**MITSUBISHI HEAVY INDUSTRIES, LTD.**
16-5, KONAN 2-CHOME, MINATO-KU
TOKYO, JAPAN

July 1, 2010

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffery A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-10185

**Subject: Amended MHI's Responses to US-APWR DCD RAI No.63-849 Revision 0, RAI No.64-735 Revision 0, RAI No.327-2401 Revision 1 and RAI No.356-2549 Revision 1.**

**References:**
1) "Request for Additional Information No. 63-849 Revision 0, SRP Section: 09.04.01 – Control Room Area Ventilation System, Application Section: Tier 2 FSAR Section 9.4.1" dated September 4, 2008.
2) "MHI's Responses to US-APWR DCD RAI No. 63, UAP-HF-08215, dated October 3, 2008"
3) "Request for Additional Information No. 64-735 Revision 0, SRP Section: 09.04.05 – Engineered Safety Feature Ventilation System, Application Section: Tier 2 FSAR Section 9.4.5" dated September 4, 2008.
4) "MHI's Responses to US-APWR DCD RAI No. 64, UAP-HF-08216, dated October 6, 2008"
5) "Request for Additional Information No. 327-2401 Revision 1, SRP Section: 09.04.01 – Control Room Area Ventilation System, Application Section: 9.4.1" dated April 8, 2009.
6) "MHI's Responses to US-APWR DCD RAI No. 327-2401 Revision 1, UAP-HF-09323, dated June 19, 2009"
7) "Request for Additional Information No. 356-2549 Revision 1, SRP Section: 09.04.05 – Engineered Safety Feature Ventilation System, Application Section: DCD Tier 2 FSAR Section 9.4.5 and 6.5.1" dated May 7, 2009.
8) "MHI's Responses to US-APWR DCD RAI No. 356-2549 Revision 1, UAP-HF-09386, dated July 17, 2009"

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") documents as listed in Enclosures.

Enclosed are the amended responses to RAIs contained within Reference 1, 3, 5 and 7.

This letter amends the previously transmitted answers submitted under MHI References UAP-HF-08215 on October 3, 2008 (Reference 2), UAP-HF-08216 on October 6, 2008 (Reference 4), UAP-HF-09323 on June 19, 2009 (Reference 6) and UAP-HF-09386 on July 17, 2009 (Reference 8) in order to reflect the design progress and the results of NRC audit held from May 24, 2010 to May 28, 2010.

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of this submittal. His contact information is provided below.

D081
NRO

Sincerely,

Y. Ogata

Yoshiki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Enclosures:

1. Amended Response to Request for Additional Information No. 63-849, Revision 0

2. Amended Response to Request for Additional Information No. 64-735, Revision 0

3. Amended Response to Request for Additional Information No. 327-2401, Revision 1

4. Amended Response to Request for Additional Information No. 356-2549, Revision 1

CC: J. A. Ciocco
C. K. Paulson

Contact Information
C. Keith Paulson, Senior Technical Manager
Mitsubishi Nuclear Energy Systems, Inc.
300 Oxford Drive, Suite 301
Monroeville, PA 15146
E-mail: ck_paulson@mnes-us.com
Telephone: (412) 373-6466

Enclosure 1

UAP-HF-10185
Docket Number 52-021

# Amended Response to Request for Additional Information No. 63-849, Revision 0

July, 2010

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

06/29/2010

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

| | |
|---|---|
| **RAI NO.:** | **NO.63 REVISION 0** |
| **SRP SECTION:** | **09.04.01 – CONTROL ROOM AREA VENTILATION SYSTEM** |
| **APPLICATION SECTION:** | **09.04.01 MAIN CONTROL ROOM HVAC SYSTEM** |
| **DATE OF RAI ISSUE:** | **09/04/2008** |

---

**QUESTION NO. : 09.04.01-14**

Provide additional details for the DCD section 9.4.1 calculations used to establish the equipment design data including: fan unit airflow, cooling coil, and heating coil capacities described in Table 9.4.1-1, including assumptions and margins. Provide sufficient calculations per SRP 9.4.1 Section IV.1.C to enable staff to support conclusions for the equipment design capacities listed above in Table 9.4.1-1.

---

## ANSWER:

The MCR air handling unit (AHU) fan airflow rate (design) is determined by required cooling supply airflow rate. Required cooling supply airflow rate is calculated by following formula.

$$Q = q / (\rho\ Cp\ (ti - to)\ 60)$$

where,

| | |
|---|---|
| Q | : Supply airflow rate (CFM) |
| q | : Heat load (BTU/h) |
| ρ | : Density (0.075 lb/ft$^3$) |
| Cp | : Specific heat (0.24 BTU/lb-F) |
| ti | : Design room temperature (deg F) |
| to | : Supply air temperature (deg F) |

The design airflow rate of each room is as follows:

| Area | Heat Load (BTU/h) | Required Cooling Supply Airflow Rate (CFM) | Design Airflow Rate (CFM) |
|---|---|---|---|
| MCR | ~~131,000~~**132,000** | ~~9,330~~**10,812** | 11,000 |
| Other | ~~105,000~~**106,000** | ~~7,480~~**8,682** | 9,000 |
| Total | - | - | 20,000 |

Note 1: Heat load of each area is assumed based on the existing plant experience.
Note 2: Design airflow rate includes margin more than 15%.

The cooling coil capacity of MCR AHU is determined by sum of following heat loads **in consideration of the normal operation mode and the emergency pressurization mode conditions:**

| | | **Normal Operation Mode** | **Emergency Pressurization Mode** |
|---|---|---|---|
| Outdoor Air | | ~~63,000~~**62,000**BTU/h | **47,000BTU/h** |
| Fan ~~Motor~~ | **AHU Fan** | 59,000 BTU/h | **62,000BTU/h** |
| | **EFU Fan** | **-** | **18,000BTU/h** |
| Room Internal Load | | ~~118,000~~**119,000**BTU/h | **119,000BTU/h** |
| **EFU Electric Heating Coil** | | **-** | **71,000BTU/h** |
| Moisture | | ~~83,000~~**88,000**BTU/h | **-** |
| Margin | | ~~18,000~~**13,000**BTU/h | **24,000BTU/h** |
| Total | | 341,000BTU/h | **341,000BTU/h** |

Note: Each cooling load includes a margin of 15%.

