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FINAL

CONTROL TECHNOLOGY ASSESSMENT
FOR
COAL GASIFICATION AND LIQUEFACTION PROCESSSES

University of Minnesota Heating Plant
FW-Stoic Gasification Facility
Duluth, Minnesota

Report for the Site Visit of
January 1981

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Submitted to:

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Foreword

On January 19 and 20, 1981, a visit was made to the University of Minnesota, Duluth Campus Heating Plant to conduct a study of the technology used to control worker exposure to hazardous chemical and physical agents at the FW-Stoic Gasification Facility. An initial meeting, held to acquaint personnel with the objectives of the Control Technology Assessment Study, was attended by the following persons:

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Richard Lewis, Senior Plant Engineer
Faye Thompson, Assistant Professor of Environmental Health
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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION

A. Contract Background

The objective of the "Control Technology Assessment for Coal Gasification and Liquefaction Processes" program is to study the control technology that is available to prevent occupational exposure to hazardous agents in coal conversion plants. This information is gathered by conducting site visits to architecture and engineering firms and existing gasification and liquefaction facilities. The industrial use of low-Btu coal gasification processes is important because of its potential to replace more expensive and scarce fuels such as natural gas and oil. One of a number of low-Btu coal gasification processes that are commercially available in the United States is based on the Stoic two-stage gasifier. This report details the control technology and industrial hygiene information gathered on the Foster Wheeler (FW) Stoic gasifier and ancillary equipment in use at the University of Minnesota, Duluth (UMD) Heating Plant during the site visit of January 19 and 20, 1981. A visit to this facility was important to the study because the Oak Ridge National Laboratory and UMD have developed and implemented an industrial hygiene program designed specifically to address the potential hazards at the UMD gasification facility.

B. History of the University of Minnesota, Duluth Coal Gasification Project

The University of Minnesota, Duluth (UMD) Coal Gasification Project is part of the Department of Energy's "Gasifiers in Industry" program. The purpose of this program is to develop technical, economic, and environmental data on commercially available low-Btu gasification processes to provide acceptable alternatives to the industrial consumption of natural gas and fuel oil. The total estimated cost of the UMD project is $5.5 million with the Department of Engery (DOE) providing 46 percent of the funding.

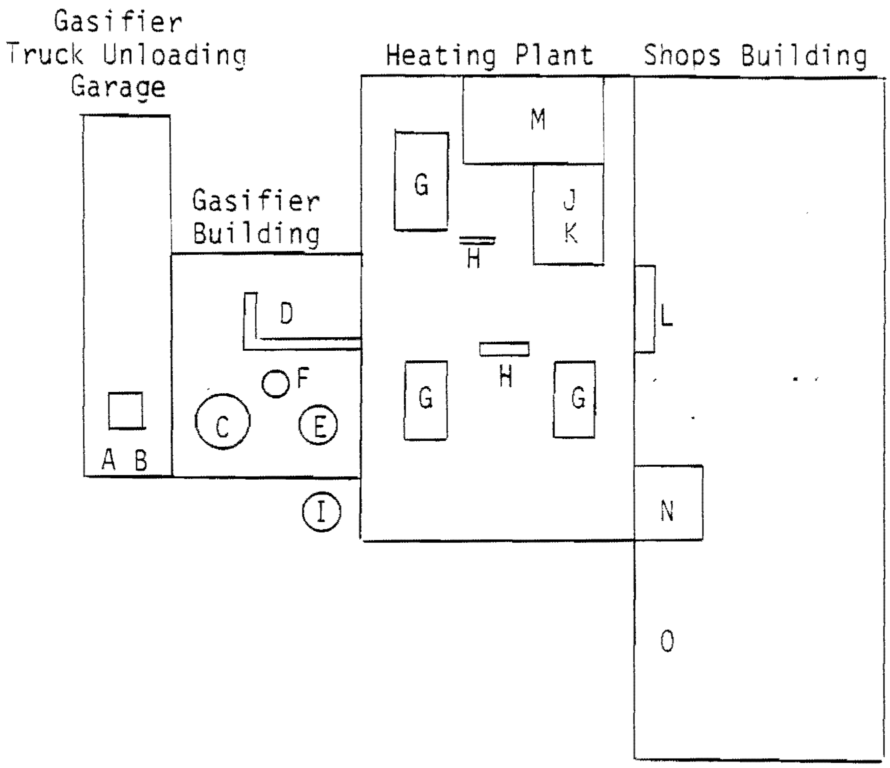
DOE, through the Oak Ridge National Laboratory (ORNL), has developed an environmental and health program for the UMD Coal Gasification Project. This program provides data and information for assessments of low-Btu gasification technology to determine potential environmental and health impacts of further commercialization of low-Btu gasification processes.

In early 1977, the University of Minnesota and Foster Wheeler began the preliminary engineering phase of a gasification project based on a 10-foot diameter, two-stage Stoic gasifier (FW-Stoic). This gasifier provides steam heating for the Duluth, Minnesota campus. By the end of 1977, major equipment had been received at the campus heating plant site, and construction of the gasifier had begun. Major construction was completed by October 1978 and seven periods of operation were conducted by April 1980. Equipment defects and design deficiencies, some of which are described in this report, became apparent during these shakedown operations. These runs, demonstrated that substantial modifications of existing designs are sometimes required to provide safe, reliable and environmentally acceptable operation of this gasification scheme in the United States. Sufficient operational experience has been achieved to meet the original technical objectives of the project.

C. Description of the Facilities

The University of Minnesota, Duluth Heating Plant is located in the southeast portion of the campus. The plant building is an enclosed brick-and-metal, multi-level structure housing coal handling and storage equipment, the FW-Stoic gasifier and its ancillary equipment, including control area, three boilers, enclosed operators offices, computerized process monitoring area and shower area and lunch room. Figure 1 is a diagram of the plant showing each of these areas.

The UMD Heating Plant, at one time, used coal-fired boilers to provide steam to the campus. When these boilers were converted to oil-fired



A	Coal Unloading Area	I	Boiler Stack
B	Ash Pick-Up Area	J	Industrial Hygiene Office
C	Gasifier	K	Industrial Hygiene Storeroom
D	Gasifier Control Area	L	Operator's Office
E	Electrostatic Precipitator	M	Lunch Room
F	Bottom-Gas Cyclone	N	Locker Area and Shower Room (2nd Floor)
G	Steam Boilers	O	Garage Area, Shops Building
H	Boiler Control Panel		

Figure 1. Layout of the UMD Heating Plant Building Showing Main Floor (unless otherwise noted).

boilers, the original coal handling equipment was put in "mothball" status. Much of this equipment, with some modifications, was incorporated into the design of the gasification facility. The gasifier and ancillary equipment are located on the west side of the heating plant building as show in Figure 1. The unloading area is in an enclosed brick facility where trucks dump coal through a grate into an underground bin. There is no outside coal storage. Double underground conveyors transport the coal to the modified original coal handling and bulk storage bins located along the north side of the original building.

The gasifier building is an enclosed metal multi-level structure attached to the original building with glass forming a large portion of the south-facing wall. The west wall of the original building has been removed. The major floor levels, as shown in Figure 2 are: basement, main floor (level 1), poking* area (level 2), top of gasifier (level 3) and top coal handling platform. The top-gas electrostatic precipitator (detarrer) is located between levels 1 and 3, and the bottom-gas cleanup cyclone is located between levels 2 and 3. The process control room area is located on the main floor (level 1) adjacent to and in open view of the gasifier.

D. Process Description

The major UMD Heating Plant operations associated with the gasifier facility include coal handling and storage, gasification, top and bottom gas cleanup, tar and oil storage, and ash handling and storage. A diagram of the process is shown in Figure 3.

Low-sulfur coal is shipped to the dock in Duluth where it is sized and cleaned. The sized coal is trucked to the UMD Heating Plant and dumped through a grate in the enclosed unloading facility into a storage

* Poking is inserting steel rods through ports in the gasifier in order to determine fire-bed depth and ash-bed depth.

