Type Agreement: Purchase Order No. 83-2104

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Sponsor Amount:
Estimated: $9,950
Funded: $9,950

Cost Sharing Amount: None

Purpose: Plan for a Engineering College Wide Occupational Safety and Health Course

Administrative Data:
OCA Contact: William F. Brown Ext. 4820
1) Sponsor Technical Contact: Mr. John Talty, Project Officer
Mr. Carl Hufnagel, Contracting Off.

2) Sponsor Admin/Contractual Matters:
Nat'l Inst. for Occupational Safety & Health
Robert A. Taft Labs
4676 Columbia Parkway
Cincinnati, OH 45226
(513) 684-8217

Military Security Classification: None

Restrictions:
See Attached Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval — Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with

Comments:
Project Director shall notify Grants and Contract Accounting when each task is complete and accepted for billing purposes.

Copies To:
Project Director
Research Administrative Network
Research Property Management
Accounting
GTRI
Library
Project File
Other I. Newton
Procurement/EES Supply Services
Research Security Services
Reports Coordinator (OCA) —
Research Communications (2)
GEORGIA INSTITUTE OF TECHNOLOGY

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 2/5/85

Project No. E-25-615

Includes Subproject No.(s) N/A

Project Director(s) J. L. Carden

Sponsor National Institute for Occupational Safety and Health

Title Plan for an Engineering College Wide Occupational Safety and Health Course

Effective Completion Date: 10/1/83 (Performance) 10/1/83 (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [x] Final Invoice or Final Fiscal Report
- [ ] Closing Documents
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certification
- [ ] Classified Material Certificate
- [ ] Other

Continues Project No.

Continued by Project No.

COPIES TO:

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- GTRI
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- Project File
- Other

M. Heyser
A. Jones
HAZARDOUS MATERIALS

A Lecture

Prepared by

Dr. John L. Carden, Jr.
Nuclear Engineering and Health Physics Program
School of Mechanical Engineering
Georgia Institute of Technology
Atlanta, Georgia 30332

P. O. Number 83-2104

U.S. Department of Health and Human Services
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Training and Manpower Development
Cincinnati, Ohio 45226

November 1984

GEORGIA INSTITUTE OF TECHNOLOGY
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
SCHOOL OF MECHANICAL ENGINEERING
ATLANTA, GEORGIA 30332
Dear John:

Please find enclosed the required copies of my lecture "Hazardous Materials". I have reformatted the lecture as you requested despite the fact that the original version corresponded closely to the format of the NIOSH 510 Course. Your educational materials are presented in a variety of styles as I am sure you are aware and as is well illustrated by the examples you sent to me on 10/18/84. In any case I hope the formatting of this lecture will contribute to a more uniform presentation of your materials. I was pleased to contribute the time required for this task and I hope you will forgive the delay it caused.

I have also enclosed the consent letters you requested for the use of copyrighted material in the handouts. The publishers were most cooperative in granting permission for the use of their materials. As we discussed they requested copies of the lecture and I will comply upon submitting this material to you.

I trust you will agree that the enclosed material fulfills all requirements outstanding on your P.O. 83-2104

The preparation of this material was most enjoyable and I hope it will prove to be of some value to NIOSH. I wish you great success in our important program and I look forward to working with you again in the future.

Sincerely,

John L. Carden, Jr., Ph.D.
Visiting Associate Professor
December 3, 1984

Mr. John L. Carden  
Nuclear Engineering  
Georgia Institute of Technology  
Atlanta, GA 30332

Dear Mr. Carden:

This letter confirms our telephone conversation and grants you permission to make use of the Baker SAF-T-DATA™ Guide in your lecture program.

I've included 20 copies of the guide per your request.

Thank you for your support and interest in J. T. Baker Chemical Company. If I can be of further assistance, please feel free to call.

Sincerely,

John J. Elmo  
Director, Marketing Programs

JJE:imz  
Enclosure  
cc: R.J. Pickerel  
K.R. Weber
November 16, 1984

Dr. John Carden
Nuclear Engineering
Georgia Tech
Atlanta, GA 30332

Dear Dr. Carden:

Enclosed is our MSDS Sheet #1116 on POLYISOCYANATE ACTIVATOR 192-S.

You have our permission to reprint it and incorporate it into your Lecture Material Handout for the NIOSH lecture on finding Hazardous Material Handling info.

Please note that as of September 25, 1984 the former General Electric Co. MSDS Collection was sold to a new spin-off company formed by GE Company employees.

Thank you for using our sheet.

Sincerely,

GENIUM PUBLISHING CORPORATION

( Joseph O. Accrocco
Vice President, Operations

JOA/vlw
enc.
cc: Michael Cinquanti, President
    Robert A. Roy, Manager - New Product Development
November 16, 1984

Dr. John Carden
Nuclear Engineering
Georgia Tech
Atlanta, GA  30332

Dear Dr. Carden:

Please send us a copy of your NLOSH lecture on finding Hazardous Materials Handling Info.

As we discussed, GPC is interested in producing a video tape on various aspects of MSDS Sheet creation and use. We would welcome discussions with you on how you could contribute to this project as a paid consultant.

