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UNION CARBIDE

UNION CARBIDE CORPORATION

P.O. BOX 50, HAHNVILLE, LA 70057

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EPA AIR DOCKET

May 12, 1995

Mr. John Schaefer
U. S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Mail Drop 13
research Triangle Park, NC 27711

Re: Comments to Proposed MACT for the THBA Production Source Category

Dear Mr. Schaefer:

On March 29, 1995, representatives of EPA-RTP, LDEQ-AQD and Union Carbide participated in a conference call and discussed EPA's proposal for MACT standards for the THBA production facility at Union Carbide's Taft Plant in Louisiana. During that discussion, Union Carbide agreed to evaluate EPA's proposed MACT, to identify and discuss the issues and to recommend alternate MACT control technologies for the THBA process. The attached document, Re: Proposed MACT For The THBA Production Source Category, Union Carbide Taft Plant, is intended to satisfy that commitment.

As agreed during that conference call our next steps would be for EPA and LDEQ to review our attached comments and then to reconvene either over another conference call or a meeting. Union Carbide prefers a meeting if possible.

Also attached is (1) a copy of a test of waste water Method 304 as performed on Union Carbide Taft/Star waste water by an independent consultant, (2) an equipment layout drawing showing the location of leak detectors and (3) a printout of a process control computer screen showing continuous monitoring results from fixed point leak detectors.

If you have any questions, please call me at (504) 468-4603 or Mr. Joe Hovious at (203) 794-5183. Written correspondences should be addressed to Mr. W. T. Gray, Jr., Taft Plant Manager.

Sincerely,

T. J. Covin

T. J. Covin
Health, Safety and Environmental Dept.

Attachments (4)
TJC/tjc

cc: Atly Brasher
LDEQ/AQD - Baton Rouge

PROPOSED MACT FOR THE THBA PRODUCTION SOURCE CATEGORY
UNION CARBIDE TAFT PLANT

BACKGROUND

The Union Carbide Corporation owns and operates a major organic chemical and polyethylene manufacturing facility at its Taft/Star manufacturing complex in St. Charles Parish, Louisiana. Within this facility are a number of production lines, some of which produce primary intended products that are listed in Table 1 of 40 CFR Part 63, Subpart F, and are therefore subject to the maximum achievable control technology (MACT) standards under the Hazardous Organic NESHAPS (HON) Rule for Synthetic Organic Chemical Manufacturing Industry (40 CFR, part 63, subparts F, G, and H).

The primary intended product of one production line at the Taft/Star complex is tetrahydrobenzaldehyde (THBA) which is not listed in Table 1 of subpart F and is therefore, not subject to the HON. In the "Documentation for Developing the Initial Source Category List' (EPA-450/3-91-030, July 1992), EPA included a source category entitled "Butadiene Dimers Production" under the industry group of Miscellaneous Processes. In the description of that category, EPA incorrectly lists THBA as a "Butadiene Dimer". The Butadiene Dimers source category is scheduled for regulation by November 15, 1997.

All facilities at the Taft/Star complex are subject to Louisiana MACT (Title 33, Part III, Chapter 51, Subchapter A - Comprehensive Toxic Air Pollutant Emission Control Program) requirements with a compliance date of December 20, 1996. On December 20, 1992, Union Carbide submitted a compliance plan proposing a compliance strategy for the Louisiana MACT rule. In the absence of other information, Union Carbide elected to submit a compliance strategy for all affected units which was based on the requirements of the pre-proposal HON drafts. In the intervening period, Union Carbide has been developing specific compliance plans for the Louisiana MACT standard for all facilities including the THBA unit.

In a facsimile received by Union Carbide on March 29, 1995, EPA indicated that THBA production is the only chemical covered in the Butadiene Dimer source category and proposed to add THBA to the list of HON affected chemicals with the next Source Category List update. Union Carbide's Taft/Star complex is the only US manufacturing facility for THBA.

In a phone call with EPA and Louisiana DEQ personnel on March 29, 1995, Union Carbide expressed concerns regarding the addition of THBA to the HON affected chemicals because of certain differences between THBA manufacture and other HON chemicals and agreed to review the EPA proposal and document those concerns. The concerns identified by Union Carbide will also impact the Louisiana MACT compliance plan. This memoranda is prepared to document concerns and propose an alternate MACT compliance plan.

THBA PROCESS

The line of equipment used to manufacture THBA is one of four manufacturing lines in the Specialty Products Unit (SPU) at the Taft/Star complex. Each of these four equipment lines is used for the production of a specific (and different) primary product. Only Line 1 is used for the production of THBA. While THBA is the primary intended product, the manufacturing line producing THBA is a flexible operation unit as that concept is defined in the HON and produces more than one product. Line 1 of the SPU is also capable of producing methoxydihydropyran (MDP) during separate production runs.

THBA is produced through the reaction of acrolein and butadiene. Acrolein is a very reactive material with a very low odor threshold and is a severe lachrymator. Acrolein is also highly reactive with caustic and water and is toxic to biota in biological treatment systems. As a result, the facilities used to manufacture THBA have certain special design and operating safety considerations that are not present in other SOCMI facilities. These differences must be considered when comparing the THBA facilities with other SOCMI facilities.

EPA is proposing to add THBA to the list of HON affected chemicals with the next Source Category List update and, therefore, to have the Union Carbide THBA production facilities subject to 40 CFR, part 63, subparts F, G, and H. The HON MACT requirements for control of HAP (hazardous air pollutant) emissions from storage tanks, process vents, loading operations, waste water operations and equipment leaks would then apply to the facility.

Union Carbide is of the opinion that the THBA process is similar to other facilities controlled by the SOCMI HON such that control requirements for storage tanks, process vents, and transfer operations are appropriate control requirements. In fact, we believe that the process presently meets the HON MACT standards for these emission points.

However, Union Carbide is of the opinion that the waste water control requirements for THBA production are fundamentally different from other SOCMI facilities and the reference control technology specified in the HON is not appropriate for THBA production. Union Carbide is also of the opinion that, because of the special design and operating procedures installed to manage the odor and lachrymator characteristics of acrolein, the controls currently in place at the THBA process for equipment leaks are equivalent to subpart H requirements and should be specified as a compliance alternate to the leak detection and repair work-practice specified in subpart H. Additional periodic leak detection programs are neither necessary nor justified. Union Carbide requests that these suggested changes be reflected in both the Louisiana air toxic control plan and the MACT standard for THBA.

WASTE WATER OPERATIONS

For the line one THBA and MDP processes, the following four Table 9 volatile organic hazardous air pollutants (VOHAP) are discharged into waste water streams: (1) acrolein, (2) 1,3-butadiene, (3) acetaldehyde and (4) methanol. Acetaldehyde and methanol are discharged from Line 1 to the waste water only during MDP production.

The waste water treatment provisions of the HON allow several options to meet removal and destruction efficiencies for Group 1 waste water streams. The required removal and destruction efficiencies (%) for the waste water (liquid) and vent (vapor) for the Table 9 materials are:

VOHAP	**Waste water treatment**	**Vent**
acrolein	96	95
acetaldehyde	95	95
1,3-butadiene	99	95
methanol	31	95

As an alternative, the source can simply apply the reference control technology (RCT), steam stripping in a specified system, to any group 1 waste water streams. Several other compliance options are available under the HON.

As noted above, acrolein is highly toxic to biomass in a biological waste water treatment system (>0.01 mg/l) of the type used at the Taft/Star complex to meet NPDES discharge requirements. Any emissions of acrolein to the air from waste water would also be highly odorous and could cause individual exposure problems in the unit or waste water treatment facilities. To remedy these problems, waste waters from the lines 1 (THBA), 3, and 4 of the SPU are treated in a caustic waste treatment reactor (CWTR) designed to react any contained acrolein to a water soluble polymer in a sodium hydroxide medium. The CWTR is more than 98% efficient in the destruction of acrolein. The effluent from the CWTR is hard-piped to a biological waste water treatment facility that is located on-site. The CWTR is a very important treatment device for the unit because of the reactivity and toxicity of acrolein. The CWTR is vented to a flare to burn overhead vapors occurring in the reactor.

The other HAP present in the THBA waste water which is treated in the CWTR is 1, 3-butadiene. Under the reactive conditions, the CWTR flashes greater than 99% of the butadiene overhead for destruction in the flare. These destruction efficiencies for acrolein and 1, 3-butadiene were submitted as a part of the process unit's CAA §114 Questionnaire. Thus, all HAPs generated in the production of THBA are treated in the CWTR to greater than the required efficiency specified in the HON MACT. The CWTR would meet HON MACT standards and would be the technology of choice for THBA MACT because of the special requirements for treatment of the acrolein containing waste water and its demonstrated efficiency.

As a treatment device, the CWTR vent stream would be regulated by §63.138(c)(2) *process waste water provisions--treatment processes* and 63.139 *process waste water provision -- control devices.* As described in the HON and BID, residues from HON waste waters streams are generated as a result of non-destructive treatment processes. The examples cited as residues included overheads from steam and air strippers, or an organic layer from a decanter. Due to the destructive reaction occurring in the CWTR, the tails discharged to the biological waste water treatment would not be a waste water residue per the HON provisions.

WASTE WATER OPERATIONS - (con't)

As noted above, the THBA facility (Line 1) is a flexible operation unit as that term is defined in the HON. During certain times Line 1 produces MDP. During the periods when the THBA equipment is producing MDP, the waste water from the process going to the CWTR from line 1 also contains an additional two VOHAPs, acetaldehyde and methanol. Under the HON, facilities with flexible unit operations must meet the MACT standard at all times. The CWTR is more than 98% efficient in the destruction of acetaldehyde. However, the methanol removal required to comply with subpart G of the HON (31%) is not achieved in the CWTR. Therefore, when line 1 is manufacturing MDP, the CWTR tail stream will require further treatment to achieve destruction target as specified in §63.138(c)(1)(iii)(D).

The THBA manufacturing process as practiced at the Taft/Star facility therefore provides a unique situation which Union Carbide suspects was not anticipated in the development of the HON standard or the Louisiana air toxic rule. The HON, in requiring a flexible operation unit to achieve compliance with the standard at all times, anticipated operation of the same controls during times when the primary intended product and other materials were manufactured. However, in the case of THBA, a different control strategy may be required during the production of the alternate product to destroy methanol in the waste water stream, potentially requiring significant new investment for an alternate product that is not covered by the intended standard in the HON.

The HON provides that the required removals of VOHAPs in waste water may be achieved by a variety of treatment techniques or several treatment operations in series as stated in §63.138(c)(1)(iii)(D). One treatment option is to use biological treatment in conjunction with the CWTR to achieve the required removal of VOHAPs. The waste water from the CWTR is hard-piped to a biological waste water treatment facility where the methanol is biodegraded. This option would utilize the current system in existence at Taft/Star. However, demonstration of the required degradation using the prescribed Method 304 in 40CFR Part 63 Appendix C has proven impossible to obtain reproducible results due to fundamental flaws in the experimental procedure. In addition, other issues must be resolved prior to utilizing the combination of CWTR and biological treatment for MACT compliance. The issues needing resolution are discussed in the Biological Treatment Option Section below.

BIOLOGICAL TREATMENT OPTION

After line 1 waste water streams are treated in the CWTR, they are hard piped to the Taft/Star biological waste water treatment system. Once the waste water leaves the CWTR, it does not contact the air until it arrives at the waste water treatment plant where it is combined with other process waste waters from the location.

The first step of waste water treatment involves physical and chemical treatment in the form of removing floating materials and settleable solids and pH adjustment with sodium hydroxide or sulfuric acid. This treatment occurs in open clarifiers and pH adjustment tanks. The waste water is then pumped into fixed roof waste water tanks where it is gently mixed for equalization purposes and then is piped to the first stage of biological treatment. The first stage of biological treatment consists of extended aerated stabilization followed by additional biological oxidation in a UNOX® system and/or final clarification. The effluent from final clarification is a permitted NPDES discharge point.

BIOLOGICAL TREATMENT OPTION - (con't)

Methanol is a readily biodegradable material and continued treatment in the existing biological system is a reasonable solution for MACT compliance. However, as currently promulgated in the HON, there are several practical issues with this compliance option. These issues are all topics of ongoing litigation between CMA and EPA regarding the HON. The list of issues is as follows:

- Methanol is a low volatility material which should not be considered a VOHAP for purposes of regulation under the HON.
- The gentle mixing in the equalization tank would require controls on the tank vent for a very low volatility combined waste water stream as required by §63.133(a)(2).
- The demonstration of biological treatment system efficiency required under Method 304 has been tried and simply does not work at Taft/Star. Union Carbide submitted comments regarding these studies as part of the comments on the HON proposal (copy attached).

STEAM STRIPPER REFERENCE CONTROL TECHNOLOGY OPTION

As noted in section §63.138(c)(1)(iii)(A) of the HON, the control requirements for Group 1 streams can be met by applying the RCT for process waste water, steam stripping with suppression of vapors. The RCT requires destruction of 99% or greater of the waste water residuals and 95% destruction or greater of vapors from Group 1 waste water streams.

The steam stripper RCT was the original Union Carbide proposal in 1992 for Louisiana MACT compliance. Significant changes have occurred to the design and performance of the HON MACT steam stripper since the HON MACT was proposed. In performing design studies for installation of the steam stripper in THBA service, Union Carbide has determined that the use of a steam stripper is not appropriate to treat waste water streams from the THBA process for safety reasons and for operating conditions specific to the THBA process. Two operating scenarios were considered in evaluating the efficacy of the RCT for treating waste water streams from the THBA process; (1) before the CWTR and (2) after treatment in the CWTR.

If a steam stripper were placed upstream of the CWTR, the feed to the stripper would contain mostly water with small concentrations of methanol (0.3%), acetaldehyde (2.0%), acrolein (0.8%), and butadiene (which could potentially occur during cleanups if the ambient temperature is below 37° F) in a stream of about 1300 pounds per hour (pph). Historically THBA has not been produced around December 1 through mid-February due to the freezing point of cyclohexane. Acrolein has a solubility of 20.8% by weight in water at 20°C. Most of the acrolein would be taken overhead in the stripper. Sending this overhead stream to a tank or other vessel prior to final disposal presents a serious safety concern. The concern is the temporary storage of acrolein in water. After steam stripping, the condensed overhead would contain approximately 20% acrolein in water. Layering would occur between the acrolein and water and an interface would develop and this condition could result in a runaway reaction of the acrolein. This is a situation that Union Carbide operational safety standards do not allow. The reaction between acrolein and water can lead to a runaway reaction via self-heating, which results in a significant increase in pressure. This over-pressurization can result in equipment rupturing. Therefore, the storage and handling of the mixed organic stream from the steam stripper overheads presents unacceptable safety hazards.

STEAM STRIPPER REFERENCE CONTROL TECHNOLOGY OPTION - (con't)

The second alternative could be to place a steam stripper after the CWTR destroys acrolein. If placed downstream of the CWTR, the main concern would be that of caustic contained in the CWTR effluent and the reactivity problems associated with it. The main concerns are the handling of the vent stream and the buildup of caustic in the circulating base of the steam stripper. The vent stream from the stripper would undoubtedly contain some residual caustic that would be entrained overhead. Because of the requirement in §63.139(c) to obtain 95% reduction of the vent stream VOHAP level, the vent stream from the steam stripper would be sent to an existing flare header for destruction. This is the same flare header that receives other acrolein containing vents. The concern is that caustic entering the flare header would mix with other acrolein containing streams normally venting into the flare header. Acrolein is highly reactive in the presence of caustic which could result in an unsafe condition in the flare header. Current conditions with operating the CWTR does not force the caustic into the vapor phase and, therefore, does not pose a potentially unsafe condition in the flare header. A second concern of operating a steam stripper after the CWTR is heat exchanger fouling and plugging in the steam stripper's heat exchanger and sieve trays. The effluent from the CWTR is highly caustic. It is quite common in processes, such as steam strippers, that flash materials away from caustic to have caustic salts deposited on the tubes of the heat exchanger and sieve trays. This condition eventually reduces the effectiveness of the heat exchange and affects the on-stream time and operability, which could result in compliance problems. Fouling of the heat exchanger and sieve trays was addressed as a potential operational problem in the CMA Report "Evaluation of HON Rule Steam Stripping Requirements".

The installation of a steam stripper in SPU to remove methanol poses several safety and operational concerns and should not be considered as a MACT compliance option. Therefore, Union Carbide wishes to amend the Louisiana MACT plan submitted in December 1992.

WASTE WATER SUMMARY

The current operation using the CWTR is the most safe and cost effective method of treating process waste water from the THBA process and meets HON MACT standards. The CWTR destroys >98% of acrolein and acetaldehyde and flashes >99% of the butadiene to a flare. However, due to the fact that the THBA process is a flexible operation unit, some treatment operation in addition to the CWTR would be necessary to remove methanol to comply with the THBA HON MACT during periods when MDP is manufactured in Line 1 of the unit.

Union Carbide is of the opinion that, if methanol continues to be a Table 9 material under the HON, the CWTR coupled with the biological waste water treatment facility meets the HON MACT waste water requirements for the line 1 THBA and MDP processes. The four VOHAPs from line 1 are meeting MACT with a combination of the CWTR and biological waste water treatment facility. Union Carbide can provide existing operating and modeling studies that demonstrate the destruction effectiveness of these two treatment devices for the four VOHAPs of concern.

