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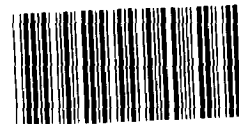
BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Grain Dust Explosions-- An Unsolved Problem

Deaths and injuries from grain dust explosions have increased since 1975, and several Congressmen, accordingly, asked GAO to examine a number of factors regarding such explosions. Specific causes of most of the explosions are not known. The Department of Labor's Occupational Safety and Health Administration did not determine the causes of explosions it investigated, and GAO concluded that it should make a greater effort to do so. The report shows compliance with existing safety standards may not be enough to prevent explosions. The adequacy of Labor's standards and the numerous proposals for reducing grain dust explosions need a thorough evaluation.



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Report

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report discusses the grain dust explosion disasters
of December 1977 and January 1978 and potential ways to
prevent similar disasters.

We made our review at the request of the Chairman,
Subcommittee on Agriculture, Rural Development and Related
Agencies, Senate Committee on Appropriations; Congressman
George Hansen; and Congressman Edward R. Madigan. Because of
broad interest in the subject, the requesters agreed that we
issue our report to the Congress.

Copies are being sent to the Director, Office of Manage-
ment and Budget; the Secretary of Agriculture; the Secretary
of Health, Education, and Welfare; the Secretary of Labor;
and the Administrator, Environmental Protection Agency.

Lucas B. Steels

Comptroller General
of the United States

Please note
the requesters



D I G E S T

Of all the industrial dust explosions in the United States, those in grain elevators cause the most injuries and property damage. Between December 1977 and January 1978, several grain dust explosions occurred, killing 62 persons and injuring 53.

Under the Occupational Safety and Health Act of 1970 (29 U.S.C. 651), the Department of Labor's Occupational Safety and Health Administration is authorized to develop and enforce occupational safety and health regulations. The agency had not adopted or developed any standards specifically designed for grain elevators. Instead, it uses its

--General Industry Standards and

--General Duty Clause, which requires employers to keep workplaces free of recognized hazards that cause or could cause death or serious harm.

The four factors that must be present in any explosive situation are well known and provide a useful framework for thinking about ways to eliminate explosions in grain elevators. The four factors are:

--Fuel source--in this case, grain dust.

--Oxygen.

--Ignition source.

--Confinement (a condition that contributes to turning a fire into an explosion).

Any measure proposed to reduce the incidence of grain dust explosions must effect changes in at least one of these four factors.

There is general agreement that the possibility of explosions cannot be eliminated entirely. A number of proposals have been made to reduce the risk of explosions by reducing the presence of dust and by reducing the possibility of ignition. Lack of information on the specific circumstances of most grain elevator explosions makes it more difficult to know which actions would be most effective in trying to prevent explosions.

Labor identified hazards that may have caused or contributed to the explosions, but it did not determine the specific causes. Explosion experts maintained that the purpose of explosion investigations should be to help develop methods for preventing future explosions. This requires a thorough and prompt investigation by experts of all factors that could have caused the explosion. However, the Occupational Safety and Health Administration, which appears to have few persons with expertise in explosions, did not use outside experts in its investigations. (See p. 10.)

Several other organizations made limited investigations of the explosions, but apparently none of them determined the specific causes. (See p. 12.)

The National Institute for Occupational Safety and Health has contracted with the National Academy of Sciences to study the physical and chemical nature of dust atmospheres in the workplace. The contract calls for the Academy's Committee on Evaluation of Industrial Hazards, working with Federal and private organizations, to study dusts, classify them as to hazard, and recommend

--standards relating to ignition sources and

--research projects covering areas in which data are inadequate.

According to an Institute official, recommendations for monitoring systems and devices may result, but preventative measures will not be studied.

GAO believes the Committee could serve as a center for coordinating, guiding, and evaluating the numerous research efforts on ways to prevent grain dust explosions or lessen their effects; however, the contract does not provide for such a broad role. (See pp. 8 and 36.)

Questions have been raised about whether Environmental Protection Agency and Food and Drug Administration regulations contribute to grain elevator explosions. GAO found nothing to indicate that Food and Drug Administration regulations contribute to the explosions.

However, several participants at an international symposium stated that the practice of returning fine dust, collected as a result of Environmental Protection Agency regulations, to the grain increases the fuel that could cause an explosion. They recommended that the fine dust not be returned but did not suggest changing the Agency's regulations. Also, GAO was told that

--the Agency's requirements that grain dust be confined eliminated the natural explosion venting that elevators had in the past and

--further research is needed to develop explosion venting systems that are effective and structurally feasible. (See p. 15.)

The explosions between December 1977 and January 1978 prompted extensive interest in improving grain elevator safety. The Federal Grain Inspection Service has established procedures to help protect its personnel. (See p. 24.)

Labor's grain elevator inspections have increased in number and appear to have improved in quality. More emphasis has been placed on the factors that cause explosions and fires, such as ignition sources and dust accumulations. (See p. 21.)

Although Labor's standards deal with many hazards that could cause explosions, there is no assurance that full compliance

with ~~Labor's and the industry's~~ present standards would prevent explosions. Labor has contracted with the National Academy of Sciences to determine whether existing standards are adequate, but the scope of the contract should be expanded to achieve more useful results. (See p. 19.)

Also, although grain dust poses certain health hazards, Labor appears to be giving limited emphasis to such hazards. (See p. 22.)

Numerous methods have been proposed for improving grain elevator safety. Some involve costly equipment or modifications. Much of the proposed technology is not new, yet it has not been widely adopted.

The conditions that contribute to explosions are well known, but where the explosions start and why are usually unknown. Thus, a grain elevator operator could use many methods to prevent explosions without assurance of success.

The grain industry is reluctant to adopt costly methods without proof of their effectiveness. Chemical company officials, who say their dust problems are similar to those of the grain industry, believe that methods for reducing grain elevator explosions exist and that the grain industry should implement them.

Many people, from both inside and outside the grain industry, have recommended that grain dust, especially the finer dust collected by control systems, not be re-introduced to the grain. However, persons associated with the grain industry have pointed out that following this recommendation could lose revenue for elevator operators since there are not always markets for dust and its value is much less as dust than as part of the grain. The extent to which the probability of an explosion would be reduced by not returning dust to the grain has not been quantified. (See p. 27.)

RECOMMENDATIONS

The Department of Labor should:

- Make timely and thorough investigations of future grain explosions using explosion experts. Labor should also require comparable investigations of any explosions at locations where Labor has given States enforcement authority.
- Have safety inspectors do health sampling for dust during grain elevator inspections.
- Expand the scope of its contract with the National Academy of Sciences to provide enough time for a more thorough study.

The Department of Health, Education, and Welfare should modify its proposed contract with the National Academy of Sciences to provide that the Committee on Evaluation of Industrial Hazards thoroughly consider potential methods of reducing grain explosions, including dust control and explosion venting.

AGENCY COMMENTS

Labor said it is developing a program for responding to workplace disasters of all kinds. The team of experts, knowledgeable in grain elevator operations and disaster investigations, which is working on Labor's contract with the National Academy of Sciences would, if asked, make its own investigation of a grain elevator explosion and be available for consultation. Disaster response teams could be made available to States.

Labor added that it consulted with some of the explosion experts referred to in GAO's report. Although explosion experts were consulted after the explosions, they were not used in the investigations.

Labor said its policy is that safety compliance officers who have been trained to identify health hazards should sample for dust when inspecting grain elevators.

Labor said a decision to expand its contract with the National Academy of Sciences should not be made until the Academy has had an opportunity to fully assess the problems it identifies. (See p. 37.)

The Department of Health, Education, and Welfare agreed that all potential methods of reducing grain dust explosions should be examined. It stated that the National Institute for Occupational Safety and Health will consider GAO's proposal to modify its contract with the Academy and an alternative method--a control technology assessment--and take appropriate action. (See p. 40.)

The Environmental Protection Agency stated that the intent of its regulations is that dust be captured at the points where it is generated within the elevator and transported by air handling equipment to a control device, where the dust is separated and the clean air is exhausted. It said that, if this practice were followed, doors and windows could be opened because the quantity of dust escaping would be minimal.

The Agency said GAO's report did not determine if construction practices for grain elevators have changed to comply with air pollution control regulations or because larger, more efficient reinforced concrete facilities are replacing older elevators. (See p. 41.)

The Department of Agriculture's Federal Grain Inspection Service and Acting Special Coordinator for Grain Elevator Safety and Security also commented on a draft of this report, and their views have been considered in preparing the report. (See p. 42.)

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ABBREVIATIONS

EPA	Environmental Protection Agency
FDA	Food and Drug Administration
FGIS	Federal Grain Inspection Service
GAO	General Accounting Office
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration

CHAPTER 1

INTRODUCTION

Between December 21, 1977, and January 21, 1978, several grain dust explosions occurred, killing 62 workers and injuring 53.

In January and February of 1978, Senator Thomas F. Eagleton, Chairman, Subcommittee on Agriculture, Rural Development and Related Agencies, Senate Committee on Appropriations; Congressman George Hansen; and Congressman Edward R. Madigan requested that we review these grain elevator explosions. They asked that we

- provide a historical perspective of grain elevator explosions (see p. 2);
- determine if the Bureau of Mines explosibility indexes are still valid (see p. 7);
- provide information on Federal and other investigations to determine the causes of the explosions (see p. 10);
- determine if grain elevator explosions have become more frequent and if such factors as the increased volume of grain handled and the increased capacity of elevators contribute to explosions (see p. 13);
- determine if Federal regulations have contributed to the explosions (see p. 15);
- determine if more stringent standards should be developed (see p. 19);
- determine if there are standards, good work practices, and protective equipment that might be used to control human exposure to chemical and grain dust health hazards (see p. 22);
- delineate the currently known methods of preventing or reducing the likelihood of elevator explosions (see p. 27);
- determine if dust removed from the grain should not be reintroduced and if the operators have incentives to permanently remove the dust (see p. 30);

- make recommendations to reduce the likelihood of grain elevator explosions (see p. 36); and
- describe the circumstances surrounding certain grain elevator explosions (see app. IV).

HISTORY OF GRAIN DUST EXPLOSIONS

An Iowa State University study 1/ stated that, of all the industrial dust explosions in the United States, those in grain elevators occur most frequently and cause the most injuries and property damage. Between 1860 and 1975 there were 340 grain elevator explosions which killed 170 persons and injured 638. (Data were not available for 1957.) Between January 1975 and December 1977, 29 such explosions occurred, killing 83 and injuring 91. Also, an average of about 2,900 grain elevator fires took place each year. According to the Department of Agriculture, there are about 15,000 grain handling facilities in the United States.

Modern statistics with grain dust explosions have been relatively consistent. The Iowa State study showed that an average of 6.7 grain elevator explosions occurred each year from 1938 to 1946, with a total of 130 injuries and 33 deaths. The average dropped to about 2 explosions each year from 1947 to 1955, with a total of 7 deaths and 13 injuries. There was an increase to about 8 per year from 1958 to 1975, with a total of 37 deaths and 215 injuries. Data on explosions since 1958 are presented on the following table. Data for 1976 and 1977 were obtained from Kansas State University and Grain and Farm Service Centers magazine. The data were not consistent in some cases, and the magazine did not always state whether there were deaths or injuries. We did not attempt to reconcile the differences.

1/"Literature Survey of Dust Explosions in Grain Handling Facilities: Causes and Prevention" (March 1976).

<u>Year</u>	<u>Number of grain elevator explosions</u>	<u>Dead</u>	<u>Injured</u>
1958	8	0	7
1959	7	1	14
1960	7	4	18
1961	9	0	15
1962	8	2	49
1963	9	2	19
1964	3	0	7
1965	7	2	4
1966	10	2	20
1967	13	1	8
1968	10	5	8
1969	1	0	0
1970	12	1	14
1971	10	4	9
1972	4	0	3
1973	7	0	1
1974	8	7	11
1975	6	6	8
1976	13	18	45
1977	<u>10</u>	<u>59</u>	<u>38</u>
	<u>162</u>	<u>114</u>	<u>298</u>

Note: The Iowa State study stated that complete records on dust explosions were not available. The statistics were compiled from periodicals supplemented by data from an insurance company. Fatality and injury data may be understated, according to a University of Wisconsin study, because an adequate data base does not exist.

Sixty-two people were killed and 53 injured as a result of five explosions in grain handling facilities during December 1977 and January 1978. The accidents at the four grain elevators and two feed mills that led to the deaths, injuries, and damage losses shown below are described in detail in appendix IV. The damage at Capital Elevator #4 was caused by fire, not by an explosion, and there were no injuries or fatalities.

	<u>Dead</u>	<u>Injured</u>	Estimated cost of damage (note a) (millions)
Continental Grain Co., Westwego, La.	36	10	\$30.0
Farmers Export Co., Galveston, Tex.	18	22	25.0
Desert Gold Feed Co., Liberty, Mo.	3	6	.7
Sunshine Mills, Tupelo, Miss.	4	15	1.0
Capital Elevator #4, Duluth, Minn.	-	-	1.7
Behimer & Kissner, Inc., Wayne City, Ill.	<u>1</u>	<u>-</u>	<u>1.5</u>
	<u>62</u>	<u>53</u>	<u>\$59.9</u>

a/Estimated damage costs were obtained from such sources as company officials, insurance companies, and the National Fire Protection Association. We did not verify the estimates.

CHARACTERISTICS OF A GRAIN ELEVATOR

Grain elevators are centers for receiving and distributing grain. The elevators receive grain by truck, railroad cars, or barges.

There are four classes of elevators: country, regional, terminal, and processing plant. Country and regional elevators generally perform similar functions, but regional elevators are larger. Raw grain comes to these elevators directly from the farm. The grain is graded, cleaned, sometimes dried, and weighed. The grain is either stored or shipped immediately to terminal elevators for distribution to users and processors in the United States and abroad.

The terminal elevator may be similar to the regional elevator in operation and size. The grain at the terminal elevator is usually received from the country or regional elevators rather than directly from the farm. Processing plants, which manufacture food and feed products, receive and store grain in the same manner as the other elevators.

The grain is dumped into receiving bins and transferred by conveyor belts to the elevator. Buckets transfer the grain to the top of the elevator for distribution to storage bins or loading facilities.

An elevator has two sections: the workhouse and the storage bins (or silos). The workhouse includes several stories that contain the receiving, elevating, cleaning, weighing, and distributing equipment, as well as bins for holding, shipping, and mixing processes. The workhouse is usually a rectangular building located at one end of a bank of storage bins or between two banks of bins. It is connected to the bins by overhead walks at bin top level and also by underground tunnels. With a height of about 100 to 250 feet, the workhouse is 40 to 60 feet above the storage bins to accommodate the machinery and movement of the grain. The extended portion is called the headhouse because it houses the head pulleys of the bucket elevators. A one-story structure on the top of the bank of storage bins which extends their entire length encloses a belt conveyor for moving grain from the workhouse to various bins. This structure is referred to as the Texas-house or long-house.

REGULATORY AUTHORITY AND RESPONSIBILITY

The Occupational Safety and Health Act of 1970 (29 U.S.C. 651) was passed to assure, as far as possible, safe and healthful working conditions for every worker in the Nation.

The Labor Department's Occupational Safety and Health Administration (OSHA) is authorized under the act to develop and enforce occupationally related safety and health regulations. OSHA has not adopted or developed any standards specifically designed for grain elevators. To inspect grain elevators OSHA uses the General Industry Standards found in 29 CFR 1910. OSHA can also enforce the General Duty Clause, section 5(a)(1) of the act, which requires each employer to furnish a workplace free from recognized hazards that cause or can cause death or serious physical harm, even though no specific OSHA standards deal with the hazards.

Grain elevator workers have the right to request an OSHA inspection when they believe a violation exists threatening physical harm. OSHA investigates certain accidents, including those resulting in fatalities.

The act makes the Department of Health, Education, and Welfare's (HEW's) National Institute for Occupational Safety and Health (NIOSH) responsible for research, experiments, and demonstrations relating to occupational safety and health. NIOSH is to develop criteria for new and improved standards and recommend such standards to OSHA.

Thirteen employees of the Department of Agriculture's Federal Grain Inspection Service (FGIS) were killed in the December 1977 explosions. Section 19a of the act and Executive Order No. 11807 require that Federal agencies establish and maintain effective and comprehensive occupational safety and health programs for their employees consistent with OSHA's standards promulgated under section 6 of the act.

SCOPE OF REVIEW

We made our review at (1) OSHA and FGIS headquarters in Washington, D.C., (2) OSHA's area offices in Houston, Texas; Kansas City, Missouri; New Orleans, Louisiana; Minneapolis, Minnesota; Jackson, Mississippi; and Peoria, Illinois, and (3) a district office in Belleville, Illinois. We interviewed officials of the grain handling facilities listed on page 4.

