Application of Emergency Action Levels from Potential Release at Research Reactor HANARO

Jongsoo Kim*, Goan Yub Lee, Hae Choi Lee, Bong Suk Kim
Korea Atomic Energy Research Institute Daedeok-St., Yuseong, Daejeon 305-353 Korea
**Corresponding author: jskim4@kaeri.re.kr*

1. Introduction

Execution of the protective action promptly is possible that Emergency Action Levels (EALs) must be established for a radiological release from nuclear facility. The EALs for electric power reactor are already developed and applied to recognize an emergency situation rapidly. However, research reactor isn't true to allow in international. Recently the IAEA published the safety report including the EALs for research reactor. This paper describes the EALs to apply for a potential release pathway at the research reactor HANARO.

2. Methods and Results

The release pathway can considered for the stack release and the ground release, respectively. The stack is applied by before stopping of the emergency ventilation system. After then, radiological substances are retained in the containment. These substances are released to environment slowly through any penetration holes depending on not only an inside and outside pressure but also outside weather condition of the containment building, respectively. The EALs by the both releases are applied that a radiological effects aren't exceed the protective action guide at site boundary. Ambient radiation dose rate is considered due to the releases at the site boundary.

2.1 EALs Establishment

Exposure pathways from the release can consider direct external from the plume and internal exposure from inhalation of the radioactive material during the plum passing. Total exposure is sum of external and internal exposure such as formula 1.

$$\mathrm{TD} = \left(\frac{x}{Q}\right) \times Q_i \times t_{i,s} \times (DCF1_i + DCF2_i) \qquad (1)$$

Where,
TD: Total exposure from the plume (mSv)
$\left(\frac{x}{Q}\right)$: Annual average atmospheric dispersion factor (sec/m^3)
$Q_{i,s}$: Stack release rate of isotope i (Bq/sec)
$t_{i,s}$: Stack release duration of isotope i (hr)
$DCF1_i$: External dose conversion factor of isotope i from plume (mSv/hr per Bq/m^3)
$DCF1_i$: Internal dose conversion factor of isotope i from inhalation (mSv/Bq)

The EAL resulting from the stack release is to set the concentration rate of the effluent monitors installed inside of the stack. To calculate the effluent monitors for the radionuclides concentration from the stack, the formula 1 is modified as shown formula 2 when the effluent airflow from stack is applied.

$$C_i = Q_{i,s} \times \frac{1}{R_i} \qquad (2)$$

Where,
C_i: Release concentration from stack (Bq/m^3)
R_i: Airflow rate from stack (m^3/hr)

On the other hand, the EAL of the ground release is to establish from interrelation both HANARO specific leak rate and radioactive concentrations in the containment because there are no effluent monitors at the leakage points. It can express such as formula 3.

$$C_i = Q_{i,g} \times L_i \times t_{i,g} \qquad (3)$$

Where,
$Q_{i,q}$: Area air monitors of radionuclide i in containment (Bq/m^3)
L_i : Specific leak rate of radionuclide i from penetration (m^3/hr)
$t_{i,g}$: Ground release duration of radionuclide i (hr)

2.2 EALs Application for HANARO

To calculate the EALs from the formula 2 and 3, the effluent monitors for the General Emergency(GE) are reading that in 1 hour the doses at site boundary is applied greater than the protective action guide, i.e. 10mSv of whole body and 50mSv of thyroid. For the Site Area Emergency (SAE), the effluent monitors are that in 4 hour the dose at site boundary is applied greater than 0.1 of the protective action guide. The atmospheric dispersion factor $\frac{x}{Q}$ is applied 1.001 E-05 sec/m^3. This value is obtained from the annual average weather at maximum exposure point of site boundary, 800 meters by using XOQDOQ computer modeling program. R_i of formula (2) is 6,200 m^3/hr. L_i of formula (3) depending on both wind velocity and deferential pressure between outside and inside of the containment. It is ranging from zero to 530 m^3/hr, respectively. The radionuclides from the release are selected ^{85}Kr of noble gas, ^{131}I of halogen and ^{137}Cs of particulate to compensate in exposure point of view. DCF1 and DCF2 are refered the dose conversion factors provided by Sendia National Lab. of United States America [1].

The results of the stack release EALs are showed in the Table 1. The alert EALs are applied the release of radioactivity to environment great than 100 times the effluent management specification for HANARO. It is based on IAEA EPR-Research Reactor 2011 [2].

Table 1. EALs for the potential stack release (μCi/cc)

	GE	SAE	Alert
Noble Gas	>4.4E+01	>1.1E+00	>1.6E-03
Halogen	>6.2E-01	>4.1E-03	>1.0E-05
Particulate	>2.7E+00	>6.8E-02	>5.2E-05

For the EALs application due to the ground release from formula 3, it can be assumed that the leak rate is applied the maximum leak rate of 1,060 m^3/hr conservatively. However, because it is very unlikely to occur in any circumstance, the leak rate of 280 m^3/hr caused by annual average wind speed and differential pressure is more actuality. Therefore, the results of the ground release EALs are calculated as expression in the Table 2.

Table 2. EALs for the potential ground release (μCi/cc)

	GE	SAE	Alert
Noble Gas	>7.2E+03	>3.8E+02	>3.8E-01
Halogen	>5.6E+01	>6.3E-01	>2.7E-2
Particulate	>4.2E+02	>8.5E+00	>7.3E-03

The results of the table 1 and 2 aren't considered any radiological decay and ground deposition as well as building blocking effects when the plume is passing through the site boundary from the release points. The plume will reach to the site boundary. It is also applied to EALs such as formula 4 for the GE.

$$\mathrm{GE} = \frac{PAG}{t_d} \qquad (4)$$

Where,
PAG: Protective action guide
t_d: Continuous release time

The PAG is applied the evacuation action level of 50mSv. t_d is assumed that the release is continuous for 4 hours [3]. The GE is approximately 1mSv. It means that if any measured value at the site boundary is excess 1mSv or expect then any evacuation or substantial shelter should be recommended for the vicinity public. Generally, the SAE is applied 0.1 times of the PAG. The alert is applied 100 times of the site specific background. The thyroid committed dose is established in consideration of the 1;5 ratio of the PAG whole body and thyroid [4].

Therefore, the EALs at the site boundary are calculated simply as shown table 3.

Table 3. EALs at the site boundary

	GE	SAE	Alert
Whole body	1mSv/h	0.1mSv/h	10μSv/h
Thyroid	5mSv/h	0.5mSv/h	50 μSv/h

3. Conclusions

The results of table 1 and 2 will be higher than actual because the weather condition in real situation is difference. However, the EALs applying the potential stack release, ground release and site can be useful for research reactor HANARO making the emergency declaration. The EALs at the site boundary of the table 3 can be applied to protect the off-site public.

REFERENCES

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