VARIANTS OF REPAIR OF DIESEL GENERATOR IN TERMS OF NUCLEAR ACCIDENTS

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ABSTRACT

The paper is focused on the issues that relate to restoration of electrical power supply. There is evaluated significance and importance of the use of diesel generator and it is described the possible consequences of its failure. It examines the situation of the repair of diesel generator in radiation contaminated area of Dukovany nuclear power plant. Based on the simulated radioactive leak, there can be proposed a variant of movement of worker associated with the repair of diesel generator. A comparison of variants gives the most appropriate process of restoration of electrical power supply from diesel generator.

1. INTRODUCTION

The Dukovany nuclear power plant (EDU) consists of two main production blocks. The main production block has two reactor blocks. Each of reactor blocks has VVER-440 reactors with all directly related facilities, including the engine turbines and generators. The main task of the operation of nuclear power plant is to work effectively, safely and trouble-free. It all depends on ensuring a reliable power supply for its self-consumption. The self-consumption of power plant is generally considered the consumption of electrical energy necessary for the production of electricity, including power auxiliary operations.

In the case of a black-out, there is a chronology of the re-use power sources, depending on the specific situation and complexity of disorder. This event is addressed through a special service provision. It may happen that due to black-out and other events there release of radioactive substances into the environment. Sometime shift engineer requires a manual repair and start of diesel generator. Diesel generator is responsible for power supply of self-consumption when the main and reserve sources are lost. It allows to start up very quickly, so the power equipment can be supplied for 15 seconds after the command to start. Because of this property generator is very indispensable for the safe operation of power plants.

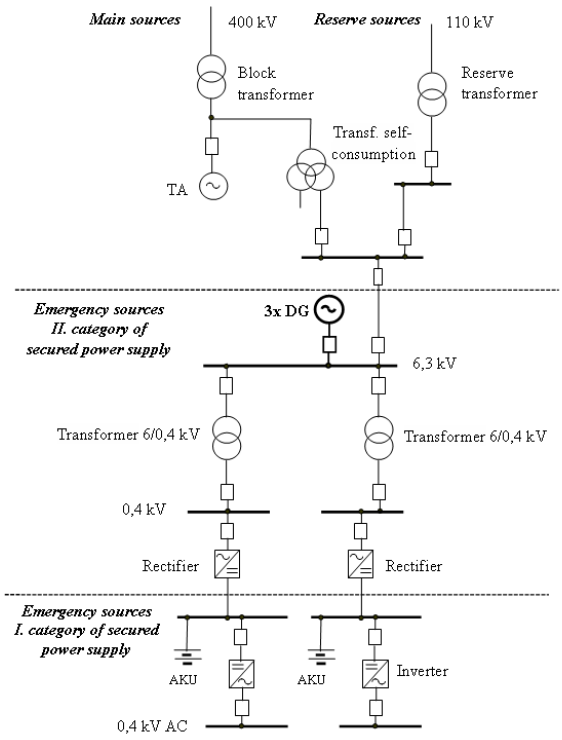
In case of that worker will be located in the radiation environment, the state of the radiation situation and the prediction of the spread of radioactive must be absolutely known. Then the diesel generator can be repaired safely but the most optimal variant of movement has to be found. Simulation of a nuclear accident can be made in the program 3D model EDU. This application represents a true copy of the Dukovany nuclear power. In this ap-

plication, the radiation conditions or the distribution of radioactivity can be defined. On the basis of the distribution of radioactivity, this application simulates the movement of worker who repairs diesel generator.

2. DIESEL GENERATOR IN EDU

Self-consumption of nuclear power plant is supplied from main sources, reserve sources and from emergency sources of electrical energy. All electrical devices of self-consumption system are divided by the importance of their function in emergency situations. Therefore, power systems are divided into three categories. There are category of unsecured power supply, II. category of secured power supply and I. category of secured power supply. In the case of loss of main and reserve sources, systems and appliances important for security of electricity are supplied from emergency sources. Emergency sources are batteries and diesel generators in Dukovany. Batteries supply most important low power devices. Other very important devices are supplied from diesel generators. Each reactor block has three diesel generators. These generators are completely autonomous source of electrical energy.

