1 of 1

Station 21
AUG 12 1993

ENGINEERING DATA TRANSMITTAL

OCT 1

Page 1 of 1
1. EDT 161091

2. To: (Receiving Organization) WRAP Project Engineering		3. From: (Originating Organization) Solid Waste Project Integration W24940		4. Related EDT No.: 161083, 158290	
5. Proj./Prog./Dept./Div.: W026/WRAP/Projects/EA		6. Cog. Engr.: J. L. Stroup		7. Purchase Order No.: N/A	
8. Originator Remarks: Release of WHC-SD-W026-TA-001.				9. Equip./Component No.: N/A	
				10. System/Bldg./Facility: N/A	
11. Receiver Remarks:				12. Major Assm. Dwg. No.: N/A	
				13. Permit/Permit Application No.: N/A	
				14. Required Response Date: N/A	

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	Impact Level	Reason for Trans- mittal	Orig- inator Dispo- sition	Receiv- er Dispo- sition
1	WHC-SD-W026-TA-001		0	Technical Assessment: WRAP 1 HVAC Passive Shutdown	4	1		

16. KEY					
Impact Level (F)		Reason for Transmittal (G)		Disposition (H) & (I)	
1, 2, 3, or 4 (see MRP 5.43)		1. Approval	4. Review	1. Approved	4. Reviewed no/comment
		2. Release	5. Post-Review	2. Approved w/comment	5. Reviewed w/comment
		3. Information	6. Dist. (Receipt Acknow. Required)	3. Disapproved w/comment	6. Receipt acknowledged

(G)	(H)	17. SIGNATURE/DISTRIBUTION (See Impact Level for required signatures)				(G)	(H)				
Reason	Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	Reason	Disp.
1	1	Cog.Eng. JL Stroup	<i>[Signature]</i>	8/3/93	H1-60	JG Riddelle	<i>[Signature]</i>	8/3/93	H5-33	1	1
1		Cog. Mgr. DE Ball	<i>[Signature]</i>	8/4/93	G6-46	TL Yount	<i>[Signature]</i>	8/3/93	H1-60	1	1
		QA									
		Safety									
		Env.									
1	1	BA Mayancsik	<i>[Signature]</i>	8-3-93	H5-33						
1	1	CR Nash	<i>[Signature]</i>	8/30/91	G6-46						

18. J. L. Stroup <i>[Signature]</i> Signature of EDT Originator		19. D. R. Lucas <i>[Signature]</i> Authorized Representative for Receiving Organization		20. <i>[Signature]</i> D. E. Ball Cognizant/Project Engineer's Manager		21. DOE APPROVAL (if required) Ltr. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	
--	--	--	--	---	--	--	--

ORIGINAL

Date Received: 8-10-93 CW		INFORMATION RELEASE REQUEST		Reference: WHC-CM-3-4	
Complete for all Types of Release					
Purpose ☐ Speech or Presentation ☐ Full Paper (Check only one suffix) ☐ Summary ☐ Abstract ☐ Visual Aid ☐ Speakers Bureau ☐ Poster Session ☐ Videotape			☐ Reference ☒ Technical Report ☐ Thesis or Dissertation ☐ Manual ☐ Brochure/Flier ☐ Software/Database ☐ Controlled Document ☐ Other		
			ID Number (include revision, volume, etc.) WHC-SD-W026-TA-001 REV 0		
			List attachments. EDT 161091		
			Date Release Required July 30, 1993		
Title Technical Assessment: WRAP 1 HVAC Passive Shutdown				Unclassified Category UC-	Impact Level 4
New or novel (patentable) subject matter? ☒ No ☐ Yes If "Yes", has disclosure been submitted by WHC or other company? ☐ No ☐ Yes Disclosure No(s).			Information received from others in confidence, such as proprietary data, trade secrets, and/or inventions? ☒ No ☐ Yes (Identify)		
Copyrights? ☒ No ☐ Yes If "Yes", has written permission been granted? ☐ No ☐ Yes (Attach Permission)			Trademarks? ☒ No ☐ Yes (Identify)		
Complete for Speech or Presentation					
Title of Conference or Meeting			Group or Society Sponsoring		
Date(s) of Conference or Meeting		City/State		Will proceedings be published? ☐ Yes ☐ No Will material be handed out? ☐ Yes ☐ No	
Title of Journal					
CHECKLIST FOR SIGNATORIES					
Review Required per WHC-CM-3-4		Yes	No	Reviewer - Signature Indicates Approval	
				Name (printed)	Signature
Classification/Uncontrolled Nuclear Information		☐	☒		
Patent - General Counsel		☒	☐	S. W. Berglin	
Legal - General Counsel		☒	☐	S. W. Berglin	
Applied Technology/Export Controlled Information or International Program		☐	☒		
WHC Program/Project		☒	☐	J. A. Swenson	
Communications		☐	☒		
RL Program/Project		☒	☐	R. E. Bley	
Publication Services		☒	☐	(Housekeeping)	
Other Program/Project		☐	☒	(reviser only)	
Information conforms to all applicable requirements. The above information is certified to be correct.					
References Available to Intended Audience		☒	☐	INFORMATION RELEASE ADMINISTRATION APPROVAL STAMP	
Transmit to DOE-HQ/Office of Scientific and Technical Information		☒	☐	Stamp is required before release. Release is contingent upon resolution of mandatory comments.	
Author/Requestor (Printed/Signature) JL Stroup/CR Nash		☒	☐
Intended Audience ☐ Internal ☐ Sponsor ☒ External					
Responsible Manager (Printed/Signature) D. E. Ball		Date 8/4/93			
		Date Cancelled		Date Disapproved	

SUPPORTING DOCUMENT		1. Total Pages 784 RD
2. Title Technical Assessment: WRAP 1 HVAC Passive Shutdown	3. Number WHC-SD-W026-TA-001	4. Rev No. 0
5. Key Words HVAC, Passive, Confinement, WRAP, WRAP-1, W026	6. Author Name: JL Stroup [REDACTED] CR Nash [REDACTED] <i>JL Stroup</i> Signature <i>[Signature]</i> Organization/Charge Code W24940/A423D	
7. Abstract As the result of careful interpretation of DOE Order 6430.1A and other DOE Orders, the HVAC system for WRAP 1 has been greatly simplified. The HVAC system is now designed to safely shut down to Passive State if power fails for any reason. The fans cease functioning, allowing the Zone 1 and Zone 2 HVAC Confinement Systems to breathe with respect to atmospheric pressure changes. Simplifying the HVAC system avoided overdesign. Construction costs were reduced by eliminating unnecessary equipment. This report summarizes work that was done to define the criteria, physical concepts, and operational experiences that lead to the passive shutdown design for WRAP 1 confinement HVAC systems.		
8. PURPOSE AND USE OF DOCUMENT - This document was prepared for use within the U.S. Department of Energy and its contractors. It is to be used only to perform, direct, or integrate work under U.S. Department of Energy contracts. This document is not to be released for public release until reviewed. PATENT STATUS - This document copy, since it is made available in confidence solely for use in performance of work under contracts with the U.S. Department of Energy. This document is not to be published nor its contents otherwise disseminated or used for purposes other than specified above before patent approval for such release or use has been secured, upon request, from the Patent Counsel, U.S. Department of Energy Field Office, Richland, WA. DISCLAIMER - This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.		10. RELEASE STAMP APPROVED FOR PUBLIC RELEASE <i>cu</i> 8-11-93 OFFICIAL RELEASE 28 BY WHC DATE AUG 12 1993 <i>Station 21</i>
9. Impact Level 4		

TECHNICAL ASSESSMENT
WRAP-1 HVAC PASSIVE SHUTDOWN

April 1993

D.E. Ball
Solid Waste Systems Engineering

C. R. Nash
J. L. Stroup
Solid Waste Project Integration

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

CONTENTS

1.0	INTRODUCTION	1
2.0	EXECUTIVE SUMMARY	1
3.0	WRAP 1 ENGINEERING PROCESS	2
3.1	CONCEPTUAL HVAC DESIGN REPORT	3
3.2	PRELIMINARY SAFETY EVALUATION	3
3.3	PRELIMINARY DESIGN REPORT - TITLE I	4
3.3.1	Study Phase	4
3.3.2	Title I Design	5
3.4	DETAILED DESIGN REPORT - TITLE II	5
4.0	DESIGN VALIDATION	6
4.1	CRITERIA CRITIQUE	6
4.1.1	DOE Order 6430.1A Review	6
4.1.2	Preliminary Safety Evaluation	7
4.1.3	Confinement Philosophy: Active vs Passive	7
4.2	HANFORD OPERATIONAL EXPERIENCE	7
4.2.1	Introduction	7
4.2.2	Pu Transport Mechanisms	8
4.2.3	PFP Contamination History	8
4.2.4	Hanford Static Confinement Systems	9
4.2.5	Hanford Electrical Outage History	9
4.3	INDEPENDENT HVAC CONSULTANT	9
4.4	FIELD TRIP - LOS ALAMOS NATIONAL LABORATORY	10
4.5	COMPARISON OF SAVANNAH RIVER'S TRU WASTE FACILITY (TWF) WITH WRAP-1	10
4.5.1	WRAP-1 Regulatory Basis	11
4.5.2	TWF Regulatory Basis	11
4.5.3	Passive Shutdown Comparison- WRAP-1 With TWF	11
4.6	INEL-WCF	12
4.7	ORNL-WHPP	12
APPENDIX A	HANFORD OPERATIONAL EXPERIENCE PERTINENT TO PASSIVE SHUTDOWN WRAP-1 HVAC SYSTEMS	A-1
APPENDIX B	CONTRACT #MLW-073750, TASK S-92-11, REV B; WRAP-1 PRELIMINARY DESIGN REVIEW OF HEATING, VENTILATING AND AIR CONDITIONING DESIGN	B-1
APPENDIX C	PASSIVE SHUTDOWN PHILOSOPHY LOS ALAMOS NATIONAL LABORATORY TA-55 HVAC SYSTEM	C-1
APPENDIX D	COMMENTS ON THE SAFE SHUTDOWN CONCEPT REVIEW FOR THE WASTE CHARACTERIZATION FACILITY	D-1
APPENDIX E	WHPP VENTILATION DBA OPERATIONAL PHILOSOPHY/WHPP DRAFT PSAR	E-1

TECHNICAL ASSESSMENT WRAP-1 HVAC PASSIVE SHUTDOWN

1.0 INTRODUCTION

This report summarizes the systematic process of engineering, design, technical reviews, safety reviews, and onsite and offsite investigations of Heating, Ventilation and Cooling (HVAC) system practices in support of the choice of Passive Shutdown of the WRAP 1 HVAC system.

The Conceptual Design Report (CDR), WRAP 1, WHC-SD-W026-CDR-001, shows an elaborate, costly HVAC system, designed to meet requirements of a Moderate Hazard classification. After detailed Pre-Title I review, the simpler Passive Shutdown system was adopted by the project (HVAC CONFINEMENT STUDY, dated July 29, 1991). The simplified design reduced CDR HVAC costs by an estimated \$1,590,000.

Through all the subsequent design stages, the Passive Shutdown design was extensively reviewed and challenged. Concerns were expressed by many reviewers, especially those having experience with engineering of nuclear power and/or Pu processing plants. Also, the Senior Design Review Board (SDRB) requested that experience at other DOE sites be investigated.

The choice of passive shutdown for WRAP 1 is validated by this extensive engineering and review process.

2.0 EXECUTIVE SUMMARY

Passive shutdown of a nuclear facility's HVAC system is a relatively new concept. Careful review of criteria uncovered the fact that DOE Order 6430.1A does not require the HVAC system of nuclear facilities to remain operational after loss of power, provided that Safety Analyses show that onsite and offsite radiological dose limits are met.

Historically, the Conceptual Design of WRAP 1 was classified a Moderate Hazard facility, based on assumed source terms. Subsequently, the Preliminary Safety Evaluation (PSE), using updated source terms, rated WRAP 1 a Low Hazard facility. Its unmitigated accidental radiological releases fell within the site boundary guidelines of MRP 5.46 and WHC-CM-1-3. The HVAC was no longer a critical safety issue, and so became a prime candidate for simplification.

As worked out in the WRAP 1 design, passive shutdown simply means that if power fails, the HVAC equipment will cease functioning. Zone I and II HVAC air pressure differentials will not be preserved, the HVAC system will seek equilibrium with atmospheric pressure, and will passively breathe to accommodate atmospheric pressure changes. Virtually all lost power events will not be due to design basis accidents that could damage the gloveboxes. The gloveboxes would therefore continue to provide confinement and the HEPA filters at the inlet and outlet ports will keep contamination within the gloveboxes themselves. Costly air train redundancies and expensive emergency backup power are no longer needed.

The PSAR (WHC-SD-W026-SAR-001 REV 0) review of Title II designs again determined that WRAP 1 should be rated a low hazard facility because dose consequences from both mitigated and unmitigated accidents do not exceed site boundary exposure limits. The following accident and natural phenomena scenarios were analyzed:

- ♦ Fire in glovebox
- ♦ Explosion in glovebox
- ♦ Release in container handling
- ♦ Fire in container handling
- ♦ Explosion in container handling
- ♦ Design basis earthquake
- ♦ Truck accident

NOTE: Confinement is lost under certain of these accident scenarios because the gloveboxes and/or the facility walls and roof are defined as having failed, which violates a DOE Order 6430.1A requirement. A request to deviate from DOE Order 6430.1A, Section 1161.2 is required to support the design. Plans to obtain such a deviation are contained in letter 9355770, Resolution to WRAP-1 Fire Protection Design Issues.

The HVAC design was thoroughly evaluated at several stages by experienced reviewers. In parallel, the SDRB brought in an outside HVAC consultant to assist in their independent reviews. Experience at Hanford was reviewed, along with experience of other DOE facilities:

- ♦ Los Alamos TA-55 facility has 15 years' experience operating a passive shutdown HVAC system.
- ♦ INEL's WCF plant, whose design bases are the same as WRAP-1, is planning passive shutdown.
- ♦ ORNL's design philosophy is that quality construction and HEPA filtration of their WHPP facilities process cells will prevent escape of radioactivity upon shutdown, without active utility or support systems.
- ♦ The source terms and accident scenarios of Savannah River's TRU Waste Facility are not comparable to WRAP-1. Although a comparison was attempted, the results were not meaningful.

Passive Shutdown, in summary, is not a safety issue. It is an operational issue, and its selection for WRAP-1 is fully supported by the investigations into operational history summarized above and provided in detail in this report.

3.0 WRAP 1 ENGINEERING PROCESS

The WRAP 1 HVAC System design evolved over many design phases and was perfected by many design reviews. The first concept was reviewed at the completion of Conceptual Design, when the Facility was classified Moderate Hazard. Then, after the PSE reclassified the facility to Low Hazard, the Pre-Title I study that recommended Passive Shutdown was reviewed. And finally,

evolving details were reviewed in depth at Title I (Preliminary Design) and at Title II (Final Design).

3.1 CONCEPTUAL HVAC DESIGN REPORT

The Conceptual Design Report (CDR), was issued on May 30, 1989. At that time, based on the preliminary source terms used, WRAP-1 was classified a Moderate Hazard Facility. Its Safety Class systems had to actively function after DBA's (DOE Order 6430.1A, Section 1324), to prevent exposure of offsite people to radiation levels above acceptable limits. Structures and Safety Class equipment therefor were designed to withstand severe natural phenomena and worst-case accidents.

Effectively, the CDR identifies four HVAC zones:

Process Enclosures	I
Category I Process Operation Areas	II
Noncategory I Process Areas	III
Shipping/Receiving	IIIa
Administration	IV
Standby Diesel Generator Area	IVa

Air balancing of this complex system had to distinguish between small pressure differentials of the many zones. This was considered a critical issue that would require depressurization testing in order to assure that air balances could be maintained.

HVAC Zone I in the CDR included the Processing Enclosures (gloveboxes and connected HVAC ducting, plenums, HEPA filters and fans) and the category I HVAC equipment room. The rooms containing processing equipment and HVAC equipment were designed to meet seismic category I requirements (SDC 4.1). Fully redundant, seismically qualified air handling equipment was provided.

Air pressures of all Zones were to be kept negative with respect to outside ambient. Air flow gradients were progressively more negative toward areas of highest contamination. The Zone II flow was normally recirculated, with the option for once through if operating area contamination levels became elevated above acceptable limits. Airlocks at entry points maintained established pressure gradients.

Both primary and secondary HVAC systems were designed to Category I seismic requirements. This included ductwork, duct supports and hangers, and the diesel generators providing standby power. The redundant equipment with its controls and interlocks, all seismically qualified, was estimated to cost about \$1.5 M.

3.2 PRELIMINARY SAFETY EVALUATION

The Preliminary Safety Evaluation (PSE) report, WHC-SE-W026-PSE-001, April 3, 1991, was issued nearly two years after the CDR was issued. Two key design parameters were affected by the PSE:

- ♦ Facility hazard classification: The PSE evaluated a number of accident scenarios that could release radioactivity to the environs. The Design Basis Earthquake (DBE) was determined to be the accident of greatest radiological consequence. The DBE would cause the building to collapse, major structural members would fall onto waste containers, and radioactive material would be released. The consequences of this accident were found to fall within the risk acceptance guidelines of WHC-CM-4-46. The PSE conclusion: WRAP-1 should be categorized a low-hazard non-reactor nuclear facility.
- ♦ Equipment safety class designations: None of WRAP-1's systems require safety class designations. Using the WHC designations, all WRAP-1 systems fall into Safety Class 3 (WHC-CM-1-3), which pertains only to occupational safety items whose failure could exceed acceptable radiological or hazardous material consequences to personnel. At this early stage of safety evaluation, only single failures were considered.

