

## Air Filtering Unit Design of DUP Exhaust System in IMEF

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### 1. Introduction

The nuclear fuel and materials are transferred into and treated in the Irradiated Materials Examination Facility (IMEF). The contaminated air ventilated from a radiation region including a hot cell is exhausted to the atmosphere through the DUP air filtering unit in which a HEPA and a charcoal filter are installed.

Due to the deterioration of an existing filter bank in IMEF, four DUP filtering units will be designed, manufactured and installed.

Considering the serviceableness of a leak test and the reduction of the amount of radioactive wastes, a cartridge type charcoal filter is changed to a bulk type charcoal filter(Fig.1) in the DUP filtering unit.

### 2. Design and Construction

#### 2.1 General

- The AFU shall be designed and fabricated in accordance with codes, standards and regulations.
- The AFU shall be designed for ease of maintenance of replacement of filters.
- The pressure sensor of each equipment shall be capable of sensing differential pressure of filter.

#### 2.2 Capacity :

5,600 CMH/Unit, 4ea

#### 2.3 Filter Housing :

Housing shall be fabricated to meet the leakage criteria requirements in ASME 509. (4650\*910\*1945mm (L\*W\*H) Size)

#### 2.4 Filter Bank(1<sup>st</sup> Stage):

Pre HEPA filter( 610\*610\*292mm Size, min 99.97% efficiency at 0.3µm DOP) 2ea

#### 2.5 Filter Bank (2<sup>nd</sup> Stage):

Adsorber bank(Type III, 2" Bed, min 99.95% efficiency(Halide))

#### 2.6 Filter Bank(3<sup>rd</sup> Stage):

Post HEPA filter( 610\*610\*292mm Size, min 99.97% efficiency at 0.3µm DOP) 2ea

#### 2.7 Test canisters :

Test canisters shall be installed in a location where they will be exposed to the same airflow conditions as the absorbent in the system. 8ea

#### 2.8 Isolation Damper:

Isolation damper levers shall be easily operable to isolate the air flow to/from the AFU. 2ea

#### 2.8 The Others:

Door, Lighting, Temperature Sensor, PDI, DOP Sampling Manifold Port etc., .

### 3. Inspection and Testing

The Buyer has the right to inspect and witness Supplier's manufacturing and testing operations for the equipment. AFU inspection and testing shall be in accordance with ASME N509 and N510.

#### 3.1 AFU Housing

- Housing shall be visually inspected in the shop prior to shipping. Visual inspection shall be performed in accordance with applicable sections of ASME N510, Section 5.
- Housing or housing sections shall be leak tested in the shop prior to shipment in accordance with ASME N510, Section 6. Leakage shall not be greater than 0.1% of rated flow at the test pressure of 1.25 times maximum operating pressure.

- Calculate leak rate from the equation;

$$Q = (P_i/T_i - P_f/T_f)(V/\rho R \Delta t) \quad (1)$$

Where Q = average leakage rate(CMM)

V = volume within test boundary(m<sup>3</sup>)

P<sub>i</sub> = initial pressure within test boundary(Kg/m<sup>2</sup>)

P<sub>f</sub> = final pressure within test boundary(Kg/m<sup>2</sup>)

T<sub>i</sub> = absolute temperature at start of test(°K)

T<sub>f</sub> = absolute temperature at end of test(°K)

Δt = time interval

R = gas constant for air(29.4kg-m/kg °K)

- Air-aerosol mixing uniformity tests shall be performed in the shop for each manifold which is

provided by the manufacturer to be mounted within the filter housing.

### 3.2 In-place leak test for HEPA filter bank

-With the system fan operating, DOP aerosol is injected into the airstream of the HEPA filter bank. Concentration shall be determined upstream and downstream of the filter bank and percent penetration is calculates from the ratio of DOP concentrations in the filtered air (downstream value) to the unfiltered air (upstream value).

- Calculate leak rate from the equation;  

$$P=100(Cd/Cu) \quad (2)$$

Where P= % penetration  
 Cd =downstream concentration of aerosol  
 Cu = upstream concentration of aerosol

### 3.3 In-place leak test for Adsorber bank

-A hilide challenge gas is injected into the airstream upstream of the adsorber bank. Concentration shall be determined upstream and downstream of the

bank. Percent penetration is determined from the ratio of downstream to upstream.

