Study on Safety Management of Explosive Storage Room Based on Fault Tree

JUE TANG, GUOXUN JI and XINLI SUN

ABSTRACT

In this paper, the safety deposit was carried out by using the accident tree method. Based on the conclusion of the evaluation and the characteristics of the explosive, a set of measures for the safe management of the explosive storage chamber was developed, which could be used for the safety management of the explosive storage chamber. The storage and management of explosives.

INTRODUCTION

With the continuous development of national defense construction and national economy, the use of explosives gradually expanded, not only used in industry, agriculture, transportation, communications, defense and other industries, but also in human daily life is also widely used [1]. Large-scale use of explosives poses a serious challenge to the storage and management of explosives. Explosive in the storage process, there is the risk of explosive, poisoning, and the accident occurred, resulting in a great loss of personnel and property. In 2014, Liuyang City, Hunan Province, the export of fireworks factory fireworks explosion occurred, resulting in five people were killed in the explosion, , One injured [2]. Analysis of the reasons, the majority of security measures are not perfect, or workers in violation of rules and regulations, therefore, for the characteristics of explosives and storage characteristics of the site, the establishment of scientific and preventive measures and systems to enhance the safe storage of explosives is of great significance. The

There are relatively few articles on the safety of explosives, but there are fewer documents to consider the safety of explosives storage sites. In this paper, the explosive storage room for the study, to carry out safety assessment and analysis.

ANALYSIS OF ACCIDENT OF EXPLOSIVE STORAGE ROOM

Explosives bring great convenience to people's lives, but at the same time the poor management of explosives can bring great catastrophe to mankind. Combined with the characteristics of our school storage room, through on-site research and analysis, summed up the relevant literature results [3-5] the storage room explosives explosion of the main predisposing factors summarized as three factors. The first category is open flame, there are three conditions that require a fire, that is, a little fire source, flammable material and fire extinguishing device failure. The second category is

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lightning, lightning strikes may lead to explosive explosions, the current best for lightning strikes, lightning strikes, the use of high-power appliances, electrical overload operation, etc. are likely to produce ignition source; Protection is lightning rod. No installation of lightning rod, installation of the lightning rod failure, or installation of the lightning rod failure may lead to storage of indoor explosives explosion; the third category is static, static electricity is the most common hidden dangers, wearing fiber clothes in the air-dry environment, It is very easy to produce static electricity, if not released in time, the explosive is a major security risk. At the same time, the staff are generally by touching the grounding rod to release static electricity, the success of the release of static electricity cannot be judged, so once the release of static electricity failure, carrying static electricity personnel will become a huge storage safety hazard, at any time may cause explosives accident.

SET UP THE FAULT TREE

The fault tree analysis (FTA) is a very important analysis and evaluation method in the safety system engineering based on the absolute logical relationship between the failures events. It can take into account the overall process of the accident [6-7] The Based on the analysis method of the accident tree analysis method, the influencing factors of the explosion occurred at the time of storage were analyzed in order to take the explosion event as the top event T of the accident tree and find the basic event of the explosion accident X. According to the logical relationship between events, construct the accident tree as shown below:
Figure 1. The fault trees.

TABLE 1. THE SYMBOL OF THE MEANING.

<table>
<thead>
<tr>
<th>symbol</th>
<th>meaning</th>
<th>symbol</th>
<th>meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1</td>
<td>Fire extinguisher break down</td>
<td>X2</td>
<td>Fire extinguisher expiration</td>
</tr>
<tr>
<td>X3</td>
<td>Flammable exist</td>
<td>X4</td>
<td>Person take the fire</td>
</tr>
<tr>
<td>X5</td>
<td>Heat is not release enough</td>
<td>X6</td>
<td>Use the high-power electric</td>
</tr>
<tr>
<td>X7</td>
<td>Use the power long time</td>
<td>X8</td>
<td>Thunderstorm frequent</td>
</tr>
<tr>
<td>X9</td>
<td>The lighting rod break down</td>
<td>X10</td>
<td>Install in wrong place</td>
</tr>
<tr>
<td>X11</td>
<td>Lightning rod with high resistance</td>
<td>X12</td>
<td>Ground wire break down</td>
</tr>
<tr>
<td>X13</td>
<td>Ground wire with high resistance</td>
<td>X14</td>
<td>Not release static electricity</td>
</tr>
<tr>
<td>X15</td>
<td>The air in room is dry</td>
<td>X16</td>
<td>The clothes is not suitable</td>
</tr>
</tbody>
</table>

