APPENDIX A : DESIGN VERIFICATION REVIEW REPORT

This document is provided to illustrate the types of operational hazards addressed during the engineering phase.

DESIGN VERIFICATION REVIEW (DVR)

Alternative Fuels Development Unit (AFDU)

Spring 1991 DME Run

LaPorte, Texas

14 February 1990

Review Team

T. E. Conway	Start-up Engineering
S. Cronauer	Process Engineering
D. M. Herron	Process Engineering
E. Heydorn	Operations - LaPorte
M. R. Jocsak	Project Engineering
G. A. Peters	PSG Engineering Safety
R. L. Williams	Project Engineering

Design Verification Review (DVR)
Alternative Fuels Development Unit (AFDU)
Spring 1991 DME Run
LaPorte, Texas

Table of Contents

Appendices

Tables

References

1. Preliminary Process Hazards Review Report - March 1991 Run (DME), 16 October 1990.

2. Alternative Fuels Development Unit (AFDU) Engineering Flow Sheet No. ATT-1016, Rev. 1.

3. Liquid Phase Methanol Engineering Flow sheet No. 87-7-1533, Rev. 13.

I. INTRODUCTION

A Design Verification Review (DVR) meeting was conducted on 14 February 1991 for the Spring '91 DME (dimethyl ether) run of the Alternative Fuels Development Unit (AFDU) located in LaPorte, Texas. The Spring '91 run requires modifications and additions to the Liquid Phase Methanol Process Development Unit which are funded under the Alternative Fuels I contract. The objective of this run is to demonstrate higher conversion levels of snygas by coproducing dimethyl ether and methanol. Verification of R&D lab and simulation results is also desired.

The purpose of the DVR was to ensure that all items relating to the Preliminary Hazards review (PrHR) have been satisfactorily resolved and to review any additional safety concerns. The PrHR meeting was conducted on 16 October 1990. Due to this project's relatively short schedule, it was decided to not conduct a Design Hazards review meeting. The Hazards review process will be concluded with an on-site Operational Readiness Inspection (ORI) prior to start-up.

The DVR confirmed that a satisfactory review of most of the PrHR items has been performed. Those items requiring further review will be confirmed during the ORI. Furthermore, additional hazard items were reviewed and are documented in part III B. The matrix attendance to the ORI was discussed and a meeting will be conducted in approximately two weeks prior to the ORI to outline the ORI requirements.

II. Scope Changes and Process Modifications

There have been no significant scope changes or process modifications since the PrHR was conducted.

III. Status of Hazard Items

A. The following table (labeled III A., Status of PrHR Items) documents the status of the conclusions and recommendations that were developed during the Preliminary Hazards Review (PrHR).

B. Table III B., Additional Hazard Items, documents the results and status of additional hazard items identified following the PrHR.

III A. STATUS OF PrHR ITEMS

Hazard	Preliminary Hazards Review (PRHR) Recommendation/Follow-up	Design Verification Review (DVR) Status
1. Runaway reaction in the 27.10 reactor vessel caused by a loss of oil flow or fin fan in the utility oil loop.	Although the catalyst composition will be different from previous runs, it was determined that the existing high temperature shutdowns should provide sufficient protection. The appropriate high temperature shutdown set points on the existing switches need to be determined by Process Engineering but will probably be the same as was used for previous runs.	High temperature SD set points will be the same as those used in previous runs. The existing high temperature shutdowns will be calibrated and proof tested prior to the ORI.
✓ 2. Personnel exposure to the new alumina catalyst that will be used in the 27.10 reactor.	The existing procedures for catalyst reduction, handling of catalyst, and sampling will apply and should be utilized.	No further review was required.
3. Equipment or piping system corrosion or damage caused by material incompatibilities due to the presence of DME and larger quantities of CO_2 and water in the system downstream of 27.10 reactor. DME is a solvent.	Review material composition requirements of existing equipment, piping, gaskets, o-rings, etc.	A comprehensive review of existing plant machinery, piping systems, and valves was performed with the scope limited to the equipment that will be used during the DME run. The review was focused on identifying equipment that contain Viton, Buna-N, or neoprene materials in contact with the DME process stream. The Air Products technical manual on DME

Hazard	Preliminary Hazards Review (PRHR) Recommendation/Follow-up	Design Verification Review (DVR) Status
3. Continued		identifies these materials as being unacceptable with DME aerosol filling equipment and highlights Teflon and EPR o-rings as exhibiting acceptable performance. A list of questionable valves was developed (Table 1) and reviewed during the DVR meeting. The DVR recommendation is to not replace the subject valves due to the anticipated short DME production operating period (5 days) and the relatively low concentration of DME in the associated process streams (~2-10%). It was agreed that these valves will be periodically monitored for signs of leaks during the run and afterwards, disassembled and inspected for signs of deterioration from DME incompatibilities. The review of existing machinery is in progress and will be completed prior to the ORI. It was agreed to replace all DME process-side Viton, Buna-N, or neoprene seals during the machinery refurbishment process as long as an acceptable alternative material is readily available. The results will be reviewed during the ORI.

