANALYSIS FOR DST PRIMARY VENTILATION SYS EMISSIONS CONTROL & MONITORING		
Date	9/30/99		
Originator	SEDERBURG JP	Originator Co.	ARES
Recipient		Recipient Co.	
References			
Keywords			
Projects	RPP		
Other Information	PAGES 1 THRU D10		

2. To: (Receiving Organization) Distribution		3. From: (Originating Organization) J. P. Sederburg, Retrieval Eng.		4. Related EDT No.: NA	
5. Proj./Prog./Dept./Div.: RPP / Waste Feed Delivery		6. Design Authority/Design Agent/Cog. Engr.: J. P. Sederburg		7. Purchase Order No.: NA	
8. Originator Remarks: For approval and release.				9. Equip./Component No.: NA	
				10. System/Bldg./Facility: NA	
				12. Major Assm. Dwg. No.: NA	
				13. Permit/Permit Application No.: NA	
11. Receiver Remarks:				11A. Design Baseline Document? ☐ Yes ☒ No	
14. Required Response Date:					

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	HNF-4245	--	0	Alternatives Generation and Analysis for Double-Shell Tank Primary Ventilation Systems Emissions Control and Monitoring	NA	2	1	

16. KEY		
Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D, O, R, N/A (See WHC-CM-3-S, Sec. 12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)											
(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
		Design Authority				1	1	A. F. Choho		3/27/99	
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		QA									
		Safety									
		Env.									

18. Signature of EDT Originator J. P. Sederburg 9/1/99		19. Authorized Representative for Receiving Organization R. L. Treat 9/28/99		20. Design Authority/Cognizant Manager P. J. Certa 9/28/99		21. DOE APPROVAL (if required) Ctrl No. _____ ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	
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Alternatives Generation and Analysis for Double-Shell Tank Primary Ventilation Systems Emissions Control and Monitoring

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U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 625993

UC: 721

Org Code: 82400

Charge Code: 108534 BA10 HN920481

B&R Code: EW02J1190

Total Pages: 299

Key Words: AGA, primary ventilation, feed delivery, retrieval

Abstract: This AGA addresses the question: "What equipment upgrades, operational changes, and/or other actions are required relative to the DST tanks farms' ventilation systems to support retrieval, staging (including feed sampling), and delivery of tank waste to the Phase I private contractor?" Issues and options for the various components within the ventilation subsystem affect each other. Recommended design requirements are presented and the preferred alternatives are detailed.

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Janis Cordal 9-30-99
Release Approval Date

Release Stamp

Approved For Public Release

HNF-4245

Rev. 0

**ALTERNATIVES GENERATION AND ANALYSIS FOR
DOUBLE-SHELL TANK PRIMARY VENTILATION SYSTEMS
EMISSIONS CONTROL AND MONITORING**

September 1999

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**Prepared for
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Richland, Washington**

ACKNOWLEDGEMENTS

The author would like to thank the following contributors:

R. D. Potter of Mactec Associates for providing input and subsequent oversight on matters of environmental permitting and regulation,

J. R. Nicholson of Fluor Daniel Northwest for providing details about the mechanical components which comprised each of the alternatives evaluated, and oversight of the cost estimates that were performed,

C. T. Li of Fluor Daniel Northwest for providing details about the chemical behavior of the individual alternatives evaluated,

D. L. Johnson of Fluor Daniel Northwest for providing input on matters of industrial safety,

B. M-C Johnson of E2 Consulting Engineers, Inc. for providing technical editing, graphics, and coordination of the production of this report, and

Numerous others who provided various kinds of support to each of the people listed above.

EXECUTIVE SUMMARY

This alternatives generation and analysis (AGA) report addresses the question: *What equipment upgrades, operational changes, and/or other actions are required relative to the double-shell tank (DST) farms' (AN, AP, AW, AY, AZ, and SY) ventilation systems to support retrieval, staging (including feed sampling), and delivery of tank waste to the Phase I private contractor?*

The recommendation of the Retrieval Engineering organization that resulted from this study is to proceed with the hybrid alternative of installing a system comprised of

- dry adsorption beds for removal of volatile organic compounds,
- dry absorption beds for removal of ammonia,
- an improved continuous air monitor for radionuclides,
- a gas characterization and monitoring system for non-radionuclide emissions, and
- taller exhaust stacks than are presently in use (these should be as tall as is convenient to construct within the present tank farm system).

This recommendation is shown graphically in Figure ES-1.

BACKGROUND

The problem statement addressed by this report was derived from three main issues regarding the DST ventilation systems:

Possible Future Non-Compliance – The existing systems are expected to become non-compliant with respect to emerging non-radiological monitoring and control requirements. Emerging operating standards are being formulated for DST primary ventilation systems, and it is expected that monitoring and/or control of non-radioactive emissions, which are not currently regulated, will soon be required. As a minimum, this would require upgrades of the ventilation systems to provide for monitoring of the emissions

(exhaust stacks), and at most could entail the deployment of a technology to remove the non-radionuclide (chemical) components.

Possible Recurrence of Emission Event – During a sluicing operation in November 1998, there was an unexpected volatile organic compound emission from single-shell tank 241-C-106 which exceeded permit allowances. This emission event resulted in operational delays that lasted until April 1999. Currently there is insufficient data to predict emissions from future operations, however, gathering and assessing opportunistic data prior to retrieval of DSTs should be considered.

Unexpected Elevated Emissions – Future operations could experience delays due to the following scenarios:

- Workers experiencing uncomfortable odor levels,
- Emissions approaching or exceeding industrial hygiene emission levels, and
- Exceedance of the Clean Air Act emission threshold.

Emissions could be diluted by addition of clean air into the effluent air stream or the exhaust height of the stack could be raised to address the first two of these scenarios. The third issue would require emissions control and monitoring via process control or abatement equipment.

Because of the uncertainty about the amount and type of potential non-radiological emissions, and the fact that obtaining data for the potential emissions that will be present during future operations is difficult, time consuming, and expensive, the cost structure of this decision (i.e., cost of a treatment system versus potential idle facility fees) favors a robust engineering solution.

Typically (i.e., in the past and until the present) the primary ventilation systems for the DSTs have served two purposes:

- Removal of heat, air, evaporated water, and evolved gases from the primary tank, and
- Control of any potential spread of radionuclide contamination by maintaining the more contaminated regions (such as the primary tank) at a greater vacuum than less contaminated regions (such as the annulus).

At present, delivery of feed to the private contractor requires that the following functions be performed: degassing, separation of solids and liquids, dissolving solids, mobilizing solids, sampling waste, and transferring the waste. The TWRS Privatization Contract (DOE-RL 1998) between the Department of Energy and the private contractor allows the PC to be reimbursed if their facilities are idle due to the late delivery of waste feed. It is important to ensure that the feed will be delivered on time since these fees may range up to \$2.5 million per day. Delays in the construction and commissioning of upgraded ventilation systems as well as shutdown of waste feed delivery operations because of excessive releases could potentially result in late delivery of feed.

PROCESS USED TO DEVELOP AND EVALUATE ALTERNATIVES

Standard decision-making techniques were used to develop and evaluate alternative upgrades to the ventilation systems. Based upon this approach, the raw results (i.e., without considering risk or uncertainty) are shown in Table ES-1. Table ES-1 reflects that there are four major groups of alternatives. Each of the alternatives in the groups had relative scores such that they were indistinguishable within their group, but clearly distinguishable from the alternatives in the other groups.

Table ES-1. Relative Ranking of Alternatives.

Control Technology	Alternative*	Group and Rank
These alternatives do not treat the off-gas.	Construction of Tall Stack	1
	Instrumentation & Procedure Upgrade	
	Dilution by Independent Clean Air Stream**	2
	Controlled Gas Venting Rate	3
These alternatives treat the off-gas.	Dry Adsorption/Absorption Beds	
	Combination Dry Adsorption Beds & Wet Scrubber	4
	Thermal Oxidation (catalytic)	

* The alternatives are listed in order from most to least favorable.

** In some applications, dilution could be considered contrary to the intent of promulgated regulations. Therefore, this would only be a viable alternative if no environmental limits were exceeded prior to implementing the dilution option.

In an attempt to identify the issues that have the greatest influence on the decision to be made regarding ventilation systems, three primary drivers were identified. These drivers are:

- Programmatic risk,
- Reliability of feed delivery, and
- Modifications to the presently accepted authorization basis.

It is therefore important to seriously consider these issues when making a ventilation decision.

Also identified as a result of this study was the fact that even though emissions limits imposed by Federal and Washington State oversight agencies (i.e., Department of Ecology, Department of Health, and EPA) are clearly identified, the source term (i.e., the types and quantities of vapor phase material that would need to be managed by the primary ventilation systems) is not very well defined. Any decision would therefore need to account for either the uncertainty of the source term (i.e., be conservative) or obtain additional data to reduce this uncertainty.

Furthermore, the collection of additional characterization data must account for three factors in order to influence this decision. These factors are briefly discussed below:

- *Representativeness of the data* — Will characterization data obtained from static waste be representative of the conditions expected during waste feed delivery operations? The static condition of the waste that is presently in the tanks would very likely result in a high degree of uncertainty regarding the accuracy of any characterization data obtained.
- *Timeliness of the data* — Can the data be obtained in time to influence the decision? The time required to obtain characterization data would likely be lengthy, and it is probable that resulting data would be presented too late to influence the decision (refer to Figure ES-2). Note that in Figure ES-2 data-gathering and decision-making would need to be completed by now for a new project (in order to be completed prior to beginning work on the CDR). Only in the case of using an existing project for LAW tanks would time still be available in which to make a delayed decision.
- *Value of additional data* — The cost of the additional data must be balanced against both the costs of the alternatives (including potential idle facility fees) and the expected change in uncertainty associated with the decision. The cost of obtaining additional characterization data would be very high relative to the cost of treatment systems. Figure ES-3 shows how the costs of decisions to treat or not treat are related to the probability of non-compliance.

RECOMMENDATION

Based upon these data, Retrieval Engineering believes that delaying this decision in order to obtain additional characterization data presents an unacceptable risk to the waste feed delivery program.

In order to make a decision, notwithstanding the uncertainty in the source term data, two paths were evident:

- Proceed with an alternative that includes treatment/control technology, or
- Use an alternative that does not treat the off-gas.

Retrieval Engineering believes that the more conservative path (providing treatment/control technology) is the prudent path. **The recommendation of the Retrieval Engineering organization that resulted from this study is to proceed with the hybrid alternative of installing a system comprised of**

- **dry adsorption beds for removal of volatile organic compounds,**
in order to maintain compliance with WAC 173-400 and WAC 173-460, which includes mitigating the higher risks of exceeding regulatory permit limits associated with retrieval operations,
- **dry absorption beds for removal of ammonia,**
in order to maintain compliance with WAC 173-400 and 173-460, which includes mitigating the higher risks of exceeding regulatory permit limits associated with retrieval operations,
- **an improved continuous air monitor for radionuclides,**
which will allow continued compliance with WAC 246-247,
- **a gas characterization and monitoring system for non-radionuclide emissions,**
thereby meeting the requirements of WAC 173-400 and WAC 173-460, and
- **taller exhaust stacks than are presently in use,**
which will provide an added margin of protection for workers and help to ensure continued compliance with 29 CFR 1910.

Refer to Figure ES-1 for a graphic depiction of the above recommendation.

The dry adsorption/absorption bed system is the highest-ranking alternative of the treatment systems. The tall stack is recommended because it provides the added benefit of protecting the workers from chronic and accidental releases of chemicals.

OTHER RECOMMENDATIONS

While performing this study, several issues outside of the formal decision frame for this AGA were identified. Retrieval Engineering's recommendations for resolving these issues and reducing overall risk to the program are:

- Perform opportunistic sampling to assist with source term definition for design basis and permit preparation. Existing Data Quality Objectives should be reviewed for applicability to this opportunistic sampling and include decision criteria for key parameters.
- Perform an engineering study to define the precise source term to be used for design and procurement of ventilation equipment. Such an engineering study should assess the data presently available and any data that come available as a result of work performed under the previous bullet.
- Upgrade the primary tank ventilation flow capacity for the AY and AZ tanks to provide the necessary flow capacity to support the numerous simultaneous operations planned for the AY and AZ farms within the 90% Planning Case (Kirkbride et al. 1999).
- Provide additional flexibility to the present primary ventilation control strategies to allow for more efficient support of the 90% Planning Case operations that are required.
- Investigate the need to provide additional treatment capability for the portable exhausters. In other words, determine whether the portable exhausters are still usable without non-radionuclide treatment control and monitoring capability.

Acting on these "other recommendations" may allow the retrieval program an opportunity to modify the conservative decision of installing a VOC and ammonia treatment system.

Figure ES-1. Selected Alternative:
Double-Shell Tank Primary Ventilation Systems Emission Control & Monitoring.

The recommended systems are shown in bold and surrounded by the dotted line.
Components of the ventilation system unaffected by this recommendation are shown in gray.

Figure ES-2. Influence of Time on Decision.

Figure ES-3. Cost Structure of Treatment / No Treatment Decision.

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C.....	Decision Criteria Development
D	Life Cycle Cost Analysis Process and Results
E.....	Vendor Data, Records of Conversation, Calculations, Sketches and Drawings Specific to Alternatives Evaluated
F	Ventilation Volumetric Flow Evaluation
G	Special Analyses

ACRONYMS & ABBREVIATIONS

AB	authorization basis
AGA	alternatives generation and analysis
ALARACT	as low as reasonably achievable radionuclide control technology
ALC	air lift circulator
ANSI	American National Standards Institute
AOP	air operating permit
ASTM	American Society for Testing and Materials
ASIL	acceptable source impact level
BARCT	best available radionuclide control technology
BLCC	building life cycle cost
CAM	continuous air monitor
DCRT	double-contained receiver tank
CFR	Code of Federal Regulations
D&D	decontamination and decommissioning
DoD	Department of Defense
DOE-RL	Department of Energy, Richland Operations Office
DST	double-shell tank
Ecology	Washington State Department of Ecology
EDE	effective dose equivalent
EPA	(United States) Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act (1986)
GOCO	government-owned/contractor-operated
GC	gas chromatograph
GCS	gas characterization system
GRE	gas release event
HAP	hazardous air pollutant
HASP	(TWRS) health and safety plan
HEGA	high-efficiency gas adsorber
HEME	high-efficiency mist eliminator
HEMF	high-efficiency metal filter
HEPA	high-efficiency particulate air (filter)
HLW	high-level waste
ILAW	immobilized low-activity waste
IWFSS	intermediate waste feed staging system
LAW	low-activity waste
LLW	low-level waste
NBS	National Bureau of Standards
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
NOC	notice of construction
NO_x	nitrous oxide / nitrogen oxide
NPDES	national pollutant discharge elimination system
OMB	Office of Management and Budget
OM&R	operating, maintenance and recurring

OSHA	Occupational Safety and Health Administration
PC	private contractor
PEL	permissible exposure limit
PNNL	Pacific Northwest National Laboratory
PPE	personnel protective equipment
RCRA	Resource Conservation and Recovery Act (1976)
RPP	River Protection Project*
S/RID	standards/requirements identification document
SCBA	self-contained breathing apparatus
SHMS	standard hydrogen monitoring system
SQER	small quantity emission rate
SST	single-shell tank
SWDP	state waste discharge permit
TAP	toxic air pollutant
TPA	Tri-Party Agreement (Hanford Federal Facility Agreement and Consent Order)
TWRS	Tank Waste Remediation System*
TWRSO&UP	TWRS Operation and Utilization Plan (Kirkbride et al. 1999)
VOC	volatile organic compound
WAC	Washington (State) Administrative Code
WDOE	Washington (State) Department of Ecology
WDOH	Washington (State) Department of Health
WFD	waste feed delivery
WG	water gauge

* In the final stages of the composition of this AGA, direction was received from DOE to discontinue use of the acronym TWRS in favor of RPP. Although TWRS will be used throughout this document, please note that future and supporting documents will use RPP exclusively.

1.0 INTRODUCTION

The double-shell tank (DST) waste retrieval system and the tank waste system will work together as a single system to stage batches of low activity (LAW) and high level waste (HLW) feed to the private contractor (PC).

A significant component of the waste retrieval system is the ventilation systems, which provide the ability to manage vapors and gases that are present as a result of the operations associated with the affected tanks. Five specific primary ventilation systems service twenty-eight double-shell tanks that are contained in six DST farms.

The individual components of a ventilation system must function as a unit, and therefore equipment options must be combined with synergy in mind. Alternatives are generated that represent combinations of options for the various ventilation systems. Documentation and analyses of these ventilation system alternatives are contained in this report.

Of specific interest throughout this study are the difficulties associated with identifying the materials (gases and vapors) that will be managed by the ventilation systems. Therefore, discussions in this study will be largely qualitative.

1.1 PROBLEM STATEMENT

The term "privatization" refers to DOE's approach to the remediation of Hanford's tank waste. The *Tank Waste Remediation System Mission Analysis* (Acree, Jr. 1998) states that the mission of the TWRS includes the aspects of managing the waste that is presently in storage, providing for retrieval and preparation for immobilization, providing for the disposal of immobilized low-activity waste (ILAW), and providing interim storage of immobilized high level waste (IHLW). The physical systems required to perform the mission will be acquired through a combination of privately-owned/operated and government-owned/contractor-operated (GOCO) resources in a two-phased acquisition strategy. During the first phase, GOCO resources will stage waste from the DSTs as feed to the private contractor. The private contractor will then treat the waste feed producing low-activity and high level waste products.

To supply waste to the PC, active ventilation systems are required in order to manage the vapor phase components as they are routed through the DSTs associated with the intermediate waste feed staging system (IWFSS). The details associated with these ventilation systems are the focus of this AGA.

This AGA addresses the following question:

What equipment upgrades, operational changes, and/or other actions are required relative to the double-shell tank (DST) farms' (AN, AP, AW, AY, AZ, and SY) ventilation systems to support retrieval, staging (including feed sampling), and delivery of tank waste to the Phase I private contractor?

Both the treatment/control and subsequent monitoring of non-radionuclide emissions from the primary exhausters for the DSTs are within the scope of this analysis. Also, this AGA assesses advantages and disadvantages of various options for monitoring potential radionuclide emissions. For the purpose of this study, the existing HEPA filtration technology in use at the Hanford Site for treatment/control of radionuclide emissions is considered the best available radioactive control technology (BARCT).

1.2 BOUNDARIES

This AGA has these boundaries:

1. Only the primary ventilation aspects for double-shell tanks are considered. This AGA does not address emissions from annulus ventilation systems.
2. Neither single-shell tanks (SSTs) nor double-contained receiver tanks (DCRTs) are within the scope of this AGA.
3. Required backup/portable exhaust systems are within the scope of this AGA.
4. This AGA addresses the treatment/control and subsequent monitoring of non-radioactive emissions.
5. Treatment/control and monitoring of radioactive emissions are within the scope of this study. They are mentioned briefly, however, as is reported later in this document, these aspects of the primary ventilation system are covered by pre-existing constraints and assumptions.

1.3 BACKGROUND

Typically (i.e., in most instances of past and present operations), the primary ventilation systems have served two purposes:

1. Removal of heat, air, evaporated water, and evolved gases from the primary tank, and
2. Control of any potential spread of radionuclide contamination by maintaining the more contaminated regions (such as the primary tank) at a greater vacuum than less contaminated regions (such as the annulus).

1.3.1 Background to Problem

This AGA examines the ventilation systems to determine if the past operating conditions are still applicable today. From the activation of the first double-shell tank farm (AY farm, circa 1969) until the most recent farm was constructed (AP farm, completed around 1986) no explicit requirements or needs to control odors or noxious gases and vapors existed (i.e., no requirements imposed by WA Dept. of Health, WA Dept. of Ecology, or EPA).

Shortly after the AP tank farm was completed, regulatory agencies (EPA and the state of Washington) as well as affected workers began to express their concerns over the various non-radiological emissions from the tank farms. (In the late 1980s, ammonia releases from AW farm, AP farm, and the 242-A Evaporator process ventilation systems were an issue [Winkler 1987]). These types of issues continued from the late 1980s until recent events during tank C-106 sluicing operations.

During initial operations of the C-106 sluicing system "...irritant affects and strong odor were noted..." by those who were performing the operations at the time. Direct reading vapor monitoring indicated elevated organic vapor concentrations in the work area greater than limits in the Tank Farm Health and Safety Plan for work without respiratory protection. Eleven people subsequently were treated by health care professionals for symptoms. Preliminary sampling and analysis of the tank's exhaust stack indicated that volatile organic compounds (VOCs), nitrous oxides (NO_x), and ammonia were being emitted from C-106. It was determined that the VOC emissions (measured at approximately 450 ppm) had exceeded the permit allowance (50 ppm). The reference for these data is Occurrence Report Number RL—PHMC-TANKFARM-1998-0141. Subsequent to this initial occurrence, further emissions were realized during December 1998 and March 1999 that had much lower measured VOC concentrations.

The apparent trouble associated with the C-106 sluicing system is relevant to DSTs supporting the Phase I Waste Feed Delivery (WFD) mission because it reveals a potential weakness in the systems that support the mobilization of waste that has been sitting idle for a number of years. This AGA will evaluate the existing DST ventilation systems, the associated wastes that will be routed through the tanks that are connected to these ventilation systems, the regulatory requirements and permits for these systems, and the options for complying with these requirements and permits. The purpose of this analysis is to ensure that no problems such as those that were encountered with the C-106 sluicing operation develop while performing the actions/operations necessary to feed waste to the PC.

It is important to note that there is concern about the age of some of the equipment supporting the DSTs. The first DST farm that was activated (AY farm) has now been in service for nearly 30 years. Detailed descriptions of the ventilation equipment that presently serves the double-shell tanks are given in Appendix A. By the time these systems are needed to service waste feed delivery to the PC, many of them will have surpassed their design life if left in their present condition.

At present, the Phase II scope of the W-314 Project only includes upgrading the ventilation systems at AN, AP, and AW farm to improve the seal pot drainage and filtration systems (Gilbert 1998). However, recent findings from a series of Tank Farm System Evaluations (Carlson 1998a, 1998b, and Willis 1998, 1999a, 1999b) have revealed that some of the necessary upgrades to the existing ventilation systems may not have been identified within the scope of current and/or planned projects. It is therefore desirable that this AGA evaluate potential alternatives sufficient for proper decisions and guidance prior to re-scoping any current projects (i.e., Projects W-314 and/or W-211) or beginning any new projects that may be deemed necessary.

1.3.2 Background to Development of Alternatives

Alternatives in this AGA are generated using a strategy generation table. (The use of a strategy generation table is described in Clemen 1996.) This method breaks the problem down into its basic elements (or functions) and develops options under each function. The options are first reviewed, and any that are clearly not feasible are removed in order to reduce the number of alternative solutions that must subsequently be assessed. After this filtering step, the options are joined together to make viable solutions to the problem statement. The list of alternatives is examined and inconsistent alternatives (those for which specific options do not work well together) are removed.

The resulting alternatives are then described and assigned a number that will be maintained for the remainder of the process. The alternatives are compared against the distinguishing assumptions, constraints and requirements, and those that fail to meet one of these are eliminated.

The remaining alternatives are compared using the decision criteria that have been developed from the fundamental objectives of the waste feed delivery program. These comparisons result in a ranking of alternatives, and those that appear to be most promising are selected for further analysis.

In the final step, the remaining alternatives are examined for risk, and those that have the most acceptable overall risks are presented to the decision-maker for his consideration.

1.4 INTERACTING DECISIONS

There is a potential that the HLW Tank Heat Removal decision and the corresponding AGA (Poe et al. 1999) will have an impact on this decision. Specifically, should the HLW Tank Heat Removal decision determine that a change in the existing primary ventilation system (i.e., the 702-AZ system) be made, then a portion of this AGA may need to be modified based on those results/recommendations.

This DST Primary Ventilation decision could potentially impact the LAW Retrieval System decision, specifically in two main areas:

1. This Ventilation AGA could impose constraints on the operation of the mixer pumps for degassing, and
2. This Ventilation AGA will be used as a portion of the safety bases for the LAW AGA (Tables 4.1 and 4.3).

Decisions and results derived from ongoing SY-101 transfer efforts could influence this AGA.

Results from the ongoing process tests for sluicing tank C-106, and operation of the ALCs in AZ farm could influence this AGA.

Information from this AGA will also affect the development of the scope of Project W-314 for Phase II, and address operability and maintainability with respect to Project W-314. Impacts of the recently revised ANSI N13.1 Standard ("Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities") will also need to be integrated into any future ventilation design modifications.

This AGA may also be affected by the physical limitations of some of the existing primary ventilation systems (e.g., 702-AZ cannot presently support multiple simultaneous activities in the AY and AZ tank farms). Therefore, in some cases (like the case of the 702-AZ ventilation system) upgrades/new systems will be necessary to provide multiple in-tank operations capabilities.

2.0 ASSUMPTIONS, CONSTRAINTS AND REQUIREMENTS

This section describes the assumptions, constraints, and requirements that are applicable to the control and monitoring of gas and vapor from the DSTs to the atmosphere.

The assumptions, constraints, and requirements listed in this section serve as the basis for distinguishing between potential alternatives. The focus here is on those assumptions, constraints, and requirements that will allow one alternative to be distinguished from another.

2.1 ASSUMPTIONS

For the purpose of this AGA, the assumptions listed in this section are interim guides such as performance characteristics of a process or circumstances under which the outcome of a decision will be implemented. The assumptions listed in this section are used to reduce extremely complex situations to problems of manageable proportion.

2.1.1 Radionuclide Treatment Control

The existing radionuclide treatment/control is adequate; that is, the HEPA filtration-based technology used in the DST farms is considered the best available radioactive control technology (BARCT, see Section 2.2.1.1).

2.1.2 Radionuclide Emission Monitoring

It will be necessary to upgrade the monitoring of radionuclide emissions from tank farm primary ventilation systems to comply with the latest guidelines contained in ANSI N13.1 (i.e., upgrade from minor to major stack-monitoring status).

2.1.3 Control Point Definition

Primary tank ventilation treatment/control and subsequent monitoring will be conducted on a farm basis and not on a tank-specific basis (i.e., the approximately one exhaust system per DST farm is adequate as it is currently configured, and there is no need to have any new exhaust system[s] dedicated directly to any one tank). The portable exhaust system that is presently in place in the SY tank farm is within the scope of this AGA in the configuration that it presently occupies.

2.1.4 Organic Carbon

Organic compounds have contacted the wastes that are currently present in all tank farms, and total organic carbon concentrations in each tank is less than or equal to 10 wt%. (Refer to the constraints [Section 2.2.1.3] for added details on this subject.)

2.1.5 Source Waste Composition

During the initial C-106 occurrence in November 1998, VOC concentrations were reported to be as high as 450 ppm. Subsequent emissions from C-106 were substantially lower. Furthermore various projects have considered VOC and ammonia prior to design and/or operational start up. An evaluation of the various potential waste compositions that could be transferred through the DSTs is presented in Appendix B. Based upon the data presented in Appendix B, a gas composition equivalent to that which was recently emitted from tank C-106 was used for comparison between the various alternatives in this AGA. These data from the recent tank C-106 emissions were deemed to be reasonably representative of what could be expected during future operations within the tanks. It was noted that uncertainty could exist in using the C-106 data, however these data were determined to be adequate for comparing the various alternatives in this report.

2.1.6 In-Tank Activities

The TWRSO&UP (Kirkbride et al. 1999) identifies the various activities that will need to take place throughout the Phase I privatization contract. The 90% Planning Case included within the scope of the TWRSO&UP indicates that up to three tanks could have multiple major waste-intrusive activities taking place at any one time (i.e., operation of mixer pumps, incoming/outgoing transfers, etc.) associated with a single primary ventilation system.

2.1.7 Bounding Gas Flow Rate

Based upon the present ducting, fans, and major equipment sizing and configuration, each of the primary ventilation systems for the DSTs has a limited achievable flow rate. Because of this present limitation, a nominal maximum flow rate of 1000 scfm from each emission point (i.e., exhaust system) was chosen for this AGA.

2.2 CONSTRAINTS

Constraints are requirements that are imposed by external organizations. The design, operation, and maintenance of the ventilation systems are affected by state and federal regulations, agreements, DOE Orders, and Hanford Site contractual requirements. In addition, there are guidelines and specifications that set forth engineering requirements deemed necessary for safe design and construction of ventilation systems.

Two specific categories of constraints are directly applicable to this AGA. These are described in Sections 2.2.1 and 2.2.2.

2.2.1 Environmental Constraints

Environmental regulations are imposed upon the design, construction and operation of ventilation systems which have an emission point into the atmosphere. In general, the standards require that potential emissions be estimated for comparison against applicable regulatory limits, control technologies be implemented to reduce emissions, new sources of emissions be reviewed and approved by the responsible regulatory agency prior to construction, and emissions be monitored and reported to the agencies during operations.

2.2.1.1 Radionuclide Emissions. Radionuclide emissions to the atmosphere from the Hanford Site are regulated under two programs:

1. The Federal National Emission Standards for Hazardous Air Pollutants (NESHAP), and specifically 40 CFR Part 61 Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities." The U.S. Environmental Protection Agency (EPA) administers these regulations, and has delegated their implementation to the state of Washington.
2. State regulations at Chapter 246-247 WAC, Radiation Protection-Air Emissions. The Washington State Department of Health (WDOH) administers the state regulations, and by delegation from EPA, the federal regulations as well.

The federal and state regulations set an emission standard (limit) for the entire Hanford Site at a public effective dose equivalent (EDE) of 10 millirem per year (mrem/yr). The regulations require that potential radionuclide emissions from each new and existing source (e.g., stack) on the Hanford Site be assessed to estimate emission rates. The regulations require the implementation of best available radionuclide control technology (BARCT) for new and modified sources, and as low as reasonably achievable radionuclide control technology (ALARACT) for existing sources. The regulations require that sources of radionuclide emissions be monitored at least periodically. More frequent (e.g., continuous) monitoring is mandated for release points which have the potential to discharge radionuclides into the air in quantities which could cause an EDE in excess of 1% of the standard (0.1 mrem/yr or greater).

It is further recognized that alternatives considered in this AGA must comply with federal regulations regarding occupational radiation protection (10 CFR 835).

2.2.1.2 Non-Radionuclide Emissions. Non-radionuclide emissions from the Hanford Site to the atmosphere are regulated primarily under the following standards, which are administered by the Washington State Department of Ecology (Ecology):

WAC 173-400, General Regulations for Air Pollution Sources. This regulation lists criteria pollutants (e.g., particulates, nitrous oxides, carbon monoxide), requires annual reporting of specified (non-radionuclide) air contaminant emissions, and requires that new emission sources or modifications of existing sources be reviewed and approved by Ecology.

WAC 173-401, Operating Permit Regulation. This regulation lists regulated hazardous air pollutants, and is the basis for developing and administering a site-wide Hanford Site Air Operating Permit (AOP). The AOP establishes a broad-based set of permit conditions that must be satisfied for the Hanford Site in general, and consolidates the case-by-case approval conditions granted for each new and modified air emission source.

WAC 173-460, Controls for New Sources of Toxic Air Pollutants. This regulation lists toxic air pollutants (TAPs), requires Ecology review and approval for new or modified sources of TAPs, sets acceptable source impact levels (ASILs) limiting the TAPs that a source may emit, and establishes small quantity emission rates (SQERs) for exempting new and modified sources.

Comparable federal regulations exist, but the federal rules have been incorporated into the state program, and EPA has delegated the federal authority for implementation and enforcement to Ecology.

2.2.1.3 Dangerous Wastes. Ecology implements the Washington State Dangerous Waste Regulations, Chapter 173-303 WAC, and is the delegated authority for the federal Resource Conservation and Recovery Act (RCRA) program. The state standards impose organic emission control requirements on certain tank systems through adoption by reference of federal rules that appear in 40 CFR Parts 264 and 265, Subparts AA and BB. The standards only apply if the tank system is used to store or treat a waste that contains, or came in contact with a waste that contained, 10% or more of organic compounds. The consensus within TWRS has been that these regulations are not applicable to the 200 Area DSTs. Recent concerns have been raised about waste transfers from SSTs (e.g., 241-C-103) and other sources (e.g., K Basins) in which organic concentrations might exceed 10%. Such events could subject some or all of the DSTs to the dangerous waste organic emission standards, but at this time the DST system is not considered to be covered by these requirements.

In the past, concerns have been raised that condensates generated from the cooling and collection of DST system vapors may be regulated as dangerous waste under Chapter 173-303 WAC, although no official position has been established with Ecology. The current TWRS opinion is that primary ventilation condensate is not designated as a listed dangerous waste under state regulations. TWRS recently implemented a characterization activity to assess whether condensate might be designated dangerous waste for other reasons (e.g., toxicity). TWRS will affirm or modify the position on requirements for condensate, as appropriate, after assessing the results of the characterization work. In the meantime, secondary containment and other tank system requirements under Chapter 173-303 WAC are not considered applicable to condensate return systems. It should be noted that other factors, such as maintaining ALARA or confining radionuclides, may result in condensate routings that have secondary containment, leak detection, and similar features. These controls are provided on a case-by-case basis.

2.2.1.4 Other Toxic Chemical Releases. The Emergency Planning and Community Right-to-Know Act (EPCRA) requires that records of toxic chemical inventories be maintained and that the community be informed of activities and environmental releases involving these chemicals. 40 CFR Part 372 sets forth requirements for the estimation of toxic chemical releases and submission of release information to EPA. The facilities that must report are defined in 40 CFR

372.22, the thresholds for reporting are established in 40 CFR 372.25, and the reportable chemicals are listed in 40 CFR 372.65.

2.2.2 Industrial Health Constraints

Industrial health requirements for employee exposures to hazardous substances are found in the Occupational Safety and Health Administration (OSHA) standards (specifically, Chapter 29 of the Code of Federal Register, Part 1910 [29 CFR 1910], Subpart Z—Toxic and Hazardous Substances). The 1910 OSHA Standards are commonly called General Industry Safety Standards.

Furthermore construction activities are governed under Chapter 29 CFR, Part 1926. The Industrial Safety Organization at the Hanford site develops and maintains a program for periodic survey and inspection of TWRS that covers all physical facilities, programs, procedures, and operations in order to identify actual or potential hazards or undesirable conditions. These efforts contribute to a safe working environment and provide assistance to management in accident investigations.

Subpart Z of 29 CFR 1910 provides tables of substances that can be hazardous to employees and sets limits for employee exposure to these substances. The limits given are for eight-hour time-weighted averages (i.e., average exposure over a normal workday) and ceiling values which may not be exceeded. The time-weighted limits are called permissible exposure limits (PELs).

The alternatives developed in this study for treatment/control and subsequent monitoring of the emissions from the primary ventilation systems of the DSTs must maintain emissions below the PELs and ceiling values in OSHA 1910, Subpart Z. Maintaining emissions below the limits established in 29 CFR 1910 would ensure that employees do not become ill from over-exposure to hazardous substances in the workplace.

2.2.3 TWRS Health and Safety Plan

The TWRS Health and Safety Plan (HASP) contains recommended emissions limits that are lower than outside state and federal laws. The limitations of the TWRS HASP shall be implemented prior to undertaking any design and/or operational actions, however, for the purposes of this AGA, the information presented in Sections 2.2.1 and 2.2.2 above will be used for comparison of the alternatives presented in this AGA.

2.2.4 Fire Protection

Fire protection is an important attribute of systems structures and equipment maintenance. Specific requirements are imposed by the National Fire Protection Association (NFPA). It is recognized that the requirements of the NFPA would need to be applied if a detailed design modification or operational change were recommended by this AGA.

2.2.5 Nuclear Safety

Nuclear Safety is the area of safety that encompasses activities and systems that prevent the potential for uncontrolled nuclear criticality, and the release of fission products or other radioactive materials that could adversely affect the environment, the workers, and the public. TWRS Nuclear Safety Professionals ensure that compliance to the appropriate waste tank nuclear safety requirements, as described in the standards/requirements identification document and specifically in the Authorization Basis (Grams et al. 1997) is achieved through prevention and mitigation.

2.3 REQUIREMENTS

A system or systems shall be incorporated in such a manner as to limit radioactive and non-radioactive airborne emissions from all major TWRS facilities such that compliance with the Hanford site governing procedures and policies is achieved (Grenard et al. 1998).

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

The needs established in Section 2 require provision of treatment/control and monitoring of gaseous emissions from the DSTs. The system(s) that are required can be classified into two main areas, depending upon the type of material that needs to be either removed or monitored:

1. Radionuclide System(s), and
2. Non-radionuclide System(s).

In this section, the three-step process of generation and screening of the alternatives is presented.

3.1 STRATEGY GENERATION TABLE

The first step in the development of the alternatives for this AGA was the identification of the different attributes of the problem as stated in Section 1.1. For this process, the two main areas of radiological and non-radiological concerns can be grouped with the treatment/control need and the monitoring of emissions need, using the strategy generation table technique described in Clemen 1996.

3.1.1 Development of Strategy Generation Table

Table 3-1 shows the combination of attributes for this AGA presented in the form of a strategy generation table. From Table 3-1 it is noted that the appropriate consideration for this AGA is the determination of the treatment/control technology for non-radiological gaseous emissions. Non-radiological gaseous emissions includes those that are potentially harmful to both the environment and the health of workers and the public.

Table 3-1. Strategy Generation Table.

Radionuclide Treatment / Control	Non-Radionuclide Treatment / Control*	Radionuclide Monitoring	Non-Radionuclide Monitoring
HEPA filters in accordance with BARCT determination	No Treatment Equipment	New monitoring system(s) in accordance with the guidelines of ANSI N13.1	New monitoring system(s) in accordance with the SHMS and GCS designs
	Addition of Chemicals to Liquid to Control Odors		
	Masking and Odor Neutralization		
Modified radionuclide filtering capability	Condensation	No change from present.	No change from present.
	Thermal Oxidation		
	Adsorption		
	Chemical Scrubbing		
	Dry Chemical Scrubbers		
	Biological Systems		
	Hybrid Systems		
	Particulate Collection		

* Reference: Rafson 1998

Note: Cells that are shaded contain options that are screened out in Section 3.1.2.

3.1.2 Screening and Removal of Table Options

As is noted in Table 3-1, Radionuclide Treatment/Control, Radionuclide Monitoring, and Non-Radionuclide Monitoring only have one option, so they are carried forward. However, with all of the various options under Non-Radionuclide Treatment/Control further screening is warranted prior to defining the alternatives for this AGA.

3.1.2.1 Removal of Option: Addition of Chemicals to Liquid to Control Odors.

This option involves many subsets, but the most common includes the introduction of oxygen into a wastewater system for control of H₂S-type emissions. The management of H₂S-type emissions is not of interest in this particular AGA. This option and its subsets are removed from further consideration.

3.1.2.2 Removal of Option: Masking and Odor Neutralization. This set of options is based on human olfactory perceptions. However, this AGA intended to focus on the regulatory limits as set forth by state and federal governmental agencies. This option and its subsets are therefore not viable for further consideration within the context of this AGA.

3.1.2.3 Removal of Option: Biological Systems. Biofilters have been used extensively to control odors generated at wastewater treatment and composting facilities. Efforts are presently

underway to move this technology into other treatment areas such as VOCs, HAPs, various petroleum hydrocarbons, and other organic and inorganic compounds. Until these other areas are further developed, this option and its associated subsets are not valid for further consideration in this AGA because the TWRS is not concerned with classical wastewater treatment and composting needs.

3.1.2.4 Removal of Option: Particulate Collection. This option and its associated subsets are directed at the removal of particulate matter that may be present in gas or air streams (i.e., particulate materials are often carried along with VOCs in the stream). However, the BARCT for radionuclides will also remove these types of materials, so for the TWRS facilities this control technology would be implemented through the existing HEPA filters.

3.2 ALTERNATIVES FROM SURVIVING TABLE OPTIONS

After removing the non-viable options from Table 3-1, a set of viable options remain, and these are presented in Table 3-2. It is noteworthy that each of the options that are converted into alternatives have some features in common. These common features are

1. use of the BARCT (HEPA filtration technology presently in service),
2. new radionuclide emission monitoring equipment, and
3. new non-radionuclide gas monitoring equipment.

Each of the options translated into alternatives described in Table 3-2 is therefore presented according to the distinguishing features (i.e., the non-radiological treatment/control portion of the options/alternative).

Table 3-2. Viable Options Translated into Alternatives.

Option Attribute from Table 3-1	Description of Alternative to be Carried Forward into this AGA
No Treatment Equipment	<i>Upgrade Instrumentation and Procedures</i>
	<i>Construct a Taller Stack</i>
	<i>Add Independent Dilution Equipment</i>
	<i>Control Venting Rate from the Liquid/Solid Phase</i>
Condensation	<i>Low Temperature Condensation</i>
Thermal Oxidation	<i>Non-Catalytic Thermal Oxidation</i>
	<i>Catalytic Thermal Oxidation</i>
Adsorption	<i>Dry Adsorption/Absorption Beds</i>
Dry Chemical Scrubbing	
Chemical Scrubbing	<i>Wet Scrubber</i>
Hybrid Systems	<i>Combination Dry Adsorption Beds and Wet Scrubber</i>

3.3 DESCRIPTION AND SCREENING OF ALTERNATIVES AGAINST ASSUMPTIONS, CONSTRAINTS AND REQUIREMENTS

The alternatives generated from the options described in the sections above share the following attributes: use of present BARCT (HEPA filtration), new radionuclide emission monitoring equipment, and new non-radionuclide gas monitoring equipment. The alternatives that contain these common attributes are those which will be considered further in this AGA. Descriptions of each of these alternatives, minus the common features, are provided in this section.

3.3.1 Instrumentation and Procedure Upgrade, Alternative 1

As mentioned above, the existing CAMs will require upgrades because the present systems do not comply with the emerging standards. Any SHMS and/or GCS monitoring systems presently in use may also require upgrades to meet the needs of emerging standards, specifically in regards to non-flammable gases such as toxic and noxious odors. In order to install the required new instrumentation, a new stack (at least the same height as the existing stack) will be required. It is further expected that the procedure(s) for operating the primary ventilation system will also need to be modified/revised. Personnel operating the system could be required to wear personnel protective equipment (PPE) such as the self-contained breathing apparatus (SCBA) presently available.

3.3.2 Construction of Tall Stack, Alternative 2

This alternative capitalizes on the effects of atmospheric dispersion due to the discharge of gaseous emissions at higher elevations. Specifically, the concentration at ground level of a contaminant released from a tall stack will be lower than that of a contaminant released from a low stack. Therefore, ground level (i.e., in the area of the affected workers) hazardous gas concentrations can meet the industrial hygiene limits if the height of the stack is properly selected such that it is as tall a stack as necessary.

As in Alternative 1 above, it is expected that new gas monitoring equipment (CAMs SHMS and/or GCS) will be required.

3.3.3 Dilution by Independent Clean Air Stream, Alternative 3

The gaseous stream that leaves the HEPA filters (radionuclides are removed at this point) can be diluted with a stream of clean ambient air by means of a separate fan system. The resultant mixed air stream would therefore be exhausted up the stack. The amount of the air to be introduced is determined by industrial hygiene requirements and the concentration of the contaminants in the ventilated gas.

Because the amount of gas exiting from the stack (i.e., a combination of the present primary ventilation system gas stream and new dilution air stream) would increase, a new stack that is large enough to handle the new effluent will be required. To ensure the quality of the

effluent gas, new gas monitoring systems including CAMs, SHMS's and/or GCS's will be required. Furthermore, a system to control the mixing of the ventilation gas and dilution air stream would be required.

3.3.4 Controlled Gas Venting Rate, Alternative 4

It is believed that agitation of the tank waste by in-tank equipment (e.g., mixer and/or transfer pumps) may release gas bubbles trapped in the non-convective layer of waste in the tank. These gas bubbles, if present, may contain contaminants, hydrogen, nitrogen oxides, VOC and ammonia which would end up in the ventilation gas.

The current baseline uses mixer pumps to mix the tank contents or release entrapped gases in some of the tanks in farms AN, AW, AP, SY, AY, and AZ. For LAW, suspended solids will be allowed to settle, and the supernatant will be transferred to a staging tank by means of decanting. For HLW, the solids will be suspended and slurried to the PC.

As designed, both the direction and flow rate of mixer pump jets are controllable (Rasmussen 1998). Therefore, it is theoretically possible that if the mixer pump is properly controlled, the rate of gas released from the non-convective layer can be regulated such that the concentrations of contaminants in the effluent of the ventilation system will not exceed regulatory limits.

For this alternative, a control system which can change the rate and the direction of flow is needed for the mixer pump. A dome space gas monitoring system is also required for each tank equipped with a mixer pump. By controlling the operating conditions with a monitoring and pump control system, it is expected that the concentrations of contaminants in the gas stream traveling to the ventilation system can be controlled.

3.3.5 Dry Adsorption / Absorption Beds, Alternative 5

Columns packed with solid adsorbent/absorbent can be used to selectively remove some gaseous contaminants from a flowing stream. The primary ventilation gas from the fan of the existing ventilation system is fed to columns of solid chemicals which remove contaminants such as VOCs and ammonia from the contaminated gas stream. Examples of solid chemicals used for removal of contaminants are activated carbons with different pretreatments. References for these materials can be found in three sources:

1. "Air Pollution Control, Traditional and Hazardous Pollutants," Woward D. Hesheth, Technomic Publishing Company, Inc. 1991.
2. "Air Pollution Engineering Manual, Air & Waste Management Association," Edited by Anthony J. Buonicore and Wayne T. Davis, Van Nostrand Reinhold, New York, 1992.
3. "Purification with Activated Carbon," John W. Hassler, Chemical Publishing Co., Inc., New York, 1974.

Two sets of columns are used in most designs; while one set is in use, the other remains in standby mode. Each set would contain two beds: one bed for VOC removal and one bed for ammonia removal.

Instruments required for monitoring adsorbers include a gas-monitoring system to detect the breakthrough of contaminants in columns, and a differential pressure (DP) gauge to measure the pressure drop across the beds. The DP gauge will indicate the extent of particulate build-up in the bed. A flame arrestor would be installed at the inlet to the column to prevent backflashing of flame in the event a fire started in the column. This is necessary because a fire can result from carbon or other combustible adsorbents overheating due to the heat generated during adsorption of contaminants.

It is important to note that the primary ventilation system of 241-AZ and 241-AZ tank farms presently employs a high-efficiency gas adsorber (HEGA) system to address WAC 173-460 abatement requirements because of predicted arsenic emissions. Radio-iodine removal was taken credit for, but was not the primary driver for the HEGA. Although HEGAs are charcoal (solid adsorbent) bed systems that also may remove some VOCs and/or ammonia, they are not designed for removal of all of the chemicals in the gas stream. Therefore, a dry adsorption bed other than the present HEGA design may be deemed necessary for use at the 702-AZ building.

3.3.6 Thermal Oxidation, Alternative 6

Thermal oxidation of harmful contaminants can be accomplished in a variety of reactors. To oxidize contaminants in a gas stream with low-heating value, a supplemental fuel such as natural gas or propane gas is required to supply the energy required for reactions. Two specific applications of this are presented in the following options. These options are utilized commercially for abating pollutants in gas streams.

3.3.6.1 Non-Catalytic Thermal Oxidization. A non-catalytic thermal oxidation process oxidizes contaminants of the gas stream in a reactor under high temperature conditions. A supplemental liquid or gas fuel is usually supplied to provide the energy required for the oxidation reaction. The design goal in this case would be a system which allows non-harmful gas products to be vented to the atmosphere through a stack. The reactor may also be equipped with some kind of heat recovery system such as heat exchangers or a ceramic heat recuperator to lower the operating cost by reducing the amount of supplemental fuel required.

Because of the high temperature reaction, ammonia in the gas stream may be converted to nitrous oxides (NO_x). These NO_x are one of the environmentally harmful contaminants that are being addressed by this AGA, and therefore, depending upon the concentration of ammonia in the gas stream, the NO_x could require further treatment.

The non-catalytic thermal oxidation alternative oxidizes contaminants in the gas stream in a relatively high-temperature environment. Chlorinated hydrocarbons are comparatively difficult to destroy utilizing this method, however, the gas streams to be treated as they evolve from the waste tanks will not be rich in these types of compounds. At high temperatures, compounds containing nitrogen (such as ammonia) are usually converted to NO_x .

