# Evaluation of Leak Path Factor using MELCOR in Non-Nuclear Facilities

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## 1. Introduction

This paper presents a methodology to evaluate the Leak Path Factor (LPF) for a postulated accident scenario in a building containing uranium dioxide powder when the resulting outside release is partly through the ventilation and filtration system and partly through other pathways such as building access manifold. When analyzing an accident scenario involving the release of radioactive powders inside a facility, various pathways for the release to the outside environment can exist.

The goal of this paper is the calculation of the LPF, which represents the fraction of respirable radioactive particulate material that is made airborne that leaves the building through the various pathways.

The computer code used for LPF assessment is MELCOR. The analysis results can be used for the transport, dispersion of powder material released to the atmosphere and to estimate the LPF. The methodology suggested can be used as a model for performing analyses for systems similar in nature where releases can propagate to the outside environment via filtered pathways. This work provides guidance to analysts outlining the essential steps needed to perform a sound and defensible analysis [1].

## 2. Methods and Results

### *2.1 MELCOR*

MELCOR 1.8.5 was developed by Sandia National Laboratories under the support of the United Stated Nuclear Regulatory Commission. MELCOR is a fully integrated, engineering-level computer code whose primary purpose is to model the progression of accidents in LWPs (light water reactor nuclear power plants). MELCOR is a mature code with worldwide use for a wide spectrum of evaluating the Leak Path Factor for accident conditions in nonreactor nuclear facilities using its robust built-in model's capabilities in aerosol dynamics. MELCOR modeling is general and flexible, making use of a “control volume” approach in describing the plant/ facility system. The various code packages have been written using a modular structure with well-defined interfaces between them. The MELCOR code is composed of several modules for evaluating various phenomena taken place in the nuclear power plant systems. LPF analysis is possible with a number of modules including CVH package, RN package and HS package so as to establish modeling of the release and transport of aerosolized materials [2-5].

### *2.2 Analysis*

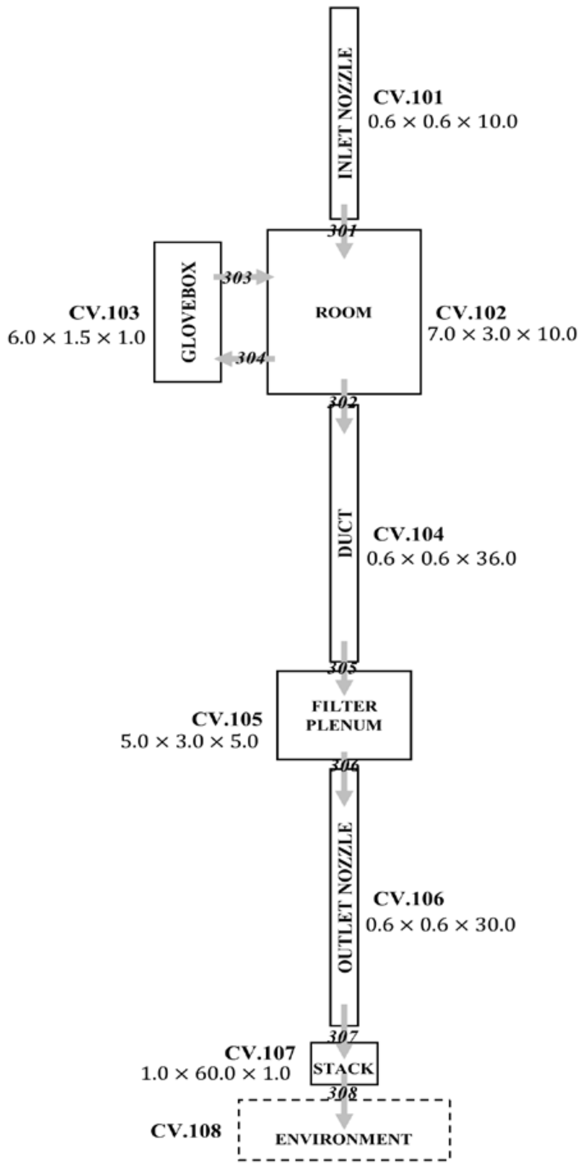


Figure 1. Sketch of the sample building

The first step for this analysis is to define the nodalization for the facility and make up MELGEN input file. Then the assessment of the LPF is followed with MELCOR input for transient calculation. Figure 1 is the facility nodalization defining the control volumes where materials transport and deposition.