OSHA's investigation reports and related files were reviewed. In addition, we interviewed officials and reviewed reports at the Department of Agriculture; National Fire Protection Association; Bureau of Alcohol, Tobacco, and Firearms, Department of Treasury; Federal Bureau of Investigation; Environmental Protection Agency (EPA); Food and Drug Administration (FDA); National Academy of Sciences; and local and State fire and police departments.

CHAPTER 2

SPECIFIC CAUSES OF GRAIN ELEVATOR

EXPLOSIONS NOT KNOWN

Determining the causes of explosions is an important step in developing methods to prevent future explosions. The factors that can cause grain elevator explosions have been known for many years. However, the specific causes of most explosions are not known.

The Occupational Safety and Health Administration did not determine the causes of the explosions that it investigated in early 1978, nor did it study methods for preventing future explosions. OSHA needs to make more comprehensive investigations.

Other organizations also investigated the recent explosions. As far as we could determine, none of them determined the causes. Some investigations were not completed, and the reports of others were not available to us because of company policy or pending litigation.

Questions have been raised as to what extent increases in the volume of grain handled have contributed to the recent explosions. We could not determine any relationship between the number of explosions and the volume of grain handled. The number of explosions has not significantly increased in recent years, although deaths and injuries have.

EXPLOSIVE PROPERTIES OF GRAIN DUST

A Bureau of Mines report compared the explosive hazards of agricultural dusts using Pittsburgh coal dust as a standard. An explosibility index greater than 1 indicates the explosive hazard is greater than that posed by Pittsburgh coal dust. The index number represents a combination of the ease of ignition and the explosive force.

Some dusts that can be present in a grain mill and their relative explosibility are shown below. Wheat starch, for example, is almost 50 times more explosive than Pittsburgh coal dust.

<u>Material</u>	<u>Index of explosibility</u>
Wheat	2.5
Soybean meal	7.5
Corn	8.4
Grain dust, mixed	9.2
Cornstarch	35.6
Wheat starch	49.8

Bureau of Mines officials said that, while the index could be used for research on grain dust explosions, it has limited application for elevator operators. The index only rates the relative explosibility of various grain dusts. There is no practical way of using the index to determine the presence or extent of explosion hazards within an elevator at any time. Variable factors, such as dust particle size and moisture content, affect the degree of hazard. Experimental work has not quantified the relationship of these variables.

The National Institute for Occupational Safety and Health has contracted with the National Academy of Sciences to study the physical and chemical nature of oxidizable dust atmospheres found in the workplace. The contract involves continuing work that the Academy was doing for OSHA, but the scope has been expanded to cover more chemicals, vapors, and dusts. The Academy will try to determine how much ignition energy is necessary to ignite a certain amount of suspended dust, including grain dusts. Recommendations for monitoring systems and devices may result, according to Institute officials, but preventative measures will not be studied.

The contract calls for the Academy's Committee on Evaluation of Industrial Hazards, working with Federal and private organizations, to study dusts, classify them as to hazard, and recommend (1) standards relating to ignition sources and (2) research projects covering areas for which data are inadequate.

Conditions for a dust explosion

For an explosion to occur:

--Oxygen must be present.

--Dust must be suspended in a concentration that is within an explosive range.

--An ignition source of sufficient energy and duration to start the explosive chain reaction must be present.

--The reaction must occur in a confined area.

When the first three conditions occur, a flash fire will develop. However, the rapid buildup of explosive pressures inherent in the working definition of grain dust explosions will result only when the reaction occurs in an enclosed space.

CAUSES OF EXPLOSIONS
USUALLY UNKNOWN

The term "cause" has generally been applied to the ignition source. Reports on explosions have noted where the explosion started and what ignited it. The Iowa State University study, which covered 137 grain elevator explosions occurring between 1958 and 1975, cited the following ignition sources:

<u>Ignition source</u>	<u>Number of explosions</u>	<u>Percent</u>
Unknown	85	62.0
Welding or cutting torch	14	10.2
Friction	12	8.8
Fire other than welding	11	8.0
Electrical	6	4.4
Lightning	4	2.9
Motors	3	2.2
Spontaneous combustion	2	1.5
	<u>137</u>	<u>100.0</u>

Similarly, the location of the primary explosion was reported as being unknown for most of the 137 incidents.

<u>Location</u>	<u>Number of explosions</u>	<u>Percent</u>
Unknown	95	69.0
Bucket elevator	26	19.0
Storage bin	7	5.0
Headhouse	2	1.5
Electrical panel	2	1.5
Other	5	4.0
	<u>137</u>	<u>100.0</u>

A Kansas State University survey and our review of literature on dust explosions showed the following causes for grain elevator explosions that occurred between January 1976 and December 1977.

<u>Cause</u>	<u>Number of explosions</u>	<u>Percent</u>
Unknown	11	47.8
Friction	5	21.7
Welding	4	17.4
Other	<u>3</u>	<u>13.1</u>
	<u>23</u>	<u>100.0</u>

OSHA INVESTIGATIONS NOT ADEQUATE
TO DETERMINE CAUSES OF EXPLOSIONS

OSHA investigated the explosions at five of the six locations listed on page 4. It did not investigate the fire at Capital Elevator #4, Duluth, Minnesota. Minnesota enforces its own standards under an OSHA-approved plan. There were no fatalities or injuries at Capital Elevator #4.

The primary purposes of accident investigations, according to OSHA's field operations manual, are to determine whether:

- A violation of Federal safety and health standards contributed or may have contributed to the occurrence.
- The accident could have been avoided had proper safety and health regulations been enforced and followed.
- OSHA standards should be revised to remedy the hazardous working condition which led to the accident.

We believe the purposes specified in OSHA's operations manual cannot be achieved without comprehensive investigations.

In June 1978, Labor's Assistant Secretary for Occupational Safety and Health stated that, although the causes of the accidents were not determined, OSHA has identified hazards which, either by themselves or in combination, may have caused or contributed to the explosions.

OSHA requires that accident investigations be conducted in accordance with workplace inspection procedures and by an individual or team with expertise in the particular

condition that may have caused the accident. Under OSHA's workplace inspection procedures, inspectors are to determine whether employers are complying with safety and health standards and furnishing places of employment free from recognized hazards. The procedures set forth the administrative requirements associated with workplace inspections but do not establish the minimum scope or detail required during accident investigations.

The explosions were investigated by OSHA compliance officers. The accident investigation training that three of the investigators had received was oriented to personal injuries, not catastrophic accidents. According to several OSHA officials, the accident investigation training provided compliance officers is inadequate.

The investigators of the Sunshine Mills accident were engineers who had experience with explosives. They investigated all of the factors necessary for an explosion but were unable to establish the source of ignition. A certified fire investigator was assigned to the Continental Grain Company accident. He concluded that arson or sabotage and the ignition of carbon disulfide or some other fumigant were possible causes that should be examined further by other investigatory agencies. At the conclusion of our review, the Bureau of Alcohol, Tobacco, and Firearms was investigating the possibility of arson or sabotage.

OSHA's recent grain industry accident investigations had the following shortcomings:

- Information obtained through interviews during the Continental Grain Company and Farmers Export Company investigations was insufficiently detailed and/or conflicting. Some personnel were not interviewed to gain more knowledge about the accident or to resolve conflicting information.
- Although there were indications that smoking materials were the source of ignition for the Desert Gold Feed Company accident, smoking was ruled out based on employees' statements. No examination was made for physical evidence.
- Because investigators did not supervise the removal of debris at the Behimer & Kissner, Inc., accident site, physical evidence potentially relevant to the cause of the accident was destroyed. OSHA investigators have only limited authority to control access and activities at any accident site so that physical evidence is not destroyed or altered.

- Information involving the locations and preaccident activities of the dead and injured, and the specific cause of death or injury was not investigated in detail for the Continental Grain Company and Farmers Export Company accidents.

Explosion expertise

According to explosion experts the primary purpose of explosion investigations should be to help develop methods for preventing future explosions. This requires a thorough investigation to determine what caused the explosion. Determining cause is not limited to determining the ignition source. The other contributing factors--fuel, oxygen, and confinement--must be studied. They said expertise in explosions requires an academic background in chemistry, physics, and mechanics and extensive work experience in explosion investigations and prevention. The experts we talked with estimated there were only about 12 individuals who are considered to be explosion experts.

Two explosion experts said that the guidelines they follow in investigating an explosion include

- making a careful examination of the damage (rubble), considering such things as the energy release of the explosion (how far the debris was thrown);
- determining where the explosion started and what the ignition source was;
- determining where and why the explosion spread; and
- interviewing all available witnesses and following up to resolve any conflicting testimony.

OTHER INVESTIGATIONS LIMITED

Local offices of the Federal Bureau of Investigation; the Bureau of Alcohol, Tobacco, and Firearms; the Environmental Protection Agency; and the Department of Agriculture made limited investigations of some of the accidents. Investigations included only such actions as

- determining that Federal criminal laws were not violated,
- determining that explosives were not involved, and
- monitoring the investigation efforts of other agencies.

Some State and local agencies investigated or helped investigate the six accidents. They focused on such specific accident elements as

- identifying and locating the dead and injured;
- interviewing eyewitnesses in conjunction with OSHA investigators;
- investigating complaints, rumors, and reports of alleged wrongdoings; and
- directing rescue and firefighting operations.

The National Fire Protection Association conducted fact-finding investigations at the elevators operated by Continental Grain Company and Farmers Export Company. They did not determine the cause of either accident.

Although the insurers for five of the grain-handling facilities made investigations, four of the reports were not available to us--three because of pending litigation and one because of company policy. The insurance company's investigation at the Behimer and Kissner grain elevator did not identify the cause.

THE RELATIONSHIP BETWEEN GRAIN PRODUCTION AND GRAIN DUST EXPLOSIONS IS NOT EVIDENT

Grain production in the United States, except for 1974, increased from 1972 through 1977. The average annual grain production for those years was about 10.9 billion bushels, compared to an 8.9-billion-bushel average for 1966 through 1970.

During 1972 through 1977 there were about 48 explosions in grain elevators--an average of 8 a year. Figures available for 1966 through 1970 showed 46 explosions--an average of 9 a year.

We tried to establish a correlation between U.S. grain production for each of the last 6 years and the number of grain elevator explosions. As shown below, we found no correlation.

<u>Year</u>	<u>U.S. grain production</u> (billions of bushels)	<u>Grain elevator explosions</u>
1972	10.375	4
1973	10.989	7
1974	9.255	8
1975	11.298	6
1976	11.357	13
1977	12.087	10

The Iowa State University study considered:

"* * * if a relationship exists between the number of explosions in a given state and some possible contributing factors such as total volume of commercial grain storage facilities, the amount of grain produced (especially the volume of grain sold off the farm) and the types of grains produced in that state."

According to the study:

"* * * Although no simple correlations are apparent between explosion occurrences, storage capacity, total volume of grains marketed, or types of grain, it may be that some combination of these together with other, as yet undefined, factors may be relevant."

The study added that factors which may have contributed to the increase of average yearly explosions in the 1958-75 period include:

"* * * abandonment of old, unprofitable plants and expansion or construction of more efficient units, often of reinforced concrete; greatly increased production, marketing, and export of grain * * *."

In conclusion, the study cited the need for a more detailed examination of factors contributing to grain elevator explosions.

CHAPTER 3

HAVE FEDERAL REGULATIONS CONTRIBUTED

TO EXPLOSIONS?

Questions have been raised as to whether Environmental Protection Agency or Food and Drug Administration regulations contribute to grain explosions. We found nothing to indicate that FDA's regulations contributed to the explosions. Several participants at an international symposium felt that the practice of returning fine dust, collected as a result of EPA regulations, to the grain creates an explosive hazard. They recommended that the fine dust not be returned but did not suggest changing EPA's regulations. Also, we were told that (1) EPA's requirements that grain dust be confined eliminated the natural explosion venting that elevators had in the past and (2) further research is needed to develop explosion venting systems that are effective and structurally feasible.

FDA REGULATIONS

The Food and Drug Administration, together with State agencies that operate under work-sharing or cooperative agreements with it, inspect grain elevators to " * * * promote the sanitary storage of wheat and other grains to prevent contamination of these basic food materials with filth and/or other contaminants."

FDA inspected the five elevators that exploded in December 1977 and January 1978 to determine if the grain salvaged was fit for consumption.

In covering the grain elevator explosions, the news media reported that FDA regulations prohibit adding moisture to grain, because the moisture would adulterate the grain. The Department of Agriculture has established maximum percentages of moisture allowable in different grades of grain, but FDA has no regulations or administrative guidelines limiting the (1) moisture content in grains or (2) addition of moisture to grains.

EPA STANDARDS

Under the Clean Air Act, the Environmental Protection Agency establishes national air quality standards. The States adopt and enforce rules to meet the general standards, and EPA reviews and approves State programs to assure that the standards have been met. In 1971 EPA adopted air

quality standards for particulate matter because studies showed that such matter, including grain dust, causes several health hazards.

Questions have been raised about whether pollution control requirements have contributed to grain elevator explosions because elevator operators are often prohibited from venting dust into the air. Also, according to three participants at the International Symposium on Grain Elevator Explosions, the actions taken to comply with EPA requirements contributed to the explosion problem. They said that finer and drier dust, which is more hazardous, is collected in filters and returned to the grain. All three recommended that the fine dust not be returned. None, however, recommended changing EPA regulations. Two recommended changes in the Department of Agriculture's regulations: one, to ban reintroduction of fine dust, the other, to permit weight loss from not reintroducing fine dust to be called an uncontrollable loss.

Before the House Committee on Labor and Education in January 1978, EPA's Administrator testified that good air pollution control practices do not increase the risk of fires or explosions in elevators and that properly operated air control equipment reduces these risks. He stated that officials from the grain industry, the Department of Agriculture, and OSHA concurred.

EPA noted that air pollution control rules do not require that dust be accumulated inside grain elevators. Dust collection devices are recommended by insurance companies and the National Fire Protection Association to reduce fires and explosions in elevators. To have effective pollution control and safety, the control devices must be correctly installed and properly maintained.

EPA is responsible only for regulating the emission of particulate matter into the ambient air; ensuring the safety of workers in the elevator is OSHA's responsibility. Normally, State air compliance officers do not inspect dust control systems of companies that comply with pollution requirements. State inspectors did not inspect the dust control systems at the five elevators that exploded in December 1977 and January 1978.

However, in January 1978 EPA requested that State agencies go beyond a routine check for visible emissions of dust and inspect dust control systems to ensure that they are properly operated and maintained. In January 1978, OSHA instructed its regional offices that every grain elevator inspection must include an inspection of the air control system.

Explosion venting

We were advised that (1) compliance with EPA's regulations has reduced the natural explosion venting that existed when grain elevators were less enclosed and (2) effective explosion venting systems are difficult to design. Explosion venting involves leaving open areas or enclosures, such as lightly attached panels, that will blow out when pressure increases, relieving pressure and minimizing damage.

Of the five explosions OSHA investigated, three involved elevators that did not use explosion venting. The Continental Grain Company and Farmers Export Company elevators had some explosion venting, but not enough to prevent massive destruction. According to the National Fire Protection Association, the lack of effective explosion venting at Continental may have contributed to 25 fatalities because the concrete rubble destroyed an adjoining office building. In the explosion at Farmers, an adjoining office building was also destroyed, but it was unoccupied the night the explosion occurred. According to the National Fire Protection Association, a lot of people would have been in the building in the daytime.

According to OSHA officials, their recent inspections resulted in no citations for lack of explosion venting because OSHA has no specific standards requiring venting. OSHA could not demonstrate a violation of the general duty clause because venting of the total facility is not a common industry practice.

A Continental Grain official who helped develop the Association's consensus standards for grain elevators said that explosion venting was not considered necessary in the past. Before EPA issued its regulations, grain handling facilities were relatively open and had natural venting. To comply with EPA requirements, elevator operators had to confine grain dust, and explosion venting became important. He added that grain handling facilities have become bigger and more mechanized in recent years.

According to this official, the Association's consensus standards did not recommend explosion venting until 1971 and did not really emphasize it until 1973. He believed the standard for explosion venting should be further revised to describe the extent that is effective and feasible. Regarding the new Continental Grain Company facility to replace the one that exploded, he said it will not have a headhouse or bucket elevators and will have explosion venting where

necessary and practical. He added that the office building will be a safe distance (300 to 400 feet) from the main operation.