I will have our MSDS editors review your lecture and we will be back in touch as our plans progress.

Good luck with your important work.

Sincerely,

GENIUM PUBLISHING CORPORATION

Joseph A. Occrocco
Vice President, Operations

cc:  Michael Cinquanti, President
      Robert A. Roy, Manager - New Product Development
HAZARDOUS MATERIALS

A Lecture

Prepared by

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U.S. Department of Health and Human Services
Public Health Service
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National Institute for Occupational Safety and Health
Division of Training and Manpower Development
Cincinnati, Ohio 45226

November, 1984
## LECTURE OVERVIEW

### Hazardous Materials

**METHODS**
Lecture  
**LENGTH:** 50 Minutes

**PURPOSE**
To create an awareness of hazardous materials in the industrial setting, to introduce methods for recognizing these materials and to introduce information sources on hazardous materials.

**OBJECTIVES**
The identification of common hazardous industrial operations, the introduction of labeling systems for hazard control and the introduction of practical sources of information on hazardous materials.

**INSTRUCTOR MATERIALS**
Overhead transparencies prepared from the lecture figures.

**STUDENT MATERIALS**
Handouts contained in lecture package
HAZARDOUS MATERIALS

1. Introduction

Hazardous materials are to be found in virtually every industry. They are there because of necessity or utility, and their presence does not in itself represent a risk to safety or health. The presence of hazardous materials does, however, require that a management system be developed to insure adequate precautions are taken. This lecture deals with the components of such a management system.

1.1. Five industrial activities requiring special attention to hazardous materials

Hazardous materials may be found almost anywhere in an industrial operation (Figure 1). We will consider the problems of hazardous materials in operations that are common to almost every industry. Such common operations include: receiving, storage, distribution, production and waste treatment and disposal.

1.2. Definition of hazardous material

We all have a feeling for what is meant by a "hazardous" material: a material or agent which can in some way inflict harm on people or property is a common sense statement of what we have in mind. Any attempt to make this definition more precise does, however, quickly run into the reality that we are discussing a rather complex and perhaps controversial topic. Drowning after all represents serious harm, but we don't usually consider water a hazardous material. Materials (Figure 2) described by the following adjectives are generally accepted as being hazardous: toxic, explosive, flammable, corrosive and radioactive. Certainly other descriptors could be included, but this list is a good start. Common sense supported by careful consideration of the information available about a particular material is really the best guide; otherwise, it is possible to get into a predicament like that of the EPA in formulating a legally acceptable definition of a hazardous waste. Their definition runs for pages.
1.3. Factors increasing risk

The threat posed by a hazardous material can be increased by a number of common conditions. These include (Figure 3) handling by inadequately trained personnel, transportation from one location to another, transferring from one container to another, storage with incompatible materials and storage in inadequate facilities. We will discuss such risk increasing conditions as we consider each of the five industrial activities listed above.

2. Receiving

We will begin with receiving (Figure 4). This is an important activity for two reasons; the risk is relatively high, and it is the point at which a material should be classified as hazardous so those handling and using it can be alerted. The risk is high because of the extensive handling required in the receiving process, the fact that the laborers actually handling the materials generally do not have the technical training required to fully appreciate the hazard associated with many materials and the temporary storage of incoming incompatible materials until they can be distributed.

2.1. How do you decide if a material is hazardous?

When a material arrives on site it must be characterized with respect to the hazard it poses. Basically it should be known if a material is hazardous and, if so, the severity of the hazard and its nature. If the hazardous materials management system is functioning well, this information will be obtained prior to ordering. The bottom line is, some one must evaluate the hazard associated with all incoming materials. How is this done? There are a number of guides that can assist in dealing with a material that you are not familiar with. I will tell you about the more important ones.

2.1.1. Material Safety Data Sheet (MSDS)

Some years back NIOSH recommended a standard format for providing information about the hazardous properties of chemicals. This format was called a material safety data sheet (MSDS) and while the standard was never adopted the MSDS has become the
most important vehicle for manufacturers of
materials with hazardous properties to inform their
customers. All reputable companies will (if
requested) provide a MSDS with their product. Let
me point out the type of information normally
provided on a MSDS.

The NIOSH recommendation for a standard format for a
MSDS is published as "An Identification System for
Occupationally Hazardous Materials" and is
available as HEW Publication 75-126. Nine classes
of information are required including (Figure 5):
1. Product identification, 2. Hazardous
ingredients, 3. Physical data, 4. Fire and
explosion data, 5. Health hazard information, 6.
Reactivity data, 7. Spill or leak procedures, 8.
Special protection information, and 9. Special
precautions. Let's take a quick look at each class
of information. (Figure 6) "Product Identification"
contains the information necessary to positively
identify the product and to obtain additional
information from the manufacturer if needed. The
manufacturer should have extensive experience with
the material so an emergency telephone number for
the manufacturer can be very valuable in a crisis
situation. Synonyms can also be important if other
information sources must be searched for properties
of the material. (Figure 7) "Hazardous Ingredients"
lists the components of a material. Having this
information allows a more competent judgement of the
hazard associated with a material for your
particular application. For example (Figure 8) a
cleaning agent containing a small amount of
hydrochloric acid might pose a minimal hazard under
most conditions, but if you were also using
formaldehyde in the area, these two components react
in the gas phase to produce bischloromethylether, a
powerful human carcinogen. (Figure 9) "Physical
Data" provides information needed to predict how the
material will behave under varying environmental
conditions. For instance, knowledge of the vapor
pressure data is useful for estimating fire and
explosion hazard or potential for inhalation
exposure while the vapor density allows predictions
concerning the tendency of the vapor to "pool" in
sinks or on the floor. (Figure 10) "Fire and
Explosion Data" provides the basic information
needed to recognize concentrations or conditions
capable of initiating or sustaining combustion.
Fire fighting procedures are also provided including extinguishing agents and likely combustion products.

