Accident Databases: What Do They Tell Us?

Eboni T. McCray
Chemical Engineering Department
Texas A&M University

In response to the occurrence of several catastrophic chemical accidents in the 1980's, numerous regulatory measures have been taken to improve the safety of the chemical industry. Government agencies such as the Occupational Safety and Health Administration (OSHA) and the U.S. Environmental Protection Agency (EPA) have developed safety programs and legislation to provide chemical facilities with explicit safety guidelines. During this time, the facilities have been required to report any releases, accidents, and other hazardous issues to various government and public agencies. As a result of this reporting, countless databases have emerged, each with its own data-collecting methodology.

Thorough investigation of these databases will offer insight into the state of industrial safety since the implementation of these mandates. Developing a "timeline" that chronicles chemical accidents facilitates a clear and concise assessment of those chemical safety programs being followed. Once performed, this assessment will determine whether or not mandatory risk management plans are effective programs or inadequate political pacifiers. It is imperative that valid metrics are devised which will direct the chemical industry into a safer and more responsible millenium.

In light of the EPA's compliance deadline of June 21, 1999 for submission of a risk management plan, those metrics must be developed and implemented now. The study of accident databases will allow for the development of realistic programs that are sensitive to public, environmental, and employee issues, as well as to the chemical industry's objectives. Furthermore, analyzing the current databases leads to the development of more comprehensive databases for the future, and results in more clearly defined safety objectives.

The databases chosen in this investigation originate from many sources, each with different objectives. The following is a list of the databases included in this analysis:

- OSHA Statistics of Workplace Injuries Annual Survey - Bureau of Labor and Statistics (1974-1991)
- Census of Fatal Occupational Injuries - Bureau of Labor and Statistics (1992-1997)
- Office of Pipeline Safety (1986-1998)
- Hazardous Materials Incidents - U.S. Department of Transportation (1987-1996)
- Bureau of Transportation Statistics (1987-1996)
- National Board of Boiler and Pressure Vessel Inspectors Incident Report (1992-1997)
- Emergency Response Notification System - EPA (1987-1998)
- Accident Release Information Program – EPA (1986-1997)

OSHA Statistics for Workplace Injuries/Fatalities

This database is OSHA's rudimentary program that documents work-related injuries and fatalities by using data from the Bureau of Labor and Statistics (BLS). With statistics dating from the mid-1970's to 1991, this annual survey reports fatalities in many different industries. The industries of interest here are the private, mining, manufacturing and transportation industries. The Bureau is of the opinion that this database considerably underestimates the number of workplace fatalities, due to their rare occurrences. As a result, the BLS developed the Census of Fatal Occupational Injuries (CFOI) in order to collect more comprehensive data. The CFOI is discussed later in this paper.

Data Interpretation: (See Table I and Charts I & II.)

Despite a few fluctuations, there is a definite downward trend in the number of workplace fatalities in the private industry from 1974-1991 (Chart I). The maximum number of fatalities, 4970, occurs in 1974 and lowest, 2800, occurs in 1991. This represents a 43% decrease during the 17-year period. The same trend, however, is not as definitive for the other industries. Chart II shows the number of fatalities occurring from 1978 to 1991 in the manufacturing, mining, and transportation/public utilities industries.

In the manufacturing industry, a definite decline in fatalities is exhibited from 1978 to 1983, with a maximum of 1170 fatalities and a low of 730 fatalities, respectively. However, from 1984 to 1987, the number of fatalities begins to fluctuate and hover around 800. Then in 1988 the number decreases to 660, and fluctuates again each year from 500 in 1990, to 600 in 1991. Although the numbers do not decline consecutively for all the years in this data set, the number of fatalities exhibits a general downward trend. This trend illustrates a 48% reduction in the number of fatalities.

The same yearly fluctuations are present for the mining industry. The maximum number of fatalities, 500, occurs in 1981, and the lowest occurs in 1991 with a total of 100 fatalities. This represents an 80% decline in fatalities for the ten-year period. It should be noted that no fatality data is available for this industry in 1990.

For the transportation/public utilities industry exhibits a general decline in fatalities. The greatest number of fatalities, 970, occurs in 1982, and the smallest number, 400, occurs in 1991. For this nine-year period, the number of fatalities decreases by 58%.