We asked this official whether, in general, office facilities could feasibly be kept a safe distance from grain handling operations. He replied that an office for clerical work could be constructed at a safe distance but, if control and monitoring of operations were done from the office, it would not be practical to move it.

An Association official said that explosion venting is less of a problem with facilities built before EPA clean air standards and more of a problem with the newer facilities designed to seal in the dust. The official said that the state of the art for explosion venting has not developed to the point where definite requirements and methods can be specified; that a revised, more specific version of the Association's explosion venting standards would be issued in about a year; but that those standards would still be inadequate on proper methods of explosion venting. According to him, more research is needed to determine the extent of explosion venting required and to develop ways of installing it without weakening the structure.

CHAPTER 4

ARE FEDERAL EFFORTS TO

PROTECT WORKERS ADEQUATE?

The December 1977 and January 1978 explosions prompted increased interest in improving the safety of grain elevators. The Occupational Safety and Health Administration has placed special emphasis on inspecting grain elevators, and the Federal Grain Inspection Service has established procedures to help protect its personnel.

OSHA's grain elevator inspections have increased in number and improved in quality. However, although OSHA's standards deal with many hazards that could cause explosions, there is no assurance that full compliance with OSHA and industry standards would prevent all explosions. OSHA has contracted with the National Academy of Sciences to determine whether existing standards are adequate, but the scope of the contract should be expanded to permit a more thorough study. Also, OSHA appears to be giving limited emphasis to the health hazards associated with grain dust.

ADEQUACY OF EXISTING STANDARDS NOT KNOWN

OSHA has not adopted standards exclusively designed for the grain industry; instead, it uses the General Industry Standards in title 29 of the Code of Federal Regulations. The sections that are applicable to grain elevators include:

- Section 1910.309, which references the National Electrical Code's requirements about electrical wiring and equipment in environments containing dust.
- Section 1910.252, which contains requirements pertaining to welding, cutting, and brazing.
- Sections 1910.36 and .37, which pertain to emergency escape exits.
- Section 1910.68, which contains requirements for manlifts.
- Sections 1910.132, .133, .134, .135, and .136, which address personal protective equipment.
- Section 1910.151, which contains medical and first aid provisions.

- Sections 1910.22(a) and 1910.141(a)(3), which address housekeeping.
- Section 1910.1000, which contains requirements pertaining to air contaminants.
- Sections 1910.157, .158, .159, and .160, which address fire protection requirements.
- Sections 1910.212 and 1910.219, which contain machine and machine guarding requirements.
- Sections 1910.242 and .244, which address hand and portable power tools.
- Section 1910.178, which contains requirements for powered industrial trucks.

In addition, under the General Duty Clause of the Occupational Safety and Health Act of 1970 (section 5(a)(1)), each employer is required to furnish a place of employment which is free from recognized hazards that cause or are likely to cause death or serious physical harm. This requirement covers serious hazards not covered by specific OSHA standards. To support section 5(a)(1), OSHA uses nationally recognized consensus standards, such as the National Fire Protection Association's Standard 61-B, 1973, "Grain Elevators and Bulk Grain Handling Facilities."

Standard 61-B covers such subjects as structural features, ventilation, explosion relief, equipment, dust control, housekeeping, and safeguards to prevent ignition.

After 6 months of reviewing and investigating grain elevator explosions, OSHA could not determine whether its standards were adequate to prevent explosions. Also, OSHA has not determined if specific standards for grain elevators need to be established or if some other rulemaking should be undertaken. Instead, to obtain the basis for a decision, OSHA contracted with the National Academy of Sciences in September 1978 to (1) conduct followup studies on grain elevator dust explosions and fires and provide a panel report on their probable cause or causes and (2) study on a long-range scale dust hazards in other industries and make recommendations on prevention and control measures for grain handling facilities. The work will take about a year.

National Academy of Sciences' officials said that, because of the limited duration of the contract, the Academy will not consider its work a final product. They also stated that the Academy will not make recommendations to prevent recurrences. To do this would require a longer study. The Academy will review OSHA's and other organizations' investigative work. It will also review OSHA's standards, but according to the officials, without determining the cause of explosions, it cannot thoroughly evaluate and arrive at specific conclusions as to the adequacy of each OSHA standard.

INSPECTIONS EMPHASIZED MORE

Because of the recent accidents, OSHA has been inspecting more grain elevators and its inspections have become more comprehensive and responsive to hazards that can cause explosions.

Past OSHA inspections often did not detect the types of hazards identified in the 1978 accident investigations. Most violations cited involved the kinds of personnel safety hazards (such as unguarded machinery, defective ladders, and ungrounded electrical equipment) covered by the General Industry Standards. Two OSHA area directors stated that in the past compliance officers were not knowledgeable about elevator operations.

The Continental Grain Company elevator in Westwego, Louisiana, was inspected in October 1977. The compliance officer who made the inspection specialized in maritime safety and had limited experience in grain elevator operations. His inspection covered the company office building, maintenance shop, elevator basement, several floors in the headhouse, one of two railcar unloading facilities, and the barge unloading facility. Because the compliance officer was not familiar with grain elevator operations, he depended upon the union steward and the elevator management to identify problem areas. Continental was cited only for an improperly grounded refrigerator and improperly marked exit doors in the office building.

At Farmers Export Company, no previous OSHA inspection had been made (except a construction inspection). According to an OSHA official, an inspection at that elevator before the explosion would have made little difference because his compliance officers lacked the expertise to conduct adequate grain elevator inspections.

After the December 1977 explosions OSHA established a training program on the hazards of grain elevators for its compliance officers. It also issued a grain elevator hazard alert to elevator operators to highlight safety and health requirements and recommendations.

OSHA's training effort has apparently resulted in more thorough safety inspections. In the 32 inspections made at 10 elevators by the New Orleans OSHA area office between 1971 and 1977, only 86 violations were cited. No citations were issued in 13 (41 percent) of the inspections made. Only 12 percent of all standard violations that the area office cited before 1978 were related to fire/explosion hazards.

Between January 1, 1978, and March 22, 1978, the area office made eight inspections which disclosed 209 standard violations. Citations were issued for each of the eight facilities inspected, and 38 percent of the violations cited were related to fire/explosion hazards.

From December 1977 through May 1978, OSHA made 798 grain elevator inspections, compared with 382 such inspections for all of 1977.

Health hazards of grain dust

Excessive grain dust exposure has long been recognized as a cause of such respiratory problems as rhinitis, coughing, wheezing, shortness of breath, emphysema, and pulmonary fibrosis. Dust collection systems are generally not designed to limit dust to a safe respirable level.

The National Institute for Occupational Safety and Health made a health hazard evaluation of eight grain elevators in the Port of Duluth-Superior in 1975-76. Grain dust concentrations in some employees' breathing zones significantly exceeded OSHA nuisance dust standards (no specific standard exists for grain dust).

NIOSH's medical and environmental research studies are to be used as a basis for a criteria document (recommended standard and supporting information) in fiscal year 1981 for grain handlers. According to a NIOSH official, the study was about half complete as of June 1978 and will be completed sometime in 1979.

OSHA's grain elevator hazard alert stated that:

"Although the immediate concern is eliminating conditions that might cause explosions, serious health hazards such as grain dust and toxic substances also exist in grain elevators and may, over the long-run, cause many more deaths than result from the kind of dramatic catastrophes that recently occurred."

From 1972 through 1977 OSHA had taken dust samples at only 19 grain elevators. Of 132 samples taken, half exceeded the OSHA nuisance dust standard. Although OSHA made 798 grain elevator inspections between December 1977 and May 1978, only 59 (7 percent) of the elevators were sampled for dust, with 33 (24 percent) of the samples exceeding the standard.

According to an OSHA official, few elevators were sampled for dust because emphasis was placed on looking for explosion hazards and there is a lack of industrial hygienists. Although safety compliance officers can take dust samples and submit the samples to a laboratory to obtain exposure levels, industrial hygienists are needed for followup action. This involves determining the factors that are causing the dust and recommending engineering changes or administrative actions to correct the problem. He said that, when OSHA cites an operator for violations of the dust standard, it must prove the feasibility of correcting the problem through engineering changes or administrative actions.

The official said that, when OSHA's industrial hygienists sample for dust, they also sample for other toxic substances such as fumigants and silica because they should tell the operators the exposure levels of other toxic substances that employees are exposed to. For example, the operator may be in compliance with the nuisance dust standard but not in compliance with the silica standard. However, most safety compliance officers are not trained to sample and analyze the samples for fumigants and other toxic substances.

We recognize that safety officers cannot make comprehensive health inspections of grain elevators. However, we believe safety officers should take dust samples when they inspect elevators. If laboratory analysis shows that the nuisance dust standard is exceeded, the matter should be referred for a comprehensive inspection by an OSHA industrial hygienist.

FEDERAL GRAIN INSPECTION SERVICE
ESTABLISHES PROCEDURES
TO PROTECT ITS PERSONNEL

FGIS inspects and weighs grain and supervises State grain inspection and weighing services at about 89 export grain elevators. FGIS grain inspectors are assigned to 43 of these elevators full time. The grain inspectors work inside the elevators and are exposed to the same hazards as elevator employees.

The Occupational Safety and Health Act of 1970 does not provide for OSHA coverage of Government employees. However, it does require the head of each Federal agency to establish and maintain a safety and health program that provides for safe and healthful workplaces for its employees. In July 1977, FGIS hired two full-time safety specialists to develop a safety program and make safety inspections of export elevators where FGIS had personnel. In May 1978, two additional full-time safety specialists were added to the safety staff. FGIS safety inspectors have no enforcement authority. Before the December 1977 explosions, FGIS relied on the cooperation of elevator owners to correct any hazardous conditions. FGIS can request OSHA to inspect privately owned grain elevators for safety and health violations.

Six weeks before the accident at Farmers Export Company, the FGIS safety manager inspected the elevator and noted several hazardous conditions--in particular, dust clouds and ignition sources. FGIS officials did not notify OSHA of the hazards. They told the inspectors not to notify OSHA but to rely on the FGIS safety program to correct the problem.

On December 23, the FGIS area supervisor requested authority to withdraw the FGIS employees from the elevator because of dust and low humidity. Withdrawal of FGIS employees could have resulted in shutting down elevator operations since FGIS must weigh incoming grain and weigh and inspect outgoing grain at export elevators. FGIS headquarters denied the request because there was no written authority to withdraw and low humidity was not known to be a factor in dust explosions. The elevator exploded on December 27.

In February 1978, FGIS issued "Alert Guideline Procedures and Policies Upon Encountering 'Hazardous Conditions' in Grain Elevators." These guidelines are designed to protect FGIS employees from situations posing an immediate threat to life, limb, or property. FGIS has established a policy that

gives its supervisors authority to evacuate FGIS employees from an elevator when certain conditions exist. These conditions include:

- When the 10-hour moving average relative humidity is below 45 percent and the dust collection system is inoperable, shut down, or nonexistent.
- When open flames, such as from matches or lit cigarettes, are observed.
- When sparks are observed coming from foreign objects, metal parts, rotating machinery, mills or grinders or from nails in shoes.
- When fire or smoke is observed in the headhouse or in grain storage bins.
- When excessive fumigant odors exist.

FGIS personnel are to advise the elevator management and OSHA of the reasons for evacuating.

The guidelines also established a policy for discretionary evacuation for other hazardous conditions if observed hazards go unabated. Authority for such evacuation must be obtained from FGIS headquarters. Some of these hazards include

- observation of hot surfaces, including light bulbs, hot bearings, slipping V-belts;
- observation of static electricity;
- use of unapproved portable lamps in storage bins; and
- poor housekeeping.

To determine other hazardous conditions, personnel use applicable sections of OSHA general industry standards and National Fire Protection Association codes.

Before the guidelines were issued, there were some evacuations of grain elevators, but most were due to bomb threats. From that time (February 1978) until September 21, 1978, there were 122 evacuations. The reasons for the

evacuations were: bomb threats (14), dust and humidity (49), fires (31), and other reasons (28). According to the Department of Agriculture's Acting Special Coordinator for Grain Elevator Safety and Security, there were 135 evacuations as of October 20, 1978.

The Department of Agriculture is studying the (1) causes of the recent explosions, (2) additional safety precautions needed, and (3) safety guidelines for FGIS employees. The Department also has intensified its research efforts on grain dust and grain dust explosions. The Department surveyed about 100 grain elevators which had an explosion or fire in the last 3 years or which had FGIS employees assigned to them, to gather information on

- equipment being used, dust systems, etc.;
- safety procedures;
- availability and response of rescue services; and
- causes of the explosions or fires.

Questionnaires and investigation reports of these accidents made by other Federal, State, or local agencies were analyzed, as were existing legislation, enforcement practices, and regulations. A Department of Agriculture official said the study would probably not be released before early 1979.

CHAPTER 5

WHAT SHOULD BE DONE TO REDUCE EXPLOSIONS--

AN UNRESOLVED ISSUE

Many methods have been proposed for improving grain elevator safety. Some involve costly equipment or modifications. Much of the technology proposed is not new, but it has not been widely adopted. The Iowa State University study reported that, although the conditions contributing to grain dust explosions and the means of preventing or controlling them were known in the 1950s, little progress has since been made in implementing or improving preventative measures.

The grain industry is reluctant to adopt costly methods without proof of their effectiveness. However, chemical company officials, who say their dust problems are similar to those of the grain industry, believe that the methods for reducing grain elevator explosions exist and that the grain industry should implement them.

Many people, from both inside and outside the grain industry, have recommended that grain dust, especially finer dust, that has been collected by control systems not be re-introduced to the grain. However, persons associated with the grain industry have pointed out that following this recommendation could lose revenue for elevator operators since there are not always markets for dust and its value is much less as dust than as part of the grain. The extent to which the probability of an explosion would be reduced by not returning dust to the grain has not been quantified.

PROPOSALS FOR PREVENTING EXPLOSIONS

Ignition source

The following were among the recommendations made for controlling ignition sources:

- Install belt slippage indicators that can be seen from the operator's station (friction from slipping belts can cause fires).
- Install audible alarms to indicate when the speed of an elevator leg falls to 80 to 85 percent. A representative of one firm that operates several

elevators stated that slow-down devices and motion switches were used in his firm's elevators. These devices shut down the drive motor if belt speed drops below 90 to 95 percent of motor speed.

- Establish a system to automatically shut down other interconnected conveyor belts when they slip.
- Install better bearings and mount them outside of enclosures containing dust.
- Install magnets to remove ferrous materials that can produce sparks.
- Install ground fault detection systems to detect short circuits and shut down equipment.
- Install devices to detect such things as humidity, gases, dust concentration, and static electric charges.

However, it is generally recognized that not all ignition sources can be eliminated. The best that can be done is to reduce the risk.

Oxygen source

Oxygen in the air which suspends grain dust in explosive mixtures can be displaced by noncombustible gases through a method known as inerting. Experimental data indicate that reducing oxygen content from 21 percent to 12 to 14 percent would prevent flame propagation.

The Department of Agriculture investigated and promoted inerting between 1914 and 1935. Although some industries adopted it, the grain and feed mill industries generally did not. The cost and feasibility of using inerting in a grain elevator have not been studied.

Controlling the fuel (dust) source

The FGIS Administrator told the Subcommittee on Compensation, Health and Safety of the House Committee on Education and Labor that:

"* * * we ought to recommend a change of emphasis where considering grain dust explosions. In the past, emphasis was placed on the ignition source

that caused an explosion and the elimination of this part of the explosive ignition-fuel-oxygen combination. By and large, the fuel part of the combination has been neglected in the past. I don't mean to suggest neglect of ignition sources in the explosion triangle. But I do mean that we should give greater attention to adequate removal of dust from grain handling facilities. Such a course of action would greatly reduce the explosion hazard."

The National Fire Protection Association believes that dust collection and removal is a vital aspect of explosion prevention. The Association's standards state that dust shall be collected at specific locations within grain elevators and bulk handling facilities. The standard also states that dust control systems shall be designed and installed so as to eliminate or reduce the known fire or explosion hazards inherent in the systems' operation. The standards do not specify how effective the system must be. Neither maximum dust levels, minimum air flows, nor other measures of efficiency are set forth.

According to dust control system designers, an explosive level of dust will always exist in grain elevators at some time or another whenever grain is being moved, especially when the grain falls at the various transfer points. They stated that present technology is not advanced to a point where a system can be designed to prevent the dust from reaching the explosive range. According to the Iowa State University study and research done at the University of Wisconsin, most dust control systems in grain elevators appear to be only partially effective.