Fig. 1 shows diagram of power self-consumption on the reactor block EDU and parameters of diesel generator



Parameters of diesel generator at first main production block

Nominal apparent power	3500kVA
Nominal current	321A
cos φ	0,8
Voltage	6300V
Nominal speed	500 ot/min
Excitation voltage	107V
Excitation current	319A

Figure 1: Diagram of power self-consumption on the reactor block EDU and parameters of diesel generator [4]

The level of nuclear safety of nuclear power plant is provided by the security systems. Diesel generator is responsible for the operation of devices (security systems) which are involved in the cooling reactor. If situation requires production of electricity from the diesel generator (but electricity is not provided), it can lead to dangerous operation of the plant. The failure of diesel generator can be one of many reasons of beginning of meltdown of

the active core and the initiation of radioactive leak. However, this extreme situation is highly improbable.

3. SIMULATION AND CALCULATION OF VARIATIONS

Definition of characteristic values of the distribution of radioactivity is created by the system software applications in the program 3D model EDU. Therefore the composition and characteristics of each group of contaminants have to be defined. All values characterize the particular simulated accident. Input data must fully characterize the radioactive leak and its the specific location.

Work examines three variants of repair of diesel generator. On the basis of the results demonstrates the importance of irregular movement of worker in areas where there are radioactive substances. Determination of total effective dose depends on the dose rate and the total time when the worker was exposed to radioactive radiation. Time of repair of the diesel generator is chosen about 5 minutes in the simulation. Exposure time is always composed of the time walking to the diesel generator, the repair time and time walking from the diesel generator. The movement of worker can be optimized so that the radiation is less risky.

Fig. 2 shows the variations of movement of worker, depending on the distribution of radioactivity.

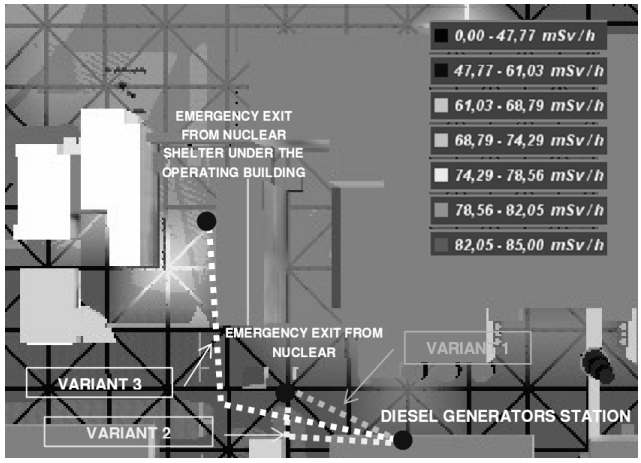


Figure 2: Simulated the distribution of radioactivity and examined variations of movement of worker.

Variant 1 simulates the movement of worker who enters from the emergency exit from nuclear shelter to the contaminated area. Worker goes directly to the diesel generator. In variant 2 the worker enters through the emergency exit again. Based on knowledge of the distribution of radioactivity the movement of worker is optimized. Last variant demonstrates the wrong choice of entry of worker into the radioactive environment. This variant could possibly arise in ignorance of the distribution of radioactivity.

3.1. VARIANT 1

The main purpose of this variation is the most reduced the total exposure time. The path of movement is diagonal and leads directly to the diesel generator.

Fig. 3 shows the dose rates received by a worker during the walk in variant 1.

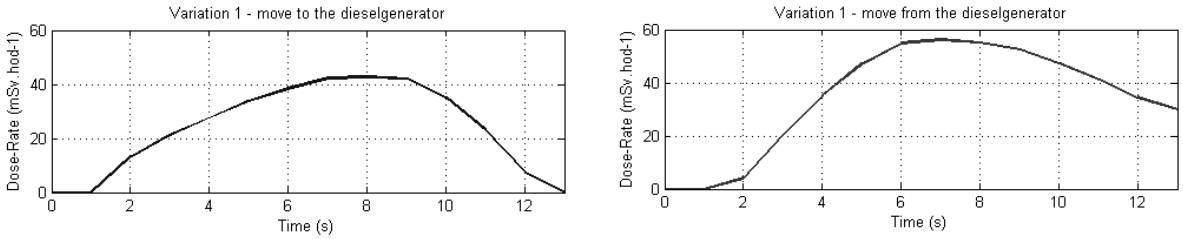


Figure 3: Dose rates received by a worker in variant 1.

Worker does not respect the distribution of radioactivity. This fact is represented by a peak in the charts. These peaks represent critical points of movement. Worker passes through the strongest contaminated area in the middle of his movement in both directions. Location of the diesel generator is not a dangerous to health, because it is located outside the effects of the contaminated area. The total repair time, including movement of worker, is 5 minutes and 59 seconds. Movement is made in areas where there is low level radioactivity and therefore worker receives an effective dose of 0.28 mSv. Dose rate is in the range of (0-60) $mSv \cdot h^{-1}$.