In order to determine a true trend in fatalities for the four industries being discussed, Table II provides average annual employee numbers. This employee data comes from the Bureau of Labor and Statistics Employment, Hours, and Earnings Data.

Census of Fatal Occupational Injuries (CFOI)

For over 100 years, the Bureau of Labor and Statistics (BLS) has collected occupational injury/illness statistics. Over those years the data collection methods have

evolved to help facilitate a better analysis of workplace safety. A desire to provide more complete work-place fatality data lead to the development of the Census of Fatal Occupational Injuries in 1992. The CFOI is a comprehensive database that provides descriptive information on workers and the circumstances surrounding their deaths.

This database is a census of information collected from various industries. These industries report their statistics voluntarily, and the information is not mandated by any particular federal or state agency mandates the information. This program collects its information from death certificates, medical examiner's reports, workers' compensation fatality claims, and other Federal and State agency reports in order to provide a more substantiated count of work-place fatalities.

Although the CFOI provides data for general and very specific industries, this analysis is concerned with the private, manufacturing, mining, and transportation/public utilities industries. These industries cover a broader spectrum of the private and public sectors, and allow comparisons to be readily made. The total number of fatalities is based on average annual estimates of employed civilians who are 16 years of age and older, from the Current Population Survey.

Data Interpretation:

Tables III and IV contain the fatality data by industry and event/exposure. Charts III and IV illustrate the total number of fatalities for all industries from 1993-1996 as well as the number of fatalities by industry. Charts V through IX show the number of fatalities by event/exposure for the industries of interest.

Fatalities by Industry

The total number of fatalities has changed very little since 1993. In 1994, a total of 6632 fatalities occurred, and in 1996 the number decreases to 6112, which represents a mere 3% decline. The fatality numbers for each of the four industries show the same minimal changes. The manufacturing industry had a 10% decline in fatalities from 1994 to 1995. However the following year that number increased by 1.8%. The private industry numbers exhibited a maximum decline of 8.1% between 1994 and 1995. Nevertheless, in 1996 a 1.5% increase in fatalities occurred. The mining industry statistics showed the highest decline percentage with a 15.5% decrease from 1994 to 1996. In contrast, the transportation industry illustrated an overall increase in the number of fatalities occurring over the 4-year period. Although the lowest number of fatalities, 880 occur in 1995, the highest number, 947, occurs the next year. This is a 7% climb in the number of fatalities.

Fatalities by Event/Exposure

The total number of fatalities and those for each industry are separated into different categories. The general categories of interest in this analysis are exposure to harmful substances and environments, fires and explosions, and contact with objects and equipment.

Total Number of Fatalities (Chart V)

The exposure to harmful substances/environments category illustrated a maximum decline in fatalities from 1994 to 1996, with a 16.8% decrease. Yet, in 1997 that number of fatalities increases slightly by 3%. The event with the least number of fatalities is fires and explosions. The lowest number of fatalities, 167, occurs in 1992, while the highest number occurs in 1995, with 205 deaths. Since the numbers remain essentially constant from 1993 to 1995, then fall slightly in 1996, the trend over the 5-year period is an increasing one. The contact with objects/equipment category showed the most fatalities. The lowest number of fatalities, 916 occurs in 1995, but all other years exceed 1000 fatalities. From 1995 to 1997 number of fatalities increases 11.4%.

Private Industry (Chart VI)

In general the number of fatalities due to exposure to harmful substances/environments in the private industry exhibited a steady decline from 1994 to 1996. This decline is equivalent to an 18.7% decrease. The number of fatalities due to fires and explosions fluctuates slightly from year to year, with a 4.5% decrease from 1995 to 1996. Despite this decrease the number of fatalities remains basically constant over the 4-year period. Once again contact with objects and equipment garners the most fatalities. From 1993 to 1995 the number of fatalities decreases consistently, however, in 1996 the number increases by 8.8%.

Manufacturing Industry (Chart VII)

In 1993 and 1994 the number of fatalities remain constant at a value of 81. The following two years show a decrease in fatalities, with the number falling to 56. This represents a 30.8% decrease for this event. Fires and explosions account for the least number of fatalities for each year. From 1994 to 1995, the number of fatalities increased by 16.9%. The fatality count for contact with objects and equipment oscillates from year to year, with the maximum number, 304, occurring in 1994. The next year the numbers decrease by 17.7% to 250. However, in 1996 the number increases to 278, which is a 10% increase.