Housekeeping practices

Air currents, vibrations, and sweeping operations can stir up enough dust to provide an explosive atmosphere. Small explosions also may shake dust accumulations loose and ignite them. A series of explosions may be the result. Also, grain and feed dust can decompose into highly combustible chemical compounds.

According to OSHA, good housekeeping is essential to reduce the possibility of a dust explosion. Dust accumulations should be periodically removed from equipment, pipes, floors, beams, and walls. OSHA's grain elevator hazard alert discussed procedures for elevator housekeeping.

In commenting on a draft of this report, FGIS stated that its safety manager visited Australia in June 1978 to find why that country's grain industry has never had a grain dust explosion. During the trip Australian grain industry officials reported three minor elevator explosions that damaged equipment but did not cause structural damage or personal injury. The Australians believed that their intensive housekeeping eliminates both suspended and static dust and that the resulting absence of fuel prevents major explosions. The FGIS safety manager agreed that housekeeping in Australian grain handling facilities was vastly better than in U.S. facilities.

Moistening dust

Researchers for the Cargill Grain Research Lab and Factory Mutual Research are experimenting with adding moisture to grain dust to make it less explosive. The researchers feel that more detailed experiments in this area are needed, even though results of current tests are encouraging.

Another system has been developed which uses a water mist to induce dust to agglomerate and fall out of suspension. This system has been used commercially for other dusts. Some tests have been made for grain dust, and more are planned.

Dust disposal

Collected grain dust is returned to the grain by many elevator operators. As a result, the fuel needed for an explosion becomes drier and finer and, consequently, more explosive. Incoming grain includes dust, and as the grain is moved through the elevator, more dust is created. Dust is collected at numerous transfer points, decreasing the weight of the grain. By returning the dust to the grain as it moves through the elevator--often just past the point at which it was collected--the operator can recover dust weight losses.

No regulations prohibit the return of grain dust. FGIS, OSHA, researchers, members of the industry, and insurance companies have stated that dust should not be returned for safety reasons. Also, grain dust contributes to grain quality deterioration as its presence increases the risks of infestation and molding during shipment. Australian grain elevator operators reportedly do not return dust to the grain.

The Federal Grain Standards Act advisory committee has recommended that collected dust not be returned to the grain. The Department of Agriculture is making a study of dust particle sizes, which would serve as a basis for developing standards that would specify what size dust particles could be recirculated safely.

A July 18, 1978, joint letter from OSHA and the Department of Agriculture requested that the grain industry voluntarily prohibit the return of grain dust.

Not returning dust can be costly. For example, a large elevator may handle 500,000 tons of grain a month. According to the Department of Agriculture's U.S. Grain Marketing Research Laboratory, dust can be less than 0.02 percent or as much as 1 percent by weight in grain.

If 0.1 percent by weight of grain is in the form of dust, as much as 6,000 tons of dust can be collected a year. If the grain handled were entirely wheat, which sells for about \$3.20 a bushel, the value of the dust if included with the grain would be about \$660,000 a year. Because wheat dust has a value of about \$10 to \$25 a ton and wheat has a value of about \$107 a ton, elevator operators have a strong economic incentive to return collected dust to the grain.

Marketing the dust can also be a problem. Some grain companies have found a market for their dust by selling it for animal feed. This market, however, is not always available.

The U.S. Grain Marketing Research Laboratory began doing research on grain dust on a small scale in 1974. Since the grain elevator explosions in December 1977 and January 1978, the research has been intensified. The Research Laboratory is now studying incentives for marketing wheat, corn, soybean, and sorghum dust. It is also studying the causes of grain dust explosions and ways of preventing them.

METHODS FOR MINIMIZING EXPLOSIONS AND THEIR EFFECTS

Explosions can be minimized through the use of flame arrestors, explosion suppression devices, and explosion venting.

Flame arrestors quench a flame front and prevent it from spreading. Design criteria for these devices are being

investigated. However, flame arrestors are not likely to be effective in quenching an explosion-type flame front.

In a typical elevator, an explosion in the elevator leg can spread to various bins through the belt conveyor at the top or the belt conveyor in the tunnel at the bottom of the bins. Proper closures at bin openings isolate the bins and should prevent the flame front from entering bins not being used.

One company has developed an explosion suppression system consisting of charged containers of flame extinguishing material located at strategic points in an enclosed space. According to the manufacturer, when pressure or temperature caused by a flame rises beyond a preset level, all charged containers release the flame extinguisher into the enclosure. The system is said to work so quickly that the flame will be extinguished before damage is done.

The system is being used to protect equipment used to process starch, flour, and wheat, but it is not used in the grain industry. The manufacturer, which believes this system would be suitable for elevator legs and dust collectors with relatively small volumes but probably unsuitable for silos, is working with a major grain company to study the system's application to its grain operations.

Explosion venting was discussed on page 17.

GRAIN INDUSTRY RELUCTANT TO ADOPT UNPROVEN THEORIES

On July 11, 1978, the Director of Technical Services, National Grain and Feed Association, spoke to the International Symposium on Grain Elevator Explosions. He expressed the industry's concern about explosions, adding that the industry's efforts were being directed toward eliminating ignition sources from overheated equipment or breakdowns. He said that research should be concentrated on identifying the causes of and means to prevent primary explosions rather than on preventing secondary explosions.

According to the Director, many theories have been offered as to the causes of dust explosions, but no theory can explain all explosions. For example, although returning grain dust has been theorized as a significant contributing cause, explosions have occurred where grain dust was not returned. He said industry dust handling practices should not

be changed until (1) more is known about the explosibility of various dust concentrations, (2) dust concentrations present in facilities and equipment have been measured, and (3) the benefits to be gained from not returning dust to the grain stream have been determined.

The Director said the industry is concerned that changes in elevator practices and operations based on theories or incomplete, inadequate analysis and research into elevator explosion problems may result in wasted spending with little or no reduction in the number of explosions. He stressed the need for additional research.

However, some grain companies are implementing, or are supporting, many of the proposed methods of reducing explosions. For example, one grain company official said his company was in its fourth year of a 6-year program of major improvements to the dust control systems of its terminal elevators. He added that grain dust is returned to the grain stream at only 1 of the company's 16 terminal elevators and that elevator is being modified.

CHEMICAL COMPANY OFFICIALS BELIEVE
GRAIN INDUSTRY EFFORTS NOT ADEQUATE

During the International Symposium, a representative of Monsanto Industries said research is being done on the theoretical causes of dust explosions and the practical application of such research to grain elevators. He believes that much of this research has already been done and that researchers should use the existing information. He added that Monsanto has successfully applied preventative measures and that some of this technology is applicable to grain elevators.

A Dow Chemical representative noted that the chemical industry has spent a great deal of money for measures to prevent or reduce explosions. According to him, the grain industry has made only a minimal investment in preventative measures and should start spending some money to apply existing technology to its elevators.

CHAPTER 6

CONCLUSIONS, RECOMMENDATIONS,

AGENCY COMMENTS, AND OUR EVALUATION

CONCLUSIONS

Although the number of grain explosions has remained relatively constant over the last 20 years, the results have changed. The years 1975, 1976, and 1977, while accounting for 18 percent of the explosions during the period 1958 to 1977, also accounted for 73 percent of the deaths and 31 percent of the injuries.

Why deaths and injuries have increased is unknown. Several possible reasons have been advanced, including

- the increased volume of grain handled and increased elevator capacity;
- the replacement of older facilities with more efficient, larger, and often reinforced concrete facilities;
- the Environmental Protection Agency regulations that require the confinement of grain dust and make explosion venting more difficult; and
- the reintroduction of filtered grain dust, especially the smaller and drier particles, to the grain stream.

The causes of most grain explosions are not known. OSHA's accident investigations are intended to determine whether (1) compliance with standards could have prevented the accident and (2) revised standards are needed to prevent similar accidents. However, OSHA's investigations of grain elevator explosions neither determined whether compliance with standards would have prevented the explosions nor developed methods of preventing future explosions. Explosion experts told us that prompt investigations (before the evidence is disturbed) by explosion experts are necessary to develop methods for preventing future explosions.

We believe that, when a grain elevator explosion occurs, OSHA should immediately obtain the services of explosion experts to make investigations aimed at determining the cause of the explosion and ways to prevent future explosions.

OSHA placed little emphasis on grain elevator inspections in the past. As a result of the December 1977 explosions, OSHA issued an alert to grain elevator operators describing hazards and ways of dealing with them. OSHA also increased the number and improved the quality of its elevator inspections. Because of other high priorities and a limited inspection staff, OSHA has not decided whether it will continue the present emphasis on grain industry inspections.

OSHA's increased inspections have been directed toward explosion hazards, although OSHA has stated that the health hazards of grain elevators may be a more serious problem. OSHA does not have enough industrial hygienists to make comprehensive health inspections at grain elevators and address other high priorities. However, we believe that, when safety officers inspect grain elevators, they should sample for dust. If the dust standard is exceeded, the matter should be referred to an industrial hygienist for a comprehensive health inspection.

Although existing standards address many hazards and compliance with them would help prevent explosions, it is not known whether additional standards are needed to further reduce explosion hazards. OSHA has contracted with the National Academy of Sciences to study grain dust explosions and fires. However, we were advised that the scope of the contract is not sufficient to achieve the desired objectives. We believe that OSHA should expand the scope of the Academy study.

Numerous recommendations have been proposed for reducing the probability of grain elevator explosions. Some of these recommendations have been implemented by certain elevator operators, and others are being studied. Many individuals and organizations, including chemical company officials, believe the grain industry needs to do more to reduce explosions. However, a spokesman for the grain industry has expressed the industry's reluctance to implement costly changes based on unproven theories.

We found no data that quantified the extent to which implementing various recommendations would reduce the likelihood of an explosion or minimize its effects. For example, there have been numerous recommendations and requests, including a joint request from OSHA and the Department of Agriculture, that grain operators not return dust to the

grain stream. Disposing of the dust separately could involve revenue losses, especially where there is no market for it. And the extent to which the probability of explosions would be reduced if dust were not returned is not known.

Because of a lack of data on the causes of explosions and the effectiveness of proposed modifications to facilities or operating practices in reducing explosions, further research is necessary.

The work to be done by (1) the National Academy of Sciences for the National Institute for Occupational Safety and Health, (2) the Academy for OSHA, if OSHA expands the scope of the contract, and (3) private industry should provide additional information on the effectiveness of the many proposed safety precautions for grain elevators.

The Academy's Committee on Evaluation of Industrial Hazards could serve as a center for coordinating, guiding, and evaluating the numerous research efforts on ways to prevent grain dust explosions or lessen their effects. However, in developing recommendations for improved standards, the Committee should not limit its consideration to ignition sources. Such areas as dust control, explosion venting, and limiting employee presence in hazardous locations to essential personnel should also be studied.

RECOMMENDATIONS

We recommend that the Secretary of Labor direct OSHA to:

- Make thorough, immediate investigations of future grain explosions using explosion experts. OSHA should also assure that comparable investigations are made if explosions occur at locations where OSHA has given States enforcement authority.
- Have safety inspectors making grain elevator inspections do sampling for dust.
- Expand the scope of its contract with the National Academy of Sciences to provide enough time for a more thorough study, which should include a thorough evaluation of the causes of grain dust explosions and the adequacy of OSHA's standards.

We recommend that the Secretary of Health, Education, and Welfare direct NIOSH to modify its contract with the National Academy of Sciences to expand the role of the Committee on Evaluation of Industrial Hazards to assure that all potential methods of reducing grain explosions are considered.

AGENCY COMMENTS AND
OUR EVALUATION

In December 1978 and January 1979 the Departments of Agriculture, Labor, and Health, Education, and Welfare and the Environmental Protection Agency commented on our draft report. Their comments and our evaluation of these comments are presented below.

Department of Labor

The Department of Labor stated (see app. VI) that its compliance officers had arrived at the worksites within hours of each explosion discussed in this report and had started the investigations as soon as possible.

Labor stated that determining the precise cause of a grain elevator explosion is usually impossible and noted that an Iowa State University study was unable to identify the ignition source in 62 percent of the explosions studied and the location of the primary ignition source in 69 percent of the explosions studied. 1/

Labor stated that OSHA's inspections had identified a number of factors that have been known to contribute to explosions and cited one instance in which the cause of the explosion was identified.

Labor pointed out a number of steps OSHA has taken to provide safer workplaces for grain elevator employees, including issuing a hazard alert, increasing the number of inspections, and training compliance officers. We mentioned these matters in this report.

1/Although it is probably true that the causes of most grain dust explosions cannot be determined, it should be noted that the Iowa study did not include an independent determination of the cause or location of explosions. The above-cited statistics were compiled primarily from periodicals, and the study's authors stated that "No endorsement of possible causes * * * is intended or implied."

According to Labor, we should recognize that Government efforts alone cannot protect workers from grain elevator hazards--that employers have the burden of responsibility for providing safe and healthful working conditions. We agree. Our report neither states nor implies that the Government has primary responsibility for worker protection. Rather, it discusses the setting and enforcement of workplace standards--which are OSHA's responsibility.

Labor said that compliance with OSHA and industry standards would lead to a significant reduction in grain dust fires and explosions. It said preventative measures by employers to protect workers should not await the results of further research. It stated, as our report already recognizes, that some grain elevator operators are already using engineering controls to reduce hazardous conditions. We do not advocate delays in using preventative measures pending further research. We do note grain industry reluctance to adopt some measures without proof of their effectiveness.

OSHA is responsible for establishing and enforcing workplace standards. We are recommending that thorough efforts be made to evaluate (1) methods of reducing grain dust explosions and (2) the adequacy of pertinent OSHA standards. Such evaluations could serve as a basis for

--convincing grain elevator operators who would act voluntarily if they had more proof and

--having enforceable standards to help assure implementation of safe practices by employers who would not do so voluntarily.

Labor said that adverse comments by a few agency officials about the competence of compliance officers (see p. 21) were erroneous. They were individual opinions that do not represent the views of the agency regarding OSHA's capability to make grain elevator inspections.

We recognize that these were individual opinions. However, these views, as well as similar views by other officials that were not discussed in our report, are the opinions of persons with day-to-day responsibility for supervising inspections. It should be noted that these opinions related to inspectors' capability before the explosions discussed in this report.

Labor agreed with our recommendation that OSHA and the States make immediate, thorough investigations of future grain explosions using explosion experts. However, Labor took issue with our implication that OSHA did not use available expertise in its explosion investigations. Labor said that

- OSHA did consult some of the explosion experts referred to in our report;
- OSHA believes that, in addition to knowledge of explosions, knowledge of grain elevator operations, which it believes its compliance officers have, is essential to such investigations; and
- fires were a major aspect of the explosions, and an OSHA fire expert took part in one investigation.

Our report recognizes that an OSHA fire expert took part in one investigation. And although OSHA has consulted with outside explosion experts, these experts did not participate in the investigations discussed in this report. We agree that knowledge of grain elevator operations is essential. We would expect that explosion experts would be used as part of a team which included persons knowledgeable about grain elevators.

Labor stated that OSHA is developing a disaster response program that will go beyond our recommendation and will improve OSHA's response to all workplace disasters. Disaster response teams would include experts from OSHA and, if necessary, other Federal agencies, the academic community, private consultants, or private industry. According to Labor, such teams could be made available for States' workplace disaster investigations. Labor added that the team of experts working on OSHA's contract with the National Academy of Sciences could be called upon to investigate and consult with OSHA regarding grain elevator explosions.

We believe that disaster response teams as described above would (1) improve the quality of explosion investigations and (2) help develop data to assist in preventing future explosions.

Regarding our recommendation concerning dust sampling, Labor said that OSHA's policy is that safety officers who have been trained regarding health hazards will sample for dust during grain elevator inspections. Labor says that such

sampling, which is a first step in determining whether a complete health inspection is required, has been and will continue to be part of OSHA's grain elevator inspection effort.

As of January 1, 1978, over half of OSHA's safety officers had received training regarding health hazards. However, dust samples were taken in only 7 percent of the grain elevator inspections made between December 1977 and May 1978. We believe that OSHA needs to assure that its policy of having safety inspectors take dust samples is followed.

Labor said OSHA feels that a decision should not be made on our recommendation to extend its contract with the National Academy of Sciences until the Academy has had an opportunity to fully assess the problems identified by the initial study. Labor stated that its contract requires the Academy to (1) make recommendations for improving investigations to determine the causes of grain elevator explosions and (2) evaluate the adequacy of OSHA's standards that may apply to potential causes of explosions. According to Labor, the Academy will study preventative measures regarding explosions and will make recommendations to prevent explosions. Labor stated that (1) the current contract does not preclude a later contract to address areas that need further investigation, (2) the Academy is expected to list areas needing further study, and (3) the duration of the overall effort required to complete this study could not be determined at the time its comments were prepared.