The calculations used to establish the equipment design date of MCR emergency filtration unit is provided by the response to RAI No.49 Question No.06.04-4.

**Impact on DCD**

There is no impact on the DCD.

**Impact on COLA**

There is no impact on the COLA.

**Impact on PRA**

There is no impact on the PRA.

Enclosure 2

UAP-HF-10185
Docket Number 52-021

# Amended Response to Request for Additional Information No. 64-735, Revision 0

July, 2010

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**06/29/2010**

**US-APWR Design Certification**
**Mitsubishi Heavy Industries**
**Docket No. 52-021**

| | |
|---|---|
| **RAI NO.:** | **NO.64-735 REVISION 0** |
| **SRP SECTION:** | **09.04.05 – Engineered Safety Feature Ventilation System** |
| **APPLICATION SECTION:** | **Tier 2 FSAR Section 9.4.5** |
| **DATE OF RAI ISSUE:** | **9/04/2008** |

---

**QUESTION NO. : 09.04.05-1, RAI 9.4.5-3**

The US APWR DCD section 9.4.5.2.1 indicates the annulus emergency exhaust system draws down the penetration and safeguarded component areas to a negative pressure of 0.25 in. wg with regard to adjacent areas. SRP 9.4.5 section III.1 requires a review for normal and emergency operations, and the ambient temperature limits for the areas serviced. Provide calculation procedures and methods, including assumptions and margins supporting maintaining a negative pressure of 0.25 in. wg.

---

**ANSWER:**

The annulus emergency exhaust system fan airflow rate (design) is determined following design basis.

(1) Design Condition
   a) Target negative pressure : 0.4in.wg. (> 0.25 in.wg.)
   b) Requirement time for achieving target negative pressure : 180 sec. (< 240 sec)
   c) Requirement time for achieving design fan speed : 130 sec ~~(assumption)~~

(2-1) Required Airflow Rate for the Penetration Area
The required airflow rate for achieving target negative pressure is calculated by following equation.

$$Q_a = \frac{60 \cdot (P + \Delta P_a') \cdot V_a}{P_{ai} \cdot (T_a - T_f)} + Q_{al}$$

Where,

| | | |
|---|---|---|
| $Q_a$ | : Required Airflow Rate | $ft^3/min$ |
| P | : Target Negative Pressure | 0.4in.wg. |

| | | |
|---|---|---|
| $\Delta P_a'$ | : Effect of the expansion of CV ~~(assumption)~~. | ~~0.6~~**0.8**in.wg. |
| $V_a$ | : Volume of the Penetration area | ~~494,000~~**441,022**$ft^3$ |
| $P_{ai}$ | : Initial Pressure (Std Ambient Pressure) | 407in.wg. |
| $T_a$ | : Requirement time for achieving target negative pressure | 180sec |
| $T_f$ | : Requirement time for achieving design fan speed | 130sec |
| $Q_{al}$ | : Maximum allowable in-leak ~~(assumption)~~ | 1,500$ft^3$/min |

Therefore,

$$Q_a = \frac{60 \cdot (0.4 + 0.8) \cdot 411{,}022}{407 \cdot (180 - 130)} + 1{,}500 = \cancel{2{,}957}\ \mathbf{2{,}955} \times 1.15 \text{ (margin)} = \cancel{3{,}401}\mathbf{3{,}399},\ \mathbf{USE}$$

**3,500 $ft^3$/min**

(2-2) Required Airflow Rate for the Safeguard Component Area
The required airflow rate for achieving target negative pressure is calculated by following equation.

$$Q_s = \frac{60 \cdot P \cdot V_s}{P_{si} \cdot (T_a - T_f)} + Q_{sl}$$

Where,

| | | |
|---|---|---|
| $Q_s$ | : Required Airflow Rate | $ft^3$/min |
| P | : Target Negative Pressure | 0.4in.wg. |
| $V_s$ | : Volume of the Safeguard Component Area | ~~289,300~~**312,426**$ft^3$ |
| $P_{si}$ | : Initial Pressure (Std Ambient Pressure) | 407in.wg. |
| $T_a$ | : Requirement time for achieving target negative pressure | 180sec |
| $T_f$ | : Requirement time for achieving design fan speed | 130sec |
| $Q_{sl}$ | : Maximum allowable in-leak ~~(assumption)~~ | 1,500$ft^3$/min (42$m^3$/min) |

Therefore,

$$Q_a = \frac{60 \cdot 0.4 \cdot 312{,}426}{407 \cdot (180 - 130)} + 1{,}500 = \cancel{1{,}842}\ \mathbf{1{,}869} \times \cancel{1.15}\mathbf{1.10} \text{ (margin)} = \cancel{2{,}119}\mathbf{2{,}056},\ \mathbf{USE\ 2{,}100}$$

**$ft^3$/min**

(3) Fan Airflow rate
The fan airflow rate Q is **5,600 $ft^3$/min**

**Impact on DCD**

There is no impact on the DCD.

**Impact on COLA**

There is no impact on the COLA.

**Impact on PRA**

There is no impact on the PRA.

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**06/29/2010**

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

| | |
|---|---|
| **RAI NO.:** | **NO.64-735 REVISION 0** |
| **SRP SECTION:** | **09.04.05 – Engineered Safety Feature Ventilation System** |
| **APPLICATION SECTION:** | **Tier 2 FSAR Section 9.4.5** |
| **DATE OF RAI ISSUE:** | **9/04/2008** |

---

**QUESTION NO. : 09.04.05-1, RAI 9.4.5-4**

The US APWR DCD section 9.4.5.2.2.2 indicates the volume of air exhausted from the battery rooms (Class 1E Electrical Room HVAC system) is sufficient to maintain the hydrogen concentration well below 2%. SRP 9.4.5 section III.1 requires a review for normal and emergency operations, and the ambient temperature limits for the areas serviced. Provide calculation procedures and methods, including assumptions and margins supporting maintaining the hydrogen concentration below 2% by volume for the battery rooms.