Mining Industry (Chart VIII)

The mining industry possesses the least number of fatalities for all years and categories. The number of deaths due to exposure decreased steadily from 1994 to 1996. This declining trend from 1994 to 1996 denotes a 59.2% decrease. In contrast, the number of deaths due to fires/explosions fluctuates from 8 in 1993 to 27 in 1994. This continues in 1994 when the number decreases to 16, but increases by to 17 in 1996. Over the 4-year period, the trend is an increasing one.

Transportation/Public Utilities (Chart IX)

Exposure to harmful substances/environments accounts for 42 fatalities in 1993, which is the lowest figure in the 4-year period. For 1994, 1995, and 1996 the figures are 59, 52, and 68, respectively. Despite these minor oscillations, there is a slight upward trend for this event, which illustrates a 38.2% increase from 1993 to 1996. The fatalities resulting from fires and explosions have decreased over the 4-year period. The highest number occurs in 1994, with 22 fatalities. The lowest number, 7, occurs the next year, followed by a slight increase for each succeeding year. However, the number of deaths that occur in 1996 is only 13, which is still 40.9 % less than the highest figure. The highest figures are accumulated in the contact category. For this event no real trend can be determined due to the variable fluctuations of the numbers.

These observations suggest that more safety measures should be taken to help decrease the large number of fatalities due to contact with equipment. Also, since the private industry employees the most people out of all the industries, it is logical the more workplace injuries and fatalities occur in this industry. However, these fatalities should be the easiest to prevent, namely through safer work practices, personal protection equipment, and better equipment design. Industries may be neglecting this area of safety because events such as fires, explosions, and chemical releases tend to cause multiple fatalities, greater property damage, and more public attention. As a result, greater measures are taken to prevent these devastating events.

Office of Pipeline Safety

This database consists of information reported to the Office of Pipeline Safety by various pipeline operators. The information dates back to 1986, with some earlier data collected in 1984. The four areas of documented in these data tables are: number of incidents, number of injuries, number of fatalities, and the amount of property damage occurring each year. Transmission, distribution, and hazardous liquid pipeline operators document these areas.

Transmission Operators (Table V & Charts X, XI, XII, XIII)

From 1986 to 1998 the number of incidents, injuries, and fatalities for transmission operators shows a noticeable oscillation. In 1989 the number of incidents, injuries, and fatalities were at a maximum, while the property damage was moderate. This fact leads to the conclusion that an increase in fatalities, injuries, and incidents does not necessarily mean an increase in property damage. Furthermore, the events leading to such casualties are not specifically linked to massive equipment or product loss, which would surely incur great expense. Thus, it is surmised that these incidents are linked to more common, every-day errors that are undetected or ignored. These statements are further complimented by the 1994 statistics. In 1994 over 45 million dollars of property damage was incurred. However, during that year only 81 incidents and 22 injuries were reported. No fatalities were reported during 1994. Besides these observable trends, the other years exhibit fluctuations that cannot be readily defined.

Distribution Operators (Table VI & Charts XIV, XV, XVI, XVII)

The data in distribution operators tables exhibit more erratic fluctuations than the transmission data. The one similarity between the two groups is the fact that property damage and injury/fatality data do not coincide. The distribution operators accumulated over 53 million dollars in property damage, the most over the 12-year period. Conversely, the number of fatalities, injuries, and incidents were mid-range. So, again it is concluded that the casualties result from less catastrophic events. In 1996 the maximum number of fatalities, 47, resulted from the 110 incidents reported. However, only 12.5 million dollars in damages were amassed.

Hazardous Liquid Operators (Table VII, Charts XVIII, XIX, XX, XXI)

For this sector of pipeline operators the maximum number of incidents did correlate with the greatest amount of property damage. In 1994, 56 million dollars worth of property damage was accumulated as a result to the 243 reported incidents. This correlation may be indicative of the nature of the materials in the pipeline. These hazardous liquids increase the risk of equipment damage due to potential for corrosion, which in turn increases the potential for equipment failure. These failures, no doubt, result in a great loss of product and equipment.

The number of fatalities and injuries do not follow the same trend as property damage and incidents. This may be attributed to the fact that the hazardous nature of the liquids elicits more primary and secondary means of protection for the employees. No more than five fatalities have occurred in a given year for the entire 12-year period. Even though 1997 and 1998 injuries, incidents, and fatalities are small, the property damages are still very large.

