LOUISIANA ENERGY

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December 10, 1992

Mr. John W. N. Hickey, Chief
Fuel Cycle Safety Branch
Division of Industrial and
Medical Nuclear Safety
Office of Nuclear Material Safety
and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Docket No.: 70-3070
Louisiana Energy Services
Claiborne Enrichment Center
Requests For Additional Information
File: MTS-6046-00-2001.01

Dear Mr. Hickey:

Enclosed in Attachment A is additional information related to the issues in your letter to Louisiana Energy Services (LES) dated October 29, 1992. These issues were discussed in detail at a meeting on October 20, 1992. Also enclosed are "Information Only" copies of the pages of the Safety Analysis Report (SAR) that will be revised as a result of providing this information. A formal update to the SAR will be made in the near future.

If there are any questions concerning this, please do not hesitate to call me at (704) 373-8466.

Sincerely,

Peter G. LeRoy

Peter G. LeRoy
Licensing Manager

PGL/N75.122

Enclosures

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NF04 1/1

xc: (w/ enclosures)

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October 29, 1992
Request for Additional Information

4.3 Facilities Design Criteria

In the November 7, 1991, NRC request for additional information (RAI) to Louisiana Energy Services (LES), there were five questions in this area. You have not yet submitted complete responses. Consistent with the Advance Notice of Proposed Rulemaking (ANPR), Federal Register Notice Volume 53, No. 78, pages 13276-13282, the NRC staff will evaluate the following:

1) Function of all equipment under normal operating conditions.
2) Function of Class I systems at design basis conditions.
3) Interaction of Classes I and II systems.

The mechanical or structural analysis on which such an evaluation would be based has not been provided by you. In the absence of this information, sections 4.8 and 4.9 of the DSER cannot be prepared.

Response:

[NOTE: For ease of review, the five questions from the November 7, 1991 letter are repeated below in *italics* and detailed responses in **bold** are provided below each question.]

1. Provide analyses (seismic, structural, etc.) demonstrating that the CEC System Class I components listed in SAR Table 4.6-1 maintain their safety function under design basis conditions.

Response:

The System Class I components listed in SAR Table 4.6-1 (i.e., Feed, Blending, and Sampling Autoclave air temperature protection loops, air pressure protection loops, associated panels, and panel supports) "System Class I autoclave instrumentation" maintain their safety function under design basis conditions. Totally separate instrumentation is used to regulate the air temperature and pressure inside the autoclaves to allow for the uranium hexafluoride inside the cylinder, which is inside of the autoclave, to liquefy. Under expected, abnormal conditions these instruments interrupt power to the autoclave electric heaters. The functions, during normal and abnormal operations, of the System Class I autoclave instrumentation is to provide a second line of defense against autoclave high air pressure or high temperature and explained in detail in SAR sections 6.3.1 (Feed Autoclave instrumentation), 6.3.5 (Product Liquid Sampling

Autoclave instrumentation), 6.3.6 (Blending Autoclave instrumentation) and 6.4.10 (Control Systems).

An incident in which the autoclave control system fails (i.e, "runs away") and the autoclave heaters fail to trip off would result in the only credible, though highly unlikely accident, whereby the off-site exposure limits to uranium and hydrogen fluoride (reference NUREG-1391) could possibly be exceeded. This scenario is explained in detail in SAR section 9.2.2.2. Since this was the only credible incident whereby the off-site exposure limits could be exceeded, the instruments listed in SAR Table 4.6-1 were classified as System Class I, thus assuring their operability during incidents that could result in release of uranium hexafluoride. The evaluation of possible incidents and their effect on facility equipment is discussed more thoroughly below in response to questions concerning classification of structures, systems and components.

Beyond the incidents that might impact these instruments, the instruments will also withstand the design basis natural phenomena listed in the Advance Notice of Proposed Rulemaking (ANPR). These natural phenomena are earthquakes, high winds (i.e., tornadoes), and floods. The facility can also withstand expected impact of accidents at nearby industrial, military, or transportation facilities.

The Separations Building, where the System Class I instruments are located, is designed to withstand the design basis natural phenomena (i.e., earthquake, tornado, flood). An evaluation was also performed on the possible interaction during the Design Basis Earthquake from surrounding structures. None of the site buildings (i.e., the Centrifuge Assembly Building, the Cylinder Receipt & Dispatch Building, Standby Diesel Generator Building, Office Building & Guardhouse, Pump House, Fire Water Storage Tanks, Switch Yard) at the facility impact the Separations Building during an earthquake. The gaseous effluent stacks are located on the north wall of Plant Unit 1 of the Separations Building. Since the stacks could impact the Separations Building and the System Class I autoclave instrumentation, the stacks have been designed to withstand the design basis natural phenomena.

LES has submitted detailed information on the design of the Separations Building demonstrating it will remain intact during and after the design basis natural phenomena (reference LES letters to the NRC dated June 26, 1991, and March 31, 1992). The Separations Building is a System Class II structure and is designed and built in accordance with the Quality Assurance (QA) Level 2 program requirements detailed in SAR section 10.19. The gaseous effluent stacks are also System Class II structures

designed and built in accordance with the QA Level 2 program.

The analyses provided in SAR section 2.1.2 demonstrate there are no nearby, industrial, transportation nor military activities that could effect the autoclave instrumentation.

The System Class I autoclave instrumentation is also designed to ensure no interaction between System Class II structures, systems or components (SSC) can initiate a failure of the System Class I instrumentation. This includes analyses that demonstrate that failures of System Class II SSC, whether process related or related by physical configuration, can not result in failure of the System Class I autoclave instrumentation. To fully analyze the physical configuration interaction between the System Class I and II SSC, the final placement of all equipment in the area of the autoclaves must be performed. This is not done until construction is nearly complete, to allow for field routing of support systems (e.g., piping, cables, lighting). Once all equipment is in place a final analysis occurs demonstrating that no adverse interaction is possible.

In summary, the System Class I instruments listed in SAR Table 4.6-1 are able to function during all postulated normal, expected abnormal, and accident conditions. Prior to commencement of enrichment at the facility, the detailed interaction analyses explained in the above paragraph will be completed and available for NRC review.

2. *Provide analyses demonstrating that failure of Class II components (e.g., separations building, stacks, autoclaves, piping, instrument air and electrical supplies, equipment supports, etc.) does not reduce the functioning of Class I components.*

<u>Response:</u>

LES has submitted detailed information on the design of the Separations Building demonstrating it will remain intact during and after the design basis natural phenomena (reference LES letters to the NRC dated June 26, 1991, and March 31, 1992). The Separations Building is a System Class II structure and is designed and built in accordance with the Quality Assurance (QA) Level 2 program requirements detailed in SAR section 10.19. The gaseous effluent stacks are also System Class II structures designed and built in accordance with the QA Level 2 program.

The analyses provided in SAR section 2.1.2 demonstrate there are no nearby, industrial, transportation nor military activities that could effect the autoclave instrumentation.

The System Class I autoclave instrumentation is also designed to ensure no interaction between System Class II structures, systems or components (SSC) can initiate a failure of the System Class I instrumentation. This includes analyses that demonstrate that failures of System Class II SSC, whether process related or related by physical configuration, can not result in failure of the autoclave instrumentation. The System Class I instrumentation is designed in accordance with the criteria detailed in SAR section 6.4.10 (e.g., protection from fires, protection from earthquakes, adequate electrical separation, appropriate setpoints).

To fully analyze the physical configuration interaction between the System Class I and II SSC, the final placement of all equipment in the area of the autoclaves must be performed. This is not done until construction is nearly complete, to allow for field routing of support systems (e.g., piping, cables, lighting). Once all equipment is in place a final analysis is performed demonstrating that no adverse interaction is possible.

3. *Provide analyses (seismic, structural, etc.) demonstrating that Class II components (e.g., separations building, stacks, autoclaves, piping, equipment supports, instrument air and electrical supplies, etc.) whose failure could interfere with the function of Class I systems do not fail under design basis conditions.*

Response:

LES has submitted detailed information on the design of the Separations Building demonstrating it will remain intact during and after the Design Basis Earthquake (reference LES letters to the NRC dated June 26, 1991, and March 31, 1992). The Separations Building is a System Class II structure and is designed and built in accordance with the Quality Assurance (QA) Level 2 program requirements detailed in SAR section 10.19. The gaseous effluent stacks are also System Class II structures designed and built in accordance with the QA Level 2 program.

The analyses provided in SAR section 2.1.2 demonstrate there are no nearby, industrial, transportation nor military activities that could effect the autoclave instrumentation.

The System Class I autoclave instrumentation is also designed to ensure no interaction between System Class II structures, systems or components (SSC) can initiate a failure of the System Class I instrumentation. This includes analyses that demonstrate that failures of System Class II SSC, whether process related or related by physical configuration, can not result in failure of the autoclave instrumentation. The System Class I instrumentation is designed in accordance with the criteria detailed in SAR section 6.4.10 (e.g., protection from fires, protection from earthquakes, adequate electrical separation, appropriate setpoints).

To fully analyze the physical configuration interaction between the System Class I and II SSC, the final placement of all equipment in the area of the autoclaves must be performed. This is not done until construction is nearly complete, to allow for field routing of support systems (e.g., piping, cables, lighting). Once all equipment is in place a final analysis is performed demonstrating that no adverse interaction is possible.

4. *Provide a structural analysis demonstrating that cylinders, autoclaves, piping and desublimers and connectors used in these systems maintain confinement at expected operating conditions. Present numerical results with an estimate of margin to failure.*

Response:

The design requirements (e.g., design pressures, design temperatures) for the UF6 systems are provided in Tables 4.3-1 through 4.3-19. All equipment has been sized and selected to meet or exceed the listed design requirements. For example, UF6 process piping is specified in accordance with B31.3 - 1987. Vessels and tanks are specified in accordance with appropriate ASME, AWWA or NFPA codes. Detailed information regarding normal operating conditions is provided in SAR section 6.3.

