# AN ENGINEERING REPORT ON THE ALLEGED EXECUTION GAS CHAMBERS AT AUSCHWITZ, BIRKENAU AND MAJDANEK POLAND

Prepared for
ERNST ZÜNDEL

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by

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## Foreword

Fred A. Leuchter, 45, is an engineer living in Boston, Massachusetts, who specializes in the design and fabrication of execution hardware used in prisons throughout the United States. One of his major projects was the design of a new gas chamber at the Missouri State Penitentiary at Jefferson City.

In January of 1988, I was in Toronto, Canada, assisting in the defence of Mr. Ernst Zündel, a German-Canadian who was on trial for spreading false news by publishing Did Six Million Really Die?, a booklet which challenged the prevailing view that six million Jews were killed by the Nazis during World War II, primarily through the use of gas chambers using hydrocyanic gas (Zyklon B gas).

Ernst Zündel had been previously tried on the same charge in 1985. The trial lasted seven weeks and ended with a conviction and a sentence of fifteen months imprisonment. In January 1987, the Ontario Court of Appeal overturned the judgment because of grave errors in law and ordered that a new trial be held. The retrial began on January 18, 1988 and at the time of this writing is still proceeding.

My initial conversations with Fred Leuchter took place in Boston on the 3rd and 4th of February, 1988. I was impressed with the conciseness and pointedness of his answers to my questions and by his ability to explain every detail of gassing procedures. He confirmed to me the particularly dangerous nature of an execution by hydrocyanic gas.

Executions using this gas were carried out for the first time in the United States in 1924, but as late as 1988 major difficulties still existed in the construction of execution gas chambers, including the problem of leakage. I noticed that Fred Leuchter did not question the standard notion of the Holocaust.

After my return from Boston to Toronto and after I had reported to Ernst Zündel on my discussions with Fred Leuchter, Mr. Zündel decided to ask the latter to prepare an expert opinion on the alleged gas chambers in Auschwitz, Birkenau and Majdanek.

Mr. Leuchter accepted the assignment after a weekend in Toronto reviewing wartime aerial photographs of the camps, plans of the crematoriums and alleged gas chambers, documents on Zyklon B and slides taken of the sites in the 1970's by the Swedish researcher Ditlieb Felderer.

On February 25, 1988, Mr. Leuchter left for Poland together with his wife Carolyn, his draftsman Howard Miller, cinematographer Jürgen Neumann, and Polish interpreter Theodor Rudolph. They returned eight days later on March 3rd.

Upon return, Fred Leuchter wrote his report of 192 pages including appendices. His conclusions were clear: the evidence was overwhelming that there were no execution gas chambers at Auschwitz, Birkenau and Majdanek and that the alleged gas chambers at these sites could not have been, then or now, utilized or seriously considered to function as execution gas chambers.

On the 20th and 21st of April, 1988, he stood on the witness stand in Toronto. At first, he replied to the questions put to him by Mr. Zündel's defence lawyer, Douglas H. Christie, the latter assisted by Keltie Zubko and Barbara Kulaszka. He then faced cross-examination by the Crown Prosecutor, John Pearson, an official who had been assisted throughout the trial by another Crown Attorney, a law clerk and frequent consultations with Jewish advisors sitting immediately behind him in the courtroom.

The examination and cross-examination took place in the presence of a judge and an eleven-member jury. In the courtroom, the atmosphere was one of extreme tension. I was sitting beside a number of Revisionist experts, including Dr. William Lindsey, chief research chemist for Dupont Corporation before his retirement in 1985. Everyone in the courtroom, regardless of their own personal viewpoints on the topic under examination, were acutely aware, I think, of participating in a historical event. The myth of the gas chambers was ending.

The previous day, the director of the Missouri State Penitentiary, Bill Armontrout, had given testimony explaining the procedures and practical operation of a hydrocyanic gas chamber. For every attentive listener it was revealed that if it was so difficult to execute a single person in this manner, then the alleged execution of hundreds of thousands of persons by the Germans using Zyklon B would equal the problem of trying to square the circle.

Following Fred Leuchter on the witness stand came Dr. James Roth, Ph.d. (Cornell Univ.), Manager of Alpha Analytical Laboratories in Ashland, Massachusetts. Dr. Roth reported on the analysis of samples taken from the walls, floors, ceilings and other structures inside the alleged gas chambers of Auschwitz I and Birkenau. These tests revealed either no detection of traces of hydrocyanic acid or extremely low levels. The only exception was the control sample number 32 taken from Delousing Facility Number 1 at Birkenau. These results were graphically produced in Appendix I of the Report and displayed to the jury on an overhead projector. The difference in detected hydrocyanic acid between the delousing facility on one hand and the alleged gas chambers on the other, was spectacular. The extremely low levels of cyanide found in some crematoria was likely, in my opinion, to have resulted from disinfection of the premises during the war.

I think I was the first to point out that all studies of the alleged German execution gas chambers using Zyklon B should commence with a study of the American execution gas chambers. As early as 1977, with the help of an American friend, Eugene C. Brugger, a lawyer in New York City, I began an inquiry into this area. During this research, I obtained information from six American penitentiaries, those of San Quentin, California; Jefferson City, Missouri; Santa Fe, New Mexico; Raleigh, North Carolina; Baltimore, Maryland; and Florence, Arizona. I was forced to conclude at that time that only an expert in American gas chamber technology could finally determine whether the alleged German execution gas chambers were capable of having been used as described in Holocaust literature.

During the next several years, my articles on German gas chambers always referred to the American gas chambers. These articles included "The Rumor of Auschwitz or the Gas Chamber Problem", published on the 29th of December, 1978 in the French daily newspaper, Le Monde, and a long interview published in August, 1979 in the Italian periodical Storia Illustrata. I visited the gas chamber in Baltimore, Maryland in September, 1979 and obtained eight photographs of the chamber and additional documentation. Then, during a meeting held in New York City under the chairmanship of Fritz Berg, I showed the Gas Chamber Procedure Check Sheet of the Baltimore penitentiary and discussed its implications. In 1980, in the first issue of the newly-created Journal of Historical Review, I published an article entitled "The Mechanics of Gassing", in which I described in some detail the gas chamber procedures used in the United States. In the same year, I published in Verite historique ou verite politique?, the eight photographs of the Baltimore gas chamber. My video entitled "The Gas Chamber Problem", made in 1982, began with an analysis of the American gas chambers. In 1983, I prepared for the Institute for Historical Review, Los Angeles, a book in English on the Holocaust controversy which was to include, for the first time, a list of the questions put to the penitentiary wardens and their answers. The book, however, was never published: on July 4, 1984, American Independence Day, the archives of the Institute were destroyed by arson. This fire, for all intents and purposes, destroyed the financial viability of the Institute and a number of projects, including that of my book, were abandoned.

The Holocaust has appeared to be a subject of enormous proportion. But this "giant", as Dr. Arthur Butz has pointed out in the Hoax of the Twentieth Century, is a giant with feet of clay. To see the feet of clay, one need only go to Auschwitz Concentration Camp in Poland. In the words of Dr. Wilhelm Stäglich, "the extermination thesis stands or falls with the allegation that Auschwitz was a 'death factory'." And for me, the whole mystery of Auchwitz is, in turn, concentrated on the 65 square metres of the alleged gas chamber of Auschwitz I and on the 210 square metres of the alleged gas chamber of Birkenau. These 275 square metres should have been forensically examined immediately after the war by the Allies, but no such examination was ever carried out then or since. The Polish examining magistrate, Jan Sehn, ordered some forensic examinations at Auschwitz but not of the alleged execution gas chambers themselves.

Research by Revisionists has shown that the places alleged to be execution gas chambers could not have been used for such a purpose. Ditlieb Felderer published photographs indicating the flimsy construction of vents and doors to the gas chambers and the lack of prussian blue stain on the walls. I myself discovered in 1975 in the archives of the Auschwitz State Museum (archives which are well-guarded by the Communist officials) the plans of these alleged gas chambers and was the first to publish them in various books and articles. These plans were also shown at the first convention of the Institute for Historical Review in Los Angeles in 1979, when Mr. Zündel was present. In reality, these alleged gas chambers had been mortuaries or, as indicated on the plans, "Leichenhalle" for Krema I (later transformed into an air-raid shelter) and "Leichenkeller" for Krema II.

Nevertheless, in order to obtain an entirely scientific confirmation of what simple common sense compelled us to see and what revisionist research work and documents had revealed, it was necessary to look for an American gas chamber specialist. I desperately tried to find such a specialist, but frankly, I had little hope of finding a man who was not only an expert in gas chamber technology, but also one courageous enough to carry out such an investigation in a Communist country and to publish the results if ever they confirmed revisionist conclusions. Fortunately, I was wrong.

Fred Leuchter was this specialist. He went to Poland, conducted the forensic examination, wrote his report and testified in a Canadian court on behalf of Mr. Zündel. In so doing, he has quietly entered history.

Fred Leuchter is a modest but quietly determined man who speaks precisely. He would be an excellent professor and has the real gift of making people understand the intricacies of any difficult problem. When I asked him whether or not he was afraid of any dangerous consequences, he replied, "A fact is a fact." Upon reading the Leuchter Report, David Irving, the famous British historian, said on April 22nd, 1988 during his testimony in Toronto that it was a "shattering" document which would become essential for any future historian writing on the Second World War.

Without Ernst Zündel, almost nothing of what has now transpired would have been conceivable. He sacrifices everything in his search for historical accuracy and lives under difficult conditions, facing influential and powerful enemies. The pressure on him is permanent and takes the most unexpected and sometimes, the most vicious forms. But he has a strong personality and charisma. He knows how to analyze any given situation, to evaluate the ratios of forces, to turn adversity into advantage. From all parts of the world he attracts and mobilizes highly competent people. He is a profound man, a genius who combines common sense with a keen understanding of people and situations.

He may once again go to prison for his research and beliefs or be threatened with deportation. All this is possible. Anything may happen when there is an intellectual crisis and a realignment of historical concepts of such a dimension. Revisionism is the great intellectual adventure of the end of this century. Whatever happens, Ernst Zündel is already the victor. He is the pacifist-activist who has achieved this victory through the powers of reason and persuasion.

Robert Faurisson

April, 23, 1988
Toronto

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0.000 **INTRODUCTION.** In February of this year (1988), I was contacted by Dr. Robert Faurisson for Mr. Ernst Zündel and asked to consider an assignment to investigate and forensically evaluate the extant crematoria and alleged execution gas chambers operated by the Nazis in Poland and to render an engineering opinion as to their feasibility and efficacy. After a meeting with Mr. Zündel, defense lawyer Douglas H. Christie and staff members in which the project was discussed, I was told that my findings were to be used in conjunction with the case of The Queen v. Zündel, then before the District Court in Toronto. Understanding this, it was determined that the investigation would include Auschwitz, Birkenau and Majdanek (Lublin), and all associated crematoria and alleged execution gas chambers. I accepted the assignment and on February 25, 1988, I led a party of investigators to Poland. This party consisted of myself; my wife Carolyn Leuchter; Mr. Howard Miller, draftsman; Mr. Jürgen Neumann, cinematographer; and Mr. Theodor Rudolf, Polish interpreter. We returned on March 3, 1988 after inspecting all the required facilities at Auschwitz, Birkenau and Majdanek. This report and my findings are resultant to those investigations conducted in Poland.

1.000 **PURPOSE**. The purpose of this report and the investigation upon which it is based is to determine whether the alleged execution gas chambers and crematory facilities at three (3) sites in Poland, namely, Auschwitz, Birkenau and Majdanek, could have operated in the manner ascribed them in Holocaust literature. This purpose includes the investigation and inspection of the physical facilities, design of these facilities, and a description of procedures utilized at these facilities with an eye to determining the quantities of gas utilized, the times involved in these usages (i.e. execution and ventilation times), the physical sizes of chambers relative to the inclusion of occupants and the procedures and times involved in handling and cremating corpses with the intent of determining the veracity and credibility of unsupported operational reports. This purpose does not include a determination of any numbers of persons who died or were killed by means other than gassing or as to whether an actual Holocaust occurred. It, further, is not the intent of this author to redefine Holocaust in historical terms, but simply to supply scientific evidence and information obtained at the actual sites and to render an opinion based on all available scientific, engineering and quantitative data as to the purpose and usages of the alleged execution gas chambers and crematory facilities at the investigated locations.

2.000 **BACKGROUND**. The principal investigator and author of this report is a specialist on design and fabrication of execution hardware and specifically has worked on and designed hardware in the United States used in the execution of condemned persons by means of hydrogen cyanide gas.

2.001 The investigator has inspected the facilities at Auschwitz, Birkenau and Majdanek, made measurements, taken forensic samples, reviewed design and procedural literature on DEGESCH delousing chambers and procedures, Zyklon B gas, and materials on execution procedures. Much of the reviewed material was literature purchased and viewed at the sites in Poland, including copies of original drawings of Kremas I, II, III, IV and V.

3.000 **SCOPE.** The scope of this report includes a physical inspection and quantitative data obtained at Auschwitz, Birkenau and Majdanek, literature supplied by the officials at the three (3) museum sites, blueprint copies of Kremas I, II, III, IV and V obtained at the museums, material relative to DEGESCH delousing chambers and facilities (including equipment and procedures utilized with Zyklon B gas), a description of operational procedures at the facilities in question and forensic samples taken at the Kremas investigated. Additionally, data on the design of U.S. gas chambers and operational procedures coming from the investigator's own personal knowledge and work in the field, as well as, an investigation of U.S. crematories and procedures, were utilized in the production of this report.

3.001 Utilizing all of the above data, the investigator has limited the focus of this study to a determination of:

(a) the capability of the alleged execution gas chambers to have accomplished the mass murder of human beings by the use of Zyklon B gas in Auschwitz I and Birkenau and carbon monoxide and/or Zyklon B gas in Majdanek;

(b) the capability of the investigated kremas to have accomplished the alleged number of human cremations in the alleged time period.

4.000 **SYNOPSIS AND FINDINGS.** After a study of the available literature, examination and evaluation of the existing facilities at Auschwitz, Birkenau and Majdanek, with expert knowledge of the design criteria for gas chamber operation, an investigation of crematory technology and an inspection of modern crematories, the author finds no evidence that any of the facilities normally alleged to be execution gas chambers were ever used as such, and finds, further, that because of the design and fabrication of these facilities, they could not have been utilized for execution gas chambers.

4.001 Additionally, an evaluation of the crematory facilities produces conclusive evidence that contradicts the alleged volume of corpses cremated in the generally alleged time frame. It is, therefore, the best engineering opinion of the author that none of the facilities examined were ever utilized for the execution of human beings and that the crematories could never have supported the alleged work load attributed to them.

5.000 **METHODOLOGY**. The procedures involved in the study and forensic analysis which resulted in the report were as follows:

1. A general background study of the available material.

2. An on-site inspection and forensic examination of the facilities in question which included the taking of physical data (measurements and construction information) and a considered removal of physical sample material (brick and mortar) which was returned to the United States for chemical analysis.

3. A consideration of recorded and visual (on-site) logistic data.

4. A compilation of the acquired data.

5. An analysis of the acquired information and comparison of this information with known and proven design, procedural and logistic information and requirements for the design, fabrication and operation of actual gas chambers and crematories.

6. A consideration of the chemical analysis of the materials acquired on-site.

7. Conclusions based on the acquired evidence.

6.000 **USE OF HCN AND ZYKLON B AS A FUMIGANT.** Hydrogen cyanide gas (HCN or hydrocyanic acid) has been utilized as a fumigant since before W.W. I. It has been used side by side with steam and hot air and during W.W. II with D.D.T. by the United States and its Allies.

6.001 HCN is generally manufactured by a chemical reaction of sodium cyanide with dilute sulfuric acid. The chemical reaction results in HCN being given off into the air with a remainder of prussic acid (hydrocyanic acid). This reaction is normally contained in a ceramic crock pot.

6.002 This procedure has been utilized for pest and vermin control on ships, in buildings and in specially designed chambers and structures. Special design and handling considerations must be followed to ensure the safety of the users (technicians). Hydrogen cyanide is one of the most powerful and dangerous of all fumigation chemicals.

6.003 Buildings especially constructed or modified for this purpose were used by all militaries and health organizations throughout the world. HCN has been used everywhere for disease control; specifically for plague and typhus i.e. rat, flea and lice control. Special chambers were used since W.W. I in Europe and the United States. Some of these chambers were used by the German Army in Europe before and during W.W. II and much earlier by the United States Immigration Service at Ellis Island, New York Harbor. Many of these fumigation chambers were made for DEGESCH, a German firm located in Frankfurt am Main, Germany. During the war, DEGESCH supervised the distribution of Zyklon B. DEGESCH presently manufactures HCN .

6.004 Zyklon B was a special commercial preparation containing hydrocyanic acid. The name "Zyklon B" was itself a trade name. HCN was prepared at the factory and delivered in a form where the HCN was absorbed in a porous carrier, either wood pulp or diatomaceous earth (chalk). It was supplied either in discoids or snippets and pellets. This preparation was sealed in an airtight can which required a special can opener. In this form the HCN - Zyklon B was much safer and easier to handle. The resultant Zyklon B gas was HCN. The discoids, snippets or pellets had to be spread on the floor of the area to be fumigated or utilized in a chamber which circulated and heated the air within the chamber in excess of 78.3°F (25.7°C). If used in buildings, ships, or tents to fumigate trees and produce, the area must be heated to an excess of 78.3°F temperature, the boiling point of HCN. Failure to do this will result in a much longer time to complete the fumigation. Fumigation takes a minimum of 24 to 48 hours.

6.005 After the fumigation, the ventilation of the area must take a minimum of 10 hours, depending on the location (and volume), and longer if the building has no windows or exhaust fans. The fumigated area must then be chemically tested for the presence of gas before entering. Gas masks are sometimes used, but are not safe and should not be used for more than ten (10) minutes. A complete chemical suit must be worn to prevent skin poisoning. The warmer the temperature and the drier the location, the faster and safer the handling will be.

6.006 The specifications for the gas are found in Table 1.

6.007 **Table I**

**(Specifications for HCN)**

| | |
|---|---|
| **Name:** | HCN, hydrocyanic acid; prussic acid |
| **Boiling point:** | 25.7°C/78.3°F at 760 mm Hg |
| **Specific gravity:** | 0.69 at 18°C/64°F |
| **Vapor density:** | 0.947 (air = 1) |
| **Melting point:** | -13.2°C/8.2°F |

| | |
|---|---|
| **Vapor pressure:** | 750mm Hg at 25°C/77°F 1200mm Hg at 38°C/100°F |
| **Solubility in water:** | 100% |
| **Appearance:** | clear |
| **Color:** | slightly bluish |
| **Odor:** | bitter almond, very mild, non-irritating (odor is not considered a safe method of determining presence of the poison) |

**Hazards:**

1. Unstable with heat, alkaline materials and water.

2. Will explode if mixed with 20% sulfuric acid.

3. Polymerization (decomposition) will occur violently with heat, alkaline material or water. Once started, reaction is autocatalytic and uncontrollable. Will explode.

4. Flash point: -18°C/0°F

5. Autoignition temperature: 538°C/1000°F

6. Flammable limits in air
volume - %
lower 6
upper 41

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Source: Hydrogen Cyanide, Dupont Publication, 7-83

7.000 **DESIGN CRITERIA FOR A FUMIGATION FACILITY.** A fumigation facility, whether a building or a chamber, must adhere to the same basic requirements. It must be sealable, heatable, have both circulation and exhaust capability for the air, must have a sufficiently high stack for the exhaust (at least 40 feet) or an incinerator for the exhaust and a means for distribution of the gas evenly (likewise the Zyklon B material).

7.001 First, if a chamber is used today, it must be a welded and pressure tested vessel coated with an inert (epoxy) paint or stainless steel or plastic (PVC). The doors must be gasketed with an HCN resistant material (pickled asbestos, neoprene or Teflon®). If a building, it must be of brick or stone and coated both inside and out with an inert (epoxy) paint or pitch, tar or asphalt. The doors and windows must be gasketed or sealed with a rubberized or pitched canvas and sealed with neoprene sealant or tar. In either case, the area must be extremely dry. The term "sealing" has two meanings: first, to mechanically prevent leakage from the facility; and second, to render the exposed, porous surfaces of the facility impervious to impregnation by Zyklon B gas.

7.002 Second, the chamber or structure must have a gas generator or distribution system for Zyklon B which would force hot air over the Zyklon B or the generator (generator may be heated with water if sealed) and circulate the warm air and gas. The mixture required for fumigation is 3200 parts per million (ppm) or 0.32% total volume HCN. The chamber must be free of obstructions and have a capability for a strong, constant and copious air flow.

7.003 Third, the chamber or structure must have means for evacuating the poisonous air/gas mixture and replacing it with fresh air. Generally, this is done with an exhaust or intake fan with either exhaust or intake valves or louvred ports of sufficient size to allow reasonable air change per hour. Usually, a sufficient cubic feet per minute (cfm) fan and intake and exhaust aperture should permit a complete air change in 1/2 hour and should be run for at least twice the required time of one hour, or two hours. The larger the facility, the less practical this becomes (due to the size of available fans) and exhaust times may take several hours or longer.

7.004 The exhaust must be vented at a safe distance above the facility where the air currents can disperse the gas. This is normally 40 feet above the structure, but should be more if the structure is sheltered from the wind. If an incinerator is used, the stack may be only several feet in height. It is generally too costly to incinerate the HCN because of the air volume it must handle in a short time period.

7.005 The temperature of the walls and the air within the facility, and the intake air, must be kept at least 10 degrees above the boiling point of the hydrocyanic acid (78.3°F) to prevent condensation of HCN on the walls, floor and ceiling of the facility, as well as, in the exhaust system. If the temperature is below 79°F and condensation occurs, the facility must be decontaminated with chlorine bleach or ammonia, the former being the most effective. This is accomplished by spraying the walls either automatically or manually. If done manually, protective suits (generally neoprene) must be worn and the technicians must utilize air breathing cylinders, as gas masks are unsafe and dangerous. The interior of the building must be evacuated longer to allow the chlorine bleach vapors to neutralize the liquid HCN in the exhaust system. The interior of the building must be washed with water and thoroughly mopped and dried before the next use.

7.006 Additionally, a check of the air inside the building must be done to determine whether all of the HCN has been removed. The test may be either by gas detector or by the copper acetate/benzidene test. In the former, an electronic readout is provided with detection to 10 ppm. In the other, a benzidene solution is mixed with a copper acetate solution and is used to moisten a piece of test paper which will turn blue in varying degrees if HCN is present.

8.000 **DESIGN CRITERIA FOR AN EXECUTION GAS CHAMBER.** Many of the same requirements for the fumigation facility apply to an execution facility. Generally, however, the execution facility will be smaller and more efficient. Zyklon B is not recommended for use in an execution gas chamber generally because of the time it takes to drive the gas from the inert carrier. Up until now, the only efficient method has been to generate the gas on-site by chemical reaction of sodium cyanide and 18% sulfuric acid. Recently, a design for a gas generator has been completed which will be utilized in the two (2) man gas chamber at the Missouri State Penitentiary, Jefferson City, Missouri. The author is the design consultant for this execution gas chamber.

8.001 This generator employs an electrically heated water jacket to preboil HCN in a cylindrical vessel. At the time of use, the HCN is already vaporized and is released through valves into the chamber. A nitrogen burst system clears the plumbing after use. The total time of the execution is less than four minutes. The chamber is evacuated at a rate of once each two minutes for a 15 minute time period, providing some seven (7) complete air changes.

8.002 The chamber may be of welded steel construction or of plastic PVC. The doors and windows should be of standard marine watertight construction. The door is gasketed with a single handle pressure seal. All lighting and electrical hardware is explosion-proof. The chamber contains the gas distribution plumbing, the gas generator with the bottle of liquid HCN, electronic heart monitoring equipment, two (2) seats for the condemned and a gas detector reading externally, electronically to 10 ppm.

8.003 Because the chamber contains so lethal a gas, it is operated at a negative pressure to guarantee that any leak would be inward. The chamber pressure is controlled by a vacurizer system which should hold the chamber at a partial vacuum of 10 pounds per square inch (psi) (operational: 8 psi plus 2 psi of HCN). The negative pressure is maintained utilizing the outside ambient as a standard. This system is controlled electrically and supported by a 17.7 cfm displacement vacuum pump. Additionally, a pressure switch is set to trigger emergency systems if the chamber pressure reaches 12 psi, 3 psi above the operational limit.

8.004 The inlet and exhaust system is designed for an air change every two (2) minutes. The air is supplied by a 2000+ cfm fan on the inlet side of the chamber and exhausted through the top of the chamber. The inlet and exhaust valves are both of the inwardly closing type to prevent vacuum loss and are timed to electrically open in sequence, the exhaust valve first. This is evacuated through a 40 foot high 13 inch diameter PVC pipe where the wind disperses the gas harmlessly. The intake air should have preheat capability to guarantee that no HCN will condense and thereby escape evacuation.

8.005 Gas detectors are utilized for safety. First, in the chamber where it will electrically prohibit the door from opening until the chamber is safe; second, outside the chamber in the witness and personnel areas where they sound alarms and initiate an air exhaust and intake system to protect the witnesses, as well as, abort the execution and evacuate the chamber. The safety systems contain warning bells, horns, and lights, as well.

8.006 Further, emergency breathing apparatus (air tanks) is available in the chamber area, as well as, special HCN first aid kits, emergency medical equipment for HCN and a resuscitator in an adjacent area for medical personnel.

8.007 Execution gas chamber design requires the consideration of many complicated problems. A mistake in any area may, and probably will, cause death or injury to witnesses or technicians.

9.000 **UNITED STATES EXECUTION GAS CHAMBERS SINCE 1920.** The first gas chamber for execution purposes was built in Arizona in 1920. It consisted of an air tight chamber with gasketed doors and windows, a gas generator, an explosion proof electrical system, an air intake and exhaust system, provision for adding ammonia to the intake air and mechanical means for activating the gas generator and air exhaust. The air intake consisted of several mechanically operated valves. Only the hardware has changed to the present.

9.001 The gas generator consisted of a crockery pot filled with a dilute solution (18%) of sulfuric acid with a mechanical release lever. The chamber had to be scrubbed with ammonia after the execution, as did the executee. Some 25 - 13 gram sodium cyanide pellets were used and generated a concentration of 3200 ppm in a 600 cubic foot chamber.

9.002 In the years that followed, other states adopted the HCN gas chamber as a mode of execution and design techniques changed. Eaton Metal Products designed, built and improved most of the chambers. Most had two chairs and were fitted with a vacuum system to guarantee a negative pressure and only inward leakage. All systems employed the gas generator technique because it was the most effective and simplest procedure available up until the late 1960's. No system ever was designed to use, or ever used, Zyklon B. The reason for this is quite simple. Zyklon B takes too long to evaporate (or boil off) the HCN from the inert carrier and requires heated air and a temperature controlled system. Not only is the gas not instant, but a danger of explosion always exists. The overall gas mixture is generally below the lower explosion limit (LEL) of the gas air mixture of 0.32% (since the mixture normally should not exceed 3200 ppm), but the concentration of the gas at the generator (or as in the case of Zyklon B, at the inert carrier) is much greater and may well be 90% to 99% by volume. This is almost pure HCN and this condition may exist at points of time in pockets in the chamber. The ambient air temperature or the heated air temperature must be considerably higher and artifically controlled for Zyklon B (since evaporation is strictly a physical process), where, with the gas generator, the temperature can be lower and uncontrolled since the chemical reaction in the generator is self-catalytic after starting. Electrical contacts and switches must be kept at a minimum, explosion-proof and outside the chamber. Technology available only since the late 1960's has enabled the Missouri system, which will be the most advanced system ever built, to utilize a gas vaporizer and delivery system for liquid HCN, eliminating the dangerous problem of the handling and disposal of the prussic acid residual after the execution.

9.003 Zyklon B, which would seem on the surface to have been a more efficient means of supplying gas and eliminating the prussic acid residue problem, was not the solution to the problem. In fact, the use of Zyklon B would have increased the execution time and therefore lengthened the time for handling the dangerous gas and, also, because of the heater requirements, caused a risk of explosion. An alternate solution would have been to heat the gas externally and circulate the gas/air mixture through plumbing outside the chamber and back into the chamber as the DEGESCH delousing equipment did, but this would only have caused a greater risk of leakage and hazard to the users. It is poor design and extremely dangerous to allow the gas outside the pressurized chamber. The DEGESCH equipment was intended to be utilized in the open, or in a well-ventilated area, and only in the presence of trained personnel and not with untrained people present.

9.004 In the United States, Arizona, California, Colorado, Maryland, Mississippi, Missouri, Nevada, New Mexico, and North Carolina have utilized gas as a mode of execution. But because of the inherent dangers in handling the gas and the expensive maintenance costs for the equipment used, some states (Nevada, North Carolina and New Mexico) have legislated for lethal injection, either as the only, or as a choice procedure. Other states will probably follow. The author has been a consultant to the states of Missouri, California and North Carolina.

9.005 In any event, because of the cost of manufacture of HCN gas, and because of the excessive hardware and maintenance costs of the equipment, gas has been in the past, and still is, the most expensive mode of execution.

10.000 **TOXIC EFFECTS OF HCN GAS.** Medical tests show that a concentration of hydrogen cyanide gas in an amount of 300 ppm in air is rapidly fatal. Generally, for execution purposes a concentration of 3200 ppm is used to ensure rapid death. This is a weight/volume of some 120 to 150 grams/ 2 cubic feet of gas, depending upon temperature and pressure. Some 100 ppm of HCN is fatal within half an hour. Toxic effects are skin irritation and rashes, eye irritation, blurring of vision and permanent eye damage; non-specific nausea, headache; dizziness; vomiting and weakness; rapid respiration, lowered blood pressure, unconsciousness, convulsions and death; symptoms of asphyxia, dyspnea, ataxia, tremors, coma and death through a disruption of the oxidative metabolism.

10.001 Hydrocyanic acid does not have to be breathed to be fatal. In concentrations of over 50 ppm, the user must wear a chemical suit to completely protect his body and breathe bottled air. Gas masks are generally ineffective and should never be utilized. Specialized first aid kits and medical supplies are available and should be present in all areas where a person may contact the gas.

11.000 **A BRIEF HISTORY OF THE ALLEGED GERMAN EXECUTION GAS CHAMBERS.** Based on material available to the author, it has been determined that the Germans allegedly constructed a series of large (three or more executees) gas chambers for execution purposes beginning sometime in late 1941 and utilized them until late 1944. Beginning with the first alleged gassing in a basement at Auschwitz I, two converted farmhouses at Birkenau (Auschwitz II) known as the Red and White houses or Bunkers 1 and 2, Krema I at Auschwitz, Kremas II, III, IV and V at Birkenau and an experimental facility at Majdanek, these facilities allegedly utilized hydrocyanic acid in the form of Zyklon B as the gas. Majdanek allegedly also used carbon monoxide (CO).

11.001 According to official literature obtained at the Auschwitz and Majdanek State Museums, these execution facilities were located in concentration camps constructed in highly industrial areas and their inmates supplied forced labor to the factories producing materials for the war effort. These facilities also included crematories for disposal of the remains of those allegedly executed.

11.002 Additionally, other alleged facilities which only utilized CO as the execution gas were located at Belzec, Sobibor, Treblinka and Chelmno (gas vans). These additional facilities were allegedly destroyed either during or after W.W. II, have not been inspected and are not directly the subject of this report.

11.003 Carbon monoxide (CO) gas, however, will be considered briefly at this point. CO gas is a relatively poor execution gas in that it takes much too long to effect death, perhaps, as long as 30 minutes, and if poorly circulated, longer. In order to utilize CO, a quantity of 4,000 ppm would be required making it necessary to pressurize the chamber at approximately 2.5 atmospheres with CO. Additionally, $CO_2$ (carbon dioxide) has also been suggested. $CO_2$ is even less effective than CO. These gasses, it has been alleged, were produced by diesel engines. Diesel engines produce exhausts which contain very little carbon monoxide and would require that the execution chamber be pressurized with the air/gas mixture in order to have sufficient gas to cause death. Carbon monoxide in quantities of 3000 ppm or 0.30% will cause nausea and headache after exposure for one hour and perhaps some long term damage. Concentrations of some 4000 ppm and above will prove fatal for exposure times of over 1 hour. The author would submit that a chamber filled to capacity with persons occupying approximately 9 square feet or less (the minimum area required to enable gas circulation around the occupants), that the occupants would die of suffocation due to their own exhaustion of the available air, well before the additional gas would take effect. Thus, simply closing the executees in this confined space would obviate the need of either CO or $CO_2$ from an external source.

11.004 The alleged execution facilities in Auschwitz I (Krema I), and Majdanek still exist, in allegedly original form. In Birkenau, Kremas II, III, IV, V are collapsed, or razed to the foundations; Bunker I (the Red House) is gone and Bunker II (the White House) is now restored and utilized as a private residence. At Majdanek, the first oil-fired crematory has been removed and the crematory with the alleged gas chamber has been rebuilt with only the ovens being original.

11.005 Krema I at Auschwitz, Kremas II, III, IV, and V at Birkenau, and the existing crematory at Majdanek were allegedly crematories and gas chambers combined. The Red and White houses at Birkenau were allegedly only gas chambers. At Majdanek, the experimental gas chambers were not adjacent to a crematory and there was a separate crematory which is not now extant.

12.000 **DESIGN AND PROCEDURES AT THE ALLEGED EXECUTION GAS CHAMBERS.** It appears, through investigation of the available historical documents and the facilities themselves, that most of the alleged execution gas chambers were converted from an earlier design, purpose and structure. This is true except for the so-called experimental chambers at Majdanek, which were allegedly specifically built as gassing facilities.

12.001 Bunkers I and II are described in Auschwitz State Museum literature as converted farm houses with several chambers and windows sealed. These do not exist in their original condition and were not inspected. Kremas I, II, III, IV and V are described historically and on inspection were verified to have been converted mortuaries or morgues connected and housed in the same facility as crematories. The on-site inspection of these structures indicated extremely poor and dangerous design for these facilities if they were to have served as execution gas chambers. There is no provision for gasketed doors, windows or vents; the structures are not coated with tar or other sealant to prevent leakage or absorption of the gas. The adjacent crematories are a potential danger of explosion. The exposed porous brick and mortar would accumulate the HCN and make these facilities dangerous to humans for several years. Krema I is adjacent to the S.S. Hospital at Auschwitz and has floor drains connected to the main sewer of the camp - which would allow gas into every building at the facility. There were no exhaust systems to vent the gas after usage and no heaters or dispersal mechanisms for the Zyklon B gas to be introduced or evaporated. The Zyklon B was supposedly dropped through roof vents and put in through windows - not allowing for even distribution of gas or pellets. The facilities are always damp and not heated. As stated earlier, dampness and Zyklon B are not compatible. The chambers are too small to physically contain the occupants claimed and the doors all open inward, a situation which would inhibit removal of the bodies. With the chambers fully packed with occupants, there would be no circulation of the HCN within the room. Additionally, if the gas eventually did fill the chamber over a lengthy time period, those throwing Zyklon B in the roof vents and verifying the death of the occupants would die themselves from exposure to HCN. None of the alleged gas chambers were constructed in accordance with the design for delousing chambers which were effectively operating for years in a safe manner. None of these chambers were constructed in accordance with the known and proven designs of facilities operational in the United States at that time. It seems unusual that the presumed designers of these alleged gas chambers never consulted or considered the United States technology, the only country then executing prisoners with gas.

12.002 The facilities at Majdanek are likewise incapable of fulfilling the alleged purpose. First, there is a rebuilt crematory with an alleged gas chamber. The only portions of the building which existed prior to the rebuilding were the cremation ovens. Allegedly, the building was reconstructed from plans which do not exist. The facility is built in such a manner that gas could not have been contained within the alleged chamber, the chamber itself is too small to have accommodated the volume of victims attributed to it. The building is too damp and cold to utilize Zyklon B gas effectively. The gas would have reached the ovens, and after killing all the technicians, would have caused an explosion and destroyed the building. Further, the construction, poured concrete, is radically different from the other buildings at the facility. In short, the building could not be used for its alleged purpose and fails to follow even minimal gas chamber design.

12.003 The second facility at Majdanek is shown on maps to be a U-shaped building and is now, in reality, two separate buildings. This complex is designated Bath and Disinfection Building 1 and 2. One of the buildings is strictly a delousing facility and is designed as were the other accepted delousing facilities at Birkenau. The second building of the complex is somewhat different. The front portion of the building contains a shower room and an alleged gas chamber. The existence of blue stains in this room is consistent with the blue stains found in the Birkenau delousing facility. This room has two roof vents which were for venting the room after a delousing procedure. The Zyklon B would have been placed by hand on the floor. This chamber is clearly not an execution chamber. It has provision for air circulation but no stack for venting. It, like the other facilities, is not designed for, or capable of being used as, an execution gas chamber.

12.004 In the back of this building are the alleged experimental gas chambers. This area includes a breezeway, control booth and two chambers allegedly used as gas chambers. A third room was sealed and not available for inspection. These chambers are unique in that both have piping for allegedly using carbon monoxide gas controlled from the booth. One of the chambers has a potential vent in the ceiling that was apparently never cut through the roof. The other chamber has a heating circulatory system for moving heated air into the chamber. This circulatory system is ineffectively designed and constructed with the intake and outlet too close together to function properly and has no provision for a vent. Remarkable about both chambers is what appears to be a rabbet or groove cut into the four (4) steel doors, which is consistent with placement of a gasket. Purportedly, both chambers were used for Zyklon B or carbon monoxide. This cannot be true.

12.005 Of the two chambers, one was not completed and never could have been used for carbon monoxide. It is also not designed for HCN, even though it allegedly was utilized for this purpose. The larger chamber was not designed for HCN. Notwithstanding the sign at the door saying "experimental", this chamber would have been incapable of providing execution by CO because of the need to produce 4,000 ppm (the lethal concentration) at the required 2.5 atmospheres of pressure. Both chambers fail to meet the design requirements for venting, heating and circulating, and leakage. Nowhere were the bricks, stucco and mortar ever coated with a sealant, inside or out.

12.006 A most remarkable characteristic of this complex is that these chambers were surrounded on three sides by a depressed concrete walkway. This is totally inconsistent with intelligent gas handling design in that gas seepage would accumulate in this trench and, being sheltered from the wind, would not dissipate. This would make the entire area a death trap, especially with HCN. The author must therefore conclude that this facility was never intended for even the limited use of HCN gas.

13.000 **CREMATORIES.** A consideration of crematories, both old and new, must be made to determine the functionability of the German Kremas at accomplishing their attributed tasks.

13.001 Cremation of the dead is not a new concept. It has been practiced by many cultures for many centuries. Although practiced several thousand years ago, it was frowned upon by the Catholic Church and not practiced recently until the Church relaxed its opposition in the later part of the 18th century. Cremation was forbidden by Orthodox Judaism. By the early 1800's, Europe was again practicing cremation on a limited basis. It becomes advantageous to control disease, free up much needed land in crowded areas and eliminate the need of storing corpses in winter when the ground is frozen. Europe's early crematories were coal or coke fired furnaces.

13.002 The oven or furnace which is used to cremate corpses is properly termed a retort. Early retorts were merely ovens which cooked all the moisture out of the corpse and reduced it to ash. Bones cannot be burned and must be pulverized, even today. The early mortar and pestle has been replaced by a crushing machine, however. Modern retorts are mostly gas fired, although some are still supplied for oil. None are still fired by coke or coal in the United States or Canada.

13.003 Earlier retorts were simply a drying or baking kiln and simply dried the human remains. Modern retorts of brick-lined steel actually blow fire from a nozzle onto the remains setting them afire, causing combustion and rapid burning. Modern retorts also have a second or afterburner for reburning all the pollutants in the combusted gaseous material. This second burner is a requirement set by the various state agencies responsible for air pollution. It should be noted that the human remains are not responsible for the pollution. It is caused entirely by the fossil fuels used. An electric retort, although cost prohibitive to run, would have no pollutants.

13.004 These modern retorts or crematories burn at a temperature of 2000+°F, with an afterburner temperature of 1600°F. This high temperature causes the body to combust and consume itself, allowing for the burner to be shut down. Wooden caskets and paper boxes are burned with the body, today, although not in the past, with no added time of burning due to the high temperature. Some European units are operated at a traditional lower temperature of 800°C (1472°F) and for a longer time period.

