"FAMILIARITY BREEDS CONTEMPT" - THE NEED TO ENGINEER PASSIVE DEVICE TECHNOLOGY TO MINIMIZE HUMAN INTERACTION IN SAFETY PROCESSES

Andrew Abrams, Thomas Steinbach, Joseph Abrams

Introduction

"Familiarity Breeds Contempt" implies that the more one knows about something, the more they lose respect for its characteristics and in this case potential hazards. Never has a simple phrase been so appropriate for industrial safety analysis. The more that we establish protocols and safety processes, the more that we see human behavior circumventing, disregarding or simply ignoring the facts and procedures that have been established to specifically benefit them. This paper will analyze four specific situations that more fully exemplify what we call "***The Four Horseman of the Hose Failure Apocalypse", Familiarity, Ambivalence, Laziness and Status Quo.*** We will identify this trend, contrast it with one of the leading industrial behavioral studies, and explain its recent industry cases when this syndrome occurred. We will also provide an understanding of the benefits of passive devices for line and hose failures to safety, cost and regulatory compliance through its growing trend and regulatorily encouraged use.

The Four Horsemen of the Hose Apocalypse- *Familiarity, Ambivalence, Laziness and Status Quo*

1. *Familiarity* – Atofina and Neglect towards PPE and Over Reliance on Excess Flow Valves

Familiarity is defined in psychological terms as a mental heuristic, or rule of thumb in which current behavior is judged to be correct based on how similar it is to past behavior and its outcomes. Individuals assume that the circumstances underlying the past behavior still hold true for the present situation and that the past behavior thus can be correctly applied to the new situation. These three unfortunate workers had been involved in other similar events in the past and such positive outcomes would negate their need to behave per the proper procedures for PPE. The result was tragic.

About 3:45 a.m., eastern daylight time, on July 14, 2001, at the **Atofina** plant in Riverview, Michigan, a pipe attached to a fitting on the unloading line of a railroad tank car fractured and separated, causing the release of methyl mercaptan, a poisonous and flammable gas. About 4:09 a.m., shortly after the Riverview Fire Department chief arrived on scene, the methyl mercaptan ignited, engulfing the tank car in flames and sending a fireball about 200 feet into the air. Fire damage to cargo transfer hoses on an adjacent tank car resulted in the release of chlorine, a poisonous gas that is also an oxidizer. The fire was extinguished about 9:30 a.m. Three plant employees were killed in the accident. There were several other injuries; most of the injured were treated for respiratory symptoms and released. About 2,000 residents were evacuated from their homes for about 10 hours. Two tank cars, railroad track, and plant equipment (including hoses and fittings) were damaged in the fire. /1/

The Safety Board determined that the probable cause of the accident was a fractured cargo transfer pipe that resulted from (1) the failure of **Atofina** to adequately inspect and maintain its cargo transfer equipment, and (2) inadequate Federal oversight of unloading operations involving hazardous materials. Contributing to the accident was **Atofina**'s reliance on a tank car excess flow valve to close in the event of a leak from cargo transfer equipment and the company's failure to require appropriate safety equipment for employees involved in tank car loading and unloading operations.

While **Atofina** could not provide data or records to confirm whether or when the transfer pipe that failed in this accident had last been inspected under the mechanical integrity program, the erosion-corrosion that was found within the failed pipe indicated that the program had clearly not been effective. The Safety Board concluded that **Atofina**'s failure to implement effective procedures for inspection and maintenance of its unloading pipes and fittings allowed the transfer pipe in this accident to gradually deteriorate and ultimately fail.