3.3 PRELIMINARY DESIGN REPORT - TITLE I

3.3.1 Study Phase

Many unresolved issues related to the CDR remained when WRAP-1's Preliminary Design (Title I) started in early 1991. DOE Order 6430.1A was issued on April 6, 1989, a month after the CDR, and the PSE provided opportunities for simplification. Some 19 Pre-Title I studies were identified, the HVAC system being one of the most important.

HVAC CONFINEMENT STUDY, REVISION A, was issued July 29, 1991. The main objective of the study was to avoid overdesign of primary and secondary confinement systems. Its scope included comprehensive review of design criteria, evaluation of different confinement zone arrangements, and comparisons of costs of the most viable alternatives.

The recommended system had two confinement zones:

Process Enclosures	I
Special Processing and HEPA Filter Rooms	II
NDA/NDE and Shipping/Receiving Areas	IIa

The exhaust ductwork, ductwork supports, and the HEPA filter housings were designed to withstand 0.12 g free field horizontal acceleration, which is the Safety Class 3 DBE (WHC-CM-4.1). The exhaust fan(s) were not required to operate after the DBE, and standby power was not provided. This is not a safety class system and is not housed in a Category I structure. Glovebox exhaust air passes through 3 stages of HEPAs; the first stage at the glovebox exit is not testable. Redundant fans and HEPA filters were provided mainly for maintenance purposes.

The recommended HVAC system saved at least \$735,000 from CDR costs; deleting the standby generators saved another \$855,000. Total cost reduction from the CDR estimate was \$1,590,000.

3.3.2 Title I Design

The Title I design expanded on the approved study configuration, providing more refinement and more detail in definition of the design. Three zones were defined, two confinement zones and one non-zone:

Process Gloveboxes and Zone I ventilation system	I
Process Room Exhaust Ducts & HEPA Filter Plenums	II
Balance of Plant	Non-Zone

Both the Zone I (process gloveboxes) and Zone II (Process Room) exhaust ductwork and HEPA filter plenums were designed to withstand a "low hazard" safety class facility seismic event (see above). The total HVAC system for all three zones would shut down to a safe static condition upon loss of electrical power. The control hierarchy prevented single failure of control elements from disabling the HVAC systems. Redundancy sufficient to keep the HVAC systems running during filter changeout and other routine maintenance was provided.

The Shipping and Receiving and the NDA/NDE areas are not considered confinement zones. This is because the waste packages qualify as primary containment and the drums qualify as secondary containment (6430.1A, Section 1324-6.1, par.3). Therefore, these two areas are designated as interim storage, do not require dedicated HEPAs and negative pressure is not maintained during normal operations.

Primary confinement, comprising the gloveboxes and the exhaust HVAC through the second stage of testable HEPAs, is ventilated by the Zone I HVAC. Non-testable pushthrough HEPAs are provided at the glovebox outlet and inlet ducts, the key feature that confines contamination within the gloveboxes during flow reversals. Negative pressure of Zone I is controlled by throttling the glovebox exhaust to maintain negative pressure setpoints.

Secondary confinement, comprising the building structures that contain the gloveboxes and the Confinement HVAC equipment, is ventilated by the Zone II HVAC. Zone II air provides supply air to the Zone I gloveboxes.

3.4 DETAILED DESIGN REPORT - TITLE II

The Title II design, in its turn, built on the approved Title I configuration. The main thrust of Title II was production of construction drawings and purchasing specifications. The three zone philosophy was preserved:

Process Gloveboxes and Zone I Ventilation System	I
Process Room Structures and Zone HVAC Exhaust System	II
Balance of Plant	Non-Zone

The Title II passive shutdown follows the route prescribed for the Title I design, viz., the total HVAC system will shut down to a safe static condition in the event electrical power is interrupted or lost.

The Primary and Secondary confinement systems (Zone I gloveboxes, exhaust ducts, fans and testable HEPA filters) are designed to maintain structural integrity during and after low hazard DBAs (WHC-CM-4.1). The PSAR

demonstrates that onsite and offsite exposures to radioactive contamination are within regulation limits. Non-testable HEPA filters mounted at Glovebox inlet and outlet ports equalize pressure when passive shutdown occurs. CAMs are provided in the ductwork downstream of these non-testable HEPAs. Redundant exhaust fans and air handling units permit the system to run during routine maintenance.

Secondary confinement provides air flows needed to control potential airborne contamination (ERDA 76-21). Zone II supplies air to the gloveboxes. Zone II runs at 0.15-inches W.G. negative pressure relative to adjacent non-zone areas, establishing air flow into the waste process and process HVAC areas. Flow from the process HVAC room into the glovebox room is established by a negative pressure differential of 0.10-inches W.G. Shutdown confinement of Zone II rooms is provided by two testable HEPA exhaust filters and a closable low leakage supply duct damper.

As established in Title I, the Shipping and Receiving and NDA/NDE areas are not considered confinement zones, do not have a HEPA filtration system, and negative pressure is not maintained.

Administrative areas and locker/change rooms operate on a pre-programmed "occupied - unoccupied" schedule. The HVAC systems come on and maintain temperature and humidity during working hours, but shut down during off hours. The computer and control room, on the other hand, have redundant air handlers to sustain 24-hours per day operation.

The Zone I and Zone II dampers and controls elements are designed to fail- safe, i.e., uninterrupted power supplies assure that air flows and pressure relationships will be preserved upon single failure of an equipment item.

4.0 DESIGN VALIDATION

4.1 CRITERIA CRITIQUE

4.1.1 DOE Order 6430.1A Review

The UE&C "HVAC Confinement Study," Revision A, included a comprehensive review of DOE Order 6430.1A, which was released in April, 1989, just after the WRAP-1 CDR was issued. A parallel WHC review covered intensive study of DOE Orders 5480.4, WHC-CM-4-10 and WHC-EP-0063/3, as well. Computer key word-search techniques were used to retrieve references to criteria relevant to the WRAP-1 HVAC system design. The criteria were then classified according to their relevance to low hazard, non-safety class Radioactive Solid Waste Facilities. Finally, these and other industrial codes and criteria were compiled into one comprehensive design requirements document.

DOE Order 6430.1A sets the basic requirements for design of nuclear facilities. DOE Orders 5400 series establishes limits for public exposures to radioactive contamination. Safety Analyses then evaluate whether the design features provided in accordance with DOE Order 6430 are adequate to satisfy exposure criteria of the 5400 Orders. DOE Order 6430.1A (1300-1.4.2 (paragraph 1), 1550-99.0.2 (paragraph 2) and 1550-99.0.2, second bullet,

Additional requirements for Process Facilities) requires redundancy in plant systems to the extent that guidelines for accidental release of radionuclides to the environs are not violated. Compliance must be validated by the Safety Analysis.

4.1.2 Preliminary Safety Evaluation

The Preliminary Safety Evaluation (PSE) of the WRAP-1 CDR used updated source terms to assess onsite and offsite radiological consequences resulting from an incredible accident scenario. Its findings were that accidental release guidelines were not exceeded under any circumstances. No further evaluation was therefore required to determine whether the facility design meets exposure criteria. On the strength of these criteria evaluations, WRAP-1 was classified a Low Hazard, Non-Reactor Nuclear Facility.

4.1.3 Confinement Philosophy: Active vs Passive

Active ventilation sets up pressure differentials providing airflow that controls outleakages of contamination. Airflow also helps smooth out glovebox pressure transients due to operational activities such as glove pumping. In WRAP-1, active ventilation also provides capture airflow around drums in the entrance and exit port seals.

DOE Order 6430.1A states that "...at least one confinement system [must] remain[] fully functional following any credible DBA..." Furthermore, "...the total combustible loading...[shall not]..exceed the fire resistance rating of the area enclosure." The PSAR and the Fire Hazard Analysis DBF scenarios are out of compliance with both of these requirements, but because the unmitigated doses are within DOE guidelines, a waiver of the confinement requirements of DOE Order 6430.1A Sections 0111-99.0.1 and 1161.2.

Passive Confinement, i.e., leak tightness is important when the HVAC system is in passive shutdown. The gloveboxes, exhaust ducting and HEPA filter plenums are designed to not collapse or crumple from the Design Basis Earthquake.

Hanford's thousands of sealed and vented 55-gallon drums of waste are one example of passive confinement. A properly designed glovebox can be relied upon to similarly perform the function of passive confinement. Furthermore, the gloveboxes will have a set of Q.A. credentials significantly more complete than those provided with 55-gallon drums. Another example of passive confinement is the practice of passive shutdown of the Los Alamos TA-55 facility HVAC system over 15 years of operating experience.

4.2 HANFORD OPERATIONAL EXPERIENCE

4.2.1 Introduction

Over many years, active HVAC systems were considered essential to preventing spread of Pu around Hanford reprocessing plants. Many contamination releases are recorded. In order to use that Hanford experience to evaluate WRAP-1's passive shutdown, the causes of past contamination releases had to be understood.

Hanford background pertinent to operation of confinement systems was researched (Appendix A). Topics addressed included:

- ♦ Plutonium Transport Mechanisms (the physics of how plutonium disperses)
- ♦ A review of the history of PFP contamination incidents
- ♦ Static confinement systems
- ♦ Summary of Electrical Power reliability

4.2.2 Pu Transport Mechanisms

The four ways to transport Plutonium are: Diffusion by Electrical Charge, Chemical/Fluid Transport, Mechanical Transport, and Airborne Transport. Analysis of these transport mechanisms can show whether a facility's design will provide effective control features.

- ♦ The diffusion of electrically charged particles is a surface phenomena that is not affected by air flow. Contaminants can escape by leakage through cracks or corrosion breaches. Constructing leak tight gloveboxes of corrosion resistant materials and providing effective seals at penetrations can preclude leakage from the diffusion mechanism, which is not significantly affected by the status of the ventilation system.
- ♦ Mechanical transport of Pu contamination can be prevented by assuring that transfer equipment and associated penetration's contaminated surfaces cannot touch uncontaminated surfaces, particularly if contamination is thereby carried outside of the glovebox.
- ♦ HVAC provides air sweeps that are vital in control of airborne contamination in hoods and airlocks. HVAC provides the pressure differentials essential to assure that air moves from areas of less to greater contamination, should leak paths exist. If a breach occurs, air flow helps prevent outleakage of contaminants.
- ♦ Confinement barriers provide the attributes essential to contamination control, with or without air flow, e.g., leak tight glovebox walls and seals or good quality drums and seals. Pressure equalization between confinement and nonconfinement areas avoids the inclination for contaminants to leak from one area to another. Storage drums, a good example of passive status, are provided with HEPA filters that relieve pressure buildup. The WRAP-1 gloveboxes likewise allow passive pressure equalization through HEPA filters at both inlet and outlet nozzles.

4.2.3 PFP Contamination History

The "Historical Occurrences and Incidents" list (Appendix A, Attachment 1) was evaluated to determine if PFP accidental contamination releases might have been more severe without active glovebox ventilation. Of the 28 listed accidents, two caused overpressurization that could have been more severe without active ventilation. One was rupture of a pressure vessel in a glovebox; another was use of a fire extinguisher on a small glovebox fire.

Thirteen of the recorded accidents were due to fires, some of which spread contamination outside the gloveboxes. Power interruptions occurred at PFP more frequently than accidental fires, but no radiological consequences were reported. Although loss of power is a higher probability event, it has not led to contamination release.

4.2.4 Hanford Static Confinement Systems

A number of static confinement systems were found at Hanford. Some of the older ones have quite marginal confinement barriers. Contamination did not spread from these systems unless some outside energies created disturbances. (Appendix A). As long as containment barriers remain intact when operations are terminated, it is very difficult to postulate credible events that would lead to a contamination release.

Here are several interesting examples of passive confinement at Hanford:

- ♦ Z-9 Crib/Mine: After completion of recovery mining operations, this crib was sealed off effectively through a HEPA filter to the outside. No contamination releases have been reported.
- ♦ 291-Z Exhaust Ducting: Over 20 grams of Pu reading fixed and smearable contamination up to about 20,000 dpm/100 cm² rests unaffected by normal airflow through this duct. High stack readings have occurred on occasion, directly correlatable with activities that create ground vibrations near the building.
- ♦ Polycubes: The Z vaults are open rooms cooled by HEPA filtered HVAC. Over time the polycubes have partially disintegrated into powder that lays on the bottoms of storage cans that are vented through crude filters. One serious cleanup problem arose when powder was spilled from a polycube can. Since that incident, about 200 cans containing unconfined, but undisturbed, powder are still stored in the Z-vault.
- ♦ Division of Military Applications (DMA) D&D: Many large DMA gloveboxes were swept out, sealed off and disconnected from HVAC. These static packages were stored both inside and outside of PFP for many weeks without spread of contamination.

4.2.5 Hanford Electrical Outage History

An estimated average of one long (2-hr) outage and 2 momentary (30-sec) outages can be expected each year. An average of one/year is realistic. Generally, power loss occurs one at a time to the eight 200 Area feeders, affecting a few contiguous buildings. The Table in Appendix A lists power loss data gathered from 1990 to the present, mentioning length of outage, location and causes. The longest outage was four hours.

4.3 INDEPENDENT HVAC CONSULTANT

To provide additional outside judgment on Passive Shutdown, the SDRB hired an independent consultant. The consultant's opinion (Appendix B) was that:

- ♦ "Continuous operation is difficult to achieve and very expensive and is not necessarily more desirable than a passive safe shutdown."
- ♦ "The failure of a system that was designed for continuous operation may happen in an undesirable mode. Designing a system for a safe passive shutdown will assure that the system is shutdown in the most desirable mode."
- ♦ "Due to the nature of the materials and glovebox integrity, the system, if undisturbed, [sic] no further action is required to maintain confinement. The nature of the WRAP process and material is such that no significant stored energy is present that needs to be dissipated. In the passive shutdown mode there will be no motive force to disturb the material within the glovebox enclosures."
- ♦ The final conclusion of the independent HVAC consultant was:
 - "Passive shutdown is a viable alternative to continuous operation; when planned for and controlled."

4.4 FIELD TRIP - LOS ALAMOS NATIONAL LABORATORY

The Los Alamos TA-55 facility is a Laboratory designed for Plutonium Chemistry, Metallurgy and R&D (Appendix C). This facility has been operational for 15 years with a HVAC system that fails passively. The facility source term is approximately 50-100 times greater, on a Pu weight basis, than the WRAP-1's. There have been an average of 3 ventilation shutdowns per year with no radiological consequences attributable to passive shutdown. Los Alamos feels that even minor leak paths don't cause problems if one simple principle is practiced: "Killing all pressure differential is imperative. It's what keeps leak paths from leaking".

Los Alamos has proven the principle of passive shutdown while housing nuclear materials and process systems that have far greater hazard potential than the WRAP-1 facility.

4.5 COMPARISON OF SAVANNAH RIVER'S TRU WASTE FACILITY (TWF) WITH WRAP-1

Many of the new nuclear waste processing facilities in the US are candidates for Passive Shutdown, mainly because of low-source terms. Significant economies of design and construction, and simplicity of operation, can be realized. The viability of passive shutdown begins with determining risks, which requires definition of radiological source terms. Then, Safeguards Analyses can determine the consequences of design basis accidents (DBAs) to onsite and offsite receptors.

4.5.1 WRAP-1 Regulatory Basis

The WRAP-1 PSAR (WHC-SD-W026-SAR-001 REV F-1) calculates dose rates from a glovebox fire to be:

<u>Unmitigated</u>		<u>Mitigated</u>	
<u>Onsite</u>	<u>Offsite</u>	<u>Onsite</u>	<u>Offsite</u>
2.46 E-01 rem	3.19 E-02 rem	1.22 E-04 rem	1.59 E-05 rem

The WRAP-1 unmitigated offsite doses are less than Safety Class 1 criteria of 500 mrem EDE; the onsite consequences are less than Safety Class 2 criteria of 5 rem EDE (WHC-CM-1-3). On this basis, WRAP-1 is classified a Low Hazard, Non-Reactor Nuclear Facility. Its Safety Class 3 systems do not require operation during or after design basis events, equipment failure, or loss of electric power.

4.5.2 TWF Regulatory Basis

The report available to us does not actually state the TWF PSAR's calculated onsite/offsite receptor dose rates. The report does state that the TWF facility is classified Moderate Hazard. The conceptual design provides HVAC systems having the familiar redundancies and backup power.

4.5.3 Passive Shutdown Comparison- WRAP-1 With TWF

The SARs do not evaluate doses to plant operators. When SRS decided to evaluate passive shutdown as a possible cost conserving measure, they hired an outside consultant to figure out a scenario that would be a threat to plant operators. They decided on smoke leaking out of small hole in the wall of a process cell. A hot fire was chosen (14 drums of solvent) that generates a lot of smoke that carries a large quantity of plutonium in its updraft. Based on the source terms and DBF scenario used in the calculations, calculated operator dose consequences were unacceptably high. The analysis concludes that passive shutdown of the TWF is not justifiable.