- Calculate leak rate from the equation;  

$$P=100(Cd/Cu) \quad (3)$$

Where P= % penetration  
 Cd =downstream concentration of halide  
 Cu = upstream concentration of halide

## 4. Results and Consideration

Air filtering unit (AFU) is essential to prevent from the contamination of the air due to the ventilation of a contaminated air from a nuclear facility. This unit should be designed, manufactured and installed according to the regulations. We examined the bulk type charcoal filter(Type III) of the DUP air filtering unit that is to be installed in IMEF.

The results obtained in this study will be an important information to construct the nuclear facility in the future.

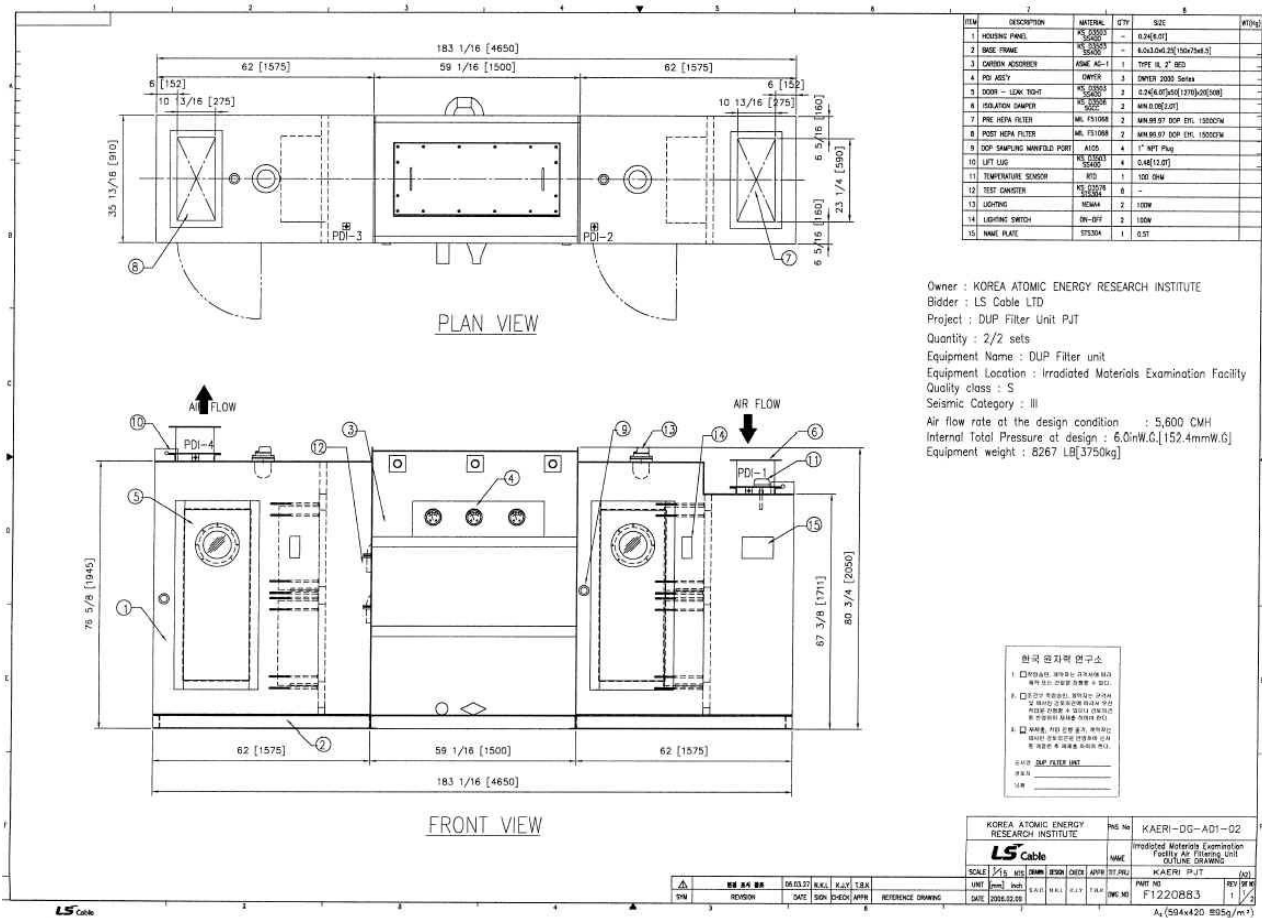


Fig. 1 Schematic Drawing of Air Filtering Unit in IMEF.