Hazardous Materials Incidents – U.S. DOT (Table VIII)

This database, maintained by the DOT, contains information submitted by companies in an incident report form. This form documents information regarding hazardous materials incidents involving vehicular accidents and derailments. The four transportation categories of interest are air, highway, railway, and water. The database chronicles the number of incidents, injuries, and deaths as well as the amount of property damage accrued from 1987-1996.

Data Interpretation: (Chart XXII, XXIII, XXIV, & XXV)

From the data, it becomes obvious that highway and railway transportation of hazardous materials accounts for all the deaths and injuries, and almost accidents and the property damage accumulated over the 10-year period. The number of highway incidents appears to follow no definite trend, and the same can be said for the number of railway incidents. The number of highway incidents seems to hover around 250 incidents per year with slight increases and decreases from year to year. The number of railway incidents tends to oscillate around 50 incidents per year.

From 1987 to 1995 highway incidents account for all the deaths on the chart. The number of fatalities hits a maximum in 1992 and then begins a constant decline to the lowest figure of 5 in 1996. In 1996 two fatalities occur as a result of railway incidents. However, this isolated year, is not indicative of the constant no-fatality trend from 1987-1995. Although there is one water accident recorded in 1992, this isolated incident is considered an anomaly.

The number of injuries resulting from highway accidents fluctuates from 1987 to 1990, Then in 1991 the number begins to an upward climb, and hits a peak in 1994 with 95 injuries. The railway accidents garnered numerous injuries in 1995 and 1996 with 842 and 962 injuries, respectively. These two figures are a huge jump from the very small number of injuries encountered in previous years.

The amount of property damage accrued due to highway accidents remained fairly constant form 1987 to 1989. After a small increase in 1990, the amount skyrocketed to almost 24 million dollars. During next two years the amount decreases dramatically, but the last three years show a constant increase. The railway damages exhibit much more varied behavior, however, in 1996 the damages reach a maximum of over 15 million dollars. The most noticeable aspect of this data show that no correlation can be may between the number of accidents that occur and the amount of property that is accumulated.

Bureau of Transportation Statistics – U.S. DOT (Table IX & Table X)

The Bureau of Transportation (BTS) operates under the administration of the U.S. Department of Transportation and was established in December 1992. The primary objective of BTS is to increase public awareness of the nation's transportation system and to provide a sound knowledge base to aid in public decision making. In order to accomplish this the BTS has developed a system of data-collection and analysis, which assists the DOT in assessing the safety practices of the nation's transportation system.
The modes of transportation are identical to those in the DOT's Hazardous Materials Incident report, namely air, highway, railway, and water.

Data Interpretation: (Charts XXVI through XXXII)

Note: Due to the fact that data is not available for 1976-1979, 1981-1984, and 1986-1989, a complete analysis of possible trends cannot be performed.

Hazardous Material

The number of air accidents has gradually increased since 1991 to 1996, excluding the small decrease in 1995. The number of railway accident has remained fairly constant over that same time period, averaging over 1000 per year. In contrast, the number of highway incidents remains relatively steady from 1990 to 1992. In 1993, the number increases, and then reaches almost 14,000 in 1994. The number of highway incident starts to decrease in 1995 and then again 1996. Despite these changes, the

general trend for this mode of transportation is an increasing one. The number of water incidents has fluctuated slightly, but has still maintained relatively low values in comparison to the other modes of transportation.

No fatalities are incurred over the entire time period for water transportation. Air fatalities, however, did occur in 1996. During this year 110 people died. Further investigation of this data show that all 110 deaths are the result the crash of Valujet Flight 592 in the Florida Everglades. This event is considered an anomaly, since no other deaths are recorded for the entire 21-year period.

The number of highway fatalities has declined overall since 1975. From 1990 to 1992 the numbers increase slightly, then begin to decrease from 1993 to 1996. Railway fatalities are zero for the entire time span, except for the 2 deaths recorded in 1980.

The injury data shows no more than 3 injuries have resulted from water accidents during the entire 21-year period. The number of injuries caused by air accidents has increased since 1975, but this increase has not followed any definite pattern. Railway accidents have caused a varied number of injuries each year, which cannot be defined as a trend. However, in 1996, 925 injuries are recorded, which is uncharacteristic on the previous years' numbers. The highway injuries have decreased in number overall since 1975. This is despite a period of growth from 1990 to 1993 when numbers begin to increase and peak at 511. In 1994 the numbers begin to decline and reach 211 in 1996, the second lowest number recorded.