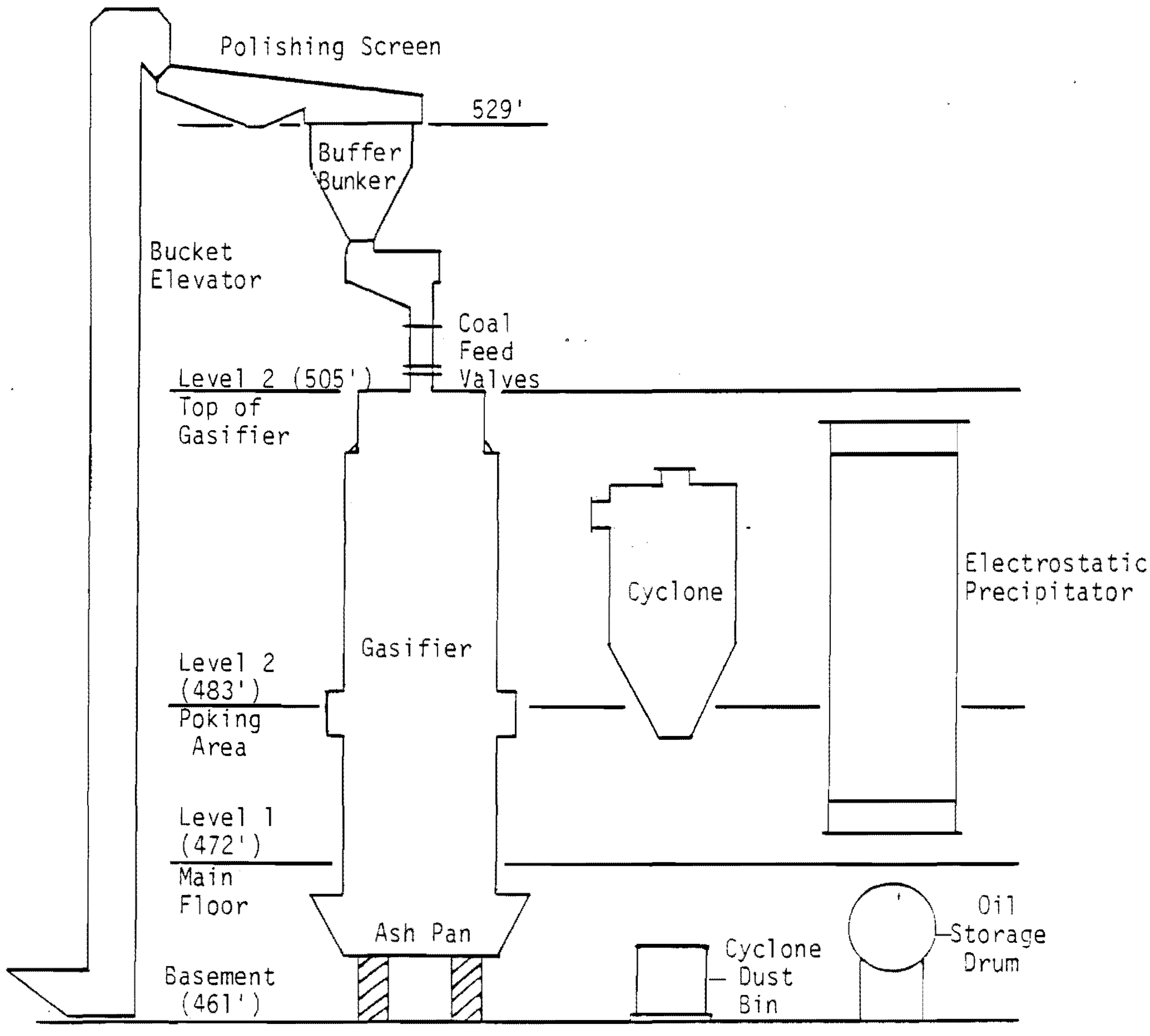


Figure 2. Major Levels in the Gasifier Building at the UMD Heating Plant.

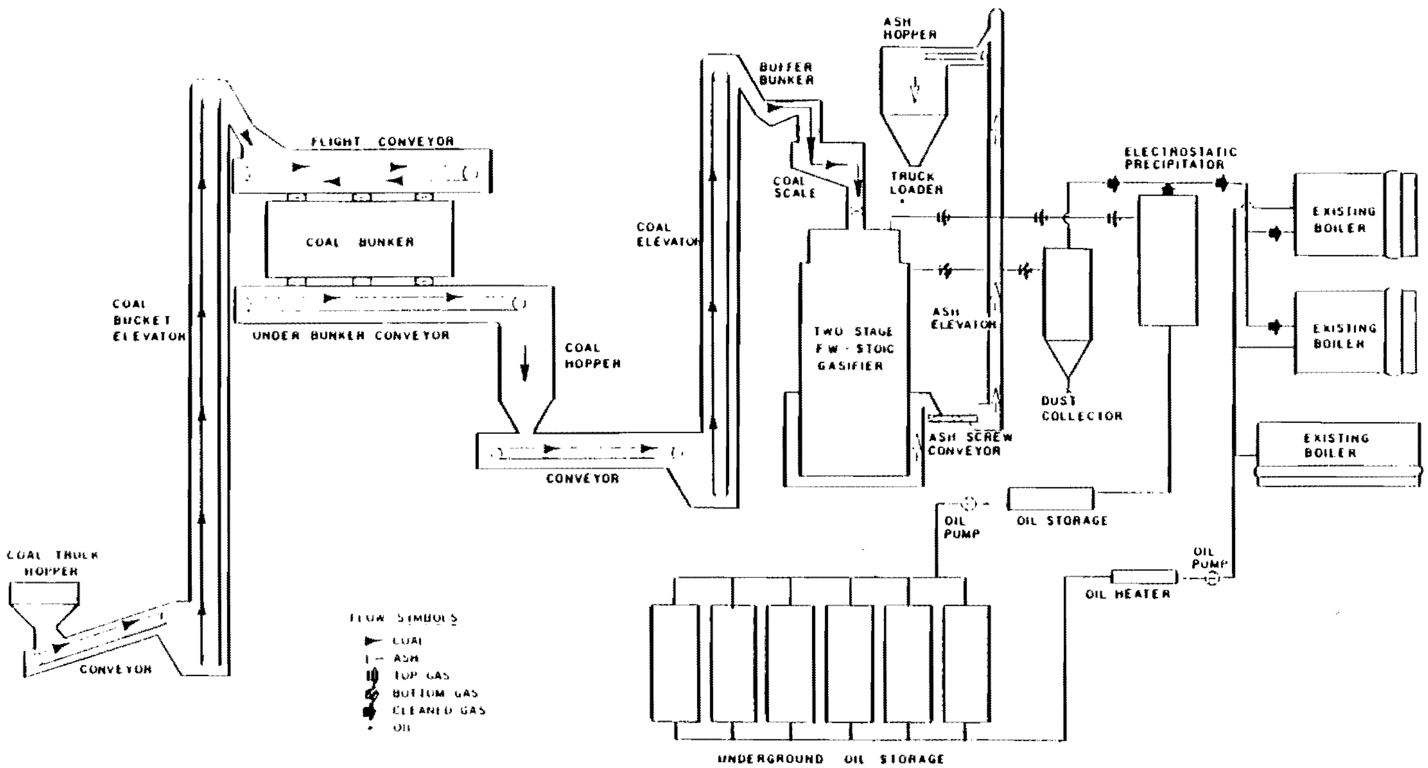


Figure 3. Diagram of the University of Minnesota, Duluth (UMD) Heating Plant Operations Including FW-Stoic Gasifier

bin. Coal is conveyed under a tramp-iron magnet and elevated to storage bunkers. As needed, coal is brought by an under-bunker conveyor to an intermediate coal hopper, conveyed and elevated to a buffer bunker and magnet above the top of the gasifier.

After fines are removed, the coal is weighed and fed through three valves at the top of the gasifier. The gasifier is an air-blown, two-stage, fixed-bed, low pressure, FW-Stoic unit. Steam and air are fed through the bottom grate. Top product gas is sent through an electrostatic precipitator to remove by-product tars and oils which are stored for use as a substitute for No. 6 heating fuel in the boilers. A bottom product gas, sent through a cyclone for entrained particulate removal, is combined with the cleaned top gas to give a low-Btu gas for use in existing boilers for steam generation.

E. Potential Hazards

Table 1 gives a summary of the major potential hazards at each of the process areas or pieces of equipment cited. Control of exposure to each major hazard is detailed in later sections of this report.

The major health hazards of concern to the UMD Health and Safety Office are carbon monoxide (CO), heat stress, coal dust, polynuclear aromatics (PNAs), and noise. Potential exposure to coal dust is limited to the coal handing system where open conveyor belts are used. The use of an open conveyor system promotes the presence of a dusty environment. Current control of worker exposure is through the use of respirators with high efficiency dust filters.

Exposures to CO and PNAs can potentially occur anywhere in the gasifier facility except in the coal handling system. Control is primarily through the maintenance of the integrity of the closed process system, a method regarded as highly effective. Exposures to these contaminants should therefore be connected with a breakdown in the integrity

TABLE 1

MAJOR POTENTIAL HAZARDS BY PROCESS AREA
University of Minnesota, Duluth
Heating Plant (FW-Stoic, Gasifier)

Process Area	Potential Hazard
COAL STORAGE AND HANDLING	
Raw Coal Handling, Sizing, Storage	• Noise • Fire • Respirable Coal Dust • Explosion
GASIFICATION	
Weigh Scale & Buffer Bunker	• Noise
Gasifier	• Polynuclear Aromatic Hydrocarbons • Carbon Monoxide
ASH REMOVAL SYSTEM	• None
GAS CLEANING	
Electrostatic Precipitator	• Carbon Monoxide • Polynuclear Aromatic Hydrocarbons
Cyclone Collection	• Carbon Monoxide
BY-PRODUCT STORAGE	
Oil Storage Drum	• Polynuclear Aromatic Hydrocarbons

of the closed system. Breakdown can occur during emergencies, repair work and manual poking. Respirators are used during each of these breakdown situations. Other protective equipment specified to minimize skin contact with PNA-containing tars are discussed in section II-C.

Emergency situations are monitored by the use of carbon monoxide continuous monitoring devices. The monitors are set to sound an audible alarm when carbon monoxide levels exceed 50 ppm, the current personal exposure limit. Carbon monoxide is used as a indicator gas. If the carbon monoxide level is kept below 50 ppm it is presumed that the other gas and vapor constituents are below their toxic levels.

Coal feeding and manual poking, which break the integrity of the closed system, are the only activities conducted on a periodic basis. A steam venturi is used to keep process gas from leaking out of the port into the workplaces. Carbon monoxide levels up to 150 ppm were reported during the adjustment of the steam venturi with nondetectable levels thereafter. A valving sequence incorporating DeZurik knife-gate valves is used to minimize leakage of product gas during coal feeding. Details of these controls are presented in Section II.

Noise levels in excess of 90 dBA were reported throughout the facility during manual poking and while operating the coal conveyor and coal feed valve. Exposure to high noise levels at the coal conveyor and in poking operations is currently controlled by the use of ear muffs and foam ear plugs. Mufflers were installed at the coal feed valve to reduce noise levels to 75 dBA.

Measurements taken by ORNL[3,6] have shown that heat stress problems may occur during poking operations, especially during warm weather. Control measures being evaluated to correct this potential problem are discussed under "Gasification" in Section II.