3.2. VARIANT 2

Based on knowledge of distribution of radioactivity the movement of worker is optimized and worker can be directed to area where is not a high level of radioactivity. Worker avoids maximum dose rates. Optimization is successful, if it fulfills two conditions. The effective dose is lower and the total time is not much longer than in previous variant.

Fig. 4 shows the dose rates received by a worker during the optimized walk in variation 2.

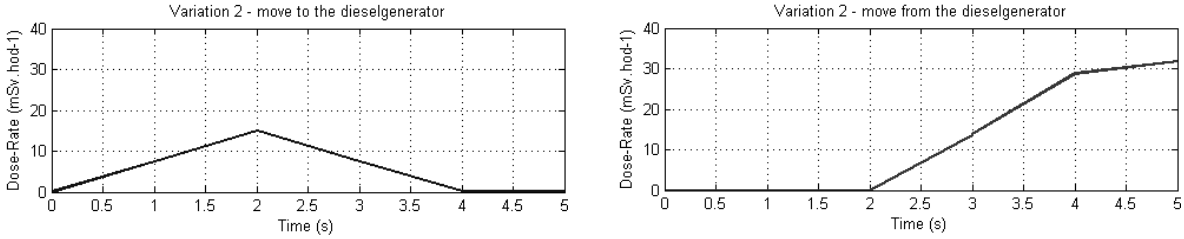


Figure 4: Dose rates received by a worker in variation 2 – optimized movement.

The total repair time, including movement of worker, is 6 minutes and 11 seconds. In this variant is an increase of the total time, only about 16 seconds. Small extension of the exposure could mean a large increase in the effective dose received. In this case it not happens, the worker moves in the radioactivity with a low dose rate, in the range (0-40) $mSv \cdot h^{-1}$. Worker receives an effective dose of 0.024 mSv. Optimization is so successful because effective dose is one order of magnitude lower and the total time is not much longer than in previous variation.

3.3. VARIANT 3

Worker receives an effective dose of 3.227 mSv it is one order of magnitude higher than in previous variation because radioactive substances are spread directly to the emergency exit from nuclear shelter under the operating building.

Fig. 5 shows the dose rates received by a worker during the walk in variation 3.

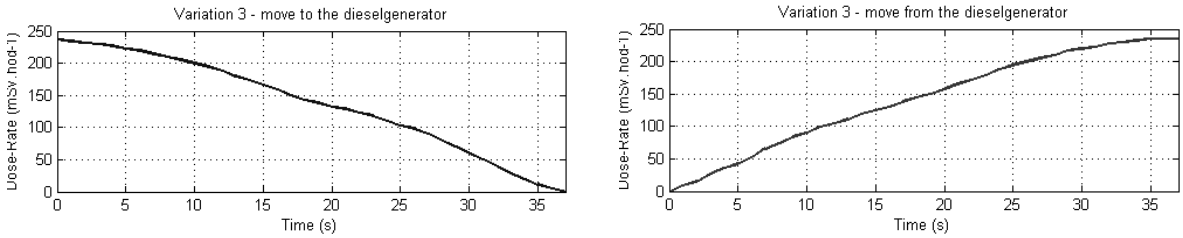


Figure 5: Dose rates received by a worker in variation 3 – incorrect movement.

At the beginning of intervention is worker in strong radioactivity. Level of a dose rate is about 240 $mSv \cdot hod^{-1}$. The first part of the path must be accomplished in such a way that the exposure time as short as possible. The second part of the path is carried out according to variant 2 and it uses optimized movement in front of diesel generator's stations. The variant is thus inappropriate to use the recovery power. Total time is the longest, due to location of emergency exit to the diesel generator. The total repair time, including movement of worker is 7 minutes and 15 seconds.

4. CONCLUSION

In the case of loss of main and reserve sources, systems and appliances important for security of electricity are supplied from emergency sources. Diesel generator is responsible for power supply of self-consumption when the main a reserve sources are black-outed. Its failure can be one of many reasons of beginning of the initiation of radioactive leak but it is highly improbably.

Before the worker starts to repair, he must sign a specific document. In this document are presented specific instructions of repair and possible health risks, depending on the size of effective dose. If worker respects the distribution of radioactivity, it will significantly reduce the effective dose received by himself. This is the main reason for the combination of simulation radioactive leak and repairing device of security systems. Implementation of this combination would be welcomed by workers dealing with emergency power conditions. Their decision would be effective and they could better respond to the immediate situation.

ACKNOWLEDGEMENT

This paper contains the results of research works funded from project of specific research program of Brno University of Technology No. FEKT-S-11-2.

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