BFGoodrich

The BFGoodrich Company
Chemical Group
6100 Oak Tree Boulevard
Cleveland, Ohio 44131
216 447-6256

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Mr. H.G. Olson, Sec.
Vinyl Chloride Safety Association
Ethyl Corporation
P.O. Box 341
Baton Rouge, LA 70821

Dear Herb:

I have attached a copy of the talk given by Mr. John A. Davenport at the Vinyl Chloride Safety Association meeting. As we discussed on the phone, you could send this out to the members when other information on meeting dates, etc., would be transmitted.

Sincerely,

Glen

Glen D. Schaaf
Manager
Manufacturing Processes
PVC Resins

/glg

Attachment

OCC 4013

ANALYSIS OF LOSSES IN THE CHEMICAL INDUSTRY
AS IT APPLIES TO THE POLYVINYL CHLORIDE INDUSTRY *

C. W. Conaway, J. A. Davenport (Speaker), G. P. Norstrom
Industrial Risk Insurers

SUMMARY: This paper details an analysis of losses to Industrial Risk Insurers in the Chemical Industry for the period 1978 through the first ten months of 1980. This analysis shows that the type of plant that is the most susceptible to loss is the type which predominates the PVC Industry.

Industrial Risk Insurers is an Association of 45 leading insurance companies. IRI has a substantial stake in the Chemical Industry in general and the PVC Industry in particular. Our liability in force is approximately $500 billion. Approximately $65 billion or 14% of this liability is in the Chemical Industry. According to an article by Cameron, et al[1], the annual capacity of PVC producers in the United States is about 7.2 billion pounds. IRI now insures 3.7 billion pounds of this capacity, or 51%.

IRI recently did an analysis of the losses in the chemical and allied classes for the years of 1978, 1979, and the first nine months of 1980. During this period, there were 967 occurrences which produced a loss to Industrial Risk Insurers of $116,336,882. It is important to note that during this period there were no catastrophic losses--that is, a loss greater than $20 million.

PERIL ANALYSIS

In every analysis that we have ever run of losses in the chemical industry, explosions have been shown to be the most expensive type. In the analysis

* A Paper delivered to the Vinyl Chloride Safety Association Meeting at the Holiday Inn, St. George, Bermuda, October 23, 1980.

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of the 1978-1980 losses, explosions represented almost 60% of the dollars from only one quarter of the occurrences. (See Table 1)

OCCUPANCY ANALYSIS

The next thing we looked at in the loss analysis is the occupancy class where the losses occurred. (See Table 2) The extra heavy hazard chemical class is that involving organic peroxide and explosive manufacture, nitrations, Claisen and Grignard reactions, and other very vigorous and thermally unstable chemical reactions. The petrochemical occupancies include processes utilizing petroleum hydrocarbons or similar feed stocks. Olefin facilities predominate this occupancy class. The heavy hazard class is one of the largest classes and includes most polymerization processes like PVC plants, as well as solvent extraction, sulfonation, low pressure hydrogenation, and other processes involving flammable and combustible materials. The light hazard class involves primarily inorganic operations. The remaining classes are self-explanatory.

The table shows that the bulk of the dollar loss is in the petrochemical and heavy hazard class. The figures show that there is a 42% chance that a loss will occur in these two classes and 75% of the dollar loss was in these two classes. One item of note is the excellent loss record of the pharmaceutical class. This experience should be tempered with the understanding that firms in this class usually purchase their insurance with a lower deductible than that of firms with predominantly petrochemical or heavy hazard chemical operations. Therefore, the higher frequency is to be expected.

SIZE OF LOSS ANALYSIS

Table 3 shows an analysis of the size of loss. Here it is noted that 50.7% of all occurrences reported to the IRI resulted in no dollar loss while a mere 1.3% of all occurrences result in loss greater than $2.5 million. Clearly, major losses in the chemical industry can be characterized as having relatively low frequency but enormous dollar loss associated with them. It has been suggested that this data is support for Murphy's Law. That is, if you examine the trend, ever-decreasing frequency produces an ever-greater loss. This would logically lead us to the point of view that the loss which will probably never happen will always be large.