An ideal nonreactor nuclear facility is the subject of this study. For this purpose, a sample building has been defined as Figure 1. This building consists of an inlet nozzle, a room, a glovebox, a duct, a filter plenum, an outlet nozzle, and stack. There is also the volume representing the environment for venting. The location selected for the spill is CV102 in Figure 1, where the release of uranium dioxide of 10kg takes place.

The building internal air temperature and the building outside environment temperature are assumed as 298K. The uranium dioxide powder particle size distribution used is obtained from pre-experimental data for free fall spills in the static air [2].

With all allowed information at hand, the MELCOR analysis can be done to evaluate the various contributors to the building overall leak path factor. It is needed to have an individual environmental volume for making the gas flow leading out of the building which is an important contributor to the overall LPF throughout the flow paths. An MELCOR analysis is performed spill location and the results provided show how the total building LPF is accounted for [1, 3-5].

The scenario postulated the elevated release of uranium dioxide powder in a non-radioactive facility resulting in the free-fall spill with unyielding surface.

Typical spills could result in a free-fall distance of 1.2meters from CV102. The mass of powder spilled is 10kg of $UO_2$. In this paper, two parameters are considered such as global decontamination factor for the filter and particle diameter.

Firstly, the filter in the ventilation system significantly reduces the amount of aerosolized material that exits the stack through the pathway. Global decontamination factor for the filter, DFG is obtained mass entering filter divide to mass not removed by a filter. DFG factor should be greater than or equal to 1. As a result, figure 2 shows the LPFs calculated by MELCOR with different DFGs.

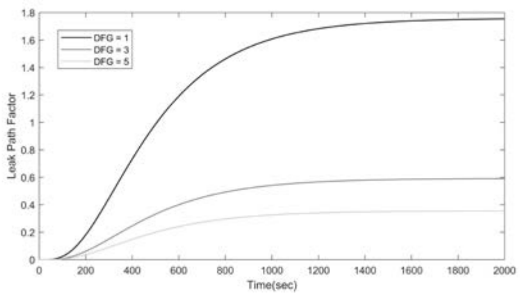


Figure 2. Leak Path Factor according to DFG of CV105

Secondly, the distribution of the particle size was seen to have considerable effects on the exit amount of the particles. Figure 3 shows the LPF transition according to the diameter of particles. It is found that the smaller particle size would have the lower LPF.

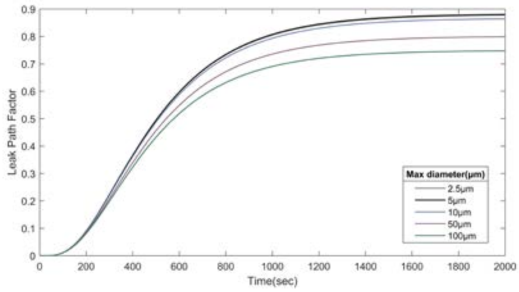


Figure 3. Leak Path Factor according to maximum diameter of aerosol

## 3. Conclusions

As a result, this paper presented a sample assessment of LPF (Leak Path Factor) for a spill release of uranium powder in the sample powder facility using MELCOR. The LPF is defined as the fraction of the airborne radioactive particulate material that is in the respirable size range within the building that escapes via available pathways to the outside environment.

The facility characteristic and the power source condition were imposed in the MELCOR calculation and the LPF could be quantified based on the calculation results. Also the effect of filter efficiency and the particle size on the LPF could be obtained in a reasonable way. The use of MELCOR for estimate LPF will be a viable methodology to evaluate a source term for the subsequent consequence analysis.

Further study will carry out additional studies to verify the methodology. MELCOR validates based on the verification test result, and we will perform analysis that is built on experience.

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