

**THE PSYCHOLOGY OF SAFETY IN THE FIREWORKS  
INDUSTRY**

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## **THE PSYCHOLOGY OF SAFETY IN THE FIREWORKS INDUSTRY**

Creating a safer environment by nurturing the conscience and culture of safety in the fireworks industry.

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### **ABSTRACT**

All of the workshops, seminars, plans, regulations and signs posted on the wall for safety regulations will be insignificant if there is not a culture of safety instilled in fireworks factories and fireworks communities. This can especially be an issue in countries where a majority of workers have only had access to basic levels of education and training.

How then can the fundamentals of safety be instilled into the conscience of the fireworks workers and the uniqueness of the fireworks community?

A company's organizational culture, or corporate culture, is created in large by its employee's attitudes and beliefs. This holds true for any company, including fireworks factories. The correct and continuous attitude towards safety is critical to prevent incidents. Labour laws and safety professionals commonly use the word "safety incidents" instead of "accidents".

The development of habits to identify safety and risky behaviors on site could result in the long term in a greater culture of workplace safety. Workplace strategies to measure attitudes towards safety can help minimize risk but also can promote awareness of problems and changes needed.

This paper discusses some of the most relevant studies on the safety culture in Hazardous Industries, and how they may relate and adapt to the unique needs of the fireworks industry.

## INTRODUCTION

What is safety culture? If we look at diverse definitions we will find that there is a consensus in the essential behavioral, ethical, conscience and awareness values. Definitions from various sources are given below.

### ***Cambridge English Dictionary***

“The way that a company or organization thinks about, plans for, and manages the safety of its employees and customers, especially when their safety is considered to be one of the most important things”.

### ***Flight Safety Foundation***<sup>1</sup>

“Safety Culture is the way safety is perceived, valued and prioritized in an organization. It reflects the real commitment to safety at all levels in the organization. It has also been described as "how an organization behaves when no one is watching”.

### ***Wikipedia***<sup>2</sup>

“Safety culture is the collection of the beliefs, perceptions and values that employees share in relation to risks within an organization, such as a workplace or community”.

### **INSAG’s (1986) ‘Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident’**

"That assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance.”

### ***U.K. Health and Safety Commission***

"The product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization’s health and safety management”. "Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures.”

### ***OSHA***<sup>3</sup>

“Safety cultures consist of shared beliefs, practices, and attitudes that exist at an establishment. Culture is the atmosphere created by those beliefs, attitudes, etc., which shape our behavior.”

### ***SENTIS***<sup>4</sup>

Safety culture is an organization’s shared attitudes, beliefs and values about safety—essentially, 'the way things are done around here'. There are four key components in any safety culture: environment, practices, person and leadership.

### ***DuPont***<sup>5</sup>

A good example in the explosives industry is DuPont, which has more than 200 years of successful experience in risk management in high-risk environments. Safety culture has become a core component of the DuPont Safety Management System genetics. This is evident from DuPont’s own history of development:

In 1802, DuPont founded a gunpowder manufacturing plant and put it into operation.

In 1811, the first safety rules were enacted.

In 1912, a safety incident audit was initiated.

In the 1940s, the concept of “all accidents can be prevented” was established.

In the 1950s, an extra-work safety program was launched.

In the 1990s, the goal of “zero accidents, zero injuries” was established.

We can see that Safety Culture is essentially referred for a collective; “an organization”, “a company”, “collection of”, “assembly of characteristics”, “product of individual and group”, and “shared attitudes”.

The elements that are the attributes of the culture are; “think”, “plan”, “manage”, “perceptions”, “beliefs”, “values”, “risks”, “attitudes”, competencies’, and “patterns”.

## APPROACH

### Safety Culture and Regulations

Are regulations the solution to maintaining a healthy safety culture?

Regulations are part of it but not the only way to a solution. When properly and regularly enforced they can contribute to create a safer physical environment. Physical conditions such as safety distances between buildings, design, materials, and construction specifications of structures, are more easily enforced and can contribute greatly to reduce the magnitude of incident fatalities. However, financial inability to comply with some structural regulations by some companies makes it more economical to just pay the fines. Regulations can also establish labor procedures to be observed but ultimately the implementation depends on the workers themselves.

