

Using the event tree analysis in the investigation of a work accident

Radu Emil Mares^{1*}, Mariana Nagy², and Ioan Radu²

¹University of Petrosani, 332003 Str. Universitatii nr.20, Petrosani, Romania

²"Aurel Vlaicu" University of Arad, 310130 Bd. Revolutiei no.77, Arad, Romania

Abstract. Work accidents occur when the system doesn't work properly and the safety barriers are avoided. The analysis of such events can be made by different methods. This paper aims at demonstrating how a work accident can be investigated by the use of the Events' Tree decision method. Applying the steps of the algorithm, the method leads to determinate the causes of a work accident that occurs during the starting procedure of an equipment. By building the events' tree, a graphical representation of the operations and decisions lead to a logical framework that explains the work accident. The case study consists of the description, analysis, investigation and mitigation of a work accident that occurred at the Rehabilitation of a road in Arad County. Using the Events' Tree decision method, the cause of the accident was found to be the weak training of the operator and the carelessness of the job manager.

1 Introduction

To understand any risk it is necessary to understand its structure and its behavior [1-3]. Consequently, its complexity and all the fields necessary for its understanding must be approached. A wide range of actions are needed as life is a continuing risk and there can be no progress to increase our comfort without taking certain risks. This progress leads more and more to the treatment of the "expected" risks, resulting from human activities carried out in the work processes. However, there are "unexpected" risks (related to road traffic, domestic or leisure activities) that should not be neglected either. [2]

2 Theoretical aspects

Event Tree Analysis is a method that allows, starting from an initiating event, to chain events that may result in a potential accident [4, 5].

The method finds a particular applicability for the study of the security means architecture (prevention, protection, intervention), existing or applicable in a system. On the other hand, if it is used without an adequacy study in complex systems, the method

* Corresponding author: radumares50@gmail.com

becomes very difficult to be applied. The method is also frequently used in a posteriori analysis to explain the observed consequences resulting from a system failure.

The general approach applicable to the analysis by means of the events' tree involves the following steps:

- I Defining of the initiating event;
- II Identifying the safety functions - preventive;
- III Building the events' tree;
- IV Analysis and valorising of the tree [3].

3 Case study: work accident – rehabilitation of a road in Arad county

The case report file for the investigation of a worker named MFE must contain [6, 7]:

- A. identification of the work accident;
- B. accident investigation report;
- C. onsite findings report;
- D. technical inspection report of the heating device;
- E. the technical verification report of the heating device;
- F. sketch of the accident site;
- G. pictures from the scene of the accident;
- H. injured statement;
- I. witness statement;
- J. job manager statement.

For drawing up the events' tree, the belonging of the constitutive elements of the accident investigation file to the four elements of the events' tree are identified.

3.1 Defining of the initiating event

I) While attempting to switch on the heating device of the bitumen emulsion within the bitumen spraying machine by using a flame burner powered by a gas tank, due to the gas accumulation, an explosion occurred, which led to the injury of MFG causing the burning of his face. The event occurred around 10.15 hrs on 15.11.2013.

3.2 Identifying the safety functions

II) Accident investigation report:

- a - date of drawing the report: 25.11.2013;
- b - the name of the persons conducting the investigation and their quality: the undersigned BR, head of the Internal office of Health and Labour Safety, MR, Inspector in the same office, CI, engineer at Human Resource department, were the members of the investigation committee, nominated through the Decision no.12 of 15.11.2013;
- c - the time and place where the investigation was carried out: the investigation of the circumstances and the causes that led to the accident was carried out between 15.11.2013 and 25.11.2013 at the site of the event at Rehabilitation DJ Arad county;
- d - the object of the investigation: the investigation was performed in order to determine the circumstances and the causes of the accident, the legal regulations that were violated, the responses and the measures to be taken for preventing the occurrence of other similar cases and to determine the character of the accident;
- e - date - the date and time of the event: the event took place on 15.11 2013 around 10.15 hrs;

f - place of the event: the event took place at Rehabilitation DJ Arad county;

g - employer identification data: SC AC SRL;

h - victim identification data: named MFG, Romanian citizen, truck driver, 34 years old, 5 years work experience, 4 years seniority;

i - detailed description of the place, the equipment, the circumstances and the way in which the event took place: on 15.11.2013 at 10.20 am, OV, HR Manager called MR, the head of the company's Health and Labour Safety department, about the occurrence of a work accident that took place at the Rehabilitation DJ Arad county. The accident consisted of the injury of MFG driver by burning his face;

i.1 – detailed description of the event's location: from the statements in the file, the event took place at the Rehabilitation DJ Arad County. At the place where the incident occurred, there were asphalt bedding machines parked. In the parking place, about 2 m north of the DJ Arad county road, there were asphalt bedding machines, among which the truck with the plate XX on which the bitumen spraying platform was set up;