WASTE WATER SUMMARY - (con't)

However, several issues obstruct the simple incorporation of THBA into the HON MACT Rule. Union Carbide has significant safety concerns in specifying the steam stripper as a RCT for THBA production. The selection of low volatility methanol as a VOHAP is the subject of ongoing litigation regarding the HON MACT Rule. While biological treatment is a viable candidate for removal of methanol, the HON MACT requirements to use Method 304 to demonstrate biosystem effectiveness is a major concern. Method 304 has been tested at Taft/Star by an internationally recognized biological treatment consulting firm who were unsuccessful in obtaining reasonable results. The results of that test are attached. The method 304 demonstration requirement is the subject of ongoing litigation.

Given the above issues Union Carbide recommends:

1. Recognize the CWTR as reference control technology for THBA waste water
2. Delay requiring controls on MDP waste water pending settlement of the HON litigation.

EQUIPMENT LEAKS

The THBA process is not presently regulated by any existing equipment leak detection and repair programs. However, because of the odoriferous and toxic nature of the material handled such as acrolein, the facility does have an effective program in place for minimizing equipment leaks and for detecting acrolein spills, releases and leaks. The program consists of a combination of administrative controls, equipment standards and an acrolein leak detection network.

Administrative Controls

Administrative controls include leak testing, equipment inspection, and testing performed on equipment prior to the introduction of chemicals. Examples of the extensive in-place administrative controls are as follows:

- All equipment that is opened must be sensitive leak tested when closed and before being returned to service. This test is done by pressuring the system using nitrogen for pneumatic testing. All components that are susceptible to leaks are then checked with a soapy solution. Any leaks are repaired.

- All equipment must pass a standing pressure test. This test is done by pressuring the system pneumatically and then monitoring for any pressure loss. Any loss is investigated and corrected.

- Following a sensitive leak test and a standing pressure check, the high pressure reaction system is then pressured with boiler feed water to 800 psig and observed for any leaks or pressure loss. Any discrepancies are corrected.

- In addition to a sensitive leak test and a standing pressure check, any vacuum systems must also pass a standing vacuum test. This is done by pulling as low a vacuum as possible on the vessel and then monitoring for 30 minutes for any increase in pressure. Any increase in pressure beyond 25 mmHg in 30 minutes is investigated and corrected.

Equipment Standards

Equipment in HAP service meets the following equipment standards:

- Open ended valves and lines are either plugged or blind flanged.
- Pressure relief devices are vented to a flare.
- All sampling is by closed loop sampling systems.
- Quarter turn valves are used whenever possible instead of rising stem valves. Quarter turn valves provide an inherently low leak design.
- Low fugitive emission valve and piping specifications were used in the design of the facility.
- Pumps are equipped with dual mechanical seals. Acrolein tank pumps are equipped with dual seals (packed and mechanical) with a pressure-nitrogen sweep applied across the packing to purge any leakage back into the tank. Pumps in liquid HAP service are equipped with double mechanical seals with a pressurized liquid buffer fluid. There are flow sensors on the buffer lines to verify that there is a flow of buffer across the seals. In addition there are local gauges to verify that the pressure of the buffer system is adequate to prevent process fluid from leaking out.
- There are no compressors, bottom receivers or surge control vessels in HAP service.

Leak Detection Programs

Rapid detection, identification and elimination of acrolein leaks is necessary due to its toxicity and lachrymator characteristics. The manufacturing process is manned 24 hours per day and all operators are carefully trained to respond to leaks detected by sight, sound or smell. If a leak is suspected, equipment in the area is monitored with a organic vapor analyzer to locate the leak. All leaks that are found are repaired as soon as possible.

In lieu of a periodic monitoring program, the SPU has a fixed point detection system for detecting acrolein leaks. The system consists of 23 discrete fixed sampling locations, two gas chromatographs with flame ionization detectors, a computer to graphically display the results of the sampling/analytical systems and an alarm system. The sampling system is strategically located to surround the equipment that is in acrolein service. Ambient air samples are drawn continuously via two double headed vacuum pumps and the analyzers are capable of analyzing a stream every 3 minutes. The 23 sampling points are split between the two analyzers which allows for each sample point to be analyzed every 33-36 minutes. Attached is a plot plan showing the location of the sampling points relative to the layout of the facility.

The analyzers have a good response at less than 0.1 ppm acrolein. Low warning alarms are set at 0.2 ppm and high alarms are set at 0.3 ppm except for the sump detection, which is set at 0.5 ppm and 1.0 ppm, respectively. Information from each stream is fed into a computer system that provides a graphic display for the control board technician. Wind direction and speed is also provided on the display to aid the production staff in trouble shooting a leak. Attached is a print out of the graphic display that is available to operating personnel.

Leak Detection Programs - (con't)

For all of these reasons, the SPU and the THBA process have very low fugitive emissions. In 1988, a fugitive emissions survey of the SPU was conducted by CK Associates in response to a request from Mr. Jack R. Farmer, U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Of the 1559 components checked during that survey, only 11 had readings above background. Of those 11 components, 8 had readings of less than 50 ppm, 2 at approximately 200 ppm and one (a flange) at 5000 ppm. The HON allows 10%, or 3 leaking pumps; the SPU had none. The HON allows 2% leaking valves; the SPU had none. The HON allows 0.5% leaking connectors; the SPU had 0.07%. Consequently, it is Union Carbide's opinion that this system is equivalent to RCT for equipment leaks and the additional expense and work of a periodic leak detection program for this unit is not justified from an emissions or cost basis.

Union Carbide requests that the systems in place to control equipment leaks in line 1 be recognized in the THBA MACT development process as an alternative compliance option. Union Carbide would be willing to work with EPA to conduct an additional test to verify equivalency and to develop regulatory language to reflect this alternate compliance alternative.

COMPLIANCE TIMING

In the March 29, 1995 conference call, EPA suggested that if THBA were added to the HON listing, the compliance date would be the compliance date for the Louisiana MACT standard. Given the number of unresolved waste water issues with pending litigation regarding the HON and issues identified in this paper, Union Carbide suggests that the schedule for THBA production should be as proposed for the Butadiene Dimers source category, promulgation by November 15, 1997. Compliance would follow at a reasonable time, but no later than 3 years after that date. In no event should compliance be specified on a common timetable with the HON which would require compliance with the equipment leak provisions immediately (even if THBA is a group V material).

SUMMARY

Union Carbide requests that:

1. Process vents, storage vessels, and transfer operation MACT for THBA production be set at HON levels.
2. The Steam stripper be deleted from the Louisiana MACT compliance plan
3. The use of the HON leak detection and repair program be deleted from the Louisiana MACT compliance plan and be replaced with the currently utilized work practice and design standards.
4. EPA consider whether the requirements that flexible operation units under the HON comply at all times considered that additional treatment operations could be needed only for periods of the flexible operations.
5. MACT requirements for THBA waste water treatment include the CWTR as a reference control technology.
6. Requirements for methanol treatment from the production of MDP be deferred pending resolution of the CMA litigation on the HON.
7. Requirements for demonstration of biological system removals be deferred pending resolution of the CMA litigation on the HON.

UNION CARBIDE

Union Carbide Corporation
Health, Safety & Environment
39 Old Ridgebury Road Danbury, CT 06817-0001

April 19, 1993

EPA Air Docket, (LE-131)
Attention Docket Nos. A-90-18, A-90-19, A-90-20, A-90-21, A-90-22, and A-90-23
Room M1500
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

To Whom it May Concern:

Union Carbide Corporation is pleased to submit comments on the Environmental Protection Agency's (EPA) December 31, 1992 proposed rule on National Emission Standards for Hazardous Air Pollutants for Source Categories: Organic Hazardous Air Pollutants from the Synthetic Organic Chemical Manufacturing Industry and Seven Other Processes (57 Fed. Reg., 62607 et. seq., December 31, 1992. Union Carbide owns and operates production facilities which will be affected by the proposed rule.

Union Carbide is a member of the Chemical Manufacturers Association (CMA) and, as such, has been an active participant in development of CMA comments on the proposed rule and is in agreement with, and incorporates by reference, the comments submitted by CMA on behalf of its membership. In addition, Union Carbide has participated in the preparation of comments for the Ethylene Oxide Industry Council and the CMA Olefins Panel and incorporates those comments by reference.

In addition to the referenced CMA, Ethylene Oxide Industry Council, and Olefin Panel comments, we would like to take this opportunity to amplify what we view as particularly critical issues and to provide data specific to Union Carbide facilities. Included as an attachment are Union Carbide specific comments. Because these comments pertain to all provisions of the December 31, 1992 proposal, Union Carbide is providing 12 copies of our comments so that you may place 2 copies in each of the docket "subgroups".

Many of the Union Carbide comments reference operations or compliance conditions at specific facilities without providing the name or location of the facility for purposes of business confidentiality. If EPA should need additional information regarding specific facilities, Union Carbide will provide additional documentation. If there are requests for additional facility documentation or other questions, please contact me at 203-794-5183.

Very truly yours,

J C Hovious

Joseph C. Hovious
Assistant Director
Environmental Affairs

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will be operated in such a manner to comply with 63.138. This provision is essentially impossible to comply with and does not take into account the significant investment in place to control these wastewater discharges and comply with NPDES and pretreatment requirements.

Public Owned Treatment Works (POTW) are also an existing MACT source category which will be evaluated and controlled in a future rule making. The requirement that streams be treated to 99% HAP in wastewater before discharge to a POTW eliminates the need for a POTW and its effectiveness will be greatly reduced.

SUGGESTION: Specify that the owner/operator is responsible within his facility for compliance. Retain the owner/operator notification in 63.132(i)(1) if transferred off site is not through a sewer system. Retain provisions of 63.132(i)(3). Emissions from TSDF facilities and POTW's and similar facilities not owned or operated by SOCMI owner/operator should be covered in the future source category MACT standards that directly impact these facilities.

ISSUE: Method 304 is Technically Unsound and Cannot be used to Demonstrate Biological Kinetics

A field study was undertaken at a Union Carbide facility using the draft Method 304. A copy of the report is attached. Method 304, as proposed, was not found to be representative of the operation of real biological wastewater treatment systems. Other conclusions were:

- Experimental setup and procedures described in the proposed Method 304 are inappropriate for operating conditions, such as, range of dissolved oxygen, and volume of reactor.
- Incomplete removal of ethylene glycol, indicating incomplete biological oxidation of this readily degradable compound under the test conditions.
- Essentially no methanol removed in the Method 304 reactor. Methanol is an easily biodegradable
- Negligible sludge yield was observed for the Method 304 reactor. The reactor's MLVSS could not be increased with time even without sludge wastage. This indicates that there was little or no bio-mass being produced.
- A white fungus-like growth was observed on the unstripped reactor clarifier liquid surface during the treatability study. In addition to the fungus growth the mixed liquid color changed to black.
- Inherent problems encountered in the operation of a closed activated sludge system with off-gas recycle.

SUGGESTION: Delete the use of Method 304 as a required test method to demonstrate biological degradation. Include the alternative test methods recommended by CMA in the final rule.

ISSUE: Demonstration of other types of effective biological treatment systems is needed.

Biological treatment methods offer low cost and high removal efficiencies for many of the HAP. The waste products from aerobic biological system are CO2 and water. Demonstration of biological treatment systems using validated models should be allowed under the rule. In addition to traditional

DRAFT

METHOD 304

EXPERIMENTATION REPORT

Prepared for:

UNION CARBIDE CORPORATION
Taft, Louisiana

Prepared by:

ECKENFELDER INC.®
227 French Landing Drive
Nashville, Tennessee 37228
(615) 255-2288

April 1993

6734

ECKENFELDER INC.

DRAFT

April 14, 1993

6734

Mr. Steve Mason
Union Carbide
Taft Plant
P.O. Box 50
Hahnville, LA 70057

RE: Method 304 Experimentation Report

Dear Mr. Mason:

We are hereby submitting our Draft Report of the subject study at your request. This document has not received a full technical review in accordance with our internal quality assurance procedures.

We look forward to completing this work.

Sincerely,

ECKENFELDER INC.®

Stephen R. Tate
Assistant Director
Wastewater Management Division

cc: Jack L. Musterman, Ph.D., P.E.

Q:\6734\TSLMAS.DOC

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1.0 INTRODUCTION

1.1 BACKGROUND

National Emissions Standards for Hazardous Air Pollutants for Source Categories are included in 40 CFR Part 163 and authorized by the Clean Air Act, Sections 101, 112, 114, 115, and 301. It has been proposed that Part 163 be amended by adding Subpart F (National Emission Standards for Organic Hazardous Air Pollutants from the Synthetic Organic Chemical Manufacturing Industry) and Subpart G which is specific to process vents, storage vessels, transfer operations, and wastewater in the industry. Union Carbide's (UCC) Taft, Louisiana plant has undertaken a study to determine the applicability of these proposed regulations to the Taft facility. ECKENFELDER INC. was retained to assist in this endeavor while engaged in conducting a comprehensive wastewater treatability investigation at the plant.

The proposed regulations specify Method 304 be used ("Determination of Biodegradation Rates of Organic Compounds") to estimate the removal of regulated volatile organic hazardous air pollutants (VOHAP) in biological treatment plants. A copy of the Method is provided in Appendix A.

The UCC Taft facility includes a large activated sludge plant consisting of aerated stabilization basins (surface aerators) and aeration tanks (previously pure oxygen activated sludge vessels) and final clarifiers. As such, ECKENFELDER INC. applied Method 304 and used the process operating conditions (F/M, MLSS, etc.) of the existing activated sludge plant at the Taft facility.

1.2 OBJECTIVES

The objectives of the study were to provide the following information:

1. Estimated biodegradation potential of specific organic compounds (volatile, semivolatile and non-volatile) in the UCC Taft wastewater treated at the activated sludge operating conditions of the UCC Taft plant, however, in a closed vessel with off-gas recycle.

2. Removal or reduction of specific organic compounds by air stripping.

3. Estimated biodegradation potential of the residual specific organic compounds after air stripping, and then treated at the similar activated sludge conditions as No. 1 above.

4. Performance of the closed vessel activated sludge systems with respect to BOD and COD removal.

5. Sludge settling and clarification characteristics.

2.0 EXPERIMENTAL METHOD AND MATERIALS

2.1 EXPERIMENTAL APPARATUS

The Method 304 experimentation was conducted with continuous flow, closed activated sludge reactor systems with continuous off-gas recycle. A schematic diagram of the experimental apparatus is presented in Figure 2-1.

The aeration reactor is constructed of glass with a 10-liter aeration/mixing volume and a separate, closed 4-liter settling/clarification vessel. Off-gas is collected and recycled to aerate the vessel. The reactor column is completely sealed with a single sampling port. Mixing of the reactor is accomplished by a combination of mechanical mixing, recycled gas input, and oxygen input. Oxygen and recycle gas are introduced at the bottom of the reactor column in separate inlets as shown in Figure 2-1. Oxygen was only added to the reactor intermittently as necessary to maintain a minimum dissolved oxygen (DO) concentration of 2.0 mg/L. Oxygen was supplied directly from an oxygen cylinder by regulating the oxygen flow at approximately 10 cc/min. The reactor headspace gas was recycled to the bottom of the reactor with a variable speed, peristaltic pump at a rate of 1,000 cc/min which did not create a vacuum. All recycle gas was passed through a 1 liter knockout flask to remove entrained moisture.

The mixed liquor overflowed into the clarifier as shown in Figure 2-1. The settled sludge was recycled to the bottom of the reactor column by a variable speed, peristaltic pump. The clarified effluent was collected in an effluent container through an in-line gas trap.

Two identical reactor systems were used in the study. The first reactor system, designated as the "unstripped reactor" received wastewater feed from a 20 liter, refrigerated, collapsible (zero headspace), polyethylene container equipped with a spigot cap. The wastewater was pumped from the container with a variable speed, peristaltic pump into the bottom of the reactor.

