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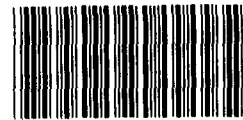
United States General Accounting Office

Report to the Chairman, Committee on
Energy and Commerce, House of
Representatives

September 1990

MOTOR VEHICLE SAFETY

Information on Accidental Fires in Manufacturing Air Bag Propellant



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**Resources, Community, and
Economic Development Division**

B-240858

September 28, 1990

The Honorable John D. Dingell
Chairman, Committee on Energy
and Commerce
House of Representatives

Dear Mr. Chairman:

In response to your September 22, 1989, request, this report discusses recent accidental fires at the U.S. and Canadian facilities that make gas generant (propellant) for automobile air bags and at the Canadian facility that makes sodium azide, which is a main propellant ingredient. As agreed with your office, we identified the (1) general hazards associated with manufacturing propellant; (2) causes of the fires and resulting injuries; (3) safety and health investigations conducted at the U.S. facilities; and (4) the impact of the fires on suppliers' ability to meet the automotive industry's air bag needs. As explained in detail later in the scope and methodology section, some information on the causes of the fires, results of investigations, and manufacturers' corrective actions is based on unconfirmed oral evidence. The manufacturers would not provide us with some documentary evidence because they considered the information to be proprietary.

Results in Brief

Air bag propellant manufacturing is not risk-free because sodium azide, while not an explosive, can form explosives. When sodium azide comes in contact with an acidic solution such as water, it becomes hydrazoic acid, an explosive, which can detonate from shock or heat. Also, if sodium azide comes into contact with heavy metals such as copper or lead it may form new compounds that are extremely sensitive and easily detonated. Manufacturers told us that they control and monitor to prevent conditions that may create hydrazoic acid or expose sodium azide to heavy metals in the manufacturing process.

The three principal manufacturers (2 U.S. and 1 Canadian) of air bag propellant for the U.S. automotive industry and the principal manufacturer (Canadian) of sodium azide have had a total of 11 sodium azide-related fires since February 1988. The two U.S. manufacturers have had two accidental fires each but no fatalities or serious injuries. The Canadian sodium azide manufacturer has had two fires but no fatalities or

serious injuries. The Canadian propellant manufacturer had five accidental fires and no fatalities; four employees were seriously injured in two of the five fires.

Two U.S. fires occurred in Arizona and were investigated by the responsible state agency. The agency's investigations showed that human error was the most probable cause of both fires. The other two U.S. fires occurred in Utah and were investigated by the manufacturer. The manufacturer's investigations showed that one accident resulted from equipment failure and the other, most likely, from hydrazoic acid or metal azide. Both manufacturers told us that corrective actions, such as requiring employees to take safety training, revising a safety manual, and redesigning equipment and facilities, have been taken or initiated.

Six of the seven Canadian accidents were investigated by the manufacturer and the seventh was investigated jointly by the responsible Canadian agencies and the manufacturer. The manufacturers told us that four accidents were caused by human error, one by improper equipment design, one by improper manufacturing procedure, and one by improper equipment design and human error combined. After the last fire at the propellant manufacturer's facility in March 1990, Canadian agencies closed the facility until the investigation is completed and corrective action taken to ensure a safe workplace. The manufacturer expects to reopen for production in October 1990. Both manufacturers told us that they have corrected or are correcting the problems identified.

To ensure that employees are provided with a safe and healthy work environment at the two U.S. manufacturers' facilities, Arizona and Utah agencies have conducted five investigations. These are in addition to the two accident investigations that Arizona conducted. The Arizona agency conducted four investigations in 1989—three before and one after the two fires. It found that the manufacturer had failed to adequately inform and/or train employees on the potential hazards of chemicals being used. The Utah agency found in a September 1986 investigation that the manufacturer was complying with applicable safety and health requirements.

The 11 fires disrupted both sodium azide and propellant production. Despite these disruptions, U.S. manufacturers have been able to keep the automotive industry supplied with the propellant needed for driver-side air bags—the great majority of the demand. However, the Ford Motor Company has had to market about 75,000, 1990 luxury cars

without passenger-side air bags because the Canadian plant was closed after the March 1990 fire.