Both OSHA and the Environmental Protection Agency (EPA) required Atofina to develop and document safety plans for the Riverview facility that included safeguards intended to reduce the risk and consequences of catastrophic releases of hazardous materials. Atofina's risk management plan (mandated by the EPA) and process hazard analysis (mandated by OSHA) included an accident scenario that involved the failure of a flexible hose on the unloading apparatus for a methyl mercaptan tank car - a scenario similar to this accident. Under both plans, Atofina indicated that the release of methyl mercaptan would be stopped by the automatic closure of the tank car's excess flow valve. Further, **Atofina**'s risk management plans explicitly noted that excess flow valves on the tank car would activate in the event of a pipeline or unloading hose rupture. **<u>However, when the transfer pipe/hose failed on July 14, 2001, the excess flow valve on the tank car did not close and stop the release of the methyl mercaptan.</u>**

Calculations made by Safety Board engineers and parties to the investigation indicated that the flow rate of methyl mercaptan through the broken transfer piping was insufficient to cause the excess flow valve to close. Excess flow valves are designed to close and stop the release of product from the tank car in the event a tank car valve or fitting is broken or sheared off during transit. Attaching cargo transfer apparatus to a tank car can change product release rates and flow rate characteristics and can prevent the excess flow valve from closing in the event of an emergency. As noted by the Chlorine Institute in its *Chlorine Manual Pamphlet 57* and by the Safety Board in its investigation of a July 30, 1983, accident at the Formosa Plastics plant in Baton Rouge, Louisiana, tank car excess flow valves are not designed to act as an emergency shutoff device during cargo transfer. /4/

To determine whether reliance upon tank car excess flow valves as safety mechanisms during transfer operations is restricted to **Atofina** or is a broader problem, Safety Board investigators interviewed a sampling of domestic chemical companies. Interviews with personnel responsible for company safety plans revealed that six of nine companies surveyed rely on tank car excess flow valves as a method of stopping or limiting a leak in the transfer equipment. Only one company reported having remotely operated shutoff valves on the unloading piping just outside the tank car dome. (The other two companies did not respond to the Safety Board's inquiry.) Although the Safety Board's sampling was limited, the results suggest that the **<u>inappropriate use of tank car excess flow valves may be a widespread practice in the chemical industry.</u>**

As a result of its investigation of the Riverview accident, the National Transportation Safety Board therefore made the following safety recommendation to the Occupational Safety and Health Administration: Assist the U.S. Department of Transportation in developing safety requirements that apply to the loading and unloading of railroad tank cars, highway cargo tanks, and other bulk containers that address personal protection requirements, emergency shutdown measures (passive device technology), and the inspection and maintenance of cargo transfer equipment.

In this case, the employees familiarity with the equipment that they had been relying upon yet had been informed of its limitations resulted in their death.

2. *Ambivalence* - Path of least resistance– DPC Enterprises and the Chlorine Hose Manufacturers Defects

Ambivalence is a state of having emotions of both positive and negative valence or of having thoughts or actions in contradiction with each other, when they are related to the same object, idea or person. The term is also commonly used to refer to situations where 'mixed feelings' of a more general sort are experienced or where a person experiences uncertainty or indecisiveness concerning something. Here employees knew that maintenance on the valves was essential yet this did not occur and the hose manufacturer knew that the hose material was absolutely critical but did not enegage the necessary meatlurgic studies resulting in this incident.

A chlorine repacking plant receives 4 railcars contained nearly 250,000 lbs of chlorine to be repacked into cylinders and other distribution. After 59 days, a hose wrongfully identified as a chlorine hose catastrophically failed spilling 48,000 pounds of Chlorine over 3 ½ hours. The root cause in addition to the hose failure, is that backup systems (ESD'S) as well as Excess Flow Valves (EFV's) failed to work./5/


DPC Chemical, Festus, Missouri August 2003

Below is the section of the hose that failed after three workers on break heard a loud "pop", which clearly was this hose failing. The hose was made of stainless steel not suitable for Chlorine uses, although it was identified as hastelloy by the manufacturer, a material that is suitable for Chlorine usage. There is no visual difference between stainless steel and hastelloy, therefore the chlorine repackagers employees relied upon the manufacturers representation that they were indeed shipped the correct hose. Moreover, the facility relied upon the four valves (ESDs and Excess Flow Valves) in case of this precise type of error.

Ruptured chlorine transfer hose with its Teflon inner layer exposed;
when the hose burst it ejected pieces of Teflon as well as other components of the hose.