The second reactor system designated as "stripped reactor" received the same wastewater feed as the other reactor, however, this feed was air stripped and fed

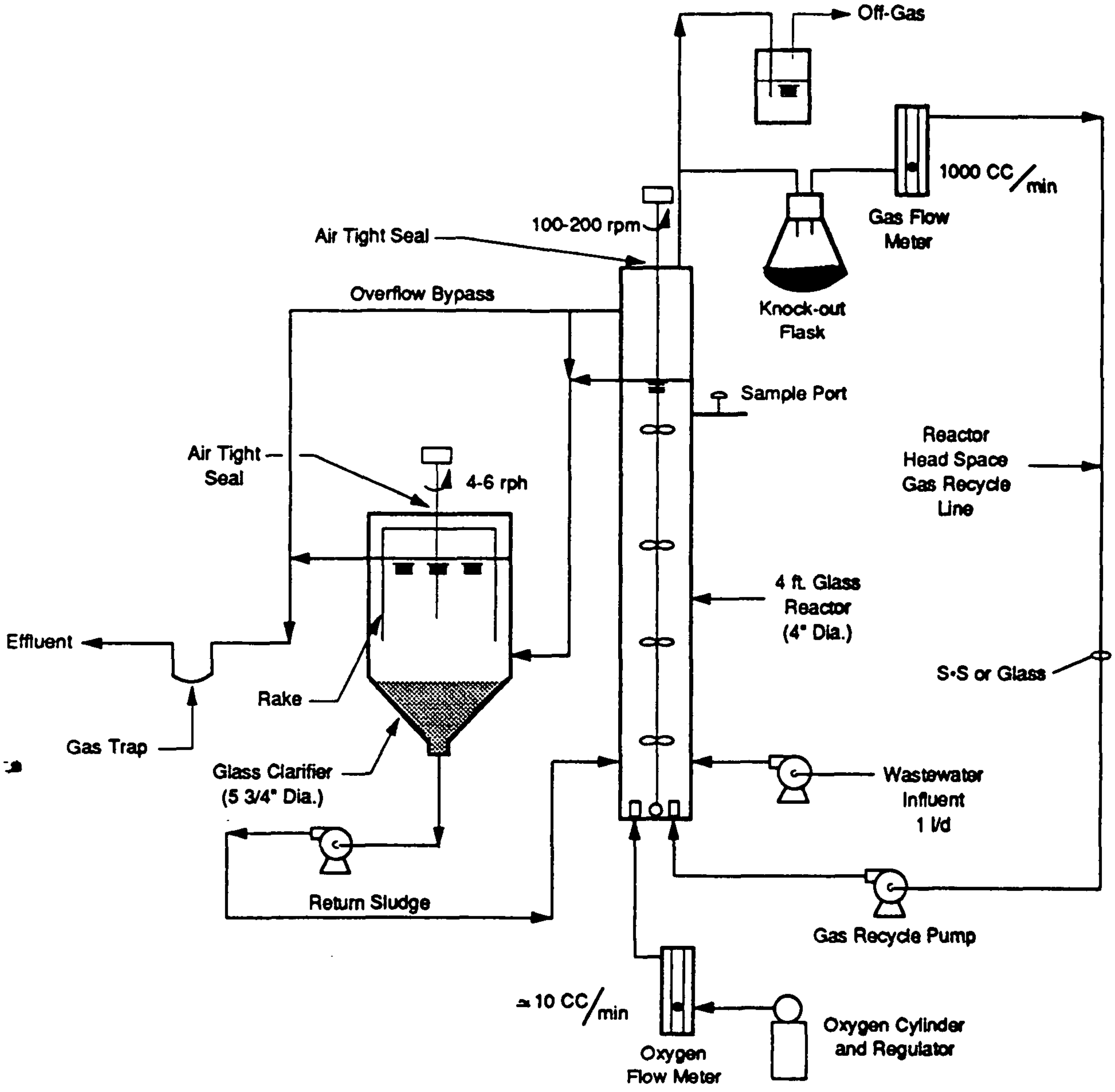

FIGURE 2-1
SCHEMATIC DIAGRAM
EXPERIMENTAL APPARATUS FOR
METHOD 304 STUDY

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Mahwah, New Jersey
Rochester, New York

from an open container. The stripped wastewater was also pumped by a variable speed, peristaltic pump into the bottom of the second reactor.

The raw wastewater was air tripped mainly to determine the gross removal of volatile organic compounds and then aluate the biodegradation potential of non-volatile organics in the closed activated sludge reactor with off-gas recycle. The raw wastewater was transferred from 1 gallon collapsible polyethylene containers to a 5 gallon open plastic container. The initial volume was noted in the container. The wastewater was then vigorously aerated under the hood for approximately 12 to 15 hours with airstone diffuser using compressed air. The loss of volume due to evaporation during the stripping process was accurately adjusted back to the initial volume with distilled water. This air stripped wastewater was then used in the stripped reactor for the evaluation of biodegradation potential of non-volatile organic compounds.

2.2 EXPERIMENTAL OPERATION

2.2.1 Startup

The experimental reactors were initially seeded and started up in early August 1992 at the UCC-Taft facility. The activated sludge reactors were seeded with biological sludge from the existing UCC-Taft activated sludge system. The "unstripped" and "stripped" reactors received their respective wastewater feeds during an acclimation period. The wastewater feed for both reactors consisted of 24-hr composite samples collected at sampling location D1 which is the raw wastewater prior to the primary clarifier. An aliquot of the collected wastewater was air stripped and then fed to the "stripped" reactor. In the third week of August 1992, the reactors were shutdown and relocated to the ECKENFELDER INC.'s wastewater laboratory in Nashville, Tennessee because of the threat of Hurricane Andrew.

Both experimental reactors were restarted in early September 1992 in ECKENFELDER INC.'s wastewater laboratory in Nashville, Tennessee. Over the course of the study, raw wastewater 24-hr composite samples were collected at D1 by UCC-Taft personnel and shipped overnight to ECKENFELDER INC.'s wastewater laboratory for the work. Each shipment consisted of six 1-gallon collapsible polyethylene containers with no headspace. Three gallons of the wastewater were transferred to the 20-liter refrigerated, collapsible, polyethylene container without stripping or introducing any turbulence during the transfer process. The other three gallons were placed in a 5-gallon container and vigorously air stripped (compressed air/airstone diffuser) overnight to remove volatile organic compounds (VOCs). The loss of volume due to evaporation during the stripping was adjusted back with distilled water. The unstripped and stripped wastewater samples were characterized for pH, TCOD and TBOD. Phosphorus nutrient was added to each wastewater feed in the form of phosphoric acid in order to maintain the proper macronutrients required for biological treatment.

2.2.2 Operation and Monitoring

The two activated sludge reactors were operated as continuous flow systems. The feed flow rate to the "unstripped" and "stripped" reactors was maintained at approximately 1 liter per day to provide a hydraulic retention time (HRT) of 10 days in both reactors. This HRT is approximately equivalent to the HRT of the full-scale Taft activated sludge system. The MLSS concentration in the reactors was also maintained closely similar to the MLSS concentration in the full-scale system. The reactors were monitored daily for pH, temperature, and dissolved oxygen (DO). Mixed liquor samples were analyzed two times per week for total suspended solids, volatile suspendid solids, and oxygen uptake rate (OUR). To evaluate system performance, composite effluent samples were collected at a minimum of two times per week and analyzed for pH, SCOD, SCBOD, TSS and VSS. Batch settling tests were conducted with the mixed liquor in 1-liter graduated cylinders with stirrers to evaluate the settling characteristics of the sludge.

2.2.3 Sampling and Analysis for Specific Organic Compounds

In order to estimate the biodegradation potential of the specific organic compounds of interest, representative influent and effluent samples were collected from both the unstripped and stripped reactors and analyzed for the specific organic compounds. For this analysis, only one influent sample was used. The influent for the unstripped and stripped reactors was sampled on September 22, 24, and 26. The influent sample was collected from the reactor feed line directly into VOA bottles on the three different days and analyzed individually for the specific organic compounds. Sampling and analysis of the same influent sample over five days was believed to provide for a more accurate analysis of the influent characteristics. Corresponding effluent samples were collected from the effluent line of both the reactors on September 29, October 1, and October 3. In this way, the first effluent sample was collected after approximately half of an HRT (5 days). The third effluent sample was collected after approximately one HRT (10 days) so that the effluent was representative of the influent fed to the reactor. The three effluent samples were analyzed individually for the specific organic compounds.

2.3 DEVIATION FROM THE PROPOSED METHOD 304 STUDY APPARATUS

The experimental apparatus for the study differed in some ways from the proposed apparatus described in Method 304.

- The biological oxidation reactors used were 10-liter glass columns of 10 liter volume instead of 6-liter conical reactors.
- The reactors were not equipped with internal probes to measure dissolved oxygen and temperature, a pressure monitor with vacuum setpoint control or a water-cooled condenser and alkaline scrubber on the off-gas.
- Mixing in the reactor column was provided by a combination of mechanical propeller mixing, and oxygen and recycle gas instead of aeration gas (oxygen and recycle gas combined) only.
- Oxygen for aeration was introduced through a separate inlet from the recycle off gas. In the proposed Method 304 apparatus, oxygen is introduced into the recycle gas line.
- The DO of the reactor widely fluctuated (1.5 mg/L to >20 mg/L) and could not be maintained as specified in Method 304, i.e. DO of the full-scale system, ±0.5 mg/L.
- A peristaltic pump was used for reactor headspace gas recycle instead of a gas blower.
- The reactor feed entered the bottom of the reactor and exited from the top after treatment as compared to the reverse of this in the proposed method.

- The volume of the clarifier was 4 liters with some headspace as compared to a 2 liter volume without headspace in the proposed apparatus.

The reactor volume was designed comparatively larger than the proposed Method 304 study in order to avoid a low feed flow rate because of the 10 day HRT. The reactor was designed as a column and fed at the bottom in order to provide for a more effective mixing regime. The DO in the reactor was monitored and controlled manually. The reactor DO was difficult to control and could not be maintained as recommended by the proposed Method 304. The intermittent addition of small amounts of oxygen resulted in supersaturation of the mixed liquor within minutes. Pressure monitoring with a vacuum setpoint was not required to regulate oxygen input because a vacuum was never created in the reactor at the gas recycle rate of 1,000 cc/min. Since the reactor was operated at ambient room temperature, heating and continuous temperature monitoring were not required.

The reactors were not equipped with alkaline scrubbers on the headspace recycle gas. Alkaline scrubbers are normally used to remove carbon dioxide (CO_2) from the recycle gas so that the reactor pH is not reduced drastically in the closed system. In this study, the food to microorganism (F/M) ratio was low, (0.10 d^{-1}) thus a very low CO_2 concentration in the system. Hence, the pH in the reactor system was easily controlled between 6.5 and 7.2 with the addition of caustic (sodium hydroxide) as required.

The peristaltic pump used for gas recycle (instead of a blower) resulted in less condensation. Since clarifier headspace gas was also recycled back to the reactor (as shown in Figure 1) a gas trap was located in the effluent line.

2.4 ANALYTICAL METHODS

Analytical methods used in the analysis of the parameters of interest are presented in Table 2-1.

TABLE 2-1

ANALYTICAL TEST METHODS

Parameter	Test Method	Reference
Total[a] Biochemical Oxygen Demand	410.4	1
Soluble Carbonaceous[b] BOD	410.4	1
Total Chemical Oxygen Demand	405.1	1
Soluble[c] Chemical Oxygen Demand	405.1	1
Total Kjeldahl Nitrogen	351.3	1
Ammonia Nitrogen	350.3	1
Total Suspended Solids	160.2	1
Volatile Suspended Solids	160.2	1
Total Phosphorus	365.2	1
Soluble Phosphorus	365.2	1
Volatile Organics	8240	2
Methanol	8015	2
Acrylic Acid	8015	2
Acetaldehyde	8015	2
Ethylene Glycol	8015	2
EG Monomethyl Ether	8015	2
DG Monomethyl Ether	8015	2
Formaldehyde	P&CAM 125	3
pH	9040	1
Mixed Liquor Suspended Solids	160.2	1
Mixed Liquor Volatile Suspended Solids	160.2	1
Oxygen Uptake Rate	2710B	4
Specific Oxygen Uptake Rate	2710B	4
Zone Settling Velocity	NA	5
Dissolved Oxygen	4500-OG	4
Temperature	170.1	1

[a] All total analyses performed on unfiltered samples.
[b] Analyses performed on filtrate following 1µm filtration, with nitrification inhibitor.
[c] Analyses performed on filtrate following 1 µm filtration.

1 "EPA Methods for Chemical Analyses of Water and Wastes," EPA 600/4-79-020.
2 "EPA Test Methods for Evaluating Solid Waste," SW-846, 1990.
3 *NIOSH Manual of Analytical Methods*, 2nd Edition, Vol. 1, P&CAM 125, U.S. Department of Health, Education and Welfare, Publ. (NIOSH) 77-157-A, 1977.
4 *Standard Methods for the Examination of Water and Wastewater*, APHA-AWWA-WPCF, 17th Edition, 1989.
5 ECKENFELDER INC.

3.0 RESULTS AND DISCUSSION

The "unstripped" and "stripped" reactors were operated under similar operating conditions within the following parameter ranges:

- HRT: 9.3 - 10.5 days
- F/M (BOD basis): 0.10 - 0.20 d^{-1}
- Temperature: 22°C to 23°C

The wide variation in F/M was primarily due to the variation in wastewater BOD concentration in the short term study. Summary tables of influent flow and characterization, reactor operating conditions, and effluent characteristics for the unstripped and stripped reactors are presented in Appendix B.

3.1 "UNSTRIPPED" REACTOR (CLOSED ACTIVATED SLUDGE REACTOR RECEIVING RAW WASTEWATER)

3.1.1 Operating Parameters

The unstripped reactor was operated to evaluate the biodegradation potential of specific organic compounds in the UCC wastewater. The pH of the reactor mixed liquor was maintained between 6.5 and 7.2 with the addition of caustic soda in the reactor as required. The mixed liquor suspended solids (MLSS) generally varied from 3,000 mg/L to 4,200 mg/L with an average value of 3,590 mg/L. The mixed liquor volatile suspended solids (MLVSS) generally varied from 2,800 mg/L to 3,500 mg/L with an average value of 3,130 mg/L. The DO of the reactor varied from 1.5 mg/L to >20 mg/L. The wide variation in DO was primarily due to intermittent addition of oxygen to the reactor. Oxygen could not be added continuously due to supersaturation of mixed liquor with DO. The intermittent addition of small amounts of oxygen also resulted in supersaturation of the mixed liquor within minutes. The reactor temperature varied from 21°C to 23°C. Standard oxygen uptake rates varied from 6 mg/(g·hr) to 23.4 mg/(g·hr) with an average value of 11.9 mg/(g·hr).

3.1.2 Observations

During the operation of the unstripped reactor, a white growth continually developed on the clarifier liquid surface which appeared fungus-like. The old growth gradually turned black with time and mixed with the reactor biomass. The new growth on the clarifier liquid surface remained white. Eventually the reactor solids became light black in color. These observations were notable in that such never occurred in open activated sludge reactors in numerous other UCC treatability studies.

3.1.3 Performance

The performance of the unstripped reactor with respect to BOD and COD removal was poor as compared to the UCC-Taft full-scale open activated sludge system operating under similar conditions. The average effluent SCBOD and SCOD for the study period were 478 mg/L and 1,495 mg/L, respectively. The reactor MLVSS concentration also did not increase over the entire study period, even though sludge was not wasted from the reactor. The activated sludge system normally produces excess biological sludge (cell synthesis) from the oxidation of organic matter in the wastewater. The net amount of sludge produced is a balance between the amount of incoming solids, the biological solids synthesized, and the quantity of biological growth oxidized due to endogenous respiration. The average net sludge produced (which includes effluent solids and waste sludge) per substrate removed, (BOD or COD) is the observed sludge yield. The observed sludge yield for the unstripped reactor was very low (0.014 mg TSS/mg BOD_R).

The poor substrate removal performance and very low sludge yield of the reactor appeared to be primarily due to continuous off-gas recycle in the closed activated sludge reactor. The biochemical mechanisms by which this occurred is not clear, however, some theories are offered. A buildup of non-biodegradable VOCs and/or compounds that volatilized due to partial biodegradation in the off-gas recycle could inhibit the biological activity, thus impacting substrate removal performance and yield. Since oxygen was only added to the reactor intermittently at approximately 10 cc/min, there was minimal effluent gas loss from the reactor and concentrating of the recycle off-gas. The results indicate that a change in bacterial culture occurred in the closed system with off-gas recycle compared to an open activated sludge system. Evidence of this was indicated by the following factors:

- Poor BOD removal performance
- Low sludge yield
- White fungus-like growth
- Change in mixed liquor color
- Deteriorated settling characteristics

In order to evaluate the biodegradation potential of the specific organic compounds of interest, the influent wastewater and effluent samples were collected as discussed in Section 2.2 and analyzed for specific organic compounds. The analytical results are summarized in Table 3-1. The laboratory test reports are presented in Appendix C. It is difficult to imagine what factors may be responsible for the variation in the ethylene glycol results. The three values from the stripped feed suggest that the analytical method used is capable of producing values which range from 5,300 to 8,600 for the same sample, if we can assume that these samples were all equal in concentration. The much wider range of values observed for the three samples of unstripped feed suggests that some other factor could be responsible rather than uncertainty in the analytical process, perhaps nonhomogeneity of the samples. Because the stripping process would not be expected to change the concentration of ethylene glycol, the six values could be looked at as six attempts to measure the ethylene glycol concentration of the feed. In this case, an average value of about 7,800 would seem to be a good estimate.

The average influent and effluent ethylene glycol concentrations for unstripped reactor were 7,880 mg/L and 510 mg/L, respectively. The average influent and effluent acetaldehyde concentrations were 62 mg/L and 8.2 mg/L, respectively. The average feed methanol concentration was 18 mg/L. Surprisingly, no methanol removal was observed in the reactor. Methanol is an easily biodegradable organic compound. This indicates that there was an inhibition to bacteria even for methanol biodegradation in the closed activated sludge reactor with off-gas recycle, treating UCC wastewater. The average influent and effluent formaldehyde concentrations were 689 mg/L and 27.3 mg/L, respectively. The average influent and effluent acetone concentrations were 4.2 mg/L and 3.7 mg/L, respectively. This indicates that acetone was neither volatilized nor biodegraded in the unstripped reactor.