3.3.6.2 Catalytic Thermal Oxidation Alternative. Organic contaminants and hydrogen can be oxidized to non-harmful gas products such as water vapor and carbon dioxide by passing the gas stream through a reactor with a catalyst. Ammonia can be oxidized to nitrogen or nitrogen oxides (NO_x). Depending upon the concentration of ammonia (or the concentration of NO_x), and the regulatory emission limitation on NO_x , a process for further treatment of NO_x may be required. Because of the low heating value of the gas stream to be treated, the energy required for reactions must be supplied separately. The energy required for the oxidation can be supplied by the combustion of a supplemental gas or liquid fuel. For safety reasons, the former is considered the preferred process. The catalytic oxidation process has the advantage of carrying out the reaction at lower temperatures and with less nitrogen oxide formation than the non-catalytic oxidation process which operates at higher temperatures. The catalyst needs to be regenerated from time to time, or proper disposal of the exhausted (spent) catalyst may be required.

A catalyst-packed bed, heating system (a heat exchanger system), and pressure and temperature instruments would be required with this alternative. As in previous alternatives, replacement of existing stack and gas monitoring systems and/or addition of new monitoring systems to meet the generic needs of radiological and non-radiological gaseous emissions requirements will be required.

3.3.7 Low Temperature Condensation, Alternative 7

A low temperature condensation process can remove VOCs and other contaminants in an air/gas stream via a phase change (from gas to liquid) mechanism. At temperatures lower than the dew points of the target contaminants, vapor contaminants condense to form liquid, which can then be easily separated from the non-condensable gas stream.

A condenser and a refrigeration system to supply the cold medium to the condenser would be required. The condenser would be located between the fan and the stack. The capacity of the refrigeration system would depend on the quantity and temperature of the gas stream to be treated. The kind of contaminant to be removed would determine the operating temperature of the condenser. For example, most of the VOCs in the primary ventilation system could be condensed to form liquid at a temperature of about 40 °F, but ammonia would require a temperature lower than -30 °F.

The recirculation condenser cooling system presently in use at 241-AY and 241-AZ tank farms (including tanks AY-101, AY-102, AZ-101 and AZ-102) cools the recirculating stream and is capable of condensing many VOCs from the gas stream to liquid and returning them to the tank. Gas streams from the four affected tanks (AY-101, AY-102, AZ-101, and AZ-102) are subsequently combined and routed to another condenser for the entire gas exhaust system. In the overall condenser the gas is cooled to 40 °F to remove any condensable vapor including the residual VOC.¹ Therefore, the existing ventilation system for 241-AY and 241-AZ tank farms is equipped with a cooling system that is capable of removing most of the VOCs. However, in the existing system the gas stream is not cooled enough to remove ammonia.

¹ Further details about these systems are available in Appendix A.

The cooling process required for the removal of ammonia from the gas stream generates a liquid secondary waste which requires further treatment and/or disposal. Additionally, at these low temperatures, water vapor in the gas stream condenses and forms ice, which blocks the condenser and eventually renders it inoperable. Because of these considerations and because super-cooling is not practical, this alternative would be used primarily to treat gas streams containing no ammonia or contaminants having boiling points higher than the freezing point of water. Therefore, due to lack of flexibility, this alternative is not considered further in this AGA.

3.3.8 Wet Scrubber, Alternative 8

Some liquid absorbers can selectively remove gaseous contaminants from gas streams via wet scrubbers. Scrubbers can be a packed column, a venturi, or any other gas-liquid contacting device. Liquid absorbents can be aqueous or non-aqueous. The former are primarily used for treatment/control of inorganic gas compounds, and the latter for organic gas compounds. Non-aqueous liquid absorbents, however, have some associated fire hazards and are therefore not very suitable for use at the Hanford Site. It is noteworthy that ammonia, as a contaminant in the gas exhausted from the primary ventilation system, can effectively be scrubbed with water or a weak acidic solution such as sulfuric acid.

Due to potential flammability concerns associated with gases to be treated, only an aqueous absorbent is considered viable for use in a wet scrubber process for the tank farms. This would only allow for ammonia and water-soluble contaminants to be removed from the ventilation gas, leaving most of the VOCs untreated by this process. An additional consideration is that the spent absorbent utilized by the wet scrubber would need to be regenerated and the waste from the regeneration would then require further treatment/disposal.

A packed-column scrubber system, an absorbent regeneration system (or treatment system), and associated instrumentation would be required for this alternative.

Based on these analyses, it is determined that aqueous scrubbing for ammonia is the only potentially viable option to carry forward, and this is accomplished by combining it with a previously discussed option for VOC treatment control to create the next alternative.

3.3.9 Combination Dry Adsorption Beds and Wet Scrubber, Alternative 9

This alternative is a hybrid of the dry adsorption bed and wet scrubber alternatives. The ventilation gas exiting from the existing fan is fed to a dry adsorption bed packed with an adsorbent such as activated carbon to remove VOCs. The gas, free of VOCs, then passes through a wet scrubber to remove ammonia (and soluble contaminants). Ammonia is usually removed from the gas stream by a weak acid solution shower through the scrubber packed with inert gas-liquid contacting material such as Rasching rings.

This alternative requires a new stack with new gas monitoring instrumentation (CAMs, SHMS's and/or GCS's) as in previous alternatives. This alternative would also require a pair of dry adsorption beds (one in use and one in standby mode) to remove VOCs, and a wet scrubber using a weak acid solution as an absorbent to remove ammonia.

Figure 3-1. Instrumentation / Procedure Upgrade Alternative (Alternative 1).

Figure 3-2. Tall Stack Alternative (Alternative 2).

Figure 3-3. Clean Air Dilution Alternative (Alternative 3).

Figure 3-4. Controlled Gas Vent Rate Alternative (Alternative 4).

Figure 3-5. Dry Adsorption / Absorption Beds Alternative 5).

Figure 3-6. Thermal Oxidation Alternative (Alternative 6).

Figure 3-7. Low Temperature Condensation Alternative (Alternative 7).

Figure 3-8. Wet Scrubber Alternative (Alternative 8).

Figure 3-9. Dry Bed Adsorption and Wet Adsorption Alternative (Alternative 9).

4.0 FUNDAMENTAL OBJECTIVES AND DECISION CRITERIA

To further evaluate the alternatives of this AGA, a qualitative analysis process was developed. In this section, the major objectives of the waste feed delivery program (WFD) are considered and then used to establish the criteria to determine when these objectives are met for the specific needs of this AGA. These objectives are general and are used to make many decisions across the WFD Program.

The specific decision criteria presented in this section are used to distinguish between the alternatives derived from Section 3 above. Informed decisions about primary tank ventilation needs are then possible based upon the alternatives and criteria that are presented.

4.1 FUNDAMENTAL OBJECTIVES

The major fundamental objectives of the waste feed delivery program are provided here. The items listed in *italics* in Table 4-1 for each objective are the key words that are used to identify the distinguishing objectives and specific decision criteria used in this AGA (i.e., used again in the tables that follow).

4.1.1 Fundamental Objectives for the Waste Feed Delivery Program

The fundamental objectives of the WFD program are derived from two sources:

1. The fundamental objectives from the DOE-RL Waste Disposal Division, and
2. The mission of the waste feed delivery program.

The DOE-RL Waste Disposal Division specified five fundamental objectives for itself. (For more information, see Section 1.5.1 of the TWRS Waste Disposal Division Planning Guidance, issued September 18, 1998.) These objectives were derived from and are therefore consistent with DOE-Headquarters, Hanford Site, TWRS-level objectives, and TWRS systems engineering. These five objectives are:

1. Minimize environmental, worker safety, and public health risks,
2. Minimize costs,
3. Maximize regulatory compliance, including the TPA,
4. Develop stakeholder confidence and acceptance, and
5. Develop and deploy technology to solve Hanford Site and DOE-Complex problems.

Of these five objectives, the first three are suitable to serve as the bases for decision criteria for the WFD program. The fourth is a process objective, and the fifth is best met by actually developing and deploying equipment to accomplish the mission of the program.

The mission of the waste feed delivery system is to deliver the proper tank waste feed to the vitrification plant on time and in the right amount (volume and composition), thereby allowing this material to be immobilized and removed as a threat to the Columbia River.

Based on the requirements discussed above, four high-level fundamental objectives have been identified for the waste feed delivery system. They are

1. maximize safety (environmental, worker and public),
2. maximize compliance with regulations,
3. minimize life-cycle cost, and
4. maximize the reliability of feed delivery to the vitrification plant.

(Note that the terms “maximize” and “minimize” are used in the sense of “to increase towards a maximum” or “to reduce towards a minimum” with due weight given to all other legitimate—and sometimes conflicting—objectives. The terms do not mean “to make the maximum” or “to make the minimum” without regard to other objectives.)

In summary, it is the overall objective of the waste feed delivery program to deliver the proper waste feed to the vitrification plant in a timely manner. While doing this, the safety of the environment, public and workers must be protected; the cost must be acceptable; and compliance with regulations of external organizations must be maximized.

Each of these high-level fundamental objectives can be further subdivided into lower-level fundamental objectives. The action of subdividing can go on almost indefinitely, however, it is best to subdivide only until the first point where the objectives will be useful in decision-making. All other things being equal, the smallest possible set of objectives is preferred. The high-level fundamental objectives and the corresponding sub-tier objectives are shown in Table 4-1, Objectives Hierarchy for Tank WFD System.

4.1.2 Distinguishing Objectives for This Decision

Although in principle all objectives apply to all decisions, in many cases each foreseeable alternative will satisfy a particular objective equally (or near-equally) well, and therefore this objective may not help to distinguish between the alternatives sufficiently well that it might lead to one alternative being chosen over another. For the purpose of decision-making, an objective is dropped from the list and no decision criteria are developed for it when the objective does assist in distinguishing between alternatives.

For this decision, the objectives listed in Table 4-1 are screened for those that will be used in this decision. This screening process and the associated explanations of why each objective is considered distinguishing or not distinguishing is provided in Appendix C.

Table 4-1. Objectives Hierarchy for Tank Waste Feed Delivery System.

1. Maximize Safety	1.1 Maximize Public Safety	1.1(a) Radiation Releases	1.1(a)i Chronic Exposure	
			1.1(a)ii Accidental Exposure	
		1.1(b) Chemical Releases	1.1(b)i Chronic Exposure	
			1.1(b)ii Accidental Exposure	
	1.2 Maximize Worker Safety	1.2(a) Radiation Exposure	1.2(a)i Chronic Exposure	
			1.2(a)ii Accidental Exposure	
		1.2(b) Chemical Exposure	1.2(b)i Chronic Exposure	
			1.2(b)ii Accidental Exposure	
	1.2(c) Industrial Safety			
	1.3 Maximize Environment Safety	1.3(a) Protection of Biota		
		1.3(b) Groundwater and Vadose Zone Protection	1.3(b)i Chronic Releases	
			1.3(b)ii Accidental Releases	
		1.3(c) Atmospheric Protection	1.3(c)i Chronic Releases	
	1.3(c)ii Accidental Releases			
2. Maximize Regulatory Compliance	2.1 DOE			
	2.2 Washington Dept of Ecology and EPA			
	2.3 Washington Dept of Health and EPA			
3. Minimize Life-Cycle Cost	3.1 Design & Construction Cost			
	3.2 Operating Cost			
	3.3 Decontamination & Decommissioning			
4. Maximize Feed Delivery Reliability	4.1 Feed Delivery On Time	4.1(a) Initial Delivery		
		4.1(b) Routine Delivery		
	4.2 Proper Quantity of Feed	4.2(a) Initial Quantity		
		4.2(b) Routine Quantity		
	4.3 Feed Within Specifications			
	4.4 Obligations and Milestones	4.4(a) Contractual Obligations		
4.4(b) TPA Agreement Milestones				

Note: Objectives in bold italics are those criteria which are distinguishing for this AGA; those that are not distinguishing have been shaded.

4.2 DECISION CRITERIA AND PERFORMANCE MEASURES

To implement the fundamental objectives, a decision criterion has been developed for each objective that is distinguishing for this decision. These decision criteria are listed in Appendix C, Decision Criteria. The bases for use of the fundamental objectives as decision criteria in this AGA are repeated here in Table 4-2.

In order to allow the possibility of applying decision-aiding techniques that use numbers to represent relative judgements, each decision criterion as framed through the Appendix C process is such that the least desirable outcome is given the value one and the most desirable outcome is given the value ten. It is emphasized that the presence of the scale is not to be construed to indicate that the use of such decision-aiding techniques is required.

Table 4-2. Determination of Which Objectives to Consider as Ventilation AGA Criteria.

Fundamental Objective		Applicable to Ventilation AGA as a Discriminating Objective? (yes / no)	Basis for Selection or Rejection as Criteria for this Ventilation AGA
Number	Title		
1.0	Maximize Safety		
1.1	Maximize Public Safety		
1.1.1	Radiological	No	From a public safety perspective, all ventilation alternatives are equal because the public is assumed to be at a relatively equal (small) risk of radiological exposure.
1.1.2	Chemical	Yes	RCRA and other similar chemical safety aspects could be discriminating in this AGA (this might be a discriminating factor).
1.2	Maximize Worker Safety		
1.2.1	Radiological	No	The existing radionuclide treatment/controls (demister pads and HEPA filters) are considered BARCT and affect each alternative equally.
1.2.2	Chemical	Yes	Various chemical exposures could be possible from each of the differing alternatives (this might be a discriminating factor).
1.2.3	Industrial	Yes	Potential risks of tripping, falling, etc. hazards may be increased in cases where SCBA types of PPE are used. Furthermore, fire hazards associated with use of a dry carbon bed adsorber need to be considered.
1.3	Maximize Environmental Safety		
1.3.1	Biota (plants and animals)	No	
1.3.2	Groundwater & Vadose Zone	No	Each alternative will result in relatively the same amount of (small) risk to the indigenous plant and animal life.
1.3.3	Atmosphere	Yes	Varying levels of atmospheric protection may result from the different alternatives (this might be a discriminating factor).
2.0	Maximize Compliance with Regulation		
2.1	DOE	Yes	
2.2	WA Ecology / EPA	Yes	Differing levels of compliance may result for the various alternatives. (These might be discriminating factors.)
2.3	WA Health / EPA	Yes	
3.0	Minimize Life-Cycle Cost		
3.1	Design & Construction Cost	Yes	There may be differences in the design and construction costs for the various alternatives (this might be a discriminating factor).
3.2	Operations Cost	Yes	Very large differences in operations and maintenance costs associated with each of the alternatives are likely. (This might be a discriminating factor.)
3.3	D&D Cost	No	Each alternative is expected to result in roughly the same relative cost for removal upon completion of its useful life.
4.0	Maximize the Reliability of Feed Delivery		
4.1	Feed On Time		
4.1.1	Initial Delivery of Feed	Yes	
4.1.2	Routine Delivery of Feed	Yes	There could be wide variability between each of the alternatives that results in significant differences in difficulty and/or probability of successful design, construction, and/or demonstration of operational readiness (these might be discriminating factors).
4.2	Proper Quantity of Feed		
4.2.1	Initial Quantity	No	
4.2.2	Routine Quantity	No	None of the ventilation alternatives are expected to affect the physical and/or chemical composition of the waste that is fed to the PC. Rather, the expectation is that the opposite affect will be realized (i.e., the waste feed physical and chemical composition may affect the ventilation systems.) However, for the purpose of this AGA, the assumptions are that these effects will be relatively equal when taken on a farm-by-farm basis.
4.3	Feed Within Specifications	No	
4.4	Obligations & Milestones		
4.4.1	Contract Obligations not covered by 4.1, 4.2, & 4.3 above	No	
4.4.2	Tri-Party Agreement Milestones	No	No other contract obligations, TPA milestones, etc. are expected to create any discrimination between alternatives in this AGA.

4.3 RETRIEVAL ENGINEERING-RECOMMENDED WEIGHT FACTORS

Retrieval Engineering employed a multi-attribute analysis technique in this AGA. Retrieval Engineering established weighting factors for each of the criteria carried forward from Table 4-2. These are shown in Table 4-3.

Using values from one to ten, each of the criteria was pair-wise compared by Retrieval Engineering personnel, starting with the highest-ranked criterion (Criterion 4.1.1 in Table 4-3) and moving to the lowest-ranked criterion (Criterion 1.1.2.1 in Table 4-3). In the comparison, criteria are compared one at a time to determine their relative importance (e.g., How much more important is the criterion ranked as 1 in Table 4-3 than the criterion ranked as 2?). The results of the pair-wise comparison were normalized to provide the associated criterion weighting factors that are also provided in Table 4-3. Refer to Appendix C for further details on how these criteria were developed.

Table 4-3. Major Criteria, Associated Rank, and Weighting Factors.

Rank	Criterion Number	Criterion Title	Comparison Results	Weighting Factor
1	4.1.1	Initial Delivery of Feed	10	20
2	4.1.2	Routine Delivery of Feed	10	20
3	2.1	DOE Regulatory Compliance	6	12
4	1.2.2.1	Chronic Chemical Release to Worker	3	6
5	2.2	WA Ecology / EPA	3	6
6	3.1	Design and Construction Cost	3	6
7	3.2	Operations Cost	3	6
8	1.2.2.2	Accidental Chemical Release to Worker	2	4
9	1.3.3.2	Accidental Release to Atmosphere	2	4
10	1.1.2.2	Accidental Chemical Release to Public	2	4
11	1.2.3	Worker Industrial Safety	2	4
12	2.3	WA Health / EPA	1	2
13	1.3.3.1	Chronic Release to Atmosphere	1	3
14	1.1.2.1	Public Chemical Chronic Exposure	1	3
Total			49	100

5.0 EVALUATION OF ALTERNATIVES AGAINST DECISION CRITERIA

In this section, each of the alternatives that satisfactorily passed through the screening process of Section 3 (i.e., Alternatives 1 through 6 and Alternative 9) are combined with the specific criteria developed from Section 4. Each of the alternatives is evaluated against the decision criteria according to the performance measures of Appendix C.

5.1 EVALUATION BY CRITERIA

Each of the alternatives that passed through the screening process in Section 3 above were evaluated according to the criteria for the WFD Program (refer to Section 4 and Appendix C for discussions of criteria). Retrieval Engineering convened a group of representatives from the various organizations within TWRS to solicit their opinions on these criteria and alternatives. The individuals who participated are listed in Appendix F. Consensus from this group is shown in Tables 3-1 through 3-14 below.

5.1.1 Washington State Departments of Ecology and Health & EPA

Alternatives 1, 2, 3 and 4 are expected to continuously release about the same (relatively small) amount of contaminated gas to the atmosphere. It is expected that the permitting required for these four alternatives will be easier to obtain than for the remaining three alternatives. Alternative 6 oxidizes contaminants at elevated temperatures, thus potential hazards from fire should carefully be evaluated, especially should the process be performed in the vicinity of a tank farm. Furthermore, the potential of Alternative 6 producing NO_x gases in should not be ignored because it is a regulated substance like those from which it would be produced. Tables 5-1 and 5-2 list the relative scoring for this criterion.

5.1.2 Public Chronic Exposure to Chemical Release

All seven alternatives are expected to result in continuous releases of chemicals to the atmosphere. However, from a public safety perspective it was believed that the largest mitigating factor for this criterion was the fact that all tank farm activities take place in controlled areas where the public is not allowed direct access. The non-radioactive (chemical) releases which could thereby potentially reach the public are expected to be the lowest for Alternatives 5, 6 and 9. Table 5-3 lists the relative scoring for this criterion.

5.1.3 Accidental Chemical Release to the Public

Accidental release of chemicals to the public is expected to parallel the chronic conditions described in Section 5.1.2 above. Table 5-4 lists the relative scoring for this criterion.

5.1.4 Worker Exposure to Chronic Chemical Release

Each of the alternatives is expected to result in some possible exposure to the affected worker. However, passive controls are expected to be somewhat controlling for Alternatives 5 and 9. Specifically, Alternatives 5 and 9 provide adsorption/absorption systems that remove potential toxic chemicals from the gaseous/vapor stream prior to its release up the stack to the atmosphere. Therefore, the stack effluent is expected to contain fewer chemical contaminants. Table 5-5 lists the relative scoring for this criterion.

5.1.5 Worker Exposure to Accidental Chemical Release

The potential that new accidents could be initiated associated with Alternatives 1, 2, and 3 is expected to be relatively low. Table 5-6 lists the relative scoring for this criterion.

5.1.6 Initial Feed Delivery on Schedule

All seven of the alternatives considered in this study are constructable and could be easily deployed in the vicinity of the present primary ventilation systems. However, Alternatives 5, 6 and 9 are expected to be more difficult to construct than the other four alternatives.

When considering the schedule of delivering feed, a major consideration relative to the ventilation systems is the technical maturity of alternatives considered. The technologies for all seven alternatives considered in this study are available. Alternative 4 has been tested, in a relative sense, in tank SY-101. During the SY-101 mixer pump operations it has been demonstrated that gases evolve at a greater rate when the mixer pump is operated, than when it is off. However, the degree of controllability of the mixer pump (i.e., how precisely this control mechanism can be operated) has not yet been proven. Alternative 5 is a commercially-available standard VOC and ammonia abatement process, and only differs from the present 702-AZ HEGA system in size and bed material(s) selection. Alternative 6 is also a commercially-available process, but does not have a comparable Hanford equivalent. Catalysts used in the process described by Alternative 6 can be custom-made so that they are able to remove special group(s) of contaminants. Alternative 9 uses two commercially-available processes to remove both VOC and ammonia.

Another feature worth considering when trying to determine which alternative yields the most timely delivery of feed materials is the aspect of complexity. From this perspective, Alternatives 5 and 9 (involving different adsorption beds and/or scrubber systems) are the most complex processes. Alternatives 1 and 2 are the most simple of the alternatives considered. Alternative 6 uses a catalytic converter to oxidize VOCs and ammonia under a set of closely-controlled operating conditions. The level to which VOCs may be removed is uncertain, and even if removal is relatively thorough, Alternative 6 may be considered as complicated or more complicated than Alternatives 5 and 9. The systems in Alternatives 3 and 4 would require relatively complicated control systems.

Table 5-7 lists the relative scoring for this criterion.

5.1.7 Routine Delivery of Feed on Schedule

When considering the elements that would allow an alternative to support the routine delivery of feed on schedule, the issues of operability, maintainability, and control of the process are considered.

The short and tall stacks of Alternatives 1 and 2, respectively, would be relatively easy to maintain. The fan for Alternative 3 is a piece of standard equipment and would not be difficult to maintain. The control system for the mixer pump of Alternative 4 would be somewhat more complicated than Alternatives 1, 2, and 3, and would require routine maintenance. The adsorption/absorption bed system of Alternative 5 is a piece of relatively complicated equipment, and maintenance of this type of system would likely require more skill. The heater of Alternative 6 may also need extensive maintenance, and occasionally the catalysts in the converter would need replacement or regeneration.

With regard to operability, Alternatives 1, 2, and 3 are expected to be relatively easy to start up and shut down. Alternatives 4, 5, 6, and 9 would, however, require much operator attention during startup and shutdown periods.

The process control needs for Alternatives 1, 2, and 5 are relatively simple. However, Alternatives 3, 4, 6, and 9 would require a more complicated process control scheme. Furthermore, Alternative 6 would require very precise control of temperature.

Troubleshooting and response to off-normal conditions are necessary considerations with regard to how well a particular alternative could maintain routine feed delivery.

Once the height of the stack is fixed in either Alternative 1 or 2, it would be difficult to modify for the purpose of handling off-normal conditions. Alternative 3 and 4 have more control variables to correct for potential variability and off-normal conditions. Because of the use of packed beds, Alternatives 5 and 9 require more complicated procedures for troubleshooting and response to off-normal conditions. Lower-than-designed operating temperature and/or loss of activity of a catalyst in the converter are potential reasons that Alternative 6 would not remove VOC and ammonia properly.

Once up and operating, Alternatives 1 and 2 would require almost no operator interaction (i.e., they would be almost equal to present operations). Alternatives 3 and 4 would likely require a moderate amount of operational time. The control systems for Alternatives 3 or 4 could be integrated into a present manned facility. However, Alternatives 5, 6, and 7 would likely require more operators than are utilized for present operations. Table 5-8 lists the relative scoring for this criterion.

5.1.8 Chronic Release to Atmosphere

For Alternative 1, chemical concentrations discharged from the ventilation systems will be roughly equivalent to present operational conditions. It is therefore expected that under the

conditions of WFD operations there may be cases (as in the recent C-106 sluicing operations) wherein the normal atmospheric release rates are unacceptably high. However, in the cases of Alternatives 2, 3, and 4 it is believed that acceptable release concentrations can be maintained by administrative management practices. Under these types of conditions, however, total quantities of chemicals released would not necessarily be in compliance. These chemical contaminants could affect the quality of the atmosphere. In the cases of Alternatives 5, 6, and 9, the major chemical contaminants could conceivably be removed from the carrier gas by means of the specific treatment technology (adsorption, thermal oxidation [chemical reaction], and/or wet scrubber [absorption]). It is therefore expected that releases to the atmosphere of not only lower concentrations, but lower total quantities of hazardous and potentially hazardous materials would be realized for Alternatives 5, 6, and 9 under normal operating conditions. Table 5-9 lists the relative scoring for this criterion.

5.1.9 Accidental Release to Atmosphere

This criterion looks at the alternatives from the perspective of "risk of initiating a new accident" not presently addressed in the authorization basis.

Alternative 1 provides no treatment/control capability for gas streams exhausted except the removal of radionuclides, therefore, it could release harmful chemical contaminants as a direct response to in-tank activities. For example, should a specific tank experience a gas release event (GRE), then Alternative 1 would provide no direct means of controlling it; only monitoring of the event would be possible. In Alternative 2, which specifies a taller stack than Alternative 1, the concentrations of gases in close proximity to the stack would be mitigated slightly, however, these effects are still very dependent upon the atmospheric conditions at the time (i.e., wind direction, velocity, etc.). Alternatives 3 and 4 employ equipment with more moving parts, (i.e., an additional fan and a mixer pump, respectively) than are involved in Alternatives 1 and 2. This additional equipment could fail when especially needed, and therefore the chance of accidental release of hazardous gases could be as great as in Alternatives 1 and 2. Alternatives 5, 6, and 9 employ treatment/control technology, including standby unit(s) which could mitigate potential accidental releases from a tank. However, Alternatives 5, 6, and 9 could also bring new potential accident conditions to bear, such as the loaded adsorption bed (a full, or nearly-full canister of chemicals) failing in such a manner (e.g., due to a fire) as to disperse this new "accumulated source of materials" to the atmosphere. In the case of Alternative 6, this could take the form of a "poisoning of the catalyst" by unexpected chemical compound(s) being released from the tank. Of further note: if the supply of auxiliary fuel to the thermal oxidation unit in Alternative 6 is discontinued, then harmful contaminants could be released from the stack to the atmosphere due to incomplete conversion of contaminants. Table 5-10 lists the relative scoring for this criterion.

5.1.10 Worker Industrial Safety

In Alternatives 1, 2, 3, and 4, personnel may be required wear personnel protective equipment (PPE) such as masks with an air supply system. Any time PPE is utilized, safety concerns such as mask fogging problems and other losses of vision, added weight burdens, and increased risk of tripping and/or falling arise. The industrial safety implications for ventilation system alternatives should not be ignored.

Another aspect of industrial safety includes the consideration of carbon and/or catalysts used in Alternative 5, 6, and 9. These agents would require change-out periodically. Therefore, the need to move cartridges or bulk materials from place to place using equipment such as hoists and forklifts is a consideration. Table 5-11 lists the relative scoring for this criterion.

5.1.11 Design and Construction Cost

The design and construction (capital investment) costs for the equipment of each alternative has been estimated. Details about these capital costs are shown in Appendix E. From Appendix E it can be seen that Alternative 1 would require the least capital investment among the alternatives considered. The major equipment costs associated with implementing Alternative 2 would be second to Alternative 1. The next two Alternatives (3 and 4) are comparable and would virtually tie for third-least-expensive to implement. Alternatives 5, 6, and 9 would require more capital investment than the other four alternatives considered here. Table 5-12 lists the relative scoring for this criterion.

5.1.12 Operations Costs

The operating and maintenance costs for Alternatives 1 and 2 are expected to be roughly the same, and are expected to be within a budget that is considered reasonable. Alternative 3 would consume more electricity than Alternatives 1 and 2 to run the fan for introduction of extra air, in order to dilute the exhaust gas of the ventilation system. Alternative 4 would not consume much extra energy to control the mixing pump, however it would likely require further calibration of instrumentation, and maintenance of equipment. Alternatives 3 and 4 are likely to be roughly equivalent in operational and maintenance costs, but greater than Alternatives 1 and 2. Alternative 5 employs dry adsorbents/absorbents to remove contaminants from the gas stream to be treated. The spent adsorbents/absorbents would thereby require proper disposal, and fresh materials would need to be added back into the system from time to time. The operating and maintenance costs of Alternative 5 could be relatively high. Alternative 6 would require materials be managed in a fashion similar to that of Alternative 5, however, the added aspects of liquid fuel and a catalytic chemical reaction make Alternative 6 more complicated than the purely dry chemical needs of Alternative 5. The fuel requirements of Alternative 6 are highly dependent upon operating temperature and other operating conditions of the process. Alternative 9 consumes carbon (from Alternative 5) and a weak acid solution to remove contaminants. Therefore, operating and maintenance costs of the requisite materials for Alternative 9 are major costs, making this the lowest-ranking alternative in this consideration. Table 5-13 lists the relative scoring for this criterion.

5.1.13 DOE Regulatory Compliance

It is expected that Alternatives 1 and 2 will require only minimal modifications—if any—to the present authorization basis. Alternative 3 is also expected to require minimal modifications with relatively easy approval. Alternative 4 is expected to be the most difficult alternative, and almost no chance of regulatory approval is expected. Of the remaining three alternatives, Alternative 5 is expected to be the easiest, with the last two (Alternatives 6 and 9)

requiring extensive modifications and significant risk to individuals, thereby making the approval process more difficult. Table 5-14 lists the relative scoring for this criterion.

5.2 EVALUATION BY ALTERNATIVE

Each of the alternatives was evaluated against the criteria above. In this section, these evaluations are combined and summarized in accordance with the specific alternative to which they correspond. Table 5-15 summarizes the raw scores from Tables 5-1 through 5-14 and combines them with the weighting factors from Table 4-3 to yield a sorting by alternatives.

5.2.1 Alternative 1

Although Alternative 1 would be the least expensive of the seven to design, construct, operate, and maintain, it does pose the most risk with regard to the many unknowns of the presently undisturbed wastes. As the WFD Program matures, it is highly probable that the wastes in the DSTs will create situations analogous to those that were recently experienced at tank C-106. This alternative would therefore not be highly recommended under these conditions. A more refined analysis of risk is presented in Section 6.

5.2.2 Alternative 2

This alternative provides a slight improvement over Alternative 1, however, there is expected to be the same relatively high degree of risk associated with it, too.

5.2.3 Alternative 3

With the choice of this alternative, it is expected that the needs of protecting the environment will not fully be met. Specifically, this alternative is not effective in meeting a total pollutant mass. This alternative is only of value when a concentration limit needs to be met (i.e., in order to protect the health of the worker and/or public).

5.2.4 Alternative 4

For this alternative, it is expected that the necessary "refined" control of the mixer pump could be difficult to achieve. Furthermore, the same total mass verses concentration limits would need to be addressed as in Alternative 3.

5.2.5 Alternative 5

Of the treatment/control alternatives, this one is the least expensive to build, operate, and maintain. Difficulties in obtaining permitting and buy-in from regulatory agencies could conceivably be overcome by starting that process sufficiently early.

5.2.6 Alternative 6

This alternative is expected to be relatively expensive, and pose many new hazards to the workers beyond the current baseline.

5.2.7 Alternative 9

This alternative is expected to be relatively expensive, and pose many new hazards to the workers beyond the current baseline.

Figure 5-1. Criteria Scoring for Public Chronic Chemical Exposure.

<i>Select the answer that more closely describes the system's ability to minimize the exposure of the public to chronic chemical releases.</i>			Alternatives						
			Instrumentation & Procedure Upgrade	Construction of Tall Stack	Dilution by Independent Clean Air Stream	Controlled Gas Venting Rate	Dry Adsorption / Absorption Beds	Thermal Oxidation (Catalytic)	Combined Dry Adsorption Beds & Wet Scrubber
Criterion 1.1.2.1 Public Chronic Chemical Exposure			1	1	1	2.5	7.5	5	5
No potential for chronic chemical releases to the public are anticipated.	Excellent	10					7.5		
Chronic chemical releases to the public are anticipated to be controlled well below permit levels.	Good	5				2.5		5	5
Uncontrolled long-term chronic releases to the public are anticipated.	Very Poor	1	1	1	1				

Figure 5-2. Criteria Scoring for Accidental Chemical Release to Public.

<i>Select the answer that more closely describes the system's ability to minimize the chance of accidentally releasing chemicals to the public.</i>			Alternatives						
			Instrumentation & Procedure Upgrade	Construction of Tall Stack	Dilution by Independent Clean Air Stream	Controlled Gas Venting Rate	Dry Adsorption / Absorption Beds	Thermal Oxidation (Catalytic)	Combined Dry Adsorption Beds & Wet Scrubber
Criterion 1.1.2.2 Accidental Chemical Release to Public			8	8	6	3	2	2	2
Little or no potential for accidental releases that would likely exceed guidelines for the public.	Excellent	10	8	8					
Potential for accidental releases exceeding guidelines for the public are within the level considered acceptable.	Good	5			6				
High potential for accidental releases that would exceed guidelines for the public.	Very Poor	1				3	2	2	2

Figure 5-3. Criteria Scoring for Chronic Chemical Release to Worker.

<i>Select the answer that more closely describes the system's ability to minimize the exposure of the worker to chronic chemical releases.</i>			Alternatives						
			Instrumentation & Procedure Upgrade	Construction of Tall Stack	Dilution by Independent Clean Air Stream	Controlled Gas Venting Rate	Dry Adsorption / Absorption Beds	Thermal Oxidation (Catalytic)	Combined Dry Adsorption Beds & Wet Scrubber
Criterion 1.2.2.1 Chronic Chemical Release to Worker			2.5	5	5	2.5	7.5	5	7.5
No potential for chemical exposure to workers above OSHA requirements.	Excellent	10					7.5		7.5
Chronic chemical exposures to workers are anticipated to be controlled well below OSHA requirements.	Good	5		5	5			5	
Uncontrolled exposures in excess of OSHA requirements are anticipated.	Very Poor	1	2.5			2.5			

Figure 5-4. Criteria Scoring for Accidental Chemical Release to Worker.

<i>Select the answer that more closely describes the system's ability to minimize the chance of accidentally releasing chemicals to the worker.</i>			Alternatives						
			Instrumentation & Procedure Upgrade	Construction of Tall Stack	Dilution by Independent Clean Air Stream	Controlled Gas Venting Rate	Dry Adsorption / Absorption Beds	Thermal Oxidation (Catalytic)	Combined Dry Adsorption Beds & Wet Scrubber
Criterion 1.2.2.2 Accidental Chemical Release to Worker			8	8	6	3	2	2	2
Little or no potential for accidental releases that would likely exceed limits for workers.	Excellent	10	8	8					
Potential for accidental releases exceeding limits for workers are within the level considered acceptable.	Good	5			6				
High potential for accidental releases that would likely exceed limits for workers.	Very Poor	1				3	2	2	2

Figure 5-5. Criteria Scoring for Worker Industrial Safety.

<i>Select the answer that more closely describes the system's ability to protect the worker from undue industrial safety hazards.</i>			Alternatives						
			Instrumentation & Procedure Upgrade	Construction of Tall Stack	Dilution by Independent Clean Air Stream	Controlled Gas Venting Rate	Dry Adsorption / Absorption Beds	Thermal Oxidation (Catalytic)	Combined Dry Adsorption Beds & Wet Scrubber
Criterion 1.2.3 Worker Industrial Safety			5	4	5	5	3	1	1
Reduced risk of injury or death over current practices.	Excellent	10							
Expected risk of injury and death similar to present.	Good	5	5	4	5	5			
High risk of industrial accidents leading to death or serious injury due to frequent high-risk activities.	Very Poor	1					3	1	1

Figure 5-6. Criteria Scoring for Chronic Release to Atmosphere.

<i>Select the answer that more closely describes the system's ability to limit chronic releases of chemicals to the atmosphere.</i>			Alternatives						
			Instrumentation & Procedure Upgrade	Construction of Tall Stack	Dilution by Independent Clean Air Stream	Controlled Gas Venting Rate	Dry Adsorption / Absorption Beds	Thermal Oxidation (Catalytic)	Combined Dry Adsorption Beds & Wet Scrubber
Criterion 1.3.3.1 Chronic Release to Atmosphere			5	5	5	5	8	8	8
No expected releases of chemicals to the atmosphere.	Excellent	10					8	8	8
Potential releases of chemicals to the atmosphere that can be mitigated.	Good	5	5	5	5	5			
Potential releases of chemicals to the atmosphere that cannot be mitigated.	Very Poor	1							

Figure 5-7. Criteria Scoring for Accidental Release to Atmosphere.

<i>Select the answer that more closely describes the system's ability to limit accidental releases of chemicals to the atmosphere.</i>			Alternatives						
			Instrumentation & Procedure Upgrade	Construction of Tall Stack	Dilution by Independent Clean Air Stream	Controlled Gas Venting Rate	Dry Adsorption / Absorption Beds	Thermal Oxidation (Catalytic)	Combined Dry Adsorption Beds & Wet Scrubber
Criterion 1.3.3.2 Accidental Release to Atmosphere			8	8	6	3	2	2	2
No expected releases of chemicals to the atmosphere.	Excellent	10	8	8					
Potential releases of chemicals to the atmosphere that can be mitigated.	Good	5			6				
Potential releases of chemicals to the atmosphere that cannot be mitigated.	Very Poor	1				3	2	2	2

Figure 5-8. Criteria Scoring for DOE Regulatory Compliance.

<i>Select the answer that more closely describes the system's ability to maximize the chance of compliance with DOE regulations.</i>			Alternatives						
			Instrumentation & Procedure Upgrade	Construction of Tall Stack	Dilution by Independent Clean Air Stream	Controlled Gas Venting Rate	Dry Adsorption / Absorption Beds	Thermal Oxidation (Catalytic)	Combined Dry Adsorption Beds & Wet Scrubber
Criterion 2.1 DOE Regulatory Compliance			9	9	8	1	4	2	3
No modifications requiring regulatory approval.	Excellent	10	9	9	9				
Modifications requiring regulatory approval; likely that regulatory approval will be forthcoming.	Good	5					4		
Little or no chance of regulatory approval.	Very Poor	1				1		2	3

Figure 5-9. Criteria Scoring for State of WA Dept. of Ecology & EPA Regulations.

<i>Select the answer that more closely describes the system's ability to comply with State of WA Dept. of Ecology and EPA regulations.</i>			Alternatives						
			Instrumentation & Procedure Upgrade	Construction of Tall Stack	Dilution by Independent Clean Air Stream	Controlled Gas Venting Rate	Dry Adsorption / Absorption Beds	Thermal Oxidation (Catalytic)	Combined Dry Adsorption Beds & Wet Scrubber
Criterion 2.2 WA Dept. of Ecology & EPA Regs.			3	3	2	3	1	1	1
No permits, approvals, or facility changes needed to achieve and demonstrate compliance.	Excellent	10							
Physical changes to and/or re-engineering of facility installations are required to achieve and demonstrate regulatory compliance.	Good	5							
Authorization to proceed highly unlikely (i.e., in opposition to public or agency priorities).	Very Poor	1	3	3	2	3	1	1	1

Figure 5-10. Criteria Scoring for State of WA Dept. of Health & EPA Regulations.

<i>Select the answer that more closely describes the system's ability to comply with State of WA Dept. of Health and EPA regulations.</i>			Alternatives						
			Instrumentation & Procedure Upgrade	Construction of Tall Stack	Dilution by Independent Clean Air Stream	Controlled Gas Venting Rate	Dry Adsorption / Absorption Beds	Thermal Oxidation (Catalytic)	Combined Dry Adsorption Beds & Wet Scrubber
Criterion 2.3 WA Dept. of Health & EPA Regs.			3	3	2	3	1	1	1
No permits, approvals, or facility changes needed to achieve and demonstrate compliance.	Excellent	10							
Physical changes to and/or re-engineering of facility installations are required to achieve and demonstrate regulatory compliance.	Good	5							
Authorization to proceed highly unlikely (i.e., in opposition to public or agency priorities).	Very Poor	1	3	3	2	3	1	1	1

Figure 5-11. Criteria Scoring for Design & Construction Cost.

<i>Select the answer that more closely describes the system's ability to minimize design and construction costs.</i>			Alternatives						
			Instrumentation & Procedure Upgrade	Construction of Tall Stack	Dilution by Independent Clean Air Stream	Controlled Gas Venting Rate	Dry Adsorption / Absorption Beds	Thermal Oxidation (Catalytic)	Combined Dry Adsorption Beds & Wet Scrubber
Criterion 3.1 Design & Construction Costs			7	6	4	3	5	2	2
The cost of the alternative is expected to be well within the level considered reasonable, and overruns are unlikely or expected to be small if they do occur.	Excellent	10	7	6					
The cost of the alternative is expected to be comfortably within the level considered reasonable, and overruns, if they do occur, would be expected to be small.	Good	5					5		
The cost of the alternative is expected to be very much greater than the level considered reasonable, and would require a time-consuming and difficult procedure to attempt to get funding. There is considerable uncertainty whether the funding effort would succeed. There are large potential overruns.	Very Poor	1			4	3		2	2

Figure 5-12. Criteria Scoring for Operations Cost.

<i>Select the answer that more closely describes the system's ability to minimize operational and maintenance costs.</i>			Alternatives						
			Instrumentation & Procedure Upgrade	Construction of Tall Stack	Dilution by Independent Clean Air Stream	Controlled Gas Venting Rate	Dry Adsorption / Absorption Beds	Thermal Oxidation (Catalytic)	Combined Dry Adsorption Beds & Wet Scrubber
Criterion 3.2 Operations Costs			5	5	4	5	3	2	3
The cost of the alternative is expected to be well within the level considered reasonable, and overruns are unlikely or expected to be small if they do occur.	Excellent	10							
The cost of the alternative is expected to be comfortably within the level considered reasonable, and overruns, if they do occur, would be expected to be small.	Good	5	5	5	4	5			
The cost of the alternative is expected to be very much greater than the level considered reasonable, and would require a time-consuming and difficult procedure to attempt to get funding. There is considerable uncertainty whether the funding effort would succeed. There are large potential overruns.	Very Poor	1					3	2	3

Figure 5-13. Criteria Scoring for Initial Feed Delivery On-Time.

<i>Select the answer that more closely describes the system's ability to maximize the chance that the initial delivery of feed will be on time.</i>			Alternatives						
			Instrumentation & Procedure Upgrade	Construction of Tall Stack	Dilution by Independent Clean Air Stream	Controlled Gas Venting Rate	Dry Adsorption / Absorption Beds	Thermal Oxidation (Catalytic)	Combined Dry Adsorption Beds & Wet Scrubber
Criterion 4.1.1 Initial Feed Delivery On Time			10	10	8	5	1	1	1
Little or no doubt that the alternative will support delivery of the initial feed on time.	Excellent	10	10	10					
Estimated 80% chance that the alternative will support delivery of the initial feed on time.	Good	5			8	5			
Almost no chance that the alternative will support delivery of the initial feed on time.	Very Poor	1					1	1	1

Figure 5-14. Criteria Scoring for Routine Delivery of Feed.

<i>Select the answer that more closely describes the system's ability to maximize the chance that the routine delivery of feed will be on time.</i>			Alternatives						
			Instrumentation & Procedure Upgrade	Construction of Tall Stack	Dilution by Independent Clean Air Stream	Controlled Gas Venting Rate	Dry Adsorption / Absorption Beds	Thermal Oxidation (Catalytic)	Combined Dry Adsorption Beds & Wet Scrubber
Criterion 4.1.2 Routine Feed Delivery On Time			2	2	2	5	7.5	7.5	7.5
Little or no doubt that the alternative will support delivery of the routine feed on time.	Excellent	10					7.5	7.5	7.5
Estimated 80% chance that the alternative will support delivery of the routine feed on time.	Good	5				5			
Almost no chance that the alternative will support delivery of the routine feed on time.	Very Poor	1	2	2	2				

Figure 5-15. Criteria Scoring Sorted by Alternatives.

Criteria	Weighting Factor	Alt. 1		Alt. 2		Alt. 3		Alt. 4		Alt. 5		Alt. 6		Alt. 9	
		Raw	Total	Raw	Total	Raw	Total	Raw	Total	Raw	Total	Raw	Total	Raw	Total
SAFETY	28		149		160		140		94		128		97		108
1.1.2.1 Public Chronic Chemical Exposure	3	1	3	1	3	1	3	2.5	8	7.5	23	5	15	5	15
1.1.2.2 Accidental Chemical Release to Public	4	8	32	8	32	6	24	3	12	2	8	2	8	2	8
1.2.2.1 Chronic Chemical Release to Worker	6	2.5	15	5	30	5	30	2.5	15	7.5	45	5	30	7.5	45
1.2.2.2 Accidental Chemical Release to Worker	4	8	32	8	32	6	24	3	12	2	8	2	8	2	8
1.2.3 Worker Industrial Safety	4	5	20	4	16	5	20	5	20	3	12	1	4	1	4
1.3.3.1 Chronic Release to Atmosphere	3	5	15	5	15	5	15	5	15	8	24	8	24	8	24
1.3.3.2 Accidental Release to Atmosphere	4	8	32	8	32	6	24	3	12	2	8	2	8	2	8
REGULATIONS	20		132		132		112		36		56		32		44
2.1 DOE Reg. Compliance	12	9	108	9	108	8	96	1	12	4	48	2	24	3	36
2.2 WA Dept. of Ecology & EPA Regs.	6	3	18	3	18	2	12	3	18	1	6	1	6	1	6
2.3 WA Dept. of Health & EPA Regs.	2	3	6	3	6	2	4	3	6	1	2	1	2	1	2
LIFE-CYCLE COST	12		72		66		48		48		48		24		30
3.1 Design & Construction Costs	6	7	42	6	36	4	24	3	18	5	30	2	12	2	12
3.2 Operations Costs	6	5	30	5	30	4	24	5	30	3	18	2	12	3	18
RELIABILITY	40		240		240		200		200		170		170		170
4.1.1 Initial Feed Delivery On Time	20	10	200	10	200	8	160	5	100	1	20	1	20	1	20
4.1.2 Routine Feed Delivery On Time	20	2	40	2	40	2	40	5	100	7.5	150	7.5	150	7.5	150

6.0 RISK ASSESSMENT OF REMAINING ALTERNATIVES

Upon concluding the evaluation of the seven alternatives in Section 5 above, it is readily apparent that Alternatives 6 and 9 are not acceptable to consider further here. These two alternatives have the following strikes against them because they

1. pose greater hazards to workers,
2. would result in increased potential for accidental release of chemicals,
3. would have little or no chance of regulatory approval,
4. are much more expensive,
5. would likely not support delivery of feed on time, and
6. have little chance of obtaining authorization (from state and federal oversight agencies) to proceed (i.e., they are in greatest opposition to public or agency priorities).

The risks associated with the five remaining alternatives are discussed in this section. The discussions in this section are made in order to determine the acceptability of the alternative(s) with regard to the risk(s) that might be assumed for each should it/they be selected as the preferred alternative(s).

6.1 DISCUSSION OF RISKS

The discussion below encompasses the risks from three different sources:

1. the analysis done in this particular AGA,
2. those resulting from potential changes in external requirements, and
3. other risks.

Of the three primary categories presented in this study (i.e., Assumptions, Constraints, and Requirements) the assumptions carry the greatest risks. The assumptions (see Section 2.1) are therefore discussed here relative to the risks that they incur.

6.1.1 Existing Radioactive Treatment Control is Adequate

Based upon the preliminary findings from the BARCT study performed for the Project W-236A ventilation system, it is estimated that further need to treat/control for radioactive species is highly unlikely. Furthermore the HEPA filters will provide control technology for non-radioactive hazardous chemical particulates. The HEPA filters are there by estimated to be a relatively low risk.