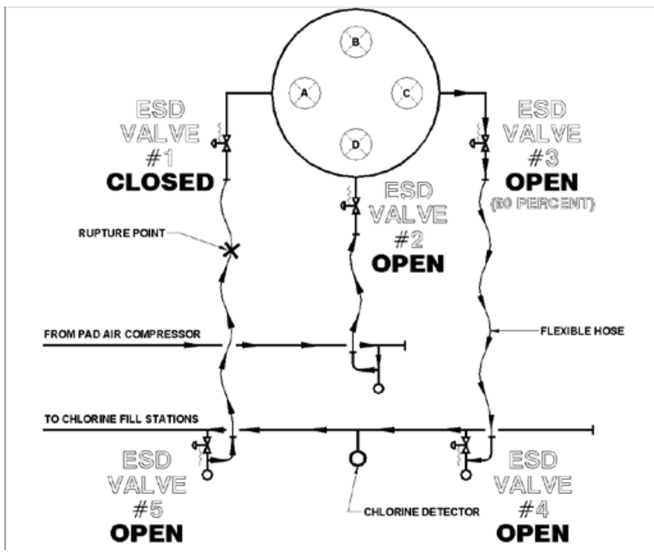
The illustration below shows the positions of all valves and hoses as it relates to this incident. Determining the actual positioning of the five ESD valves at tank car station #3 led the United States Chemical Safety Board's investigators to conclude that the chlorine flowed through the partially opened ESD valve #3, to the attached intact liquid CTH line, into the plant side piping, and back through the ruptured hose (see arrows denoting product path). Closing tank car valve A did not stop the release because valve C continued to supply chlorine through the intact liquid CTH line. Even if these events replayed themselves the product flowing through the building because of the failure of the ESD's would have been stopped by known passive device technology.. This technology would have effectively shut the system down between ESD's 1 & 5 or at the hose connection points. The pressure of the product itself would have kept the plunger/valve sealed and limited loss of product to what was in the hose, likely below the RQ (reportable quantity).

Factors that enabled this incident excluding the wrong type of hose:

1. The employees moved their hazmat suits which would have allowed them to shuts of the chlorine via valves on the car to an area near the door leading to the car. The chlorine enveloped these suits early in the incident making them inaccessible and thus eliminating this remedy. This was is direct violation of established and know company policy. The flow was eventually stopped at the railcar by independent emergency responders 3 ½ hours later in the exact same hazmat suits.
2. Upon realizing that they could not reach their hazmat suits the employees evacuated. Upon leaving the building the activated the remotely operated emergency shutdown devices, the switch went from "open to closed" as it head

during regular testing of the switch. However, nobody had inspected the actual valving to see if they were closing per the command, they were not closing. This lack of regular inspection of the ESD's themselves was in direct violation of company requirements of regular equipment functionality inspections.

3. The operators of this plant relied upon EFV's to recognize hose failure as excess flow which the EFV's were not and have not been designed to do.



CSB investigators concluded that it is all but impossible to determine all possible routes of escape for hazardous materials or the infinite numbers of LPHC (Low Probability/High Consequence) scenarios. It is however abundantly clear that the hose is the weakest link in the chain and that devices, training and other precautions have proven to be inadequate in combating hose failures. In most reports of hazardous material release incidents we submit that one constant seems to be that employees do not follow regulations, rules and precautions that management, organizations and agencies have mandated and reasonably assume are being followed. Moreover, the valving technology that relies upon excess flow principles has been vastly over relied upon to address these incidents and governmental regulatory bodies have taken notice through he issuance of warnings and landmark Special permits encouraging the use of the passive device system mandated in 49 CFR 173.315.

3. Laziness – Tacoma Washington, Oct 2007 – Disregarding the Mandatory Use of a Passive Device

Laziness is the lack of desire to perform work or expend effort. In this case, Mr. McDonald chose to use a hose that was attached to the foundry's facility even though he had a GPSS , required by law, on his cargo tanker. His decision, in part, resulted in Mr. McDonalds being severly burned and three days later succumbng to his injuries and the destruction of the facility.