TABLE 3-1

SPECIFIC ORGANIC COMPOUNDS TEST RESULTS[a]
UNSTRIPPED REACTOR

Compounds	MDL[b]	Influent				Effluent				Percent Removal (%)
		9/22	9/24	9/26	Average[d]	9/29	10/1	10/3	Average	
Methanol	5	16	19	19	18	22	BMDL	27	17.2	4.4
Acetaldehyde	5	78	58	50	62	BMDL[c]	8.2	14	8.2	86.8
Ethylene Glycol	75	840	18,000	4,800	7,880	390	180	960	510	93.5
EG Monomethyl Ether	10	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	-
DG Monomethyl Ether	10	BMDL	BMDL	51	20	BMDL	BMDL	BMDL	BMDL	75.0
Formaldehyde	10	571	916	580	689	19	17	46	27.3	96.0
Acrolein	0.01	BMDL	1.4	0.16	0.522	BMDL	BMDL	BMDL	0.005	99.0
1,4-Dioxane	0.02	BMDL	3.7	BMDL	1.24	3.1	2.5	3.1	2.9	-
Benzene	0.001	0.43	0.47	0.49	0.463	BMDL	BMDL	BMDL	BMDL	99.9
Toluene	0.001	0.15	0.21	0.22	0.193	BMDL	BMDL	BMDL	BMDL	99.7
Xylene	0.002	BMDL	0.024	BMDL	0.0087	BMDL	BMDL	BMDL	BMDL	88.5
Ethylene Dichloride	0.001	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	-
Acetone	0.005	4.3	4.2	4.2	4.2	3.3	3.8	3.9	3.7	11.9

[a] All units are in mg/L unless otherwise noted.

[b] MDL = Method Detection Limits.

[c] BMDL = Below Method Detection Limits

[d] Influent and effluent average values were calculated based on one-half of BMDL value for compound concentrations below method detection limits.

Most of the other organic compounds in the influents and effluents were either in low concentrations or below method detection limits.

Even though the removal of acetaldehyde, ethylene glycol, and formaldehyde was over 87 percent, it cannot be assumed that all three compounds were completely biodegraded to end products (CO_2 and water) in the activated sludge system. A portion of the removal could be due to either direct volatilization and/or volatilization of intermediate biodegradation byproducts of these compounds. The volatilized (stripped) organic compounds might be accumulated in the off-gas recycle without biodegradation. The reactor off-gas should also be analyzed for specific organic compounds to perform a reasonable mass balance for each compound around the reactor system. The high effluent SCBOD was due to the high effluent concentrations of ethylene glycol, methanol, and acetaldehyde.

The specific organic compounds biodegradation test results presented in this report are representative of the Proposed Method 304. However, the results cannot be modeled due to the poor performance (low sludge yield, poor BOD removal) of the unstripped reactor compared to the UCC Taft full-scale open activated sludge system. The proposed Method 304 study might work for other types of wastewaters, but it did not work for UCC wastewater in the limited short-term study. More detailed treatability studies should be performed to evaluate and define the biodegradation potential of specific organic compounds for UCC wastewater.

During operation of the reactor, batch settling tests were conducted periodically on the reactor mixed liquor. The Sludge Volume Index (SVI) for the unstripped reactor sludge varied from 113 mL/g to 245 mL/g with an average value of 186 mL/g. The zone settling velocity (ZSV) varied from 0.11 ft/hr to 2.38 ft/hr with an average value of 1.16 ft/hr. The settling of the unstripped reactor biological sludge was fair at the start of the study and deteriorated with time, probably due to change in bacterial culture.

3.2 STRIPPED REACTOR

The stripped reactor which received the air stripped wastewater was primarily operated to model biodegradation of nonvolatile organic compounds and to evaluate the performance of the system with respect to BOD and COD removal in the absence of volatile organic compounds.

The operating conditions of this reactor was similar to the unstripped reactor. However, the stripped reactor biomass concentration was slightly lower than the unstripped reactor. The higher biomass in the unstripped reactor could have been as a result of the white growth developed in the clarifier. The average MLSS and MLVSS concentrations for the stripped reactor were 2,800 mg/L and 2,260 mg/L, respectively. Stirred oxygen uptake rates varied from 5.6 mg/(g·hr) to 15.0 mg/(g·hr) with an average value of 9.2 mg/(g·hr). The average SOUR of 9.2 mg/g·hr is slightly lower than the average SOUR of the unstripped reactor as might be expected. Interestingly, the white growth was not observed on the liquid surface of the clarifier and the mixed liquor was always light brown in color.

The specific organic compounds test results are summarized in Table 3-2. The laboratory test reports are presented in Appendix C.

Air stripping of the UCC wastewater reduced the average methanol concentration of the wastewater from 18 mg/L to 6.4 mg/L. The average acetaldehyde concentration was reduced from 62 mg/L to 5.1 mg/L. The ethylene glycol reduction was minimal by air stripping. The average formaldehyde concentration was reduced from 689 mg/L to 486 mg/L. The specific organic compounds such as benzene and toluene were reduced below method detection limits. The average acetone concentration was reduced from 4.2 mg/L to 0.3 mg/L. While these results may indicate that air stripping could be a viable alternative prior to activated sludge, the unstripped reactor results showed that benzene and toluene are effectively biodegraded.

Like the unstripped reactor, the performance of the stripped reactor was also not good with respect to BOD, COD, and ethylene glycol removal. The average effluent SCBOD and SCOD concentrations were 308 mg/L and 1,460 mg/L, respectively. The average influent and effluent ethylene glycol concentrations were 7,067 mg/L and 1,262 mg/L, respectively. The concentration of MLVSS in the reactor could not be increased even without sludge wastage, probably as a result of very low bacterial growth rate as discussed in Section 3.1.3. The observed sludge yield for the stripped reactor in terms of BOD was 0.018 mg/mg. As with the unstripped reactor, the dynamics of the activated sludge system considerably changed when operated in a

TABLE 3-2

SPECIFIC ORGANIC COMPOUNDS TEST RESULTS[a]
STRIPPED REACTOR

Compounds	MDL[b]	Influent				Effluent				Percent
		9/22	9/24	9/26	Average[d]	9/29	10/1	10/3	Average	Removal (%)
Methanol	5	BMDL[c]	7.1	7.0	5.5	BMDL	BMDL	BMDL	BMDL	54.5
Acetaldehyde	5	5.1	BMDL	5.2	4.3	BMDL	BMDL	30	11.7	-
Ethylene Glycol	75	8,600	5,300	7,300	7,067	1,400	1,800	590	1,263	82.1
EG Monomethyl Ether	10	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	5	-
DG Monomethyl Ether	10	BMDL	19	BMDL	9.7	BMDL	BMDL	BMDL	5	48.5
Formaldehyde	10	470	489	498	486	17	13	15	15	96.9
Acrolein	0.01	0.38	0.8	0.42	0.533	BMDL	BMDL	BMDL	0.005	99.1
1,4-Dioxane	0.02	2.4	1.8	3.2	2.5	1.9	1.9	2.0	1.9	24.0
Benzene	0.001	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	-
Toluene	0.001	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	-
Xylene	0.002	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	-
Ethylene Dichloride	0.001	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	-
Acetone	0.005	0.30	0.27	0.31	0.293	0.97	0.36	0.22	0.517	-

[a] All units are in mg/L unless otherwise noted.

[b] MDL = Method Detection Limits.

[c] BMDL = Below Method Detection Limits

[d] Influent and effluent average values were calculated based on one-half of BMDL value for compound concentrations below method detection limits.

closed off-gas recycle mode. Since this reactor received a prestripped feed, influent VOCs cannot alone be implicated for the poor performance except perhaps for the white fungus-like growth. The poor performance of both reactors must at least partially be attributed to compounds which were byproducts of either partial or complete biodegradation and then volatilized into the recirculating off-gas.

Batch settling tests were conducted periodically on the mixed liquor from the stripped reactor. The SVI varied from 72 mL/g to 250 mL/g with an average value of 141 mL/g. The ZSV varied from 1.08 ft/hr to 10.8 ft/hr with an average value of 5.25 ft/hr. Interestingly, the settling characteristics of the stripped reactor sludge were measurably better than the unstripped reactor sludge. However, settling characteristics were excellent at the beginnings of the study and slowly deteriorated. At the end of the study, the SVI and ZSV were 250 mL/g and 1.08 ft/hr, respectively.

The problems encountered in the operation of closed activated sludge systems with off-gas recycle are the following:

- accumulation of VOCs and/or intermediate organic biodegradation byproducts that volatilized
- accumulation of carbon dioxide in the reactor
- wide variation in DO concentration
- possible bacterial culture change in the system

The activated sludge system was also under slight pressure (approximately one inch of water). These conditions do not exist in an open activated sludge system. In order to evaluate and develop biodegradation constants for the UCC wastewater parameters of concern, and define the problems contributing to poor performance of the closed activated sludge system with off-gas recycle, additional treatability study would be required.

4.0 CONCLUSIONS

In order to evaluate the biodegradation potential of specific organic compounds present in the UCC plant wastewater, a biological treatability study similar to the Method 304 Study proposed by the Environmental Protection Agency, was conducted with continuous flow self-contained activated sludge reactor systems. Based on treatability results presented in this report and ECKENFELDER INC. experience with biological wastewater treatment systems, the following conclusions are made:

- The average effluent ethylene glycol concentrations for unstripped and stripped reactors were 510 mg/L and 1,263 mg/L, respectively, indicating incomplete removal of this compound.

- There was no methanol removal in the unstripped reactor.

- The average effluent SCBOD and SCOD for the unstripped reactor were 486 mg/L and 1,495 mg/L, respectively, as compared to the stripped reactor values of 308 mg/L and 1,460 mg/L.

- The performance of the unstripped and stripped reactor with respect to BOD removal was not good considering the HRT of 10 days and F/M ratio of around 0.15 in terms of BOD.

- Overnight air stripping of the UCC plant wastewater removed 69 percent methanol, 93 percent acetaldehyde, 10 percent ethylene glycol, 29 percent formaldehyde, 94 percent acetone, and over 99 percent benzene, toluene, and xylene.

- Negligible sludge yield was observed for both the unstripped and stripped reactors. The reactors MLVSS could not be increased with time even without sludge wastage.

- The stripped reactor biomass settled much better than the unstripped reactor biomass.

- A white growth was observed on the unstripped reactor clarifier liquid surface during the treatability study.

Additional treatability studies should be performed in order to evaluate the biodegradation potential of specific organic compounds in detail due to a few concerns discussed earlier under Section 4.1 such as constant reactor head space gas recycle in absence of gas emissions, accumulation of compounds in the recycle gas, accumulation of carbon dioxide in the recycle gas and dissolution of carbon dioxide in the mixed liquor, and negligible sludge yield. Hence, the specific organic compounds biodegradation test results presented in this report might not be representative.

APPENDIX B

DATA SUMMARY

Union Carbide Corporation - Taft Facility
304 Method Treatability Study
Unstripped Reactor

Date	Influent FLOW l/d	Influent pH	Influent TCOD (mg/l)	Influent TBOD (mg/l)	Influent TKN (mg/l)	Influent TP (mg/l)	Reactor TEMP (C)	Reactor pH	Reactor D.O. (mg/l)	Reactor OUR (mg/l/hr)	Reactor SOUR (mg/g.hr	Reactor MLSS (mg/l)	Reactor MLVSS (mg/l)
3-Aug-92		7.2					30	8.40	5.0				
4-Aug-92							32	8.45	4.7				
5-Aug-92							32	8.50	3.6			2860	
6-Aug-92		6.7					33	8.45	4.8			2800	
7-Aug-92							30	8.50	5.0	39.0	15.6		
8-Aug-92							31	8.70					
9-Aug-92							32	7.70	4.9				
10-Aug-92		7.9					34	8.10	7.1	20.0	6.7		
11-Aug-92							29	7.50	6.1				
12-Aug-92		7.3					29	7.60	5.8	56.0	17.3	3980	3240
13-Aug-92							29.5	8.30	6.9				
14-Aug-92	0.93	6.3					30.7	7.80	6.9	48.0	14.8		
15-Aug-92	1.00						27	8.00	7.0				
16-Aug-92	1.00						27	7.90	7.4				
17-Aug-92	1.00	7.0					28	7.70	7.3				
18-Aug-92	1.00						28	7.70	6.9				
19-Aug-92	0.95	7.0					26.5	7.30	>20	25.0	8.3	3240	3000
20-Aug-92	0.90						28	6.80	>20				
21-Aug-92	1.00						25.5	7.30	>20	58.0	19.3		
22-Aug-92													
23-Aug-92													
24-Aug-92													
25-Aug-92													
26-Aug-92													
27-Aug-92													
28-Aug-92													
29-Aug-92													

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304 Method Treatability Study
Unstripped Reactor

Date	Influent FLOW l/d	Influent pH	Influent TCOD (mg/l)	Influent TBOD (mg/l)	Influent TKN (mg/l)	Influent TP (mg/l)	Reactor TEMP (C)	Reactor pH	Reactor D.O. (mg/l)	Reactor OUR (mg/l/hr)	Reactor SOUR (mg/g.hr	Reactor MLSS (mg/l)	Reactor MLVSS (mg/l)
30-Aug-92													
31-Aug-92													
1-Sep-92													
2-Sep-92													
3-Sep-92													
4-Sep-92													
5-Sep-92													
6-Sep-92													
7-Sep-92													
8-Sep-92	1.00	6.8											
9-Sep-92	0.97	6.7											
10-Sep-92	1.00	6.5								14.1	6.0		
11-Sep-92	1.00	5.5								15.0	6.4		
12-Sep-92	1.00	5.5											
13-Sep-92	1.00	5.5											
14-Sep-92	1.00	5.5		3330								4450	3300
15-Sep-92	0.95	7.2		3330			23	6.80	3.0	46.0	15.3		
16-Sep-92	0.95	7.2	6860	4030			23	6.70	2.0	18.0	7.8	3350	2800
17-Sep-92	0.95	7.7	6860	4030			23	6.60	8.0				
18-Sep-92	0.95	7.6	6860	4030			23	6.60	2.0			3550	2950
19-Sep-92	0.97	7.7	6860	4030			23	6.80	>20				
20-Sep-92	1.00	7.7	6860	4030			23	6.70					
21-Sep-92	1.00	7.8	6860	4030			23	6.60	2.0	27.0	7.9	4250	3425
22-Sep-92	1.00	5.5	7340	3725			23	6.60	2.5	20.0	6.7		
23-Sep-92	1.00	5.5	7340	3725			23	6.65	>20				
24-Sep-92	1.00	5.5	7340	3725			23	6.50	1.5			3150	3050
25-Sep-92	1.00	5.5	7340	3725			23	6.50	4.0				
26-Sep-92	1.00	5.5	7340	3725			23	6.40	5.0				

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Unstripped Reactor

Date	Influent FLOW l/d	Influent pH	Influent TCOD (mg/l)	Influent TBOD (mg/l)	Influent TKN (mg/l)	Influent TP (mg/l)	Reactor TEMP (C)	Reactor pH	Reactor D.O. (mg/l)	Reactor OUR (mg/l/hr)	Reactor SOUR (mg/g.hr	Reactor MLSS (mg/l)	Reactor MLVSS (mg/l)
27-Sep-92	1.00	5.5	7340	3725			23	6.50	16.0				
28-Sep-92	1.02	5.5	7340	3725			23	6.40	2.0				
29-Sep-92	1.00	5.5	7340	3725			23	6.50	18.0	24.0	8.0	3180	2980
30-Sep-92	1.00	5.5	7340	3725			23	6.50	2.5				
1-Oct-92	1.00	5.5	7340	3725			23	6.40	2.5	30.0	10.9	2900	2750
2-Oct-92	1.00	5.5	7340	3725			23	6.50	>20				
3-Oct-92	1.00	5.5	7340	3725			23	6.60	>20				
4-Oct-92	1.00	5.5	7340	3725			23	6.70	18.0	36.0	12.0		
5-Oct-92	1.00	4.5	9840	5630			23	6.90	9.0				
6-Oct-92	1.00	4.5	9840	5630			23	6.70	2.0	72.0	23.4	3325	3075
7-Oct-92	1.00	4.7	9840	5630			23	7.10	18.0				
8-Oct-92	1.00	4.7	9840	5630			23	6.50	3.0			3200	3050
9-Oct-92	1.00	4.5	10250	6800	158	0.5	23	6.50	16.0				
10-Oct-92	1.00	4.5	10250	6800	158	0.5	22	6.40	>20	36.0	11.3		
11-Oct-92	1.00	4.5	10250	6800	158	0.5	23	6.70	8.5				
12-Oct-92	1.08	4.5	10250	6800	158	0.5	23	6.20	4.0				
13-Oct-92	1.08	5.0	10250	6800	158	0.5	23	6.75	16.0	33.0	8.7	4200	3800
14-Oct-92	1.08	5.0	10250	6800	158	0.5	23	6.50	3.5				
15-Oct-92	1.00	5.0	10250	6800	158	0.5	23	6.40	3.5				
16-Oct-92	1.00	5.5	10250	6800	158	0.5	23	6.80	18.0			3765	3465
17-Oct-92	1.00	5.5	10250	6800	158	0.5	22	6.60	5.5				
18-Oct-92	0.95	5.5	10250	6800	158	0.5	23	6.60	9.5				
19-Oct-92	0.95	5.5	10250	6800	158	0.5	22	7.10	19.0				
20-Oct-92	1.00	5.9	6480				23	7.00	10.0	80.0	23.3	4130	3430
21-Oct-92	1.00	5.7	6480				23	7.00	4.0				
22-Oct-92	1.05		6480				22	7.00	5.0				
23-Oct-92	1.05	6.5	6480				23	6.80	14.0	48.0	16.6	4200	2900
24-Oct-92	1.00	6.5	6480				23	6.60	2.0				

