Crisis management with applicability on fire fighting plants

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Abstract. The paper presents a case study for a crisis management analysis which address to fire fighting plants. The procedures include the steps of FTA (Failure tree analysis). The purpose of the present paper is to describe this crisis management plan with tools of FTA. The crisis management procedures have applicability on anticipated and emergency situations and help to describe and planning a worst-case scenario plan. For this issue must calculate the probabilities in different situations for fire fighting plants. In the conclusions of paper is analysed the block diagram with components of fire fighting plant and are presented the solutions for each possible risk situations.

1. Introduction
For designing a fire extinguishing installations, it is good to know the compatibility of the extinguishing substances used and the fuel medium, the efficient extinction substances used and the safety and protection of users space. The specific main properties of the substances used in extinguishing installations, mainly to ensure: efficient extinction, impairment in a smaller measure of objects and materials from the space on fire; safe entry of people in to the space on fire; no deterioration of quality of extinguishing substance during storage; insignificant consequences on environment, health and life of the users, by products resulting from extinguishing action; dielectric characteristics. In this paper it is analyzed a crisis situation for an fire fighting ship plant with foam at 4,800 dwt ship. The fire fighting ship plant may be with inner or external foam forming.

The piping water supply is even the main pipe of fire extinguishing water system. On the ship there are two extinguishing foam stations located one at stern and another at bow. The main pipe it is connected to both stations. For each protected compartment it is mounted water mixers and foaming substance.

2. Case study-Fault Tree Analysis for fire fighting ship plant

2.1. Technical data for fire fighting plant with inner formation of foam

Fault Tree Analysis (FTA) is an efficient and productive hazard identification method [2]. The FTA process is used to solve a wide variety of problems to prevent and resolve hazards and failures [3]. The FTA diagram for fire fighting ship plant is presented in Figure 1.
Figure 1. FTA diagram for fire fighting ship plant with inner formation of foam.

The data of the equipment is shown below in Table 1 [4],[5].

Table 1. Technical Data of equipments.

| Location                  | Intensity of mixture discharge [l/m².min] | Operational time [min] |
|---------------------------|------------------------------------------|------------------------|
| Cargo tanks and decks     | 7776.00                                  | 13.333                 |
| Fuel tanks                | 1845.281                                 | 20.00                  |
| Dry cargo holds           | 1024.00                                  | 45.00                  |
| Machines                  | 1.00                                     | 1.00                   |
| Compartments              |                                         |                        |

Infammable cargo 1845.281 20.00

Gutter: 0 cm

Header: 0 cm

Footer: 0 cm

2.1.1. Conditions for foaming mixture

a. The intensity of mixture discharge should not be less than the greater of the amount below [5,6]:

- 6 l/min/m² on the orizontal section of the area’s largest tank;
- 0.6 l/min on the each m² of the cargo area;
3 l/min/m² of the protected surfaces by cannon discharge with the highest flow rate, this area being located entirely in front of the gun, but the gun flow rate must not less than 1250 l/min.

b. The quantity of foaming mixture must be sufficient to produce foam for minimum 20 minutes at tankers equipped with an inert gas plant, or for 30 minutes at oil tankers which are not fitted with an inert gas plant, at most high intensity discharge of foaming mixture (according point a).

c. The quantity of foaming mixture must be sufficient to produce foam in volume equal to 5 times the volume of the largest room.

d. The intensity of the discharge of the mixture should be just enough to fill the volume of protected room for 15 minutes.

e. For the area of the largest horizontal section of the most room.

2.1.2. Conditions for fire fighting plant

a. Ship fire fighting plant with foam must respect the following conditions:

- To be permanently ready to operate, regardless of whether the ship is underway or stationary;
- To be safe in operational conditions and with high vitality;
- To have opportunities for local and distance actuation;
- To act upon the outbrack of fire, so as to preclude the possibility of re-ignition;
- Extinguishing substances must to retain the properties even after a prolonged non-use;
- Extinguishing substances must not cause corrosion of metals;
- Must not be hazardous for people.

b. In any emergency situation caused by a fire at a ship may not operate with parameters for the following reasons:

- The dispenser is blocked, does not constitute a determination of the proportion corresponding to obtain an emulsion quality and further appropriate foam;
- The water does not get into the bowl for realization emulsion foam/water;
- Mixing device of emulsion foam/water with air (ejector) is blocked so that the resulting foam does not have correctly foaming coefficient;
- On-board staff is not trained to use the facilities;
- Sparkling liquid and lost properties (low foaming coefficient).

2.2. Fault Tree Analysis data

Data requirements:

- A complete understanding of how the plants/system functions;
- Knowledge of the plant/system equipment failure modes and their effects on the plant/system.

Failure Modes Effects and Criticality Analysis (FMECA), often referred to as FMEA is process analysis that help to identify potential failures of system.

2.2.1. The common mode-failures within Fault Trees

- First must construct block diagram for flow of case study; after this, must develop the upper levels of the trees via a top down process. The logical relationships are graphically generated as described below using standardized FTA logic symbols (Fig. 2).
Using Boolean logic [3][7] for event symbols, gate symbols (to describe the relationship between input and output events), transfer symbols (used to connect the inputs and outputs of related fault trees), can evaluate time of good maintenance (\( \lambda \))(unit-years), the mean times to failure (MTTF\( \sim \tau \))(unit-hours/week/month) and failure rate (the probability density function PDF) (Fig. 3) [3].

Top event is: \( Q_{\text{TOP}} = 7.23 \times 10^{-6} \); \( \lambda_{\text{TOP}} = 1/20 \text{[year]} \).
2.2.2. Unavailability importances

The unavailability importances can be calculated with equation (1)

\[ I_{Q_{\text{cut set}}} = \frac{Q_k}{Q_{\text{TOP}}} \]  

(1)

and will obtained the following results: for set (2) - \( I_{Q_{\text{cut set}}} = 0.32 \); for set (1,3) - \( I_{Q_{\text{cut set}}} = 0.088 \); for set (1,4) - \( I_{Q_{\text{cut set}}} = 0.0012 \); for set (1,5) - \( I_{Q_{\text{cut set}}} = 0.58 \); for set (3) - \( I_{Q_{\text{cut set}}} = 0.088 \); for set (4) - \( I_{Q_{\text{cut set}}} = 0.0012 \); for set (5) - \( I_{Q_{\text{cut set}}} = 0.53 \).[3]

2.2.3. Unreliability importances

The unreliability importances of events can be calculated with equation (2)

\[ I_{R_{\text{cut set}}} = \frac{\lambda_K}{\lambda_{\text{TOP}}} \]  

(2)

and will obtained the following results: for set (2) - \( I_{R_{\text{cut set}}} = 0.8 \); for set (1,3) - \( I_{R_{\text{cut set}}} = 0.026 \); for set (1,4) - \( I_{R_{\text{cut set}}} = 0.004 \); for set (1,5) - \( I_{R_{\text{cut set}}} = 0.167 \); for set (3) - \( I_{R_{\text{cut set}}} = 0.026 \); for set (4) - \( I_{R_{\text{cut set}}} = 0.004 \); for set (5) - \( I_{R_{\text{cut set}}} = 0.167 \).[3]

The study can be upgraded with a detailed risk analysis [3].

3. Conclusions

With FTA were identified combinations of equipment failures and human errors that can result in an accident event. With FMECA were completely clearly header informations which conduct to corrective action during operational time. The minimum value for unavailability importances is 0.0012 for set (1,4). The minimum value for unreliability importances is 0.004 for set (1,4). FMECA is a best procedure for availability control and costs control.

4. References

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