Background

Chrysler, Ford, and General Motors are installing driver-side air bags in an increasing number of passenger cars to comply with a National Highway Traffic Safety Administration (NHTSA) safety requirement. Air bag demand increased from about 500,000 in model year 1989 to about 2 million in model year 1990, and is expected to increase to 5 or 6 million in 1993. Ford is the only U.S. manufacturer to offer passenger-side air bags as standard equipment in some of its model year 1990 cars.

The propellant for air bags is made primarily from sodium azide blended with an oxidizer, such as cupric oxide or ferric oxide, and is hermetically sealed in an inflator. According to NHTSA, sodium azide based propellant is (1) safe and stable when hermetically sealed in the inflator and (2) ideally suited for air bags because, as part of the propellant, it does not explode when ignited, but begins a burning process that generates nontoxic nitrogen gas to inflate the air bag. Research is being conducted to develop other types of propellants, but to date, there is no approved alternative to sodium azide.

Hazards and Safety Procedures Involved With Manufacturing Air Bag Propellant

Because of the inherent nature of sodium azide, manufacturing air bag propellant is not risk-free. Sodium azide, while not an explosive by itself, forms an explosive (hydrazoic acid) when it comes into contact with an acidic solution such as acid water and can detonate from shock or heat. Also, when sodium azide comes into contact with heavy metals such as copper or lead it may form new compounds that are extremely sensitive and can also be detonated by impact or heat. Manufacturers told us they control and monitor to prevent conditions that may create hydrazoic acid or expose sodium azide to heavy metals in the manufacturing process.

NHTSA and knowledgeable chemists believe that manufacturing processes and procedures are available to produce air bag propellant safely. In addition to controlling and monitoring for the formation of explosives, the processes and procedures include such measures as (1) installing blow-out walls in the event of a fire or explosion to channel and control the forces generated, (2) using remote control to allow employees to conduct operations from a safe area, (3) performing different manufacturing steps in separate buildings to minimize employee exposure to potential dangers, (4) monitoring the air within the plant,

(5) requiring employees to wear protective clothing and safety goggles, and (6) inspecting process equipment and facilities to ensure that sodium azide is not exposed to heavy metals. (See app. I.)

Accidental Fires, Causes, and Resulting Injuries

Between February 1988 and May 1990, TRW Vehicle Safety Systems, Inc., in Mesa, Arizona, and Morton International, in Ogden, Utah, (U.S. propellant manufacturers) had two accidental fires each, and Sabag, Inc., McMasterville, Quebec, (Canadian propellant manufacturer) had five fires. Additionally, CIL Inc., in McMasterville, Quebec, (Canadian manufacturer of sodium azide) had two fires.¹ Sodium azide was involved in all 11 fires, and each fire was investigated by either the manufacturer involved or by an external organization. No employees were killed in the 11 fires. Also, no one was seriously injured in the four U.S. fires. In two of the seven Canadian fires, four employees were seriously injured. NHTSA believes the safety measures manufacturers have built into their facilities and operations before the accidents occurred contributed largely to the fact that there were no fatalities.

The two TRW fires, which occurred on June 16 and July 28, 1989, were investigated by the Arizona Division of Occupational Safety and Health (ADOSH). ADOSH found that human error was the most probable cause of both fires. According to their investigation of the June 16 fire, equipment was not maintained as required; consequently sodium azide and other chemicals were exposed to heat. ADOSH cited TRW for failing to eliminate a recognized hazard from the workplace that could result in death or serious injury. Concerning the July 28 fire, ADOSH concluded that the most probable cause was a spark from a metal scoop accidentally dropped into equipment used to blend sodium azide and other chemicals. As a result of these accidents, TRW took several actions to improve workplace safety. For example, TRW (1) established a requirement that all employees take 40 hours of safety training, (2) revised its safety manual to require a written test for job certification, and (3) started to construct separate buildings for performing its major manufacturing steps, which reduces the number of employees exposed to potential harm in the event of an accident.

The two Morton fires, which occurred on July 24 and August 14, 1989, were investigated by Morton officials. According to the investigation, the July fire started when a spark from a broken press part ignited the

¹CIL was renamed ICI Explosives-Canada on May 1, 1990. CIL has been producing sodium azide for over 40 years and is the only commercial producer in North America.

propellant. The August fire started when the propellant mixture was ignited by a unknown source. Morton officials told us that several corrective actions have been taken to prevent recurrence of similar problems and to improve overall workplace safety. Corrective actions include (1) running inert material through the press to ensure that it is working properly and (2) installing fireproof cabinets to store finished propellant after it is manufactured.