---

**ANSWER:**

**The Class 1E battery room exhaust fan capacity is designed to exhaust battery room air to limit concentration of the hydrogen below 1% not 2% by volume in accordance with Regulatory Gide 1.128 and 1.189 and the responses to RAI #388, Question No. 08.03.02-15.**
The necessary ventilation airflow for the Class 1E battery room is calculated by the following equation:

$$Q = v \cdot q \cdot s \cdot Igas \cdot Cn/100$$

where,

$Q$ = Ventilation air flow [$ft^3$/min]
$v$ = Dilution factor : ~~50~~**99**
$q$ = Maximum hydrogen evolution rate : 0.000269 [$ft^3$/min per charging ampere per cell] (Note1)
$s$ = Number of Cell
$Igas$ = Current producing gas during the gassing phase of charge [Amp/100Ah]
$Cn$ = Nominal capacity [Ah]

Note1: IEEE Std 484$^{TM}$ – 2002

**Impact on DCD**

There is no impact on the DCD.

**Impact on COLA**

There is no impact on the COLA.

**Impact on PRA**

There is no impact on the PRA.

06/29/2010

**US-APWR Design Certification**
**Mitsubishi Heavy Industries**
**Docket No. 52-021**

| | |
|---|---|
| **RAI NO.:** | **NO.64-735 REVISION 0** |
| **SRP SECTION:** | **09.04.05 – Engineered Safety Feature Ventilation System** |
| **APPLICATION SECTION:** | **Tier 2 FSAR Section 9.4.5** |
| **DATE OF RAI ISSUE:** | **9/04/2008** |

**QUESTION NO. : 09.04.05-1, RAI 9.4.5-22**

DCD Section 9.4.5.4, second paragraph reads that ".... *The air handling units airflows are balanced to provide proper air mixing throughout the served areas*". Neither DCD Section 9.4.5 nor its related Tables and Figures, provide design airflow rates to the areas served to ensure proper air mixing and as in the case of the Annulus Emergency Exhaust System to ensure the capability to control airborne particulate material accumulation as required by SRP 9.4.5 Section I.2.F. Please provide design air flow rates to the plant areas served by ESF Ventilation System.

## ANSWER:

The design airflow rates for various Engineered Safety Features (ESF) Ventilation System presented in US-APWR DCD, Rev. ~~0~~**2**, are summarized in the Table below.

| ESF Ventilation System | Table | CFM | Figure |
|---|---|---|---|
| Annulus Emergency Exhaust System (See Note 2) | 9.4.5-1 | 5,600 | 9.4.5-1 |
| Class 1E Electrical Room HVAC System (See Note 3 & 4) | 9.4.5-1 | ~~53,000~~**40,000** - Train A & B | 9.4.5-2 |
| | | ~~65,000~~**52,000** - Train C & D | |
| Safeguard Component Area HVAC System (See Note 1 & 4) | 9.4.5-1 | ~~7,100~~**5,000** | 9.4.5-3 |
| Emergency Feedwater Pump Area HVAC System (See Note 1) | 9.4.5-1 | ~~2,300~~ **2,100**- Motor Driven | 9.4.5.4 |
| | | ~~1,200~~ **1,300**– Turbine Driven | |
| Safety Related Component Area HVAC System (See Note 1) | 9.4.5-1 | 1,000 - Annulus Emergency Filtration Unit Area | 9.4.5-1<br>9.4.5-5 |
| | | 5,000 Penetration area | |
| | | 1,000 - Charging Pump Area | 9.4.5-5 |

| | | | |
|---|---|---|---|
| | | 1,000 - CCW Pump Area | 9.4.5-5 |
| | | 1,000 - Essential Chiller Unit Area | 9.4.5-5 |
| | | **1,500 - Spent Fuel Pit Pump Area** | **9.4.5-5** |

Notes:

1. The above airflow rates for Safeguard Component Area, Emergency Feedwater Pump Area, and Safety Related Component Area HVAC System are during a design basis accident or LOOP conditions. The corresponding cooling is provided by individual air handling units.
2. Annulus Emergency Exhaust System has two 100% capacity emergency exhaust filtration units, each capable of performing its safety function under all associated design basis accidents coincident with LOOP.
3. Class 1E Electrical room HVAC system consists of four redundant trains, each is sized to satisfy 100% of the cooling and heating demand of two trains, i.e., train A or B can provide cooling and heating for both trains A & B, and train C or D can provide cooling and heating for both trains C & D.
4. Airflows into each individual space will be determined during the detail design phase.

The design air flow rates required for proper air mixing throughout the various areas served by the Engineered Safety Features (ESF) Ventilation Systems will be decided during the detail design phase.

**Impact on DCD**

There is no impact on the DCD.

**Impact on COLA**

There is no impact on the COLA.

**Impact on PRA**

There is no impact on the PRA.

Enclosure 3

UAP-HF-10185
Docket Number 52-021

Amended Response to Request for Additional Information
No. 327-2401, Revision 1

July, 2010

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**06/29/2010**

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

| | |
|---|---|
| **RAI NO.:** | **NO.327-2401 REVISION 1** |
| **SRP SECTION:** | **09.04.01 – Control Room Area Ventilation System** |
| **APPLICATION SECTION:** | **Tier 2 DCD FSAR Section 9.4.1** |
| **DATE OF RAI ISSUE:** | **04/08/2009** |

---

**QUESTION NO. : 09.04.01-5**

The staff finds the applicant's response for RAI #63-849/Question No.09.04.01-14 as incomplete.

The Staff has the following questions/concerns with the applicant's response:

(a) Note 1 of applicant's response reads "Heat Load of each area is assumed based on existing plant experience".