II. CONTROL TECHNOLOGY

This section presents the occupational health hazard control technology used at the UMD Heating Plant to mitigate worker exposure to the chemical and physical agents associated with the FW-Stoic gasifier and ancillary operations. Potentially hazardous chemical and physical agents associated with this process facility were identified in Section I.E of this report. The control technology used to minimize exposures to these agents is presented in four categories: Engineering Controls, Work Practices, Personal Protective Equipment and Monitoring. Those agents that remain major concerns after implementation of various controls were presented in Table 1 as major potential hazards* by process area. Additional controls being implemented and/or considered for these agents are also presented in the following sections. Conclusions on the controls presented here and recommendations for modifications and/or additional controls are given in Section III.

A. Engineering Controls

1. Introduction

A two part discussion of each process area of the gasification facility is presented. The first part is a process description. The second part is a discussion of potentially hazardous chemical and physical agents and associated engineering controls. The term "engineering controls" includes the use, addition and/or substitution of:

- hardware
- chemical agents
- process conditions
- unit processes
- instrumentation/process controls

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* "potential hazard" is synonymous with potentially hazardous agent

that result in a reduction or elimination of occupational exposures to potentially hazardous agents.

During the start-up and early operation of the UMD gasification facility, various design deficiencies contributed to operating and worker exposure problems. Modifications and repairs[4,5] made to the facility are discussed in terms of their effect on worker exposures.

2. Coal Receiving and Storage

(a) Process Description

Non-caking, low-swelling index coal is shipped by rail to docks in Duluth where it is sized. Fines are transported to the University of Minnesota, Minneapolis, while the balance is taken to the UMD heating plant in 40 ton trucks. Trucks pull into the unloading facility, a door is closed to retain dust, and the coal is dumped through a grate to an underground hopper. Two workers required for the operation, the truck driver and a helper, remain in the room until all the coal is through the grate. A conveyor carries the coal from the hopper under a tramp-iron magnet to a bucket elevator. A flight conveyor is used to distribute the coal to an open, horizontal coal bunker (3-day supply: 216 tons) located on the third floor. An under-bunker conveyor transports the coal from the bunker and drops it to an intermediate coal hopper (surge vessel). Coal from the hopper drops to another conveyor, and is carried by bucket elevator to a chute above the gasifier. Coal is then passed over a fines screen, under another tramp-iron magnet, and into a buffer bunker above the coal weigh scale. Fines from the screen are sent by chute to a fines bunker. The fines are returned to dock in Duluth for shipment to the Minneapolis campus.

(b) Control Technology

The potential hazards associated with the Coal Receiving and Storage operations are due to the generation of coal dust and noise. These potential hazards include potential exposure to high levels of respirable coal dust and noise and the potential for coal dust and/or fines fire and explosion. The front end of the system, a modification of an original system in use when the heating plant burned coal in their boilers, generates these elevated noise and dust levels. This is due to extensive coal handling and the type and age of the coal used. The age of the coal refers to the time lapse between mining and its use. An "older" coal is more likely to become friable due to moisture loss. Lower rank coals tend to be more friable than higher rank coals.

The primary engineering controls for this operation involve isolating the worker from the generated coal dust. To accomplish this, all equipment in the coal handling system, with the exception of the main storage bunker, is enclosed or is being enclosed. In addition, ventilation lines being installed on conveyors, elevators, screens and hoppers are to draw off generated dust. The purpose of this modification is to reduce the amount of dust entering the workplace and, at the same time, maintain dust concentrations in the system at levels which are lower than that required for coal dust explosions. The ventilation system uses the B-131 vent blower to draw air and entrained dust through the S-134 vent cyclones. Dust collected in the cyclone drop through discharge duct work to the fines bunker. The air stream vented from the vent cyclone is fed to the gasifier B-130 A/B primary air blowers. The B-131 vent blower is rated for 570 acfm at 15 inches of water-pressure.

The engineering controls in the coal unloading area include two manually activated water/detergent sprays located above and below the hopper to suppress dust and a manually activated induced draft fan which exhausts to a fabric filter baghouse. The collected dust is sent to the coal fine bunker.

At the time of this visit, noise and dust levels were a control problem, though UMD expected improvement due to enclosing additional equipment and installation of ventilation lines. Personal protective equipment used to reduce dust and noise exposure is discussed in section II.-C.

3. Gasification

(a) Process Description

Coal Feeding - Coal released from the buffer bunker, drops onto an enclosed coal scale and is held there until the gasifier is ready to accept another load. From the coal scale, the coal passes through a series of three DeZurik knife valves and into the top of the gasifier. The valving sequence just prior to coal feeding begins with all three valves in a closed position. The top valve is opened and coal from the weigh scale falls onto the middle knife valve grate. When the correct weighed amount of coal has dropped, the top knife slides shut. Low pressure steam is then used to pressurize the volume between the top and middle valves after which both the middle and bottom valves are opened. When enough time has elapsed for the coal to enter the gasifier, the middle, then bottom valves slide shut; steam pressure is discontinued and the volume is vented to the S-134 vent cyclone by the B-131 vent blower. The blower is rated for 570 acfm at 15 inches of water. This vacuum removes gases that had escaped from the gasifier.

Gasification - The gasifier in use at the UMD heating plant is a 3 ton-per-hour (tph), FW-Stoic, air blown, 2-stage, fixed-bed (wet bottom) unit designed by Foster Wheeler Energy Company according to process license from Stoic Combustion Pty. Ltd. A simplified diagram of the gasifier is shown in Figure 4. The gasifier is 40 feet high from the ash pan to the top of the unit and 10 feet in diameter at the water jacket. Poke holes are located at two levels: 12 on the bottom stage for fire-bed depth check and 8 on the top stage to break up bridge formations. Design operating temperatures decrease with height of the gasifier from approximately 2100 F (1149 C) at the fire-bed to 250 F (121 C) at the top of the gasifier. Operating pressure in the gasifier is approximately 20 inches of water (approximately 0.25 psig).

The gasifier is designed to use a low sulfur (less than 0.5%), non-caking, low-swell index coal with a 3 ton per hour design capacity and a turn-down ratio of 5 to 1. Products from the gasifier are a top

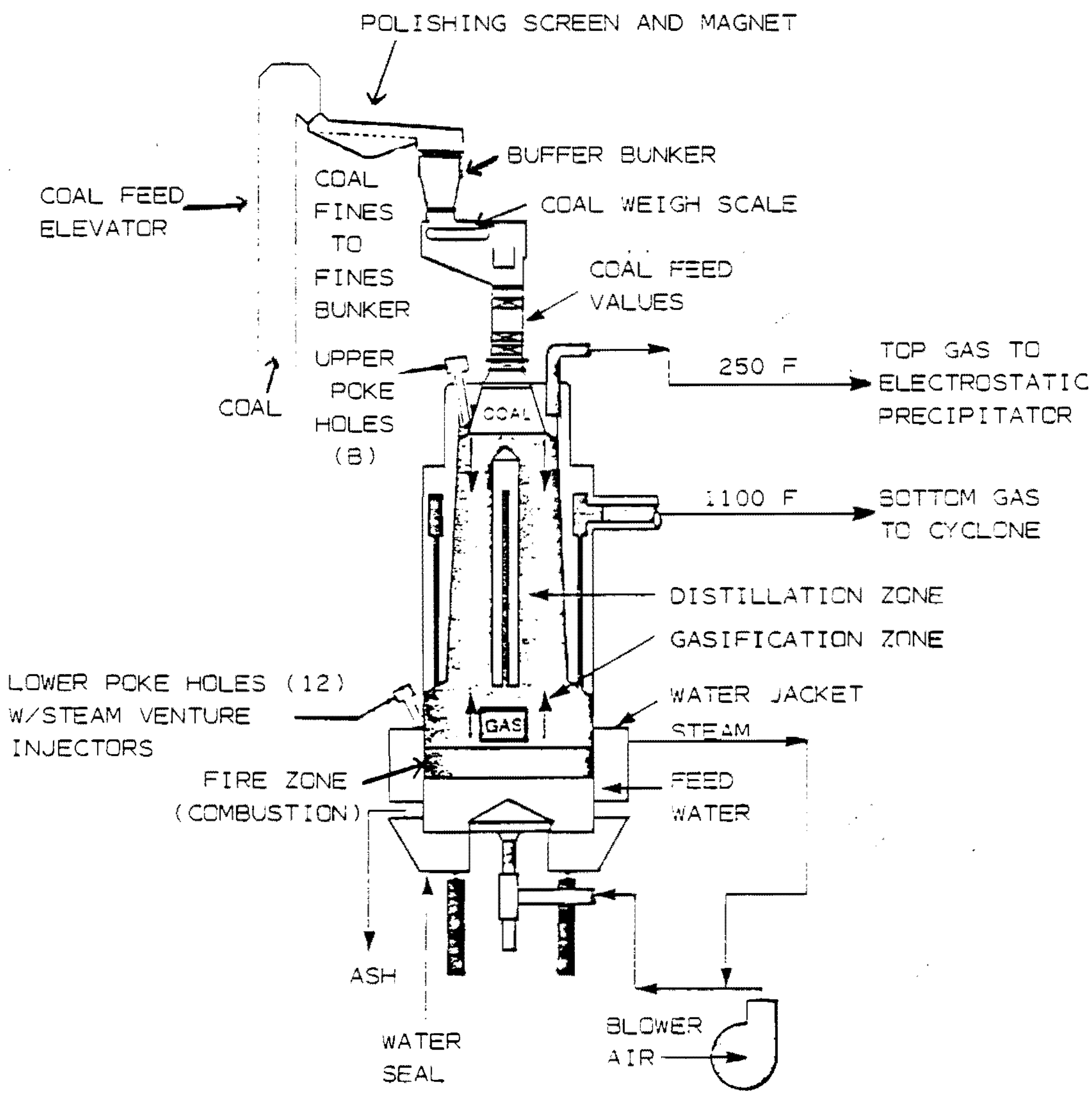

Figure 4. Simplified Diagram of the Foster Wheeler (FW)-Stoic, Two-Stage Gasifier (adapted from reference 6).

gas, consisting of coal distillation products (tars, oils), CO, hydrogen (H_2) and nitrogen (N_2); and a bottom gas from the gasification zone consisting mainly of CO, H_2 and N_2. These two product streams cleaned of tars, oils and particulates, are combined to give a low-Btu gas with a heating value of approximately 160 Btu/scf and a temperature of 750 F (399 C) to feed the boilers. Design temperature is 250 F (121 C) for the top gas and 1100 F (593 C) for the bottom gas.