Of the five Sabag fires, which occurred between February 1988 and March 1990, four were investigated by the manufacturer and the fifth was investigated jointly by two Canadian agencies—Department of Energy, Mines, and Resources, Office of the Chief Inspector of Explosives; and the Commission of Health and Work Security—and the manufacturer. According to the manufacturer, hydrazoic acid was the most probable cause of one fire. The manufacturer was using dry ice to cool equipment, and moisture from the ice came into contact with sodium azide. The most probable cause of another fire was copper azide and human error combined. Brass screws used to secure a conveyor lid first caused copper azide to form and then was ignited from the shock of a mallet being used by employees to dislodge a blocked conveyor. The manufacturer said human error was the most probable cause of the other fires. Specifically,

- an employee was making adjustments to a machine before it had been decontaminated (cleaned), and a spark from a screwdriver ignited the propellant mix;
- employees failed to secure a dust filter properly, and a spark ignited the propellant mix; and
- maintenance employees, without proper clearance, were drilling above a piece of equipment, and the cuttings from the drill ignited the propellant mix.

The Department of Energy, Mines, and Resources and the Commission of Health and Work Security closed the Sabag plant until the investigation of the fifth fire was completed and the problems are corrected. The manufacturer expects to reopen the plant for production in October 1990. Moreover, the manufacturer told us that action had been or is being taken to correct the problems identified in this investigation, as well as the other investigations. For example, liquid nitrogen is now being used to cool equipment in place of dry ice.

CIL investigated its two fires, which occurred on October 8 and November 1, 1989. CIL officials said that a pressure-reducing valve regulating steam heat going to equipment used to dry the sodium azide (dryer) was the most probable cause of the first fire. The valve was located too close to the dryer and caused the sodium azide to overheat. The officials also said the most probable cause of the second fire was sodium azide contacting raw sodium. They were temporarily storing wet sodium azide in drums that had previously contained raw sodium. The drums were to have been cleaned before storing wet sodium azide, but one was not. CIL officials said that they have (1) relocated the valve, (2) stopped storing wet sodium azide in drums that previously contained raw sodium, and (3) established rigid procedures to verify that the drums are clean. (See app. II.)

Safety and Health Investigations at U.S. Facilities

The Occupational Safety and Health Administration (OSHA), Department of Labor, has primary responsibility for ensuring that employees are provided with a safe and healthy work environment. OSHA can delegate this responsibility to any state that develops an approved plan that adopts standards and enforcement requirements which are at least as effective as federal requirements. Currently, 25 states have approved plans, including Arizona and Utah—the states where propellant is made.

Investigations at TRW

TRW purchased the Mesa, Arizona, propellant facilities from Talley Defense Systems in April 1989. Since that time, ADOSH has conducted four investigations in addition to the investigations it conducted of TRW's two fires. Three investigations were made prior to the first fire in June 1989. In its first investigation, ADOSH cited TRW for (1) not maintaining in the workplace copies of safety data sheets for each hazardous chemical being used and (2) not providing required information and training to employees on hazardous chemicals used in the workplace. ADOSH classified each violation as serious and initially assessed TRW a \$700 penalty—\$350 for each violation. ADOSH reduced the penalty to \$400 because TRW had inherited some of the problems from the previous owner and because of TRW's positive attitude and corrective efforts. The next two investigations did not identify any serious safety or health violations.

The last investigation, conducted after the July 1989 fire, showed that some employees were still working with sodium azide without receiving proper training about its hazards. ADOSH again classified this violation as

serious and assessed TRW a \$1,000 penalty. ADOSH reduced the penalty to \$640 because TRW was in the process of implementing a hazard communication program at the time of the investigation. TRW told us that the program was administered to all employees by the end of October 1989.

We did not evaluate the reasonableness of the penalties assessed by ADOSH because it was not within the scope of this review. (See app. III.)

Investigations at Morton International

On September 25, 1986, Utah Occupational Safety and Health (UOSH) conducted a safety investigation of Morton's facilities for manufacturing air bags.² UOSH found that Morton was in compliance with applicable safety requirements and reported that Morton had an excellent attitude toward safety. According to the director, UOSH did not investigate either of the two Morton fires because neither fire met the criteria for triggering an investigation. (See app. III.)