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Date	Influent FLOW l/d	Influent pH	Influent TCOD (mg/l)	Influent TBOD (mg/l)	Influent TKN (mg/l)	Influent TP (mg/l)	Reactor TEMP (C)	Reactor pH	Reactor D.O. (mg/l)	Reactor OUR (mg/l/hr)	Reactor SOUR (mg/g.hr	Reactor MLSS (mg/l)	Reactor MLVSS (mg/l)
25-Oct-92	1.00	6.5	6480				23	6.50	18.0				
26-Oct-92	1.00	6.5	6480				23	7.10	15.0				
27-Oct-92	1.00	6.5	6480				23	6.95	>20	26.4	9.0	4133	2933
28-Oct-92	1.00	6.5	6480				23	6.70	8.5				
29-Oct-92	1.00	6.4	6480				23	6.60	3.0				
30-Oct-92	1.00	5.7	6840	4590			23	6.90	>20	21.6	7.2		
31-Oct-92													
Avg.	1.00	6.0	8007	4897	158	0.5		7.03		36.1	11.9	3592	3134
Max	1.08	7.9	10250	6800	158	0.5	34	8.70	20.0	80.0	23.4	4450	3800
Min	0.90	4.5	6480	3330	158	0.5	22	6.20	1.5	14.1	6.0	2800	2750
Std	0.03	1.0	1560.43	1388	0	0	3.3	0.69		18.7	5.6	547	284

Date	Reactor SVI (ml/g)	Reactor ZSV (ft/hr)	Reactor Air/O2 (cc/min)	Reactor Recycle Gas Flow (cc/min)	Effluent FLOW (l/d)	Effluent pH	Effluent SCOD (mg/l)	Effluent SCBOD (mg/l)	Effluent TSS (mg/l)	Effluent VSS (mg/l)	Effluent NH3-N (mg/l)	Effluent PO4-P (mg/l)
3-Aug-92			500	1000								
4-Aug-92			500	1000								
5-Aug-92			500	1000								
6-Aug-92			500	1000		8.5						
7-Aug-92			500	1000		8.7						
8-Aug-92			500	1000		8.4						
9-Aug-92			500	1000								
10-Aug-92			450	1000		9						
11-Aug-92			500	1000		8.8						
12-Aug-92			500	1000		8.7						
13-Aug-92			500	1000		9						
14-Aug-92			500	1000		8.9						
15-Aug-92			500	1000		8.7						
16-Aug-92			500	1000		8.6						
17-Aug-92			500	1000		8.4						
18-Aug-92			500	1000		8.5						
19-Aug-92			80	1000		8.6						
20-Aug-92			50	1000		7.9						
21-Aug-92			100	1000		8						
22-Aug-92												
23-Aug-92												
24-Aug-92												
25-Aug-92												
26-Aug-92												
27-Aug-92												
28-Aug-92												
29-Aug-92												

Date	Reactor SVI (ml/g)	Reactor ZSV (ft/hr)	Reactor Air/O2 (cc/min)	Reactor Recycle Gas Flow (cc/min)	Effluent FLOW (l/d)	Effluent pH	Effluent SCOD (mg/l)	Effluent SCBOD (mg/l)	Effluent TSS (mg/l)	Effluent VSS (mg/l)	Effluent NH3-N (mg/l)	Effluent PO4-P (mg/l)
30-Aug-92												
31-Aug-92												
1-Sep-92												
2-Sep-92												
3-Sep-92												
4-Sep-92				1000								
5-Sep-92				1000								
6-Sep-92				1000								
7-Sep-92				1000								
8-Sep-92				1000								
9-Sep-92				1000								
10-Sep-92				1000								
11-Sep-92				1000								
12-Sep-92				1000								
13-Sep-92				1000								
14-Sep-92				1000				179	215	110		
15-Sep-92			0	1000	0.99	7.5						
16-Sep-92	113	2.38	0	1000	0.80	7.9	1274	464				
17-Sep-92			10	1000	0.93	7.7						
18-Sep-92	149	2.30	0	1000	0.95	7.6	1372	500	75	65		
19-Sep-92			10	1000	0.95	7.5						
20-Sep-92			0	1000	0.94	7.4						
21-Sep-92			0	1000	0.94	7.4	1200	340				
22-Sep-92			10	1000	0.90	7.5						
23-Sep-92	165	2.16	0	1000	0.74	7.4						
24-Sep-92			0	1000	0.95	7.4	1590	360	30	30	0.90	
25-Sep-92			10	1000	0.94	7.4						
26-Sep-92			0	1000		7.4						

Date	Reactor SVI (ml/g)	Reactor ZSV (ft/hr)	Reactor Air/O2 (cc/min)	Reactor Recycle Gas Flow (cc/min)	Effluent FLOW (l/d)	Effluent pH	Effluent SCOD (mg/l)	Effluent SCBOD (mg/l)	Effluent TSS (mg/l)	Effluent VSS (mg/l)	Effluent NH3-N (mg/l)	Effluent PO4-P (mg/l)
27-Sep-92			10	1000		7.4						
28-Sep-92			0	1000	0.90	7.4						
29-Sep-92	245	1.22	10	1000	0.90	7.4	1490	994	70	66	2.30	
30-Sep-92			0	1000	0.86	7.2						
1-Oct-92			10	1000	0.98	7.5	2110	885	12	12		
2-Oct-92			10	1000	0.92	7.5						
3-Oct-92			10	1000	0.90	7.6	2775	920	37	27		
4-Oct-92			0	1000		7.6						
5-Oct-92			0	1000		7.7						
6-Oct-92			10	1000	0.88	7.9						
7-Oct-92			0	1000	0.93	7.5						
8-Oct-92			10	1000	0.96	7.4	1260	298			12.00	
9-Oct-92	178	1.30	0	1000	0.91	7.4						
10-Oct-92			10	1000	0.90	7.4						
11-Oct-92			0	1000	0.90	7.8						
12-Oct-92			10	1000	0.90	7.5						
13-Oct-92	186	0.79	0	1000	0.95	7.7	1590	503	48	42	11.00	0.32
14-Oct-92			0	1000	0.97	7.7						
15-Oct-92			10	1000	0.93	7.6						
16-Oct-92	210	0.72	0	1000	0.91	7.6	1590	327	92	60		
17-Oct-92			10	1000		7.5						
18-Oct-92			10	1000		7.5						
19-Oct-92			0	1000	0.88	7.8						
20-Oct-92	183	0.72	0	1000	0.90	7.8	905	302	15	10		
21-Oct-92			10	1000	0.90	7.7						
22-Oct-92			10	1000	0.93	7.5						
23-Oct-92	202	0.36	0	1000	0.94	7.7	1835	520	42	24		
24-Oct-92			10	1000	0.85	7.6						

Date	Reactor SVI (ml/g)	Reactor ZSV (ft/hr)	Reactor Air/O2 (cc/min)	Reactor Recycle Gas Flow (cc/min)	Effluent FLOW (l/d)	Effluent pH	Effluent SCOD (mg/l)	Effluent SCBOD (mg/l)	Effluent TSS (mg/l)	Effluent VSS (mg/l)	Effluent NH3-N (mg/l)	Effluent PO4-P (mg/l)
25-Oct-92			0	1000	0.85	7.6						
26-Oct-92			10	1000	0.85	8.1						
27-Oct-92	233	0.11	0	1000	0.94	7.5	1090	315	90	70		
28-Oct-92			0	1000	0.94	7.8						
29-Oct-92			10	1000	0.87	8.0						
30-Oct-92	183	0.72	0	1000	0.93	7.9	850	263	76	68		
31-Oct-92												
Avg.	186	1.16		1000	0.91	7.8	1495	478	67	49	6.55	0.32
Max	245	2.38		1000	0.99	9.0	2775	994	215	110	12.00	0.32
Min	113	0.11		1000	0.74	7.2	850	179	12	10	0.90	0.32
Std	37.61575	0.79		0	0.05	0.49	503	255	54	30	5.76	#DIV/0!

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Stripped Reactor

Date	Influent FLOW l/d	Influent pH	Influent TCOD (mg/l)	Influent TBOD (mg/l)	Influent TKN (mg/l)	Influent TP (mg/l)	Reactor TEMP (C)	Reactor pH	Reactor D.O. (mg/l)	Reactor OUR (mg/l/hr)	Reactor SOUR (mg/g.hr	Reactor MLSS (mg/l)	Reactor MLVSS (mg/l)
3-Aug-92		7.6					30	8.6	5.6				
4-Aug-92							33	8.5	4.8				
5-Aug-92							32	8.65	4.9			2580	2340
6-Aug-92		7.2					33	8.4	5.4				
7-Aug-92		7.6					30	8.4	5.5	30	12.8		
8-Aug-92							31	8.6					
9-Aug-92							31	8.5	4.6				
10-Aug-92		7.8					34	8.4	5.9	14	5.6		
11-Aug-92							29	8.5	6.1				
12-Aug-92		6.5					29	8.1	6	32	10.7	3540	2980
13-Aug-92							29.5	8.3	7.1				
14-Aug-92	0.93	7.7					30.3	8.1	6.5	42	15.0		
15-Aug-92	1.00							8	6.4				
16-Aug-92	1.00							8.1	6.8				
17-Aug-92	1.00	6.9					28	8	6.9				
18-Aug-92	1.00						28	8	6.7				
19-Aug-92	0.95	7.4						7.7	20	21	8.3	2860	2520
20-Aug-92	0.90						28	7.2	1.6				
21-Aug-92	1.00							8.3	>20	17	6.7		
22-Aug-92													
23-Aug-92													
24-Aug-92													
25-Aug-92													
26-Aug-92													
27-Aug-92													
28-Aug-92													
29-Aug-92													

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Stripped Reactor

Date	Influent FLOW l/d	Influent pH	Influent TCOD (mg/l)	Influent TBOD (mg/l)	Influent TKN (mg/l)	Influent TP (mg/l)	Reactor TEMP (C)	Reactor pH	Reactor D.O. (mg/l)	Reactor OUR (mg/l/hr)	Reactor SOUR (mg/g.hr	Reactor MLSS (mg/l)	Reactor MLVSS (mg/l)
30-Aug-92													
31-Aug-92													
1-Sep-92													
2-Sep-92													
3-Sep-92													
4-Sep-92													
5-Sep-92													
6-Sep-92													
7-Sep-92													
8-Sep-92	1.00	6.5											
9-Sep-92	0.97	6.5											
10-Sep-92	1.00	5.5											
11-Sep-92	1.00	5.5								15	7.9		
12-Sep-92	1.00	5.5											
13-Sep-92	1.00	5.5											
14-Sep-92	1.00	5.5		2864								4200	2500
15-Sep-92	0.95	8.7		2864			23	6.8	4	18	7.5		
16-Sep-92	0.95	8.5	6220	3620			23	6.8	4	15	6.5	3350	2300
17-Sep-92	0.95	8.4	6220	3620			23	6.9	4				
18-Sep-92	0.95	8.3	6220	3620			23	6.9	3	27	12.0	2800	2250
19-Sep-92	0.97	8.3	6220	3620			23	6.9	>20				
20-Sep-92	1.00	8.2	6220	3620			23	6.8	-				
21-Sep-92	1.00	8.1	6220	3620			23	6.7	2.5	21	9.3	2975	2250
22-Sep-92	1.00	6.4	6840				23	6.8	>20				
23-Sep-92	1.00	6.4	6840				23	6.7	9	17	8.0		
24-Sep-92	1.00	6.4	6840				23	6.6	2	18	8.5	2300	2125
25-Sep-92	1.00	6.4	6840				23	6.8	16				
26-Sep-92	1.00	6.4	6840				23	6.7	4				

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Date	Influent FLOW l/d	Influent pH	Influent TCOD (mg/l)	Influent TBOD (mg/l)	Influent TKN (mg/l)	Influent TP (mg/l)	Reactor TEMP (C)	Reactor pH	Reactor D.O. (mg/l)	Reactor OUR (mg/l/hr)	Reactor SOUR (mg/g.hr	Reactor MLSS (mg/l)	Reactor MLVSS (mg/l)
27-Sep-92	1.00	6.4	6840				23	6.8	18				
28-Sep-92	1.02	6.4	6840				23	6.7	2				
29-Sep-92	1.00	6.4	6840				23	6.7	18	12	6.3		
30-Sep-92	1.00	6.4	6840				23	6.6	3.5				
1-Oct-92	1.00	6.4	6840				23	6.7	18	15	8.3	1975	1800
2-Oct-92	1.00	6.4	6840				23	6.7	9				
3-Oct-92	1.00	6.4	6840				23	6.7	4				
4-Oct-92	-		6840				23	6.8	>20				
5-Oct-92	1.00	4.5	9960	5970			23	6.8	18				
6-Oct-92	1.00	4.5	9960	5970			22	6.6	2			2080	1900
7-Oct-92	1.00	4.7	9960	5970			23	7	19	21	10.0		
8-Oct-92	1.00	4.8	9960	5970			23	6.5	4			2350	2200
9-Oct-92	1.00	5.5	8080	5520	158	0.5	23	6.6	>20				
10-Oct-92	1.00	5.5	8080	5520			22	6.5	2.5				
11-Oct-92	1.00	5.5	8080	5520			23	6.5	17				
12-Oct-92	1.08	7.3	8080	5520			23	6.4	8				
13-Oct-92	1.08	7.3	8080	5520			23	6.6	16	21	7.8	3100	2700
14-Oct-92	1.08	7.3	8080	5520			23	6.6	4				
15-Oct-92	1.00	7.3	8080	5520			23	6.8	17				
16-Oct-92	1.00	7.2	8080	5520			23	6.8	2	24	10.1	3200	2370
17-Oct-92	1.00	7.2	8080	5520			22	6.7	18				
18-Oct-92	0.95	7.2	8080	5520			23	6.6	9				
19-Oct-92	0.95	7.2	8080	5520			22	6.6	4				
20-Oct-92	1.00	6.9	4740				23	6.7	14	28	14.7	2370	1900
21-Oct-92	1.00	6.5	4740				23	6.8	18				
22-Oct-92	1.05	7.1	4740				22	6.8	>20				
23-Oct-92	1.05	7.1	4740				23	6.7	18	24	12.2	2335	1970
24-Oct-92	1.00	7.0	4740				23	6.7	4				

Union Carbide Corporation - Taft Facility
304 Method Treatability Study
Stripped Reactor

Date	Influent FLOW l/d	Influent pH	Influent TCOD (mg/l)	Influent TBOD (mg/l)	Influent TKN (mg/l)	Influent TP (mg/l)	Reactor TEMP (C)	Reactor pH	Reactor D.O. (mg/l)	Reactor OUR (mg/l/hr)	Reactor SOUR (mg/g.hr	Reactor MLSS (mg/l)	Reactor MLVSS (mg/l)
25-Oct-92	1.00	7.0	4740				23	6.6	>20				
26-Oct-92	1.00	7.0	4740				23	6.7	18				
27-Oct-92	1.00	7.0	4740				23	6.7	18	11	5.6	2575	1950
28-Oct-92	1.00	7.0	4740				23	6.6	6				
29-Oct-92	1.00	6.9	4740				23	6.6	>20				
30-Oct-92	1.00	7.1	6000	4290			23	6.6	16	20	8.2	3067	2433
Avg.	1.00	6.74	6852.44	4847	158	0.5		7.1		21	9.2	2803	2264
Max	1.08	8.7	9960	5970	158	0.5	34	8.65	20	42	15.0	4200	2980
Min	0.90	4.5	4740	2864	158	0.5	22	6.4	1.6	11	5.6	1975	1800
Std	0.03	1.0	1419.568	1105.986	#DIV/0!	#DIV/0!	3.527719	0.750316	5.990498	7.351334	2.7	609.1774	319.757

Date	Reactor SVI (ml/g)	Reactor ZSV (ft/hr)	Reactor O2 Flow (cc/min)	Reactor Recycle Gas Flow (cc/min)	Effluent FLOW (l/d)	Effluent pH	Effluent SCOD (mg/l)	Effluent SCBOD (mg/l)	Effluent TSS (mg/l)	Effluent VSS (mg/l)	Effluent NH3-N (mg/l)	Effluent PO4-P (mg/l)
3-Aug-92			500	1000								
4-Aug-92			500	1000								
5-Aug-92			500	1000								
6-Aug-92			500	1000		8.7						
7-Aug-92			500	1000		8.8						
8-Aug-92			500	1000		8.6						
9-Aug-92			500									
10-Aug-92			500			9.0						
11-Aug-92			500			8.9						
12-Aug-92			500	1000		8.8						
13-Aug-92			500	1000		9.0						
14-Aug-92			500	1000		8.9						
15-Aug-92			500	1000		8.9						
16-Aug-92			500	1000		8.8						
17-Aug-92			500	1000		8.6						
18-Aug-92			500	1000		8.7						
19-Aug-92			150	1000		8.8						
20-Aug-92			150	1000		8.6						
21-Aug-92			1000	1000		8.6						
22-Aug-92												
23-Aug-92												
24-Aug-92												
25-Aug-92												
26-Aug-92												
27-Aug-92												
28-Aug-92												
29-Aug-92												