LARGE LOSS ANALYSIS

Next, we examined a typical six-quarter segment of this three-year period. (See Table 4.) This was an in-depth analysis of larger losses; that is, occurrences which have produced dollar loss greater than $100,000 combined property damage and business interruption. In this analysis we attempted to isolate the critical factors which are of importance to safety and property conservation engineers. We specifically examined explosion and fire losses from the point of view of the type, cause, location, and key contributing factors which are associated with these more severe occurrences. Notice that in this case the explosion occurrence tracks our other analyses.

LARGE EXPLOSION LOSS ANALYSIS

We first examined the type of loss for explosion losses greater than $100,000. (See Table 5.) It is noted here that the explosion losses involving chemical reaction developed 44.2% of frequency and 85.9% of total dollar loss. Fired equipment explosions produce another 23.5% of frequency and all "other" explosions comprise the other 32.3% of occurrence. However, the dollar loss associated with these occurrences produce only 14.1% of dollar loss. For those of you who are familiar with the IRI's vapor cloud theories, be assured that if a major vapor cloud explosion were to have occurred during this period, the data would be slanted towards this "other" category. The work that we have done on vapor cloud explosions has indicated that none of the PVC plant releases with subsequent explosion could be classed as an unconfined, free-air vapor cloud explosion. We feel that the amount of material released has not been sufficient to produce an unconfined explosion outside the reactor building. As reactors get bigger, this probability is increasing.

Examining the chemical reaction loss cause analysis (see Table 6), it is noted that accidental and uncontrolled chemical reactions are the causes in 73.3% of all cases. Recalling that chemical reactions are responsible for 44.2% of all major explosions, it is apparent that about one-third of all major explosions in the chemical industry will be due to either accidental or uncontrolled chemical reaction. "Chemical reaction-accidental" is the term for an incident caused by the accidental contact of materials. "Chemical reaction-uncontrolled" is the intentional combination of materials which become uncontrolled as the result of agitation or coolant loss, a contaminant, instrument failure, etc.

We now examine where in the plant this type of incident, an explosion causing damage greater than $100,000, would be more likely to occur. (See Table 7). We see that the odds are approximately two to one, or that 66.7% of all losses will occur in an enclosed process building as opposed to an open process structure or other areas, such as a tank farm, laboratory building, etc.

In this enclosed building, the type of process which will probably be involved will be that of a batch chemical reaction as contrasted to a continuous chemical reaction system or other type of unit (Table 8).

The last area we will examine as respects major explosion losses will be that of contributing factors (See Table 9). Needless to say, in any given loss, one or more contributing factors may be involved in determining the magnitude of loss. Often, the size of the loss is proportional to the number of contributing factors. Accordingly, we will only identify the four major contributing factors which we have found to be involved in large explosion losses during this period. The first and most major factor is the rupture of a vessel or equipment, or the mechanical failure of piping, valves, agitators, etc. These failures would be at pressures below the design pressures. Three other elements which find their way into 20% of all losses during this period are the human element or carelessness, inadequate venting resulting in vessel overpressure, and, finally, the improper location of equipment or congestion.

LARGE FIRE LOSS ANALYSIS

Even though explosions caused the greatest loss, it is still important to examine the fire losses. Table 10 is a breakdown of the causes of fires in the large loss category. The principal cause is that of a flammable liquid or gas release or overflow. The next major cause is the overheating of hydrocarbon materials, followed by the failure of a pipe or fitting, static electricity or electric sparks, electrical or mechanical breakdown. Just as with the explosion losses, we must keep the process materials in the pipes or vessels.

As in the case of the explosion peril, we have attempted to place the location in the plant where such incidents will occur (Table 11). We find that, in contrast to the explosion incident, the frequency of loss in an enclosed process building versus an outdoor process structure is approximately equal in the case of major fire losses. This would lead us to the conclusion that leaks occur in process equipment outside of buildings as often as inside. This leak inside of a building is, however, much more likely to cause an explosion.