6.1.2 Compliance with Modified Radionuclide Emission Monitoring Guidelines

It is expected that a high degree of compliance with the emerging ANSI N13.1 guidelines can be achieved as long as future improvements to the DST primary ventilation system monitoring are comparable to the systems that are presently being installed under the scope of Project W-420.

6.1.3 Farm Basis Control Point Definition for Treatment / Control & Monitoring

This assumption works in conjunction with the two other assumptions:

1. No net increase in the number of in-tank activities which need to be accomplished per operating exhaust, and
2. No need for greater than 1000 scfm per emission point.

Within this context, it is highly likely that greater volumetric flow rates will be necessary at some point in the future. Specific tank farms with the highest probability of a need to increase the air flow through the headspace of the tanks are AN, AY, and AZ farms. These three farms (presently serviced by two primary ventilation systems) will likely experience the greatest number of evolutions between now and the time that WFD operations commence. Therefore, should the flow increase, so will the chance that additional exhaust points will be needed. (As an example, the recent C-106 sluicing operations were deemed to require an added exhaust point in the form of a portable exhaust in the AY tank farm). Other potential scenarios include the separation of some of the tanks from the present ventilation system to a new system(s) in parallel.

6.1.4 Organic Carbon

Organic carbon is assumed to have contacted all tank wastes. The resultant concentrations of organic carbon in any/all tanks could exceed the 40 CFR 265, Subpart BB compliance limit of less than or equal to 10 wt%. A specific case-in-point is the fact that tank C-103 has a separate floating organic-rich phase, which is much greater than 10 wt% organic carbon. Another case in point is Erlandson 1999 in which compliance with Subpart BB requirements are questioned.

6.1.5 Source Waste Composition

There is uncertainty associated with the speciation of tank farm gas phase chemical contaminants (i.e., organic carbon and ammonia). These gas phase components could require control/treatment upon entry to the primary ventilation system. The analysis presented in Appendix B indicates that experience has shown actual operations differ from those which were planned by the projects. However, it is not expected that obtaining further analytical data will reduce the uncertainty associated with making a decision on ventilation treatment/control. Three specific points of interest within this area are:

1. Concentration of ammonia as a variable,
2. Concentration of TOC as a variable, and
3. Speciation of TOC as a variable

6.1.6 Number of In-Tank Activities

It is assumed that there will be no more than three in-tank activities per farm. This is the assumption least likely to hold up over time. The basis for this statement is that in recent history, many changes have been realized with regard to operational sequences, source feed tanks, etc. It is highly likely that a scenario will be proposed that will require more than three tanks have simultaneous significant in-tank activities.

6.1.7 Emission Point

It is assumed that there will be no need for more than 1000 scfm per emission point. This assumption could be the second most likely to not hold. Within the last 10 years, the variability of the flow through the headspace of tank SY-101 has been modified several times. SY-101 presently supports the greatest vapor phase flow of the entire DST system (at times in excess of 400 scfm). Should a scenario be proposed that requires three tanks in AN farm to be simultaneously maintained at this level (i.e., tanks AN-103, AN-104, and AN-105), then the AN farm primary ventilation system would be at a nominal 1200 scfm without the approximately 100 scfm from tanks AN-101, AN-102, AN-106, and AN-107 (a contribution of 400 scfm more, resulting in 1600 scfm for the seven tanks).

6.2 ASSESSMENT OF ALTERNATIVES AGAINST RISK

An assessment of each alternative against risk is discussed in this section based on the probability (frequency, likelihood) of occurrence, and the seriousness of consequence (injury, impact and damage) to operators and public, to the environment, and to the equipment. The probability and consequence are ranked with a system as typically used in risk analysis tables. (Reference *Chemical Engineering Progress*, March 1999, Vol. 95/ No. 3, page 67.) The assessment is best presented in a table, which lists the type of risks and consequences to each of the alternatives selected.

The risk analysis for each alternative in this AGA is presented in Tables 6-2 through 6-8.

Table 6-1. Assessment of Alternative 1 (Instrument & Procedure Change) Against Risk.

Event Description	Probability	Consequence(s)	Suggested Action(s)
Change of gas compositions: Pollutant concentrations higher than the assumed bounding case of tank C-106 exhausts.	9	This could result in exceeding the permitted limits thereby shutting down transfers while resolving the occurrence. Injury to operators is low provided that proper PPE is used. Some impacts to public and environment are possible. No damage to equipment is expected. (9)	Sampling and characterization program along with engineering modeling to better define/refine gaseous components and their concentrations.
Change from one tank transfer at a time to simultaneous multi-tank transfer operations. Pollutant concentrations increase as the number of simultaneous tank transfers increases.	5	This will have little effect on the operators wearing proper PPE. Impacts to the public and the environment could be severe. No damage to equipment is expected. (7)	Lock in the tank operating sequence such that combinations of tanks will be known.
Process fails to operate as expected due to mechanical or non-mechanical failure.	5	Malfunction of PPE air supply system could result in a severe effect to operators. No effects to the public and environment are expected. (7)	Appropriate levels of redundancy and/or dual failure design methods.
Change of weather pattern: increase in wind speed.	5	Higher dilution rate helps: operators wearing PPE will not be affected. The dilution is favorable to operators, the public, and the environment. (2)	None
Change of weather pattern: reduced wind speed.	5	Not expected to affect operators wearing PPE. Pollutant concentrations at the ground level could increase. The public and environment could be affected. No damage to equipment is expected. (6)	Ensure PPE is available to Operations personnel.
Fire Hazard.	5	Not expected to be a large effect. (2)	None
Regulation change: lower the allowable emission.	2	Does not affect operators wearing PPE. The emission of pollutants could exceed the new limits. (5)	Work with/through state and federal agencies early in the design process.
Reduction of DOE's funding: Capital.	2	The impact is minimal because only a minimal upgrade is needed. (3)	None
Reduction of DOE's funding: Operating.	2	Primarily affects personnel wages. (2)	None
Sabotage.	2	Sabotage on PPE will result in severe exposure to toxic chemicals. (8)	Employ site security measures.

Table 6-2. Assessment of Alternative 2 (Tall Stack) Against Risk.

Event Description	Probability	Consequence(s)	Suggested Action(s)
Change of gas compositions: Pollutant concentrations higher than the assumed bounding case of tank C-106 exhausts.	9	As in Alternative 1 this could result in exceeding permitted limits. Once designed and constructed, the height of the stack cannot be changed easily. Concentrations of pollutants could therefore be high at the ground level. Both operators and public could be affected. No equipment damage. (8)	Same as for Alternative 1
Change from one tank transfer at a time to simultaneous multi-tank transfer operations. Pollutant concentrations increase as the number of simultaneous tank transfers increases.	5	The height of the stack is difficult to change once it is built. The consequence to operators would be severe. The public and the environment could also be affected. No damage to equipment. (8)	Same as for Alternative 1
Process fails to operate as expected due to mechanical or non-mechanical failure.	5	Due to passive nature, chance of process failure is small. (3)	Same as for Alternative 1
Change of weather pattern: increase in wind speed.	5	Favorable dilution effects could be realized for this alternative, however, very high wind speeds may damage the tall stack (equipment). (7)	Secure tall structures against excessive wind damage potential (i.e., over-design).
Change of weather pattern: reduced wind speed.	5	Operators, the public and environment could be affected by the increase in pollutant concentrations. No damage to equipment. (7)	Same as for Alternative 1
Fire Hazard.	5	Not affected. (2)	None
Regulation change: lower the allowable emission.	2	The emission of pollutants could exceed the new limits. (5)	Same as for Alternative 1
Reduction of DOE's funding: Capital.	2	Only engineering/construction of a tall stack and the upgrade of system instrumentation is required; therefore, impact of funding reduction is minimal. (2)	None
Reduction of DOE's funding: Operating.	2	No change over Alternative 1. (2)	None
Sabotage.	2	Not affected. (2)	None

Table 6-3. Assessment of Alternative 3 (Clean Air Dilution) Against Risk.

Event Description	Probability	Consequence(s)	Suggested Action(s)
Change of gas compositions: Pollutant concentrations higher than the assumed bounding case of tank C-106 exhausts.	9	As in Alternatives 1 and 2, this could result in exceeding permitted limits. More clean air would need to be introduced to the system. Therefore, limitations of the fan capacity could be reached. Above this capacity, both operators and the environment will be affected. No equipment damage. (7)	Same as for Alternative 1
Change from one tank transfer at a time to simultaneous multi-tank transfer operations. Pollutant concentrations increase as the number of simultaneous tank transfers increases.	5	More dilution air would be needed. If the fan cannot supply the extra amount of air, the pollutant concentrations at the ground level will exceed the allowable emission limit. Impacts to operators, public and environment are serious. No damage to equipment. (6)	Same as for Alternative 1
Process fails to operate as expected due to mechanical or non-mechanical failure.	5	If the fan fails, concentrations of pollutants in the effluent of the system may exceed the acceptable limits. Operators, the public, and the environment will be affected. (8)	Same as for Alternative 1
Change of weather pattern: increase in wind speed.	5	Favorable to this alternative. (2)	None
Change of weather pattern: reduced wind speed.	5	By increasing the clean air flow rate within the capacity of the fan, pollutants in the stack exhaust can be diluted to meet the limitation. Impacts to operators, the public and the environment are small. No damage to the equipment. (3)	None
Fire Hazard.	5	Not affected. (2)	None
Regulation change: lower the allowable emission.	2	Within the capacity of the fan, concentrations of pollutants can be diluted to meet the new lower limitation. (4)	Same as for Alternative 1
Reduction of DOE's funding: Capital.	2	Only fan/duct work and upgrade of instrumentation are required; the impact of funding reduction is small. (3)	None
Reduction of DOE's funding: Operating.	2	Affects the wages of operators and the cost of the power to run the fan. (4)	None
Sabotage.	2	Minimally affected. (3)	Same as for Alternative 1

Table 6-4. Assessment of Alternative 4 (Controlled Gas Vent Rate) Against Risk.

Event Description	Probability	Consequence(s)	Suggested Action(s)
Change of gas compositions: Pollutant concentrations higher than the assumed bounding case of tank C-106 exhausts.	9	If the composition change is due to the rate of de-gassing, the gas venting rate can be changed to reduce the pollutant concentrations in the effluent of the primary ventilation system. However, if the composition change is due to the composition of waste in the tank, the system will not be able to cope with the situation. Furthermore, this could result in exceeding permitted limits (as in Alternatives 1, 2, and 3). Operators and the public could be injured. Environment could be contaminated. No equipment damage. (8)	Same as Alternative 1
Change from one tank transfer at a time to simultaneous multi-tank transfer operations. Pollutant concentrations increase as the number of simultaneous tank transfers increases.	5	Gas venting rates of tanks which transfer waste at the same time should be controllable individually. Then, as long as the pollutant concentrations of the exhaust gas of the stack are lower than the limits set by regulations, the process is acceptable. (3)	Same as Alternative 1
Process fails to operate as expected due to mechanical or non-mechanical failure.	5	Failure of the mixer pump will stop the degas operation and it is assumed that no more gas will evolve from the tank waste. Consequences to operators, the public, and the environment are low. (3)	Same as Alternative 1
Change of weather pattern: increase in wind speed.	5	Favorable to this alternative. (2)	None
Change of weather pattern: reduced wind speed.	5	By lowering the gas venting rate, pollutant concentrations in the system exhaust can be controlled to satisfy required limits. Impacts to operators, the public and the environment are not expected to be significant. No damage to equipment. (3)	None
Fire Hazard.	2	Not affected. (2)	None
Regulation change: lower the allowable emission.	2	The emission limits may be met by lowering the rpm of the mixer pump, thereby decreasing the gas-venting rate. (3)	Same as Alternative 1
Reduction of DOE's funding: Capital.	2	Only upgrade of instrumentation is required. Impacts are minimal. (3)	None
Reduction of DOE's funding: Operating.	2	Affects wages and energy cost of running the mixer pump. (4)	None
Sabotage.	5	Monitoring composition of gas exiting the tank is critical. Any sabotage on the monitoring system could result in massive emission of pollutants. (7)	Ensure that tank emission monitoring systems have appropriate redundancy and/or planning for backup.

Table 6-5. Assessment of Alternative 5 (Dry Adsorption Beds) Against Risk.

Event Description	Probability	Consequence(s)	Suggested Action(s)
Change of gas compositions: Pollutant concentrations higher than the assumed bounding case of tank C-106 exhausts.	9	Within certain limitations, a system of this nature can handle the increase of the pollutant concentrations. The bed design is usually based on 10 to 15% of the bed loading at the breakthrough point. Therefore, 30 to 40% of bed loading is tolerable in many cases. Therefore this Alternative would have very little likelihood of exceeding permitted limits thereby allowing for continuity of operations. The system can be designed in a multi-train fashion to handle larger variations in the composition. Under these conditions, consequences to operators, the public, and the environment are not severe. However, adsorbents could need to be changed more often. (4)	Same as Alternative 1
Change from one tank transfer at a time to simultaneous multi-tank transfer operations. Pollutant concentrations increase as the number of simultaneous tank transfers increases.	5	Unless the multi-train adsorption beds are used, the system design will not be able to handle the increased concentrations of pollutants due to the change in operation mode. Impacts to operators, public, and environment could be significant. Adsorbent could need to be changed more often. (4)	Same as Alternative 1
Process fails to operate as expected due to mechanical or non-mechanical failure.	5	Chance of mechanical breakdown for this alternative is small. Fire arrestors may fail to operate and the impact could be fatal. However, improper packing of beds may cause the process to fail. (5)	Same as Alternative 1
Change of weather pattern: increase in wind speed.	5	Not affected by weather change. Indirectly, the effluent of the adsorption beds will be further diluted. (3)	None
Change of weather pattern: reduced wind speed.	5	Does not affect this alternative. Consequences are minimal. (3)	None
Fire Hazard.	5	Unless the fire arrestors work properly, a fire in the adsorption beds (which could release large quantities of toxic chemicals) could be fatal. (7)	Appropriate levels of design
Regulation change: lower the allowable emission.	2	By decreasing bed loading (the break-through point) and changing adsorbents more often, regulations can be met. Consequences are low. (3)	Same as Alternative 1
Reduction of DOE's funding: Capital.	2	The capital cost for this alternative is high. Therefore, funding reduction will affect the procurement and construction of the process significantly. (8)	Work with DOE to ensure proper funding levels.
Reduction of DOE's funding: Operating.	2	Wages and the cost of adsorbent will be affected. (7)	Work with DOE to ensure proper funding levels.
Sabotage.	2	Tight control of operating conditions is needed. Any sabotage on the operating system will result in release of pollutants. (7)	Same as Alternative 1

Table 6-6. Assessment of Alternative 6 (Catalytic Thermal Oxidation) Against Risk.

Event Description	Probability	Consequence(s)	Suggested Action(s)
Change of gas compositions: Pollutant concentrations higher than the assumed bounding case of tank C-106 exhausts.	9	Operating conditions are tightly controlled if the process removes most of pollutants from the gas stream. Change of gas composition will affect the pollutant removal efficiency of the process. Emission of pollutants from the system is possible. Impacts to operators, the public and the environment are possible. No equipment damage, except catalyst activity may decrease faster. (6)	Same as Alternative 1
Change from one tank transfer at a time to simultaneous multi-tank transfer operations. Pollutant concentrations increase as the number of simultaneous tank transfers increases.	5	Impacts to operators, public, and environment are significant. No damage to equipment, except catalyst may need to be changed or regenerated more often. Same as Alternative 5. (4)	Same as Alternative 1
Process fails to operate as expected due to mechanical or non-mechanical failure.	5	Catalyst may be poisoned and the process fail to convert pollutants to non-harmful products. Operators, the public and the environment will be affected. Same as Alternative 5. (5)	Same as Alternative 1
Change of weather pattern: increase in wind speed.	5	Same as Alternative 5.	Same as Alternative 5
Change of weather pattern: reduced wind speed.	5	Does not affect this alternative. Consequences are minimal. (2)	None
Fire Hazard.	2	It is important to carefully control reactor temperature. (6)	Same as Alternative 5
Regulation change: lower the allowable emission.	2	Because of tightly-controlled operating conditions, it will be difficult to further reduce the pollutant concentrations to meet the new lower allowable limits. (4)	Same as Alternative 1
Reduction of DOE's funding: Capital.	2	Same as Alternative 5.	Same as Alternative 5
Reduction of DOE's funding: Operating.	2	Wages and the cost of catalyst will be affected. (high)	Same as Alternative 5
Sabotage.	5	Same as Alternative 5.	Same as Alternative 5

Table 6-7. Assessment of Alternative 9 (Dry Adsorption / Wet Scrubbing) Against Risk.

Event Description	Probability	Consequence(s)	Suggested Action(s)
Change of gas compositions: Pollutant concentrations higher than the assumed bounding case of tank C-106 exhausts.	9	The dry adsorption part of the process (removing VOC) can tolerate the change in concentration (refer to Alternative 5). Increase of flow rate and/or the concentration of the liquid adsorbent are methods available to handle the change for removing the extra ammonia. Release of pollutants higher than the limit is possible. Impacts to operators, the public and environment are moderate. No damage to the equipment except need to change both adsorbent and absorbent more often. (6)	Same as Alternative 1
Change from one tank transfer at a time to simultaneous multi-tank transfer operations. Pollutant concentrations increase as the number of simultaneous tank transfers increases.	5	Same as Alternative 5, and additionally, impacts to operators, public and environment could be significant. No damage to equipment, except catalyst may need to be changed or regenerated more often. (6)	Same as Alternative 1
Process fails to operate as expected due to mechanical or non-mechanical failure.	5	Same as Alternative 5. (5)	Same as Alternative 5
Change of weather pattern: increase in wind speed.	5	Same as Alternative 5. (3)	Same as Alternative 5
Change of weather pattern: reduced wind speed.	5	Does not affect this alternative. Consequences are minimal.	None
Fire Hazard.	2	Same as Alternative 5.	Same as Alternative 5
Regulation change: lower the allowable emission.	2	Same as Alternative 6.	Same as Alternative 1
Reduction of DOE's funding: Capital.	2	Same as Alternative 5.	Same as Alternative 5
Reduction of DOE's funding: Operating.	2	Wages and costs of adsorbent and absorbent media will be affected. (5)	Same as Alternative 5
Sabotage.	2	Same as Alternative 5.	Same as Alternative 5

7.0 RECOMMENDATIONS

For each of the alternatives considered in this AGA, criterion evaluation scores were combined with the weighting factors for each criterion. Table 7-1 provides the results of combining the weighting factors (from Appendix C) with the individual scores for each alternative (from Section 5). Based upon a simple point scoring system, Alternative 2 (simply adding compliant monitoring to new taller stacks) is preferred. However, consideration of risk and uncertainty led to the selection of a different alternative.

Additionally, in completing the process of generating alternatives and subsequently analyzing them within this AGA, the authors and contributors arrived at other conclusions and recommendations. Specifically, it is expected that certain requirements be passed from this engineering study into the specifications for the DST system, and any subsequent projects that result.

7.1 RECOMMENDED ALTERNATIVE

Of the seven specific alternatives considered in this evaluation, four did not involve any direct addition of equipment to remove, or treat/control, non-radioactive (chemical) constituents. However, all four of the alternatives in this category would require the acceptance of a relatively high degree of risk that another C-106-type of event could occur (refer to background discussion in Section 1.3.1).

Based upon consideration of risk, Retrieval Engineering recommends a hybrid of alternatives two and five:

- dry adsorption beds for removal of volatile organic compounds,
- dry absorption beds for removal of ammonia,
- an improved continuous air monitor for radionuclides,
- a gas characterization and monitoring system for non-radionuclide emissions, and
- taller exhaust stacks than are presently in use (these should be as tall as is convenient to construct within the present tank farm system).

7.2 OTHER RECOMMENDATIONS

In addition to the recommendation of a preferred alternative (from the final list of seven) other conclusions were drawn during the process of evaluating these various options.

7.2.1 Need for Upgrading of Emissions Monitoring (Radiological & Non-Radiological)

Because the ANSI N13.1 Standard has recently been modified and is presently being negotiated into the associated constraining regulatory requirements, it is recommended that monitoring systems (equivalent to those that are presently being installed on the DCRTs under Project W-420) be installed on the primary ventilation exhaust points for the DSTs.

7.2.2 Need for Additional Sampling and Characterization Data

As is most directly evident from the data presented in Appendix B, a solidly defensible set of vapor phase characterization data is needed. Many opportunities have presented themselves in the past, are presently available, and will be available in the future to "perform opportunistic sampling."

In order to take best advantage of sampling and analysis opportunities, it is recommended that an overall characterization strategy be developed. The strategy should incorporate input from a workgroup of knowledgeable personnel from the TWRS characterization, environmental, operations, and engineering support organizations. At a minimum, the strategy should provide direction and planning on the following:

1. Data quality objectives should be identified for the characterization efforts. These objectives should include an assessment of what types and how many data would be needed to develop an acceptable level of certainty for environmental actions and decisions.
2. Data compilation and reporting should be described. An approach should be developed for using the collected information to proceed with and defend decisions, and to interact with the regulatory agencies.
3. Specific opportunities for sampling and analysis should be identified. Opportunity selection should be based on the data quality objectives, and other relevant criteria such as ease, timeliness, and cost of gathering the desired data.
4. Selected sampling opportunities that meet appropriate integrated permitting and program schedules should be identified within the TWRS Characterization, Operations, and Environmental groups.
5. Cost estimates and planning for budget requests to support characterization opportunities should be addressed.

One of the specific points within the 18 chapters of the Nationally Recognized Conduct of Operations Manual is titled "Operational Aspects of Facility Chemistry and Technical Processes." It is important to adhere to these standards, specifically in regards to sampling and characterization of Hanford's tank farm wastes (Gossell 1999).

Specific areas that could be addressed within the scope of sampling and analysis include:

7.2.2.1 Sluicing and Subsequent Transfer of C-106 Solids to AY-102. During the first sluicing of sludge from tank 241-C-106 on November 18, 1998, an unexpectedly high concentration of VOCs was measured in the 296-C-006 ventilation stack. Five opportunistic samples were collected during the November 18, 1998 sluicing operation. On December 16,

1998 a process test sluicing operation was conducted whereby many more samples were obtained. Preliminary results from the December 16, 1998 sample analyses are available in Bartley 1999. Further process testing with sampling of the vent stacks at C farm and 702-AZ as well as the headspace of tank AY-102 was conducted on March 7, 1999 and March 28, 1999, respectively. These data that have been obtained to date, and any similar data that can be obtained in the future should be considered so that events such as were experienced on November 18, 1998 at the C tank farm are minimized in the future.

7.2.2.2 ALC Testing in AZ Tank Farm. In addition to the transfer of sluiced solids from tank C-106 into tank AY-102, other analogous operations include the plans to force air down through the ALCs in AZ farm to see if the "solids will move around." When these ALCs are "tested" there is a potential for any trapped gases that may be present in the AZ farm tanks to be released and travel into the 702-AZ ventilation system. Therefore, the headspaces of tanks AZ-101 and AZ-102 as well as the 702-AZ stack should be monitored and/or sampled for VOCs and ammonia in a fashion similar to that which was used during the C-106 sluicing operation.²

7.2.2.3 Operation of Mixer Pumps in Sludge and Salt Tanks. Several DSTs presently have mixer pumps installed in them, and several more are to be added to other tanks in the coming years. It is expected (based on results of operation of currently-installed pumps) that when operated, these mixer pumps will result in "major waste disturbing activities" such that any trapped gases will be released from the present solid-liquid matrices. These activities should be monitored and sampled as rigorously as the C-106 operations have been, so that we may demonstrate that we are maintaining the appropriate level of "conduct of operations" specifically regarding "facility chemistry and technical processes." Any potential differences in waste types (i.e., salt slurries versus sludges) should be investigated to determine if there are distinguishing features for each.

7.2.2.4 Other Tank-to-Tank Transfers. Transferring solids and liquids out of one DST into another will also "disturb" the waste such that gases may be released. In this case, both the sending and receiving DST headspace and/or ventilation stack could be monitored and/or sampled to establish the needed characterization information.

7.2.2.5 Static Tanks. Tanks that contain undisturbed waste need not be monitored and/or sampled. For this AGA, the needs specifically address "major waste disturbing activities."

² A vapor sampling and analysis plan (Templeton 1999) has been prepared and is to be implemented during the ALC test operations (which are presently delayed).

7.2.3 Ventilation Flow Rate Capability

There is a need to increase ventilation flow rate capability for individual tanks to maintain capture velocities during certain activities. This could increase the entire ventilation system flow capabilities in some instances. The assumption carried throughout this analysis is expected to be challenged to a greater extent as time goes on. Therefore, it is recommended here that one or more of the following actions be taken:

1. Evaluate the structural integrity and design ratings of the individual tanks and pertinent buried piping to determine flow limitations. (That is, what increased flow capacity would be acceptable for the existing tanks and buried piping?)
2. Investigate the possibilities of replacing some or all of the ductwork coming from the tanks to the exhaust systems.
3. Consider increasing capability of the fans, filters, demisters, heaters, monitoring systems (commensurate with allowable limits of the buried piping and tanks) to the maximum allowed. It is important to note that this would provide maximum flexibility which would be useful in accommodating future decisions.
4. Increase the flexibility of 702-AZ. There are physical limitations to some of the existing primary ventilation systems (e.g., 702-AZ can not presently support multiple simultaneous activities in the AY and AZ tank farms). Therefore, the 702-AZ ventilation system should be upgraded to allow for multiple in-tank operations.
5. Monitor and control flow rates of exhausted gases from individual tanks.
This would be for the purpose of very precise monitoring and control of and readjustment (rebalancing) flows as necessary. This could be accomplished by adding flow meters and control valves, respectively to the duct piping networks at the points where the piping has left the individual tanks, yet prior to where they converge into the common vent headers. In this scenario, given enough maneuverability in operational schedules, one could conceivably valve tank #1 into the exhaust system on day 1 at a very high flow rate (e.g., 400 scfm) [perhaps to de-gas the waste] while maintaining the other tanks at a lower flow rate (e.g., 100 scfm per tank). Then on day 2, tank #2 could be valved-in and the flow rate for tank 1 moved back to 100 scfm. With this type of operating scheme, the approximate rate of 1000 scfm could be maintained, while still allowing for needed flexibility. Appendix F provides further discussion regarding this matter.

7.2.4 Specific Design Requirements Recommendation

Traditional requirements that have been imposed upon primary ventilation systems for new DST designs have included words such as; "...Stack effluent air monitors and air samplers shall be installed on the ventilation exhaust stack systems to detect and measure radioactive material releases to the atmosphere...Devices (such as HEPA filters) shall be installed in the primary ventilation system to provide for the adequate removal of solid radioactive particles prior to the release of the treated waste stream to the atmosphere...Each primary ventilation

system in conjunction with the annulus ventilation system and/or other systems shall be designed to remove the heat being generated in the tanks...”

However, in bringing Alternative 5 forward as the recommended alternative in this study, provision is included for a new requirement to be imposed. This new requirement is:

“...Devices shall be installed in the primary ventilation system such that potential non-radioactive chemicals shall be collected prior to releasing the affected vapor phase stream to the atmosphere...The non-radioactive chemical removal requirements will be established during the course of definitive design...”

7.2.5 Portable Exhaust Systems

Because portable exhaust systems have been used in the tank farms as “backup systems” in the event that a primary system fails or otherwise cannot maintain the load, they too should be upgraded to the same level of detail at which the corresponding primary system is maintained. Specifically, it is recommended here that provisions be made for one of the following:

1. Dry adsorption/absorption beds to be designed into the existing portables,
2. Design of new portables (as all-in-one units with the added chemical-constituent-removal capability),
3. Design of an “add-on to the add-on” such that the existing non-chemical-removing portables could be connected in-series to achieve the desired radiological and chemical removal efficiencies.

Figure 7-1. Ventilation System Alternatives Decision Criteria Matrix.

Criteria																
	Weighting Factor	4.1.1 Initial Feed Delivery On Time	4.1.2 Routine Delivery of Feed On time	2.1 DOE Reg. Compliance	1.2.2.1 Chronic Chem. Release to Worker	2.2 WA Dept of Ecology & EPA	3.1 Design & Construction Cost	3.2 Operations Cost	1.2.2.2 Accidental Chem. Release to Worker	1.3.3.2 Accidental Chem. Release to Atmosphere	1.1.2.2 Accidental Chem. Release to Public	1.2.3 Industrial Safety of Worker	1.3.3.1 Chronic Chem. Release to Atmosphere	1.1.2.1 Chronic Chem. Release to Public	2.3 WA Dept of Health & EPA	TOTAL SCORE
		20	20	12	6	6	6	6	4	4	4	4	3	3	2	
1	Instrumentation & Procedure Upgrade	200	40	108	15	18	42	30	32	32	32	20	15	3	6	593
2	Construction of Tail Stack	200	40	108	30	18	36	30	32	32	32	16	15	3	6	598
3	Dilution by Independent Clean Air Stream	160	40	96	30	12	24	24	24	24	24	20	15	3	4	500
4	Controlled Gas Venting Rate	100	100	12	15	18	18	30	12	12	12	20	15	8	6	378
5	Dry Adsorption / Absorption Beds	20	150	48	45	6	30	18	8	8	8	12	24	23	2	402
6	Thermal Oxidation (Catalytic)	20	150	24	30	6	12	12	8	8	8	4	24	15	2	323
9	Combination Dry Adsorption Beds & Wet Scrubber	20	150	36	45	6	12	18	8	8	8	0	24	15	2	352

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9.0 GLOSSARY

Alternative — A set of options that covers all functions.

Assumption — Interim guides imposed by the decision maker such as performance characteristics of a process or circumstances under which the outcome of the decision will be implemented. The assumption is a credible non-validated requirement or architecture selection. Assumptions are used to reduce extremely complex situations to problems of manageable proportion. (Wilson 1999b, Zimmerman 1999)

Constraint — An externally-imposed restriction or requirement. Constraints are beyond the control of the manager/decision maker. (Peck 1998, Wilson 1999a, Wilson 1999b)

Interacting Decisions — Prior decision outcomes upon which the current decision depends or subsequent/parallel decisions which will be constrained by the decision outcome. (Zimmerman 1999)

Option — A choice within a specific function.

Requirement — Outlines the level to which products must perform in quantitative terms and defines the environment in which they must operate. The extent to which the mission or function must be executed. (Peck 1998, Wilson 1999a, Wilson 1999b)

Source Term — Mass, volume, and/or rate data which define the material(s) to be transferred into a system.

APPENDIX A

DESCRIPTIONS OF THE EXISTING PRIMARY VENTILATION SYSTEMS FOR THE DOUBLE-SHELL TANKS

APPENDIX A

DESCRIPTIONS OF THE EXISTING PRIMARY VENTILATION SYSTEMS FOR THE DOUBLE-SHELL TANKS

A.1 INTRODUCTION

Various types of equipment are currently in operation ventilating the 28 DSTs within the six DST farms. The existing equipment primarily consists of centrifugal exhaust fans; filters; de-entrainers; heat exchangers; and radiation detection, monitoring, and alarm systems. This section describes this equipment as it is presently configured relative to the five primary exhaust units within the scope of this AGA.

A.2 241-AN TANK FARM PRIMARY VENTILATION SYSTEM

The DST ventilation exhaust system for 241-AN tank farm has two separate but interrelated parts: the primary and annulus. The purpose of the primary system is to cool the tank contents and to maintain the vacuum conditions required for safe containment of the primary tank waste. The annulus ventilation system assists in maintaining the vacuum by removing air from the DST annulus, however, it retains separate controls from the primary system. It also includes air distribution chambers to provide air cooling for the primary tank and a volume of air for the primary leak detection system. The constant flow of air through the annulus system is monitored to prevent any contaminants from being released to the atmosphere.

The primary ventilation system for the AN tank farm is the focus of this study, and is depicted graphically in a simplified flow diagram in Figure A-1.

In the primary ventilation system, outside air is drawn into the primary tank through an air inlet station connected to a 12-inch tank riser. The purpose of the air inlet stations is to provide paths by which air can enter the primary tanks and thus enhance tank airflow, to provide pressure control capability, and to provide a filtered pathway for air to exit each tank should tank pressure(s) exceed atmospheric pressure.

The primary components of each air inlet station include an air flow controller, a pre-filter, a HEPA filter, and a 12-inch isolation butterfly valve. A vacuum breaker is connected in parallel with the flow controller to limit tank negative pressure in the event that flow control capability is lost. An alternate primary tank air inlet line containing an orifice plate and isolation valve is connected in parallel with each air inlet station for use during air inlet station maintenance or in the event that the normal air path through the air inlet station becomes obstructed.

Air is drawn out of the primary tank through a 12-inch diameter duct and into a below-grade exhaust header. Primary tank exhaust ducts have air volume control butterfly valves located in ventilation pits. After leaving the ventilation pits, exhaust ducts combine into one

15-inch diameter duct. The exhaust header terminates at the K-1 de-entrainer structure which provides radiation shielding for two de-entrainers. The de-entrainers (one in operation and the other on standby) separate entrained moisture and particulates from the air stream.

The exhaust duct extends from the de-entrainer structure to the primary ventilation pad where the air can be directed through the K1-1 or K1-2 exhaust subsystems. Either subsystem can ventilate all seven primary tanks. The primary tanks' operating pressure may range from -0.5 to -3.5 inches WG (vacuum), at a maximum system flow rate of approximately 800 cfm. Only one system will operate at a time, while the other system is in standby mode.

The K1-1 system consists of a filter housing assembly containing a heater, pre-filter, and two HEPA filters; and an exhaust fan which discharges into an exhaust stack. The K1-2 system is a version of the K1-1 system with the filter housing assembly stacked on top and an exhaust fan that discharges into a common exhaust stack.

The primary tank exhaust air stream enters the K1-1 or K1-2 system where it is heated and pre-filtered. Next, two HEPA filters mounted in series remove particulates as small as $0.3\text{ }\mu\text{m}$ with at least 99.95% efficiency. Smaller particles can be trapped by the filter, but the filter is not rated for particles smaller than $0.3\text{ }\mu\text{m}$. Two differential pressure indicators monitor the pressure drop across the HEPA filters. Low differential pressure indicates low airflow or a failed filter. High differential pressure indicates blockage caused by accumulated solids or possibly ice formation on the filters.

After passing through the filters, the air is drawn through a K-1 fan and exhausted out of the K-1 stack. A CAM monitors effluent radioactivity levels and a record sampler collects representative samples before the air is discharged to the atmosphere. If the K-1 exhaust fan fails, the backup K-1 (K1-2) ventilation system fan starts automatically and the ventilation path is switched to the standby exhaust system.

The 241-AN tank farm primary ventilation exhaust systems for DSTs AN-101, AN-103, AN-104, AN-105, AN-107 and the AN stack are capable of continuously monitoring for gases with the standard hydrogen monitoring system (SHMS). The SHMS consists of hydrogen-specific monitors and a grab sampler which allows vapor samples to be collected and transported to a laboratory for measurement of hydrogen and other gases.

The headspace of tank 241-AN-105 has a gas characterization system (GCS) installed in addition to the SHMS. The GCS has a gas chromatograph (GC) for hydrogen measurements, another GC for nitrous oxide and methane measurements, and a Fourier transform infrared spectrometer for ammonia measurements.

A.3 241-AP TANK FARM PRIMARY VENTILATION SYSTEM

The 241-AP DST farm ventilation exhaust system has two separate but interrelated parts: the primary and annulus. The purpose of the primary system is to cool the tank contents, and to maintain the vacuum conditions required for safe containment of the primary tank waste. The annulus ventilation system assists in maintaining the vacuum by removing air from the DST annulus, however, it retains separate controls from the primary system. It also includes air distribution chambers to provide air cooling for the primary tank and a volume of air for the primary leak detection system. The constant flow of air through the annulus system is monitored to prevent any contaminants from being released to the atmosphere.

The primary ventilation system for the AP tank farm is the focus of this study, and is depicted graphically in a simplified flow diagram in Figure A-2.

For the primary ventilation system, outside air is drawn into the primary tank via in-leakage through pit cover blocks, drains, and risers due to the vacuum created by the primary exhaust fans. Air is also introduced into the tank headspace through air purge instruments. Air is drawn out of the primary tank through a 12-inch diameter duct and into a below-grade exhaust header. Primary tank exhaust ducts have manually-operated air volume control butterfly valves located in one of two ventilation pits. After leaving the ventilation pits, exhaust ducts combine into one 16-inch diameter duct. The exhaust header terminates at the primary ventilation pad. At the ventilation pad, the air can be directed through the K1-1 or K1-2 subsystems. Either subsystem can ventilate all eight primary tanks. Primary tank operating pressure may range from -0.5 to -3.5 inches WG (vacuum), at a maximum flow rate of approximately 1100 cfm. Only one system will operate at a time, while the other system is in standby mode.

The K1-1 subsystem consists of a de-entrainer (moisture separator); a filter housing assembly containing a heater, pre-filter, and two HEPA filters; and an exhaust fan which discharges into a 10-inch diameter primary exhaust stack. The K1-2 subsystem is a version of the K1-1 subsystem with the filter housing assembly stacked on top and a de-entrainer and exhaust fan that discharges into primary exhaust stack.

Either de-entrainer may be used with either HEPA filtration system via a ventilation duct cross tie. The de-entrainer vaults, filter housings and related ducting are enclosed within an eight-foot-high radiation-shielding wall on the central exhaust station pad. The system fans and primary ventilation exhaust stack are located outside the wall of the enclosed area.

The primary tank exhaust air stream enters the K1-1 system where entrained moisture is separated, heated, and pre-filtered. Next, two HEPA filters mounted in series remove particulates as small as 0.3 μm with at least 99.95% efficiency. Smaller particles can be trapped by the filter, but the filter is not rated for particles smaller than 0.3 μm . Two differential pressure indicators monitor the pressure drop across the HEPA filters. Low differential pressure indicates low airflow or a failed filter. High differential pressure indicates blockage caused by accumulated solids or possibly ice formation on the filters.

After passing through the filters, the air is drawn through a K-1 fan and exhausted out of the K-1 stack. A CAM monitors effluent radioactivity levels and a record sampler collects representative samples before the air is discharged to the atmosphere. If the K-1 exhaust fan fails, the backup K-1 (K1-2) ventilation system fan starts automatically. Under normal operating conditions, one of the K-1 de-entrainers is in operation and the adjacent de-entrainer is used as backup.

There is no additional primary ventilation air stream monitoring equipment installed at this time.

A.4 241-AW TANK FARM PRIMARY VENTILATION SYSTEM

The 241-AW tank farm directly supports the 242-A evaporator providing feed, receipt of slurry and emergency receipt of the evaporator re-boiler process loop emergency dump in addition to the storage, retrieval, transfer, and delivery of radioactive tank waste.

The DST ventilation exhaust system for 241-AW tank farm has two separate but interrelated parts: the primary and annulus. The purpose of the primary system is to cool the tank contents, and to maintain the vacuum conditions required for safe containment of the primary tank waste. The annulus ventilation system assists in maintaining the vacuum by removing air from the DST annulus, however, it retains separate controls from the primary system. It also includes air distribution chambers to provide air cooling for the primary tank and a volume of air for the primary leak detection system. The constant flow of air through the annulus system is monitored to prevent any contaminants from being released to the atmosphere.

The primary ventilation system for the AW tank farm is the focus of this study, and is depicted graphically in a simplified flow diagram in Figure A-3.

In the primary ventilation system, outside air is drawn into the primary tank (due to the vacuum created by the primary exhaust fan) through an air inlet station connected to a 12-inch tank riser. The air inlet stations are intended to be the only paths by which air can enter the primary tanks. The purpose of the air inlet stations is to enhance tank airflow, provide pressure control capability, and to provide a filtered pathway for air to exit each tank should tank pressure(s) exceed atmospheric pressure.

Primary components of each air inlet station include an air flow controller, a pre-filter, a HEPA filter, and a 12-inch isolation butterfly valve. A vacuum breaker is connected in parallel with the flow controller to limit tank negative pressure in the event that the flow control capability is lost. An alternate primary tank air inlet line containing an orifice plate and isolation valve is connected in parallel with each air inlet station for use during air inlet station maintenance or in the event that the normal air path through the air inlet station becomes obstructed.

Air is drawn out of the primary tank through a 12-inch diameter duct and into a below-grade exhaust header. Primary tank exhaust ducts have manually-operated air volume control butterfly valves located in one of two ventilation pits. After leaving the ventilation pits, exhaust ducts combine into one 12-inch diameter duct. The exhaust header terminates at the K-1 de-entrainer structure which provides radiation shielding for two de-entrainers. The de-entrainers (one in operation and the other on standby) separate entrained moisture and particulates from the air stream.

The exhaust duct extends from the de-entrainer structure to the primary ventilation pad where the air can be directed through the K1-5-1 or K1-5-2 exhaust subsystems. Either subsystem can ventilate all six primary tanks. The primary tanks' operating pressure may range from -0.5 to -3.5 inches WG (vacuum) at a maximum system flow rate of approximately 1000 cfm. Only one sub-system will operate at a time, while the other sub-system is in standby mode.

The K1-5-1 system consists of a filter housing assembly containing a heater, pre-filter, and two HEPA filters; and an exhaust fan which discharges into an exhaust stack. The K1-5-2 system is a version of the K1-5-1 system with the filter housing assembly stacked on top and an exhaust fan that discharges into a common exhaust stack.

The primary tank exhaust air stream enters the K1-5-1 or K1-5-2 system where it is heated and pre-filtered. Next, two HEPA filters mounted in series remove particulates as small as 0.3 μm with at least 99.95% efficiency. Smaller particles can be trapped by the filter, but the filter is not rated for particles smaller than 0.3 μm . Two differential pressure indicators monitor the pressure drop across the HEPA filters. Low differential pressure indicates low airflow or a failed filter. High differential pressure indicates blockage caused by accumulated solids or possibly ice formation on the filters.

After passing through the filters, the air is drawn through a K-1 fan and exhausted out of the K-1 stack. A CAM monitors effluent radioactivity levels and a record sampler collects representative samples before the air is discharged to the atmosphere. If the K-1 exhaust fan fails, the backup K-1 (K1-2) ventilation system fan starts automatically and the ventilation path is switched to the standby exhaust system. Under normal operating conditions, one of the K-1 de-entrainers is in operation and the adjacent de-entrainer is used as backup.

The 241-AW tank farm primary ventilation exhaust duct for DST AW-101 and the AW stack (between the de-entrainers and the filter housings) are capable of continuously monitoring for gases with the standard hydrogen monitoring system. The SHMS consists of hydrogen-specific monitors and a grab sampler allowing vapor samples to be collected and transported to a laboratory for measurement of hydrogen and other gases.

The primary ventilation exhaust duct from tank 241-AW-101 has a GCS installed in addition to the SHMS. The GCS has a gas chromatograph for hydrogen measurements, another GC for nitrous oxide and methane measurements, and a Fourier transform infrared spectrometer for ammonia measurements.

A.5 241-AY / AZ TANK FARM PRIMARY VENTILATION SYSTEM

The ventilation system for 241-AY/AZ tank farms consists of two separate but interrelated ventilation exhaust systems: the primary and annulus systems.

The primary ventilation system for the AY/AZ tank farms is the focus of this study, and is depicted graphically in a simplified flow diagram in Figure A-4.

In 1997, the original 241-AY/AZ primary ventilation system was replaced by a new primary ventilation system under Project W-030, "Tank Farm Ventilation Upgrade". This new system is in operation at this time and consists of primary tank air intake stations, a primary tank recirculation ventilation cooling loop, and a primary ventilation treatment/exhaust system.

The primary ventilation system is provided with individually controlled air intake stations and a common ventilation exhaust for the four 241-AY and 241-AZ tank farm primary tanks (241-AY-101, 241-AY-102, 241-AZ-101, and 241-AZ-102). The individual primary tank air intake station consists of a heater, pre-filter, high-efficiency particulate air (HEPA) filter, and flow control valve. The risers, which are used to exhaust the tanks, are manifolded into a common duct, thereby providing a path for a combined air stream. The combined air stream is then cooled and filtered prior to being exhausted to the atmosphere through a stack. The air cleaning units are redundant to maintain primary tank pressures during anticipated maintenance or component failures.

The primary tank ventilation system performs the following functions:

1. Provides filtered inlet air to the primary tank for cooling and gas dilution of any flammable gases.
2. Maintains a pressure in the primary tanks of approximately -250 to -747 Pa (-1 to -3 inches water gauge [WG]) during normal operation.
3. Provides secondary cooling/condensing of the off-gas streams from the four primary tanks.
4. Removes particulate, condensable vapors, and iodine gas from the radioactive exhaust air streams from the four primary tanks.
5. Exhausts the off-gas air stream to the atmosphere through a primary exhaust stack.
6. Monitors and samples exhaust emissions.

The primary ventilation system is required to ventilate the primary tank vapor space. Pressure in the primary tanks will be maintained at approximately -250 to -747 Pa (-1 to -3 inches WG) to confine contamination within the primary tank, provide cooling of the tank contents and dilute any potentially flammable gases which might collect in the primary tank vapor space. Instrumentation is provided at each DST to monitor and control primary tank pressure. The negative pressure in the primary tank, as well as airflow into the tank is modulated with a control valve at the air intake stations.

Each primary tank is provided with an intake station that contains an air cleaning unit provided with a heater (for excessive humidity and frost), a pre-filter (which protects the HEPA from unnecessary particulate loading), and a HEPA filter as part of the intake air stations. The air

intake stations are provided with a vacuum relief valve to protect the primary tanks from out-of-specification negative pressure (maximum allowable negative pressure is 6 inches WG).

A recirculation ventilation cooling system is provided for each primary tank to help reduce air emissions and remove generated heat. The ventilation cooling equipment is located in concrete vaults and includes a condenser, moisture separator and recirculation fan. The vaults are reinforced concrete structures with equipment access from the top and personnel access through a door.

The recirculation ventilation cooling system draws approximately 47 to 236 L/s (100 to 500 cfm) of air from the primary tank with the recirculation fan and returns from 0 to 189 L/s (0 to 400 cfm) — depending on the tank heat load — to the primary tank. The remaining primary tank exhaust air stream from 47 to 236 L/s (100 to 500 cfm), is exhausted through the primary tank ventilation system and eventually to the atmosphere. The inlet to the recirculation fan is provided with a moisture separator that removes entrained moisture from the air stream to protect the fan from erosion. At a maximum ventilation flow rate of 236 L/s (500 cfm) through the shell side of the recirculation condensers, the maximum heat removal for DSTs 241-AY-101, AY-102, and AZ-102 is approximately 878,000 Btu/hr each, at a primary tank exhaust air stream temperature of 89 °C (192 °F) in the primary recirculation loop. For the DST AZ-101 condenser, AZ101-K4-8-1, heat removal is approximately 1.5 million (M) Btu/hr at a primary tank exhaust air stream temperature of 97 °C (206 °F). For all four DSTs, the heat is rejected to the atmosphere via the recirculation condenser cooling system.

The recirculation condenser cooling system consists of an evaporative fluid cooler, two circulation pumps, an expansion tank, an air separator, and instruments for monitoring the closed-loop cooling system. The cooling medium used is a 40% by volume propylene glycol mixture that is circulated between the evaporative fluid cooler and the recirculation condenser.

When the primary tank exhaust air stream temperature is sufficiently low that condenser cooling ceases, the recirculation ventilation cooling system is placed in a bypass mode.

When the mixer pumps are operating, valves in the ventilation system are aligned for high-heat mode, and airflow out of the primary tank is increased from 47 L/s (100 cfm) to a maximum of 236 L/s (500 cfm).

The four primary tanks' (AY-101, AY-102, AZ-101, and AZ-102) exhaust air streams, drawn off each tanks' recirculation ventilation cooling system, are combined and then routed through condenser AK-K1-81 where the air stream is cooled to 4 °C (40 °F). To eliminate any water droplet carryover from the condenser to the filters, the air stream then flows through a high-efficiency mist eliminator (HEME). Upon exiting the HEME, the gas stream is heated by electric heaters to decrease the relative humidity of the air stream. Heating the air will protect the HEPA filters and charcoal adsorber downstream from the effects of high-humidity exhaust air (wetting from condensation and possible blow-out of the filters).