WRAP-1 considered a case parallel to that of the TWF, a fire in the TRU glovebox. The WRAP-1 case assumed a burn the same size as the TWF fire, the same amount of smoke driven out of the glovebox through the same size hole. However, the Pu concentration in the smoke was assumed to be that of a single WRAP-1 drum, which is 1/14 of the smoke-borne Pu assumed in the TWF calculations. Because of the much lower WRAP-1 source terms, even under the grossly pessimistic fire/smoke scenario borrowed from the TWF calculations, the exposure risk to an operator in WRAP-1 is extremely low.

The Table below compares some of the key parameters of those studies. The intent is to indicate why dose rates to WRAP-1 operators would be inconsequential compared to the TWF plant.

COMPARISON TABLE

PARAMETERS	TWF	WRAP-1
NUMBER OF DRUMS RELEASING Pu	14	1
RELEASE FRACTION OF Pu	1.0E-2	(PSE) 5.4E-4
VENTILATION SYSTEM STATUS	SHUT DOWN	SHUT DOWN
SMOKE ESCAPING THROUGH HOLE	6E+55 cc	6E+55cc
Pu IN OPERATOR'S WORKING AIR, DILUTION RATE = 40 to 1	9.0E-4 uCi/cc	6.9E-10 uCi/cc

4.6 INEL-WCF

The INEL Waste Characterization Facility passive shutdown philosophy is based on the belief that maintaining the integrity of the confinement structure maintains the essential safe shutdown function of confinement (Appendix D).

The requirements of DOE Order 6430.1A that support the INEL design include Section 1300-3.2, "Safety class Items," (paragraph 6), Those..."required to achieve and maintain the facility in a safe shutdown condition". A safe shutdown condition is further defined and bound by 1300-3.1, which requires design, construction and testing..."commensurate with the hazards and potential consequences." Further, 1300-1.4.2, "Accidental Releases," requires that..."at least one confinement system remains fully functional following any credible DBA." Also, that confinement system must be able to..."preclude offsite releases that would cause doses in excess of the DOE Order 5400 series limits for public exposure."

Facility features key to the safety of a passive shutdown facility cited by INEL include:

- ♦ Minimal source term (Low Hazard),
- ♦ Waste matrixes that reduce dispersability,
- ♦ No high energy processes requiring post event control, and
- ♦ Limited fuel sources for fire.

These key facility features and design bases are the same basic foundation upon which the WRAP-1 HVAC was designed.

4.7 ORNL-WHPP

The Oakridge National Laboratory's Waste Handling and Packaging Plant (ORNL-WHPP) is a Conceptual Design (with PSAR) for a facility processing remote handled TRU (>200 mr on contact). The source term consists of a menagerie of transuranic waste from research and isotope production that includes californium and curium. Included in the facility source term are waste packages reading 1,500 R/hr.

The ORNL WHPP technical team are on record in project steering committee meeting minutes on HVAC criteria, "WHPP's interpretation of 6430.1A perceives no requirements for maintaining an active ventilation system" (Appendix E).

Consequently, ORNL has designed a confinement system that meets all DBA's by maintaining integrity of confinement. ORNL's position is that..."Confinement can be established, and will be established for WHPP, by making the cells essentially "leak proof" to radioactive particulates by sealing all penetrations and HEPA filtering all ventilation openings." All sealing components that make up the cell confinement will become safety class items, up to and including the first HEPA filter outside the cell. There will be... "no direct pathways to the environment..," and the system will be..."designed so that no active utility or support systems will be required to maintain the shielding/confinement integrity."

Active ventilation confinement systems are required..."to provide appropriate contamination control during normal operation and anticipated operational occurrences of the WHPP facility." The WHPP has additional potential high-energy hazards that are mitigated separately, e.g., nitrogen atmosphere prevents fires in the cells, and automatic shutdown systems are provided for a microwave sludge drier and linear accelerator. The safety class designation is applied only to those systems that could affect confinement.

APPENDIX A HANFORD OPERATIONAL EXPERIENCE PERTINENT TO PASSIVE SHUTDOWN
WRAP-1 HVAC SYSTEMS

REPORT:
HANFORD OPERATIONAL EXPERIENCE
PERTINENT TO PASSIVE SHUTDOWN
WRAP-1 HVAC SYSTEMS

April 1993

J.L. Stroup
Solid Waste Project Integration

HANFORD OPERATIONAL EXPERIENCE
PERTINENT TO PASSIVE SHUTDOWN

PROBLEM STATEMENT:

WRAP 1 was designated a safety class III facility as analyzed by the Preliminary Safety Evaluation (PSE). Thus, because environmental and public dose commitment criteria are not exceeded (DOE 5400 series) under even incredible circumstances, 6430.1A does not require back-up power for the ventilation system in the event of loss of normal power.

However, from an operational standpoint (ALARA), questions have been raised as to whether on loss of normal power, allowing the gloveboxes to go to neutral air pressure will cause unacceptable operating consequences (primarily contamination release).

The purpose of this study is to review relevant Hanford operating experiences, evaluate them against mechanisms of contamination release germane to WRAP-1 specific design features and WRAP-1 operation modes, to determine whether the proposed ventilation system is unacceptable for any specific reasons.

ANALYSIS:

The following analysis is broken down into four parts.

1. Plutonium Transport Mechanisms
2. Review of PFP Contamination Releases
3. Experience with Static Systems and Contamination Problems
4. Electrical outage summary.

Plutonium Transport Mechanisms

Plutonium can be found in many forms of solids, liquids and gases depending on the source and intended use. By far the majority of plutonium processed at WRAP-1 will be particulate with occasional instances of plutonium bearing liquid solutions. The forms analyzed here are particulates and liquid solutions.

1. Diffuse Transport by Electrical Charge: Due to the alpha emissions from plutonium, the particulates become electrically charged and diffuse at a relatively rapid rate thus appearing to have "legs". Plutonium surface contamination will spread to adjoining surfaces and will diffuse into any crack or crevice it may encounter in its enclosure. This is a surface phenomena which is not affected by ventilation air flow.
2. Chemical/Fluid Transport: Plutonium contained in liquids will of course flow to wherever the liquid may go. A special case exists with Plutonium acids (ie Pu Nitrate) which can attack surfaces and by corrosion create its own transport paths. Ventilation airflow/pressure is not generally a factor in chemical/fluid transport. A special case exists with criticality drains or glovebox piping systems which could be transported by pressure differentials.

3. Mechanical Transport: Physical contact of a non-contaminated surface by a Plutonium contaminated surface will transfer the contamination to the clean surface. This newly contaminated surface can then transfer contamination to other clean surfaces. Any physical item that enters a contaminated glovebox will become contaminated. The glovebox itself provides a physical barrier preventing the escape of contamination from the inside of the glovebox. In an accident such as a glove puncture, this barrier is penetrated and the penetrating object provides the means to transfer contamination through the barrier.

Mechanical transport also include "launching" the contaminate through the air by applying some unwanted energy to the plutonium source (ie, dropping and breaching a container, forklift accidents, explosions).

Mechanical transport is also the starting point of the next transport mechanism, Airborne Transport. In this case, mechanical transport disperses the particulates into the air. The dividing line between physical transport and airborne transport depends on particle size/density and the resuspension air velocity.

4. Airborne Transport: Once Plutonium contamination has been suspended in air, it is available for transport to wherever air flows through holes larger than the particles that are suspended. HEPA filters are effective barriers in that they provide a large surface area for airflow with flow channels that are small enough to exclude/trap fine particulates. Control of airborne contamination is provided by physical barriers such as glovebox walls to contain the air and contamination or HEPA's to confine the contamination. A confinement barrier may also be the smooth flow (no back eddies) of clean air from a clean zone to a contaminated zone. This is the principle used in an open face hood where physical barriers are not practical. In this case, as long as airborne contamination exists within the hood, airflow is required to maintain confinement. In a leak-tight glovebox, which provides a physical barrier, positive to negative ventilation flow is non-existent (other than through the filters) until a barrier is breached. In this instance, assuming that an airborne condition exists, or was created by the act of breaching the barrier, airflow is required to contain airborne contaminants. Otherwise, a glovebox that is sitting passively, is not unlike a waste container that passively contains its contents by maintaining its confinement barrier integrity.

Review of PFP Contamination Releases

The attached "Historical Occurrences and Incidents" list (Attachment 1) was evaluated to determine if the accidents (as summarized in the attachment) could have been more severe without active glovebox ventilation. Of the 28 accidents listed, I felt 3 had potential for being more severe without active ventilation and one did not apply to a ventilation failure (criticality). 13 of the accidents were due to fire. Fires generally spread a large amount of contamination over a large area. Based on the PFP information it would appear

that a contamination spread due to fire has a high probability/consequence. A passive shutdown of a non-backed-up HVAC has a higher probability of occurrence but low consequence. The probability of any significant consequence for an accidental release due to HVAC shutdown is very low.

The 3 accidents that may have been more severe without ventilation (3-2-52, 11-4-63 and 3-25-76) were due to pressurization of the glovebox. It is assumed that if there was a glovebox pressurization and a simultaneous loss of ventilation, that the release would be more severe than an event with normal ventilation. An analysis of WRAP-1 glovebox processes and control systems was performed (and will be repeated) to assure that a power loss or control failure does not cause a pressurization of the glovebox. An analysis and testing of the dynamics that occur during the ventilation shutdown following a power loss will also be required to assure freedom from compartment pressurization and backflow.

As for glovebox fires and ventilation, there are many arguments as to the value or impairment attributed to ventilation during glovebox fires. It also involves simultaneous unrelated events. UE&C addresses fire/ventilation issues in the Fire Protection Analysis section of the Title I design report.

Experience with Contamination Problems and Static Systems

Many PFP operations people were interviewed to get their views on where contamination problems exist and to inquire about "static confinement" systems that they are aware of. The following is a compilation of this information.

Contamination Problems

Leaking Glovebox Flange Seals

Gloveboxes in Miscellaneous Treatment (236-Z), Rm 41,
This problem of leaking glovebox flange seals persists in spite of continuous ventilation. This is likely due to transport mechanism #1.

Leaking Seal on 231-Z Chopper Hood drive motor

The chopper drive shaft penetrates the glovebox through a seal. Although subject to continuous ventilation, contamination leakage persists. During its operating years, transport mechanism #3 was likely the primary leak mechanism. Since deactivation, transport mechanism #1 was predominate.

Welded joints leaked in PRF after approx. 2 years. fixed with Epoxy. Access cones from canyon also leak - poor configuration for getting quality welds.

Transport mechanisms #2 and #1 appear to apply here since these gloveboxes are exposed to a wet/acidic Plutonium nitrate atmosphere. This also demonstrates the need for glovebox designs that are easily constructable to assure top quality welds. This also emphasizes the importance of quality leak testing. It

is doubtful that the PRF glovebox/canyon configuration was realistically testable.

Rotten gloves - old rubber gloves vs new hypalon etc compounds
poor physical conditions - heat, chemicals, (CCl₄, Nitric)
Degradation of gloves due to high radiation and chemical attack is a problem that requires routine maintenance. This should be a non-problem at WRAP-1 since any gloves in use will be manufactured from resistant materials and the environment that they are exposed to is relatively benign.

No known contamination releases associated with ventilation problems (not including open face hoods)

Except for open face hoods where airborne transport is a highly probable means of contaminate transport, there have been no known contamination releases associated with ventilation problems. On the flip side, known unplanned total losses of ventilation are also non-existent (all known static systems have been planned or accepted).

Static Systems

The following systems exist(ed) without spread of contamination and without the assistance of airflow or negative pressures to aid confinement.

Z-9 Crib/Mine : This crib became highly contaminated with plutonium to the extent that recovery operations (mining) were initiated. After completion of mining operations, this area was sealed off with a static connection to a glovebox which is in turn statically connected to outside HEPA. There have been no problems with contamination releases.

291-Z Exhaust Ducting : This ducting is in the exhaust fan building at the base of the 291-Z stack, downstream from the HEPA filters. The walls of the ducting are covered with fixed and smearable contamination up to approx. 20,000dpm/100cm². The amount of Plutonium in this ducting is estimated at 20 gms (more than the average WRAP-1 drum). Since it is not normally disturbed, it is unaffected by the airflow through the duct. When disturbed (transport mechanism #3), it is placed in the stack airflow for distribution via transport mechanism #4. These mechanisms are evident in that high stack readings have been correlated with activities in the 291-Z area that create ground vibrations.

Incident with polycubes: Approx. 200 cans of polycubes are held in the Z vaults. This is not a glovebox but a open room/vault with room ventilation for cooling (HEPA filtered). The container configuration is a polycube in a bag in a can with a hole punched in the can top for venting, with a "rock stopper" filter taped over the hole. A fresh polycube is clean on the outside

and can be handled in the open. These polycubes are old and have partially disintegrated into powder (laying on the bottom of the can).

An incident occurred when counting a polycube container due to the fact that part of the counting process involves turning the can upside down. At this point the loose powder leaked out the hole in the top and through the filter. This resulted in a multi-month clean-up effort. The approx. 200 cans of polycubes are still stored in the Z-vault in this "unconfined" and now undisturbed configuration with no problems.

Division of Military Applications (DMA) D&D

A large D&D effort was performed on the old DMA portion of the PFP process areas. This consisted of many large gloveboxes used in the fabrication/inspection of weapons parts. Gloveboxes were swept out (not decontaminated), sealed off and disconnected from ventilation. These static packages were stored inside and out for many weeks without any contamination problems.

Electrical Outage History

There are eight 138 kW lines for the 200 areas. It is rare that power is lost to all lines. Generally power is lost on one feeder which will effect one to three "buildings" (ie the Z complex would be a "building"). A long outage typically last for 2 hours. A short (or momentary) outage is generally around 30 seconds. On the average, one could expect a single 2 hour outage and 2 momentary outages per year.

No records kept (other than daily logs) prior to 1990.

Year	Affected Area	Event	Outage Length
4/90	200-E	Failed lightning arrester	2 hrs
6/90	200-E	Whirlwind	45 min
6/90	2 facilities	broken jumper	2 hrs
7/90	1 facility	Blown fuse	2 hrs
7/90	1 facility (100-D)	Trip and re-close	30 secs
9/90	0	Voltage Transient Lightning	0
10/90	Line 3&4	Bird, trip and re-close	few seconds
10/90	200 E&W	Voltage dip	few seconds
1/91	300 Area	Cable Splice failed	4 hrs
1/91	1 facility	Bird, trip and re-close	35 min
6/91	Line 6&7	Trip and re-close lightning	30 sec
6/91	Line 230	Trip and re-close lightning	30 sec

7/91	Line 6&7	Trip and re-close lightning	30 sec
7/91	100-D	Trip and re-close lightning	30 sec
8/91	Line 1&4	Trip and re-close lightning	30 sec
9/91	Line 6 200-E	Crane	1 hr
11/91	Line 4	Trip and re-close	30 sec
11/91	0	Excavation	0
12/91	Line 230	Trip and re-close	0

Perspectives

Many people have compared WRAP-1 and PFP HVAC systems and have found some obvious differences. There are also differences in source terms and processes that account for a very large difference in their respective hazards.

TRU Source Terms: The front end glovebox for the PFP C-line process has a material hold-up during processing (mostly powder) of approximately 15 kgs. Per the source terms in the SDRD, 2.14.2, the average WRAP drum will contain 11 grams of TRU and 95% of the drums contain less than 75 grams of TRU. Additionally, there will be gram quantity restrictions due to criticality limitations (probably <200 grams). Therefore, including only C-line and projecting 10 drums in process at WRAP-1 (high estimate) gives a two orders of magnitude difference in source term. If one were to include all plutonium in both facilities and considers the dispersability of the materials, the difference becomes even greater.

Potential Adverse Energy Sources: Both the C-line and WRAP gloveboxes contain sources of energy with potential for unwanted/uncontrolled releases which are capable of causing a breach of containment. Many of the high energy sources at C-line will continue to remain active or potentially active regardless of power or ventilation loss. (Firing furnaces-heat and pressure, calciners-heat). In WRAP-1 the only source of energy that could remain during a power loss are the pneumatic lines entering the glovebox. These sources are getting special attention to assure positive closure during a power loss and freedom from failure during operations.

One other interesting perspective is sample shipping limits. Sample shipping limits are such that except for volume (samples range from 30cc's to liter quantities) a large portion of the WRAP waste could be shipped via commercial carrier. Typical limits for shipping are as follows:

Non-actinide: 40 microcuries, Actinides: 0.3 microcuries liquids, 3.0 microcuries solid. Less than 2.0 microcuries/gram is not considered radioactive (2,000 nanocuries/gram).

