MATHEMATICAL AND INSTRUMENTAL METHODS IN ECONOMICS

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ASSESSING THE VALUE OF A LICENSE FOR THE OIL-ABSORBING BARRIER TECHNOLOGY

SUMMARY. The article focuses on the method of assessing the value of a license for a water-reservoir cleaning technology from the oil spill in the accident at an oil platform. The volume of the license is proportional to a mathematic expectation of damage caused by an accident, and the probability density of damage is given by the degree function with an index equalling 1.5. With the normalization the probability density functions used the lower and upper limits as 1/100 and 1 from the costs of cleaning the surface of water during an accident on the platform Deepwater Horizon, which was equal to $ 3 billion. Mathematical expectation of damage from an accident a year was 1/10 of the mentioned costs. The license price was determined by eliminating royalty as a sum of the discounted annual expectation damages. The royalty rate was 4% and the discount rate was 20% per year. The market value of the license for the technology of "oil absorbing barrier (bon)" for one oil platform of British Petroleum with the right to use this technology for unlimited time was RUB 18 million. The developed method can be used to estimate the cost of technologies that eliminate the effects of major technological disasters.

KEY WORDS. Assessment of license value, damage from an accident, oil absorbing barrier (bon).

Last decade has witnessed an increase in the frequency and scale of anthropogenic accidents at oil platforms. There is a task to eliminate operational oil spills without causing further damage to the environment. The Tyumen State University owns appropriate technology of "oil absorbing barrier (bon)" [1], based on the adsorption of water onto oil polymer fibers, where it is processed by microorganisms. This technology has been successfully applied by British Petroleum (BP) for the liquidation of the accident on the Deepwater Horizon platform in December 2010.

We set a task to estimate the market value of the license for the technology of "oil absorbing barrier (bon)" for one BP oil platform, provided that the right to use this technology is not limited in time. For this we shall predict and calculate the damage from an accident on an oil platform in the future.

Until recently it was believed [2-4] that the damage from man-made disasters obeys Gaussian normal distribution, as well as conventional minor accidents and disasters. "The tails" of the distribution fall off very quickly and the possibility of giant deviations can be neglected [5]. So the probability of failure of an oil platform or a nuclear power plant during one year, calculated according to Gaussian law is 10^{-7}-10^{-6}. The analysis of disasters of the last decade shows that this value is underestimated by 400-500 times [6].

It turned out that the fundamental nature of disasters (earthquakes, floods, tornadoes, market crashes, damage from leaks of confidential information, the scale of industrial accidents, etc.) is in self-organized limits [2], and therefore they obey not the Gaussian, but the degree law of distribution with "heavy tails" [2-5]. The consequence of the degree law of probability density of accident scale is that the damage from one accident can exceed the total damage from all accidents of this type [7]. It was found out [2-5], that the probability density $\varphi(x)$ of disastrous events has a form $\varphi(x) \approx x^{-n}$, where x is a scale of the disaster, and the exponent n is equal to 1.25-1.45 for earthquakes, to 1.4-1.6 for hurricanes, to 1.35-1.4 for floods and tornadoes, and 1.6. for wildfires.

We shall now estimate the probable damage from an accident at the oil platform. Based on statistical analysis of large-scale accidents in refineries, petrochemical and chemical plants it was revealed that for them $\varphi = Ax^{-1.5}$ [3].

The A-factor can be defined by the normalization of the probability density function. We shall consider that the degree law of distribution is valid only for disasters, while ordinary accidents, which do not provoke any subsequent massive destruction, are well described by Gaussian law. Therefore, with the normalization of the probability density the lower limit should be equal not to zero, but to the least possible scale of a man-made (anthropogenic) disaster.

We shall take as the typical scale of the accident on an oil M platform the costs of BP to clean the water surface on the Deepwater Horizon platform in December 2010 [8] which amounted to \$ 3 billion, or RUB 91.5 billion at the exchange rate of RUB 30.5 to a United States Dollar for 31.12.10, and the relationship m/100 will serve as the lower scale disaster.

Then the normalization of the probability density function will have the form:

$$\int_{M/100}^{M} \varphi(x)dx = \int_{M/100}^{M} A\ x^{-1.5}dx = 18AM^{-0.5} = 1$$

$$\Rightarrow \quad A = M^{0.5}/18$$

Then the expectation of damage from an accident on one oil platform for one year equals:

$$\int_{M/100}^{M} \varphi(x)x\,dx = \int_{M/100}^{M} Ax^{-1.5}x\,dx = 1.8AM^{0.5} = M/10$$

If we take into account that the oil absorbing barriers (bons) constitute α% of the cost of cleaning water surface, and the royalty rate is r, the probable value of L license fees per year will be: $L = M\alpha r/10$.

At a discount i rate the R sum of discounted annual royalty payments that in fact is the cost of the license as a single (lump-sum) payment amount, will make $R = M\alpha r/10i$. The average royalty rate of gross production or operations used in determining the price of the license to "equipment for chemical industry" [9], are equal to 4%. We also use $\alpha = 1\%$ and $i = 20\%$ per annum or 0.2 [10]. Then the cost of the license will be: R = 91,5 billion rubles. × 0.01 × 0.04 / 10 × 0.2 ≈ 18 million rubles.

Thus, as of December 31, 2010, the market value of the license for the technology of "oil absorbing barrier (bon)" for a British Petroleum oil platform with the right to use this technology for unlimited time, stood at about RUB 18 million. With the spread of this license on the *N* number of platforms its value increases proportionally. So for five existing BP platforms in the Gulf of Mexico [11] the license price is RUB 90 million.

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