For some materials (Figure 11) the products of combustion are much more dangerous than the material itself. For example, how about that innocuous and inert material Teflon. Teflon burns in air to form carbonyl fluoride, the fluorine analog of phosgene or nerve gas, and hydrofluoric acid; both of which, as you can see, are very toxic. (Figure 12) "Health Hazard Data" includes a brief description of the health consequences of exposure by various possible routes and appropriate first aid procedures.

(Figure 13) "Reactivity Data" provides information about chemical properties of the material which can lead to health or property threatening conditions. For example, Potassium cyanide would be noted as incompatible with acids. This information is useful for evaluating the safety of planned reactions and for safely arranging chemicals in storage areas.

(Figure 14) "Spill or Leak Procedures" are provided to assist when these inevitable problems occur. Obviously it is far wiser to plan a response than to make a judgement call at the line of scrimmage. Sometimes more is required than just identifying the right neutralizing agent to use on a spill. In April 1974 a 1.2 million-gallon silicon tetrachloride tank in Chicago developed a leak. This material reacts (Figure 15) with water to form hydrogen chloride gas which can then drift with the wind. Before this 8 day emergency was over, 18,000 people were evacuated and three national guard battalions were mobilized. (Figure 16) "Special Protection Information" specifies the personal protective equipment and engineering controls required for safe handling. (Figure 17) "Special Precautions" includes precautionary labels that should be attached to containers of the material and in some cases posted in areas where it is used.

The information and format we have just discussed was recommended by NIOSH, and many companies use this model with some modifications.

Your handout contains an example of a commercial MSDS. This particular one was prepared by the Genium Publishing Corporation on a paint component. Note that the components and their toxicities are listed.
One of them, hexamethylene diisocyanate, is a particularly bad actor, and, as you can see in "Special precautions and comments", is a special problem for allergy-prone individuals. Note that disposal procedures have been included in the category dealing with leaks and spills.

2.1.2. Department of Transportation (DOT) shipping labels

The Department of Transportation (DOT) requires that materials moving in interstate commerce be properly labeled for shipment by common carrier. These DOT labels provide information about the hazards associated with a material. (Figure 18) In particular the label provides information about: the hazard class of the material, the identity of the material, the precautions to be taken in handling, and what to do in case of an emergency. As you can see from the J. T. Baker Chemical Company label included in your handout, the basic requirements have evolved into a system which provides very practical information for formulating an adequate response to an accident or for alerting to potential hazards.

While such labeling is very helpful in evaluating the gross hazard associated with a material, it is not adequate for developing a health protection program for routine use of the material. For instance if you were exposed to acetone routinely you would want to determine what is meant by a "slight" health hazard.

In addition to material safety data sheets and container and shipping labels a number of references are available to provide information about specific materials. Some of these resources are listed in your handout.

2.2. Keeping track of hazardous materials

With the hazardous materials identified and the hazards characterized, what is next? A useful device for maintaining control over hazardous materials is to utilize an inventory system which contains vital information about the materials it tracks. A computer based system is best for this purpose. The system should alert users and handlers
of the hazards involved and provide emergency
response information.

Some regulated substances require special control
procedures and a good inventory control system is
invaluable in maintaining the required records.
Radioactive materials, carcinogens and narcotics
are examples of materials of this type.

2.3. Handling during the receiving process

When materials come on site they must be unloaded
and transferred to a storage location. These tasks
are often performed by poorly trained laborers. The
fact is, these tasks expose those involved to
hazardous materials under conditions which can
easily result in accidents. It is important that
the workers involved understand the hazards and be
trained in dealing with spills, fires, explosions,
exposures and other likely emergencies. The
equipment required to respond to such emergencies
should also be readily available. Specialized
materials handling systems have been devised to
minimize the risk associated with the routing of
some particularly hazardous materials. Ventilation
may also be necessary to control the airborne
concentration of a hazardous material during off
loading to temporary storage.

2.4. Temporary storage during receiving process

It is common to find storage areas in which
potentially hazardous concentrations of materials
develop because of poor ventilation. Many vapors
are heavier than air, thus if the air is still,
vapor tends to concentrate near the floor. Under
such conditions significant concentrations can
develop over time. A ventilation system which
extracts air from near the floor is a good solution
to this problem. In temporary storage, associated
with receiving, it is best to assume the possibility
exists for heavy vapor accumulation since the
materials present are constantly changing.