Pressurized air and steam are introduced into the gasifier through a rotating conical ash grate at the bottom of the gasifier. Ash drops past the grate into a water-filled ash pan where an ash plow directs the ash to the remainder of the ash removal system.

The gasification process in the FW-Stoic gasifier is similar to other top-feed, fixed-bed gasifiers. Coal is dropped from the DeZurick knife valves into the top of the gasifier. The coal moves slowly downward (counter current to the gas stream moving upward) through three distinct reaction zones: 1) demoisturization and devolatilization, 2) gasification, and 3) combustion. In the upper section of the gasifier, coal is heated by rising hot product gases from the gasification zone below. The result is demoisturized and partially devolatilized coal with char remaining. The generated product gases, vapors, and aerosols exit at approximately 250 F (121 C) through a take-off at the top of the gasifier, and are sent to an electrostatic precipitator. The heavier tars and oils are removed by the electrostatic precipitator and stored in a steam traced drum.

As ash is removed from the bottom of the gasifier, char and coal move from the devolatization zone to the gasification zone where an endothermic reaction takes place with hot combustion gases and excess air and steam coming from the bottom of the reactor. This results in a bottom product gas that is composed principally of CO, H_2 and N_2. The internal structure of the gasifier is such that one portion of this gas is directed toward the devolatization zone while the remaining portion rises through an annulus-like path to the bottom gas take-off. The temperature of the gas at this point is approximately 1100 F (593 C).

Partially gasified char and any remaining coal move into the combusion zone where the exothermic reaction with incoming air produces heat for the gasification zone above. Spent ash is dropped through the circumferential gap between the rotating grate and the gasifier wall to the water sealed ash pan. Temperature in the combustion zone is maintained below the ash fusion temperature by using a water jacketed gasifier wall and controlling the amount of steam introduced through the grate. As mentioned before, poke holes in the lower stage are used to determine fire-bed depth and to break up any bridging or agglomeration just above the firebed. There are twelve poke holes; three holes, 120° apart, are poked each hour.

(b) Control Technology

The major potential hazards in the gasification area are exposure to carbon monoxide, polynuclear aromatic hydrocarbons, noise, and heat stress. Exposure to mercury, a former hazard, has been eliminated by a design modification. In the original design, a mercury seal was used at the bottom of the gasifier at the point where the air injection system entered the gasifier. Pressure fluctuations in the gasifier blew mercury out of this seal on two separate occasions in 1979, contaminating the crawl space beneath the gasifier. The mercury seal was replaced by a double mechanical seal to eliminate this problem. In addition, Soderberg[4] reports that the new seal is effectively preventing the emission of CO.

According to plant personnel, there were many carbon monoxide excursions above 500 ppm during the first two runs. These were due primarily to gasifier gas-line flange leaks and precipitator flange leaks.

These flanges were designed for low pressures (approximately 2 psig) and were easily warped (developed "fish-mouths") when they were overtightened. Neither new gasketing material nor re-torquing the flange bolts could effectively seal the flanges. Boxes were welded around each of the flanges to prevent emissions from reaching the work area.

Steam venturi ejectors are used to prevent gasifier gas from escaping into the workplace during the poking operation. The steam supply has to be at a high enough pressure and capacity to function properly. The original steam supply for the poke holes came from a low pressure system for the gasifier. This system also supplied all steam for tracing and makeup steam for the gasifier blast air ejector. When operating the gasifier at pressures greater than 30 inches of water, not enough steam pressure was available for poking more than one hole at a time without gas escaping. A 150 psig steam pressure line was installed around the gasifier just below the poke hole circle. The steam pressure is reduced at that point to 30 psig. A hand-held CO monitor placed in ejector exhaust during a demonstration for the CTA survey team showed no problem with producer gas escaping while poking three holes. However, re-design of the ejectors would be necesary to eliminate the backflow of steam into the workplace. This would also reduce the high noise levels caused by the backflow.

Upper poke holes are located at the top of the gasifier vessel. They are used to check for bridging in any of the four internal quadrants. If bridging occurs, rods can be inserted to "break up" the bridging. Originally, one steam valve was furnished and a steam hose was planned to be used for each poke hole. When bridging occurred while operating on Cannel coal, UMD found it necessary to increase steam capacity to poke the upper holes. Modification included installing a steam loop and piping steam to each ejector at the upper poke holes. This permits one or two quadrants per shift to be checked for bridging.

A potential problem exists under the gasifier due to the air scavenger and ventilation system, which pulls the CO escaping from the gasifier down into the basement. At the time of the visit (January 1981), the problem had not been solved.

According to plant personnel, 900 to 1,000 gallons of low-temperature tar are produced per day from western sub-bituminous coal by the FW-Stoic gasifier. Coal tars are present in all lines from the top of the gasifier to the electrostatic precipitator storage tanks. Operators have been exposed to tar liquids which are potential skin-contact hazards, especially when the electrostatic precipitator fails, when the precipitator is drained, and when lines between the precipitator and the storage tanks freeze. This latter problem has been alleviated by steam tracing all tar-bearing lines.

All leaks from the upper portion of the gasifier where low-temperature tar is produced contain PNA material. Condensed tars have been detected on poke hole covers, lockhopper valves, and in the coal feed system, including the area around the coal feed weigh belt. A steam line has been installed between the series of DeZurik knife valves to pressurize the area prior to coal loading. In addition, to prevent gasifier generated gases from entering the coal weigh chute, a vacuum line was installed between the top and second knife valves to remove any escaping carbon monoxide and/or tar and oils. As an additional precaution, the buffer bunker is supplied with a vacuum line, Both of these lines are routed to the S-134 vent cyclone which is used to draw dust from the coal handling operation. Vacuum is supplied by the B-131 vent blowers which is rated at 570 acfm at 15 water gauge (WG). Exhaust from the cyclone is sent to the primary air blowers for the gasifier.

Other potential hazards in the gasification area are noise and heat stress. High noise levels are present in the gasifier area during the poking and/or coal feeding operations. The cross contamination of noise from the coal handling equipment which is located adjacent to the gasifier, further elevates noise levels. Mufflers added to the knife valve exhaust ports in the coal feeding system reduced noise levels from 97-101 dBA to approximately 75 dBA[3]. In another case, rebalancing the air-feed blowers essentially eliminated this source of excess noise.[4]

At present, noise protection equipment is made available to all operators who are involved with the poking operation. The major source of noise in this operation is the steam venturi used to prevent escape of gasifier gases through the poke holes. Aside from redesigning the steam venturi ejectors, the use of noise protection equipment may be the only available means for controlling exposures to this source of noise. The successful use of automatic poking devices has yet to be demonstrated.

The potential for heat stress exists in the gasification area particularly in warm, sunny weather. There is a heat input through the south-facing windows in the gasifier area. In addition, the FW-Stoic gasifier has a water jacket which extends only to just above the combustion zone (see Figure 4). Even though the gasifier wall above the water jacket is protected by three layers of refractory insulation, outerskin temperatures are as high as 266 F (130 C)[4].

The risk of heat stress is particularly high in the poking operation. Poking is conducted on an hourly basis to determine the depth of the gasifier fire-bed. The work is performed by two operators and involves inserting a 10 foot steel "poke" rod through a port into the combustion zone. The risk of heat stress is greater when extensive poking is required. The poking operation normally takes about ten minutes to poke three holes, 120° apart, unless the coal in the gasifier forms a bridge. Manually breaking this bridge may take up to 45 minutes. The use of heat shielding and/or insulation to reduce exposure to heat from the gasifier has been under review.

4. Ash Removal System

(a) Process Description

The ash removal system for the gasifier consists of a conical, screw-shaped grate, a lobed ash grate holder, and a water-filled ash pan; all of which rotate beneath the gasifier. Conveyors transfer the ash to an ash hopper where it is stored until it is trucked offsite to a landfill.

The function of the grate in the ash removal system is to continuously move dry ash from the combustion zone or fire-bed to allow for the downward movement of coal from the top of the gasifier (see Figure 5). The screw-shaped design of the grate forces the ash downward and radially.