SUMMARY & CONCLUSION:

Summary:

1. The four ways to transport Plutonium are: Diffusion by Electrical Charge, Chemical/Fluid Transport, Mechanical Transport, and Airborne Transport. To effectively build confinement barriers, one must identify the accident scenarios and the resultant mechanisms which transport the contaminants from Zone 1 to Zone 2, or Zone 2 to non-regulated areas.
2. A Review of Contamination Releases at the PFP indicate that the vast majority of contamination incidents would have occurred regardless of ventilation. Ventilation played no apparent mitigating role. The number one cause of contamination release accidents was fire, with a much higher probability of significant consequence than a passive shutdown of the HVAC. That is, a passive shutdown of the HVAC, although a high probability event, has a very low probability of leading to a significant contamination release.
3. A number of static confinement systems were found at Hanford, some with even marginal confinement barriers. They have not been found to cause contamination spreads unless disturbed by some outside energies.
4. Based on the 1990-91 data, a conservative estimate of the number of electrical outages is 3 times per year. An average of 1 is probably more realistic. About half of the outages were less than a minute. The longest outage was for four hours. The average time of the outages that lasted for more than one minute was 105 minutes. Three of the listed outages were not actually outages but voltage transients that were significant enough to upset some electrical equipment, thus they were recorded as incidents.
5. There is a significant difference in the source term of dispersable radionuclides in plutonium processing gloveboxes and the availability of energies available to produce dispersal in an accident situation.

Conclusion:

1. As long as the glovebox containment barriers remain intact and operations are terminated, it is very difficult to postulate credible events that would lead to a contamination release.
2. In the event of a breach of a glovebox containment barrier and a simultaneous loss of ventilation, the lack of ventilation backup may be the cause of a contamination release. Although not incredible, this scenario is highly unlikely when you combine the statistical occurrence of each. Additionally, double failures are outside the safety class 3 single failure criteria envelope.

3. Bottom line is: The cost/benefit of providing back-up power to the ventilation system is marginal. Back-up power for ventilation may have the appearance of ALARA, or make us feel more comfortable and give us more political clout with the public, but technically I feel it is a poor allocation of resources. ALARA principles would suggest that resources should be assigned to more beneficial use. (such as glovebox fire protection).

Date	Brief description of Incident	Estimated Release to Environs
3-2-52	A pressure vessel ruptured, spreading an estimated 0.1 g throughout several rooms in the building. The stack emissions were within normal range.	nil*
12-14-53	A fire occurred in a glovebox in the development laboratory when excess propane from a system leak filled the gloves and ignited. The room was contaminated to 40,000 dpm/100 cm ² . Stack emissions were within normal range.	nil
7-27-54	A fire started in an ice cream carton containing 900 g of plutonium machine turnings while the turnings were being sealed out of a hood. The turnings burned completely. All surfaces of the area were highly contaminated. Stack emissions were within normal range.	nil
9-19-55	A plutonium turnings fire occurred in room 179. The room was contaminated to 5 million dpm/100 cm ² . One employee received a deposition of about 20% of the maximum permissible body burden. Stack emission was within normal range.	nil
11-11-55	Widespread contamination was encountered during the removal and burial of waste cartons. The 200 West Area burial ground gate and lock, a pickup truck, loading dock, and several rooms and corridors in building 234-52 were contaminated up to 40,000 dpm/100 cm ² .	1 mg Pu
4-7-62	A nuclear excursion occurred in the Recuplex Operation. An initial burst of about 10 ¹⁶ fissions occurred and personnel evacuated. Three workers received radiation doses of 19 to 110 rem. The nuclear reaction continued intermittently for 38 hours for a total yield of about 8.0 x 10 ¹⁷ fissions. The vessel in which the reaction took place was under vacuum and the vacuum pumps discharged into the 200-foot stack. A calculated 10 ⁴ curies of noble gases were discharged. The quantity of radionuclides released was too small to have caused more than incidental exposure to plant workers or the public.	10 ⁴ Ci Noble gases
10-20-62	A fire occurred in storage vault 174 in an ice cream carton containing scrapings from a glove box. The vault was highly contaminated and some contamination was noted in the adjoining corridor. No personnel were contaminated. Emission from the building was within normal range.	nil
9-27-63	A fire occurred in a waste carton in Building 234-52 waste hutment. The hutment was highly contaminated. No contamination was found outside the facility.	nil
11-4-63	A fire occurred in a glove box in room 227. The use of a fire extinguisher pressurized the glove box momentarily, resulting in contamination of the surrounding area to 20,000 dpm/100 cm ² . Releases from the stack were within normal range.	nil
12-17-63	A fire occurred in the copper glove box in the 232-Z incinerator building. Personnel were contaminated to 20,000 dpm/100 cm ² skin or surface. Stack emissions were within normal range.	nil
4-4-64	A fire occurred in the chopper glovebox in the 232-Z incinerator building. Personnel were contaminated to 20,000 dpm/100 cm ² skin. The area surrounding the hood was contaminated to 40,000 dpm/100 cm ² . Stack emissions were within normal range.	nil

ATTACHMENT 1
Historical Occurrences and Incidents at the PFP

Date	Brief description of Incident	Estimated Release to Environs
6-8-64	A pressurization in a piece of laboratory equipment in a glove box in room 149 of the analytical laboratory caused release of contamination through the gravity duct vents to the building roof with measured contamination to 40,000 dpm/100 cm ² . Some specks with contamination up to 500 cpm/particle were found east of the building. Personnel contamination up to 40,000 dpm/100 cm ² skin occurred. The total release was on the order of 1 to 10 Ci.	100 mg
7-5-65	A fire involving four glove box gloves and a plastic bag port occurred in the 232-Z incinerator building. Contamination outside the glove box of up to 10,000 dpm/100 cm ² was measured. The exhaust filters were contaminated to 40,000 dpm/100 cm ² but emissions from the stack were within normal range.	nil*
3-18-66	Contamination was released during a change of 241-Z vent pit filters. Contamination up to 40,000 dpm/100 cm ² was detected on the ground.	<1 mg Pu
11-23-66	A fire caused by nitric acid on paper occurred in room 143 of the analytical laboratory. No spread of contamination was detected.	nil
8-9-67	A contamination spread of 40,000 dpm/100 cm ² occurred in rooms 152, 148, 153, corridor 40, and outside the analytical laboratory on the ground when a tygon tubing water line to a condenser broke, washing the contamination out of the hood.	<1 mCi Pu
10-23-70	A container of process material ruptured inside storage vault 192-C causing a high-level contamination spread within the vault. No abnormal stack emissions were noted.	nil
4/71	The 216-Z-18 crib line from building 234-5 broke at a location 6 feet south and 12 feet west of the southwest corner of Building 236-Z. An excavating 25 feet long by 6 feet wide by 7 feet deep uncovered gross alpha contamination in soil to 6 million dpm/100 cm ² of surface. Approximately one hundred 55-gallon barrels of contaminated soil were removed and buried in 200 West Area transuranic burial ground. Contamination still remains under 6 feet of uncontaminated soil.	10 gm Pu (0.6 Ci) to soil
1-23-72	A fire occurred in a glove box in room 227 when a propane cylinder leaked. Extensive hood equipment damage and high contamination levels throughout the room resulted. No abnormal stack emission occurred.	nil
1-9-76	The D-7 sample cabinet and the blacktop and soil under the cabinet area (70 ft ²) at the 241-Z liquid waste handling facility were contaminated with up to 80,000 dpm total alpha from a leak in a pipe union at the cabinet. The contaminated cabinet was removed and buried. Contaminated soil was packaged and buried.	nil
11-9-75	A package of hood sweepings ruptured in vault 173, causing high levels of contamination throughout the vault. No abnormal stack emissions occurred.	nil
3-25-76	Backup of process solution from building 236-Z into process water supply system allowed discharged of 60 grams of plutonium(IV) to the 216-Z-19 ditch via building 236-Z. Cooling water dams were placed in the 216-Z-19 ditch to help retain the activity in the ditch. A new water header system was provided to separate building 236-Z process and cooling water supplies. Capability was provided to prevent backup of process solution into the process water supply system.	60 g Pu to 216-Z-19 ditch
7-6-76	During the removal of a pressure vessel flange lid from a L-10 shipping container, an operator was contaminated with plutonium. After decontamination, his residual body burden was approximately 10% of a maximum permissible body burden. Corridors which were lightly contaminated were subsequently decontaminated. There was no detectable release to the environs.	nil
8-30-76	An exothermic chemical reaction resulted in an explosion in a cation exchange column processing ²⁴¹ Am in hood WF-2 in room 912 of the 242-Z building. One operator received gross external and internal ²⁴¹ Am contamination. Measured release of 50 Ci of alpha activity from the stack was not detectable in environs around the plant.	9415 mg ²⁴¹ Am** (most from sources other than stack)

ATTACHMENT 1
Historical Occurrences and Incidents at the PFP

Date	Brief description of Incident	Estimated Release to Environs
9-24-79	When vent cap was removed from an L-3 shipping container, plutonium nitrate solution was released to the immediate area of the container. Room 227-1 was contaminated but no personnel contamination resulted.	nil
10-9-79	During HEPA filter replacement in building 232-Z, radioactive particulates were dislodged from filters and/or filter holders and released to the atmosphere via the 291-Z-1 stack.	200 Ci of alpha emitting radioactivity
3-18-80	During scrap repackaging operations in hood HA-20-MB, exposed plutonium metal fines spontaneously ignited and burned the plastic wrapping on the opened inner container. The fire was smothered by placing a larger can over the inner can.	nil
10-9-80	A container of scrap material received in 1965 was repackaging in a 1-pound, slip-lid can in hood HA-40F and bagged out. Shortly thereafter, a low-level explosion occurred which blew off the slip lid and breached the double plastic wrapping. The resultant fire was extinguished using a dry chemical extinguisher. Three individuals received extensive plutonium contamination and building room surfaces were highly contaminated as a result of the incident.	12.9 Ci of alpha emitting radioactivity

*The word "nil" is used in those instances when stack monitors showed only the normal instrument variation for such measurements. Thus, any release from the incident was not measurable.

**Assuming all measured alpha released due to ^{241}Am , and assuming measured release could be up to a factor of 10 low.

WHC-SD-W026-TA-001 REV 0

APPENDIX B CONTRACT #MLW-073750, TASK S-92-11, REV B; WRAP-1 PRELIMINARY
DESIGN REVIEW OF HEATING, VENTILATING AND AIR CONDITIONING DESIGN

Science Applications International Corporation
An Employee-Owned Company

058GAN.92
August 6, 1992

Mr. D. E. Ball, Manager - Solid Waste Systems Engineering
Mr. B. F. Campbell, Chairman - Senior Design Review Board, WRAP Technology
Westinghouse Hanford Company
P. O. Box 1970
Richland, WA 99352

SUBJECT: Contract #MLW-073750, Task S-92-11, Rev B; WRAP-1 Preliminary Design -
Review of Heating, Ventilating and Air Conditioning Design

Gentlemen:

The third party review of the WRAP-1 Heating, Ventilation and Air Conditioning (HVAC) design by Mr. W. D. McNeese, consultant, is attached for your information. As I stated earlier, the final draft report differs from the working draft presented by Mr. McNeese only in editorial changes for improved clarity and the addition of a qualification to a statement regarding ALARA considerations.

I will be happy to discuss any of the editorial changes with you. If you have any questions please call me on 943-3133.

Sincerely,
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

A handwritten signature in cursive script, reading "G. A. Nicholson".

G. A. Nicholson

cc: w/attachment

G. L. Borsheim R2-11
J. D. Keck G6-46
R. J. Parazin H5-49
C. A. Petersen H1-60
G. W. Reddick H5-49
L. H. Rodgers T5-54

J. L. Stroup G6-46
J. A. Swenson G6-45
J. A. Teal H5-71
F. F. Walters T4-10
D. J. Washenfelter S6-18
File/Task S-92-11

wo/attachment

P. K. Brockman/SAIC-RL
D. L. Wilson G1-59
GAN/LB

WDM/92
July 17, 1992

Mr. G. A. Nicholson
Science Applications International Corporation
1845 Terminal Drive Suite #202
Richland, WA 99352

SUBJECT: WRAP-1 Preliminary Design - Review of Heating, Ventilating, and
Air Conditioning (HVAC) Design

I have been asked to make an independent review of the HVAC Confinement Study and associated drawings for the Waste Receiving and Processing Facility (WRAP-1). I will try to express my opinion on the following:

- The WHC issues presented.
- Will the HVAC perform its required function as designed and if not, what changes must be made?
- What changes should be made to improve the operability of the system and save costs?
- Other suggestions or questions.

Sincerely;

Wilbur D. McNeese

**Review - Waste Receiving and Processing Facility Heating,
Ventilating, and Air Conditioning Preliminary Design**

A. WHC IDENTIFIED ISSUES : CRITERIA VS WRAP-1 DESIGN

WHC ISSUE #1 Passive Shutdown

CONCERN: Is the concept of passive shutdown viable.

POSITION: Continuous operation is difficult to achieve and very expensive and is not necessarily more desirable than a passive safe shutdown. The failure of a system that was designed for continuous operation may fail in an undesirable mode. Designing a system for a safe passive shutdown will assure that the system is shutdown in the most desirable mode. In the passive shutdown mode there will be no motive force to disturb the material within the glovebox enclosures. Due to the nature of the materials and glovebox integrity the system, if undisturbed, no further action is required to maintain confinement. The nature of the WRAP process and material is such that no significant stored energy is present that needs to be dissipated. By having HEPA filters on the supply and exhaust of the ventilation system (the primary paths to the outside) the environment will be protected. No one would be allowed back into the facility until stable system operation is attained and approved by the proper authority.

CONCLUSION: Passive shutdown is a viable alternative to continuous operation; when planned for and controlled.

**WHC ISSUE #2: HEPA Filtered Ventilation In The Shipping & Receiving and
NDE/NDA Areas**

CONCERN: Should the WRAP 1 S&R AND NDE/NDA areas have their exhaust filtered through HEPA filters vs. the current design of exhausting directly to the atmosphere

POSITION: The current design, even though it may meet the minimum regulatory requirements, does not take additional, reasonable steps to mitigate the release of contamination to the environment exterior to the WRAP 1 facility. This is, in my opinion, not in accordance with ALARA philosophy/policy.

The current design specifies a slightly positive pressure for the S&R and NDE/NDA areas during normal operations. During a drum handling accident (e.g., fork truck tire rupture of a waste container, crane drop causing a drum breach) contamination will be released and may exit to the environment through the exhaust ductwork and S&R doors.

Attempts to mitigate this potential problem by continuous air monitors interlocked to the ventilation system that will shut down the ventilation flow and a "panic button", provided to allow the operator or control room to shut down the ventilation system in the event of a known release, may not be sufficient. There is no assurance that the contamination detection system and associated HVAC system interlocks will be successful in containing contamination within the WRAP 1 facility. There are no controls of any kind to prevent contamination migration through the S&R doors. The positive pressure which is maintained in the S&R and NDE/NDA areas will result in the migration of contaminants.

CONCLUSION: The design should allow for the following features to mitigate the release of contamination to the environment:

1. Install HEPA filtration on the S&R and NDE/NDA area supply and exhaust ducts
2. Operate the S&R and NDE/NDA areas at a negative pressure (as compared to the ambient) but still positive delta pressure in relation to the WRAP 1 Zone 2 area. Operation of the S&R area at a negative pressure may require "truck collars" at the receiving dock or interlocks/permissives between S&R container movement operations and the S&R doors.

WHC ISSUE #3 HEPA STAGES FOR ZONE 1 EXHAUST

CONCERN: Are two testable stages adequate to meet routine effluent release limits?

POSITION: The number of stages of HEPA filtration should be determined by safety analysis. This should be developed based on a worst case scenario using an agreed upon source term and from that determine the challenge to the HEPA filters. Then using the accepted decontamination factor for each stage of tested HEPA filters the required number can be determined. The designer should also consider the possibility of breaching of a HEPA stage to determine the need for additional stages of filtration.

CONCLUSION: Two testable stages of HEPA filtration are generally adequate, but this must be verified by analysis (source term and dispersion calculations).

B. ADDITIONAL DISCUSSION

Does the Design Meet All Applicable Criteria?

It does meet all specific applicable criteria as defined in 6430.1A and WHC documents (CM-4-9 and EP-0063) but does not meet the intent of ALARA. For example, in the S&R area, no HEPA filter exhaust system is provided to mitigate credible events. Although the credible accidental release would not exceed the DOE limits at the site boundary, the ALARA concept is that where possible, one should do better than simply meet minimum applicable requirements. Historically, the allowable release limits have been reduced rather than increased and this trend is expected to continue in the future. A facility minimally designed to today's limits may not be acceptable in the future.

C. ANALYSIS OF THE HVAC SYSTEM BY AREA

Administrative Area:

This is a normal system that should work satisfactorily. It may be over instrumented. This could cause a lack of stability and does cost additional money for unnecessary instrumentation. In the electric room the UPS batteries should be hooded and vented through the roof and not be recirculated.

Locker Room:

It is required that the air from the hot change room be exhausted through a HEPA filter. The present design shows the air to be dumped into the zone II process air system thus the dirt and dust from this area eventually ends up on the zone II exhaust HEPA's. It would be better if this were handled in another manner such as a HEPA filter in a roof exhauster.

Shipping & Receiving and NDA/NDE (see above analysis - WHC concern #2)

Process Area HVAC (zone II)

At least one bank of HEPA filters should be installed in the air supply system. It will provide a filtered path to the outside in the event of a flow reversal. During normal operations this will provide a much cleaner air to the operation area and will increase the time between changes of the exhaust HEPA filters.