We believe that Labor should review OSHA's actions when the contract is completed to assure that needed follow-on work is undertaken.

Department of Health,
Education, and Welfare

HEW recommended (see app. V) that greater emphasis be placed on the health hazards of grain dust, which may cause more deaths than explosions. HEW said greater emphasis should be placed on the concept that both the explosion and health hazards of grain dust are potentially controllable by one set of protective measures, which could provide additional incentive to implement the control measures.

Regarding our recommendation that HEW direct NIOSH to modify its contract with the National Academy of Sciences, HEW agreed with the thrust and rationale of the recommendation-- that all potential methods of reducing grain dust explosions

should be examined. However, HEW expressed uncertainty about whether contract modification would be the best way to achieve the purposes of our recommendation. HEW said an alternative method would be a control technology assessment, which would examine the process and control methods available to the grain handling industry and would consider cost and effectiveness in protecting employees. According to HEW, NIOSH has made such assessments in a number of industries, with EPA involvement in some cases to simultaneously consider environmental emission control. HEW said NIOSH will consider both alternatives and take appropriate action.

We believe the alternative method proposed by HEW would achieve the same purposes as the approach we recommended.

Environmental Protection Agency

EPA stated (see app. VIII) that its regulations do not require that grain dust be confined within grain elevators. EPA says that the intent of its regulations is that dust be captured where it is generated within the elevator and transported by air handling equipment to a control device, where the dust is separated and the clean air is exhausted. EPA added that, if this practice were followed, doors and windows could be opened because the quantity of dust escaping would be minimal. According to EPA, most people agree that a properly operated and maintained dust control system would reduce the potential of a dust explosion.

EPA also noted that we did not

- determine whether grain elevator construction practices have changed to comply with air pollution control regulations or because larger, more efficient reinforced concrete facilities are replacing older elevators or
- describe the technology developed by chemical companies or how it might be used in the grain handling industry.

We believe all the factors EPA cited have a bearing on grain elevator construction practices, but we do not know which predominate. We believe the alternatives NIOSH is considering should thoroughly address the applicability of chemical industry explosion control technology to grain elevators.

Department of Agriculture

FGIS sent us its comments and those of the Department of Agriculture's Acting Special Coordinator for Grain Elevator Safety and Security. (See app. VII.)

According to FGIS, it did not notify OSHA about the hazards at Farmers Export Company because a procedure to do so had not been established by either FGIS or OSHA. FGIS said that, before the explosion at Farmers Export Company, OSHA's policy did not permit a response to complaints or requests from individuals who were not employed by the facility to be inspected.

FGIS's understanding of OSHA's policy is not correct. Since 1976, OSHA's policy has been to respond to all complaints without regard to their source or the way they are received. Two of our other reviews, which included complaints made before December 1977, showed that OSHA was investigating nearly all complaints regardless of who made them or how they were made.

FGIS also made several technical comments which have been incorporated into the report.

The Acting Special Coordinator for Grain Elevator Safety and Security made a number of comments on our draft report. Most were of a technical nature, and we have revised the report to reflect them where appropriate. Several of his comments dealt with areas that are primarily the responsibility of other Federal agencies whose views are reflected in this report.

According to the Acting Special Coordinator, our report presents a misleading examination of the reintroduction of grain dust into the grain stream. He said the Department of Agriculture's position is that collected dust should not be reintroduced. We have clarified the report with regard to the Department's position. However, it should be noted that, although Agriculture believes that dust should not be returned, this is not prohibited.

The Acting Special Coordinator added that not returning the dust to the grain may not be as costly as our report indicates. He said we should consult FGIS regarding the costs. FGIS, which gave us both its comments and the comments of the Acting Special Coordinator, made no mention of dust removal or related costs.

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January 6, 1978

Mr. Elmer B. Staats
Comptroller General
General Accounting Office Building
441 G Street, NW
Washington, D. C. 20548

Dear Mr. Staats:

As we watch grain elevator after grain elevator explode in various places in the nation, one cannot help but be alarmed and wonder what could be causing such a rash of disasters in this industry after many years of emphasis on health and safety practices.

To witness the obviously confused inspectors of the Environmental Protection Agency and Occupational Safety and Health Administration surging to the countryside with a renewed call for greater compliance, a serious question comes to mind, "Are federal regulations causing violent deaths among working Americans in the name of safety and health?"

As a former grain buyer and elevator manager with dust fire experience, I am seriously concerned that the bumbling lack of expertise, which has caused the Occupational Safety and Health Administration to become a national laughing stock, has now turned out to be fatal in the handling of serious industrial matters.

Already OSHA could be judged with apparent neglect in the tragic Kepone situation, and now we find strong reason to expect that OSHA and the EPA regulations are actually the cause of explosions causing death and heavy damage.

Anyone even remotely acquainted with the characteristics of combustible materials knows that a spark under well-ventilated circumstances may cause smoldering or even fire but presents a threat of explosion under closed circumstances. Thus OSHA and EPA in their regulations demanding recycling, filtering, and confinement of grain elevator dust might well be tragically stocking the nation with thousands of dust bombs such as those recently witnessed.

It is important to note that both OSHA and EPA are being named along with grain and insurance companies in multi-million dollar damage suits because of questionable operation practices and regulations concerning the handling of dust. It may well be that the same agency which occupied itself with the frequency and design of toilet facilities both rural and urban missed its safety mission and created a fatal dust bomb which is currently blasting elevators with frequency.

We cannot take a chance in the face of such tragedy that well-intended government programs might not only be unproductive but dangerous and damaging. Therefore, as a Member of Congress interested in the welfare of the nation as it applies to our responsibilities, I must demand that the General Accounting Office investigate the impact of OSHA and EPA on the grain industry.

I suggest that you also include the inspection service of the U.S. Department of Agriculture and the Food and Drug Administration in such a review. As you know, Agriculture has direct responsibility while FDA is involved on a secondary basis primarily in moisture content and quality control. Even this could have an impact on the dryness and combustibility required of grain prior to shipment.

Because of the urgency and deadly aspects involved, I would hope that this matter could be addressed with dispatch and look forward to your early reply.

Sincerely,



GEORGE HANSEN
Member of Congress

GH:mw

P.S. In a report prepared for me by the Congressional Research Service of the Library of Congress dated January 4, 1978, a veteran spokesman for the Mill and Elevator Mutual Insurance Companies is said to have commented that the rumor regarding EPA's part in the disasters could be considered "partly correct" since EPA's air pollution regulations had prevented the omission of dust-laden air through open vents, as had formerly been the practice.

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United States Senate

COMMITTEE ON APPROPRIATIONS

WASHINGTON, D.C. 20510

January 31, 1978

Mr. Elmer B. Staats
 Comptroller General of the United States
 General Accounting Office
 441 G Street
 Washington, D. C. 20548

Dear Mr. Staats:

Within the past month there have been six explosions and fires at grain elevators in Louisiana, Mississippi, Kansas, Texas, Missouri and Minnesota. A list of the date, place, number of deaths, and name of facility is attached. There has been extensive press coverage of these grain elevator accidents. I am particularly concerned since it has been reported that between 1958 and 1975, 36 people died in grain elevator accidents with total damages amounting to approximately \$50 million. This contrasts significantly with grain elevator accidents in the past two years which involved more than three times the number of fatalities and three times the property damage.

What is further disturbing to me is that the explosion at Galveston, Texas, occurred in a grain elevator that was less than two years old. News reports indicated that this elevator had never been inspected by the Occupational Safety and Health Administration (OSHA). Trade publications have reported that OSHA has not inspected anywhere near the approximately 10,000 grain elevators in this country.

In addition, I have been told that OSHA has not finalized guidelines to reduce hazards at elevators. It is my understanding that OSHA, EPA and the Department of Agriculture are presently working on these guidelines to determine when elevators should be evacuated and to identify specific causes of the recent explosions.

Of further interest is that the Federal Grain Inspection Service (FGIS) does not have the authority to close down elevators, and even though FGIS employees can and have been directed

to leave unsafe elevators, their operations can still continue if non-graded grain is being processed.

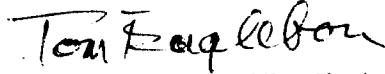
There have been reports that the recent explosions could be caused by a lack of maintenance caused by an unusually large volume of grain for export.

The Committee would like the General Accounting Office to conduct a complete review of this matter to include the following:

- 1) Place the recent explosions in their proper perspective in relation to explosions that have occurred during the past 25 years.
- 2) Work with the investigatory agencies who are looking into the explosions to determine, to the extent possible, the cause of the explosions and report the findings to the Committee. (Of course, the Committee does not expect GAO to duplicate the investigations performed by OSHA or other agencies).
- 3) Delineate the currently known methods of preventing or reducing the likelihood of elevator explosions and report on their feasibility, advisability and cost.
- 4) Make appropriate recommendations on actions that could be taken to reduce the likelihood of occurrence of these tragedies.
- 5) Consider and report on the advisability of establishing more stringent standards for grain elevators and of increasing the utilization of the special expertise available in the Federal Grain Inspection Service in an advisory capacity to OSHA so that prompt elimination of any hazard is assured.
- 6) Compile a separate report on each of the six accidents cited in the enclosure that includes date, location, estimated cost of damages, general description of damages, type of facility, number of deaths, number of injured, and any other narrative or statistics deemed to be appropriate by GAO.

Please contact Mr. Richard Lieberman of the Subcommittee staff on 224-7272 to discuss this request and to establish a timetable for completion of the report.

Yours very truly,



THOMAS F. EAGLETON, Chairman
Subcommittee on Agriculture, Rural
Development and Related Agencies

TFE:dli

Enclosure

RECENT GRAIN EXPLOSIONS AND FIRES

(January, 1978)

<u>DATE</u>	<u>LOCATION</u>	<u>NAME OF COMPANY</u>	<u>DAMAGES</u>
Dec. 22, 1977	Westwego, La.	Continental Grain Company (elevator)	35 dead, estimated \$100 million damage
Dec. 22, 1977	Tupelo, Miss.	Sunshine Mills and Grain Inc. (grain drying room)	2 deaths
Dec. ? , 1977	Courtland, Kansas	J & R Grain Company	0
Dec. 28, 1977	Galveston, Tx.	Farmers Export Company (terminal)	16 or 18 deaths
Jan. 19, 1978	Liberty, Mo.	Desert Gold Feed Co. (feed mill)	3 deaths
Jan. 21, 1978	Duluth, Minn.	International Multifoods Company (Elevator #4)	Unknown

SOURCE: Information compiled from news clippings

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U.S. House of Representatives
Committee on Agriculture
Room 1304, Longworth House Office Building
Washington, D.C. 20515

February 6, 1978

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Mr. Elmer B. Staats
Comptroller General of the United States
General Accounting Office
441 G Street
Washington, D. C. 20548

Dear Mr. Staats:

This refers to a recent meeting held with representatives of your office concerning a study of the recent explosions which have occurred in grain elevators throughout the country. Several people have been killed or injured as a result of these explosions, and property loss has been substantial. The explosions at export port locations are said to have had an adverse effect on the exports of farm commodities.

I am interested in having the grain elevator explosions investigated by the General Accounting Office (GAO) for the reason that there is a need to explain what appears to be an increasing frequency of such explosions. In addition, I believe that an objective entity should conduct the study and investigation rather than those agencies which are involved directly or indirectly with the inspection of grain (the Federal Grain Inspection Service), the safety measures imposed on elevators and the environment within the elevator (the Office of Safety and Health Administration), or the air pollution standards for emissions from grain elevators (Environmental Protection Agency).

Among the items which I believe should be studied and investigated, some are quite technical and should, I believe, be conducted by the National Academy of Sciences under some contractual or other arrangement with GAO. In my opinion, the Committee on Industrial Hazards, National Academy of Sciences, under the chairmanship of Dr. Homer Carhart, is especially qualified to examine the following:

1. A probability study of recent explosions to determine whether, in fact, the numbers or frequency of elevator explosions have increased and what significantly different conditions may account for the variations, if any;
2. What the sources of ignition are which may--given conditions under which grain dust becomes explosive and causes fires (assuming dust will not explode unless confined)--cause grain dust to explode; and,
3. What measurements of the flammability characteristics of grain dust can be determined so that monitoring standards can be established for guides in alerting grain elevator owners and operators of explosion dangers.

Questions which I believe GAO is especially well equipped to examine are, among others, as listed below:

1. Is the equipment installed or the dust standards imposed by Federal agencies in grain elevators in order to reduce pollution emissions or the standards imposed to protect the working environment of employees contributing to grain elevator explosions?
2. Is there a need for a change in grain inspection standards such that dust removed from grain is not reintroduced into grain shipped out of a elevator or terminal? Is there a simple way of giving an incentive to elevator owners and operators to permanently remove dust in grain?
3. Are explosivity indexes prepared by the Bureau of Mines valid and reliable today?
4. Is the increased speed of moving grain contributing to explosions?
5. Does the increased capacity of elevators (such as export terminals) have an effect on the probability of elevator explosions?
6. Does cleaning increase the probability of explosions, and are the processes to effect cleaning reliable and validated?
7. Is dust technology perfected; is there agreement on standards; and, is equipment properly operated, maintained, and tested to insure that it is effective?
8. Do Federal and State laws adequately legislate in the area of grain elevator inspections, grain inspection standards, elevator safety standards, etc.? Is there a need for a uniform State law that could address this issue?

9. Is there a positive relationship between Federal and State regulatory standards and inspections and the prevention of elevator explosions?

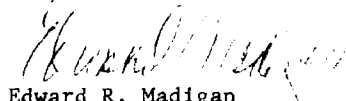
10. Are there reliable recommended tolerances in grain elevators for certain chemical hazards (such as fumigants and pesticides) and practices and devices (such as personal hygiene and personal protective equipment) which may be utilized to control human exposure to chemical and grain dust health hazards while minimizing fire and explosion hazards?

Finally, it appears to me that perfect conditions in elevators that would insure no explosions would be difficult to achieve within available owner/operator resources and Federal or State inspection resources. Therefore, I would appreciate it if you include recommendations resulting from your study which are common sense and reasonable. Recommendations which balance owner/operator and government (taxpayer) costs, a high concern for employee safety and health hazards, practicability for implementation, etc., are desirable objectives for the GAO study.

Your cooperation in addressing the foregoing matters in the course of an investigation and study of grain elevator explosions would be deeply appreciated.

With kind regards.

Sincerely,



Edward R. Madigan
Member of Congress

ERM:jhw

cc: National Academy of Sciences

DATA ON SIX 1977-78 GRAIN DUSTEXPLOSIONS AND FIRESCONTINENTAL GRAIN COMPANY

Continental Grain Company owned and operated an export grain elevator at Westwego, Louisiana, with a storage capacity of about 6.5 million bushels. In a December 1977 accident, 36 people died and 10 were injured. Although the cause of the accident is unknown, OSHA citations were issued for numerous violations of the Occupational Safety and Health Act of 1970. The citations are being contested. OSHA had inspected the elevator about 2 months before the accident.

The facility

The grain elevator consisted of 73 silos, 5 grain tanks, 2 railcar unloading facilities, a barge unloading facility, a ship loading facility, a headhouse, an office, and other miscellaneous structures. The elevator could handle about 15 to 20 million bushels per month.

The silos were constructed in three stages--24 were completed in 1960, 21 in 1962, and 28 in 1977. The silos were all 110 feet high; the headhouse, located on the east end of the silos, was 260 feet high. Just north of the headhouse was a two-story office building with offices for Federal Grain Inspection Service and Continental Grain Company employees. Dust control equipment complied with Louisiana Air Control Commission regulations. Dust collected at the barge unloading facility was returned to the grain, whereas all other collected dust was sold.

The accident

On December 22, 1977, about 75 employees and contractor personnel were at the facility. Corn was being loaded on the motor vessel Vesteroy. Loading had been continuous since December 20. Most of the people present were at their assigned jobs. Some employees had just finished work on the night shift, and others were picking up Christmas gifts from the company.

At about 9:05 a.m., a series of explosions occurred. Area fire departments arrived at the scene to find burning silos and a mass of concrete and steel where the office

building and headhouse had been. Rescue efforts were initiated and injured personnel were transported to local hospitals. Explosions continued throughout the morning.

Eventually, 35 bodies were located throughout the rubble. Eleven people were injured, one of whom died several weeks after the initial incident, bringing the fatality count to 36. Of the 36, 26 were killed when the headhouse exploded and the top half fell onto the office building they occupied.