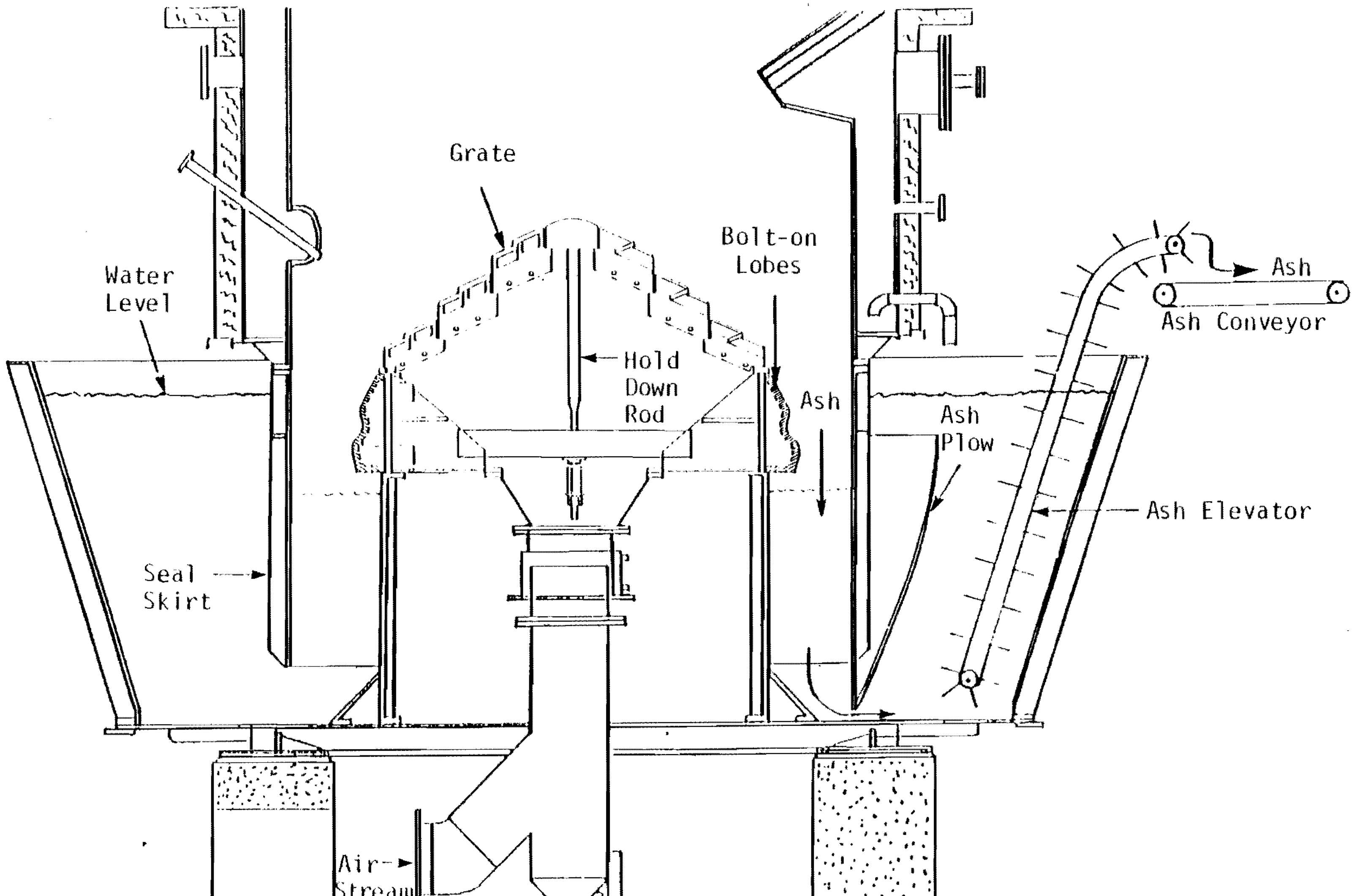

Figure 5. Diagram of the Ash Removal Mechanism

The ash drops past a lobed grate holder, which breaks clinkers, to the water-filled ash pan. The ash pan is attached to and rotates with the grate via the grate holder. A plow on each side of the gasifier accumulates and directs the quenched ash to an elevator which moves the ash out of the pan. Two short conveyors move the ash from the elevator to a cross auger. The cross auger moves the ash to a stub auger that feeds a bucket elevator. The bucket elevator empties into the ash hopper located along the west side of the gasifier facility in the coal unloading room. Periodically, the ash hopper is unloaded into a truck for disposal.

(b) Control Technology

A wet granular ash is produced by the FW-Stoic gasifier. The wet ash removal system is an effective method of controlling inhalation of ash dust, a potential hazard associated with gasifiers using dry-ash removal systems. Enclosed conveyors for ash removal at UMD are not necessary for dust suppression.

If skin-contact with the wet ash is frequent, dermatitis can result. Frequent exposures at the UMD facility occurred during maintenance of malfunctioning ash removal equipment. The following are examples of solutions to ash removal equipment problems that resulted in a concurrent reduction in maintenance related contact with the wet ash.

- The original drive mechanism for the ash hopper dump gate was an internal worm-and-gear mechanism. Plugging of this mechanism meant that the gate to the hopper could not be closed after being opened to load a truck. This caused the entire hopper to empty. Exposure of clean-up personnel to the wet ash was initially reduced by dumping the ash more frequently to ensure that the hopper had less than a truckload of ashes. This work practice was discontinued when a new gate using an external drive was installed giving satisfactory control over ash flow from the hopper.

- There were numerous problems with the ash elevator, the stub auger, and the ash conveyors caused by the rapid deterioration of metal parts by the corrosive action of the wet ash. The replacement of the chains and sprockets with belt drives appeared to solve the problem. Exposure of maintenance people to the ash was significantly reduced.

- Wet ash tended to plug the chute feeding from the cross auger to the ash elevator, requiring maintenance and exposure. The chute was replaced with an auger, improving the feed to the bucket elevator and minimizing worker exposure.

- The originally designed plow discharge throats were wider than the ash buckets and caused ash to overflow. Ash had to be manually raked into the buckets to maintain a reasonable ash level in the ash pan. A deflector plate was installed on the plow to divert ash into the buckets. This reduced the amount of attention and worker exposure required to maintain flow in the ash removal system.

5. Top Gas Cleaning System

(a) Process Description

Top gas from the gasifier consists mainly of carbon monoxide, hydrogen, nitrogen, tars and oils. The slightly positive pressure in the gasifier moves the raw top gas to an electrostatic precipitator (ESP) to remove aerosols of tars and oils. The ESP, with double insulated electrodes, is operated at a temperature of at least 200 F (93 C) to prevent heavier compounds from solidifying and plugging the unit. Lighter (lower boiling point) top gas constituents pass through the ESP and are mixed with the cleaned, hot, 1100 F (593 C), bottom gas to produce a 750 F (399 C) low-Btu fuel (160 Btu/scf) for direct use in either of the two previously coal-fired boilers. High sulfur coals cannot be used at UMD because there is no acid gas removal equipment. Tars and oils that collect at the bottom of the ESP are gravity fed through steam-traced lines to a steam-traced, horizontally mounted fuel oil storage drum located on the basement level of the gasifier facility. Between 900 to 1,000 gals/day of tars and oils are collected at 50% operating capacity (36 tpd of coal).

(b) Control Technology

maintenance of the top gas cleanup system involves opening the electrostatic precipitator and its associated tar/oil-containing lines. This maintenance procedure potentially exposes personnel to the inhalation of and skin contact with process constituents such as PNAs and carbon monoxide. The following are examples of engineering solutions that resulted in a reduction of maintenance to this equipment, thereby reducing worker exposure.

- A precipitator bypass line was installed to eliminate fines build-up in the precipitator when starting up on coke. This has resulted in less exposure by reducing the frequency of maintenance.

- During periods of start-up and after long periods of "hot-standby", operators found it difficult to sustain precipitator temperatures for proper tar flow. This resulted in delayed operation and, at times an increase of maintenance. A 30 psig steam coil installed to augment the insulator compartment heaters resulted in improved tar flow. Two other modifications, removal of the tar float from the precipitator outlet and double steam tracing the tar line to the tar drum, aided in reducing the frequency and amount of maintenance required to maintain proper operation.

Plant personnel originally thought that the top gas temperature through the electrostatic precipitator would have to be maintained at a minimum temperature of 200 F (93 C) in order to avoid plugging and arcing problems. Consequently, a four inch line from the hot gas cyclone discharge to the top gas line into the precipitator was installed to heat the top gas. The precipitator has operated successfully at temperatures as low as 150 F (66 C) however; consequently, the line has never been used.

6. Bottom Gas Cleaning System

(a) Process Description

A portion of the product gas from the gasification zone is forced by gasifier pressure up the outside annulus of the gasifier to the bottom take-off port and into the dust cyclone for particulate removal. The cyclone is refractory lined to operate at the temperature, 1100 F (593 C), of the bottom gas. The hot, cleaned bottom gas exits the top of the cyclone to a refractory lined duct that joins with the cleaned top-gas line from the ESP. The design temperature of the combined gas, used as fuel to the boilers, is approximatey 750 F (399 C). Dust drops to the bottom of the cylcone and is unloaded into bins through two dust dump gate valves followed by a pneumatically operated knife valve.

(b) Control Technology

Producer gas leaks occurred with the original two pneumatically operated cyclone dust unloading (dump) valves when material would deposit on the valve seat. Operation and maintenance of these valves exposed personnel to high levels of carbon monoxide and the high operating temperature, 1100 F (593 C), of the cyclone. The installation of an 8-inch pneumatically operated knife valve behind the two dump valves resulted in a positive shutoff and eliminated the gas leakage. However, because the dumping operation is manual, exposure to cyclone dust is a concern. Personal protective equipment used to reduce exposure to the dust is described in Section II-C.

7. By-Product Storage

(a) Process Description

Tars and oils from the electrostatic precipitator flow by gravity to the "oil" storage drum. All oil carrying lines, the storage drum, and the bottom of the precipitator are steam traced to aid tar flow. The storage drum is vented back to the precipitator discharge lines.

Tar and oil production amounts to approximately 900 to 1000 gallons per day when the gasifier is operating at 50% operating capacity. When the 1000 gallon storage drum is full, the oil, similar to No. 6 heating fuel, is pumped to underground storage tanks. When additional fuel is required, or when a large amount of oil has accumulated, it is heated and pumped to any of the three boilers.

(b) Control Technology

Oil flow problems occurred because of insufficient heating capacity of the single wrap steam trace line, especially during startup operations or after long periods on hot standby. Operation of the electrostatic precipitator was hampered because of oil backup caused by the limited flow. A second wrap added to the steam traced line greatly improved the flow of oil. This reduced maintenance to both the lines and the precipitator, thereby reducing worker exposure to PNAs in the oil.

B. Work Practices

1. Work Force

The University of Minnesota, Duluth gasifier is operated 24 hours per day, 7 days per week. Three shifts with a minimum of three workers per shift are needed to keep the plant operating continuously. The shift personnel include at least one plant operator and two workers drawn from the junior engineer trainee and utility man job categories.