The head loads in each area need to be specified in the FSAR and need to be verified prior to operation. Please include in the FSAR the design basis heat loads and propose a ITAAC and a startup test to verify the actual heat load are bounded by the analysis.

(b) The Staff requests access to heat load calculations that provide the quantitative numbers for Outdoor Air, Fan Motor etc. in the applicant's response. The staff needs this access to perform of confirmatory calculations to support write up of the SER.

(c) The "Note" that follows the second Table of the applicant's response reads "Each cooling load includes a margin of 15%" By this Note it appears that the actual heat load for the MCR AHUs equals 274,550 Btuh and the "Total" 341,000 Btuh then represents an excess margin of 24.2%. Why would the Heat Load values used in the derivation of needed fan capacities (i.e. first Table of applicants response) not use 341,000 Btuh instead of 236,000 Btuh (i.e. 131,000 + 105,000) to determine needed design flow rates?

From this observation, it appears that the fans may be undersized and not have the 15% margin described in Note 2.

(d) The line item heating coil capacity listed as 45 kW in Revision 0 DCD Table 9.4.1-1 for the Main Control Room AHUs has been removed from the Table in its entirety in Revision 1 of the DCD.

Why is there no line item in Table 9.4.1-1 for the heating coil in Revision 1 of the DCD and designated as a COL information item [i.e. COL 9.4(4)]? If it is not a COL information item, how will the heating coil capacity be determined?

(e) Assuming that the applicant's heat load values of the second Table of the applicant's response numbers are based on design calculations (and not existing plant experience) AND are based on the worst case design basis accident or anticipated operational occurrence (with respect to MCR heat load), does not the 274,550 Btuh then become the "Assumed Heat Load" that needs to be demonstrated in SR 3.7.10.5?

If not, what is the value of the "Assumed Heat Load" that must be demonstrated in SR 3.7.10.5? And, how is this value derived?

---

**ANSWER:**

(a) Note1 is deleted in the response for RAI #63-849/Question No.09.04.01-14 because Heat Load of each area is not assumed based on existing plant experience but designed values.

The ITACC to verify the actual heat load is bounded by the analysis has been addressed in MHI's response to RAI No.184 Question No. 14.03.07-26 transmitted by UAP-HF-09166 dated 04/09/2009.

(b) The heat load evaluated for Outdoor Air, Fan Motor etc is calculated by following formula. The following heat loads indicate the 100% cooling requirements for the MCR AHUs~~ except for Fan Motor~~. These are designed as four 50% capacity supply system. Therefore, the cooling requirements per AHU will be in half.

**The heat load during the normal operation mode is as follows:**

Outdoor Air:

$q = 60 \times \rho \times Q \times \Delta h \times 1.15 =$ ~~124,821~~ **123,890** BTU/h

Therefore, Outdoor Air load per unit is ~~62,411~~ **61,945** (=q/2), USE ~~63,000~~**62,000** BTU/h

where,

q : Outdoor air load (BTU/h)
$\rho$ : Density (0.075 lb/ft$^3$)
Q : Supply airflow rate (1800 CFM)
$\Delta h$ : enthalpy change (~~13.4~~ **13.3**BTU/lb)

**AHU** Fan **and** Motor :

$q = 2545 \times 0.000157 \times H \times Q / (\eta_f \times \eta_m) \times 1.15 =$ ~~58,349~~**58,350**, USE 59,000 BTU/h

where,

q : Fan motor load (BTU/h)
H : Fan motor total pressure (8.0 in. of water)
Q : Fan flow rate (10,000 CFM)
$\eta_f$ : Fan efficiency (0.7)
$\eta_m$ : Motor efficiency (0.9)

Room Internal Load :

$q = (q_1+q_2+q_3+q_4) \times 1.15 =$ ~~235,060~~ **236,854** BTU/h

Therefore, Room Internal Load per unit is ~~117,530~~ **118,427** (=q/2), USE ~~118,000~~**119,000** BTU/h where,

- q : Room Internal load (BTU/h)
- $q_1$ : Component (~~45,200~~ **45,050** BTU/h)
- $q_2$ : Lighting (~~67,600~~ **67,530** BTU/h)
- $q_3$ : People (9,100 BTU/h)
- $q_4$ : heat load through the concrete walls (~~82,500~~ **84,280** BTU/h)

Moisture :

**Moisture load associated with the operation of humidifier is below:**

$q=60 \times \rho \times Q \times \Delta h \times 1.15=$ ~~165,600~~ **175,950** BTU/h

Therefore, Moisture load per unit is ~~82,800~~ **87,975** (=q/2), USE ~~83,000~~**88,000** BTU/h

where,

- q : Moisture load (BTU/h)
- $\rho$ : Density (0.075 $lb/ft^3$)
- Q : Room internal flow rate(AHU flow rate) (20,000 CFM)
- $\Delta h$ : enthalpy change (~~1.6~~ **1.7** BTU/lb)

**The heat load during the emergency pressurization mode is as follows:**

**Outdoor Air:**

**$q=60 \times \rho \times Q \times \Delta h \times 1.15=93{,}771$ BTU/h**

**Therefore, Outdoor Air load per unit is 46,886 (=q/2), USE 47,000 BTU/h**

**where,**

- **q : Outdoor air load (BTU/h)**
- **$\rho$ : Density (0.075 $lb/ft^3$)**
- **Q : Supply airflow rate (1200 CFM)**
- **$\Delta h$ : enthalpy change (15.1BTU/lb)**

**AHU Fan and Motor:**

**$q=2545 \times 0.000157 \times H \times Q / (\eta_f \times \eta_m) \times 1.15=61{,}851$, USE 62,000 BTU/h**

**where,**

- **q : Fan motor load (BTU/h)**
- **H : Fan motor total pressure (8.0 in. of water)**
- **Q : Fan flow rate (10,600 CFM)**
- **$\eta_f$ : Fan efficiency (0.7)**
- **$\eta_m$ : Motor efficiency (0.9)**