A fail close damper in the air supply line should be removed. Any accidental failure of the valve system will cause it to close. A sudden closure while the system is in normal operation will cause an instant stop of all supply air and the room will go dangerously negative to the glovebox enclosures and will violently slam all partially open doors. This damper should be replaced by a manually fixed supply control damper. (The current design uses an approved backflow damper in the supply duct to provide backflow protection.)

Air should be supplied to the room through overhead ducts and properly spaced, low turbulence diffusers. Manually fixed dampers should be install in the laterals to the diffusers to fix the design quantity of air. Air should be exhausted from the room through a grilled wall duct near the floor.

From my experience working with various filter change systems, I would recommend that the zone II exhaust filter plenum should be a walk in type with a "Farr" roughing filter and two HEPA filters (provided this is supported by the safety analysis). Provision should be made for in-place filter testing. Local readout (not remote) pressure differential gages should be installed for each bank of filters. Pressure drop across the HEPA clean-up train should be recorded in the control room. Two 50% capacity filter units should be provided with an enclosed corridor work space between them.

The HEPA filter plenums and their exhaust duct through the outside zone II enclosure wall to a closure damper must be safety class. If the exhaust monitor (environmental) is installed in the duct between the plenum and the damper, then the rest of the exhaust system beyond the damper including blowers, stack, etc., can be non-safety class and outside of the zone II enclosure.

The number of exhaust blowers should be determined by a reliability maintainability analysis.

A variable damper in the exhaust controls the flow to maintain a designed fixed negative pressure in the exhaust header duct. This should sense the outside pressure using a good reliable atmospheric pressure sensing system designed and installed as a reference pressure for all of the room pressure control systems. By manually adjusting the supply damper and all of the air distribution dampers and automatically varying the exhaust to maintain a fixed negative in the exhaust duct the airflows will remain constant.

Glovebox HVAC System (zone I)

A 100% redundant glovebox filter system may be required due to operational requirements or by reliability/maintainability calculations. The blower output should be controlled by a by-pass or similar system sensing the room pressure to provide a fixed negative pressure in the exhaust manifold. Flow into and out of the glovebox through HEPA filters should be regulated by manually fixed valves to give the required volume and pressure differential to the room.

The quantity of air or air change rate should be a minimum to maintain a dynamic condition for the box. That is, a perturbation such as pumping the gloves should not cause the box to become positive to the room or excessively negative. As a minimum, normal airflow should equal or exceed the quantity required to maintain containment velocity through the design basis breach. A pressure differential gage showing the pressure between the room and the glovebox should be visible to the operators. It is a good idea to over design the capacity of the system

and then tune it to meet the above conditions. Excessive airflow is not good. It continuously stirs up the contents of the box and causes excessive trash loading of the exhaust filter. The purpose of the glovebox enclosure HVAC is to provide a pressure differential which will cause a flow into the glovebox for normal leaks and accidental breaching.

D. PHILOSOPHY AND GOOD PRACTICES

1. The glovebox ventilation system is designed for very specific glovebox use. The limitations should be specified and recorded early and made a part of the criteria for design and operation. If requirements beyond these limitations are imposed upon the system, changes should be made (i.e., designed for particulates only will not be adequate for removal of hazardous or noxious gases and vapors).
2. It must be an operational requirement that the gloveboxes be kept clean at all times and especially during non-work times. Accumulation of trash will increase the probability of a fire or other accident.
3. A well thought out plan must be incorporated for system shutdown and sequential startup to prevent flow reversals. If any part of the glovebox HVAC fails, all other HVAC associated with it must shutdown. On startup, the glovebox exhaust must startup first, then the room exhaust followed immediately by the room supply.
4. All HVAC must be working properly to allow operations in the process area.

The following things are not a part of this report but give me concern:

1. Will four air changes provide enough energy transfer to provide operator comfort (72°) in this quality building in the climate?
2. I have seen no operational or equipment requirement for humidity control. Can it be justified?
3. Even though this is classified as a "Low Hazard" facility the buildings should be reasonably air tight. Is this the intent?

WDM
07/17/92

APPENDIX C PASSIVE SHUTDOWN PHILOSOPHY LOS ALAMOS NATIONAL LABORATORY TA-55
HVAC SYSTEM

REPORT:
PASSIVE SHUTDOWN PHILOSOPY
LOS ALAMOS NATIONAL LABORATORY
TA-55 HVAC SYSTEM

April 1993

J.L. Stroup
Solid Waste Project Integration

REPORT
PASSIVE SHUTDOWN PHILOSOPHY
LOS ALAMOS NATIONAL LABORATORY
TA-55 HVAC SYSTEM

1.0 OBJECTIVE

To provide a written record of the Los Alamos HVAC system configuration and operating philosophies in sufficient detail to assure that the WRAP-1 HVAC system is suitably understood and designed for safe operations without backup power.

2.0 END ITEM DELIVERABLES

The purpose of this report is to provide a comprehensive review of the HVAC system at Los Alamos with special attention to the passive shutdown features of the system. This will be of sufficient detail to allow comparison of WRAP-1 to the confinement features of the Los Alamos system. This will include a piece-by-piece review of the HVAC system, its purpose and mode of operation in normal and shutdown conditions. This will also include a review of all available detail with respect to power failures, system shutdowns, facility source terms, actions required for restart and associated radiological consequences.

3.0 BACKGROUND

3.1 SUMMARY OF PROBLEM

Design of low hazard facilities that contain plutonium is a relatively new area at Hanford. Although 6430.1A does not require backup power for confinement ventilation of Radioactive Solid Waste Facilities, there is very little apparent experience with confinement systems that fail in the passive mode. This has caused concern with some people. Although a review of the physical means of contamination migration indicates that passive shutdown is not a contributing factor to contamination problems and current static confinement systems have not been a problem, it would be desirable to have confirmation of a facility that operates under the passive shutdown philosophy and an evaluation of how it compares to the configuration/source term of the WRAP-1 facility. Currently, the only known facility that operates like this is the Los Alamos PF-4 facility in the TA-55 area.

4.0 SCOPE

This report will be limited to a comparison with WRAP-1 to the Los Alamos ventilation systems for PF-4 and any other TRU facilities in the TA-55 area. A future assessment of other DOE facilities that are proposing similar design features as WRAP-1 will be made at a later date if required.

5.0 TASK DESCRIPTION AND COMPLETION

EXECUTIVE SUMMARY

The Los Alamos TA-55 building is a laboratory dealing with the Chemistry, Metallurgy and R&D of various isotopes of Plutonium. They have been operational for 15 years. Passive shutdown of the HVAC as a failure mode has been in practice since facility start-up. The facility source term generally ranges from 10-20 kilograms of Plutonium of many chemical forms and isotopes. Many ventilation shutdowns have occurred (average 3/yr) without consequence. Although somewhat different than the WRAP-1 design there are no unusual features that are required to make the system safe to fail in a passive mode. The primary differences are the use of a Zone 2 recirculation system, more filtration (higher source term) and the use of HEPA filtered supply. All of the WRAP-1 design features that are different are supported by referencable and recognized standards. Both systems embrace the same basic operating philosophy of a hardwired/controlled start-up sequence and total system shutdown on failure.

Los Alamos relies on and has proven through operations the concept that stagnant air does not provide the means for the spreading of contamination. As long as airflows and pressures are either in the proper direction, zero or through a HEPA, there is no problem. The WRAP-1 HVAC system is based on the same concept and will assure positive flows, no flow at all or passive flow through a HEPA.

DETAILED NARRATIVE

The task of describing the PF-4 facility is divided into six major sections: 1) Facility operating history and source terms, 2) Supply ventilation, 3) Exhaust ventilation, 4) Confinement details, 5) Power supply systems and 6) Operating philosophies and procedures.

NOTE: The following information was obtained through discussions and plant tours at Los Alamos. The Los Alamos personnel providing this information are as follows.

Charlie Smith	PF-4 start-up crew for instrumentation then ran power and computer systems for facility operations. Moved 1987 to SNML (Special Nuclear Materials Lab) project (not built) and then the NMSF (Nuclear Materials Storage Facility) program in an effort to find solutions/funding to fix a flawed design. Current title - Adjunct Facilities Manager
---------------	---

Wilber McNeese	Consultant, 30 years with Labs, prime technical engineer/ operator for the design and operation of the facility HVAC systems.
Bill Maraman	Past group leader of CMD11, a chemical/metallurgical group in charge of the PF-4 design/operation starting at the conceptual stage. One of the innovators of the low flow concept for Plutonium facilities. Worked closely with Wilber in the HVAC design.
Jim Corri	Operations Manager for PF-4. Overall responsibility for operations and maintenance of the facility. Prof Engr, Ph.D.

5.1 Facility operating history and source terms.

The PF-4 facility was designed for Plutonium (mostly 238 and 239); Chemistry, Metallurgical Handling and R&D as its mission objectives. PF-4 is divided into two sections with two "areas" in each section. Each section is provided with an independent and identical HVAC system. Each area has approximately 8 labs for a total of 32 laboratory rooms. There are approximately 84 glovebox lines with 6-8 gloveboxes per line for a total of approximately 500-670 gloveboxes total in TA-55.

5.1.1 How long has this facility operated under the passive shutdown philosophy?

The entire life of the facility - 15 yrs. NOTE: see 5.6.2 for configuration of passive shutdown.

N/A for WRAP-1

5.1.2 What nuclear materials in what form (ie dispersability) and in what quantities are contained in the passive shutdown facility? What is the maximum amount at any one time in a single glovebox? (minimum, average).

Much of this data is classified. Primary quantities are Pu 238 and 239. 10's of kilos in the facility at any one time is a good average. Worst case in one glovebox - 1000 gms of 239 in PuF4 form. Many other radionuclides are present at various times since this is a lab.

The average TRU content of a drum = 11 grams @ 83.95% by weight Pu-239. The maximum TRU content of a drum = 350 grams @ 83.95% by weight Pu-239. Normally drums are limited to 200 gms Pu. If the TRU sorting glovebox had an exit drum full (200 gms), the 350 gm drum in process and another 200 gm drum contents in temporary storage locations plus 200 gms worth of non-compliant materials in the TRU RWM glovebox, we would have a total of 950 gms of plutonium in the zone 1 confinement system. This does not include the miscellaneous non-TRU materials in the LLW gloveboxes. The remainder of the plutonium is contained in drums in zone 2 and the non-confinement areas (S&R and NDA/E). This material is un-affected by the status of the ventilation system since it is passively contained.

5.1.3 How many ventilation shutdowns have occurred during the passive shutdown period?

Once a year intentionally as a test. LANL is confident enough in their system that they occasionally perform this test during lunch break. Other shutdowns occur about 3 times per year due to various reasons. Generally no more than 20 minute power loss. The single point electrical feed for Los Alamos is split at two

sub-stations to form two ring busses connected in a loop around LANL. PF-4 obtains power from each ring bus, ie. dual feed with significant isolation from common source perturbations. Power availability is 0.9999. A hardwired high speed transfer system selects the alternate feeder upon loss of preferred feeder service within approximately 10 cycles (0.6 sec.). Thus operations are unaffected by this power source switching.

N/A, but it is reasonable to expect at least 3 ventilation shutdowns per year. This is based on the best guess estimate (no formal records) of 3 power outages/anomalies per year.

- 5.1.4 What type of survey is conducted after a ventilation shutdown and what have the results been? Has there been any area or personnel contamination attributed to a ventilation loss. What was the cost of clean-up if any?

Monitors do a full sweep of the building on face mask. No one recalls a contamination incident due to a ventilation shutdown. There is no means of reverse flow in the plant.

A full sweep of the facility on face mask will likely be the mode of operation at WRAP-1. The gloveboxes could experience reverse flow through the inlet HEPA during a passive shutdown, but there is no motive differential pressure to cause this to happen. The zone 2 supply is protected by a positive shut-off backflow preventer (per Title II comment resolution).

- 5.1.5 What is the hazard class and safety class of the PF-4 facility (ie low, moderate or high hazard and SC-1, 2, or 3)?

Moderate hazard facility- no explosive potential. (based on industrial safety). Only non-active systems required to maintain confinement are SC-1 (such as facility structure).

WRAP-1 is a low hazard facility built to SC-3 standards.

5.2 Supply Ventilation

- 5.2.1 What components make up the supply ventilation to Zone 1 and Zone 2?

Zone 1 is supplied dry air (-80 °F dew point) from zone 3 by transfer (extraction) through two HEPA filters. Individual gloveboxes may be closed off from the common Zone 1 supply system and operated with inert gas or operated as a standard glovebox with supply through a HEPA installed on the box. Zone 2 make-up is outside air drawn into intakes at the roof line (approx. 20 ft. above grade) through bird-screen and preheated by hot water coils (fan & by-pass wing) before entering facility. Entry into facility is through a tight shut-off butterfly valve just inside the hardened perimeter. This supply air is then passed through a plenum containing a roughing filter, one stage of HEPA filtration (to provide a cleaner air within the facility and thus reduce the loading of subsequent HEPA filter) and then a chilled water coil to decrease the summer season dewpoint below the coldest exposed central circulating chilled water components within the facility. LANL felt that mechanical separators would be very effective at removing large particles from the supply for problem areas.

For WRAP-1 the glovebox supply (zone 1) is extracted from the process room (zone 2) through the inlet HEPA filter on the glovebox. The zone 2 components are as follows: Air enters the facility through wall mounted intake louvers (approx. 14 ft above grade), is joined by the defrost bleed duct (provides warm air from operating damper to frozen damper), passes through an isolation damper, air handler and another isolation damper. There is complete redundancy to this point. After the airhandler join to the main duct are the humidity controls, backflow damper (fail close isolation damper), the distribution system with fire dampers at fire walls and the supply diffusers across the middle of the room ceiling. The

air handlers are configured as follows: 30% and 80% filters, heat recovery coil, electric heat coil, cooling coil and fan.

5.2.2 What is the filtration efficiency of the supply air handler?

*Pre-filter, 35% ASHRAE efficiency and HEPA, 99.97%.
30 and 80% for WRAP-1.*

5.2.3 What is the configuration of the devices designed to prevent backflow of contaminated air?

Backflow prevention is provided by the fail closed, tight shutoff butterfly valve (closes pneumatically upon loss of filter differential using gas bottle). Filtered backflow could be provided by two HEPA filter stages (instead of the current one stage) and thus allow the butterfly valve to remain open. LANL feels this would be an improvement to their current design. As it stands, an inadvertent closure of this damper before Zone 2 exhaust action has stopped places severe stress (pressure drop) rapidly across personnel portals into the facility and unwanted flow action within the facility. They would prefer a nuclear grade damper just outside the perimeter in the event the need to seal the facility should arise. This would be a manual operation, not automatic.

WRAP-1 uses a fail closed isolation damper for backflow prevention in the main supply duct. Fail open isolation dampers are provided through-out the supply and exhaust confinement systems to allow free breathing through exhaust HEPA's.

5.2.4 What is the configuration and philosophy behind the configuration of fire dampers (or duct wrapping)?

Generally no fire dampers in ducts passing through fire walls. They also do not use duct wrapping. Los Alamos feels that fire dampers pose an upset to the HVAC in a fire scenario and that the requirement for slight negative confinement pressures is more beneficial than system shutdown (due to fire dampers) in a fire.

WRAP-1 uses fire dampers in all HVAC ducting that passes through a fire wall except for the zone 1 & 2 exhaust ducts. 6430.1A, 1530-99.0, para 22; requires duct wrapping where fire dampers can't be used due to the need to maintain confinement.

5.2.5 What air conditioning is provided (such as humidity control)?

LANL uses dew point limit control. They use a 50 degree cooling coil which is the coldest part of the system.

WRAP-1 provides humidity controls per 6430 requirements.

5.2.6 What is the filter change-out interval and the filter pressure drop at change-out time?

LANL wanted to make clear that trending does not work. Due to off-normal or "unusual" lab activities (applies to exhaust filters only) and the fact that filters work better as they load and thus load faster, the filter loading can change dramatically. Supply HEPA filter life is typically 6 months to 2 years depending on conditions of service. They normally shoot for a filter loading of 1-1.25 inches (designed for 1.75) over clean. (see 5.3.7)

N/A for WRAP-1

5.2.7 Which components are redundant and why?

The PF-4 Zone 2 supply does not provide air handler (plenums like 5.2.1) redundancy except for redundant fans. An improvement over the PF-4 design is as noted by the SNML design, ie. provide the same supply redundancy as exhaust redundancy because the unmatched redundant systems frequently negate some installed redundancy. Whenever the single Zone 2 supply air handler is shutdown for any reason, ie roughing filter change, the complete Zone 2 exhaust (bleed-off) must be shutdown even though it has redundant air handlers and three fan stations (only one used at a time). (see exhaust ventilation below for exhaust redundancy 5.3.9)

WRAP-1 supply is provided by two redundant air handlers. The fans are integral with the air handlers and are thus dedicated to one air handler only.

5.3 Exhaust Ventilation

5.3.1 How many stages of testable and non-testable HEPA filters are there for the Zone 1 and zone 2 spaces?

Testable HEPA's : Zone 1 - three for Pu 239 and four for Pu 238. Zone 2 two for recirculation system and two for bleed off (note: this amounts to four stages for most of the zone 2 since the bleed-off has already gone through the recirculation system. Zone 2 air containing noxious fumes (ie fume hoods) bypasses the recirculation system and goes directly to the zone 2 bleed-off filters.

