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NUMERICAL MODELLING OF THE MITIGATION EFFECTS DURING EMERGENCY HYDROGEN-AIR EXPLOSION

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The aim of this study is to assess numerically the conditional probability of the harmful impact on hydrogen fueling station personnel that is exposed to the hydrogen explosion pressure wave (fig. 1).

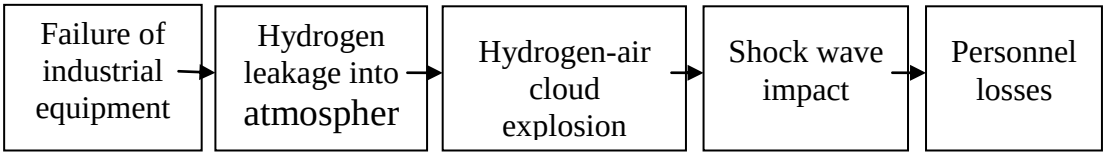

Fig. 1. A development scheme of technogenic accident

A three-dimensional mathematical model of the instant explosion of hydrogen-air cloud formed after the destruction of the high-pressure storage cylinders is developed [1].The mathematical model takes into account the complex terrain and three-dimensional non-stationary nature of the explosion wave propagation process.

The conditional probability *P* of harmful impact on a person that is under the influence of an explosion shock wave depends on the probit-function Pr – the upper limit of a definite integral of the normal distribution law with mathematical expectation 5 and variance 1

$$P = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\Pr} e^{-\frac{1}{2}(t-5)^2} dt, \qquad (1)$$

where *t*is an integral degree of impact.

For example, the probability of human health lethal damage caused by overpressure can be estimated by the following ratio [2]:

$$\Pr_1 = 5 - 0,26 \ln\left[\left(17500 / \Delta P_+\right)^{8,4} + \left(290 / I_+\right)^{9,3} \right], \qquad (2)$$

where ΔP_+,Pa – maximum overpressure and I_+ – impulseof the wave compression phase, Pa·s.

A computer technology how to define the personnel damage probability field on the basis of probit analysis of the generated shock wave is developed. To

automate the process of computing the "probit function-damage probability" tabular dependence is replaced by a piecewise cubic spline(fig 2).

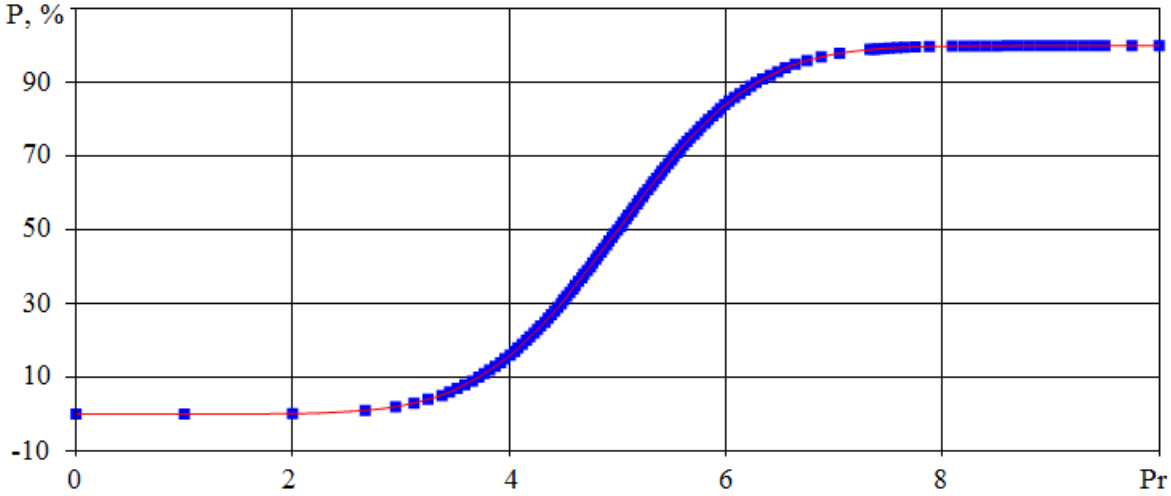

Fig. 2. Interpolating tabular dependency ofprobability P on probit-function Pr

The results of calculations of overpressure fields, impulse loading, and finally the probability of damage (fig. 3) to fueling station personnel who is protected by different cases of wall construction from exposition to the explosion wave are obtained.

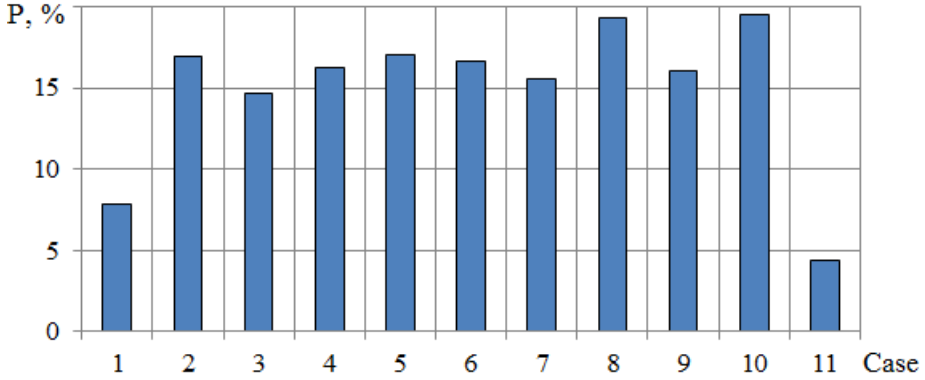

Fig. 3. Conditional damage probability (2) in the control point for different protection cases

The developed computer technology allows to carry out an automated analysis of the safety situation at the fueling station and to carry out a comparative analysis of the effectiveness of different types of protective facilities.

REFERENCES

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