13.005 At 2000°F or more with a 2500 cfm blowered air supply from the outside, modern retorts will cremate one corpse in 1.25 hours. Theoretically, this is 19.2 in a 24 hour time period. Factory recommendation for normal operation and sustained use allows for three (3) or less cremations per day. Older oil, coal and coke furnaces with forced air (but no direct flame application ) normally took 3.5 to 4 hours for each corpse. Theoretically, this could allow for 6.8 corpses in a 24 hour time period at a maximum. Normal operation permits a maximum of three (3) cremations in a 24 hour time period. These computations are based on 1 corpse per retort per cremation. These modern retorts are of all steel construction and lined with high quality refractory brick. The fuel is piped directly to the retort and all controls are electric and automatic. The coal and coke fired furnaces did not burn at an even temperature (approximately 1600°F max.) and had to be constantly fed fuel by hand and dampered up and down. Since there was no direct application of flame to the corpse, the blower only fanned the flames and increased the temperature of the kiln. This crude mode of operation probably produced an average temperature of about 1400°F.

13.006 The crematories utilized at the inspected German facilities were of the older type. They were constructed of red brick and mortar and lined with a refractory brick. All of the ovens had multiple retorts, some were blowered (although none had direct combustion), none had afterburners and all were coke fired except one facility no longer in existence at Majdanek. None of the retorts inspected and examined at all of the locations were designed for multiple corpse incineration. It should be noted that unless specifically designed for a greater bone to flesh to heat ratio, the retort will not consume the materials placed within it. Theoretical and real-time estimated maximum 24 hour outputs, based on one (1) corpse per retort per cremation are found in Table II.

13.007 **Table II**
**(Theoretical and Real-time Estimated Maximum 24 Hour Crematory Outputs)**

| | | |
|---|---|---|
| **Krema I:** | 3 furnaces, 2 retorts each | |
| | 6 retorts x 6.8 corpses | 40.8 |
| | 6 retorts x 3 corpses | 18 |
| **Krema II:** | 5 furnaces, 3 retorts each | |
| | 15 retorts x 6.8 corpses | 102.0 |
| | 15 retorts x 3 corpses | 45 |
| **Krema III:** | 5 furnaces, 3 retorts each | |
| | 15 retorts x 6.8 corpses | 102.0 |
| | 15 retorts x 3 corpses | 45 |
| **Krema IV:** | 2 furnaces, 4 retorts each | |
| | 8 retorts x 6.8 corpses | 54.4 |
| | 8 retorts x 3 corpses | 24 |
| **Krema V:** | 2 furnaces, 4 retorts each | |
| | 8 retorts x 6.8 corpses | 54.4 |
| | 8 retorts x 3 corpse | 24 |
| **Majdanek I:** | 2 furnaces, 1 retort each | |
| | 2 retorts x 6.8 corpses | 13.6 |
| | 2 retorts x 3 corpses | 6 |

| | | |
|---|---|---|
| **Majdanek 2:** | 5 furnaces, 3 retorts each | |
| | 15 retorts x 6.8 corpses.......... | 102.0 |
| | 15 retorts x 3 corpses.............................. | 45 |

**Total Bodies Cremated in 24 hours (theoretical)............................................ 469.2**

**Total Bodies Cremated in 24 hours (real-time)................................................................ 207**

14.000 **FORENSIC CONSIDERATIONS OF HCN, CYANO-COMPOUNDS AND CREMATORIES.** As stated earlier, forensic samples of brick, mortar, concrete and sediment were selectively taken from sites in Poland. Cyanide and cyanide compounds may remain in a given location for long periods of time and if they do not react with other chemicals may migrate around in brick and mortar.

14.001 Thirty-one samples were selectively removed from the alleged gas chambers at Kremas I, II, III, IV and V. A control sample was taken from delousing facility #1 at Birkenau. The control sample was removed from a delousing chamber in a location where cyanide was known to have been used and was apparently present as blue staining. Chemical testing of the control sample #32 showed a cyanide content of 1050 mg/kg, a very heavy concentration. The conditions at areas from which these samples were taken are identical with those of the control sample, cold, dark, and wet. Only Kremas IV and V differed, in the respect that these locations had sunlight (the buildings have been torn down) and sunlight may hasten the destruction of uncomplexed cyanide. The cyanide combines with the iron in the mortar and brick and becomes ferric-ferro-cyanide or prussian blue pigment, a very stable iron-cyanide complex.

14.002 The locations from which the analyzed samples were removed are set out in Table III.

14.003 **Table III**
**(Locations of Analyzed Samples)**

**Auschwitz I:**

Krema I - samples #25 through #31.

**Birkenau (Auschwitz II):**

| | |
|---|---|
| Krema II - | samples #1 through #7; |
| Krema III - | samples #8 through #11; |
| Krema IV - | samples #13 through #20; |
| Krema V - | samples #21 through #24; |

Sample #12 is a gasket sample from the Sauna at Birkenau.
Sample #32 is the Control Sample obtained from Delousing Facility #1, Birkenau

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14.004 It is notable that almost all the samples were negative and that the few that were positive were very close to the detection level (1mg/kg); 6.7 mg/kg at Krema III; 7.9 mg/kg at Krema I. The absence of any consequential readings at any of the tested locations as compared with the control sample reading 1050 mg/kg supports the evidence that these facilities were not execution gas chambers. The small quantitites detected would indicate that at some point these buildings were deloused with Zyklon B - as were all the buildings at all these facilities.

14.005 Additionally, the areas of blue staining show a high iron content, indicating ferric-ferro-cyanide, no longer hydrogen cyanide.

14.006 One would have expected higher cyanide detection in the samples taken from the alleged gas chambers (because of the greater amount of gas allegedly utilized there) than that found in the control sample. Since the contrary is true, one must conclude that these facilities were not execution gas chambers, when coupled with all the other evidence gained on inspection.

14.007 Evidence as to Krema function is non-existent since Krema I's oven has been completely rebuilt, Kremas II and III are partially destroyed, with components missing and Kremas IV and V are gone. At Majdanek, one Krema is completely gone and the second Krema has been rebuilt, except for the ovens. Visual inspection of the memorial ash heap at Majdanek shows ash of a strange color, beige. Actual human-remains ash (as per the author's own investigations) is oyster gray. There may be some sand in the mixture at the memorial at Majdanek.

14.008 Additionally, the author will discuss the alleged burning (cremation) pits in this section. The author personally inspected and photographed the burning pits at Birkenau. Most remarkable about these pits is a high water table - perhaps as high as 1.5 feet from the surface. The historical description of these pits is that they were 6 meters (19.55 feet deep). It is not possible to burn corpses under water, even with the use of an artificial accelerant (gasoline). All pit locations officially designated on museum maps were inspected and as anticipated, since Birkenau was constructed on a swamp, all locations had water within 2 feet of the surface. It is the opinion of this author that no burning pits existed at Birkenau.

15.000 **AUSCHWITZ, KREMA I.** A detailed study of the officially alleged execution gas chamber at Krema I and a detailed analysis of the existing blueprints acquired from the museum officials indicates that the alleged gas chamber was, at the time of the alleged gassings, a morgue and later an air raid shelter. The drawing supplied by the author of this report of Krema I has been reconstructed for the time period from September 25, 1941 through September 21, 1944. It shows a morgue of some 7680 cu. ft. with two doorways, neither door opening externally. One doorway opened into the crematory and the other into the washroom. Apparently, neither opening had a door, but this was not verifiable since one wall had been removed and one opening had been moved. It should be noted that the official Auschwitz State Museum guidebook says that the building physically remains in the same condition as it was on liberation day on January 27, 1945.

15.001 There are 4 roof vents and 1 heater flue in the morgue area. The flue is open, showing no evidence of ever having been closed. The roof vents were not gasketed and new wood indicated they had recently been rebuilt. The walls and ceiling are stucco and the floor is poured concrete. The floor area is 844 sq. ft. The ceiling is beamed and on the floor one can see where the air raid shelter walls were removed. The lighting was not, and is not now, explosion-proof. There are floor drains in the floor of the chamber which connect into the main camp drain and sewer system. Assuming a 9 sq. ft. area per person to allow for gas circulation, which is nevertheless very tight, a maximum of 94 people could fit into this room at one time. It has been reported that this room could hold up to 600 persons.

15.002 The alleged execution gas chamber is, as stated earlier, not designed to be used in such a manner. There is no evidence of an exhaust system or fan of any type in this structure. The venting system for the alleged gas chamber consisted simply of four (4) square roof vents exhausting less than two (2) feet from the surface of the roof. Ventilating HCN gas in this manner would undoubtedly result in the poison gas reaching the confines of the SS hospital a short distance across the road, with patients and support personnel being killed. Because of the fact that the building has no sealant to prevent leakage, no gasketed doors to prevent gas reaching the crematory, drains that would permit gas to reach every building in the camp, no heating system, no circulatory system, no exhaust system or venting stack, no gas distribution system, constant dampness, no circulation due to the number of people in the chamber, and no way of satisfactorily introducing the Zyklon B material, it would be sheer suicide to attempt to utilize this morgue as an execution gas chamber. The results would be an explosion or leaks gassing the entire camp.

15.003 Further, if the chamber were used thus (based on DEGESCH figures of 4 oz. or 0.25 lbs. per 1000 cu. ft.), 30.4 oz. or 1.9 lbs. of Zyklon B gas (gross weight of Zyklon B is three times that of Zyklon B gas: all figures are for Zyklon B gas only) would be used each time for 16 hours at 41° F (based on German government fumigation figures). Ventilation must take at least 20 hours and tests must be made to determine if the chamber is safe. It is doubtful whether the gas would clear in a week without an exhaust system. This clearly is contradictory of the chamber's alleged usage of several gassings per day.

15.004 Computed theoretical and real-time usage rates of Krema I and alleged execution gas chamber at maximum capacity are set out in Table IV.

15.005 **Table IV**

**(Hypothetical Execution and Crematory Usage Rates of Krema I)**

| | |
|---|---|
| Execution rate | 94 people/week (hypothetical) |
| Cremation rate | 286 people/week (theoretical) |
| | 126 people/week (real-time) |

16.000 **BIRKENAU - KREMAS II, III, IV AND V.** A detailed study of these Kremas resulted in the following information.

16.001 Kremas II and III were mirror image installations consisting of several morgues and a crematory of 15 retorts each. The morgues were in the basement and the crematories on the ground floor. An elevator was utilized for corpse transport from the morgues to the crematory. The included drawings were generated from original blueprints obtained at the Auschwitz State Museum and observations made and measurements taken on location. Construction was of brick, mortar and concrete.

16.002 The investigated areas were the alleged gas chambers designated as morgue #1 on both drawings. As noted for Krema I, there was no ventilation, no heating system, no circulation system, no sealant inside or out and further, no doors on the morgues in Krema II. The area has been examined by the author and no evidence of doors or door frames has been found. This investigator could not make this determination for Krema III since portions of the structure are missing. Both structures had roofs of reinforced concrete without any apparent openings. Further, reports of hollow gas-carrying columns are not true. All the columns are solid, reinforced concrete exactly as indicated in the captured German plans. The roof vents are not gasketed. These facilities would be very dangerous if used as gas chambers and this use would probably result in the death of the users and an explosion when the gas reached the crematory. Each facility had a corpse elevator of 2.1 meters x 1.35 meters. Clearly, this elevator was large enough for only one (1) body and an attendant.

16.003 The alleged gas chamber in each of Kremas II and III had an area of 2500 sq. ft. This would accommodate 278 people based on the 9 square foot theory. If the chamber were filled with the required HCN gas (0.25 lbs./1000 cu. ft.) and assuming a ceiling height of 8 feet and 20,000 cubic feet of space, then 5 lbs. of Zyklon B gas would be required. Again, assume at least 1 week to vent (as at Krema I). This ventilation time is again doubtful, but will serve to compute our numbers.

16.004 Computed usage rates for Kremas II and III (theoretical and real-time) and alleged execution gas chamber at maximum capacity are set out in Table V.

16.005 **Table V**
**(Hypothetical Execution and Crematory Usage Rates for Kremas II and III)**

**Krema II**

| | | |
|---|---|---|
| Execution Rate | 278 people/week | (hypothetical) |
| Crematory Rate | 714 people/week | (theoretical) |
| | 315 people/week | (real-time) |

**Krema III**

| | | |
|---|---|---|
| Execution Rate | 278 people/week | (hypothetical) |
| Crematory Rate | 714 people/week | (theoretical) |
| | 315 people/week | (real-time) |

16.006 Kremas IV and V were mirror image installations consisting of crematories of 2 furnaces with 4 retorts each and numerous rooms utilized as mortuaries, offices and storage. The interior rooms did not conform to the mirror image. Some of these rooms were allegedly used as gas chambers. It is impossible to ascertain much from the physical sites since the buildings were razed long ago. No sealant was found anywhere on the foundation or floor. According to reports, Zyklon B gas pellets were allegedly thrown in through wall ports which are now non-existent. If the plans of the building are correct, these facilities likewise were not gas chambers, for the same reasons iterated earlier for Kremas I, II and III. Construction was apparently red brick and mortar with a concrete floor and no basement. It should be noted that the existence of cremation and execution facilities at Kremas IV and V is unsubstantiated.

16.007 Based upon statistics, obtained from the Auschwitz State Museum and measurements made at the site, for Kremas IV and V relative to the alleged gas areas, and assuming a ceiling height of 8 feet, the computed statistics are as follows:

*Krema IV*

1875 sq. ft.; will hold 209 people. 15,000 cu. ft. will use 3.75 lbs. of Zyklon B gas at 0.25 lbs./1000 cu. ft.

*Krema V*

5125 sq. ft.; will hold 570 people. 41,000 cu. ft. will use 10.25 lbs. of Zyklon B gas at 0.25 lbs./1000 cu. ft.

16.008 Computed alleged usage rates for Kremas IV and V (theoretical and real-time) and gas chamber at maximum capacity and 1 week ventilation time are set out in Table VI.

16.009

**Table VI**
**(Hypothetical Execution and Crematory Usage Rates for Kremas IV and V)**

| | | |
|---|---|---|
| **Krema IV** | | |
| Execution rate | 209 people/week | (hypothetical) |
| Crematory rate | 385 people/week | (theoretical) |
| | 168 people/week | (real-time) |
| **Krema V** | | |
| Execution rate | 570 people/week | (hypothetical) |
| Crematory rate | 385 people/week | (theoretical) |
| | 168 people/week | (real-time) |

16.010 The Red and White houses, otherwise designated as Bunker I and II, were alleged to be gas chambers only, and there are no estimates available or statistics on the buildings.

17.000 **MAJDANEK.** At Majdanek, there are several facilities of interest: the original crematory, now removed; the crematory with the alleged execution gas chamber, now rebuilt; the Bath and Disinfection Building #2, which was apparently a delousing facility, and Bath and Disinfection Building #1, which contained a shower, delousing and storage room and the alleged experimental CO and HCN gas chambers.

17.001 The first free standing crematory, which has been removed, has been discussed earlier. For Bath and Disinfection #2, although closed, an inspection through the windows confirms its function was only a delousing facility, similar to those at Birkenau. The rebuilt crematory and alleged gas chamber, although discussed earlier, will be considered briefly, again. The furnaces are the only portion of the original facility which has not been rebuilt. The basic structure appears to be of wood, as are the other facilities at Majdanek (except for the experimental chambers). However, closer inspection reveals that much of the building is of reinforced concrete, totally inconsistant with the remaining portions of the camp. The alleged execution gas chamber is adjacent to the crematory with apparently no means of containing the HCN gas. The building is not sealed and would be inoperable for its alleged purpose. Allegedly rebuilt from an original plan, which does not exist, it physically appears to be nothing more than a crematory with several morgues. It is by far the smallest and most insignificant alleged gas chamber of all.

17.002 The delousing/storage area at Bath and Disinfection #1 is an L-shaped room with an internal wooden partition and door. It comprises some 7657 cu. ft. of volume and has an area of 806 sq. ft. It has stuccoed walls, beam construction and two ungasketed roof vents. It contains an air circulatory system which is improperly designed whereby the inlet and outlet are in close proximity to each other. Blue staining, apparently caused by ferric-ferro-cyanide pigment, visibly coats the surface of the walls. It would appear from design that this was a delousing room or storage room for deloused materials. The roof vents are only capable of providing long term airing of stored materials. The doors are not gasketed and are not designed to be tight. The room is not sealed inside or out with sealant. There were several areas in this building that were permanently sealed and not available for the author's inspection. This room, clearly, was not an execution chamber and meets none of the described criteria. See drawing.

17.003 If this were utilized as a presumed execution chamber, it would hold 90 people, at most, and require 2.0 lbs. of Zyklon B gas. Venting time should be at least one week. Maximum usage execution rate - 90 people/week.

17.004 The alleged experimental gas chambers, located at Bath and Disinfection Building #1, are a brick building connected to the main facility by a loose wood structure. This building is surrounded on three sides by a depressed concrete walkway. There are two chambers, an unknown area and a control booth, which has two steel cylinders, allegedly having contained carbon monoxide, which are piped into the two chambers. There are four steel doors with a rabbet, presumably for a gasket. The doors open out and are fastened shut with two mechanical latches and a locking bar (hasp). All four doors have glass peep holes and the two inner doors have chemical test cylinders, to test the air in the chamber. The control booth has an open window of some 6 inches x 10 inches, never having provision for glass or gasketing, barred horizontally and vertically with reinforcing rods and opening into chamber #2. See drawing. Two of the doors open into chamber #1, one front and one rear, to the outside. One door opens into chamber #2 in the front. The remaining door opens into an unknown area behind chamber #2. Both chambers have piping, allegedly for carbon monoxide gas, but that in chamber #2 is incomplete, apparently never having been completed. Chamber #1 has finished piping, terminated in gas ports at two corners of the room. Chamber #2 has provision for a roof vent, but it appears never to have been cut through the roof. Chamber #1 has a heater/circulatory system for the air, which is not properly designed (the inlet and outlet are too close) and has no provision for venting. The walls are of stucco, the roof and floor are of poured concrete, none of which has been sealed inside or out. There are two heater circulators built as sheds on the side of the building, one for chamber #1 and the other for something in the Bath and Disinfection facility, forward, (see drawing) neither of which are properly designed and have no provision for vent/exhaust. The walls in chamber #1 have the characteristic blue ferric-ferro-cyanide staining. The building is unheated and damp.

17.005 Although at first glance these facilities appear properly designed, they fail to meet all the required criteria for an execution gas chamber or delousing facility. First, there is no sealant on any of the inside or outside surfaces. Second, the depressed walkway is a potential gas trap for HCN, making the building extremely dangerous. Chamber #2 is incomplete and probably was never used. The piping is incomplete and the vent has never been opened in the roof. Although chamber #1 is operational for carbon monoxide, it is poorly vented and not operational for HCN. The heater/circulator is improperly installed. There is no vent or stack.

17.006 Therefore, it is the author's best engineering opinion that chambers #1 and #2 were never, and could not ever, be used as execution gas chambers. None of the facilities at Majdanek are suitable, or were used, for execution purposes.

17.007 Chamber #1 has an area of 480 sq. ft., a volume of 4240 cubic feet, will hold 54 persons and used 1 lb. of Zyklon B gas. Chamber #2 has an area of 209 sq. ft., a volume of 1850 cu. ft., will hold 24 persons and use 0.5 lbs. of Zyklon B gas. Assuming gas chamber usage, the maximum weekly execution rate would have been the figures set out in Table VII.

17.008 Table VII
(Hypothetical Execution Rates for Majdanek)

| | |
|---|---|
| Chamber #1 | 54 persons/week |
| Chamber #2 | 24 persons/week |

18.000 **STATISTICS.** The statistics set out in Table VII were generated for this report. Assuming the gas chambers existed (and they did not), these figures represent the maximum 24-hour, 7-day a week outputs of each facility and the amount of Zyklon B gas required.

18.001 Table VIII
(Compiled Hypothetical Maximum Execution and Crematory Usage Rates)

| | **Gassed** (Hypothetical) | **Cremated** (Theoretical) | **Cremated** (Real-time) | **lbs./kg.** |
|---|---|---|---|---|
| **Krema I - 11-41 -5-43** Inclusive | | | | |
| 72 wks. @ 94/wk. | 6,768 | | | |
| 72 wks. @ 286/wk. | | 20,592 | | |
| 72 wks. @ 126/wk. | | | 9,072 | |
| Total Zyklon B gas | | | | 136/61.2 |
| **Krema II - 3-43 -11-44** Inclusive | | | | |
| 84 wks. @ 278/wk. | 23,352 | | | |
| 84 wks. @ 714/wk. | | 59,976 | | |
| 84 wks. @ 315/wk. | | | 26,460 | |
| Total Zyklon B gas | | | | 420/189 |
| **Krema III - 6-43 -11-44** Inclusive | | | | |
| 72 wks. @ 278/wk. | 20,016 | | | |
| 72 wks. @ 714/wk. | | 51,408 | | |
| 72 wks. @ 315/wk. | | | 22,680 | |
| Total Zyklon B gas | | | | 360/162 |
| **Krema IV - 3-43 -10-44** Inclusive | | | | |
| 80 wks. @ 209/wk. | 16,720 | | | |
| 80 wks. @ 385/wk. | | 30,800 | | |
| 80 wks. @ 168/wk. | | | 13,440 | |
| Total Zyklon B gas | | | | 300/135 |

| | Gassed (Hypothetical) | Cremated (Theoretical) | Cremated (Real-time) | lbs./kg. |
|---|---|---|---|---|
| **Krema V - 4-43 -11-44** | | | | |
| Inclusive | | | | |
| 80 wks. @ 570/wk. | 45,600 | | | |
| 80 wks. @ 385/wk. | | 30,800 | | |
| 80 wks. @ 168/wk. | | | 13,440 | |
| Total Zyklon B gas | | | | 820/369 |
| **Majdanek 9-42 -11-43** | | | | |
| Delousing Facility at Bath #1 | | | | |
| 60 wks. @ 90/wk. | 5,400 | | | |
| Total Zyklon B gas | | | | 120/54 |
| **Experimental Chambers** | | | | |
| #1 60 wks. @ 54/wk. | 3,240 | | | |
| Total Zyklon B gas | | | | 60/27 |
| #2 60 wks. @ 24/wk. | 1,440 | | | |
| Total Zyklon B gas | | | | 30/13.5 |
| **Krema and Chamber** | | | | |
| 60 wks. @ 24/wk. | 1,440 | | | |
| 60 wks. @ 714/wk. | | 42,840 | | |
| 60 wks. @ 315/wk. | | | 18,900 | |
| Total Zyklon B gas | | | | 30/13.5 |
| **Krema Old** | | | | |
| 60 wks. @ 96/wk. | | 5,760 | | |
| 60 wks. @ 42/wk. | | | 2,520 | |
| **Totals** | **Gassed** (Hypothetical) | **Cremated** (Theoretical) | **Cremated** (Real-time) | **lbs./kg.** |
| | **123,976** | **242,176** | **106,512** | **2276/ 1024.2** |

Source re operational periods of crematorium: Hilberg, Destruction of the European Jews, 2nd ed., 1985.

18.002 Relative to the additional alleged execution facilities of Chelmno (gas vans), Belzec, Sobibor, Treblinka and any others, it should be noted that carbon monoxide gas was allegedly used. As discussed above, carbon monoxide gas is not an execution gas and the author believes that before the gas could take effect, all would have suffocated. Therefore, it is the author's best engineering opinion that no one died of CO execution.

18.003 International Military Tribunal Document L-022 claims 1,765,000 Jews were gassed at Birkenau between April, 1942 and April, 1944. Yet, at full capacity, the alleged execution gas chambers could only process 105,688 persons at Birkenau over a greater time period.

19.000 **CONCLUSION.** After reviewing all of the material and inspecting all of the sites at Auschwitz, Birkenau and Majdanek, your author finds the evidence as overwhelming. There were no execution gas chambers at any of these locations. It is the best engineering opinion of this author that the alleged gas chambers at the inspected sites could not have then been, or now, be utilized or seriously considered to function as execution gas chambers.

Prepared this 5th day of April, 1988 at Malden, Massachusetts.

Fred Leuchter Associates

Fred A. Leuchter, Jr.
Chief Engineer

# BIBLIOGRAPHY

## EIGHT (8) DRAWINGS

Krema I
Krema II
Krema III
Krema IV
Krema V
Delousing chamber, Building #1
Experimental gas chambers
Unknown heater circulator

All prepared for this report by H. Miller, Fred A. Leuchter Associates

## CHEMICAL ANALYSIS - 32 SAMPLES

Prepared by Alpha Analytical Labs
For Fred A. Leuchter Associates

## ASSORTED PHOTOS

By Fred A. Leuchter Associates

## SAMPLE LOG

2-25-88 through 3-2-88

## JOURNAL

2-25-88 through 3-3-88

## GERMAN BLUEPRINTS

9-25-41
10-16-44

## FLOOR PLANS

Krema IV, V
Krema II, III

**DOCUMENT NT 9912,** Office of Chief War Counsel for War Crimes Zyklon B

**ZYKLON B, TRIAL OF BRUNO TESCH,** Lindsey, Fall 1983, Journal of Historical Review

**GERMAN DELOUSING CHAMBERS,** Berg, Spring 1986, Journal of Historical Review

**DIESEL GAS CHAMBERS, MYTH WITHIN A MYTH,** Berg, Spring 1984, Journal of Historical Review

**ZYKLON B FOR PEST CONTROL,** Degesch Publication

**HOAX OF THE TWENTIETH CENTURY,** Butz, Historical Review Press

**DESTRUCTION OF THE EUROPEAN JEWS,** Hilberg, Holmes & Meier, New York, 1985.

**AUSCHWITZ,** 1940-1945, Museum Guide Book, Auschwitz State Museum

**AUSCHWITZ, CRIME AGAINST MANKIND,** Auschwitz State Museum, 1988

**MAJDANEK CONCENTRATION CAMP,** Rajca, Lublin, 1983, State Museum

**MAJDANEK,** Marszalek, State Museum, Auschwitz, 1983

**MAJDANEK,** Duszak, Auschwitz State Museum, 1985

**MAJDANEK,** Marszalek, Interpress, 1986

**MAPS AND MATERIAL,** Auschwitz and Majdanek State Museums

**PROPOSAL, MISSOURI STATE PENITENTIARY GAS CHAMBER,** Leuchter, Leuchter Associates, 1987

**HYDROGEN CYANIDE,** Dupont Publication, 7-83

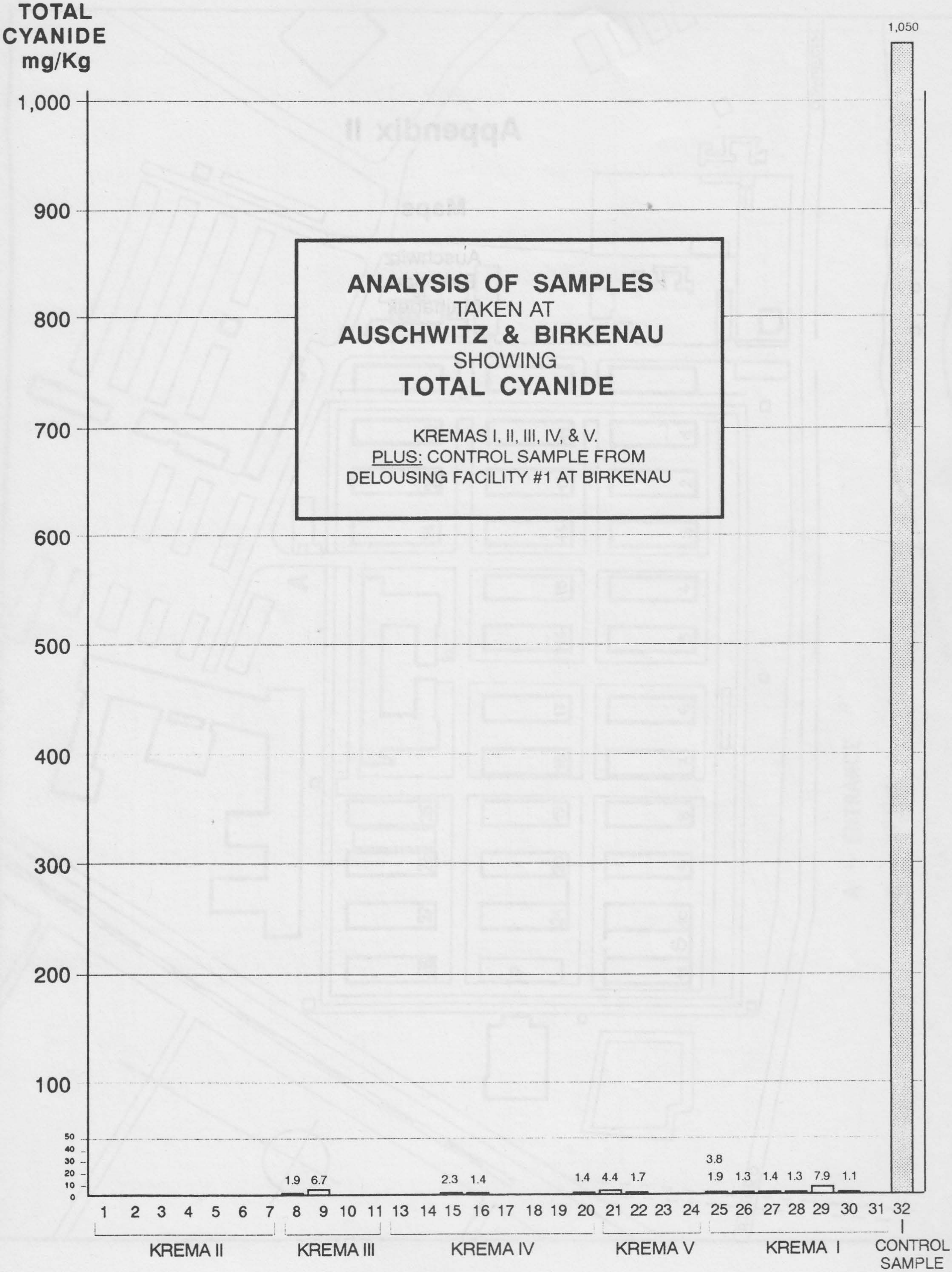
**SODIUM CYANIDE,** Dupont Publication, 7-85

**MATERIAL SAFETY DATA SHEET,** Dupont Publication, 8-85

**INDUSTRIAL ENGINEERING DATA SHEET,** Crematories

# Appendix I

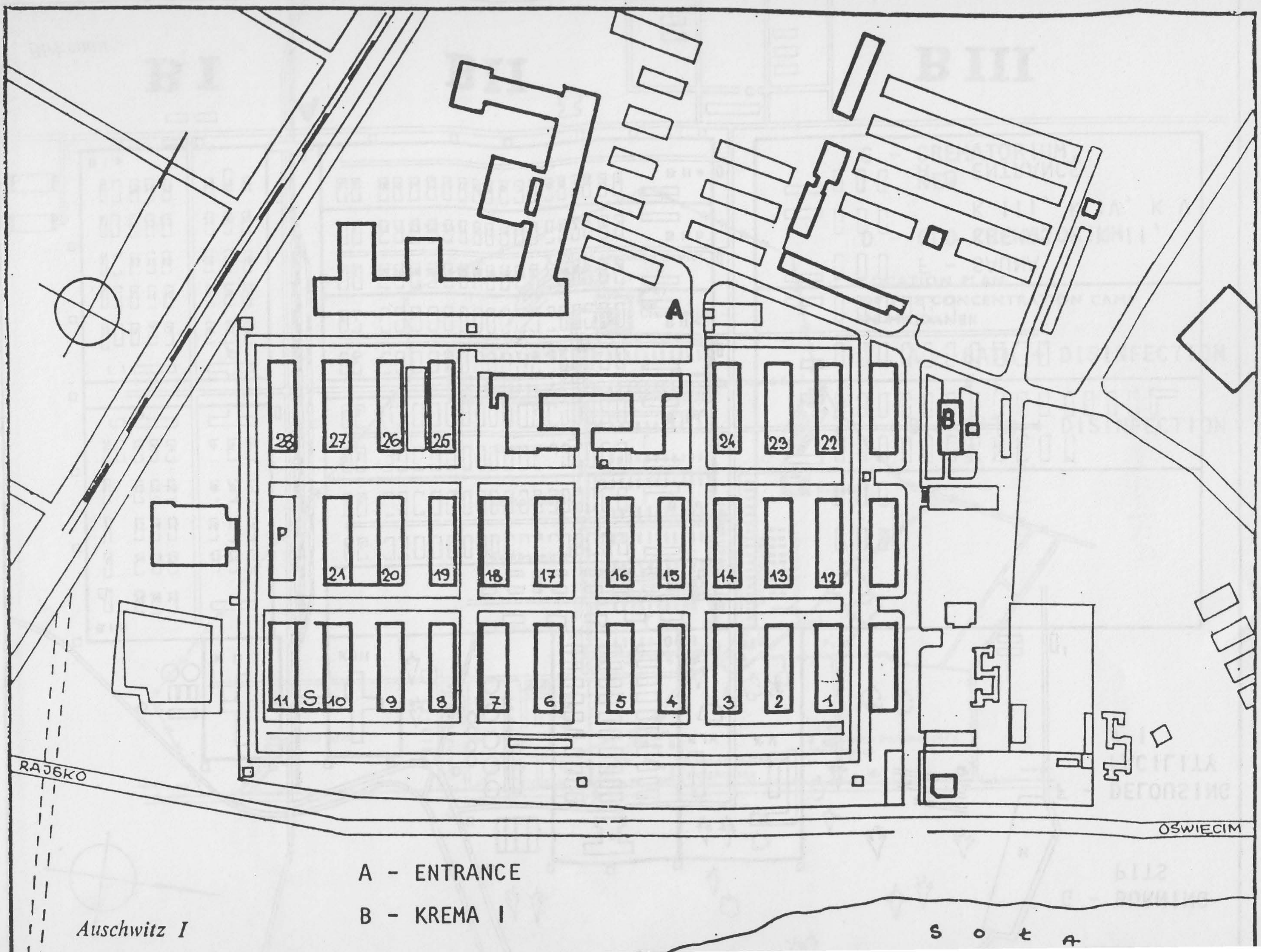
**Graphic Analysis of Samples Taken at Auschwitz & Birkenau Showing Total Cyanide**


TOTAL CYANIDE mg/Kg
ANALYSIS OF SAMPLES
TAKEN AT
AUSCHWITZ & BIRKENAU
SHOWING
TOTAL CYANIDE
KREMAS I, II, III, IV, & V.
PLUS: CONTROL SAMPLE FROM
DELOUSING FACILITY #1 AT BIRKENAU
1,000
900
800
700
600
500
400
300
200
100
50
40
30
20
10
0
1,050
1.9 6.7
2.3 1.4
1.4 4.4 1.7
3.8
1.9 1.3 1.4 1.3 7.9 1.1
1 2 3 4 5 6 7 8 9 10 11 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
KREMA II
KREMA III
KREMA IV
KREMA V
KREMA I
CONTROL SAMPLE

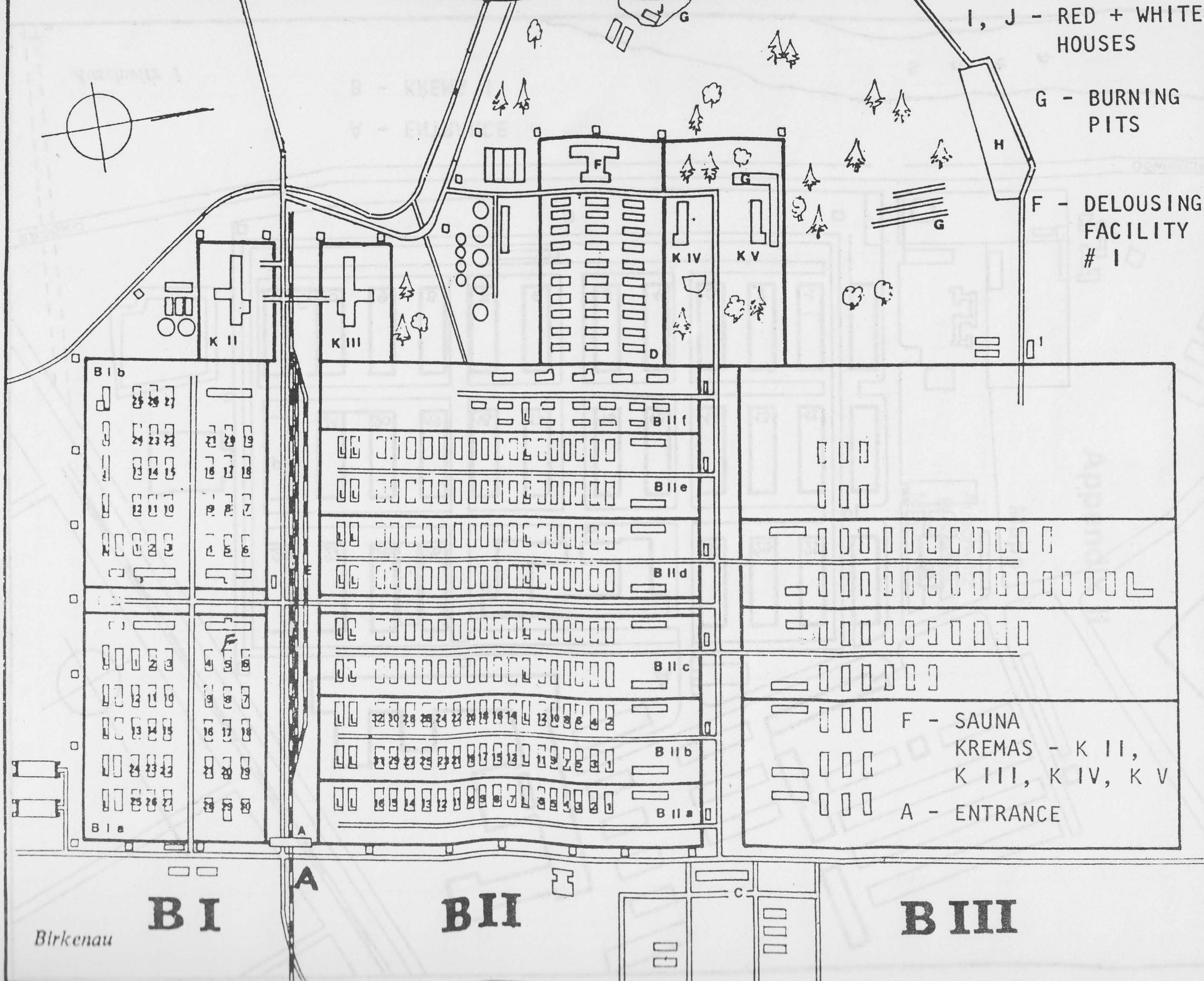
# Appendix II

## Maps

Auschwitz
Birkenau
Majdanek


A
B
P
S
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
RAJSKO
OŚWIĘCIM
S o t A
A - ENTRANCE
B - KREMA I

*Auschwitz I*


I, J - RED + WHITE HOUSES
G - BURNING PITS
F - DELOUSING FACILITY # I
F - SAUNA
KREMAS - K II, K III, K IV, K V
A - ENTRANCE
K II
K III
K IV
K V
H
G
F
D
E
C
A
B I b
B I a
B II a
B II b
B II c
B II d
B II e
B II f
B I
B II
B III
Birkenau