To ensure conservatism when analyzing the effects of possible abnormal operations and accidents, structures, systems and components (SSC) were assumed to fail unless specific initiating event design criteria were established for the SSC. For example, the Separations Building was designed specifically to resist the forces from natural phenomena (i.e., high winds, earthquakes, floods). Therefore, for accident analysis purposes, an earthquake does initiate failure of the Separations Building. However, for accident analysis purposes, SSC like the autoclaves, UF6 cylinders, desublimers were allowed to fail. The failure of all major UF6 equipment was assumed during the accident analysis for the CEC. This analysis included:

- Failure of centrifuge containment,
- Failure of desublimer pipe,
- Failure of UF6 positive pressure pipe,
- Opening a contaminated autoclave (i.e., failure of autoclave door interlock logic protection),
- Failure of a UF6 cylinder,
- Failure of UF6 negative (subatmospheric) pressure pipe,
- Failure of a chemical trap,
- Fire in Separations Building,
- Autoclave overheating and subsequent failure of UF6 cylinder and autoclave,
- Criticality event, and
- Protection against natural phenomena.

During the analysis no credit was taken for equipment to contain UF6 releases. For example, since the Separations Building was not designed to act as a containment vessel, no credit was taken for containment of a UF6 release by the Separations Building.

5. *Provide a discussion explaining why the components of Class II systems whose function is required to protect Class I systems (e.g., the separations building, stacks, autoclaves, etc.) are not subject to the quality assurance requirements applied to Class I systems.*

Response:

The function of the Separations Building is to provide protection against natural phenomena only - it has no function related to Class I systems and no credit is taken for the building providing any secondary containment function. It is designed to withstand various external events such as the design basis flood, earthquake, and tornado.

The function of the autoclave is to provide secondary containment of UF_6 in the event of a breach of the primary containment. It has no function related to Class I systems. The autoclave and its associated Class I instrumentation is designed to withstand various external events such as the design basis flood, earthquake, and tornado.

The function of the stacks are to channel all gaseous discharges past air monitoring and sampling systems and release those gases at an appropriate height for dispersion. The stacks have no function related to Class I systems. The stacks are designed to withstand various external events such as the design basis earthquake, tornado, and flood.

The components of Class II systems whose passive function (i.e., maintain support) is required to protect Class I systems are subject to the Quality Assurance (QA) Level 2 requirements detailed in SAR section 10.19. The QA Level 2 program requires, among other things, that personnel performing activities are qualified, work activities (e.g., design, construction, maintenance) are performed in accordance with written procedures, and design shall be defined, controlled, and verified. This provides reasonable assurance that these SSC will function as assumed in the accident analysis process described in detail in SAR sections 9.0, 9.1 and 9.2.

4.6 *Classification of Structures, Systems, and Components*

As discussed in our meeting of October 20, 1992, the issue of completeness of the LES analysis for identification of structures, systems, and components important to safety remains open, pending submission of additional information. In this subject area, you need to fully address the three questions of our November 7, 1991, and the two questions of our May 20, 1992, requests for additional information. Your presentation, at our last meeting of October 20th, of a suitable logic diagram for the process is a step in the right direction. But, you must also include in your analysis the details of the dispersion modeling and the steps in the scenario development. We have yet to see the analysis supporting the position that relatively small releases of UF_6 do not lead to exposures in excess of the NUREG-1391 guidelines. The nature of the dispersion modeling that you used in this analysis is not clear. Furthermore, the use of TRIAD for such analysis would need technical support. In addition, you need to document the development of administration procedures for mitigation of selected scenarios identified in the analysis procedure, for example, limiting fuel in transporters. We would require formal commitment to the administrative procedures.

Response:

The details of the accident analysis performed, assumptions used (i.e., steps in the scenario development and inputs into dispersion modeling) for dispersion modeling and results of the modeling are presented in detail in SAR sections 9.1 and 9.2. In order to fully address the concerns raised at the NRC-LES meeting on October 20, 1992 and the RAI in your letters of November 7, 1991, and May 20, 1992, those specific RAI are repeated below and responses are provided. The responses include a complete description of the methodology and steps of the accident analysis, and determination of System Class.

To ensure that fuel in cylinder transporters is limited, the proposed license conditions submitted by LES by letter dated June 30, 1992 included license condition 6.0 A.6. This license condition requires that "only designated vehicles shall be allowed in the UF6 storage yards." This license condition is intended to require that the vehicles are specifically reviewed to ensure the fuel in the vehicles does not pose an undue safety risk. The transporters are designed to use diesel fuel. If necessary, the license condition can be expanded to require this review and/or design feature explicitly.

It should be noted (as stated in SAR section 9.2.2.3.1) that

other factors contribute to preventing or mitigating a potential fire in the UF6 cylinder storage areas. No combustibles are allowed to be stored in cylinder storage areas. Also, exterior fire protection is provided for the cylinder storage areas as described in SAR section 6.4.5.3. The fire protection system includes redundant and diverse (1 electrically powered, 1 diesel powered) 100 percent capacity pumps, and two 100 percent capacity fire water tanks. The system provides adequate water supply from two directions.

November 7, 1991 RAI
4.6 Summary of Structures, Components, and Systems Criteria

1. *The description of the method for identification of structures, systems and components important to safety presented in SAR Section 4.6 indicates that only events involving liquid UF_6 were considered. Provide support for this approach by discussing release scenarios involving sublimation of solid UF_6 from cylinders stored outside the separations building and from cylinders and desublimers inside the building. Drops, punctures, and earthquake should be among the accident initiators considered. Identify the extent of potential containment damage, release rates of UF_6 duration of the event, and dispersion parameters (ground level and elevated) used to project consequences.*

In the initial review of possible scenarios in which UF6 could be released from UF6 cylinders and/or plant systems, events involving both liquid and solid UF6 were considered. A review of the physical characteristics of UF6 and NUREG-1140 "A Regulatory Analysis on Emergency Preparedness for Fuel Cycle and Other Radioactive Material Licensees" indicated the most appropriate source term to be used for accident analysis is a heated 14-ton cylinder of UF6 (see NUREG-1140, section 2.2.3.2). This is the same accident source term used for conversion plants and in this regard, uranium enrichment plants are similar to conversion plants (see NUREG-1140, section 2.2.4).

An accident involving a cylinder of solid UF6 does not release enough UF6 and its hydrolysis reaction products - UO_2F_2 and HF to even approach the accident limits in NUREG 1391. BNFL has performed a calculation of release of UF6 through a 20 square mm hole (calculation enclosed). The release rate of UF6 for a cylinder at 20°C is 0.936 grams per second. The release rate of UF6 for a cylinder at 56°C is 2.3 grams per second. Assuming a release of 30 minutes, this would result in a total release of from 1.7 to 4.1 kg of UF6.

Applying the ratio of 4.1 kg UF6 release to the 9500 kg UF6 release considered in NUREG-1140, section 2.2.3.3, would result in the following maximum exposures:

Uranium -

4.1/9500 = exposure/110 (from NUREG-1140, p. 37)

exposure ≈ 0.05 mg uranium

This is well below the 10 mg uranium "limit" specified in NUREG-1391.

Hydrogen Fluoride (HF) -

4.1/9500 = exposure/160 (from NUREG-1140, p. 37)

exposure ≈ 0.07 mg/m^3 HF

This is well below the 25 mg/m^3 HF "limit" specified in NUREG-1391 for a 30 minute release.

This demonstrates that UF6 releases from cylinders or other equipment containing solid UF6 are of no consequence to persons off-site.

As indicated on page 35 of NUREG-1140, "[T]he most important parameter for determining the release is the temperature of the [UF6] cylinder." As shown above, releases of UF6 are significant only if the UF6 is in the liquid state. To determine the amount of UF6 that must be released in order to exceed the limits determined by the NRC to cause significant effects to persons offsite, the information in NUREG-1140 was used to "back-calculate" the amount. This determination is outlined below:

Before the publication of draft NUREG-1391, the upper "limit" for uranium exposure was 40 mg (reference ANPR, Regulation of Uranium Enrichment Facilities, 53 FR 13276, April 22, 1988). Applying a similar ratio as above:

Uranium -

UF6 release quantity/9500 = 40/110 (from NUREG-1140, p. 37)

UF6 release quantity ≈ 3455 kg UF6

NUREG-1391 was issued in February 1991 and the "limit" for uranium exposure was established at 10 mg uranium. Applying a similar ratio as above:

UF6 release quantity/9500 = 10/110 (from NUREG-1140, p. 37)

UF6 release quantity ≈ 864 kg UF6

Hydrogen Fluoride (HF) -

UF_6 release quantity/9500 = 25/160 (from NUREG-1140, p. 37)

release quantity ≈ 1484 kg UF_6

Therefore, there is the potential to affect persons off-site if a release of approximately 864 kg or more of liquid UF_6 can realistically occur. As discussed in the response to question 2 below, this information was used to determine the classification (i.e., System Class I vs. System Class II) for facility structures, systems and components.

2. *The method used for identification of structures, systems and components important to safety with respect to public health and safety should identify quantities of material at risk which if released at ground level or at stack height would result in exceedance of NUREG-1391 guidance. This step of the analysis procedure does not rely on mechanistic identification of scenarios but is a screening tool which identifies parts of the facility requiring closer examination. If done using the dispersion estimation methods of Regulatory Guide 1.145, this analysis identifies 200 kg and 4200 kg as the quantities of concern for ground level and elevated releases, respectively. The quantities of material of concern should be combined with single failure and common cause initiated scenarios to provide more detailed analysis of those system components which could potentially contribute to exceedance of NUREG-1391 guidance. For example, could a design basis earthquake which damaged Class II equipment, such as autoclave supports, autoclaves, or feed and produce desublimers or an out-of-doors drop of a feed or tails cylinder, cause exceedance of NUREG-1391 guidance?*

Using the 864 kg liquid UF6 amount as determined as discussed above in the response to question 1, an analysis of facility structures, systems and components (SSC) was performed. This analysis is provided in Chapter 9 of the Safety Analysis Report. The analysis reviewed the possible effects of the following:

- **Failure of centrifuge containment,**
- **Failure of desublimer pipe,**
- **Failure of UF6 positive pressure pipe,**
- **Opening a contaminated autoclave (i.e., failure of autoclave door interlock logic protection),**
- **Failure of a UF6 cylinder,**
- **Failure of UF6 negative (subatmospheric) pressure pipe,**
- **Failure of a chemical trap,**
- **Fire in Separations Building,**
- **Autoclave overheating and subsequent failure of UF6 cylinder and autoclave,**
- **Criticality event, and**
- **Protection against natural phenomena. This included review of possible floods, high winds (tornadoes), and earthquakes.**

All of the events analyzed, except for the autoclave overheating event, involve solid UF6. Because the UF6 must be liquid form when released in order to exceed the NUREG-1391 limits, none of the other events (as discussed in the following paragraphs) have the possibility of resulting in releases of UF6 which can exceed the NUREG-1391 limits.