i.2 - description of the technical equipment involved in the accident: the truck with registration number XX on which the E20G bitumen spraying machine was set up. It is manufactured in 2007, uses heated fuel, and has a capacity of 10m³, driven by MFG. The heating of the tank in which the bituminous emulsions are prepared is accomplished by means of injectors controlled by a thermal motor;

i.3 - detailed description of the circumstances: on 15.07. 2013, SC AC SRL won the Arad County Roads Rehabilitation works. The technological process of road rehabilitation must follow the following steps: digging – road excavation at the level given by the designer, bedding a ballast stone layer of 25 cm, bedding a 20 cm crushed stone layer, bedding a base asphalt layer of 8 cm, bedding an asphalt bonding layer of 6 cm, bedding a 4 cm top asphalt bed, rehabilitation of bridges, as well as the setting of the road safety elements. The following specific work equipment is needed to carry out these works: roller compactors, trucks, asphalt distributors, asphalt mixer, as well as BITUMEN SPRAYING MACHINES. All this work equipment is used by workers having expertise related to their handling and driving.

On the morning of 15.11.2013 MFG went to the SC AC SRL headquarters with the asphalt team, led by RO and PC, to the workplace in S using a microbus. Once in the workplace, eng. PC assigned the work to his subordinates according to the previous day's schedule.

From the attached statements, on 15.11.2013 at 10 hrs, MFG victim was assigned by the job manager of the workplace to start working on the bitumen spraying machine heated by a E20G tank. The heating of the bituminous emulsion, which has the role of primer to create the base in the road asphalt layer, must be raised to a higher temperature than 70°C. The temperature is achieved by means of a thermal motor with which the tank is equipped.

On 15.11.2013 when the work started, the emulsion sprayer was out of order, causing the MFG driver to heat up the bitumen emulsion with the flame burner powered by a tank;

i.4 - detailed description of how the event occurred: from the on-site investigation and witness's statements, the accident in which MFG was involved had the following succession of events:

The event took place on 15.11.2013 around 10.15 hrs. From MFG's statement it follows that he was given the job from eng. PC to start the bituminous emulsion sprayer machine. Since the bituminous heating device was defective, Mr MFG had used the gas burner on his own initiative to heat the device. Due to the fact that the flame from the burner stopped and MFG noticed it late, the gas was spilled from the tank to the heating system of the emulsion sprayer. After the burner was turned on again and positioned at the Emulsion Sprayer, due to gas accumulation, an explosion took place, which led to MFG's injury causing burning of the face. The victim was urgently transported to the county hospital;

j - consequences of the event and / or consequences of injuries: from the medical certificate series CCX no. 123, it follows that the victim has suffered injuries corresponding to diagnosis code 952, that is, BODY AND HEAD BURNS;

k - the cause of the event: from the analysis of circumstances and the dynamics of the event, the commission considers as the main cause that the worker heated the work equipment without verifying it is fully functional and he used an artisanal device for heating the work equipment.

By the way he acted using the flame burner without waiting for the heating system to be repaired, the worker violated the provisions of Art. 22 of the Law 319 / 2006 of Health and Labour Safety: "Every worker must work in accordance with his / her training and instruction as well as observing the instructions received from the employer so as not to endanger to injury or occupational disease either himself or others who may be affected by their actions or omissions during the work process."

The specific provisions for mechanic equipment have also been violated: Art.13: It is forbidden to use the appliances / equipment for any purpose other than that intended. Art.14: It is mandatory to keep clean the workplace and the technical equipment. Art.16: At the beginning of the work, the worker must to check the existence of protective devices and protectors as well as the technical condition of the work equipment. Art.19: It is forbidden to work or to continue working with technical equipment when there are disturbance in their operation;

l - other causes that have contributed to the occurrence of the event: inappropriate supervision of the activities carried out at the workplace by the manager of the workplace and violating the provisions of Art. 13 (f) of the Law 319 / 2006 of Health and Labour Safety: to ensure and check the knowledge and its observance, by all the workers, of the measures provided in the established prevention and protection plan and of the legal provisions in the field of security and health at work, through designated workers, through their own expertise or through external services;

m - other findings during the investigation of the event: 1. The employer ensured the organization of prevention and protection in the unit by setting up an internal prevention and protection office under its direct coordination. 2. The employer is in possession of an injury risk assessment for the workplace where the event occurred and, on its basis, a prevention and protection plan was drawn up. 3. The victim of the accident was trained on the rules of safety and health at work, the last periodic training being performed on 15.10.2013. 4. Specific rules for work health and safety have been drawn up related to the activity carried out. 5. The job description defines the duties and responsibilities of the MFG worker in the field of occupational safety and health, related to the position occupied;

n. - the individuals responsible for violating the legal regulations in the chapters at letter k are:

1. MFG driver, for those set forth above in (k);
2. eng. PC job manager, for those set out at (l);

o - proposals for administrative and disciplinary sanctions: MFG driver with written warning according to Law 53 / 2003 updated, Art. 248 (1) a, and eng PC, workplace manager with written warning according to the same paragraph;

q - proposals for criminal investigation: Not applicable;

r - the character of the accident: according to the provisions of Art. 32 (1) of the Law 319 / 2006, updated, referring to Art. 135 (1) from the Government Decision nr. 1425 / 2006, the accident suffered by MFG is registered as an accident with temporary lost work capacity;

s - measures to prevent other similar events and the individuals responsible for their implementation:

1. presenting of the causes and circumstances of the incident to all the workers in the company. Deadline: 10 days after the receipt of the investigation report, Responsible: administrator;

2. the measures of the prevention and protection plan shall be reviewed taking into account the causes of the work accident and other situations that arose after its drawing, as required by Art. 46 par.1 of the Methodological Norms for the application of the provisions of the Law 319 / 2006 of Health and Labour Safety updated, approved by the Government Decision nr. 1425 / 2006 and amended by the Government Decision nr. 955 / 2010. Deadline: 10 days after receipt of the investigation report. Responsible: administrator;

3. the assessment of the risks of injury and professional illness shall be revised as required by Art. 15 (1) of the Methodological Norms for the application of the provisions of the Law 319 / 2006 of Health and Labour Safety updated, approved by the Government Decision nr. 1425 / 2006 and amended by the Government Decision nr. 955 / 2010. Deadline: 10 days after receipt of the investigation report. Responsible: administrator;

t - the deadline for reporting to the Territorial Labour Inspectorate regarding the implementation of the measures provided above in (s): the Territorial Labour Inspectorate will be informed in writing on the implementation of the measures within 15 days of the date of approval of the investigation file;

u - the number of copies in which the report is drawn and their distribution: this report has been drawn in four copies transmitted as follows:

- one copy to SC AC SRL;
- one copy to County Territorial Labour Inspectorate;
- one copy to the County House of pensions;
- one copy to the victim MFG;

w - employer's approval: administrator.

3.3 Building the events' tree

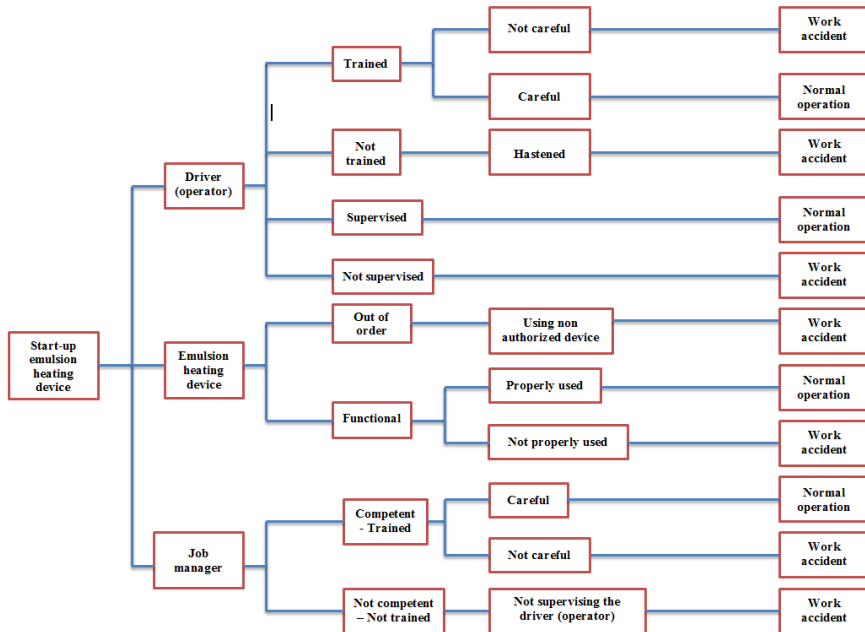


Fig. 1. The events' tree

3.4 Analysis and valorising of the tree

IV) Valorising the tree:

- If the driver (operator) is trained and is careful when starting the emulsion heating machine then the whole system will operate normally;
- If the driver (the operator) is trained but careless during the start of the emulsion heating machine, an accident will occur;
- If the driver is not trained and hastened during the start of the emulsion heating machine, a work accident will occur;
- If the machine is defective and it is used with unauthorized devices, it will result in a work accident;
- If the manager of the workplace is aware and trained, there is a normal operation of the system;
- If the manager of the workplace is not trained and does not supervise the machine and driver (operator), then an accident will occur.

4 Conclusions

As shown above, by using the Event Tree Analysis in the investigation of a work accident, starting from an initiating event and systematically scrolling the sequence of events, we can determine the causes of the accident and provides safety measure to be taken in order to increase the work security. This quick and effective method is useful because:

- It allows to establish which provisions in the legislation, specific norms, and internal rules have not been complied with;
- It reveals the necessary organizational and technical measures needed in order to prevent other accidents;
- The deterministic cause-effect relationship can be established with pretty good accuracy.

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