Historical data shows that from 1932 to 1969, 32 years, without a regulatory agency in the USA the fatalities in the workplace dropped by 52%. In 1969 OSHA Act regulations were put in place and it took OSHA 40 years to get a similar drop in fatalities. From 1992 to 2011 the fatalities only dropped 1.4/100 in the workforce (Figure 1). Statistically the regulations did not make a significant difference.



**Figure 1 - Number of fatal injuries 1992-2011**

In addition, twenty years after OSHA was put in place, 93% of accidents with fatalities were never brought to the criminal justice system, therefore there was no enforcement. So basically there were rules in place, but lack of enforcement of the rules.

The regulatory agencies can draw and put rules in place, and controls on the workplace environment, but in the end it is all about people. People who are unaware, careless, overconfident, or unprepared are what cause incidents (Figures 2 and 3).

**Figure 1- Unsafe behavior in real life?**

**Figure 2 -**

Overconfidence

“Regulations have done a lot by setting minimum standards of acceptable environmental conditions, identifying workers’ rights, etc. These should not be viewed as a goal, but a “backstop,” and one that is

helpful when companies do not see urgency to do anything different than they have been doing. So, environment and people are not really an “either/or” – they should both be targets for attention and intervention because both are important predictors of safety.”<sup>6</sup>

Three basic reasons why workers do not work safely arise from their knowledge, skill, and motivation. Knowledge and skill are evident but motivation is less clear to define.

In the fireworks industry there are many situations where workers may not have sufficient knowledge and skill. For this reason, safety training is critical. However many companies overemphasize rules and training and forget about mindset: motivation. Safety regulations and training are important foundations to build a strong safety culture but this must also include environment and motivational practices with leadership and persons.

If an organization wants to become a successful business, a safe business, it needs to take safety into its own hands. The regulatory agencies inspectors will not be there all the time. The organization has to change the paradigm on its own. To do that, they need to have data and be able to measure what happens in people’s brains, the mentality of their workers, what is the safety climate, the overall safety culture of the organization. Using that data they then take measures to improve the level of information, education, participation and control on safety.

How can we move from an environmental mindset to a people mindset?

### **Safety Culture versus Safety Mindset**

A "culture" is a set of knowledge, practices, customs, traditions, and values of a society or group. The sum of individuals sharing these makes the culture a norm of behavior with diverse manifestations.

A cohesive Safety Culture cannot be built without individuals sharing the same levels of safety mindset. Individual and personal attitudes towards safety must be shared by all and preferably at the same levels. The safety culture in an organization can be compromised in an accident, by just one individual not observing its safety practices. Therefore any improvements on safety and creation of a safety culture must start and focus on the individuals first. Your organization is only as safe as the least safe worker.

The personal safety attitude and beliefs of each worker are essential for an organization to grow leaders who can assess, motivate, educate, drive, and manage the safety of the whole group. The leader’s role in modeling and communicating the importance of safety is absolutely necessary in order to build a positive safety culture in a company.

The organization relies on the safety mindset of their employees. When employees have a loose attitude to risk taking and safety they are more susceptible to make mistakes that can cause incidents. Some people are more prone to take risks than others with harmful consequences for their coworkers.

We need to realize also that in many countries where fireworks are manufactured there may be in general a low mind set about safety concerns due to the culture in which they were raised. If a culture itself has a low safety attitude, workers naturally bring this upbringing and lifestyle outside of work into the company. These attitudes need to be addressed and re-configured inside the community of the company.

For an organization to have a stable or homogenous safety culture all the employees need to be brought to the same safety mindset standards, personal responsibility and accountability.

We have to look at people first!

### **Safety Climate and Safety Culture, Types of Assessments**

To act one needs to know first what and why safety can be compromised. It is necessary to obtain as much data as possible on the state of one's organization. Many companies do marketing analysis, financial reports, but not safety studies.

*“Safety culture is an organization's shared attitudes, beliefs and values about safety—essentially, ‘the way things are done around here’ with regards to safety. It influences safety performance and the likelihood of safety incidents occurring. It is deeply embedded into the fabric of an organization, often below conscious awareness, making it difficult to observe. It requires a qualitative approach to measurement and an expert, third-party analysis to eliminate potential bias.*

*Safety climate is more easily measurable and reflects employees' shared perceptions of the extent to which safety is valued within an organization. It's essentially a snapshot of an organization's safety culture at any one point in time. Safety climate is commonly measured via quantitative methods.”<sup>7</sup>*

An important first step is to use an assessment tool that measures the validity of the information obtained from the individual. Objective data will help to set the safety benchmark of the company to take the next steps to first remove unsafe behavior and then customize safety training.