To ensure conservatism when analyzing the effects of possible abnormal operations and accidents, structures, systems and components (SSC) were assumed to fail unless specific initiating event design criteria were established for the SSC. For example, the Separations Building was designed specifically to resist the forces from natural phenomena (i.e., high winds, earthquakes, floods). Therefore, for accident analysis purposes, an earthquake does initiate failure of the Separations Building. However, for accident analysis purposes, SSC like the autoclaves, UF6 cylinders, desublimers were allowed to fail. The failure of all major UF6 equipment was assumed during the accident analysis for the CEC. To complete each analysis, the events, either human errors or equipment failures, that must occur to release UF6 were determined. This sometimes resulted in conclusions, that the described event was highly unlikely and therefore no release of UF6 was probable.

The analyses demonstrated that the only possible release of liquid UF6 in excess of the 864 kg could come from a cylinder of UF6 heated in an autoclave. This is discussed in detail in SAR section 9.2.2.2. The other possible abnormal events are analyzed and discussed in the SAR sections as shown below:

Centrifuge Containment Failure - Described in SAR section 9.1.1

In one plant unit there is only approximately 150 kg UF6. Therefore, since this quantity is below the 864 kg amount, even if all the UF6 was released at once, it would not exceed the NUREG-1391 limits. This scenario conservatively assumes the following:

- The cascade piping fails in such a way as to release the entire inventory of UF6. This is extremely unlikely.
- Instrumentation and equipment that is QA Level 2 that is designed to detect expected process upsets and evacuate the centrifuges (cascades), fails to operate (normal extraction route).
- Instrumentation and equipment that is QA Level 2 that is designed to detect expected process upsets and evacuate the centrifuges (cascades), fails to operate (contingency dump).

Desublimer Pipe Rupture - Described in SAR section 9.1.2

In each plant unit, there are four desublimers (three product desublimers and one feed purification desublimer). In addition there is one product blending desublimer located in the Blending Area of the Separations Building. The basic element of construction in each desublimer is a stainless steel pipe 16.0 inches in internal diameter and 17.5 feet in length. Two copper tubes are coiled around the outside diameter of the desublimer pipe. One copper tube circulates cold Freon R11 and the other circulates hot Freon R11 during desublimation and sublimation operations, respectively. Each of the feed purification desublimers contains four of these pipes. Each of the product and product blending desublimers contains only one of these pipes. In each of the desublimers, the stainless steel pipe(s) is enclosed within a gas-tight stainless steel casing. The casing is thermally insulated with rigid polyurethane foam and a non-rigid fill such as rock wool. The casing is blanketed with dry nitrogen from the Nitrogen System to prevent the intrusion of atmospheric moisture.

The amount of UF6 collected in a desublimer is determined by monitoring the duration of venting operations and the weight of the donor cylinder. Each desublimer pipe has a maximum capacity of approximately 8500 lbs UF6 at the -94 F desublimation temperature. The operational fill limit is approximately 1100 lbs UF6 or 13 percent of the maximum capacity. In normal operation, a desublimer pipe is emptied when its UF6 capacity is approximately one fifth the operational fill limit (approximately 220 lbs). The filling to this operational limit takes approximately two weeks and it is checked each time desublimer operations take place.

The UF6 is not allowed to liquefy or reach a pressure above atmospheric at any time during the sublimation operation.

Therefore, even in the unlikely case of release of UF6 from a desublimer, the most that could be reasonably be expected to be available for release would be approximately 100 kilograms solid UF6. Since this quantity is below the 864 kg amount and in the solid form, even if all the UF6 was released at once, it would not exceed the NUREG-1391 limits.

An additional scenario involving desublimers was analyzed and is detailed in SAR section 9.1.2. This scenario involves the rupture of an overfilled desublimer. The analysis concludes that because multiple faults must occur over a very long period of time (i.e., weeks), by different people, while several Quality Level 2 instruments fail simultaneously, the event is not credible.

UF6 Positive Pressure Piping Failure - Discussed in SAR section 9.1.3

Analysis of UF6 positive pressure piping failure assumes a pigtail break due to metal fatigue or a faulty weld, valve, or flange connection. It also assumes the operators fail to follow procedures required to check the integrity of the piping after connections are made to UF6 cylinders. Although defective piping could fail during normal process operations, this is very unlikely because of the absence of vibration, the relatively low operating pressures, and the use of corrosion resistant materials. In any event, the UF6 is contained within the autoclave. Therefore, no release of UF6 occurs.

Erroneously Opening a Contaminated Autoclave - Described in SAR section 9.1.4

The most likely cause of this event would be operator error during the verification of and response to a release of UF6 inside an autoclave. The autoclave design includes several layers of design features to alert operators to the presence of contamination. Additional design features decrease the probability of operator errors associated with erroneous autoclave door operation. These design features are as follows:

- Redundant System Class I air pressure sensors would detect the increase in air pressure associated with a large leak of UF6 inside an autoclave. A visual and audible alarm inside the Central Control Room would alert operators to the potential for contamination within a specific autoclave and shut down the heaters within the autoclave. A small leak would be detected by the increase in the pressure/temperature ratio within the autoclave.

- The autoclave door is interlocked with an air pressure sensor to prevent the door from opening until the autoclave air pressure is equal to or less than atmospheric pressure. Also, the autoclave vent valve must be opened before the automatic door lock would release.

- The valve to the Gaseous Effluent Vent System physically restricts autoclave door operation until it is moved to the open position. Therefore, it must be

open before the autoclave door could be opened. Plant operating procedures require that the valve to the Gaseous Effluent Vent System remain open longer than the HF detector's response time. The presence of HF would be detected by the HF detector in the Gaseous Effluent Vent System, alerting plant operators to the presence of contamination in the autoclave.

- In the event of a suspected UF6 release within an autoclave, the operating procedures will mandate that following the heater trip no further action is taken until the autoclave contents have cooled and solidified. Consequently, even if the above means of detection are assumed to fail, the release would be very small, because the UF6 would be in solid form.

<u>Cylinder Rupture due to UF6 Reactions - Described in SAR section 9.1.5.</u>

There are two postulated ways for reactive material to enter a UF6 cylinder. One way is for a reactant to be introduced into a cylinder through the UF6 piping. Another way is for a reactive impurity to be present in a supposedly clean, empty cylinder when it is received.

Water reacts too quickly with UF6 to ever enter a cylinder as a process impurity. Free liquid water cannot exist at UF6 process pressures. Any residual moisture would quickly react with UF6, causing a process shutdown. It is conceivable, however, for hydrocarbons to be accidentally introduced into a cylinder containing UF6. In the CEC, hydrocarbons and other reactive substances are not used where leakage into a UF6 system is possible. A chemical reaction would be possible only if hydrocarbon oil was unintentionally substituted for Fomblin oil, an inert substance.

The only credible scenario for in-leakage begins with the substitution of a hydrocarbon oil for the inert Fomblin oil used in process vacuum pumps. Two simultaneous, major operating errors would have to occur for a hydrocarbon to be substituted for Fomblin oil. First, a hydrocarbon lubricating oil would have to be introduced into the storage area for the Fomblin oil used in all process vacuum pumps. This would be a violation of material handling procedures. Second, the maintenance technician would have to mistakenly fill a process vacuum pump with the hydrocarbon oil, despite its different appearance and density. This would be a

violation of maintenance procedures. Pumps that use Fomblin oil are maintained in a separate area of the pump workshop.

Having installed an incorrectly filled pump into the plant, there is still no reason why the oil would travel t- a cylinder. In the case of the low and high pressure UF6 pumps, where the oil is exposed to process gas, these pumps would rapidly fail on overload. In the case of the desublimer vent pumps the oil will not be rapidly degraded as only traces of uranium are expected to reach the pump. For the oil to travel to a cylinder, the pump non-return valve <u>and</u> the pump inlet valve would have to fail to allow the oil initially into the piping local to the pump. The likelihood of this oil reaching a take-off cylinder is equally as remote as that of the low and high pressure UF6 pump oil.

Empty cylinders are received only from suppliers that follow the procedures of ANSI N14.1 - Packaging of Uranium Hexafluoride for Transport for all cylinders. ANSI N14.1 specifies that new cylinders be cleaned, degreased, thoroughly dried, inspected internally, and plugged. Although cylinder suppliers are required to meet these specifications, cylinders must undergo thorough inspection procedures upon arrival at the CEC.

To check for the presence of reactive materials, empty cylinders are weighed for discrepancies with the cylinder supplier's data upon receipt at the CEC. The weighed cylinder is then inspected internally with a boroscope to check for grease or other material. If the cylinder is clean, an inspected superior valve is installed. The cylinder is then vacuum tested to see if any volatile impurity is present. The test is performed with a vacuum pump lubricated with Fomblin oil. The vacuum pump has a suction reservoir and oil traps to prevent the back-flow of pump oil into the cylinder.

At least 90 lbs of UF6 is required to over-pressurize a product cylinder containing sufficient hydrocarbons for a complete reaction; more would be required to over-pressurize a feed or tails cylinder. Because of possible over-pressurization, the initial charge of UF6 at the cylinder fill station is limited to 20 lbs. Over 100 lbs of UF6 is required to over-pressurize a product cylinder containing sufficient water for a complete reaction. After the initial charge, the filling is stopped until the absence of chemical reaction products is verified by monitoring the cylinder for zero pressure rise.