QUALITATIVE ANALYSIS

Solving the Minimum Cut Sets

The combination of the minimum number of basic events that can cause the top event to occur is the minimum cut set. The smaller the number of cut sets, the higher the risk of storage room. Each minimum cut set is a failure mode of the system, that is,
a dangerous source (weak link). We usually use the Boolean algebra method to find the minimum cut set. By finding the minimum cut set, we can qualitatively obtain the influence of the basic event on the top event, and provide the reference for the safety management. It is known from the accident tree that there are 16 basic events that cause the accident, and the Boolean set method is used to solve the minimum cut set as follows:

\[
T = P_1 + P_2 + P_3 = P_4 X_3 P_5 + X_8 P_7 + P_8 P_9
\]

\[
= (X_1 + X_2) X_3 (X_4 + P_6) + X_8 (X_9 + X_{10} + X_{11}) + (X_{12} + X_{13}) X_{14} X_{15} X_{16}
\]

\[
= (X_1 + X_2) X_3 (X_4 + X_5 X_6 X_7) + X_8 (X_9 + X_{10} + X_{11}) + (X_{12} + X_{13}) 0 X_{14} X_{15} X_{16}
\]

\[
= X_1 X_3 X_4 + X_1 X_3 X_5 X_6 X_7 + X_2 X_3 X_4 + X_2 X_3 X_5 X_6 X_7 + X_3 X_9 + X_8 X_{10} + X_8 X_{11} + X_{12} + X_{13} + X_{14} X_{15} X_{16}
\]

After analyzing the Minimum Cut Sets:

**Analysis of Structural Importance of Basic Events**

The impact of the basic events on the top of the event is different, in taking measures, should be prioritized. The structural importance of the explosive tree can reflect the degree of influence of the basic events on the top of the explosion of explosives, and the greater the structural importance of a basic event, the corresponding explosion of the explosive The greater the degree of impact.

Structural importance analysis can be used in two ways: one is to accurately determine the structural importance coefficient; the other is the minimum cut set or minimum diameter set out the importance of structural order, is an approximation method. In this paper, due to the basic events, accurate calculation is very complex, using the minimum cut set approximate calculation method.

(1). The analysis principle is as follows:

The minimum coefficient of basic event structure is the largest in the single event minimum cut

(2). The important coefficients of all the basic event structures that appear only in the same minimum set are equal

(3). When the number of basic events in multiple minimum sets is equal, the number of basic events appearing in each minimum cut set, the greater the structural importance is;

(4). When two basic events occur in multiple minimum sets of basic events, the structural importance is determined according to the following

If they appear equal to the number of occurrences in the minimum cut set, the structural importance of the basic event that occurs in the minimum cut set containing the basic event is large.

If they occur less frequently in the minimum cut set with less basic events, the number of occurrences or more complex cases in the minimum cut set containing the basic event is given by the following formula:

\[
I(i) = \sum X_i \in k_j 2^{1-n}
\]

According to the above principles, the gradual analysis of the basic events of the importance of the size of the order were:
From the importance of the structure can be seen in all the factors, the thunderstorm weather plays a pivotal role, is the largest storage potential of explosives hidden dangers. In addition, other factors, the impact of electrical spontaneous combustion in the explosion of explosive storage room in the low degree of impact, for this purpose, the main factors for the reduction of some of the risk of reducing the storage chamber recommendations.

THE PROPOSED MEASURES TO REDUCE THE RISK OF EXPLOSIVE STORAGE ROOM

Through the analysis of the accident tree, the thunderstorm weather is a huge security risk of explosives storage, thunderstorm weather we cannot avoid, but we can expect the timely prevention, through the establishment of a sound lightning protection system can effectively prevent accidents. The lightning protection system includes external and internal parts. The external lightning protection system includes the lightning arrester (lightning rod, interception band), the lead wire and the grounding device. The function is to intercept the lightning current through the lightning arrester, The internal lightning protection system includes electromagnetic shielding, equipotential bonding, common grounding system and surge absorption protection four subsystems, through which they can be introduced into the building surge voltage and surge current diarrhea To the earth and clamp it to a certain voltage range. Through the establishment of external and internal two lightning protection devices, can be a good way to reduce the impact of lightning on the explosive storage room.

Even if there are advanced experimental equipment, must also have serious and responsible personnel to implement and supervise. All the work must have a closed loop, the establishment of a sound supervision mechanism. Is to improve the quality of storage room management and reduce the most effective measures. The relevant responsible departments should be irregular from the storage room to carry out surprise checks to see whether the relevant staff due diligence, if there is a negative slow down, irresponsible, in accordance with the provisions of their responsibilities. And in the operation but also to carry out strict safety inspection, and gradually regulate the storage room safety management system. So as to from the subjective and objective to prevent explosives explosion.

CONCLUDE

There are three types of hazards that cause explosions in the explosive storage room. There are 16 basic events. Through the establishment of explosives explosion accident tree, solve the minimum cut set analysis of the importance of each basic event. The
actual situation of the two basic events is relatively large, and a set of preliminary schemes for lightning prevention is given for the main basic events, and the static electricity is optimized. Release device, the explosive storage room to prevent the explosion has a certain reference role.

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