Hazard	Preliminary Hazards Review (PRHR) Recommendation/Follow-up	Design Verification Review (DVR) Status
3. Continued		A review of existing valve packing material resulted in the acceptance of existing materials which is either John Crane I87-1 asbestos or Grafoil.
4. Rupture of 22.10 separator vessel caused by deterioration of vessel walls from corrosion that may have occurred during previous operating runs. The vessel is carbon steel construction.	Measure the wall thickness of vessel to determine if any corrosion has taken place. Project Engineering will initiate.	The vessel will be internally visually inspected and dye penetrate tested for indications of corrosion. Further testing (i.e., ultrasonic) will be performed if the visual inspection indicates significant corrosion.
5. Improper disposal of methanol from the storage tank after the run is complete. The methanol composition will contain larger quantities of CO_2 and water and may include DME.	This is an environmental issue. Address the potential options for disposal of the methanol and determine if any new risks exist. Project Engineering will initiate.	A customer has been identified for the sale of the methanol. A market search is being performed for the sale of the DME product.

Hazard	Preliminary Hazards Review (PRHR) Recommendation/Follow-up	Design Verification Review (DVR) Status
6. An operability concern was identified with the recycle compressor and the potential for exposing its suction side to low temperatures due to a failure of the new CO_2 exchanger's (21.80) temperature control system.	Although this concern was not identified as a hazard, these follow-up items were recommended: a) Determine the need and appropriate set point for a low temperature alarm on the compressor's suction line. b) Review the compressor material compatibilities at low operating temperatures.	A low temperature alarm TAL-233 on the inlet to the 22.12 has been included in the design and will be installed to protect the compressor from exposure to temperatures below -20°F.
7. Carry over of alumina catalyst into equipment (new and existing) downstream of 27.10 reactor could cause a reaction.	Review the reactivity grid. Process Engineering	Process Engineering completed a reactivity review associated with the carry over of alumina and methanol catalyst (See Table 2). The temperature rise in downstream equipment is not expected to exceed design limits. Because the alumina catalyst in the reactor will be at nearly saturated conditions (w/ H_2O and CO_2), the additional heat effect is negligible.

Hazard	Preliminary Hazards Review (PRHR) Recommendation/Follow-up	Design Verification Review (DVR) Status
8. Damage or rupture of the 22.14 separator vessel caused by the presence of cold gas into the vessel as a result of a failure of the pressure control system on the CO_2 exchanger (21.80). The vessel is 1-1/4 Cr - 1/2 Mo construction.	A review of the temperature/ pressure capabilities of the equipment downstream needs to be performed considering the short duration of the proposed run. A low temperature protection system may have to be installed in accordance with results from previous fault trees developed for similar systems. In addition to the 22.14 vessel, other equipment located downstream (21.38, 22.18, DME storage tank) could be exposed to the low temperatures.	A fitness for services analysis of the 22.38, 22.14, and 22.18 vessels was performed and a conclusion reached stating that these vessels are satisfactory for both the expected and worst upset conditions (Reference Appendix A, 4 Dec. '90 memo from J. C. Tafuri). It was decided, however, to provide in the design redundant low temperature shutdown interlocks. A supplemental shutdown circuit (SD-1A) was added.
9. Liquid carry-over from the 22.18 separator vessel vent to downstream equipment due to a failure of the vessel's LIC.	The thermal effects of introducing liquid to the knockout pot which is located downstream of the vapor outlet nozzle on the 22.18 should be reviewed.	The equipment and piping located downstream of the 22.18 vent are of carbon steel construction. The minimum low temperature exposure as a result of a failure of the LIC-693 circuit was determined to be -13°F. As a result, it was agreed no further action is required. Additionally, it was noted that the time required to overfill the 22.18 would be at least 2-3 hrs.