Cylinder receipt inspections and cylinder filling are performed in different buildings. As a result, the procedures are independent tasks. The following independent errors would have to occur in order for a presumed clean cylinder to be over-pressurized:

a. On arrival, the cylinder contains enough reactive impurities to potentially over-pressurize it.

b. The visual examination is performed incorrectly or omitted.

c. Either the vacuum test is performed incorrectly or the reactive impurity is non-volatile.

d. Too much UF6 is added initially or the operators somehow continue filling after recording high pressure and temperature indications, in violation of procedures.

It is highly unlikely for more than two of the above events to occur independently while inspecting the same cylinder. Therefore, this incident is highly unlikely and no release of UF6 is assumed.

<u>Hydraulic Rupture of UF6 Low Pressure Piping - Described in SAR section - 9.1.6.</u>

The only potential cause of a low pressure UF6 pipe rupture is a heat tracing and/or hot box failure that allows UF6 to desublime inside the pipe, and subsequent operator error which allows the pipe to be reheated before the solid UF6 is evacuated. The following sequence of faults must occur before a release of UF6 is possible:

a) Failure of the heat tracing and/or hot box heater circuit, or loss of primary and standby power supply to the heaters, or operator error that erroneously de-energizes heaters.

b) Failure of the temperature sensor and/or alarm in the heater circuit that controls temperature. This is independent of the above failure because the heater and sensors receive power from different sources.

c) Failure of the temperature sensor and/or alarm in the independent protection circuit.

d) Failure of the pressure and/or flow instrumentation to alarm in response to changes in these parameters associated with the formation of a flow restricting plug. Note that this failure does not apply to lines in which there is no flow such as isolated branch connections.

The above failures would allow UF6 to desublime in the pipe or component. At least three independent failures must occur to form a plug due to UF6 desublimation. In addition, the following events must occur before liquefaction of UF6 could rupture the pipe:

e) The operator erroneously re-energizes the heat tracing and/or hot box heater before evacuating the desublimed UF6. The operator could also fail to de-energize an inadvertent restoration of power before evacuating the desublimed UF6. Note that this fault is not necessarily independent of (a), (b), and (c) above because the operator would not be aware of the potential for a problem if the alarms failed.

Chemical Trap Rupture - Described in SAR section 9.1.7

The potential hazard with respect to a chemical trap rupture is for uncontrolled UF6 flow into the activated charcoal/alumina traps downstream of the desublimers. Either (i) the desublimer is in a cold venting state, and hot freon erroneously flows around the desublimer, or (ii) the desublimer is in a hot pressurized state, and UF6 backflow through the desublimer discharge valve occurs.

In the former case the potential is for the desublimer vent pump to pull large quantities of UF6 through the chemical traps. In the latter case the potential is for large quantities of UF6 to pass through the desublimer outlet valve into the chemical traps.

Under these conditions, the adsorption of UF6 on the activated carbon bed of the chemical trap would cause the temperature of the bed to rise sharply over a period of several minutes, evolving several pounds of carbon monoxide. The sharp temperature rise in the chemical trap would exceed its design temperature and cause it to expand, which could in turn cause it to fail mechanically. Thus, air in-leakage is assumed to occur which could produce an explosive mixture of CO and oxygen. This mixture is assumed to ignite due to

either a static spark in the bed, a spark from the vacuum pump, or auto-ignition.

The possibility of the desublimer vent pump pulling on a hot desublimer is precluded by the following:

a) the desublimer logic precludes this.
b) the hot freon supply valve fails closed making the possibility of incorrect freon flow due to valve failures remote.
c) A flow switch on the hot freon line prevents access to a desublimer vent state, if the hot freon is flowing.
d) A temperature trip on the desublimer body prevents access to a desublimer vent state unless the desublimer is chilled.

Since at least two unlikely, independent failures must occur, the explosive rupture of a chemical trap is not credible during the on-line, standby, or purification modes of operation.

Note that the vent vacuum pump normally operates during the on-line, standby, and purification modes evaluated above. During the heat and gas-over modes (hot freon modes), the vacuum vent pump does not operate. Therefore, if the desublimer outlet valve fails open (unlikely; fail closed valve), very little UF6 would transfer from the desublimer to the chemical trap because the pressure in the desublimer and the chemical trap would equalize. The reaction would be self-limiting because the generation of heat within the chemical trap would establish a temperature gradient. If the chemical trap failed mechanically due to the temperature rise, very little air could enter the trap before the closed volume within the desublimer and chemical trap reached atmospheric pressure. Therefore, there are no credible circumstances by which an explosive mixture could be formed within a chemical trap during the heat and gas-over modes of operation.

Even if this unlikely event were to occur, the chemical traps would contain a maximum of approximately 28 kilograms of solid UF6.

<u>Fire in Separations Building - Described in SAR section 9.1.8</u>

An evaluation was performed to determine the fire hazards in the CEC. The Technical Service Area in the Separations Building, the diesel fuel storage area, and areas in which

transformers are located were determined to have the greatest potential fire hazards. Fire hazard assessments were based on anticipated inventories of combustible materials and their proximity to the Cascade Halls and UF6 Handling Areas. This evaluation demonstrates that postulated fires in the most likely locations would not damage safety class equipment and would not contribute to the release of UF6.

Separate calculations were performed to determine maximum fire duration in each room or area designated above. Estimated inventories of combustible material included both stationary and transient combustible materials. The calculations for the equivalent fire severity were based on methodology given in the NFPA Fire Protection Handbook. The calculated fire durations for each room and area assumed total failure of the Fire Protection System and no response from the fire brigade. The calculations conclude that none of these worst case fires could penetrate fire barriers or spread to areas in which UF6 is processed.

The calculations for maximum fire durations assumed no fire suppression or brigade response. Therefore, the combustible material in each room or area would be consumed and some equipment would be destroyed in the postulated fires. The calculations demonstrate that the fire-rated barriers would contain the postulated worst case fires assuming all combustible material is consumed. Therefore, postulated fires in the most hazardous locations would not damage safety class equipment and would not contribute to the release of UF6.

The only potential release of radioactive materials would occur as a result of a fire consuming spent HEPA filters or contaminated solid waste. Small quantities of radioactive materials would be released to the building with only trace quantities released to the atmosphere.

Possible Accidents Resulting From Natural Phenomena - Described in SAR section 9.2.1.

The Separations Building is designed to withstand the following natural phenomena: Earthquake, Tornado, Hurricane, and Flood. The design bases intensities of the natural phenomena are discussed in detail in SAR section 9.2.1.1 through 9.2.1.4. The analysis of these events provided in the above references sections of the SAR demonstrates that none have the possibility to cause a release of UF6.

Fire In Storage Yard - Described in SAR section 9.2.2.3.

The cylinder storage yards are designed in conjunction with the fire protection systems to prevent fires from occurring. Based upon the evaluation discussed in SAR section 9.2.2.3, a fire in the UF6 cylinder storage yards does not result in the release of UF6.

Transportation Accident

The NRC and U.S. Department of Transportation (DOT) have looked closely at postulated accidents involving cylinders transported by trucks (refer to SAR references 9.2-16, 17 and 20). They concluded that a wreck, combined with a fire, is the transportation event which is likely to post the greatest hazard to the public. These NRC and DOT analyses are relevant to CEC in regard to accidents involving over-the-road trucks which come onto the site. The DOT analysis concluded that, should a truck wreck and fire occur, resulting in a breach of the cylinder, then the persons in the most serious danger would be those in the immediate vicinity of the fire (i.e., persons involved in the wreck).

Based on the analyses and tests referenced above, the NRC and DOT concluded that the public would not be endangered by truck transport of UF6 cylinders if cylinders are designed and certified per ANSI N14.1-1982, and if vehicles are properly operated. Based on this, the NRC and DOT have licensed transport of UF6 cylinders by truck.

Accidental Criticality

The LES, CEC, Criticality Safety Engineering Report, Revision 1, submitted to the NRC by LES by letter dated June 30, 1992 provides a comprehensive review of possible accidental criticalities at the CEC. It concludes that a criticality at the CEC is highly unlikely.

Autoclave Heater Malfunction - Described in SAR section 9.2.2.2.

This accident is discussed in detail in SAR section 9.2.2.2. It concludes, that since this is the only equipment in the facility that contains liquid UF6 in significant quantities, that the possibility exists for more than 864 kg of liquid UF6 to be released. Therefore, two temperature and two air pressure instruments, any one of which is capable of

tripping the autoclave heaters, have been designated System Class I and will be designed, built and operated in accordance with the LES QA Level 1 program. Therefore, the instruments may be assumed to function thus eliminating the possibility of release of UF6 from the autoclaves.

It should be noted that the analysis of UF6 release using the TRIAD method was performed and provided in SAR section 9.4 for information only. The methodology used in NUREG-1140 is very conservative. Section 2.1.5 of NUREG-1140 lists the conservatisms associated with the modeling technique. The TRIAD results provide another indication of possible exposures assuming worst case accident scenarios at the CEC. The results from the TRIAD modeling were not used to make any decisions regarding the classification of SSC nor determination of the need for an emergency plan for the CEC.

3. SAR Section 4.6 (p 4.6-1, paragraph 3) indicates that detailed analyses of credibility and potential consequences of postulated abnormal conditions and accidents were performed. Provide summary descriptions of these analyses of abnormal conditions and accidents and detailed descriptions of the analyses for those events with potential for significant impacts on workers or members of the public.

See response to question 2 above. The descriptions of the analyses and abnormal conditions and accidents are provided in SAR Chapter 9.

May 20, 1992 RAI
4.6 SUMMARY OF STRUCTURES, COMPONENTS, AND SYSTEMS CRITERIA

Question 1:

Provide a copy of the 7DI report on identification of structures, components and systems important to safety.

Response:

SAR section 4.6 is the report that contains the information regarding the identification of structures, systems, and components (SSC) important to safety (i.e., safety-related). Since the only credible UF6 release scenario which could occur at the CEC that exposes the public to values of uranium and/or hydrogen fluoride (HF) beyond those stated in NUREG-1391 is one in which at least one cylinder of liquified UF6 and its associated autoclave fail simultaneously, the autoclave instruments for air temperature and air pressure have been designated as safety related. Since there are two instruments for temperature and pressure for each autoclave, this ensures a redundant and diverse method for preventing an accidental release from cylinders containing liquid UF6.