The plant operator spends about 80 percent of his time at the control board monitoring the process and collecting plant operation data. The remaining time is spent in other sections of the gasifer facility in a routine check of process equipment. The process control board section is not enclosed and is located at the ground level of the gasifier facility. Therefore, the plant operators are potentially exposed to emissions from the gasification process.

The engineer trainees and utility men job categories differ only with regard to their position on the university staff. Length of time in the facility for each of these categories is highly variable and dependent upon assigned daily duties. Responsibilities include the unloading of coal shipments, the coal conveyor system, gasifier fire-bed determination (poking), and mechanical and maintenance work.

2. Administrative Procedures

Health and safety issues concerning the gasifier and assigned personnel are handled by the UMD Health and Safety Office. This office has no offical responsibility regarding gasifier personnel because of the absence of a health and safety clause in the union contract. Therefore, the official office role is to provide recommendations for the control of health hazards. Steps are being taken to formalize the role of the UMD Health and Safety Office.

The UMD office uses monthly safety meetings to keep workers aware of the potential hazards associated with the gasifier and to provide for worker participation in the health and safety program. At these meetings the potential hazards associated with specific jobs are reviewed and safe work practices, including the use of protective clothing and equipment, are discussed. Supplemental information such as job training and training in the use of respirators and qualitative fit testing are also conducted at these meetings.

These meetings are used as a basis for discussing worker complaints and for covering possible solutions. This time is also used to keep workers apprised of any sampling conducted during the prior month, the purpose and results, and a progress report on unfinished business.

The UMD office works closely with the supervisor of the gasification facility in evaluating and implementing new health and safety guidelines formulated at the monthly meetings. All guidelines are given verbally by the supervisor and are re-emphasized at the monthly meeting to insure that the workers understand these guidelines.

3. Hygiene

Personal hygiene is stessed by the UMD office and involves:

- discouraging storage or consumption of food and beverages where contact with tars is likely,
- discouraging the use of tobacco and chewing gum, and cosmetics in these areas,
- encouraging washing of hands prior to using toilet facilities or eating, and
- showering promptly if body or clothing is contaminated by tars.

These hygiene provisions were based on recommendations set forth in "NIOSH Criteria for a Recommended Standard. . .Occupational Exposures in Coal Gasification Plants."

Locker and shower facilities are available and workers are encouraged to use these on a daily bases. Remodeling these facilities to provide clean and dirty change rooms as recommended in the NIOSH document has been approved by UMD and is expected to be completed in the near future.

4. Medical

The medical program for the UMD gasifier personnel has been described in detail by Oak Ridge National Laboratory in the report "Proposed Environmental and Health Program for University of Minnesota Gasification Facility"[2] prepared for the Department of Energy in January 1978. This program has since been modified and this version is presented here.

A complete physical examination is given prior to employment and annually thereafter. The examination consists of a review of all organ systems with a careful recording of any abnormalities found, especially of the skin because coal tars contain skin carcinogens. Family and occupational history including exposures to toxic materials and radiation, major illnesses or injuries, and smoking history of the patient are also included. A medical form (Appendix A) is used to keep track of this information.

Laboratory studies conducted at the preemployment and annual examinations include:

- Audiogram at 500, 1000, 2000, 3000, 4000, and 8000 Hz
- Complete blood analysis consisting of hemoglobin, hematocrit, red blood cell count and white blood cell and differential.
- Routine urinalysis
- Corrected/uncorrected vision

- 12-lead electrocardiogram
- Pulmonary function tests: FVC, FEV_1, FEV_3, $FEF_{25-75\%}$
- 14" x 17" chest x-ray
- Color slide photograph of skin

The preemployment examination is given to all new workers or transferees from other UMD facilities. This examination serves as a baseline for future examinations.

Illness records are kept for all gasifier employees by the UMD medical officer. The attending physician diagnosis of the illness is required for any worker missing one week or more to ensure that the worker's health experience is complete and up-to-date.

This medical program has been in effect for 3 years; a time too short for evaluating long-term exposure effects. However, no adverse effects have been reported that may be job related. Early reports from Oak Ridge provided some support for these medical findings indicating that tars from the electrostatic precipitator were slightly to moderately toxic in acute animal toxicity studies conducted orally, dermally, and on the eyes.[3]

C. Personal Protective Clothing and Equipment

Protective clothing and equipment supplement engineering controls by providing additional protection in situations involving leaks in the system and in activities where there exists a potential for exposure to process materials. Their use is recommended to provide protection against the toxicants carbon monoxide, hydrogen sulfide, coal dust, and polynuclear aromatics. Other materials found in process streams are considered a lesser hazard either because of their lower toxicity or because of their low concentration in the process stream. Providing controls for the four major contaminants should produce adequate control of these other process materials.

Protective clothing and equipment requirements are specified for two plant conditions, operation and shutdown. Shutdown is considered the more hazardous situation because of the multitude of maintenance activities required to repair and upgrade the system. Workers engaged in maintenance activities use cotton coveralls and cotton gloves and a half-mask respirator if deemed necessary by the supervisor of the facility or UMD Safety Office. Other workers present during shutdown need only hardhats and safety glasses. While the plant is operating, hardhats, safety glasses or goggles, and cotton coveralls are required.

Ear protection is recommended for workers engaged in activities where noise levels exceeding 90 dBA were recorded. These activities include manual poking and coal handling. However, noise measurements taken by UMD have indicated that other sections of the facility may exceed the 90 dBA level while manual poking and coal handling activities are in progress. Workers in these other areas would be subject to potential noise problems and should be encouraged to use ear protection while these activities are in progress.

In addition to engineering controls, respirators serve as another means for reducing worker exposure to process toxicants such as carbon monoxide, hydrogen sulfide, coal dust, and polynuclear aromatics. The half-mask respirator is intended to protect workers against organic vapors, coal dust, and PNAs. Two Willson full-face respirators are available for hydrogen sulfide protection and for job operations where potentially high concentrations of organic vapors may be released. These full-face respirators equipped with the proper cartridges provide greater protection than the half-mask respirators because of better fit.

Six MSA gas masks with Type N canisters and three Survivair self-contained breathing apparatus (SCBA) are located on each floor of the facility. The SCBAs are used for emergency situations immediately hazardous to life or health, such as oxygen difficient atmospheres, and for carbon monoxide concentrations greater than 500 ppm. The gas masks, MSA Type N, are intended for protection against carbon monoxide at concentrations between 50 and 500 ppm, hazards associated with emergency situations not covered by SCBA usage, and for use during activities such as poking.

The supervisor of the gasification facility is responsible for the periodic inspection and maintenance of all respirators. In addition, the UMD Safety Office conducts independent checks on the condition of the respirators. Respirators are assigned to workers within the facility with each worker being responsible for inspecting his respirator prior to and after each use. The worker is responsible for cleaning his own respirator after each use.

In addition to respirators, special protective clothing and equipment are provided for workers engaged in activities where exposure to tars is likely. This equipment includes cotton coveralls, nondisposable impervious gloves, and chemical safety goggles and face-shields. Soiled clothing and contaminated protective equipment are either cleaned before re-use or discarded. Tools and contaminated surfaces are cleaned with a methylene-base paint stripper. Coveralls are cleaned by an outside contractor who is familiar with the hazards involved.

D. Monitoring

The occupational health sampling program implemented at the UMD facility has been described in a report prepared by Oak Ridge National Laboratory for the Department of Energy[2]. The program objective is to identify, evaluate and control exposures that may produce overt health effects. Personal and area sampling supported by medical surveillance was used to meet the program objective.

For the three years that this program has been in effect the program has focused on the following:

- Carbon monoxide
- Mercury

- PNAs
- Dust and Particulates
- Noise
- Heat

Results were reported in a 1980 Department of Energy publication titled, "Briefing for Environmental Working Group - Gasifiers in Industry" and are summarized below for carbon monoxide, mercury, volatile aromatics, PNAs, dust and particulates, noise and heat stress.

Carbon Monoxide

Carbon monoxide levels were monitored using multipoint continuously monitoring sensors equipped with visual and audio alarms set for 50 ppm. Results showed a general decrease in the facility ambient levels of CO during the three years of operation. During the initial runs CO levels peaked at concentrations exceeding 500 ppm, decreasing to an average of 20 to 30 ppm and finally to 10 to 15 ppm. Tables 2 and 3 summarize data from 1979 and 1980.

Mean CO dosimeter readings (Table 4) for this three-year period never exceeded the 50 ppm time-weighted average exposure limit. However, maximum readings in excess of 50 ppm were reported leading to modifications in the system to reduce leakage.

Mercury

Mercury spills on two separate occasions in 1979, contaminated the crawl space beneath the gasifier and produced a potential mercury exposure problem. A maximum mercury level of 5 milligrams per cubic meter (mg/m^3) was reached in the second incident, dropping slowly after clean-up.

TAB

Summary of CO Are[illegible]

November 19 - December 13, 1979

Location	Aver Concent pp	[illegible]
Coal Feed (802)	30.[illegible]	[illegible]
Lock Hopper (615)	35.[illegible]	
Poke Holes (452)	32.	
Char Hopper (316)	21.	[illegible]
Basement (108)	26.	
Gasifier Control Panel	22.[illegible]	
Boiler Catwalk	8.	[illegible]
Boiler Control Panel	9.	[illegible]

Cowser, K.E., et al [3]

TA

Summary of CO Are[illegible]

February 2 - March 3, 1980

Location	Aver Concent pp	[illegible]
Coal Feed (802)	12	[illegible]
Lock Hopper (615)	18	[illegible]
Poke Holes (452)	12	[illegible]
Char Hopper (316)	7	[illegible]
Basement (108)	7	[illegible]
Gasifier Control Panel	7	[illegible]
Boiler Catwalk	2	[illegible]
Boiler Control Panel	3	[illegible]

Cowser, K.E., et al [3]

TABLE 4

ry of CO Dosimeter Data

3 Hr. TWA's in PPM

AX	PERSON	MEAN	MIN	MAX
.30	17	5.95	2.50	9.40
.90	18	5.05	3.20	6.90
.00	19	8.80	4.30	14.20
.00	20	3.20	3.20	3.20
.60	21	7.15	4.60	14.60
.40	22	4.08	0.00	14.00
.80	23	1.10	0.30	1.90
.00	24	24.40	24.20	24.20
.90	25	18.97	9.10	24.30
.30	27	4.03	0.00	12.70
.50	28	3.68	0.00	9.10
.00	29	7.60	0.00	13.90
.30	30	14.75	12.00	17.50
.80	31	10.20	10.20	10.20
.80	32	6.44	1.70	16.60

Volatile Aromatics

Charcoal tube area samples were analyzed by gas chromatography/mass spectometry for the major aromatics including benzene, toluene, cresol, and phenol. For the 20 samples no significant levels were observed for these aromatics with total aromatics being less than 5 micrograms per sample.