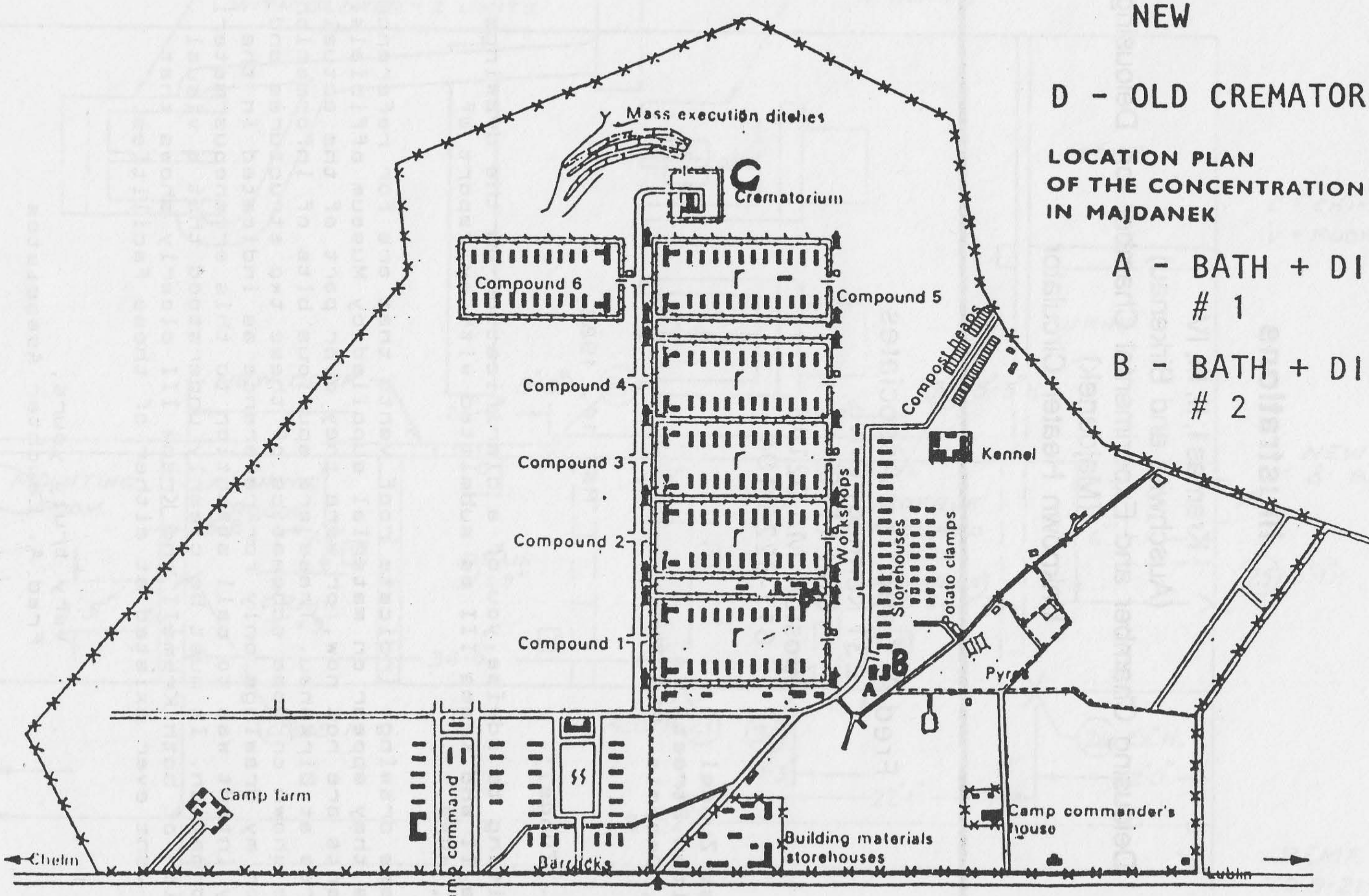
C - CREMATORIUM, NEW

D - OLD CREMATORIUM

**LOCATION PLAN OF THE CONCENTRATION CAMP IN MAJDANEK**

A - BATH + DISINFECTION # 1

B - BATH + DISINFECTION # 2



# Appendix III

## Illustrations

Kremas I, II, III, IV
(Auschwitz and Birkenau)
Delousing Chamber and Experimental Chamber for Delousing
(Majdanek)
Unknown Heater Circulator

Fred A. Leuchter, Associates
231 Kennedy Drive
Unit #110
Boston MA 02148
617-322-0104

Mr. Ernst Zundel
206 Carlton Street
Toronto, Ontario M5A 2L1
Canada

May 14, 1988

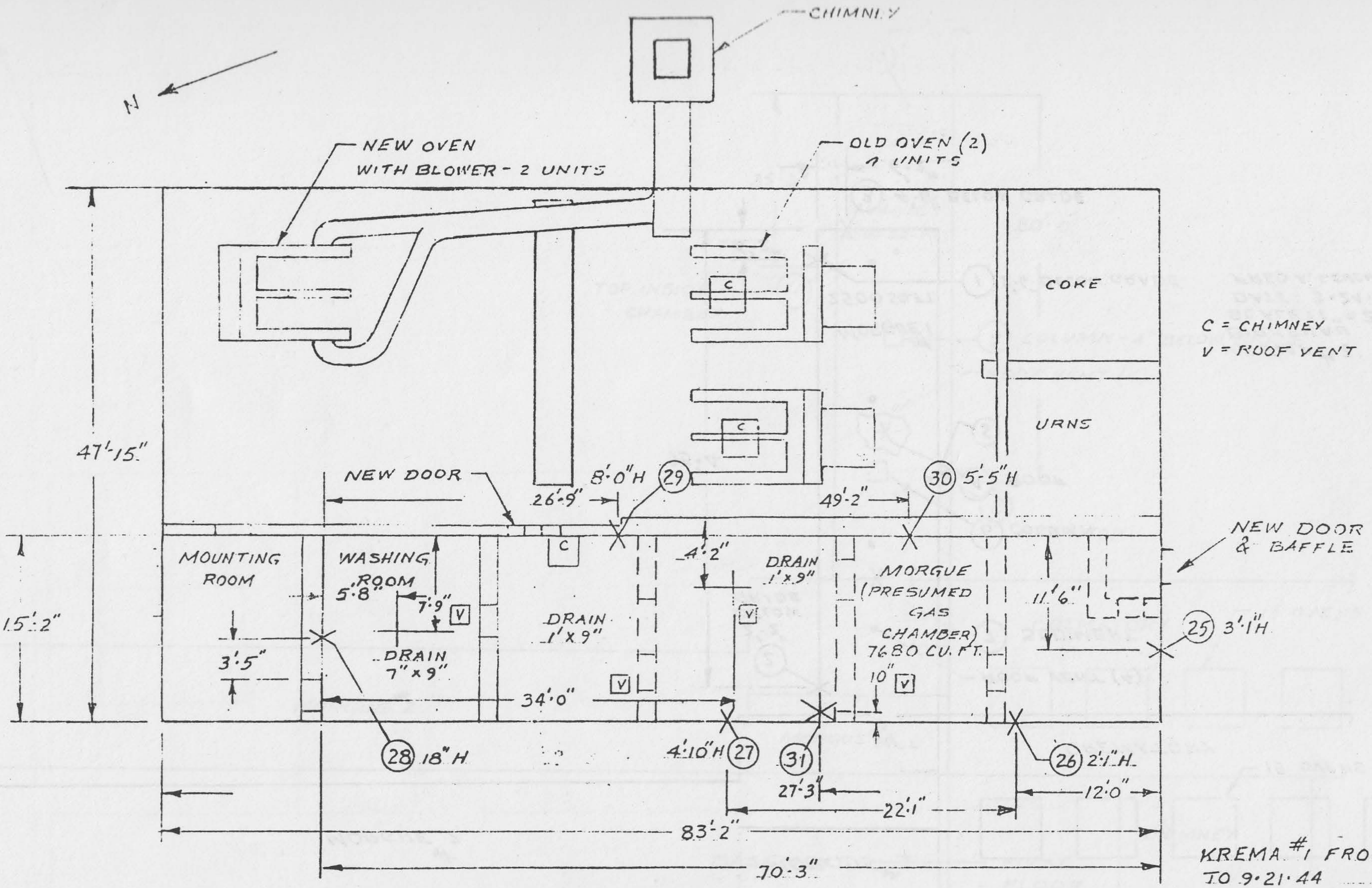
Dear Mr. Zundel:

I am writing to advise you of a clarification on the drawings of Krema II and Krema III as submitted with my report of April 5, 1988.

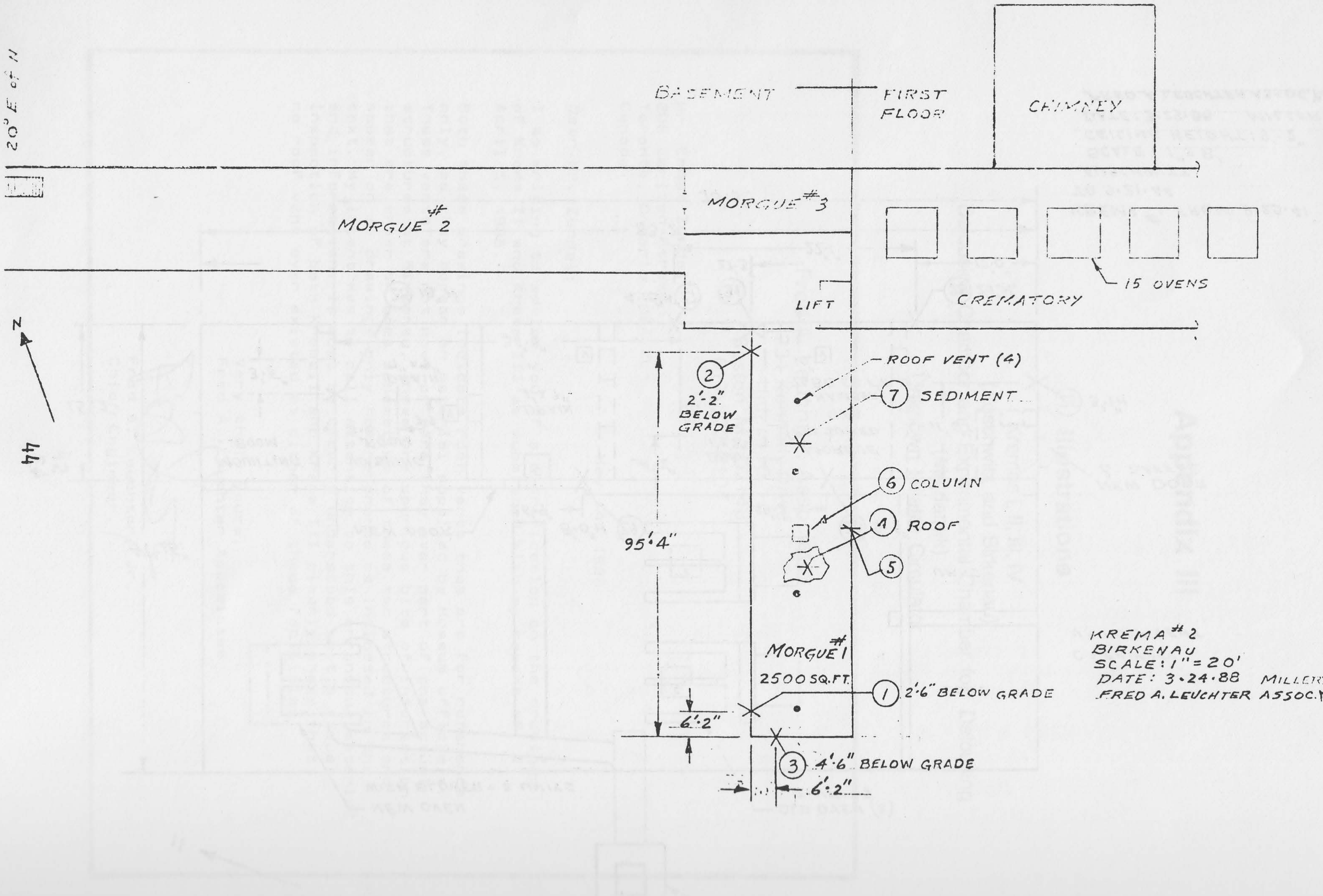
Both these drawings indicate roof vents that are for reference only, as they appear on material supplied by Museum officials. These vents are not now, or were they ever part of the actual structures at Birkenau. These are spurious bits of information that are shown on some schematics of these two structures and appear on my drawings only for reference as indicated in the text. My intent was to call attention to this erroneous material and information. It must be clearly understood that a visual inspection of both KremaII and Krema III clearly shows that no roof vent ever existed at either of these facilities.

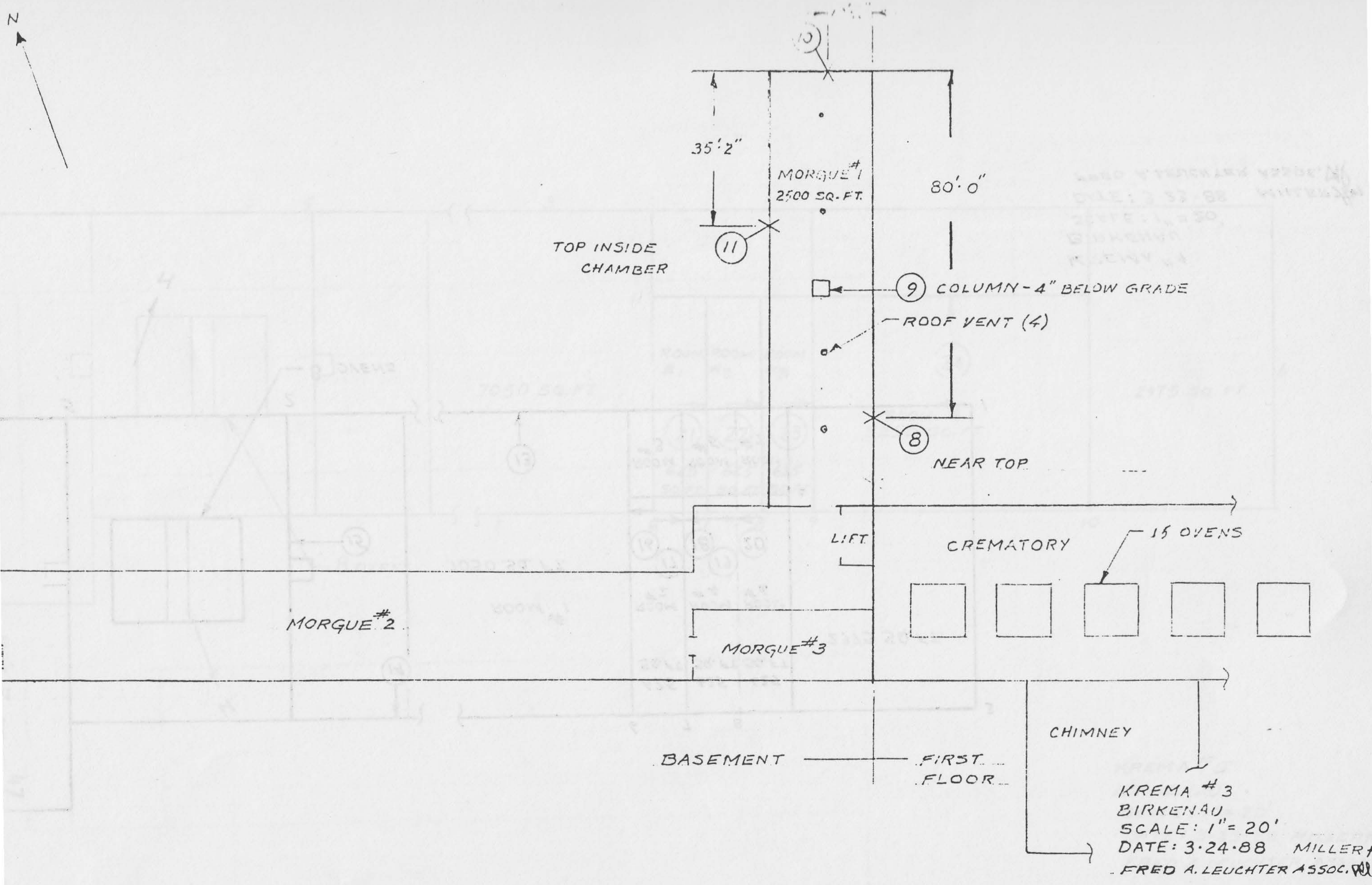
Very truly yours,
Fred A. Leuchter Associates

Fred A. Leuchter, Jr.
Chief Engineer.

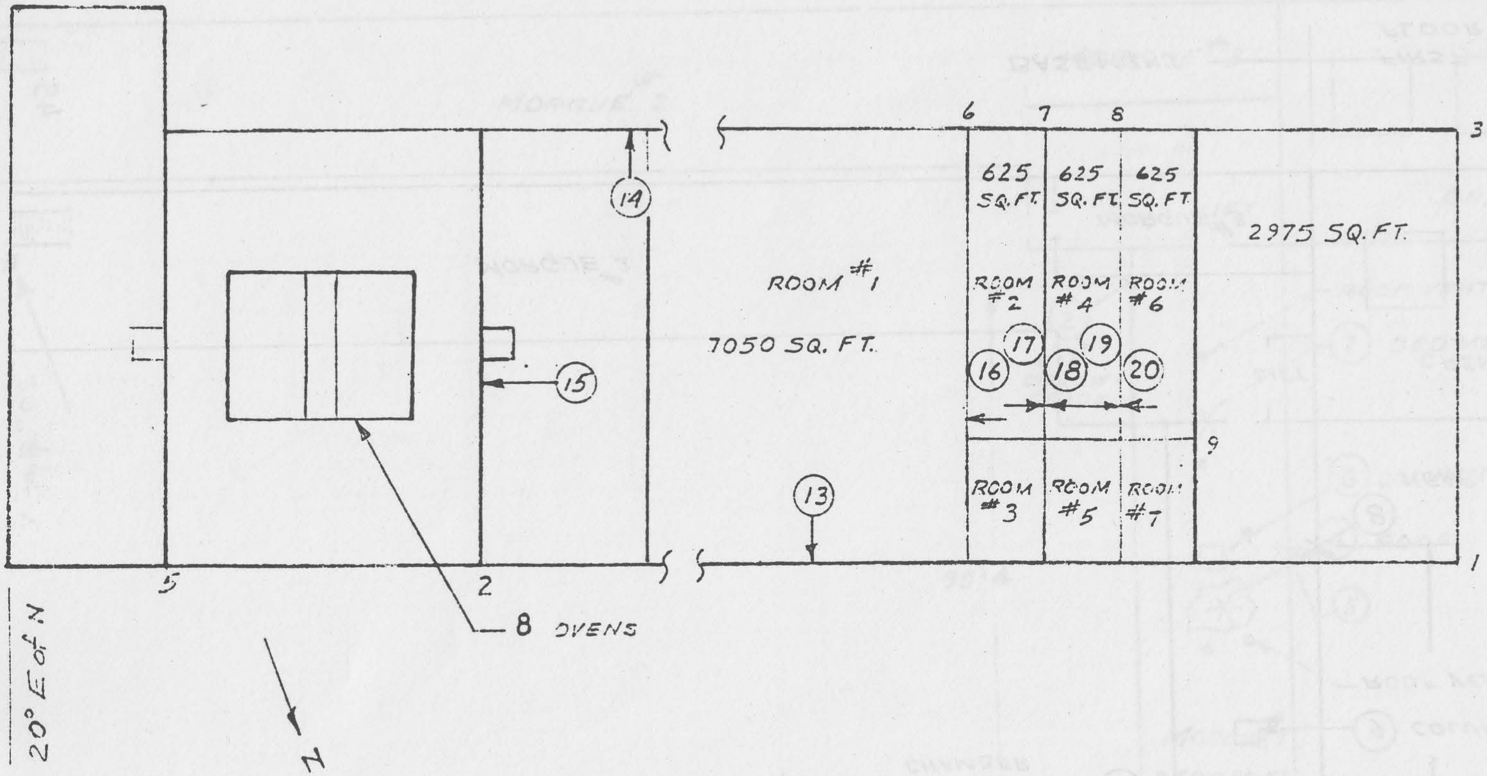



KREMA #1 FROM 9·25·41
TO 9·21·44
AUSCHWITZ
SCALE: 1" = 8'
CEILING HEIGHT: 9'-2"
DATE: 3·23·88 MILLER
FRED A. LEUCHTER ASSOC.

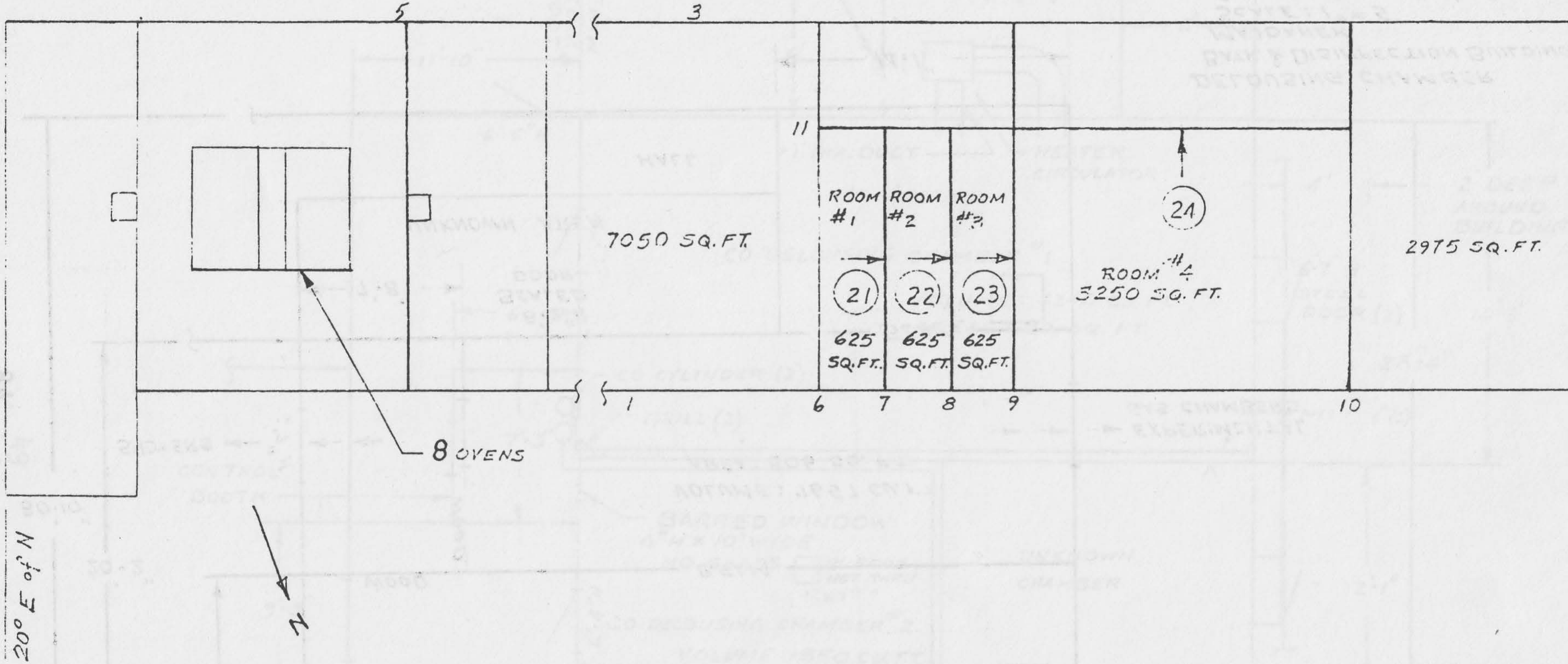

20° E of N
N
BASEMENT
FIRST FLOOR
CHIMNEY
MORGUE #2
MORGUE #3
15 OVENS
LIFT
CREMATORY
ROOF VENT (4)
(2) 2'-2" BELOW GRADE
(7) SEDIMENT
(6) COLUMN
(4) ROOF
(5)
95'4"
MORGUE #1
2500 SQ.FT.
(1) 2'6" BELOW GRADE
6'2"
(3) 4'6" BELOW GRADE
6'2"
KREMA #2
BIRKENAU
SCALE: 1" = 20'
DATE: 3·24·88 MILLER
FRED A. LEUCHTER ASSOC.



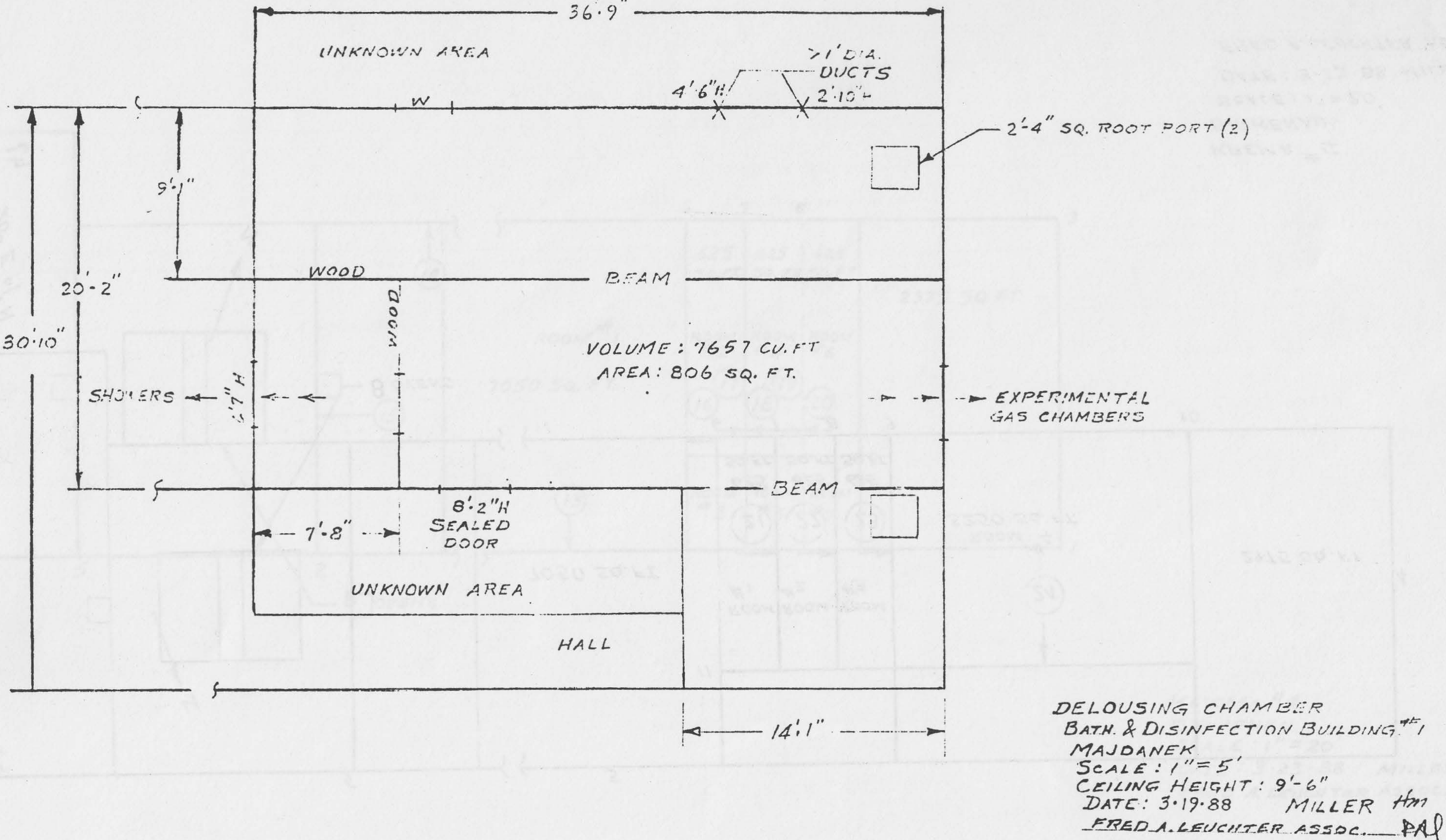
N
35'2"
MORGUE #1
2500 SQ. FT.
80' 0"
TOP INSIDE CHAMBER
11
10
9 COLUMN - 4" BELOW GRADE
ROOF VENT (4)
8
NEAR TOP
LIFT
CREMATORY
15 OVENS
MORGUE #2
MORGUE #3
CHIMNEY
BASEMENT
FIRST FLOOR
KREMA #3
BIRKENAU
SCALE: 1" = 20'
DATE: 3-24-88
FRED A. LEUCHTER ASSOC.

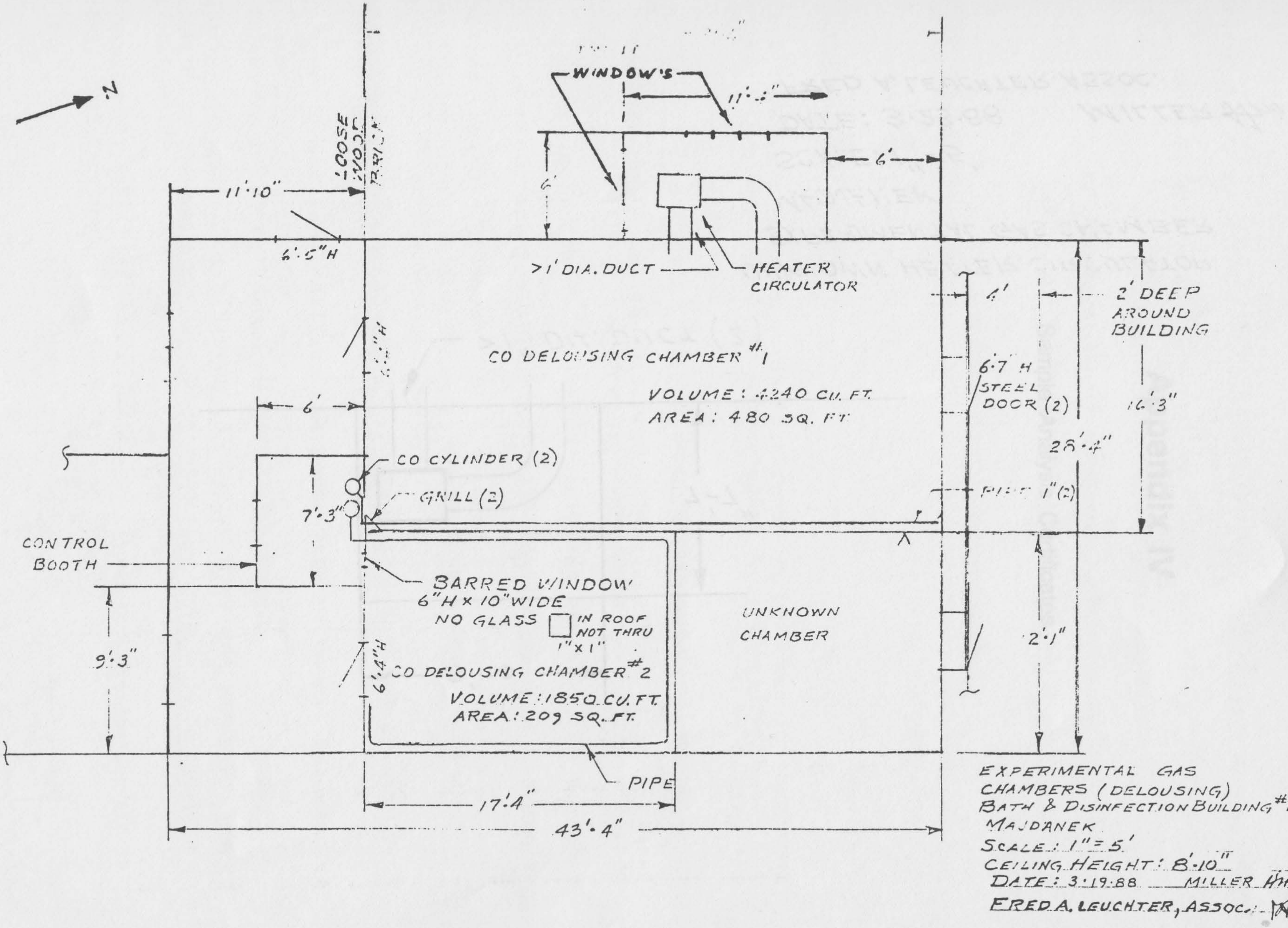


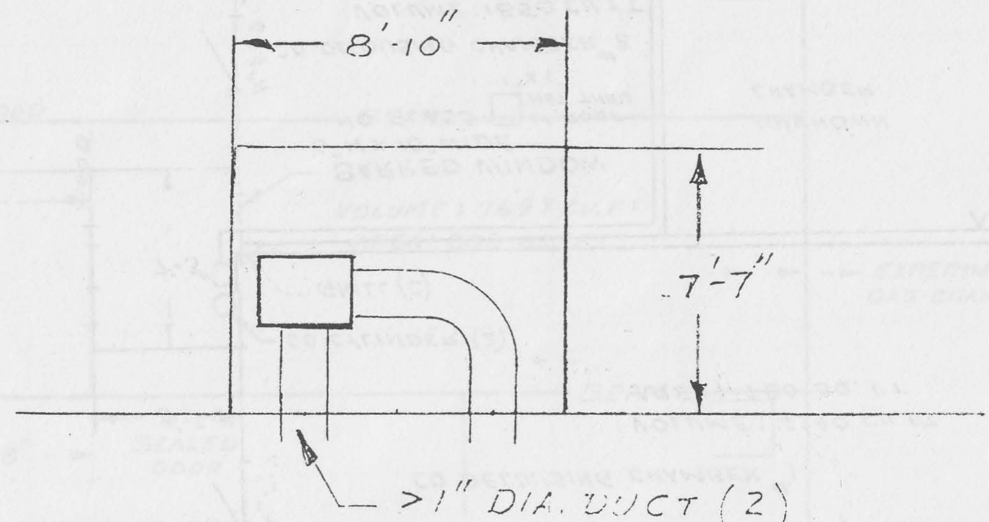

KREMA #1
BIRKENAU
SCALE: 1" = 20'
DATE: 3·23·88 MILLER
FRED A. LEUCHTER ASSOC.




KREMA #5
BIRKENAU
SCALE: 1" = 20'
DATE: 3-23-88 MILLER
FRED A. LEUCHTER ASSOC


36'-9"
UNKNOWN AREA
>1' DIA. DUCTS
4'6"H
2'10"H
W
2'-4" SQ. ROOF PORT (2)
9'-1"
20'-2"
30'-10"
WOOD
BEAM
WOOD
VOLUME: 7657 CU. FT
AREA: 806 SQ. FT.
SHOWERS
5'7"H
EXPERIMENTAL GAS CHAMBERS
BEAM
8'-2"H SEALED DOOR
7'-8"
UNKNOWN AREA
HALL
14'-1"
DELOUSING CHAMBER
BATH. & DISINFECTION BUILDING #1
MAJDANEK
SCALE: 1" = 5'
CEILING HEIGHT: 9'-6"
DATE: 3·19·88
MILLER
FRED A. LEUCHTER ASSOC.


N
WINDOW'S
11'-3"
6'
6'
LOOSE WOOD BRICK
11'-10"
6'-5"H
>1' DIA. DUCT
HEATER CIRCULATOR
4'
2' DEEP AROUND BUILDING
CO DELOUSING CHAMBER #1
VOLUME: 4240 CU. FT.
AREA: 480 SQ. FT.
6'-7" H STEEL DOOR (2)
16'-3"
28'-4"
6'
CO CYLINDER (2)
GRILL (2)
7'-3"
CONTROL BOOTH
BARRED WINDOW
6"H x 10" WIDE
NO GLASS
IN ROOF NOT THRU
1" x 1"
UNKNOWN CHAMBER
9'-3"
2'-1"
6'-4"H
CO DELOUSING CHAMBER #2
VOLUME: 1850 CU. FT.
AREA: 209 SQ. FT.
PIPE
17'-4"
43'-4"
EXPERIMENTAL GAS CHAMBERS (DELOUSING)
BATH & DISINFECTION BUILDING #1
MAJDANEK
SCALE: 1" = 5'
CEILING HEIGHT: 8'-10"
DATE: 3-19-88 MILLER
FRED A. LEUCHTER, ASSOC.




UNKNOWN HEATER CIRCULATOR
EXPERIMENTAL GAS CHAMBER
MADJANEK
SCALE: 1"=5'
DATE: 3-23-88 MILLER
FRED A. LEUCHTER ASSOC.

# Appendix IV

## Sample Analysis Certificates

551-3503
scott mclean

Fred A. Leuchter, Associates
231 Kennedy Drive
Unit #110
Boston MA 02148
617-322-0104

March 9, 1988

Alpha Analytical
200 Homer Street
Ashland, MA 01721

Gentlemen:

Enclosed, please find 32 samples of materials for analysis. All are for determination of cyanate residue except # 12 which is for definition of material.

Sample # 32 is control sample. Note blue color. Other samples should equal or exceed cyanate content.

Sample # 12 is Gasket material. Determine composition.

Sample # 7 is sediment material. Determine cyanate content.

Samples #1 through # 11; Samples # 13 Through 32. Brick, mortar and sediment. Cyanate content.

Test results for court litigation. Please certify.

All samples stored in cool, damp and sunlight free locations.

Please complete analysis as soon as possible.

Very truly yours,
Fred A. Leuchter, Associates

Fred A. Leuchter, Jr.
Chief Engineer

Received 32
pieces 3/9/88
Alpha Analytical Labs
Kimi McLean

# The Commonwealth of Massachusetts
## Department of Environmental Quality Engineering
## Lawrence Experiment Station
37 Shattuck Street, Lawrence, Massachusetts 01843

CERTIFICATION FOR CHEMICAL ANALYSIS OF WATERS

LABORATORY: MA086
Alpha Analytical Labs
200 Homer Ave.
Ashland, MA 01721

DATE: 03/15/88

EXPIRATION DATE: 09/15/88

DIRECTOR: Scott McLean
617) 881-3503

PRIMARY PARAMETERS AND CATEGORIES (DRINKING WATERS)

FULL CERTIFICATION: Trace Metals, Fluoride, Trihalomethanes, Volatile Organics, Corrosivity Series, Sodium

PROVISIONAL CERTIFICATION: Pesticides

SECONDARY PARAMETERS AND CATEGORIES

FULL CERTIFICATION: Metals, Minerals, Nutrients, PCB, Pesticides, Volatile Halocarbons, Volatile Aromatics, Cyanide, Phenolics

PROVISIONAL CERTIFICATION: None at present

Massachusetts Department of Environmental Quality Engineering will accept results from all parameters and categories listed above.

This certificate supercedes all previous certificates issued to this laboratory. Reporting of analyses other than those authorized above shall be cause for revocation of certification.

Original Certificate, not copies, must be displayed in a prominent place at all times. Certification subject to approval by OGC.

Joseph E. O'Brien
Joseph E. O'Brien, Ph.D.
Director, Laboratory Certification
For the Commissioner

100th Anniversary
1887 —— 1987

ALPHA ANALYTICAL LABORATORIES
200 Homer Avenue
Ashland Technology Center
Ashland, Massachusetts 01721
(617) 881-3503

# CERTIFICATE OF ANALYSIS

Client: Fred A. Leuchter, Associates

Job Number: 880451

Address: 231 Kennedy Drive; Unit #110

Boston, MA 02148

Invoice Number: 3964

Date In: 03/18/88

Attn: Fred Leuchter

Date Reported: 03/22/88

Sample Description: Three brick samples

---

REFERENCES:

1. Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. 1982.
2. Standard Methods for Examination of Water and Waste Water. APHA-AWWA-WACF. 15th Edition. 1980.
3. Methods for Chemical Analysis of Water and Wastes. EPA 600/4-82-055. 1982.

---

Authorized by: [signature]
Scott McLean--Laboratory Director

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

Client: Fred A. Leuchter, Associates | Sample Number: 880451.1

Analysis Requested: Total Iron | Date Received: 03/18/88

Date Reported: 03/22/88

Client Ident: 9
Sample Location:
Sample Description: Brick
Sample Container: Bag | # of Containers: 1
Field Prep: None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Iron | 7,580 | mg/Kg | 1.0 | ICP | 1 | 6010 | ----- | 03/21/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880451.2

**Analysis Requested:** Total Iron **Date Received:** 03/18/88

**Date Reported:** 03/22/88

**Client Ident:** 29
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Bag **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Iron | 6,280 | mg/Kg | 1.0 | ICP | 1 | 6010 | ----- | 03/21/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates  **Sample Number:** 880451.3

**Analysis Requested:** Total Iron  **Date Received:** 03/18/88

**Date Reported:** 03/22/88

**Client Ident:** 32
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Bag  **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Iron | 6,170 | mg/Kg | 1.0 | ICP | 1 | 6010 | ----- | 03/21/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
200 Homer Avenue
Ashland Technology Center
Ashland, Massachusetts 01721
(617) 881-3503

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Client:** | Fred A. Leuchter, Associates | **Job Number:** | 880386 |
| **Address:** | 231 Kennedy Drive; Unit #110 | **Invoice Number:** | 3943 |
| | Boston, MA 02148 | **Date In:** | 03/09/88 |
| **Attn:** | Fred A. Leuchter, Jr. | **Date Reported:** | 03/18/88 |

**Sample Description:** Thirty-two brick samples

REFERENCES:


1. Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. 1982.