The 702-AZ air cleaning unit includes a heater, HEPA filters, and charcoal adsorbers (HEGA filters). The operating heater, either AZ-K1-2-1A or AZ-K1-2-1B, is determined by which air cleaning unit is in operation. Normally, one unit will be in operation while the second unit is in standby. Each air-cleaning unit consists of two HEPA filter banks and a charcoal adsorber bank. Instrumentation is provided to monitor the pressure differential across each filter bank and the downstream air temperature of each bank. The operating unit will shut down and switch over to the standby unit upon high differential pressure across any filter bank of the air cleaning unit, upon heater failure, or when the heater high temperature set point is tripped.

The exhaust air stream, after passing through one of the two filter banks and the charcoal adsorber, is exhausted by one of two exhaust fans up the exhaust stack to the atmosphere. One fan is in standby while the operating fan maintains a vacuum in the four primary tank vapor spaces. Instrumentation is provided for each fan to monitor speed and the position of the inlet damper, outlet damper, and back draft damper. Controls are provided to operate the fan while providing status via monitoring the electrical current drawn by the fan motor.

The exhaust stack is external to the ventilation building and extends 16.8 meters (55 feet) above grade. The stack provides the point-of-air-discharge for the primary tank ventilation system. The primary tank exhaust air stream is sampled for particulate and iodine, and is monitored for beta/gamma radioactivity at the exit duct prior to discharge via the stack. The flow rate of the exhausted air stream is also monitored.

The 241-AY/AZ tank farm primary ventilation exhaust system for DSTs AY-102, AZ-101, and AZ-102 is equipped with instrumentation that has the capability to continuously monitor for gases via the SHMS, which consists of hydrogen-specific monitors and a grab sampler allowing vapor samples to be collected and transported to a laboratory for measurement of hydrogen and other gases.

A.6 241-SY TANK FARM PRIMARY VENTILATION SYSTEM

The 241-SY tank farm is the only DST farm located in the 200 West Area, and it consists of three tanks. These DSTs have received wastes from various facilities in the 200 East and 200 West Areas. DST 241-SY-101 was used as a double-shell slurry-holding tank to support 242-S Evaporator operations. Recently, because of flammable gas concerns in 241-SY-101, a mixer pump and monitoring and control systems have been added. Tank 241-SY-102 receives waste generated by 200 West Area SSTs and other 200 West Area facilities (e.g., T-Plant and 222-S Laboratory). 241-SY-102 has also served as the feed tank for the 242-S Evaporator and as a cross-site tie for transfers between the 200 East and 200 West Areas. DST 241-SY-103 was used to store high strontium concentrated liquor.

The 241-SY DST farm has two separate but interrelated ventilation exhaust systems: the primary and annulus. The purpose of the primary ventilation system is to maintain a vacuum in the primary tank headspace to contain airborne waste contaminants, to cool the primary tank waste and to remove flammable gases from the primary tank headspace. The annulus ventilation system provides a secondary confinement in which a vacuum can be maintained and controlled

separately from the primary system. The annulus ventilation system draws outside air through the secondary tank. It also includes air distribution chambers in the annular space to provide air cooling for the primary tank and a volume of air for the primary leak detection system. The constant flow of air through the annulus system is monitored for contaminated waste leaks from the primary tank which may evaporate and become airborne.

The primary ventilation system for the SY tank farm is the focus of this study, and is depicted graphically in a simplified flow diagram in Figure A-5.

In the primary ventilation system, outside air is drawn into the primary tank through air inlet stations, pit cover blocks, and risers due to the vacuum created in the primary tank by the primary exhaust fan (blowers). Air is drawn out of the primary tank through a 12-inch diameter duct and into an above-grade exhaust header. Primary tank exhaust ducts have manually-operated air volume control butterfly valves located in the above-grade header. The exhaust header terminates at the primary K1-4-1 treatment exhaust train located on the primary ventilation pad on the south end of the tank farm.

At the primary ventilation pad, air flows through the K1-4-1 exhaust system which ventilates all three DSTs. The primary tanks' operating pressure may range from less than 0.0 to -4.0 inches WG (vacuum), at a maximum flow rate of approximately 700 cfm (minimum flow 400 cfm).

The K1-4-1 system consists of a filter housing assembly containing a de-entrainer pad, heater, pre-filter, and two HEPA filters; and an exhaust fan which discharges into an exhaust stack.

The primary tank exhaust air stream enters the K1-4-1 system where it is heated and pre-filtered. Next, two HEPA filters mounted in series remove particulates as small as 0.3 μm with at least 99.95% efficiency. Smaller particles can be trapped by the filter, but the filter is not rated for particles smaller than 0.3 μm .

After passing through the filters, the air is drawn through a K1-4-1 fan and exhausted out of the stack. A CAM monitors effluent radioactivity levels and a record sampler collects representative samples before the air is discharged to the atmosphere. Unlike other DST primary ventilation systems, there is not a redundant parallel treatment train available for backup operation. A portable trailer-mounted treatment train, identified as the P-28 backup exhaust, is provided as a backup unit when the K-1 system is down for maintenance or repair.

The 241-SY tank farm primary exhaust system for DSTs SY-101, SY-102, SY-103 and the SY stack are equipped with standard hydrogen monitoring systems which have the capability to continuously monitor the air for gases. The SHMS consists of hydrogen-specific monitors and a grab sampler allowing vapor samples to be collected and transported to a laboratory for measurement of hydrogen and other gases.

Gas characterization systems have been installed on the primary ventilation stack and tank SY-101. (Tank SY-101 has a GCS with three sample points from one tank riser, and

another GCS with a single sample point from the primary ventilation header.) The GCS's have a gas chromatograph for hydrogen measurements, another GC for nitrous oxide and methane measurements, and a Fourier transform infrared spectrometer for ammonia measurements.

The primary tank ventilation system has been modified from the original design with the addition of a new treatment train, VTP-EF-3102, located on a separate concrete equipment pad east of the K-2 and K1-4-1 treatment trains equipment pad. The VTP-EF-3102 has not been made operational, although it has been physically installed and it is anticipated that it will be running in 1999. The K1-4-1 treatment train will serve as a backup, and the portable exhaustor, P-28, will be removed when the VTP-EF-3102 exhaust train becomes operational.

The VTP-EF-3102 exhaustor system contains a moisture separator, an electric heater, a pre-filter, two HEPA filters, a fan and an exhaust stack. A CAM monitors effluent radioactivity levels and a record sampler is installed on the stack.

Figure A-1. AN Farm Primary Ventilation System.

AN

Figure A-2. AP Farm Primary Ventilation System.

AP

Figure A-3. AW Farm Primary Ventilation System.

AW

Figure A-4. AY / AZ Farm Primary Ventilation System.

Figure A-5. SY Farm Primary Ventilation System.

SY

APPENDIX B

COMPARISONS OF VARIOUS GAS COMPOSITIONS FOR VENTILATION SYSTEMS

APPENDIX B**COMPARISONS OF VARIOUS GAS COMPOSITIONS
FOR PRIMARY VENTILATION SYSTEMS**

In this study, a basis for compositions of the gases to be treated in the primary ventilation system needed to be established in order to evaluate each of the alternatives generated. In Projects W-320, W-030, and W-236A gas compositions are established based on available literature and engineering judgements. The gas compositions established in these projects were for purposes of:

<u>Project</u>	<u>Purpose of Gas Data</u>
W-320	emission permit application
W-030	emission permit application
W-236A	design basis

The sluicing operation of tank 106-C is of added value as it yielded actual gas samples. These project and operating data are useful in developing a basis for the current AGA study.

B-1. GAS COMPOSITION USED IN PROJECT W-320

The gas compositions used in Project W-320 are presented here for comparison. To limit the discussion, only the organic gas constituents and ammonia are presented. These data for Project W-320 are shown in Table B-1.

Table B-1. Gas Composition Used by Project W-320.

Chemical Compound	mg/min	mg/m ³	ppm _v
Sodium salt of EDTA	6.79 E-01	2.20 E-02	Particulate
Sodium salt of HEDTA	5.34 E-01	1.73 E-02	Particulate
Sodium citrate	3.48 E+00	1.13 E-01	Particulate
Sodium oxalate	4.86 E+00	1.57 E-01	Particulate
Sodium formate	4.97 E+00	1.61 E-01	Particulate
Ammonia	211.11 E+02	6.84 E+00	9

The above data are obtained from H-2-818478, Environmental, *Tank 241-C-106 Ventilation Mass Balance*. The gas flow rate used in the calculation is 1090 scfm.

The following note is copied from H-2-818478:

"Specific contaminant concentrations and total aerosol density in the tank ventilation off-gas are presented in Attachment 3 of PROJECT W-320 REVISED HEADSPACE CHARACTERIZATION (Internal Memo 71320-94-055), Dec. 6, 1994 of PROJECT 93L-EWW-320, TANK 241-C-106 SLUICING, LETTER OF INSTRUCTION, DEFINITIVE DESIGN, ADDENDUM 7. Following modifications of the reported characterization are made (also see DSIs from Li to Bradshaw on June 19, 1995):

- a. ----
- b. ----
- c. ----
- d. Ammonia with a concentration of 9 ppm_v is added.
- e. Organic compounds, sodium salts of EDTA, HEDTA, citric acid, oxalic acid and formic acid are added."

In the W-320 Emission Permit Application, only aerosols of five sodium salts of organic compounds were considered. Volatile organic compounds (VOC) either were assumed to be not existent or were completely ignored.

B.2 GAS COMPOSITION USED IN PROJECT W-030

In a prepared material balance sheet for Project W-030, concentrations of organic compounds and ammonia are listed. These concentration data, which were developed to support the construction of the new 702-AZ system that was recently activated, are presented in Table B-2.

Data in Table B-2 are obtained from Project W-030, "Standard Operations in Every AY and AZ Tank Off-Gas Cooling from Primary & Secondary Condensers." The specific concentrations are given in Appendix A of document WHC-SD-W030-RD-001 (Keller 1997). The flow rate for the above calculation is 800 scfm.

Table B-2 shows that the gas stream to be treated by the W-030 ventilation system was expected to consist of approximately 1.49 E+00 ppm_v of VOC and 1.08 E+02 ppm_v of ammonia.

Table B-2. Gas Composition Used by Project W-030.

Chemical Compound	lb/min	lb/ft ³	Molecular Wt.	ppm _v
1-Butanol	1.62 E-05	2.03 E-08	74.1	9.83 E-02
Methylene Chloride	1.15 E-08	1.44 E-11	84.9	6.09 E-05
Acetone	1.16 E-05	1.45 E-08	58.1	8.96 E-02
Carbon Disulfide	8.4 E-10	1.38 E-15	76.1	4.95 E-06
1,2-Dichloroethane	2.67 E-10	3.34 E-14	99.0	1.21 E-06
Trichlorofluoromethane	9.28 E-09	1.16 E-11	137.4	3.03 E-05
Bromomethane	1.03 E-10	1.29 E-13	94.9	4.88 E-07
1,1,1-Trichloroethane	1.44 E-09	1.80 E-12	133.4	4.84 E-06
Carbon Tetrachloride	6.16 E-11	7.70 E-14	153.8	1.80 E-07
1,2-Dichloropropane	1.03 E-10	1.29 E-13	113.0	4.10 E-07
Benzene	8.16 E-09	1.02 E-11	78.1	4.69 E-05
Dibromochloromethane	2.06 E-11	2.57 E-14	208.3	4.43 E-08
1,1,2-Trichloroethane	5.77 E-10	7.21 E-13	133.4	1.94 E-06
Vinyl Acetate	5.74 E-09	7.18 E-12	86.1	2.99 E-05
2-Butanone (MEK)	1.90 E-6	2.37 E-09	72.1	1.18 E-02
Trichloroethylene	1.86 E-10	2.32 E-13	131.4	6.34 E-07
Bromoform	1.15 E-09	1.44 E-12	252.7	2.05 E-06
2-Hexane (MBK)	3.06 E-07	3.82 E-10	100.2	1.37 E-03
Tetrachloroethylene	1.71 E-09	2.14 E-12	165.8	4.63 E-06
Toluene	1.46 E-08	1.82 E-11	92.1	7.09 E-05
Chlorobenzene	1.23 E-10	1.54 E-13	112.6	4.91 E-07
4-Methyl-2-Pentanone (MIBK)	1.06 E-07	1.33 E-10	100.2	4.77 E-04
Ethyl Benzene	2.06 E-11	2.57 E-14	106.2	8.69 E-08
1,1,2,2-Tetrachloroethane	2.86 E-09	3.58 E-12	167.9	7.66 E-06
O-xylene	4.46 E-07	5.57 E-10	106.2	1.88 E-03
NPH (Kerosene-type diluent)	2.61 E-04	3.26 E-07	170.3	6.87 E-01
TBP (Tributyl Phosphate)	6.42 E-06	8.03 E-09	266.3	1.08 E-02
EDTA	1.83 E-05	2.29 E-08	292.2	2.81 E-02
HEDTA	3.48 E-04	43.35 E-07	278.3	5.61 E-01
Total VOC				1.49 E+00
Ammonia	4.10 E-03	5.10 E-06	17.0	1.08 E+02

B.3 GAS COMPOSITIONS USED IN PROJECT W-236A

Data in this section are obtained from Project W-236A, "Multi-Function Waste Tank Facility Operations, Best Available Control Technology for Toxic Demonstration." This BACT was submitted to Westinghouse Hanford Company, under Purchase Order No. MJK-SVV-296951, Task No. 16, Prepared By CH2M HILL/IT CORPORATION, January 1994.

The "200 East MWTF Uncontrolled Hazardous Air Pollutant Emissions" are reported in Table 4-2 of the W-236A BACT. These data are reprinted here in Table B-3.

Table B-3. Gas Compositions Used by Project W-236A for 200 East Area Tanks.

Expected Air Pollutant	Expected Annual Emission (lb/yr)	Molecular Weight	Expected Concentration, ppm_v
Acetone	3.75 E+03	58.08	8.82 E+01
Benzene	3.69 E+00	78.11	6.45 E-02
1-Butanol	1.03 E+05	74.12	1.90 E+03
Carbon Tetrachloride	2.81 E-02	154	2.49 E-04
2-Hexanone (MBK)	1.51 E+02	100.16	2.06 E+00
4-Methyl-2-pentanone (MIBK)	1.06 E+04	100.16	1.45 E+02
Normal Paraffin Hydrocarbons (NPH)	5.83 E+06	170.03	4.68 E+04
Total VOC			4.93 E+04
Ammonia	3.50 E+03	17.00	2.81 E+02

The "200 West MWTF Uncontrolled Hazardous Air Pollutant Emissions" are reported in Table 4-3 of the W-236A BACT. These data are reprinted here in Table B-4.

Table B-4. Gas Compositions Used by Project W-236A for 200 West Area Tanks.

Expected Air Pollutant	Expected Annual Emission (lb/yr)	Molecular Weight	Expected Concentration, ppm_v
Acetone	2.81 E+03	58.08	6.61 E+01
Benzene	4.00 E+00	78.11	7.00 E-02
1-Butanol	7.70 E+04	74.12	1.42 E+03
Carbon Tetrachloride	2.81 E-02	154	2.49 E-04
2-Hexanone (MBK)	7.95 E+02	100.16	1.08 E+00
4-Methyl-2-pentanone (MIBK)	4.37 E+06	100.16	3.51 E+04
Normal Paraffin Hydrocarbons (NPH)	5.83 E+06	170.03	4.68 E+04
Total VOC			3.69 E+04
Ammonia	2.08 E+03	17.00	1.67 E+02

The gas flow rate for the above calculations is 500 scfm per tank. The Uncontrolled Hazardous Air Pollutant Emissions data were interpreted as equivalent to the tank headspace gas concentrations to be treated by the ventilation system. Therefore, ranges of VOC and ammonia used for W-236A Multi-Function Waste Tank Facility Operations are from 3.69 E+04 to 4.93 E+04 and 1.67 E+02 to 2.81 E+02 ppm_v, respectively.

B.4 GAS COMPOSITIONS FROM A SINGLE SAMPLE OBTAINED DURING C-106 SLUICING OPERATION

During the 241-C-106 sluicing operation, gas samples were obtained and subsequently analyzed by PNNL. Table B-5 presents the data from the report titled "Sample VP006-006.C226, C-106 Sluicing Test 12/16/1998, Sample Collected in Summa Canister 2.5 Hours After Start of Sluicing, PNNL GC/MS Analysis by Cryoconcentration, Tentatively Identified Compounds (TICs)."

Table B-5. Gas Compositions of Sample from C-106 Sluicing.

Tentatively Identified Compound (TIC)	ppb _v
Propene	477
Propane	291
Methyl nitrite	30
1-Propene, 2-Methyl-	589
1-Butene	42
2-Butene, (Z)	105
1-Butene, 2-methyl	49
2-Pentene, (E)-	49
2-Pentene, (Z)	42
1-Pentene, 4-Methyl-	20
Silanol, trimethyl-	25
Pentane, 2-methyl-	40
Butanal	46
1-Hexene	464
2-Hexene	50
1,4-Pentadiene, 3-methyl-	12
2-Hexene	31
1-Pentene, 2-methyl	19
Cyclopentane, methyl-	9
1-Butyne, 3-methyl-	90
3-Hexene, 2-methyl-, (E)	69
Butanenitrile, 2-methylene-	276
3-Heptene	261
1-Heptene	1412
(z)-3-Heptene	7541
2-Heptene	8809
2-Heptene, (E)-	6423
Cyclopentane, ethyl-	116
2-Butenal, 2-ethenyl-	2409

Table B-5. Gas Compositions of Sample from C-106 Sluicing.

Tentatively Identified Compound (TIC)	ppb _v
Cyclopentane, 1,2-dimethyl-, cis-	261
Unknown C8 Alkene/Cycloalkane (mw 112)	21
2-Heptyne	245
2-Hexanone	93
4-Octene, (E)-	96
Heptane, 3-methyl-	422
Hexanal	9
Heptane, 3-methylene-	476
4-Heptenal, (Z)-	33
3-Heptene, 3-methyl-	112
2-Octene, (E)-	48
2-Heptene, 3-methyl	92
2-Octene	47
3-Hexanone, 5-methyl-	24
Unknown hydrocarbon	9
Unknown hydrocarbon	10
Furan, tetrahydro-2,2,5,5-tetramethyl-	33
3-Heptanone	1216
2-Heptanone	406
Ethanol, 2-butoxy-	109
2-Heptanol, (S)-	30
Cyclopropane, 1-methyl-2-pentyl-	47
Hexanenitrile, 3-methyl-	24
Unknown Alkene/Cycloalkane	10
1, 3-Diethyl-1,4-epoxybutane	238
Unknown Alkene/Cycloalkane	369
1,2-Diethyl-1,4-epoxybutane	278
Unknown hydrocarbon	310
Unknown C (Alkene/Cycloalkane [mw 126])	65

Table B-5. Gas Compositions of Sample from C-106 Sluicing.

Tentatively Identified Compound (TIC)	ppb _v
Heptanenitrile	74
4-Octanone	40
2-Hexenal, 2-ethyl-	9
Unknown hydrocarbon	12
3-Octanone	9
2-Octanone	32
1-Hexene, 3,3,5-trimethyl-	30
Unknown Alkene/Cycloalkane	10
Unknown hydrocarbon	9
Unknown hydrocarbon	200
Unknown C9 Alkene/Cycloalkane (mw 126)	32
Cyclohexane, 1-methyl-3-propyl-	27
1-Hexanol, 2-ethyl-	121
Decane, 4-methyl-	63
Cyclohexane, (2-methylpropyl)-	50
Unknown C9 Alkene/Cycloalkane (mw 126)	20
Octanenitrile	21
Decane, 5-methyl-	15
Unknown Alkane	14
Unknown Alkane	11
1-Ethyl-2,2,6-trimethylcyclohexane	15
Unknown C11 Alkene/Cycloalkane (mw 154)	11
Naphthalene, decahydro-,trans-	31
Unknown C11 Alkene/Cycloalkane (mw 154)	11
Unknown hydrocarbon	26
Unknown C11 Alkene/Cycloalkane (mw 154)	23
Unknown C11 Alkene/Cycloalkane (mw 154)	18
Unknown Cycloalkene	13
Unknown C12 Alkane (mw 170)	10

Table B-5. Gas Compositions of Sample from C-106 Sluicing.

Tentatively Identified Compound (TIC)	ppb_v
Cyclohexane, pentyl	13
Naphthalene, decahydro-2-methyl	29
Undecane, 4-methyl-	5
Decane, 2,9-dimethyl-	12
Undecane, 3-methyl-	5
Naphthalene, decahydro-1,5-dimethyl-	7
Naphthalene, decahydro-2,6-dimethyl-	6
Undecane, 2,6-dimethyl-	43
Unknown Alkyl Decahydronaphthalene	8
Cyclohexane, 2-butyl-1,1,3-trimethyl-	10
Cyclohexane, (4-methylpentyl)-	13
Tricane, 7-methyl-	30
Sum of all TIC Compounds (VOC)	36072

In Table B-5, the total VOC is 36072 ppb_v (or 36 ppm_v) with no ammonia identified.

B.5 EVALUATION OF DATA

Table B-6 summarizes the various data presented.

Table B-6. Summary of Gas Concentrations.

Project / Operation	VOC, ppm_v	Ammonia, ppm_v
W-320	0	9
W-030	1.49	108
W-236A, 200 East	49300	281
W-236A, 200 West	36900	167
C-106 Sluicing (sample)	36	N/A

From Table B-6 it is noted that with the exception of tank C-106 sluicing data, all data are believed to be obtained from literature or suggested based on engineering judgement, and are therefore somewhat artificial. However, the C-106 data are results of actual field samples. In the case of C-106 sluicing operations, the headspace gas from tank C-106 first passes through a chilled water condenser, then through the rest of the ventilation system (HEME, HEMF, and HEPAs). At the condenser, some low-boiling VOCs may be condensed and removed from the gas system prior to passing through the HEME. However, the VOC concentration difference between the W-236A data and C-106 sluicing data is approximately three orders of magnitude, which is a very large discrepancy that has yet to be explained. A possibility includes an indication that the removal efficiency of the condenser is as high as 99.90%. Another possibility includes the use of such a high concentration of VOCs in W-236A for an increased safety margin. Note that it is very common during the development of project design criteria to use numbers as high as possible to cover as many uncertainties as possible.

The characteristics of the solid and liquid in-tank waste varies from tank to tank, as do compositions of headspace gas to be treated in the ventilation systems. For detailed designs of gas treatment systems, the actual gas composition from individual tanks should be used if possible, or should at least be based on the worst-case scenario (the bounding case). Compositions of gases to be treated are related to the equipment design and operating conditions, and will directly affect the choice of alternative.

In this AGA study, VOC concentrations of 40 to 60 ppm_v were used as bounding because of the C-106 data in Table B-5. Ammonia concentrations of 35 to 70 ppm_v were used as bounding for all alternatives generated based on verbally-communicated C-106 data (i.e., not yet documented). For detailed design in the future, real gas compositions obtained from laboratory analyses of samples from the tank headspace are preferred.

As this report was being completed, actual tank data regarding speciation of the total organic carbon (TOC) for tank C-106 became available (Stauffer & Stock 1999). For comparison purposes, the TOC data for a selection of the DSTs is presented in Table B-7 along with datum for tank C-106. A significant number of DSTs are reported to contain a greater inventory of TOC than tank C-106; whether these data are pertinent will not be known until further speciation beyond the bulk inventory (i.e., determination of how much of the TOC is volatile and/or semi-volatile).

Table B-7.

BBI Estimates for TOC

Tank	Inventory (kg)	Reference
C-106*	15,200	HNF-4261, Rev. 1
AN-102	107,000	LMHC 1999, Tank Characterization Database, Internet query September 23, 1999 at http://twins.pnl.gov:8001/TCD/main.html
AN-103	10,500	
AN-104	19,300	
AN-105	37,300	
AN-107	161,000	
AW-101	18,100	
AW-103	11,000	
AW-104	20,800	
AW-105	7,900	
AY-101	31,100	
AY-102	9,160	
AZ-101	6,050	
AZ-102	6,240	
SY-101	103,000	
SY-102	4,080	
SY-103	37,900	

• Before Sluicing

APPENDIX C
DECISION CRITERIA DEVELOPMENT

APPENDIX C

DECISION CRITERIA DEVELOPMENT

C.1 INTRODUCTION

The fundamental objectives from Table 4-1 are listed in Table C-1. Also listed in Table C-1 are the corresponding determinations and bases for selection of the appropriate objectives to apply to this AGA. From Table C-1, Retrieval Engineering personnel found 14 total criteria to be appropriate for use in evaluating alternatives in this AGA.

Table C-2 presents the criteria for the associated major objectives (carried forward from Table C-1). The corresponding rankings and weighting factors determined by Retrieval Engineering to be applicable to this AGA for each criterion are also presented in Table C-2.

Using values from one to ten, each of the criteria was pair-wise compared by Retrieval Engineering personnel, starting with the highest-ranked criterion (Criterion 1 in Table C-2) and moving to the lowest-ranked criterion (Criterion 14 in Table C-2). In the comparison, criteria are compared one at a time to determine their relative importance (e.g., How much more important is the criterion ranked as 1 in Table C-2 than the criterion ranked as 2?). The results of the pair-wise comparison were normalized to provide the associated criterion weighting factors that are also provided in Table C-2.¹

The decision criteria applicable to each of the entries in Table C-1 that were deemed applicable to this AGA are provided in Figures C-1 through C-14. These criteria are then passed back to the document for use in evaluating the alternatives from Section 3 (see Section 5).

¹ This is a form of multi-attribute ranking or analysis which is commonly used for these types of analyses.

Table C-1. Determination of Which Objectives to Consider as Ventilation AGA Criteria.

Fundamental Objective		Applicable to Ventilation AGA as a Discriminating Objective? (yes / no)	Basis for Selection or Rejection as Criteria for this Ventilation AGA
Number	Title		
1.0	Maximize Safety		
1.1	Maximize Public Safety		
1.1.1	Radiological	No	From a public safety perspective, all ventilation alternatives are equal because the public is assumed to be at a relatively equal (small) risk of radiological exposure.
1.1.2	Chemical	Yes	RCRA and other similar chemical safety aspects could be discriminating in this AGA (this might be a discriminating factor).
1.2	Maximize Worker Safety		
1.2.1	Radiological	No	The existing radionuclide treatment/controls (demister pads and HEPA filters) are considered BARCT and affect each alternative equally.
1.2.2	Chemical	Yes	Various chemical exposures could be possible from each of the differing alternatives (this might be a discriminating factor).
1.2.3	Industrial	Yes	Potential risks of tripping, falling, etc. hazards may be increased in cases where SCBA types of PPE are used. Furthermore, fire hazards associated with use of a dry carbon bed adsorber need to be considered.
1.3	Maximize Environmental Safety		
1.3.1	Biota (plants and animals)	No	
1.3.2	Groundwater & Vadose Zone	No	Each alternative will result in relatively the same amount of (small) risk to the indigenous plant and animal life.
1.3.3	Atmosphere	Yes	Varying levels of atmospheric protection may result from the different alternatives (this might be a discriminating factor).
2.0	Maximize Compliance with Regulation		
2.1	DOE	Yes	
2.2	WA Ecology / EPA	Yes	
2.3	WA Health / EPA	Yes	Differing levels of compliance may result for the various alternatives. (These might be discriminating factors.)
3.0	Minimize Life-Cycle Cost		
3.1	Design & Construction Cost	Yes	There may be differences in the design and construction costs for the various alternatives (this might be a discriminating factor).
3.2	Operations Cost	Yes	Very large differences in operations and maintenance costs associated with each of the alternatives are likely. (This might be a discriminating factor.)
3.3	D&D Cost	No	Each alternative is expected to result in roughly the same relative cost for removal upon completion of its useful life.
4.0	Maximize the Reliability of Feed Delivery		
4.1	Feed On Time		
4.1.1	Initial Delivery of Feed	Yes	
4.1.2	Routine Delivery of Feed	Yes	There could be wide variability between each of the alternatives that results in significant differences in difficulty and/or probability of successful design, construction, and/or demonstration of operational readiness (these might be discriminating factors).
4.2	Proper Quantity of Feed		
4.2.1	Initial Quantity	No	None of the ventilation alternatives are expected to affect the physical and/or chemical composition of the waste that is fed to the PC.
4.2.2	Routine Quantity	No	Rather, the expectation is that the opposite affect will be realized (i.e., the waste feed physical and chemical composition may affect the ventilation systems.) However, for the purpose of this AGA, the assumptions are that these effects will be relatively equal when taken on a farm-by-farm basis.
4.3	Feed Within Specifications	No	
4.4	Obligations & Milestones		
4.4.1	Contract Obligations not covered by 4.1, 4.2, & 4.3 above	No	No other contract obligations, TPA milestones, etc. are expected to create any discrimination between alternatives in this AGA.
4.4.2	Tri-Party Agreement Milestones	No	

Table C-2. Major Criteria, Associated Rank, and Weighting Factors.

Rank	Criteria Number	Criteria Title	Comparison Results	Weighting Factor
1	4.1.1	Initial Delivery of Feed on Schedule	10	20
2	4.1.2	Routine Delivery of Feed on Schedule	10	20
3	2.1	DOE Regulatory Compliance	6	12
4	1.2.2.1	Chronic Chemical Release to Worker	3	6
5	2.2	WA Ecology / EPA	3	6
6	3.1	Design and Construction Cost	3	6
7	3.2	Operations Cost	3	6
8	1.2.2.2	Accidental Chemical Release to Worker	2	4
9	1.3.3.2	Accidental Release to Atmosphere	2	4
10	1.1.2.2	Accidental Chemical Release to Public	2	4
11	1.2.3	Worker Industrial Safety	2	4
12	2.3	WA Health / EPA	1	2
13	1.3.3.1	Chronic Release to Atmosphere	1	3
14	1.1.2.1	Public Chemical Chronic Exposure	1	3
Total			49	100

Figure C-1.

Objective: Accidental Chemical Release to Public	
Criterion: 1.1(b)(ii) — 1.1.2.2	
10	(Excellent) Little or no potential for accidental releases that would likely exceed guidelines for the public.
9	
8	
7.5	(Very good)
7	
6	
5	(Good) Potential for accidental releases exceeding guidelines for the public is within the level considered acceptable.
4	
3	
2.5	(Poor)
2	
1	(Very poor) High potential for accidental releases that would likely exceed guidelines for the public.

Figure C-2.

Objective: Public Chemical Chronic Exposure	
Criterion: 1.1(b)(i) — 1.1.2.1	
10	(Excellent) No potential for chronic chemical releases to the public anticipated.
9	
8	
7.5	(Very good)
7	
6	
5	(Good) Chronic chemical releases to the public are anticipated to be controlled well below permit levels.
4	
3	
2.5	(Poor)
2	
1	(Very poor) Uncontrolled long-term chronic chemical releases to the public anticipated.

Figure C-3.

Objective: Chronic Worker Chemical Exposure	
Criterion: 1.2(b)(i) — 1.2.2.1	
10	(Excellent) No potential chemical exposure above OSHA requirements.
9	
8	
7.5	(Very good)
7	
6	
5	(Good) Chronic chemical exposures to workers are anticipated to be controlled well below OSHA requirements.
4	
3	
2.5	(Poor)
2	
1	(Very poor) Uncontrolled exposures in excess of OSHA requirements are anticipated.

Figure C-4.

Objective: Accidental Chemical Release to Worker	
Criterion: 1.2(b)(ii) — 1.2.2.2	
10	(Excellent) Little or no potential for accidental releases that would likely exceed limits for workers.
9	
8	
7.5	(Very good)
7	
6	
5	(Good) Potential for accidental releases exceeding limits for workers is within the level considered acceptable.
4	
3	
2.5	(Poor)
2	
1	(Very poor) High potential for accidental releases that would likely exceed limits for workers.

Figure C-5.

Objective: Worker Industrial Safety	
Criterion: 1.2(c) — 1.2.3	
10	(Excellent) Reduced risk of injury or death over current practices.
9	
8	
7.5	(Very good)
7	
6	
5	(Good) Expected risk of injury and death similar to present.
4	
3	
2.5	(Poor)
2	
1	(Very poor) High risk of industrial accidents leading to death or serious injury due to frequent high risk activities.
Set of considerations to arrive at an estimate for an alternative:	
1. Amount of added PPE required.	
2. Tripping/ falling potential.	
3. Fire hazards.	

Figure C-6.

Objective: Accidental Release to Atmosphere	
Criterion: 1.3(c)(ii) — 1.3.3.2	
10	(Excellent) No expected releases of chemicals to the atmosphere.
9	
8	
7.5	(Very good)
7	
6	
5	(Good) Potential releases of chemicals to the atmosphere that can be mitigated.
4	
3	
2.5	(Poor)
2	
1	(Very poor) Potential releases of chemicals to the atmosphere that cannot be mitigated.

Figure C-7.

Objective: Chronic Release to Atmosphere	
Criterion: 1.3(c)(i) — 1.3.3.1	
10	(Excellent) No expected releases of chemicals to the atmosphere.
9	
8	
7.5	(Very good)
7	
6	
5	(Good) Potential releases of chemicals to the atmosphere that can be mitigated.
4	
3	
2.5	(Poor)
2	
1	(Very poor) Potential releases of chemicals to the atmosphere that cannot be mitigated.

Figure C-8.

Objective: DOE Regulatory Compliance	
Criterion: 2.1	
10	(Excellent) No modifications requiring regulatory approval.
9	
8	
7.5	(Very good) Minimal modifications must be approved and minimal increase in risk to any individual, worker, or public.
7	
6	
5	(Good) Modifications requiring regulatory approval; likely that regulatory approval will be forthcoming.
4	
3	
2.5	(Poor) Extensive modifications to the authorization basis or significant increase in risk to any individual (worker or public) must be approved.
2	
1	(Very poor) Little or no chance of regulatory approval.
Note: DOE has incorporated OSHA regulations, and compliance with them is required. Also, the S/RIDs system indicates how regulations are being implemented.	

Figure C-9.

Objective: State of WA Department of Health & EPA Regulations	
Criterion: 2.3	
10	(Excellent) No permits, approvals or facility changes needed to achieve and demonstrate compliance.
9	Only administrative changes (e.g., notifications, records, reports) are required to achieve and demonstrate regulatory compliance.
8	Prior agency review and concurrence is required (informal administrative approval) before the alternative can be fully implemented, but design and procurement of the alternative can proceed "at-risk" pending final agency concurrence.
7.5	(Very good)
7	Process and/or procedural changes are required to achieve and demonstrate regulatory compliance, but no physical modifications or re-engineering of the facility are needed.
6	Prior agency review and concurrence regarding an administrative position (e.g., regulatory interpretation, adequacy of corrective actions) is required prior to implementing the alternative.
5	(Good) Physical changes to and/or re-engineering of facility installations are required to achieve and demonstrate regulatory compliance.
4	A permit-by-rule or other minor permit modification is required, but there is a presumption that the alternative is considered to be approved unless indicated otherwise by the agency; or, a new registration, license, or other application must be filed with the agency to qualify the alternative to proceed with implementation (the action could be rejected if the filing is deficient, but very unlikely).
3	A permit modification must be submitted and approval is required prior to implementing the alternative: modification of an existing Notice of Construction (NOC). (Note: A Notice of Construction applies to airborne release.)
2.5	(Poor)
2	A new permit must be submitted and approval is required prior to implementing the alternative: new NOC approval.
1	(Very poor) Authorization to proceed highly unlikely (in opposition to public or agency priorities).

Figure C-10.

Objective: State of WA Department of Ecology & EPA Regulations	
Criterion: 2.2	
10	(Excellent) No permits, approvals or facility changes needed to achieve and demonstrate compliance.
9	Only administrative changes (e.g., notifications, records, reports) are required to achieve and demonstrate regulatory compliance.
8	Prior agency review and concurrence is required (informal administrative approval) before the alternative can be fully implemented, but design and procurement of the alternative can proceed "at-risk" pending final agency concurrence.
7.5	(Very good)
7	Process and/or procedural changes are required to achieve and demonstrate regulatory compliance, but no physical modifications or re-engineering of the facility are needed.
6	Prior agency review and concurrence regarding an administrative position (e.g., regulatory interpretation, adequacy of corrective actions) is required prior to implementing the alternative.
5	(Good) Potential releases of chemicals and radionuclides to the atmosphere that can be mitigated.
4	A permit-by-rule or other minor permit modification is required, but there is a presumption that the alternative is considered to be approved unless indicated otherwise by the agency; or, A new registration, license, or other application must be filed with the agency to qualify the alternative to proceed with implementation (the action could be rejected if the filing is deficient, but very unlikely).
3	A permit modification must be submitted and approval is required prior to implementing the alternative: a Class 1 RCRA modification; or modification of an existing Notice of Construction (NOC); or modification of an existing State Waste Discharge Permit (SWDP). (Note: A Notice of Construction applies to airborne release, and a State Waste Discharge Permit applies to water quality.)
2.5	(Poor)
2	A new permit or permit modification must be submitted and approval is required prior to implementing the alternative: a Class 2 or 3 RCRA modification or a new RCRA permit; or new NOC approval; or modification of an existing National Pollutant Discharge Elimination System (NPDES) permit; or new NPDES or SWDP permit. (Note: The NPDES applies to surface water discharges)
1	(Very poor) Authorization to proceed highly unlikely (in opposition to public or agency priorities).

Figure C-11.

Objective: Design and Construction Cost	
Criterion: 3.1	
10	(Excellent) The cost of the alternative is expected to be well within the level considered reasonable and overruns are expected to be unlikely and small if they do occur.
9	
8	
7.5	(Very good)
7	
6	
5	(Good) The cost of the alternative is expected to be comfortably within the level considered reasonable, and overruns, if they occur, would be expected to be small.
4	
3	
2.5	(Poor)
2	
1	(Very poor) The cost of the alternative is expected to be very much greater than the level considered reasonable, and would require a time-consuming and difficult procedure to attempt to get the money. There is considerable uncertainty whether the funding effort would succeed. There are large potential overruns.
Set of considerations to arrive at an estimate for an alternative:	
1. Vendor quotes for specific alternatives.	
2. Potential risks for overrunning a prospective budget.	

Figure C-12.

Objective: Operations Cost	
Criterion: 3.2	
10	(Excellent) The cost of the alternative is expected to be well within the level considered reasonable, and overruns are expected to be small if they do occur.
9	
8	
7.5	(Very good)
7	
6	
5	(Good) The cost of the alternative is likely to be comfortably within the level considered reasonable, and overruns, if they occur, would be expected to be small.
4	
3	
2.5	(Poor)
2	
1	(Very poor) The cost of the alternative is expected to be very much greater than the level considered reasonable, and would require a time-consuming and difficult procedure to attempt to get the money. There is considerable uncertainty whether the funding effort would succeed. There are large potential overruns.
Set of considerations to arrive at an estimate for an alternative:	
1. Potential risks for overrunning a prospective budget.	
2. Large number of varying technologies than are presently deployed in tank farm operations.	

Figure C-13.

Objective: Initial Feed Delivery On-Time	
Criterion: 4.1(a) — 4.1.1	
10	(Excellent) Little or no doubt that the alternative will support delivery of the initial feed on time.
9	
8	
7.5	(Very good) Estimated 95% chance that alternative will support initial feed delivery on time.
7	
6	
5	(Good) Estimated 80% chance that alternative will support initial feed delivery on time.
4	
3	
2.5	(Poor) Estimated 50% or less chance that the alternative will support initial feed delivery on time.
2	
1	(Very poor) Almost no chance that the alternative will support delivery of initial feed on time.
Set of considerations to arrive at an estimate for an alternative:	
<ol style="list-style-type: none"> 1. Construction and turnover on schedule (e.g., increase or decrease in the programmatic and operational float in the 90% Planning Case). 2. Flexibility to deal with changing requirements and failures. 	

Figure C-14.

Objective: Routine Feed Delivery On-Time	
Criterion: 4.1(b) — 4.1.2	
10	(Excellent) Little or no doubt that the alternative will support delivery of the routine feed on time.
9	
8	
7.5	(Very good) Estimated 95% chance that alternative will support routine feed delivery on time.
7	
6	
5	(Good) Estimated 80% chance that alternative will support routine feed delivery on time.
4	
3	
2.5	(Poor) Estimated 50% or less chance that the alternative will support routine feed delivery on time.
2	
1	(Very poor) Almost no chance that the alternative will support delivery of routine feed on time.
Set of considerations to arrive at an estimate for an alternative: <ol style="list-style-type: none"> 1. Operability 2. Maintainability 3. Flexibility 	

APPENDIX D

LIFE-CYCLE COST ANALYSIS PROCESS AND RESULTS

APPENDIX D

LIFE-CYCLE COST ANALYSIS PROCESS AND RESULTS

D.1 INTRODUCTION

The National Institute of Standards and Technology (NIST) Building Life-Cycle Cost (BLCC) computer program is an economic analysis tool kit for evaluating the relative cost effectiveness of alternative buildings and building-related systems or components. Typically, this program is used to evaluate design alternatives which have higher initial costs but lower operating-related costs over the project life than the lowest-initial-cost design, while providing a comparable level of service. The BLCC program can be used for evaluating federal projects, projects in the private sector, and projects at the state and local government levels. For the analysis of energy conservation investments in federal facilities (other than DoD facilities), BLCC complies with NBS Handbook 135, *Life-Cycle Costing Manual for the Federal Energy Management Program*. For other investments in federal buildings, the BLCC program complies with OMB Circular A-94 (revised), "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," October 29, 1992.

The BLCC program also complies with the American Society for Testing and Materials (ASTM) standard practices for building economics, including:

- E917 (Practice for Measuring Life-Cycle Costs of Buildings and Building Systems),
- E964 (Practice for Measuring Benefit-to-Cost and Savings-to-Investment Ratios for Buildings and Building Systems),
- E1057 (Practice for Measuring Internal Rate of Return and Adjusted Internal Rate of Return for Investments in Buildings and Building Systems),
- E1074 (Practice for Measuring Net Benefits for Investments in Buildings and Building Systems), and
- E1121 (Practice for Measuring Payback for Investments in Buildings and Building Systems).

While this program is intended primarily for use with buildings and building systems, it can be applied to almost any type of capital investment that is intended to reduce future operating-related costs. For example, it can be used to evaluate alternative automobile models in a fleet management program, or to evaluate alternative highway, bridge, or pipeline construction specifications that directly impact the life or maintenance requirements of those facilities.

D.2 LAW DST PRIMARY VENTILATION NON-RADIONUCLIDE CONTROL / TREATMENT TECHNOLOGY

Four DST primary ventilation systems presently in use to manage gases and vapors from tanks that contain LAW (AN, AP, AW, and SY farms) were considered for upgrades. The life-cycle costs of seven viable alternatives for treatment/control of non-radionuclides for the primary

ventilation of these DSTs were evaluated using the quick input module of the BLCC computer code. The detailed input and output files are attached, while the results are summarized in Table D-1. It can be seen that primarily due to lower operating, maintenance, and recurring (OM&R) costs, the short and tall stack alternatives have lower life-cycle costs by more than \$1 million over the next lowest alternative (dilution). The evaluation also shows that the potential energy savings between the alternatives is fairly minimal (specifically, the largest energy cost would be for dilution at just less than \$300,000).

Table D-1. Life-Cycle Cost of Seven LAW Ventilation Upgrade Alternatives.

Alternative Name	Present Value Costs			
	Initial Investment Costs*	OM&R Costs†	Energy Costs†	Total Life-Cycle Costs
Short Stack	\$ 4,068,654	\$ 0	\$ 0	\$ 4,068,654
Tall Stack	\$ 4,479,007	\$ 0	\$ 0	\$ 4,479,007
Dilution	\$ 6,326,263	\$ 155,662	\$ 280,983	\$ 6,762,908
Controlled Venting	\$ 7,415,020	\$ 0	\$ 0	\$ 7,415,020
Adsorption Bed	\$ 5,708,100	\$ 2,572,580	\$ 112,393	\$ 8,393,073
Catalytic Oxidation	\$ 8,824,167	\$ 0	\$ 211,418	\$ 9,035,585
Wet Scrubber & Carbon Bed	\$ 8,793,506	\$ 4,190,410	\$ 51,088	\$ 13,035,004

• Refer to Appendix E for more details on these data.

† The data in this column are for comparison only.

D.2 HLW DST PRIMARY VENTILATION NON-RADIONUCLIDE CONTROL / TREATMENT TECHNOLOGY

One primary ventilation system that is presently in use to manage gases and vapors from DSTs that contain HLW (the 702-AZ system which ventilates the tanks in AY and AZ farms) was considered for upgrades. The life-cycle costs of five viable alternatives (six were run in the program, but one was for a short stack, which does not apply) for treatment/control of non-radionuclides for the primary ventilation of these DSTs were evaluated using the quick input module of the BLCC computer code. The detailed input and output files are attached, while the results are summarized in Table D-2. It can be seen that primarily due to lower operating, maintenance, and recurring (OM&R) costs, the tall stack alternative has lower life-cycle costs by more than \$1 million over the next lowest alternative (dilution). The evaluation also shows that

the potential energy savings between the alternatives is fairly minimal (specifically, the largest energy cost would be for dilution at just less than \$300,000).

Table D-2. Life-Cycle Costs of Six HLW Ventilation Upgrade Alternatives.

Alternative Name	Present Value Costs			
	Initial Investment Costs*	OM&R Costs†	Energy Costs†	Total Life-Cycle Costs
Tall Stack	\$4,479,007	\$0	\$0	\$4,479,007
Dilution	\$6,326,263	\$155,662	\$280,983	\$6,762,908
Controlled Venting	\$7,415,020	\$0	\$0	\$7,415,020
Adsorption Bed	\$5,708,100	\$2,572,580	\$112,393	\$8,393,073
Catalytic Oxidation	\$8,824,167	\$0	\$211,418	\$9,035,585
Wet Scrubber & Carbon Bed	\$8,793,506	\$4,190,410	\$51,088	\$13,035,004

* Refer to Appendix E for more details on these data.

† The data in this column are for comparison only.

QuickBLCC (QBLCC 2.5-98) 03-23-1999/14:45:33

QBLCC filename = ANVENT.QI

Analysis type = Federal Analysis--Projects Subject to OMB A-94

Project name = Ventilation An Farm

Base date of study = 1999

Service date = 2003

Study Period = 20 years

Service Period = 16 years

Discount rate = 3.7%

Annually recurring costs and energy costs discounted from middle of year.

DOE energy price escalation rate file = ENCOST98

Number of alternatives in file = 7

Number of groups in file = 1

Note: Project alternatives displayed in increasing order of investment cost

Group code:	-----Present-Value Costs-----			
Alternative Name	Investment Costs*	OM&R Costs	Energy Costs	Total Life-Cycle Costs
Short Stack	\$4068654	\$0	\$0	\$4068654<-
-MIN LCC				
Tall Stack	\$4479007	\$0	\$0	\$4479007
Adsorb Bed	\$5708100	\$2572580	\$112393	\$8393073
Dilution	\$6326263	\$155662	\$280983	\$6762908
Cont Vent	\$7415020	\$0	\$0	\$7415020
Wet Scrub&CB	\$8793506	\$4190410	\$51088	\$13035004
Catalytic TOX	\$8824167	\$0	\$211418	\$9035585

Comparative measures are only calculated for the alternative with lowest LCC relative to alternative with the lowest present-value investment cost.

* Investment costs include capital replacements (if any).
Residual values are not calculated.

QBLCC filename = ANVENT.QI

Analysis type = Federal Analysis--Projects Subject to OMB A-94

Project name = Ventilation An Farm

Base Date of Study = 1999

Service Date = 2003

Study Period = 20 years

Discount rate = 3.7%

Inflation rate = 0.00%

Cap replacements and residual values (if any) included as investment costs.

Residual values NOT calculated for capital components.

Residual values NOT calculated for capital replacements.

