7.03 ENVIRONMENTAL IMPACT ASSESSMENT OF AN INDUSTRIAL ACCIDENT USING ISC – AERMOD VIEW. A CASE STUDY

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INTRODUCTION

Romanian iron and steel industry use, handle, store or undertake important amounts of raw materials, fuels, energy, gases, waste waters and different type of wastes. In iron and steel plants are processed raw materials under high temperature and pressure using big amounts of fuels and energy. This activity has a significant environmental impact, therefore important amounts of pollutant gases, waste waters and wastes produced by them. In some working cases (abnormal or even normal cases, but in favourable environmental conditions) this activity may be a risk source for the people, environment and property.
In this paper is analysed the impact on environment and peoples, caused by a major accident at an blast furnace shaft from ISPAT SIDEX Galati (the mainly iron and steel works in south –east Europe).

MODEL APPROACH

The modelling of possibility of top event issue "blast furnace shaft cracking and major accident" was undertaken using the fault tree method, which permitted the critical points identification from the event development. Based on statistical analyze of the working data of a blast furnace from ISPAT SIDEX Galati were calculated the likelihood of a base events or considering base events from the fault tree.

A close workings / faults examination of the blast furnace no. 5 was achieved during a tree years period (January 1999 – December 2001), issuing a data set containing 760 records.
The analysis was focused to:

- types of effects through blast furnace (stopped or low working)
- the cause of these issues;
- event type;
- the factor / raw material / utilities reached by the interventions in this period or the causes of the faults;
- the consequences / modalities for rehabilitation;
- the length of rehabilitation / (expressed in minutes).

The stopping or low working causes has been grouped together in six main types: technological, mechanical, electrical, control, planned stopping and management reasons.

Based on fault tree method for top event "blast furnace shaft cracking and major accident" has been assigned the probability to reach this event. The likelihood corresponding to the basic events and for these considered like basic events, it had been calculated using the data recorded in the working period January 1999 – December 2001 of the blast furnace no. 5 (*Hritac, M, M. Balanescu and other*, 2001-2004). We have to stress the fact that the fault tree was realized in the worst case.
Because the assignment of the likelihood class depending on calculated amount of this is difficult to reach, it has been choose a frequency scale (hence the differences between likelihood amount are more clearly underlined). The assignment of the score for frequencies and for the gravity of the consequences has been achieved based on predefine scales (*Hritac,*

M, M. Balanescu and other, 2001-2004). The final score was calculated through the multiplication of the likelihood and the gravity scores, in order to highlight the differences between the points corresponding to the each event.

Then, the procedure used for this model foresees the deduction of the minimal cuts hence those minimal events combinations, witch could leads to the achievement of the top events. The minimal cuts had been prioritized based on score obtained like a sum of points for the minimal cut events. The repartition of the significant minimal cuts (with a score above 105) depending on score class leads to a distribution very closed on normal distribution in accordance with the studied phenomenon.

IMPACT ASSESSMENT

Supposing that likelihood of the top event is 1, was modelled the atmospheric dispersion of a pollutants emitted (CO, PM10, SO_2) using ISC – AERMOD View software. For this purpose was considered the main atmospheric pollutant sources from the ISPAT SIDEX Galati and for the blast furnace was estimated concentrations, speeds, and temperatures for the pollutants and used like input data.

The meteorological conditions in the Galatzi area are characterized through annual variation of the frequency of appearance of the ground wind. This has the biggest amount (43.4 %) for the north direction (considering like a sum of north, NNE, NE, NW, NNW directions), followed by SW (9.02 %). The calm atmosphere represents 9.31 %. The annual average of the wind speed on the ground is 4.71 m/s. The atmospheric thermal layer in the Galatzi area is neutral prevalent (54.8 %).

The surface used for dispersion modelling is 400 km^2 (20 km on Ox axis and 20 km on Oy axis). The plant is situated in the centre of this surface. A uniform Cartesian receptors grid was set up. The grid is constituted by 121 receptors placed 2 km far one to the other, on the two directions (X, Y) of the surface.

For the environmental impact assessment caused by this accident was modelled the atmospheric dispersion of the main pollutants emitted (SO_2, PM_{10}, CO) using ISC – AERMOD View software. For this purpose was calculated the pollutants concentration ($\mu g/Nm^3$) for the entire surface using receptors grid specified above. The results obtained were compared with standard value.