Impact of Fires on Supply

Although the accidents have disrupted production and reduced the supply of both propellant and sodium azide, U.S. propellant manufacturers have been able to meet the automotive industry's demand for driver-side air bags—the great majority of the demand for air bags. The Ford Motor Company, on the other hand, has had to market about 75,000 of its 1990 luxury cars without passenger-side air bags, which were to be standard equipment, because it could not get propellant after the Sabag plant was closed in March 1990. (See app. IV.)

Scope and Methodology

To obtain information on the hazards of making air bag propellant, the accidental fires, and the impact of the fires on the automotive industry, we interviewed NHTSA headquarters officials in Washington, D.C.; TRW officials in Washington, Michigan; and Mesa, Arizona; Morton International officials in Ogden, Utah; CIL Inc. and Sabag officials in McMasterville, Quebec; ADOSH officials in Phoenix, Arizona; and UOSH officials in Salt Lake City, Utah. We toured TRW's air bag plant in Mesa, Arizona, and CIL's sodium azide plant in McMasterville, Quebec.

We requested all internal and external reports prepared on the accidental fires. We received external reports on the two TRW fires and

²Morton International was created in July 1989 by Morton Thiokol, Inc., to handle all its commercial operations, including the manufacture of air bags and propellant.

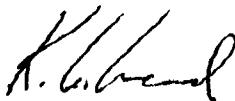
internal reports on the two Morton fires, one of which had large sections deleted for proprietary reasons. Also, we received some written information on the second CIL fire. However, both CIL and Sabag declined our requests for copies of the investigative reports on their seven fires for proprietary reasons. Accordingly, unconfirmed oral evidence supports much of the information related to the fires, particularly those that occurred in Canada.

In addition, we interviewed OSHA headquarters officials and Environmental Protection Agency (EPA) headquarters and regional officials to identify the safety and environmental regulations applicable to the manufacturing of air bag propellant and to ascertain who investigated the accidental fires. Further, we interviewed Chrysler, Ford, and General Motors officials to determine whether the fires adversely affected their production of automobiles. We performed our work between December 1989 and May 1990. We discussed the information in this report with the sodium azide and propellant manufacturers, state agencies, and OSHA, EPA, and NHTSA officials who agree with the facts. However, as requested, we did not obtain official agency comments on a draft of this report.

As agreed with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time, we will provide copies to other interested congressional committees, the Secretary of Transportation, the Secretary of Labor, the NHTSA Administrator, the OSHA Administrator, the EPA Administrator, and other interested parties. If you have any questions about this report, please contact me on (202) 275-1000.

Majors contributors to this report are listed in appendix V.

Sincerely yours,



Kenneth M. Mead
Director, Transportation Issues

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Abbreviations

ADOSH	Arizona Division of Occupational Safety and Health
EPA	Environmental Protection Agency
GAO	General Accounting Office
NHTSA	National Highway Traffic Safety Administration
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit
UOSH	Utah Occupational Safety and Health

Hazards of Manufacturing Air Bag Propellant and Safety Measures to Protect Employees

In its natural state, sodium azide is a colorless crystal that, by itself, is insensitive to impact and friction and will not detonate. Sodium azide based propellant is a low-energy propellant, possessing about one-third the energy of rifle powder and one-thirtieth that of gasoline. However, sodium azide, in acidic solution such as water with a high acid content, forms hydrazoic acid—a highly toxic and volatile chemical which can explode when shocked or heated. Moreover, sodium azide in contact with heavy metals, such as lead, mercury, cadmium, silver, and copper and its alloys can form extremely sensitive explosives that can also be detonated by impact or heat. Manufacturers told us that they control and monitor to prevent conditions that may create hydrazoic acid or expose sodium azide to heavy metals.

Furthermore, sodium azide is a poison and, while it is not mutagenic to humans or carcinogenic, it can cause health problems if it (1) is inhaled, (2) comes into contact with skin or eyes, and (3) is ingested. For example, it can cause severe lowering of blood pressure, severe irritation of the respiratory tract, skin irritations, and blurred vision.

A NHTSA report, Sodium Azide in Automotive Air Bags, originally issued in March 1978 and updated in February 1981, stated that adequate safeguards exist or can be put into place to ensure occupational safety and health. Also, the report stated that sodium azide and inflator manufacturers are experienced in handling chemicals whose danger is at least as great as is the danger of sodium azide.