**EFU Fan:**

**$q=2545 \times 0.000157 \times H \times Q / \eta_f \times 1.15=17{,}251$, USE 18,000 BTU/h**

**where,**

**q : Fan motor load (BTU/h)**
**H : Fan motor total pressure (7.3 in. of water)**
**Q : Fan flow rate (3,600 CFM)**
**$\eta_f$ : Fan efficiency (0.7)**

**EFU Electric Heating Coil:**
**Heat gain from MCR EFU electric heating coil is 18kW.**
**Therefore, cooling load of heating coil is 71,000 BTU/h in consideration of the margin of 15%.**

**Room Internal Load :**
**Room internal load during the emergency pressurization mode is equivalent to the normal operation mode condition.**

**Moisture:**
**Moisture load associated with humidification is not considered because the operation of humidifier is not required during the emergency pressurization mode as described in RAI# 475-3780 Question 09.04.01-13.**

(c) The cooling coil capacity was originally calculated in the early stages of design. Then each heat load capacity changed during detailed design, but the cooling coil capacity was kept constant to be conservative. So the total heat load that the MCR AHUs remove by the cooling coil equals 341,000 Btu/h.

(d) The heating capacity and cooling capacity is calculated by the component heat load and the outside air condition. The design minimum ambient air temperature for the standard plant design (i.e. -40F;for safety-related HVAC system) is the extreme condition. Therefore, the heating capacity changes significantly according to the minimum design outside air condition. So MHI considers that the heating coil capacity in Revision 1 of the DCD is a COL information item as site-specific. The COL information item is also specified in Revision 1 of the DCD Subsection 9.4.1.2.

(e) The heat load values are calculated on the condition that the design condition is the worst case condition. The cooling coil capacity is designed 341,000 Btu/h in the light of the margin. So MHI consider that the values should be confirmed in SR.3.7.10.5 is 341,000 Btu/h that is the cooling coil capacity.

**Impact on DCD**

There is no impact on the DCD.

**Impact on COLA**

There is no impact on the COLA.

**Impact on PRA**

There is no impact on the PRA.

Enclosure 4

UAP-HF-10185
Docket Number 52-021

Amended Response to Request for Additional Information
No. 356-2549, Revision 1

July, 2010

# RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**06/29/2010**

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

| | |
|---|---|
| **RAI NO.:** | **NO.356-2549 REVISION 1** |
| **SRP SECTION:** | **09.04.05 –Engineered Safety Feature Ventilation System** |
| **APPLICATION SECTION:** | **Tier 2 DCD Sections 9.4.5 and 6.5.1** |
| **DATE OF RAI ISSUE:** | **05/07/2009** |

---

**QUESTION NO. : 09.04.05-3**

The staff finds the applicant's response for RAI #64-735 / Question Number RAI 9.4.5-3 as incomplete. In its response, the applicant provided two formulas with a supporting calculation that derived the required air flow rates for the Penetration Areas and the Safeguard Component Areas of the plant. The derived value from this calculation for the air flow rate of the Annulus Emergency Exhaust Filtration Unit equals 5,600 ft3/min. This is consistent with value found in Table 9.4.5-1 for the Annulus Emergency Exhaust Filtration Unit.

The staff requests additional information for the following questions:

a. In reviewing the calculation it is not obvious to the staff the origin of the equations used. What is the source of these equations?
b. In addition, staff could not locate values for the volume of the penetration areas nor the volume of the safeguard component areas within DCD Chapter 3 "Design of Structures,Systems,Components and Equipment". Are these values documented elsewhere in Tier 2 of the DCD?
c. What is the basis for the assumptions used in the two equations? In particular, the "Effect of the expansion of CV" and the "Maximum allowable in-leak" for the two areas.
d. What amount or percentage of the in-leakage into the Penetration Area and the in-leakage into the Safeguard Component Area comes from the Containment leakage?
e. How did the applicant account for effects of the outside environment and associated uncertainty on the drawdown rate?

---

**ANSWER:**

a. The origin and source of the equations described Question Number RAI 9.4.5-3 (2-1), (2-2) is the Boyle's law. In the light of the ideal gas, the pneumatic energy discharged until achieving target negative pressure is equaled with the pneumatic energy in the Penetration Area at the target negative pressure.

b. The volume of the penetration areas and the safeguard component areas are not documented in Tier 2 of the DCD. The volume of the penetration areas is ~~494,000~~**<u>411,022</u>**ft$^3$, and the volume of the safeguard component areas is ~~289,300~~**<u>312,426</u>**ft$^3$.

c. The “Effect of the expansion of CV” is calculated by following equation.

$\Delta P = P \times \{V / (V - \Delta V) - 1\}$ ~~x 1.5~~
=~~0.4~~**0.67**, USE ~~0.4~~**0.8**inWG

where,

$\Delta P$ : Effect of the expansion of CV (inWG)
P : Initial Pressure (407 inWG)
V : Volume in the Penetration Area (~~494,000~~ **411,022** $ft^3$)
$\Delta V$ : Volume Decrease in the Penetration Area (~~488.1~~ **675.9** $ft^3$)

The volume decrease in the Penetration Area

$\Delta V =$ **3.14 x** $\{(Rcvo + \Delta R)^2 - Rcvo^2\} \times h$
=~~488.1~~ **675.85** USE ~~488.1~~**675.9** $ft^3$

where,

$\Delta V$ : Volume Decrease in the Penetration Area ($ft^3$)
Rcvo : External Radius of CV (78.92 ft)
$\Delta R$ : Expansion Rate of CV (~~0.013~~ **0.018** ft)
h : Altitude of the Penetration Area (75.75 ft)

The Penetration Area is conservatively assumed that it surrounds CV.