Hazard	Preliminary Hazards Review (PRHR) Recommendation/Follow-up	Design Verification Review (DVR) Status
10. Equipment or piping overpressurization due to the presence of a different fluid composition. (The addition of DME.)	Review the sizing of existing relief devices and establish criteria for relief devices on new equipment. Process Engineering/ Start-Up	A comparison of vapor mole weights for MeOH and DME runs was performed and is attached as Table 3. Additionally, the adequacy of all affected existing relief devices was reviewed and all were determined acceptable (excluding the following) for the DME run (Table 4). Safety device PSE-628 was identified as requiring further review. Following the DVR, Process has reviewed the tube rupture case associated with PSE-628 and concluded the device is adequately sized. (Reference Appendix C) However, the associated forces (in the event of a rupture) in the piping system attached to PSE-628 have been identified as being significantly increased (approximately 70% greater). A stress engineering review of this system will be performed and modifications implemented as required prior to the plant start-up. The ORI will verify that proper action has been taken.

Hazard	Preliminary Hazards Review (PRHR) Recommendation/Follow-up	Design Verification Review (DVR) Status
11. Methanol storage tank fire.	The existing fire protection system should be adequate. The incremental DME levels in the methanol poses no additional fire risks that cannot be handled by existing equipment.	No further review was required.
12. DME storage tank fire (external) caused from a leak, overfill, or open drain valve.	Review the plant design layout with regard to the location of DME storage tank and methanol storage tank. Review the need for additional fire protection systems.	It was decided that the existing fire protection system (fire monitors) will sufficiently cover the DME storage tank. The tank is designed and located in accordance with the requirements of NFPA-58. The NFPA-58 requirements for installation and operation will be verified during the ORI.

III B. ADDITIONAL HAZARD ITEMS IDENTIFIED FOLLOWING THE PrHR

Hazard	Recommendation/Follow-up	Status
13. 21.80 Vent Stacks		
a) Exposure of personnel to hazardous levels of CO_2	a) The CO_2 release rates from the 21.80 vent stack during the DME recovery and no DME recovery cases need to be calculated. Additionally, the CO_2 vent stack discharge nozzle diameter and height above the top platform need to be established.	a) The CO_2 release rates for both operating cases were established and a dispersion analysis was conducted. The resulting vent stack recommendation calls for a 1" diameter discharge nozzle located 10' above the highest working platform. (Reference 3 Jan. '91 memo from G. A. Peters) Additionally, it was recommended that a heat collar be installed on the vent tip to prevent ice buildup.
b) Exposure of personnel to hazardous levels of flame radiation from the venting fluid (21.80 tube-rupture case)	b) The extent of personnel exposure to excessive heat levels should be estimated. Based on this finding and the vent sizing/height conclusions from part 13a, a recommendation should be made.	b) The flame radiation exposure review resulted in the same vent stack height recommendation as in hazard 13a. Additionally, it was suggested that personnel access to the top platform during the runs should be limited. ORI to confirm.
14. Failure or rupture of the purge nitrogen system due to inadequate protection.	A detailed review of the existing and new purge nitrogen systems needs to be performed to verify conformance with current APCI standards.	Start-up Engineering performed a detailed review of the purge nitrogen system and the areas requiring modification are detailed on the Rev. 13 P&ID (F/S 87-7-1533). These modifications will be made prior to the DME run.

Hazard	Recommendation/Follow-up	Status
15. High pressure process gas leakage from the new piping system SS10X3 (i.e., leaking flange) due to high temperate exposure - above 350°F - during a plant upset.	Include in the design a high temperature shutdown interlock in the SD-2 circuit protecting the piping system installed for the DME run.	A shutdown interlock was added to the existing high temperature switch - TSH-309 - which is located downstream of the 21.30 exchangers. Although the maximum design temperature under SS10X3 is 350°F, it was decided to set this switch at 175°F, as this temperature should never be reached under normal conditions.
(The following items are not considered hazards but are documented for the purpose of maintaining a record of the entire meeting discussions.)		
16. 21.80 vent noise levels	It was recommended that the noise levels caused by the CO_2 vent system be estimated and corrective action be included in the design as necessary.	A preliminary noise level estimation performed by Design indicated a continuous sound pressure level in excess of 90 dBA. However, a second review was conducted and the estimated level reduced to 73 dBA. No sound attenuation measures are being taken.
17. Tie-in to 16.20 CO_2 tank and selection of associated safety relief valves.	Due to the lack of sufficient information available from the CO_2 tank supplier, the proper selection and set points of the required safety relief valves were deferred until the completion of the tank delivery and installation.	Operations will provide Process and Design Engineering with information required to properly check the size of safety relief valves for this system. The completion of this issue will be verified during the ORI.

IV. Follow-Up Work

The following items have been identified as requiring development and documentation:

Item	Responsibility
A. Process design limitations	Process Engr.
B. Process Run-Authorizations	Process Engr.
C. Operator Training Documentation	Operations
D. Start-up procedures	Process/Start-up/Operations
E. ORI check list	Project Engr.
F. ORI planning meeting	HR Team
G. ORI	HR Team