Examining the major contributing factors (Table 12), we see that the lack of automatic sprinkler protection is the key factor which has been involved in almost 40% of these fire losses. The basis of the founding of the old Factory Insurance Association as well as the Factory Mutuals was the insuring of risks which were adequately protected by automatic sprinklers. Still, today inadequate sprinkler protection is a major contributing factor in our fire losses.

CONCLUSIONS

To summarize the conclusions from this analysis:

1) Taken together, explosion and fire losses provide the greatest frequency and severity of incident in the chemical industry.

2) The explosion loss is of much more severe character than that of the fire loss.

3) Major explosion losses will be most likely caused by either accidental or uncontrolled chemical reaction.

4) Major explosion losses will occur in enclosed process buildings involving batch chemical reactions.

5) The magnitude of loss will be contributed to by the rupture of vessels or equipment.

6) In the case of major fire losses, the cause will be due to the release of either a flammable liquid or gas and will occur with equal frequency in enclosed buildings or outdoor process structures.

7) The principal contributing factor to major fire loss will be the lack of automatic sprinklers or water spray.

Industrial Risk Insurers believes that to reduce losses in the Chemical Industry a vigorous loss prevention program that has the full backing of top management is vital. IRI has published a booklet[2] which outlines our "Guiding Principles for Protection of High Hazard Chemical and Petrochemical Plants."

LITERATURE CITED

1) Cameron, J. B., A. J. Lundeen and J. H. McCulley - "Trends in Suspension PVC Manufacture," Hydrocarbon Processing, March 1980.

2) Industrial Risk Insurers, Loss Prevention and Protection for Chemical and Petrochemical Plants, Hartford, Connecticut

TABLE 1

LOSSES IN THE CHEMICAL INDUSTRY

IRI CHEMICAL AND ALLIED CLASSES

1978 - 1980 PERIL ANALYSIS

PERIL	% OCCURRENCES	% $ LOSS
Explosion	23.6%	58.2%
Fire	42.4%	26.3%
Windstorm	14.3%	8.8%
All Other	19.7%	6.7%
	100%	100%

TABLE 2

LOSSES IN THE CHEMICAL INDUSTRY - IRI CHEMICAL AND ALLIED CLASSES

1978 - 1980 OCCUPANCY ANALYSIS

OCCUPANCY CLASS	% OCCURRENCES	% $ LOSS
63 - Extra Heavy Hazard	4.8%	4.6%
64 - Petrochemicals	9.3%	27.4%
65 - Heavy Hazard	32.6%	47.7%
66 - Light Hazard	22.8%	11.6%
67 - Paint, Dyestuffs, Inks	10.5%	4.3%
68 - Soaps and Veg. Oil	6.0%	1.0%
69 - Pharmaceutical & Fine Chem.	14.0%	3.4%
	100%	100%

TABLE 3

LOSSES IN THE CHEMICAL INDUSTRY - IRI CHEMICAL AND ALLIED CLASSES

1978 - 1980 SIZE OF LOSS ANALYSIS

SIZE	% OCCURRENCES		% $ LOSS	
No Claim	50.7%		0	
$ 0 - $ 9,999	14.6%		.4%	
$ 10,000 - $ 24,999	9.4%		1.3%	
$ 25,000 - $ 49,999	6.1%		1.7%	
$ 50,000 - $ 99,999	6.1%		3.4%	
$ 100,000 - $ 249,999	4.0%		4.6%	
$ 250,000 - $ 499,999	4.4%		12.9%	
$ 500,000 - $ 999,999	2.0%	13.2%	11.7%	93.2%
$1,000,000 - $2,499,999	1.5%		17.0%	
$2,500,000 & Over	1.3%		47.0%	

TABLE 4

LOSSES IN THE CHEMICAL INDUSTRY

IRI CHEMICAL AND ALLIED CLASSES

LARGE LOSS*ANALYSIS

TYPICAL 6-QUARTER PERIOD

TYPE OF LOSS	% OCCURRENCE	% $ LOSS
Explosion	51.4%	73.2%
Fire	33.3%	20.1%
Windstorm	1.5%	.2%
All Other	13.8%	6.5%
	100%	100%

