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Dispersion of radioactive materials from JRTR following a postulated accident using HOTSPOT code

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1. Introduction

Jordan Research and Training Reactor (JRTR) is the first nuclear facility in Jordan. The JRTR is 5 MW, light water moderated and open type pool reactor [1]. In case of an accident, the radioactive materials will be released to the surrounding environment and endanger the people living in the vicinity of the reactor. However, up to now, no study has been published about the dispersion of radioactive materials from JRTR in case of an accident.

As preliminary stage for the construction of the JRTR, the dispersion of the radioactive materials from JRTR in case of an accident was studied using HOTSOT code.

2. Meteorological data

The meteorological data (specifically the wind speed, wind direction and rainfall) for the year 2011 for JRTR site were available from Al-Ramtha weather station in six hour intervals at the ground level. The hourly wind speed and wind direction were then generated assuming that the wind speed, wind direction and the rainfall don't change during this period of time. Figure 1 shows the wind rose generated for the available data using a ground anemometer for ground level. As can be seen from Figure 1, the dominant wind direction was west and the average wind speed in that direction was 3.6 m/s.

3. Source term

Difficulties arose in obtaining the source term for JRTR since it has yet to be constructed and only general specifications are being released to the public. Nevertheless, upon comparing the proposed JRTR to a reactor already built in Pakistan (the PARR-1) it was found that the source term of the latter could serve as a stand-in for the unavailable data [2].

4. Modeling

There are a number of tested models that have been shown to predict dispersion values that tolerably coincide with those obtained experimentally. One such model, which is most commonly used, is the Gaussian plume [3]. The program "HotSpot" used in this analysis is based upon this model.

The radioactive elements were assumed to be released from the ground level with an average speed of 3.6 m/s and dominant wind direction to the west. The dispersion of the radioactive elements was then estimated using HOTSPOT code based upon the Gaussian model.

HOTSPOT code uses Pasquill stability classification method to determine the possible stability categories. The Pasquill method requires selecting the solar insolation factor and the ground level speed. At 3.6 m/s speed and according to Pasquill method, the possible stability classes are B (moderately unstable), C (slightly unstable) and D (neutral).

An off-site acceptance criterion of .25 Sv was taken based on NRC regulatory guide 1.195 to perform the analysis [4].

5. Results and discussion

The total effective dose equivalent (TEDE) and the arrival time at different downwind distances from the site of JRTR were calculated for a ground level release accident using HOTSPOT code. Figure 2 shows the total effective dose equivalent as function of the downwind distance from the reactor site for Pasquill stability class B. As can be seen, the maximum dose occurred at the release point and decreased with distance, and this is acceptable since the release was occurred from the ground level. Table 1 shows the TEDE and the corresponding arrival time for different downwind distances for stability class B at the ground level. From Table 1, we see that the maximum dose occurred at the release point and decreased with distance.

6. Conclusions

The result of the report indicates that for ground level release with an average speed of 3.6 m/s of hourly averaged meteorological data for one year with a dominant direction from the west a person located at distance .062 km from the reactor site will receive .25 Sv.

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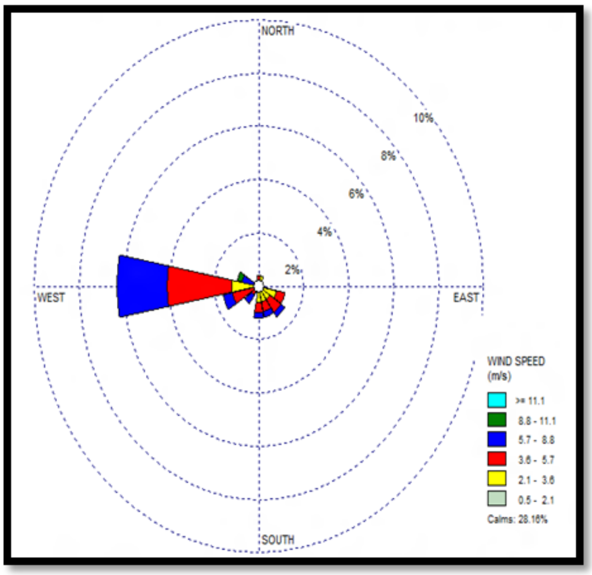

Figure 1. Wind rose for ground level release

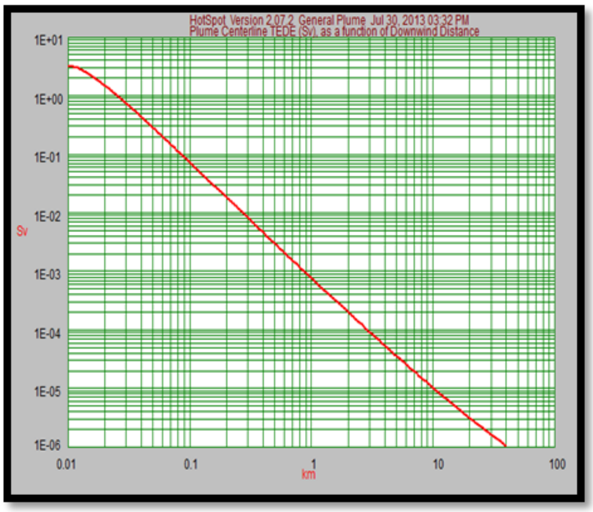

Figure 2. Total effective dose equivalent as function of downwind distance for B Pasquill stability class for ground level release

Table 1: TEDE and the corresponding arrival time for B Pasquill stability class for the ground level

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	7.5E-01	2.6E+11	<00:01
0.100	7.3E-02	2.5E+10	<00:01
0.200	1.8E-02	6.4E+09	00:01
0.300	8.2E-03	2.8E+09	00:01
0.400	4.7E-03	1.6E+09	00:02
0.500	3.0E-03	1.0E+09	00:02
0.600	2.1E-03	7.2E+08	00:03
0.700	1.5E-03	5.3E+08	00:03
0.800	1.2E-03	4.1E+08	00:04
0.900	9.4E-04	3.2E+08	00:04
1.000	7.7E-04	2.6E+08	00:05
2.000	2.0E-04	6.9E+07	00:10
4.000	5.4E-05	1.9E+07	00:20
6.000	2.6E-05	8.9E+06	00:31
8.000	1.5E-05	5.3E+06	00:41
10.000	1.0E-05	3.6E+06	00:51
20.000	3.2E-06	1.1E+06	01:43
40.000	1.0E-06	3.5E+05	03:27
60.000	5.4E-07	1.9E+05	05:10
80.000	3.4E-07	1.2E+05	06:54