The headhouse structure was virtually destroyed, and what little remained had to be pulled down during body recovery operations. More than half of the silos were destroyed during the explosions. It was estimated that the damage was \$30 million and that it will take at least 2 years to rebuild the facility.

The cause

The cause of the explosion is not known. Based on the statements of eyewitnesses and an examination of the damage, OSHA investigators concluded that an explosion occurred in the basement of the second set of silos, followed by chain reaction explosions in the basement of the headhouse, the bin deck, and finally the silos below the bin deck. The first explosion probably occurred as a result of a fire which started near the top of the headhouse and progressed across the top of the silos and down into the silo basement. The cause of this fire is unknown.

OSHA investigators discovered violations of the Occupational Safety and Health Act of 1970 throughout the elevator. Potential ignition sources included diesel powered front-end loaders not approved for operation in hazardous dust areas, equipment capable of producing sparks, static electricity sources that were not properly protected, and electrical equipment that was not approved for use in hazardous dust locations.

Although both employees and Federal grain inspectors considered housekeeping in the elevator to be good, violations involving dust accumulations and unsafe practices in handling grain dust were cited.

Prior inspections

The grain elevator had been inspected by OSHA personnel four times--in 1971, in 1976, and twice in 1977. In 1971 the employer was found to be in compliance with OSHA standards.

The second inspection was made in response to a complaint about welding being done by a contractor. The welding operation was inspected, and conditions were found to be satisfactory.

An October 1977 inspection covered a new office building, the maintenance shop, the elevator basement, several floors in the headhouse, one of the railcar unloading facilities, and the barge unloading facility. Two violations were cited: (1) improperly marked exit doors and (2) an improperly grounded refrigerator. The fourth inspection was a followup in November 1977 which determined that the above conditions had been corrected.

FARMERS EXPORT COMPANY

The export grain elevator owned and operated by Farmers Export Company in Galveston, Texas, had a capacity of about 4.6 million bushels. In a December 1977 accident, 18 people died and about 22 were injured. The cause of the accident is unknown. OSHA citations, which are being contested by the company, were issued for several violations of the Occupational Safety and Health Act of 1970. The elevator had not been inspected by OSHA since the start of grain handling operations. A construction inspection was made when the elevator was being built.

The facility

The grain elevator, built in 1976, consisted of 60 silos, 2 grain tanks, a railcar unloading facility, a truck unloading facility, a ship loading facility, a barge unloading facility, a headhouse, an office building, and other miscellaneous structures. The elevator had handled between 7.7 and 14.2 million bushels per month.

The silos were 125 feet high with 7-inch reinforced concrete walls and 5-inch reinforced concrete roofs. The 230-foot-high headhouse was also of reinforced concrete construction. Just south of the headhouse was a one-story office building, and southwest of the office building was a metal railroad car dump shed. Grain was transferred from the dump shed to the headhouse by underground concrete tunnels which ran under the office building.

The facility was equipped with dust collection equipment, which was being upgraded at the time of the accident. Collected grain dust was reintroduced into the grain.

The accident

On the evening of December 27, 1977, about 47 people were on duty at the elevator. Wheat was being unloaded from railcars, and wheat was being loaded aboard the motor vessel Sutjeska.

At about 8:31 p.m., a violent explosion occurred. On arrival at the elevator, fire and police department personnel began rescue operations and injured personnel were transported to a local hospital. As a result of the accident, 18 people died and 22 were injured.

The railcar unloading facility was completely destroyed, along with the conveyor tunnel connecting the facility to the headhouse. The headhouse was so damaged that it had to be torn down. One grain tank collapsed, and the contents of the second grain tank caught fire. When the conveyor tunnel between the railcar unloading facility and the headhouse exploded, the explosion destroyed the unoccupied general office building, which would have been occupied during the day.

Because of pending litigation an estimate of the cost of the damages was not available from the owner or insurer of the elevator. One report estimated the cost to be more than \$25 million.

The cause

The cause of the explosions is not known. Based on eyewitness statements and an inspection of the damage, OSHA investigators concluded that an explosion occurred in the railcar unloading facility, followed by explosions in the conveyor tunnel and the headhouse.

OSHA investigators found several possible ignition sources in the railcar unloading facility. A diesel electric locomotive, which produced coupler sparks, exhaust sparks, generator sparks, and electric motor sparks, was in the facility. Additionally, spark producing tools were used to open railcars, smoking was allowed immediately outside the facility, and electrical equipment was used which was not approved for hazardous dust locations. These and other potential ignition sources found throughout the elevator were cited as violations of OSHA standards.

Housekeeping in the elevator was not considered to be good by employees and Federal grain inspectors. As noted on page 24, an FGIS official had requested authorization to

withdraw his inspectors. OSHA inspectors cited the existence of dust accumulations and unsafe practices in handling grain dust. Another violation was cited because the dust collectors for two sections of the unloading facility were inoperative on the evening of the explosion.

DESERT GOLD FEED COMPANY

The feed mill near Liberty, Missouri, owned and operated by Desert Gold Feed Company, produced feed for poultry and livestock. Three people died and six were injured in an accident of unknown cause in January 1978. Several violations of the Occupational Safety and Health Act of 1970 were cited. The company has contested the citations. OSHA had inspected the feed mill 4 years earlier.

The facility

The feed mill, constructed in 1955, consisted of a mill building, warehouse, and six metal grain tanks. Storage capacity was provided for about 330,000 bushels of raw materials and finished products. The mill was capable of packaging about 110,000 pounds of finished products a day.

The mill building and the ground floor of the adjoining warehouse were constructed of reinforced concrete. Three storage silos, each divided into numerous bins, were part of the mill building. Dust control equipment was provided for the mixing and bagging areas of the mill building and a portion of the warehouse. Collected dust was mixed with residues from the feed production process.

The accident

On the evening of January 19, 1978, six Desert Gold employees and three contractor employees were working at the feed mill. A 4,000-pound batch of "Aureomycin 50," a meal, was being mixed and packaged. At the same time, contractor personnel were salvaging spilled aureomycin, a major component in the meal being produced, in the basement of the mill building. The salvaged aureomycin was being air pumped through a plastic pipe to the top of a silo and into a bin. Contractor personnel observed and were concerned about aureomycin dust being generated and static discharges along the pipe. Desert Gold employees assured them that aureomycin was not flammable and that the sparking was normal.

At about 9:20 p.m., an explosion occurred. Law enforcement and fire department personnel arrived to find the warehouse burning and debris scattered around the area. Six injured persons were transported to area hospitals, while the search for the three missing employees was delayed because of intense smoke. Their bodies were recovered later that night.

The warehouse and half of the feed production equipment were destroyed. The cost of damages was estimated to be \$678,000, and another \$60,000 worth of finished products were lost.

The cause

The cause of the explosion is not known. OSHA investigators concluded, based on eyewitness accounts and an inspection of the damaged facility, that the salvage operation generated an aureomycin dust cloud, which was probably ignited by a static electric discharge from the plastic pipe.

OSHA investigators cited as violations a number of potential ignition sources throughout the mill and warehouse. These included a motor driven forklift and electrical equipment not approved for use in hazardous dust areas, in addition to the nonconductive piping that generated the static electricity. One unsafe practice in handling grain dust was cited.

An investigation report prepared for an insurance company indicated smoking as a possible cause of the explosion. The employees were reportedly told to take a break when the pump truck malfunctioned. Minutes later the explosion occurred. The employees were said to be smokers, and one was to be disciplined for previously smoking in a no smoking area.

Prior inspections

OSHA personnel had inspected the feed mill in January 1974. Six violations were cited relating to

- two instances of unguarded machinery,
- inadequate inspection of fire extinguishers,
- inadequate stairway railings,
- improperly marked exits, and

--excessive air hose pressure.

According to OSHA documents, corrective actions were taken.

SUNSHINE MILLS, INC.

Sunshine Mills, Inc., owned and operated a grain elevator and pet food mill at Tupelo, Mississippi. The elevator consisted of 20 silos and bins, and a headhouse with a storage capacity of 316,000 bushels. The pet food mill, a separate operation, had a storage capacity of 200 tons. Four people died and 15 were injured in an accident at the pet food mill in December 1977.

The facility

The elevator and mill were built in 1957. The mill had since been modified numerous times. The mill consisted of a four-story milling building and an adjoining packaging and storage building. Raw materials were ground, mixed, pelleted, and dried before being packaged. Production amounted to about 150,000 tons per year.

The mill was equipped with a dust control system which, according to mill officials, was operating properly at the time of the accident.

The accident

On the morning of December 22, 1977, 50 Sunshine employees and 9 contractor employees were on duty at the mill. Dog food was being manufactured, and contractor personnel were installing a new product line.

At about 11:30 a.m., there were two explosions and a brief fire. Fire, police, and medical units arrived at the scene. Rescue operations began immediately, and 19 injured people were transported to local hospitals. Four of them died as a result of burns.

The explosions, which occurred almost simultaneously, blew out the east and west walls of the mill building and did extensive damage to some equipment. The estimated cost of the damages was \$1 million.

The cause

The cause of the explosion has not been determined. Based on eyewitness accounts and an examination of the

damages, OSHA investigators concluded that, immediately after a weld was completed on a wheat bin, the grinder feeding the bin was started. This blew wheat grain dust into the bin, and it exploded. OSHA investigators believe that the hot weld was the most likely source of ignition. Also, static electricity or arcing from binmounted electrical equipment are considered possible sources of the ignition.

OSHA investigators discovered a number of potential ignition sources throughout the mill and elevator. These included other sources of static electricity and electrical equipment not approved for use in hazardous dust locations. In addition, dust accumulations were cited in both the mill and elevator.

Prior inspections

OSHA had inspected the feed mill twice in the past. The first inspection, in November 1975, resulted in citations for the following violations.

- Failure to provide a railing to protect workers from falls.
- Exposure of employees to excessive noise.
- Use of a nonapproved gasoline container.
- Failure to provide guards on equipment.
- Failure to provide face and eye protection.
- Failure to properly ground electrical equipment.

A followup inspection in December 1975 resulted in citations for the following violations.

- Failure to provide a railing on a platform.
- Failure to provide for a safe stairway.
- Failure to provide approved electrical equipment for use in hazardous dust locations.

According to OSHA officials, the employer corrected all the conditions cited.

CAPITAL ELEVATOR #4

International Multi-Foods, Inc., owned and operated Capital Elevator #4, a 900,000-bushel storage capacity grain elevator at Duluth, Minnesota. In January 1978, the elevator was completely destroyed by fire, the cause of which is unknown. No one was injured. OSHA officials did not make an investigation. State officials visited the scene but did not consider their visit as an investigation.

The facility

Capital Elevator #4, a wood frame structure, was built about 1895. It consisted of a 220-foot-high headhouse, an adjoining structure containing storage bins, and a ship loading facility. The elevator could handle 40,000 bushels per hour, but in recent years it had been used only for overflow storage from another elevator owned by International Multi-Foods, Inc. The elevator was operated only about 10 percent of the time.

Fire protection consisted of an automatic alarm system, a sprinkler system, and a heat indicator system for belts and bearings. The elevator was also equipped with a dust collection system.

The accident

On January 21, 1978, the elevator was unoccupied and not in operation, having been shut down since 3:00 p.m. of the previous day. The Great Lakes bulk carrier Harry L. Allen was berthed for the winter next to the elevator.

At about 3:05 p.m., employees at an adjacent elevator noticed smoke coming from openings near the roof of Capital Elevator #4. At 3:26 p.m., the sprinklers in a section of the elevator turned on and the alarm system was activated. Upon arrival at the scene, fire department personnel found that the floor around one elevator leg had been burned through from the boot pit area below the floor. Just as the fire was brought under control, a fireball developed in the headhouse above the firefighters. The frame building was then completely engulfed in flames, and the firefighters withdrew.

The structure was completely destroyed. Additionally, the Harry L. Allen suffered damage from fires started aboard by the heat of the burning elevator and falling debris. The elevator, valued at \$1.7 million, was completely destroyed. Damages to the bulk carrier were estimated at \$2 million.

The cause

The exact cause of the fire is not known. Based on the situation first encountered by the firefighters, the Duluth fire marshall concluded that the fire started in the boot pit and that an overheated bearing or a rubbing belt may have caused a fire which smoldered since the day before, when the elevator was in operation. The flash fire which caused the firefighters to withdraw is believed to have occurred when dust in the dust collection system was shaken loose.

State officials were unable to examine the physical damage because a contractor had cleared the area where the fire originated, thereby destroying any usable evidence.

Prior inspections

OSHA had inspected the grain elevator in 1974 as the result of a complaint. At the time of that inspection, the elevator was empty and not in operation. The following violations were cited:

- Poor housekeeping in some areas of the elevator.
- Unsafe flooring.
- Improper door clearance.
- Dangerous ladders.
- Insufficient fire extinguisher inspections.
- Several unguarded machines.
- Unguarded fire pole.
- Failure to provide approved electrical equipment for use in hazardous locations.

Corrective action was taken.

BEHIMER & KISSNER, INC.

Located in Wayne City, Illinois, the grain elevator leased and operated by Behimer & Kissner, Inc., received, stored, and shipped grain. The elevator was built in 1964. One person died as the result of the accident in December 1977. The cause of the accident is unknown. Several violations of the Occupational Safety and Health Act of 1970 were cited. OSHA had not previously inspected the elevator.

The facility

The grain elevator consisted of 26 storage bins, including a drying silo, 3 metal grain tanks, 2 truck dump pits, a headhouse, and an office. The elevator had been handling about 8 million bushels of grain a year.

The grain drying silo, consisting of 3 bins, was 141 feet tall with 9-inch reinforced concrete walls. The headhouse, of wood construction, was located on top of the drying silo. Dust control equipment was provided in the elevator legs, truck receiving pits, rail load out spout, and the grain drying silo. Collected dust was reintroduced into the grain near the source of collection.

The accident

On the morning of December 21, 1977, 25 Behimer & Kissner employees were working at the elevator. The elevator was in operation. About 30 to 35 trucks had unloaded consignments of corn. At the time of the accident there were three trucks at the elevator. One truck was at a truck dump pit, one at a probing platform, and one at the approach to the probing platform. Besides the three truck drivers, a receiving pit operator, and an employee on the probing platform, no other personnel were present at the elevator. All other elevator employees had left for lunch.

At about 11:57 a.m., an explosion occurred. The debris from the headhouse and grain drying silo fell on top of a truck driver who was standing outside of his truck at the truck dump pit. He was the only fatality. There were no injuries.

The grain drying silo, headhouse, dump pits, and related equipment were destroyed. The cost of damages sustained by the silo, dump pits, and machinery was \$1,412,387, and \$119,681 worth of grain was lost.

The cause

The cause of the explosion is not known. OSHA investigators concluded, based on eyewitness accounts and an inspection of the damaged facility, that an explosion originated near the base of the boot pit area; traveled up the manlift shaft to the headhouse, blowing out the headhouse as it traveled through it; then went back down the manlift shaft blowing out the grain drying silo and its three bins. A tunnel between the silo and truck dumps was also damaged.

OSHA investigators cited as violations a number of potential ignition sources throughout the elevator. These included the lack of tramp metal collectors, electrical devices and fittings not approved for use in hazardous dust areas, and the lack of heat sensors and automatic alarm systems to warn against overheated bearings or other hot spots on electric motors, belts, pulleys, etc. Excessive dust accumulations on the floor, walls, and electrical equipment were also cited.

Prior inspections

OSHA had not inspected the grain elevator before the accident.



DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

DEC 12 1978

Mr. Gregory J. Ahart
Director, Human Resources
Division
United States General
Accounting Office
Washington, D.C. 20548

Dear Mr. Ahart:

The Secretary asked that I respond to your request for our comments on your draft report entitled, "Grain Dust Explosions--An Unsolved Problem." The enclosed comments represent the tentative position of the Department and are subject to reevaluation when the final version of this report is received.

We appreciate the opportunity to comment on this draft report before its publication.

Sincerely yours,

A handwritten signature in cursive script that reads "Thomas D. Morris".

Thomas D. Morris
Inspector General

Enclosure

GAO note: The page reference in this appendix may not correspond to the page number in the final report.

COMMENTS OF THE DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
ON THE GENERAL ACCOUNTING OFFICE DRAFT REPORT ENTITLED
"GRAIN DUST EXPLOSIONS--AN UNSOLVED PROBLEM"

General Comments

Although the report concentrates on the problems associated with grain elevator explosions, we would recommend that greater emphasis should be placed on the health hazards of grain dust which may cause more deaths than explosions.