Common energy data	#1	#2	#3	#4
Energy type:	Electric	LPG		
Units:	(kWh)	(MBtu)		
Price per unit:	\$0.065	\$4.360		
Escalation type code:	2	2		

Data for DOE escalation rates:

DOE Escalation Rate File = ENCOST98

Rate Schedule Type = 3

State Abbreviation = WA

DOE Price escalation rates for Electric

Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)
1999 -3.2186	2009 -0.0870	2019 0.0000		
2000 -2.1655	2010 -1.3055			
2001 -1.1858	2011 -1.5873			
2002 -0.1600	2012 -0.8961			
2003 -1.5224	2013 -0.9042			
2004 -1.7087	2014 -1.3686			
2005 -1.6556	2015 -0.8326			
2006 -1.1785	2016 -0.4664			
2007 -1.5332	2017 -0.8435			
2008 -0.5190	2018 -0.6616			

DOE Price escalation rates for LPG

Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)
1999 0.3802	2009 1.4035	2019 1.3746		
2000 0.3788	2010 0.3460			
2001 -0.3774	2011 -0.6897			
2002 0.3788	2012 0.6944			
2003 0.0000	2013 0.0000			
2004 0.3774	2014 -0.6897			
2005 1.8797	2015 -0.3472			
2006 1.8450	2016 0.3484			
2007 2.1739	2017 0.0000			
2008 1.0638	2018 1.0417			

Number of alternatives in file = 7

Number of groups in file = 1

CAPITAL ANNUAL NON-ANNUAL OM&R

HNF-4245

Rev. 0

ALT #	ALTERNATIVE NAME	GROUP CODE	LIFE (Y/M)	INITIAL COST(\$)	REPLACEMENTS FREQ*	COST(\$)	OM&R COST(\$)	FREQ*	COST(\$)
1	Tall Stack		20/0	5179605	0/0	0	0	0/0	0
2	Dilution		20/0	7315806	0/0	0	9900	0/6	2550
3	Cont Vent		20/0	8574864	0/0	0	0	0/0	0
4	Adsorb Bed		20/0	6600951	0/0	0	245200	0/0	0
5	Short Stack		20/0	4705066	0/0	0	0	0/0	0
6	Catalytic TOX		20/0	10204428	0/0	0	0	0/0	0
7	Wet Scrub&CB		20/0	10168971	0/0	0	399400	0/0	0

*FREQ = Frequency of occurrence (in years/months)

ALT #	ALTERNATIVE NAME	GROUP CODE	ANNUAL ENERGY USE		AN. ELEC. DEMAND CHARGE(\$)
			Electric (kWh)	LPG (MBtu)	
			---#1---	---#2---	
1	Tall Stack		0	0	0
2	Dilution		481800	0	0
3	Cont Vent		0	0	0
4	Adsorb Bed		192720	0	0
5	Short Stack		0	0	0
6	Catalytic TOX		97985	3154	0
7	Wet Scrub&CB		87600	0	0

Ayaz.qlr

QuickBLCC (QBLCC 2.5-98) 03-23-1999/14:50:17

QBLCC filename = AYAZVENT.QI

Analysis type = Federal Analysis--Projects Subject to OMB A-94

Project name = Ventilation AY/AZ Farm

Base date of study = 1999

Service date = 2003

Study Period = 20 years

Service Period = 16 years

Discount rate = 3.7%

Annually recurring costs and energy costs discounted from middle of year.

DOE energy price escalation rate file = ENCOST98

Number of alternatives in file = 7

Number of groups in file = 1

Note: Project alternatives displayed in increasing order of investment cost

Group code:	-----Present-Value Costs-----			
Alternative Name	Investment Costs*	OM&R Costs	Energy Costs	Total Life-Cycle Costs
-----	-----	-----	-----	-----
Short Stack	\$3262290	\$0	\$0	\$3262290<-
-MIN LCC				
Tall Stack	\$3588893	\$0	\$0	\$3588893
Adsorb Bed	\$4567111	\$2572580	\$112393	\$7252084
Dilution	\$5059100	\$155662	\$280983	\$5495745
Cont Vent	\$5377279	\$0	\$0	\$5377279
Catyalic TOX	\$6303179	\$0	\$211418	\$6514597
Wet Scrub&CB	\$6553404	\$4190410	\$51088	\$10794901

Comparative measures are only calculated for the alternative with lowest

LCC relative to alternative with the lowest present-value investment cost.

* Investment costs include capital replacements (if any).
Residual values are not calculated.

QBLCC filename = AYAZVENT.QI

Analysis type = Federal Analysis--Projects Subject to OMB A-94

Project name = Ventilation AY/AZ Farm

Base Date of Study = 1999

Service Date = 2003

Study Period = 20 years

Discount rate = 3.7%

Inflation rate = 0.00%

Cap replacements and residual values (if any) included as investment costs.

Residual values NOT calculated for capital components.

Residual values NOT calculated for capital replacements.

Common energy data	#1	#2	#3	#4
Energy type:	Electric	LPG		
Units:	(kWh)	(MBtu)		
Price per unit:	\$0.065	\$4.360		
Escalation type code:	2	2		

Data for DOE escalation rates:

DOE Escalation Rate File = ENCOST98

Rate Schedule Type = 3

State Abbreviation = WA

DOE Price escalation rates for Electric

Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)
1999 -3.2186	2009 -0.0870	2019 0.0000		
2000 -2.1655	2010 -1.3055			
2001 -1.1858	2011 -1.5873			
2002 -0.1600	2012 -0.8961			
2003 -1.5224	2013 -0.9042			
2004 -1.7087	2014 -1.3686			
2005 -1.6556	2015 -0.8326			
2006 -1.1785	2016 -0.4664			
2007 -1.5332	2017 -0.8435			
2008 -0.5190	2018 -0.6616			

DOE Price escalation rates for LPG

Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)
1999 0.3802	2009 1.4035	2019 1.3746		
2000 0.3788	2010 0.3460			
2001 -0.3774	2011 -0.6897			
2002 0.3788	2012 0.6944			
2003 0.0000	2013 0.0000			
2004 0.3774	2014 -0.6897			
2005 1.8797	2015 -0.3472			
2006 1.8450	2016 0.3484			
2007 2.1739	2017 0.0000			
2008 1.0638	2018 1.0417			

Number of alternatives in file = 7

Number of groups in file = 1

CAPITAL ANNUAL NON-ANNUAL OM&R

HNF-4245

Rev. 0

ALT #	ALTERNATIVE NAME	GROUP CODE	LIFE (Y/M)	INITIAL COST(\$)	REPLACEMENTS FREQ*	COST(\$)	OM&R COST(\$)	FREQ*	COST(\$)
1	Tall Stack		20/0	4150261	0/0	0	0	0/0	0
2	Dilution		20/0	5850436	0/0	0	9900	0/6	2550
3	Cont Vent		20/0	6218383	0/0	0	0	0/0	0
4	Adsorb Bed		20/0	5281490	0/0	0	245200	0/0	0
5	Short Stack		20/0	3772572	0/0	0	0	0/0	0
6	Catyalic TOX		20/0	7289111	0/0	0	0	0/0	0
7	Wet Scrub&CB		20/0	7578476	0/0	0	399400	0/0	0

*FREQ = Frequency of occurrence (in years/months)

ALT #	ALTERNATIVE NAME	GROUP CODE	ANNUAL ENERGY USE		AN. ELEC. DEMAND CHARGE(\$)
			Electric (kWh)	LPG (MBtu)	
			---#1---	---#2---	
1	Tall Stack		0	0	0
2	Dilution		481800	0	0
3	Cont Vent		0	0	0
4	Adsorb Bed		192720	0	0
5	Short Stack		0	0	0
6	Catyalic TOX		97985	3154	0
7	Wet Scrub&CB		87600	0	0

**This document was too large to scan
as a single document. It has
been divided into smaller sections.**

Section 2 of 2

Document Information			
Document #	HNF-4245	Revision	0
Title	ALTERANTIVES GENERATION & ANALYSIS FOR DST PRIMARY VENTILATION SYS EMISSIONS CONTROL & MONITORING		
Date	9/30/99		
Originator	SEDERBURG JP	Originator Co.	ARES
Recipient		Recipient Co.	
References			
Keywords			
Projects	RPP		
Other Information	PAGES E1 THRU G13		

APPENDIX E

VENDOR DATA, RECORDS OF CONVERSATION, CALCULATIONS, SKETCHES, AND DRAWINGS SPECIFIC TO ALTERNATIVES EVALUATED

TABLE OF CONTENTS FOR APPENDIX E

Option 1.....	E-3
Option 2.....	E-10
Option 3.....	E-20
Option 4.....	E-35
Option 5.....	E-43
Option 6.....	E-67
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Estimating Sheets for Ventilation AGA Options.....	E-117

OPTION 1 — SHORT STACK BASELINE LAW CASE

New 12-foot Exhaust Stack with compliant CAM, SHMS, and GCS-type instrumentation upgrades.

Reference: Project W-420 estimate.

Rev. 0

[illegible]

PLAN

241-AZ-701
GEN BLOC

241-AZ-702
VENTILATION B

241-AZ-271
CONTROL BLDG

NEW STOCK
w/ CONC TAG

4-7-1963
1-3-1963

THE CHANGING FACE OF THE AMERICAN WEST

Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECH No.	Page
—	—	—	BA MEYER		—	1

TYPICAL UNDERGROUND TANK

ENHANCED MONITORING -- BASE LINE

OPTION #1

OPTION 2 — TALL STACK (BASELINE HLW CASE)

1. See attached drawings H-2-131272 sheet 2, and H-2-131025 sheet 1 for stack and foundation to support Options 1, 4, 5 and 8 (pages 2 and 3 of this package).
2. For Option 3, see page 4 of this package.

Back out stack and foundation costs from W-420 estimate and add the attached stack and foundation cost.

[illegible]

TALL STACK FOUNDATION FOR OPTIONS
NO. 1, 4, 5 & 8

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NOTES:

1. FOR GENERAL MATTER SEE H-2-13701
2. FOR DISTRICT COURT LINES SEE H-2-13702, FOR DISTRICT COURT JURY AND RETURN LINES SEE H-2-13703 - ALSO H-2-13704, FURNISHED COUNTY SEE H-2-13705

TALL STACK FOR OPTION #3

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APPLY 30% FACTOR TO FOUNDATION
FOR OPTIONS 1, 4, 5 & 8 (H-2-131025)

A diagram showing a north arrow pointing to the left, labeled "NORTH", and a compass rose with a crosshair.

[illegible][illegible]

PLAN
SCALE 1/2" = 1'-0"
OPTION #1

CONTRACT NO.	2	DATE 02/07/98
U.S. DEPARTMENT OF ENERGY		
PLUMBING DIVISION		
241-SY-FARM		
HVAC EQUIPMENT SYSTEMS		
UPGRADE		
10-120 JAMES VENTILATION SYSTEM UPGRADE		
10-120	10-120	ES-AGA6.7-M110

DATE	10/10/97	BY	WJH	REVISION	1
DATE	10/10/97	BY	WJH	REVISION	2
DATE	10/10/97	BY	WJH	REVISION	3
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DATE	10/10/97	BY	WJH	REVISION	7
DATE	10/10/97	BY	WJH	REVISION	8
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DATE	10/10/97	BY	WJH	REVISION	11
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DATE	10/10/97	BY	WJH	REVISION	97
DATE	10/10/97	BY	WJH	REVISION	98
DATE	10/10/97	BY	WJH	REVISION	99
DATE	10/10/97	BY	WJH	REVISION	100

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NORTH

241-AZ-701
GEN BLDG

241-AZ-702
VENTILATION BLDG

241-AZ-271
CONTROL BLDG

PLAN
SCALE 3/16" = 1'-0"
OPTION #1

Page E-16

U.S. DEPARTMENT OF ENERGY	DATE: 11/02/15/79
CLIMATE CONTROL, INDIANAPOLIS, IN	
241-AZ & AZ FARM	
HVAC EQUIPMENT SYSTEMS	
UPGRADE	
ES-AGA6.7-M110	

2. PLOT SCALE 1" = 24'

U.S. DEPARTMENT OF ENERGY		241-AP FARM	
HVAC EQUIPMENT SYSTEMS		UPGRADE	
PROJECT NO.	ES-AGA6.7-M10	DATE	10/1/78
DESIGNED BY		CHECKED BY	
DRAWN BY		APPROVED BY	
SCALE	1/2" = 1'-0"	PLANT SCALE	1/2" = 1'-0"

PLAN
SCALE 1/2" = 1'-0"
OPTION #1

U.S. DEPARTMENT OF ENERGY	
241-AN FARM HVAC EQUIPMENT SYSTEMS UPGRADE	
PLUMBING, HEATING, AND AIR CONDITIONING	
ES-AGA6.7-M1.0	
2 PLAT SCALE 1/8" = 1'-0"	

PLAN
SCALE 1/8" = 1'-0"
OPTION #1

12.

Ref Dwg	Sh	Rev	Prepared By	Checked By	ECH No	Page
	-	-	BA MEYER		-	2

TYPICAL UNDERGROUND TANK

TALL STACK
OPTION #2

OPTION 3 — CLEAN AIR DILUTION

1. Fan buffalo size 365 BI SWSI 18.25 wheel diameter, 3324 rpm and 20-hp motor
2. Flanders B G series filter housing stainless steel (bag-in/bag-out)

3-high, 2-wide for GGF 24" x 24" x 11.5" HEPA filters, stainless steel with sections shown above.

3. Heater — 40 kW to heat inlet air stream for 3-high, 2-wide GGF housing shown above.
4. Interconnecting piping 304L schedule 10S welded construction.

Flanders/ CSC[®]

BG-SERIES AND KG-SERIES CONTAINMENT HOUSINGS

**Gasket Seal Filter Housings for
Bag-Out or Non Bag-Out Applications**

**For The Containment of Airborne Hazards in
In-Line Exhaust Systems**

Flanders/CSC KG-Series

Gasket Seal Non-Bag-In/Bag-Out Containment Housings

High Quality and Guaranteed Performance in a Non-Bag-In/Bag Out Filter Housing

Introduction

Industries and research facilities concerned with filtration of potentially hazardous airborne particulates or gases may have the need for a high quality, high efficiency filtration system, but do not need a system which includes the bag-in/bag-out feature.

The Flanders/CSC KG-Series is a high efficiency, side servicing filter housing that has been designed to give the user maximum quality and performance in a non-bag-in/bag-out configuration. Manufactured under stringent quality assurance controls, KG-Series housings are subjected to thorough inspections and leak tightness tests before leaving the factory, and are guaranteed to pass both DOP or Freon in-place tests. This guarantee is contingent upon the use of properly installed Flanders HEPA filters and Flanders/CSC adsorbers.

Depending on the user's requirements, the KG-Series housings may have an assortment of filter arrangements including in-place test housings, prefilters, HEPA filters and carbon adsorbers. KG-Series housings are designed to accommodate standard gasketed HEPA filters or carbon adsorbers.

System Configurations

3H2W Housings consisting of Prefilters, Upstream Test Sections, HEPA's, Adsorbers and Downstream Test Sections. Access Doors on One Side Only.

3H4W Housing consisting of two 3H2W housings in parallel. Access doors on both sides.

1H1W with separate prefilter door

1H1W

1H2W

1H3W

Basic Housings

All housings are available with optional prefilter sections behind primary filter door or with a separate prefilter door.

Ordering Information

BG-Series Housing Reference Chart (Continued on opposite page)

Modeling Size Examples

The D/6 in this model number —————> represents the two following model numbers:
BG1-1H1W-CCD-304-D1 to contain a HEPA Filter, or
BG1-1H1W-CC6-304-D1 to contain a Carbon Adsorber.

The F/12 in this model number —————> represents the two following model numbers:
BG1-1H1W-GGF-304-D1 to contain a HEPA Filter, or
BG1-1H1W-GG12-304-D1 to contain a Carbon Adsorber.

Notes

Description	Depth	Height	Weight	Weight
BG1-1H1W-CCD/6-304-D1	18"	15"	17 3/8"	75 lbs.
BG1-1H1W-CCF/12-304-D1	18"	15"	23"	85 lbs.
BG1-1H1W-CGF/12-304-D1	18"	27"	23"	100 lbs.
BG1-1H1W-CG16-304-D1	18"	27"	27 1/2"	115 lbs.
BG1-1H1W-GCF/12-304-D1	30"	15"	23"	120 lbs.
BG1-1H1W-GC16-304-D1	30"	15"	27 1/2"	140 lbs.
BG1-1H1W-GGF/12-304-D1	30"	27"	23"	145 lbs.
BG1-1H1W-GG16-304-D1	30"	27"	27 1/2"	160 lbs.
BG1-1H1W-GG18-304-D1	30"	27"	29 1/2"	165 lbs.
BG1-1H1W-2CCF/12-304-D1	18"	15"	26"	90 lbs.
BG1-1H1W-2CGF/12-304-D1	18"	27"	26"	115 lbs.
BG1-1H1W-2CG16-304-D1	18"	27"	30 1/2"	125 lbs.
BG1-1H1W-2GCF/12-304-D1	30"	15"	26"	130 lbs.
BG1-1H1W-2GC16-304-D1	30"	15"	30 1/2"	145 lbs.
BG1-1H1W-2GGF/12-304-D1	30"	27"	26"	155 lbs.
BG1-1H1W-2GG16-304-D1	30"	27"	30 1/2"	170 lbs.
BG1-1H1W-2GG18-304-D1	30"	27"	32 1/2"	175 lbs.
BG1-1H1W-2/4/6CCF/12-304-D3	18"	15"	35 3/4"	115 lbs.
BG1-1H1W-2/4/6CGF/12-304-D3	18"	27"	35 3/4"	145 lbs.
BG1-1H1W-2/4/6CG16-304-D3	18"	27"	40 1/4"	155 lbs.
BG1-1H1W-2/4/6GCF/12-304-D3	30"	15"	35 3/4"	160 lbs.
BG1-1H1W-2/4/6GC16-304-D3	30"	15"	40 1/4"	170 lbs.
BG1-1H1W-2/4/6GGF/12-304-D3	30"	27"	35 3/4"	185 lbs.
BG1-1H1W-2/4/6GG16-304-D3	30"	27"	40 1/4"	205 lbs.
BG1-1H1W-2/4/6GG18-304-D3	30"	27"	42 1/4"	210 lbs.

Ordering Information

Housing Series
BG1 = Bag-Out type,
for Gasket Seal Filters

Nominal Depth of Prefilter
2 = 2" Deep Prefilter
4 = 4" Deep Prefilter
6 = 6" Deep Prefilter
Blank = No Prefilter

Size Designator of Primary Filter
See Filter Size Designator Below

Housing Construction Material
304 = Type 304 SST¹
304L = Type 304L SST
316 = Type 316 SST
316L = Type 316L SST
ALZ = Aluminized Steel
¹ = Standard Material

BG1-1H2W-2GGF-304-D1

Number Of Filters High
1H = One Filter High
2H = Two Filters High
3H = Three Filters High
4H = Four Filters High

Number of Filters Wide
1W = One Filter Wide
2W = Two Filters Wide
3W = Three Filters Wide

Access Door Arrangement
D1 = One Access Door
D2 = Two Access Doors, One per Side
D3 = Two Access Doors on One Side
(One for Primary Filter, One for Prefilter)
D4 = Four Access Doors, Two on Each Side
(One for Primary Filter, One for Prefilter)

BG-Series Housing Reference Chart (Continued from opposite page)

BG1-1H1W-2/4/6CC-304-D1 ①	18"	15"	14"	60 lbs.
BG1-1H1W-2/4/6CG-304-D1 ①	18"	27"	14"	70 lbs.
BG1-1H1W-2/4/6GC-304-D1 ①	30"	15"	14"	80 lbs.
BG1-1H1W-2/4/6GG-304-D1 ①	30"	27"	14"	90 lbs.
BG1-1H2W-GGF/12-304-D1	30"	51"	23"	205 lbs.
BG1-1H2W-GG16-304-D1	30"	51"	27 1/2"	225 lbs.
BG1-1H2W-GG18-304-D1	30"	51"	29 1/2"	235 lbs.
BG1-1H2W-2GGF/12-304-D1	30"	51"	26"	220 lbs.
BG1-1H2W-2GG16-304-D1	30"	51"	30 1/2"	240 lbs.
BG1-1H2W-2GG18-304-D1	30"	51"	32 1/2"	250 lbs.
BG1-1H2W-2/4/6GGF/12-304-D3	30"	51"	35 3/4"	275 lbs.
BG1-1H2W-2/4/6GG16-304-D3	30"	51"	40 1/4"	295 lbs.
BG1-1H2W-2/4/6GG18-304-D3	30"	51"	42 1/4"	300 lbs.
BG1-1H2W-2/4/6GG-304-D1 ①	30"	51"	14"	120 lbs.
BG1-1H3W-GGF/12-304-D1	30"	75"	23"	265 lbs.
BG1-1H3W-GG16-304-D1	30"	75"	27 1/2"	290 lbs.
BG1-1H3W-GG18-304-D1	30"	75"	29 1/2"	300 lbs.
BG1-1H3W-2GGF/12-304-D1	30"	75"	26"	280 lbs.
BG1-1H3W-2GG16-304-D1	30"	75"	30 1/2"	305 lbs.
BG1-1H3W-2GG18-304-D1	30"	75"	32 1/2"	320 lbs.
BG1-1H3W-2/4/6GGF/12-304-D3	30"	75"	35 3/4"	350 lbs.
BG1-1H3W-2/4/6GG16-304-D3	30"	75"	40 1/4"	375 lbs.
BG1-1H3W-2/4/6GG18-304-D3	30"	75"	42 1/4"	390 lbs.
BG1-1H3W-2/4/6GG-304-D1 ①	30"	75"	14"	150 lbs.

Filter Size Designators
(HEPA Filters and Carbon Adsorbers)
Actual Filter dimensions are listed

*CCD 12" x 12" x 5 7/8"
*CCF 12" x 12" x 11 1/2"
*CGF 12" x 24" x 11 1/2"
*GCF 24" x 12" x 11 1/2"
*GGF 24" x 24" x 11 1/2"

*CC6 12" x 12" x 5 7/8"
*CC12 12" x 12" x 11 1/2"
*CG12 12" x 24" x 11 1/2"
*GC12 24" x 12" x 11 1/2"
*GG12 24" x 24" x 11 1/2"
*CG16 12" x 24" x 16"
*GC16 24" x 12" x 16"
*GG16 24" x 24" x 16"
*GG18 24" x 24" x 18"

* Insert 2, 4 or 6 to indicate a
2", 4" or 6" prefilter track.

① These housings are designed to
accommodate prefilters only.

BG and KG-Series Containment Housing Features

Standard Options

Lifting Lugs

Lifting lugs of 1/4 inch thick Type 304 stainless steel with a 1 1/2 inch diameter lifting eye can be welded to the top or side of the housing.

Drilled Flange Measurement Chart
(continued from opposite page)

Housing Size	1H1W GG	1H2W GG	1H3W GG	2H1W GG	2H2W GG	2H3W GG	3H1W GG	3H2W GG	3H3W GG	4H1W GG	4H2W GG	4H3W GG
W Width	27	51	75	27	51	75	27	51	75	27	51	75
A Horizontal Spaces	3 $\frac{41}{64}$	3 $\frac{51}{64}$	3 $\frac{43}{64}$	3 $\frac{41}{64}$	3 $\frac{51}{64}$	3 $\frac{43}{64}$	3 $\frac{41}{64}$	3 $\frac{51}{64}$	3 $\frac{43}{64}$	3 $\frac{41}{64}$	3 $\frac{51}{64}$	3 $\frac{43}{64}$
No. of Spaces (A) Between Corner Holes	7	13	20	7	13	20	7	13	20	7	13	20
H Height	30	30	30	60	60	60	90	90	90	120	120	120
B Vertical Spaces	3 $\frac{9}{16}$	3 $\frac{9}{16}$	3 $\frac{9}{16}$	3 $\frac{29}{32}$	3 $\frac{29}{32}$	3 $\frac{29}{32}$	3 $\frac{27}{32}$	3 $\frac{27}{32}$	3 $\frac{27}{32}$	3 $\frac{53}{64}$	3 $\frac{53}{64}$	3 $\frac{53}{64}$
No. of Spaces (B) Between Corner	8	8	8	15	15	15	23	23	23	31	31	31

Note: All Dimensions Are Given In Inches

HNF-4245

Rev. 0

**Size 365
BI
SWSI**

Wheel Diameter 18.25 inches

Outlet Area 1.92 sq. ft.

Limit Load H.P. Factor = 0.573

CFM	OV	1/4" SP		1/2" SP		3/4" SP		1" SP		1-1/4" SP		1-1/2" SP		2" SP		2-1/2" SP		3" SP		3-1/2" SP	
		RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
1500	782	559	0.10	673	0.17	783	0.25	885	0.33	998	0.49	1081	0.60	1250	0.93						
1800	938	628	0.14	724	0.22	819	0.30	911	0.40	1028	0.58	1105	0.69								
2100	1094	701	0.19	786	0.28	888	0.37	949	0.47	1069	0.68	1138	0.80	1273	1.05	1401	1.32				
2400	1250	778	0.26	853	0.35	926	0.45	998	0.56	1069	0.68	1138	0.80								
2700	1407	856	0.34	925	0.45	990	0.56	1055	0.67	1118	0.79	1181	0.92	1305	1.19	1425	1.48	1539	1.78	1648	2.10
3000	1563	936	0.44	1000	0.56	1059	0.68	1118	0.80	1175	0.93	1233	1.06	1346	1.35	1457	1.65	1565	1.97	1669	2.31
3300	1719	1016	0.56	1076	0.69	1131	0.82	1185	0.95	1238	1.09	1290	1.23	1394	1.52	1497	1.84	1597	2.18	1696	2.53
3600	1875	1098	0.69	1154	0.84	1205	0.98	1255	1.12	1304	1.27	1352	1.42	1448	1.73	1543	2.06	1637	2.41	1729	2.78
3900	2032	1179	0.85	1232	1.01	1281	1.17	1328	1.32	1374	1.47	1419	1.63	1507	1.96	1595	2.30	1683	2.67	1769	3.05
4200	2188	1262	1.04	1312	1.21	1358	1.38	1403	1.54	1446	1.71	1488	1.87	1571	2.22	1653	2.58	1734	2.95	1815	3.35
4500	2344	1344	1.25	1392	1.44	1436	1.61	1479	1.79	1519	1.97	1559	2.14	1637	2.51	1714	2.88	1790	3.27	1866	3.68
4800	2500	1427	1.49	1473	1.69	1515	1.88	1555	2.07	1594	2.26	1632	2.45	1706	2.83	1778	3.22	1850	3.62	1921	4.04
5100	2657	1511	1.75	1555	1.97	1595	2.18	1633	2.38	1670	2.58	1706	2.78	1777	3.18	1845	3.59	1913	4.01	1981	4.45
5400	2813	1594	2.05	1636	2.28	1675	2.51	1712	2.72	1747	2.93	1782	3.14	1849	3.57	1914	4.00	1979	4.44	2043	4.88
5700	2969	1678	2.38	1718	2.63	1756	2.87	1791	3.10	1825	3.32	1859	3.55	1923	3.99	1985	4.44	2047	4.90	2107	5.36
6000	3125	1762	2.75	1801	3.01	1837	3.27	1871	3.51	1904	3.75	1936	3.98	1998	4.45	2058	4.92	2116	5.40	2174	5.88
6300	3282	1846	3.16	1884	3.43	1918	3.70	1952	3.96	1983	4.21	2014	4.46	2074	4.95	2131	5.44	2187	5.94	2243	6.44
6600	3438	1930	3.60	1967	3.89	2000	4.17	2032	4.45	2063	4.71	2093	4.97	2150	5.49	2206	6.00	2260	6.52	2313	7.04
6900	3594	2015	4.08	2050	4.39	2082	4.69	2113	4.97	2143	5.25	2172	5.53	2228	6.07	2281	6.61	2334	7.15	2385	7.69
7200	3750	2099	4.61	2133	4.93	2165	5.24	2195	5.54	2224	5.84	2252	6.13	2306	6.70	2357	7.26	2408	7.82	2458	8.38
3000	1563	1768	2.65	1884	3.27	1973	3.65	2078	4.38	2159	4.78	2257	5.58	2332	6.03	2405	6.49	2476	6.96	2546	7.44
3300	1719	1791	2.89	1908	3.55	1994	3.95	2102	4.69	2180	5.13	2257	5.58	2332	6.03	2405	6.49	2476	6.96	2546	7.44
3600	1875	1820	3.15	1939	3.85	2021	4.27	2130	5.05	2206	5.51	2280	5.97	2353	6.45	2425	6.92	2494	7.41	2563	7.90
3900	2032	1855	3.44	1975	4.18	2053	4.61	2164	5.44	2237	5.91	2308	6.39	2379	6.88	2448	7.38	2516	7.89	2582	8.40
4200	2188	1895	3.75	1975	4.18	2053	4.61	2164	5.44	2237	5.91	2308	6.39	2379	6.88	2448	7.38	2516	7.89	2582	8.40
4500	2344	1942	4.10	2017	4.53	2091	4.98	2184	5.88	2257	6.35	2341	6.84	2409	7.35	2475	7.86	2541	8.38	2606	8.92
4800	2500	1993	4.48	2063	4.93	2134	5.39	2227	6.32	2301	6.81	2378	7.32	2443	7.85	2507	8.37	2570	8.91	2633	9.46
5100	2657	2048	4.89	2114	5.35	2181	5.83	2274	6.81	2348	7.32	2425	7.85	2490	8.37	2553	8.91	2615	9.46	2676	9.99
5400	2813	2108	5.35	2170	5.82	2233	6.31	2295	6.81	2358	7.32	2420	7.84	2482	8.38	2543	8.92	2604	9.46	2664	9.99
5700	2969	2168	5.84	2228	6.33	2288	6.83	2347	7.34	2407	7.87	2466	8.40	2525	8.95	2584	9.51	2642	10.1	2700	10.7
6000	3125	2232	6.37	2289	6.88	2346	7.39	2403	7.92	2460	8.46	2516	9.01	2572	9.57	2629	10.1	2684	10.7	2740	11.3
6300	3282	2298	6.95	2353	7.47	2407	8.00	2461	8.54	2515	9.09	2569	9.65	2623	10.2	2677	10.8	2730	11.4	2784	12.0
6600	3438	2366	7.57	2418	8.11	2471	8.65	2522	9.21	2574	9.77	2626	10.3	2677	10.9	2728	11.5	2779	12.1	2831	12.8
6900	3594	2436	8.24	2486	8.79	2536	9.35	2586	9.92	2635	10.5	2685	11.1	2734	11.7	2783	12.3	2832	12.9	2881	13.6
7200	3750	2507	8.95	2555	9.52	2603	10.1	2651	10.7	2698	11.3	2745	11.9	2793	12.5	2840	13.1	2887	13.8	2934	14.5
7500	3907	2579	9.71	2625	10.3	2672	10.9	2718	11.5	2764	12.1	2809	12.7	2855	13.4	2900	14.0	2945	14.6	2990	15.3
7800	4063	2652	10.5	2697	11.1	2742	11.7	2786	12.3	2830	12.9	2874	13.5	2918	14.2	2962	14.8	3005	15.5	3049	16.2
8100	4219	2726	11.3	2769	12.0	2813	12.6	2856	13.3	2898	13.9	2941	14.6	2983	15.2	3025	15.9	3067	16.6	3109	17.3
8400	4375	2800	12.3	2843	12.9	2885	13.5	2926	14.3	2968	14.9	3009	15.6	3050	16.3	3090	17.0	3131	17.7	3171	18.3
8700	4532	2875	13.3	2917	13.9	2958	14.6	2998	15.3	3038	16.0	3078	16.7	3118	17.4	3157	18.1	3196	18.8	3235	19.5
4500	2344	2648	8.32	2775	9.87	2894	11.7	3008	13.5	3117	15.4	3223	17.5								
4800	2500	2669	9.45	2794	10.5	2914	11.7	3028	13.5	3137	15.4	3243	17.5								
5100	2657	2695	10.6	2819	11.8	2939	12.3	3053	14.2	3162	16.1	3268	18.3								
5400	2813	2724	10.8	2842	11.9	2962	12.3	3076	14.2	3185	16.1	3291	18.3								
5700	2969	2758	11.2	2871	12.3	2991	12.7	3105	14.9	3214	16.2	3322	18.5								
6000	3125	2795	11.9	2905	12.9	3025	13.4	3139	15.7	3248	17.0	3356	19.3								
6300	3282	2837	12.6	2942	13.3	3062	14.2	3176	16.6	3285	17.8	3399	20.1								
6600	3438	2882	13.3	2983	14.0	3103	14.7	3217	17.4	3326	18.7	3440	21.0								
6900	3594	2930	14.2	3027	14.8	3144	15.6	3254	18.2	3363	19.6	3477	21.9								
7200	3750	2981	15.1	3075	15.6	3192	16.4	3300	19.1	3409	20.6	3522	22.8								
7500	3907	3036	16.0	3125	16.5	3240	17.3	3344	20.0	3453	21.5	3566	23.7								
7800	4063	3092	16.9	3179	17.4	3294	18.2	3398	20.9	3507	22.4	3620	24.6								
8100	4219	3151	17.9	3233	18.3	3348	19.1	3452	21.8	3551	23.3	3673	25.5								
8400	4375	3212	18.9	3292	19.3	3407	20.0	3511	22.7	3610	24.2	3732	26.4								
8700	4532	3275	20.2	3353	20.8	3468	20.9	3572	23.6	3671	25.1	3793	27.3								
9000	4688	3338	21.8	3414	21.5	3529	21.9	3633	24.5	3732	26.0	3854	28.2								

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Ratings:

- Class I - Black on White
- Class II - Black on Light Blue
- Class III - Black on Dark Blue

Ratings are at 70° F and 29.92" Hg barometer.

The underlined figures indicate maximum static efficiency

Performance shown is for installation Type B: Free Inlet, Ducted Outlet or
Installation Type D: Ducted Inlet, Ducted Outlet per AMCA publication 210-85.
BHP does not include drive losses.
Ratings are for a base unit and do not include the effects of airstream
appurtenances. The addition of appurtenances may affect the performance.

4045

SDF2001

buffalo forge
An American-Patented Company
Buffalo, N.Y. U.S.A.

CL 1 & 2

AEROCLINE FANS

ARR 1 SIZE 245-1460
ARR 4 SIZE 245-730
ARR 9 SIZE 245-1200
ARR 10 SIZE 245-730

FOUNDATION PLAN VIEW

245 to 540

600 to 1200

1320 to 1460

SIZE

245 to 540

600 to 1200

1320 to 1460

FOUNDATION PLAN VIEW

245 to 540

600 to 1200

1320 to 1460

ARR 1 SIZE 245-1460
ARR 4 SIZE 245-730
ARR 9 SIZE 245-1200
ARR 10 SIZE 245-730

FOUNDATION PLAN VIEW

245 to 540

600 to 1200

1320 to 1460

ARR 1 SIZE 245-1460
ARR 4 SIZE 245-730
ARR 9 SIZE 245-1200
ARR 10 SIZE 245-730

FOUNDATION PLAN VIEW

245 to 540

600 to 1200

1320 to 1460

ARR 1 SIZE 245-1460
ARR 4 SIZE 245-730
ARR 9 SIZE 245-1200
ARR 10 SIZE 245-730

FOUNDATION PLAN VIEW

245 to 540

600 to 1200

1320 to 1460

ARR 1 SIZE 245-1460
ARR 4 SIZE 245-730
ARR 9 SIZE 245-1200
ARR 10 SIZE 245-730

FOUNDATION PLAN VIEW

245 to 540

600 to 1200

1320 to 1460

ARR 1 SIZE 245-1460
ARR 4 SIZE 245-730
ARR 9 SIZE 245-1200
ARR 10 SIZE 245-730

FOUNDATION PLAN VIEW

245 to 540

600 to 1200

1320 to 1460

ARR 1 SIZE 245-1460
ARR 4 SIZE 245-730
ARR 9 SIZE 245-1200
ARR 10 SIZE 245-730

FOUNDATION PLAN VIEW

245 to 540

600 to 1200

1320 to 1460

ARR 1 SIZE 245-1460
ARR 4 SIZE 245-730
ARR 9 SIZE 245-1200
ARR 10 SIZE 245-730

FOUNDATION PLAN VIEW

245 to 540

600 to 1200

1320 to 1460

ARR 1 SIZE 245-1460
ARR 4 SIZE 245-730
ARR 9 SIZE 245-1200
ARR 10 SIZE 245-730

FOUNDATION PLAN VIEW

245 to 540

600 to 1200

1320 to 1460

ARR 1 SIZE 245-1460
ARR 4 SIZE 245-730
ARR 9 SIZE 245-1200
ARR 10 SIZE 245-730

FOUNDATION PLAN VIEW

245 to 540

600 to 1200

1320 to 1460

ARR 1 SIZE 245-1460
ARR 4 SIZE 245-730
ARR 9 SIZE 245-1200
ARR 10 SIZE 245-730

FOUNDATION PLAN VIEW

245 to 540

600 to 1200

1320 to 1460

ARR 1 SIZE 245-1460
ARR 4 SIZE 245-730
ARR 9 SIZE 245-1200
ARR 10 SIZE 245-730

FOUNDATION PLAN VIEW

245 to 540

600 to 1200

1320 to 1460

ARR 1 SIZE 245-1460
ARR 4 SIZE 245-730
ARR 9 SIZE 245-1200
ARR 10 SIZE 245-730

FOUNDATION PLAN VIEW

245 to 540

600 to 1200

1320 to 1460

NOTE: Dimensions are approximate. Do not use for construction.

14

A

SCALE: 1/2" = 1'-0"

Ref Dwg	Sh	Rev	Prepared By	Checked By	ECN No	Page
	-	-	BA MEYER		-	3

TYPICAL UNDERGROUND TANK

CLEAN AIR DILUTION

OPTION #3

SOLUTION TO TEMPORARY
CONDITION IN 2-3 WEEKS
EACH MONTH

U.S. DEPARTMENT OF ENERGY	
241-AW FARM	
HVAC EQUIPMENT SYSTEMS	
UPGRADE	
ES-AGA6.7-M3	0

PLAN
SCALE: 1/2" = 1'-0"
OPTION #3

REF. NO.	REF. NUMBER	REF. TITLE	REF. USED ON
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
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7	7	7	7
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U.S. DEPARTMENT OF ENERGY	
241-AN FARM	
HVAC EQUIPMENT SYSTEMS	
UPGRADE	
ES-AGA6.7-M3.0

PLAN
SCALE: 1/8" = 1'-0"

OPTION #3

REVISION	DATE	BY	CHKD	APPD	DESCRIPTION
1	02/07/99				ISSUED FOR CONSTRUCTION
2	02/07/99				REVISED TO SHOW REVISIONS
3	02/07/99				REVISED TO SHOW REVISIONS
4	02/07/99				REVISED TO SHOW REVISIONS
5	02/07/99				REVISED TO SHOW REVISIONS
6	02/07/99				REVISED TO SHOW REVISIONS
7	02/07/99				REVISED TO SHOW REVISIONS
8	02/07/99				REVISED TO SHOW REVISIONS
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100	02/07/99				REVISED TO SHOW REVISIONS

U.S. DEPARTMENT OF ENERGY	
FLUOR DUNEL, BOSTON, MA	
241-AP FARM	
HVAC EQUIPMENT SYSTEMS	
UPGRADE	
DATE	12/07/98
BY	ES-AGA6.7-M3
NO.	0
3. PLOT SCALE: 1"=24'

PLAN
SCALE: 1/8" = 1'-0"
OPTION #3

REV	NO	DATE	DESCRIPTION
1	0	12/07/98	ISSUED FOR CONSTRUCTION

HNF-4245
Rev. 0

NORTH

241-AZ-701
GEN BLDG

241-AZ-702
VENTILATION BLDG

241-AZ-271
CONTROL BLDG

EXIST 24" STACK TO BE
REMOVED

EXIST ELECTRICAL WEAIR

NEW 10" PWC

NEW 12" APPROX

NEW 24" STACK
W/ CONC PAD

EXISTED PLASTER W/ CORNER
APPROX 6'-0" x 6'-0"

EXIST CONC PAD
APPROX 3'-0" x 6'-0"

STANDARD HYDRO MONITOR STATION
8'-0" x 7'-0"

CLEAN AIR DILUTION
8'-0" x 30'-0"
NOTE: BOOSTER CON / AIR
SHALL BE HIGH VOLUME

ONE CHANGEOVER SYSTEM
8'-0" x 10'-0"

PLAN
SCALE: 3/16" = 1'-0"
OPTION #3

U.S. DEPARTMENT OF ENERGY	
FLUKE BUREAU, BOSTON, MASS.	
241-AZ & AZ FARM	
HVAC EQUIPMENT SYSTEMS	
UPGRADE	
DATE	11/1/78
BY	ES-AGA6.7-M3
CHKD	10
APP'D	
DESIGNED BY	
CHECKED BY	
IN CHARGE	
SCALE	1" = 24'

OPTION 4 — CONTROL GAS VENTING RATE

1. Local and remote indication and alarm

HNF-4245

Rev. 0

A	B
AN-103	12"
AN-104	12"
AN-105	12"
AP-102	12"
AP-104	12"
AP-108	12"
AW-101	12"
AY-101	12"
AY-102	12"
AZ-101	12"
AZ-102	12"
SY-101	12"
SY-102	12"

(4) 1/2" SST TUBE
TO CAM

SECTION C-C

HNF-4245

Rev. 0

TO: Flour Daniel Northwest
1135 Jadwin Ave.
Richland, WA 99352
Attn: Will Thomas
Phone: 509-376-7578

REFERENCE: Toxic/Combustible Gas Monitors

ITEM NO.	QTY.	DESCRIPTION	UNIT PRICE	TOTAL
1	1	Model TDX-2400 Explosion proof Sensor/Transmitter, NH ₃ 0-100ppm • 4-20ma Signal output	\$1,395.00	\$1,395.00
2	1	Model EX-5000-MOS Explosion proof Sensor/Transmitter, H ₂ 0-50% LEL • 4-20ma Signal output	\$ 895.00	\$ 895.00
3	1	Model 24VDC Gas Sampler Non-Explosion proof with nema 4x fiberglass enclosure	\$1,095.00	\$1,095.00
4	1	Sensor chambers for both NH ₃ & H ₂ Sensor/Transmitters	\$295.00	\$295.00

Assistance in system installation is available from ENMET on a per man-day basis, plus travel and living expenses.

ALL PRICES ARE QUOTED IN U.S. DOLLARS, F.O.B., ANN ARBOR, MICHIGAN, USA.
THIS QUOTATION IS FIRM FOR 30 DAYS.

DELIVERY: 4-6 Wks (App) DATE: February 10, 1999
TERMS: To be determined SIGNED: [Signature]

Page E-37

Randy Bondy

THE MAJOR ATMOSPHERIC HAZARDS IN CONFINED SPACES: OXYGEN, COMBUSTIBLE, AND TOXIC GASES

HNF-4245

Rev. 0

Key

NIOSH = Health Related
 OSHA = Safety Related
 LEL = Lower Explosive Limit
 TWA = Time Weighted Average
 IDLH = Immediately Dangerous to Life or Health

UEL = Upper Explosive Limit
 TLV = Threshold Limit Value
 PPM = Parts Per Million (1% = 10,000 ppm)
 STEL = Short Term Exposure Limit

HNF-4245

Rev. 0

HNF-4245
Rev. 0

TDX-Series

Explosionproof Toxic
Sensor/Transmitter

FIGURE 4: SENSOR/TRANSMITTER EXPLOSIONPROOF ENCLOSURE DIMENSIONAL DIAGRAM

HNF-4245
Rev. 0

TOP VIEW

$\frac{\text{IN}}{\text{MM}}$

SIDE VIEW

NOTES : UNLESS OTHERWISE SPECIFIED

[illegible]

OPTION 5 — DRY ADSORPTION BED (CARBON)

1. Flame Arrestor — 2 each DFA 1608/C-66R units, 316 SST. Enardo Mfg. Co.

Price each \$18,275

TOTAL \$36,550

Shipping weight = 3,400 lbs. for two

2. Charcoal Adsorbers — Cameron Environmental Inc.

1 each TSU-1000R stainless steel radial-flow carbon adsorber filled with CEI-R 4x6 mesh carbon — \$7,995

1 each TSU-1000R stainless steel radial-flow carbon adsorber filled with CEI-NHC citric acid-impregnated carbon for ammonia removal — \$8,750

3. HEPA Filters — Flanders

2 each GIF-GGF-304 HEPA filter housings

4. Fan — 20-hp, 1000 cfm @ 15" WG

5. CO₂ Fire Suppression System

6. Insulate and heat trace all piping (ducting) and carbon adsorbers

7. Interconnecting piping 304L schedule 10S welded construction

Fan selection carbon bed @ 1000 cfm

ΔPs:	1. TSU-1000 R unit, 2 each @ 2"	= 4" WG
	2. Flame Arrestor, 2 in parallel	= 3.2" WG
	3. HEPA Filter	~ 2.0" WG
	4. Piping, valves, dampers	<u>~ 6" WG</u>
		15.2" WG

From fan catalog Buffalo, 1000 cfm @ ~15" H₂O out-of-range, assume a 20-hp fan.

Flanders / ESC®

G-SERIES FILTER HOUSING FOR BAG-IN/BAG-OUT APPLICATIONS

**For The Containment of Airborne Hazards in
In-Line Exhaust Systems**

Ordering Information

G-Series Model Number Designations

G1F - GGF - 304

HOUSING SERIES / TYPE

G1F = Bag-In/Bag-Out Fluid Seal
(For non-bag-out applications delete bags and straps)

HOUSING MATERIAL TYPE

304 = Type 304 Stainless Steel*
304L = Type 304L Stainless Steel
316 = Type 316 Stainless Steel
316L = Type 316L Stainless Steel
* Standard Material

PRIMARY FILTER SIZE

(High) (Wide) (Deep)*

CCD = 12" X 12" X 5 7/8" (Filter)
CCF = 12" X 12" X 11 1/2" (Filter)
CC12 = 12" X 12" X 12 1/4" (Adsorber)

(High) (Wide) (Deep)*

GGD = 24" X 24" X 5 7/8" (Filter)
GGF = 24" X 24" X 11 1/2" (Filter)
GG12 = 24" X 24" X 12 1/4" (Adsorber)
GG16 = 24" X 24" X 16 3/4" (Adsorber)
GG18 = 24" X 24" X 18 3/4" (Adsorber)

*In Direction of Air Flow

Model Number	Filter Type	Housing Dimensions (inches)			Filter Dimensions (inches)			Flow Capacity (CFM)
		X	Y	Z	HEIGHT	WIDTH	DEPTH	
G1F-CCD-304	CCD	22 1/8"	24"	18 1/8"	12"	12"	5 7/8"	105 CFM
G1F-CCF-304	CCF	22 1/8"	24"	18 1/8"	12"	12"	11 1/2"	160 CFM
G1F-CC12-304	CC12	22 1/8"	24"	18 1/8"	12"	12"	12 1/4"	165 CFM
G1F-GGD-304	GGD	40 1/8"	24"	36 1/8"	24"	24"	5 7/8"	500 CFM
G1F-GGF-304	GGF	40 1/8"	24"	36 1/8"	24"	24"	11 1/2"	1000 CFM
G1F-GG12-304	GG12	40 1/8"	24"	36 1/8"	24"	24"	12 1/4"	1000 CFM
G1F-GG16-304	GG16	40 1/8"	28"	36 1/8"	24"	24"	16 3/4"	1000 CFM
G1F-GG18-304	GG18	40 1/8"	28"	36 1/8"	24"	24"	18 3/4"	1250 CFM

High Pressure Housings

Add 7 1/2" to the "Y" (Height) dimension for High Pressure G-Series Housings and use the Suffix (SP) in the model number. Example: G1F-GGF-304(SP) SP=High Pressure Design, Customer to specify pressure.

CAMERON

ENVIRONMENTAL, INC.

527 Van Ness Ave. Torrance, CA 90501

Tel: 310.212.0610 • Fax: 310.212.7222

HNF-4245

Rev. 0

*Activated Carbon, Pollution Control Systems
and Waste Management Services* **Fax Cover Sheet**

TO: Dan Evans
COMPANY: Fluor Daniel
FAX #: 509-373-5712
PHONE #: 509-373-2688

FROM: Chuck Jarnecke
DATE: December 15, 1998
PAGE: 1 OF 3
QUOTE: 1843

Dear Mr. Evans,

I have some options for your consideration for stainless steel carbon filters.