The expansion rate of CV : $\Delta R$

$\Delta R = P \times R^2/(E \times t)\ (1-\upsilon/2)$
=~~0.013~~**0.0177**, USE ~~0.013~~**0.018**ft (conservative)

where,

$\Delta R$ : Radius Displacement of CV (ft)
P : Internal Pressure of CV (68 psi)
R : Average Radius of CV (76.75 ft)
t : Thickness of CV (4.33 ft)
E : Young's Modulus of Concrete (4,769 ksi)
$\upsilon$ : Poisson Ratio (0.17)

The “Maximum allowable in-leak” for the two areas is the design value based on the experience of the ~~domestic~~**Japanese** PWR plants.

d. The in-leakage into the penetration area comes from the containment leakage is 50 percent **of the containment leakage**. The in-leakage into the safeguard component area comes from containment leakage is no considered. **The remained 50 percent of the containment leakage is the leakage to the environment.** This information is described in DCD Tier 2, Chapter 15, Table 15.6.5-4.

e. The specific account for effect of the outside environment and associated uncertainty on the drawdown rate is not considered in this calculation. However, margin in calculation is considered 15 percent, and the allowable in-leak has actually enough margin. Hence, those uncertainties are included in these margins.

**Impact on DCD**

There is no impact on the DCD.

**Impact on COLA**

There is no impact on the COLA.

**Impact on PRA**

There is no impact on the PRA.

This completes MHI's responses to the NRC's questions.

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**06/29/2010**

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

| | |
|---|---|
| **RAI NO.:** | **NO.356-2549 REVISION 1** |
| **SRP SECTION:** | **09.04.05 –Engineered Safety Feature Ventilation System** |
| **APPLICATION SECTION:** | **Tier 2 DCD Sections 9.4.5 and 6.5.1** |
| **DATE OF RAI ISSUE:** | **05/07/2009** |

---

**QUESTION NO. : 09.04.05-4**

The staff finds the applicant's response for RAI #64-735 / Question Number RAI 9.4.5-4 as insufficient. The applicant in its response provided a basic formula with no US-APWR plant specific design data for calculating the necessary ventilation airflow for the Class 1E battery rooms.

The staff anticipated that the applicant would respond with a detailed engineering calculation, with relevant and realistic assumptions and margins, based on plant design parameters (e.g. room size, number of batteries etc). This calculation would yield an air flow value to the Class 1E battery rooms that will ensure hydrogen concentration levels within the battery rooms remain well below a threshold value of 2%. This engineering calculation would provide the basis for the Class 1E Battery Room Exhaust Fan size (with adequate margins) identified in DCD Table 9.4.5-1.

From the applicant's response, the staff has to draw the conclusion that the detailed design phase of the US-APWR is not complete. Should the detailed design phase be delayed and deferred to the COL applicant stage, the staff cannot satisfy the review requirements of SRP 9.4.5 "Areas of Review" section I.2. In particular, item D.

D. The capability of the system to circulate sufficient air to prevent accumulation of flammable or explosive gas or fuel-vapor mixtures from components such as storage batteries and stored fuel;

If the detailed design phase is to be delayed and deferred to the COL applicant, then at a minimum the staff recommends that applicant create a Combined License Information item in DCD section 9.4.7 to capture this expectation and commitment. Alternatively or in addition to, the staff requests that the applicant consider establishing an ITAAC or a Condition for Licensing that provides the guarantee that the COL applicant satisfies the requirements of item D above.

Pursuant to the requirements of RG 1.206 the DCD needs to contain a design of sufficient detail so that the staff can perform its own set of confirmatory calculations (on a select basis) or review the applicant's calculations to support the writing of the Safety Evaluation Report.

The staff requests that the applicant redress its response to RAI 9.4.5-4 to allow the staff to complete its DCD review requirements.

If the applicant's response to this RAI warrants an amendment of the DCD, the staff requests that the applicant include in their response the revision of the DCD that the amendment will appear in.

---

**ANSWER:**

Air flow capacity of the Class 1E Battery Room Exhaust Fan was originally decided in early design stage as 5,200 cfm including conservative assumption and margin. Afterward MHI confirmed that this air flow capacity is sufficient to maintain hydrogen concentration levels within the battery rooms well below ~~2~~1%. The necessary ventilation air flow for the Class 1E battery room is calculated by the following equation:

Q = v x q x s x n x Igas x Cn x $10^{-3}$

= ~~403.6~~**815.6**

where,

Q = Ventilation air flow (CFM)
v = Necessary dilution factor : (100-~~2~~1)/~~2~~1 = ~~49~~**99**
q = Maximum hydrogen evolution rate : 0.000269 ($ft^3$/min per charging ampere per cell)
s = Safety factor : 5
n = Number of Cell : 120
Igas = Current producing gas in mA per Ah : 20 Amp/Ah (Note1)
Cn = Nominal capacity : 2552 Ah

Note1: EN 50272-2 : 2001

Hence, the air flow capacity of the Class 1E Battery Room Exhaust Fan is sufficient to maintain hydrogen concentration levels within the battery rooms well below ~~2~~1%.

**Impact on DCD**

There is no impact on the DCD.

**Impact on COLA**

There is no impact on the COLA.

**Impact on PRA**

There is no impact on the PRA.

This completes MHI's responses to the NRC's questions.

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**06/29/2010**

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

| | |
|---|---|
| **RAI NO.:** | **NO.356-2549 REVISION 1** |
| **SRP SECTION:** | **09.04.05 –Engineered Safety Feature Ventilation System** |
| **APPLICATION SECTION:** | **Tier 2 DCD Sections 9.4.5 and 6.5.1** |
| **DATE OF RAI ISSUE:** | **05/07/2009** |

---

**QUESTION NO. : 09.04.05-9**

The staff finds the applicant's response for RAI #64-735 / Question Number RAI 9.4.5-22 as insufficient. The applicant in its response did not provide any additional information for design flow rates for the four subsystems of the ESF Ventilation System beyond what was already in the DCD.

The applicant indicates in Note 4 of their response that airflows into each individual space will be determined during the detail design phase. If the detailed design phase is delayed and deferred to the COL applicant stage, the staff cannot satisfy the review requirements of SRP 9.4.5 "Areas of Review" section I.2. In particular, items A, D and F.