Date	Reactor SVI (ml/g)	Reactor ZSV (ft/hr)	Reactor O2 Flow (cc/min)	Reactor Recycle Gas Flow (cc/min)	Effluent FLOW (l/d)	Effluent pH	Effluent SCOD (mg/l)	Effluent SCBOD (mg/l)	Effluent TSS (mg/l)	Effluent VSS (mg/l)	Effluent NH3-N (mg/l)	Effluent PO4-P (mg/l)
30-Aug-92												
31-Aug-92												
1-Sep-92												
2-Sep-92												
3-Sep-92												
4-Sep-92												
5-Sep-92												
6-Sep-92												
7-Sep-92												
8-Sep-92				1000								
9-Sep-92				1000								
10-Sep-92				1000								
11-Sep-92				1000								
12-Sep-92				1000								
13-Sep-92				1000								
14-Sep-92				1000				6	280	145		
15-Sep-92			0	1000	1.00	7.8						
16-Sep-92	72	10.80	0	1000	0.80	8.0	490	39	48	28		
17-Sep-92			0	1000	0.94	8.2						
18-Sep-92	96	10.10	10	1000	0.97	8.2	930	350	87	60		
19-Sep-92			0	1000	0.95	8.0						
20-Sep-92			0	1000	0.95	8.0						
21-Sep-92			10	1000	0.95	7.9	930	240	63	50		
22-Sep-92			0	1000	1.00	7.6						
23-Sep-92	104	7.92	0	1000	0.75	7.9						
24-Sep-92			10	1000	1.05	7.7	1900		30	24	0.5	
25-Sep-92			0	1000	0.93	7.7						
26-Sep-92			10	1000		7.6						

Date	Reactor SVI (ml/g)	Reactor ZSV (ft/hr)	Reactor O2 Flow (cc/min)	Reactor Recycle Gas Flow (cc/min)	Effluent FLOW (l/d)	Effluent pH	Effluent SCOD (mg/l)	Effluent SCBOD (mg/l)	Effluent TSS (mg/l)	Effluent VSS (mg/l)	Effluent NH3-N (mg/l)	Effluent PO4-P (mg/l)
27-Sep-92			0	1000		7.7						
28-Sep-92			10	1000	0.91	7.8						
29-Sep-92	133	7.20	0	1000	0.90	7.8	1950	684			0.3	
30-Sep-92			10	1000	0.94	7.7						
1-Oct-92			0	1000	0.93	7.9	3260	633	44	42		
2-Oct-92			0	1000	0.91	7.8						
3-Oct-92			10	1000	0.93	7.8	1925	485	45	35		
4-Oct-92			0	1000								
5-Oct-92			0	1000		8.0						
6-Oct-92			10	1000	0.88	7.6						
7-Oct-92			0	1000	0.91	7.7						
8-Oct-92			10	1000	1.00	7.7	1460	347			11.0	
9-Oct-92	115	7.20	0	1000	0.40	7.6						
10-Oct-92			10	1000	0.90	7.6						
11-Oct-92			0	1000	0.90	8.4						
12-Oct-92			10	1000	0.90	7.7						
13-Oct-92	126	1.80	0	1000	0.94	7.9		297	78	58	15.0	0.29
14-Oct-92			10	1000	0.91	7.9						
15-Oct-92			0	1000	0.92	8.0						
16-Oct-92	88	5.04	10	1000	0.90	7.9		293	12	12		
17-Oct-92			0	1000		7.9						
18-Oct-92			0	1000		8.0						
19-Oct-92			10	1000	0.91	8.0						
20-Oct-92	215	1.44	10	1000	0.90	7.9	1245	333	47	20		
21-Oct-92			10	1000	0.90	7.9						
22-Oct-92			0	1000	0.96	7.7						
23-Oct-92	176	3.60	0	1000	0.94	7.7	1635	244	156	124		
24-Oct-92			10	1000	0.88	7.6						

Date	Reactor SVI (ml/g)	Reactor ZSV (ft/hr)	Reactor O2 Flow (cc/min)	Reactor Recycle Gas Flow (cc/min)	Effluent FLOW (l/d)	Effluent pH	Effluent SCOD (mg/l)	Effluent SCBOD (mg/l)	Effluent TSS (mg/l)	Effluent VSS (mg/l)	Effluent NH3-N (mg/l)	Effluent PO4-P (mg/l)
25-Oct-92			0	1000	0.88	7.6						
26-Oct-92			10	1000	0.88	7.6						
27-Oct-92	250	1.08	0	1000	0.90	7.5	1090	259	170	130		
28-Oct-92			10	1000	0.93	7.5						
29-Oct-92			0	1000	0.94	7.4						
30-Oct-92	176	1.62	10	1000	0.91	7.5	700	96	128	100		
Avg.	141	5.25		1000	0.91	8.0	1460	308	91	64	6.7	0.29
Max	250	10.80		1000	1.05	9.0	3260	684	280	145	15.0	0.29
Min	72	1.08		1000	0.40	7.4	490	6	12	12	0.3	0.29
Std	45.17466	3.38		0	0.10	0.5	770.4914	202.1368	76.0703	42.71832	7.5	#DIV/0!

APPENDIX C

LABORATORY TEST REPORTS

ECKENFELDER INC.

CLIENT: UNION CARBIDE CORPORATION #6734.05

DATE SAMPLED: 9/22/92, 9/24/92
DATE RECEIVED: 10/5/92
DATE REPORTED: 10/29/92

ECKENFELDER SAMPLE NUMBER		6219	6220	6221	6222
CLIENT SAMPLE DESCRIPTION		UNSTRIPPED FEED 9/22	STRIPPED FEED 9/22	UNSTRIPPED FEED 9/24	STRIPPED FEED 9/24
GC/FID	DETECTION LIMITS	CONC	CONC	CONC	CONC
METHANOL	5	16	BMDL	19	7.1
ACRYLIC ACID (1)	-	-	-	-	-
ACETALDEHYDE	5	78	5.1	58	BMDL
ETHYLENE GLYCOL	75	840 E	8600 E	18000 E	5300 E
ETHYLENE GLYCOL MONOMETHYL ETHER	10	BMDL	BMDL	BMDL	BMDL
DIETHYLENE GLYCOL MONOMETHYL ETHER	10	BMDL	BMDL	BMDL	19 E

ALL RESULTS EXPRESSED IN MILLIGRAMS/LITER
UNLESS OTHERWISE NOTED.

BMDL = BELOW METHOD DETECTION LIMITS

DUE TO THE NATURE OF THIS STUDY, SOME REGULATORY HOLDING TIMES, PRESERVATION TECHNIQUES, AND SAMPLE STORAGE REQUIREMENTS WERE NOT ALWAYS ACHIEVABLE. THE ANALYTICAL RESULTS SHOULD BE CONSIDERED ACCURATE FOR WASTE CHARACTERIZATION.

(1) = ACRYLIC ACID WAS UNSTABLE IN WATER, POLYMERIZES READILY IN THE PRESENCE OF OXYGEN.

E = ESTIMATED VALUE, MIDPOINT CHECK ABOVE 25%.

227 French Landing Drive
Nashville, Tennessee 37228
615.255.2288
FAX 615.256.8332

ECKENFELDER INC.

CLIENT: UNION CARBIDE CORPORATION #6734.05
DATE SAMPLED: 9/26/92, 9/29/92
DATE RECEIVED: 10/5/92
DATE REPORTED: 10/29/92

ECKENFELDER SAMPLE NUMBER		6223	6224	6225	6226
CLIENT SAMPLE DESCRIPTION		UNSTRIPPED FEED 9/26	STRIPPED FEED 9/26	UNSTRIPPED EFFLUENT 9/29	STRIPPED EFFLUENT 9/29
GC/FID	DETECTION LIMITS	CONC	CONC	CONC	CONC
METHANOL	5	19	7.0	22	BMDL
ACRYLIC ACID (1)	-	-	-	-	-
ACETALDEHYDE	5	50	5.2	BMDL	BMDL
ETHYLENE GLYCOL	75	4800 E	7300 E	390 E	1400 E
ETHYLENE GLYCOL MONOMETHYL ETHER	10	BMDL	BMDL	BMDL	BMDL
DIETHYLENE GLYCOL MONOMETHYL ETHER	10	51 E	BMDL	BMDL	BMDL

ALL RESULTS EXPRESSED IN MILLIGRAMS/LITER
UNLESS OTHERWISE NOTED.

BMDL = BELOW METHOD DETECTION LIMITS

DUE TO THE NATURE OF THIS STUDY, SOME REGULATORY HOLDING TIMES, PRESERVATION TECHNIQUES, AND SAMPLE STORAGE REQUIREMENTS WERE NOT ALWAYS ACHIEVABLE. THE ANALYTICAL RESULTS SHOULD BE CONSIDERED ACCURATE FOR WASTE CHARACTERIZATION.

(1) = ACRYLIC ACID WAS UNSTABLE IN WATER, POLYMERIZES READILY IN THE PRESENCE OF OXYGEN.

E = ESTIMATED VALUE, MIDPOINT CHECK ABOVE 25%.

ECKENFELDER INC.

CLIENT: UNION CARBIDE CORPORATION #6734.05
DATE SAMPLED: 10/1/92, 10/3/92
DATE RECEIVED: 10/5/92
DATE REPORTED: 10/29/92

ECKENFELDER SAMPLE NUMBER		6227	6228	6229	6330
CLIENT SAMPLE DESCRIPTION		UNSTRIPPED EFFLUENT 10/1	STRIPPED EFFLUENT 10/1	UNSTRIPPED EFFLUENT 10/3	STRIPPED EFFLUENT 10/3
GC/FID	DETECTION LIMITS	CONC	CONC	CONC	CONC
METHANOL	5	BMDL	BMDL	27	BMDL
ACRYLIC ACID (1)	-	-	-	-	-
ACETALDEHYDE	5	8.2	BMDL	14	30
ETHYLENE GLYCOL	75	180 E	1800 E	960 E	590 E
ETHYLENE GLYCOL MONOMETHYL ETHER	10	BMDL	BMDL	BMDL	BMDL
DIETHYLENE GLYCOL MONOMETHYL ETHER	10	BMDL	BMDL	BMDL	BMDL

ALL RESULTS EXPRESSED IN MILLIGRAMS/LITER
UNLESS OTHERWISE NOTED.

BMDL = BELOW METHOD DETECTION LIMITS

DUE TO THE NATURE OF THIS STUDY, SOME REGULATORY HOLDING TIMES, PRESERVATION TECHNIQUES, AND SAMPLE STORAGE REQUIREMENTS WERE NOT ALWAYS ACHIEVABLE. THE ANALYTICAL RESULTS SHOULD BE CONSIDERED ACCURATE FOR WASTE CHARACTERIZATION.

(1) = ACRYLIC ACID WAS UNSTABLE IN WATER, POLYMERIZES READILY IN THE PRESENCE OF OXYGEN.

E = ESTIMATED VALUE, MIDPOINT CHECK ABOVE 25%.

ECKENFELDER INC.

D. RICK DAVIS
VICE PRESIDENT/ANALYTICAL & TESTING SERVICES

ECKENFELDER INC.

.IENT: UNION CARBIDE #6734
TE SAMPLED: 9/22/92, 9/24/92
TE RECEIVED: 10/5/92
TE REPORTED: 10/21/92

:KENFELDER SAMPLE NUMBER			6219	6220	6221	6222
ENT SAMPLE DESCRIPTION			UNSTRIPPED FEED 9/22	STRIPPED FEED 9/22	UNSTRIPPED FEED 9/24	STRIPPED FEED 9/24
WET CHEMISTRY	DETECTION LIMITS	USEPA METHOD*	CONC	CONC	CONC	CONC
FORMALDEHYDE	10	125	571	470	916	489

. RESULTS EXPRESSED IN MILLIGRAMS/LITER
LESS OTHERWISE NOTED.

. SAMPLES WERE EXTRACTED AND/OR ANALYZED WITHIN
EPA HOLDING TIMES UNLESS OTHERWISE NOTED.

REFERENCE PHYSICAL AND CHEMICAL ANALYSIS BRANCH
ALYTICAL METHOD.

227 French Landing Drive
Nashville, Tennessee 37228
615 255 2288
FAX 615 256 8332

ECKENFELDER INC.

.IENT: UNION CARBIDE #6734
TE SAMPLED: 9/26/92, 9/29/92
TE RECEIVED: 10/5/92
TE REPORTED: 10/21/92

KENFELDER SAMPLE NUMBER			6223	6224	6225	6226
ENT SAMPLE DESCRIPTION			UNSTRIPPED FEED 9/26	STRIPPED FEED 9/26	UNSTRIPPED EFF. 9/29	STRIPPED EFF. 9/29
WET CHEMISTRY	DETECTION LIMITS	USEPA METHOD*	CONC	CONC	CONC	CONC
FORMALDEHYDE	10	125	580	498	19	17

. RESULTS EXPRESSED IN MILLIGRAMS/LITER
.ESS OTHERWISE NOTED.

. SAMPLES WERE EXTRACTED AND/OR ANALYZED WITHIN
:PA HOLDING TIMES UNLESS OTHERWISE NOTED.

ꓱEFERENCE PHYSICAL AND CHEMICAL ANALYSIS BRANCH
ⱯLYTICAL METHOD.

ECKENFELDER INC.

LIENT: UNION CARBIDE #6734
ATE SAMPLED: 10/1/92, 10/3/92
ATE RECEIVED: 10/5/92
ATE REPORTED: 10/21/92

CKENFELDER SAMPLE NUMBER			6227	6228	6229	6230
LIENT SAMPLE DESCRIPTION			UNSTRIPPED EFF. 10/1	STRIPPED EFF. 10/1	UNSTRIPPED EFF. 10/3	STRIPPED EFF. 10/3
WET CHEMISTRY	DETECTION LIMITS	USEPA METHOD*	CONC	CONC	CONC	CONC
FORMALDEHYDE	10	125	17	13	46	15

LL RESULTS EXPRESSED IN MILLIGRAMS/LITER
NLESS OTHERWISE NOTED.

LL SAMPLES WERE EXTRACTED AND/OR ANALYZED WITHIN
SEPA HOLDING TIMES UNLESS OTHERWISE NOTED.

= REFERENCE PHYSICAL AND CHEMICAL ANALYSIS BRANCH
NALYTICAL METHOD.

CKENFELDER INC.

. RICK DAVIS
ICE PRESIDENT/ANALYTICAL & TESTING SERVICES

ECKENFELDER INC.

LIENT: UNION CARBIDE #6734
ATE SAMPLED: 9/22/92
ATE RECEIVED: 10/5/92
ATE REPORTED: 10/26/92

CKENFELDER SAMPLE NUMBER			6219D	6219D	6220	6220D	6220D
LIENT SAMPLE DESCRIPTION			UNSTRIPPED FEED 9/22	UNSTRIPPED FEED 9/22	STRIPPED FEED 9/22	STRIPPED FEED 9/22	STRIPPED FEED 9/22
VOLATILE ORGANICS BY USEPA METHOD 8240	MDL	PQL	10X (1) CONC	100X (1) CONC	CONC	2X (1) CONC	10X (1) CONC
HLOROMETHANE	2.0	20	U	U	U	U	U
ROMOMETHANE	2.0	20	U	U	U	U	U
INYL CHLORIDE	2.0	20	U	U	U	U	U
HLOROETHANE	2.0	20	U	U	U	U	U
ETHYLENE CHLORIDE	2.0	20	U	U	U	U	U
CETONE	5.0	50	4300 DE	6200 D	300 E	230 D	U
ARBON DISULFIDE	2.0	20	U	U	U	U	U
,1-DICHLOROETHENE	2.0	20	U	U	U	U	U
,1-DICHLOROETHANE	1.0	10	U	U	U	U	U
,2-DICHLOROETHENE (TOTAL)	1.0	10	U	U	U	U	U
HLOROFORM	1.0	10	U	U	U	U	U
,2-DICHLOROETHANE	1.0	10	U	U	U	U	U
-BUTANONE	10	100	U	U	U	U	U
,1,1-TRICHLOROETHANE	1.0	10	U	U	U	U	U
ARBON TETRACHLORIDE	1.0	10	U	U	U	U	U
INYL ACETATE	1.0	10	U	U	U	U	U
ROMODICHLOROMETHANE	1.0	10	U	U	U	U	U
,2-DICHLOROPROPANE	1.0	10	U	U	U	U	U
,3-DICHLOROPROPENE	1.0	10	U	U	U	U	U
RICHLOROETHENE	1.0	10	U	U	U	U	U
IBROMOCHLOROMETHANE	1.0	10	U	U	U	U	U
,1,2-TRICHLOROETHANE	1.0	10	U	U	U	U	U
ENZENE	1.0	10	430 D	320 JD	U	U	U
RICHLOROFLUOROMETHANE	2.0	20	U	U	U	U	U

LL RESULTS EXPRESSED IN MICROGRAMS/LITER
NLESS OTHERWISE NOTED.

EE ATTACHED PAGE FOR DEFINITIONS OF TERMS
ND QUALIFIERS.

LL SAMPLES WERE EXTRACTED AND/OR ANALYZED WITHIN
SEPA HOLDING TIMES UNLESS OTHERWISE NOTED.

