Variation of doses with classes of atmospheric stability and wind speed in a DBA scenario

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The safety analysis implements studies that consider the hypothetical occurrence of accidents in nuclear or radioactive installations, simulating as a consequence, the release of radioactive material into the atmosphere. Atmospheric dispersion models to estimate the behavior of the radioactive plume are implemented, including important estimates of the radiological impact on the public. In this work, the influence of atmospheric stability and wind speed on the transport of a radioactive plume generated by a hypothetical loss of refrigerant in a generic PWR was analyzed and the radiological impact on the public exposed to the plume was studied. For this purpose, the HotSpot 3.0.3 software [1] was used to simulate different scenarios and generate the total effective dose and the compromised equivalent dose received by the public according to the classes of atmospheric stability and wind speed.

In order to simulate the radiological impact of a DBA, a source term generated by a LOCA of a generic PWR reactor [2] and the atmospheric conditions of the site were considered, taking into account the six classes of Pasquill-Gifford stability and the variation of the wind speed at the reference height of 10 meters. It is assumed that LOCA resulted in the release of radionuclide into the reactor room, which had its exhaust ventilation system and gas purge both shut down. While members of the operating team tried to save the situation, the radionuclide activity of the reactor core escaped through the chimney of the reactor building in the form of gas and particulates and then spread to the atmosphere. The total activity of the generated radionuclides was 1.11E + 16 Bq. The HotSpot software generates several output data, among which we will highlight the total effective dose and the equivalent committed doses for 23 organs and tissues. Tables 1 and 2 show, respectively, the maximum values of the total effective dose and the committed equivalent dose of the thyroid, the organ that suffered the highest dose, among the 23, varying with the stability classes (A, B, C, D, E, F) and with the wind speed in 10 meters height.

Table 1 - Variation of the Maximum Total Effective Dose with the Wind Speed.

Wind speed (m/s)	Maximum total effective dose (Sv)					
	A	B	C	D	E	F
0.5	0.381	0.315	0.274	0.164	0.076	0.023
1.0	0.191	0.158	0.138	0.083	0.039	0.012
1.5	0.128	0.106	0.092	0.056	0.026	0.00812
2.0	0.096	0.08	0.069	0.042	0.019	0.00613
2.5	0.077	0.064	0.056	0.034	0.016	0.00492
3.0	0.064	0.053	0.046	0.028	0.013	0.00411
3.5	0.055	0.045	0.04	0.024	0.011	0.00353
4.0	0.048	0.04	0.035	0.021	0.00979	0.0031
4.5	0.043	0.035	0.031	0.019	0.0087	0.00276
5.0	0.038	0.032	0.028	0.017	0.00784	0.00248
5.5	0.035	0.029	0.025	0.015	0.00713	0.00226
6.0	0.032	0.027	0.023	0.014	0.00654	0.00207

Table 2 - Thyroid - Variation of Maximum Committed Equivalent Dose with Wind Speed.

Wind speed (m/s)	Maximum Committed Equivalent Dose (Sv)					
	A	B	C	D	E	F
0.5	3.5	3	2.6	1.5	0.71	0.22
1.0	1.7	1.5	1.3	0.77	0.36	0.11
1.5	1.2	1	0.88	0.52	0.24	0.077
2.0	0.87	0.75	0.66	0.39	0.18	0.058
2.5	0.7	0.6	0.53	0.31	0.14	0.047
3.0	0.58	0.5	0.44	0.26	0.12	0.039
3.5	0.5	0.43	0.38	0.22	0.1	0.033
4.0	0.43	0.38	0.33	0.19	0.091	0.029
4.5	0.39	0.33	0.29	0.17	0.081	0.026
5.0	0.35	0.3	0.26	0.16	0.073	0.023
5.5	0.32	0.27	0.24	0.14	0.066	0.021
6.0	0.29	0.25	0.22	0.13	0.061	0.02

It was observed that, for the same stability class, the maximum values of the total effective doses are gradually reduced with increasing wind speed. The initial maximum values of the doses are reduced by a factor of approximately 12, when the wind speed is varied from 0.5 m / s to 6.0 m / s. It was also observed that, for the same wind speed, the maximum values of the total effective doses are gradually reduced as it moves from the least stable class to the most stable class. This behavior also occurs with the maximum values of committed equivalnte dose.

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References

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