A. The ability of the heating and cooling systems to maintain a suitable ambient temperature range in the areas serviced, assuming proper performance of equipment contained in these areas;

D. The capability of the system to circulate sufficient air to prevent accumulation of flammable or explosive gas or fuel-vapor mixtures from components such as storage batteries and stored fuel;

F. The capability of the system to control airborne particulate material accumulation.

If the detailed design phase is to be delayed and deferred to the COL applicant, then at a minimum the staff recommends that applicant create a Combined License Information item in DCD section 9.4.7 to capture this expectation and commitment. Alternatively or in addition to, the staff requests that the applicant consider establishing an ITAAC or a Condition for Licensing that provides the guarantee that the COL applicant satisfies the requirements of A, D and F above.

Pursuant to the requirements of RG 1.206, the DCD needs to contain a design of sufficient detail so that the staff can perform its own set of confirmatory calculations (on a select basis) or review the applicant's calculations to support the writing of the Safety Evaluation Report.

The staff requests that the applicant redress its response to RAI 9.4.5-22 to allow the staff to complete its DCD review requirements.

If the applicant's response to this RAI warrants an amendment of the DCD, the staff requests that the applicant include in their response the revision of the DCD that the amendment will appear in.

---

**ANSWER:**

A. The capacity of cooling coils for the following systems are calculated by heat loads evaluated for Fan Motor and Room Internal Load.
   - Class 1E Electrical Room HVAC System
   - Safeguard Component Area HVAC System
   - Emergency Feedwater Pump Area HVAC System
   - Safety Related Component Area HVAC System
     - ✓ Essential Chiller Unit Area Air Handling Unit (AHU)
     - ✓ CCW Pump Area Air Handling Unit (AHU)
     - ✓ Annulus Emergency Filtration Unit Area Air Handling Unit (AHU)
     - ✓ Charging Pump Area Air Handling Unit (AHU)
     - ✓ Penetration Area Air Handling Unit (AHU)

The heat loads are calculated by following formulase.

Fan Motor Load

$$q=2545 \times 0.000157 \times H \times Q / (\eta_f \times \eta_m) \times 1.15$$

where,

- $q$ : Fan motor load (BTU/h)
- $H$ : Fan motor total pressure (in. of water)
- $Q$ : Fan flow rate (CFM)
- $\eta_f$ : Fan efficiency
- $\eta_m$ : Motor efficiency

Room Internal Load

$$q= ( q_1+q_2+q_3+ q_4 ) \times 1.15$$

where,

- $q$ : Room Internal load (BTU/h)
- $q_1$ : Component (BTU/h)
- $q_2$ : Lighting (BTU/h)
- $q_3$ : heat load through the concrete walls (BTU/h)
- $q_4$ : heat load through the piping (BTU/h)

Outdoor Air Load

$$q=60 \times \rho \times Q \times \Delta h \times 1.15$$

where,

- $q$ : Outdoor air load (BTU/h)
- $\rho$ : Density (0.075lb/ft$^3$)
- $Q$ : Supply airflow rate (CFM)
- $\Delta h$ : enthalpy change (BTU/lb)

In-leak Load

$$q = 60 \times \rho \times Q \times \Delta h \times 1.15$$

where,

q : In-leak load (BTU/h)
$\rho$ : Density (0.075lb/ft$^3$)
Q : In-leak airflow rate (CFM)
$\Delta h$ : enthalpy change (BTU/lb)

Recirculated **Leakage**~~In-leak~~ Water Load

$$q = 60 \times \rho \times Q \times \Delta h \times 1.15$$

where,

q : Recirculated **leakage**~~in-leak~~ water load (BTU/h)
$\rho$ : Density (0.075lb/ft$^3$)
Q : **Leakage**~~In-leak~~ water rate (CFM)
$\Delta h$ : enthalpy change (BTU/lb)

The input values and the output values used to evaluate the heat loads are the following table.

| | | | | Class 1E Electrical Room HVAC System A,B train | Class 1E Electrical Room HVAC System C,D train |
|---|---|---|---|---|---|
| Input value | Fan **and** Motor Load | AHU Internal Fan | H(in. of water) | 11.0 | 11.0 |
| | | | Q(CFM) | 40,000 | 52,000 |
| | | | $\eta_f$ | 0.7 | 0.7 |
| | | | $\eta_m$ | 0.9 | 0.9 |
| | | Return Air Fan | H(in. of water) | 2.4 | 2.4 |
| | | | Q(CFM) | ~~34,800~~**37,400** | ~~46,800~~**49,400** |
| | | | $\eta_f$ | 0.55 | 0.55 |
| | | | $\eta_m$ | 0.9 | 0.9 |
| | Room Internal Load | | $q_1$(BTU/h) | ~~556,400~~**581,880** | ~~809,230~~**838,990** |
| | | | $q_2$(BTU/h) | ~~36,150~~**42,570** | ~~47,580~~**54,310** |
| | | | $q_3$(BTU/h) | ~~149,080~~**169,520** | ~~244,600~~**256,660** |
| | | | $q_4$(BTU/h) | - | - |
| | Outdoor Air Load | | Q(CFM) | ~~5,200~~**2,600** | ~~5,200~~**2,600** |
| | | | Δh(BTU/lb) | ~~13.9~~**14** | ~~13.8~~**13.2** |
| Output value | Fan **and** Motor Load | AHU Internal Fan | q(BTU/h) | ~~320,920~~ **320,921** | 417,197 |
| | | | Used value q per train(BTU/h) | 321,000 | 418,000 |
| | | Return Air Fan | q(BTU/h) | ~~77,530~~**83,323** | ~~104,265~~**110,058** |
| | | | Used value q per train(BTU/h) | ~~78,000~~**84,000** | ~~105,000~~**111,000** |
| | Room Internal Load | | q(BTU/h) | ~~852,875~~**913,066** | ~~1,266,622~~**1,322,454** |
| | | | Used value q per train(BTU/h) | ~~857,000~~**923,000** | ~~1,276,000~~**1,422,000** |
| | Outdoor Air Load | | q(BTU/h) | ~~374,049~~**188,370** | ~~371,358~~**177,606** |
| | | | Used value q per train(BTU/h) | ~~375,000~~**189,000** | ~~372,000~~**180,000** |