2. Standard Methods for Examination of Water and Waste Water. APHA-AWWA-WACF. 15th Edition. 1980.

3. Methods for Chemical Analysis of Water and Wastes. EPA 600/4-82-055. 1982.

4. Oil Spill Identification System. CG-D-52-77 U. S. Coast Guard. 1977.


Authorized by: [signature]
Scott McLean--Laboratory Director

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

Client: Fred A. Leuchter, Associates

Sample Number: 880386.1

Analysis Requested: Total Cyanide

Date Received: 03/09/88

Date Reported: 03/18/88

Client Ident: 1
Sample Location:
Sample Description: Brick
Sample Container: Plastic Bag
# of Containers: 1
Field Prep: None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880386.2

**Analysis Requested:** Total Cyanide **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 2
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.3

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 3
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.4

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 4
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880386.5

**Analysis Requested:** Total Cyanide **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 5
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.5D

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 5 (duplicate)
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**Field Prep:** None

**# of Containers:** 1

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Referencé as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.6

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 6
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880386.7

**Analysis Requested:** Total Cyanide **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 7
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880386.7S

**Analysis Requested:** Total Cyanide (spike recovery) **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 7
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag **# of Containers:** 1
**Field Prep:** None

| COMPOUND | % RECOVERY |
|---|---|
| Total Cyanide | 119% |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880386.8

**Analysis Requested:** Total Cyanide **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 8
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.8D

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 8 (duplicate)
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | 1.9 | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.9

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 9
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**Field Prep:** None

**# of Containers:** 1

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | 6.7 | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.10

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 10
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.11

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 11
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**Field Prep:** None

**# of Containers:** 1

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.12

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 12
**Sample Location:**
**Sample Description:** Gasket Material
**Sample Container:** Plastic Bag

**# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880386.13

**Analysis Requested:** Total Cyanide **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 13
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

# ALPHA ANALYTICAL LABORATORIES
## CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.14

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 14
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**Field Prep:** None

**# of Containers:** 1

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates
**Sample Number:** 880386.15

**Analysis Requested:** Total Cyanide
**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 15
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | 2.3 | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880386.16

**Analysis Requested:** Total Cyanide **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 16
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | 1.4 | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880386.16S

**Analysis Requested:** Total Cyanide (spike recovery) **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 16
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag **# of Containers:** 1
**Field Prep:** None

| COMPOUND | % RECOVERY |
|---|---|
| Total Cyanide | 96% |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates
**Sample Number:** 880386.17
**Analysis Requested:** Total Cyanide
**Date Received:** 03/09/88
**Date Reported:** 03/18/88

**Client Ident:** 17
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.18

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 18
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**Field Prep:** None

**# of Containers:** 1

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

# ALPHA ANALYTICAL LABORATORIES
## CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.18S

**Analysis Requested:** Total Cyanide (spike recovery)

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 18
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**# of Containers:** 1
**Field Prep:** None

| COMPOUND | % RECOVERY |
|---|---|
| Total Cyanide | 100% |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880386.19

**Analysis Requested:** Total Cyanide **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 19
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.19S

**Analysis Requested:** Total Cyanide (spike recovery)

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 19
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**# of Containers:** 1
**Field Prep:** None

| COMPOUND | % RECOVERY |
|---|---|
| Total Cyanide | 120% |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880386.20

**Analysis Requested:** Total Cyanide **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 20
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ------ | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880386.20D

**Analysis Requested:** Total Cyanide **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 20 (duplicate)
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | 1.4 | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880386.21

**Analysis Requested:** Total Cyanide **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 21
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | 4.4 | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.22

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 22
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | 1.7 | mg/Kg | 1 | Spect | 2 | 412B+D | ------ | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.23

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 23
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.24

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 24
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**Field Prep:** None

**# of Containers:** 1

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates  **Sample Number:** 880386.25

**Analysis Requested:** Total Cyanide  **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 25
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag  **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | 3.8 | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880386.25D

**Analysis Requested:** Total Cyanide **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 25 (duplicate)
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | 1.9 | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.26

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 26
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | 1.3 | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates
**Sample Number:** 880386.26S

**Analysis Requested:** Total Cyanide (spike recovery)
**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 26
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**# of Containers:** 1
**Field Prep:** None

| COMPOUND | % RECOVERY |
|---|---|
| Total Cyanide | 140% |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880386.27

**Analysis Requested:** Total Cyanide **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 27
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | 1.4 | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates
**Sample Number:** 880386.28

**Analysis Requested:** Total Cyanide
**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 28
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | 1.3 | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

Client: Fred A. Leuchter, Associates | Sample Number: 880386.29

Analysis Requested: Total Cyanide | Date Received: 03/09/88

Date Reported: 03/18/88

Client Ident: 29
Sample Location:
Sample Description: Brick
Sample Container: Plastic Bag | # of Containers: 1
Field Prep: None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | 7.9 | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates | **Sample Number:** 880386.30

**Analysis Requested:** Total Cyanide | **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 30
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag | **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | 1.1 | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

Client: Fred A. Leuchter, Associates — Sample Number: 880386.30D

Analysis Requested: Total Cyanide — Date Received: 03/09/88

Date Reported: 03/18/88

Client Ident: 30 (duplicate)
Sample Location:
Sample Description: Brick
Sample Container: Plastic Bag — # of Containers: 1
Field Prep: None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates **Sample Number:** 880386.31

**Analysis Requested:** Total Cyanide **Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 31
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag **# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | ND | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

**Client:** Fred A. Leuchter, Associates

**Sample Number:** 880386.32

**Analysis Requested:** Total Cyanide

**Date Received:** 03/09/88

**Date Reported:** 03/18/88

**Client Ident:** 32
**Sample Location:**
**Sample Description:** Brick
**Sample Container:** Plastic Bag
**# of Containers:** 1
**Field Prep:** None

| PARAMETER | RESULT | UNITS | MDL* | INST | REF** | METHOD | EXTRACT | ANALYSIS |
|---|---|---|---|---|---|---|---|---|
| Total Cyanide | 1050 | mg/Kg | 1 | Spect | 2 | 412B+D | ----- | 03/10/88 |

* MDL--Method Detection Limits (same units as the Results)
** REF--Reference as cited on the cover (first) page of this report.

# Appendix V

## Document

International Military Tribunal, Doc. L-022

# PROCÈS

DES

# GRANDS CRIMINELS DE GUERRE

DEVANT

## LE TRIBUNAL MILITAIRE INTERNATIONAL

NUREMBERG

14 NOVEMBRE 1945 — 1er OCTOBRE 1946

102



ÉDITÉ À NUREMBERG, ALLEMAGNE

1949

## DOCUMENT L-022.

EXTRAITS DU RAPPORT PRÉSENTÉ EN NOVEMBRE 1944 PAR LE COMITÉ DES RÉFUGIÉS DE GUERRE, WASHINGTON D.C. SUR LES CAMPS D'EXTERMINATION (AUSCHWITZ ET BIRKENAU) AVEC UNE ESTIMATION DU NOMBRE DES JUIFS GAZÉS À BIRKENAU, D'AVRIL 1942 À AVRIL 1944. (COTE D'AUDIENCE USA-294.)

EXPLANATORY NOTE:

Offset printed copy; orig. in archives of U. S. State Dept; report consists of two accounts of escaped concentration camp inmates—two young Slovakian Jews and a Polish major

Executive Office of the President
War Refugee Board
Washington, D. C.

German Extermination Camps —
Auschwitz and Birkenau.
(page 33)

Careful estimate of the number of Jews gassed in BIRKENAU between April, 1942 and April, 1944 (according to countries of origin).

| | | |
|---|---|---|
| Poland (transported by truck) | approximately | 300,000 |
| " " " train) | " | 600,000 |
| Holland | " | 100,000 |
| Greece | " | 45,000 |
| France | " | 150,000 |
| Belgium | " | 50,000 |
| Germany | " | 60,000 |
| Yugoslavia, Italy and Norway | " | 50,000 |
| Lithuania | " | 50,000 |
| Bohemia, Moravia and Austria | " | 30,000 |
| Slovakia | " | 30,000 |
| Various camps for foreign Jews in Poland | " | 300,000 |
| | approximately | 1,765,000 |

# Appendix VI

## Zyklon B

Sodium Cyanide (Dupont)
Hydrogen Cyanide (Dupont)
Material Safety Data Sheet (Dupont)
Zyklon for Pest Control (Degesch)

DU PONT

# SODIUM CYANIDE

## *Properties, Uses, Storage and Handling*

DU PONT

REG. U.S. PAT. & TM. OFF.

**NOTICE: SODIUM CYANIDE MAY BE FATAL IF SWALLOWED OR INHALED. CONTACT WITH ACIDS OR WEAK ALKALIES LIBERATES POISONOUS GAS. CAUSES EYE BURNS AND MAY IRRITATE SKIN. See Personal Safety, First Aid and Medical Treatment.**

**DO NOT USE SODIUM CYANIDE AS A PESTICIDE**

**FOR EMERGENCY ASSISTANCE CALL:**

**DU PONT:** (901) 357-1546
This is an emergency sodium cyanide "HOT LINE." Do not use for routine technical or commercial information.

**CHEMTREC:** (800) 424-9300
See "TRANSPORTATION EMERGENCIES" page 9.

# TABLE OF CONTENTS

# INTRODUCTION

Du Pont sodium cyanide (NaCN) is available in two convenient all-purpose forms: a briquette form (CYANOBRIK® sodium cyanide) and a granular form (CYANOGRAN® sodium cyanide). The briquettes of CYANOBRIK are of uniform size, average 13 grams or about ½ ounce in weight and have overall dimensions of approximately 3.5 × 3.5 × 1.3 cm or 1⅜ × 1⅜ × ½ in. They are resistant to breakage and dusting, easy to scoop up, and readily soluble in water. The white granules of CYANOGRAN are also of uniform size so they flow better and generate a minimum of dust. The crystalline solid passes 99% through USS Sieve No. 2; 10% maximum through USS Sieve No. 50. Also available is a granular compounding grade which will pass 100% through USS Sieve No. 8, and a reagent grade meeting A.C.S. Specifications.

The Chemical Abstract Service Registry Number for NaCN is 143-33-9.

## SPECIFICATIONS AND TYPICAL ANALYSIS

| | Specifications | Typical Analysis* |
|---|---|---|
| Sodium cyanide, % | 99, min | 99 |
| Sodium hydroxide, % | 0.5, max<br>0.03, min | 0.1 |
| Sodium formate, % | 0.5, max | 0.3 |
| Sodium chloride, % | | 0.01 |
| Water, % | | |
| briquette | 0.1, max | 0.05 |
| granular | 0.2, max | 0.06 |
| Sulfides (as S), ppm | | <1 |
| Carbonates (as $Na_2CO_3$), % | | 0.5 |

*The above table gives typical analyses based on historical production performance. Du Pont does not make any express or implied warranty that future production will demonstrate or continue to possess these typical analyses.

## PHYSICAL PROPERTIES

| | | |
|---|---|---|
| Formula weight | | 49.007 |
| Melting point, F | | 1044 |
| C | | 562 |
| Boiling point, F | | 2786 |
| C | | 1530 |
| Specific gravity, solid— | | |
| 77 F, 25 C | | 1.60 |
| Specific gravity, liquid— | | |
| 1560 F, 850 C | | 1.19 |
| Heat of formation ($\Delta H^c_f$) | | |
| | 77 F, Btu/lb | −788 |
| | 25 C, cal/g | −438 |
| | 25 C, kJ/kg | −1833 |
| Specific heat (78-163 F, 26-73 C) | | |
| Btu/lb·F or cal/g C | | 0.335 |
| kJ/kg·K | | 1.402 |
| Heat of fusion (mp), Btu/lb | | 77 |
| | cal/g | 43 |
| | kJ/kg | 179 |
| Heat of vaporization (bp), Btu/lb | | 1309 |
| | cal/g | 722 |
| | kJ/kg | 3041 |
| Vapor pressure, mm Hg | | |
| | 1470 F, 800 C | 0.76 |
| | 2190 F, 1200 C | 89.8 |
| | 2480 F, 1360 C | 314.0 |
| Solubility in water, g NaCN/100 g water (See Fig. 1) | | |
| | −4 F, −20 C | 35.4 |
| | 68 F, +20 C | 58.3 |

# USES AND APPLICATIONS

The metal, chemical and mining industries are the principal consumers of sodium cyanide. Typical uses include—

### Electroplating

Cyanide brass, cadmium, copper, gold, silver, and zinc baths deposit decorative and/or functional metal coatings on a variety of substrates. The good throwing power of the electrolyte causes relatively uniform deposition of the metal on intricately shaped parts. Small amounts of special additives in the baths give bright metal deposits even on recessed surfaces of the work. Cyanide electroplating baths are versatile: they are capable of high production rates whether the work consists of massive or minute parts.

### Ore Extraction and Ore Flotation

The cyanide process for extracting gold and silver from low-grade ores uses aqueous solutions of sodium cyanide with oxygen (air) to convert the noble metal (M) to soluble NaM $(CN)_2$, from which M can be recovered der, carbon absorption, or by electrowinning.

In the flotation of galena (lead sulfide) to separate it from mixed ores containing sphalerite (zinc sulfide) and pyrite (iron sulfide), sodium cyanide acts as a depressor; that is, it reduces the tendency of gangue materials to travel along on the froth and so impair the separation. Sodium cyanide finds similar use in the separation of pentlandite from pyrrhotite and molybdenite from copper concentrates by flotation. It is also used to purify the molybdenite by extraction of copper impurities.

### Case Hardening Steel

Molten salt baths containing 10-30% sodium cyanide find extensive use for case hardening steels at temperatures below 1600 F (870 C). The molten bath process is fast, easy to operate, and yields mixed carbon-nitrogen cases that have excellent wear resistance and uniformity. The addition of activators or accelerators to the bath results in deeper cases than those obtained with

The life of keen-edged tools improves when the high-speed steel is cyanide-nitrided in molten cyanide baths at about 1050 F (565 C).

### Metal Cleaning

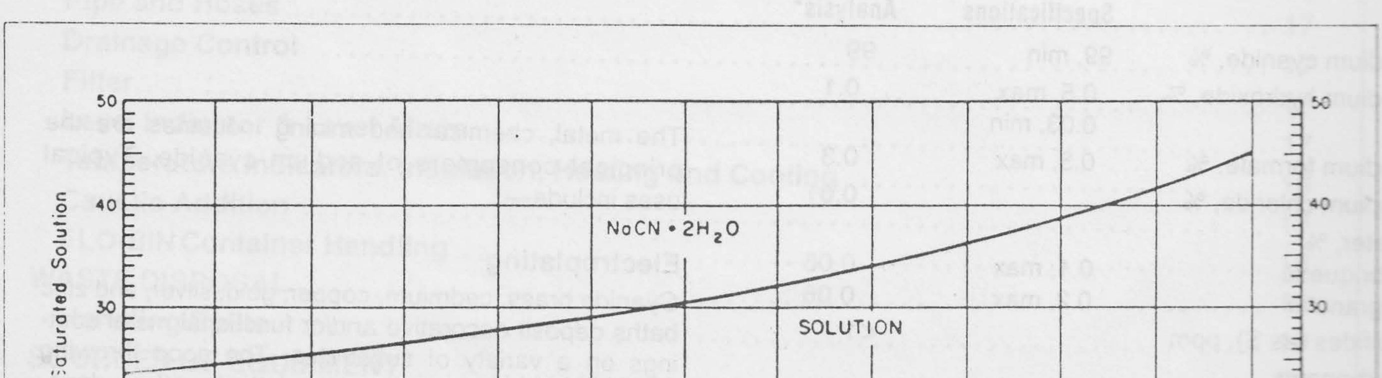
Aqueous solutions of sodium cyanide are effective metal cleaners, especially for smut removal after acid pickling.

### Chemical Manufacture

Sodium cyanide is used to make other chemicals that lead to such diverse products as drugs and vitamins, dyes and pigments, insecticides, sequestrants, polymers, and catalysts. (See CHEMICAL REACTIONS SECTION).

In any synthesis or formulation involving sodium cyanide, no cyanide compound should survive in the final product as an impurity. This is especially important with regard to consumer products.

## FIGURE 1. Solubility of Sodium Cyanide in Water



# CHEMICAL REACTIONS

The most hazardous property of sodium cyanide is its reaction with acids to form lethal hydrogen cyanide gas.

Sodium cyanide deliquesces in moist air. Crystals of the dihydrate, $NaCN \cdot 2H_2O$, form when saturated solutions of sodium cyanide cool at temperatures below 95 F (35 C). Sodium cyanide dissolves in methanol[a] [6.05 g/100 mL saturated solution at 59 F (15 C)]. It also dissolves in liquid ammonia[a] [3.7 g/100 mL $NH_3$ at −27.4 F (−33 C)].

## Sodium Cyanide Reactions in Water

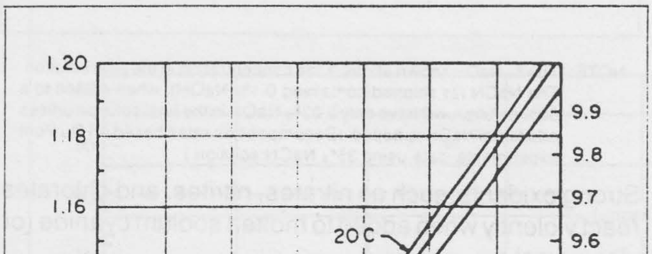
Sodium cyanide (NaCN) dissolved in water forms an equilibrium between ionized sodium cyanide and highly volatile hydrogen cyanide (HCN). In sodium cyanide solutions, HCN concentrations must be kept low to avoid toxic fumes. HCN formation varies with pH, cyanide concentration, and temperature. At pH 7 or less. essentially all of the cyanide will be in the HCN form. To suppress HCN formation in typical concentrated sodium cyanide make-up solution, a pH of 12 is required at ambient temperature (See Fig. 3). A pH of 12 generally provides a small safety factor; the critical importance of avoiding toxic HCN fumes makes a margin of safety essential. Higher temperatures and higher solution concentrations increase HCN fumes.

When making a cyanide solution, the proper procedure is to add about 0.5% sodium hydroxide (caustic) or 50 lb caustic/1,000 gallons water, *before* adding the cyanide. More caustic will not be chemically harmful to the cyanide, but increased alkalinity increases eye hazards from splashes. If process chemistry requires lower pH storage or use, adequate precautions in design and operation must be taken to protect against HCN fumes and HCN polymerization or hydrolysis.

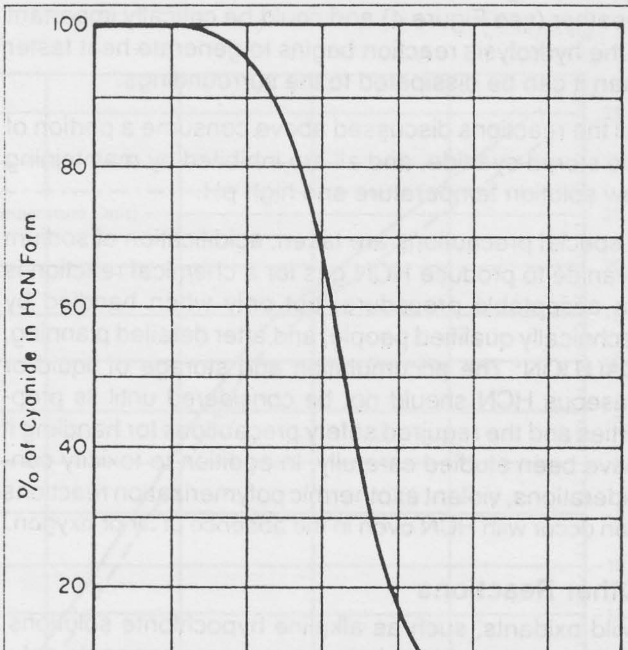
Hydrogen cyanide molecules will polymerize to form the extremely inert HCN polymer. In dilute solutions, HCN polymer will generate colors ranging from pale yellow to dark reddish brown. In stronger solutions, a dark brown precipitate resembling iron rust can form which will

[a]Also a Du Pont product

## FIGURE 2. Densities of NaCN Solutions




## FIGURE 3. Effect of pH on Cyanide Ionization




Data based on work by D. Milne, 1950, for dilute sodium cyanide solutions at ambient temperature. Toxic HCN fumes increase as temperatures and solution concentrations increase requiring higher pH for safe operation.

interfere with heat transfer, plug pumps, orifices, etc. and may cause significant cyanide loss. Again, high pH values give low HCN concentration and reduce the tendency for polymer formation.

Cyanide also reacts with water to form ammonia and formate ions. In the acid pH range, hydrolysis products are formic acid and ammonium salts. Alkaline solutions produce formate salts and volatile ammonia. With strong solutions, the volume of ammonia evolved can cause dangerous pressure build-up. One gallon of 30% sodium cyanide solution can produce more than 25 ft$^3$ of ammonia. For this reason, extra vent capacity is recommended for storage tanks.

Ordinarily the reaction between cyanide and water proceeds slowly. However, the reaction rate increases exponentially with an increase in temperature, having a critical range around 60-70 C (140-158 F). At temperatures below this range, the reaction can be controlled by cooling and, where practical, by dilution. At higher temperatures, however, the reaction can be uncontrollable and may proceed until substantially all the cyanide has been consumed. For this reason, temperature control and adequate cooling and venting capacity are needed. Sodium cyanide solution storage tanks should be equipped with facilities for measuring and controlling the temperature of the solution (see EQUIPMENT, page 17). Heating may be needed to assist in dissolving the NaCN (see Figure 1) and to prevent freezing (see Figure 3). Cooling helps to minimize cyanide loss in hot weather (see Figure 4) and could be critically important if the hydrolysis reaction begins to generate heat faster than it can be dissipated to the surroundings.

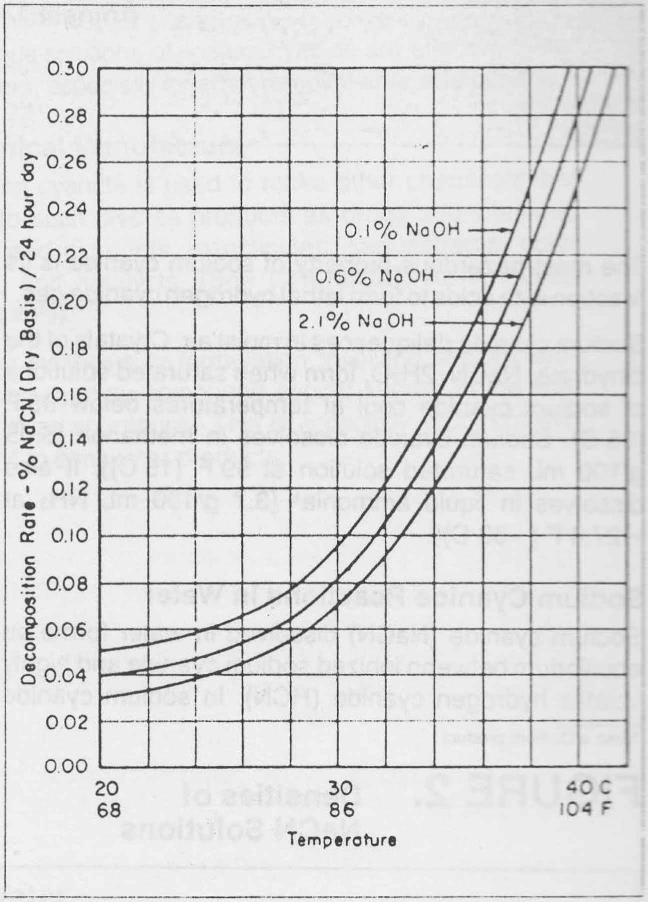
All the reactions discussed above consume a portion of the stored cyanide, and all are inhibited by maintaining low solution temperature and high pH.

If special precautions are taken, acidification of sodium cyanide to produce HCN gas for a chemical reaction is an acceptable procedure; but only when handled by technically qualified people, and after detailed planning. CAUTION: The accumulation and storage of liquid or gaseous HCN should not be considered until its properties and the required safety precautions for handling it have been studied carefully. In addition to toxicity considerations, violent exothermic polymerization reactions can occur with HCN even in the absence of air or oxygen.

## Other Reactions

Mild oxidants, such as alkaline hypochlorite solutions, hydrogen peroxide solutions,[a] and permanganate solutions can oxidize cyanide to sodium cyanate. The reaction finds wide use in the control of cyanides in effluents.[b] These oxidation reactions must be done in dilute solutions to avoid formation of highly toxic gases. (See "Waste Disposal".)

**FIGURE 4.** Decomposition Rate of NaCN Solutions




NOTE: The % NaOH shown above is the concentration in the final solution. The NaCN (as shipped-containing 0.1% NaOH), when diluted to a 30% solution, will have only 0.03% NaOH in the final solution unless additional NaOH is added. (Decomposition rates based on Du Pont experimental data using 35% NaCN solution.)

Strong oxidants, such as nitrates, nitrites, and chlorates react violently when added to molten sodium cyanide (or vice versa).[c]

With the exception of lead and platinum, most metals (when finely divided) dissolve in aqueous sodium cyanide in the presence of oxygen.

Alkaline solutions of sodium cyanide dissolve water-insoluble cuprous cyanide and zinc cyanide with formation of sodium tricyanocuprate and sodium tetracyanozincate, respectively.

Reacting an alkyl halide, sulfate, or toluene-sulfonate ($p\text{-}CH_3C_6H_4SO_2OR$) with sodium cyanide in aqueous alcohol, DMF[a], or similar aprotic solvent leads to an alkyl cyanide (nitrile). Fusing a sodium aryl sulfonate with sodium cyanide yields the aryl nitrile; for example, sodium benzene-sulfonate (sodium phenyl sulfonate) gives benzonitrile (phenyl cyanide).

---

[a] Also a Du Pont product

[c] See "Manual of Hazardous Chemical Reactions," NFPA No. 491 M-1975, published by the National Fire Protection Assn., 470 Atlantic Ave., Boston

Hydrogen cyanide, generated by reacting an acid with sodium cyanide, is capable of adding to isolated double bonds and to the carbonyl group of an aldehyde or ketone. In the case of acetophenone, for example, the corresponding cyanohydrin forms which hydrolyzes to atrolactic acid [α-phenyllactic acid, $C_6H_5(CH_3)C(OH)COOH$][d]. Similarly, when preparing an α-amino acid from an aldehyde or ketone by Strecker synthesis, the hydrogen cyanide and ammonia needed can come from ammonium cyanide formed in the reaction of sodium cyanide with ammonium chloride.

One method of synthesizing the sodium salt of ethylenediaminetetraacetic acid (tetrasodium EDTA, a chelating agent) combines ethylenediamine with formaldehyde[a] and sodium cyanide in hot (175 F, 80 C) alkaline solution.

---

[a] Also a Du Pont product

[d] E. L. Elial and J. P. Freeman. *Organic Syntheses*, Wiley, New York. Coll. Vol. 4, 58-62 (1963).

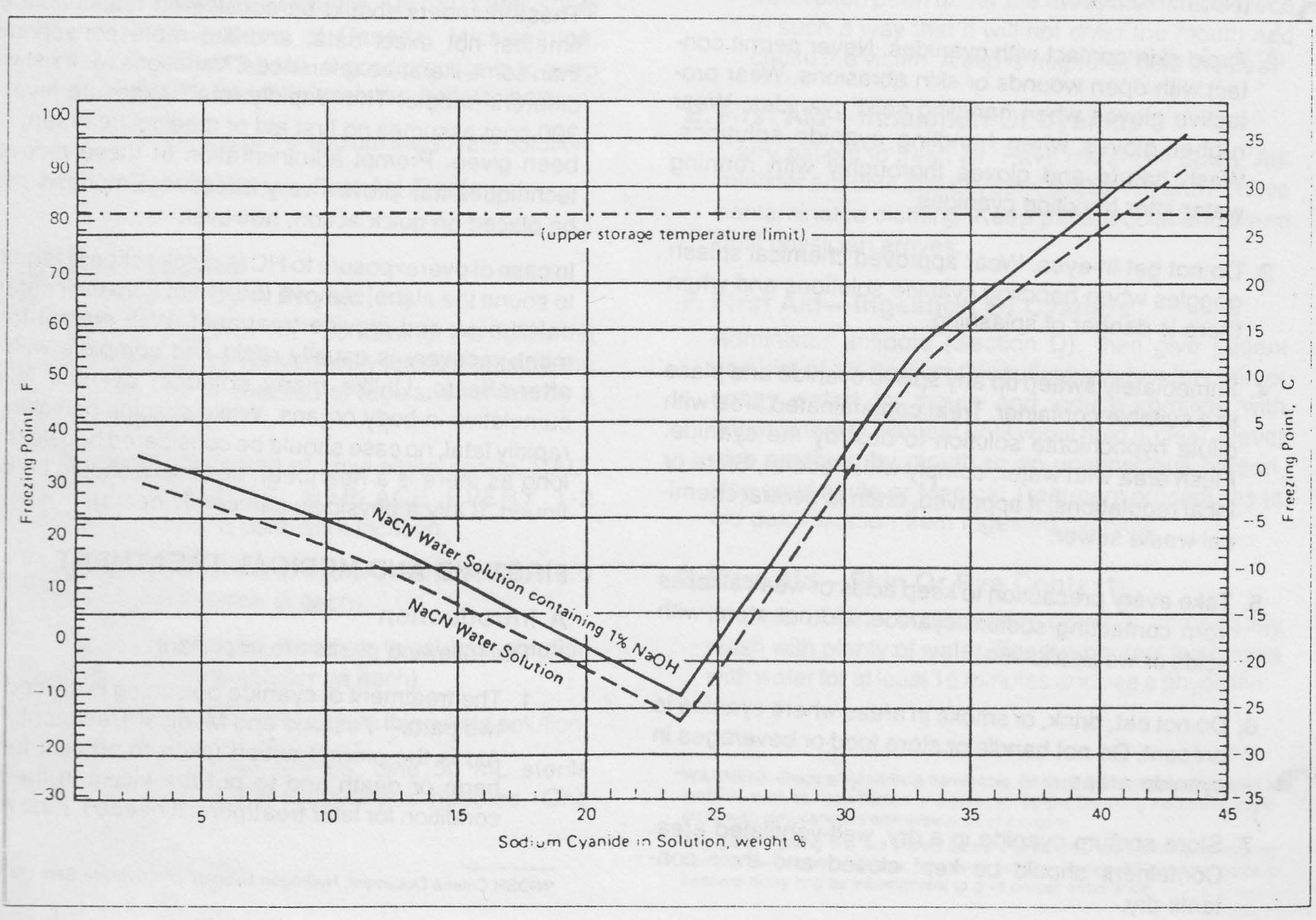
# PERSONAL SAFETY, FIRST AID AND MEDICAL TREATMENT

## HEALTH HAZARDS

Because of the toxicity of sodium cyanide, all persons working with it should be completely familiar with and observe the established safety practices.

Sodium cyanide is a rapidly fatal poison when taken internally. Poisoning may occur if sodium cyanide dust is inhaled. Prolonged contact with the skin may cause irritation and possibly poisoning, particularly if there are open wounds or skin abrasions. Sodium cyanide is alkaline and causes eye burns.

## FIGURE 5. Freezing Points of Sodium Cyanide Solutions



SODIUM CYANIDE IN CONTACT WITH ACIDS OR WEAK ALKALIES LIBERATES HIGHLY TOXIC AND FLAMMABLE HYDROCYANIC ACID (HCN) GAS. ALSO, TOXIC AMOUNTS OF HCN CAN BE LIBERATED FROM WATER SOLUTIONS OF SODIUM CYANIDE (SEE PP 4-5).

The U.S. Department of Labor (OSHA) has ruled that an employee's exposure to cyanide in any eight-hour workshift of a 40-hour week shall not exceed a time-weighted average of 5 mg of cyanide (calculated as CN) per cubic meter of air. It also cautions that since cyanide may penetrate the skin, especially if broken, control of vapor or dust inhalation alone may not be sufficient to prevent absorption of an excessive dose (Title 29 CFR 1910.1000 Air Contaminants).

## SAFETY PRECAUTIONS

The Basic Safety Precautions are:

1. Do not breathe dust or gas. Wear an approved dust respirator when there is danger of inhaling cyanide dust. The respirator should be one approved by the Mining Enforcement and Safety Administration or by the National Institute for Occupational Safety and Health (NIOSH). See pp. 5-7 of NIOSH's Recommended Standard for Occupational Exposure of Hydrogen Cyanide and Cyanide Salts, 1977 (No. 757-009/22).

2. Avoid skin contact with cyanides. Never permit contact with open wounds or skin abrasions. Wear protective gloves when handling solid cyanides. Wear rubber gloves when handling cyanide solutions. Wash hands and gloves thoroughly with running water after handling cyanides.

3. Do not get in eyes. Wear approved chemical splash goggles when handling cyanide solutions and when there is danger of splashing.

4. Immediately sweep up any spilled cyanide and place in a suitable container. Treat contaminated area with dilute hypochlorite solution to destroy the cyanide. Flush area with water; comply with Federal, State or local regulations. If approved, drain to neutral chemical waste sewer.

5. Take every precaution to keep acids or weak alkalies from contacting sodium cyanide. Do not store with acids or weak alkalies.

6. Do not eat, drink, or smoke in areas where cyanide is present. Do not handle or store food or beverages in cyanide areas.

7. Store sodium cyanide in a dry, well-ventilated area. Containers should be kept closed and their contents dry.

### Symptoms of Cyanide Poisoning

Personnel should be constantly alert and ready to take immediate action in case of exposure to cyanide. The following are symptoms of cyanide poisoning. They can result from many other causes, but these symptoms should be investigated when they occur around cyanide areas.

| | |
|---|---|
| Reddening of the eyes | Headache |
| Irritation of the throat | Weakness of arms and legs |
| Palpitation | Giddiness |
| Difficulty in breathing | Collapse and convulsions |
| Salivation | Numbness |
| Nausea | |

### Effects of Exposure to HCN Vapor

The following toxicity data are the "Reported (Estimated) Human Responses to Various Concentrations of HCN Vapors"[e]:

| | |
|---|---|
| 300 ppm | Rapidly fatal |
| 100-200 ppm | Fatal within ½ to 1 hour |
| 45-54 ppm | Tolerated for ½ to 1 hour without immediate or delayed effects |
| 20-40 ppm | Slight symptoms after several hours |
| 10 ppm | Threshold Limit/Time-Weighted Average for a normal 8-hour workday |
| 2-5 ppm | Odor threshold |

These numbers should be considered reasonable estimates, not exact data, and are more conservative than some literature references. Variations will exist with different people. The "rapidly fatal" exposure level of 300 ppm assumes no first aid or medical treatment has been given. Prompt administration of these recovery techniques has proven very effective. Emphasis must be placed on quick action, however.

In case of overexposure to HCN, quick action is required to sound the alarm, remove the victim from the contaminated area and provide treatment. With prompt treatment, recovery is usually rapid and complete with no after-effects. Unlike many poisons, cyanide is not cumulative in body organs. While cyanide poisoning is rapidly fatal, no case should be considered hopeless; as long as there is a heartbeat, treatment should be continued. (Only a physician can certify death).

## FIRST AID AND MEDICAL TREATMENT

### A. Introduction

The following points are important:

1. The treatment of cyanide poisoning is divided into two parts—First Aid and Medical Treatment. First Aid is the prompt action taken to prevent further harm or death and to put the victim in the best condition for later treatment, if needed. First Aid is

[e]NIOSH Criteria Document, *Hydrogen Cyanide and Cyanide Salts* (1976).

generally given by the layman before a doctor arrives. Medical Treatment is administered by the physician.

2. A key to treatment of cyanide poisoning is the rapid administration of antidotes and oxygen. Always have on hand a supply of the materials listed in Sections B and C below for immediate use.

3. Actions to be taken in case of exposure should be studied and planned *before* beginning work with cyanides.

4. *In case of cyanide contact, start treatment immediately. Call a physician.*

## B. First Aid Supplies

First aid supplies should be located in the cyanide area, and immediately accessible at all times. They should be inspected at least twice a week by the individuals who would be using them in an emergency. The following items are required:

1. Two boxes (2 dozen) of amyl nitrite pearls. CAUTION: UNSTABLE. REPLACE EVERY 1-2 YEARS. Store in cool, dark location.
2. Oxygen resuscitators. The Flynn Series III resuscitator, from O-TWO Systems, has performed satisfactorily since it is light weight, rugged, and easy to use. For information. contact Mid-South Oxygen Company, Memphis, TN (901) 396-5058 or O-TWO Systems of Canada, Mississauga, Ontario. (416) 677-9410. A good practice is to keep six amyl nitrite pearls in each resuscitator box.
3. Two 1-pint bottles of 1% sodium thiosulfate solution.
4. A set of instructions on First Aid Treatment.

## C. Medical Supplies (For Use Only By A Physician)

A "Medical Supplies Kit" containing the following supplies, should be conveniently located outside the cyanide area, and checked at regular intervals by a responsible person.

1. Two boxes (2 dozen) of amyl nitrite pearls. CAUTION: UNSTABLE. REPLACE EVERY 1-2 YEARS. Store in cool, dark location.
2. Two sterile ampules of sodium nitrite solution (10 mL of a 3% solution in each).
3. Two sterile ampules of sodium thiosulfate solution (50 mL of a 25% solution in each).
4. Two 1-pint bottles of 1% sodium thiosulfate solution.
5. One 10 mL sterile syringe. One 50 mL sterile syringe. Two sterile intravenous needles. One tourniquet.
6. One stomach tube.
7. One dozen gauze pads.
8. A set of instructions on Medical Treatment.

## D. First Aid—Directions for Giving Antidote

### 1. If Patient Is Conscious and Breathing

For inhalation and/or absorption, if the victim is conscious, oxygen may be all that is needed. But if victim is not fully conscious or shows signs of poisoning, follow procedure in 2 below.

### 2. If Patient Is Unconscious But Breathing

Break an amyl nitrite pearl* in a cloth and hold lightly under the patient's nose for 15 seconds, repeating 5 times at about 15-second intervals. If necessary, repeat this procedure every 3 minutes with fresh pearls until 3 or 4 pearls have been given. Give oxygen from a resuscitator to aid recovery.

### 3. If Patient Has Stopped Breathing

Use oxygen resuscitator (preferably) or give artificial respiration until breathing starts. Also break an amyl nitrite pearl* in a cloth and hold lightly under the patient's nose for 15 seconds, repeating 5 times at about 15-second intervals. If necessary, repeat this procedure every 3 minutes with fresh pearls until 3 or 4 pearls have been given. When giving amyl nitrite to a victim not breathing, place the broken pearl under the resuscitator face-piece in such a way that it will not enter the mouth and choke the victim. A clip is helpful to hold the pearl.

## E. First Aid—Inhalation Of Cyanide

Carry patient to fresh air. Have patient lie down. Administer antidote and oxygen (Section D) and remove contaminated clothing. Keep patient quiet and warm until physician arrives.

## F. First Aid—Ingestion Of Cyanide

Administer antidote (Section D), then give patient one pint of 1% sodium thiosulfate solution (or plain or soapy water) by mouth and induce vomiting with finger in throat. Repeat until vomit fluid is clear. Never give anything by mouth to an unconscious person. Use amyl nitrite or Medical Treatment procedures to aid detoxification from ingested cyanide.

## G. First Aid—Skin Or Eye Contact

In case of skin contact with cyanide, immediately wash with plenty of water. For eye contact flush eyes with water for at least 15 minutes and see a physician.

---

***WARNING:** Since amyl nitrite is flammable, be careful to remove all sources of ignition, such as open flames or cigarettes, before breaking the pearls, especially with simultaneous administration of oxygen.

Any person giving first aid should be careful to keep the broken pearls away from his own mouth and nose; otherwise he may inhale sufficient amyl nitrite to become dizzy and be incompetent to give proper assistance.

## H. Medical Treatment

### 1. Treatment of Cyanide Poisoning

While preparations for sodium nitrite and sodium thiosulfate injections are being made, break an amyl nitrite pearl* in a cloth and hold it lightly under the patient's nose for 15 seconds, repeating 5 times at about 15-second intervals. If victim is not breathing, use oxygen resuscitator or artificial respiration.

Discontinue administration of amyl nitrite and inject the solution of sodium nitrite (10 mL of a 3% solution) intravenously at the rate of 2.5 mL/minute, then immediately inject the sodium thiosulfate (50 mL of a 25% solution) at the same rate, taking care to avoid extravasation.

Watch patient continuously for 24-48 hours if cyanide exposure was severe. If there is any return of symptoms during this period, repeat the treatment, but use one-half the amounts of sodium nitrite and sodium thiosulfate solutions.

If signs of excessive methemoglobinemia develop (i.e., blue skin and mucous membranes, vomiting, shock and coma), 1% methylene blue solution should be given intravenously. A total dose of 1 to 2 mg/kg of body weight should be administered over a period of five to ten minutes and should be repeated in one hour if necessary. In addition, oxygen inhalation will be helpful and transfusion of whole fresh blood may be considered if there has been mechanical injury with bleeding or internal blood loss simultaneously with the cyanide exposure.

NOTE: A second injection of the antidotes on one-half the dosage initially used can be administered two hours after the initial treatment to help the patient ward off a relapse.

### 2. Treatment of Cyanide Sores

Should sores or skin irritation develop coincidentally with handling cyanide or its solutions, consult a physician or dermatologist.

### 3. Treatment Of Burns

Burns from molten cyanide mixtures are the same as those from alkalies and should be treated in a similar manner. Wash the burns thoroughly with warm water to remove all cyanide and alkalies present, then treat as any burn and consult a physician.

*See page 8.

# PACKAGES

Du Pont sodium cyanide in the form of briquettes (CYANOBRIK®), granular (CYANOGRAN®) and granular compounding grade is available in nonreturnable 100-lb net (108-lb gross) and 200-lb net (218-lb gross) steel drums. The 100-lb (45.4-kg) drums are shipped palletized 18 to a pallet and the 200-lb (90.7-kg) drums are 8 or 10 to a pallet. The drums can be stored 6 high in a warehouse.