*Loss > $100,000 net of deductible

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TABLE 5

LOSSES IN THE CHEMICAL INDUSTRY
IRI CHEMICAL AND ALLIED CLASSES
EXPLOSION LOSSES > $100,000
TYPE ANALYSIS

TYPE OF LOSS	% OCCURRENCE	% $ LOSS
Chemical Reaction	44.2%	85.9%
Boiler Explosion	17.7%	5.3%
Furnace Explosion	5.8%	.8%
Explosion - Other	32.3%	8.0%
		100%

TABLE 6

LOSSES IN THE CHEMICAL INDUSTRY
IRI CHEMICAL AND ALLIED CLASSES
MAJOR CHEMICAL REACTION LOSSES > $100,000
CAUSE ANALYSIS

CAUSE	% NO. OF LOSSES	
Chemical Reaction (Accidental)	33.3%	73.3%
Chemical Reaction (Uncontrolled)	40.0%	
Decomposition of Unstable Materials	13.3%	
Other	13.4%	
	100%	

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TABLE 7

LOSSES IN THE CHEMICAL INDUSTRY

IRI CHEMICAL AND ALLIED CLASSES

CHEMICAL REACTION LOSSES > $100,000

LOCATION ANALYSIS

LOCATION	% OF NO. OF LOSSES
Enclosed Process Building	66.7%
Open Process Structure	20.0%
Other	13.2%
	100%

TABLE 8

LOSSES IN THE CHEMICAL INDUSTRY

IRI CHEMICAL AND ALLIED CLASSES

CHEMICAL REACTION LOSSES > $100,000

OCCUPANCY ANALYSIS

OCCUPANCY	% OF NO. OF LOSSES
Chemical Reaction Process - Batch	60%
Chemical Reaction Process - Continuous	13.6%
Recovery Unit	6.6%
Evaporation Unit	6.6%
Other	13.2%
	100%

TABLE 9

LOSSES IN THE CHEMICAL INDUSTRY

IRI CHEMICAL AND ALLIED CLASSES

CHEMICAL REACTION LOSSES > $100,000

MAJOR CONTRIBUTING FACTOR ANALYSIS

CONTRIBUTING FACTOR	% OF NO. OF LOSSES
Rupture of Vessel or Equipment or Mechanical Failure	40.0%
Human Element - Carelessness	20.0%
Inadequate Venting	20.0%
Improper Location of Equipment or Congestion	20.0%

TABLE 10

LOSSES IN THE CHEMICAL INDUSTRY

IRI CHEMICAL AND ALLIED CLASSES

FIRE LOSSES > $100,000

CAUSE ANALYSIS

CAUSE	% OF NO. OF LOSSES
Flammable Liquids or Gas - Release, Overflow	28.5%
Overheating	24.3%
Failure of Pipe or Fitting	14.3%
Static Electricity or Electric Spark	9.5%
Electrical or Mechanical Breakdown	9.4%
All Other	14.0%
	100%

TABLE 11

LOSSES IN THE CHEMICAL INDUSTRY

IRI CHEMICAL AND ALLIED CLASSES

FIRE LOSSES > $100,000

LOCATION ANALYSIS

LOCATION	% OF NO. OF LOSSES
Enclosed Process Building	38.5%
Outdoor Process Structure	33.3%
Other	28.2%
	100%

TABLE 12

LOSSES IN THE CHEMICAL INDUSTRY

IRI CHEMICAL AND ALLIED CLASSES

FIRE LOSSES > $100,000

MAJOR CONTRIBUTING FACTOR ANALYSIS

CONTRIBUTING FACTOR	% OF NO. OF LOSSES
Sprinklers Needed	38.1%
Human Element	19.0%
Vapor Laden Atmosphere	14.3%
Excessive Residue or Deposits	9.5%