NHTSA and knowledgeable chemists believe that manufacturing processes and procedures exist to allow safe production of air bag propellant. In addition to controlling and monitoring for hydrazoic acid, the processes and procedures include such measures as (1) installing blow-out walls to channel and control the pressure wave generated in the event of a fire or explosion, (2) using remote control to allow employees to conduct operations from a safe area, (3) performing different manufacturing steps in separate buildings to minimize employee exposure to potential dangers, (4) monitoring the air within the plant, (5) requiring employees to wear protective clothing and safety goggles, and (6) inspecting process equipment and facilities to ensure that sodium azide is not exposed to heavy metals.

Accidental Fires, Causes, and Resulting Injuries

From February 1988 to May 1990, air bag propellant and sodium azide manufacturers have had a total of 11 accidental fires. Internal and external investigations showed that 6 of the 11 fires were caused by human error, and the remaining fires were caused either by improper procedures, improper equipment design, faulty equipment, improper equipment and human error combined, or formation of hydrazoic acid. No one has been killed in any of these fires, and no employee has been seriously injured in the fires at U.S. plants or at the CIL plant. Four employees were seriously injured, however, in two of Sabag's fires. (See table II.1.)

In a January 11, 1990, letter to the Chairman, House Committee on Energy and Commerce, NHTSA stated:

These events [fires], both in Canada and the U.S., have fortunately not caused loss of life, mostly as a consequence of the design and layout of the facilities which employ state-of-the-art safety construction and remote control systems for operator safety. Each of the events has led to improved safety in subsequent production, and the long history of commercial production of sodium azide provides confidence that production of this material can be safely accomplished to satisfy air bag application needs.

Table II.1: Accidental Fires at Air Bag Propellant and Sodium Azide Manufacturing Facilities—February 1988 to March 1990

Manufacturer	Date of Accident	Injuries		Probable Cause
		Serious	Minor	
United States				
TRW	6/16/89	0	0	Human error
	7/28/89	0	5	Human error
Morton	7/24/89	0	0	Equipment failure
	8/14/89	0	0	Hydrazoic acid or metal azide
Canada				
Sabag	2/17/88	1	3	Human error
	3/11/89	0	0	Human error
	7/13/89	0	0	Improper procedure caused hydrazoic acid to form
	12/08/89	0	2	Human error
	3/14/90	3	0	Human error and improper equipment design
CIL	10/08/89	0	0	Improper equipment design
	11/01/89	0	0	Human error

Note: No fatalities resulted from the fires.

Source: Internal and external investigation reports and oral testimony from manufacturers' officials.

TRW

TRW had two accidental fires in 1989—June 16 and July 28—while blending sodium azide and the oxidizer. No fatalities or serious injuries resulted, but in one fire five employees received minor injuries—three were bruised, one developed ringing in the ears, and one received glass in one eye. Both fires were investigated by the Arizona Division of Occupational Safety and Health (ADOSH) along with the fire department of Mesa, Arizona. Representatives of the Arizona Department of Environmental Quality were present during these investigations but did not participate in them. ADOSH found that the first fire was caused by improper maintenance of the blender. It concluded that the most probable cause of the second fire was a spark from a metal scoop that was accidentally dropped into the blender. (See appendix III for more details on the investigations conducted by ADOSH.)

After TRW acquired the propellant manufacturing facilities from Talley Defense Systems in April 1989, it initiated the following safety actions:

- Hired several additional employees with expertise in safety/environmental areas.
- Established a requirement that all employees take 40 hours of safety training.
- Revised its safety manual, which was reviewed and approved by ADOSH. TRW now requires all its operators to take a written test for job certification and to be recertified periodically.
- Established tool-control procedures.
- Started to construct separate facilities for its three major manufacturing steps—grinding, blending, and pressing.
- Decided to install a smaller blender in the new facilities to mix propellant in reduced-lot sizes.
- Contracted with an architect and engineering firm to design a system for automatic loading of the blender.

ADOSH officials told us that TRW has been very cooperative in assisting ADOSH since the accidents and is concerned about safety. This position was substantiated by a Mesa fire department report that stated TRW's cooperation in its investigation and cleanup and in providing information was exemplary.

Morton International

Morton also had two fires in 1989. No one was killed or injured in either of these fires. Also, according to the Director, Utah Occupational Safety

and Health, neither of the fires met the federal or state criteria for triggering an investigation—one or more fatalities, five or more people hospitalized, or an imminent danger situation.