CYANOBRIK is also available in 3000-lb net (3550-lb gross) FLO-BIN® containers, 24 to 44 bins per rail car or 12 bins per trailer truck.

Customers using sodium cyanide as a water solution can receive it dry in "Wet-Flo" tank cars (55 000 to 65 000 lb) and tank trucks (35 000 lb). The tank cars and trucks are unloaded by circulating premeasured water from a storage tank to dissolve the NaCN.

Drum shipments can be by ocean, rail freight or truck. Sodium cyanide is not mailable. The Department of Transportation (DOT) hazard classification is Poison B. A DOT Poison label is required. Truckloads, carloads and tank cars must carry "Poison" placards.

Due to changing government regulations, such as those of the Department of Transportation, Department of Labor, U.S. Environmental Protection Agency and the Food and Drug Administration, references herein to government regulations may be superseded. You should consult and follow the current government regulations, such as Hazard Classification, Labeling, Food Use Clearances, Worker Exposure Limitations and Waste Disposal Procedures for the up-to-date requirements for the products described in this literature.

# TRANSPORTATION EMERGENCIES

If a shipment of Du Pont sodium cyanide is involved in an accident or emergency anywhere in the continental United States, make a toll-free call to the Chemical

## E. I. du Pont de Nemours & Co. (Inc.)
## Wilmington, Delaware 19898

### U.S. Sales and Services

For placing orders or requesting additional product information, please use our convenient 24-hour toll-free telephone number. If you prefer, you can write to us.

**By Phone**

Toll free in continental U.S. (except Delaware)
(800) 441-9442

In Delaware
(302) 774-2099

**By Mail**

E. I. du Pont de Nemours & Co. (Inc.)
Chemicals and Pigments Dept.
Customer Service Center
Wilmington, DE 19898

### International Sales Offices

**CANADA**
Du Pont Canada Inc.
Box 660
Montreal S, P.Q. H3C 2V1
(514) 861-3861

Du Pont Canada Inc.
P.O. Box 2300
Streetsville Postal Station
Mississauga, Ontario L5M 2J4
(416) 821-5570

**LATIN AMERICA**
E. I. du Pont de Nemours & Co. (Inc.)
Chemicals and Pigments Dept.
Latin America Sales Office
Brandywine Building
Wilmington, DE 19898
(302) 774-3403

**EUROPE**
Du Pont de Nemours International S.A.
P.O. Box
CH-1211
Geneva 24, Switzerland
022-378111

**ASIA-PACIFIC**
Du Pont Far East, Inc.
Kowa Building No. 2
11-39 Akasaka 1-chome
Minato-ku
Tokyo 107, Japan
585-5511

Du Pont Far East, Inc.
Maxwell Road
P.O. Box 3140
Singapore 9051
273-2244

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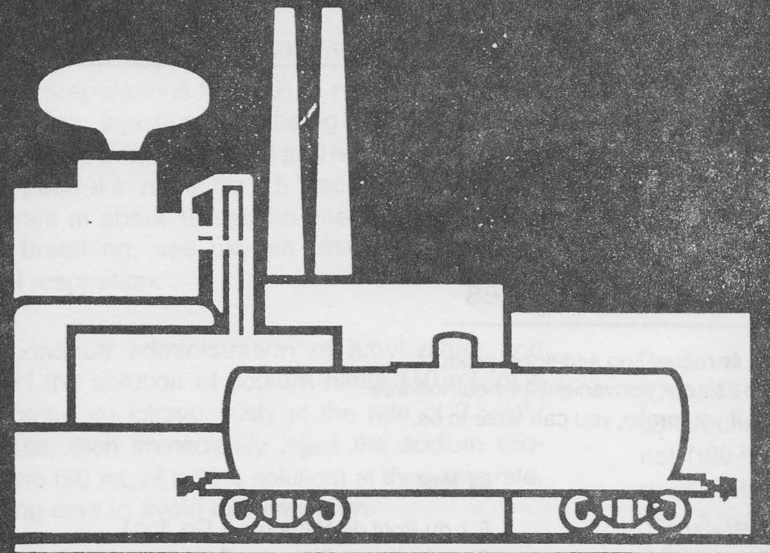


# HYDROGEN CYANIDE

## *Storage and Handling*

**NOTICE: Hydrogen Cyanide is an extremely hazardous liquid and vapor. It is highly toxic and may be fatal if inhaled, absorbed through the skin, or swallowed. HCN is extremely volatile and flammable and forms explosive mixtures in air. It can polymerize violently from alkalinity, heat or water. See PERSONAL SAFETY AND FIRST AID on page 4.**

## TABLE OF CONTENTS



**FOR EMERGENCY ASSISTANCE CALL:**

**DU PONT (901) 357-1546**

**This is an emergency Cyanide Hotline to our Memphis, TN plant. Do not use for routine technical or commercial information.**

**CHEMTREC (800) 424-9300**

**See TRANSPORTATION EMERGENCIES on page 9.**

**FOR COMMERCIAL OR TECHNICAL INFORMATION CALL:**

**Your Du Pont Marketing Representative or a District Sales Office listed on the back of this bulletin.**

# PRODUCT INFORMATION

## Introduction

Hydrogen cyanide (hydrocyanic acid, prussic acid, HCN) is a clear to bluish liquid with a weak but identifiable odor (see Sniff Test on page 9). The Department of Transportation (DOT) proper shipping name for HCN is Hydrocyanic Acid, Liquefied and the DOT Hazard Class is Poison A.[1]* The Chemical Abstracts Index Name for HCN is hydrocyanic acid (CAS Registry Number 74-90-8).

HCN can be ignited by an open flame or spark and can form explosive mixtures with air (Class 1A Flammable Liquid)[2]. It is highly volatile, boiling at 25.7°C (78.3°F). HCN gas is slightly lighter than air and normally will rise. Its combustion products – carbon dioxide, water, and nitrogen – dissipate harmlessly into the atmosphere.

HCN is extremely toxic by inhalation, skin absorption, or ingestion. Dangerous concentrations of HCN can be present without discomfort because the weak odor is not irritating or obnoxious. Brief exposure to HCN concentrations of about 300 ppm or more in air can result in rapid loss of consciousness and death, unless first aid is promptly administered. If proper treatment is given quickly, recovery is normally rapid and complete, since HCN is not a cumulative poison.

*Superscript numbers in parenthesis refer to REFERENCES AND NOTES on page 24.

HCN will polymerize violently from alkalinity, heat, or water, and can hydrolyze violently with some strong, concentrated acids. These reactions can be extremely destructive, and precautions must be taken to avoid contact with reaction initiators.

Anyone planning to work with HCN should be thoroughly familiar with its properties and the necessary safety precautions described in this bulletin. They should be proficient in product handling, emergency, and first aid procedures; and have the necessary safety equipment, first aid and medical supplies for these procedures.

Du Pont ships HCN in tank cars only. Before Du Pont will ship HCN to any use location, both a site inspection and an inspection of the bulk handling facilities are required.

Early evaluation of the proposed site by Du Pont is important to avoid wasting development time and money on a site not suitable for HCN use. When construction is nearly complete, Du Pont will make a bulk facilities inspection. On-site technical service will be provided by Du Pont during the first delivery. After start-up, Du Pont will make periodic safety inspections as a continuing customer service. (See Site Selection on page 10).

For consulting assistance on any aspect of handling or design of HCN facilities, contact your Du Pont representative or the nearest District Office listed on the back cover of this bulletin.

## Specifications

For industrial uses, Du Pont offers high purity HCN whose Specifications and Typical Analyses are listed in Table I.

## Physical Properties

Hydrogen cyanide physical properties are summarized in Table II. Additional physical properties appear in Figures 7 to 12 on pages 25 to 28.

**TABLE I**

**SPECIFICATIONS AND TYPICAL ANALYSES**
**DU PONT HYDROGEN CYANIDE**

| | Specifications | Typical Analyses* |
|---|---|---|
| Hydrocyanic acid, minimum % | 99.5 | 99.6 |
| Water, maximum % | 0.5 | 0.3 |
| Acidity ($H_2SO_4$ and $SO_2$ combined, calc. as $H_2SO_4$) | 0.06-0.10 | 0.08 |
| Color | Not darker than APHA 20 (Saybolt 24) | 5 |

*This column gives typical analyses based on historical production performance. Du Pont does not make any express or implied warranty that future production will demonstrate or continue to possess these typical analyses.

TABLE II

| PHYSICAL PROPERTIES* OF HYDROGEN CYANIDE (HCN) | |
|---|---|
| Molecular weight | 27.03 |
| Boiling point, °C | 25.7 |
| °F | 78.3 |
| Melting point, °C | −13.24 |
| °F | 8.17 |
| Conductivity, µS/cm 0°C (32°F) | 3.3 |
| Critical temperature, °C | 183.5 |
| °F | 362.3 |
| Critical pressure, atm | 53.2 |
| MPa | 5.4 |
| Critical density, g/mL (Mg/m³) | 0.195 |
| Density, vapor (air = 1), at 31°C | 0.947 |
| liquid, g/mL (Mg/m³) at 0°C | 0.7150 |
| liquid, g/mL (Mg/m³) at 20°C | 0.6884 |
| Dielectric constant, 0°C (32°F) | 158.1 |
| 20°C (68°F) | 114.9 |
| Explosive range, vol. % in air at 100 kPa and 20°C, min. | 6 |
| max. | 41 |
| Flash point, TCC (ASTM D-56), °C | −17.8 |
| °F | 0 |
| Heat of combustion, kcal/mol | 159.4 |
| kJ/mol | 667 |
| Heat of formation, kcal/mol, | |
| gas at 25°C | −30.7 |
| liquid at 18°C | −24.0 |
| kJ/mol | |
| gas at 25°C | −128.4 |
| liquid at 18°C | −100.4 |
| Heat of fusion, at −14°C, kcal/mol | 1.72 |
| kJ/mol | 7.2 |
| Heat of vaporization, kcal/mol at 25°C | 6.03 |
| kJ/mol at 25°C | 25.2 |
| Autoignition temperature, °C | 538 |
| °F | 1000 |
| Specific heat, cal/mol·C, −33.1°C (−27.6°F) | 13.95 |
| 16.9°C (62.4°F) | 16.94 |
| Surface tension, dyn/cm (mN/M) at 10°C | 19.1 |
| 17°C | 18.2 |
| 25°C | 17.2 |

*These property data are drawn from various Du Pont and literature sources. Du Pont does not make any express or implied warranty that the commercial product will have these properties.

## Chemical Properties

Hydrogen cyanide is miscible in all proportions with water, methanol, ethanol and ethyl ether. Aqueous solutions of hydrogen cyanide are weak acids and are sensitive to light.

The chemical reactions of hydrogen cyanide are discussed in the Encyclopedia of Chemical Technology[3]. Certain hazardous chemical reactions involving HCN are described on page 8 under Precautions in Use. A review of these reactions and the PERSONAL SAFETY AND FIRST AID section is essential before attempting laboratory reactions with HCN.

## Uses

Hydrocyanic acid is essential for manufacturing many important products in our modern society, including detergents, pharmaceuticals, nylon, chelating agents, blue dyes, methacrylate and acrylate resins, insecticides, and weed killers.

## Shipping Containers

Du Pont ships hydrogen cyanide in tank cars only (See Table III for net volumes and weights). They are specially built DOT 105A-500W or 105A-600W cars. Figure 1 shows the distinctive red and white tank colors adopted for rail shipments by all HCN producers. The cross section shows construction of HCN cars built to Du Pont specifications, which exceed Department of Transportation regulations. A rupture disk/safety valve in the dome, set at 225 psig (1550 kPa) and 213 psig (1470 kPa) respectively, relieves excess pressure under conditions of extreme heat. Placards on the sides and ends of the car identify the product, give instructions for isolating the car if a leak develops, and give Du Pont's Cyanide Hotline phone number.

TABLE III

DU PONT HCN TANK CARS

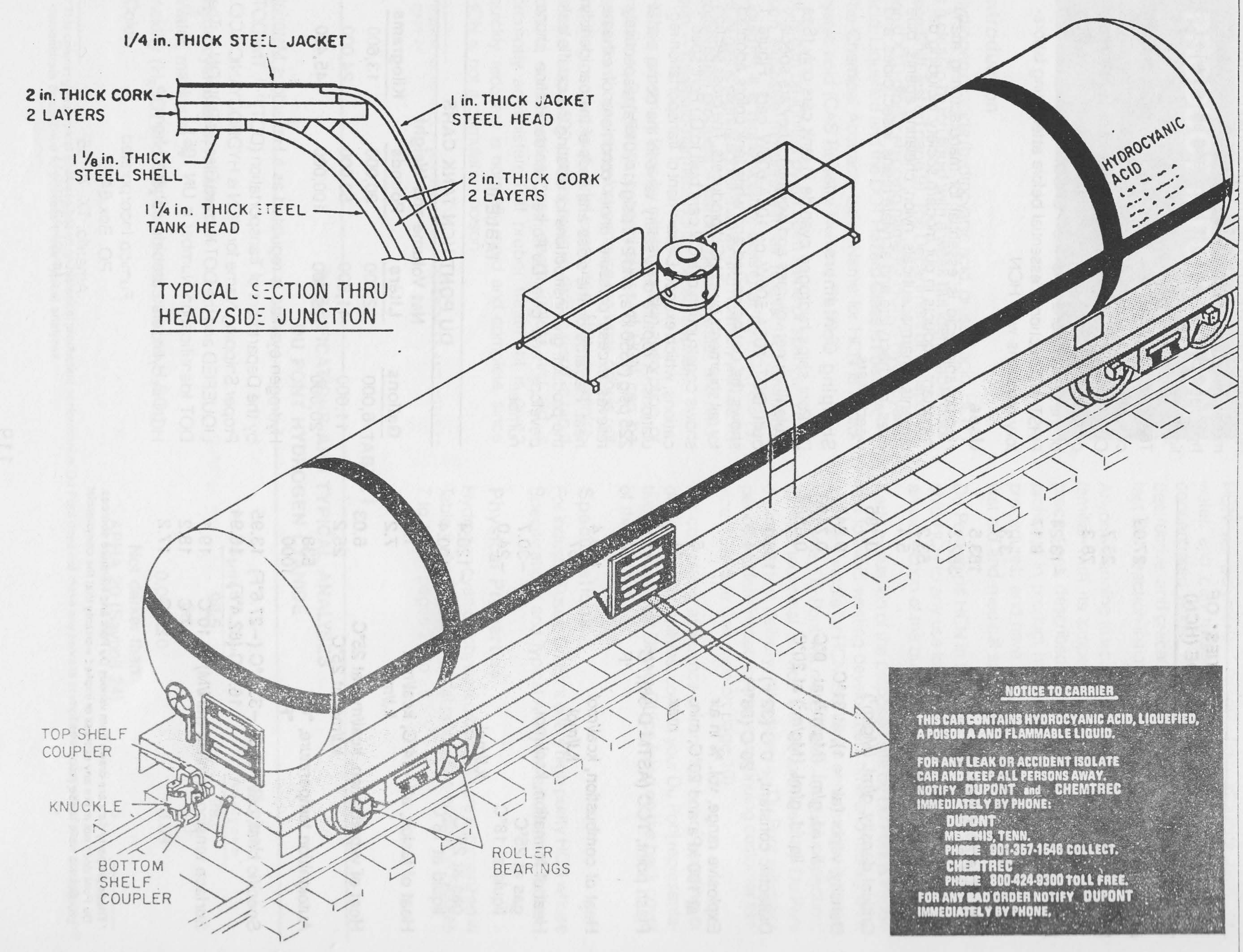
| Net Volume and Weight | | | |
|---|---|---|---|
| Gallons | Liters | Pounds | Kilograms |
| 6,000 | 22,700 | 30,000 | 13,600 |
| 11,000 | 41,600 | 53,000 | 24,000 |
| 20,000 | 75,700 | 100,000 | 45,400 |

Hydrogen cyanide is regulated as a Hazardous Material by the Department of Transportation (DOT)[1-4]. The DOT Proper Shipping Name for HCN is HYDROCYANIC ACID, LIQUEFIED and the DOT Hazard Class is POISON A. The DOT Identification Number is UN 1051.

HCN in cylinders can be purchased from:

Fumico Incorporated
P.O. Box 3459
Amarillo, TX 79106
(806) 355-6831

FIGURE 1 DU PONT HYDROGEN CYANIDE TANK CAR



# PERSONAL SAFETY AND FIRST AID

## Health Hazards

Hydrogen cyanide is a Class A poison. It is fast acting and can cause death quickly at low levels of exposure. Its toxic effect inhibits the oxidation processes in the body cells by restricting oxygen transfer from the blood to body tissues, including the heart and brain. Poisoning can result from breathing HCN fumes; absorption of hydrogen cyanide vapor or liquid through the skin, particularly the eyes, mucous membranes, and feet; and from ingestion of liquid HCN. Because of the possibility of skin absorption of HCN fumes, air monitoring for HCN is required even when wearing an air mask.

The U.S. Department of Labor (OSHA) has ruled that an employee's exposure to HCN in any 8-hour workshift of a 40-hour week shall not exceed a time-weighted average of 10 ppm HCN (10 mg/m$^3$). It also cautions that since hydrogen cyanide may penetrate the skin, control of vapor inhalation alone may not be sufficient to prevent absorption of an excessive dose[5]. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that the 10 ppm limit be treated as a ceiling value[6]. Du Pont observes the ACGIH limit and for 12-hour work shifts recommends a 5 ppm airborne exposure limit, time-weighted average.

HCN is not a cumulative poison. It is believed that there are no chronic effects from cyanide poisoning. With prompt treatment, recovery is normally quick and complete.

## Safety Precautions

The following are general precautions and procedures necessary for the safe use of HCN. Detailed procedures must be developed for each plant.

1. Do not breathe HCN gas. Use only with adequate ventilation. Carry an escape mask at all times when working in areas where exposure may occur; but carrying an escape mask is not necessarily required for merely walking through an area. A self-contained air mask is required for many operations in HCN areas and protective clothing may be required.
2. Any time you believe you are exposed to dangerous amounts of HCN, immediately call out to attract attention or call on the radio for help and to alert people that there is an HCN release. This should be done immediately because you may lose consciousness quickly.
3. Do not get HCN liquid or vapor in your eyes. Wear goggles when performing any operation such as starting a pump or turning a valve. In case of contact, immediately call for help and flush with water for at least 15 minutes. See First Aid on page 5.
4. Wear rubber gloves at all times when working on equipment, pumps, or lines. If HCN liquid is spilled onto the gloves, remove them immediately and thoroughly wash hands with plenty of water.
5. Do not get HCN on skin or on clothing. In case of contact, call for help and immediately flush the skin with large quantities of water while removing contaminated clothing. See First Aid on page 5.
6. Always check the nearest safety shower before starting any job involving HCN handling. Do not start work unless it is in satisfactory working condition.
7. Always pressure test equipment/piping before using HCN if any connections have been made or broken. Make sure no lines are plugged. Check position of all valves involved before and after each pumping.
8. Never trap liquid HCN in a confined place such as between two valves or inside valve cavities of gate, ball, or plug valves since stagnation, particularly in direct sunlight, can cause a polymerization explosion.
9. All personnel should be trained to recognize HCN poisoning and be able to administer first aid to poison victims.
10. Tanks or process vessels may not be entered without the express permission of plant supervision. Standard procedures (details not included here) for entering tanks must be followed. For all work inside HCN tanks or process vessels, a chemical safety suit must be worn unless the vessel is thoroughly decontaminated and no HCN can be detected. Persons entering must carry five-minute escape masks, and an HCN detector. Two safety men, each carrying a five-minute air escape mask, must be in attendance. One must be observing operations inside the tank. The other must be within easy call distance.
11. Protective clothing, including a rubber suit or chemical suit with breathable air supply should be worn when breaking connections in any line or equipment possibly containing HCN. A rubber or chemical suit is not required after a line has been depressurized, decontaminated, the first break made, and it is posi-

tively established that the line or equipment is not plugged and does not contain HCN.

12. When possible, work on the upwind side. Approach all HCN leaks or spills from upwind.

## Symptoms of HCN Poisoning

Personnel should be constantly alert for symptoms of cyanide poisoning in themselves and others. The following poison symptoms can result from other causes, but should be investigated promptly when they occur around cyanide:

| | |
|---|---|
| Reddening of the eyes | Nausea |
| Irritation of the throat | Headache |
| Palpitation | Weakness of arms and legs |
| Difficulty in breathing | Giddiness |
| Salivation | Collapse |
| Numbness | Convulsions |

Reddening of the eyes is one of the earliest symptoms.

## Effects of Exposure to HCN Vapor

The following toxicity data show the "Reported Human Response to Various Concentrations of HCN Vapor"[7]:

| | |
|---|---|
| 2-5 ppm | Odor threshold |
| 10 ppm | OSHA exposure limit, time-weighted average for normal 8-hour work day[8] |
| 20-40 ppm | Slight symptoms after several hours |
| 45-54 ppm | Tolerated for ½ hour to 1 hour without significant immediate or delayed effects |
| 100-200 ppm | Fatal within ½ hour to 1 hour |
| 300 ppm | Rapidly fatal (if no treatment) |

These numbers should be considered reasonable estimates since effects vary for different people, and data are not exact. These data are more conservative than some literature references. The "rapidly fatal" exposure level of 300 ppm assumes no first aid or medical treatment. Both are vey effective if used quickly.

Prompt administration of the recovery techniques outlined below has proven very effective, but emphasis must be placed on quick action. Seconds count and treatment should be provided within about 200 seconds (3-4 minutes). In case of overexposure to HCN, quick action is required to sound the alarm, remove the victim from the contaminated area, and provide treatment. With prompt treatment as prescribed, recovery is normally quick and complete with no after effects. Unlike many poisons, HCN is not cumulative in body organs. While HCN poisoning can be rapidly fatal, no case should be considered hopeless; continue treatment until a physician can certify death.

## First Aid and Medical Treatment

A. Introduction – Treatment for cyanide poisoning can be provided in two ways, "First Aid" and "Medical Treatment." Both require immediate action to prevent further harm or death. First aid using amyl nitrite and oxygen is generally given by a layman before medical help arrives. Medical treatment involves intravenous injections and must be administered by qualified medical personnel. Even if a doctor or nurse is present, the need for fast treatment dictates using first aid treatment with amyl nitrite and oxygen while medical treatment materials for intravenous injection are being prepared. Experience shows that first aid given promptly is usually the only treatment needed.

Medical treatment is given if the victim does not respond to first aid. It provides a larger quantity of antidote including sodium thiosulfate to chemically destroy cyanide in the body. However, even under optimum conditions, amyl nitrite can be administered faster and should be used even if medical treatment follows.

Always have on hand the materials listed in paragraphs B and C below. Actions to be taken in case of cyanide exposure should be planned and practiced before beginning work with cyanides. Workers should be trained to provide immediate first aid using amyl nitrite and oxygen resuscitators.

In case of cyanide poisoning, start first aid treatment immediately, then call a physician in all cases.

B. First Aid Supplies – Adequate first aid supplies should be conveniently placed throughout cyanide use areas and be immediately accessible at all times. They should be routinely inspected (typically daily) by people who would use them in an emergency. The total number of each item listed below should be adequate to handle the largest number of poison cases reasonably anticipated, taking into account that some supplies may be wasted, destroyed, or inaccessible in the emergency.

1. Amyl Nitrite Ampules (antidote) – One box of one dozen ampules per station is usually satisfactory.

   CAUTION: Unstable and must be replaced every 1 to 2 years. Store in the original dated box, and away from heat. (See paragraph B.2 for storage in resuscitator case).

2. Oxygen Resuscitators – The Flynn Series III Model by O-Two Systems has performed well in Du Pont use. It is lightweight, rugged, and easy to use.

   A common Du Pont practice is to use the resuscitator as the storage point for the amyl nitrite ampules.

3. A set of cyanide first aid instructions. Workers should be fully trained since in a real emergency there will be insufficient time to "read the book."
4. Two 1-pint bottles of 1% sodium thiosulfate solution for use in case of cyanide ingestion or plain water can be used. In many areas, the low probability of cyanide ingestion does not warrant distribution of thiosulfate.

C. Medical Supplies – Medical Supply Kits should be conveniently located for easy access by medical people. Materials for intravenous injection are intended for use only by a physician or fully qualified medical personnel. The location of kits should be carefully planned as part of the emergency pre-plan. Suggested locations for kits include:

- in or near the cyanide area
- plant medical station
- ambulance or emergency vehicle
- local hospital
- doctor's office and residence.

Kits should be accessible but secured against tampering. They should be inspected regularly and the amyl nitrite ampules replaced every 1-2 years. Medical supply kits should contain the following:

1. Two boxes, each containing one dozen amyl nitrite ampules. (See First Aid Supplies, Item 1.)
2. Two sterile ampules of sodium nitrite solution (10 mL of a 3% solution in each).
3. Two sterile ampules of sodium thiosulfate solution. (50 mL of a 25% solution in each.)
4. Two 1-pint bottles of 1% sodium thiosulfate solution (See First Aid Supplies, Item 4.)
5. One 10 mL sterile syringe. One 50 mL sterile syringe. Two sterile intravenous needles. One tourniquet.
6. One stomach tube.
7. One dozen gauze pads.
8. A set of cyanide instructions on first aid and medical treatment.

D. First Aid – Directions for Giving Amyl Nitrite Antidote and Oxygen –

1. **If Victim is Conscious:** For inhalation and/or absorption if the victim is alert, oxygen may be all that is needed. But if he is not fully conscious or shows signs of poisoning, follow paragraph D-2 below. For swallowing, see paragraph F below.
2. **If Victim is Unconscious But Breathing:** Break an amyl nitrite ampule in a cloth and hold lightly under the victim's nose for 15 seconds, repeating 5-6 times at about 15-second intervals. If necessary, repeat this procedure every 3 minutes with a fresh ampule until 3 or 4 ampules have been given. Give oxygen to aid recovery.
3. **If Victim Has Stopped Breathing:**
   a. Give artificial respiration, preferably with an oxygen resuscitator. Give amyl nitrite antidote by placing a broken ampule inside the resuscitator face piece, being careful that the ampule does not enter the victim's mouth and cause choking.
   b. If using manual artificial respiration, give amyl nitrite antidote as in paragraph D-2 above except keep the first amyl nitrite ampule under the nose until it is used up.
4. Amyl Nitrite Notes
   a. It is highly volatile and flammable; do not smoke or use around sources of ignition.
   b. If treating poison victim in a windy or drafty area, provide something – a rag, shirt, wall, drum, cupped hands, etc. – to prevent the amyl nitrite vapors from being blown away. Keep the ampule upwind from the nose. The objective is to get amyl nitrite into the victim's lungs.
   c. Rescuers should avoid amyl nitrite inhalation so they won't become dizzy and lose competence.
   d. Do not overuse. Amyl nitrite dilates the blood vessels and lowers blood pressure. Excessive use might put the victim in shock, but this has not occurred in practice at Du Pont plants and we are not aware of any death from treatment with amyl nitrite. (See paragraph H below.)

E. First Aid – Inhalation of Cyanide – Carry victim to fresh air. Lay victim down. Administer amyl nitrite antidote and oxygen (Paragraph D). Remove contaminated clothing. Keep patient quiet and warm. Call a physician.

F. First Aid – Swallowing Cyanide –

1. **If Victim is Conscious:** Immediately give patient one pint of 1% sodium thiosulfate solution (or plain water) by mouth and induce vomiting with finger in throat. Repeat until vomit fluid is clear. Never give anything by mouth to an unconscious person. Call a physician.

2. If Victim is Unconscious: Follow first aid procedure as in paragraphs D-2 and D-3 (and/or medical treatment in paragraph H) and call a physician. If the victim revives, then proceed with paragraph F-1.

G. First Aid – Skin or Eye Contact (Skin Absorption) –

1. For Eye Contact: Immediately flush with plenty of water, remove contaminated clothing, and keep victim quiet and warm. Call a physician.

2. For Skin Contact: Wash skin to remove the cyanide while removing all contaminated clothing, including shoes. Do not delay. Skin absorption can occur from cyanide vapor or liquids. Absorption takes time and its severity depends on cyanide concentration in the vapor (HCN) or liquid (HCN, NaCN, or other cyanides) and the area of skin involved.

   Follow paragraph D if treatment is needed, but even severe skin contact may not require treatment if 1) no inhalation or swallowing has occurred and 2) the cyanide is promptly washed from the skin and contaminated clothing removed. If skin contact is prolonged, nausea may follow. Even after washing the skin, the victim should be watched for at least 1 to 2 hours because absorbed cyanide can continue to work into the bloodstream. Wash clothing before reuse and destroy contaminated shoes.

H. Medical Treatment – While preparing for sodium nitrite and sodium thiosulfate injections, use amyl nitrite and oxygen as outlined in paragraph D. When ready, and if the victim is not responding to first aid, first inject the solution of sodium nitrite (10 mL of a 3% solution) intravenously at the rate of 2.5 mL/minute, then immediately inject the sodium thiosulfate (50 mL of a 25% solution) at the same rate, taking care to avoid extravasation.

This is a fairly lengthy treatment (24 minutes) since a total of 10 + 50, or 60 mL is injected at a rate of 2.5 mL/minute. Some consideration should be given to the size and condition of the victim as treatment is proceeding. It is not essential that full quantities be given just because treatment was started.

Watch patient continuously for 24-48 hours if cyanide exposure was severe. If there is any return of symptoms during this period, repeat the treatment using one-half the amounts of sodium nitrite and sodium thiosulfate solutions.

Medical treatment is normally provided by a physician, but might be provided by a professionally trained "qualified medical person" where a need exists and where state and local laws permit.

If signs of excessive methemoglobinemia develop (i.e., blue skin and mucous membranes, vomiting, shock and coma), 1% methylene blue solution should be given intravenously. A total dose of 1 to 2 mg/kg of body weight should be administered over a period of five to ten minutes and should be repeated in one hour if necessary. In addition, oxygen inhalation will be helpful. Transfusion of whole fresh blood may be considered if there has been mechanical injury with external or internal bleeding and simultaneous cyanide exposure.

Du Pont's experience in treating cyanide poison cases is that first aid procedures using amyl nitrite and oxygen were effective and the only treatment needed in most cases. Medical treatment, using intravenous injections, was used in a few cases. Both procedures have been successful.

## Personal Protective Equipment

The following safety material should be provided in all work areas where hydrogen cyanide is handled or used. The number of each item needed depends on the number of people, the area, and number of floors in the cyanide plant. Adequate types and amounts of safety and emergency equipment should be available and readily accessible in all plant areas.

**AMYL NITRITE AMPULES** – Boxes of the antidote should be readily available throughout the cyanide area. Ampules are available through local pharmacies with a doctor's prescription. Ampules should be routinely inspected and replaced every 1-2 years. Storing amyl nitrite in all resuscitators in the HCN area is desirable.

**MEDICAL TREATMENT KITS** – These kits, containing amyl nitrite ampules and medical treatment supplies for intravenous injection, should be conveniently located with adequate back-up supplies to handle the largest number of poison victims reasonably expected to need treatment. Typical storage locations include the plant medical office, plant ambulance, and the local doctor's office or hospital.

**OXYGEN RESUSCITATOR** – For administering 99.5% USP oxygen. O-Two Systems' Flynn Series III resuscitator has proven very satisfactory in emergency use.

**HCN DETECTOR (PORTABLE)** – For accurate determination of HCN concentrations from 0 to 50 ppm in air. Bendix, Draeger or MSA detectors are recommended for spot checks. MDA Scientific's "Monitox" detector has worked well for continuous testing with a portable analyzer.

**STATIONARY HCN DETECTOR/ALARM SYSTEM** – Contact Du Pont for information.

**CHEMICAL SAFETY GOGGLES**

**RUBBER GLOVES** – High quality, butyl rubber gloves are recommended to minimize leaks and HCN permeation.

**RUBBER SUIT** ("Rain Suit" or "Acid Suit") – For work where protection is desired but a full chemical suit is not necessary.

**CHEMICAL SUIT** – High quality, vapor tight chemical suit which can be used in conjunction with a back-pack air tank and mask or a remote air supply from cylinders. With a mask fed from stationary cylinders, the wearer should also be equipped with a 5-minute escape mask. A safety man should always be in attendance when using a chemical suit.

**ESCAPE MASK** – For escape use only, with 5-minute air cylinder. To carry in HCN areas with limited exits and for use with air mask and stationary air supply systems.

**AIR MASK** – For work purposes, frequently used in conjunction with chemical suit, equipped with clearview face piece, speaking diaphragm, demand regulator, 30-minute capacity air cylinder, or air supply hose from stationary cylinders.

**TWO-WAY RADIO** – To call for help and provide communications in an emergency.

**SAFETY SHOWERS** – Quick-opening safety showers conveniently located in exposure area.

**FUME HOODS** – For taking HCN process samples or for laboratory use. An efficient hood with exhaust to a safe area should be provided. (See Fig. 6 on page 21.)

**FLARE GUN AND SHELLS** – To ignite an HCN spill.

**RAILROAD FLARES** – With 15 minute burning time. To ignite an HCN spill.

**WIND SOCKS** – Located so personnel in all parts of the plant can readily determine wind direction to escape upwind or crosswind from HCN fumes.

**EMERGENCY ALARM SYSTEM** – To alert all plant personnel of an HCN release. Set off by HCN detectors and manual stations.

**OTHER MISCELLANEOUS EQUIPMENT** needed for safety and emergencies – Stretchers, blankets, emergency power and lights, any special safety equipment, maintenance tools, etc.; must be provided as required by the plant emergency plan.

# STORAGE AND HANDLING

## Precautions in Use

Flammability and Fire Fighting – Hydrogen cyanide is extremely flammable and can be ignited by an open flame, hot surface, or spark. HCN is normally stored and used in closed systems with nitrogen padding. The closed cup flash point of HCN is −17.8°C (0°F); the autoignition temperature is 538°C (1000°F). If HCN is escaping and burning, it is usually best to let it burn, while cooling the container with water. HCN combustion products, $CO_2$, $N_2$ and $H_2O$ have very low toxicity. Cool surrounding equipment with water, while the HCN continues to burn. Quench waters should be contained and detoxified with a dilute solution of calcium or sodium hypochlorite.

Explosion Hazard in Air – Explosive limits of HCN in air are 6% to 41% by volume. In closed containers above 4°C (39.2°F) the vapor pressure of HCN produces an atmosphere greater than the 41% upper explosive limit, thus minimizing the danger of explosion within the container. Optimum storage temperatures of 5-8°C (41-46.4°F), rather than lower temperatures, minimize explosion hazards. However, outside of closed containers, HCN is likely to form flammable mixtures because of its high volatility. Hydrogen cyanide vapors are slightly lighter than air, having a relative density of about 0.95.

Exothermic Reactions Under Alkaline or Heated Conditions – Addition of alkaline chemicals to hydrogen cyanide, such as NaCN, NaOH, $NH_3$, $Ca(OH)_2$, and $Na_2CO_3$, must be avoided. Alkalis promote polymerization and induce decomposition. Ammonia, a by-product of the decomposition, and heat released from the exothermic reaction induce further polymerization, and the reaction becomes autocatalytic and may cause an explosion. Polymerization/decomposition can also start from water and/or from heat. Polymerization rates increase much more rapidly if alkalinity or temperature is increased.

Exothermic Reactions Under Acidic Conditions – Although small quantities of acids and acid-forming compounds are used as stabilizers for hydrogen cyanide, the addition of large quantities of strong, concentrated acid, (over 15% by weight of concentrated sulfuric acid) can cause rapid decomposition with a large heat release. In a closed container this can cause an explosion if the temperature is not controlled. Unless adequate precautions

# E. I. du Pont de Nemours & Co. (Inc.)
# Wilmington, Delaware 19898

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DU PONT

# MATERIAL SAFETY DATA SHEET

## IDENTIFICATION

NAME
Hydrogen Cyanide

GRADE
Technical

SYNONYMS
HCN; Hydrocyanic Acid;
Prussic Acid

CAS NAME
Hydrocyanic Acid

I.D. NOS./CODES
NIOSH Registry No. MW6825000

MANUFACTURER/DISTRIBUTOR See Last Page
E. I. du Pont de Nemours & Co. (Inc.)

ADDRESS
Wilmington, DE 19898

CHEMICAL FAMILY
Cyanide

FORMULA
HCN

CAS REGISTRY NO.
74-90-8

PRODUCT INFORMATION
Phone (800) 441-9442
Medical Emergency Phone
(800) 441-3637

TRANSPORTATION EMERGENCY PHONE
Du Pont Cyanide HOTLINE
(For emergencies ONLY)
(901) 357-1546
CHEMTREC (800) 424-9300

## PHYSICAL DATA

BOILING POINT, 760 mm HG.
25.7°C (78.3°F)

SPECIFIC GRAVITY
0.69 at 18°C (64°F)

VAPOR DENSITY
0.947 (Air=1)

pH INFORMATION
Acidic; stabilized with acid

FORM
Liquid

MELTING POINT
-13.2°C (8.2°F)

VAPOR PRESSURE
750 mm Hg at 25°C (77°F)
1200 mm Hg at 38°C (100°F)

SOLUBILITY IN $H_2O$
100%

EVAPORATION RATE (BUTYL ACETATE=1)
>1

APPEARANCE
Clear

COLOR
Colorless to slightly bluish

ODOR
Bitter almond - very mild, non-irritating

## HAZARDOUS COMPONENTS

| MATERIAL(S) | APPROXIMATE % |
|---|---|
| Hydrogen Cyanide | 100% |

## HAZARDOUS REACTIVITY

INSTABILITY
Unstable with heat, alkaline materials, and water (see Polymerization below). DO NOT STORE WET HCN. May react violently with strong mineral acids. Experience shows mixtures with about 20% or more sulfuric acid will explode. Effects with other acids are unknown, so any such mixtures should be considered potentially explosive.

INCOMPATIBILITY
See Instability and Polymerization.

DECOMPOSITION
See Polymerization

POLYMERIZATION
Can occur violently in the presence of heat, alkaline materials, or moisture. Once initiated, polymerization becomes uncontrollable since the reaction is autocatalytic, producing heat and alkalinity ($NH_3$). Confined polymerization can cause a violent explosion.

## FIRE AND EXPLOSION DATA

FLASH POINT -18°C (0°F)

METHOD TCC

AUTOIGNITION TEMPERATURE
538°C (1000°F)

FLAMMABLE LIMITS IN AIR, % BY VOL.
LOWER 6
UPPER 41

AUTODECOMPOSITION TEMPERATURE
See Polymerization

FIRE AND EXPLOSION HAZARDS
Extremely flammable.

EXTINGUISHING MEDIA
Allow escaping HCN to burn, if practical. Since HCN is highly toxic, it is usually safer to let it burn to non-toxic $CO_2$ and $N_2$. If necessary, water may be used to extinguish fires.

SPECIAL FIRE FIGHTING INSTRUCTIONS

Cool tanks with water to avoid violent polymerization/decomposition, but allow escaping HCN to burn if practical. Stay upwind. Consider downwind evacuation. Wear chemical suit with breathing air supply; avoid contact with liquid or vapor. If HCN is escaping, quench waters should be contained and detoxified with a dilute calcium or sodium hypochlorite solution.

## HEALTH HAZARD INFORMATION

PRINCIPAL HEALTH HAZARDS (Including Significant Routes, Effects, Symptoms of Over-Exposure, and Medical Conditions Aggravated by Exposure)

May be fatal if inhaled, swallowed, or absorbed through the skin. Extremely hazardous liquid and vapor under pressure.

Inhalation 5 minutes LC50: 484 ppm in rats
Oral ALD: 10 mg/kg in rats

Hydrogen Cyanide is a fast acting, highly poisonous material. Toxic effects described in animals from exposure include asphyxia, dyspnea, ataxia, tremors, coma, and cardiac abnormalities. Tests in animals demonstrate no carcinogenic activity.

Human health effects of overexposure may initially include: nonspecific discomfort, such as nausea, headache, dizziness, vomiting, and weakness. Higher exposures may lead to these effects: rapid respiration; lowered blood pressure; unconsciousness; and fatality from overexposure. Evidence suggests that skin permeation can occur in amounts capable of producing the effects of systemic toxicity. There are no reports of human sensitization. Epidemiologic studies do not demonstrate a significant risk of human cancer from exposure to this compound. Individuals with preexisting diseases of the central nervous system may have increased susceptibility to the toxicity of excessive exposures.

CARCINOGENICITY

HCN is not listed as carcinogenic by IARC, NTP, OSHA, ACGIH or Du Pont.

EXPOSURE LIMITS (PEL (OSHA), TLV (ACGIH), AEL (DU PONT), ETC.)