Another consideration in this type of transient
storage is segregation of incompatible materials.
Obviously it is less than wise to store a bottle of
potassium cyanide next to a bottle of hydrochloric
acid. Many chemical incompatibilities exist, and identifying them can be a real problem! The compromise often adopted is to put materials with gross chemical similarities together. For example, strong oxidizers are stored together and away from easily oxidized materials, strong acids are stored together and away from bases, etc. To help users identify incompatible chemicals, some chemical companies are now including a storage code on their labels. The J.T. Baker label in your handout uses a color code. Chemicals with the same color code can be stored together. Segregation of incompatibles can prevent a minor spill or small fire from becoming a catastrophe.

The storage of flammable materials poses obvious risks and must in most locations meet state or local codes. These codes are generally based on the NFPA or National Fire Prevention Association Codes. Types of containers, allowable volumes, and storage cabinets are among the types of things covered under the NFPA code. The NFPA has also developed a system to alert users or emergency personnel to hazards posed by a material. The NFPA system (Figure 19) uses a diamond label with 4 areas for codes providing hazard estimates. The diamond is divided into blue, red, yellow and white areas. The blue area is for health hazards, the red for flammability, the yellow for reactivity and the white for special hazards such as radioactivity, water reactive etc. A numeric code is used for the first three areas with 0 representing no hazard and 4 representing extreme hazard.

3. Storage of hazardous materials

Many industries store large volumes of hazardous material on site for use as feed stocks. The presence of a few million gallons of this or that is not uncommon. Such stocks represent a real potential for disaster and appropriate precautions must be taken to minimize the risk involved. Tank farms are commonly used for this type of bulk storage. Dikes are built around each tank providing a retaining volume adequate to capture and hold the tanks contents should it rupture. This precaution can often prevent a fire from spreading from an involved tank to its neighbors. Here again things can get complicated however. For instance water
applied to control a tank fire can float out a flammable liquid causing the fire to spread.

Of course stored materials can pose hazards other than fire. Leaking containers or transfer lines can represent a human exposure hazard or a threat to the environment. Inhalation may be the major route of human exposure from such leaks although contaminated clothing and skin can lead to local tissue damage or absorption through the skin. Contaminated clothing can also become a vehicle for carrying the material home. This appears to have been the case with some asbestos workers whose children developed disease associated with asbestos exposure.

The storage of finely divided solids often poses a severe explosion hazard. Storage and transfer equipment must be designed to minimize the possibility of a spark or heat source that could initiate an explosion and to very rapidly relieve pressure if a flame front is initiated.

4. Hazardous materials in the production process

On to the management of hazardous chemicals during their use in an industrial process. It is not unusual for hazardous materials to be used in large quantities ranging from hundreds to thousands of gallons per day.

4.1. Good engineering practice

This imposes a general and overriding need for good engineering practice in the design and maintenance of a facility. Loosing sight of this imperative can be very costly. A deviation from accepted engineering design and testing practice during repairs at a chemical plant in Flixborough in the U.K. resulted in that country's worst industrial accident to date. Fortunately, the failure and ensuing explosion occurred on a Saturday afternoon minimizing the loss of life. Still, of the seventy employees on site at the time of the explosion, 28 (40%) were killed and 36 (51%) required treatment for injuries.

In addition to the overall need for good engineering, there are a number of special
considerations that must be kept in mind when evaluating the safety of a production process.

4.2. Emergency preparedness

Emergencies are nearly inevitable, thus emergency procedures, including evacuation plans, must be meticulously developed. Routes must be devised which avoid areas in which injuries or exposures may occur. Special protective equipment may have to be provided to insure escape. Gas masks are a common device of this sort. In addition to planning, practice is required to improve the chances of success under disaster conditions. Since disaster planning generally involves preparation for an event which has never occurred, drills can help identify hazards or conditions which have been overlooked.

4.3. Job planning and training

An industrial facility will generally have a detailed set of operating procedures. These procedures are very important for insuring adequate control of hazardous materials. The level of detail must go right down to the individual job description. Each worker must understand the threat posed by the materials being used and must know how to get the job done while avoiding this threat.

4.4. Shutdown and Startup

Periods of transition are particularly hazardous times during the normal operation of a facility. Start-ups, shut-downs and switch-overs are typical examples. Procedures for operation during such periods should contain contingencies for unusual events which may occur. It is prudent to have on-site individuals with sufficient training and experience to understand and control the unexpected events which will occur during such periods. The former management at TMI can verify the cost effectiveness of maintaining a staff capable of understanding and responding to abnormal system states. You can hire a lot of good engineers for $3 billion.

4.5. Process intermediates

The hazardous materials in a plant are not limited to raw materials. Intermediates can also represent
a threat if they find their way out of the process and into the working environment. For this reason a thorough knowledge of intermediates and by products is required. The manufacture of trichlorophenoxyacetic acid (the herbicide 2,4,5-T) is a process which has the dubious distinction of having a byproduct many times the toxicity of the product. The byproduct is of course dioxin. The presence of such a material certainly changes the criteria for acceptable engineering controls.