Question 2:

The response to this question indicates that the threshold quantity of UF_6 which, if released through the stack, would exceed NUREG-1391 limits is 3700 kg. NRC staff analysis, conducted using the methods of Regulatory Guide 1.145 and the revised meteorological data, indicates that this threshold quantity may be as low as 1800 kg. The 95 percent over-all concentration per unit release factor (X/Q) was estimated as approximately 1.6×10^{-5} s/m^3. Provide detailed documentation supporting the proposed threshold quantity, including description of the dispersion analysis and cumulative distribution for X/Q. If method used in calculation of the X/Q differs from that of Regulatory Guide 1.145, provide a justification for use of the alternative method.

See response to question 1 (November 7, 1991) above. The results of the analysis using the NUREG-1140 methodology was that used to determine the safety related structures, systems, and components (SSC) for the facility.

SAR section 9.2, Figures 9.2-3 and 9.2-4 provide the estimated exposures to HF and uranium with respect to distance from the source of the release. The figures were developed using the NUREG-1140 methodology. The TRIAD results were provided for comparison only.

Specifically, SAR section 9.2.4 provides a detailed description of the atmospheric dispersion analysis used, the exposures predicted by the TRIAD analyses, and the uncertainties associated with the analyses.

October 29, 1992
6.4.10 Control System

This issue remains open pending submission of additional information discussed during our October 20 meeting. Primarily, we need technical support for our evaluation of the function of Class I systems (question 2, of our November 7, 1991, letter). As indicated in the specific questions presented below, the primary technical issue requiring clarification is the review of the logic for implementation of the Class I function.

Specific Clarifying Questions for Instruments and Controls:

1. *The logic diagram of Figure 6.4-40 appears to indicate that the combinations of signals from PE-115 with TE-122 and of PE-118 with TE-127 de-energize the heaters along independent paths. The Mechanical Flow Diagrams for the Feed Autoclave System show the signals from TE-122 and TE-127 entering a common logic unit and the signals from PE-115 and PE-188 entering another common logic unit. Resolve the apparent inconsistency.*

Response:

Figure 6.4-40 has been revised to indicate more clearly the signal combinations that satisfy the logic that de-energizes the autoclave heaters and to ensure consistency with the Feed Autoclave Mechanical Flow Diagram (SAR Figure 6.8-1). A copy of revised SAR Figure 6.4-40 is enclosed and will be added to the Safety Analysis Report (SAR). As shown on the revised figure there is no reliance upon Class II autoclave heater interlocks to de-energize the autoclave heater contacts in the event of high autoclave pressure or high autoclave air temperature.

2. *Figure 6.4-40 appears to indicate that Class II autoclave heater interlocks must be functional to de-energize the autoclave heater contacts. Is this a correct interpretation of this design? If not, clarify the proposed function. If so, provide a rationale for making the function of a Class I system dependent upon the function of a Class II system. Identify the interlocks in question.*

Response:

Figure 6.4-40 has been revised to indicate more clearly the signal combinations that satisfy the logic that de-energize the autoclave heaters. A copy of revised SAR Figure 6.4-40 is enclosed and will be added to the Safety Analysis Report (SAR). As shown on the revised figure there is no reliance upon Class II autoclave heater interlocks to de-energize the autoclave heater contacts in the event of high autoclave pressure or high autoclave air temperature.

3. *Are the control circuits PE-112/PI-112 (trip heaters on high cylinder pressure), PT-113/PI-113 (isolate cylinder on high autoclave exit line pressure), and PT-502/PI-502 or PT-503/PI-503 (isolate plant unit feed header) active in the eight autoclave states?*

Response:

The PE-112/PI-112 pressure trip system referred to is that associated with the pressure side of the (process gas/autoclave air temperature) cascaded controller, which controls the autoclave air heaters.

The cascaded controller comprises the control elements of the PE-111/PI-111 & TE-121/TI-121 transducers, see SAR Fig 6.8-1. The control function is not required in the two autoclave states ISOLATE and COLD PURIFY and is consequently inhibited in these states (reference Control and Logic Descriptions - LES letter to NRC dated March 24, 1992). The control function is activated in the remaining six autoclave states.

The PE-112/PI-112 trip function (which trips the air heaters and fan at 14 psia) is similarly only functionally required in the same six states, noted above, when the heaters are activated. In the interests of circuit simplification, and because there is no operational disadvantage, the PE-112/PI-112 trip function is left activated in all eight autoclave states.

The PT-113/PI-113 pressure trip system referred to is that associated with the control function of the PT-114/PIC-114 pressure system. This system is located on the sub-atmospheric process gas pipe outside the autoclave.

The PT-114/PIC-114 control function modulates the process gas let-down valve HV-134 located within the autoclave. This control function is only activated in the states HOT PURIFY and HEELS REMOVAL of the autoclave state switch.

The trip function of PT-113/PI-113 (at approximately 1.16 psia) is to isolate the feed flow from the autoclave if the process gas pressure erroneously approaches ambient condensation pressure. This will always be a valid trip function and consequently, unlike the control function, it will always be active in all eight autoclave states (reference Control and Logic Descriptions - LES letter to NRC dated March 24, 1992).

The pressure trip transducers PT-502/PI-502 and PT-503/PI-503 referred to are those associated with the PT-501/PIC-501 control and trip pressure transducer on the plant unit feed distribution manifold. The function of PT-502/PI-502 and PT-503/PI-503, to isolate the feed header on a pressure rise, is always valid. Consequently the trip function of the two transducers in question is active in all eight autoclave states.

4. *Figure 6.8-1 shows that the signal from PIC-111 to the heater logic control until is routed through TIC-121? What role does autoclave temperature play in this control loop?*

Response:

The 48" cylinder in the autoclave and thus its contents are heated indirectly via air drawn over the electrical heaters. The air temperature (measured on TE-121) is controlled using a cascaded controller (TIC-121) whose setpoint is adjusted with relation to the UF_6 pressure within the container (measured on PE-111 and controlled by PIC-111). This functions so that the temperature setpoint of controller TIC-121 is increased, within an overall maximum value, as the measured UF_6 pressure falls below the PIC-111 control point and vice versa, within an overall minimum value. Figure 1 enclosed shows the relationship between the UF_6 pressure and air temperature control point during the container warm-up phase.

Thus, from cold, the air temperature will be raised to the maximum cut-off value. This will be maintained until the measured UF_6 pressure rises to a value which will cause the temperature setpoint to reduce. The air temperature setpoint will continue to reduce until the triple point is reached where it will remain steady. When the UF_6 has liquefied, the pressure will continue to rise and the temperature setpoint will fall. When the measured UF_6 pressure reaches its control point and the container contents are in equilibrium, the temperature setpoint will remain steady.

During the initial warm-up phase the pressure controller setpoint will be set at a value greater than that required for feeding to the pair of assay units. This will have the effect of reducing the time taken to fully liquefy the UF_6. During standby duty, the controller setpoint will be reduced to its online duty control point.

UF_6 has a high thermal inertia, more noticeable in the solid than in the liquid phase. The inertia is due to two factors. Firstly, the poor thermal conductivity of UF_6 causes a time lag between energy being fed into the system and its effect being noted, and secondly, the contents of the container represent a high thermal mass. Liquid UF_6 has a relatively lower thermal inertia because of the convective currents which can be generated in the liquid which will allow for a more nearly isothermal regime to obtain. This inertia will cause an over- and under-shoot of control, which using the above control philosophy, will be rapidly attenuated even using purely proportional control.

5. *Provide logic diagrams, analogous to Figure 6.4-40 for all Class I systems (e.g., for blending and sampling autoclaves).*

Response:

SAR Figure 6.4-40 has been relabeled to indicate this logic diagram is the same for Blending and Sampling, as well as Feed Autoclaves.

6. *The notes on Figure 6.8-2 refer to the autoclave vent valve. Identify the location and function of this valve.*

Response:

The autoclave vent valve is valve HV-139 shown on SAR Figure 6.8-1, Frame 2 of 4, section 5. The function of this valve is to isolate the purification header from the main UF6 supply route from the autoclaves to the cascades. The valve is operated via the autoclave state switch.

7. *Are the feed autoclave valves HV-136 and HV-137 closed in each of the eight autoclave states? When are the valves open? How are they opened?*

Response:

The eight position autoclave state switch does not directly command the valves HV-136 and HV-137.

In six of the eight positions of the autoclave state switch (HEAT UP, HOT PURIFY, MANUAL STANDBY, AUTO STANDBY, ON LINE and HEELS REMOVAL) the autoclave heaters are energized. A series of interlocks ensures that in all of these state switch positions the valves HV-136 and HV-137 are CLOSED.

These interlocks are:

HV-137	NOT CLOSED NOT OPEN	Inhibits air heaters. Inhibits autoclave door from being unlocked.
HV 136	NOT CLOSED NOT OPEN	Inhibits air heaters. A mechanical interlock prevents the autoclave door from being opened.
Autoclave differential air pressure	DIFFERENTIAL PRESSURE NOT ZERO	Inhibits HV-137 from being opened. Inhibits autoclave door from being unlocked.
Autoclave door	NOT CLOSED NOT OPEN	Inhibits air heaters. Removes inhibit on air heaters.

Autoclave door lock	NOT LOCKED LOCKED	Inhibits air heaters. Removes inhibit on air heaters.
State Switch	HEAT UP HOT PURIFY MANUAL STANDBY AUTO STANDBY ON LINE HEELS REMOVAL	Removes heater inhibit Removes heater inhibit Removes heater inhibit Removes heater inhibit Removes heater inhibit Removes heater inhibit
State Switch	ISOLATE COLD PURIFY	Inhibits air heaters Inhibits air heaters

Following feed heels removal the autoclave state switch will be set to ISOLATE.

The gaseous effluent vent valve HV-136 will be opened. The autoclave air pressure will be noted to fall and the absence of an HF alarm in the gaseous effluent vent system will be noted. HV-136 will be opened remotely from the autoclave local control center (LCC).

Following establishment of the above noted conditions the atmospheric vent valve HV-137 will be opened again by remote operation from the autoclave LCC.

The autoclave door will now be unlocked and opened. Consequently in ISOLATE the valves HV-136 and HV-137 will be either OPEN or CLOSED as appropriate.