There are many different safety culture assessment tests and companies specialized in realizing them. It is also important that the assessment is made by a third party foreign to your organization but with a wide knowledge on safety culture and ideally in the pyrotechnics or explosives industry.

The assessment will analyze and lay out the current conditions of the organization and most importantly will provide strategies to obtain a positive outcome, which is the main reason an assessment is often necessary. The results will show in a multifaceted way the different areas where safety can be improved, not just in the specific pyrotechnic and explosive hazards, but in also in the work environment and employees mindsets and health issues.

The University of Missouri researchers Dr. Christ Martin and Dr. Geoffrey Cowan, listed the following 12 key metrics to assess the level of safety culture in an organization.

1. Interactional Clarity
2. Total of All Environmental Negativity
3. Negative Physical discomfort
4. Negative mental Activity
5. Discouragement Leading to or including depression
6. Carelessness in all aspects of life
7. Carelessness Causing Physical discomfort
8. Fearlessness in all aspects of life
9. Fearlessness producing physical pain
10. Hopelessness in all aspects of life
11. Hopelessness Extending physical pain
12. Hopelessness Prolonging Trouble or stress

### **The Sources of Safety Risks**

Based on this study we can establish two main categories of factors that compromise safety, External and Internal.

#### ***External Sources***

- External environment - Overall negativity in the environment

Sometimes people feel trapped in their jobs and cannot change the situation. For example they know that handling chemicals and breathing them is bad for their health but they go back everyday.

- Physical discomfort, aches, and pains

One of the major causes of incidents is due to workers who have physical discomfort that diminishes their attention to tasks that have inherent risks.

- Anxiety discouragement and depression

It is proven that when a person is under anxiety or experiences depression, the adrenaline increases, and the cognitive ability decreases, not being able to reason and think clearly.

### ***Internal sources***

- Carelessness

For example - not using goggles, masks, gloves or other personal safety equipment, allowing a large amount of finished shells in the work area, and dropping hard cases containing shells or compositions

- Fearlessness - Overconfidence and Underestimation

“I always did it like this”, “My boss does it this way too”, “It has been done always like this and nothing ever happened”.

- Overestimation of our capacities

Trying to do a job too fast and cutting corners in a process, like sieving and mixing powders all at once and not in steps

- Hopeless nature

“Cannot get out of this job”, “There is nothing else for me to do”, “It has been always like this, it cannot change” - This has a massive impact on safety.

## **METHOD**

### **Towards a Good Safety Culture**

We have seen the negative culture impacts on safety. But what does a positive safety culture look like in an organization?

#### 1. Leadership Commitment

There is a clear definition from the leaders and directors of the organization to cultivate safety and empower the employees in participating to achieve the vision of the safety level that has to be achieved.

#### 2. Employing Safe People

The company hires people who have proven in tests that they have a good safety conscience or mindset in all aspects of life. The candidates pass an exam before being hired on the safety rules of the organization.

#### 3. Safety Meetings

Safety is the first point in the agenda on any meeting and there must be regular safety meetings exclusively dedicated to improve and educate on safety.

#### 4. Constant Supervision Authority

There are safety leaders among the management and workers who are supervising and taking executive decisions with full authority on any safety issue in the production. Any worker has the authority to stop an activity that presents a clear risk of accident.

Example - “You have too many shells in your room, take them away to storage and work with less quantities” action will follow.

#### 5. Employees Participation

Workers help and survey each other to maintain safety in an open and amiable way. Any advice on safety is always welcome. The workers feel comfortable reporting safety problems and managers receive them enthusiastically.

#### 6. Prevention by Foreseeing Risks

The organization leaders are always looking for potential hazards. They do not wait until an incident occurs to take preventive measures.

#### 7. Employees Knowledge

The employees have a good knowledge and are educated in the risks inherent to their labor and the nature of the environment. They sign a contract commitment to follow safety rules.

#### 8. Managers Hands On

The managers are in the working areas very often, observing and able to identify any safety problem and encourage the workers to comply with the safety rules in place.