Non-Testable HEPA's : A "housekeeping" (no decontamination credit) push-through HEPA is provided at the glovebox exhaust. NOTE: Although no credit is given, Los Alamos can test installed glovebox HEPA's with a state-of-the-art "DOP" test system.

WRAP-1 provides two stages of HEPA's for zone 1 & 2. Zone 1 is also provided a non-testable push-through HEPA at the glovebox exhaust.

5.3.2 What is the efficiency of the filter train pre-filters?

Zone 2 recirculation plenums use FARR pre-filters which are approx. 35% efficient. These stainless steel filters are also used in all Zone 1, 2 & 3 exhaust for their characteristic to drop any water (such as fire cool-down water) vertically. While LANL does not have an efficiency value for the mesh filters in the LAB Zone 2 returns ("rock stoppers" clipped over the exhaust grilles), they are very beneficial in reducing the loading on plenum filters. These filters are routinely changed by custodians as they are normally cold. In the event of a spill they are collected as part of the decontamination waste and replaced as a part of the cleanup.

WRAP-1 uses fire screens and a 45% efficient filter. The use of "rock stopper" filters is typical at Hanford and it is expected that this would also be the operating practice at WRAP.

- 5.3.3 What is the air exchange rate for the serviced spaces, in terms of fresh air and recirculated air?
Zone 1 minimum flow to maintain the negative differential, no specific exchange rate. This does not consider heat removal or dilution of flammable gases. LANL does not use ventilation for heat removal and does not use flammable gases (requiring exhaust/dilution) in gloveboxes as a rule (In the rare event flammable gases are used special procedures are used such as inert gas atmosphere, not exhaust/dilution with air). Zone 2 is 7 air changes/hr with 10 to 20% makeup.
 WRAP-1 provides 4 ac/hr for the process area and 8 ac/hr for the gloveboxes, 100% once through. There are no inert or otherwise hard-piped supplies to WRAP-1 gloveboxes.
- 5.3.4 What contamination levels (typical and max) are found in the Zone 1 duct work, pre-filters, HEPA filters and the ductwork beyond the HEPA filters?
Depending on the process the glovebox "housekeeping" filter (non-testable push-thru HEPA's) will load anywhere from 1 to 50 grams. The oil in the pressure relief bubblers can also capture recoverable quantities. Recovery is provided by the group operating the glovebox. Beyond that point ducts, pre-filters (FARR) and 1st HEPA of the exhaust filter plenum pick up counts (200-300 cpm) but no recoverable quantities. In some cases the Zone 1 ducts beyond the initial glovebox filter has had enough to detect gamma from outside of the duct due to blow out of housekeeping filters and due to liquid transport accidents (up to a few grams). Have had incidents of recoverable (1-2 gms) in 1st HEPA but generally just contamination. Have not had contamination beyond the 1st testable HEPA filter (including the ducting etc.)
 No operational history for WRAP-1. It is expected that WRAP-1 will have less migration down-stream of the HEPA's since our source term is significantly less.
- 5.3.5 Are all the gloveboxes served by the same Zone 1 HEPA filter trains?
Each of the four compartments in the facility (100,200,300,400 areas) have their own dedicated fully redundant exhaust/blower system.
 WRAP-1 has one redundant zone 1 exhaust system serving all WRAP-1 gloveboxes.
- 5.3.6 Have you ever experienced any failure of a HEPA filter?
Once a HEPA has passed its initial installed "DOP" test, we have had none that failed in subsequent tests. That is, filters in use have never failed to "filter" ie no HEPA filters in use have been penetrated. Depending on the process, Zone 1 HEPA filters have "loaded" to the point when pressure drop exceeded a desired level and a shift to the redundant system was made either automatically (at an assigned condition) or the operator actuated the shift for a pre-scheduled filter replacement. This applies to the air clean-up train only, there have been failures of glovebox exhaust HEPA's due to various abuses.
 N/A for WRAP-1.

- 5.3.7 What is the pre-filter and HEPA filter replacement interval? What is the maximum and normal pressure drop across the pre-filter and HEPA filter at change-out?

Zone 1 exhaust HEPA filter life is a function of the process stream. As a general rule : 400 area once every 6 months (chemical area), 200 area once per year, 100 and 300 area 1 year to 18 months. Shorter time intervals are generally due to off-normal events. (see 5.2.6) Zone 2/3 HEPA life at PF-4 approaches the shelf life with HEPA pre-filtering for lint, dust, etc in the facility supply (typically 8 yrs.).

(NOTE: The PF-4 process/lab area is actually two mirror imaged buildings (including the HVAC) that are joined together. These areas are further divided into the 100,200 and 300,400 areas.

N/A for WRAP-1.

- 5.3.8 What type of radiation monitoring is there for the ducts and filter train?

Continuous Air Monitoring in front of every zone 2 exhaust grille. In-line zone 1,2,3 exhaust duct monitors after the last filter before combining flows in stack. Recycle system - CAM after last filters. The normal stack monitoring system is also provided for the combined exhaust flows.

WRAP-1 monitors the glovebox exhaust duct downstream of the glovebox "housekeeping" HEPA to monitor filtration effectiveness. Monitoring points are available downstream of a air clean-up train HEPA's. A stack monitoring system is provided for the combined gases.

- 5.3.9 Which components are redundant and why? see supply redundancy
Filter trains, fans etc that could affect building negative (like zone 2 bleed-off - this is manually redundant), zone 2 recirculation system is two 50% units (one will supply approx 60%). This is a degree of redundancy open to interpretation. Upon loss of one system the air change rate is reduced for the compartments (Zone 2 rooms) but for normal operations this state can be acceptable during the period of outage. The PF-4 design does require several hours to perform a facility flush. Although not intended for fume, vapor, gasses - but rather particulate filtration, should a flush be required the recirculation units would be shutdown and only the make-up and bleed-off systems are used for Zone 2 ventilation. You will note our recommended design for the storage facility (NMSF PF-41) is an installed system capable of 0 to 100% manually adjusted for 15% fresh air and 85% recirculated air. Should the need arise the system can be set for full flush, ie once through or any ratio MANUALLY. Automatic control would still be limited to approx. 10% of exhaust to achieve facility differentials relative to facility ambient (across personnel portals).

The zone 1 & 2 exhaust systems for WRAP-1 are configure as follows: Air enters exhaust grilles near the floor (generally on one end of the room). It then goes through a isolation damper, the clean-up train, a fan, control damper, isolation damper and then joins a common header to the stack. The air clean-up train consists of a fire screen, 45% pre-filter and two stages of HEPA's including the required test sections and hardware. The zone 2 clean-up train also includes a heat recovery coil. Both zone 1 & 2 systems are redundant. Dampers for the exhaust system are designed to fail open. The fans are dedicated to a filter housing (clean-up train). This does defeat redundancy during filter change-out.

5.4 Confinement

- 5.4.1 What are the zone pressure relationships? What is the configuration of the pressure reference header?
Had a pressure reference header on all four corners tied to a tank. Now have a "shower head" (by Air Monitor Corp.) on top of building. Pressure relationships (inches water gauge) : outside-basement -0.1, outside-zone 2 rooms -0.2, corridor (not controlled) -0.15-0.17 (to outside), glovebox-room -0.5. Zone 1 exhaust header -2.0, bleed-off header -0.6 with respect to atmosphere.
- 5.4.2 What is the physical configuration and airflow paths for the airlocks.
LANL supplies air to the airlocks and allows leakage both ways. WRAP-1 airlocks were designed with the guidance of ASHRAE VA-89-18-6, "Nuclear Facility Air Lock Design Criteria". With this method 25% of the air is supplied to the airlock and the remainder flows through the airlock.
- 5.4.3 What types of seals do the gloveboxes have? What are the weak spots (ie. subject to leakage)? Are there any places that are dependent on airflow for confinement?
Zippered windows and u-gasket. No known trouble spots. The introductory hood is cold. When the door is open between the glovebox and the introductory hood and while using "pencil drops" to introduce small items into a glovebox there is a temporary dependance on confinement airflow.
WRAP-1 glovebox seals include clamped u-gasket type windows, the inlet and outlet HEPA seals, glove seals (some push thru, some normal glove and ring) and the entry exit system as follows for TRU process: The drum is introduced to the entry glovebox via the double lid system. While in use the double lid system depends on ventilation flow for capture velocity around the seal with the 83 gallon overpack drum. This entry glovebox is normally clean. Once the drum is inside, a solid lid is placed over the double lid entry system and the next step can take place. The HEPA filtered lid on the sphincter seal port is lifted and the drum is pushed into the sphincter to take place of the current drum in the sphincter. The displaced drum is now in the glovebox and the HEPA filtered lid is placed back on the sphincter seal port. The sphincter seal port also depends on ventilation flow for capture velocity while in use. The double lid system and sphincter are software interlocked to prevent opening of both system, at once. The exit port uses a one trip transfer system that maintains sealed containment. The LLW process glovebox uses the double lid system for both entry into the entry glovebox and process glovebox exit. The exit to the process box from the entry glovebox is via a door with no seals.
- 5.4.4 What is the building in-leakage rate?
Approximately 1000 cfm for each half (used to be 2500 cfm before a "caulking campaign"). Total facility flow one building 7000 cfm fresh in basement, 9000 cfm in corridor. 100 and 200 areas recirculation 32,000 cfm in each, exhaust 17,000 cfm from building. Zone-I 1,400-1,700 cfm (of the 17,000), bleed-off 11-13,000 cfm.
N/A except for a conservative estimate of 1,500 cfm - used to size HVAC equipment. Considering the size of the facility and HVAC system this should be grossly over-estimated. It is not reasonable to specify an infiltration rate for the structure, but specifications do cover the sealing of the structural shell. Based on the LANL experience, a "caulking campaign" would be a reasonable post testing/pre-operational activity.
- 5.4.5 What test procedure was used to test glovebox integrity? Is there any on-going testing to assure glovebox integrity?
Helium leak test on original installation. No formal on-going testing, see section 5.6.4 for "in-use" testing.
WRAP-1 will also helium leak test the installed gloveboxes.

5.4.6 What is the configuration of the zone 2 supply diffusers and exhaust grilles?
Normal round diffuser located evenly spaced towards the center of the room. (Like Kruger diffusers)
 WRAP-1 uses the same arrangement.

5.4.7 What are the airflow sweep velocities for zone 1 and II?
LANL does not try to obtain any specific airflow sweep velocities. They only ventilate to a minimum to reduce contamination spread. They balance out their gloveboxes to maintain glovebox negatives through normal glovebox operations that cause pressure fluctuations such as glove pumping. PF-4 was designed for 7 air changes per hour for Zone 2 (secondary), up to 3 ac/h for Zone 3 (tertiary) and no specific air change rate for Zone 1 (primary). WRAP-1 does not attempt to maintain any airflow sweep velocities except for case of a ruptured glove on a glovebox. The air exchange rate for WRAP-1 is 4 ac/hr for the process area and 8 ac/hr for the gloveboxes.

5.5 Power Supply Systems

5.5.1 It is understood that a diesel generator is available for zone 1 ventilation in the event of an extended power failure. Is this a fixed or portable system? Is there redundancy? How long does it take to restore power with the diesel generator and how reliable has it been?
It is available, but not as a safety device. Could be used in an extended outage for the "B" bus only. (The "A" bus is for equipment you don't want to run until ventilation is up and running). Generator start-up is remote-manual and takes approximately one minute. It is not a portable system. Normally you wait for power to come back. In one instance, after approximately 10 hrs, the diesel generator was used to operate facility HVAC. LANL was unsure of the reasoning why the generator was used at that time. They do not feel it was a safety issue. LANL stated that the auxiliary diesel generator was not adequate to operate facility ventilation in summer or winter months due to additional loads during hot or cold days (the chiller and hot water boiler systems are not provided backup power and are normally required for HVAC operation). LANL considers the diesel generator as a convenience, not a safety system. Access to the UPS primary feed is provided outside the facility to allow auxiliary power input at any time after loss of the facility redundant "B" buss power. this action need not be continuous, rather it can be employed long after the UPS has shutdown down to low battery voltage (105 Vdc). The data logger is not required to operate longer than 30 minutes following an incident. However, with the capabilities of powering up the UPS and thus its critical loads from outside the facility and with the operations center outside the radiological control area, real time analysis of conditions within the facility can be assessed long after a passive shutdown and then maintained as long as required. This approach is very beneficial in designing such safety class systems as exhaust stack monitoring by reducing the installed power requirements within the facility.

A standby power generator is not available for WRAP-1. Normal power to WRAP-1 is provided by one 13.8 kv line feeding two 750 kva transformers supplying 480 volt power to the facility. Normally both transformers are in use but most facility loads can be provided by one transformer. The HVAC equipment is tied into both transformers so that loss of one will not affect the HVAC system. (other non-essential equipment is on a dedicated transformer and requires manual switching to be energized).

- 5.5.2 What percentage of ventilation is available under back-up power when made available?

Assuming appropriate atmospheric conditions allow the system to run: 100% of Zone 1 and 50% of Zone 2. This is only a reduction in air change rate for Zone 2. The differential pressure relationships remain the same. This reduced air change rate is acceptable for most lab operations following a loss of or maintenance on one of the two 50/50% Zone 2 recirculation units.
N/A for WRAP-1.

- 5.5.3 What percentage of the ventilation system failures are due to power problems?

Approximately once per 3 years due to total power loss. There are also occasional shutdowns due to transients (this is becoming more rare).
N/A for WRAP-1.

- 5.5.4 How long is a typical power loss? What is the length of the longest power outage? Do you keep a log of power outages?
Generally short due to power fluctuations. Can be up to 20 minutes. Longest was 10-15 hrs. Used the generator that time to operate the ventilation. If it is too hot or cold, they CAN NOT operate on diesel generator power. No power-loss logs available. In recent years site power availability has improved and transient perturbation has decreased. Charlie Smith discussed this with the LANL power plant operating contractor, JCI who elaborated, "Improved grounding of the overhead static conductor was accomplished by grounding at every second pole - previously it was done at every fifth pole. Also, an improved "conduct of operation" on the part of the power plant personnel has significantly reduced operator errors". A new system called a Static VAR Compensator is to be added within the next year or so to the LANL power loop. Transients such as lightning strikes (which is the most frequently occurring perturbation on the power system at Los Alamos) are masked for several cycles. Electrical maintenance can require an outage or shift to alternate sources (generally scheduled). The electrical and HVAC equipment redundancies at PF-4 provide system availability while performing maintenance off line.

With the little history available for Hanford power reliability, the following is estimated for WRAP-1 : A high estimate of 3 outages/yr with 1 outage/yr being more realistic. About half of the outages were less than one minute. The longest outage was 4 hours. The average of outages longer than one minute was 105 minutes.

5.6 Operating Philosophies and procedures

- 5.6.1 Which items of equipment are relied upon to function (ie specific failure mode) during a power loss or other failure?
UPS for 30 minutes operating the control/monitoring system is required. In reality the UPS functions for up to 10 hours and can run continuously with recharge by portable generator. It is PF-4 policy to have all personnel exit the building on loss of Zone 2. Personnel can either leave PF-4 or go to the other side of PF-4 (a separate Zone 2) until the failed Zone 2 is restarted. On a loss of any Zone 1 both Zones 2 & 3 systems shutdown automatically. In this case all personnel exit PF-4. A total power loss would also cause this. Depending on the set-up one PF-4 power substation could fail and all Zone 1 & 2 systems and Zone 2 make-up and bleed-off service continue on the other power substation.

WRAP-1 will also have a UPS for computer systems, critical alarms and stack monitoring. We have not currently settled on how long the UPS will be required to run. For the computers and critical alarms the need is to shutdown in an orderly manner and evacuate the facility. The stack monitor may be required to run for many hours. The only other equipment that performs a function in an outage are the isolation dampers. The fail closed backflow isolation damper prevents potentially contaminated air from backflowing through the supply ventilation and the fail open isolation dampers allow the building to "breathe" through the exhaust HEPA's.

- 5.6.2 Is there any attempt at controlling shutdown in a sequential manner?
On a total power loss all HVAC stops. Short of that extreme, several options for operating PF-4 HVAC are provided. The loss of any bleed-off causes an automatic shutdown of all Zone 2 & 3 systems in that side of the facility (ie North or South half). The redundant bleed-off and make-up blowers for Zone 2 are cross-powered. The loss of a Zone 1 unit due to loss of MCC power results in the automatic start of the redundant system and thus no shutdown of the Zone 2 systems if the required Zone 1 header negative is established with 23 seconds (normally established within 4 secs.)

In a power outage, the computer system will collect current data on system status and shutdown. All other HVAC components shutdown completely. Fan failures could lead to system shutdown due to hardwired fan interlocks. Loss of zone 1 exhaust shuts down the entire system. Loss of zone 2 exhaust shuts down the zone 2 system. Other failure modes lead to switch over to the standby system where redundancy is provided.