4.6. Engineering control systems

A plant will normally have a number of engineering control systems designed to limit worker exposure to toxic materials. Surveillance of these systems to insure they are providing the protection which they were designed to deliver is very important for controlling worker exposure. Fortunately, adequate surveillance of an engineering control system often only involves the routine measurement of a single relatively simple environmental parameter such as the air velocity into an exhaust hood opening. Individual devices, such as respirators, can in some cases be used for the same purpose, but consider the difficulty in assuring the adequate performance of each of these devices relative to determining if a single exhaust system is functioning adequately.

5. Distribution

Let’s move on to consider the hazards that can be associated with the distribution of some products. Products can themselves be a hazardous material or can be converted into hazardous forms by fire or reactions with common environmental constituents, such as water or air. Such hazards must be considered when planning for storage and distribution of these products. Areas for the storage of such materials while awaiting distribution may require special fire control equipment or ventilation. Segregation of incompatible products may also be required.

5.1. Toxic Substances Control Act

There are a number of laws which regulate products once they are put into commerce. I will mention a few of these laws. The Toxic Substances Control Act
(TOSCA) (Figure 20) went into effect in 1977 and requires toxicological testing and the establishment of use restrictions necessary to prevent unreasonable risk of injury to health or the environment. TOSCA applies to "new" chemicals being introduced into commerce. The designers of the bill sought to establish an acceptable level of consumer and environmental protection without establishing unnecessary economic barriers to innovation. Needless to say both compliance with TOSCA and its enforcement have proven complex. The EPA has the task of enforcement.

5.2. Food, Drug and Cosmetic Act

Foods, drugs and cosmetics production and quality are regulated under, as you might expect, the Food, Drug and Cosmetic Act. This law was passed in 1938 and has undergone a series of significant amendments since. The regulations promulgated under the authority of this bill not only set quality standards for products, but also establish so called "good manufacturing" and "good laboratory" practices. Any production process for items covered by this act must meet these standards. The Food and Drug Administration is charged with rule making and enforcement.

The Consumer Product Safety Act

The Consumer Product Safety Act was passed in 1972 to provide regulation of most items available to the consuming public. Items regulated under other acts were excluded as were a number of clearly unsafe items such as motor vehicles and tobacco. The Act established the Consumer Product Safety Commission (CPSC) as an independent governmental entity. The CPSC was also given the responsibility for enforcing a number of other acts related to consumer protection including:

The Flammable Fabrics Act of 1972
The Federal Hazardous Substances Act of 1967
The Poison Prevention Packaging Act of 1970
The Refrigerator Safety Act of 1956

You are, I am sure, getting the idea. Products do not go from the drawing board to the market place without an investigation of the hazard associated with their use and a review of the law as it may apply to them.
6. Waste Management

Finally, most processes produce some type of waste. In fact many of these wastes have properties which would make their uncontrolled release into the environment hazardous to humans or to the environment. Prior to 1976, the disposal of hazardous chemical waste was regulated under a number of outdated and largely ineffective laws. It is not surprising that under such conditions unscrupulous operators did on occasion dispose of their chemical waste by the cheapest means possible; means which were often totally unacceptable from an environmental or public health point of view. Drum disposal sites like the "Valley of the Drums" in Bullett County, Kentucky are monuments to disposal by disappearance. The infamous Love Canal in New York represents another type of problem. There, the chemical company involved disposed of its waste by burying it in an abandoned canal. The canal actually had good geological properties to contain the waste. The problem of human exposure began when the local government refused to heed the warnings of the company that the land had been rendered unfit for use because of the buried chemicals. The municipality threatened to condemn the land if it was not donated. Eventually the municipality built a school on part of the property and sold part of it to a real estate developer. We all know the sad outcome of inappropriate use of this toxic chemical burial site. Ultimate disposal is not our interest here today, but bare in mind that history has demonstrated that a high degree of supervision is required to protect society.

6.1. Resource Conservation and Recovery Act

We are concerned with the control of hazardous waste on an industrial site. In 1976 the Resource Conservation and Recovery Act (RCRA) (Figure 21) was passed providing a complex regulatory structure with the stated purpose of controlling hazardous chemical waste from cradle to grave.

RCRA requires the following facilities and activities for controlling hazardous waste on site (Figure 22):
* Identification of the waste. This may involve determining the actual chemical composition or it may involve identifying the process producing the waste.
* Waste production rates and schedules
* An inventory system to document waste generation and disposal activities.
* An approved facility for holding or storing waste.
* Training of employees involved in any hazardous waste activities.
* A detailed emergency response plan with the necessary equipment.

The regulations relating to these requirements are found in Title 40 of the Code of Federal Regulations in subparts 260 through 262. Subpart 263 contains regulations for transporters of hazardous chemical waste, and subparts 264 and 265 contain regulations for treaters, storers, or disposers.

Hazardous materials can be used safely, but doing so requires adequate knowledge of the potential problems they can produce and what conditions lead to the expression of these problems. With this information handling, storage, use and disposal can be engineered so that risk to personnel, property and the environment is acceptable.