#### 9. Financial Investment on Safety.

The company invests in safety equipment, renews, maintains structures and environment in safe conditions, according to and beyond regulations. Safety is considered an investment and a necessary expense. New masks, goggles, clothing and other protective equipment are always available. Working areas are thoroughly cleaned. Older mixtures are discarded when an incident occurs and all compositions and formulas that might be involved are reviewed.

#### 10. Safety before Profit

Safety conditions must always be put first before production. Manufacturing a large order in a rush because it is good business or for customer satisfaction might compromise safety. Working with larger quantities of explosive material and cutting time becomes a greater risk.

#### 11. Open Communication on Safety Reporting

There exists a continuous communication on safety topics and how to improve and take preventive measures. Reporting problems is celebrated and encouraged in the organization.

#### 12. Safety Rewards Reporting

The company rewards workers that report real potential risks for incidents. Reporting is valued and underreporting is discouraged. Consider the following statistics<sup>8</sup>.

33% of incidents go unreported for those who have been in their company for less than 1 year

41% of incidents go unreported for those who have been in their industry for less than 1 year

44% of incidents go unreported for those aged < 20 years old

#### 13. Safety Assessments

The company hires external auditors that come to the factory to independently review procedures.

#### 14. Health Condition Respect

The company cares about health issues of the workers, physical and psychological. Workers with pains, depression or family problems are cared for and removed from high risk labor.

#### 15. Safety Due Diligence

When a safety problem arises it is dealt with speed and effectively, whatever is the cost.

## DISCUSSION

### **How to develop a safety culture for the pyrotechnic industry?**



The pyrotechnic industry presents different types of risks based on the different areas of activity, manufacturing, storage, transportation, display (use), retail. Incidents have happened in all these activities to different degrees and circumstances.

It may seem obvious that manufacturing is the area with the highest levels of casualties but that differs from country to country. As examples, in China there have been incidents that have hundreds of casualties in factories, in Mexico on the contrary the highest concentration of numbers in a single event have been in retail areas.

The safety mindsets of the people involved in these different areas of pyrotechnics must be approached in completely different ways. Each area of activity is in a different environment involving people of different skill sets and pyrotechnic knowledge and training. For this reason a different set of safety mind sets must be developed for each area.

### ***Transportation Example***

The driver of a truck full of pyrotechnics may have minimum knowledge of what type of pyrotechnic product exactly he is carrying, other than it is explosive material. He may not understand the potential individual hazards of certain products, during transport, safe and secure loading and unloading etc.

### ***Retail Example***

The vendor in a small stand may not have the knowledge or safety conscience that is required in case of an accident or even to prevent incidents in certain situations, such as not having large quantities of product exposed, distance among products, exit strategy, etc.

Consider the different Pyrotechnic activities, what safety conditions are theoretically in place in each situation, and how the risks differ in each area.

### ***Manufacturing Pyrotechnics***

#### *Rules exist*

Workers have specialized skills

Management supervision exists

Environment is regulated by government and laws

Specialized storage according to quantities of explosives, proximity and propagation (Figure 3)

#### *Potential Risks*

Improper manufacturing set up: “Too large Quantities and too little Distance” (Figure 4)

Too high concentration of explosives

Contamination of compositions

Static electricity

Workers not sufficiently trained in safety techniques



**Figure 3 -** Quantities and proximity. No protective equipment



**Figure 4 -** Complete exposure to substances

### ***Transportation of Pyrotechnics***

#### ***Packaging standards***

Load is limited by weight and content is listed (Figure 5)

Drivers have special licenses for explosives transportation, which requires passing an exam

Regular drug tests are in place

Awareness of travel itinerary and parking limitations, due to high concentration of explosives in a single load



**Figure 5 - How much more can this van fit inside?**

*Potential Risks*

Driver is not sufficiently trained in potential risks of transportation of pyrotechnics  
Improper loading , unloading techniques  
Load has not been properly secured  
Boxes are not properly handled (boxes are dropped or treated roughly, risk of impact or friction).  
Not wearing proper safety equipment  
Reckless driving, not observing safe itinerary and safe parking areas

***Pyrotechnic Show Display***

*Safety Mindset*

Workers have different levels of skills, with minimum training, including amateurs  
Explosives are spread out over large areas  
Supports are secured.  
Safety distances to audience are observed