1) = SAMPLES WERE DILUTED BY THE NUMERICAL VALUE DISPLAYED,
ETECTION LIMITS SHOULD INCREASE BY THE SAME FACTOR.

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ECKENFELDER INC.

JENT: UNION CARBIDE #6734
TE SAMPLED: 9/22/92
TE RECEIVED: 10/5/92
TE REPORTED: 10/26/92

:KENFELDER SAMPLE NUMBER			6219D	6219D	6220	6220D	6220D
JENT SAMPLE DESCRIPTION			UNSTRIPPED FEED 9/22	UNSTRIPPED FEED 9/22	STRIPPED FEED 9/22	STRIPPED FEED 9/22	STRIPPED FEED 9/22
VOLATILE ORGANICS BY USEPA METHOD 8240 CONT'D	MDL	PQL	10X (1) CONC	100X (1) CONC	CONC	2X (1) CONC	10X (1) CONC
CHLOROETHYLVINYL ETHER	1.0	10	U	U	U	U	U
ROMOFORM	1.0	10	U	U	U	U	U
METHYL-2-PENTANONE	2.0	20	U	U	U	U	U
HEXANONE	2.0	20	U	U	U	U	U
TRACHLOROETHENE	1.0	10	U	U	U	U	U
,2,2-TETRACHLOROETHANE	1.0	10	U	U	U	U	U
LUENE	1.0	10	150 D	U	U	U	U
LOROBENZENE	1.0	10	U	U	U	U	U
HYL BENZENE	1.0	10	U	U	U	U	U
YRENE	1.0	10	63 JD	U	U	U	U
LENE (TOTAL)	2.0	20	U	U	U	U	U
2-DICHLOROBENZENE	1.0	10	U	U	U	U	U
3-DICHLOROBENZENE	1.0	10	U	U	U	U	U
4-DICHLOROBENZENE	1.0	10	U	U	U	U	U
CROLEIN	10	100	U	U	380 E	2000 DE	470 JD
DIOXANE *	20*	200*	U	U	2400 E	1700 D	U

L RESULTS EXPRESSED IN MICROGRAMS/LITER
NLESS OTHERWISE NOTED.

E ATTACHED PAGE FOR DEFINITIONS OF TERMS
ND QUALIFIERS.

L SAMPLES WERE EXTRACTED AND/OR ANALYZED WITHIN
SEPA HOLDING TIMES UNLESS OTHERWISE NOTED.

: ESTIMATED

) = SAMPLES WERE DILUTED BY THE NUMERICAL VALUE DISPLAYED,
ETECTION LIMITS SHOULD INCREASE BY THE SAME FACTOR.

ECKENFELDER INC.

CLIENT: UNION CARBIDE #6734
DATE SAMPLED: 9/24/92
DATE RECEIVED: 10/5/92
DATE REPORTED: 10/26/92

ECKENFELDER SAMPLE NUMBER			6221D	6221D	6222D	6222D
CLIENT SAMPLE DESCRIPTION			UNSTRIPPED FEED 9/24	UNSTRIPPED FEED 9/24	STRIPPED FEED 9/24	STRIPPED FEED 9/24
VOLATILE ORGANICS BY USEPA METHOD 8240	MDL	PQL	10X (1) CONC	100X (1) CONC	2X (1) CONC	5X (1) CONC
CHLOROMETHANE	2.0	20	U	U	U	U
BROMOMETHANE	2.0	20	U	U	U	U
VINYL CHLORIDE	2.0	20	U	U	U	U
CHLOROETHANE	2.0	20	U	U	U	U
METHYLENE CHLORIDE	2.0	20	U	U	U	U
ACETONE	5.0	50	4200 DE	5300 D	270 D	270 D
CARBON DISULFIDE	2.0	20	U	U	U	U
1,1-DICHLOROETHENE	2.0	20	U	U	U	U
1,1-DICHLOROETHANE	1.0	10	U	U	U	U
1,2-DICHLOROETHENE (TOTAL)	1.0	10	U	U	U	U
CHLOROFORM	1.0	10	5.8 JD	U	U	U
1,2-DICHLOROETHANE	1.0	10	U	U	U	U
2-BUTANONE	10	100	U	U	U	U
1,1,1-TRICHLOROETHANE	1.0	10	U	U	U	U
CARBON TETRACHLORIDE	1.0	10	U	U	U	U
VINYL ACETATE	1.0	10	U	U	U	U
BROMODICHLOROMETHANE	1.0	10	U	U	U	U
1,2-DICHLOROPROPANE	1.0	10	U	U	U	U
1,3-DICHLOROPROPENE	1.0	10	U	U	U	U
TRICHLOROETHENE	1.0	10	U	U	U	U
DIBROMOCHLOROMETHANE	1.0	10	U	U	U	U
1,1,2-TRICHLOROETHANE	1.0	10	U	U	U	U
BENZENE	1.0	10	470 D	410 JD	U	U
TRICHLOROFLUOROMETHANE	2.0	20	U	U	U	U

ALL RESULTS EXPRESSED IN MICROGRAMS/LITER
UNLESS OTHERWISE NOTED.

SEE ATTACHED PAGE FOR DEFINITIONS OF TERMS
AND QUALIFIERS.

ALL SAMPLES WERE EXTRACTED AND/OR ANALYZED WITHIN
USEPA HOLDING TIMES UNLESS OTHERWISE NOTED.

(1) = SAMPLES WERE DILUTED BY THE NUMERICAL VALUE DISPLAYED,
DETECTION LIMITS SHOULD INCREASE BY THE SAME FACTOR.

ECKENFELDER INC.

CLIENT: UNION CARBIDE #6734
DATE SAMPLED: 9/24/92
DATE RECEIVED: 10/5/92
DATE REPORTED: 10/26/92

ECKENFELDER SAMPLE NUMBER			6221D	6221D	6222D	6222D
CLIENT SAMPLE DESCRIPTION			UNSTRIPPED FEED 9/24	UNSTRIPPED FEED 9/24	STRIPPED FEED 9/24	STRIPPED FEED 9/24
VOLATILE ORGANICS BY USEPA METHOD 8240 CONT'D	MDL	PQL	10X (1) CONC	100X (1) CONC	2X (1) CONC	5X (1) CONC
2-CHLOROETHYLVINYL ETHER	1.0	10	U	U	U	U
BROMOFORM	1.0	10	U	U	U	U
4-METHYL-2-PENTANONE	2.0	20	U	U	U	U
2-HEXANONE	2.0	20	U	U	U	U
TETRACHLOROETHENE	1.0	10	U	U	U	U
1,1,2,2-TETRACHLOROETHANE	1.0	10	U	U	U	U
TOLUENE	1.0	10	210 D	U	U	U
CHLOROBENZENE	1.0	10	U	U	U	U
ETHYL BENZENE	1.0	10	U	U	U	U
STYRENE	1.0	10	67 JD	U	U	U
XYLENE (TOTAL)	2.0	20	24 JD	U	U	U
1,2-DICHLOROBENZENE	1.0	10	U	U	U	U
1,3-DICHLOROBENZENE	1.0	10	U	U	U	U
1,4-DICHLOROBENZENE	1.0	10	U	U	U	U
ACROLEIN	10	100	1400 D	U	800 DE	950 D
P-DIOXANE	20*	200*	3700 D	U	1800 D	1600 D

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DETECTION LIMITS SHOULD INCREASE BY THE SAME FACTOR.

ECKENFELDER INC.

CLIENT: UNION CARBIDE #6734
DATE SAMPLED: 9/26/92
DATE RECEIVED: 10/5/92
DATE REPORTED: 10/26/92

ECKENFELDER SAMPLE NUMBER			6223D	6223D	6224	6224D
CLIENT SAMPLE DESCRIPTION			UNSTRIPPED FEED 9/26	UNSTRIPPED FEED 9/26	STRIPPED FEED 9/26	STRIPPED FEED 9/26
VOLATILE ORGANICS BY USEPA METHOD 8240	MDL	PQL	10X (1) CONC	100X (1) CONC	CONC	10X (1) CONC
CHLOROMETHANE	2.0	20	U	U	U	U
BROMOMETHANE	2.0	20	U	U	U	U
VINYL CHLORIDE	2.0	20	U	U	U	U
CHLOROETHANE	2.0	20	U	U	U	U
METHYLENE CHLORIDE	2.0	20	U	U	U	U
ACETONE	5.0	50	4200 DE	5300 D	310 E	U
CARBON DISULFIDE	2.0	20	U	U	U	U
1,1-DICHLOROETHENE	2.0	20	U	U	U	U
1,1-DICHLOROETHANE	1.0	10	U	U	U	U
1,2-DICHLOROETHENE (TOTAL)	1.0	10	U	U	U	U
CHLOROFORM	1.0	10	U	U	U	U
1,2-DICHLOROETHANE	1.0	10	U	U	U	U
2-BUTANONE	10	100	U	U	U	U
1,1,1-TRICHLOROETHANE	1.0	10	U	U	U	U
CARBON TETRACHLORIDE	1.0	10	U	U	U	U
VINYL ACETATE	1.0	10	U	U	U	U
BROMODICHLOROMETHANE	1.0	10	U	U	U	U
1,2-DICHLOROPROPANE	1.0	10	U	U	U	U
1,3-DICHLOROPROPENE	1.0	10	U	U	U	U
TRICHLOROETHENE	1.0	10	U	U	U	U
DIBROMOCHLOROMETHANE	1.0	10	U	U	U	U
1,1,2-TRICHLOROETHANE	1.0	10	U	U	U	U
BENZENE	1.0	10	490 D	460 JD	U	U
TRICHLOROFLUOROMETHANE	2.0	20	U	U	U	U

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ECKENFELDER INC.

CLIENT: UNION CARBIDE #6734
DATE SAMPLED: 9/26/92
DATE RECEIVED: 10/5/92
DATE REPORTED: 10/26/92

ECKENFELDER SAMPLE NUMBER			6223D	6223D	6224	6224D
CLIENT SAMPLE DESCRIPTION			UNSTRIPPED FEED 9/26	UNSTRIPPED FEED 9/26	STRIPPED FEED 9/26	STRIPPED FEED 9/26
VOLATILE ORGANICS BY USEPA METHOD 8240 CONT'D	MDL	PQL	10X (1) CONC	100X (1) CONC	CONC	10X (1) CONC
2-CHLOROETHYLVINYL ETHER	1.0	10	U	U	U	U
BROMOFORM	1.0	10	U	U	U	U
4-METHYL-2-PENTANONE	2.0	20	U	U	U	U
2-HEXANONE	2.0	20	U	U	U	U
TETRACHLOROETHENE	1.0	10	U	U	U	U
1,1,2,2-TETRACHLOROETHANE	1.0	10	U	U	U	U
TOLUENE	1.0	10	220 D	210 JD	U	U
CHLOROBENZENE	1.0	10	U	U	U	U
ETHYL BENZENE	1.0	10	U	U	U	U
STYRENE	1.0	10	52 JD	U	U	U
XYLENE (TOTAL)	2.0	20	U	U	U	U
1,2-DICHLOROBENZENE	1.0	10	U	U	U	U
1,3-DICHLOROBENZENE	1.0	10	U	U	U	U
1,4-DICHLOROBENZENE	1.0	10	U	U	U	U
ACROLEIN	10	100	160 JD	U	420 E	U
P-DIOXANE	20*	200*	U	U	3200 E	1700 JD

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ECKENFELDER INC.

CLIENT: UNION CARBIDE #6734
DATE SAMPLED: 9/29/92
DATE RECEIVED: 10/5/92
DATE REPORTED: 10/26/92

ECKENFELDER SAMPLE NUMBER			6225D	6225D	6226	6226D
CLIENT SAMPLE DESCRIPTION			UNSTRIPPED EFF. 9/29	UNSTRIPPED EFF. 9/29	STRIPPED EFF. 9/29	STRIPPED EFF. 9/29
VOLATILE ORGANICS BY USEPA METHOD 8240	MDL	PQL	10X (1) CONC	20X (1) CONC	CONC	10X (1) CONC
CHLOROMETHANE	2.0	20	U	U	U	U
BROMOMETHANE	2.0	20	U	U	U	U
VINYL CHLORIDE	2.0	20	U	U	U	U
CHLOROETHANE	2.0	20	U	U	U	U
METHYLENE CHLORIDE	2.0	20	U	U	7.4 J	U
ACETONE	5.0	50	3300 DE	2700 D	970 E	1400 D
CARBON DISULFIDE	2.0	20	U	U	U	U
1,1-DICHLOROETHENE	2.0	20	U	U	U	U
1,1-DICHLOROETHANE	1.0	10	U	U	U	U
1,2-DICHLOROETHENE (TOTAL)	1.0	10	U	U	U	U
CHLOROFORM	1.0	10	U	U	U	U
1,2-DICHLOROETHANE	1.0	10	U	U	U	U
2-BUTANONE	10	100	U	U	34 J	U
1,1,1-TRICHLOROETHANE	1.0	10	U	U	U	U
CARBON TETRACHLORIDE	1.0	10	U	U	U	U
VINYL ACETATE	1.0	10	U	U	U	U
BROMODICHLOROMETHANE	1.0	10	U	U	U	U
1,2-DICHLOROPROPANE	1.0	10	U	U	U	U
1,3-DICHLOROPROPENE	1.0	10	U	U	U	U
TRICHLOROETHENE	1.0	10	U	U	1.0 J	U
DIBROMOCHLOROMETHANE	1.0	10	U	U	U	U
1,1,2-TRICHLOROETHANE	1.0	10	U	U	U	U
BENZENE	1.0	10	26 JD	U	U	U
TRICHLOROFLUOROMETHANE	2.0	20	U	U	U	U

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ECKENFELDER INC.

CLIENT: UNION CARBIDE #6734
DATE SAMPLED: 9/29/92
DATE RECEIVED: 10/5/92
DATE REPORTED: 10/26/92

ECKENFELDER SAMPLE NUMBER			6225D	6225D	6226	6226D
CLIENT SAMPLE DESCRIPTION			UNSTRIPPED EFF. 9/29	UNSTRIPPED EFF. 9/29	STRIPPED EFF. 9/29	STRIPPED EFF. 9/29
VOLATILE ORGANICS BY USEPA METHOD 8240 CONT'D	MDL	PQL	10X (1) CONC	20X (1) CONC	CONC	10X (1) CONC
2-CHLOROETHYLVINYL ETHER	1.0	10	U	U	U	U
BROMOFORM	1.0	10	U	U	U	U
4-METHYL-2-PENTANONE	2.0	20	U	U	U	U
2-HEXANONE	2.0	20	U	U	U	U
TETRACHLOROETHENE	1.0	10	U	U	1.7 J	U
1,1,2,2-TETRACHLOROETHANE	1.0	10	84 JD	79 JD	180	210 D
TOLUENE	1.0	10	U	U	U	U
CHLOROBENZENE	1.0	10	U	U	U	U
ETHYL BENZENE	1.0	10	U	U	U	U
STYRENE	1.0	10	U	U	U	U
XYLENE (TOTAL)	2.0	20	U	U	U	U
1,2-DICHLOROBENZENE	1.0	10	U	U	U	U
1,3-DICHLOROBENZENE	1.0	10	U	U	U	U
1,4-DICHLOROBENZENE	1.0	10	U	U	U	U
ACROLEIN	10	100	U	U	U	U
P-DIOXANE	20*	200*	3100 D	2900 JD	1900	2000 D

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ECKENFELDER INC.

CLIENT: UNION CARBIDE #6734

DATE SAMPLED: 10/1/92
DATE RECEIVED: 10/5/92
DATE REPORTED: 10/26/92

ECKENFELDER SAMPLE NUMBER			6227D	6227D	6228	6228D
CLIENT SAMPLE DESCRIPTION			UNSTRIPPED EFF. 10/1	UNSTRIPPED EFF. 10/1	STRIPPED EFF. 10/1	STRIPPED EFF. 10/1
VOLATILE ORGANICS BY USEPA METHOD 8240	MDL	PQL	10X (1) CONC	20X (1) CONC	CONC	2X (1) CONC
CHLOROMETHANE	2.0	20	U	U	U	U
BROMOMETHANE	2.0	20	U	U	U	U
VINYL CHLORIDE	2.0	20	U	U	U	U
CHLOROETHANE	2.0	20	U	U	U	U
METHYLENE CHLORIDE	2.0	20	U	U	7.6 J	6.9 JD
ACETONE	5.0	50	3800 DE	2200 D	360 E	360 D
CARBON DISULFIDE	2.0	20	U	U	U	U
1,1-DICHLOROETHENE	2.0	20	U	U	U	U
1,1-DICHLOROETHANE	1.0	10	U	U	U	U
1,2-DICHLOROETHENE (TOTAL)	1.0	10	U	U	U	U
CHLOROFORM	1.0	10	U	U	U	U
1,2-DICHLOROETHANE	1.0	10	U	U	U	U
2-BUTANONE	10	100	230 JD	U	U	U
1,1,1-TRICHLOROETHANE	1.0	10	U	U	U	U
CARBON TETRACHLORIDE	1.0	10	U	U	U	U
VINYL ACETATE	1.0	10	U	U	U	U
BROMODICHLOROMETHANE	1.0	10	U	U	U	U
1,2-DICHLOROPROPANE	1.0	10	U	U	U	U
1,3-DICHLOROPROPENE	1.0	10	U	U	U	U
TRICHLOROETHENE	1.0	10	U	U	U	U
DIBROMOCHLOROMETHANE	1.0	10	U	U	U	U
1,1,2-TRICHLOROETHANE	1.0	10	U	U	U	U
BENZENE	1.0	10	21 JD	U	U	U
TRICHLOROFLUOROMETHANE	2.0	20	U	U	U	U

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ECKENFELDER INC.