Hazardous Liquid and Natural Gas

Since 1970 the number of incidents involving hazardous liquid has declined. However, the number has been relatively constant since 1991, with about 200 incidents per year. The number of natural gas incidents has exhibited the same drastic decline since 1980, but has remained constant at about 200 since 1990.

The number of fatalities for both hazardous liquids and gas has varied over the 26-year period. In the latter years, 1994 to 1996, hazardous liquid fatalities has declined steadily, while the gas fatalities have steadily increased. Injury data shows that hazardous liquids generally cause fewer injuries than gas. In 1994, a record number of injuries, 1858, occur, which can only be considered an anomaly when compared to the other years. Injuries resulting from natural gas accidents have declined since 1970, but minor fluctuations have occurred since 1991. Finally, the amount of property damage has increases significantly since 1970 for both hazardous liquid and gas categories.

The data shows that although the number of incidents has declined steadily, the amount of property damage has increased steadily. This inversely proportional behavior contradicts what would normally be expected.

National Board of Boiler and Pressure Vessel Inspectors Incident Report

The National Board of Boiler and Pressure Vessel Inspectors was established in 1919 to provide better safety standards for boiler and pressure vessel usage, manufacture, inspection, and maintenance. In 1992, the National Board began documenting the number of accidents, injuries, and deaths that occur involving boilers and pressure vessels. The incident reports are divided into four categories: power boilers, water heating boilers, steam heating boilers, and unfired pressure vessels.

Data Interpretation: (Tables XI, XII, & XIII and Charts XXXIII through LVI)

The data in these incident reports list several incident causes. A qualitative analysis of the data shows which events cause the most incidents, injuries, and deaths is performed here.

Power Boiler

Operator error/poor maintenance and low water cut off are the major causes of accidents for power boilers. The number of accidents follows no trend of increase or decline. Injuries due to power boiler accidents are also mostly caused by these same two events. Injuries caused by operator error/poor maintenance vary greatly in number, but the number has declined steadily since 1995. Conversely, injuries caused by low water cut off have declined drastically to zero over the last four years. No fatalities have resulted from low water cut off, but a few fatalities have occurred due to operator error. The number of fatalities has not exceeded 4 over the 5-year period.

Heating Boiler (water)

As with the power boilers, low water cut off and operator error/poor maintenance are the primary causes of accidents for these boilers. The number of low water cut off-incidents declines consistently form 1994 to 1996, but increases sharply to 647 in 1997. Operator error/poor maintenance-incidents climb steadily from 1993 to 1996, then plummets to 97 in 1997. Burner failure is another significant contributor to accidents for water boilers. The number of incidents caused by this event has increased since 1992.

Operator error, burner failure, limit controls and improper installation cause the most injuries. However, the number of injuries for any of the events never exceeds 7 per year. No true trend can be devised from the injury data for any of the events, except operator error, which has declined in injuries over the past 5 years. Fatalities are rare for this type of boiler. However, when they occur, no more than 3 deaths have resulted in a given year.

Heating Boiler (Steam)

Again, operator error/poor maintenance and low water cut off cause the most accidents. The former has been rather constant in the number of accidents since 1993, whereas the latter has declined significantly since 1993. Injury data show that burner failure and operator error/poor maintenance caused the most injuries over the 5-year period. This is mainly due to the large numbers of injuries recorded in 1996 for both events. Omitting 1996 from the comparison shows that no real injury trend is evident in the data for any of the events. Fatalities are extremely rare for these steam boiler accidents. The only 3 fatalities over the 5-year period result from improper repair (1 fatality) and burner failure (2 fatalities).

Unfired Pressure Vessel

Accidents involving these vessels result mainly from four different events: safety relief valve failure, limit controls, improper installation and repair, and operator error/poor maintenance. All of these events are significant contributors, but operator error/poor maintenance is the number one cause with over 140 accidents per year. One common thread among these events is the fact that the accident numbers vary, leading to no obvious trend.