Further, greater emphasis should also be placed on the concept that both the explosion and health hazards of grain dust are potentially controllable by a single set of protective measures. The possible benefit to be derived from one set of protective measures, covering both explosion and dust hazards, provides additional incentive to implement the control measures.

GAO Recommendation

"That the Secretary of Health, Education, and Welfare direct NIOSH to modify its proposed contract with the National Academy of Sciences to expand the role of the Committee on Evaluation of Industrial Hazards to assure that all potential methods of reducing grain explosions are considered."

Department Comment

We concur with the thrust and rationale of the recommendation, that all potential methods of reducing grain dust explosions should be examined. However, we are not sure at this time whether a contract modification would be the best method to achieve the purposes of the GAO recommendation.

An alternative is a control technology assessment of the grain handling industry. Such an assessment examines the process and control methods available to an industry and considers cost and effectiveness in protecting employees. NIOSH has performed such studies in a number of industries, with EPA involvement in some cases, to simultaneously consider environmental emission control. Both alternatives will be explored by NIOSH, and action will be taken as appropriate.

Technical Comments

The last paragraph on page 44 discusses health hazards of grain dust and makes mention of "lung disease" and "lung problems." Within the context of the paragraph, it would be more proper to substitute "respiratory" for "lung."

U.S. DEPARTMENT OF LABOR
OFFICE OF THE SECRETARY
WASHINGTON

DEC 19 1978

Mr. Gregory J. Ahart
Director
Human Resources Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Ahart:

Enclosed, as requested, is the Department of Labor's
response to the draft GAO report, "Grain Dust Explosions--
An Unsolved Problem."

Sincerely,



R. C. DeMarco
Inspector General- Acting

Enclosure

GAO note: The page references in this appendix may not
correspond to the page numbers in the final
report.

The Occupational Safety and Health Administration's
Response to the Draft GAO Report, "Grain Dust Explosions--An
Unsolved Problem"

This draft GAO report responds to a number of Congressional requests to undertake a review of the grain elevator explosions which occurred between December 21, 1977 and January 21, 1978. OSHA welcomes the opportunity to keep GAO and the Congress informed of the actions the agency has taken to better protect workers from the type of destructive fires and explosions described in this report.

Within hours of each of the explosions discussed in this report, compliance officers from OSHA offices were at the workplace. As soon as it was physically possible, OSHA began accident investigations of the worksites, seeking to determine the cause of the explosions and to determine whether violations of the Occupational Safety and Health Act had occurred. Although the general causes of grain elevator explosions are well known, the precise cause of an individual grain elevator explosion is, in most cases, impossible to determine. An Iowa State University study of 137 grain elevator explosions occurring between 1958 and 1975 was unable to identify the ignition source in 62 percent of the explosions studied. The study could not ascertain the location of the primary explosion in 69 percent of the explosions studied.

The physical destruction resulting from a grain elevator explosion is often so devastating that determining the point at which the explosion originated is extremely difficult. Nevertheless, OSHA inspectors identified a number of the factors that have been known to contribute to explosions: excessive dust levels acting as a fuel; and sources of ignition such as sparks from welding, heat from various electrical malfunctions, and possibly even smoking. For instance, OSHA investigators were able to identify hot welding points coming into contact with grain dust as the ignition source for one of the explosions. Investigations of the explosions were initiated as soon as officials could safely gain access to the scene; however, OSHA is developing a strategy to further improve its ability to respond quickly to these disasters, as will be discussed later.

OSHA has taken positive steps toward prevention of future tragedies of this kind by increasing its inspections of grain elevators; by providing specific training for all

compliance officers on grain elevator hazards in order to develop more expertise within the agency on the operations of the grain industry and its hazards; and by providing guidelines to assist employers in providing for the safe operation of grain elevators. These actions will be discussed in more detail below.

GAO should recognize that government efforts alone cannot protect workers from grain elevator hazards. The Occupational Safety and Health Act of 1970 places on the employer the burden of responsibility to provide safe and healthful working conditions for his employees. Employers must exercise greater supervision and vigilance to reduce workplace hazards, especially in the control of grain dust, both airborne and accumulations on surfaces in the elevator. Employees must be trained in, and supervisory personnel must assure adherence to, safe work practices.

Compliance with OSHA's general industry standards, such as those dealing with welding and cutting and fire protection would address many of the principal hazards associated with grain elevators. Compliance with existing OSHA standards and with voluntary consensus standards such as the National Fire Protection Association's standard No. 61-B, "Grain Elevators and Bulk Grain Handling Facilities," would lead to a significant reduction in grain dust fires and explosions.

Preventive measures by employers to protect the safety and health of workers should not await the results of further research; much is already known about the causes of dust explosions (as was pointed out by chemical company officials in this report). The Occupational Safety and Health Act and its underlying concepts are remedial legislation. Congress and the courts have stated that efforts to protect workers should not be slowed by the fact that research is continuing. Some elevator operators have already taken steps to use engineering controls to reduce hazardous conditions in their workplaces.

OSHA has taken the following steps to provide safer workplaces for grain elevator employees.

1. Issuance of a Hazard Alert. As a result of the series of explosions which occurred in December 1977 and January 1978, a Grain Elevator Industry Hazard Alert was issued in January 1978. The alert was based on existing OSHA standards, applicable industry consensus standards and information obtained by consultation with industry, government and academic experts in the field. The purpose of the alert was to attempt to prevent future explosions by

providing employers, workers and public officials with information concerning grain elevator safety and health hazards.

2. Increased Inspections. OSHA has greatly increased inspections of grain elevator facilities in the past year, and has continued to give priority to grain elevator inspections. In regions where grain elevators are located, those facilities are receiving first priority in scheduled inspections of high-hazard industries. (It is OSHA policy that inspection efforts be directed first to workplace fatalities and catastrophes and to complaints before scheduled inspections of other workplaces can be made.)

3. Training of Compliance Officers. While the agency had a number of compliance officers who were knowledgeable regarding grain elevator hazards, the magnitude of the recent disasters required an expansion of the inspection effort. Thus an extensive training program for compliance officers has been undertaken. OSHA has prepared training and informational materials to instruct compliance officers, including a training film and a 12-hour training course entitled "Safety and Health Hazards in Grain Elevators." This course will become part of the regular training curriculum at OSHA's Training Institute. A May 19, 1978 memorandum to all regional administrators and area directors provided additional direction to compliance officers regarding proper citation of hazards encountered in grain elevators.

GAO recommendations as to future actions the agency should take are responded to below:

RECOMMENDATION: GAO recommends that the Secretary of Labor direct OSHA to make thorough investigations of future grain explosions by making immediate investigations using explosion experts. OSHA should also assure that comparable investigations are made if explosions occur at locations where OSHA has allowed States to perform enforcement.

RESPONSE: OSHA concurs with this recommendation but takes issue with GAO's implication that the agency did not use available expertise in conducting investigations of recent grain elevator explosions. The agency did consult some of the explosion experts GAO referred to in its report and subsequently identified in a later meeting. In addition to knowledge of explosions in general, specific knowledge

of grain elevator operations was also essential in conducting the investigations, and OSHA feels that its compliance officers had that specialized knowledge. For example, a fire expert from the Dallas regional office took part in an inspection, and fires were a major aspect of the tragedies. Adverse comments made by a few agency officials in the report (pp. 42, 43) regarding the competence of compliance offices were erroneous; these were individual opinions which do not represent the views of the agency regarding OSHA's capability to conduct grain elevator inspections.

The agency is taking steps to further improve its capability to respond to a workplace disaster so that a thorough and professional investigation can be made as quickly as possible. OSHA is now in the process of developing a disaster response program that will go beyond GAO's recommendation concerning future grain explosions to improve the agency's response to workplace disasters of all kinds. This effort, begun last summer, started with a study of disaster response programs of other federal agencies. The major components of nine federal agencies' disaster response efforts were reviewed. These components included personnel selection, preparation and placement; on-site and interagency coordination; headquarters coordination and disaster investigative reports.

A significant element of all the programs studied was the identification of qualified persons who could be marshalled into disaster response teams (depending on the nature and extent of a given disaster). These experts would come from within the agency, or, if necessary, from another federal agency, the academic community, private consultants or private industry. When the program is in place, disaster response teams can be made available to States with their own safety and health programs (18(b)States) should a workplace disaster occur in one of those States.

One resource already available to the agency is the team of experts, knowledgeable in both grain elevator operations and in disaster investigation, who are working on the National Academy of Sciences/OSHA contract discussed later in this response. This team, if called upon, would make its own investigation and evaluation of a grain elevator explosion and would be available to OSHA for consultation.

RECOMMENDATION: GAO recommends that the Secretary of Labor direct OSHA to have safety inspectors do health sampling for dust when they are making grain elevator inspections.

RESPONSE: It is OSHA policy that compliance safety officers who have received training in the identification of health

hazards sample for dust when inspecting grain elevators. These specially trained compliance safety officers take air samples for total or respirable dust during an inspection, as a first step in determining if a health hazard exists. The samples must be evaluated by the area director and a senior industrial hygienist to determine whether a complete health inspection is required. Such sampling has been, and will continue to be, a part of the grain elevator inspection effort.

OSHA's continuing concern for workers exposed to health hazards in grain elevator facilities was reflected in the Grain Elevator Industry Hazard Alert mentioned earlier. This alert described the nature of health hazards in the grain industry and recommended measures employers should institute for the protection of worker health.

Emphasis must also be placed, however, on dust control through well-designed dust collection systems and better housekeeping practices in grain elevators. More efficient dust control systems would not only minimize the accumulation of dust as a fuel source for explosions, but would also reduce health hazards associated with grain dust. These hazards include exposure to fumigants and pesticides as well as respiratory and skin ailments associated with grain dust.

RECOMMENDATION: GAO recommends that the Secretary of Labor direct OSHA to expand the scope of its contract with the National Academy of Sciences to provide the Academy sufficient time to perform a more thorough study, which should include a thorough evaluation of the causes of grain dust explosions and the adequacy of OSHA's standards.

RESPONSE: OSHA feels that a decision to extend the contract with the National Academy of Sciences should not be made until the Academy has had an opportunity to fully assess the problems identified by the initial study. The initial one-year contract requires the Academy to make recommendations for the improvement of information-gathering and investigative techniques used to determine the causes of grain elevator explosions; and to review and make recommendations concerning the adequacy of OSHA's current safety standards which may have application to potential causes of explosions. The Academy will study preventive measures regarding explosions and will make recommendations to prevent recurrence of explosions. This contract does not preclude a subsequent contract to address specific issues that the Academy and OSHA feel require further investigation. OSHA recognizes that issues such as dust control and conveyors may require labora-

tory testing and further research. The Academy is expected to list problem areas in need of further research and development. The duration of the overall effort required to complete this study thus cannot be determined at this time.

In conclusion, OSHA is expanding its efforts to protect workers from the hazards associated with grain elevators. The Agency will continue efforts to increase its knowledge of the causes and prevention of explosions, to protect the health as well as safety of workers in the industry, and to more effectively respond to workplace disasters when they occur.



**UNITED STATES
DEPARTMENT OF
AGRICULTURE**

**FEDERAL GRAIN
INSPECTION
SERVICE**

**WASHINGTON,
D.C.
20250**

December 20, 1978

Mr. Henry Eschwege, Director
Community and Economics Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

Our comments, along with those of the Grain Elevator Safety and Security Task Force, concerning the GAO Draft Report, "Grain Dust Explosions--An Unsolved Problem," are enclosed.

Sincerely,

David R. Galliant
David R. Galliant
Deputy Administrator
Program Operations

Enclosures

GAO note: The page references in this appendix may not correspond to the page numbers in the final report.



UNITED STATES
DEPARTMENT OF
AGRICULTURE

FEDERAL GRAIN
INSPECTION
SERVICE

WASHINGTON,
D.C.
20250

TO: L. E. Bartelt
Administrator

FROM: David W. Fulk, Assistant to the Director, *D. W. Fulk* DATE: October 27, 1978
Standardization Division

SUBJECT: Comments Concerning GAO Draft Report, "Grain Dust Explosions--
An Unsolved Problem"

We have reviewed the subject report and would like to offer the following comments, corrections, additions, etc.

1. Page 2 of Contents, under Chapter 4 -- change "Federal Grain Inspection Service establishes procedures to protect its inspectors" to ". . . procedures to protect its personnel."
2. Page 2, Chapter 1 -- comments at top of page are not legible.
3. Page 14, line 6 -- delete "the" after "A Bureau of the Mines . . ."
4. Page 17, lines 20, 21 -- delete ". . . if a structure were capable of withstanding the pressure."
5. Page 24, line 5 -- delete "more" after "were interviewed to gain . . ."
6. Pages 48, 49 -- these pages to be rewritten as follows:

FGIS inspects and supervises State grain inspection services at approximately 89 export grain elevators. FGIS grain inspectors are assigned to 43 of these elevators full time. The grain inspectors perform their duties inside the elevators and are exposed to the same hazards as grain elevator employees.

The Occupational Safety and Health Act of 1970 does not provide for OSHA coverage of government employees. However, the Act requires the head of each Federal agency to establish and maintain a safety and health program which provides for safe and healthful workplaces for its employees. In July 1977, FGIS hired two full-time safety specialists to develop a safety program and perform safety inspections of export elevators where FGIS had personnel. In May 1978, two additional full-time safety specialists were added to the Safety staff. FGIS safety inspectors have no enforcement authority, but rely on the cooperation of elevator owners to correct any hazardous conditions. FGIS can request OSHA to perform an inspection of privately-owned grain elevators, for safety and health violations. This has been arranged since the explosion in December 1977. Prior to the explosion, OSHA policy did not permit a response to complaints or requests from individuals who were not employed by the facility to be inspected.

FORM FGIS-1 (7-78)

Six weeks prior to the accident at Farmers Export Company, the Safety Manager for FGIS inspected the elevator and noted several hazardous conditions -- in particular, dust clouds and ignition sources. FGIS officials did not notify OSHA that the hazards existed because, at that time, a procedure to do so had not been established either by FGIS or by OSHA.

On December 23, the FGIS Field Office Supervisor requested . . .

7. Page 49, line 16 -- change "authority to permit . . ." to "authority to evacuate . . ."

8. Page 49, line 17 -- change "employees to evacuate an elevator . . ." to "employees from an elevator . . ."

9. Page 50, line 7 -- "storage lines" should read "storage bins."

10. Page 51 -- insert between paragraphs 2 & 3 the sentence: A revision of the guidelines is in draft form and will be in effect by December 1, 1978.

11. Page 57 -- insert as paragraph 2:

During June 1978, the FGIS Safety Manager visited Australia to determine why their grain industry has never had a grain dust explosion. During the trip, officials of the Australian grain industry reported three minor elevator explosions which damaged equipment, but did not cause structural damage or personal injury. The Australians believe their intensive house-keeping eliminates both suspended and static dust and the resulting absence of fuel prevents major explosions. The FGIS Safety Manager agreed that housekeeping in Australian grain handling facilities was vastly better than in U.S. facilities.

Enclosure
GAO Draft Report Returned



DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20250

NOV 1973

TO: Leland E. Bartelt, Administrator
Federal Grain Inspection Service

THRU: David Galliard, Deputy Administrator

FROM: *Donald D. Herring*
Donald D. Herring, Acting Special Coordinator
Grain Elevator Safety and Security

SUBJECT: Comments on Proposed GAO Report

This is in reply to a request by David Galliard, Deputy Administrator, FGIS, J.T. Abshier, Director, Compliance Division, FGIS, and Robert Hughes, Assistant Director, Human Resources Division, General Accounting Office (GAO) for comments on a draft of a proposed report, entitled "Grain Dust Explosions--An Unsolved Problem." Copies of these comments have been forwarded to P.R. "Bobby" Smith, Assistant Secretary for Marketing Services, USDA, and L.L. Free, Acting Director, Policy, Liaison and Information Staff, Office of the Inspector General, USDA.

Special Coordinator
for Grain Elevator Safety and Security
Office of the Secretary
USDA
Washington, D.C.

NOV 13 1978

COMMENTS
DRAFT OF PROPOSED REPORT
GRAIN DUST EXPLOSIONS-
AN UNSOLVED PROBLEM

General Accounting Office

The cover page to the Report immediately sets an improper stage not only from a technical point of view, but for its implied condemnation of the Department of Labor's Occupational Safety and Health Administration. To state that, "The cause of most explosions is unknown." is misleading. Oxygen together with an ignition source and a fuel--grain dust--causes grain dust explosions. What is not always known from each explosion is the source and the intensity of the ignition. In addition, the properties and concentration of grain dust and their parameters are not fully understood. To recommend that OSHA make a greater effort to determine the causes really means that they have not always been able to locate the source of ignition subsequent to an explosion. To date, less than 50 percent of all explosions in grain handling facilities are from a known ignition source. The devastation wrought by such explosions makes investigations difficult. It would therefore seem far more practical to emphasize the application of standards which would reduce ignition sources.