Suggested Reading

OPERATIONS THAT MAY POSE A HAZARDOUS MATERIALS RISK

* receiving
* storage
* production
* distribution
PROPERTIES THAT MAKE A MATERIAL HAZARDOUS

* toxicity
* explosivity
* flammability
* corrosivity
* radioactivity
* biological activity
CONDITIONS THAT INCREASE THE RISK POSED BY A HAZARDOUS MATERIAL

* handling by inadequately trained personnel
* transportation
* transferring from one container to another
* storage with incompatible materials
* inadequate storage facilities
RECEIVING

* risk is relatively high because of:
  * extensive handling of materials
  * skill level of workforce
  * transient storage

* hazardous materials should be identified and labeled so that they can be followed from distribution to disposal
INFORMATION TO BE FOUND ON A
MATERIAL SAFETY DATA SHEET (MSDS)

1. product identification
2. hazardous ingredients
3. physical data
4. fire and explosion data
5. health hazard information
6. reactivity data
7. spill or leak procedures
8. special protection information
9. special precautions
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<tr>
<td>ADDRESS</td>
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<td>TRADE NAME</td>
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<tr>
<td>SYNONYMS</td>
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FIGURE 6
## II HAZARDOUS INGREDIENTS

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<th>MATERIAL OR COMPONENT</th>
<th>%</th>
<th>HAZARD DATA</th>
</tr>
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</table>

**FIGURE 7**
HYDROCHLORIC ACID + FORMALDEHYDE

TLV = 5ppm
TLV = 2ppm

react in air to form

BIS(CHLOROMETHYL) ETHER + WATER

TLV = 0.001PPM

FIGURE 8
### III PHYSICAL DATA

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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<tr>
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<td><strong>MELTING POINT</strong></td>
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<tr>
<td><strong>SPECIFIC GRAVITY ( \text{H}_2\text{O}=1 )</strong></td>
<td><strong>VAPOR PRESSURE</strong></td>
</tr>
<tr>
<td><strong>VAPOR DENSITY ( \text{AIR}=1 )</strong></td>
<td><strong>SOLUBILITY IN \text{H}_2\text{O}, % BY WT.</strong></td>
</tr>
<tr>
<td><strong>% VOLATILES BY VOL.</strong></td>
<td><strong>EVAPORATION RATE (BUTYL ACETATE=1)</strong></td>
</tr>
<tr>
<td><strong>APPEARANCE AND ODOR</strong></td>
<td></td>
</tr>
</tbody>
</table>

*FIGURE 9*
<table>
<thead>
<tr>
<th>IV FIRE AND EXPLOSION DATA</th>
</tr>
</thead>
</table>
| **FLASH POINT**  
  (TEST METHOD) | **AUTOIGNITION**  
  TEMPERATURE |
| FLAMMABLE LIMITS IN AIR, % BY VOL. | LOWER | UPPER |
| EXTINGUISHING MEDIA | |
| SPECIAL FIRE FIGHTING PROCEDURES | |
| UNUSUAL FIRE AND EXPLOSION HAZARD | |

**FIGURE 10**
TEFLON
nontoxic

combustion in air
forms

HYDROFLUORIC ACID + CARBONYL FLUORIDE

TLV = 1 ppm  TLV = 2 ppm
V HEALTH HAZARD INFORMATION

<table>
<thead>
<tr>
<th>HEALTH HAZARD DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROUTES OF EXPOSURE</td>
</tr>
<tr>
<td>INHALATION</td>
</tr>
<tr>
<td>SKIN CONTACT</td>
</tr>
<tr>
<td>SKIN ABSORPTION</td>
</tr>
<tr>
<td>EYE CONTACT</td>
</tr>
<tr>
<td>INGESTION</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EFFECTS OF OVEREXPOSURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACUTE OVEREXPOSURE</td>
</tr>
<tr>
<td>CHRONIC OVEREXPOSURE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EMERGENCY AND FIRST AID PROCEDURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>EYES:</td>
</tr>
<tr>
<td>SKIN:</td>
</tr>
<tr>
<td>INHALATION:</td>
</tr>
<tr>
<td>INGESTION:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOTES TO PHYSICIAN</th>
</tr>
</thead>
</table>

FIGURE 12
<table>
<thead>
<tr>
<th>VI REACTIVITY DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONDITIONS CONTRIBUTING TO INSTABILITY</td>
</tr>
<tr>
<td>INCOMPATIBILITY</td>
</tr>
<tr>
<td>HAZARDOUS DECOMPOSITION PRODUCTS</td>
</tr>
<tr>
<td>CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION</td>
</tr>
</tbody>
</table>
## VII SPILL OR LEAK PROCEDURES

**STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED**

**NEUTRALIZING CHEMICALS**

**WASTE DISPOSAL METHOD**

*Figure 14*
SILICONE TETRACHLORIDE + WATER VAPOR

form

SILICONE DIOXIDE + HYDRAZINIC ACID

TLV = 5ppm

FIGURE 15
### VIII SPECIAL PROTECTION INFORMATION

<table>
<thead>
<tr>
<th>VENTILATION REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPECIFIC PERSONAL PROTECTIVE EQUIPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESPIRATORY (SPECIFY IN DETAIL)</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EYE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>GLOVES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>OTHER CLOTHING AND EQUIPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**FIGURE 16**
## IX SPECIAL PRECAUTIONS