Option 1: (Highly recommended to keep the static pressure low for a smaller fan)

2 each TSU-1000R Stainless Steel radial flow carbon adsorbers filled with standard CEI-R 4x6 mesh activated carbon	\$ 7,995.00 each	\$ 15,990.00
2 each TSU-1000R Stainless Steel radial flow carbon adsorbers filled with CEI-NHC citric acid impregnated carbon for Ammonia removal	\$ 8,750.00 each	\$ 17,500.00

Option 2:

2 each TSU-1000S Stainless Steel deep bed carbon adsorbers filled with standard CEI-R 4x6 mesh activated carbon	\$ 9,750.00 each	\$ 19,500.00
2 each TSU-1000S Stainless Steel deep bed carbon adsorbers filled with CEI-NHC citric acid impregnated carbon for Ammonia removal	\$ 10,505.00 each	\$ 21,010.00

The other option is too expensive and is on larger stainless steel vessels (\$ 16,000.00 per vessel plus carbon). I highly recommend the TSU-1000R vessels based on the fact that the static pressure across this unit is less than 1" W.C. If you run 4 of these units in series, the estimated static pressure across all of the units should be less than 10" including interconnecting ducting/piping.

I can fabricate these units in time to ship to you by the middle of January only if I can get you to issue a purchase order no later than the end of this week. If we don't get an order by then, I won't be able to guarantee delivery by the 3rd week in January. Please call me to discuss this further if you would like. Once you make a decision, Dave McKenzie with Cincinnati Fan should be notified so that he can adjust the size of his fan selection to meet your needs.

HNF-4245

Rev. 0

You requested information on the result of ammonia passing through our CEI-NHC impregnated carbon. The ammonia/CEI-NHC reaction that takes place results in the formation of sodium citrate.

I have included an actual shop drawing of the TSU-1000S stainless steel unit for your consideration. The specification sheet is slightly different and the shop drawing does not show the 4" FNPT connection ports which will be located in the same position as the specification sheet indicates. Call me to discuss this further if you wish. I will be in the office all day today. Thanks for your request for quotation on our products. I look forward to talking with you soon.

Best regards,

Cameron Environmental, Inc.

Chuck Jarnecke

Director of Sales and Marketing

HNH-4245

Rev. 0

HNF-4245

Rev. 0

ENVIRONMENTAL, INC.

527 Van Ness Ave. Torrance, CA 90501

Tel: 310.212.0610 • Fax: 310.212.7222

*Activated Carbon . Pollution Control Systems
and Waste Management Services* **Fax Cover Sheet**

TO: Dan Evans
COMPANY: Fluor Daniel
FAX #: 509-373-5712
PHONE #: 509-373-2688

FROM: Chuck Jarnecke
DATE: December 15, 1998
PAGE: 1 OF 10

Dear Mr. Evans,

Per our discussion this morning, please find the specification sheets on a couple of our vapor phase activated carbon unit. I will be providing you the pricing later today on your options for either of these units in stainless steel. Per our discussion, I think it best to possibly consider the TSU-1000R if at all possible if indeed you plan to run (4) units in series. Two of the unit with carbon and two with the ammonia carbon our CEI-NHC.

If you select (4) of the TSU-1000R units and run them in series, the static pressure across the (4) units combined would be an estimated 4 inches, however interconnecting ducting would also add to the equation. I would estimate somewhere around 8 - 12 inches of total static pressure depending on how many elbows, etc you have figured into the connective piping.

I have included a general graph on static pressure through 12" of carbon of various mesh sizes at various velocities. I have also included our specification on the CEI-NHC impregnated carbon as well as a couple of short articles on activated carbon. I will be back with you a bit later for further discussion.

Best regards,
Cameron Environmental, Inc.

Chuck Jarnecke
Director of Sales and Marketing

HNF-4245

Rev. 0

CAMERON

ENVIRONMENTAL, INC.

Activated Carbon, Pollution Control Systems
and Waste Management Services

TUB SCRUB UNIT

- TSU-1000R - TSU-1500R -

The radial flow Tub Scrub carbon adsorber units are designed for the efficient purification of your contaminated vapor waste or process stream. The shallow carbon bed in these uniquely designed vessels allows for the processing of high flows at extremely low pressure drop. In service nationwide, these adsorbers have a proven ability to remove organic contaminants to non-detectable levels.

To provide long life and superior corrosion resistance, these radial flow vessels are constructed of heavy duty mild steel, and are lined with a high thickness epoxy coating. The adsorber internals consist of a distributor tube and retention screen for high quality activated carbon. Inlet vapors enter the distributor tube, then proceed horizontally through the carbon bed, and then through the retention screen to free air space inside the canister wall. The purified vapors then travel to the upper collection area to exit the outlet duct. These units are also equipped with forklift channels to ease the process of vessel maintenance and carbon servicing.

These adsorbers will arrive from our warehouse ready for connection to your process piping; filled with high quality activated carbon. Once the carbon is "spent", Cameron Environmental provides a number of service and disposal options to meet each site's specific needs. Please call our service department when a carbon changeout is needed.

SPECIFICATIONS: TSU: 1000R 1500R

Inlet/Outlet Connections (duct):	10"	10"
Height:	90"	90"
Diameter:	48"	48"
Maximum Flow (cfm)	4,500	3,000
Maximum Pressure (psi):	3	3
Maximum Temperature (°F):	170	170
Carbon Capacity		

Volume (cubic feet)	33	50
Weight (lbs)	1,000	1,500

Approximate Shipping Weight (lbs)	1,650	2,150
-----------------------------------	-------	-------

CEI Warrants that these units are manufactured in accordance with the specifications herein. No warranty, expressed or implied, is made relating to the suitability of the product for any particular application or purpose.

In the presence of activated carbon, some contaminants may oxidize, polymerize or otherwise react resulting in the release of heat and a potential fire hazard. Extreme care should be taken in the design and operation of such applications.

HNF-4245

Rev. 0

CAMERON
 ENVIRONMENTAL, INC.

*Activated Carbon, Pollution Control Systems
 and Waste Management Services*

TUB SCRUB UNIT

- TSU-1000S - TSU-2000S -

The TSU-1000S and TSU-2000S Tub Scrub carbon adsorber units are designed for the efficient purification of your contaminated vapor waste or process stream. In service nationwide, these adsorbers have a proven ability to remove organic contaminants to non-detectable levels.

To provide long life and superior corrosion resistance, these vessels are constructed of heavy duty mild steel, and are lined with a high thickness fusion bonded epoxy coating. Up-flow operation is recommended. These units are also equipped with forklift channels to ease the process of vessel maintenance and carbon servicing.

These adsorbers will arrive from our warehouse ready for connection to your process piping; filled with high quality activated carbon. Once the carbon is "spent", Cameron Environmental provides a number of service and disposal options to meet each site's specific needs. Please call our service department when a carbon changeout is needed.

SPECIFICATIONS:

	<u>TSU-1000S</u>	<u>TSU-2000S</u>
Inlet/Outlet Connections (fnpt):	4"	4"
Manway	16"	16"
Height:	64"	88"
Diameter:	46"	46"
Maximum Flow (cfm)	600	600
Maximum Pressure (psi):	15	15
Maximum Temperature (°F):	175	175
Carbon Capacity		
Volume (cubic feet)	34	67
Weight (lbs)	1,000	2,000
Approximate Shipping Weight (lbs)	1,800	2,950

CEI Warrants that these units are manufactured in accordance with the specifications herein. No warranty, expressed or implied, is made relating to the suitability of the product for any particular application or purpose.

In the presence of activated carbon, some contaminants may oxidize, polymerize or otherwise react resulting in the release of heat and a potential fire hazard. Extreme care should be taken in the design and operation of such applications.

HNF-4245

Rev. 0

CAMERON

Environmental, Inc.*Activated Carbon & Pollution Control System*

CEI-NHC Activated Carbon

Cameron Environmental's CEI-NHC activated carbon is impregnated with citric acid and is designed to efficiently remove ammonia vapors. This carbon is a high activity specially treated, activated carbon.

PHYSICAL PROPERTIES:

Base Material

Carbon Tetrachloride Activity (CTC):	60 minimum
Apparent Density (lbs./cu. ft.)	30 average
Hardness (Ball Abrasion):	95 minimum
Moisture Content:	4% maximum
Mesh Sizes*:	4x8, 4x10, 6x12

*custom sizing available

Treatment

Apparent Density (lbs./cu.ft.):	44 average
Moisture Content:	10% maximum
Ammonia Removal Capacity:	16%* minimum

- This equals 30% of the weight of the base activated carbon before treatment.

These specifications represent general parameters and are subject to change. Please consult with CEI before processing with your applications.

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527 Van Ness, Avenue, Torrance, California 90501

Phone: 310.212.0610 • Fax: 310.212.7222

HNF-4245

Rev. 0

INCHES WG per 12" BED

HNF-4245

Rev. 0

ENARDO MANUFACTURING CO.
4470 South 70th East Avenue
TULSA, OKLAHOMA 74145-4607 • U.S.A.
Telephone 1-918-622-6161 • Fax 1-918-622-0004

TOLL FREE 1-800-3ENARDO

QUOTATION NO. 99-5664G
REFERENCE: RFQ - Detonation Arrestor

Date: February 4, 1999
Page : 1 of 5

Fluor Daniel Northwest
Attn: Mr. Jack Nicholson
Ph: 509-372-1656
Fax: 509-376-9766

From: Sam Garman
Technical Sales

1.	2	DFA 1608/C-66R	8" Detonation Flame Arrestor 316 S.S. Housing with 150lb RF Flange Connection with 316 Stainless Steel Group "C" Flame Element Assembly	\$ 18,275.00	\$ 36,550.00
Approx. Weight Each - 1,700 lbs					

NOTES: **Ship Date: 10 to 12 weeks from receipt of approved order.**
 SEE ATTACHED SPECIFICATIONS
 EX WORKS FACTORY - TULSA, OKLAHOMA

Best Regards,

Sam Garman
Technical Sales

IF YOU DO NOT RECEIVE ALL PAGES AS INDICATED ABOVE PLEASE CALL!

QTDASSC.DOC

ENARDO DETONATION FLAME ARRESTOR SPECIFICATION AND NOTATION DATA

CUSTOMER: Fluor Daniel Northwest
 ENARDO QUOTATION NO. 99-5664G

February 4, 1999

The following specifications apply to Model DFA 1608/C-66R

OPERATING CONDITIONS: (Split Flow - 2 units required)

MAX. GAS FLOW	500 scfm
INLET PRESSURE	Atmos.
Mol. Wt.	29 (air)
TEMPERATURE	60 F (ambient)

CALCULATED:

PRESSURE DROP - 3.2 inH₂O

MATERIALS AND DESIGN:

- 1.1 Housing and flange material: ASTM A-240 316L Stainless steel painted with a stainless steel impregnated paint.
- 1.2 Detonation flame element: Crimped ribbon type wound from AISI 316 Stainless steel material.
- 1.3 Interior flange gaskets: 1/16" tk. compressed non-asbestos.
- 1.4 Fasteners on the body section: Stainless steel studs and nuts. It does not include end connection fasteners or gaskets.
- 1.5 Options: None specified.

FEATURES AND SPECIFICATIONS:

- 2.1 The detonation flame arrestor element is removable using jack studs to spread the unit while maintaining the integrity of the piping when removing the flame arrestor element assembly and will include a lifting lug.
- 2.2 The element assembly is hinged to allow it to swing free of the housing assembly providing easier and quicker inspection and maintenance.
- 2.3 The ENARDO detonation flame arrestor is U.S. COAST GUARD ACCEPTED as bi-directional and will prevent detonation flame propagation when installed in a piping system with an initial pressure less than or equal to 20.7 psia. This unit is USCG rated Type II, continuous burning against the flame cell element is limited to 15 minutes. If burning against the element for an extended period of time is possible the flow would need to be extinguished by either a shut-off of the gas flow or by dilution of the gas flow. This unit is designed for NEC Group C gas or no greater than 0.65 mm MESG vapors.
- 2.4 All welding will be in accordance with ASME SECTION VIII, Div. I.
- 2.5 The unit will be pressure tested to 10 psig. Unit design pressure is 375 psig.
- 2.6 No post weld heat treat and no radiography testing included in the base price.
- 2.7 Material and workmanship are guaranteed for 12 months from ship date. The Enardo warranty provides replacement of the defective part FOB Tulsa, OK., incidental damages are not covered.
- 2.8 Approval drawings will be provided within one week from receipt of order. The manufacturing will begin upon return receipt of the approved drawing, unless the design approval is waived by the customer.

NOTATIONS:

- 3.1 No shipping, third party inspection, duty or taxes are included in the pricing.
- 3.2 No field installation by Enardo Manufacturing Company.
- 3.3 The quotation is valid for 90 days from quotation date.

IMPORTANT:

THE CONNECTING PIPING SHOULD BE DESIGNED TO SUPPORT THE WEIGHT OF THIS UNIT.

DFA-66C-Rev00-12/97

Enardo Manufacturing Company

4470 S. 70th E. Ave. - Tulsa, Oklahoma 74145

FC0063A

DFA 1608/C

Detonation Flame Arrestor

PRESSURE

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DEA SERIES**DETONATION FLAME ARRESTOR**

- Bi-directional Element
- Minimal Pressure Drop

- U.S. Coast Guard Accepted
- Type I Flame Stabilization Rating

- Removable Element
- Minimal Clogging

ENARDO DETONATION FLAME ARRESTORS

represent the ultimate in flame arrestment protection. They provide positive protection against flame propagation in piping systems that are manifolded or have long runs. These arrestors are bi-directional and can stop an ignited flammable vapor mixture approaching from either direction that can be traveling at subsonic or supersonic velocities. Enardo utilizes an element assembly that dampens the high velocities and pressures associated with deflagrations and detonations, while quenching the flame front. Our design is unique in the ability to provide larger flame channels which requires less frequent maintenance and greater ease in cleaning when service is required. The element is so unique that there is a patent pending on our design. This unit offers maximum flow to pressure drop characteristics enhancing the value of our product to any system.

SPECIFICATIONS: Our models have been independently tested to the U.S. Standard as published in the Federal Register; Appendix A to 33 CFR Part 154 and received acceptance from the U.S. Coast Guard. They are rated Type 1 for flame stabilization and an initial operating pressure of 22.7 psia for gases and vapors that have a MESG not less than 0.90mm. They have also been tested to the Canadian Standard Association (CSA) Z343 Rv. 12. The results prove our design meets or exceeds all criteria. All welding is performed in accordance with ASME Boiler and Pressure Vessel Code Section VIII

CONSTRUCTION

Standard Materials: *Housing* is ASTM A-234 and ASTM A-36 welded carbon steel with ANSI B16.5 150 lb. and/or 300 lb. flanges. *Arrestor assembly* is AISI 304 or 316 stainless steel material with ASTM A-36 carbon steel shell. The minimum MESG is 0.90mm for NEC Group D or IEC Group I and IIA vapors.

Options: All stainless steel materials, special alloy materials, flanged or NPT fittings for drains, pressure taps, temperature probes and/or cleaning ports. Eccentric and custom designs for unique applications. Auxiliary systems for flame sensor notification, shutdown, inerting and or enriching systems.

ORDERING INFORMATION

Consult Enardo sales engineers with specific application data for model selection. Information required would include; Connection size, Operating/Maximum rate of flow, system pressure, desired pressure drop, Gas group, Housing and Element materials, Options desired.

ENARDO MANUFACTURING CO.

Post Office Box 266
Tulsa, Oklahoma 74101
(918) 835-6974
(800) 336-2736 U.S. & Canada
FAX (918) 835-0044

MODEL	A CONNECTION SIZE	B HOUSING SIZE	C OUTSIDE DIAMETER	D OVERALL LENGTH**
DFA-401	1"	4"	9"	20"
DFA-602	2"	6"	11"	24"
DFA-803	3"	8"	13-1/2"	26"
DFA-1004	4"	10"	16"	32"
DFA-1206	6"	12"	19"	36"
DFA-1608	8"	16"	25-1/2"	51-1/4"
DFA-2010	10"	20"	30-1/2"	62-3/4"
DFA-2412	12"	24"	36"	64-1/2"
DFA-2814	14"	28"	40-1/4"	70"
DFA-3016	16"	30"	43"	79"
DFA-3418	18"	34"	47-1/2"	89"
DFA-3820	20"	38"	50"	89"
DFA-4824	24"	48"	57-3/4"	93"

(DIMENSIONS SHOWN ARE FOR REFERENCE ONLY)

**Due to variation in the manufactured components these dimensions may vary somewhat from those given in the table. Installation piping should be designed to allow for a tolerance of ± 1.0 inch. If your needs require a given dimension, we can manufacture parts to a specific tolerance.

KEY TO ENARDO DETONATION FLAME ARRESTOR MODEL NUMBER

EXAMPLE: **DFA** **1** **2** **0** **6** - **C** **S** **R** - **1** **2** **3**

Indicates a 6" Detonation Flame Arrestor with a 12" carbon steel housing, ANSI 150 lb. raised face flange connections, and a stainless steel element. It also has options of drain plugs, pressure taps and a temperature probe connection.

Ref. Desig.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
	-	-	BA MEYER		-	5

DRY ADSORPTION BEDS

OPTION #5

SEE ATTACHED P & ID
ES-AGA6.7-M5

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U.S. DEPARTMENT OF ENERGY		CONCEPTUAL	DATE	10/07/98
P & ID		PROJECT	NAME	ES-AGA6.7-M5.0
TANK VENTILATION SYSTEMS		REVISIONS	NO.	1
DRY ADSORPTION OPT #5		REVISIONS	NO.	1
ES-AGA6.7-M5.0		REVISIONS	NO.	1
2 PLAT SCALE: 1/4"		REVISIONS	NO.	1

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[illegible]

PLAN
SCALE 1/2" = 1'-0"
OPTION #5

U.S. DEPARTMENT OF ENERGY	
241-AW FARM	
HVAC EQUIPMENT SYSTEMS UPGRADE	
CONCEPTUAL	DATE: 12/10/89
DESIGNED BY: [Signature]	DATE: 12/10/89
CHECKED BY: [Signature]	DATE: 12/10/89
APPROVED BY: [Signature]	DATE: 12/10/89
PROJECT NO: ES-AGA6.7-M510	SCALE: 1/2" = 1'-0"

NO.	REVISION	DATE	BY	APP'D
1	ISSUED FOR CONSTRUCTION	12/10/89	[Signature]	[Signature]

DATE	12/10/89
BY	[Signature]
APP'D	[Signature]

U.S. DEPARTMENT OF ENERGY	
241-SY-FARM	
HVAC EQUIPMENT SYSTEMS	
UPGRADE	
ES-AGA6.7-M510	ES-AGA6.7-M510

PLAN
SCALE 1/8" = 1'-0"
OPTION #5

NO.	DATE	BY	CHKD	APP'D	DESCRIPTION
1	10/1/79	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	ISSUED FOR CONSTRUCTION
2	10/1/79	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	REVISIONS
3	10/1/79	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	REVISIONS
4	10/1/79	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	REVISIONS
5	10/1/79	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	REVISIONS
6	10/1/79	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	REVISIONS
7	10/1/79	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	REVISIONS
8	10/1/79	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	REVISIONS
9	10/1/79	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	REVISIONS
10	10/1/79	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	REVISIONS

U.S. DEPARTMENT OF ENERGY	
241-AP FARM	
HVAC EQUIPMENT SYSTEMS	
UPGRADE	
ES-AGA6.7-M5.0

PLAN
SCALE 1/2\"/>

DATE	10/1/79
BY	W. J. BROWN
CHECKED	W. J. BROWN
APPROVED	W. J. BROWN
REVISIONS	
NO.	1
DESCRIPTION	REVISIONS
DATE	10/1/79
BY	W. J. BROWN
CHECKED	W. J. BROWN
APPROVED	W. J. BROWN

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NORTH

PLAN
SCALE 3/16" = 1'-0"
OPTION #5

U.S. DEPARTMENT OF ENERGY		DATE: 07/15/95
PLUMBING DIVISION		PROJECT: 241-AZ & AZ FARM
HVAC EQUIPMENT SYSTEMS		UPGRADE
ES-AGA6.7-M510		SCALE: 1/8" = 1'-0"

NO.	REVISION	DATE	BY	CHKD.	APP'D.
1	ISSUED FOR CONSTRUCTION	07/15/95			
2	REVISED				
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100	REVISED				

OPTION 6 — THERMAL OXIDIZER, "CATALYTIC"

1. Flame Arrestor — 2 each DFA 1608/C-66R units, 316 SST. Enardo Mfg. Co.

Price each \$18,275

TOTAL \$36,550

Shipping weight = 3,400 lbs. for two

2. Anguil model 10 Catalytic Oxidizer

\$79,327

Shipping weight = 4,500 lbs.

3. Interconnecting piping 304L, schedule 10S, welded construction. Piping from Flame Arrestor to Stack is insulated.

4. Propane Supply Tank

1 each, 1000-gallon tank, 3-ft diameter x 12 ft long
tank cost \$1,500

- mount tank on concrete pad 5-ft wide x 14 ft long
- run buried 1" schedule 40 supply pipe to unit

5. Stack — Insulate stack. Exhaust gas is 395 °F.

6. Two Exhaust Fans before Stack — 15 hp each

HNF-4245

Rev. 0

ANGUIL

DATE: 3/5/99 SUBJECT: _____
FROM: Mike Thomas

If you do not receive all pages or have any problems with receiving this transmission, please call us as soon as possible. Thank you.

NAME: Jack Nicholson
COMPANY: Fluor Daniel Northwest
CITY, STATE: Richland, WA
FAX NUMBER: 509-376-9766
NUMBER OF PAGES 8

COMMENTS:

Please find attached our budgetary
proposal. A Hard copy
will follow via UPS.

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ANGUIL ENVIRONMENTAL SYSTEMS, INC.

8855 North 55th Street • Milwaukee, Wisconsin 53223 • Phone: 414-365-8400 • Fax: 414-365-6410

ANGUIL

HNF-4245

Rev. 0

March 5, 1999

Mr. Jack Nicholson
Fluor Daniel Northwest
MSB4-57
1200 Jardin Ave.
P.O. Box 1050
Richland, WA 99352

SUBJECT: BUDGETARY PROPOSAL #AES-3158 FOR VOC POLLUTION CONTROL EQUIPMENT

Dear Mr. Nicholson:

We welcome the opportunity to submit this budgetary proposal for VOC control equipment. Your application consists of a 1,000 SCFM waste stream from a tank vent. Heptane (100 ppmv) and ammonia (100 ppmv) are the contaminants you wish to destroy. We propose the Anguil Model 10 Catalytic Oxidizer for your pollution control application. The Anguil Model 10 Catalytic Oxidizer will process the waste stream from the tank vent and provide 95% destruction efficiency. Attached you will find pricing and specifications for the oxidizer.

In arriving at our equipment recommendation we have focused on the following desired results:

- Bring the process into compliance with regulatory agencies obtaining 95% VOC destruction efficiency
- Keep the overall cost of the project to a minimum
- Minimize yearly operational cost of the system
- Create no adverse effects on the operation of the current process

Heptane requires a slightly higher temperature for catalytic oxidation than many common VOCs. A temperature of 600°F is necessary. The oxidation of ammonia will create NOx in a 1:1 ratio to the ammonia processed. A simulation of the operating costs for the unit have been attached.

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ANGUIL ENVIRONMENTAL SYSTEMS, INC.

8855 North 55th Street ■ Milwaukee, Wisconsin 53223-2358 ■ 414-365-6400 ■ Fax 414-365-6410

HNF-4245

Rev. 0

The selection of Anguil as your environmental control solution has many benefits:

- A full-capability engineering, manufacturing and service firm with over 700 satisfied customers, four offices and over 60 agents around the world.
- An unsurpassed breadth of technologies including recuperative and regenerative catalytic and thermal oxidizers, rotor concentrators and ceramic filters, assuring the selection of the best technology for your application.
- Twenty (20) years of successful experience addressing VOC, HAP, NOx and odor control applications.
- Turnkey capability for single source responsibility, assuring professional installation, minimized downtime, successful process integration and start-up.
- A fully-staffed Service Department assuring prompt, professional 24-hour-a-day service.

The company philosophy at Anguil is to provide state of the art, cost-effective equipment. Our goal is to provide affordable pollution control solutions today to help our customers remain profitable tomorrow. Please review the enclosed proposal, if you have any questions please contact your local representative indicated below or our corporate office.

YOUR LOCAL REPRESENTATIVE IS:

Kent Martin
K.J. Barnett Company
17619 North East 67th Ct
Redmond, WA 98052
Phone: (425) 881-1128
Fax: (425) 883-6522

Thank you for the opportunity to be of service towards your VOC reduction objectives. We look forward to working closely with you.

Sincerely,

ANGUIL ENVIRONMENTAL SYSTEMS, INC.

Brett Archambeau
National Accounts Manager

Enclosure

cc: Kent Martin, KJ Barnett Company

ANGUIL

HNF-4245

Rev. 0

**ANGUIL MODEL 10 CATALYTIC OXIDIZER
BUDGETARY PRICING
FOR FLUOR DANIEL NORTHWEST****STANDARD BASE SYSTEM****\$ 79,327.00**

- Design flow - 1,000 SCFM
- 660° F oxidation temperature design
- 304L stainless steel reactor internals
- 6" thick mineral wool insulation
- 50% effective 304L stainless steel shell and tube heat exchanger
- Automatic heat exchanger bypass
- Forced draft system fan
- System Motor (TEFC 480V ph/60 Hz)
- Fuel train (1" diameter IRI / FM design)
- Burner (air heat type, gas or propane fired)
- Monolith catalyst (95% destruction efficiency at 1,000 SCFM)
- NEMA 12 controls (PLC based, digital temp. controllers)
- First out detector (digital message display)
- Aluminized steel exhaust stack (guy wire, single wall)
- Thorough factory quality run and test prior to shipment
- Two (2) copies - Operation & Maintenance manuals
- Start-up services and training of operators

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Rev. 0

ANGUIL MODEL 10 CATALYTIC OXIDIZER **Plan / Elevation View****Standard Model 10 Footprint****NOTE:** *Dimensions may vary according to customer specifications*

Dimensions							
A	B	C	D	E			
4' - 7"	4' - 2"	8' - 9"	13' - 0"	8' - 2"			
Standard Equipment Specifications							
Weight lbs.	Burner BTU/hr	Fuel Train Size	System Fan Motor	Comb Fan Motor	Max Catalyst Volume	Inlet Diameter	Stack Diameter
4,500	325,000	1"	10 hp	NA	3 ft ³	10"	12"

Anguil Environmental Systems, Inc.

8855 North 65th Street • Milwaukee, WI 53223 • 414-365-6400 • Fax 414-365-6410

HNF-4245

Rev. 0

$$\frac{13,000}{1.12} = 2469$$

ANGUIL ENVIRONMENTAL SYSTEMS, Inc.			
Milwaukee, Wis.			
OXIDIZER OPERATING COST SIMULATION REV. OCT. 8, 1988			
CUSTOMER/PROJECT: Finor Daniel Northwest		Modeled: 3/5/99 9:48	
PROPOSAL No: 3188			
LOCATION: Richland, WA			
REMARKS: 1000 SCFM waste stream			
100 ppmv heptane, 100 ppmv ammonia; Required IRE = 95%			
INPUT PARAMETERS			
Heat Exchanger Effectiveness	Assumes 46/80/3		
Process Temperature	50.0 %	Electricity Price	\$0.07 per KWH
Process Flow	80 Deg. F	Fuel Price	\$4.50 per MMBTU
Dilution Air	1,000 SCFM	LEL of Mixture	1.96 % by Volume
System Inlet Flow	0 SCFM	Avg Vapor Density	0.15 Lb/ft ³
System Inlet Temperature	1,000 SCFM	Pressure Drop	41 cm H ₂ O
Pressure drop	80 Deg. F	Percent LEL	1.03 %LEL
Solvent Loading	16 in H ₂ O	Compound Average	201 ppmw
Destruction Efficiency	1.83 lb/hr		
Average Bluff value	95 %DRE		
SYSTEM POINT	17,458 Btu/lb		
Process Air	TEMP	Deg. F	Flow SCFM
Dilution Air	T(i)	80	F(i) 1,000
	T(amb)	60	F(amb) 0
System Inlet	T(i)	80	F(i) 1,000
Bypass Air	T(i)	80	F(b) 1,000
Tube Side Outlet	T(i)	384	F(i) 1,000
Catalyst Inlet	T(min)	880	F(min) 1,000
Combustion Air	T(c)	77	F(c) 0
Catalyst Outlet	T(2)	688	F(2) 1,000
Exhaust	T(3)	395	F(3) 1,000
Results			
Firing Rate Pilot	13,000 Btu/hr	Fuel Cost	\$1.62 per Hour
Firing Rate Minimum		Electric Cost	\$0.22 per Hour
Firing Rate, H ₂ V	346,810 Btu/hr		
Blower Brake Horsepower (BHP)	4 HP		
Burner Type	(SAB) Secondary Air Burner		
External Combustion Air Required	0 SCFM	Total Operating Cost	\$1.84 per Hour
Percent Bypass HX	0 %		

ANGUIL ENVIRONMENTAL SYSTEMS, INC.**Catalytic Recuperative Oxidizer**

Anguil Catalytic
Recuperative
Oxidizer

- Cost-effective design
- Guaranteed compliance
- Fabricated for trouble-free operation

Committed
to
Cleaner
Air.

The Anguil Catalytic Oxidizer destroys toxic Volatile Organic Compounds (VOCs) that are discharged in industrial process exhausts. The catalytic reactor achieves destruction of the organics by the process of oxidation. The catalyst oxidizes the hydrocarbons to carbon dioxide and water vapor at significantly lower temperatures than thermal oxidizers.

How the Catalytic Recuperative Oxidizer Works

The Catalytic Oxidizer is designed based on volume of airflow, organic vapor concentrations and desired destruction efficiency. During operation, VOC-laden air is drawn into the system fan and is discharged into the system's heat exchanger. The air is preheated through the tube side of the heat exchanger and then passes the burner, where the contaminated air is raised to the operating temperature. As the VOC-laden air passes through the catalyst, an exothermic (heat releasing) reaction takes place. The VOCs in the air stream are converted to carbon dioxide and water vapor. The hot, purified air then passes on the shell side of the heat exchanger where the energy released by the reaction is used to preheat the incoming air. The heat exchanger minimizes the system's fuel consumption with the system being self-sustaining at low LEL levels. Finally, the contaminant-free air is exhausted into the atmosphere.

Anguil's Cost Effective Design

The Catalytic Oxidizer is designed as part of Anguil's broad line of technologically advanced, yet user-friendly, air pollution control products. The Anguil product line includes over 800 installations of Recuperative and Regenerative Catalytic and Thermal Oxidizers ranging in size from 100 SCFM to 100,000 SCFM (150-150,000 NM³/hr), Ceramic Filter Systems, Soil Remediation Equipment, Rotor Concentrators and Scrubbers. Each product line represents value-engineered systems with emphasis on cost minimization. All systems are designed for optimum performance and trouble-free operation.

Anguil strives to provide innovative pollution control technology including process analysis, engineering, equipment manufacturing, installation and post-sale 24-hour service.

System Components

Catalytic Oxidizer Systems include a heat exchanger, modulating burner, fuel train, catalyst bed, fan, motor, fresh air start-up valves, flanged inlet and outlet, system controls, temperature recorder, first-out shutdown detector and exhaust stack. The system has a weather-proof, insulated steel outer skin with access doors that allow service to all internal parts.

Options

- Remote monitoring/communication package
- Secondary heat exchanger
- Alternate fuel/power supplies
- Continuous Emission Monitors
- U.L. - stickered panel
- Custom systems available

Anguil Environmental Systems, Inc. • 8856 N. 55th Street • Milwaukee, WI 53223
Phone: 414 385-8200 • Fax: 414 385-8210 • Web Site: <http://www.anguil.com>

Anguil Catalytic Recuperative Oxidizer

Catalytic Recuperative Oxidizer System Schematic

Safety Shutdowns

The system will shut down safely and automatically if any of the following occur:

- Electrical power loss to the control panel
- Loss of proper air flow
- High/low temperature or gas pressure
- Flame-out of the burner
- System operation above 25% LEL

The first-out shutdown detector will indicate the cause of a Catalytic Oxidizer shutdown.

WORLD HEADQUARTERS
8855 N. 55th Street
Milwaukee, Wisconsin 53223
United States
Phone: 414 365-6400
Fax: 414 365-6410
E-mail: sales@anguil.com
Web Site - <http://www.anguil.com>

**ANGUIL ENVIRONMENTAL
EUROPE LTD.**
Brookside Business Park
Cold Mecca
Stone
Staffordshire ST15 0RZ
United Kingdom
Phone: 01785-781910
Fax: 01785-781911
E-mail: sales@anguil.co.uk

**ANGUIL ENVIRONMENTAL
EUROPE LTD.**
Via Turati 6
56125 Pisa
Italy
Phone: 050-2200048
Fax: 050-501801
E-mail: nqclp@box4.tin.it

**ANGUIL ASIA
Eurox Co., Ltd.**
Taiwan
Phone: (02)2705-2886
Fax: (02)2709-0448
E-mail: eurox@ms8.hinet.net

HNF-4245

Rev. 0

ENARDO MANUFACTURING CO.
4470 South 70th East Avenue
TULSA, OKLAHOMA 74145-4607 • U.S.A.
Telephone 1-918-622-6161 • Fax 1-918-622-0004

TOLL FREE 1-800-3ENARDO

QUOTATION NO. 99-5664G
REFERENCE: RFQ - Detonation Arrestor

Date: February 4, 1999
Page: 1 of 5

Fluor Daniel Northwest
Attn: Mr. Jack Nicholson
Ph: 509-372-1656
Fax: 509-376-9766

From: Sam Garman
Technical Sales

1.	2	DFA 1608/C-66R	8" Detonation Flame Arrestor 316 S.S. Housing with 150lb RF Flange Connection with 316 Stainless Steel Group "C" Flame Element Assembly	\$ 18,275.00	\$ 36,550.00
Approx. Weight Each - 1,700 lbs					

NOTES: **Ship Date: 10 to 12 weeks from receipt of approved order.**
 SEE ATTACHED SPECIFICATIONS
 EX WORKS FACTORY - TULSA, OKLAHOMA

Best Regards,

Sam Garman
Technical Sales

IF YOU DO NOT RECEIVE ALL PAGES AS INDICATED ABOVE PLEASE CALL!

QTDASSC.DOC

OPTIONAL CONNECTIONS
FOR DRAIN, PRESSURE
TAPS, THERMOCOUPLE, ETC.

MODEL	A' CONNECTION SIZE	B HOUSING SIZE	C OUTSIDE DIAMETER	D OVERALL LENGTH**
DFA-401	1"	4"	9"	20"
DFA-602	2"	6"	11"	24"
DFA-803	3"	8"	13-1/2"	26"
DFA-1004	4"	10"	16"	32"
DFA-1206	6"	12"	19"	36"
DFA-1608	8"	16"	25-1/2"	51-1/4"
DFA-2010	10"	20"	30-1/2"	62-3/4"
DFA-2412	12"	24"	36"	64-1/2"
DFA-2814	14"	28"	40-1/4"	70"
DFA-3018	16"	30"	43"	79"
DFA-3418	18"	34"	47-1/2"	89"
DFA-3620	20"	36"	50"	89"
DFA-4824	24"	48"	57-3/4"	93"

(DIMENSIONS SHOWN ARE FOR REFERENCE ONLY)

**Due to variation in the manufactured components these dimensions may vary somewhat from those given in the table. Installation piping should be designed to allow for a tolerance of ± 1.0 inch. If your needs require a given dimension, we can manufacture parts to a specific tolerance.

KEY TO ENARDO DETONATION FLAME ARRESTOR MODEL NUMBER

EXAMPLE: **DFA** **1** **2** **0** **6** - **C** **S** **R** - **1** **2** **3**

Indicates a 6" Detonation Flame Arrestor with a 12" carbon steel housing, ANSI 150 lb. raised face flange connections, and a stainless steel element. It also has options of drain plugs, pressure taps and a temperature probe connection.

Enardo Manufacturing Company

4470 S. 70th E. Ave. - Tulsa, Oklahoma 74145

FC0063A

DFA 1608/C

Detonation Flame Arrestor

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PRESSURE

DEA SERIES

DETONATION FLAME ARRESTOR

- ↗ Bi-directional Element
- ↗ Minimal Pressure Drop

- ↗ U.S. Coast Guard Accepted
- ↗ Type I Flame Stabilization Rating

- ↗ Removable Element
- ↗ Minimal Clogging

ENARDO DETONATION FLAME ARRESTORS

represent the ultimate in flame arrestment protection. They provide positive protection against flame propagation in piping systems that are manifolded or have long runs. These arrestors are bi-directional and can stop an ignited flammable vapor mixture approaching from either direction that can be traveling at subsonic or supersonic velocities. Enardo utilizes an element assembly that dampens the high velocities and pressures associated with deflagrations and detonations, while quenching the flame front. Our design is unique in the ability to provide larger flame channels which requires less frequent maintenance and greater ease in cleaning when service is required. The element is so unique that there is a patent pending on our design. This unit offers maximum flow to pressure drop characteristics enhancing the value of our product to any system.

SPECIFICATIONS: Our models have been independently tested to the U.S. Standard as published in the Federal Register, Appendix A to 33 CFR Part 154 and received acceptance from the U.S. Coast Guard. They are rated Type 1 for flame stabilization and an initial operating pressure of 22.7 psia for gases and vapors that have a MESG not less than 0.90mm. They have also been tested to the Canadian Standard Association (CSA) Z343 Rv. 12. The results prove our design meets or exceeds all criteria. All welding is performed in accordance with ASME Boiler and Pressure Vessel Code Section VII

CONSTRUCTION

Standard Materials: *Housing* is ASTM A-234 and ASTM A-36 welded carbon steel with ANSI B16.5 150 lb. and/or 300 lb. flanges. *Arrestor assembly* is AISI 304 or 316 stainless steel material with ASTM A-36 carbon steel shell. The minimum MESG is 0.90mm for NEC Group D or IEC Group I and IIA vapors.

Options: All stainless steel materials, special alloy materials, flanged or NPT fittings for drains, pressure taps, temperature probes and/or cleaning ports. Eccentric and custom designs for unique applications. Auxiliary systems for flame sensor notification, shutdown, inerting and or enriching systems.

ORDERING INFORMATION

Consult Enardo sales engineers with specific application data for model selection. Information required would include; Connection size, Operating/Maximum rate of flow, system pressure, desired pressure drop, Gas group, Housing and Element materials, Options desired.

ENARDO MANUFACTURING CO.

Post Office Box 266
Tulsa, Oklahoma 74101
(918) 835-6974
(800) 336-2736 U.S. & Canada
FAX (918) 835-0044

ENARDO DETONATION FLAME ARRESTOR SPECIFICATION AND NOTATION DATA

CUSTOMER: Fluor Daniel Northwest

February 4, 1999

ENARDO QUOTATION NO. 99-5664G

The following specifications apply to Model DFA 1608/C-66R

OPERATING CONDITIONS: (Split Flow - 2 units required)

MAX. GAS FLOW	500 scfm
INLET PRESSURE	Atmos.
Mol. Wt.	29 (air)
TEMPERATURE	60 F (ambient)

CALCULATED:PRESSURE DROP - 3.2 inH₂O**MATERIALS AND DESIGN:**

- 1.1 Housing and flange material: ASTM A-240 316L Stainless steel painted with a stainless steel impregnated paint.
- 1.2 Detonation flame element: Crimped ribbon type wound from AISI 316 Stainless steel material.
- 1.3 Interior flange gaskets: 1/16" tk. compressed non-asbestos.
- 1.4 Fasteners on the body section: Stainless steel studs and nuts. It does not include end connection fasteners or gaskets.
- 1.5 Options: None specified.

FEATURES AND SPECIFICATIONS:

- 2.1 The detonation flame arrestor element is removable using jack studs to spread the unit while maintaining the integrity of the piping when removing the flame arrestor element assembly and will include a lifting lug.
- 2.2 The element assembly is hinged to allow it to swing free of the housing assembly providing easier and quicker inspection and maintenance.
- 2.3 The ENARDO detonation flame arrestor is U.S. COAST GUARD ACCEPTED as bi-directional and will prevent detonation flame propagation when installed in a piping system with an initial pressure less than or equal to 20.7 psia. This unit is USCG rated Type II. continuous burning against the flame cell element is limited to 15 minutes. If burning against the element for an extended period of time is possible the flow would need to be extinguished by either a shut-off of the gas flow or by dilution of the gas flow. This unit is designed for NEC Group C gas of no greater than 0.65 mm MESG vapors.
- 2.4 All welding will be in accordance with ASME SECTION VIII, Div. I.
- 2.5 The unit will be pressure tested to 10 psig. Unit design pressure is 375 psig.
- 2.6 No post weld heat treat and no radiography testing included in the base price.
- 2.7 Material and workmanship are guaranteed for 12 months from ship date. The Enardo warranty provides replacement of the defective part FOB Tulsa, OK., incidental damages are not covered.
- 2.8 Approval drawings will be provided within one week from receipt of order. The manufacturing will begin upon return receipt of the approved drawing, unless the design approval is waived by the customer.

NOTATIONS:

- 3.1 No shipping, third party inspection, duty or taxes are included in the pricing.
- 3.2 No field installation by Enardo Manufacturing Company.
- 3.3 The quotation is valid for 90 days from quotation date.

IMPORTANT:

THE CONNECTING PIPING SHOULD BE DESIGNED TO SUPPORT THE WEIGHT OF THIS UNIT.

DFA-66C-Rw-00-12/971

Ref Dwg	Sh	Rev	Prepared By	Checked By	ECN No	Page
—	—	—	BA MEYER	—	—	6

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Rev. 0

CATALYTIC
THERMAL OXIDIZER
OPTION #7

CATALYTIC
THERMAL OXIDIZER
OPTION #7

PLOT 2

31

FLUOR DANIEL NORTHWEST, INC.				ENGINEERING DESIGN SKETCH			
Sketch No	Sh	Rev	Prepared By	Checked By	Page		
ESAGA 6.7-M7	1	0	BA Meyer		1		

HNF-4245
REV. 0

PLAN
SCALE 1/8" = 1'-0"

OPTION #7
241-AW FARM

Sketch No	Sh	Rev	Prepared By	Checked By	Page
ES-AGA 6.7-M7	2	0	BA Meyer		2

PLAN
SCALE 1/2" = 1'-0"

OPTION #7

241-AN FARM

33

FLUOR DANIEL NORTHWEST, INC.				ENGINEERING DESIGN SKETCH			
Sketch No	Sh	Rev	Prepared By	Checked By	Page		
ES-AGA 6.7-M7	3	0	BA Meyer		5		

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PLAN
SCALE 1/8\"/>

OPTION #7

241-SY FARM

ES120M7A

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Sketch No	Sh	Rev	Prepared By	Checked By	Page
ES-AGA-6.7-M7	4	0	BA Meyer		4

PLAN
SCALE 1/2" = 1'-0"
OPTIONAL #7
241-AP FARM

3 PUG SCALE: 1-24

OPTION 9 — COMBINED WET SCRUBBER & CARBON BED

1. 37-gallon portable Eyewash, 7601. 37

HAWS	\$4,150
------	---------

2. Safety Storage Building — Sharon Rodgers 1-800-344-6539. Model 15, ~16' long, 9' wide, 9' ft tall

cost	\$13,000
add lights,	
temp control	<u>\$10,000</u>
	\$23,000

FOB CA Freight	\$ 1,500
----------------	----------

3. Carbon Adsorber Bed — Cameron: 1 each TSU-1000R, \$7,995

4. Flame Arrestor — Enardo Mfg. Co.: 2 each DFA 1608/C-66R, \$18,275 each

Total \$36,550

3400 lbs (for two) shipping weight from Tulsa, OK

5. Ammonia Scrubber — Ceilcote Air Pollution Control: 1 skid-mounted scrubber system with fan, duct, pump & piping = \$32,000. Need to add shipping from Ohio.

Includes:

• vertical packed tower scrubber • recirculation pump • recirculation piping	• exhaust fan • interconnecting ductwork • selected instrumentation & control panel

6. Vent Piping from existing ventilation system to wet scrubber (fiberglass-reinforced plastic), and between the scrubber and the exhaust stack shall be 304L schedule 10S and welded construction.

7. Liner — under scrubber, recirculation pump and piping, 304L stainless 1/4"-thick plate welded joints, assume 1 ft. tall.

8. Insulation and Heat Trace—install on scrubber and recirculation piping. Note: an immersion heater/thermostat is provided on scrubber sump.

9. CO₂ Fire Suppression System for activated charcoal adsorption bed.

HNF-4245
Rev. 0

To: JACK NICHOLSON

From: Diane Roth

3-04-99 9:00am p. 1 of 3

Haws

HAWS DRINKING FAUCET COMPANY
1422 Fourth Street, Berkeley, CA 94701-1499
P.O. Box 1999
Berkeley, CA 94701-1499
(510) 525-3801
Fax: (510) 528-2812

To: JACK NICHOLSON

Date: 3/4/1999

From: Diane Roth

Page 1 of 3

7602.10 - 10 GALLON PORTABLE - \$905.00 LIST
8901.6 - HOSE OPTION FOR 7602.10 - \$156.00 ADD TO 7602.10 PRICE
7601.37 - 37 GALLON PORTABLE - \$4150.00 LIST

Rev. 0

10 Gallon Eyewash

PORTABLE

7602
SERIES

7602.10

9007
Optional cart

7602.10TW

☐ 7602.10*

10 gallon capacity

☐ 7602.10TW

10 gallon capacity with heater and insulating jacket for tempered water

Specifications

Tank: 10 gallon capacity with 7½ gallons of usable water, stainless steel with carrying handle. Air pressure filled through tire-type valve to recommended 87 PSI. Pressure gauge, safety relief valve (set at 120 PSI), and tire-type valve are mounted on the tank. Additional relief valve built into tank cover.

Heads: Twin Soft-Flo* patented ABS plastic anti-surge eyewash heads in Safety Green (Model SP12). Dust covers protect heads and automatically release with water pressure.

Heating System: Model 7602.10.2TW only, 600 watt tank heater with dual thermostats and thermofuses safely keeps water temperature between 65°F and 85°F (18°C to 29°C). Includes insulating jacket. Requires 120 A.C. to operate.

Activation: Stainless steel push flag operates a stay open chrome plated brass ball valve that is equipped with a stainless steel ball and stem.

Stream Control: Steady water flow under varying pressures assured with dual automatic pressure compensation devices.

Hydrosap: Bacteriostatic additive to permit storage of water for several months (Model 9081). See page 84.

Details

Measurements: Overall height, 43", 12¼" diameter

Shipping Weight: 7602.10 -25 lbs., 7602.10TW -27 lbs.

For ASME Coded stainless steel tank see Model 7601.10.2

Options (Additional Cost)

☐ Model 9007: Cart for ease of mobility.

7602.10

☐ Model 8901.6: Eye/face and body spray with ABS plastic Feather-Flo** spray head with integral flip top dust cover (Model SP21) operated with stay open squeeze lever handle valve mounted on 6' heavy duty rubber hose.

*Patent No. 3,809,316 **Patent No. 3,802,436

Ⓢ These models are stocked for immediate delivery in our Regional Warehouses (listed on page 3). To order from these warehouses, contact your local HAWS REPRESENTATIVE.

For current installation drawings please call our toll free INFOFAX system at 800-FAX-HAWS. See index page for instructions.

HAWS®

4405 Smith St. P.O. Box 4700, Boulder, CO 80504-4700

PORTABLE**—ASME Coded Eyewash**☒ **7601.37**

37 gallon capacity with cart

☐ **7601.10.2**

10 gallon capacity

Specifications

Tank: ASME coded stainless steel type 304, with carrying handle. Air pressure filled through tire-type air valve. Pressure gauge, safety release valve and tire-type valve are mounted on the tank. Model 7601.37 has a 37 gallon capacity with 30 gallons of usable water. ASME rating 110 PSI maximum working pressure at 100°F. Air pressure filled to recommended 100 PSI. Relief valve set at 110. Model 7601.10.2 has a 10 gallon capacity with 7½ gallons of usable water. ASME rating 130 PSI maximum working pressure at 100°F. Air pressure filled to recommended 87 PSI. Relief valve set at 120.