| | | | | Safeguard Component Area HVAC System | Emergency Feedwater Pump Area HVAC System | |
|---|---|---|---|---|---|---|
| | | | | | M/D | T/D |
| Input value | Fan **and** Motor Load | AHU Internal Fan | H(in. of water) | 5.0 | 2.0 | 2.0 |
| | | | Q(CFM) | 5,000 | 2,100 | 1,300 |
| | | | $\eta_f$ | 0.7 | 0.7 | 0.7 |
| | | | $\eta_m$ | 0.9 | 0.9 | 0.9 |
| | Room Internal Load | | $q_1$(BTU/h) | ~~109,610~~ **33,250** | 83,400 | 15,900 |
| | | | $q_2$(BTU/h) | - | ~~1,600~~**1,540** | ~~2,100~~**2,090** |
| | | | $q_3$(BTU/h) | ~~-~~**26,730** | ~~5,600~~**5,550** | ~~3,500~~**3,480** |
| | | | $q_4$(BTU/h) | ~~-~~**49,530** | - | 25,400 |
| | Outdoor Air Load | | Q(CFM) | - | - | 100 |
| | | | $\Delta$h(BTU/lb) | - | - | ~~7.5~~**7.7** |
| | Air In-leakage Load | | Q(CFM) | 375 | - | - |
| | | | $\Delta$h(BTU/lb) | 10.6 | - | - |
| | Recirculated Water Leakage Load | | Q(CFM) | 5,000 | - | - |
| | | | $\Delta$h(BTU/lb) | 0.3 | - | - |
| Output value | Fan **and** Motor Load | AHU Internal Fan | q(BTU/h) | ~~18,235~~ **18,235** | ~~3,064~~ **3,064** | ~~1,897~~**1,897** |
| | | | Used value q per train(BTU/h) | 19,000 | 3,100 | ~~1,900~~**2,000** |
| | Room Internal Load | | q(BTU/h) | ~~126,060~~ **125,937** | ~~104,190~~ **104,064** | ~~53,935~~ **53,901** |
| | | | Used value q per train(BTU/h) | ~~129,000~~ **126,000** | 105,000 | 54,000 |
| | Outdoor Air Load | | q(BTU/h) | - | - | ~~3,375~~**3,985** |
| | | | Used value q per train(BTU/h) | - | - | ~~3,400~~**4,000** |
| | Air In-leakage Load | | q(BTU/h) | ~~20,580~~ **20,571** | - | - |
| | | | Used value q per train(BTU/h) | 21,000 | - | - |
| | Recirculated Water Leakage Load | | q(BTU/h) | 7,763 | - | - |
| | | | Used value q per train(BTU/h) | 8,000 | - | - |

| | | | Essential Chiller Unit Area AHU | CCW Pump Area AHU | Penetration Area AHU |
|---|---|---|---|---|---|
| Input value | Fan **and** Motor Load | H(in. of water) | 3.0 | 3.0 | 5.0 |
| | | Q(CFM) | 1,000 | 1,000 | 5,000 |
| | | $\eta_f$ | 0.7 | 0.7 | 0.7 |
| | | $\eta_m$ | 0.9 | 0.9 | 0.9 |
| | Room Internal Load | $q_1$(BTU/h) | 7,580 | 17,920 | - |
| | | $q_2$(BTU/h) | - | - | - |
| | | $q_3$(BTU/h) | ~~8,440~~**10,850** | - | ~~243,290~~ **240,340** |
| | | $q_4$(BTU/h) | - | - | 4,770 |
| Output value | Fan **and** Motor Load | q(BTU/h) | ~~2,189~~**2,189** | ~~2,189~~**2,189** | ~~18,235~~ **18,235** |
| | | Used value q per train(BTU/h) | 3,000 | 3,000 | 19,000 |
| | Room Internal Load | q(BTU/h) | ~~18,423~~ **21,195** | 20,608 | ~~285,269~~ **281,877** |
| | | Used value q per train(BTU/h) | ~~19,000~~ **22,000** | 21,000 | ~~287,000~~ **285,000** |

| | | | Annulus Emergency Filtration Unit Area AHU | Charging Pump Area AHU | **Spent Fuel Pit Pump AHU** |
|---|---|---|---|---|---|
| Input value | Fan **and** Motor Load | H(in. of water) | 3.0 | 3.0 | **3.0** |
| | | Q(CFM) | 1,000 | 1,000 | **1,500** |
| | | $\eta_f$ | 0.7 | 0.7 | **0.7** |
| | | $\eta_m$ | 0.9 | 0.9 | **0.9** |
| | Room Internal Load | $q_1$(BTU/h) | 1,230 | 2,230 | **75,400** |
| | | $q_2$(BTU/h) | - | - | **-** |
| | | $q_3$(BTU/h) | - | - | **-** |
| | | $q_4$(BTU/h) | - | - | **-** |
| Output value | Fan **and** Motor Load | q(BTU/h) | ~~2,189~~**2,189** | ~~2,189~~**2,189** | **3,283** |
| | | Used value q per train(BTU/h) | 3,000 | 3,000 | **4,000** |
| | Room Internal Load | q(BTU/h) | 1,415 | 2,565 | **86,710** |
| | | Used value q per train(BTU/h) | 2,000 | 3,000 | **88,000** |

D. Refer to the answer to RAI.356-2549 question 09.04.05-4.

F. Refer to the answer to RAI 64-735 / Question No. RAI 9.4.5-3 and RAI.356-2549 Question No. 09.04.05-3.

**Impact on DCD**

There is no impact on the DCD.

**Impact on COLA**

There is no impact on the COLA.

**Impact on PRA**

There is no impact on the PRA.

This completes MHI's response to the NRC's question.