Polynuclear Aromatics (PNAs)

Area samples collected on silver membrane filters were analyzed for the cyclohexane soluble fraction and benzo(a)pyrene (BaP). The soluble fraction was determine gravimetrically and results are given in Table 5.

The maximum reported level of soluble fraction was 0.016 milligrams/ cubic meter. The BaP concentration of these samples ranged from 0.007 to 0.047 micrograms per cubic meter indicating that the BaP composition of the soluble fraction was less than 0.3% by weight. BaP levels were determined by fluorescence spectrometry.

The presence of BaP is an indication of the presence of coal tars in the process. UMD is planning to monitor exposures by developing a system to record the occurrence, location, and amount of tar contamination. Additional studies are also being considered to evaluate the potential problem of skin exposure to the tars. The light pipe luminoscope is used to detect fluorescense, and is being considered as a survey tool to check on tar contamiation of workers before and after washing.

Dust and Particulates

Although sample results were not given, UMD reported that coal dust levels at the facility were high during coal handling. UMD is planning additional surveys of workers in this area to evaluate the potential impact of dust exposure. Other proposed studies include particle size measurements and chemical analysis to determine source and composition.

TABLE 5

Cyclohexane Soluble Fraction
(Coal Tar Pitch Volatiles)

Sample #	Sample Location	Date	Sampling Time (hrs.)	Sample Volume (cu.ft.)	Result (mg/m^3)
25	318	10/04/79	21.42	1190	0.015
26	612	11/24/79	24.2	1448	0.015
38	318	02/07/80	23.6	1396	0.010
44	612	02/09/80	21.7	1299	0.016
54	612	02/19/80	24.1	1383	0.001 (0.0007)
55	318	02/19/80	24.0	1421	0.001 (0.0009)
63	319	02/25/80	24.4	1446	0.010
7 samples			Av. 24 hrs.	Average 1300 cu.ft.	Range = 0.001-0.016 mg/m^3 Mean = 0.0097 mg/m^3

Location 612 - 3rd level near coal feed train
Location 318 - 1st level by ESP over tar pump

Cowser, K.E. et al[3]

Noise

A survey conducted by UMD on June 5, 1979 indicated a maximum level of 85 dBA for the facility during the operation of the gasifier. Noise levels were found to increase to levels of 90 dBA or higher if poking, coal handling, or coal feeding activities were conducted at the same time. Noise levels ranged from 90 to 108 dBA during poking activities; 90 to 104 dBA for coal handling; and 97 to 101 dBA for coal feeding. Since these activities are conducted in the gasifier facility all workers present in the facility are exposed to these high noise levels.

Ear muffs and plugs are provided to all workers within the facility for use during these activities. However, UMD has evaluated the problem to determine the types and effectiveness of engineering controls that may be utilized to reduce noise levels. This evaluation has led to the installation of mufflers on the knife valve exhaust ports of the coal feed systems resulting in a noise reduction to 75 dBA.

Heat Stress

Results of wet-bulb-globe-temperature (WBGT) index tests taken by UMD in June 1979 are given in Table 6. For comparision, Table 7 presents the permissible heat exposure threshold limit values recommended by the American Conference of Governmental Industrial Hygienists. The results indicated the presence of a potential heat stress problem within the facility especially during warm weather (Table 6).

UMD reported that this problem is centered on the poking operation because of:

- high external temperature (266 F (130 C)) of the gasifier
- need for vigorous activity in the poking operation
- heat input from south facing window.

TABLE 6

Wet-Bulb-Globe-Temperature (WBGT) Index Results*
University of Minnesota, Duluth Gasification Facility
(Values are given in degrees Centigrade WBGT)

June 4, 1979 (afternoon, partly cloudy, 65 F)

Location	Dry Bulb	Wet Bulb	Globe	WBGT
415-2rd Level Gas sampling	39	27	45	32.4
605-3rd Level gas sampling area	47	29	49	35.0
685-Method 5 location	49	30	50	36.0

June 5, 1979 (afternoon, partly cloudy, 60 F)

Location	Dry Bulb	Wet Bulb	Globe	WBGT
615-3rd Level gas sampling area	31	22	31.5	24.9
604-3rd Level gas sampling area	44.5	26	46	32.0
415-2nd Level poking area	28.5	23	35.5	26.8
414-2nd Level poking area	29.0	22	37	26.6

June 6, 1979 (afternoon, sunny, 66 F)

Location	Dry Bulb	Wet Bulb	Globe	WBGT
415-2nd Level poking area	37	24	37	27.9
414-2nd Level poking area	34	25	34	27.7

*Adapted from reference 3.

TABLE 7

Permissible Heat Exposure Threshold Limit Valves*
(Valves are given in degrees Centigrade WBGT)**

	Work Load		
Work -- Rest Regimen	Light	Moderate	Heavy
Continuous	30.0	26.7	25.0
75% Work -- 25% Work, each hour	30.6	28.0	25.9
50% Work -- 50% Rest, each	31.4	29.4	27.9
25% Work -- 75% Rest, each hour	32.2	31.1	30.0

* Adapted from reference 1.
**Adapted from reference 2.

The UMD Health and Safety Office plans to conduct additional studies to determine the extent of the problem and the types of engineering controls that may feasibly reduce the heat stress problem. Maintenance workers should also be covered in these studies since certain activities, especially those connected with the servicing of heavy equipment, may require a high expenditure of energy.

III. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based on interviews and observations made by the Enviro Control Technology Assessment team at the UMD heating plant. Discussed below are engineering controls and work practices that should be considered for implementation at other low-Btu gasification plants. Also presented below are recommendations for changes where the current UMD FW-Stoic Gasification Facility design and work practices present a potential safety or health hazard.

- Mercury seals should not be used in the gasifier because of the likelihood that pressure fluctuations in the gasifier will blow the mercury out of the seal and contaminate the workplace. A mechanical, or packing type seal should be used.

- Flanges leaked, especially the precipitator flanges, because they were not made heavy enough. Tightening the flange bolts caused the flanges to bow between the bolts increasing the leak rate. Flanges should be used that are thick enough to allow them to be torqued sufficiently to stop leaks. Alternatively, a different flange design, such as the Grayloc, should be tried in this service; or, eliminate flanges in the gas lines entirely by welding all connections.

- Vessel entry procedures follow NIOSH recommendations except for the use of supplied-air respirators. Because these typesof respirators provide a greater degree of protection than air-purifying respirators, their inclusion in the procedures is recommended.

- Present UMD plans to change the health and safety program requirements from voluntary to mandatory compliance should enhance the overall effectiveness of the program.

- The containment of coal tars within the gasification facility is important because of the suspected carcinogenic nature of the tars. Better containment is expected when UMD implements its plans to provide clean and dirty change room facilities.

- A weakness in the personal hygiene program is the unrestricted access of workers wearing contaminated clothing to the lunchroom, lounge, and offices. This practice will lead to contamination of these facilities. Since workers eat and smoke in these areas, tars can be accidentally ingested. It is therefore recommended that coveralls and shoe covers be required by anyone entering the process area. Upon leaving the process area to enter the lunchroom, lounge, or office, coveralls and shoe covers must be removed.

- Volatile aromatics such as benzene, toluene, cresols, and phenols have not been observed in samples collected in the work environment, and therefore are not expected to pose a health problem to workers within the facility.

- UMD plans for expanding current monitoring programs to try to quantify and record dermal exposure to tars and evaluate the health effects should be implemented. The use of the light pipe luminoscope, an instrument used in the detection of chemical fluorescence, as a survey tool should enhance the program by providing a convenient means of checking tar contamination of workers and of the workplace.

- Because of the time required to don a self-contained breathing apparatus, these respirators are not considered suitable for emergency escape purposes. Escape-type respirators which are simple to use should be conveniently located throughout the facility for easy worker access in times of emergency.

APPENDIX

Medical Form

UNIVERSITY OF MINNESOTA, DULUTH
DULUTH, MINNESOTA 55812

SPEECH, LANGUAGE AND HEARING CLINIC
ADULT HEARING CASE HISTORY FORM

Please fill out this form as completely as possible, since this information is important in the diagnosis and treatment of the client's problem. Any additional documents relating to the client's medical, educational, or psychological history should be sent to the address at the top of this sheet. If you do not understand exactly what information is desired by any of the questions, please put a question mark in the answer space for that question. If you have any other questions regarding our services, please call us for assistance at Area Code 218-726-7274.

NAME______________________ DATE__________ CLINIC NO.______

ADDRESS____

____ PHONE________
(city) (state) (zip)

DATE OF BIRTH__________ AGE________ SEX______________

MARITAL STATUS__________ NO. OF CHILDREN_____ OCCUPATION________

REFERRED BY____

REASON FOR REFERRAL______________________________________

____

HAS YOUR HEARING BEEN TESTED ______ IF SO, WHEN?____________

WHERE?________________ WHAT WERE THE RESULTS/RECOMMENDATIONS? ___

____

HAVE YOU EVER HAD A HISTORY OF EARACHES?__________________

HAVE YOUR EARS EVER DISCHARGED OR DRAINED FLUID?___________

DO YOU PRESENTLY HAVE EARACHES?___________________________

DO YOU KNOW THE DATE OF THE LAST EARACH OR DISCHARGE?_______

DO YOU HAVE FREQUENT COLDS?_______________________________

Medical Form (Continued)

DO YOU HAVE SINUS PROBLEMS?__________ HAY FEVER?________ ANY ALLERGIES?