These comments will not address the Digest section of the Report. Presumably comments to the body of the Report will reflect on the specific areas and if accepted will be correspondingly changed in the Digest section.

Chapter 1, Pages 3 and 4--The History section should reflect the entire universe by giving the reader a relationship between the horror statistics and the approximate 15,000 grain handling facilities in this country, together with the volume of grain that is handled in a given period of time. In addition, the Report should inform the reader that there exists no official data base and how the Report's source, "Survey of Dust Explosions in Grain Handling Facilities: Causes and Prevention," acquired its data. These suggestions should afford the reader a more objective perspective.

Chapter 1, Page 10--The Regulatory section should state that OSHA is authorized to investigate fatal accidents and certain other accidents but is not required to do so. It should also be explained how OSHA utilizes certain industry standards to cite grain handling facilities and that such citations are recognized in a court of law. To leave this description as is seems to imply that OSHA has no means whatever to deal with hazardous conditions.

Chapter 1, Page 11--The Scope section is impressive on the surface but still leaves the discerning reader with a sense of void. The Report should consider listing reports and files to enhance credibility.

Chapter 2, Page 13--Again, the Reader may be confused by the statement that the "factors" that cause grain elevator explosions have been known yet the "specific" causes are not known. Careful wording here regarding ignition sources and the unknown relationship of dust properties would give more credence to the introduction of this technical section of the Report.

It would be appropriate at this point to advise the Reader that the word explosion will be used throughout the Report but that a grain dust "explosion" is really a conflagration or deflagration which is a fast burning fire preceded by a supersonic wave front. The results, of course, are as devastating as in an explosion.

Chapter 2, Pages 14 and 15--In the Explosive Properties section it appears that the Report wishes to convey a semblance of scientific explanation regarding the characteristics of dust. For the sake of accuracy, the Report should delve into the properties of dust a little further. There are considerably more "variable factors" than those presented. Writing an additional explanatory paragraph would impress the Reader with the complexity of this grain-dust problem.

The OSHA contract referred to in this section has been signed by OSHA and the National Academy of Sciences with the first meeting of the committee on November 21, 1978. Again, for accuracy the Report should cite the objectives of the actual contract. It is more comprehensive than depicted here.

Chapter 2, Pages 16 and 17--In the continuation of the Explosive Properties section, the narrative on the conditions for a dust explosion delves into questionable scientific areas. Statements such as; (1) too much or too little dust prevents ignition, (2) explosions will result only when in an enclosed space, (3) an "average" building will fail at less than 1 pound per square inch of pressure, et al., are misleading. The source of this information must be cited or a more precise and thorough presentation should be written into the Report.

Chapter 2, Pages 20 and 21--In the OSHA Investigations section it should be noted that the states adopt the Federal OSHA Act and Regulations. It is the level of enforcement that varies.

A contradiction exists between the first and last paragraph of page 21. First, the Report states that the causes for accidents are not known and then indicates violations which may have contributed to the accidents.

The purpose of this section is to show that OSHA investigations are not adequate to determine causes of explosions. This section however, discusses citations by OSHA after an accident and/or explosion. To discuss the controversial subject of citations after explosions or accidents without using a named source is biased. At the very least the Report should present the opposite point of view.

The Report refers to OSHA officials as stating they did not know if OSHA had qualified explosion experts to determine causes (ignition sources) of explosions. There exist only a few explosion experts in the entire country. There should be serious consideration when discussing this issue and recommending investigative teams as to whether explosion experts are really

required to determine the culprit, i.e., ignition source.

In the last paragraph (on page 22) it should be noted that OSHA "suggests" accident investigations; the agency does not require accident investigations.

Chapter 2, Pages 22 and 23--Continuing the OSHA Investigation section, the entire paragraph on page 23 is confusing and/or misleading. The paragraph's introduction sentence states that OSHA compliance officers were not trained to investigate explosions. Yet the paragraph states "The investigators of the Sunshine Mills accident were engineers who had experience with explosives." Also, the paragraph reads "A certified fire investigator was assigned to the Continental Grain Company accident." Unless these aforementioned engineers and the fire investigator do not represent OSHA, the entire paragraph is contradictory. If the engineers and fire investigator actually belong to another agency, the presentation of this paragraph is misleading.

Chapter 2, Page 24--Continuing the OSHA Investigation section, the itemizing of the "shortcomings" of OSHA's recent investigations is not treated objectively. The investigations of the explosions at the Continental Grain Company and the Farmers Export Company were difficult. Both companies were threatened with litigation and the plaintiffs' attorneys directed their clients not to talk for fear of jeopardizing their suits.

In the second paragraph it was stated that OSHA made no examination for physical evidence at the Desert Gold Feed Company accident. What was OSHA's explanation for not so doing? It might well seem like folly to the Reader to search for smoking materials after the devastation wrought by a grain dust explosion.

In the last paragraph autopsy reports obtained by OSHA for the Continental Grain Company deaths were mentioned. Members of the USDA Task Force reviewed these reports which gave the specific causes of death. Again, liability litigation pervaded the entire scene, making investigations extremely difficult.

Chapter 2, Page 25--To make the comment that "OSHA does not know whether any of its employees are explosion experts." without citing the source of such a statement leaves considerable room to question the creditability of the information, particularly for a Federal agency that has the accident responsibility for the entire nation.

Chapter 2, Page 28--In reference to the National Fire Protection Association in paragraph 1, the NFPA does not make investigations. They are an association which gathers and reports data and compiles statistics and they rely entirely on local authorities for their information. These paragraphs are misleading.

Chapter 2, Pages 29 and 30--Referring to the Production Effects section, there appears to be confusion in the distinction between grain production, storage and handling (throughput). The Report's Introduction indicates that the CAO was to "determine if... and an increased capacity of elevators contributes to explosions." This request does not relate to grain production.

Regardless of whether the Report responds to the requested determination, the significant factor is whether there exists a correlation between increased

grain handling or throughput and increased explosions. This is difficult to correlate because each bushel of grain from production may be handled five or six times before it is shipped from an export elevator. It is the handling of grain that creates dust or fuel for an explosion. The Iowa State University study attempted to do a correlation based on storage capacity.

Chapter 3, Pages 31 and 32--The opening paragraph is misleading. It leaves the impression that the Environmental Protection Agency requires that grain dust be confined and that fine dust should be collected. The EPA has no regulations to this effect. The EPA regulates the emission of dust, et al., into the ambient atmosphere.

The second and third paragraphs on page 32 have no relevance to Chapter 3 nor to the contribution Federal regulations have made toward explosions. If there is some relationship between the Food and Drug Administration and the USDA regulations regarding moisture content to grain elevator explosions it should be explained.

Chapter 3, Page 35--The Report's presentation on explosion venting states that the lack of explosion venting may have caused the deaths of twenty-five people at Continental because the concrete rubble of the elevator fell onto an adjoining office building. This was not the same situation at the explosion in the Farmers Export Elevator in Galveston, Texas. The office building was situated over a receiving tunnel. An explosion within the tunnel heaved, causing the destruction of the office building.

Chapter 3, Page 37--The Report uses one industry official in its further discussion of explosion venting. In the first paragraph the official replies to the GAO question as to whether it would be feasible to keep office buildings a safe distance away from grain handling facilities. To this he replied that it would not be practical. Further opinions would be helpful; it can be done but would be expensive.

The Report's entire section on explosion venting is misleading and appears to condemn EPA for its responsibility under the Clean Air Act. To treat this complex subject based almost entirely on the testimony of one industry official leaves the Reader somewhat wanting for objectivity and a more in-depth analysis.

Chapter 4, Page 47--The last paragraph appears to be a recommendation. GAO differentiates between the method of abatement and the requirement for abatement. While technically this is a valid point, in practice it is moot. No such recommendation pertaining to OSHA's activities in these two areas is cited under Chapter 6, Conclusions and Recommendations.

In the second paragraph the offhanded comment that "We believe that sampling only for dust would be better than not sampling at all." should either be developed into a recommendation or deleted. As it stands the comment smacks of sarcasm and reflects adversely on the GAO Report.

Chapter 4, Pages 48, 49 and 50--The section on the Federal Grain Inspection Service is fraught with inaccuracies and is perhaps too simplistic. For example, on page 48, the Report should state that the FGIS provides inspection and weighing services. On page 49 the Report refers to the FGIS Alert Guidelines. The onsite supervisors as well as the Field Office Supervisors have

the authority to evacuate an elevator. It is suggested that the current (November 1978) FGIS Instruction 370-3 (Policies and Procedures When "Imminent Dangers" are Found to Exist in Grain Elevators, Mills, or Other Facilities) be obtained and used as a strict guideline in the presentation of this section of the Report. There are seventeen "imminent hazard" conditions rather than the eight noted in the Report in which the supervisors may immediately remove FGIS employees from the facility.

Chapter 4, Pages 51 and 52--Continuing the FGIS section, the Report states that prior to the FGIS guidelines there were no evacuations. There were, in fact, evacuations most of which were for bomb threats.

Regarding the number of evacuations detailed in the Report, it is suggested that at the time of the final draft, GAO update their figures. As of October 20, 1978, there were 135 evacuations.

Regarding the USDA study the Report indicates that the study should be completed by November 1978. It would be accurate to state that the study will probably not be released before January 1979.

Chapter 5, Pages 53 and 54--Introducing this chapter is misleading, particularly when it is introduced by the grain industry point of view. The Report's statement, "While the conditions that contribute to explosions are well known, where the explosions started or why is usually unknown." is ambiguous. Conditions that contribute to explosions may be numerous; i.e., moisture, humidity, dust concentrations, confinement, etc., and certainly unknown as to how they contribute to an explosion.

The first paragraph refers again to an industry viewpoint by stating that it could be costly for elevator operators not to reintroduce dust into the grain stream. GAO should consult with the FGIS and carefully examine the Federal government's response to this controversy. There are many existing and potential techniques for handling the collected dust so that it is questionable whether it would be "costly".

Chapter 5, Page 57--In the section on Controlling the Fuel Source, the Report cites a source of information as the National Fire Protection Association. It is suggested that the NFPA Standards (61-B) be quoted. As cited, the reference to the Standards is not entirely accurate.

Again, the Report is delving into a highly technical area when it discusses the explosibility of dust, the levels of dust, and dust concentrations. Paragraph 2 is simplistic. The minimum concentrations of dust that would be needed for an explosion are not accepted throughout the scientific community. There is also considerable opinion that present technology does exist to control dust contrary to the Report's statement that it does not exist at present.

Chapter 5, Page 59--The second paragraph makes the statement that a system which uses a water mist had not been tested for grain dust. This is not true. The presentations of the International Symposium on Grain Elevator Explosions should be reviewed. Also, there have been tests done at USDA on the misting of grain dust.

Chapter 5, Pages 60 and 61--Again, the Report presents a misleading examination of the reintroduction of grain dust into the grain stream. Regardless of what an "official" stated, USDA is of record that its position is that collected dust should not be returned to the grain stream. On July 18, 1978, USDA's P.R. "Bobby" Smith, Assistant Secretary for Marketing Services, and Eula Bingham, Assistant Secretary for Occupational Safety and Health Administration (Labor) jointly signed a letter to this effect. This letter was mailed to approximately 150 grain handling companies.

This section on Dust Disposal again examines the collection of dust and relates it to cost. "Not returning dust can be costly." It would be less misleading if the Reader understood that it is not so much the collection cost as it is the loss of revenue for the grain elevators. Again, the experts in the FGIS should be consulted for a more accurate review of this "cost" loss. Grain elevators have an extensive system of discounting for foreign material, moisture, shrinkage, etc., in which they acquire the dust at little or no cost. Both the industry and Government views should be carefully presented.

In the last paragraph of page 60 there is an error in percentages. Dust can be as much as 0.1 percent by weight in grain, not 1.0.

In addition, the last paragraph is misleading. Fifty-five thousand bushels of grain an hour will not attain 500,000 tons a month. This is unrealistic. There exists too much downtime and other nonproductive factors to reach that volume of grain.

Finally, there appears to be a contradiction between the first and second paragraphs on page 60. In the first paragraph the Report states that a Department of Agriculture official does not support a change because there is a poor market for the dust. The second paragraph advises that FGIS has recommended dust not be returned to the grain stream.

Chapter 6, Page 66, 67 and 68--This chapter on Conclusions and Recommendations seems to confuse one with the other. Recommendations actually are expressed all through the Conclusions section. For example, on page 67 the Report recommends that OSHA obtain the services of explosion experts and make immediate investigations directed towards determining the cause of the explosion. In addition, on page 68 the Report says that CAO believes safety officers could do sampling for health hazards. There are other examples, but this section should be conclusive information rather than opinions, beliefs, or recommendations.

In this chapter where the information and data from the body of the Report are repeated, no further comment should be necessary. For example, page 66 of the Report suggests that increased grain "production" may have contributed to increased deaths or injuries. It is increased grain handling or throughput that was previously considered as a possible cause for explosions and the resulting increase in deaths and injuries.

Chapter 6, Pages 69 and 70--Again, the Report discusses as a conclusion that it is not known to what extent the probability of explosions would be reduced if dust were not returned to the grain. Added to this statement is the remark that dust was not returned to the grain at Continental Grain Company which had the most severe recent explosion. This is incorrect.

In testimony one Max Spencer, Vice President, North American Grain Division, Continental Grain Company stated that 20 of the 21 dust collection filters present in the facility at the time of the explosion did not return dust to the grain. He also testified that 90 percent of the inland grain received at the facility was by barge. All grain received from the barge unloader was conveyed by a belt system into the headhouse. Therefore, for 90 percent of the inland grain received at Continental all dust that was collected by the collection system at the unloader was returned to the grain stream. It should also be noted that Spencer testified that Continental did not recirculate or return the dust to the grain. This contradiction may have existed because the barge unloader was some distance from the elevator itself and Spencer was referring only to the elevator.

As a final comment on page 70 of the Report, it is suggested that the GAO contact the National Academy of Sciences to determine the validity of the recommendation that the NAS serve as a "center for coordinating, guiding...." The charter for the NAS precludes such activity on a continuing basis as the recommendation implies.



Donald D. Herring
Acting Special Coordinator
for Grain Elevator Safety and Security
U.S. Department of Agriculture
Washington, D.C. 20250



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 8 1979

OFFICE OF
PLANNING AND MANAGEMENT

Honorable Henry Eschwege
Director
Community and Economic Development
Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

The Environmental Protection Agency (EPA) has reviewed the General Accounting Office (GAO) draft report entitled "Grain Dust Explosions - An Unsolved Problem." We appreciate the opportunity to comment on the draft prior to its issuance to Congress. The Agency's comments are as follows:

Several references in the report (pages VI, 31, 35, 36, 37, and 66) indicate EPA regulations require that grain dust be confined within the elevator. However, this is not the case. The intent of the EPA regulations is that dust be captured at the points where it is generated within the elevator and transported by air handling equipment to a control device where the dust is separated and the clean air is exhausted. If this practice were followed, doors and windows could be opened because the quantity of dust escaping would be minimal. In fact, most people agree that a properly operated and maintained dust control system would reduce the potential of a dust explosion.

Also, the report does not determine if construction practices for grain elevators have changed to comply with air pollution control regulations or because larger, more efficient, reinforced concrete facilities are replacing older elevators.

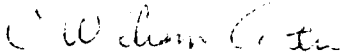
Throughout the report, the word "venting" is used to mean either explosion venting or ventilation. The phrase explosion venting should be used in every case where that is the intent of the word "venting."

GAO note: The page references in this appendix may not correspond to the page numbers in the final report.

The report indicates that chemical companies believe they have conducted pertinent research and developed practical technology for controlling dust explosions. The report does not identify what technology has been developed nor how this technology might be used in the grain handling industry.

Some important meetings were held which I feel should be mentioned in the report. On March 28 and 29, 1978, the Industrial Gas Cleaning Institute (IGCI) held a symposium, "Explosion Protection In Dust Control Apparatus" in Rosslyn, Virginia. On July 11-12, 1978, the National Academy of Sciences held a symposium, "International Symposium On Grain Elevator Explosions" in Washington, D.C. I will be glad to furnish GAO with more information on these meetings if desired.

Sincerely yours,



William Drayton, Jr.
Assistant Administrator for
Planning and Management

(20679)

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