The OSHA 8-hour Time Weighted Average (TWA) is 10 ppm, 11 mg/m$^3$. The ACGIH TLV® - TWA is 10 ppm, 10 mg/m$^3$ (ACGIH recommends this be used as a ceiling value). Both OSHA and ACGIH carry a "skin" notation indicating that HCN may penetrate the skin; therefore, control of vapor inhalation alone may not be sufficient to prevent cyanide poisoning. The Du Pont AEL is 10 ppm - 8 hour TWA, 5 ppm - 12 hour TWA.

SAFETY PRECAUTIONS

Emergency pre-planning and training is needed before beginning to work with hydrogen cyanide since prompt treatment is essential in cases of cyanide poisoning. Use HCN detectors and have Cyanide Antidote Kits on hand.

Do not breathe vapor. Do not get in eyes, on skin, on clothing. Wash thoroughly after handling.

NEVER WORK ALONE-

PERSONS DOING PHYSICAL OPERATING AND MAINTENANCE WORK WITH HCN-EQUIPMENT SHOULD USE THE BUDDY SYSTEM AND NEVER WORK ALONE. Always have at least two people on the job, both (all) trained for HCN work. While one performs the task, the other observes from upwind or crosswind, far enough away (20-30 ft; 6-9 m) so that in the event of an HCN release, the observer will not be overcome and can start alarm and rescue procedures. Both should have the same personal safety equipment, and the observer should have a working two way radio or P.A. system for calling help in an emergency. Both should be well trained in cyanide first aid and emergency procedures (refer to the Du Pont Hydrogen Cyanide Storage and Handling bulletin for more information).

FIRST AID AND MEDICAL TREATMENT

Actions to be taken in case of cyanide exposure should be planned and practiced before beginning work with cyanides. In most cases, cyanide poisoning causes a deceptively healthy pink to red skin color; however, if a physical injury or lack of oxygen is involved, the skin color may be bluish.

Treatment for cyanide poisoning can be provided in two ways, "First Aid" and "Medical Treatment". Both require immediate action to prevent further harm or death. First aid using amyl nitrite and oxygen is generally given by a layman before medical help arrives. Medical treatment involves intravenous injections and must be administered by qualified medical personnel. Even if a doctor or nurse is present, the need for fast treatment dictates using first aid treatment with amyl nitrite and oxygen while medical treatment materials for intravenous injection are being prepared. Experience shows that first aid given promptly is usually the only treatment needed.

Medical treatment is given if the victim does not respond to first aid. It provides a larger quantity of antidote including sodium thiosulfate to chemically destroy cyanide in the body. However, even under optimum conditions, amyl nitrite can be administered faster and should be used even if medical treatment follows.

Amyl nitrite and medical treatment kits for cyanide poisoning are available, with a doctor's prescription, from pharmacies.

A. <u>FIRST AID - DIRECTIONS FOR GIVING AMYL NITRITE ANTIDOTE AND OXYGEN</u>

1. <u>CONSCIOUS</u>: For inhalation and/or absorption if the victim is alert, oxygen may be all that is needed. But if he is not fully conscious or shows signs of poisoning, follow paragraph A-2 next page. For swallowing, see next page paragraph C, FIRST AID - SWALLOWING CYANIDE.

2. UNCONSCIOUS BUT BREATHING: Break an amyl nitrite ampule in a cloth and hold lightly under the victim's nose for 15 seconds, then take away for 15 seconds. Repeat 5-6 times. If necessary, use a fresh ampule every 3 minutes until the victim regains consciousness (usually 1-4 ampules). Give oxygen to aid recovery.

3. NOT BREATHING:
a. Give artificial respiration, preferably with an oxygen resuscitator. Give amyl nitrite antidote by placing a broken ampule inside the resuscitator face piece, being careful that the ampule does not enter the victim's mouth and cause choking.
b. If using manual artificial respiration, give amyl nitrite antidote as in paragraph A-2 above except keep the first amyl nitrite ampule under the nose with replacement every 3 minutes.

4. AMYL NITRITE NOTES:
a. Amyl nitrite is highly volatile and flammable; do not smoke or use around source of ignition.
b. If treating poison victim in a windy or drafty area, provide something - a rag, shirt, wall, drum, cupped hands, etc. - to prevent the amyl nitrite vapors from being blown away. Keep the ampule upwind from the nose. The objective is to get amyl nitrite into the victim's lungs.
c. Rescuers should avoid amyl nitrite inhalation so they won't become dizzy and lose competence.
d. Do not overuse. Amyl nitrite dilates the blood vessels and lowers blood pressure. While excessive use might put the victim in shock, this has not occurred in practice at Du Pont plants and we are not aware of any death from treatment with amyl nitrite. (See next page, paragraph E, MEDICAL TREATMENT).

B. FIRST AID - INHALATION OF CYANIDE

Carry victim to fresh air. Lay victim down. Administer amyl nitrite antidote and oxygen (Paragraph A). Remove contaminated clothing. Keep patient quiet and warm. Call a physician.

C. FIRST AID - SWALLOWING CYANIDE

1. CONSCIOUS: Immediately give patient one pint of 1% sodium thiosulfate solution (or plain water) by mouth and induce vomiting with finger in throat. Repeat until vomit fluid is clear. Never give anything by mouth to an unconscious person. Call a physician.

2. UNCONSCIOUS: Follow first aid procedure as in paragraphs A-2 and A-3 (and/or medical treatment in paragraph E) and call a physician. If the victim revives, then proceed with paragraph C-1.

D. FIRST AID - SKIN OR EYE CONTACT (SKIN ABSORPTION)

1. EYE CONTACT: Immediately flush eyes with plenty of water, remove contaminated clothing, and keep victim quiet and warm. Call a physician.

2. SKIN CONTACT: Wash skin to remove the cyanide while removing all contaminated clothing, including shoes. Do not delay. Skin absorption can occur from cyanide dust, solutions, or HCN vapor. Absorption is slower than inhalation, usually measured in minutes compared to seconds for inhalation.

Follow paragraph A if treatment is needed, but even severe skin contact may not require treatment if: 1) no inhalation or swallowing has occurred and 2) the cyanide is promptly washed from the skin and contaminated clothing removed. If skin contact is prolonged, HCN poisoning may occur with nausea, unconsciousness, and then death possible if source of cyanide intake is not removed and treatment provided. Even after washing the skin, the victim should be watched for at least 1-2 hours because absorbed cyanide can continue to work into the bloodstream. Wash clothing before reuse and destroy contaminated shoes.

E. MEDICAL TREATMENT

Medical treatment is normally provided by a physician, but might be provided by a professionally trained "qualified medical person" where a need exists and where state and local laws permit.

While preparing for sodium nitrite and sodium thiosulfate injections, use amyl nitrite and oxygen as outlined in paragraph A. When ready and if the victim is not responding to first aid, first inject the solution of sodium nitrite (10 mL of a 3% solution) intravenously at the rate of 2.5 mL/minute, then immediately inject the sodium thiosulfate (50 mL of 25% solution) at the same rate, taking care to avoid extravasation.

This is a fairly lengthy treatment (24 minutes) since a total of 10 + 50, or 60 mL is injected at a rate of 2.5 mL/minute. Consideration should be given to the size and condition of the victim as treatment is proceeding. It is not essential that full quantities be given just because treatment was started. Injections can be stopped at any point if recovery is evident.

Watch patient continuously for 24-48 hours if cyanide exposure was severe. If there is any return of symptoms during this period, repeat this treatment using one-half the amounts of sodium nitrite and sodium thiosulfate solutions. Caution should be used to avoid overuse of medical treatment chemicals as the prescribed dose is about 1/3 the lethal dose for an average individual.

If signs of excessive methemoglobinemia develop (i.e., blue skin and mucous membranes, vomiting, shock and coma), 1% methylene blue solution should be given intravenously. A total dose of 1 to 2 mg/kg of body weight should be administered over a period of five to ten minutes and should be repeated in one hour if necessary. In addition, oxygen inhalation will be helpful. Transfusion of whole fresh blood may be considered if there has been mechanical injury with external or internal bleeding and simultaneous cyanide exposure.

Du Pont's experience in treating cyanide poison cases is that first aid procedures using amyl nitrite and oxygen were effective and the only treatment needed in most cases. Medical treatment, using intravenous injections, was used in a few cases. Both procedures have been successful.

## PROTECTION INFORMATION

### GENERALLY APPLICABLE CONTROL MEASURES

Use only in closed systems and with ventilation adequate to keep vapor concentrations below exposure limits. Evacuate area immediately if HCN fumes are detected and put on protective clothing before re-entry. Open construction is usually best for HCN processes.

### PERSONAL PROTECTIVE EQUIPMENT

Recommended Minimum Protection - chemical splash goggles and rubber gloves (butyl or neoprene preferred). Have available and use as appropriate*:

- Rubber suits and boots
- Full-body chemical suit
- Self-contained breathing air supply
- HCN detector
- First aid and medical treatment supplies, including oxygen resuscitators.

*This is only a partial list. See Du Pont Hydrogen Cyanide Storage and Handling bulletin for more information.

## DISPOSAL INFORMATION

### AQUATIC TOXICITY

The compound is extremely toxic (96 hr. LC50 = < 0.5 mg/l). 96 hour LC50, fathead minnows: 0.157mg/l.

### SPILL, LEAK OR RELEASE

Stay upwind. Evacuate area until gas has dispersed. Set on fire if conditions warrant. Dike spill. Flush with water spray to waste water treatment system. Wear full protective clothing with breathing air supply. Comply with Federal, State and local regulations on reporting releases.

### WASTE DISPOSAL

Comply with Federal, State, and local regulations. Burning will detoxify.

## SHIPPING INFORMATION

**DOT (172.101)**

PROPER SHIPPING NAME Hydrocyanic Acid, Liquified

HAZARD CLASS Poison A
NA NO. 1051

DOT LABEL(S) Poison Gas
Flammable Gas

DOT PLACARD (TT/TC)
Poison Gas

**DOT/IMO (172.102)**

PROPER SHIPPING NAME Hydrogen Cyanide, Anhydrous, Stabilized

HAZARD CLASS Poison A, 6.1

UN NO. 1051

SUBSIDIARY RISK
Flammable Liquid

FLASH POINT
-18°C

## OTHER INFORMATION

REPORTABLE QUANTITY 10 lb/4.54 kg

SHIPPING CONTAINERS *
Railroad tank cars

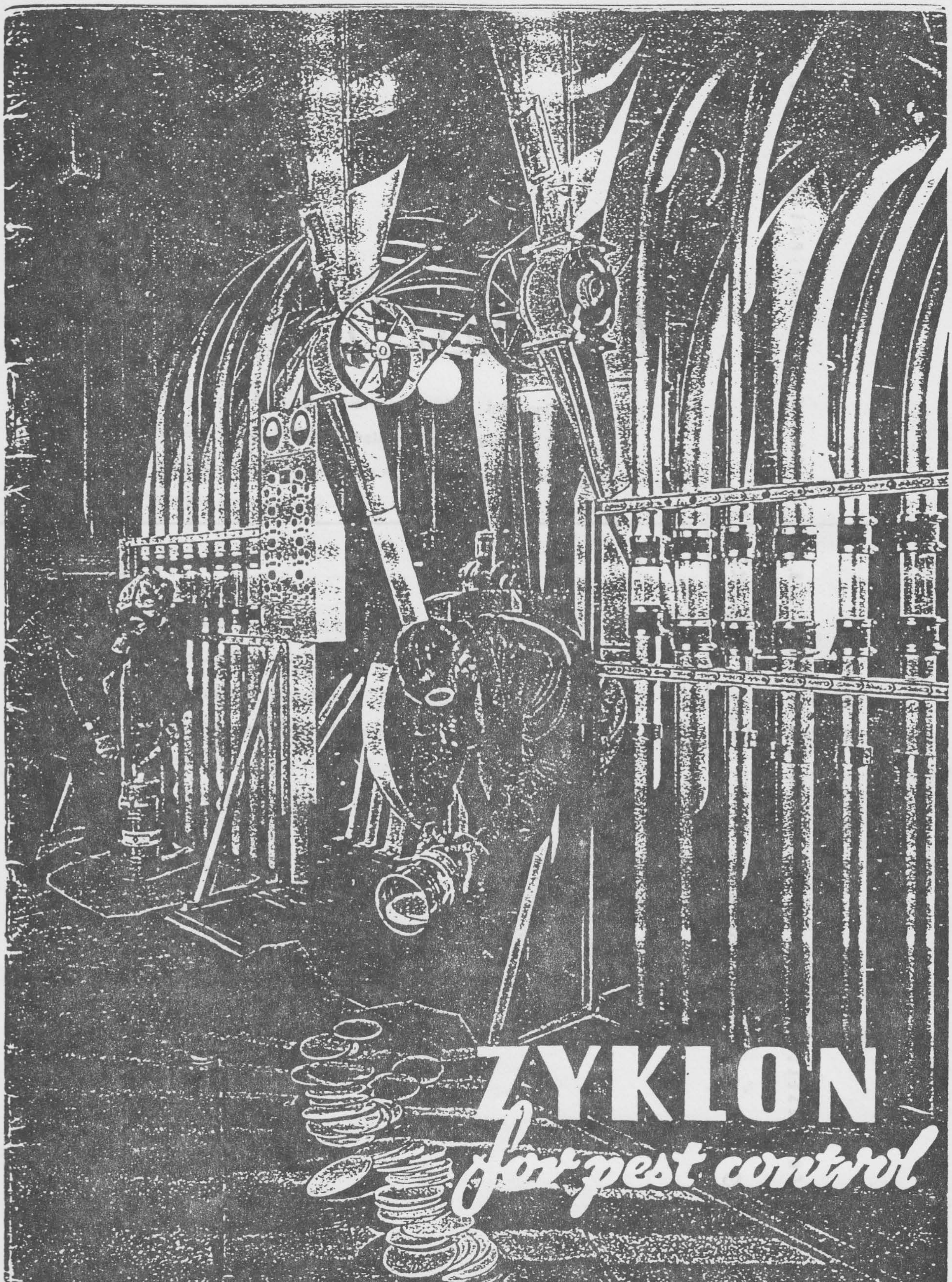
STORAGE CONDITIONS
Store only high quality, dry, HCN unless careful monitoring is done. Keep away from heat, sparks, and flame and do not contaminate. Keep container closed and use only in a closed system.

## ADDITIONAL INFORMATION AND REFERENCES

For further information, see Du Pont Hydrogen Cyanide, Storage and Handling bulletin.

DATE OF LATEST REVISION/REVIEW: 6/85
PERSON RESPONSIBLE FOR MSDS: J. C. WATTS, Du Pont Co., C&P Dept., Chestnut Run, Wilmington, DE 19898, (302) 999-4946

* **HCN in cylinders can be purchased from:**
Fumico Incorporated
P. O. Box 3459
Amarillo, Texas 79116
(806) 355-6831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32/40 Weismüllerstrasse - DG10 Frankfurt

# ZYKLON

DEGESCH

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## INTRODUCTION

Experience has shown that highly effective gases are essential for pest control – in particular for protecting stores and for plant quarantine. All signs indicate that this will remain so for an indefinite period. Realizing the necessity for keeping food and raw materials free from pests, a quick and efficient method had to be devised which required only one application. One of the very few important fumigants suitable for pest control in confined spaces is hydrocyanic acid. Most commodities can be treated with this without causing harm (even living plants, under certain conditions). It is simple to detect the presence of hydrocyanic acid, even at extremely low concentrations. As long as 80 years ago it was recognized that hydrocyanic acid could be useful in pest control but it took half this time to popularize the method. Deficiencies and disadvantages had first of all to be eliminated from the method of application.

First this had been done in such a way that hydrocyanic acid was no more developed on the spot by mixing cyanides and acid, but this process already took place in the factory: The so-called "pot method" was replaced by liquid hydrocyanic acid. The few deficiencies of this procedure were removed in the early twenties by the ZYKLON method: One added liquid HCN to a "carrier substance", thus simplifying handling whilst all favourable properties of liquid HCN were maintained. At the same time, danger to the operator was reduced to a minimum. Hydrocyanic acid in the form of ZYKLON can be safely stored for considerable periods and under all climatic conditions, any quantity of gas can be easily measured, quickly and cleanly released. Any residues are completely harmless.

## HYDROCYANIC ACID

In conjunction with its favourable chemical and physical properties hydrocyanic acid is very popular as a fumigant. This is due to its radical effect on nearly all insects, including eggs, larvae and pupae – e. g. in stored products, dwellings, etc. – and on all rodents such as rats and mice in ships, warehouses, etc.

### Chemical and Physical Properties

The chemical and physical properties of hydrocyanic acid are: –

| | |
|---|---|
| Chemical formula: | HCN |
| Molecular weight: | 27 |
| Evaporations: | 246 cal/0°C (32°F) |
| Boiling point: | 25.6°C (78°F) |
| Freezing point: | –14.8°C (5°F) |
| Density of liquid HCN: | 0.687 (20°C) (68°F) |
| Density of gaseous HCN: | 0.969 (30°C) (86°F) |
| Weight per litre of gaseous HCN: | 1.20 grammes |
| Vapour pressure: | 177 mg Hg (=3.4 lb/sq. in.) at 30°C (=86°F) |

HCN is colourless and has a slight but distinct odour.
The following conversion table should be observed when applying gaseous hydrocyanic acid for fumigation purposes: –

| | |
|---|---|
| 1 g/m³ | = 1 oz/1000 cu. ft. |
| | = 0.083 vol-% |
| | = 833 ppm (parts per million) |
| 1 lb/1000 cu. ft. | = 16 g/m³ |
| 1 vol-% | = 12 g/m³ |
| 1 ppm | = 0.0012 g/m³ |

**Stability**

Liquid **pure** HCN is very unstable for which reason only **stabilized** hydrocyanic acid is marketed. Weak acids or substances splitting off acids are used as stabilizers. Absorption in porous materials also has a stabilizing effect.

**Inflammability**

Liquid HCN burns like alcohol. Gaseous HCN forms an explosive mixture with air under certain conditions. The lower explosion limit, however, lies far above the concentration used in practical fumigation work.

**Chemical Compatibility**

Hydrocyanic acid dissolves very readily in water. Compared with liquid hydrocyanic acid, the gas is chemically very indifferent, and even in highly concentrated form under prolonged exposure it does not show a tendency to react with other substances. In consequence, it is harmless to wood, polished articles lacquers, as well as to dry foodstuffs. Weak concentrations of HCN are harmless to metals. In case of high relative humidity of air, it may happen that blank-polished surfaces of metal get tarnished, particularly in case of somewhat higher concentrations of gas. Experience over many years has also shown that neither the processing of raw materials (e.g. flour, brewing barley, tobacco, cocoa) nor the flavour of processed articles (e.g. pastries dried fruit, cigarettes) are affected; only roasted coffee and tea should never be treated with HCN. (Raw coffee, however, can be treated.)

**Penetration and Sorption**

A major contributory factor to successful treatment is the great penetrative power of hydrocyanic acid; this is valid for the treatment of packed commodities as well as for space fumigation. HCN is very volatile and therefore commodities and also whole buildings can easily be aerated. Even if dampness retains some residues, the volatility of the gas will ensure its rapid dispersal. The chemical indifference prevents, for instance, the formation of other poisonous substances from any possible absorbed residues.

## Toxicity

No thoroughly effective pesticide is known to exist which could be considered to be harmless to human beings or mammals.

Fatal concentrations of HCN impede or completely cut off the oxygen supply to the cells. The poison can enter the body in three ways: through the mouth, the respiratory organs, or the pores of the skin. The latter will occur in particular if the body is exposed to a high concentration for any length of time and in unfavourable conditions (great heat).

## Protection against Hydrocyanic Acid

The use of gas-masks, which in no case should have exhaust valves, during fumigation operations is absolutely essential. A gas-mask must be worn whenever there is a risk of gas being inhaled, particularly during the process of gassing or ventilation, or in the event of leakages.

Each operator must carry two well-fitting gas masks (one as a spare if the other should fail to function), also two special canisters giving protection against hydrocyanic acid with irritants. It is highly dangerous to use any other type of canister than those specially marked.

The capacity of a canister is limited, as its chemical filling can absorb only a small quantity of gas. Therefore, several canisters must always be on hand. A slight smell of gas or irritation of the eyes or the nose indicates that the canister is exhausted and needs replacing. This must, of course, be done in the open air. A fresh canister must be used in gas-free air for at least 2 minutes before it is used in gas-filled rooms, since it will not absorb gas before the chemical filling has become moist.

When working with fumigation chambers, it is not necessary to wear a gas-mask, as these chambers are equipped with special devices obviating a contact of the operator with the gas.

## Method of Detecting Hydrocyanic Acid

On account of the extreme toxicity of hydrocyanic acid, combined with its solubility in water, even traces of the gas can prove fatal. It is, therefore, of the utmost importance that premises and their contents be thoroughly aired before they are reoccupied. Many tests are recommended or officially prescribed to confirm that no dangerous traces of gas stay behind. The most reliable test is a chemical one. It is quite objective, simple to prepare and to use, and is sensitive to concentrations of HCN lower than the minimum that can be tolerated by man.

The so-called "copper acetate/benzidene acetate test" will determine a concentration of the gas of 15 mg/m³ (= 0.015 oz/1000 cu. ft.), while the concentration tolerated by human beings is 50 mg/m³ (0.05 oz/1000 cu. ft.). In ordinary fumigation work the concentrations are 1 to 30 g/m³ (= 1 to 30 oz/1000 cu. ft.).

Two solutions are needed for this test: –

Solution I: Dissolve 2.86 g (= 0.1 oz) of cupric acetate – $Cu(C_2H_3O_2) \cdot 2\,H_2O$ – in distilled water and dilute to 1 litre (1 3/4 pints).

Solution II: Dilute 475 ml of a saturated benzidine acetate solution with 525 ml of distilled water. If benzidine acetate is not available, dissolve 0.43 g (= 0.015 oz) benzidine in 100 ml distilled water and add 0.6 ml acetic acid.

Solution II is somewhat unstable and must therefore be protected from light and kept in a brown bottle. If precipitation or turbidity is observed, it means that the solution has deteriorated and must be replaced.

Equal parts of both solutions are mixed shortly before use. It is advisable not to mix larger quantities than needed as the mixture is very unstable.

The lower part of a strip of filter paper is dipped into the mixed reagent and excess moisture shaken off. In contact with hydrocyanic acid the test paper will show a colour varying from a very faint to an intense blue, indicating a lower or higher concentration, respectively.

The gas-test outfit contains a scale of colours: –

1) intense blue means dangerous
2) ordinary blue means less dangerous, but not allowed for release
3) pale blue means not dangerous.

To prove the efficiency of the reagent a freshly prepared test paper is inserted into the test tube provided with the gas-test outfit for 10 seconds. This tube contains a salt which develops traces of hydrocyanic acid; the colour of the test paper will thus indicate whether a solution is fit for use or not.
For the test proper, another strip of test paper is briefly immersed in the reagent and then taken into the room (or commodities) to be examined for gas, inside a stoppered tube or vial. It is then taken out, exposed in some place where traces of gas are most likely to be found, e. g. in bedding and the like. The colour assumed by the test paper at the end of 10 seconds is then compared with the colour scale, and if this reveals a still dangerous concentration, the room or commodity must be aired for at least another two hours. Then the test must be repeated with a freshly prepared strip of test paper and in the manner mentioned above. If the paper still shows a blue tint, the airing must be continued for another two hours.
Where air contains other oxidizing elements, such as chlorine or nitrogen oxide, the method described above is of no avail.

**Poisoning and Antidotes**

The first stage of poisoning manifests itself in increasing local irritation of the mucous membrane of eyes, throat or upper respiratory tract, burning sensation on the tongue, peculiar metallic and irritant taste in the mouth. The exhaled breath smells of hydrocyanic acid; there is a sensation of pressure in the forehead, general oppression, giddiness, disturbed equilibrium, stabbing pains in the head, nausea, vomiting, tenesmus. Respiration quickens at first and deepens later on; it is accompanied by a rush of blood to the head and by palpitation of the heart.
There follows an asthmatic stage, convulsive in character, and, finally, an asphyctic stage. Death takes place if the patient cannot be treated in time.

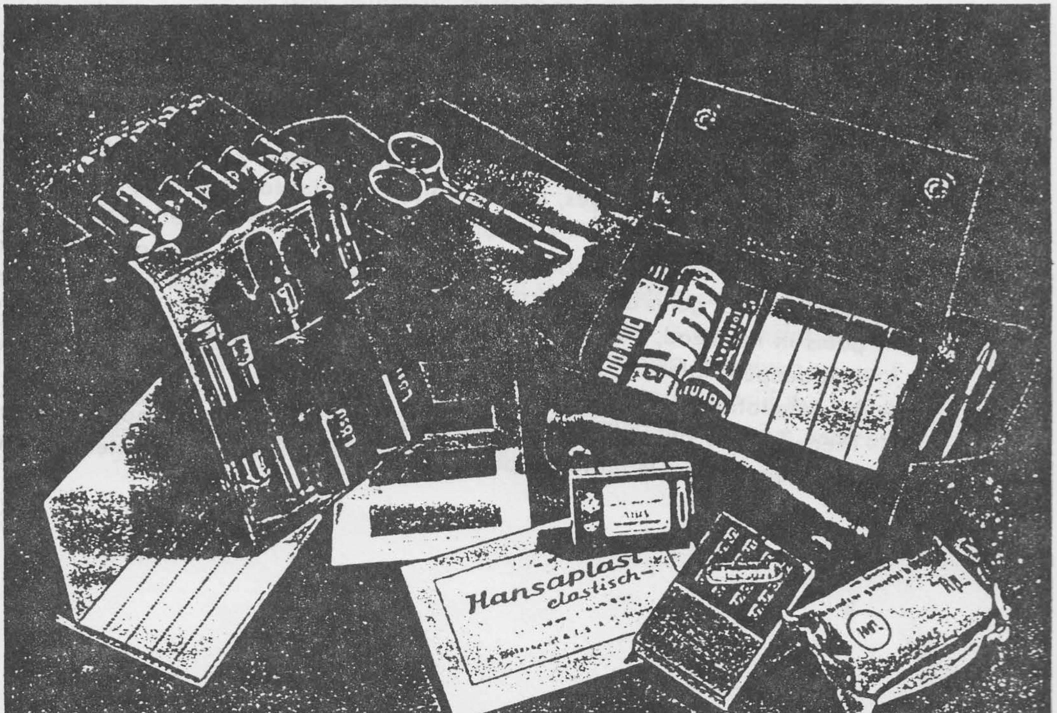
If the quantity of gas is very small, the body itself can convert it into harmless compounds. So far no clear case of chronic poisoning is on record.

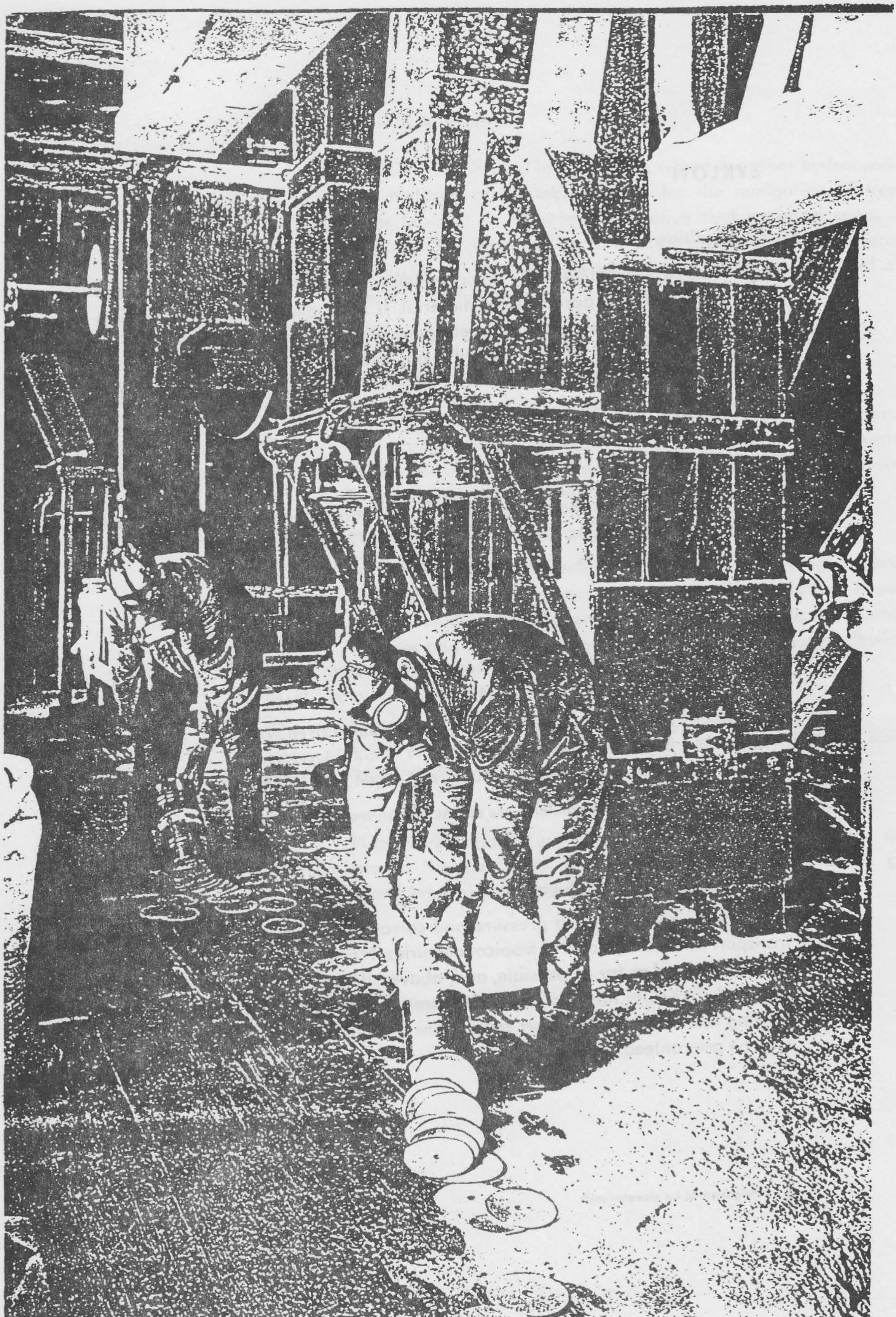
As soon as the first stage of poisoning is observed, the most important thing is to remove the patient from the gas infected area into fresh air, away from all traces of gas. Moreover, the respiration and heart action must be stimulated to the greatest possible extent in order to accelerate conversion of the gas. The patient must be treated immediately. He should be kept warm and a doctor called.

An ampoule containing amyl nitrite and wrapped in a cloth should be broken and held in front of the patient's nose for 15 seconds. This is to be repeated five times at intervals of 15 seconds.

Injections of stimulants, such as lobeline or caffeine, will be very useful. On no account should camphor be injected. Information on other anti-toxi measures can be obtained from health authorities, but their application must be left to a doctor. Should the patient lose consciousness, artificial respiration must be applied in the usual way and not be interrupted under any circumstances, a point to be borne in mind where the poisoned person must be taken to a hospital. Non-observation of this important rule may lead to death.

Gas-test and first-aid outfits.





## ZYKLON

### Composition

In ZYKLON pure (98 %–99 %) liquid hydrocyanic acid is chemically stabilized and absorbed in a porous, inert material. It is supplied in snippets or discs prepared from wood pulp. Snippets generally are preferred as in view of their larger surface they give off the gas more rapidly. Upon request also discs can be supplied. The absorbent material can easily be collected at the end of the fumigation.

### Packing

ZYKLON is packed in handy, gas-tight tins of various sizes which are packed in strong wooden cases. One case, measuring 72 x 50 x 36 cm (= 0.130 $m^3$ or 4.59 cu. ft.), contains: –

| | |
|---|---|
| Imperial units | 16 tins, each containing 40 ozs. HCN – total 40 lbs HCN or |
| | 30 tins, each containing 16 ozs. HCN – total 30 lbs HCN |
| Metric units | 12 tins, each containing 1500 g HCN – total 18 kg HCN or |
| | 16 tins, each containing 1000 g HCN – total 16 kg HCN or |
| | 30 tins, each containing 500 g HCN – total 15 kg HCN |

Upon special request smaller sizes of tins will be manufactured.

### Storage and Storage Stability

The tins are so resistant to pressure and corrosion that they will be safe for transport and storage also in tropical countries. Nevertheless, the store should be dry and cool as far as possible, and, above all, well ventilated and locked. Although ZYKLON tins can safely be stored for many years, because of the existing international transport regulations a storage time of only one year may be guaranteed.



◀ Fumigation of an elevator mill.

## Fields of Application

ZYKLON can be used in all spheres where the other hydrocyanic acid methods are suitable, except for the fumigation of trees under tents. It is, however, imperative that a closed space is available. For instance, two operators are required for an area of 350,000 cu. ft. With adequate organisation, buildings of all sizes can be fumigated.

The individual fields of application are as follows: –

**Protection of Stores:** Destruction of pests in mills, food factories, cold storage, textile factories, tobacco processing factories, warehouses for any type of commodity, goods waggons, cargo boats for transoceanic traffic and inland navigation.

**Protection of Health:** Destruction of pests in dwellings, railway carriages, passenger and cargo boats – in the latter, in particular, for the regular destruction of rats –, further, irradication of foxes and badgers in their burrows for fighting rabies (hydrophobia).

**Protection of Materials:** Treatment of museums, collections, libraries, churches, etc.

**Plant Quarantine:** Fumigation of nursery products, seeds and plants, flowers, fruits and young vines, in particular, in gas chambers which are equipped with a circulatory system.

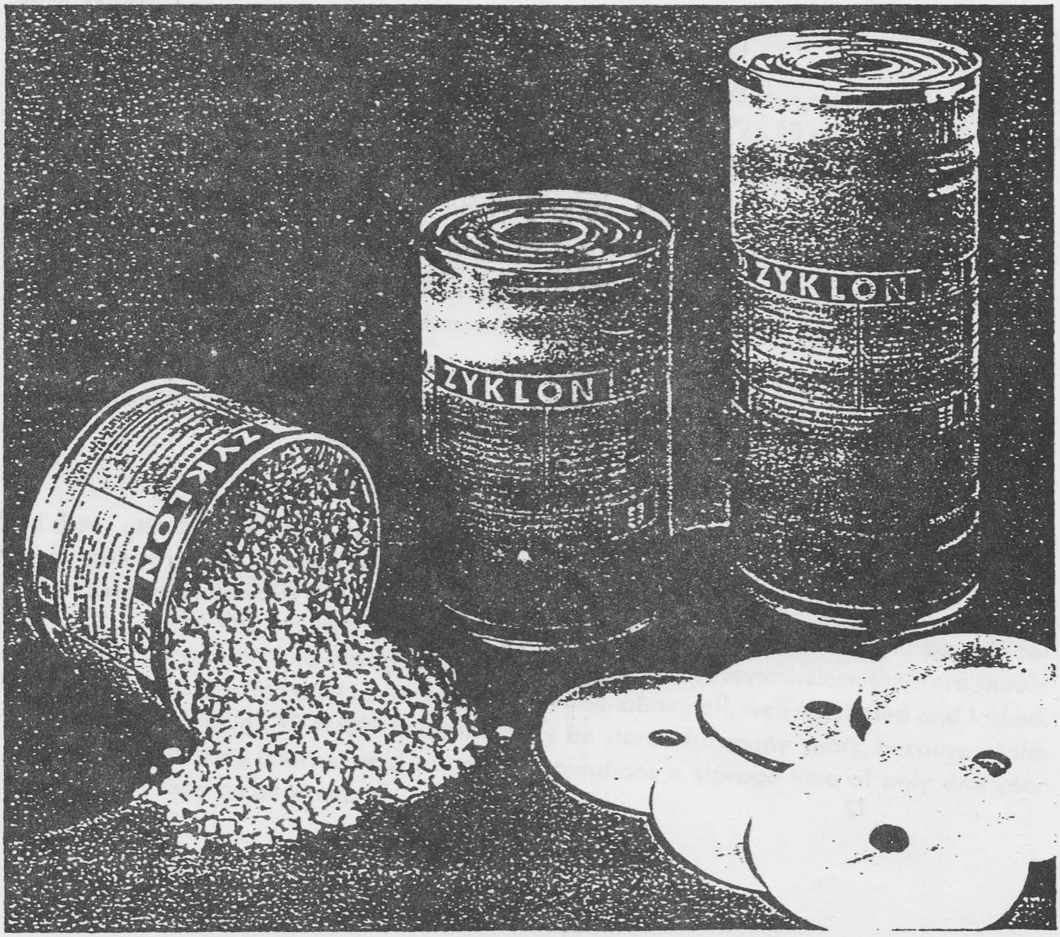
## Preparation for Fumigation with ZYKLON

For practical purposes, a close inspection of the premises to be fumigated and their immediate surroundings should precede the actual preparatory work. In particular, it should be ascertained, which types of pests have to be dealt with, when fumigation is to take place, what preparation has to be made by the client.

Full co-operation with the client facilitates the whole fumigation procedure from the preparation to the successful conclusion.

It is essential to ascertain the cubic capacity of the premises to be fumigated so that the required quantity of ZYKLON can be made available. Only the outside measurements are decisive even if the premises are empty.

ZYKLON tins with the gas-impregnated material: Snippets and discs.



Gassing of a fox burrow

Gassing of bagged raw coffee

The building to be fumigated must be sealed so as to retain an adequate gas concentration for the required time. It is made gas-tight by closing and/or sealing all doors, windows and other openings leading to the open air (chimneys, fans, exhausts, air-flaps, conveyor devices, loading platforms, etc.).

In order to accelerate diffusion of the released gas, closed machines, elevators, conveyor belts and worms are to be opened, tightly packed commodities or stacked sacks unstacked, clothes and bed clothes spread out in dwellings, wardrobes and drawers opened, etc.

The following have to be removed from rooms: –

Pets and domestic animals, living plants, moist and fatty foodstuffs which are not stored in closed containers, tea and roasted coffee, undeveloped films, fresh fruit and vegetables, finally also aqueous liquids in open containers.

## Safety Measures

As in the case of all substances containing or generating hydrocyanic acid, ZYKLON should be handled only by persons with extensive training, thorough knowledge of its properties and experience in its application. Many countries have issued official regulations for the method of application to be adopted and these are to be followed in principle. Generally speaking, attention should be paid to the following: –

As long as there is any possibility of hydrocyanic acid being present or developing, one person should never work on his own – except when doing chamber fumigation (see page 25). From the moment the tins are opened until the fumigated rooms are available again for reoccupation, a well-fitting mask equipped with the special HCN filter should be on hand and put on when necessary.

In some countries, as e. g. in Germany or England, it is necessary to evacuate rooms adjacent to those to be fumigated. However, e. g. in Italy, Sweden, etc., regulations are not so strict. In any case, windows in these adjacent rooms must be left open.

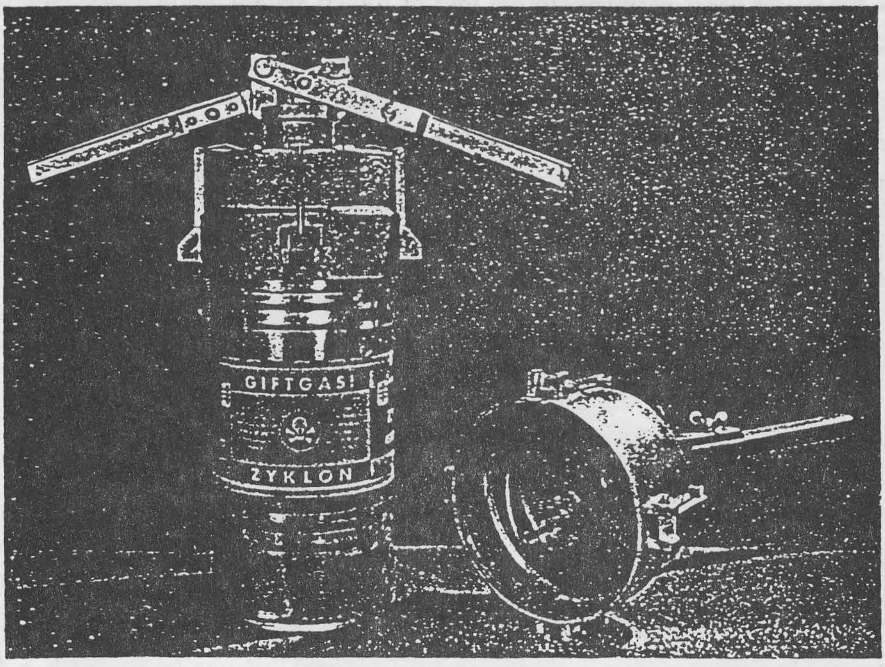
Signs warning unauthorised persons of the danger should be posted at all approaches.