- 5.6.3 What are the steps taken to assure that the system is ready for a re-start? What is the re-start logic and is it manual or automated?
The facility is checked for contamination while a knowledgeable person in charge reviews the HVAC system condition and determines the failure mode. Operating personnel do not enter the facility until it is determined that the facility is clean and the HVAC system is operating in an acceptable manner. The primary elements of the system start up logic consists of hardwired interlocks to assure a; Z-I exhaust, Z-II exhaust, Z-II supply sequence. Additionally the control system provides timing to provide a smooth pressure transition. From a control standpoint they like to maintain 90% manually dampered control and allow the control system to work with the remaining 10%. (recommend no more than 80/20 split).

The system has two identified failure modes: loss of power and loss of instrument air. While the system has several "partial

failure - component related" responses, the restart after a shutdown caused by either power or loss of I/A is completely automatic when both are restored as follows: All Zone 1 systems start independent of each other. After all Zone 1 systems have achieved their assigned negative and for a minimum time, Zone 2 bleed-off systems start automatically and independently. Thereafter, Zone 2 make-up, Zone 3 exhaust and Zone 2 recirculation systems start at assigned zone negative and time delays to provide a smooth transition to normal mode within two minutes.

For WRAP-1 it is expected that operating procedures will require a facility sweep for contamination and an evaluation of the system failure mode. Once it is determined that the system is OK for re-start, the sequence is initiated and automatic restart will follow.

- 5.6.4 Is there an ongoing activity to evaluate the integrity of the confinement system (to assure that configuration changes or components such as seals have not failed and compromised the confinement)?
Original Helium leak test only. The inert/dry gloveboxes are tested continuously via monitoring the condition of the inert/dry atmosphere. Any other test is basically a "ALPHA" test; ie. it doesn't leak contamination. This is proven by routine monitoring of the glovebox gloves as performed by Health & Safety personnel. Additionally fixed head monitoring and area swipes provide an ongoing monitoring of glovebox integrity. They feel that even minor leak paths don't cause them problems if you keep in mind one simple principle "Killing all pressure differential is imperative. It's what keeps leak paths from leaking".
 Since post-operational leak testing is not a feasible option, WRAP-1 will "test" gloveboxes by the "ALPHA" operational test. Although not quantitative, leak detection via ultrasound detection systems could prove useful in long term glovebox integrity monitoring.
- 5.6.5 Do you have a safety analysis evaluating the passive shutdown operation?
It is a part of the safety analysis but not specifically addressed as a separate standalone issue.
 Passive shutdown will be addressed by the WRAP-1 SAR.
- 5.6.6 What type of controls system do you use? What type of information is maintained/available for the failure/shutdown period to help in evaluating the incident? Is the control system on UPS?
Basically, a Johnson Controls, central control system 1975 vintage on UPS. The control system was designed by Fluor Corp. using electronic transmitters and controllers available in 1975 (Fisher & Porter) and Fisher current to pneumatic converters to industrial damper controls using Moore positioners, Raymond and CenterLine power components. Additionally, Fluor located the points for all sensors and control. Johnson Control engineered the installation and documentation of the system (Systems Engineering and Construction Division). The logic (relay functions, timing, differential pressure response values) and remote display service was incorporated in an existing facility control system which also provided data logging requirements. Fluor engineered a very successful control system supporting the 80/20% fixed/variable air balance philosophy. Johnson Controls provided a well installed, serviceable and documented operating system. Major start-up problems were associated with the facility control system (handles

both facility and HVAC functions). A stand-alone HVAC control system is preferred. A log of HVAC system information (system status) is saved by the computer to an "unlog" which is a computer logging file that describes the system condition at system failure.

WRAP-1 HVAC control is designed around a stand-alone HVAC DCS, vendor TBD. All performance/monitoring data generated by the HVAC controller is available to the PCS for inclusion in data logs.

APPENDIX D COMMENTS ON THE SAFE SHUTDOWN CONCEPT REVIEW FOR THE WASTE
CHARACTERIZATION FACILITY

U.S. DEPARTMENT OF ENERGY
GERMANTOWN, MD

EM-341 TELEFAX COVERSHEET

PAGES: 10 DATE: 1/11/93
(excluding cover sheet)

TO: Brian Sullivan, DOE-RC
FROM: Jim Davis, EM-341

Telefax # FTS 903-7231; Commercial 301-903-7231
Verify # FTS 903-7184; Commercial 301-903-7184

NOTES:

Re request. Jim Davis

*This is the INEL request/
response for passive shutdown
for the INEL "WCF" facility.*

J. Payne

*XC: D. Bal
J. Strc
D. Luc*

*Return
original*

COMMENTS ON THE SAFE SHUTDOWN CONCEPT REVIEW FOR
THE WASTE CHARACTERIZATION FACILITYGeneral

1. The issue of whether the Waste Characterization Facility (WCF) should have a passive or active safe shutdown capability is more of a design issue than anything else. The rationale for requesting headquarter's approval of this analysis is unclear, since issues of this type are typically decided by the contractor or field DOE offices.
2. For any DOE project, the objective should be to meet all environmental, safety, health, and mission requirements of the facility in a cost-effective manner. If this can be done with a less expensive passive shutdown system, then this approach should be taken. The primary criteria for a shutdown system should be whether or not all the credible accident scenarios analyzed for the facility yield consequences (radiological dose or chemical exposure) that are acceptable to the public and site coworkers (i.e., site workers not assigned to the subject facility). In many instances, it is unclear as to whether radiological hazards are included when discussing hazardous materials.
3. A very thorough review of the special safety-related design features required for special facilities, as contained in DOE Order 6430.1A, has been performed by the contractor. These have been accurately extracted from the order and considered in the analysis.
4. It is unclear as to whether or not this analysis has been prepared with regard to the preliminary hazard assessment prepared with the conceptual design report.

Page/Section

- 6/4 Dispersion of Materials An important post-accident consideration has and apparently been inappropriately applied by the contractor. The 4/2 requirements of DOE 5400 series orders, specifically DOE 5400.5, do not apply to post-accident considerations. These only specify requirements for normal operations. The only prescriptive post-accident requirements that apply to DOE facilities are the safety policy goals identified in Secretary of Energy Notice 35 (SEN 35-91). Using these numbers instead of the allowances in DOE 5400.5, would further support the decision by the contractor, for use of a passive safety shutdown capability.
- 5/3 Passive Shutdown Conditions This bullet notes that post-accident concerns for hazardous constituents are based on Threshold Limit Values (TLVs). While this might be the case, Immediate Danger to Life and Health (IDLH) values might also be used in an accident consequence study.
- 1/4 Standby Power This paragraph notes that a standby power generator and associated switchgear will be provided to power the WCF HVAC and stack monitoring systems, but none of these will be designated as safety class systems. This is certainly satisfactory for the HVAC system, but may not be satisfactory for the stack monitoring system. Consideration should be given to powering the monitoring system from a safety-class Uninterruptable Power Supply (UPS) that will retain power in a post-DBA situation.

United States Government

Department of Energy
Idaho Operations Office

memorandum

DATE: September 13, 1991
SUBJECT: Safe Shutdown Concept Review

TO: Jim Davis
FM-343
318/TREV

Attached is a copy of the subject concept description for your review and comments. Currently the Waste Characterization Facility (WCF) is conceptually designed around the Passive Safe Shutdown Concept and the title design is following this approach. This approach will also be included in the Safety Analysis Report.

I am requesting your review for advance approval of this concept as a change in this technical direction at a later date would have significant system hardware and cost impacts.

Please have your comments returned to me by October 2, 1991. If you have any questions, please call me at FTS 583-1510.

Mark R. Arenaz, Acting Project Manager
Reactor and Research/Energy
Projects Branch
Engineering and Construction
Management Division

Attachment

cc: J. J. May, DOE-ID

SAFE SHUTDOWN CONCEPT FOR THE WASTE CHARACTERIZATION FACILITY

ABSTRACT

The purpose of this report is to establish a safe shutdown concept for the Waste Characterization Facility (WCF) to be constructed at the Radioactive Waste Management Complex (RWMC) on the Idaho National Engineering Laboratory. Key elements of DOE Order 6430.1A, the WCF Conceptual Design Report, and the Preliminary Hazards Assessment have been reviewed to determine the appropriate safe shutdown concept to be implemented in the WCF design. It is concluded that operation of active systems during and after Design Basis Accidents is not required to assure the safety of the public and the environment. A "passive" safe shutdown concept is recommended for the WCF.

1.0 INTRODUCTION

The Waste Characterization Facility (WCF) is to be constructed at the Radioactive Waste Management Complex (RWMC) on the Idaho National Engineering Laboratory. The WCF will receive contact handled mixed TRU waste containers that have been retrieved from storage and examined by means of Real Time Radiography at the Stored Waste Examination Pilot Plant (SWEPP). The waste containers are comprised of drums and boxes of various sizes and configurations. The WCF will contain enclosed mechanical machinery that will handle and open the containers; pick, examine, and analyze the contents; and package characterized waste in new drums and waste boxes. The purpose of this paper is to review the DOE 6430.1A requirements for safe shutdown of special facilities, as well as the WCF Conceptual Design Report and the Preliminary Hazards Assessment, in order to recommend an appropriate safe shutdown design concept for the WCF.

Alternative Philosophies

Two facility safe shutdown models have been considered as alternative philosophies. These are referred to as "active" safe shutdown and "passive" safe shutdown concepts.

Active Safe Shutdown. The active safe shutdown concept has the following features:

- Certain systems and components are maintained in an active operating state during and after a Design Basis Accident (DBA) in order to control the potential for environmental and public exposure. Typically, the HEPA filtered HVAC system will remain active to maintain a negative pressure within the facility.
- The safety analysis for the facility assumes that these active systems will remain functional. Therefore, the active systems as well as the supporting systems required to provide electrical power must be designated and treated as Safety Class systems.

Passive Safe Shutdown. The passive safe shutdown concept has the following features:

- The passive safe shutdown philosophy accepts that a sequence of failures could result in a quiescent final state where the facility interior pressure and temperature is near equilibrium with the atmospheric surroundings and the secondary confinement structure contains the hazardous material. Designs for passive shutdown accept that specific single point failures may occur (e.g. standby generator fails to start) provided a safety analysis demonstrates that these failures will not result in unacceptable public exposure.
- The safety analysis for the facility does not assume that systems will remain active after a DBA. Therefore, systems such as HVAC and supporting systems such as standby power are not required to be Safety Class.

- Emergency and standby systems are installed without safety class criteria. It is assumed that they may fail. The passive confinement structure of the facility protects the environment and the public. The confinement structure and those portions of the facility systems that penetrate the structure must be designed to seal and remain sealed in the event of a shutdown.

2.0 DOE 6430.1A REQUIREMENTS

The WCF is classified as a special facility under the guidance of DOE 6430.1A Division 13. It is subject to the general requirements of Section 1300 as well as those given in Section 1324 "Radioactive Solid Waste Facilities". In addition, the design team has incorporated selected confinement and HVAC criteria from Section 1304 based on good engineering practice.

Design Requirements

The requirements of the order clearly indicate that the design team must plan and implement by means of systems design the safe shutdown of the facility. This requirement is identified in the text in the following areas:

Section 1300-1.3. The design of special facilities shall protect the public and facility personnel from hazards associated with the use of radioactive and other hazardous materials as a result of normal operations, anticipated operational occurrences, and DBA conditions, including the effects of natural phenomena pertinent to the site, and maintain these effects ALARA.

Section 1300-3.2. Safety class items are systems, components, and structures, including portions of process systems, whose failure could adversely affect the environment or the safety and health of the public. Specifically, safety class items are those systems, components, and structures with the following characteristics:
.....Those required to achieve and maintain the facility in a safe shutdown condition.

Abbreviations and Glossary: Design Basis Accidents (DBAs) are defined as postulated accidents, or natural forces, and resulting conditions for which the confinement structure, systems, components and equipment must meet their functional goals. These safety class items are those necessary to assure the capability: to safely shut down operations, maintain the plant in a safe shutdown condition, and maintain integrity of the final confinement barrier of radioactive or other hazardous materials; to prevent or mitigate the consequences of accidents; or to monitor releases that could result in potential offsite exposures.

Potential Consequences

The order also indicates that the determination of the meaning of safe shutdown and the implementing design is dependant upon the hazards and potential consequences associated with the facility.

Section 1300-3.1. Special facility components, systems, and structures shall be designed, fabricated, erected, and tested to standards and quality commensurate with the hazards and potential consequences associated with both the facility and the role of each component, system, and structure in mitigating the consequences of DBAs.

Section 1300-1.3. Considerations shall be given to the frequency of occurrence and the effects of DBAs in the design of special facilities. The depth of risk analysis involved in this consideration should be in some measure proportional to the level of risk associated with the facility under consideration.

Design Considerations

The order contains the following requirement for design considerations to be addressed in the safe shutdown design:

Section 1300-1.4.2. Releases of hazardous materials postulated to occur as a result of DBAs shall be limited by designing facilities such that at least one confinement system remains fully functional following any credible DBA (i.e. unfiltered/unmitigated releases of hazardous levels of such materials shall not be allowed following such releases). Facility design shall provide attenuation features for postulated accidents (up to and including DBAs) that preclude offsite releases that would cause doses in excess of DOE 5400 series limits for public exposure.

Conclusions

The conclusions that we draw from our review of the DOE 6430.1A requirements are:

Exposure: The WCF systems and structural designs must ensure that the facility can be safely shutdown as a result of all credible accidents up to and including DBAs. The safe shutdown condition must not result in an unacceptable exposure to the offsite public as defined by DOE 5400 series orders.

Barriers: At least one confinement barrier must remain fully functional following any credible DBAs.

Shutdown Mode: The mode (active or passive) of the safe shutdown is not directed by the orders. The selection of the safe shutdown design features must reflect the hazard source terms, hazard release and dispersion analysis, accident sequences and consequences, frequency and probability of occurrences, and mitigation analysis and be supported by preliminary risk assessments including hazards analysis, release dispersion modeling, and Reliability, Availability, and Maintainability analysis executed as part of the systems design development. The final design must be verified by a final risk analysis and documented in a Final Safety Assessment Report.

Design Methods: The selection of systems design methods and associated components required to achieve a safe shutdown condition is not regulated by the orders. The design team is free to choose the approach best suited to the hazards associated with the facility.

3.0 SAFE SHUTDOWN DESIGN SELECTION

The two facility safe shutdown models described above have been considered as alternative philosophies. It is our interpretation that active designs can be used for any facility but are best suited to address certain process conditions, while passive designs can only be used under limited process conditions.

Active Shutdown Conditions

While active designs can be used for any facility, the conditions that require selection of an active shutdown are:

- The form of the radioactive material or matrix contained within the facility can be easily dispersed by unattended process equipment, airflow, static charge, or vibration.
- Nuclear criticality or other runaway processes may occur that could distribute radioactive material.
- The facility contains processes and process equipment that remains active or has a long shutdown transient after loss of power. Examples would be furnaces, pyrochemical inert gas systems, and incinerators.

Passive Shutdown Conditions

Passive designs may be considered whenever none of the conditions requiring active systems are present. Prerequisites for selection of a passive safe shutdown are:

- The radiological and hazardous source terms contained in the facility could not be released to the environment in doses which exceed the 5400 series requirements or concentrations of chemical constituents which exceed the applicable TLVs.
- The form of the radioactive material or matrix is not easily dispersed by airflow, static charge, or vibration.
- The facility does not contain processes that might runaway as a result of a DBA or might require thermal control and support after a DBA.
- The fuel for the DBF should be highly limited in heat and smoke production capability as well as having a small radioactive material content. The DBF should be easily extinguished before it can disperse significant quantities of radioactive material.

4.0 WCF CONCEPTUAL DESIGN FEATURES

The passive safe shutdown approach has been selected for the WCF. The prerequisites for a passive safe shutdown design as discussed in the previous section are evident in the scope, mission, function and design of the WCF:

Dispersion of Materials

The radioactive and hazardous material in the WCF that could be available for dispersion in the event of a DBA could not result in unacceptable public or environmental exposure as directed by the DOE 5400 series orders. Four drums and one box containing solid waste could be open at a single time. These would be isolated in separate gloveboxes and cell sections so that there would not be an opportunity for an accident scenario to involve more than one container. The worst case radioactive material inventory (dispersed in the solid waste matrix) available for release as a result of a DBA is estimated to be 350 gm of Pu^{238} .

Form of Materials

The radioactive material is generally found in a solid waste matrix. It is bound tightly in the pores of gloves, glovebox metal surfaces, paper, cloth and absorbent materials. The radioactive material is in forms that would not become readily airborne (i.e. release factors of 10^{-2} to 10^{-4}).

Lack of Active Processes

All processes in the WCF utilize mechanical handling or machining equipment that will stop in place in the event that power is lost. No processes will remain active after loss of power.

Design Basis Fire

Fires that might release radioactive material as a challenge to the radioactive material confinement systems will be limited to the contents of a single container. Because containers will be isolated from one another, multiple container fires will not occur. The highly localized nature of a container will make it possible to assure that the fire can be extinguished quickly. The Preliminary Hazards Assessment (PHA) indicates that the release would be acceptable even if the fire burned to completion.

Design Analysis

These conclusions are supported by the PHA and by Engineering Design Files included in the Conceptual Design Report appendices. These calculations review the characteristics of the waste inventory that represent the input for the WCF and establish worst case containers for the purposes of safety assessment.