In figure 1 is presented emissions map obtained for SO_2. The maximum value (32290 $\mu g/Nm^3$) is situated in the blast furnace shaft area, and decrease with distance. In the area of Sendreni the value of concentration is 454 $\mu g/Nm^3$, in Galatzi - 438 $\mu g/Nm^3$ and in Vanatori -, 281 $\mu g/Nm^3$. These values are smaller than the limit value (including tolerance interval). The frequency and cumulative percentage of the value calculated is show in table 1 (350 $\mu g/Nm^3$ is the limit value and 500 $\mu g/Nm^3$ is the limit value including tolerance interval).

Table 1. Frequency and cumulative percentage for SO_2 concentration ($\mu g/Nm^3$)

Bin, $\mu g/Nm^3$	Frequency	Cumulative, %
350	40	33.06 %
500	41	66.94 %
700	20	83.47 %
1050	14	95.04 %
1400	3	97.52 %
More	3	100.00 %

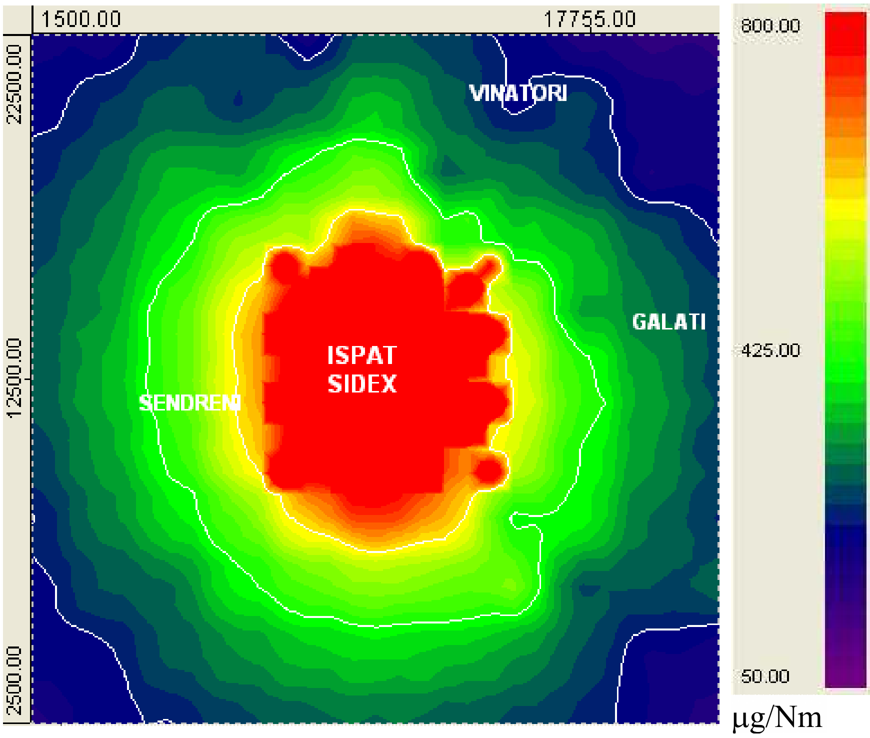

Figure 1. SO_2 emissions map

The emissions map obtained for PM_{10} is presented in figure 2. The maximum value (2647 µg/Nm^3) is situated in the blast furnace shaft area, and decrease with distance. The concentration value in Sendreni area is 78 µg/Nm^3, in Galatzi - 49 µg/Nm^3 and in Vanatori -, 18 µg/Nm^3. These values are smaller than the limit value for human health (125 µg/Nm^3). The frequency and cumulative percentage of the value calculated is show in table 2.