The cylinder will now be changed, and following installation and connection of the new cylinder, the autoclave state switch will be set to COLD PURIFY. Cold purification is carried out with the autoclave door OPEN.

Following the completion of cold purification the autoclave is prepared for heat-up. The door will be CLOSED and HV-136 CLOSED and the door LOCKED and HV-137 CLOSED. Consequently in COLD PURIFY the valves HV-136 and HV-137 will be CLOSED or OPEN as appropriate.

8. *What is the function of the control unit associated with the position of HV-131?*

Response:

ZLH-131 is a trip taken off the limit switch on the Superior valve. The Superior valve must be open (and other logic conditions met) before the heaters can be energized. If at any time this valve is closed, then the heaters and fan are de-energized immediately. The same logic holds for the hand valve (HV-133) immediately downstream of the Superior valve.

9. *Can the cylinder valve be opened or closed after the autoclave is closed?*

<u>Response:</u>

The cylinder valve is connected to an operating mechanism, the handle of which is accessible from outside the autoclave. Using this operating mechanism the cylinder valve can be closed without restriction. If the valve is closed during one of the six autoclave states in which the heaters are energized then the cylinder valve switch trip ZLH-131 (SAR Figure 6.8-1, Frame 3 of 4) will cause the air heaters and fan to trip.

10. *Paragraph 3 on SAR, page 6.3-11, indicates that the feed autoclave heaters are de-energized when the autoclave air pressure reaches 43.5 psia. Table 6.3-2 indicates that this cut-off pressure is 24.6 psia. Resolve the apparent inconsistency.*

Response:

The trip value of 43.5 psia is the trip value for the feed cylinder UF6 pressure (see SAR page 6.3-11, paragraph 4) and was inadvertently repeated in paragraph 3 on SAR page 6.3-11. The correct value for the air pressure trip level is 24.6 psia, as given in SAR Table 6.3-2. The revised SAR page is enclosed.

11. *What are the procedure and reference temperature and pressure for establishment of 1100 KG as the capacity of a single tube desublimer?*

Response:

Please Note: The capacity of the single tube desublimer, as stated on SAR page 6.3-8, is 1100 lbs (pounds) not kilograms as stated in the question.

The capacity was determined by experiment. The desublimers were developed for the product and tails take-off systems for the Almelo and Gronau plant and had to desublime about 16 kg UF_6/hour. The fill limit was determined by the cycle time needed for cooling down the desublimer, condensation of UF_6, heating up, evaporation of UF_6 and cooling again taking into account two sets of desublimers operating alternately. The reference temperatures of hot/cold refrigerant were +60/-70°C. The reference pressure was 0.8-0.4 mbar during desublimation and less than 1000 mbar during heating.

Please note that the desublimer controls are designed so that desublimer refrigerant does not rise above 55°C.

12. *What are the set points, as weight of cylinder contents, at which the inlet valves for the product and tails take-off stations are closed on over-weight signal?*

Response:

The setpoints are determined and set such that there exists a safety margin to the maximum net weight of twice the accuracy of the measuring system (i.e., the product take-off station load cells WE-855 and the tails take-off station load cells WE-865). This is approximately 60 kg for the product take-off stations and approximately 190 kg for the tails take-off stations.

13. *Frame 2 of Figure 6.8-9 shows a UF_6 Heels Transfer Line entering/exiting the desublimer. This line is separate from the UF_6 Discharge Line entering/exiting the desublimer. Frame 1 of Figure 6.8-10 indicates that the heels transfer line enters the receiver cylinder hot box but the configuration of this transfer line is not clearly shown on the hot box detailed diagram of Frame 3 of Figure 6.8-10. Does the heels transfer occur via valve HV-331? What is the flow path for transfer of heels from the desublimer to the receiver cylinder?*

Response:

DESUBLIMER HEELS TRANSFER

There are five receiving stations installed in the Product Blending System. These comprise cold Stations G-460-CB-001A through E and Hotboxes G-460-HB-003A through E shown in SAR Figure 6.8-10.

Stations A through D are for receiving blending material from the autoclaves and Station E is for receiving heels material. Heels material may be transferred into Station E from either the autoclaves or from the Blending System desublimer.

In the case of heels material being transferred from an autoclave, that autoclave will be selected to HEELS TRANSFER at the autoclave state switch. The heels receiving station, station E, will be selected to TRANSFER 1 or TRANSFER 2 as appropriate. The transfer route for the autoclave heels material (for autoclave 1) will be via HV-133, HV-134, PV-135, HV-138 along the Transfer Line 1 and then into the receiver cylinder No. 5 via HV-315.

In the case of heels material being transferred from the desublimer, the desublimer will be selected to GAS-OVER at the desublimer state switch. The heels receiving station will then be selected to VENT at the state switch for receiving station 5. The transfer route for the desublimer heels material will be from the desublimer, through the Heels Transfer Line (the line referred to in question 13) and into the hotbox of the fifth receiving station. Inside the hotbox for the fifth receiving station the material routes through HV-345 and into the receiver cylinder.

It is important to note that the Heels Transfer line routes to the hotbox of the fifth receiving station only. Heels material is only transferred into the fifth heels receiving station and

not to any other station. The valve and pipework arrangements inside all five receiving station hotboxes are, however, identical. The process difference between the Blending Receiver Stations A-D and the Heels Receiving Station E is as follows:

In the case of Stations 1-4, the process route is for material being vented from the receiving station into the Discharge Line and into the desublimer. The switch selections will be VENT and RECEIVER STATION VENT for the desublimer and receiver station.

In the case of Station 5 there are two process routes. Either the receiver station will be receiving material from the desublimer in which case, as noted above, state switch selections will be GAS-OVER and VENT for the desublimer and station 5, respectively. Or station 5 will require venting to the desublimer. It should be noted that it is not anticipated that station 5 will require venting in process as it will only receive pure heels material. To facilitate such operations as pipework degas prior to cylinder change, however, a station 5 vent facility is available. This would be achieved by state switch selections of CHILL and VENT for the desublimer and station 5, respectively.

LOGIC

To prescribe the venting arrangement for station 5 (the heels station) a modification is necessary to the logic specifications submitted by LES by letter dated March 24, 1992. The modified Product Blending System, Control and Logic Description is enclosed. The modifications are highlighted on pages 8 of 14 and 12 of 14.

Specifically, the vent selection of the station 5 state switch is only enabled in GAS-OVER and CHILL selections of the desublimer state switch.

Corresponding amendments are made to these desublimer state switch positions.

14. *Figure 6.8-10 appears to indicate that valve HV-331 connects the receiver cylinder station to the mobile pump set and N2 purge lines. Why is valve HV-331 not closed when the receiver cylinder station state switch is in the isolate position?*

Response:

Only part of the logic for the cylinder state switch is shown in NOTE 6 of FIGURE 6.8-10, FRAME 1 of 4. The full logic is provided on page 8 of 15 of the Control and Logic Description - Product Blending System (reference Control and Logic Descriptions - LES letter to NRC dated March 24, 1992).

There are two receiver cylinder station state switches.

FIRST SWITCH (4 position) - per cylinder receiving station.

TRANSFER 1	CLOSED	HV-321
		HV-341
	OPEN	HV-311
TRANSFER 2	CLOSED	HV-341
		HV-311
	OPEN	HV-321
VENT	CLOSED	HV-311
		HV-321
	OPEN	HV-341
ISOLATE	CLOSED	HV-321
		HV-341
		HV-311

SECOND SWITCH (2 position) - per cylinder receiving station.

OPEN	OPEN	HV-331	Switch only selectable to OPEN when FIRST SWITCH is selected to ISOLATE.
CLOSED	CLOSED	HV-331	

Discussion

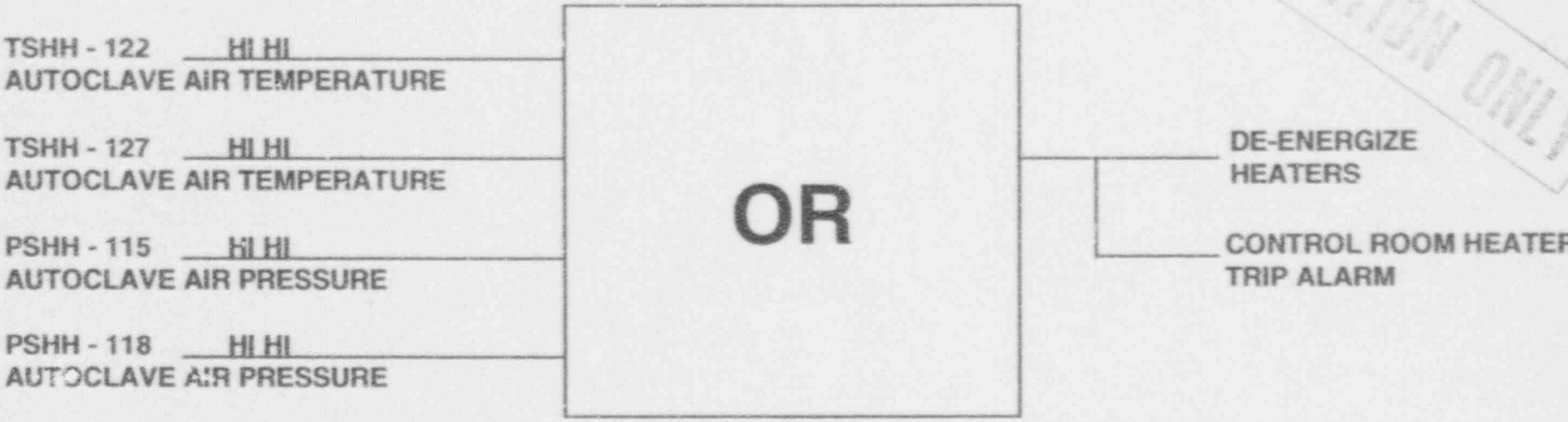
The above logic shows that when the cylinder station is either

receiving transfer material (in states TRANSFER 1 or TRANSFER 2) or venting material (in state VENT) the "maintenance valve" HV-331 is CLOSED. When the cylinder station is not receiving material it will be set to ISOLATE. ISOLATE is the only state selection in which the "maintenance valve" HV-331 can be opened.