Morton conducted its own investigations to determine the probable cause(s), and made recommendations to prevent the recurrence of similar accidents. The investigation report on the July 24, 1989, fire concluded that the most probable cause of the fire was a fractured press part that fell into the press die, and when pressure was applied the propellant ignited. The report made several recommendations that were adopted to help prevent a recurrence of this type of accident, including (1) running inert material in the press to assure that dies and steel punches are compatible and (2) installing fireproof storage cabinets to store propellant after it has been made into tablets.

The investigation report on the August 14, 1989, fire did not identify the precise cause and initiation point but stated that the accident was most likely caused by the presence of hydrazoic acid or sensitive metal azide materials. The report contained three recommendations to prevent this type of fire from happening again, but, for proprietary reasons, Morton deleted two of the recommendations completely and one partially from the copy of the report provided to us. According to Morton officials, the three recommendations were adopted.

Sabag, Inc.

Sabag, a joint venture between CIL and TRW, began making propellant in December 1987.¹ It has had five accidental fires since then. A total of nine employees sustained injuries—four serious and five minor—in three of the fires. Because of proprietary reasons, our written request for copies of the investigation reports was denied. However, we discussed the Sabag accidents with the Director of Technical Support for CIL, and he provided the following details on the Sabag fires:

- The first fire occurred on February 17, 1988; one employee received serious injuries, and three other employees received minor injuries. After the shift had ended for the day and the employees had removed their protective clothing, an employee went back to make adjustments to the coating machine. The machine had not been decontaminated (cleaned), and a spark from a screwdriver ignited the leftover material.

¹According to TRW, CIL is responsible for the design and operation of the facility and TRW is responsible for marketing the propellant.

The machine has since been completely redesigned to prevent a similar accident from occurring.

- The second fire occurred on March 11, 1989; no employees were injured. An internal investigation determined that the most probable cause was a filter in the dust collector had not been secured properly and permitted static electricity to build up and discharge, igniting leftover material in the dust collector and other equipment. Another probable cause identified by the investigation was that dry ice used to cool the grinder caused moisture to form and generated hydrazoic acid.
- Another fire occurred in the grinder on July 13, 1989, and no injuries resulted. Most probably the dry ice used to cool the machine caused moisture to form and generated hydrazoic acid. Liquid nitrogen is now used in lieu of dry ice to cool the grinder.
- A fourth fire occurred on December 8, 1989. Two maintenance employees, without proper clearance, were drilling above the equipment used to grind sodium azide, and the cuttings ignited leftover material. The machine had not been cleaned of propellant mix. Each employee received minor injuries.
- The fifth and most recent fire occurred on March 14, 1990; three employees were seriously injured. The most probable cause was twofold. Brass screws used to secure a conveyor lid caused copper azide to form which was then ignited from the shock of a mallet being used to dislodge the blocked conveyor. The facility was shut down by the Department of Energy, Mines, and Resources, Office of the Chief Inspector of Explosives; and the Commission of Health and Work Security until the ongoing joint company-government investigation is completed and the problems are corrected. The conveyor has been redesigned and brass screws will not be used in the new system. The plant will be reopened for production in October 1990.

CIL Inc.

In late 1989, CIL experienced two accidental fires that prevented it from drying sodium azide for 4 months. CIL officials told us that no injuries resulted from either fire. CIL officials also said that the company is investigating ways to do the entire drying operation by remote control.

According to CIL officials, the first fire occurred on October 8, 1989. An internal investigation found that a pressure-reducing valve for regulating steam heat was located too close to the dryer and caused the sodium azide to overheat. They said the valve has been relocated.

The second fire occurred on November 1, 1989. Since the cause of the fire was not readily apparent, CIL formed an investigating committee.

**Appendix II
Accidental Fires, Causes, and
Resulting Injuries**

CIL officials told us the investigation found that the most probable cause of the fire was the storing of wet sodium azide in a drum previously used to store raw sodium without decontaminating the drum. CIL officials said that they have stopped storing wet sodium azide in drums that previously contained raw sodium and have established rigid procedures to verify that the drums are clean.