These are the facts as we know them today of the tragic incident that occurred in Tacoma Washington on October 6 2007:

1. A mechanical failure in a propane-supply hose apparently led to the massive explosions that rocked the Atlas Castings and Technology foundry earlier this month and caused the severe burns that killed a propane-truck driver, Tacoma Fire Department investigators say.

2. While a safety hose with a passive device was on this truck Mr. McDonald contrary to his training, dictates of his company and the law made an affirmative decision to use the facilities non-regulatory hose in an effort to save time;

3. When the hose "catastrophically failed" the excess flow valves, that many erroneously depend upon to address a hose failure, did not engage ***again***. The US-EPA and US Chemical Safety Board have warned against this over reliance in a recent Warning Bulletin with a remedy defined.

4. Fire officials have said the hose connection between the driver, Mr. McDonald's truck and the larger, stationary tanks suffered a "catastrophic failure" and the escaping gas was apparently ignited by a furnace inside the nearby foundry unleashing a tower of fire into the sky and spewing truck pieces around the foundry. Three others had minor injuries and were treated and released at Tacoma-area hospitals. Mr. McDonald passed away on Sunday, October 14.

Factors that led to this incident:

1. The operator in a hurry and behind schedule decided not to use the hose equipped with a passive device which was on his delivery truck. This is a direct violation of his company's policies his training (terminable offense) and a violation of United States law.
2. Two facility workers assisted Mr. McDonald in putting an unsafe fitting onto an unsafe hose for the product transfer. This is a direct violation of their company's policies, their training and United States law.
3. The delivery truck was equipped with which were the last line of defense once the passive device equipped hose was not used and failed to recognize the hose failure as

excess flow allowing product to escape unimpeded from the truck which eventually ignited killing the driver and destroying the facility.

Sheer laziness to do what one knows is better, safer or specified is a constant theme of the four horsemen. Here the lack of effort resulted in one death and millions of dollars of destruction.

4. **Status Quo - Excess Flow Valve Technology and the related problems of Over Reliance on Limited Technology**

Status Quo is defined as the existing order of things; present customs, practices, and power relations. The continued use of the same systems that have been defined to be inadequate is what we define as Status Quo syndrome. It may be the most dangerous of the four horsemen because it is also the easiest to follow particularly in a large organization.

An excess flow valve is, typically, a metallic device inserted into the interior piping of a tank car, just below the valve(s) used to load and unload the car. In the event that the valves are sheared off in a railroad accident, there will be a sudden rush of product out the opening thus created. With nothing to impede the flow of fluid product, the excess flow valve will move toward the opening and seat, thus sealing off the opening. In response to concerns that the then-current regulatory provision for excess flow valves might be ambiguous, in 1985 the DOT published a notice of proposed rulemaking to amend the tank car specifications by adopting what is now the contemporary standard. Proponents of the clarification stated that tank-mounted excess flow valves are not intended to substitute for adequate excess flow equipment in plant loading systems. ``The only use of such valves is for protection against loss of lading due to shearing of external closure during transit.'' \2\

The hazardous materials regulations (HMR) are quite clear that excess flow valves are limited in purpose and scope: An excess flow valve as referred to in this specification, is a device which closes automatically against the outward flow of the contents of the tank in case the external closure valve is broken off or removed during transit \3\

Excess flow valves, by their nature, must encounter a high-volume, surging flow of product to be activated. If that were not the case, they might function in unintended situations, such as when a tank car is being unloaded with the aid of a strong pump. As designed, essentially any apparatus attached to the outside of the external closure valve will create sufficient internal friction (whether hose or pipe) that the flow of product will not be sufficient to activate the excess flow valve. Excess flow valves, by both design and regulation, are intended to function only when the external closure valve is sheared, broken off, or otherwise removed during transit. These devices may also function as a back-up flow control device during tank car loading or unloading activities.

Despite these clear and obvious functional limitations, in the absence of newer passive device technology, industry has placed great reliance on these types of valves to address a scenario that they are not designed for – line/hose failure. (See NTSB Report in which, inter alia, six of nine companies surveyed rely on tank car excess flow valves as a method of stopping or limiting a leak in the transfer equipment.).