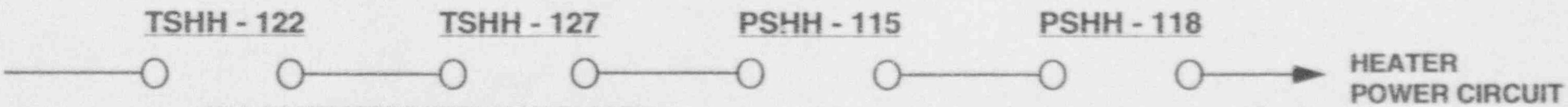
If the HV-331 state switch is selected to CLOSED when the cylinder state switch is selected to ISOLATE, then all four valves HV-311, HV-321, HV-331 and HV-341 will be CLOSED. This is the situation, for example, when the cylinder station is on stand-by waiting for duty.

If the HV-331 state switch is selected to OPEN when the cylinder state switch is selected to ISOLATE then HV-331 will OPEN, the other three valves remaining CLOSED. This is the situation, for example, during cylinder changing operations.

SCHEMATIC LOGIC DIAGRAM FOR FEED, BLENDING AND LIQUID SAMPLING AUTOCLAVES



CONTACT LOGIC DIAGRAM FOR FEED, BLENDING AND LIQUID SAMPLING AUTOCLAVES



(ALL CONTACTORS NORMALLY CLOSED)

(ALL CONTACTORS OPEN ON FAILURE OF CONTROL POWER)

(CONTACTORS OPEN ON RECEIPT OF TRIP SIGNAL)

LOUISIANA ENERGY

CLAIBORNE ENRICHMENT CENTER

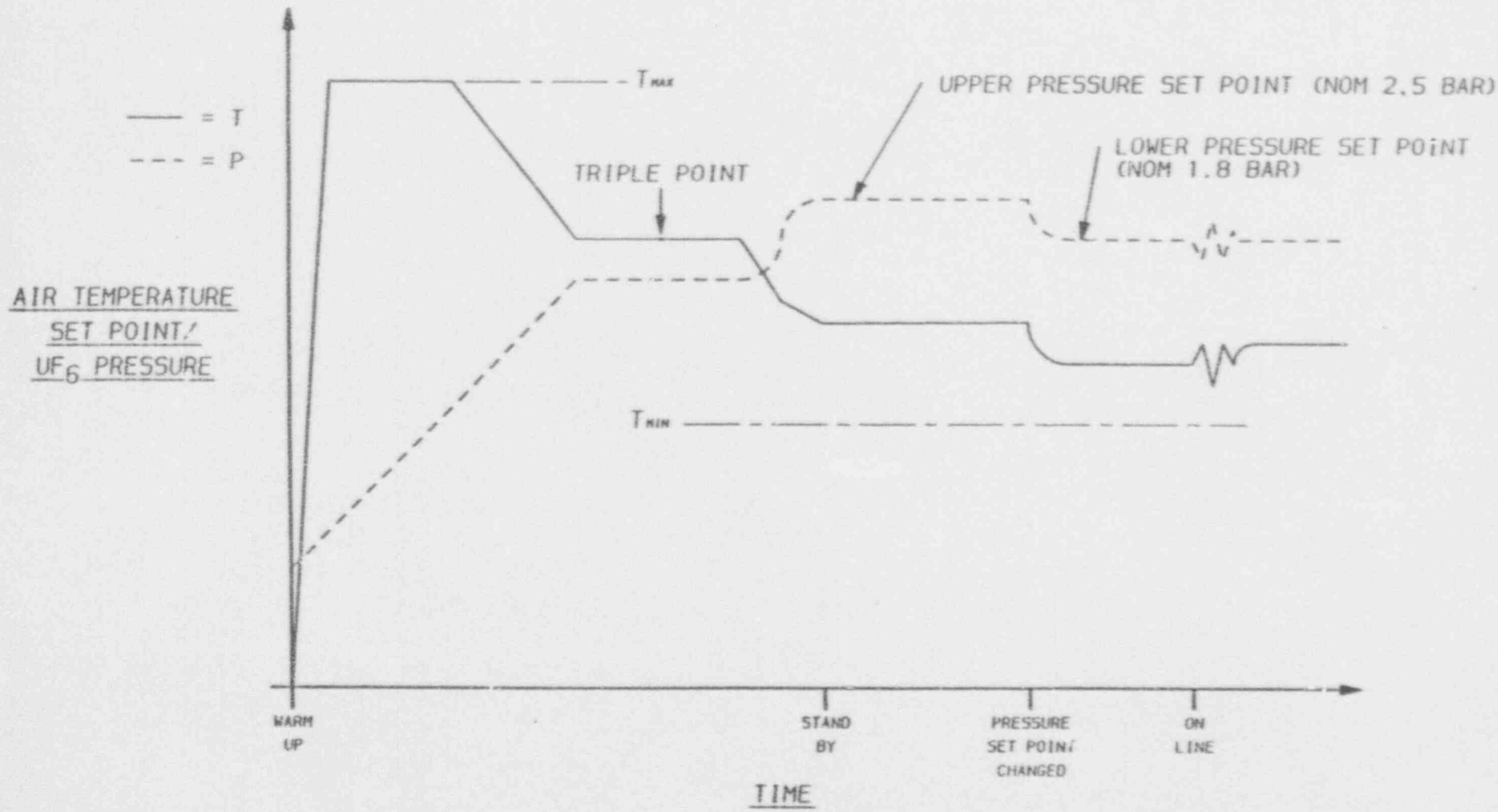
LOGIC DIAGRAM

FEED, BLENDING & LIQUID SAMPLING AUTOCLAVES
AIR TEMPERATURE AND PRESSURE
PROTECTION SYSTEM

FIGURE 6.4-40

REVISION
DECEMBER, 1992

FIG 1. RELATIONSHIP BETWEEN UF_6 PRESSURE & TEMPERATURE SET POINT DURING CONTAINER WARM-UP, STAND-BY & ON-LINE PHASES.



in accordance with the procedure described in Section 6.3.1.3, Design Description.

6.3.1.6.2 The inspection and testing procedure for the 48-inch diameter cylinders follows the requirements of ANSI N14.1.

6.3.1.7 Instrumentation

All process variables are automatically controlled. Deviations from specified values are detected and indicated via two-stage alarm signals. At the first alarm level, the process operator has the opportunity to manipulate the process to restore it to normal. At the second alarm level, automatic action is taken to provide system protection. Some sensors are duplicated for safety or equipment protection. Action is initiated if any one out of two duplicated sensors reach alarm levels. The feed system instrumentation and control system logic are shown in Table 6.3-2, Control Logic UF6 Feed System. The consequences of exceeding the parameters shown on the Logic Table are discussed in Sections 9.1 and 9.2. A complete list of the instrumentation is given in Table 6.3-16, Instrument Tabulation.

The autoclave air temperature is monitored to prevent over pressurization of the feed cylinders via overheating. Normal temperature during heating ranges from 158 to 230 F. The first alarm level is 230 F to give operator warning of high temperature. The second alarm level is 239 F and automatically de-energizes the air heater and blower.

The autoclave air pressure is monitored to prevent over pressurization, to indicate UF6 leaks, and to prevent the door from being opened while the autoclave is under pressure. Normal pressure during heating is 17.6 psia to 19.8 psia. The first alarm level is 22.0 psia to give operator warning of over pressure. The second alarm is ~~23.5~~ psia which automatically de-energizes the air heater and blower. If the autoclave air 24.6 pressure is above atmospheric pressure, the door lock prevents the door from being opened. To detect small UF6 leaks the autoclave air pressure and temperature ratio is monitored.

The feed cylinder pressure is monitored to prevent over pressurization of the cylinder, piping and valves. Normal pressure is 26.1 psia. The first alarm level is 39.2 psia to give operator warning of over pressure. The second alarm level at 43.5 psia automatically de-energizes the air heaters and blower.

The air heater electrical element surface temperature is monitored to prevent burn-out. The alarm level is 302 F and automatically de-energizes the air heaters.

PRODUCT BLENDING SYSTEM

INST	FUNCTION	DISPLAY		NORMAL OPERATION		ALARMS			TRIP ACTION	COMMENT
		LCC	CR		FROM	LCC	CR	CR GROUP		
HS-301	Receiver container staton state.		State	Four position switch. TRANSFER 1 CLOSE HV-321, HV-341 OPEN HV-311 TRANSFER 2 CLOSE HV-341, HV-311 OPEN HV-321 VENT CLOSE HV-311, HV-321 OPEN HV-341 IS[illegible] [illegible]SE HV-321, HV-341, HV-311	LCC					Per receiving container station. Transfer valves HV-311 or HV-321 may be CLOSED by WIT-361 in positions TRANSFER 1 & TRANSFER 2 of the receiver container state switch. VENT selection for receiver station 5 is only enabled in states GAS-OVER and CHILL of the desulbimer state switch.
HS-331	Vacuum/Nitrogen Valve state	/	/	Two position switch. OPEN OPEN HV-331 CLOSE CLOSE HV-331	LCC					Per receiving container station. Switch HS-331 only selectable to OPEN when vessel state switch HS-301 selected to ISOL.
WI-361 WSH	To control the quantity of UF_6 added to a receiver station from the donor station.	/	/	Will close Transfer line 1 valve HV-311 or Transfer line 2 valve HV-321 as appropriate when container has reached its preset weight limit.		/	/	/	H-Closes HV-311 or HV-321	
PI-351 PSH*	To indicate container inlet pressure.	/		Prevents transfer lines or vent line being opened to atmospheric pressure.		/			H-Closes HV-321, HV-341, & HV-311	Per receiver station. Auto-reset.
TIC-	To control hotbox temperature blending system.	/	/	Control of blending system hotbox temperature.	LCC	/	/			Per hotbox.