### PRECAUTIONARY STATEMENTS

### OTHER HANDLING AND STORAGE REQUIREMENTS

---

**FIGURE 17**
INFORMATION REQUIRED ON DOT LABEL

* hazard class
* identity of material
* precautions
* emergency procedures
NFPA Label for 1,1,1-trichloroethane

<table>
<thead>
<tr>
<th>COLOR CODE</th>
<th>HAZARD RATING SCALE (0 to 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>blue</td>
<td>health</td>
</tr>
<tr>
<td>red</td>
<td>flammability</td>
</tr>
<tr>
<td>yellow</td>
<td>reactivity</td>
</tr>
<tr>
<td>white</td>
<td>special (radioactivity ..)</td>
</tr>
</tbody>
</table>

0  no hazard
4  extreme hazard
TOXIC SUBSTANCES CONTROL ACT

(TOSCA)

FIGURE 20
RESOURCE CONSERVATION AND RECOVERY ACT

( RCRA )
RCRA REQUIREMENTS

ONSITE CONTROL OF HAZARDOUS WASTE

* identification of waste
* waste inventory
* licensed storage and holding facilities
* employee training
* emergency response plan
Useful Literature in Evaluating Health, Safety, and Disposal
Questions Concerning Hazardous Materials

1. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for (stated following year), American Conference of Governmental Industrial Hygienists, P. O. Box 1937, Cincinnati, Ohio 45201. Revised annually.


11. NIOSH Current Intelligence Bulletins, also available through U.S. G.P.O.


14. CHRIS (Chemical Hazards Response Information System) consists of four volumes:
   - CG-446-1: A Condensed Guide to Chemical Hazards
   - CG-446-2: Hazardous Chemical Data
   - CG-446-3: Hazard Assessment Handbook
   - CG-446-4: Response Methods Handbook

All available through U.S. G.P.O. (Also routine updates)
An easy-to-understand hazard classification appears on J.T. Baker labels. It will help increase your awareness of vital occupational health and safety practices. Using the BAKER SAF-T-DATA® System as a guide you can quickly learn the hazards each substance presents to your health and safety, personal laboratory protective equipment that should be used for handling, and the recommended storage of compatible products by color code.

**A NUMERICAL HAZARD CODE**
Substances are rated on a scale of 0 (non-hazardous) to 4 (extremely hazardous) in each of four hazard categories:
- **Health hazard** — the danger or toxic effect a substance presents if inhaled, ingested, or absorbed.
- **Flammable hazard** — the tendency of the substance to burn.
- **Reactivity hazard** — the potential of a substance to explode or react violently with air, water or other substances.
- **Contact hazard** — the danger a substance presents when exposed to skin, eyes, and mucous membranes.

**HAZARD SYMBOL**
A substance rated 3 or 4 in any hazard category will also display a hazard symbol. These easy-to-understand pictograms emphasize the serious stance presents to your health and safety, personal laboratory protective equipment that should be used for handling, and the recommended storage of compatible products by color code.

**STORAGE COLOR CODING**
The SAF-T-DATA label suggests a unique method for setting up your chemical storage area. Compatible products are labelled with the same color. Simply group these colors together and follow the recommendations for appropriate storage:
- **BLUE** — health hazard. Store in a secure area.
- **RED** — flammable hazard. Store in a flammable liquid storage area.
- **YELLOW** — reactivity hazard. Store separately and away from flammable or combustible materials.
- **WHITE** — contact hazard. Store in a corrosion proof area.
- **ORANGE** — substances with no rating higher than 2 in any hazard category. Store in a general chemical storage area.

**STRIPE LABELS** — incompatible materials of the same color class have striped labels. These approximately 40 products should not be stored adjacent to substances with the same colored labels. Proper storage must be individually assessed.

**B LABORATORY PROTECTIVE EQUIPMENT**
This series of pictograms suggests the personal protective clothing and equipment recommended for use when handling the substance in a laboratory situation. The pictograms relate to the combination of hazards presented by the substance.

**C SPILL CONTROL CODE**
This statement indicates which J.T. Baker spill control kit is recommended for use with the substance.

**E NFPA SYSTEM**
This system was adopted by the NFPA in 1975 to safeguard the lives of firefighters. It is based on the hazards created by a substance in a fire situation. For this reason, the hazard ratings in the Baker SAF-T-DATA® System, which are based on substances in a laboratory situation, will not always correspond with the NFPA ratings.