Injuries caused by these vessel-accidents result primary from the improper installation and operator error/poor maintenance events. The number of injuries follows no particular trend. Operator error and faulty design generally cause the fatalities. There is an upward trend in the number of fatalities caused by operator error/poor maintenance. Also, the number of fatalities resulting from faulty design shows a slight downward trend.

Emergency Response Notification System

The Emergency Response Notification System (ERNS) is a cooperative data-sharing program between the EPA, DOT, the National Response Center, and the John A. Volpe National Transportation Systems Center. Established in 1986, this database stores information regarding oil discharges and hazardous substances release notifications. The database is categorized by the 10 EPA regions, which are listed below.

Region 1: Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island, and Vermont.

Region 2: New Jersey, New York, Puerto Rico, the U.S. Virgin Islands, Lake Ontario, and eastern portion of Lake Erie.

Region 3: Delaware, Maryland, Pennsylvania, Virginia, West Virginia, and the District of Columbia.

Region 4: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee.

Region 5: Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin, Lake Huron, Lake Michigan, Lake Superior, western portion of Lake Erie.

Region 6: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

Region 7: Iowa, Kansas, Missouri, and Nebraska.

Region 8: Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming.

Region 9: Arizona, California, Hawaii, Nevada, American Samoa, Guam, the Commonwealth of the Northern Mariana Islands, and the Trust Territory of the Pacific Islands.

Region 10: Alaska, Idaho, Oregon, and Washington.

The ERNS database is a collection of the initial release reports, which are primarily made during or immediately following a release. Consequently, the details of the release are usually unknown. The quality of the data is limited by two major factors:

1. Reports are taken over the phone can result in transcription errors.
2. Multiple reports can be taken for a single incident due to original report being updated or to a private observer reporting incident that has already been documented.

Data Interpretation:

In order to gain insight into safety trends, it is advantageous to analyze the three regions that experience the most incidents, injuries and deaths over the 12-year period. Table XXIV and Chart LXXVI show that those three regions are Region 4, Region 6, and Region 9. By investigating the data for these three regions, hypotheses for the other seven regions can be made.

Region 4 (Table XVII, Charts LXII & LXIV)

The ERNS data for Region 4 shows that the number of incidents typically ranges between about 3500 and 4800. However for 1988 and 1994, the number of incidents is 7418 and 10,068, respectively. The death toll for each year typically numbers less than 50; yet, once again, for 1988 and 1994, the numbers of fatalities are abnormally high at 638 and 92, respectively. This same trend is closely followed in the injury data as well during 1988 and 1994. There is a slight difference in 1987, where the number of injuries is also high. Apart form 1988 and 1994, it is obvious that the number of incidents remains fairly constant from 1991 to 1996. For all the remaining years, the number of injuries shows a steady increase from 1990 to 1993, and a steady decline from 1995 to 1996. The injury

and accident data correspond exactly with the trends they exhibit. The death data also corresponds well with the trends.

Region 6 (Table XIX, Charts LXVII & LXVIII)

The number of incidents occurring in Region 6 has increased over the 12-year period. Most of the increase occurred between 1989 and 1996, where the average number of incidents is about 9400. In 1997 the number decreased to 8832 and decreased again in 1998 to 6101. This last value is still 11.1% greater than the lowest number, which occurred in 1987.

The injury data illustrates more fluctuation, with a maximum value, 1270, occurring in 1987. During the following years the numbers are sharply lower. Following this peak in 1987, the number drops to a minimum of 138 injuries. A period of growth occurs between 1993 and 1996, which peaks at 488. If the 1987 data is omitted, the other years on the chart show varying oscillation which exhibits no real trend.

The fatality toll is the highest in 1987, with 1015 deaths occurring. From 1988 to 1998, the number of deaths numbers less than 70. The fatality numbers vary only from 1990 to 1993. Then the numbers increase to a magnitude of about 30 to 50. The general trend is a "U" shaped plot with the minimum of 17 in 1993, and maximums of 68 and 49 in 1989 and 1996, respectively.

Region 9 (Table XIX, Charts LXVII & LXVIII)

The incident data exhibits a skewed bell-shaped curve that has a maximum value of 8316 in 1991. The left endpoint of this "curve" is 5347 for 1987, and the right endpoint is 2264 in 1998. The right side of this curve has an essentially negative slope. Therefore, it is surmised the number of incidents in Region 9 has declined by about 69% from 1994 to 1998. In contrast, the death and injury data shows no observable trend. Both data sets demonstrate random fluctuations that do not follow any observable trend.

