*Transactions of the Korean Nuclear Society Spring Meeting*
*Jeju, Korea, May 10-11, 2007*

# Operation of the Ventilation System in the HANARO FTL Rooms

D. Y. Chi, B. S. Sim, S. K. Park, K. N. Park, J. M. Lee, C. Y. Lee, S. H. Ahn
*HANARO Utilization Technology Division, 3-Pin Fuel Test Loop R&D Department, Korea Atomic Energy Research Institute, P.O.B 105, Yuseong, Daejeon, 305-353*
dychi@kaeri.re.kr

## 1. Introduction

According to the increasing demand for irradiation tests to develop new fuels, a 3-Pin FTL(Fuel Test Loop for 3 pin test fuel) facility is being designed to conduct in-core fuel performance tests at operating conditions, which will be installed in HANARO. The Ventilation system of the FTL will be dependent on that of the HANARO. The FTL has three equipments rooms, which are ; room 1, room 2 and the control room. The high pressure and high temperature equipments will be installed in room 1. The atmosphere of room 1 shall be maintained under the designed condition. This paper describes the design and operation of the FTL HVAC system in room 1 and the control room.

## 2. Design and Operation in the FTL Rooms

### *2.1 Design Criteria for Room 1*

The normal environment and operation conditions in room 1 are as follows :

- Temperature : 40 ~ 150 ℉ ( 4.4 ~ 65.5 ℃)
- Pressure : -0.25"w.g (-6.35 mmAq)
- Relative Humidity : 20 ~ 90 %RH
- Supplied Air Flow Rate : 1250CMH
- Ventilation Frequency : 6 times/hr

Supplied air conditions are as followings :

- Temperature : 25 ~ 27℃ in summer
  20 ~ 22℃ in winter
- Relative Humidity : 50+10%RH in summer
  40+5%RH in winter

### *2.2 Basic Equation and Calculation Method*

1) Generated heat from the electric motors

$$q_{em} = (P/E_M)F_{UM}F_{LM}$$

where, $q_{em}$ = generated heat (W)
P = motor capacity (W)
$E_M$ = motor efficiency
$F_{UM}$ = motor utility (under 1.0)
$F_{LM}$ = motor load (under 1.0)

2) Motor power and heat load

Motor power = [W(ℓ/MIN) × S.P(MAQ)] / [60 × 102 × η]
Heat load($q_c$) = GC($t_{room}$- $t_{inlet}$)
where, G (kg) : supplied air
C : specific heat of air (0.24 kcal/kg.℃hr)
$t_{inlet}$ : inlet air temperature (27 ℃)
$t_{room}$ : atmospheric room temperature

3) Calculation Method

The heat loads come from the lighting, hot pipe and equipment(pressurizer, heat exchangers, pumps and etc.). The air is supplied to room 1 from the reactor hall and exhausted to the stack via filters. The atmospheric room temperature is calculated from the equipments heat loads and the supplied air flow rate. This temperature is evaluated by using the design criteria requirements.

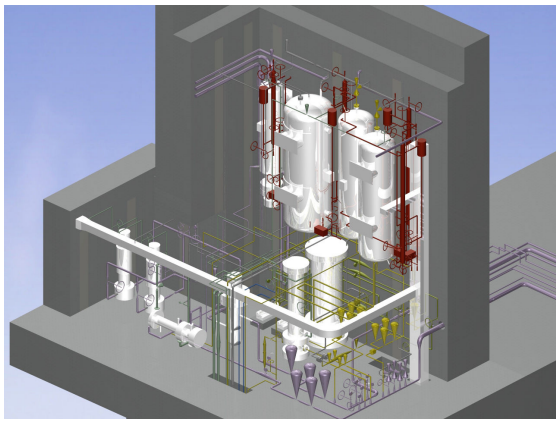

Figure 1. FTL Room 1 View and HVAC Duct

### *2.3 Input Data for the Calculation*

The major heat loads are as follows :

1) Lighting heat load at room temperature
$q_{lighting}$ = 2 kW

2) Heat load from the hot pipe and equipment

| Pipe or Equipments | Heat Dissipation(W) |
|---|---|
| Pipe-Recirculation | 142 |
| Pipe-Spray & Surge | 1,022 |
| Main Heater Vessel | 822 |
| Total ($q_{pipe}$) | 1,986 |