*National Fire Protection Association
SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: POLYISOCYANATE ACTIVATOR 192-S (VG-Y-259)
DESCRIPTION: Activator components for 2-part polyurethane enamel (see MSDS #1117)
MANUFACTURER: E.I. duPont de Nemours & Co., Inc.
Finishes & Fabricated Products Department
Wilmington, DE 19898
Telephone: (302) 774-2421

SECTION II. INGREDIENTS AND HAZARDS

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>%</th>
<th>HAZARD DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethyl Acetate (MSDS 437)</td>
<td>56*</td>
<td>8-hr TWA 400 ppm</td>
</tr>
<tr>
<td>CELLOSOLVE Acetate (MSDS 321)</td>
<td>5*</td>
<td>50 ppm (skin)**</td>
</tr>
<tr>
<td>Xylene (MSDS 318)</td>
<td>5</td>
<td>100 ppm (skin)</td>
</tr>
<tr>
<td>Poly(isocyanate) Component</td>
<td>-</td>
<td>No TLV Established</td>
</tr>
<tr>
<td>Hexamethylene Diisocyanate &lt;0.7% free monomer content based on solids</td>
<td>-</td>
<td>0.02 ppm</td>
</tr>
</tbody>
</table>

*Exact composition is classified as proprietary by manufacturer
**ACGIH(1983) TLV; (1983 Intended Changes List) TLV 5ppm (skin) (A suspected reproductive hazard in animal tests.) OSHA PEL 100 ppm

SECTION III. PHYSICAL DATA

- Boiling range, 1 atm, deg F: 168-347
- Specific gravity (H2O=1): 0.965
- Vapor pressure, mm Hg (main solvent): 100
- Percent volatile by vol.: 72.0
- Vapor density (Air=1) (main solvent): 3.0
- Evaporation rate (Ether=1): >1
- Solubility in water: Appreciable (reacts)

Appearance & Odor: Clear, pale yellow liquid; strong solvent odor.

SECTION IV. FIRE AND EXPLOSION DATA

<table>
<thead>
<tr>
<th>Flash Point and Method</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between 20 &amp; 73 F (CC)</td>
<td>1.1</td>
<td>11.2</td>
</tr>
</tbody>
</table>

Extinguishing media: Foam, carbon dioxide, dry chemical. Water spray may be ineffective against fire, but should be used to cool closed containers to prevent pressure built-up when exposed to extreme heat. Use CO2 or dry chemical for small fires. Use foam or water fog as blanketing effect in large fires.

This flammable liquid is a dangerous fire hazard when exposed to heat or flame. Firefighters should use a self-contained breathing apparatus.

Warning - vapor and spray mists are harmful.

SECTION V. REACTIVITY DATA

This material is stable in closed containers under normal storage conditions. Hazardous polymerization will not occur. Incompatible with oxidizing agents. Reacts with water. Do not mix enamel and activator until ready to use. An OSHA class IB flammable liquid. Hazardous decomposition products can include CO, CO2, smoke, nitrogen, and oxides of nitrogen.
SECTION VI. HEALTH HAZARD INFORMATION

Effects of overexposure from vapor or mist inhalation include irritation to mucous membranes and respiratory tract, dyspnea, coughing and chest pain. Early signs may be mistaken for a cold. Contact with the skin can cause defatting and possible dermatitis. Can cause eye irritation on contact. Possible sensitization from isocyanates.

FIRST AID:
- Eye Contact: Flush thoroughly with running water for 15 min. including under eyelids.
- Skin Contact: Remove contaminated clothing. Wash affected area with soap and water.
- Inhalation: Remove to fresh air. Restore and/or support breathing as required.
- Ingestion: Contact physician. Give water or milk to drink. Induce vomiting if medical help is not available and victim is conscious and alert.

Seek medical assistance for further treatment, observation and support after first aid.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel. Remove sources of heat and ignition. Provide explosion-proof ventilation. Clean up personnel need protection against skin or eye contact and vapor inhalation.

Collect spill using inert absorbant & non-sparking tools. Place in an approved metal container for disposal.

DISPOSAL: Waste may be buried in an approved landfill or burned in an approved incinerator with a scrubber. Follow Federal, State, and Local regulations. EPA (RCRA) HW No. D001 (ignitable); 40 CFR 261

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general & local exhaust ventilation (explosion-proof) to meet TLV & LEL requirements. Use NIOSH/MSHA TC-19C air line respirator or an equivalent for emergency or nonroutine procedures. Use of NIOSH/MSHA TC-23C (vapor/particulate) may be satisfactory. Wear protective gloves and apron where necessary to avoid skin contact. Use chemical safety glasses or goggles in areas where splashing may occur. An eyewash fountain and washing facilities should be available near use areas.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a well ventilated area away from heat, sparks, and open flame. Do not store above 120 F. Keep containers closed when not in use. Ground and bond containers when transferring to avoid static sparks. Use non-sparking tools. Electrical services must meet code. Handle as OSHA Class IB flammable liquid. Avoid breathing vapors or mist. Avoid contact with skin or eyes. Follow good personal hygiene. Allergy-prone individuals may be sensitized and should not be exposed to isocyanates. Observe label precautions. Animal tests with CELLOSOLVE Acetate indicate possible reproduction hazards for humans from this solvent.

DATA SOURCE(S) CODE: 1, MSDS #437,321,318

APPROVALS: MIS/CRD

INDUST. HYGIENE/SAFETY 94/88

MEDICAL REVIEW: 17 September 1983

GENIUM PUBLISHING