Safety and Health Investigations at U.S. Facilities

The Occupational Safety and Health Administration (OSHA), Department of Labor, has primary responsibility for ensuring that employees have a safe and healthy work environment. OSHA is authorized by the Occupational Safety and Health Act of 1970 to inspect the workplace of any business that affects commerce to ensure compliance with standards and regulations. Regulations require that all employers provide their employees with a safe and healthful working environment. Employers are required to report to the nearest OSHA office within 48 hours any accident that results in one or more deaths or in the hospitalization of five or more employees. Regulations also require an investigation of these reported accidents and of any situation where there is imminent danger that could cause death or serious physical harm. The act encourages states to assume full responsibility for the administration and enforcement of their job safety and health laws. To assume such responsibility, OSHA must approve a state's plan that includes standards and regulations that are at least as effective as the comparable federal standards. After approval, OSHA monitors the states' performance. OSHA has approved state plans for both Arizona and Utah—the states where propellant is made.

In March 1989, OSHA adopted a permissible exposure limit (PEL) effective September 1, 1989, for sodium azide of 0.3 milligrams per cubic meter of air. Data submitted by the American Conference of Governmental Industrial Hygienists and other data formed the basis for OSHA's PEL. Prior to 1989, sodium azide exposure was not regulated by federal or state occupational safety and health agencies.

The Environmental Protection Agency (EPA) under section 102 (a) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (P.L. 96-510) has designated sodium azide as a hazardous substance. Regulations require a company to notify the EPA of any accident that releases 1,000 pounds or more sodium azide into the environment. According to EPA officials, EPA was not involved in any of the TRW and Morton fires.

Investigations at TRW

Since TRW began producing air bag propellant in April 1989, ADOSH has conducted six investigations—three health investigations prior to the fires, and two safety investigations and one health investigation after the fires. The results of these investigations follow.

On May 9, 1989, as a result of an employee complaint, ADOSH initiated a comprehensive health investigation at plant 3 on North Greenfield Road.

The investigation showed four violations—two serious and two nonserious. Regarding the serious violations, TRW was cited for not (1) maintaining in the workplace copies of material safety data sheets for chemicals being used, such as sodium azide and cupric oxide and (2) providing required information and training to employees on hazardous chemicals used in the workplace. The two nonserious violations involved (1) employees not using available protective equipment and (2) employees not being provided with suitable eyewash facilities in the work area.

For the two serious violations, ADOSH initially assessed TRW a \$700 penalty—\$350 for each violation. ADOSH later reduced the penalty to \$400 because TRW had inherited some of the problems from the previous owner and because of TRW's positive attitude and corrective efforts.

Two other health investigations were initiated by ADOSH on May 9, 1989. One, resulting from an employee complaint, was conducted at plant 4 located on North Higley Road. The other one, resulting from a scheduled investigation, was conducted at another plant on North Greenfield Road. Concerning the complaint investigation, TRW was cited for a nonserious violation of not providing suitable eyewash and shower facilities to employees working with sodium azide. Concerning the scheduled investigation, ADOSH identified no violations.

ADOSH conducted safety investigations of the June 16 and July 28, 1989, fires. ADOSH found that the June 16 fire was caused by improper maintenance of the blender. Following its investigation, ADOSH determined that TRW had committed a serious violation and issued a citation for violating the "General Duty Clause" by failing to eliminate a recognized hazard in the workplace, and assessed a \$1,000 penalty. TRW contested (1) the occurrence of a violation, (2) the proposed penalty, and (3) the classification of the violation as serious. Both the citation and penalty were withdrawn on December 14, 1989, according to ADOSH's Assistant Chief Counsel, because (1) the blender was being leased from Talley Defense Systems, and it was uncertain who was responsible for its maintenance; (2) TRW no longer leases the Talley blender, and the conditions that caused the accident would not be repeated; and (3) a citation issued citing the "General Duty Clause" as the authority is difficult to defend in the courts.

ADOSH concluded that the most probable cause of the July 28 fire was a spark from a metal scoop that was accidentally dropped into the

blender. ADOSH noted no apparent violations of its standards and did not issue a citation or assess a penalty.

In conjunction with its safety investigation of the July 28, 1989, fire, ADOSH conducted a health investigation. The investigation showed that employees, who were transferred from other departments within the propellant manufacturing facility, were handling sodium azide and cupric oxide without receiving proper training as to the hazards in their new work area. ADOSH classified this violation as serious and assessed TRW a \$1,000 penalty. ADOSH reduced the penalty to \$640 because TRW was in the process of implementing a hazard communication program at the time of the investigation.