CLIENT: UNION CARBIDE #6734

DATE SAMPLED: 10/1/92
DATE RECEIVED: 10/5/92
DATE REPORTED: 10/26/92

ECKENFELDER SAMPLE NUMBER			6227D	6227D	6228	6228D
CLIENT SAMPLE DESCRIPTION			UNSTRIPPED EFF. 10/1	UNSTRIPPED EFF. 10/1	STRIPPED EFF. 10/1	STRIPPED EFF. 10/1
VOLATILE ORGANICS BY USEPA METHOD 8240 CONT'D	MDL	PQL	10X (1) CONC	20X (1) CONC	CONC	2X (1) CONC
2-CHLOROETHYLVINYL ETHER	1.0	10	U	U	U	U
BROMOFORM	1.0	10	U	U	U	U
4-METHYL-2-PENTANONE	2.0	20	U	U	U	U
2-HEXANONE	2.0	20	U	U	U	U
TETRACHLOROETHENE	1.0	10	U	U	2.2 J	2.2 JD
1,1,2,2-TETRACHLOROETHANE	1.0	10	51 JD	44 JD	230 E	250 D
TOLUENE	1.0	10	U	U	U	U
CHLOROBENZENE	1.0	10	U	U	U	U
ETHYL BENZENE	1.0	10	U	U	U	U
STYRENE	1.0	10	U	U	U	U
XYLENE (TOTAL)	2.0	20	U	U	U	U
1,2-DICHLOROBENZENE	1.0	10	U	U	0.7 J	U
1,3-DICHLOROBENZENE	1.0	10	U	U	U	U
1,4-DICHLOROBENZENE	1.0	10	U	U	U	U
ACROLEIN	10	100	U	U	U	U
P-DIOXANE	20*	200*	2500 D	2600 JD	1900	2000 D

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ECKENFELDER INC.

CLIENT: UNION CARBIDE #6734

DATE SAMPLED: 10/3/92
DATE RECEIVED: 10/5/92
DATE REPORTED: 10/26/92

ECKENFELDER SAMPLE NUMBER			6229D	6229D	6230	6230D	
CLIENT SAMPLE DESCRIPTION			UNSTRIPPED EFF. 10/3	UNSTRIPPED EFF. 10/3	STRIPPED EFF. 10/3	STRIPPED EFF. 10/3	METHOD BLANK
VOLATILE ORGANICS BY USEPA METHOD 8240	MDL	PQL	10X (1) CONC	50X (1) CONC	CONC	2X (1) CONC	CONC
CHLOROMETHANE	2.0	20	U	U	U	U	U
BROMOMETHANE	2.0	20	U	U	U	U	U
VINYL CHLORIDE	2.0	20	U	U	U	U	U
CHLOROETHANE	2.0	20	U	U	U	U	U
METHYLENE CHLORIDE	2.0	20	U	U	10 J	7.6 JD	U
ACETONE	5.0	50	3900 DE	3200 D	220 E	300 D	U
CARBON DISULFIDE	2.0	20	U	U	U	U	U
1,1-DICHLOROETHENE	2.0	20	U	U	U	U	U
1,1-DICHLOROETHANE	1.0	10	U	U	U	U	U
1,2-DICHLOROETHENE (TOTAL)	1.0	10	U	U	U	U	U
CHLOROFORM	1.0	10	U	U	U	U	U
1,2-DICHLOROETHANE	1.0	10	U	U	U	U	U
2-BUTANONE	10	100	310 JD	U	U	U	U
1,1,1-TRICHLOROETHANE	1.0	10	U	U	U	U	U
CARBON TETRACHLORIDE	1.0	10	U	U	U	U	U
VINYL ACETATE	1.0	10	U	U	U	U	U
BROMODICHLOROMETHANE	1.0	10	U	U	U	U	U
1,2-DICHLOROPROPANE	1.0	10	U	U	U	U	U
1,3-DICHLOROPROPENE	1.0	10	U	U	U	U	U
TRICHLOROETHENE	1.0	10	U	U	0.9 J	U	U
DIBROMOCHLOROMETHANE	1.0	10	U	U	U	U	U
1,1,2-TRICHLOROETHANE	1.0	10	U	U	U	U	U
BENZENE	1.0	10	31 JD	U	U	U	U
TRICHLOROFLUOROMETHANE	2.0	20	U	U	U	U	U

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ECKENFELDER INC.

CLIENT: UNION CARBIDE #6734
DATE SAMPLED: 10/3/92
DATE RECEIVED: 10/5/92
DATE REPORTED: 10/26/92

ECKENFELDER SAMPLE NUMBER			6229D	6229D	6230	6230D	
CLIENT SAMPLE DESCRIPTION			UNSTRIPPED EFF. 10/3	UNSTRIPPED EFF. 10/3	STRIPPED EFF. 10/3	STRIPPED EFF. 10/3	METHOD BLANK
VOLATILE ORGANICS BY USEPA METHOD 8240 CONT'D	MDL	PQL	10X (1) CONC	50X (1) CONC	CONC	2X (1) CONC	CONC
2-CHLOROETHYLVINYL ETHER	1.0	10	U	U	U	U	U
BROMOFORM	1.0	10	U	U	U	U	U
4-METHYL-2-PENTANONE	2.0	20	U	U	U	U	U
2-HEXANONE	2.0	20	U	U	U	U	U
TETRACHLOROETHENE	1.0	10	U	U	1.3 J	U	U
1,1,2,2-TETRACHLOROETHANE	1.0	10	50 JD	U	120	130 D	U
TOLUENE	1.0	10	U	U	U	U	U
CHLOROBENZENE	1.0	10	U	U	U	U	U
ETHYL BENZENE	1.0	10	U	U	U	U	U
STYRENE	1.0	10	U	U	U	U	U
XYLENE (TOTAL)	2.0	20	U	U	U	U	U
1,2-DICHLOROBENZENE	1.0	10	U	U	U	U	U
1,3-DICHLOROBENZENE	1.0	10	U	U	U	U	U
1,4-DICHLOROBENZENE	1.0	10	U	U	U	U	U
ACROLEIN	10	100	U	U	U	U	U
P-DIOXANE*	20*	200*	3100 D	U	2000	2000 D	U

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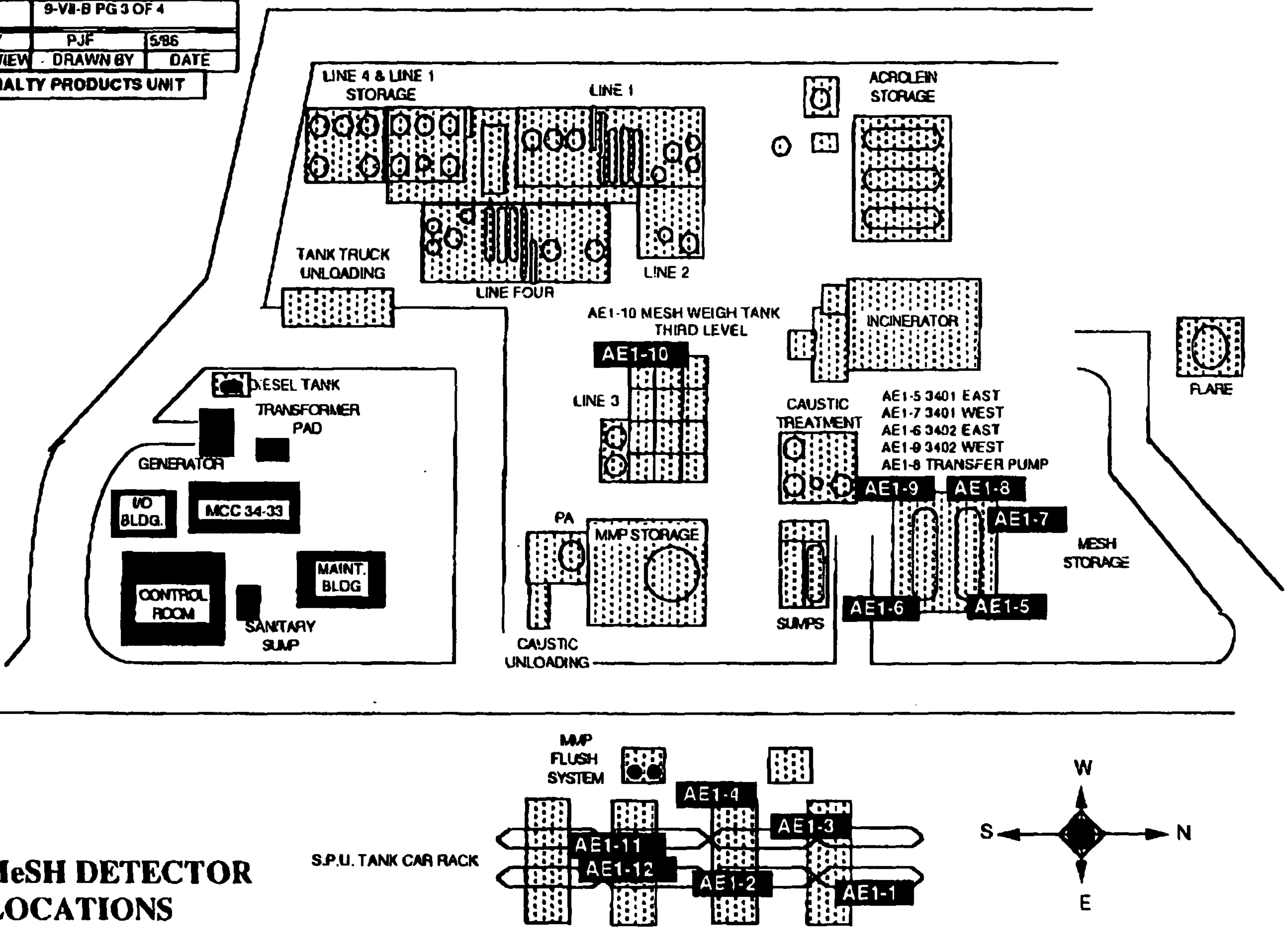
ECKENFELDER INC.

RICK DAVIS
CE PRESIDENT/ANALYTICAL & TESTING SERVICES

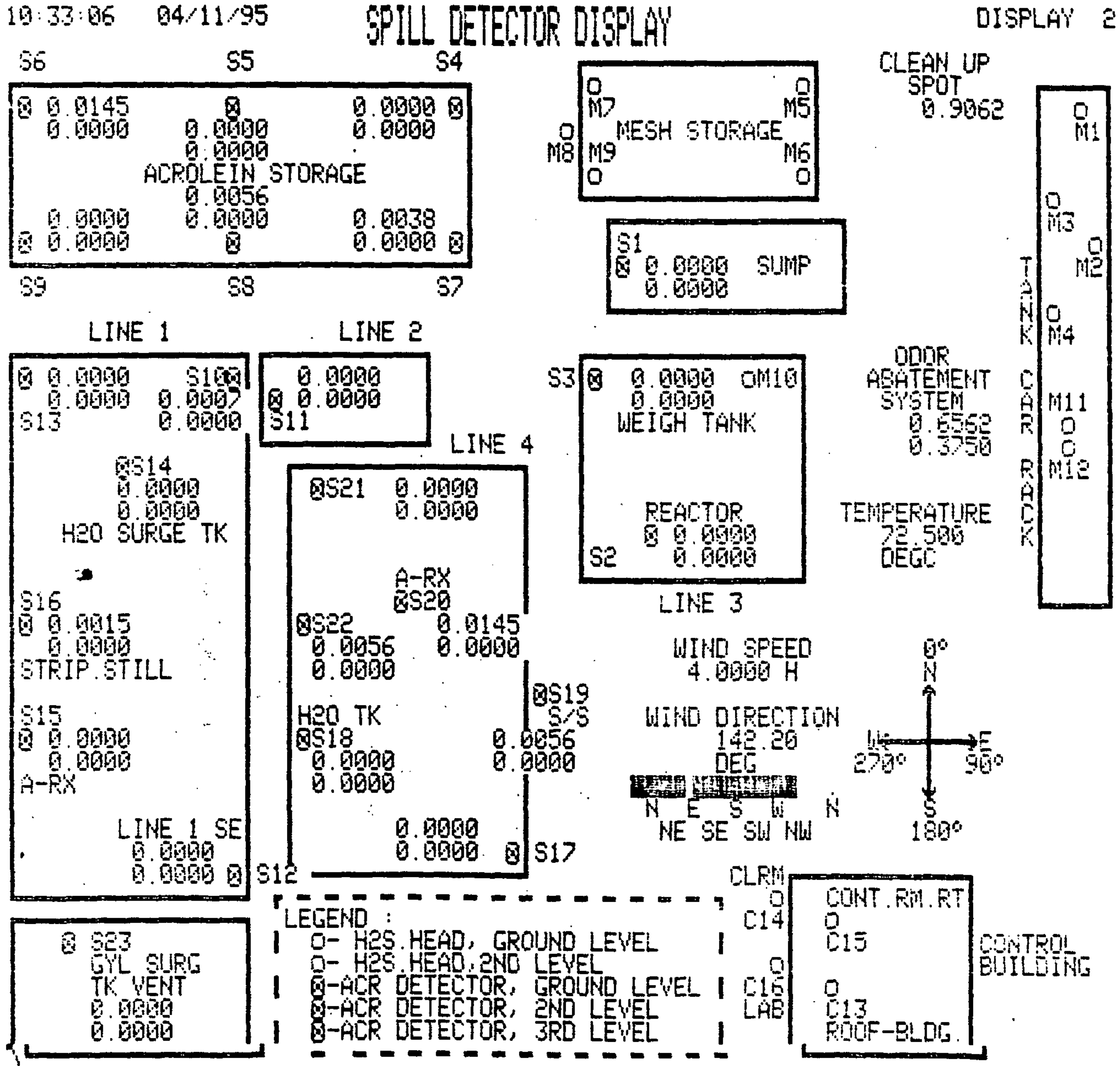
APPROVAL			
MANUAL	SPU SAFETY		
3/12/94	EMP	9-VII-B PG 3 OF 4	
DATE	BY	PJF	5/86
REVISION/REVIEW		DRAWN BY	DATE

SPECIALTY PRODUCTS UNIT



SPU MeSH DETECTOR LOCATIONS

AE1-11	ODOR ABATAMENT INLET
AE1-12	ODOR ABATEMENT OUTLET
AE1-1	23-0
AE1-2	23-1
AE1-3	PUMP
AE1-4	22-1



```
10:33:06   04/11/95        SPILL DETECTOR DISPLAY                 DISPLAY  2

 S6                  S5                  S4
0 0.0145             0             0.0000 0
  0.0000          0.0000           0.0000
                  0.0000
            ACROLEIN STORAGE
                  0.0056
  0.0000          0.0000           0.0038
0 0.0000             0             0.0000 0
 S9                  S8                  S7

   O                  O
   M7                 M5
 O      MESH STORAGE
 M8 M9                M6
   O                  O

 S1
 0 0.0000   SUMP
   0.0000

 CLEAN UP
   SPOT
   0.9062

 TANK CAR RACK
   O M1
   O M3
   O M2
   O M4
   M11 O
   O M12

        LINE 1                 LINE 2
0 0.0000       S10 0           0.0000
  0.0000     0.0007          0 0.0000
S13          0.0000          S11

          0S14
          0.0000
          0.0000
     H20 SURGE TK

S16
0 0.0015
  0.0000
STRIP.STILL

S15
0 0.0000
  0.0000
A-RX

          LINE 1 SE
            0.0000
            0.0000 0  S12

                         LINE 4
0S21      0.0000
          0.0000

           A-RX
          0S20
0S22              0.0145
 0.0056           0.0000
 0.0000
                          0S19
H20 TK                     S/S
0S18                    0.0056
 0.0000                 0.0000
 0.0000

          0.0000
          0.0000 0  S17

S3 0  0.0000    OM10
      0.0000
     WEIGH TANK

        REACTOR
       0 0.0000
S2       0.0000
        LINE 3

   ODOR
 ABATEMENT
  SYSTEM
   0.6562
   0.3750

TEMPERATURE
  72.500
   DEGC

 WIND SPEED
  4.0000 H

WIND DIRECTION
    142.20
     DEG
 N  E  S  W  N
 NE SE SW NW

        0°
        N
W               E
270°          90°
        S
       180°

 0 S23
  GYL SURG
  TK VENT
  0.0000
  0.0000

LEGEND :
 O- H2S.HEAD, GROUND LEVEL
 O- H2S.HEAD,2ND LEVEL
 0-ACR DETECTOR, GROUND LEVEL
 0-ACR DETECTOR, 2ND LEVEL
 0-ACR DETECTOR, 3RD LEVEL

CLRM
   O      CONT.RM.RT
 C14      O
          C15              CONTROL
   O                       BUILDING
 C16      O
 LAB      C13
          ROOF-BLDG.
```