In the face of this limitation and over reliance, what would the regulatory bodies do when the next major incident occurs?

Warnings are Issued - Nearly two years after the National Transportation Board made its recommendations; warnings were issued by all major regulatory bodies in the United States. In April of 2004, the United States Environmental Protection Agency issued the following warning: "Notify all facilities that are required to submit risk management plans to the **Environmental Protection Agency** that tank car excess flow valves cannot be relied upon to stop leaks that occur during tank car loading and unloading operations and that those companies that have included reliance on such valves in their risk management plans should instead identify and implement other measures that will stop the uncontrolled release of product in the event of a transfer line[hose] failure during tank car loading or unloading."

In, September 2003, the **United States Department of Transportation – Federal Railroad Administration** issued the following warning: FRA is issuing Safety Advisory 2003-02 advising all persons involved in loading and unloading products from railroad tank cars that they cannot rely on internal excess flow valves to stop the flow of product except under the limited conditions for which these valves were designed and installed.

The Atofina incident previously described occurred in July of 2001 with reports being issued within months. It should be noted that incidents #2 &3 occurred after this incident and subsequent government and manufacturers warnings of over-reliance upon EFV's in transfer line failure. Even more alarming is the following finding by the United States Chemical Safety Board in its July 2007 report on thus exact issue:

"Despite these warnings, the CSB investigators found that approximately 30 percent of the bulk chlorine users contacted during this investigation continue to rely only on excess flow valves to stop chlorine flow in the event of a transfer hose rupture."

Therefore as the last Horseman of the Apocalypse we suggest that the status quo by some in a position of responsibility for the design and maintenance of their facilities systems continue to rely upon flawed systems to protect their employees, facilities and their communities from the obvious and well known dangers posed by the first three horsemen,

Can We Truly Affect Human Behavior?

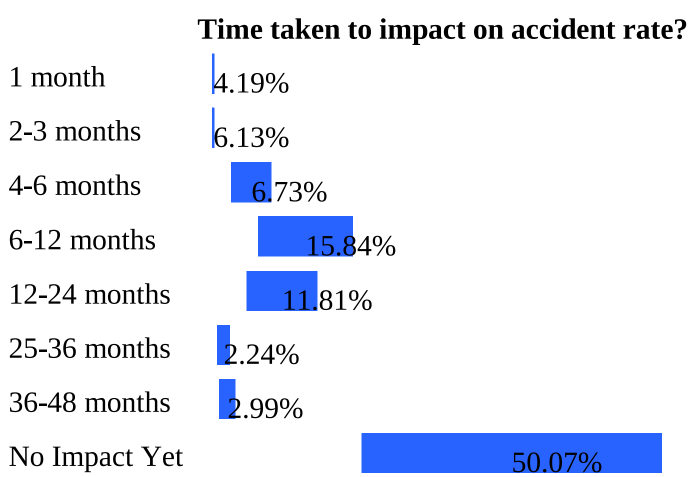
Within the field of occupational safety and health many efforts have been made to improve safety in the workplace. These efforts have focused upon legislation, engineering failure, safety awareness campaigns, safety training, and unsafe acts. Taken as a whole, these efforts have not always been successful in impacting upon accident rates. Traditionally, the legislative approach has not made much of an impact simply because the resources necessary to police the situation have not always been forthcoming. An example of this is provided by the current level of approximately 90 factory inspectors to police somewhere in the region of 100,000 construction sites, not all of which have been notified to the appropriate authorities. The legislative approach has also included attempts at 'blitz' inspections by the UK's HSE. During 1987-88 inspections of over 2,000 construction sites were conducted. These inspections revealed a worrying picture with one third of site agents and supervisors having poor knowledge of basic health and safety requirements. Most importantly during the period of the campaign there was no measurable decrease in the number of deaths or serious injuries (HSE, 1988)./4/