Design Features

The WCF Conceptual Design Report has the following features that implement the passive shutdown philosophy;

Confinement Barrier: The secondary confinement structure will be a reinforced concrete (walls, floor, and roof) building that contains the primary confinement cells. This building will be designed to remain functional during and after DBAs. Emergency doors will have automatic closure devices and seals. The fire ratings of the doors will be sufficient to assure that fires within the operating gallery will be extinguished by the fire suppression system before the doors are breached. The primary confinement cells and exhaust ducts will be designed to remain intact during a DBE. Process equipment will be designed so that it won't rupture the primary confinement during a DBE. The primary confinement may be breached during a DBF due to loss of gloves in gloveboxes.

Penetrations: Penetrations in the secondary confinement structure for pipes, conduits, and HVAC supply and exhaust will be safety class. The penetration hardware, shut-off check valves, seals, filters and supports required to assure that the penetrations will not become breaches in the confinement will be safety class items. The penetration designs will be seismically analyzed.

HVAC System: Exhaust HEPA filter trains and their mounting structures, connection of the filter trains to the stacks, and the stacks will be seismically qualified to demonstrate that they will retain confinement integrity during and after DBAs. Supply air intake ports will be shut by fail safe dampers upon loss of HVAC. Parallel HEPA filtered supply ports will allow the building to equilibrate without a breach in confinement.

Standby Power: A standby power generator and switchgear will be installed. It will have sufficient capacity to operate the HVAC and stack monitoring systems. The generator start will be accomplished using a local battery power supply. However, redundant generators; redundant generator fuel systems; a separate standby power distribution system; seismic qualification of the generator, switchgear, transmission line, and fuel system; and a safety class uninterruptible power system to supply the generator starter and controller will not be included in the WCF. Therefore, the standby power system will not be safety class and the WCF shutdown may occur without standby power for large loads such as the HVAC fans should one of the components fail as a result of a DBA.

Recovery Procedures

Should a DBA occur, the intended procedure is to evacuate the facility, assess the status of the facility while in a standby mode, and initiate recovery. Provision for standby power to keep the HVAC system functional is included in the design. However, the design allows this system to fail because the failure will not result in unacceptable exposure to the public. Should the standby power fail, operations staff should attempt to start the system and restore HVAC as the first step toward recovery.

5.0 PRECEDENCE AND SUPPORTING ANALYSIS

The use of a similar passive safe shutdown philosophy has current operational precedence within the DOE complex. The Los Alamos National Laboratory (LANL) Plutonium Processing Facility at TA-55 is presently operating with a system that includes an emergency power system which is not a safety class system. It is possible that the emergency power system could fail in the event of a DBE. LANL has performed appropriate risk assessments that indicate that should this failure occur, the facility will safely shutdown to a passive state without an operating HVAC system. The release to the public under the passive condition has been demonstrated by analysis to be acceptable.

Supporting Studies

In the process of developing the risk assessment, LANL performed two important experimental studies. First, they studied the effectiveness of HEPA filters at very low flow. It was expected that the efficiency of the filters should be downgraded in the release model because HEPA filters utilize an impact mechanism. The measurements indicated that the efficiency is greater than 90% at near zero flow. A Ph.D. thesis is currently underway to theoretically understand the low flow filtration mechanism. Second, a study was performed on the cracking of concrete wall sections under simulated earthquakes. Permeation through the cracked wall sections was measured and found to be negligible. These two experiments then provided the data that was used to determine the effectiveness of the secondary confinement barrier when challenged by credible source terms. The PHA and a preliminary release meteorology model have indicated that the projected public and site worker exposures resulting from a DBA and a subsequent passive shutdown of the WCF are well below the DOE 5400.5 requirements.

APPENDIX E WHPP VENTILATION DBA OPERATIONAL PHILOSOPHY/WHPP DRAFT PSAR

TO: BOB DASH / JIM STROUP, WHC

FROM: JIM MOORE, ORNL

FAX: 615-574-7986

PHONE: 615-574-6389

NOTE: ATTACHED ARE

- 1) MINUTES OF A MEETING IN WHICH WHPP'S VENTILATION DBA OPERATIONAL PHILOSOPHY WAS ESTABLISHED § 6430.1A INTERPRETATION.
- 2) A FEW PAGES OF WHPP'S DRAFT PSAR RE: "TURTLE CONCEPT"

IF YOU NEED ANY ADDITIONAL INFO PLEASE LET ME KNOW. (SOURCE TERM INFO IS NOT HELPFUL BECAUSE OF LACK OF DETAIL.)

Regards,

Jim Moore

4/8/93

January 19, 1989

Distribution

Minutes of Meeting on WHPP HVAC System Requirements for WHPP

On December 19, 1988 a meeting was held to discuss 1) the extent to which the cell HVAC system that would be designated and designed as a safety class item and 2) the materials of construction requirements for the cell ventilation ductwork.

Attending the meeting were:

D. J. Dypolt
J. P. England
D. L. Lennon
J. W. Moore
J. M. Morrison
J. A. Setaro
D. W. Turner

The summary of the meeting discussion follows:

- 1) DOE General Design Criteria, 6430.1A, requires that confinement be maintained to restrict any off-site radiation exposures to the established limits, in 10CFR100 and CRL15910. WHPP's interpretation of 6430.1A perceives no requirements for maintaining an active ventilation system (meaning the survival and ongoing operation of the ductwork and fan system which produces a negative pressure in the cells) during or after any of the design basis accidents.

Confinement can be established, and will be established for WHPP, by making the cells essentially "leak proof" to radioactive particulate by sealing all penetrations and HEPA filtering all ventilation openings. To this end all sealing components that make up the cell confinement will become safety class items (SCIs), and the ventilation systems from inside the cell and up to and including the first HEPA filter outside the cell will become SCIs. The ductwork after the first HEPA filter, outside the cell, and the fans will not be SCIs.

- 2) The materials of construction for the primary, secondary and off-gas systems were discussed. The Environmental Control (EC) Department feels that stainless steel should be used in order to satisfy that the DOE design life requirements. External corrosion resistance as well as internal corrosion resistance to at this time unknown chemicals which may present in the cell atmosphere or vessel off-gas are the primary reasons for EC's concerns. This topic will be readdressed as required before the CDR is issued.

WHC-SD-W026-TA-001 REV 0
WHPP HVAC System Requirements
January 19, 1989
Page 2

Please send comments to J. W. Moore.

J. W. Moore
J. W. Moore, 1000, MS 6338, ORNL (4-6389) - NoRC

Filename: HVAC_12.198

Distribution: See Transmittal WHPP-0068

PRELIMINARY SAFETY ANALYSIS REPORT

(PHASE I)

Waste Handling and Packaging Plant

M. A. Green

November 5, 1990

System Safety Engineering

MARTIN MARIETTA ENERGY SYSTEMS, INC.
Oak Ridge, Tennessee

Prepared for the U.S. Department of Energy
Under U.S. Government Contract DE-AC-05-84OR21400

2. SUMMARY

This chapter provides a comprehensive overview of the WHPP preliminary safety analysis performed at the conceptual design level. The potential WHPP hazards were systematically identified and the potential accident consequences were reviewed. Using the review results, the project design group has prepared a conceptual design that will eliminate, control, or mitigate the hazards or their consequences so that the plant operation can be conducted within an acceptable risk envelope.

2.1 SUMMARY OF THE SAFETY ANALYSIS REPORT

The WHPP will be located southwest of the Melton Valley Storage Tanks (MVST) facility in the Melton Valley area of ORNL. This area is presently an isolated area with very low workforce population. The WHPP design will include significant features to preclude a release of waste materials to the surrounding area under any credible circumstances.

The principal safety-related design criteria for the WHPP are primarily dictated by DOE Order 6430.1A. The WHPP will comply with all the applicable criteria in this order as well as applicable referenced codes and standards. Additional, more restrictive safety-related design criteria are imposed by the PSAR where deemed necessary.

An extensive effort has been made in the basic facility design to process all waste within a shielding/confinement system that has no direct pathways to the environment. The shielding/confinement system is designed so that no active utility or support systems will be required to maintain the shielding/confinement integrity; i.e., loss of any or all utilities or active support systems will result in the WHPP being in a safe shutdown condition.

The process operations of the WHPP will be simple and straight forward waste packaging operations with few intrinsic hazards that will challenge the integrity of the facility shielding/confinement system. Where these hazards can occur, specific protective measures have been taken in the design to prevent them. An oxygen-deprived environment has been used in the waste processing area to prevent the occurrence of fires in the radioactive waste being processed. Shutdown systems have been specified for the high energy linear accelerator and microwave sludge solidification systems to prevent accidental radiation exposure from these systems. Safety class structure and control interlocks will be specified for material handling systems that have the potential to breach the shielding/confinement systems.

The most important hazard control measures will be the shielding/confinement system and the process protective measures previously mentioned.

Types and quantities of non-product wastes generated by the WHPP will be small and similar to that for a small-scale non-nuclear facility. The plant is designed to process its own solid, liquid, and gaseous radioactive wastes for inclusion with waste being shipped for disposal at WHPP. A waste side-stream of slightly contaminated water will be collected and either reused or

on Limiting Exposure of the Public", at the site boundary or nearest point of public access (the guidelines in Section 1300-1.4 are the dose limits in DOE 5480 Order series)

Those that are relied upon to provide a confinement function under all credible conditions (at least one confinement system is required to remain fully functional following any credible Design Basis Accident)

Those required to maintain operating parameters within the safety limits specified in the Operating Safety Requirements (OSRs) during normal operations and anticipated operational occurrences

Those required for nuclear criticality safety

Those required to monitor the release of radioactive materials to environment during and after a DBA

Those required to achieve and maintain the facility in a safe shutdown condition

Those with capabilities credited in the safety analysis

Those that control the SCIs described above

SCIs are subject to appropriately higher-quality design, fabrication, industrial test standards, and codes such as those specified in DOE Order 6430.1A, Section 0106, "Regulatory Requirements" and Section 0109, "Reference Standards and Guides," to increase the reliability of the item and allow credit to be taken for its capabilities in the safety analysis. Additional design criteria for SCIs is contained in the following sections of DOE Order 6430.1A: Section 1300-3.3, "Single Failure Criteria and Redundancy," Section 1300-3.4, "Equipment Environmental Considerations," Section 1300-3.5, "Maintenance," and Section 1300-3.6, "Testing."

4.3 DESIGN BASIS ACCIDENTS

The following DBAs are considered in the design of the WHPP facility:

1. Design Basis Earthquake (DBE) - An earthquake with a return period of 5000 years for high hazard level category facilities, and 1000 years for moderate and low hazard level category facilities. For the Oak Ridge Reservation region this corresponds to a maximum peak horizontal ground acceleration of 0.32 g and 0.19 g respectively.
2. Design Basis Wind/Tornado (DBW or DBT) - A wind with a return period of 500 years for low hazard level category facilities which for Oak Ridge Reservation Area is a 70 mph fastest mile wind speed. A tornado with a return period of 50,000 years for moderate and high hazard level category facilities, which for the Oak Ridge Reservation area is a fastest-mile wind speed at a 10 m height of 113 mph (tornado wind speed of 130 mph). For moderate

In addition to the normal equipment and process loads, structures must be designed to withstand the loads associated with abnormal conditions such as a jet impingement, abnormal compartment pressures, liquid releases from pipe ruptures, etc. At the present stage of the WHPP facility design these loads have not been identified and quantified.

4.4.7 Combined Load Criteria

Combined load criteria for Safety Class structures is in accordance with DOE Order 6430.1A. DOE Order 6430.1A requires that the load combinations in UCRL-15910 be used.

4.4.8 Subsurface Hydrostatic Loadings

A groundwater elevation of 0 feet (completely saturated soil, water table at the ground surface) will be used to determine subsurface hydrostatic loads on below grade structures.

4.5 SAFETY PROTECTION SYSTEMS

This section presents criteria for the design, fabrication, construction, testing, and performance of safety protection systems for the WHPP facility. Safety protection systems and criteria are given in DOE Order 6430.1A, Division 13, "Special Facilities," and Section 1324, "Radioactive Solid Waste Facilities." Design, fabrication, and testing of safety protection systems will be in accordance with DOE Order 6430.1A and all its applicable referenced codes and standards. Performance criteria for the safety protection systems are presented in the following sections.

4.5.1 Confinement Barriers

Two levels of confinement structures (physical barriers) will be provided for the solid TRU wastes, sludges, and supernate in the WHPP facility. Confinement structures are SCIs and at least one level of confinement will be designed to maintain its integrity following applicable DBAs for the WHPP facility commensurate with its assigned hazard level to the extent that the dose limits to the public in the DOE 5400 series are not exceeded, or be protected by an appropriate SC system (i.e. fire protection system) designed to remain operational and functional during and after DBAs. Additional criteria for confinement systems are contained in DOE Order 6430.1A, Sections 1300-7, "Confinement Systems," and 1324-6, "Confinement Systems," and the ORNL Health Physics Manual.

4.5.2 Ventilation Systems

The concept proposed for the WHPP facility is to design the primary confinement structures to be essentially "leak tight" so that an active system such as a ventilation confinement system will not be absolutely required to maintain confinement of solid TRU wastes under DBA conditions. With this concept the ventilation system components such as the blowers, dampers, etc. that are required to maintain a negative differential pressure with respect to the surrounding environment in the primary containment cells will not be SCIs

in the sense that they must continue to perform their function following DBAs. However, the use of appropriate higher quality design, fabrication, and industrial test standards and codes, redundancy criteria, single failure criteria, environmental qualification, testing, maintenance, and quality as required for SCIs will be applied to the ventilation confinement systems. The ventilation system ducting and first HEPA filter on inlet and exhaust penetrations into the primary confinement cells will be considered to be part of the primary confinement structure, will be designated SCIs and will be designed to withstand the DBAs applicable to the primary confinement cells without loss of integrity.

Ventilation confinement of the primary and secondary confinement cells will be used to provide appropriate contamination control during normal operation and anticipated operational occurrences of the WHPP facility. The ventilation systems will be designed to provide a continuous airflow pattern from the environment into the building and then into noncontaminated areas of the building to potentially contaminated areas and then to normally contaminated areas. Thus, the airflow is toward areas of higher radioactive contamination. In addition the design of the ventilation systems will ensure the ability to maintain desired airflow characteristics when personnel access doors or hatches are open. When necessary, air locks or enclosed vestibules will be used to minimize the impact of this on the ventilation system and to prevent the spread of contamination within the facility. The ventilation system design will provide the required confinement capability under all credible circumstances with the addition of a single failure in the system. Additional requirements for the ventilation confinement systems are contained in DOE Order 6430.1A, Sections 1550-99.0.1, "General Ventilation and Off-Gas Criteria," 1550-99.0.2, "Confinement Ventilation Systems," and 1550-99.0.3, "Off-Gas Systems," and the ORNL Health Physics Manual.

4.5.3 Protection Systems and Instrumentation and Controls

Protection systems and electrical instrumentation and controls are designated SCIs if they are required to satisfy the SCI criteria in section 4.2. These components and systems are subject to the basic approach outlined in IEEE 308 standards and to higher quality assurance requirements as needed. Requirements for SCI protection systems and electrical instrumentation and controls are contained in DOE Order 6430.1A, Section 1660-99, "Special Facilities."

The SCI protection systems will automatically activate SCI systems and components that are required to ensure the safety of operating personnel and the public. They will provide audible and visual indication of system status. Automatically initiated protective actions will be provided with a manual backup.

The design of the protective systems will provide suitable redundancy and diversity to ensure that safety functions can be completed, when required, and that no single failure will result in the loss of the protective functions. The protection system will be designed to fail in a safe state following a component or channel failure or loss of power (e.g., control air or electric power).

point of public access (the guidelines in Section 1300.1.4 are the dose limits in DOE 5480 Order series)

Those that are relied upon to provide a confinement function under all credible conditions (at least one confinement system is required to remain fully functional following any credible DBA)

Those required to maintain operating parameters within the safety limits specified in the OSRs during normal operations and anticipated operational occurrences

Those required for nuclear criticality safety

Those required to monitor the release of radioactive materials to environment during and after a DBA

Those required to achieve and maintain the facility in a safe shutdown condition

Those with capabilities credited in the safety analysis

Those that control the SCIs described above

In addition systems used to protect personnel from the effects of operational accidents and unusual occurrences by preventing or mitigating consequences that could give personnel an excessive radiation dose will be designated SCIs

7.3 SAFETY CLASS ITEM DESCRIPTION.

This section provides a detailed description of the WHPP SCIs, the safety functions they perform, and the hazard level for natural phenomena resistance they will be designed to withstand. The overall hazard level for the WHPP facility has been designated as high. However since the amount, form, and processes performed on the radioactive waste materials vary throughout the WHPP, the facility will be segmented into various hazard levels to determine the level of the DBA and DBW or DBT various areas and the SCIs must withstand. The basic criteria for the different hazard levels for the WHPP are:

High Hazard Level Areas

- Areas where large quantities of unconfined TRU waste materials will be present
- Areas where a fire of such intensity that it can threaten the integrity of a sealed waste container containing significant quantities of TRU waste can occur
- Areas that are a reverse threat to the SCIs in the above areas

Moderate Hazard Level Areas

DATE

FILMED

1 / 27 / 94

END