Heads: Twin Soft-Flo* patented ABS plastic anti-surge eyewash heads in Safety Green (Model SP12). Dust covers protect heads and automatically release with water pressure.

Activation: Stainless steel push flag operates a stay open chrome plated brass ball valve that is equipped with a stainless steel ball and stem.

Body Spray: Equipped with eye/face and body wash with Feather-Flo** patented ABS plastic spray head (Model SP21) operated with stay open squeeze lever handle valve mounted on 6' heavy duty rubber hose.

Stream Control: Steady water flow under varying pressures assured with dual automatic pressure compensation devices.

Hydrossep: Bacteriostatic additive to permit storage of water for several months (Model 9081). See page 84.

Details

Measurements: 7601.37 -overall height with cart, 60"x27" deep, 7601.10.2 -overall height 44", diameter 12¼"

Shipping Weight: 7601.37 -161 lbs., less cart -112 lbs., 7601.10.2 -52 lbs.

Options

☐ 7601.37 without cart (Less cost)

☐ Model 9007: Cart for 7601.10.2 (Additional cost)

*Patent No. 3,809,315 **Patent No. 3,602,438

Haws

1425 South St. Dr. Box 1000 Berkeley, CA 94704 415-841-1400

7601.37
With cart

7601.10.2
With optional 9007 cart

For more
system
information

Page E-91

please call our toll free INFOFAX
index page for instructions.

Standard and OSHA rules and regulations relative to this type of product.

Model 7601.37 only
SP CERTIFIED
to ANSI Z35.1

ISO 9001
REGISTERED
QUALITY

Safety Storage Buildings

SAFETY STORAGE

Nationwide Manufacturer of Prefabricated Chemical and Hazardous Material Storage Buildings

Businesses and institutions must comply with federal, state, and local regulations, minimize liability, safeguard personnel and facilities, and keep our communities safe from hazardous waste and toxic chemicals.

Safety Storage buildings offer a comprehensive response to compliance requirements. Because they're from a company experienced in—and dedicated to—solving chemical and hazardous material challenges. A company with a network of field engineers who understand the complexities of compliance regulations. Backed by many years of manufacturing know-how and plants on both U.S. coasts, they're people able to tailor precise solutions to your storage requirements.

Safety Storage relocatable weather-proof buildings are proven throughout the country, in all climates and with virtually every hazardous material. They

demonstrate what no others can—solid environmental and chemical engineering know-how. Hazardous chemical and material handling, storage, and transportation is our only business. We know our business. And that's made us first choice among people who know theirs.

Our staff of professional field engineers are available nationwide for informative presentations on regulation compliance strategies and alternatives.

Safety Storage sales representatives, located in most U.S. industrial communities, are trained to help you attain safe hazardous material storage objectives. They will assess your chemical storage needs, prepare detailed storage-unit sketches and specifications, and provide written price quotations. Call today for the name of the representative nearest you.

Model	Outside Dimensions			Inside Dimensions			Tare Weight* (Lbs.)	Door Openings		Designed Storage Capacity				Sump Capacity (Gallons)
	Length	Width	Height	Length	Width	Height		Height	Width	Weight (Lbs.)	Sq. Ft.	Drums	Pallets	
22	22' 8"	9'	8' 7 1/2"	21' 11 3/4"	8' 3/8"	7' 1/2"	8,600	6' 9 3/4"	4' 6"	44,000	176	44	6	750
15	15' 3 3/4"	9'	8' 7 1/2"	14' 7 1/2"	8' 3/8"	7' 1/2"	6,000	6' 9 3/4"	4' 6"	29,250	117	28	4	500
7	8' 1/4"	9'	8' 7 1/2"	7' 3 1/2"	8' 3/8"	7' 1/2"	3,400	6' 9 3/4"	4' 6"	14,500	58	12	2	250
44FR	23' 2"	9' 3"	8' 9"	21' 11"	8'	7' 4"	14,500	6' 7 3/8"	4' 10 3/4"	44,000	176	44	6	750
30FR	15' 10"	9' 3"	8' 9"	14' 7"	8'	7' 4"	10,500	6' 7 3/8"	4' 10 3/4"	29,250	117	28	4	500
14FR	8' 6"	9' 3"	8' 9"	7' 3"	8'	7' 4"	6,500	6' 7 3/8"	4' 10 3/4"	14,500	58	12	2	250

SAFETY STORAGE

SAFETY STORAGE, INC.
2380 South Bascom Avenue
Campbell, CA 95008
Phone: 408/559-3901
Fax: 408/559-3218
1-800/344-6539

Since we cannot anticipate all conditions under which this information and our products, or the products of other manufacturers in combination with our products, may be used, we accept no responsibility for results obtained by the application of this information or the safety and suitability of our products, either alone or in combination with other products. Users are advised to make their own tests to determine the safety and suitability of each such product for their own purposes. Unless otherwise agreed in writing, we sell the products without warranty, and buyers and users assume all responsibility and liability for loss or damage arising from the handling and use of our products, whether used alone or in combination with other products.

BOB: ACID STORAGE FOR
WOT SCRUBBER

HNF-4245

Rev. 0

Ceilcote Air Pollution Control

14955 Sprague Rd., Suite 250
Strongsville, OH 44138-1758

an I T E Q company

Tel 440.243.0700
Fax 440.243.9854

PROPOSAL NO. IPG-22486 BUDGET

March 3, 1999

Fluor Daniel Northwest
Mail Stop B4-57
1200 Jadwin Avenue
P.O. Box 1050
Richland, Washington 99352-1050

Attention: Mr. Jack Nicholson

Subject: Ammonia Scrubber System

We are pleased to provide our budget proposal and pricing for the above subject scrubber system, per our recent telephone conversation(s) and your faxed inquiry dated March 2, 1999.

SYSTEM DISCUSSION

We understand that the proposed system is required to remove "70-100 ppm" of gaseous ammonia contaminants from an air stream with a volume of 1,000 ACFM at 70°F using dilute sulfuric acid. Assuming that "70-100 ppm" is the inlet loading of ammonia, the proposed system is designed to remove 99% or greater by weight of the gaseous ammonia contaminant, which will result in an outlet loading from the scrubber well below the NIOSH time-weighted average exposure limit of 25 ppm.

The proposed skid-mounted system consists of a vertical packed tower scrubber, recirculation pump, recirculation piping, exhaust fan, interconnecting ductwork, selected instrumentation and control panel. Items such as exhaust stack, pre-wiring, additional instrumentation, etc. are not included at this time, however pricing for these items can be provided if required.

VERTICAL PACKED TOWER SCRUBBER

The proposed vertical packed tower scrubber will be our Model SPT-18-60, 18" diameter by approximately 11'-6" overall height. The unit will have a capacity of 1,000 ACFM at 70°F and will require a recycle rate of approximately 11 GPM at 10 psig.

The scrubber will have a 5' deep bed of #2-K Tellerette® packing and an entrainment separator section consisting of 12" of #1 Tellerettes®. The unit will remove 99% by weight or greater of the gaseous ammonia contaminant when using dilute sulfuric acid as the scrubbing solution. The entrainment separator will remove 98-99% of particles 10 microns and larger. The pressure drop across the scrubber is approximately 2" W.C.

Material of construction for the vertical packed tower scrubber will be vinyl ester resin reinforced with approximately 25% glass. The spray nozzle and packing shall be constructed of polypropylene.

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Proposal No. IPG-22486

Fluor Daniel Northwest

March 3, 1999

Page 2 of 4

RECYCLE PUMP

The recirculation pump will be horizontal centrifugal type of FRP material of construction, as manufactured by Fybroc or equal. The pump will have a capacity of approximately 11 GPM at 65' TDH. The pump will be furnished complete with baseplate, coupling, coupling guard, mechanical seal, and a 2 H.P., 3500 RPM, 460/3/60 TEFC motor. The pump is non-overloading throughout the operating curve.

RECYCLE PIPING

? The recycle piping will be constructed of Schedule 80 CPVC, and is based on the pump being mounted at the same elevation and not more than 3' from the scrubber. The piping includes a ball valve to control the recirculation flow, a pressure gauge with gauge guard and a CPVC "Y" strainer. All recycle piping will be shipped loose for field installation by others.

FAN

The proposed fan will be our Model No. CMHP-8 centrifugal, having a paddle-wheel type impeller and rated at 1,000 ACFM and 6" W.C. as manufactured by Ceilcote Air Pollution Control. All parts in contact with the airstream are constructed of solid fiberglass reinforced plastic, using vinyl ester resin reinforced with approximately 25% glass. All metal parts are protected against corrosion. The fan will be statically and dynamically balanced at operating speed prior to shipment.

Fan Model CMHP-8**Performance:** 1,000 ACFM, 6" SPWC, 2087 RPM, 1.46 BHP
Class I Construction, Arrangement 10**Accessories:** Housing Drain
Access Door
Rectangular Outlet Flange
OSHA Canopy
Inlet Flexible Connector**Motor:** 2 H.P., 1800 RPM, 145T Frame, TEFC Enclosure, 230 / 460 Volts, 3 Phase, 60 Hz**Drive:** Fixed Speed V-Belt**INTERCONNECTING DUCTWORK**

INLET? ?

The proposed ductwork will be 10" in diameter, and will connect the scrubber gas outlet to the fan inlet.

NOTE : → The ductwork is based on the fan being mounted at the same elevation and not more than 5' from the scrubber. The ductwork will be shipped loose for field installation by others. Material of construction for the proposed ductwork will be vinyl ester resin reinforced with approximately 25% glass.

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Fluor Daniel Northwest

March 3, 1999

Page 3 of 4

INSTRUMENTATION

We understand that the proposed system will be located in a remote area with few utilities available except electrical power. As such, a limited scope of instrumentation is offered at this time (pricing for additional items is available if required). The following instrumentation is included with the proposed system:

One (1) 2 KW immersion heater with thermostat mounted in the scrubber sump (freeze protection)

Insulation and heat tracing are typically installed when the scrubber is commissioned, and are therefore typically provided by others. Insulation and heat tracing are therefore not included at this time, however pricing for these items can be provided if required.

A chemical feed system (sometimes included for automatic acid feed to the system) is not included at this time, since the proposed system is designed to recirculate dilute acid on a batch basis. Based on the current (standard) capacity of the scrubber sump (integral with the scrubber), a 5% by weight solution of H_2SO_4 should allow for approximately eleven (11) hours' continuous operation, based on 100 ppmv inlet concentration of ammonia. If additional reaction time is required, the concentration of the recirculated acid can be increased, or the scrubber sump capacity can be increased (current scrubber size allows for pre-assembly of the scrubber on the proposed skid for shipment - increased sump capacity may preclude this).

CONTROL PANEL

The enclosure for the panel will be NEMA 4 construction, water tight, and the motor controls are based on 460 volts. A pre-wired control panel with all necessary pushbuttons, indicator lights, and selector switches is provided. At the time of installation, the panel will have to be mounted, power brought to the panel, and the individual connections from the controls to the utilities made (by others).

SKID AND SHOP MOUNTING AND ASSEMBLY

Included is an epoxy-coated carbon steel skid approximately 5' wide and 7' long. The scrubber, exhaust fan, recycle pump, and control panel mounting bracket will be shop mounted on the proposed skid. The recycle piping will be assembled and shop fit, and shipped sub-assembled for minimum field installation by others. The scrubber internals, interconnecting ductwork and control panel are to be installed by others. Electrical connections from main power to the panel and from the panel to the instruments are also to be provided by others.

PRICING

For providing the equipment described herein, we quote the budget price:

One (1) Skid-Mounted Scrubber System with Fan, Duct, Pump & Piping..... \$32,000

The above budget pricing is F.O.B. point of manufacture and does not include freight or any state or local taxes, should they be applicable.

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Proposal No. IPG-22486

Fluor Daniel Northwest

March 3, 1999

Page 4 of 4

Our normal shipping date for the above items is 8-10 weeks after purchaser's approval of Ceilcote Air Pollution Control drawings. Approval drawings would be submitted approximately 3-4 weeks after receipt of a written purchase order.

Actual shipping dates are subject to review at the time of order placement.

We hope this budget proposal meets with your approval and that the information presented will enable you to place your business with us. If we can be of further service to you, please feel free to call.

CEILCOTE AIR POLLUTION CONTROL

Christopher W. Poling

Product Manager - Engineered Systems

CWP/dk

Enclosures: Bulletin 12-2, Bulletin 11-6

cc: Our Representative:

Benz Air Engineering Co.

3822 S.W. Corbett Ave.

Portland, Oregon 97201-4388

Tel: (503) 228-7296

Fax: (503) 228-7351

HNF-4245

Rev. 0

CAMERON

ENVIRONMENTAL, INC.

527 Van Ness Ave. Torrance, CA 90501

Tel: 310.212.0610 • Fax: 310.212.7222

Activated Carbon, Pollution Control Systems
and Waste Management Services **Fax Cover Sheet**

TO: Dan Evans
COMPANY: Fluor Daniel
FAX #: 509-373-5712
PHONE #: 509-373-2688

FROM: Chuck Jarnecke
DATE: December 15, 1998
PAGE: 1 OF 3
QUOTE: 1843

Dear Mr. Evans,

I have some options for your consideration for stainless steel carbon filters.

Option 1: (Highly recommended to keep the static pressure low for a smaller fan)

2 each TSU-1000R Stainless Steel radial flow carbon adsorbers filled with standard CEI-R 4x6 mesh activated carbon	\$ 7,995.00 each	— 1 EACH \$ 15,990.00
2 each TSU-1000R Stainless Steel radial flow carbon adsorbers filled with CEI-NHC citric acid impregnated carbon for Ammonia removal	\$ 8,750.00 each	\$ 17,500.00

Option 2:

2 each TSU-1000S Stainless Steel deep bed carbon adsorbers filled with standard CEI-R 4x6 mesh activated carbon	\$ 9,750.00 each	\$ 19,500.00
2 each TSU-1000S Stainless Steel deep bed carbon adsorbers filled with CEI-NHC citric acid impregnated carbon for Ammonia removal	\$ 10,505.00 each	\$ 21,010.00

The other option is too expensive and is on larger stainless steel vessels (\$ 16,000.00 per vessel plus carbon). I highly recommend the TSU-1000R vessels based on the fact that the static pressure across this unit is less than 1" W.C. If you run 4 of these units in series, the estimated static pressure across all of the units should be less than 10" including interconnecting ducting/piping.

I can fabricate these units in time to ship to you by the middle of January only if I can get you to issue a purchase order no later than the end of this week. If we don't get an order by then, I won't be able to guarantee delivery by the 3rd week in January. Please call me to discuss this further if you would like. Once you make a decision, Dave McKenzie with Cincinnati Fan should be notified so that he can adjust the size of his fan selection to meet your needs.

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You requested information on the result of ammonia passing through our CEI-NHC impregnated carbon. The ammonia/CEI-NHC reaction that takes place results in the formation of sodium citrate.

I have included an actual shop drawing of the TSU-1000S stainless steel unit for your consideration. The specification sheet is slightly different and the shop drawing does not show the 4" FNPT connection ports which will be located in the same position as the specification sheet indicates. Call me to discuss this further if you wish. I will be in the office all day today. Thanks for your request for quotation on our products. I look forward to talking with you soon.

Best regards,

Cameron Environmental, Inc.

Chuck Jarnecke

Director of Sales and Marketing

HNF-4245

Rev. 0

HNF-4245

Rev. 0

ENVIRONMENTAL, INC.

527 Van Ness Ave. Torrance, CA 90501

Tel: 310.212.0610 ♦ Fax: 310.212.7222

*Activated Carbon, Pollution Control Systems
and Waste Management Services* **Fax Cover Sheet**

TO: Dan Evans
COMPANY: Fluor Daniel
FAX #: 509-373-5712
PHONE #: 509-373-2688

FROM: Chuck Jarnecke
DATE: December 15, 1998
PAGE: 1 OF 10

Dear Mr. Evans,

Per our discussion this morning, please find the specification sheets on a couple of our vapor phase activated carbon unit. I will be providing you the pricing later today on your options for either of these units in stainless steel. Per our discussion, I think it best to possibly consider the TSU-1000R if at all possible if indeed you plan to run (4) units in series. Two of the unit with carbon and two with the ammonia carbon our CEI-NHC.

If you select (4) of the TSU-1000R units and run them in series, the static pressure across the (4) units combined would be an estimated 4 inches, however interconnecting ducting would also add to the equation. I would estimate somewhere around 8 - 12 inches of total static pressure depending on how many elbows, etc you have figured into the connective piping.

I have included a general graph on static pressure through 12" of carbon of various mesh sizes at various velocities. I have also included our specification on the CEI-NHC impregnated carbon as well as a couple of short articles on activated carbon. I will be back with you a bit later for further discussion.

Best regards,
Cameron Environmental, Inc.

Chuck Jarnecke
Director of Sales and Marketing

HNF-4245

Rev. 0

CAMERON

ENVIRONMENTAL, INC.

Activated Carbon, Pollution Control Systems
and Waste Management Services

TUB SCRUB UNIT

- TSU-1000S - TSU-2000S -

The TSU-1000S and TSU-2000S Tub Scrub carbon adsorber units are designed for the efficient purification of your contaminated vapor waste or process stream. In service nationwide, these adsorbers have a proven ability to remove organic contaminants to non-detectable levels.

To provide long life and superior corrosion resistance, these vessels are constructed of heavy duty mild steel, and are lined with a high thickness fusion bonded epoxy coating. Up-flow operation is recommended. These units are also equipped with forklift channels to ease the process of vessel maintenance and carbon servicing.

These adsorbers will arrive from our warehouse ready for connection to your process piping; filled with high quality activated carbon. Once the carbon is "spent", Cameron Environmental provides a number of service and disposal options to meet each site's specific needs. Please call our service department when a carbon changeout is needed.

SPECIFICATIONS:

TSU-1000S TSU-2000S

Inlet/Outlet Connections (fnpt):	4"	4"
Manway	16"	16"
Height:	64"	88"
Diameter:	46"	46"
Maximum Flow (cfm)	600	600
Maximum Pressure (psi):	15	15
Maximum Temperature (°F):	175	175
Carbon Capacity		
Volume (cubic feet)	34	67
Weight (lbs)	1,000	2,000
Approximate Shipping Weight (lbs)	1,800	2,950

CEI Warrants that these units are manufactured in accordance with the specifications herein. No warranty, expressed or implied, is made relating to the suitability of the product for any particular application or purpose.

In the presence of activated carbon, some contaminants may oxidize, polymerize or otherwise react resulting in the release of heat and a potential fire hazard. Extreme care should be taken in the design and operation of such applications.

CAMERON

ENVIRONMENTAL, INC.

HNF-4245

Rev. 0

Activated Carbon, Pollution Control Systems
and Waste Management Services

TUB SCRUB UNIT

- TSU-1000R - TSU-1500R -

The radial flow Tub Scrub carbon adsorber units are designed for the efficient purification of your contaminated vapor waste or process stream. The shallow carbon bed in these uniquely designed vessels allows for the processing of high flows at extremely low pressure drop. In service nationwide, these adsorbers have a proven ability to remove organic contaminants to non-detectable levels.

To provide long life and superior corrosion resistance, these radial flow vessels are constructed of heavy duty mild steel, and are lined with a high thickness epoxy coating. The adsorber internals consist of a distributor tube and retention screen for high quality activated carbon. Inlet vapors enter the distributor tube, then proceed horizontally through the carbon bed, and then through the retention screen to free air space inside the canister wall. The purified vapors then travel to the upper collection area to exit the outlet duct. These units are also equipped with forklift channels to ease the process of vessel maintenance and carbon servicing.

These adsorbers will arrive from our warehouse ready for connection to your process piping; filled with high quality activated carbon. Once the carbon is "spent", Cameron Environmental provides a number of service and disposal options to meet each site's specific needs. Please call our service department when a carbon changeout is needed.

SPECIFICATIONS: TSU: 1000R 1500R

Inlet/Outlet Connections (duct):	10"	10"
Height:	90"	90"
Diameter:	48"	48"
Maximum Flow (cfm)	4,500	3,000
Maximum Pressure (psi):	3	3
Maximum Temperature (°F):	170	170
Carbon Capacity		
Volume (cubic feet)	33	50
Weight (lbs)	1,000	1,500
Approximate Shipping Weight (lbs)	1,650	2,150

CEI warrants that these units are manufactured in accordance with the specifications herein. No warranty, expressed or implied, is made relating to the suitability of the product for any particular application or purpose.

In the presence of activated carbon, some contaminants may oxidize, polymerize or otherwise react resulting in the release of heat and a potential fire hazard. Extreme care should be taken in the design and operation of such applications.

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Rev. 0

CAMERON

Environmental, Inc.*Activated Carbon & Pollution Control System*

CEI-NHC Activated Carbon

Cameron Environmental's CEI-NHC activated carbon is impregnated with citric acid and is designed to efficiently remove ammonia vapors. This carbon is a high activity specially treated, activated carbon.

PHYSICAL PROPERTIES:

Base Material

Carbon Tetrachloride Activity (CTC):	60 minimum
Apparent Density (lbs./cu. ft.)	30 average
Hardness (Ball Abrasion):	95 minimum
Moisture Content:	4% maximum
Mesh Sizes*:	4x8, 4x10, 6x12

*custom sizing available

Treatment

Apparent Density (lbs./cu.ft.):	44 average
Moisture Content:	10% maximum
Ammonia Removal Capacity:	16%* minimum

- This equals 30% of the weight of the base activated carbon before treatment.

These specifications represent general parameters and are subject to change. Please consult with CEI before processing with your applications.

INCHES WG per 12" BED

HNF-4245

Rev. 0

ENARDO MANUFACTURING CO.
4470 South 70th East Avenue
TULSA, OKLAHOMA 74145-4607 • U.S.A.
Telephone 1-918-622-6161 • Fax 1-918-622-0004

TOLL FREE 1-800-3ENARDO

QUOTATION NO. 99-5664G
REFERENCE: RFQ - Detonation Arrestor

Date: February 4, 1999
Page: 1 of 5

Fluor Daniel Northwest
Attn: Mr. Jack Nicholson
Ph: 509-372-1656
Fax: 509-376-9766

From: Sam Garman
Technical Sales

1.	2	DFA 1608/C-66R	8" Detonation Flame Arrestor 316 S.S. Housing with 150lb RF Flange Connection with 316 Stainless Steel Group "C" Flame Element Assembly	\$ 18,275.00	\$ 36,550.00
Approx. Weight Each - 1,700 lbs					

NOTES: Ship Date: 10 to 12 weeks from receipt of approved order.
SEE ATTACHED SPECIFICATIONS
EX WORKS FACTORY - TULSA, OKLAHOMA

Best Regards,

Sam Garman
Technical Sales

IF YOU DO NOT RECEIVE ALL PAGES AS INDICATED ABOVE PLEASE CALL!

QTDASSC.DOC

ENARDO DETONATION FLAME ARRESTOR SPECIFICATION AND NOTATION DATA

CUSTOMER: Fluor Daniel Northwest

February 4, 1999

ENARDO QUOTATION NO. 99-5664G

The following specifications apply to Model DFA 1608/C-66R.

OPERATING CONDITIONS: (Split Flow - 2 units required)

MAX. GAS FLOW	500 scfm
INLET PRESSURE	Atmos.
Mol. Wt.	29 (air)
TEMPERATURE	60 F (ambient)

CALCULATED:PRESSURE DROP - 3.2 inH₂O**MATERIALS AND DESIGN:**

- 1.1 Housing and flange material: ASTM A-240 316L Stainless steel painted with a stainless steel impregnated paint.
- 1.2 Detonation flame element: Crimped ribbon type wound from AISI 316 Stainless steel material.
- 1.3 Interior flange gaskets: 1/16" tk. compressed non-asbestos.
- 1.4 Fasteners on the body section: Stainless steel studs and nuts. It does not include end connection fasteners or gaskets.
- 1.5 Options: None specified.

FEATURES AND SPECIFICATIONS:

- 2.1 The detonation flame arrestor element is removable using jack studs to spread the unit while maintaining the integrity of the piping when removing the flame arrestor element assembly and will include a lifting lug.
- 2.2 The element assembly is hinged to allow it to swing free of the housing assembly providing easier and quicker inspection and maintenance.
- 2.3 The ENARDO detonation flame arrestor is U.S. COAST GUARD ACCEPTED as bi-directional and will prevent detonation flame propagation when installed in a piping system with an initial pressure less than or equal to 20.7 psia. This unit is USCG rated Type II, continuous burning against the flame cell element is limited to 15 minutes. If burning against the element for an extended period of time is possible the flow would need to be extinguished by either a shut-off of the gas flow or by dilution of the gas flow. This unit is designed for NEC Group C gas or no greater than 0.65 mm MESG vapors.
- 2.4 All welding will be in accordance with ASME SECTION VIII, Div. I.
- 2.5 The unit will be pressure tested to 10 psig. Unit design pressure is 375 psig.
- 2.6 No post weld heat treat and no radiography testing included in the base price.
- 2.7 Material and workmanship are guaranteed for 12 months from ship date. The Enardo warranty provides replacement of the defective part FOB Tulsa, OK., incidental damages are not covered.
- 2.8 Approval drawings will be provided within one week from receipt of order. The manufacturing will begin upon return receipt of the approved drawing, unless the design approval is waived by the customer.

NOTATIONS:

- 3.1 No shipping, third party inspection, duty or taxes are included in the pricing.
- 3.2 No field installation by Enardo Manufacturing Company.
- 3.3 The quotation is valid for 90 days from quotation date.

IMPORTANT:

THE CONNECTING PIPING SHOULD BE DESIGNED TO SUPPORT THE WEIGHT OF THIS UNIT.

DFA-88C-R-00-12/971

Enardo Manufacturing Company

4470 S. 70th E. Ave. - Tulsa, Oklahoma 74145

FC0063A

DFA 1608/C

Detonation Flame Arrestor Page E-107

PRESSURE

ENARDO SERIES

DETONATION FLAME ARRESTOR

- Bi-directional Element
- Minimal Pressure Drop

- U.S. Coast Guard Accepted
- Type I Flame Stabilization Rating

- Removable Element
- Minimal Clogging

ENARDO DETONATION FLAME ARRESTORS

represent the ultimate in flame arrestment protection. They provide positive protection against flame propagation in piping systems that are manifolded or have long runs. These arrestors are bi-directional and can stop an ignited flammable vapor mixture approaching from either direction that can be traveling at subsonic or supersonic velocities. Enardo utilizes an element assembly that dampens the high velocities and pressures associated with deflagrations and detonations, while quenching the flame front. Our design is unique in the ability to provide larger flame channels which requires less frequent maintenance and greater ease in cleaning when service is required. The element is so unique that there is a patent pending on our design. This unit offers maximum flow to pressure drop characteristics enhancing the value of our product to any system.

SPECIFICATIONS: Our models have been independently tested to the U.S. Standard as published in the Federal Register; Appendix A to 33 CFR Part 154 and received acceptance from the U.S. Coast Guard. They are rated Type 1 for flame stabilization and an initial operating pressure of 22.7 psia for gases and vapors that have a MESG not less than 0.90mm. They have also been tested to the Canadian Standard Association (CSA) Z343 Rv. 12. The results prove our design meets or exceeds all criteria. All welding is performed in accordance with ASME Boiler and Pressure Vessel Code Section VIII

CONSTRUCTION

Standard Materials: *Housing* is ASTM A-234 and ASTM A-36 welded carbon steel with ANSI B16.5 150 lb. and/or 300 lb. flanges. *Arrestor assembly* is AISI 304 or 316 stainless steel material with ASTM A-36 carbon steel shell. The minimum MESG is 0.90mm for NEC Group D or IEC Group I and IIA vapors.

Options: All stainless steel materials, special alloy materials, flanged or NPT fittings for drains, pressure taps, temperature probes and/or cleaning ports. Eccentric and custom designs for unique applications. Auxiliary systems for flame sensor notification, shutdown, inerting and or enriching systems.

ORDERING INFORMATION

Consult Enardo sales engineers with specific application data for model selection. Information required would include; Connection size, Operating/Maximum rate of flow, system pressure, desired pressure drop, Gas group, Housing and Element materials, Options desired.

ENARDO MANUFACTURING CO.

Post Office Box 266
Tulsa, Oklahoma 74101
(918) 835-6974
(800) 336-2736 U.S. & Canada
FAX (918) 835-0044

OPTIONAL CONNECTIONS
FOR DRAIN, PRESSURE
TAPS, THERMOCOUPLES, ETC.

MODEL	A CONNECTION SIZE	B HOUSING SIZE	C OUTSIDE DIAMETER	D OVERALL LENGTH**
DFA-401	1"	4"	9"	20"
DFA-602	2"	6"	11"	24"
DFA-803	3"	8"	13-1/2"	26"
DFA-1004	4"	10"	16"	32"
DFA-1206	6"	12"	19"	36"
DFA-1608	8"	16"	25-1/2"	51-1/4"
DFA-2010	10"	20"	30-1/2"	62-3/4"
DFA-2412	12"	24"	36"	64-1/2"
DFA-2814	14"	28"	40-1/4"	70"
DFA-3016	16"	30"	43"	79"
DFA-3418	18"	34"	47-1/2"	86"
DFA-3620	20"	36"	50"	89"
DFA-4824	24"	48"	57-3/4"	93"

(DIMENSIONS SHOWN ARE FOR REFERENCE ONLY)

**Due to variation in the manufactured components these dimensions may vary somewhat from those given in the table. Installation piping should be designed to allow for a tolerance of ± 1.0 inch. If your needs require a given dimension, we can manufacture parts to a specific tolerance.

KEY TO ENARDO DETONATION FLAME ARRESTOR MODEL NUMBER

EXAMPLE: **DFA 1 2 0 6 - C S R - 1 2 3**

Indicates a 6" Detonation Flame Arrestor with a 12" carbon steel housing, ANSI 150 lb. raised face flange connections, and a stainless steel element. It also has options of drain plugs, pressure taps and a temperature probe connection.

CARBON BED & WET AMMONIA SCRUBBER SYSTEM
OPTION #5

Sketch No	Sh	Rev	Prepared By	Checked By	Page
ES-AGA 6.7-NB		0	BA Meyer

PLAN
SCALE: 1/2" = 1'-0"

ELEVATION A-A
SCALE: 1/2" = 1'-0"

SAFETY STORAGE FOR SULFUR CHEMICAL
8'-0" x 15'-3 3/4"

AIR TREATMENT W/PLANE ARRESTORS 10'-0" x 22'-0"
WITH CONC BRGN W/1/4" 304L STAINLESS LINER

STANDARD HYDRO MONITOR SYSTEM
5'-3" x 7'-6"

ELECT CONC PND
APPROX 3'-6" x 6'-6"

GAS CHARACTERIZATION SYSTEM
8'-0" x 10'-0"

LIGHT POLE
NEW STACK
W/ CONC PND

EXISTING EXHAUST FANS
(OUTLET TO BE ROTATED)

NEW EXHAUST DUCTWORK & DUCT
ADAPTER AND EXISTING PLATFORM,
STACK AND EQUIPMENT TO BE REMOVED

EXISTING EXHAUST EQUIPMENT
(H-2-70339 & H-2-90008)

K-1 EXHAUST SYSTEM

K-2 EXHAUST SYSTEM

PLAN
SCALE: 1/2" = 1'-0"
OPTION #5

U.S. DEPARTMENT OF ENERGY	
FLUOR DANIEL, NORTHWEST, INC.	
241-AW FARM	
HVAC EQUIPMENT SYSTEMS	
UPGRADE	
PROJECT NO.	ES-AGA6.7-M5.10
DATE	2-11-88
BY	J. HODGE
CHECKED BY	
DESIGNED BY	
REVIEWED BY	
APPROVED BY	
CONCEPTUAL	
DESIGN	
CONSTRUCTION	

NO.	REVISIONS	DATE	BY	APP'D
1	ISSUED FOR CONSTRUCTION	2-11-88	J. HODGE	

NO.	REVISIONS	DATE	BY	APP'D
2	REVISED TO SHOW CHANGES	3-1-88	J. HODGE	

NO.	REVISIONS	DATE	BY	APP'D
3	REVISED TO SHOW CHANGES	3-1-88	J. HODGE	

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Rev. 0

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U.S. DEPARTMENT OF ENERGY	
FLUOR DANIEL, NORTHWEST, INC.	
241-AN FARM	
HVAC EQUIPMENT SYSTEMS	
UPGRADE	
ES-AGA6.7-M5	0

PLAN
SCALE: 1/2" = 1'-0"
OPTION #5

REV	NO	DATE	DESCRIPTION
1	1	10/1/88	ISSUED FOR CONSTRUCTION
2	2	10/1/88	REVISED TO ADD NEW STACK
3	3	10/1/88	REVISED TO ADD NEW EXHAUST SYSTEM
4	4	10/1/88	REVISED TO ADD NEW EXHAUST SYSTEM
5	5	10/1/88	REVISED TO ADD NEW EXHAUST SYSTEM
6	6	10/1/88	REVISED TO ADD NEW EXHAUST SYSTEM
7	7	10/1/88	REVISED TO ADD NEW EXHAUST SYSTEM
8	8	10/1/88	REVISED TO ADD NEW EXHAUST SYSTEM
9	9	10/1/88	REVISED TO ADD NEW EXHAUST SYSTEM
10	10	10/1/88	REVISED TO ADD NEW EXHAUST SYSTEM

PLAN
SCALE 1/2" = 1'-0"

OPTION #5

U.S. DEPARTMENT OF ENERGY	DATE 3/15/78
PLANNING, DESIGN, AND CONSTRUCTION DIVISION	
241-SY-FARM	
HVAC EQUIPMENT SYSTEMS	
UPGRADE	
ES-AGA6.7-M510

17

[illegible] [illegible]

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U.S. DEPARTMENT OF ENERGY	DATE: 03/11/95
PLUMBING DIVISION	PROJECT: 241-AZ-701
241-AZ-701	241-AZ-701
HVAC EQUIPMENT SYSTEMS	HVAC EQUIPMENT SYSTEMS
UPGRADE	UPGRADE
ES-AGA6.7-M510	ES-AGA6.7-M510

PLAN
SCALE: 3/16" = 1'-0"
OPTION #5

DATE: 03/11/95	PROJECT: 241-AZ-701
241-AZ-701	241-AZ-701
HVAC EQUIPMENT SYSTEMS	HVAC EQUIPMENT SYSTEMS
UPGRADE	UPGRADE
ES-AGA6.7-M510	ES-AGA6.7-M510

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ESTIMATING SHEETS FOR VENTILATION AGA OPTIONS

SHORT STACK

ALTERNATIVE #0

DEMO EXIST STACK (SEE W420 286-P-16) CONC ESTIM)	ST	AP	AN	AW	SV	AV/AZ
ALLOW FOR BURIAL FEE	8,443	11,398	11,398	11,398	11,398	11,398
STACK SECTIONS	5,000	5,000	5,000	5,000	5,000	5,000
SUPPORT PAD	3,082	4,161	4,161	4,161	4,161	4,161
INSTALL NEW STACK	6,705	9,049	9,049	9,049	9,049	9,049
SEE CONCEPTUAL ESTIMATE #W420BAB3 10/27/98	6,153	8,304	8,304	8,304	8,304	8,304
55' 10" ROUND DUCT (VENT BLDG TO STACK)	24,000	-	-	-	-	-
ALLOW FOR STACK SUPPORTS 5 EA @ \$5K	25,000	-	-	-	-	-
CAM (SEE W-420)-SEE DALE HAUGHTON BACKUP	138,264	164,534	164,534	164,534	164,534	164,534
GCS - SEE D. HAUGHTON BACKUP	400,000	476,000	476,000	476,000	476,000	476,000
SHM - SEE D. HAUGHTON BACKUP	529,676	635,611	635,611	635,611	635,611	635,611
TOTAL	1,146,323	1,314,057	1,314,057	1,314,057	1,314,057	1,360,186
JOB (SPLIT 60%LAB/40%MATL)						
LABOR:						
MATL:						
INCLUDES (GEN.CONDS, GF, CONSUMABLES, ST)						
FORMV CONST MGMT @						
TOTAL	458,529	619,014	619,014	619,014	619,014	619,014
DIRECT CONSTRUCTION WITH ALLOCATIONS						
ENGINEERING @ 35%						
PROJECT MANAGEMENT @ 10%						
TOTAL	1,604,852	1,933,072	1,933,072	1,933,072	1,933,072	1,989,203

SEE D. HAUGHTON ESTIMATE

SHORT STACK

ALTERNATIVE #0

AP SWP 30%	AN SWP 80%	AW SWSP 80%	SV SWP 80%	AV/AZ SWP 0%
TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
\$ 2,448,917	\$ 2,448,917	\$ 2,448,917	\$ 2,448,917	\$ 2,515,046
\$ 206,338	\$ 550,235	\$ 550,235	\$ 550,235	-
\$ 51,585	\$ 137,559	\$ 137,559	\$ 137,559	-
\$ 2,706,840	\$ 3,136,711	\$ 3,136,711	\$ 3,136,711	\$ 2,515,046
\$ 1,353,420	\$ 1,568,355	\$ 1,568,355	\$ 1,568,355	\$ 1,257,524
\$ 4,060,280	\$ 4,705,066	\$ 4,705,066	\$ 4,705,066	\$ 3,772,572

SWP's AT 30% OF LAB (SPLIT 60%LAB/40%MATL) \$ 687,794
 SWP's AT 80% OF LAB (SPLIT 60%LAB/40%MATL) \$ 887,794
 SITE ALLOCATIONS ON SWP's
 CONTINGENCY
 TOTALS PER AREA

TALL STACK

ALTERNATIVE #1

DESCRIPTION	QTY	UNIT	PRICE	TOTAL	AP	AN	AW	SY	AVAZ
DEMO EXIST STACK (SEE W420 288-P-16) CONC ESTIM									
ALLOW FOR BURIAL FEE									
85% STACK = 12000# PH-QUOTE									
INCL. PAINT, STIFFENERS, FLANGE, INSTALL ETC.									
EXCAV. (HAND) 6" X 16" X 16" X 10MH = 6570HR									
SHORE 16" X 8" X 4EA = 512SF @ \$25F MATL									
8. 60MH/SF =									
CONC 2.5' X 16' X 16' @ \$200CY MATL &									
10MH ICY LABOR (INCLUDES REBAR)									
CONC FOOTING 6' X 8' X 8' @ \$200CY MATL &									
10MH ICY LABOR (INCLUDES REBAR)									
65' 10" ROUND DUCT (VENT BLDG TO STACK)									
ALLOW FOR STACK SUPPORTS 5 EA @ \$8K									
CAM (SEE W-420) SEE DALE HAUGHTON BACKUP									
GCS - SEE D. HAUGHTON BACKUP									
SHM - SEE D. HAUGHTON BACKUP									
JOB (SPLIT 60% LAB/40% MATL)									
MATL: 60%									
INCLUDES (GEN. CONDS. GF. CONSUMABLES, ST)									
FDNW CONST MGMT @ 40%									
TOTAL									

DIRECT CONSTRUCTION WITH ALLOCATIONS

ENGINEERING @ 35%

PROJECT MANAGEMENT @ 10%

TOTAL

SEE D. HAUGHTON ESTIMATE

TALL STACK

ALTERNATIVE #1

DESCRIPTION	QTY	UNIT	PRICE	TOTAL	AP	AN	AW	SY	AVAZ
SWP's AT 30% OF LAB (SPLIT 60% LAB/40% MATL) \$									
SWP's AT 80% OF LAB (SPLIT 60% LAB/40% MATL) \$									
SITE ALLOCATIONS ON SWP's									
CONTINGENCY									
TOTAL ESTIMATED COST									

CLEAN AIR DILUTION

ALTERNATIVE #2

MRS	SITE	AP	AN	AW	SY	AV/AZ
DEMO EXIST STACK (SEE W420 288-P-16) CONC ESTIM)	8,443 \$	11,398 \$	11,398 \$	11,398 \$	11,398 \$	11,398 \$
ALLOW FOR BURIAL FEE	5,000 \$	5,000 \$	5,000 \$	5,000 \$	5,000 \$	5,000 \$
STACK SECTIONS	3,082 \$	4,161 \$	4,161 \$	4,161 \$	4,161 \$	4,161 \$
SUPPORT PAD	6,705 \$	9,049 \$	9,049 \$	9,049 \$	9,049 \$	9,049 \$
INSTALL NEW STACK	6,153 \$	8,304 \$	8,304 \$	8,304 \$	8,304 \$	8,304 \$
SEE CONCEPTUAL ESTIMATE #W420B4B3 10/27/96						
55' 10" ROUND DUCT (VENT BLDG TO STACK)	24,000 \$					32,391 \$
ALLOW FOR STACK SUPPORTS 5 EA @ \$5K	25,000 \$					33,740 \$
HEPA FILTER TRAIN	592,083 \$	789,081 \$	789,081 \$	789,081 \$	789,081 \$	789,081 \$
CAM (SEE W-420-SEE DALE HAUGHTON BACKUP	136,284 \$	164,534 \$	164,534 \$	164,534 \$	164,534 \$	164,534 \$
GCS - SEE D. HAUGHTON BACKUP	400,000 \$	478,000 \$	478,000 \$	478,000 \$	478,000 \$	478,000 \$
SHM - SEE D. HAUGHTON BACKUP	529,676 \$	635,611 \$	635,611 \$	635,611 \$	635,611 \$	635,611 \$
TOTAL	1,736,406 \$	2,113,138 \$	2,113,138 \$	2,113,138 \$	2,113,138 \$	2,179,269 \$
JOB (SPLIT 60%LAB/40%MATT)						
LABOR: 60%	1,043,044 \$					
MATL: 40%	695,362 \$					
INCLUDES (GEN.CONDS, GF, CONSUMABLES, ST)						
PDWV CONST MGMT @ 40%	695,362 \$	938,739 \$	938,739 \$	938,739 \$	938,739 \$	938,739 \$
TOTAL	2,433,768 \$	3,051,877 \$	3,051,877 \$	3,051,877 \$	3,051,877 \$	3,116,008 \$
DIRECT CONSTRUCTION WITH ALLOCATIONS						
ENGINEERING @ 35%		3,051,877 \$	3,051,877 \$	3,051,877 \$	3,051,877 \$	3,116,008 \$
PROJECT MANAGEMENT @ 10%		608,442 \$	608,442 \$	608,442 \$	608,442 \$	608,442 \$
TOTAL		173,841 \$	173,841 \$	173,841 \$	173,841 \$	173,841 \$
		3,834,160 \$	3,834,160 \$	3,834,160 \$	3,834,160 \$	3,900,291 \$

SEE D. HAUGHTON ESTIMATE

CLEAN AIR DILUTION

ALTERNATIVE #2

MRS	SITE	AP	AN	AW	SY	AV/AZ
SWP's AT 30% OF LAB (SPLIT 60%LAB/40%MATT)	1,043,044 \$					
SWP's AT 80% OF LAB (SPLIT 60%LAB/40%MATT)	1,043,044 \$					
SITE ALLOCATIONS ON SWP's						
CONTINGENCY						
TOTALS PER AREA						
		312,913 \$	834,435 \$	834,435 \$	834,435 \$	
		78,228 \$	208,609 \$	208,609 \$	208,609 \$	
		4,225,301 \$	4,877,204 \$	4,877,204 \$	4,877,204 \$	3,900,291 \$
		2,112,651 \$	2,438,602 \$	2,438,602 \$	2,438,602 \$	1,950,145 \$
		6,337,952 \$	7,315,808 \$	7,315,808 \$	7,315,808 \$	5,850,436 \$

CONTROL GAS VENTING

MBS	SITE	ST	ALLOCATIONS		AP TOTAL	AN TOTAL	AV TOTAL	SY TOTAL	AVIAZ TOTAL
DEMO EXIST STACK (SEE W420 286-P-16) CONC ESTIM)		\$ 8,443	\$ 2,955	\$	\$ 11,398	\$	\$	\$ 11,398	\$
ALLOW FOR BURIAL FEE		\$ 5,000	\$	\$	\$ 5,000	\$	\$	\$ 5,000	\$
STACK SECTIONS		\$ 3,082	\$ 1,079	\$	\$ 4,161	\$	\$	\$ 4,161	\$
SUPPORT PAD		\$ 6,705	\$ 2,344	\$	\$ 9,049	\$	\$	\$ 9,049	\$
INSTALL NEW STACK		\$ 6,153	\$ 2,151	\$	\$ 8,304	\$	\$	\$ 8,304	\$
SEE CONCEPTUAL ESTIMATE #W420A85 10/27/95		\$	\$	\$	\$	\$	\$	\$	\$
55' 10" ROUND DUCT (NEAT BLDG TO STACK)		\$ 24,000	\$	\$	\$	\$	\$	\$	\$
ALLOW FOR STACK SUPPORTS 5 EA @ 55K		\$ 25,000	\$ 8,391	\$	\$ 11,398	\$	\$	\$ 11,398	\$
HEPA FILTER TRAM		\$ 582,083	\$ 8,740	\$	\$ 799,081	\$	\$	\$ 799,081	\$
GAH (SEE W420-SEE DALE HAUGHTON BACKUP		\$ 158,264	\$ 28,270	\$	\$ 164,534	\$	\$	\$ 164,534	\$
OC8 - SEE D. HAUGHTON BACKUP		\$ 400,000	\$ 78,000	\$	\$ 478,000	\$	\$	\$ 478,000	\$
SHM - SEE D. HAUGHTON BACKUP		\$ 528,676	\$ 105,935	\$	\$ 635,611	\$	\$	\$ 635,611	\$
(GAS VENTING FOR AP-102 ONLY									
FLANGED PLUG - 12" X 5" CONC IN PIPE W/2EA 2" S.B. TUBES PENETRATING INTO TANK. (SEE BACKUP)		\$ 22,800	\$ 6,640	\$	\$ 29,640				
SHOP FAB 2 MEN 80 M/2EA X 810K MATL"		\$ 10,000	\$ 3,000	\$	\$ 13,000				
USE TEMP PROBE INSTALL COSTS -		\$	\$	\$	\$				
- SEE MBS 316101.709404 IN ALT. 6.1		\$ 31,079	\$ 9,324	\$	\$ 40,403				
FOR AP-104 ONLY (USE SAME AS AP-102)		\$ 63,879	\$ 19,164	\$	\$ 83,043				
FOR AP-108 ONLY (USE SAME AS AP-102)		\$ 63,879	\$ 19,164	\$	\$ 83,043				
GAS VENTING FOR AP-109 (USE AP-102)		\$ 63,879	\$	\$	\$	\$ 83,043			
FOR AP-104 ONLY (USE SAME AS AP-102)		\$ 63,879	\$ 19,164	\$	\$ 83,043				
FOR AP-105 ONLY (USE SAME AS AP-108)		\$ 63,879	\$ 19,164	\$	\$ 83,043				
GAS VENTING FOR AP-101 (USE AP-102)		\$ 63,879	\$ 19,164	\$	\$ 83,043		\$ 83,043		
GAS VENTING FOR SY-101 (USE AP-102)		\$ 63,879	\$	\$	\$		\$	\$ 83,043	\$
FOR SY-102 ONLY (USE SAME AS SY-101)		\$ 63,879	\$ 19,164	\$	\$ 83,043		\$	\$ 83,043	\$

SEE D. HAUGHTON ESTIMATE

CONTROL GAS VENTING

CONTINGENCY		TOTAL	50%
TOTALS PER AREA			
SMP# AT 30% OF LAB (SPLIT 60%LAB/40%MAT	\$	1,387,980	30%
SMP# AT 80% OF LAB (SPLIT 60%LAB/40%MAT	\$	1,387,980	80%
SITE ALLOCATIONS ON SMP#			