It is pertinent at this stage to ask 'why have all the above approaches not been as successful as they might have been? Part of the answer resides in the fact that both safety training and safety campaigns concentrate upon changing peoples attitudes, in the hope of influencing their subsequent behavior. The underlying assumption being that attitudes cause behavior. However, to a large extent this assumption is inaccurate. Similarly, both the engineering and legislative approaches are based on the assumption that influencing the situation will influence peoples behavior. To some extent this is correct, but it is not the whole picture./5/

Many approaches to improving safety concentrate upon changing people's attitudes, in the hope of influencing their subsequent behavior. The underlying assumption of this approach is that attitudes cause behavior. This assumption is, however, inaccurate. A considerable body of scientific evidence shows that the relationship between attitudes and behavior is a tenuous one. Indeed, an attitude is often an expression of how we would like to see ourselves behaving, rather than the behaviors that we actually engage in. For example, evidence has shown that workers with the most favorable attitudes towards personal protective equipment, are those least likely to actually use it in practice. Similarly, senior management in many companies express the view that the safety of its employee's is of the utmost importance. However, very often these same managers design the overall workflow system, and/or the reward system in such a fashion that unsafe practices are inevitably encouraged. /6/

Noted Author and leading Industrial Safety Management Advisor, Dr. Dominic Cooper (C.Psychol AFBPsS MASSE MIRRIM FIOSH FRSH) published in 1999 his Paper entitled "Industrial Safety Management" which discussed implementing the behavior based approach to safety with the following components : (1) ***Planning*** - As with most types of interventions, some planning is required. This usually entails deciding on the scope of the intervention, in terms of which departments etc will be involved, and the necessary resources, as well as identifying the person, usually a senior manager or safety advisor, who will coordinate the overall effort. (2) ***Measuring current perceptions of the safety culture***-*i*deally, at the very beginning of this type of approach it is useful to measure employees current thinking, in terms of safety, along various dimensions. (3) ***Management Briefings*** **-** During the planning stages, briefings must be held with line management as early as possible, to outline and explain the philosophy of utilizing goal-setting and feedback to improve safety performance. (4) ***Training*** **-** Similarly, the planning stage will entail setting aside a days training for the observers, once the safety performance measures have been devised. If the plant or facility is large, it may be necessary to set aside sets of training days for groups of observers. (5) ***Establishing departmental baselines*** **-** Following the two week practice period, a copy of each department checklist should be enlarged to A3 size and publicly displayed on health and safety notice boards in the appropriate department. (6) ***Establishing departmental goals*** **-** All personnel, including senior management, should attend their respective departments 'goal-setting' meetings. The meetings are usually conducted by the observers, but this may fall to the coordinator, or line management. In practice, it may be necessary to conduct these sessions with a series of smaller groups. (7) ***Continuous improvement*** **-** Because this approach adopts the philosophy of continuous improvement, it is usually a good idea, to begin planning the following interventions, about 8 weeks after the goal-setting sessions.

Even after implementation of this highly sophisticated industrial safety approach, in total, **1404** end-users of behavioral safety have voluntarily completed the online survey. The following report provides a graphical breakdown of the responses received by the end of Dec 2007, **more than 50% said no impact on safety had been observed!**



His conclusion was although it is recognized that a combination of control measures may need to be employed, where possible:

1. *Avoid:* Eliminate the hazard altogether to avoid the risk
2. *Substitute:* Change the activity or process to one that is less harmful
3. *Isolate:* **Separate people** from the hazard or physically guard against it.
4. *Reduce:* Design a safe system of work that reduces the risk to an acceptable level
5. *Protect*: Provide the appropriate PPE, install machine guards, etc.

In sum, he recommends moving human behavior from the safety process. The question is how can we most readily do this?

What is a Passive Device?

A passive device is defined as a device that will operate without the need for human intervention.

It is the contention of this paper that proven passive device technology would have prevented each of the three incidents , immediately and mechanically without the need to change or alter human behavior, perceptions or actions. The passive device technology that exists not only works without the need for human intervention but will fail in the closed position should there be any attempt to disable or alter the device. These devices relieve management of the obligation to adhere to and to find a solution to the EFV problem which they have been cautioned about and is common in all of these and many more cases.