## Development of Hydrocyanic Acid from ZYKLON

The tins containing ZYKLON are opened by means of the „DEGESCH tin opener". It works quickly, and the cut is clean. Once a tin is opened, its contents should be used up in one operation. If it has to be distributed over several small rooms, the tin can be closed again for short periods with a rubber cap. The contents of the tin – snippets or discs – is shaken out preferably on sheets of paper or old sacks, so as to protect the floor, if necessary (see front-cover). Each disc approximately contains the same quantity of hydrocyanic acid. Therefore, it is possible to give exact dosages also in small rooms, such as e. g. ships' cabins.

Hydrocyanic acid absorbed in the carrying material develops without any auxiliaries, such as warmth, pressure, etc.; of course warmth accelerates the action, but as a rule rooms need not be pre-heated. If time is limited, a short pre-heating renders the insects more susceptible to the gas, speeds up generation, and leads to quicker results.

DEGESCH tin opener



## Concentration and Time of Exposure

Various types of pests react differently to hydrocyanic acid. Rodents can be killed with only 1.2 g/m³, larder (bacon) beetles require twenty times as much. Times of exposure also vary greatly, i.e. from 2 to 72 hours. The various types of pests, small leakages in rooms, unfavourable weather conditions, difficulties of penetration and other circumstances have to be taken into consideration when determining the concentration and time of exposure. Apart from this, quantities of gas and time of exposure to be applied are officially regulated in many countries – in particular, for rat control and plant quarantine.

## Diffusion of Gas

Tins should be distributed suitably in the rooms to be fumigated; the numerous gas sources will accelerate spreading of the fumigant. As a rule, the distribution should be uniform, but in the case of places difficult to penetrate proportionally more tins should be placed. Then the gas spreads evenly in the shortest time, and no fans or other mechanical devices are required.

## Ventilation

As a rule, it is not necessary to use fans or forced ventilation in airing fumigated rooms. Natural drafts remove the gas very rapidly, i.e. as soon as windows and doors of the rooms are opened and all other openings unsealed. Damp, cool and calm weather conditions, too tightly stored commodities, many fittings with large surface areas require prolonged airing, whereas warm and dry weather conditions, relatively empty rooms need shorter airing. Wherever possible, especially in dwellings and work-rooms, ventilation can be speeded up by heating rooms, beating clothes, bed clothes, etc., and spreading out commodities, but naturally only after rooms can be re-entered. This work should only be carried out by the fumigation personnel or under their close supervision.

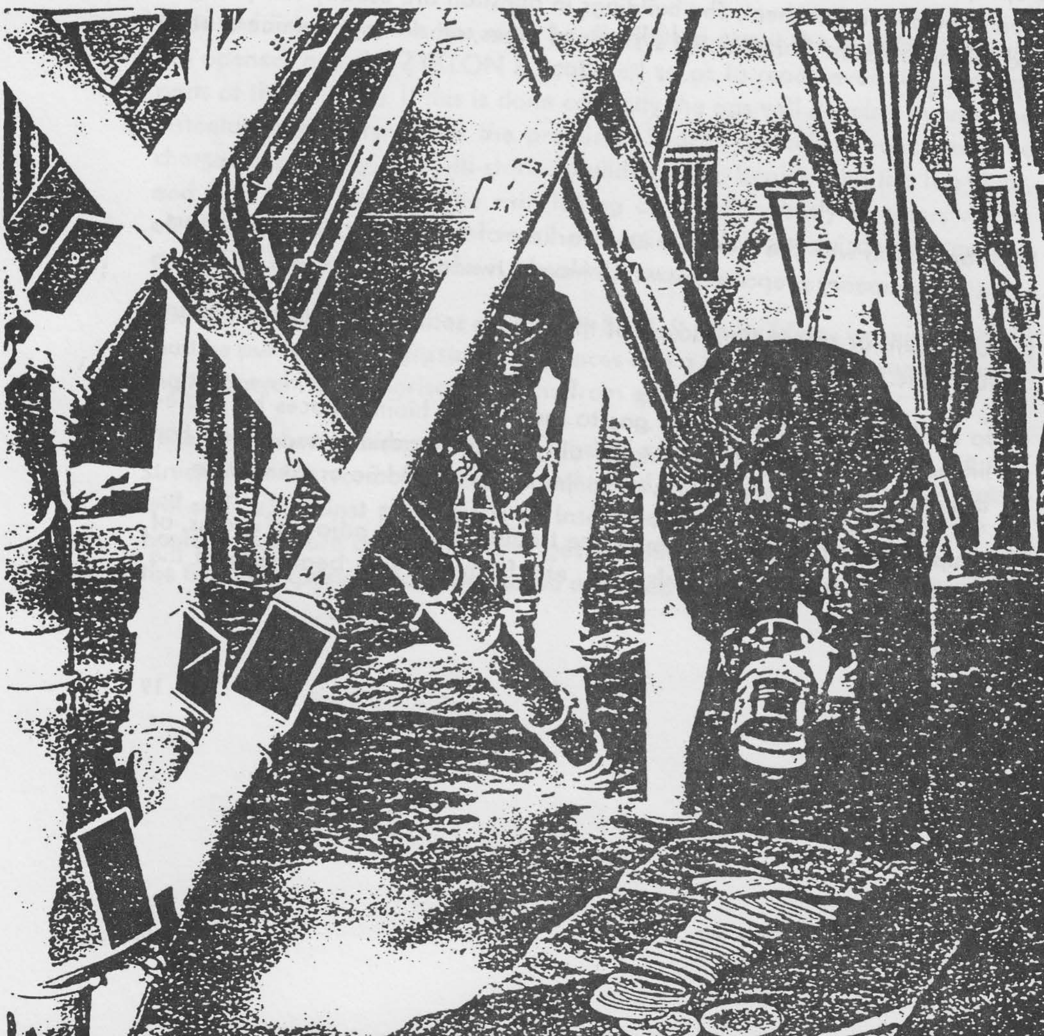
x but... "at least 10 hours" (p. 21)

17

### Clearance of Property and/or Goods Fumigated

A simple, reliable chemical test (see page 7) is used to ensure that no dangerous concentrations remain in the spaces or commodities which have undergone fumigation. It is required that these tests be carried out after the premises have been closed for at least one hour following ventilation so that conditions, especially the temperature, are as near normal as they will be when re-occupied.

Fumigation of a pneumatic mill.



Fumigation of Flour Mills, Food Factories, etc.

Mills, farinaceous food, chocolate and other food factories, provision stores and similar buildings provide very favourable living conditions and breeding grounds for all kinds of food pests. Flour moths, dried fruit moths, flour beetles, bread beetles, etc. and their larvae thrive on the food in the suitable temperature and humidity prevailing. Their presence will soon become a nuisance, and drastic action must be taken at an early stage.

ZYKLON acts rapidly and drastically. The hydrocyanic acid developed from ZYKLON penetrates all nests and breeding grounds, kills all insects in their various stages of development if the necessary dosage and time of exposure is observed, and also destroys rats and mice. After fumigation, the gas can easily be cleared away without leaving any residue or affecting the fumigated commodities in any way.

A typical fumigation in its various phases is described in the following paragraphs, naturally local conditions, such as type of building, purpose, etc., need individual adjustment. The buildings in question are usually fairly large and full of recesses. Complicated systems of pipes, machines, containers, etc. are involved.

In co-operation with the manager and workers of the factory, the fumigators make the necessary preparations which have a twofold purpose: –

(a) to prevent or retard the escape of the gas by sealing all windows, apertures, etc., of the building;

(b) to facilitate the access of the gas to the insects' hiding places by a preliminary exposure and cleaning of all parts of machines and pipes. For this purpose also dense stacks of commodities should be broken down.

It is imperative to clear the rooms to be treated, and all adjacent rooms, of human beings, domestic animals, pets, etc. from the very beginning of the fumigation until the end of the airing operation. This evacuation must be controlled by a roll-call and inspection of the premises.

The chief operator must so arrange everyone's part in the operation that it will not take more than 30 minutes in all. This applies especially to very warm climates. HCN develops more quickly at a high temperature. This important fact should always be kept in mind. Gassing should not be interrupted.

At least two – for larger buildings more – of the fumigating staff must work together and watch each other continuously. It is advisable to divide the work: one expert to open the tins, another to empty them.

Prior to fumigation, the tins must be distributed about the building. The tins are opened, and the ZYKLON is scattered so as to reach even the remotest parts of the building. If this is done correctly the gas will develop evenly and instantaneously throughout the premises. Spaces difficult to reach may be charged separately. In multi-storied buildings one begins with the top floor, and then works towards the exit, taking care that nobody re-enters rooms already charged. Even under mask protection it is not advisable to expose oneself to the gas more than is absolutely necessary.

The exit door is sealed after everybody has left the building; warning notices must be put up before gassing commences and a guard placed near the building to prevent unauthorised persons from entering.

Time of exposure depends on the type of pests to be attacked; for the destruction of the various types of moths and their pre-adult stages 24 hours will suffice, against other kinds of insect pests one should fumigate for 48 hours. If there are any dense stowages or bulks of commodities to penetrate, the time of exposure may need to be extended to 72 hours.

Ventilation

During this operation gas-masks must be worn. The ventilation takes place in the reverse direction to the gassing. All windows near the entrance are opened first, then gradually those in the rest of the building. It is advisable to work only for 10 to 15 minutes at a time and then to make interruptions of half an hour, as a precaution against skin poisoning.

Depending on concentration, outdoor temperature and weather conditions, ventilation will take at least 10 hours. Its duration also depends on the type of building, number, size, and situation of windows and other apertures.

Clearing of tins and residues may be commenced before the end of airing. Windows and doors must remain open, and gas-masks kept available. ZYKLON tins and absorbent material must always be collected and cleared away before the resumption of work. It is imperative that not a single tin be left about!

Chemical gas tests must be made in various parts of the building, according to the relative instructions.

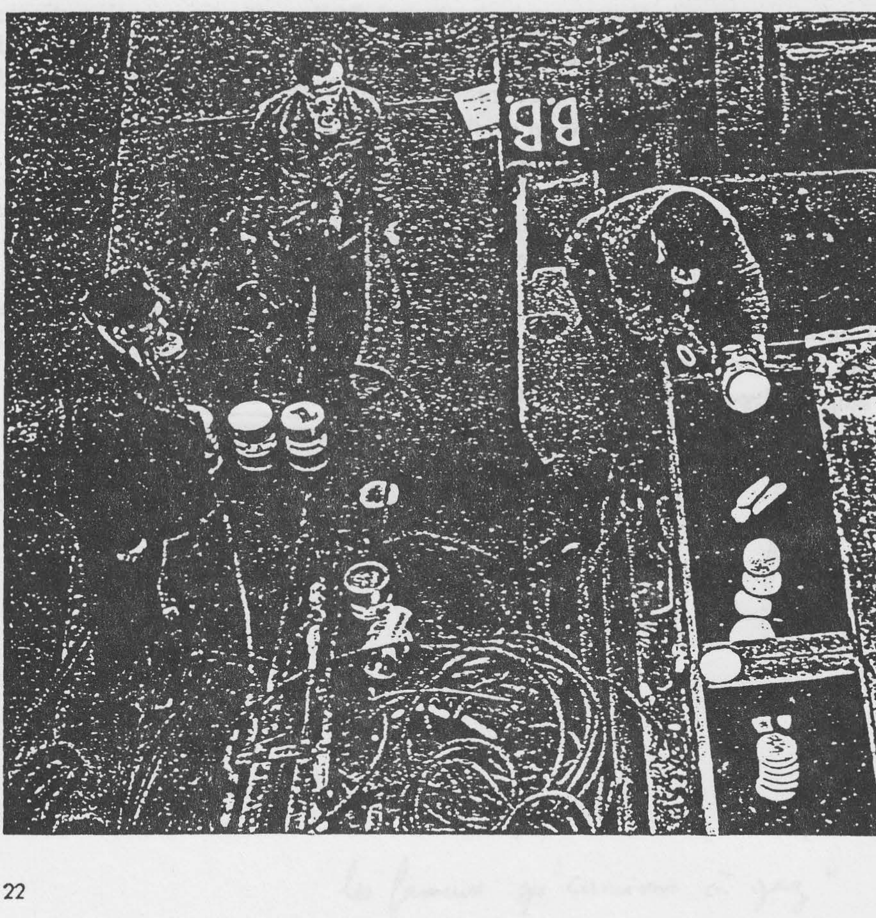
A conscientious operator should never fail to inspect the result of his work, accompanied by the client.

**Fumigation of Ships**

Passenger or cargo boats can be successfully fumigated with ZYKLON for the control of every kind of infestation.

For the extermination of rats, the ZYKLON method is expressly recognised and admitted under the regulations of the "International Sanitary Convention". Lowest concentrations and exposure time can be applied for this work as rodents are far more susceptible than insects. Fumigation takes only 6–8 hours when ships' holds are empty.

Gassing of ship. Feeding ZYKLON discs into compartment of hold. (N.B. – In German ports regulations prescribe the personal supervisions by an official of the Public Health Authorities.)



If cockroaches, ants, bugs or food pests in ships' cabins, kitchen, provision stores, etc., are to be controlled simultaneously, higher concentrations and longer exposure times should be used.

Loaded cargo vessels should be fumigated only in exceptional cases since loaded holds naturally impede the diffusion of gas, thus impairing the efficacy of the operation. In any case, fumigation would here necessitate very protracted ventilation. Cargoes of tea must under no circumstances be exposed to hydrocyanic acid.

A ship can be fumigated successfully and safely only in close co-operation with officers and crew. They may assist in the preparation, but at no time in the fumigation work.

As to preparatory measures, including liberation of the gas and ventilation, the same rules as apply to the fumigation of buildings must be observed, with a few exceptions conditioned by the particular structure of the vessel.

Where fumigation is limited to holds and food stores, no one is allowed to remain on board or to board the vessel for about two hours after re-opening the last fumigated space. Access to the deck and all places not subjected to fumigation may only be given after the chemical gas test has proved that no gas has penetrated into the non-fumigated parts of the vessel.

Port holes, for instance, need only be firmly closed, without paper insertions; canvas covers suffice for deck ventilators and funnels; hawses must be choked up, but the steerage holds must remain open. Top-hatches are to be sealed with battens and tarpaulins; a small section of the hatches should, however, be kept open for the introduction of the ZYKLON.

Where fumigation is to be confined to certain spaces only, all air passages to the outside (ventilators, etc.) should be properly sealed.

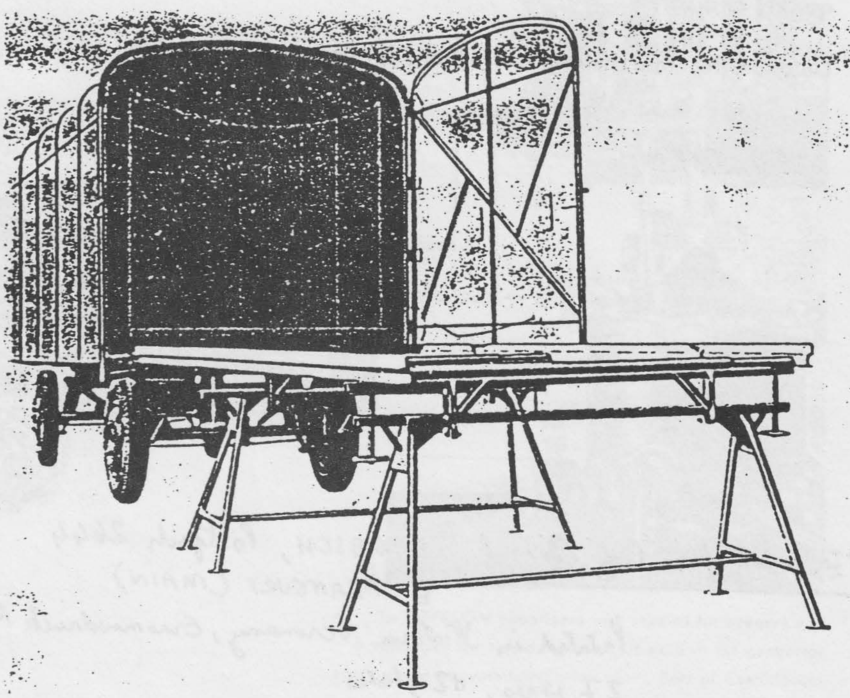
Liberation of the gas normally commences in the lower decks, in special cases the order can be reversed. The holds need not be entered, since the tins are emptied by scattering their contents into the holds from above.

For ventilation, all awnings and tarpaulins are removed first; then all doors, port holes and windows should be opened. Fans should be switched on and, as soon as possible, all bedding, mattresses, etc. taken on deck and thoroughly beaten. Heating of cabins will help to expel all traces of gas in the shortest possible time.

Tests for gas should not be made until all upholstered objects, bedding, curtains, hangings, etc. have been put back into place, and doors and windows have remained closed for at least one hour. The test for residual gas requires a temperature of at least 60° F (15° C). Therefore, during cold weather the heating should be used.

Special attention should be paid to rooms which, on the same day or during the following night, are intended to serve for prolonged occupation or for sleeping.

**Mobile fumigation chamber, capacity 20 cubic metres.**
**The standard equipment for the protection of plants and stored products.**





les fameux "camions à gaz"

Fumigation Chambers

In the main, fumigation chambers serve the purpose of disinfesting nursery products, seeds and plants, flowers and fruit, in accordance with the regulations laid down by the "International Plant Protection Convention".

Whether the fumigation chamber is a permanent installation or mobile, a DEGESCH circulatory device makes it possible to operate safely and quickly, and ensures success.

Mobile fumigation chambers are of great advantage: As they can be attached to any tractor or lorry, their possibilities for use are almost unlimited. They are economical in price and running. The standard sizes are 2 $m^3$ and 20 $m^3$, other sizes can be constructed according to special requirements.

Stationary chambers are made from steel, bricks or concrete. If constructed from bricks or concrete they must be sealed by applying a suitable coating.

Neither service personnel nor unauthorised persons come into contact with the gas; one person alone can operate the fumigation chamber; a gas-mask need not be worn. The gas-air-mixture is circulated, thus accelerating penetration and reducing exposure time. After treatment, the gas can be cleared quickly and safely.

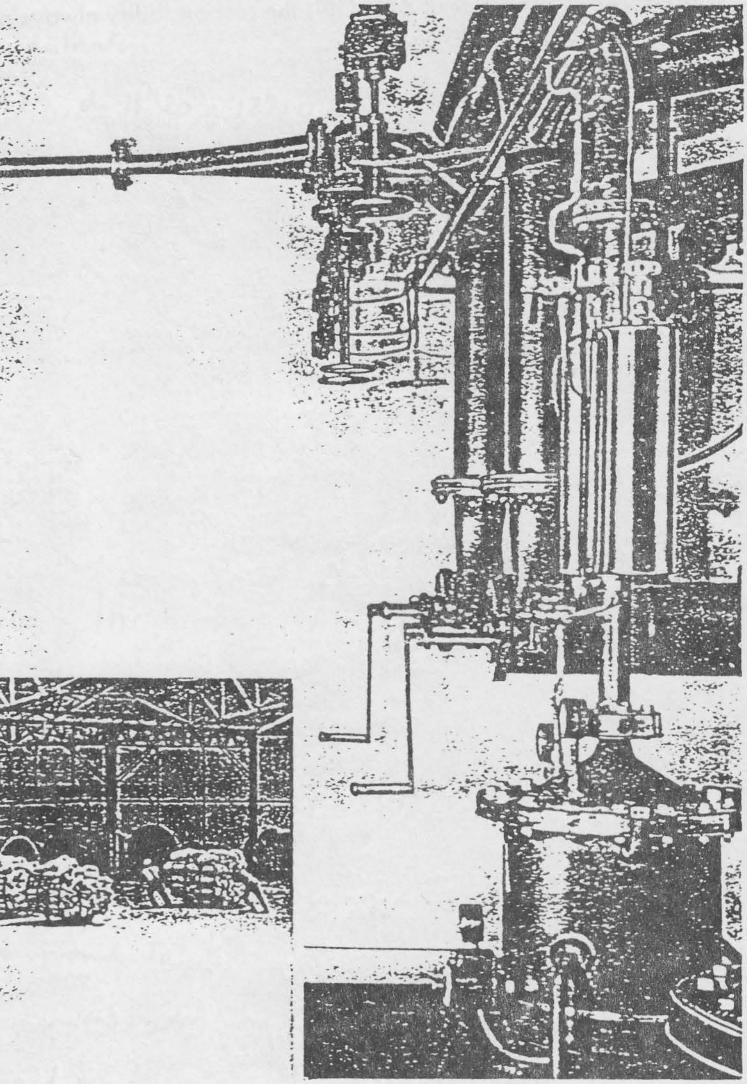
Detailed descriptions and instructions for usage are available.

I NEED THEM

Zyklon for Pest Control, DEGESCH, Postfach 2644
6 FRANKFURT (MAIN)



Printed in Western Germany, Erasmusdruck Mainz, XI 72 5,
27 pages, 12 photos.



Two ZYKLON vaporizers with special tin openers and a vaporizer for liquid hydrocyanic acid in the generator room of the vacuum fumigation plant, Port of Casablanca.

## CLOSING REMARKS

Our instructions for operational procedure are based on wide experience gained during the many years ZYKLON has been on the market; these instructions, however, cannot cover every possible condition arising in special cases. For this reason, we shall be pleased to give further information on request, but we cannot accept responsibility for any direct or indirect damage caused by or to the user of ZYKLON; the responsibility always rests with him.

Vu Monsieur MARTIN
ANPA
18 rue Goubet
75019 PARIS
200.67.01
Métro Ourcq, près Eglise de Pantin
mercredi 12 décembre 1979, de 11h20 à 12h10

A. Fournier [illegible]
Photos villages [illegible] p. 13
p. 15 a
p. 15 b
p. 22
p. 24
p. 26 a
p. 26 b

Degesch America, Inc. (American affiliate)
P.O. Box 116
275 Triangle Drive
WEYERS CAVE, VA 24486 (703) 234 9281

The room is supposed to be plenty of hydrocyanic acid
The corpses are supposed to be
With gas masks, the Sonderkommando would not be able to perform any hard work
How could they manage without (because eating and smoking [illegible] the gas is inflammable and explosive)
Baltimore Zyklon (1972). Proceedings [illegible]

# Appendix VII

Proposal for Gas Chamber and Death House Restoration (Leuchter)

Fred A. Leuchter Associates

Consulting Engineers

# Proposal

Missouri State Penitentiary

Jefferson City, Missouri

# Gas Chamber
# and
# Death House
# Restoration

December 31, 1987

Fred A. Leuchter Associates
Consulting Engineers

231 Kennedy Drive
Boston, MA 02148

617-322-0104

PROPOSAL
MISSOURI STATE PENITENTIARY
GAS CHAMBER and DEATH HOUSE
RESTORATION

1.000 SCOPE. The purpose of this proposal for the restoration of the Gas Chamber and Death House located at the Missouri State Penitentiary in Jefferson City, Missouri. It is resultant to lengthly discussions with prison personnel and on on-site inspection of the Chamber and Death House.

1.001 This proposal is broken into thirteen (13) parts.

1.000 A brief history of the Gas Chamber.

2.000 A description of the Chamber and Death House as it presently exists.

3.000 A definition of the execution procedure and problems.

4.000 An analysis and critique of the present system.

5.000 Recommendations for changes.

6.000 Discussion of the personnel safety.

7.000 A description of the recommended changes and new systems.

8.000 A discussion of procedures.

9.000 A detailed description of materiel and labor needed to design, configure, fabricate and install the new system, including components and pricing.

10.000 Total pricing broken down by system.

11.000 Certification and support.

12.000 Costing, billing, payment requirements, terms and conditions.

13.000 Disclaimer.

2.000 HISTORY. The Gas Chamber and Death House at the Missouri State Penitentiary was constructed and made operational c.1936. The Chamber appears to have been constructed at another location and either lowered through an opening in the roof or the building constructed around it. The age of the building has not been determined.

2.001 The Death House at the Missouri State Penitentiary is a nearly square building measuring approximately 27.5' x 22.5' and containing some 619 square feet, and some 7119 cubic feet, owing to a ceiling height of 11.75'. It is constructed of a sedimentary-like stone, indigenous to Missouri. It contains two (2) exterior doors measuring 2'10" x 80" and five (5) windows measuring approximately 49" x 41". It contains two (2) cells averaging some sixty (60) square feet each with two antiquated cell doors and locks. Additionally, it is broken into three (3) rooms of varying size, centering around the Gas Chamber. These rooms we will designate Area A - control room (with adjacent cells), Area B - official witness area and Area C - condemned witness area. All rooms but the control room and cells have windows. Egress is through two (2) doors, one to the control room and cell area and the other to the official witness area. Egress to the condemned witness area is through the official witness area. Heat is by a simple steam blower in the official witness area, near the egress door. Partitioning for the rooms is not complete. The cells are completely partitioned from all areas except via two (2) doors in the control room. The official witness area is open to the control room above the Chamber. The condemned witness area is partitioned completely from the other areas with only the one egress door. The roof appears to be of tar and gravel construction over wooden beams. All interior areas are finished and painted.

2.002 The Gas Chamber is of a metal tank type construction. It is a welded steel polygon containing twelve (12) sides of varying dimensions measuring a 7.5' diameter in one direction and an 8' diameter in the other. It is 8.5' high and has a volume of some 510 cubic feet. It has a door apperature of 35.25" x 80" and a ribbed clamshell-like gasketed door of some 80" high by 37.25" wide. The door opens out and closure is effected by right hand hinges and three (3) mechanical screw type latches (dogs) on the left and three (3) mechanical spring loaded screw type pressure latches (dogs) on the right. The sealing capability of this design is uneven and questionable. The Chamber contains two (2) seats for the condemned and a sheet metal flue of approximately 6" running through the dome of the Chamber and on through the roof some 40 feet in the air. It is guyed to the roof via wire. The Chamber is evacuated via a 1725 rpm fan of 1/3 horse power. It is a standard ventilation type fan. Air intake is through four (4) 3" diameter pipes welded into the base of the Chamber at an angle so as to develop a swirl type effect in the Chamber. These intakes have a small mechanical valve for admitting ammonia - a questionable agent for neutralizing the Hydrogen Cyanide Gas and a 3" diameter mechanical valve opening into the personnel area. For supplying replacement air, this design is inherently dangerous, in that these intakes open directly into the personnel area. A spring loaded valve is inset below the fan and opened for Chamber evacuation. There are five (5) windows approximately 29" square in the panels of the Chamber.

2.003 The Hydrogen Cyanide Gas is generated by mechanically dropping two (2) dozen or so Sodium Cyanide briquets from a shelf under the right hand chair into a crockery pot containing several pints of Sulfuric Acid.

2.004 External to the Chamber and to the right of the door in the control room are two (2) mechanical levers. One, mechanically via a connecting rod through the floor of the Chamber, drops the Sodium Cyanide briquets into the Sulfuric Acid. There is a questionable seal on the entry hole for this rod. The second lever opens the spring loaded valve at the top of the Chamber. It is spring loaded to close and is held open via a stop pin. It is extremely difficult to operate and may prove dangerous in use. A wire for a medical heart monitor has replaced an old mechanical stethoscope, but the seal around the wire through the Chamber wall is questionable.

2.005 PROCEDURE. A crock of dilute Sulfuric Acid is installed under the right chair and two (2) dozen or so Sodium Cyanide briquets placed on the drop shelf. These briquets are extremely dangerous to handle. The condemned is strapped into the chair and the heart monitor installed on his body. The door is closed and compressed onto the gasket via the mechanical dogs. On command, the lever is pulled and the Sodium Cyanide briquets dropped into the Acid. Hydrogen Cyanide Gas is generated and fills the Chamber, leaving a residual of Prussic Acid in the crock. After the condemned is pronounced dead by the attending physician, the Chamber is evacuated by the following procedure.

1. The exhaust fan is energized and the mechanical valve opened via the lever. The fan is not an overloading type and the valve must be opened immediately to prevent burnout.

2. The intake ports are opened first and ammonia is fed into the intakes; then the main valves are opened manually. This procedure is dangerous since gas could leak into the personnel area. The intakes should be outside the Death House. Additionally, ammonia is not a proper agent to neutralize Hydrogen Cyanide Gas. Chlorine bleach should be used, but is not necessary and may cause Cyanide to precipitate in the Chamber.

3. After the Chamber is clear, some fifteen (15) minutes after the fan was turned on, the deceased is removed and wiped with ammonia (should use chlorine bleach).

4. Chamber is then washed with ammonia (should be bleach) and the crock of Prussic Acid removed and dumped (buried in the ground). The Prussic Acid is extremely dangerous and may be lethal to those handling the material. It does, however, biodegrade reasonably well in the environment.

5. In a test run with smoke candles on the Chamber, it was observed after fifteen (15) minutes of exhaust, the Chamber was mostly cleared os smoke, but not completely.

3.000 EXECUTION PROBLEM. Medical tests show that a concentration of Hydrogen Cyanide Gas of 300 parts per million (PPM) in air is rapidly fatal. Considering a Chamber volume of approximately 600 cubic feet, and a determination that 1600 PPM would be adequate to effect death, it is determined that a double dose of 3200 PPM would be reasonable in a 600 CF Chamber to ensure rapid death. This is a volume of approximately two (2) cubic feet of gas at a weight of 120 to 150 grams. For ease and safety in handling, the HCN (Hydrogen Cyanide Gas) should be supplied as a liquid and vaporized. This would eliminate the need of handling the lethal Sodium Cyanide briquets or the dangerous Prussic Acid residue upon conclusion. The gas would be supplied in a bottle as a liquid and thence heated in a vaporizer to a gas.

3.001 Since some 100 PPM of HCN gas is fatal within half an hour, a consideration for the safety of the operational and witness personnel is in order. Toxic effects are skin irritation and rashes, eye irritation, blurring of vision and permanent eye damage; nonspecific nausea, headache, dizziness, vomiting and weakness; rapid respiration; lowered blood pressure, unconsciousness, convulsions and death. Symptoms of asphyxia, dyspnea, ataxia, tremors, coma and death through a disruption of the oxidative metabolism.

3.002 First, the Chamber should be pressure tested to 2.5 atmospheres to guarantee the integrity of the Chamber welds and seals. Second, the Chamber should be operated at a negative pressure (partial vacuum) of approximately 10 PSI (after gas release of +2 PSI) compared with a standard atmosphere of 14.7 PSI. This would ensure that if the integrity of any of the seals were breached, all leakage would be inward. This pressure should be constantly monitored and in the event that the Chamber pressure rises to 12 PSI, an automated safety procedure would activate, evacuating the Chamber through its evacuation system. Further, gas detectors should monitor gas levels outside the Chamber and audible and visual alarms should activate and exhaust fans should clear the personnel area in less than a minute. Emergency breathing apparatus should be available to all personnel and first aid kits and a resuscitator should be in the immediate area in case of personnel injury.

3.003 The entire operational procedure should be automatic and sequentially controlled to eliminate error or accident and the gas condition internal to the Chamber should be monitored via a gas detector which would prevent the Chamber door from opening until the gas has cleared. This detector would also control a red and green light which would provide a visual indication of the internal gas level in the Chamber. Mechanical and electrical over-rides should be provided for the system.

3.004 REITERATION. A gas execution system should utilize an airtight Chamber that is operated at negative pressure. Further, the gas should not be generated on site, but should be supplied as a liquid and vaporized in the Chamber. An automated control system should be used to eliminate error and a safety system should be employed to evacuate both the Chamber and personnel areas in the event of a leak. Visual monitors as to gas condition and audible and visual alarms should be incorporated into the system. Emergency breathing apparatus. special Hydrogen Cyanide first aid kits and a resuscitator should be in the immediate area in case of accident.

4.000 ANALYSIS AND CRITIQUE OF THE PRESENT SYSTEM. The present system in place at Jefferson City is extremely dangerous for the following reasons. First, the Chamber is old, gasketing is questionable, the door seal is dangerous and difficult to close (due to poor latching system), holes in the Chamber floor and wall for wires and pull rods are not properly sealed, the evacuation system is undersized and slow and the main exhaust valve is difficult to operate and may leak. Further, the air intake ports are likewise undersized and take return air from the personnel area, instead of the outside. Additionally, the ammonia ports are unnecessary and another source of potential leakage. Also, the ammonia may cause HCN to precipitate in the tank.

4.001 The gas generator system is antiquated, obsolete and is no longer necessary. Personnel should not handle Sodium Cyanide briquets or the Prussic Acic residue.

4.002 As the entire system is old, the fan may fail, the gaskets on the door and windows may leak and the valve may fail.

4.003 Additionally, there is no overall control system, no gas detectors nor personnel safety system, no exhaust fans for the work and viewing areas and no emergency breathing apparatus or first aid equipment on the premises.

4.004 The three (3) areas of the Death House are not isolated form each other which would enable leaking gas to permeate the entire Death House.

5.000 RECOMMENDED CHANGES. The following changes are recommended for the Gas Chamber and Death House at Jefferson City.

5.001 Chamber. Replacement of door and frame with a standard naval type watertight assembly with a single control handle. Replacement of all five (5) windows with standard naval watertight bulkhead windows. Removal of all mechanical release hardware for the valve and Cyanide pellet drop and welding all holes and questionable seams. Installation of hermetically sealed electrical connectors, installation of ports for guages, vacuum release and vacuum system. All to be welded. The tank now should be subjected to a positive pressure test of 2.5 atmospheres for twenty-four (24) hours to determine the integrity of the welds and seals.

5.002 The gas generation system should be eliminated and a gas vaporizer and the associated plumbing installed in the Chamber. This vaporizer is essentially a heated water jacket for the gas cylinder which is temperature controlled. A Nitrogen burst HCN clearing capability is part of this system.

5.003 A new gas evacuation system should be installed, consisting of a 13" diameter PVC air inlet feeding from the roof containing a coaxial 2285 CFM inline fan and an inward closing motorized valve; further, a 13" diameter air outlet exhausting through an inwardly closing motorized valve and a 40' PVC stack above the roof.

5.004 A Chamber vacuum system should be installed containing a 17.7 CFM displacement vacuum pump, vented to the stack, with the associated mechanical and electrical valves, pressure switches and gauges.

5.005 An electrically controlled sequentially timed system should be installed to safely control operation and integration of the essential systems. This system will include means for locking the door, releasing the gas, monitoring gas and pressure levels in the Chamber and evacuating the gas after the execution is over.

5.006 A personnel safety system should be installed to protect the lives of the operators and the witnesses. This should consist of gas detectors to sense gas leaks in the personnel areas, audible and visual alarms and a gas evacuation system installed in each of the three (3) personnel areas and inside the ceiling. This system will activate immediately on a leak and a gas concentration in an amount of 10 PPM. Additionally, special Hydrogen Cyanide first aid kits, emergency breathing apparatus and a resuscitator should be immediately available to the occupants.

5.007 Further, a wall should be constructed between the control area and the official witness area to ceiling height (7.5') and the wall between the official witness area and the condemned witness area removed above 7.5'. This will segregate the areas below the ceiling and allow the emergency air evacuation system to function above the ceiling. Do not remove any cell area walls.

5.008 A door should be installed from the condemned witness area to the outside to facilitate movement and the non-integration of the witnesses of different catagories. The door between the two witness areas should be sealed or locked.

5.009 In the cell area, two (2) new cell doors with Folger Adam 82-5 locks and paracentric keys installed. The left door should be sealed and a new door installed between the cells. The second door on the right should remain the same. This will establish an anti-room cell area for the chaplain.

5.010 Intakes for the emergency air evacuation system for the personnel areas should be installed in each personnel area and inside the ceiling, exiting to the outside.

5.011 Installation of three (3) 25 kw suspended electric heat blower units in each of the three (3) personnel areas, at ceiling height.

5.012 A suspended ceiling of 2' x 4' x 3" fibreglass should be installed at 7.5' height to seal all areas. A good quality suspension system should be used equivelent to Chicago Rolling Mills. This ceiling will provide for ventilation, heat and sound insulation.

5.013 Flourescent lighting should be installed in all areas. Three (3) - four (4) lamp fixtures in both the control and official witness areas and two (2) four (4) lamp fixtures in the condemned witness area. One (1) - four (4) lamp tamper-proof fixture should be installed in the cell and one in the chaplain area.

5.014 The Death House should be repainted and the Chamber stripped of its present coat of latex paint, inside and out, and repainted with two (2) heavy coats of good quality marine epoxy paint. The floor should be painted with a quality deck enamel.

5.015 Door installation, carpentry, ceiling, painting, and masonary work shall be completed by prison personnel. All doors to be supplied by American Engineering, Inc.

6.000 SAFETY. Personnel safety is a critical issue and at a minimum, an emergency air evacuation system must be installed which is controlled by gas detectors. Further, specialized first aid kits, emergency breathing apparatus and a resuscitator must be available at the Death House. It is further recommended that the gas generator be eliminated and a vaporizer installed, eliminating the need tc handle Sodium Cyanide pellets or Prussic Acid. All gas detectors should be operated at a level of 10 PPM, as this is the OSHA limit of exposure for one day.

7.000 CHANGES AND NEW SYSTEMS. The Gas Chamber will be sealed and tested at 2.5 atmospheres of pressure (one [1] atmosphere being 14.7 PSI) after installation of the necessary through the wall hardware. This will consist of an inlet flange at the base on one side of the Chamber; an outlet flange top dead center on the dome; a vacuum port for evacuating the Chamber, a vacuum release port, a guage port and a pressure switch port. One or more hermetically sealed electrical connectors for supply electricity and receiving sensor data (i.e. gas detector and subject pulse condition information).

7.001 A gas vaporizer and delivery system will be installed within the Chamber to supply and deliver the Hydrogen Cyanide Gas. The vaporizer shall consist of a redundant temperature controlled and heated water jacket suitable for a hazardous environment. A lecture bottle of 60 grams of HCN liquid is connected to a delivery system containing a manual shutoff for the HCN, an electrical valve for the release of the HCN and a flare nozzle for distribution. Additionally, a Nitrogen bottle supplies a purge of the system via a regulator set at 75 PSI, a pressure guage, a manual and electrical valve for release into the system. The gas is heated to 130 $^{o}$F and vaporized. The electrical valve releases the gas on command. During chamber purge (evacuation), the Nitrogen valve releases a Nitrogen purge to clear the plumbing of any residual HCN.

7.002 An air inlet PVC pipe of 13" diameter will pick up outside air on the roof and feed it through a centrifugal coaxial fan of 2285 CFM capacity and an inwardly closing motorized inlet valve into the Chamber. An inwardly closing motorized outlet valve will exhaust the Chamber through a 13" diameter PVC pipe running through the roof 40' into the air. The inlet and outlet pipes are connected to the inlet and outlet flanges on the Chamber.

7.003 A vacurizer system will vacurize the Chamber to a negative pressure value (partial vacuum) of 10 PSI (operational: 8 PSI plus 2 PSI of HCN). This vacuum will be maintained utilizing the outside ambient pressure as a standard. This will ensure that any leak would only be inward.

7.004 This will consist of a 17.7 CFM displacement vacuum pump vented to the exhaust stack of the Chamber and a back flow valve, electrically operated ball valve and a mechanically operated ball valve. Additionally, a pressure switch set to shut down the pump at 8 PSI and trigger the emergency systems if the pressure reaches a value of 12 PSI, 2 PSI above the Chamber operational pressure value of 10 PSI. Further, a mechanical gauge is utilized and a mechanical ball valve for vacuum release (break), if necessary.

7.005 A system of four (4) air evacuation fans will be employed in the event of a gas leak. These will operate in conjunction with four (4) motorized air intake louvres.

1. Control area - 15,200 CFM fan with motorized air intake through wall. Fan to be centrally located on roof.

2. Official witness area - 15,200 CFM fan with motorized air intake through existing window. Fan to be centrally located on roof.

3. Condemned witness area - 7,645 CFM fan with motorized air intake located over new door. Fan to be centrally located on roof.

4. Internal ceiling area - 3,970 CFM fan with motorized air intake through wall. Fan to be located through wall.

7.006 These fans will be activated by a single relay which will be controlled by the emergency safety system.

7.007 The emergency safety system will consist of five (5) gas detectors. One in each of the personnel areas (3), one in the ceiling and one in the Gas Chamber. A sail switch will also be employed to verify that the gas is exhausting from the Chamber. This will be located in the stack.

7.008 The safety system will also have monitor lights to determine vacuum condition, gas condition in the Chamber, gas valve open, gas valve closed and Chamber evacuation (purge) under way.

Additionally, there will be a vacuum-drop horn and beacon and a gas-leak bell and rotary beacon. The system will automatically trigger the alarms and evacuate the air in the personnel areas immediately, if a problem develops.