____

REMOVAL OF TONSILS & ADENOIDS?_________ AT AGE________ BY WHOM?__________

____

HAVE YOU EVER TAKEN MEDICINE FOR LONG PERIODS AT A TIME? (OR ARE YOU PRESENTLY TAKING ANY OF THE FOLLOWING WITH REGULARITY?)

________ QUININE _______ ASPIRIN

________ SEDATIVES _______ BIRTH CONTROL PILLS

________ ANTIBIOTICS (STREPTOMYCIN, AUREOMYCIN, PENICILLIN, ETC.)

HOW LONG HAVE YOU TAKEN THE ABOVE MEDICATION?____________________________

DO YOU SMOKE CIGARETTES?_______ IF SO, HOW MANY PACKS PER DAY?____________

DO YOU DRINK ALCOHOLIC BEVERAGES?__________ IF SO, HOW MUCH?______________

DO YOU BELIEVE THAT YOU HAVE A HEARING LOSS?_______ IF SO, WHEN DID YOU

FIRST SUSPECT THAT YOU HAD A HEARING LOSS?________________________________

DO YOUR SPOUSE AND/OR CHILDREN THINK THAT YOU HAVE A HEARING LOSS?________

IF SO, WHY DO THEY THINK YOU HAVE A LOSS? (LACK OF UNDERSTANDING, TURN TV UP, ETC.)

____

____

IS THERE ANYONE ELSE IN YOUR FAMILY THAT HAS A HEARING LOSS? (INCLUDE PARENTS, BROTHERS, SISTERS, AUNTS, UNCLES, AND COUSINS.) HOW OLD WERE THEY WHEN THE LOSS WAS FIRST NOTED?

____

____

HAVE YOU HAD ANY OF THE FOLLOWING:

______ SPINAL MENINGITIS _____ SCARLET FEVER

______ POLIOMYELITIS _____ DIABETES

______ STROKE _____ SEIZURES

______ PNEUMONIA _____ HIGH FEVER

Medical Form (Continued)

_____ MUMPS

_____ TYPHOID FEVER

_____ MEASLES

_____ TUBERCULOSIS

_____ SYPHILIS

_____ MULTIPLE SCLEROSIS

_____ OTHER ____________________

DO YOU EVER HEAR NOISES INSIDE YOUR HEAD AND/OR EARS?__________

WHICH EAR?________ HOW OFTEN?____________________ DOES ANYTHING SPECIAL SEEM TO BRING THE NOISES ABOUT OR MAKE THEM WORSE? (LYING DOWN, AFTER WORK, DRINKING, ETC.)______________________________

WHAT DO THE HEAD AND/OR EAR NOISES SOUND LIKE?

_____ RINGING

_____ SEASHELL NOISE

_____ BUZZING

_____ WHISTLING

_____ HISSING

_____ RUMBLING

_____ THE SURF

_____ TRAIN WHISTLE

_____ RUSHING WATER

_____ LOW NOISE THAT THROBS WITH HEART BEAT

_____ OTHER ______________________________

DO YOU EXPERIENCE DIZZINESS OR LIGHTHEADEDNESS WITH THE EAR NOISES?______

HAVE YOU EVER HAD ANY SEVERE INJURIES TO YOUR HEAD AND/OR EARS? IF SO, WHEN, (INCLUDE SHARP BLOWS, PUNCTURED EARDRUMS, ETC.)

HAVE YOU EVER BEEN EXPOSED TO LOUD NOISES? (FACTORY, CONSTRUCTION WORK, SNOWMOBILING, MOTORCYCLES, DIESEL TRUCKS, HUNTING, CHAINSAWS, PLANES, MILITARY, FIRECRACKERS GOING OFF CLOSE TO YOUR EARS, ETC.)

WAS THE NOISE EXPOSURE A ONE TIME OCCURENCE?____________________

DID THE NOISE HURT YOUR EARS?________ IF YOU WORKED IN A NOISY PLACE, OW LONG DID YOU WORK THERE?__________ DID THE NOISE BOTHER YOU IN ANY WAY?______________________________

Medical Form (Continued)

DESCRIBE YOUR DIFFICULTY WITH HEARING:____________________________________

____

HAS THERE BEEN A CHANGE IN YOUR HEARING WITHIN THE LAST 6 MONTHS?_________

1 YEAR?_______ LAST 2 YEARS?________ IF SO, EXPLAIN_______________________

____

HAVE YOU HAD ANY EAR SURGERY?________ EXPLAIN_____________________________

____

IS SPEECH SOMETIMES LOUD ENOUGH BUT JUST NOT CLEAR ENOUGH?_______________

CAN YOU HEAR AND UNDERSTAND WELL OVER THE TELEPHONE?____________________

WHICH EAR DO YOU USE FOR THE PHONE?______________________________________

CAN YOU HEAR AND UNDERSTAND WELL AT MOVIES?______________________________

CAN YOU HEAR AND UNDERSTAND WELL IN CROWDS?______________________________

DO YOU HAVE THE TV AND/OR RADIO TURNED UP LOUDER THAN RELATIVES NEED IT?

____

CAN YOU HEAR AND UNDERSTAND VOICES WHEN THEY ARE IN ANOTHER ROOM?_________

CAN YOU HEAR OUTSIDE NOISES? (BIRDS, TRAFFIC, CAR HORNS, ETC.)___________

DO YOU HAVE TROUBLE HEARING AND UNDERSTANDING MEN?______ WOMEN?___________

CHILDREN?_______

DO YOU UNDERSTAND MORE WHEN YOU WATCH PEOPLE'S FACES OR WHEN YOU HAVE YOUR GLASSES ON?______________ DO YOU HEAR BETTER IN A NOISY OR A QUIET PLACE?

____

DO YOU HEAR BETTER ON SOME DAYS THAN OTHERS? (DOES YOUR HEARING VARY FROM DAY TO DAY, OR FROM SEASON TO SEASON?)____________________________________

CAN YOU TELL WHAT DIRECTION A SOUND IS COMING FROM?_______________________

Medical Form (Continued)

WHICH EAR DO YOU THINK IS YOUR BETTER EAR?______________________

HOW HAS YOUR LOSS AFFECTED YOU? (DAILY LIFE, JOB, FRIENDS, SOCIAL LIFE, CHURCH, ETC.)______________________

____

HEARING AID INFORMATION:

HAVE YOU EVER WORN A HEARING AID?________ HOW LONG?____________

DO YOU WEAR AN AID NOW?________ MAKE____________ MODEL__________

HOW LONG HAVE YOU WORN YOUR PRESENT AID?______________________

WHICH EAR IS IT WORN IN?____________ DOES IT SEEM TO HELP?________

DO YOU HAVE ANY PROBLEMS WITH THE AID OR THE EAR MOLD?____________

____

WHEN (MEALS, WITH FRIENDS, ETC.) AND WHERE (CHURCH, EVERYWHERE, ETC.) IS THE AID WORN?______________________

____

HOW OFTEN DO YOU REPLACE YOUR HEARING AID BATTERIES?____________

WHEN THE AID IS TURNED ON FULL POWER, IS IT COMFORTABLE?__________

TOO LOUD?____________ NOT LOUD ENOUGH?____________

HISTORY OF REHABILITATION:

HAVE YOU EVER HAD SPEECH READING (LIP READING)?____________

AUDITORY TRAINING?__________ OTHER?______________

WHEN DID YOU HAVE THIS TRAINING AND FOR HOW LONG?____________

____

PERSONAL COMMENTS:

Medical Form (Continued)

CLINICIAN'S COMMENTS: (FOR OFFICE USE ONLY.)

(Signature)

(Date)

Medical Form (Continued)

UNIVERSITY OF MINNESOTA, DULUTH
SPEECH/LANGUAGE AND HEARING CLINIC DULUTH, MINNESOTA 55812

Authorization for Release of Information

I hereby grant permission to the Speech/Language and Hearing Clinic, University of Minnesota, Duluth, to release to appropriate professional agencies and individuals any and all information contained in the clinical record of:

____
(full name of client)

I authorize this Clinic to make customary and constructive use of information from audio and video recordings and other records pertaining to the evaluation, treatment and other services rendered the above named person and/or his family by the Clinic. It is understood that the Clinic will exercise due discretion in making use of these materials for educational, scientific and professional purposes and will endeavor to protect the identify of the person or persons to whom the materials pertain. This authorization is made in consideration of the services rendered by the Clinic.

We request you to make the above authorization so that the work of this Clinic may continue to improve. It is largely through our efforts to serve persons with speech, language, and/or hearing problems that we learn. From our diagnostic and treatment experiences, we are able to better understand individuals with difficulties of this nature. Our increased understanding enables us to develop better ways of helping these people. Your permission to discreetly use the clinical material gathered from serving you will be greatly appreciated.

Witness: ____________________ Signed: ____________________

Date: ____________________

Relationship to Client: ____________

Medical Form (Continued)

UNIVERSITY OF MINNESOTA, DULUTH
SPEECH/LANGUAGE AND HEARING CLINIC DULUTH, MINNESOTA 55812

Authorization to Obtain Information

I hereby grant permission to the Speech/Language and Hearing Clinic, University of Minnesota, Duluth, to obtain from appropriate professional agencies and individuals any and all information contained in the clinical record of:

____
(full name of client)

Witness: ______________________ Signed: ______________________

Date: ______________________

Relationship to Client: ____________