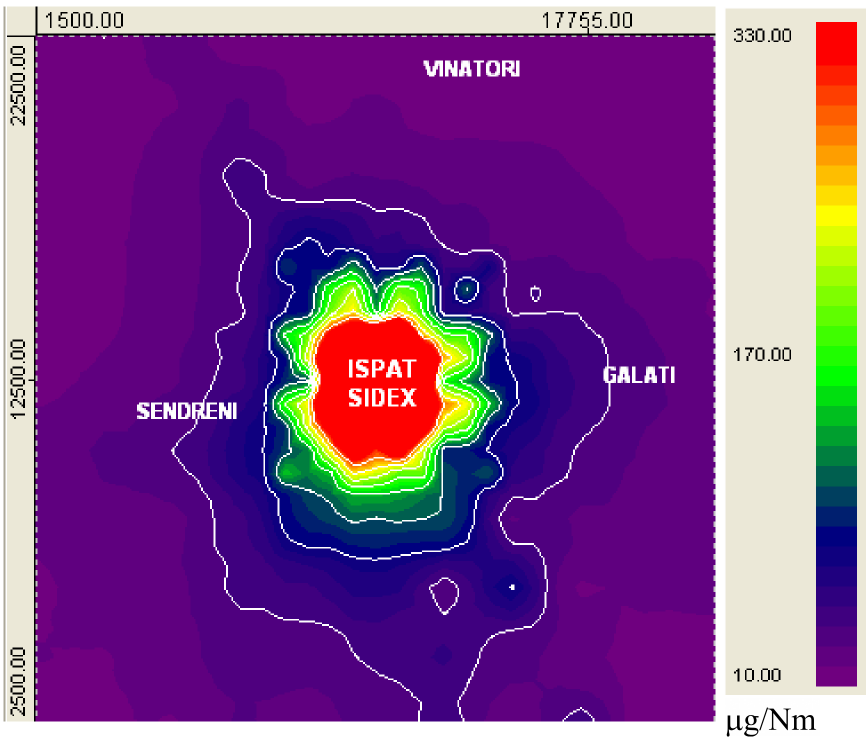

Figure 2. PM_{10} emissions map

Table 2. Frequency and cumulative percentage for PM_{10} (μg/Nm³)

Bin, μg/Nm³	Frequency	Cumulative, %
20	35	28.93 %
30	25	49.59 %
50	32	76.03 %
75	14	87.60 %
125	4	90.91 %
150	7	96.69 %
More	4	100.00 %

Regarding CO emissions in figure 3 is presented emissions map. In the blast furnace shaft area is situated the maximum value (8267 μg/Nm³) and decrease with distance. In the localities area of Sendreni, Galatzi and Vanatori the value of concentration are smaller than the limit value.

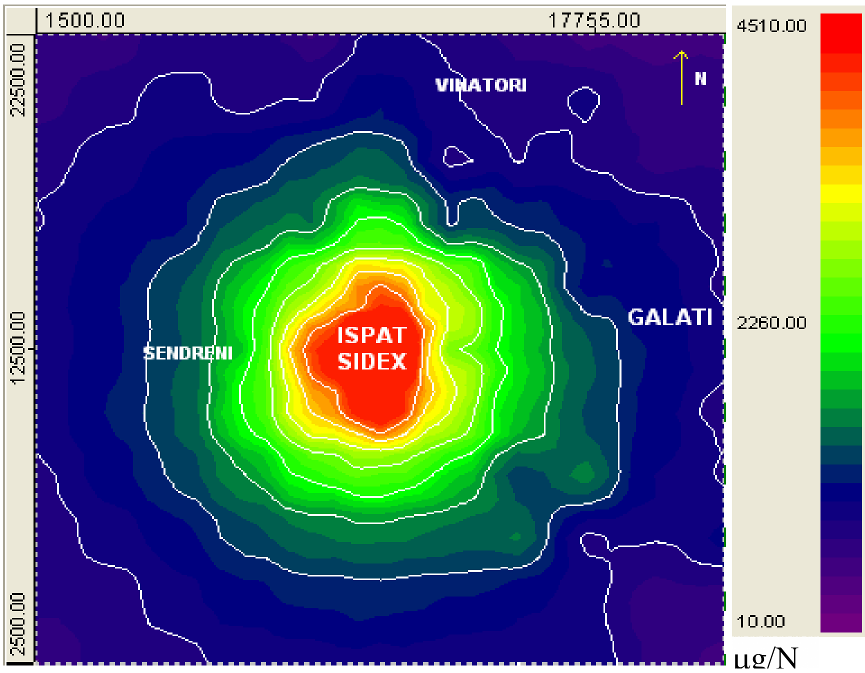

Figure 3. CO emissions map

CONCLUSIONS

The probability to achieve the top event is relative high. A explanation of these is the fact that the blast furnace is at the end of the working period. Other explanation consists in a lot of problems generated in 2001 by the analyzed events, so the appearance frequency could lead to the cracking of the shaft of blast furnace is high.

Regarding the environmental impact, 33.06 % of the value of SO_2 emissions is bigger than the limit value (including the tolerance interval) and 9.09 % for the PM_{10}. These concentration values are situated in the ISPAT SIDEX area. Hence the impact for the people is restricted to the employment's of ISPAT SIDEX.

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