3) Pressurizer heat loss($q_{pressurizer}$) = 824 W

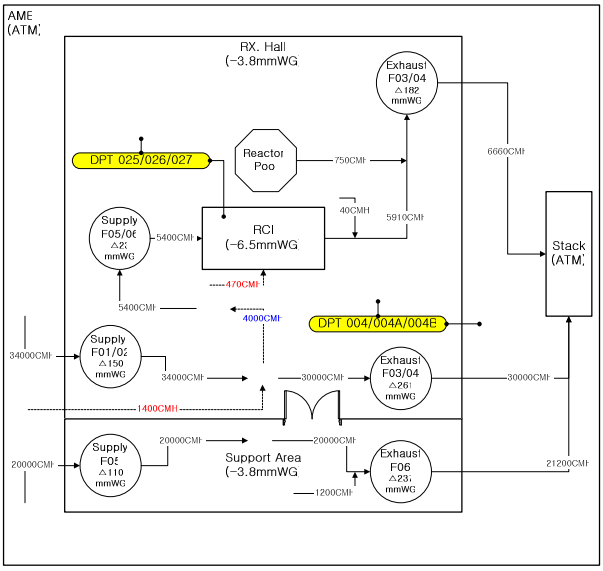


Figure 2. FTL Ventilation System in HANARO

### *2.4 Flow Calculation for the Control Room*

Basic Equation $P \cdot V = n \cdot \Re \cdot T$ $Q = mf \cdot C_p \cdot \Delta T$

Molar gas constant $\Re := 8.314472 \frac{joule}{mole \cdot K}$

Normal Condition $P_n := atm$ $T_n := 273.15K$

Standard Condition $P_s := atm$ $T_s := 273.15K + 20K$

Air (mixture) propertiesat 1.0 Atm Pressure, 20°C

Molecular Weight : $MW_{air} := 28.966 \frac{gm}{mol}$

Specific heat at p=constant : $Cp_{air} := 1.00510^3 \frac{J}{kg \cdot K}$

Specific gas costant : $\Re_{air} := \frac{\Re}{MW_{air}}$ $\Re_{air} = 287.042 \frac{J}{kg \cdot K}$

$Q := 8624 \frac{kcal}{hr}$ $T_{room} := 273.15K + 24K$ $T_{supply} := 273.15K + 13K$

$\Delta T := T_{room} - T_{supply}$ $\Delta T = 11K$

$mf_{air} := \frac{Q}{Cp_{air} \cdot \Delta T}$ $mf_{air} = 0.907 \frac{kg}{s}$

$Vf_{air\_normal} := \frac{mf_{air}}{\frac{atm}{\Re_{air}(T_n)}}$ $Vf_{air\_normal} = 2.527 \times 10^3 \frac{m^3}{hr}$

$Vf_{air\_supply} := \frac{mf_{air}}{\frac{atm}{\Re_{air}(T_{supply})}}$ $Vf_{air\_supply} = 2.648 \times 10^3 \frac{m^3}{hr}$

$Vf_{air\_standard} := \frac{mf_{air}}{\frac{atm}{\Re_{air}(T_s)}}$ $Vf_{air\_standard} = 2.712 \times 10^3 \frac{m^3}{hr}$

### *2.5 Calculation for Room 1 and Considerations*

1) Evaluation of the room temperature

The heat load(qroom#1) of FTL room 1 is,

qroom#1 = qlighting + qpipe + qpump + qpressurizer

= 5,300 W = 4,558 kcal/hr.

The room temperature of FTL room 1 is,

troom = (qc/GC) + tinlet = 39.7 ℃ (for summer)

This temperature fulfills the designed room temperature requirement(50℃). So an external cooling facility is not necessary.

2) Evaluation of the ventilation flow rate

The volume of FTL room 1 = 208 $m^3$.

The ventilation frequency(6 times/hr) is applied to the room volume for the air flow rate.

208 $m^3$ x 6 times/hr = 1,248 CMH.

This designed air flow rate(1,248CMH) fulfills the supplied air availability(1,250 CMH).

## 3. Conclusion

The HVAC air of FTL room 1 and the control room is supplied from the HANARO reactor hall. The atmospheric air temperature and flow rate are calculated and evaluated for the necessity of an external cooling facility in room 1. The room temperature is satisfactory for the design requirements and the supplied air is enough to remove the generated heat, so no external cooling facility is necessary.

## Acknowledgements

This work was performed under the Nuclear R&D Program of the Ministry of Science and Technology of Korea.

## REFERENCES

[1] Design Requirement for 3 Pin Fuel Test Loop, FL-070-DR-K001,
[2] Design Requirement for RCI Ventilation, KM-731-DR-P001.
[3] Equipment Capacity Calculation (HAN-FL-E-210-DC-H004, HAN-FL-E-210-DC-H004, HAN-FL-E-230-DC-H001)
[4] Heat Load Calculation - Others (HAN-FL-E-295-DC-H003)
[5] ASHRAE Fundamental Handbook, 1997
[6] Handbook for Facility Engineering, SAREK
[7] Handbook for Architectural Facility