Accident Release Information Program

The Accident Release Information Program is another EPA subsidiary project that takes its information from the ERNS database. The EPA selects certain releases from the ERNS database to be subjected to the ARIP 23-question survey. Those particular accidents must have occurred at fixed facilities and must have resulted in environmental damage and/or off-site consequences. Those consequences include any evacuation, casualty, shelter-in-place or other precautionary measures taken by individuals off-site as a result of the release (US EPA, 550-F-98-018). Environmental damage is defined as any death of wildlife, soil and surface water contamination, and vegetation damage (US EPA, 550-F-98-018). The purpose of the ARIP questionnaire is to document all significant accidents, and thus it is sent to all releases that result in injury or death. Since its inception in 1986, the ARIP survey has undergone several changes in order to

streamline data gathering and to target the more significant accidents. As of September 1997, ARIP has been restricted to collecting data on a maximum of nine incidents per year. Consequently, this database will not be a viable tool for data comparison in the future. Nevertheless, the data from 1986 to 1997 is included in this work.

Data Interpretation:

The number of fatalities reported to ARIP has not exceeded 11 for any given year. In fact, the number of fatalities is extremely low when compared to the number of injuries that occur from 1986 to 1997. The number of injuries reported in 1987, 1990, and 1991 are extremely high with figures of 1160, 811, and 1442, respectively. Injury figures for 1988, 1992, and 1994 are 262, 231, and 230, respectively. Although these numbers are high, they pale in comparison to the former years. Together, these six years account for the majority of the injuries reported to ARIP during this time period. The remaining six years show very few injuries. Thus, the injury and death data exhibit no authentic trend that can characterize the safety conditions in the chemical industry.

Conclusions

What this investigation provides is an outline of safety conditions that shows that in general, the number of workplace accidents, injuries, and fatalities has not changed significantly in the past decade. Despite new legislation and safety programs, the safety statistics remain stagnant. This leads to the question, "Is it realistic to expect dramatic changes in workplace safety after only a few years of program implementations?" Before this question can be answered, industry must be able to define and set realistic goals in order measure progress.

The information collected in these eight databases is varied and complex. Analysis of these databases does not give a detailed picture of the state of workplace safety. This is because the databases have different data-collecting methodologies, objectives, and chronologies. Therefore, it is imperative that stakeholders pick a starting point on the continuum from which to measure changes in workplace safety. Additionally, there must be cooperation and understanding between the various stakeholders.

Recommendations

In response to these deficient databases, a new independent accident database must be constructed. The stewards of this new database must address the problems encountered by all previous databases, namely varying data-collecting methods, inconsistent reporting requirements, and incomplete accident data. The primary tasks at hand are as follows:

- define the objectives of this new database
- select an independent agency to collect data
- determine reporting requirements and incentives
- determine the data-collecting methods.

Who/Stakeholders: Develop a **Chemical Industry Consortium** of all chemical manufacturers including food, drug, and agricultural product makers. If companies report to this database, then reporting to multiple agencies and databases such as ARIP, ERNS, and OSHA could be eliminated. Thus, this database would be a primary source of information for other databases.

What/Reporting Requirements: Report all incidents involving chemicals categorized by nature of substance, resulting injuries/illnesses, property/equipment damage, and environmental effects. Since this database would only be concerned with chemical-related and fire/explosion incidents, there would be no "contamination" of the data by other occupational injury/illness incidents such as falls and contact with objects and equipment.

Data Categorization: Annual Statistics

- Injuries/illnesses and fatalities by industry
- Injuries/illnesses and fatalities by event/exposure
- Number of incidents occurring by industry
- Rank chemicals by number of incidents involving them
- Rank incident causes by number occurring
- Rank industries by number of incidents occurring

When: After a thorough incident investigation, the data should be reported to the steward agency to be included in the annual statistics.

Where/Steward Agency: Report to independent agency possessing objective views and no obligations to any stakeholders. Since the database would be compiled by an independent agency, the data should be available to the public and private sectors. Access to the data on the internet should be made possible as well as in print.

Why/Objectives: The primary objective is to develop a database that will chronicle the state of chemical safety and serve as a benchmark to measure how well industry safety goals are being met. This is accomplished by collecting extensive and accurate data on all chemical accidents.

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