*Potential Risks*

Untrained workers or amateurs not sufficiently trained due to infrequent work in pyrotechnics (seasonal)  
Operator may not be familiar with the details of the product characteristics and how it should be safely placed (example - placing a shell with lift up, tying a Roman candle too tightly with wire)  
Risks to public for improperly secured supports (Figure 6)  
Unsafe distances in place  
Not wearing proper safety gear (Figure 7)  
General risk to public



**Figure 6 -** A bundle of 8” guns unsecured



**Figure 7 -** None of 3 men has fall-out prevention

***Pyrotechnic Retail***

***Safety Mindset:***

- Personnel is aware of explosive risks
- Stands are set up with a minimum safety distance and concentration of product
- Product is displayed within the safety distance and safe and limited concentration of products
- Products are approved for consumer use
- Products are safely stored
- Exit and shelter strategy in place

***Potential Risks***

- Non skilled personnel may be involved
- Personnel may have little or no safety or training conscience of explosives
- There may be a higher concentration of explosives than standard (Figure 8)
- Close proximity to a large general public, who are not trained in pyrotechnic safety
- Possibility of inefficient countermeasures in case of accident (fire extinguisher, exits and shelter strategy not in place)
- General risk to public



**Figure 8.-** Tultepec market, before, after explosion and the new one. Did the safety mindset change?

As we can see from the above, each category requires a different safety mind set to be instilled in the work environment.

***Manufacturing***

Controlled environment, usually workers stay long term at their jobs

Workplace mind set can be instilled in place over time

#### *Transportation*

Usually individuals, not a group environment

More difficult to instill an individual and cultural Safety Mindset

#### *Show Display*

Workers may come from various places and not work together often, may only work seasonally, may include amateurs

It may be necessary to rely on a wider organization (country or regional pyrotechnics association) to instill these Safety Mindsets

#### *Retail Sales*

Usually many individual companies in one place, little or no cross company communication

Workers may be seasonal

May be difficult to instill a Safety Mindset

Obviously in large companies, which do manufacturing, display and retail, it is easier to create a Safety work environment that crosses over to all the areas. The biggest challenge may be how to instill the Safety Environment and Safety Mindset into areas such as Display and Retail that often involve seasonal workers, worker movement between various companies, and involve amateurs or less skilled and trained workers.

## CONCLUSIONS

### **Steps to consider in Creating a Safety Environment Culture by nurturing Individual Safety Mind Sets within your Pyrotechnics business**

By using professional outside assessment, open communication and education should be possible for a pyrotechnics organization to instill fundamentals of safety into the conscience of the fireworks workers and the different areas in which they work. By working towards changing the employees' attitudes and beliefs about safe environments, the company safety culture is created.

Beyond all the safety regulations compliance, simple sets of behaviors can be implemented to make the pyrotechnics activities safer by educating the workers in attitudes towards safety. Incidents happen when humans are present and are usually caused by human activity, therefore the human brain should be the focus of any risk activity.

A culture is built from individuals. Pyrotechnic companies must guide and encourage each individual on how to develop a personal safety attitude in order to build a group safety culture. This can be achieved through the following steps.

- Choose an independent assessment test or contact a specialized company
- Schedule one on one interviews with employees to know more about their safety mindsets
- Survey each employee individually and ask them to report possible risks that they encounter, human or environmental, and how they think can be prevent it. Promote and reward risk reporting and safety ideas.
- Establish a safety committee to develop a conversation and conscience about safety issues. From these committees leaders will emerge and the whole labor force will start to get impregnated with the importance of safety awareness and conscience.
- Set up standard procedures and make an assessment on the safety issues in the company, individual and environmental
- Build a personal responsibilities and accountability structure with leaders on board

- Make the company commit to investments in personal protective equipment and construction of protective measures, increase distance, quantities of storage, blast walls, etc.
- Post clear signs in all working areas with safety messages. “Wear your protective glasses”, “Use of Mask Mandatory”, “Discharge static electricity”, “Access only with approved clothing”, etc.
- Have a book of every process involved in different manufacturing operations with the safety rules enumerated first
- Have clear and specific emergency behavior procedures and practice drills in case of an accident. Do not be afraid to face this possibility and be prepared in case it happens.
- Start everyday labor with a safety recommendation with all workers present and make sure all have their correspondent protective equipment
- Be SAFE. “SIEMPRE SEGURO”

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