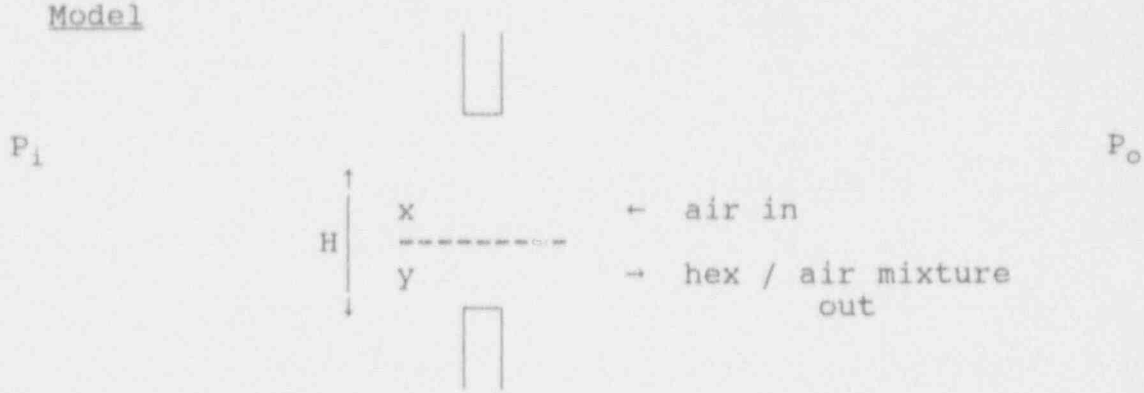
PRODUCT BLENDING SYSTEM

INST	FUNCTION	DISPLAY		NORMAL OPERATION		ALARMS			TRIP ACTION	COMMENT
		LCC	CR		FROM	LCC	CR	CR GROUP		
HS-400	Product blending desublimer state switch.	/	/	Selection Of: HEAT CLOSE Desublimer Inlet, HV-403 Desublimer outlet, HV407 Pump valve, HV-418 PUMP STOPPED, PT-414 inhibited COLD FREON OFF HOT FREON ON PT-411 & PT-412 inhibited GAS-OVER CLOSE Desublimer Inlet, HV-403 CLOSE Desublimer outlet, HV-407 Pump valve, HV-418 PUMP STOPPED, PT-414 inhibited COLD FREON OFF HOT FREON ON PT-411 & PT-412 inhibited VENT selection on station 5 enabled CHILL CLOSE Desublimer Inlet, HV-403 Desublimer outlet, HV-407 Pump valve, HV-418 PUMP STOPPED, PT-414 inhibited COLD FREON ON HOT FREON OFF PT-411 & PT-412 inhibited VENT selection on station 5 enabled S/BY CLOSE Desublimer Inlet, HV-403 CONTROLLED Desublimer outlet, HV-407, and pump valve, HV-418 on PT-411 & PT-414 HOT FREON OFF COLD FREON ON PUMP RUNNING, PT-414 & PT-412 enabled	LCC					HEAT allows warm up desublimer prior to gas-over. GAS-OVER allows transfer of desublimer contents to blending receiver station. CHILL allows desublimer to be cooled down following completion of trap transfer. Note in CHILL [illegible] freon will go through its loading cycle.

BNFL
CALCULATIONS SHEET

TITLE:	DATE:
Hex "Pouring" From A Ruptured Cylinder	**3 July 1990**

1) <u>Model</u>



Consider a rectangular aperture, height H, and width W. To the left ("inside") is a mixture of hex (at constant SVP P_i) and air. To the right is "outside", at notional pressure P_o. There is an interface at height y, above which air flows in, and below which the hex / air mixture flows out. The analysis establishes the height of the interface by equating the incoming and outgoing air mass flows (no reaction is assumed to take place between the hex and the air). These flows are driven by pressure differentials due to density differences.

2) <u>Vertical Pressure Gradients</u>

Inside, $P_i = A - \rho_v.g.h$ .... (1)
(where ρ_v is the density of the vessels' contents)
and outside, $P_o = B - \rho_a.g.h$ .... (2)
(where ρ_a is the air density and A & B are constants)

3) <u>Inflow of Air</u>

Following Bernoulli, we write:

$$P_o - P_i = \frac{1}{2}.\rho_a.v^2$$

where v is the velocity at a particular height 'h' in the aperture. Thus:

$$B - \rho_a.g.h - A + \rho_v.g.h = \frac{1}{2}.\rho_a.v^2$$

'h' being measured from the interface.

When h = 0, v = 0 and therefore B must equal A

$$2.g.h.\frac{(\rho_v-\rho_a)}{\rho_a} = v^2 \equiv 2.g.h.D_1$$

and

$$v = \sqrt{2.g.D_1}.h^{1/2} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Now the volume flow is given by:

$$Q_{in} = W.\int_0^x v.dh = W.\sqrt{2.g.D_1}\int_0^x h^{1/2}.dh$$

$$= \frac{2}{3}.W.\sqrt{2.g.D_1}\ .x^{\frac{3}{2}} \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

4) <u>Outflow of Mixture</u>

The outgoing velocity is determined from

$$P_i - P_o = \frac{1}{2}.\rho_v.v^2$$

Now when h = y, v = 0

$$A - \rho_v . g . h - B + \rho_a . g . h = \frac{1}{2} . \rho_v . v^2$$

$$\therefore A - B + g . y . (\rho_a - \rho_v) = 0$$

$$\therefore A - B = g . y . (\rho_v - \rho_a)$$

$$\therefore g . y . (\rho_v - \rho_a) + g . h . (\rho_a - \rho_v) = \frac{1}{2} . \rho_v . v^2$$

$$\therefore 2 . g . \frac{(\rho_v - \rho_a)}{\rho_v} . (y - h) = v^2 \equiv 2 . g . D_2 . (y - h)$$

$$\therefore \quad v = \sqrt{2 . g . D_2} . (y - h)^{\frac{1}{2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

As before, we integrate to arrive at the volume flow:

$$Q_{out} = W . \sqrt{2 . g . D_2} . \int_0^y (y - h)^{\frac{1}{2}} . dh$$

$$= W . \sqrt{2 . g . D_2} . \frac{2}{3} . y^{\frac{3}{2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

5) <u>Height of Interface</u>

We equate mass flows of air, ie

Inflow, $M_a = Q_{in} . \rho_a$

Outflow, $M_a = Q_{out} . \rho_a . \left(\frac{P_o - P_h}{P_o}\right)$

where P_o is the notional ambient pressure, and P_i the hex SVP.

Thus $\rho_a . \frac{2}{3} . W . \sqrt{2 . g . D_1} . x^{\frac{3}{2}} = \rho_a . \left(\frac{P_o - P_h}{P_o}\right) . W . \sqrt{2 . g . D_2} . \frac{2}{3} . y^{\frac{3}{2}}$

$$\therefore \quad x = D_3^{\frac{2}{3}} . \left(\frac{D_2}{D_1}\right)^{\frac{1}{3}} . y \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

where $D_3 \equiv \frac{P_o - P_h}{P_o}$

Now H = x + y (height of aperture)

$\therefore$ y = H - x

$$= H - D_3^{\frac{2}{3}} . \left(\frac{D_2}{D_1}\right)^{\frac{1}{3}} . y$$

$$\therefore \quad y = \frac{H}{\left[1 + D_3^{\frac{2}{3}} . \left(\frac{D_2}{D_1}\right)^{\frac{1}{3}}\right]} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

6) Hex Outflow

Equation (8) is now substituted back into equation (6), giving the outlet volume flow as:

$$Q_{out} = W.\sqrt{2.g.D_2}.\frac{2}{3}.\frac{H^{\frac{3}{2}}}{\left[1 + D_3^{\frac{2}{3}}.\left(\frac{D_2}{D_1}\right)^{\frac{1}{3}}\right]^{\frac{3}{2}}} \quad \ldots\ldots\ldots\ldots\ (9)$$

Let $\rho_{hex} = K_h.P_i$, then tne hex mass flow rate is given by

$Q_{out}.K_h.P_h$, ie

$$M_{hex} = K_h.P_h.W.\sqrt{2.g.D_2}.\frac{2}{3}.\frac{H^{\frac{3}{2}}}{\left[1 + D_3^{\frac{2}{3}}.\left(\frac{D_2}{D_1}\right)^{\frac{1}{3}}\right]^{\frac{3}{2}}} \quad \ldots\ldots\ (10)$$

Substituting back the "D's"

$$M = K_h.P_h.\frac{2}{3}.\sqrt{2.g.\frac{(\rho_v - \rho_a)}{\rho_v}}.\frac{W.H^{\frac{3}{2}}}{\left[1 + \left(\frac{P_o - P_h}{P_o}\right)^{\frac{2}{3}}.\left(\frac{\rho_a}{\rho_v}\right)^{\frac{1}{3}}\right]^{\frac{3}{2}}} \quad ..(11)$$

7) Numerical Solution

$\rho_h = K_h.P_h$

From ρ = 19.26 mgUF_6 / litre.torr (at NTP)

$$\rho_h = \frac{19.26}{133.32}.P. \quad g/m^3 \text{ (P in Pa)}$$

$$\therefore K_h = 0.1445, \text{ and}$$

$$K_a = 1.209 \times 10^{-2}$$ (from "ICAO St… d Atmosphere")

Furthermore

$$\rho_v = K_h.P_h + (P_o - P_h).K_a$$

Assume P_i = 60 kPa

P_o = 100 kPa, then

$$\rho_a = 1209 \quad g/m^3$$

$$\rho_h = 867^\circ \quad g/m^3$$

$$\rho_v = 8670 + 483.6 = 9153.6 \quad g/m^3$$

Thus $$\left[1 + \left(\frac{P_o - P_h}{P_o}\right)^{\frac{2}{3}}.\left(\frac{\rho_e}{\rho_v}\right)^{\frac{1}{3}}\right]^{\frac{3}{2}} = 1.442$$

and $$\sqrt{2.g.\frac{(\rho_v - \rho_a)}{\rho_v}} = 4.127 \quad m^{½}.sec^{-1}$$

For the case of W = H = 20 mm, we obtain from (11),
M = 0.936 g/sec.

P_i (kPa)	M_b (g/sec)	kg/hr
10	0.077	0.277
20	0.200	0.720
30	0.350	1.260
40	0.523	1.883
50	0.717	2.581
60	0.936	3.370
70	1.182	4.255
80	1.464	5.270
90	1.801	6.484
100	2.311	8.320

(Densities have been assumed constant over the temperature range appropriate to P_i).