ALTERNATIVE 3

AP SWP 30%	AN SWP 80%	AW SWSP 80%	SV SWP 80%	AVWZ SWP 0%
TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
\$ 4,494,671	\$ 4,328,588	\$ 4,162,500	\$ 4,245,543	\$ 4,145,598
\$ 418,397				
\$ 104,089	\$ 1,110,362	\$ 1,110,362	\$ 1,110,362	
\$ 5,015,167	\$ 277,590	\$ 277,590	\$ 277,590	
\$ 2,507,594	\$ 5,716,576	\$ 5,950,491	\$ 5,633,523	\$ 4,145,590
\$ 7,832,761	\$ 2,859,298	\$ 2,775,245	\$ 2,618,787	\$ 2,072,784
	\$ 6,974,864	\$ 6,323,736	\$ 6,480,500	\$ 6,218,383

DRY ABSORPTION BED

ALTERNATIVE #4

	WBS	SITE	AP	AN	AW	SY	AV/AZ
		ALLOCATIONS	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
DEMO, EXIST STACK (SEE W420 296-P-16) CONC ESTM)		\$ 8,443	\$ 2,965	\$ 11,398	\$ 11,398	\$ 11,398	\$ 11,398
ALLOW FOR BURIAL FEE		\$ 5,000	\$ -	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000
STACK SECTIONS		\$ 3,082	\$ 1,079	\$ 4,161	\$ 4,161	\$ 4,161	\$ 4,161
SUPPORT PAD		\$ 6,705	\$ 2,344	\$ 9,049	\$ 9,049	\$ 9,049	\$ 9,049
INSTALL NEW STACK		\$ 6,153	\$ 2,151	\$ 8,304	\$ 8,304	\$ 8,304	\$ 8,304
SEE CONCEPTUAL ESTIMATE #W420B4B3 10/27/88		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
ALT 4 AIR TREATMENT W/ARESTOR		\$ 429,963	\$ 150,319	\$ 580,282	\$ 580,282	\$ 580,282	\$ 580,282
55' 10" ROUND DUCT (VENT BLDG TO STACK)		\$ 24,000	\$ 8,391	\$ -	\$ -	\$ -	\$ 32,391
ALLOW FOR STACK SUPPORTS 5 EA @ \$5K		\$ 25,000	\$ 8,740	\$ -	\$ -	\$ -	\$ 33,740
CAM (SEE W-420)-SEE DALE HAUGHTON BACKUP		\$ 138,264	\$ 26,270	\$ 164,534	\$ 164,534	\$ 164,534	\$ 164,534
GCS - SEE D. HAUGHTON BACKUP		\$ 400,000	\$ 76,000	\$ 476,000	\$ 476,000	\$ 476,000	\$ 476,000
SHM - SEE D. HAUGHTON BACKUP		\$ 529,676	\$ 105,935	\$ 635,611	\$ 635,611	\$ 635,611	\$ 635,611
TOTAL		\$ 1,576,236	\$ 384,164	\$ 1,894,339	\$ 1,894,339	\$ 1,894,339	\$ 1,860,470
JOB (SPLIT 60%LAB/40%MATL)							
LABOR: 60%							
MATL: 40%							
INCLUDES (GEN.CONDS, GF, CONSUMABLES, ST)		\$ 945,772					
FDNW CONST MGMT @ 40%		\$ 630,514					
TOTAL		\$ 2,206,800	\$ 604,864	\$ 2,745,534	\$ 2,745,534	\$ 2,745,534	\$ 2,811,665
DIRECT CONSTRUCTION WITH ALLOCATIONS				\$ 2,745,534	\$ 2,745,534	\$ 2,745,534	\$ 2,811,666
ENGINEERING @ 35%				\$ 551,700	\$ 551,700	\$ 551,700	\$ 551,700
PROJECT MANAGEMENT @10%				\$ 157,628	\$ 157,628	\$ 157,628	\$ 157,628
TOTAL				\$ 3,454,863	\$ 3,454,863	\$ 3,454,863	\$ 3,520,993

SEE D. HAUGHTON ESTIMATE

DRY ABSORPTION BED

ALTERNATIVE 14

DRY ABSORPTION BED					
	AP SWP 30%	AN SWP 80%	AW SWSP 80%	SY SWP 80%	AVI/2 SWP 0%
	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
\$ 3,454,863	\$ 3,454,863	\$ 3,454,863	\$ 3,454,863	\$ 3,520,993	
\$ 283,731	\$ 756,617	\$ 756,617	\$ 756,617	\$	
	\$ 189,154	\$ 189,154	\$ 189,154	\$	
\$ 70,933	\$ 4,400,634	\$ 4,400,634	\$ 4,400,634	\$ 3,520,993	
\$ 3,809,527	\$ 2,200,317	\$ 2,200,317	\$ 2,200,317	\$ 1,760,497	
\$ 1,904,763	\$ 6,600,961	\$ 6,600,961	\$ 6,600,961	\$ 6,281,490	
\$ 6,714,290					

WET SCRUBBER

ALTERNATIVE #8

DEMO EXIST STACK (SEE W420 206-P-16) CONC ESTIM)	8,443	2,965	11,398	11,398	11,398	11,398	11,398	11,398	11,398
ALLOW FOR BURIAL FEE	\$	\$	\$	\$	\$	\$	\$	\$	\$
EXCAV. (HAND) 8'0" X 16' X 16' = 75CY X 10441- @ 6704-R	\$	\$	\$	\$	\$	\$	\$	\$	\$
SHORE 16'0" X 16' X 4'EA = 512SF @ 22SF MATL	\$	\$	\$	\$	\$	\$	\$	\$	\$
CONC 2.5' X 16' X 16' @ 2200CY MATERIAL & 10441 CY LABOR (INCLUDES REBAR)	\$	\$	\$	\$	\$	\$	\$	\$	\$
CONC FOOTING 6' X 8' X 8' @ 2200CY MATERIAL & 10441 CY LABOR (INCLUDES REBAR)	\$	\$	\$	\$	\$	\$	\$	\$	\$
55' 10" ROUND DUCT (VENT BLDG TO STACK)	\$	\$	\$	\$	\$	\$	\$	\$	\$
ALLOW FOR STACK SUPPORTS 5 EA @ \$8K	\$	\$	\$	\$	\$	\$	\$	\$	\$
WET SCRUBBER SYSTEM FOR AP	\$	\$	\$	\$	\$	\$	\$	\$	\$
WET SCRUBBER SYSTEM FOR AN	\$	\$	\$	\$	\$	\$	\$	\$	\$
WET SCRUBBER SYSTEM FOR AW	\$	\$	\$	\$	\$	\$	\$	\$	\$
WET SCRUBBER SYSTEM FOR SY	\$	\$	\$	\$	\$	\$	\$	\$	\$
ELECTRICAL COSTS	\$	\$	\$	\$	\$	\$	\$	\$	\$
CAN (SEE W420-SEE DALE HAUGHTON BACKUP	\$	\$	\$	\$	\$	\$	\$	\$	\$
GCS - SEE D. HAUGHTON BACKUP	\$	\$	\$	\$	\$	\$	\$	\$	\$
SHM - SEE D. HAUGHTON BACKUP	\$	\$	\$	\$	\$	\$	\$	\$	\$
TOTAL	\$ 3,030,180	\$ 893,057	\$ 1,951,788	\$ 1,951,328	\$ 1,957,243	\$ 1,954,450	\$ 2,052,439	\$ 487,903	\$ 487,903
JOB (SPILT 60%LAB/40%MATL)	\$ 1,818,108								
MATL: 40%	\$ 1,212,072								
INCLUDES (GEN.CONDS, GF. CONSUMABLES, ST)	\$ 40%								
FOUW CONST MGMT @ 40%	\$ 1,212,072								
TOTAL	\$ 4,242,252	\$ 1,317,292	\$ 1,636,297	\$ 1,636,297	\$ 1,636,297	\$ 1,636,297	\$ 1,636,297	\$ 1,636,297	\$ 1,636,297
DIRECT CONSTRUCTION WITH ALLOCATIONS									
ENGINEERING @ 35%									
PROJECT MANAGEMENT @ 10%									
TOTAL	\$ 3,598,063	\$ 3,597,625	\$ 3,593,540	\$ 3,593,540	\$ 3,593,540	\$ 3,593,540	\$ 3,593,540	\$ 3,593,540	\$ 3,593,540
AP SWP 30%	\$ 3,598,063	\$ 3,597,625	\$ 3,593,540	\$ 3,593,540	\$ 3,593,540	\$ 3,593,540	\$ 3,593,540	\$ 3,593,540	\$ 3,593,540
AN SWP 80%	\$ 1,090,563	\$ 1,090,563	\$ 1,090,563	\$ 1,090,563	\$ 1,090,563	\$ 1,090,563	\$ 1,090,563	\$ 1,090,563	\$ 1,090,563
AW SWP 80%	\$ 303,018	\$ 303,018	\$ 303,018	\$ 303,018	\$ 303,018	\$ 303,018	\$ 303,018	\$ 303,018	\$ 303,018
SY SWP 80%	\$ 4,951,674	\$ 4,951,206	\$ 4,957,121	\$ 4,954,329	\$ 4,954,329	\$ 4,954,329	\$ 4,954,329	\$ 4,954,329	\$ 4,954,329
AVI/2 SWP 0%	\$ 5,052,317								
TOTAL	\$ 4,951,674	\$ 4,951,206	\$ 4,957,121	\$ 4,954,329	\$ 4,954,329	\$ 4,954,329	\$ 4,954,329	\$ 4,954,329	\$ 4,954,329

SEE D. HAUGHTON ESTIMATE

WET SCRUBBER

ALTERNATIVE #8

SWP'S AT 30% OF LAB (SPILT 60%LAB/40%MATL)	\$ 1,818,108								
SWP'S AT 80% OF LAB (SPILT 60%LAB/40%MATL)	\$ 1,818,108								
SITE ALLOCATIONS ON SWP'S									
CONTINGENCY									
TOTAL ESTIMATED COST									
AP SWP 30%	\$ 4,951,674	\$ 4,951,206	\$ 4,957,121	\$ 4,954,329	\$ 4,954,329	\$ 4,954,329	\$ 4,954,329	\$ 4,954,329	\$ 4,954,329
AN SWP 80%	\$ 545,432	\$ 1,454,486	\$ 1,454,486	\$ 1,454,486	\$ 1,454,486	\$ 1,454,486	\$ 1,454,486	\$ 1,454,486	\$ 1,454,486
AW SWP 80%	\$ 136,358	\$ 363,622	\$ 363,622	\$ 363,622	\$ 363,622	\$ 363,622	\$ 363,622	\$ 363,622	\$ 363,622
SY SWP 80%	\$ 5,633,464	\$ 6,778,314	\$ 6,778,229	\$ 6,772,437	\$ 6,772,437	\$ 6,772,437	\$ 6,772,437	\$ 6,772,437	\$ 6,772,437
AVI/2 SWP 0%	\$ 2,816,732.11	\$ 3,398,657.07	\$ 3,397,614.41	\$ 3,396,218.31	\$ 3,396,218.31	\$ 3,396,218.31	\$ 3,396,218.31	\$ 3,396,218.31	\$ 3,396,218.31
TOTAL	\$ 8,450,196	\$ 10,168,871	\$ 10,162,843	\$ 10,158,656	\$ 10,158,656	\$ 10,158,656	\$ 10,158,656	\$ 10,158,656	\$ 10,158,656

CATALYTIC THERMAL OXIDIZER

ALTERNATIVE BZ

DEMO EXIST STACK (SEE W420 286-P-16) CONC ESTIM)	WBS	SITE	AP	AN	AW	SY	AVAZ
ALLOW FOR BURIAL FEE		8,443	11,368	11,368	11,368	11,368	11,368
55TH STACK = 12000# PH-QUOTE		5,000	5,000	5,000	5,000	5,000	5,000
INCL. PAINT, STIFFENERS, FLANGE, INSTALL ETC.		24,000	32,400	32,400	32,400	32,400	32,400
EXCAV. (HAND) 6D X 16" X 16" = 75CY X 104M = @ \$70/HR							
SHORE 16D X 8H X 4EA = 512SF @ \$25F MATL							
6.604MSF =							
CONC 2.5' X 16' X 16' @ \$200CY MATL &		48,388	65,325	65,325	65,325	65,325	65,325
104M CY LABOR (INCLUDES REBAR)		1,024	1,382	1,382	1,382	1,382	1,382
CONC FOOTING 6' X 8' X 8' @ \$200CY MATL &		18,003	21,598	21,598	21,598	21,598	21,598
104M CY LABOR (INCLUDES REBAR)		4,741	6,268	6,268	6,268	6,268	6,268
CONC FOOTING 6' X 8' X 8' @ \$200CY MATL &		16,583	22,394	22,394	22,394	22,394	22,394
104M CY LABOR (INCLUDES REBAR)		2,844	3,838	3,838	3,838	3,838	3,838
55' 10" ROUND DUCT (VENT BLDG TO STACK)		8,868	13,437	13,437	13,437	13,437	13,437
ALLOW FOR STACK SUPPORTS 5 EA @ \$5K		24,000	32,400	32,400	32,400	32,400	32,400
CATALYTIC THERM OX SYSTEM FOR AP		302,486	408,356	408,356	408,356	408,356	408,356
CATALYTIC THERM OX SYSTEM FOR AN		464,896	627,597	627,597	627,597	627,597	627,597
CATALYTIC THERM OX SYSTEM FOR AW		318,808	431,741	431,741	431,741	431,741	431,741
CATALYTIC THERM OX SYSTEM FOR SY		330,375	446,007	446,007	446,007	446,007	446,007
CATALYTIC THERM OX SYS FOR AVAZ		294,573	397,559	397,559	397,559	397,559	397,559
GCS - SEE W420-SEE DALE HAUGHTON BACKUP		136,264	184,534	184,534	184,534	184,534	184,534
SNM - SEE D. HAUGHTON BACKUP		400,000	476,000	476,000	476,000	476,000	476,000
JOB (SPLIT 60%LAB/40%MATL)		528,676	635,611	635,611	635,611	635,611	635,611
LABOR:		2,986,062	3,987,673	3,987,673	3,987,673	3,987,673	3,987,673
MATL:							
INCLUDES (GEN.CONDS, GF, CONSUMABLES, ST)							
PDWV CONST INHAUT @ 40%							
TOTAL		4,152,487	5,552,863	5,552,863	5,552,863	5,552,863	5,552,863

SEE D. HAUGHTON ESTIMATE

CATALYTIC THERMAL OXIDIZER

ALTERNATIVE BZ

DIRECT CONSTRUCTION WITH ALLOCATIONS	WBS	SITE	AP	AN	AW	SY	AVAZ
ENGINEERING @ 35%		1,186,425	1,581,874	1,581,874	1,581,874	1,581,874	1,581,874
PROJECT MANAGEMENT @ 10%							
TOTAL		1,186,425	1,581,874	1,581,874	1,581,874	1,581,874	1,581,874

SWP₂ AT 30% OF LAB (SPLIT 60%LAB/40%MATL)SWP₂ AT 30% OF LAB (SPLIT 60%LAB/40%MATL) \$ 1,779,637

30%

SWP₂ AT 80% OF LAB (SPLIT 60%LAB/40%MATL)SWP₂ AT 80% OF LAB (SPLIT 60%LAB/40%MATL) \$ 1,779,637

80%

SITE ALLOCATIONS ON SWP₂SITE ALLOCATIONS ON SWP₂ \$ 1,779,637

80%

CONTINGENCY

CONTINGENCY \$ 1,779,637

50%

TOTAL ESTIMATED COST

TOTAL ESTIMATED COST \$ 1,779,637

50%

WET SCRUBBER - OPTION 5 BACKUP INFORMATION

MAJOR ITEMS	SUPPORTING ITEM DESCRIPTION	HRS/ UNITS EA	\$ PER HR OR UNIT	SUB-TOTALS	LABOR ADDERS	SALES TAX	TOTAL
EYE WASH				\$ 9,150	\$ -	\$ 332	\$ 9,482
	EYE WASH UNIT	1	\$ 4,150	\$ 4,150		\$ 332	
	FREIGHT	1	\$ 5,000	\$ 5,000			
SAFETY STORAGE BUILDING				\$ 30,080	\$ 953	\$ 2,104	\$ 33,137
	BUILDING	1	\$ 24,500	\$ 24,500		\$ 1,960	
	CEMENT FOOTINGS & FLOORING	9	\$ 200	\$ 1,800		\$ 144	
	INSTALLATION LABOR	90	\$ 42	\$ 3,780	\$ 953		
CARBON ABSORPTION BED				\$ 12,195	\$ 1,058	\$ 640	\$ 13,893
	CARB ABSORPTION BED	1	\$ 7,995	\$ 7,995		\$ 640	
	BED INSTALLATION	100	\$ 42	\$ 4,200	\$ 1,058		
DUPLEX FLAME ARRESTORS				\$ 40,582	\$ 1,016	\$ 2,924	\$ 44,522
	8" DET FLAME ARR	2	\$ 18,275	\$ 36,550		\$ 2,924	
	LABOR = 48 HRS X 2 EA	96	\$ 42	\$ 4,032	\$ 1,016		
SKID MOUNTED AMONIA SCRUBBER				\$ 53,820	\$ 4,869	\$ 2,580	\$ 61,249
	SCRUBBER	1	\$ 32,000	\$ 32,000		\$ 2,580	
	SHIPPING FOR SCRUBBER	1	\$ 2,500	\$ 2,500			
	INSTALLATION	480	\$ 42	\$ 19,320	\$ 4,869		
AIR TREATMENT/FLAME ARRESTOR BASIN & LINER				\$ 65,676	\$ 11,113	\$ 1,726	\$ 78,515
	CEMENT BASIN	33	\$ 200	\$ 6,600		\$ 528	
	LABOR = 10 MHR/CY	330	\$ 42	\$ 13,860	\$ 3,493		
	STAINLESS STEEL LINER	288	\$ 52	\$ 14,976		\$ 1,198	
	INSTAL LABOR = 2.5 MHR/SF	720	\$ 42	\$ 30,240	\$ 7,620		
FIRE SUPPRESSION SYSTEM				\$ 53,872	\$ -	\$ 4,310	\$ 58,182
	FIRE SUPPRESSION SYSTEM	1780	\$ 2	\$ 3,872		\$ 310	
INSULATION & HEAT TRACE				\$ 25,000	\$ -	\$ 2,000	\$ 27,000
	FOR SCRUBBER & RECRIC PIPING	1	\$ 25,000	\$ 25,000		\$ 2,000	
PRE-VARIABLE SUBTOTAL							\$ 325,979
ROTATE FANS (APPLICABLE TO AW, AN, AP)				\$ 2,888	\$ 677	\$ 16	\$ 3,581
	ALLOW 32 HRS EA X 2	64	\$ 42	\$ 2,688	\$ 677		
	ALLOW MISC MATL X 2	2	\$ 100	\$ 200		\$ 16	
DUCT WORK				\$ 12,609	\$ -	\$ 1,009	\$ 13,618
	FIBERGLASS DUCT WORK	20	\$ 467	\$ 9,340		\$ 747	
	STAINLESS STEEL DUCT WORK	7	\$ 467	\$ 3,269		\$ 262	
WET SCRUBBER SUMMARY TOTAL FOR AP (FAN ROTATE INCL)							\$ 343,178
DUCT WORK				\$ 19,147	\$ -	\$ 1,532	\$ 20,679
	FIBERGLASS DUCT WORK	25	\$ 467	\$ 11,675		\$ 934	
	STAINLESS STEEL DUCT WORK	16	\$ 467	\$ 7,472		\$ 598	
WET SCRUBBER SUMMARY TOTAL FOR AN (FAN ROTATE INCL)							\$ 350,239
DUCT WORK				\$ 16,345	\$ -	\$ 1,308	\$ 17,653
	FIBERGLASS DUCT WORK	15	\$ 467	\$ 7,005		\$ 560	
	STAINLESS STEEL DUCT WORK	20	\$ 467	\$ 9,340		\$ 747	
WET SCRUBBER SUMMARY TOTAL FOR AW (FAN ROTATE INCL)							\$ 347,213
DUCT WORK				\$ 39,695	\$ -	\$ 3,176	\$ 42,871
	FIBERGLASS DUCT WORK	70	\$ 467	\$ 32,690		\$ 2,615	
	STAINLESS STEEL DUCT WORK	15	\$ 467	\$ 7,005		\$ 560	
WET SCRUBBER SUMMARY TOTAL FOR AY/AZ							\$ 368,850
DUCT WORK				\$ 17,746	\$ -	\$ 1,420	\$ 19,166
	FIBERGLASS DUCT WORK	30	\$ 467	\$ 14,010		\$ 1,121	
	STAINLESS STEEL DUCT WORK	8	\$ 467	\$ 3,736		\$ 299	
WET SCRUBBER SUMMARY TOTAL FOR SY							\$ 345,145

CATALYTIC THERMAL OXIDIZER - OPTION 7 BACKUP INFORMATION

MAJOR ITEMS	SUPPORTING ITEM DESCRIPTION	HRS /		\$ PER HR	SUB-TOTALS	LABOR ADDERS	SALES TAX	TOTAL
		EA	OR UNIT					
35' 10" ROUND DUCT, VALVES, ETC					\$ 34,262	\$ 381	\$ 2,820	\$ 37,263
	DUCT FITTINGS 35' X 436	35	\$ 436	\$ 15,260			\$ 1,221	
	VALVES	8	\$ 415	\$ 2,490			\$ 199	
	LABOR = 6 VALVES @ 6 HRS EA	36	\$ 42	\$ 1,512	\$ 381			
	DUCT SPTS	3	\$ 5,000	\$ 15,000			\$ 1,200	
DUPLEX FLAME ARRESTORS				\$ 40,582	\$ 1,016	\$ 2,924		\$ 44,522
	8" DET FLAME ARR	2	\$ 18,275	\$ 36,550		\$ 2,924		
	LABOR = 48 HRS X 2 EA	96	\$ 42	\$ 4,032	\$ 1,016			
CATALYTIC OXIDIZER				\$ 99,327	\$ 5,040	\$ 6,348		\$ 110,713
	SST UNIT	1	\$ 79,327	\$ 79,327		\$ 6,348		
	LABOR/CRANE TIME	200	\$ 100	\$ 20,000	\$ 5,040			
PROPANE TANK PAD				\$ 3,020	\$ 106	\$ 208		\$ 3,334
	CEMENT = 5'X14'X6" = 1 CY	1	\$ 200	\$ 200		\$ 16		
	LABOR = 10 MHR/CY	10	\$ 42	\$ 420	\$ 106			
	(INCL REBAR 3X10)			\$ -				
	BOLLARDS	8	\$ 300	\$ 2,400		\$ 192		
PROPANE TANKS				\$ 2,172	\$ 169	\$ 120		\$ 2,461
	TANK 1,000 GALLON	1	\$ 1,500	\$ 1,500		\$ 120		
	LABOR = 16 HR X 1 TANK	16	\$ 42	\$ 672	\$ 169			
AIR COMPRESSOR				\$ 24,919	\$ 2,455	\$ 1,214		\$ 28,588
	10 HP COMP 120 GC TNK	1	\$ 6,175	\$ 6,175		\$ 494		
	LABOR FOR COMP/TNK INST	27	\$ 42	\$ 1,134	\$ 286			
	CONTROL PANEL	1	\$ 2,000	\$ 2,000		\$ 160		
	LABOR FOR PANEL INST	100	\$ 42	\$ 4,200	\$ 1,058			
	MOISTURE SEPARATOR	1	\$ 3,200	\$ 3,200		\$ 256		
	LABOR FOR SEP INST	3	\$ 42	\$ 126	\$ 32			
	DRYER	1	\$ 2,800	\$ 2,800		\$ 224		
	LABOR FOR DRYER INST	2	\$ 42	\$ 84	\$ 21			
	SKID MOUNT & PIPE	1	\$ 1,000	\$ 1,000		\$ 80		
	LABOR FOR SKID MT/PIPE INST	100	\$ 42	\$ 4,200	\$ 1,058			
BURIED AIR/GAS LINE (AY/AZ)				\$ 8,664	\$ 2,153	\$ 10		\$ 10,827
	TRENCH 20'X2'X2' = 3 CY	3	\$ 1,728	\$ 5,184	\$ 1,306			
	EXC/BF 4 HRS PER FT OF TRENCH	80	\$ 42	\$ 3,360	\$ 847			
	MATERIALS \$3 PER FT X 2 LINES	40	\$ 3	\$ 120		\$ 10		
FANS				\$ 52,272	\$ 529	\$ 4,063		\$ 56,865
	15 HP FANS	2	\$ 25,296	\$ 50,592		\$ 4,047		
	LABOR FOR FAN INST @ 20 HRS	40	\$ 42	\$ 1,680	\$ 423			
	FAN PAD 6'X8'X6"	1	\$ 200	\$ 200		\$ 16		
	LABOR FOR PAD 10MHR/CY	10	\$ 42	\$ 420	\$ 106			
CATALYTIC THERMAL OX SUMMARY TOTAL FOR AY/AZ								\$ 294,573

CATALYTIC THERMAL OXIDIZER - OPTION 7 BACKUP INFORMATION

MAJOR ITEMS	SUPPORTING ITEM DESCRIPTION	HRS / UNITS EA	\$ PER HR OR UNIT	SUB-TOTALS	LABOR ADDERS	SALES TAX	TOTAL
ROTATE FANS (NOT APPLICABLE TO AY/AZ)				\$ 2,888	\$ 677	\$ 16	\$ 3,581
	ALLOW 32 HRS EA X 2	64	\$ 42	\$ 2,688	\$ 677		
	ALLOW MISC MATL X 2	2	\$ 100	\$ 200		\$ 16	
THIS ITEM IS APPLICABLE TO ALL FARMS EXCEPT AY/AZ							

BURIED AIR/GAS LINE (AP)				\$ 12,132	\$ 3,012	\$ 14	\$ 15,158
TRENCH 30'X2'X2' = 4 CY	4	\$ 1,728	\$	6,912	\$ 1,742		
EXC/BF 4 HRS PER FT OF TRENCH	120	\$ 42	\$	5,040	\$ 1,270		
MATERIALS \$3 PER FT X 2 LINES	60	\$ 3	\$	180		\$ 14	

CATALYTIC THERMAL OX SUMMARY TOTAL FOR AP	\$ 302,486
--	-------------------

BURIED AIR/GAS LINE (AN)				\$ 142,092	\$ 35,308	\$ 158	\$ 177,559
TRENCH 330'X2'X2' = 49 CY	49	\$ 1,728	\$	84,672	\$ 21,337		
EXC/BF 4 HRS PER FT OF TRENCH	1320	\$ 42	\$	55,440	\$ 13,971		
MATERIALS \$3 PER FT X 2 LINES	660	\$ 3	\$	1,980		\$ 158	

CATALYTIC THERMAL OX SUMMARY TOTAL FOR AN	\$ 464,886
--	-------------------

BURIED AIR/GAS LINE (AW)				\$ 25,992	\$ 6,459	\$ 29	\$ 32,480
TRENCH 60'X2'X2' = 9 CY	9	\$ 1,728	\$	15,552	\$ 3,919		
EXC/BF 4 HRS PER FT OF TRENCH	240	\$ 42	\$	10,080	\$ 2,540		
MATERIALS \$3 PER FT X 2 LINES	120	\$ 3	\$	360		\$ 29	

CATALYTIC THERMAL OX SUMMARY TOTAL FOR AW	\$ 319,808
--	-------------------

BURIED AIR/GAS LINE (SY)				\$ 34,416	\$ 8,612	\$ 19	\$ 43,048
TRENCH 80'X2'X2' = 12 CY	12	\$ 1,728	\$	20,736	\$ 5,225		
EXC/BF 4 HRS PER FT OF TRENCH	320	\$ 42	\$	13,440	\$ 3,387		
MATERIALS \$3 PER FT X 2 LINES	80	\$ 3	\$	240		\$ 19	

CATALYTIC THERMAL OX SUMMARY TOTAL FOR SY	\$ 330,375
--	-------------------

APPENDIX F

VENTILATION VOLUMETRIC FLOW EVALUATION

APPENDIX F

VENTILATION VOLUMETRIC FLOW EVALUATION

F.1 INTRODUCTION

Three major assumptions in this AGA that affect the conclusion are:

1. A nominal flow rate of 1,000 scfm from each emission point will be realized (Section 2.1.7),
2. There will be no more than three simultaneous in-tank activities (Section 7.1.6),
3. Ventilation treatment/control will be provided on a farm basis (Section 2.1.3).

However, for an existing or upgraded primary ventilation system to operate with the added heat loads from privatization support operations, the measurement of the primary ventilation air from each tank (controlled and infiltration) is required. Measurement devices are required for balance and control and should be installed in conjunction with the existing flow control valves in each ventilation pit throughout the farm. The monitoring and readout of flows should be included in the upgrades to the existing or new ventilation system.

F.2 FLOW MONITORING

A report titled "Test Report of Evaluation of Primary Exhaust Ventilation Flow Meters for Double-Shell Hydrogen Watch List Tanks" (Willingham 1996) documents the results of testing four different flow meters using three different technologies for use in the primary exhaust ventilation ducts of hydrogen watch list DSTs. A selection was recommended, and installation of these flow meters is expected to be complete in fiscal year 1999 for the 241-AN Hydrogen Watch List Tanks. Based upon success in AN farm, that selection should also be applied to the other DSTs. Control could range from local readout of flow with manual adjustment of the existing flow control valves to an integrated control system with remote readout of flow and adjustment of valves.

F.3 EFFECTS OF INCREASING THE NUMBER OF SIMULTANEOUS IN-TANK ACTIVITIES

For DST farms where there is the possibility of several simultaneous mixer pump and waste receipt operations (proposed case 6 of the TWRSO&UP[Kirkbride et al. 1999]), performance of thermal analysis is required to determine individual primary ventilation flow rates for each tank. Also required is an analysis of the primary ventilation underground ductwork system to determine if the current configuration could support the primary ventilation flow rates for the specific tanks within the tank farm.

F.4 RECOMMENDATIONS FOR ASSESSING THE STRUCTURAL INTEGRITY OF THE BURIED DUCTWORK

The structural integrity of the existing primary ventilation below-grade ductwork should be investigated to determine its current condition and estimate if it will maintain structural integrity throughout the waste feed delivery campaign supporting privatization.

An internal visual inspection of the primary ventilation below-grade ducting should be initiated as near to the primary tank entrance as possible. This area would have the highest-temperature tank vapor and condensate, and should present a region of highest corrosion in the ventilation duct. A potential entrance for the remote inspection could be in a ventilation pit with the probe extended to near the entrance of the primary tank duct. Cutting into the existing primary ventilation duct would present an ignition source for flammable gas, therefore, access into the existing primary ventilation duct in the ventilation pits should be investigated.

Two methods are available to examine the primary exhaust duct (welded pipeline) to investigate corrosion for the purposes of determining the remaining strength of these areas. These methods are discussed below.

F.4.1 CCTV Examination System

The CCTV examination consists of a laser-ring followed by a camera pushed into the transfer pipe for approximately 100 feet using a push pole. The laser-ring illuminates a circumferential circle on the internal surface of the pipe. These circles, which take the form of the pipe contour, are compared with a standard pipe contour to measure corrosion or scaling of the pipe material. While the laser-ring paints a contour, the camera provides a direct view of the internal surface condition. The product of the exam is the information gained by direct viewing of the laser-ring and the internal surface of the pipe wall through the monitor in the field. Videotape of both the direct viewing and the laser-ring information is available for further examination and evaluation to determine the probability of significant piping material degradation.

F.4.2 Eddy Current System

The Eddy Current instrument with remote field option is used for a broad range of tubing and piping applications in the petroleum, chemical, and power generation industries. The probe is hand fed and pushed through the ventilation duct. Power and signal data cables are connected to equipment adjacent to the point of entry of the probe. A vector analysis of the data is used to estimate pitting depth, length, and general wall thinning.

Both the CCTV Examination System and the Eddy Current System require cleanliness of the line slated for examination. Sludge buildup within the pipe will prevent the CCTV from accurately revealing pitting corrosion, and will cause the Eddy Current to function improperly.

APPENDIX G

SPECIAL ANALYSES

APPENDIX G

SPECIAL ANALYSES

G.1 COST COMPARISONS FOR INSTALLATION OF A NEW 702-AY SYSTEM

During the analyses to complete this AGA, the possible need to upgrade the 702-AZ system was identified. This appendix examines the possibility of installing a parallel system with the existing 702-AZ system (approximately equal to W-030 Project minus the control room).

NEW VENT BUILDING

WBS

VENT BUILDING

CONDENSER

OFF GAS EXHAUST SYSTEM

HIGH EFFICIENCY MIST ELIMINATOR (HEME)

GENERATOR & GENERATOR BUILDING

TIE-INTO EXISTING BURIED DUCT

CONTROLS & STACK

INSTALL BURIED DUCT

POWER WIRING & CONTROLS

CATHODIC PROTECTION

CHILLER & COOLING WATER

CONCRETE UTILITY TRENCH

JOB (SPLIT 60%LAB/40%MATL)

LABOR:

MATL:

INCLUDES (GEN.CONDS, GF, CONSUMABLES, ST)

FDNW CONST MGMT @

TOTAL

DIRECT CONSTRUCTION WITH ALLOCATIONS

ENGINEERING @ 35%

PROJECT MANAGEMENT @10%

TOTAL

SEE D. HAUGHTON ESTIMATE

	SIT	SITE ALLOCATIONS	AY/AZ TOTAL
\$	2,400,000	\$ 840,000	\$ 3,240,000
\$	60,000	\$ 21,000	\$ 81,000
\$	150,000	\$ 52,500	\$ 202,500
\$	60,000	\$ 21,000	\$ 81,000
\$	291,000	\$ 101,850	\$ 392,850
\$	202,000	\$ 70,700	\$ 272,700
\$	370,000	\$ 129,355	\$ 499,355
\$	75,000	\$ 26,221	\$ 101,221
\$	300,000	\$ 104,883	\$ 404,883
\$	200,000	\$ 69,922	\$ 269,922
\$	323,000	\$ 112,924	\$ 435,924
\$	338,000	\$ 118,168	\$ 456,168
TOTAL	\$ 4,769,000	\$ 1,668,523	\$ 6,437,523

\$ 2,861,400

\$ 1,907,600

40%

40%

\$ 1,907,600

\$ 6,676,600

\$ 2,336,183

\$ 9,012,783

\$ 9,012,783

1,669,150

476,900

\$ 11,158,833

NEW VENT BUILDING

AY/AZ SWP 0%

TOTAL

\$ 11,158,833

30%

80%

50%

SWPs AT 30% OF LAB (SPLIT 60%LAB/40%MA \$ 2,861,400

SWPs AT 80% OF LAB (SPLIT 60%LAB/40%MA \$ 2,861,400

SITE ALLOCATIONS ON SWPs

TOTAL

CONTINGENCY

TOTAL ESTIMATED COST

\$ 11,158,833

5,579,416.33

\$ 16,738,249

G.2 ROUGH IMPLEMENTATION SCHEDULES COMPARISONS FOR DESIGN AND CONSTRUCTION OF NEW / UPGRADED VENTILATION SYSTEMS

Various methods of effectively deploying ventilation system upgrades are possible. Four of these are shown in Figure H-1.

Figure G-1. Influence of Time on Decision.

**G.3 COST COMPARISONS FOR UPGRADING THE EXISTING LAW HEPA
PLENUMS**

TANK EXHAUST FILTER TRAIN

WBS	S/I	SITE ALLOCATIONS	AN TOTAL	AW TOTAL	SY TOTAL
DEMO EXISTING FILTER	\$ 259,000	\$ 90,650	\$ 349,650	\$ 349,650	\$ 349,650
DEMO EXISTING CONCRETE SLAB	\$ 42,000	\$ 14,700	\$ 56,700	\$ 56,700	\$ 56,700
NEW CONCRETE PAD	\$ 91,000	\$ 31,850	\$ 122,850	\$ 122,850	\$ 122,850
FILTER TRAIN	\$ 1,446,000	\$ 506,100	\$ 1,952,100	\$ 1,952,100	\$ 1,952,100
POWER WIRING & CONTROLS	\$ 300,000	\$ 105,000	\$ 405,000	\$ 405,000	\$ 405,000
CATHODIC PROTECTION	\$ 200,000	\$ 70,000	\$ 270,000	\$ 270,000	\$ 270,000
PROGRAM LOGIC CONTROLLER (PLC)	\$ 90,000	\$ 31,465	\$ 121,465	\$ 121,465	\$ 121,465
DOUBLE BURIED WALL DRAIN PIPING	\$ 378,000	\$ 132,152	\$ 510,152	\$ 510,152	\$ 510,152
SEAL POT	\$ 1,231,000	\$ 430,369	\$ 1,661,369	\$ 1,661,369	\$ 1,661,369
SHIELD WALL	\$ 269,000	\$ 94,045	\$ 363,045	\$ 363,045	\$ 363,045
TANK RISER TIE-IN	\$ 170,000	\$ 59,434	\$ 229,434	\$ 229,434	\$ 229,434
DEENTRAINER ALLOWANCE	\$ 800,000	\$ 279,688	\$ 1,079,688	\$ 1,079,688	\$ 1,079,688
TOTAL	\$ 5,276,000	\$ 1,845,452	\$ 6,041,765	\$ 6,041,765	\$ 7,121,452

JOB (SPLIT 60%LAB/40%MATL)
 LABOR: 60% \$ 3,165,600
 MATL: 40% \$ 2,110,400
 INCLUDES (GEN.CONDS, GF, CONSUMABLES, ST)
 FDNW CONST MGMT @ 40%

TOTAL

DIRECT CONSTRUCTION WITH ALLOCATIONS
 ENGINEERING @ 35%
 PROJECT MANAGEMENT @ 10%

TOTAL

TOTAL

SEE D. HAUGHTON ESTIMATE

TANK EXHAUST FILTER TRAIN

	AN SWP 80% TOTAL	AW SWSP 80% TOTAL	SY SWP 80% TOTAL
SWPs AT 30% OF LAB (SPLIT 60%LAB/40%MA	\$ 2,532,480	\$ 2,532,480	\$ 2,532,480
SWPs AT 80% OF LAB (SPLIT 60%LAB/40%MA	\$ 633,120	\$ 633,120	\$ 633,120
SITE ALLOCATIONS ON SWPs	\$ 14,430,605	\$ 14,430,605	\$ 15,510,292
TOTAL	\$ 7,215,302.42	\$ 7,215,302.42	\$ 7,755,146.17
CONTINGENCY	\$ 21,645,907	\$ 21,645,907	\$ 23,265,439
TOTAL ESTIMATED COST	\$ 11,265,005	\$ 11,265,005	\$ 12,344,592

Lawvntug.qlr

QuickBLCC (QBLCC 2.5-98) 04-08-1999/14:33:54

QBLCC filename = LAWVNTUG.QI

Analysis type = Federal Analysis--Projects Subject to OMB A-94

Project name = Ventilation An Farm

Base date of study = 1999

Service date = 2003

Study Period = 20 years

Service Period = 16 years

Discount rate = 3.7%

Annually recurring costs and energy costs discounted from middle of year.

DOE energy price escalation rate file = ENCOST98

Number of alternatives in file = 7

Number of groups in file = 1

Note: Project alternatives displayed in increasing order of investment cost

Group code:	-----Present-Value Costs-----			
Alternative Name	Investment Costs*	OM&R Costs	Energy Costs	Total Life-Cycle Costs
-----	-----	-----	-----	-----
Short Stack	\$22786715	\$0	\$0	\$22786715<-
-MIN LCC				
Tall Stack	\$23197068	\$0	\$0	\$23197068
Adsorb Bed	\$24426161	\$2359073	\$112393	\$26897627
Dilution	\$25044324	\$155662	\$280983	\$25480969
Cont Vent	\$26133081	\$0	\$0	\$26133081
Wet Scrub&CB	\$27511568	\$4190410	\$51088	\$31753065
Catyalic TOX	\$27542246	\$0	\$211418	\$27753664

Comparative measures are only calculated for the alternative with lowest

LCC relative to alternative with the lowest present-value investment cost.

* Investment costs include capital replacements (if any).
Residual values are not calculated.

Lawinput.qid

QBLCC filename = LAWINPUT.QI

Analysis type = Federal Analysis--Projects Subject to OMB A-94

Project name = Ventilation An Farm

Base Date of Study = 1999

Service Date = 2003

Study Period = 20 years

Discount rate = 3.7%

Inflation rate = 0.00%

Cap replacements and residual values (if any) included as investment costs.

Residual values NOT calculated for capital components.

Residual values NOT calculated for capital replacements.

Common energy data	#1	#2	#3	#4
Energy type:	Electric	LPG		
Units:	(kWh)	(MBtu)		
Price per unit:	\$0.065	\$4.360		
Escalation type code:	2	2		

Data for DOE escalation rates:

DOE Escalation Rate File = ENCOST98

Rate Schedule Type = 3

State Abbreviation = WA

DOE Price escalation rates for Electric

Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)
1999 -3.2186	2009 -0.0870	2019 0.0000		
2000 -2.1655	2010 -1.3055			
2001 -1.1858	2011 -1.5873			
2002 -0.1600	2012 -0.8961			
2003 -1.5224	2013 -0.9042			
2004 -1.7087	2014 -1.3686			
2005 -1.6556	2015 -0.8326			
2006 -1.1785	2016 -0.4664			
2007 -1.5332	2017 -0.8435			
2008 -0.5190	2018 -0.6616			

DOE Price escalation rates for LPG

Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)
1999 0.3802	2009 1.4035	2019 1.3746		
2000 0.3788	2010 0.3460			
2001 -0.3774	2011 -0.6897			
2002 0.3788	2012 0.6944			

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2003	0.0000	2013	0.0000
2004	0.3774	2014	-0.6897
2005	1.8797	2015	-0.3472
2006	1.8450	2016	0.3484
2007	2.1739	2017	0.0000
2008	1.0638	2018	1.0417

Number of alternatives in file = 7

Number of groups in file = 1

UAL OM&R					CAPITAL		ANNUAL	NON-ANN
ALT	ALTERNATIVE	GROUP	LIFE	INITIAL	REPLACEMENTS		OM&R	-----
#	NAME	CODE	(Y/M)	COST(\$)	FREQ*	COST(\$)	COST(\$)	FREQ*
COST(\$)								
1	Tall Stack		20/0	26825512	0/0	0	0	0/0
2	Dilution		20/0	28961713	0/0	0	9900	0/6
3	Cont Vent		20/0	30220771	0/0	0	0	0/0
4	Adsorb Bed		20/0	28246858	0/0	0	224850	0/0
5	Short Stack		20/0	26350973	0/0	0	0	0/0
6	Catyalic TOX		20/0	31850355	0/0	0	0	0/0
7	Wet Scrub&CB		20/0	31814878	0/0	0	399400	0/0

*FREQ = Frequency of occurrence (in years/months)

ALT	ALTERNATIVE	GROUP	ANNUAL ENERGY USE		AN. ELEC.
			Electric	LPG	
#	NAME	CODE	(kWh)	(MBtu)	DEMAND
			---#1---	---#2---	CHARGE(\$)
1	Tall Stack		0	0	0
2	Dilution		481800	0	0
3	Cont Vent		0	0	0
4	Adsorb Bed		192720	0	0
5	Short Stack		0	0	0
6	Catyalic TOX		97985	3154	0
7	Wet Scrub&CB		87600	0	0

HNF-4245

Rev. 0

Hlwvntug.qlr

QuickBLCC (QBLCC 2.5-98) 04-08-1999/15:46:10

QBLCC filename = HLWVNTUG.QI

Analysis type = Federal Analysis--Projects Subject to OMB A-94

Project name = Ventilation AY/AZ Farm

Base date of study = 1999

Service date = 2003

Study Period = 20 years

Service Period = 16 years

Discount rate = 3.7%

Annually recurring costs and energy costs discounted from middle of year.

DOE energy price escalation rate file = ENCOST98

Number of alternatives in file = 7

Number of groups in file = 1

Note: Project alternatives displayed in increasing order of investment cost

Group code:	-----Present-Value Costs-----			
Alternative Name	Investment Costs*	OM&R Costs	Energy Costs	Total Life-Cycle Costs
-----	-----	-----	-----	-----
Short Stack	\$17736508	\$0	\$0	\$17736508<-
-MIN LCC				
Tall Stack	\$18063110	\$0	\$0	\$18063110
Adsorb Bed	\$19041328	\$2572580	\$112393	\$21726301
Dilution	\$19533318	\$155662	\$280983	\$19969963
Cont Vent	\$19851496	\$0	\$0	\$19851496
Catyalic TOX	\$20777397	\$0	\$211418	\$20988814
Wet Scrub&CB	\$21027622	\$4190410	\$51088	\$25269119

Comparative measures are only calculated for the alternative with lowest LCC relative to alternative with the lowest present-value investment cost.

* Investment costs include capital replacements (if any).
Residual values are not calculated.

HNF-4245**Rev. 0**

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QBLCC filename = HLWVNTUG.QI
 Analysis type = Federal Analysis--Projects Subject to OMB A-94
 Project name = Ventilation AY/AZ Farm
 Base Date of Study = 1999
 Service Date = 2003
 Study Period = 20 years
 Discount rate = 3.7%
 Inflation rate = 0.00%
 Cap replacements and residual values (if any) included as investment costs.
 Residual values NOT calculated for capital components.
 Residual values NOT calculated for capital replacements.

Common energy data	#1	#2	#3	#4
Energy type:	Electric	LPG		
Units:	(kWh)	(MBtu)		
Price per unit:	\$0.065	\$4.360		
Escalation type code:	2	2		

Data for DOE escalation rates:
 DOE Escalation Rate File = ENCOST98
 Rate Schedule Type = 3
 State Abbreviation = WA

DOE Price escalation rates for Electric				
Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)
)	)	)	)	)
-----	-----	-----	-----	-----
-				
1999 -3.2186	2009 -0.0870	2019 0.0000		
2000 -2.1655	2010 -1.3055			
2001 -1.1858	2011 -1.5873			
2002 -0.1600	2012 -0.8961			
2003 -1.5224	2013 -0.9042			
2004 -1.7087	2014 -1.3686			
2005 -1.6556	2015 -0.8326			
2006 -1.1785	2016 -0.4664			
2007 -1.5332	2017 -0.8435			
2008 -0.5190	2018 -0.6616			

DOE Price escalation rates for LPG				
Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)	Year Rate(%)
)	)	)	)	)
-----	-----	-----	-----	-----
-				
1999 0.3802	2009 1.4035	2019 1.3746		
2000 0.3788	2010 0.3460			
2001 -0.3774	2011 -0.6897			
2002 0.3788	2012 0.6944			

HNF-4245

Rev. 0

Hlwinput.qid

2003	0.0000	2013	0.0000
2004	0.3774	2014	-0.6897
2005	1.8797	2015	-0.3472
2006	1.8450	2016	0.3484
2007	2.1739	2017	0.0000
2008	1.0638	2018	1.0417

Number of alternatives in file = 7

Number of groups in file = 1

					CAPITAL	ANNUAL	NON-ANN
UAL OM&R							
ALT	ALTERNATIVE	GROUP	LIFE	INITIAL	REPLACEMENTS	OM&R	-----
#	NAME	CODE	(Y/M)	COST(\$)	FREQ*	COST(\$)	COST(\$)
COST(\$)							

1	Tall Stack		20/0	20888510	0/0	0	0 0/0
2	Dilution		20/0	22588685	0/0	0	9900 0/6
3	Cont Vent		20/0	22956632	0/0	0	0 0/0
4	Adsorb Bed		20/0	22019739	0/0	0	245200 0/0
5	Short Stack		20/0	20510821	0/0	0	0 0/0
6	Catyalic TOX		20/0	24027360	0/0	0	0 0/0
7	Wet Scrub&CB		20/0	24316725	0/0	0	399400 0/0

*FREQ = Frequency of occurrence (in years/months)

ALT	ALTERNATIVE	GROUP	ANNUAL ENERGY USE		AN. ELEC.
			Electric	LPG	
#	NAME	CODE	(kWh)	(MBtu)	DEMAND
			---#1---	---#2---	CHARGE(\$)

1	Tall Stack		0	0	0
2	Dilution		481800	0	0
3	Cont Vent		0	0	0
4	Adsorb Bed		192720	0	0
5	Short Stack		0	0	0
6	Catyalic TOX		97985	3154	0
7	Wet Scrub&CB		87600	0	0

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