**Investigations at Morton
International**

On September 27, 1986, UOSH initiated a comprehensive safety investigation of the-then Morton Thiokol, Inc., air bag manufacturing facilities. Morton International did not come into existence until July 1989 when Morton Thiokol created it to handle all its commercial operations, including the manufacture of air bags and propellant. UOSH found that Morton was in compliance with all safety and health requirements and had an excellent attitude toward safety. According to the director, UOSH did not investigate either of the two Morton International fires.

Impact of Fires on Supply

TRW and Morton International officials said that, although the fires have caused disruptions in the production of both sodium azide and propellant, they have been able to meet the increasing demand for propellant by the U.S. automotive industry for driver-side air bags—the great majority of the demand for air bags. Chrysler, Ford, and General Motors officials confirmed that the fires have not caused any shortages in driver-side air bags. Ford has had to market about 75,000 1990 Lincoln Continental and Town Car models without passenger-side air bags because of the March 1990 fire at Sabag and its subsequent closing.

Sodium Azide Supply

According to TRW officials, CIL was TRW's only source of sodium azide until CIL experienced its two fires in 1989 that shut down its operations for drying sodium azide. To maintain their supply, TRW officials said that they began acquiring some sodium azide from two Japanese firms (Masuda and Toyo Kasei Kogyo) and one German firm (Dynamit-Nobel). Also, they continued to buy wet sodium azide from CIL.

According to Morton officials, Morton has not been affected greatly by the shutdown of CIL's drying operations because it had a 2- to 3-month supply of sodium azide when the accidents occurred and can use wet or dry sodium azide in manufacturing propellant. Morton officials said that one impact of not being able to buy dry azide from CIL was that they had to manually load the wet azide into the blender, whereas the dry azide could be loaded automatically. Morton officials said that they have also identified Toyo Kasei Kogyo, Masuda, and Dynamit-Nobel as sources of sodium azide and have made some purchases from those companies in order to initiate steps to qualify them as suppliers.

CIL officials told us that they are expanding their production capability to meet the increasing demand for sodium azide. They said that by July/August 1990, their production capacity will have increased from 450 metric tons annually to 1,300 metric tons or from 990,000 to 2,860,000 pounds. CIL officials estimated that 80 percent of the sodium azide produced will be available for manufacturing air bag propellant.

According to TRW officials, on the basis of the known expansion plans by the sodium azide producers they are using, there will be excess production capacity through model year 1994. They estimated that, after July or August 1990, production capacity for sodium azide would exceed demand by 300 percent in model year 1991, 400 percent in 1992, 268 percent in 1993, and 150 percent in 1994. Similarly, Morton officials estimated that production capacity would exceed demand from 2.0 to

4.0 million pounds in model year 1994. Furthermore, TRW and Morton officials said that if increasing demand requires it, additional production capacity could be brought on line in 2 years.

Propellant Supply

TRW officials told us that the second fire destroyed their only blender and that their new blending facilities would not be in operation until the end of 1990. For the interim, they have contracted with Talley Defense Systems to do the blending operations for them. Morton officials said that they had excess capacity to meet the demand for propellant and their fires had no adverse impact on supply. A CIL official told us that Sabag's operations were shut down after the March 1990 fire and they are not expected to come back into production until October 1990. Because of the fire, Ford has had to market about 75,000 Lincoln Continental and Town Car models without passenger-side air bags. TRW officials said that they are developing the capability for making the passenger-side propellant at their Mesa, Arizona, facility. They estimated that the facility would be operational by February 1, 1991.

TRW is increasing its production capacity to meet the increasing demand for air bags and propellant. TRW officials said that they have reached agreement with vehicle manufacturers to increase air bag production to meet the expected demand through model year 1995. By the end of 1990, TRW will have two blenders in operation for making propellant. They estimated that the capacity of 1.2 blenders will be needed to meet the demand for the 1991 model year. Also, a blender owned by Talley Defense Systems will be available to TRW as a back-up if needed. TRW fully expects to meet the industry demand with its expansion plans, if additional air bag production is needed, TRW officials estimated that a 2-year lead time would be required to bring a new production facility on line.

Morton officials said that they currently have backup blending facilities, and more than double the capacity now needed to meet their customers' demands in model year 1991.

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