There are two common denominators in the first three incidents previously described:

1. Human Behavior in each incident it was impossible to management to predict or to negate the decisions by their employees. The actions of the employees were in violation of company policy, protocols, common sense and in some cases the law.
2. In each case an EFV was part of the mechanical safety equipment and in each case the EFV predictably failed.

The Fourth Horseman "**Status Quo**" enjoys a unique position, he is the only character of the four that can effect change and influence all of the others. The Fourth Horseman, those in a position to affect change, can make change which is immediate in direct contradiction of the finding in the chart above which shows management perceiving slow or indeed no increase in safety despite well intended programs.

To be effective this device must have the following characteristics:

1. Cost Effective
2. Immediately Deployable
3. Does not change existing procedures
4. Ease of use
5. Cannot be disabled

The **Fourth Horseman** once he makes the deployment decision would have changed /prevented the above three incidents in the following ways.

Scenario #1 – the chlorine hoses while they would have burst would have sealed themselves thus preventing the introduction of chlorine to which the employees eventually succumbed. The use of a hose with a passive device therefore eliminates the first horsemen, familiarity.

Scenario #2 – if a material mistake similar to this incident occurred the hose again would have sealed itself uncovering this material mistake and the introduction of hydrochloric acid in to the system. This discovery likely would have prompted a review of the potential damage that this acid would have cause to the other systems uncovering the damage to the ESD. In all events it would have prevented the reliance upon and eventual ineffectiveness of the EFV's thereby eliminating the second horsemen, the path of least resistance.

Scenario #3 – if the driver had no choice in terms of what type of hose he used this accident would not have happened. This means that management must decide that there are no hoses without passive devices on the premises at all that could even be introduced into a process thereby eliminating, the third horsemen, laziness.

Conclusion

It has been suggested by certain academics that implementing Industrial Safety Management would be a way to overcome these human behavioral problems. This paper submits that while there is no doubt that training and instituting a safety culture is beneficial, given the numerous, detailed and accurate warnings from manufacturers, advocacy groups, government agencies and from accidents themselves, it is not reasonable for anyone be they industry or agency to be surprised when the next hose bursts and an EFV fails to stop the catastrophic consequences. These warnings are advice to beware to professionals charged with the safety of facilities, communities and individuals and are intended to be actionable.

The fourth horsemen, those that wield the influence, that install the systems, that make the upgrades are the only ones that can effect the other three. Their recent shortcoming reliance upon excess flow valves which influences all of the other three is now discernibly, clearly and economically addressed.

The EPA in its "most recent" warning on the subject included the following recommendation:

"Commercially available hoses with a self closing device at each end that will shut off flow entering the hose from either direction if the hose is pulled apart or sheared may be considered as an additional measure of protection. Such devices will protect against hose failure, but not against leaks that occur upstream or down-stream of the hose."

Therefore given the evidence and examples presented the questions remains and time will tell, "will the Fourth Horseman act before they all ride again?"

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\1\ Docket HM-166W, NPRM at 53 FR at 36418, September 19, 1988; Final Rule adopting the amendment as proposed, 54 FR 38790, September 20, 1989.

\2\ 49 CFR 179.100-13(d).

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\3\ National Transportation Safety Board, *Safety Recommendation,* Norman Minetta, July 16, 2002.

\4\ The Chlorine Institute, Pamphlet 57, Emergency Shut-Off Systems for Bulk transfer of Chlorine, Edition 3, October 1997 section 3.1.

\5\ The Chemical Safety Board, Investigation Report Chlorine Release, DPC Enterprises, May 2003, incident Festus, Missouri August 14, 2002

2 National Transportation Safety Board, *Vinyl Chloride Monomer Release From a Railroad Tank Car and Fire, Formosa Plastics Corporation Plant, Baton Rouge, Louisiana, July 30, 1983*, Hazardous Material Accident Report NTSB/HZM-85/08 (Washington, D.C.: NTSB, 1985).

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