7.009 The gas detector in the Chamber will monitor internal gas levels and announce condition with a red or green (gas or clear) light, as well as, prevent the Chamber door from opening via an electric latch, while a gas condition exists.

7.010 A control system will monitor and sequentially control all functions and operations of the equipment and Chamber. It will open the gas valve to release the HCN gas. It will time the gas condition and start the Chamber purge fan, open the outlet valve, open the inlet valve, activate the Nitrogen purge and shut down the purge fan after the execution is complete. It will return all valves to closure condition.

7.011 Additionally, a phase controlled relay will be installed to control all electrical functions in the Death House, preventing an external electrical phase error from interferring with proper systems operation.

7.012 A 7.5' 3" fibreglass suspended ceiling will be installed. Three (3) 25 kw suspended electric heaters will be installed in the three (3) personnel areas. Two (2) new cell door will be installed with Folger Adam 82-5 locks and one cell door sealed and moved to connect the two cells. An outside door to the condemned witness area will be installed. A wall will be erected separating the control area from the official witness area, not to exceed 7.5'. The wall between the control area and the condemned witness area will be opened above the 7.5' ceiling. The Dealth House will be painted. The Chamber will be stripped of all latex paint, primed and painted with two (2) heavy coats of a quality marine epoxy paint.

7.013 Specialized HCN first aid kits and emergency breathing apparatus will be installed in the Death House with detailed HCN emergency treatment procedures. A resuscitator and first aid kits will be supplied to the prison hospital with instructions for HCN exposure treatment.

8.000 PROCEDURES. A manual will be written and supplied to prison personnel which shall include maintenance, operation, safety and emergency procedures for operating the Gas Chamber and associated systems. This will include an execution operational procedure which will guarantee a trouble-free execution, if followed.

9.000 A description of materials and labor necessary to fabricate and install system.

9.001 Electrical, main

1. Phase relay
2. Main contactor
3. Multi-circuit box with main, all circuit breakers
4. Phase light
5. Miscellaneous

$5,107.00

9.002 Chamber

1. Door
2. Windows
3. Welding plates
4. Two (2) flanges, exit and entry
5. Hermetic connectors
6. Lights
7. Wiring

$22,210.00

9.003 Control System

1. Console
2. Exhaust (Chamber) fan contactor
3. Electric door latch
4. Relay, door latch
5. Gas condition light
6. Pressure switch
7. Stack, sail switch
8. Vacuum monitor lights
9. Exhaust valve closure relay
10. Electric hardware
11. Electric, labor

$11,785.00

9.004 Vacurizer

1. Vacuum pump (17.7 CFM displacement)
2. Chamber plumbing
3. Gauges
4. Vacuum shutdown solenoid
5. Two (2) manual ball valves
6. Labor

$5,525.00

9.005 Vaporizer and gas delivery system

1. Vaporizer (explosion proof)
2. Vaporizer plumbing
3. Two (2) electric ball valves (explosion proof)
4. Plumbing
5. Two (2) manual ball valves
6. Labor, electrical

$10,894.00

9.006 Gas Chamber evacuation (purge) system

1. Two (2) valves, inlet and outlet, inwardly closing
2. Eighty (80) feet PVC, 13" diameter
3. Electrical
4. PVC fillings
5. Coaxial centrifugal fan (2285 CFM)
6. Labor

$12,155.00

9.007 Safety control system

1. Five (5) gas detectors, TLD1
2. Three (3) rotary beacons
3. Three (3) alarm bells
4. One (1) vibrating horn
5. One (1) beacon light
6. Wiring

$26,098.00

9.008 Personnel exhaust

Area 1 - Control room
Area 2 - Official witness area
Area 3 - Condemned witness area
Area 4 - Ceiling (internal) area

Area 1 - 36" dia, 15,200 CFM fan, duct, motorized louvre, roof curb, miscellaneous

$8,645.00

Area 2 - 36" dia, 15,200 CFM fan, duct motorized louvre, roof curb, miscellaneous

$6,565.00

Area 3 - 24½" dia, 7,645 CFM fan, duct, motorized louvre, roof curb, miscellaneous

$5,926.00

Area 4 - 22" dia, 3,970 CFM fan, duct, motorized louvre, roof curb, miscellaneous

$3,119.00

Contactor $260.00

Wiring $650.00

Total $25,165.00

9.009 Miscellaneous

1. Two (2) cell doors
$4,054.00

2. Three (3) blower type 25 kw electric suspension heaters
$3,900.00

3. Six (6) specialized HCN first aid kits
$1,170.00

4. One (1) O'Flynn type resuscitator
$3,900.00

5. Six (6) emergency breathing apparatus
$3,120.00

6. Door, condemned witness area
$650.00

7. Ceiling

8. Stripping and painting Chamber, paint
$500.00

9. Paint Death House, including floor

10. Wall between control and official witness area

11. Remove upper portion of wall between condemned witness area and other areas to open ceiling area

Total $17,294.00

10.000 TOTAL PRICING; MATERIALS, LABOR, EXPENSES

10.001 Labor, at Boston by Fred A. Leuchter Associates

1. Engineering - 120 hours
$10,200.00

2. Drafting - 70.4 hours
$4,575.00

3. Technician - 100 hours

4. Fabrication - 75 hours
$14,775.00

10.002 Labor, at Jefferson City, Missouri

Engineer, three (3) technicians - total 12 man weeks required for installation (four [4] men, three [3] weeks).

10.003 Expenses

1. Airfare
$3,200.00

2. Meals
$5,040.00

3. Lodging
$2,520.00

4. Rental car
$900.00

$11,660.00

plus 20%
$2,332.00

Total $13,992.00

10.004 Installation labor

1. Engineer
$10,200.00

2. Technicians
$7,800.00

$18,000.00

10.005 Totals; Materiel and Labor

| | | |
|---|---|---|
| 9.001 | Electrical | $ 5,107.00 |
| 9,002 | Chamber | 22,210.00 |
| 9.003 | Control System | 11,785.00 |
| 9.004 | Vacurizer | 5,525.00 |
| 9.005 | Vaporizer and Gas Delivery System | 10,894.00 |
| 9.006 | Chamber Purge System | 12,155.00 |
| 9.007 | Safety Control System | 26,098.00 |
| 9.008 | Personnel Exhaust System | 25,165.00 |
| 10.001 | Labor, at Boston by Fred A. Leuchter Associates | 14,775.00 |
| | Subtotal | $133,714.00 |
| 10.003 | Expenses | 13,992.00 |
| 10.004 | Installation Labor | 18,000.00 |
| | Subtotal | $165,706.00 |
| 9.009 | Miscellaneous | 17,294.00 |
| | Total | $183,000.00 |

10.006 The Missouri State Pententiary will complete the following:

1. All Chamber welding, including doors and windows. Doors and windows to be supplied by Fred A. Leuchter Associates.

2. Install wall between control area and official witness area.

3. Open wall above ceiling height between condemned witness area and other Death House areas.

4. Install door in condemned witness area to outside. Door to be supplied by Fred A. Leuchter Associates.

5. Seal door to cell; open new cell door between cells, install two (2) cell doors, to be supplied by Fred A. Leuchter Associates.

6. Paint Death House (including floor).

7. Strip and paint Gas Chamber with marine epoxy paint. Paint to be supplied by Fred A. Leuchter Associates.

8. Install suspended ceiling of 3" fibreglass.

9. Electrical power will be supplied by a three pole breaker with a common. Service will consist of 220 volts three-phase four-wire 200 amp.

11.000 CERTIFICATION AND SUPPORT. Fred A. Leuchter Associates will certify the Chamber and associated systems as safe and operational for the purpose intended.

11.001 Fred A. Leuchter Associates can also, in a separate contractual arrangement, enter into a yearly <u>Maintenance Agreement</u> to maintain the equipment at a fixed yearly fee.

11.002 Execution support program. Fred A. Leuchter Associates can, in a separate contractual arrangement, enter into an Execution Support Agreement whereby it will set up, certify as ready and conduct each execution as required. The State of Missouri need only supply the Executioner.

12.000 CONTRACT, BILLING, PAYMENT

12.001 This proposal is good for ninety (90) days.

12.002 All work will be completed one hundred eighty (180) days from the receipt of contract, barring unforseen difficulties.

12.003 All engineering fabrication and installation will be completed in a professional and competent manner.

12.004 Payment. A fifty percent (50%) down payment will be required at the time of issuance of purchase order; twenty-five percent (25%) will be paid at the time of work start; final twenty-five percent (25%) will be paid thrity (30) days after work completion and final billing. All billing is net amount.

12.005 This proposal addendumed to all purchase orders.

13.000 Fred A. Leuchter Associates assumes no responsibility for the actual or intended use of this device.

Boston, Massachusetts
December 31, 1987

Fred A. Leuchter Associates

Fred A. Leuchter, Jr.
Chief Engineer

# Appendix VIII

## Crematories

Features of Ener-Tek II Cremator
Crematory Plans

Industrial Equipment & Engineering Co.
89 Mossman Road
SUDBURY, MA 01776
(617) 443-3081

# FEATURES OF THE ENER-TEK II

Some of the more outstanding features offered with the Ener-Tek II cremator are as follows:

1. The Ener-Tek II comes equipped with power front and rear doors. The doors are activated by push button control and allow easy access to both the front and rear chambers. Both the front and rear doors have manual override systems to allow operation of the doors in case of power failure.

2. The refractory and insulating materials used in the construction of the Ener-Tek II are of a very high quality which will ensure many thousands of cremations before repair of the brick work is required.

3. The Ener-Tek II is constructed with a very heavy duty steel structure and casing to ensure consistent and thorough support of all refractory materials contained within the steel structure during shipment and during operation in the crematory facility.

4. The Ener-Tek comes equipped with automatic cremation loading equipment to ensure consistent placement of the casket within the cremation chamber and to provide maximum safety for the operators of the equipment.

5. The Ener-Tek II is equipped with complete modulating temperature control system to allow precise measurement and control of temperatures in both the cremation and after chambers of this equipment.

6. The Ener-tek II comes equipped with a complete modulating fuel and air ratio system. This allows precise measurement and dispersal of fuel and air into both the cremation and afterburner chambers.

7. The Ener-Tek II is air-cooled and monitored for outside skin temperature to ensure maximum thermal efficiency of the equipment and reduced heat radiation into the surrounding areas.

8. The Ener-Tek II is supplied with a pollution monitoring and correction system to constantly regulate and check stack emissions and opacities so that appropriate action may be automatically taken to correct any pollution problems before they arise.

9. The Ener-Tek II is equipped with a complete afterburning system. This is a system that is required in the United States and many other countries for a complete control over visible emissions, odors and particulate. Afterburning systems are not generally found on British or European equipment and this should be a major consideration in any comparison you may choose to make.

10. The Ener-Tek II comes equipped with an intergrated ash collection hopper and ash cooling system. This provides the operator with an easy and very safe method of removal of the remains from the cremation equipment.

11. The Ener-Tek II comes equipped with an exhaust gas cooling system. This system will take the exhaust gases of the cremation equipment at approximately 1600 - 2200° F. and cool them down to approximately 500 - 600° F. prior to discharge into the stack and out to the atmosphere. This is another very desirable feature in that it ensures against thermal pollution and of some obnoxious odors that are associated with hot exhaust gases.

12. The Ener-Tek II comes equipped with an automatic and manual control system. It can be placed on automatic where it will cremate and regulate temperature gas and air ratios automatically. If desired, the operator may switch the equipment to manual and control temperatures, fuel and air ratios manually.

13. The Ener-Tek II may be operated with either No. 2 Fuel Oil, Natural Gas, or LP Gas. It may be provided to burn only one of the above fuels or a combination of any of the three.

14. The Ener-Tek II uses conventional flame combustion method for the cremation process. This process has been proven world wide to be the most successful method with today's technology.

15. The Ener-Tek II comes equipped with an automatic draft control and regulation system to provide a consistent negative pressure on the cremation chamber throughout its operation in various cycles.

ENER-TEK PRODUCTION CREMATION UNIT
TECHNICAL SPECIFICATIONS

1. The weight of the Ener-Tek II unit without automatic loader is 40,000 lbs.

2. The physical dimensions are:
   13' long x 9'5" high x 8' wide.

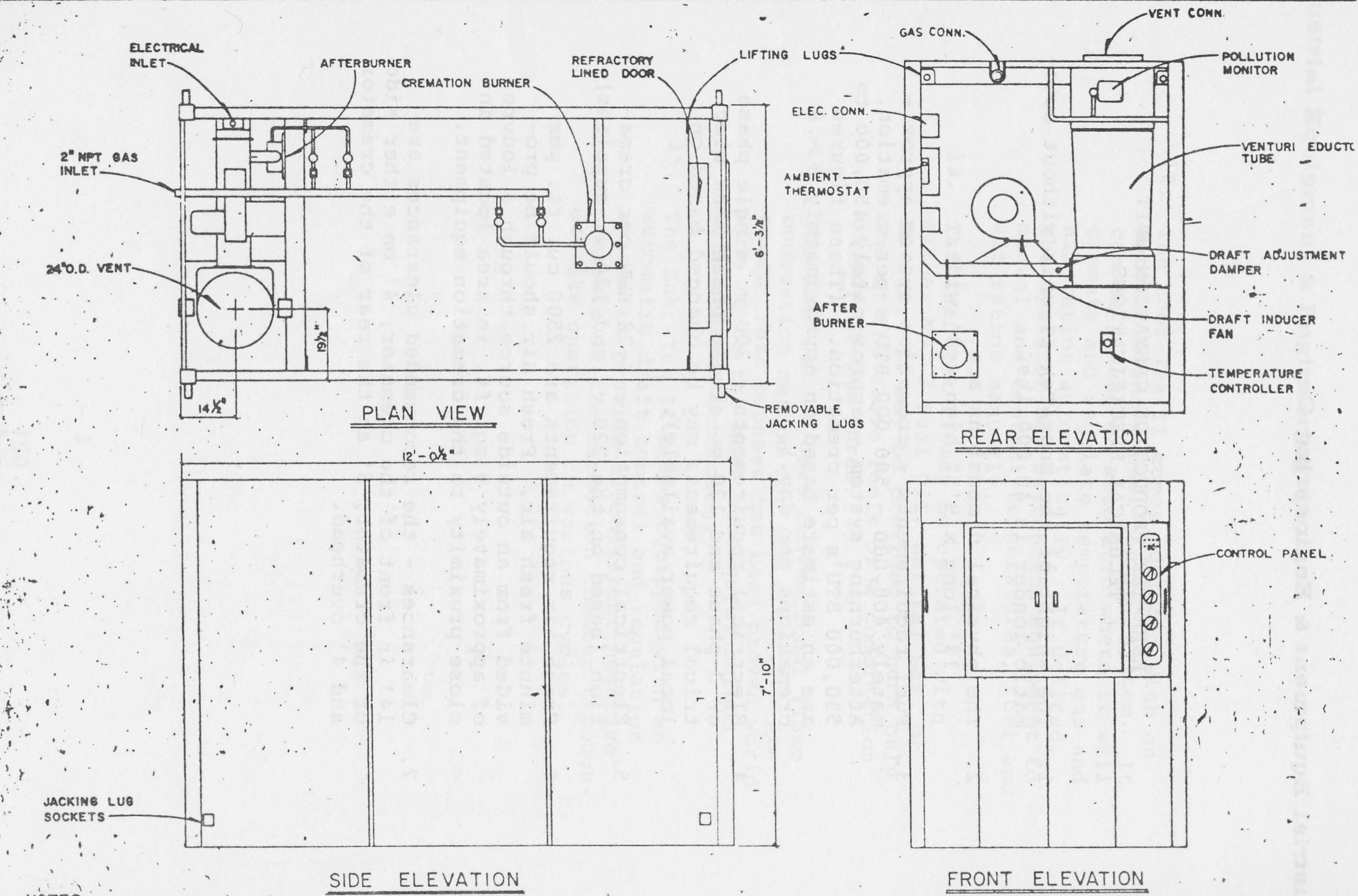
3. Fuel requirements - cremation system approximately 400,000 - 500,000 BTU's per cremation. Afterburning system - approximately 450,000 to 550,000 BTU's per cremation. (These figures are an estimate based on approximately 6 - 8 cremations per day.)

4. Electrical requirements - 200 v. single phase or 3-phase and 120 v. single phase (the electrical requirements may be changed based on local power available).

5. Electrical consumption - 6.28 KWH per cremation (based on the 220 v. and 120 v. supplies).

6. Fresh air requirements are 2500 cu. ft. per minute fresh air. Fresh air should be provided from an outside source through a louvre of approximately 9 sq. ft. in area located in close proximity to the cremation equipment.

7. Clearances - the recommended clearances are 14' in front of the cremator, 4' on either side of the cremator, 6' at the rear of the cremator and 4' overhead.




NOTES

1. FUEL INPUT – NATURAL GAS 1500 CU. FT/HR. 7" W.C. PRESSURE.
   L.P. GAS 1,500,000 BTU/HR 11" WC PRESSURE.
2. ELECTRICAL – 220 VOLTS 3 PHASE 60 HZ. FROM 30 AMP BREAKER, (1 PHASE 60 AMP.)
   110 VOLTS 1 PHASE 60 HZ. FROM 15 AMP BREAKER
3. AIR – LOCATE LOUVERS IN BUILDING NEAR REAR OF MACHINE
   CAPABLE OF PASSING 2,500 CFM OF FREE AIR (36" x 36" VENT)

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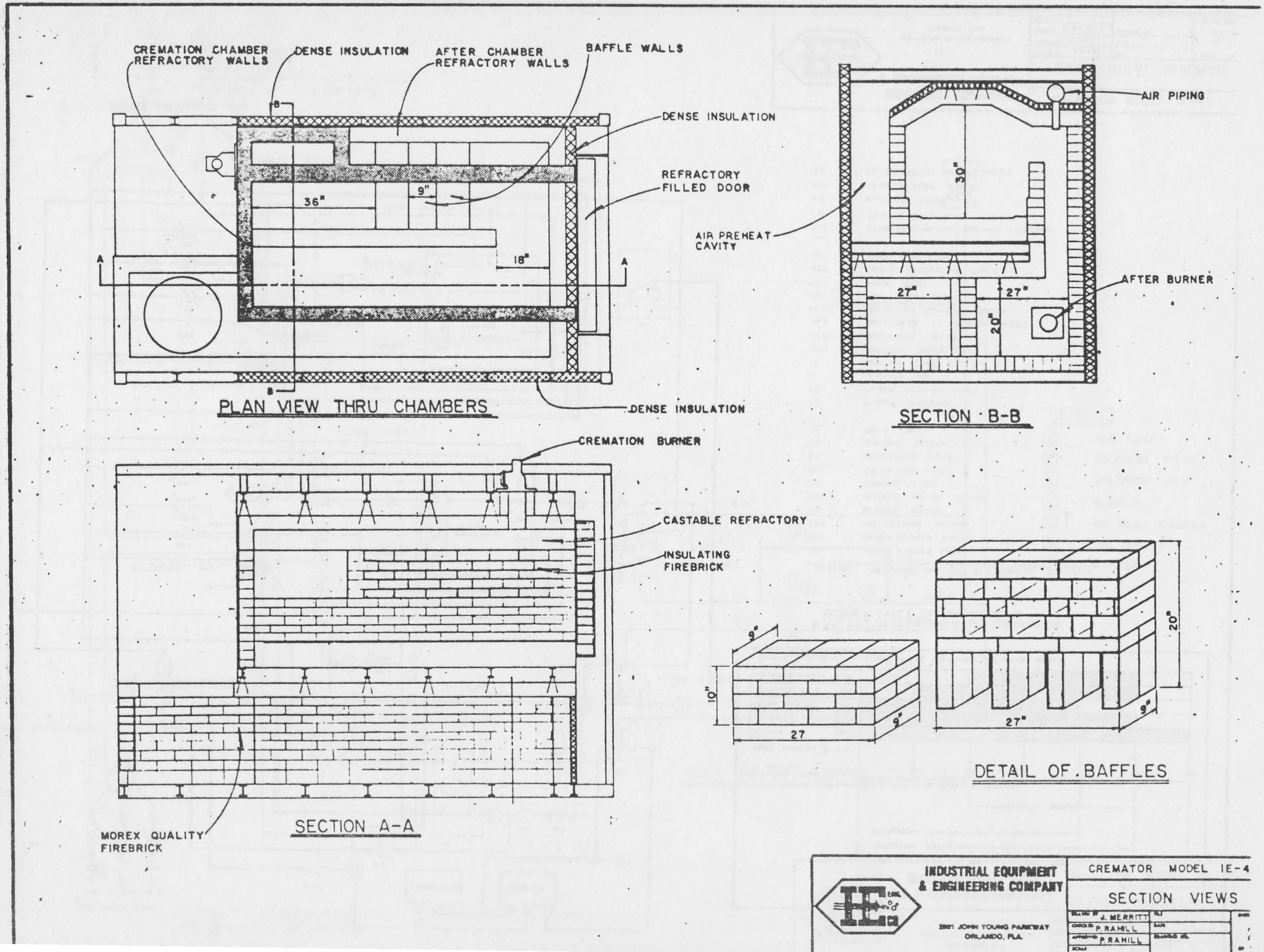
CREMATOR MODEL IE-43

ELEVATION & PLAN VIE


CREMATION CHAMBER REFRACTORY WALLS
DENSE INSULATION
AFTER CHAMBER REFRACTORY WALLS
BAFFLE WALLS
DENSE INSULATION
REFRACTORY FILLED DOOR
36"
9"
18"
A
A
B
B
DENSE INSULATION
PLAN VIEW THRU CHAMBERS
AIR PIPING
30"
AIR PREHEAT CAVITY
AFTER BURNER
27"
27"
20"
SECTION B-B
CREMATION BURNER
CASTABLE REFRACTORY
INSULATING FIREBRICK
MOREX QUALITY FIREBRICK
SECTION A-A
9"
10"
27
9"
20"
27"
9"
DETAIL OF . BAFFLES
INDUSTRIAL EQUIPMENT & ENGINEERING COMPANY
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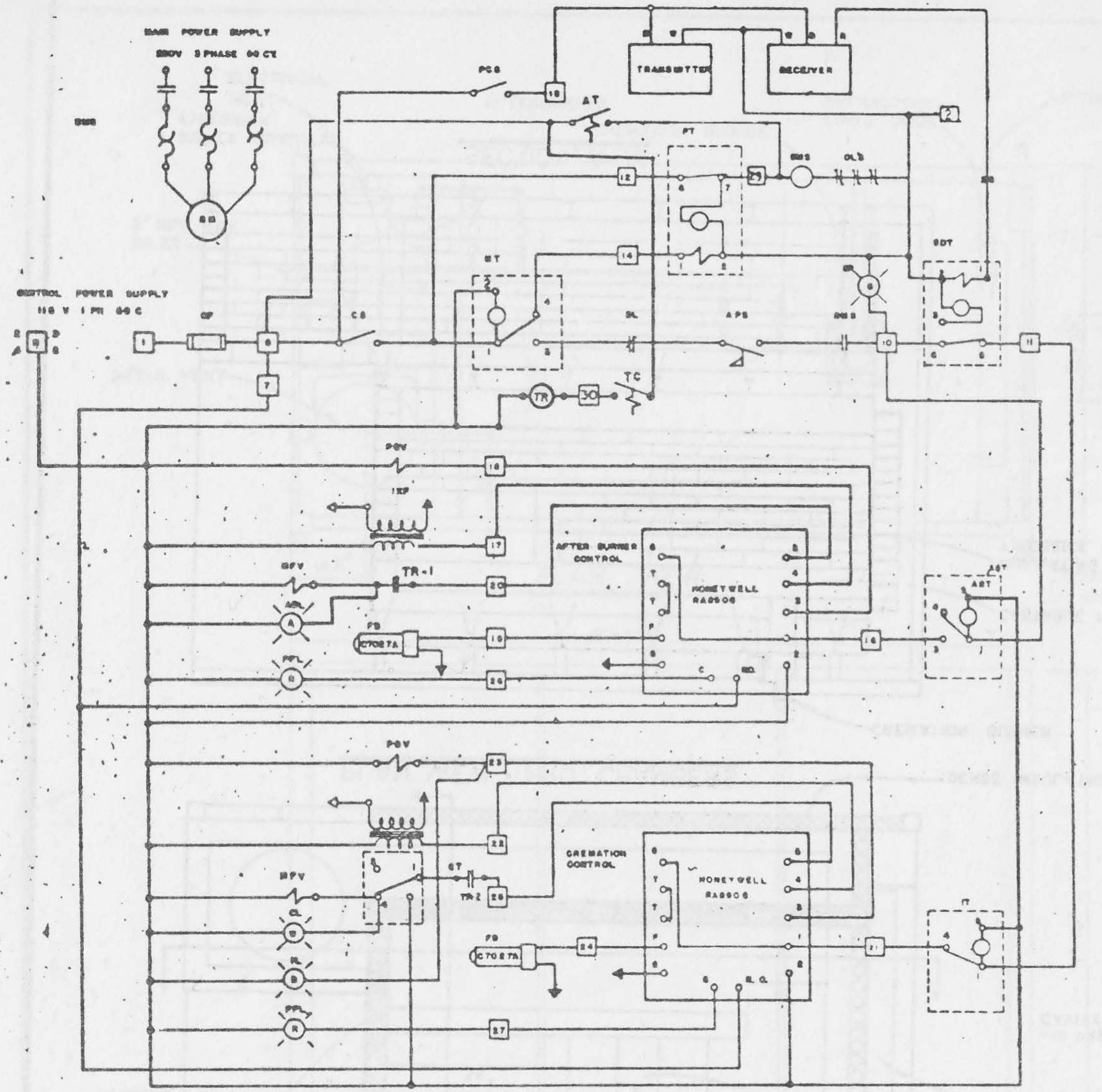
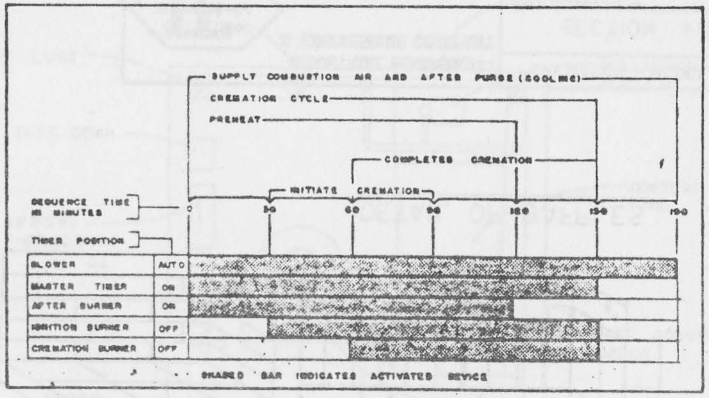
CREMATOR MODEL IE-4
SECTION VIEWS
J. MERRITT
P. RAHILL
P. RAHILL




*NOTE: AFTERBURNER AND CREMATION BURNER CYCLE ON TEMPERATURE

LEGEND: DESIGNATION OF ELECTRICAL DEVICES

| | |
|---|---|
| ABL | AFTER BURNER LIGHT |
| ABT | AFTER BURNER TIMER |
| APS | AIR PROVING SWITCH |
| BM | BLOWER MOTOR |
| BMS | BLOWER MOTOR SWITCH |
| CF | CONTROL FUSE |
| CL | CREMATION LIGHT |
| CT | CREMATION TIMER |
| CS | CONTROL SWITCH |
| DL | DOOR LIMIT |
| FD | FLAME DETECTOR |
| FFL | FLAME FAILURE LIGHT |
| IL | IGNITION LIGHT |
| IT | IGNITION TIMER |
| IXF | IGNITION TRANSFORMER |
| MFV | MAIN FUEL VALVE |
| OLS | OVERLOADS AT MOTOR SWITCH |
| PCS | POLLUTION CONTROL SWITCH |
| PGV | PILOT GAS VALVE |
| PT | PURGE TIMER |
| SDT | SMOKE DECTECTOR TIMER |
| SR | SAFE RUN LIGHT |
| □ | DENOTES CONTROL CABINET TERMINAL |
| o | DENOTES EQUIPMENT TERMINAL |
| AT | AMBIENT THERMOSTAT |
| TR | TEMPERATURE RELAY |
| TC | TEMPERATURE CONTROLLER |

INDICATOR LIGHTS COLOR CODE

| | | |
|---|---|---|
| A | AMBER | AFTER BURNER ON |
| B | BLUE | IGNITION BURNER ON |
| G | GREEN | SAFE RUN |
| R | RED | RESET FLAME FAILURE |
| W | WHITE | CREMATION BURNER ON |

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ELECTRICAL DIAGRAM

DRAWN BY J. MERRITT
CHECKED P. RAHILL
APPROVED P. RAHILL

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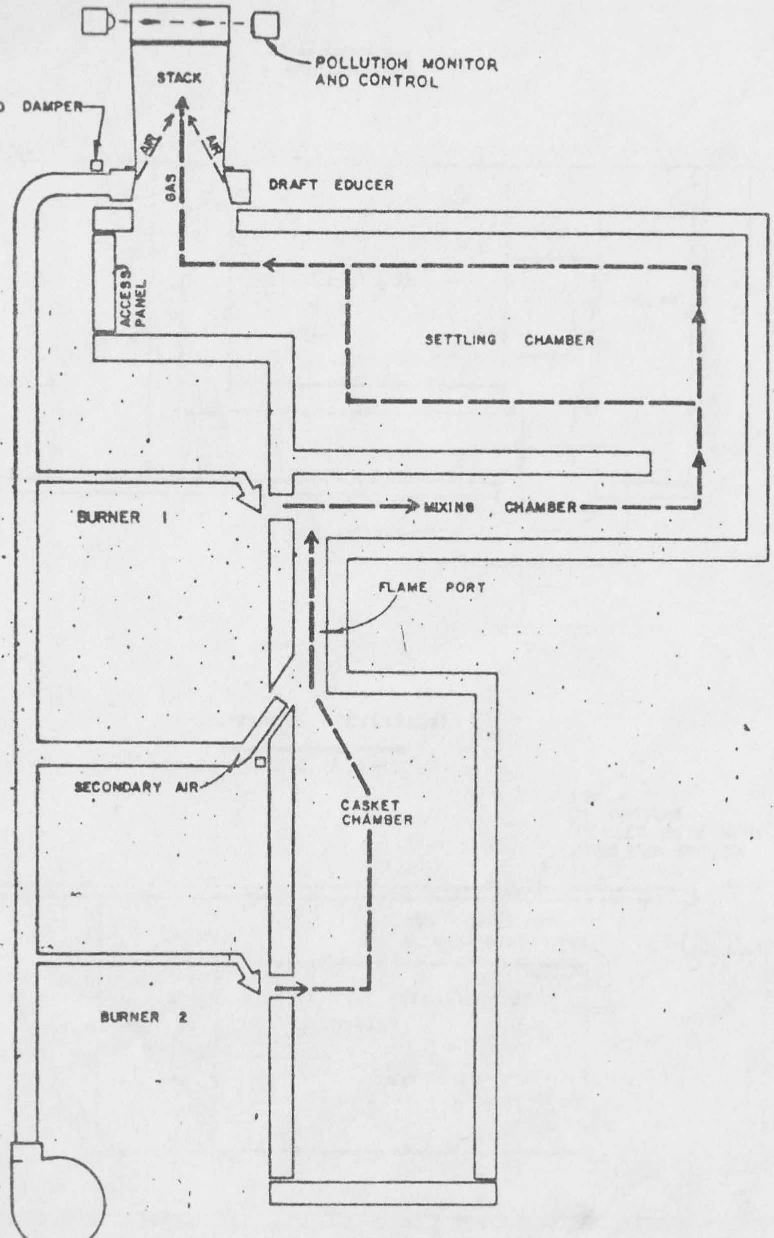
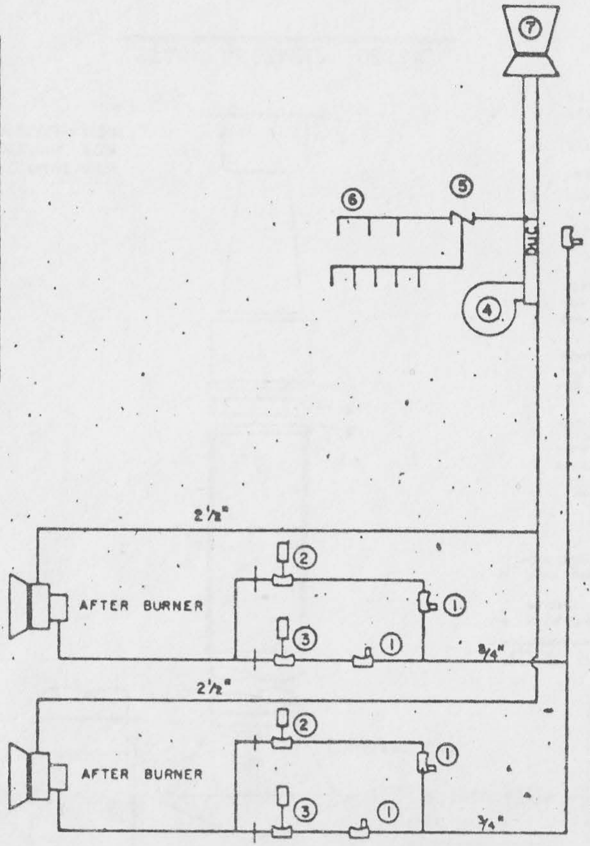



FLOW SCHEMATIC




GAS & AIR PIPING SCHEMATIC

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FLOW DIAGRAM

J. MERRITT
P. RAHILL
P. RAHILL

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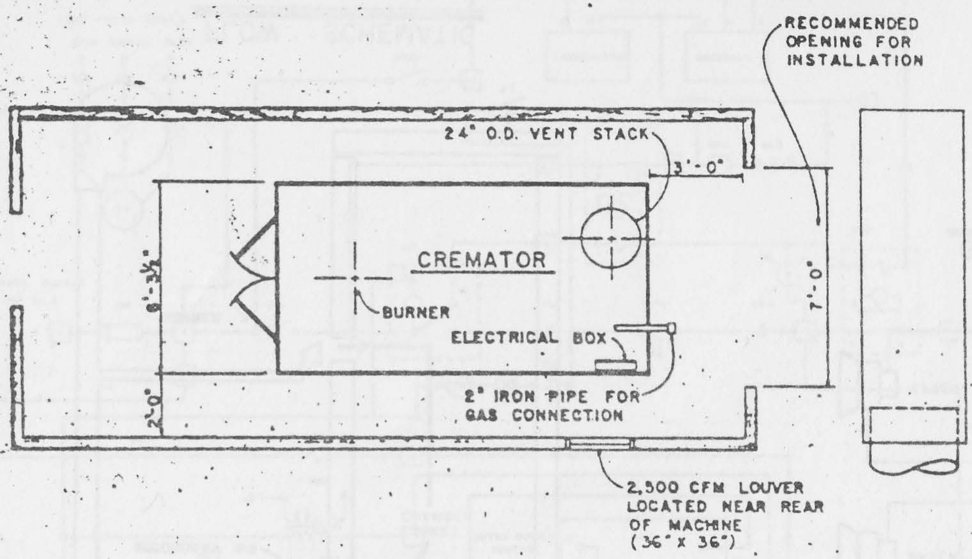
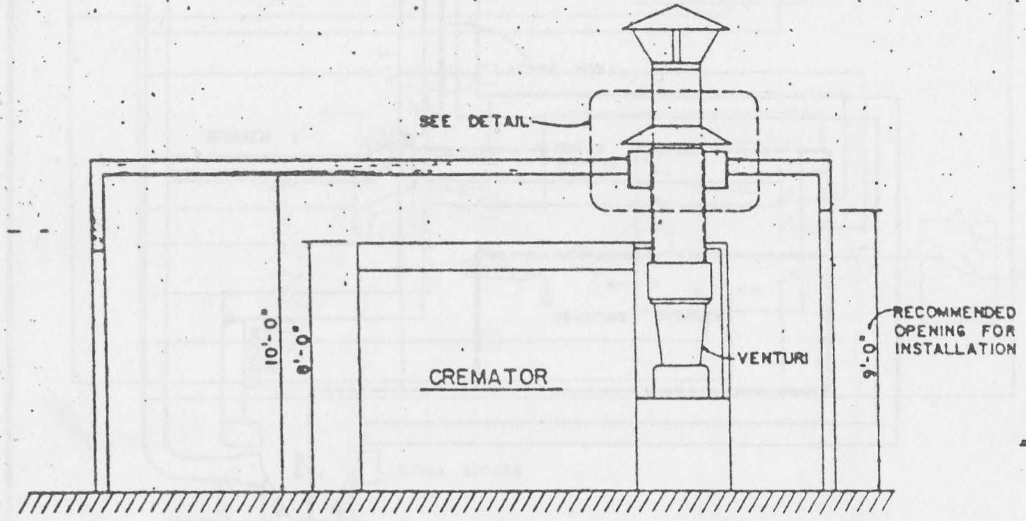
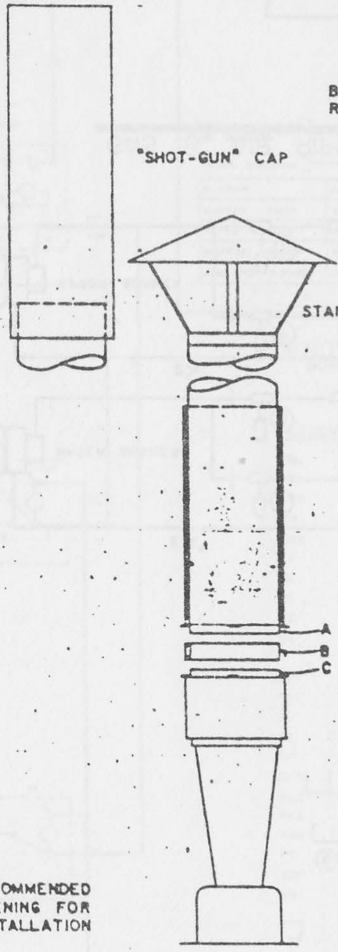



## PLAN VIEW

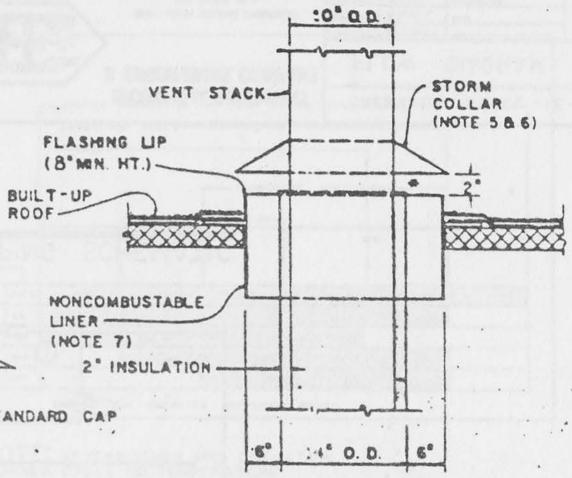
(MINIMUM CLEARANCES)




## SECTION




## STACK ASSEMBLY DETAIL




## ROOF PENETRATION DETAIL

* INSULATION MUST EXTEND 4" ABOVE ROOF FOR PROTECTION OF ROOFING MATERIALS

* ROOF OPENING MUST BE 36" FOR PROPER STACK CLEARANCE.

### STACK ASSEMBLY INSTRUCTIONS

1. PLACE DRAWBAND (B) ONTO PHOTO. LIGHT COLLAR (C) IT WILL REST ON THE SUPPORT TABS ON PHOTO COLLAR.
2. LOWER VENT STACK DOWN UNTIL THE LIP (A) WITH SUPPORT TABS RESTS ON TOP OF DRAW BAND (B)
3. TIGHTEN DRAWBAND BOLTS EVENLY UNTIL IT FORMS A TIGHT CONNECTION BETWEEN VENT. STACK AND PHOTO. COLLAR.
4. IF 50 % OF THE STACK LENGTH IS ABOVE THE ROOF, GUY WIRES SHOULD BE CONSIDERED.
5. STORM COLLAR SEALED TO STACK WITH HI-TEMP SILICON CAULKING PROVIDED BY IEE.
6. STORM COLLAR FURNISHED BY IEE CO.
7. FLASH (NON-COMBUSTIBLE LINER) PROVIDED BY CUSTOMER

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BUILDING LAYOUT

| | | |
|---|---|---|
| E.C. | | 5 |
| P.R. | | |
| P.R. | | |
| N.T.S. | | |

This is a reproduction of the original, Leuchter Report I, as it was presented to the court in Toronto, except for the foreword by Dr. Robert Faurisson and the letter by Fred Leuchter to Ernst Zündel regarding the roof vents in his drawings, reproduced on page 42 of this version.