## A Study on the Primary Requirement for the Safety of the Wolsong Tritium Removal Facility

373-1

19

가

## **Abstract**

Owing to the using a heavy water as a moderator and a coolant in Heavy water reactor, A large mount of tritium is produced due to a reaction of deuterium with neutron in the reactor and some of tritium is released to the environment. In Wolsong, 4 units (CANDU-600 type) Heavy water reactor is in operation. And the generated amount of tritium is increased with the increase of operational year of the Wolsong nuclear reactor. Decommissioning of the Wolsong unit 1 is expected to start at 2013. Before 2013, to reduce the workers internal radiation doses and environmental release of tritium, Tritium Removal Facility (TRF) is required and should be operated. Wolsong TRF (WTRF) is under developing stage by Korea Electric Power Corporation (KEPCO) and scheduled to start operation about 2006. Once the facility begins operation, it can be contributed to the greatly reduction of tritium release to the environment and worker's expose. In this situation, study about the safety assessment method and regulatory requirement is essential for safety insurance of WTRF. And this helps the safety acquirement, successful operation and reliance of WTRF.

1.

(TRF: Tritium Removal Facility)

フト (WTRF) (DTRF)

DTRF WTRF (LPCE : Liquid Phase Catalyst .1 DTRF Exchange) (VPCE) , KEPCO WTRF (LPCE) 가 DTRF . , WTRF 100kg . WTRF 가 10~60 Ci/Kg 가 D<sub>2</sub>O 99.8 mol% 99.0% T<sub>2</sub>, 3, .2 97%  $T_2$ 80% 40 99% 가 10Ci/Kg . WTRF 가 **3.** ALARA ( 1), 1.

	General Requirements for Pressure-		
CSA N285.0-95	Retaining Systems and Components in CANDU NPP	Systems & Components	
ASME BPVC Section VIII, Section III	Rules for Construction of Pressure Vessels	Class 3 Pressure Vessels	
NFPA 1990 50A Series	Handling of Hydrogen at Consumer Site	Industrial hydrogen safety standards	
CSA C22.1 & C22.2	Canadian Electrical Code	Electrical Equipment	
CSA-N293-M87	Fire Protection for CANDU NPP	Fire Protection	
CSA/ CAN3-N289.3	Design Procedures for Seismic Qualification of CANDU NPP	Seismic	

가

1.

•				(Cold Box	Glove Box)	가	, LPCE	, $D_2O$
	, CD	,			Class	3	.(	1)
•					316L .			
•		,	,		가	O		

2.

•

```
3.
                                                                                              가가
                                                       가
                  가
                 가
                                                                                                    가
                                                                , <10^{-6}atm cc sec-1 helium
               10<sup>-6</sup> 10<sup>-7</sup> cm<sup>3</sup>/sec
                                                                                                          0.25
Ci/day
                                                                                         가
                                            가
                  가
                                                                  1.0MPa(g)
                                                                          glove box
                                                                                                       0.1%
                                              N_2
                                        가
                 가
                                                                    가
                                                                                                  가
6.
7.
1.
                                  2
        2-3
                                  9m³)
                                                                .
가
                                              가
```

```
가
                                                                        가
                                     가
                        WTRF
        WTRF
• WTRF
                                                                               ( 2)
                                      2.WTRF
                                                                            < 150mg O<sub>2</sub>/kg D<sub>2</sub>O
                                                                              < 4mS/m @25 °C
                                                                                 < 5 NTU
                             PH
                                                                                       10
                      가
2.
                                    100kg
                                                            D_2O
                                                                                                                (97%
                , DF≈35)
• LPCE
                                                       D<sub>2</sub>/DT
                                                                                                 LPCE
                    224m<sup>3</sup>(STP)( 10,000 mol)
D_2
                                                                                                가
                              가
                                            LPCE
                                                                                      가
                                                                                    , CD
3.
                                                                           10ppm
                                                                                                             130kPa
                           가
• Molecular Sieve Dryer
                                           (Cryo-Absorber)
                                                                                                 가
• Cold box
                                          (10<sup>-4</sup> Pa)
                                  가가
• Cold Box
                                                              (10^{-8}-10^{-9} \text{ atm } \text{cm}^3 \text{ s}^{-1} \text{ helium})
Cold Box
         가
```

```
4.
                                                                           (metal
                          가
tritide)
                           Glove Box
  6.5L
                                                        19L 50kCi
         850g
                                                                    ),
                                    ^{3}He
                            7 8
5. Glove Box
            Glove Box
• Glove Box
                                 가
                                                   , Glove Box
                                                                      0.1%
                가 Glove Box
                                                          가가
                                                가가
                                            가가
• Glove Box
                                    가가
                                             가
                                                                 Glove Box
                                              가
                                                     가
                     2
                                                       2-3
                              WTRF
                              ( 3)
                                  3.
```

	99.78 98.65	wt % D <sub>2</sub> O wt % D <sub>2</sub> O
( 25°C)	1.5	mS/m
	10	mg Oxygen/Kg D <sub>2</sub> O
	5	NTU(Nephelometric Turbidity Units)

```
가
                              가
.
1.
                       가
                                     H_2/O_2
    가
                                      가
                             가
                        가
2.
• LPCE
가
                                               가
        가
                                    가 가
             가
3.
                    HVAC
              가
                                             가
                LPCE
                                  가
                                               가
     가 가
5.
```

가 가

1. 가 가가 가 가 가 , 가 가 가 가가 가 , 가 가 가 가 가 가 . 가 가 가 2. 가

```
가
                               ALARA
                                     .
가
          ,
가
                                       가가
                        once-through
                6~10
                                                     .( 1)
      가
           가
                         .
가
                                                 DBE
가
      ,
가
                                             가
                          HVAC
                  가
                              가
                                             가
                                                                 가
```

```
가
                                                  once-through
  가가
                                           가
                    가
                                                 가 가
       가
                                            가
                                                         가
                                                                    가
                             가
                                              (fire code)
                                                                   가
             가
                             (air cleanup recombiner condenser)
     (air cleanup drier regeneration condenser)
7 7 7
                                                                     가
                                                              가
             ,
D<sub>2</sub>, O<sub>2</sub>, He, Ne,
                                               가
                              가
- Glove Box
                 가
                                                    가
                                                                  , WTRF
      가
                                                          가
```

```
1.
                                                가
                                                                                        가
                        가
                                      .11
          10Ci/Kg-D<sub>2</sub>O
(HTO, T<sub>2</sub>)
                                                 .
가가
      НТО
3.
           가
                  가
                                    가
                                                                         가 가
5.
             12
1. 가
2.3.
                                                    가
4.
                                                가 가
5. PHT
                                                            가
가
6.
7.
                                                                                                가 가
8.
                                                                            가
9.
10.
```

```
가
11.
                      80 \quad 100 < 10^{-3} \text{ \%/day}
                                                                                                      .13
12.
                                                                                  가 가
                        14 15
13.
14.
            가16
1.
3.
                                                           가가
          가
                                                                                       가
                         가
```

5.

•

•

•

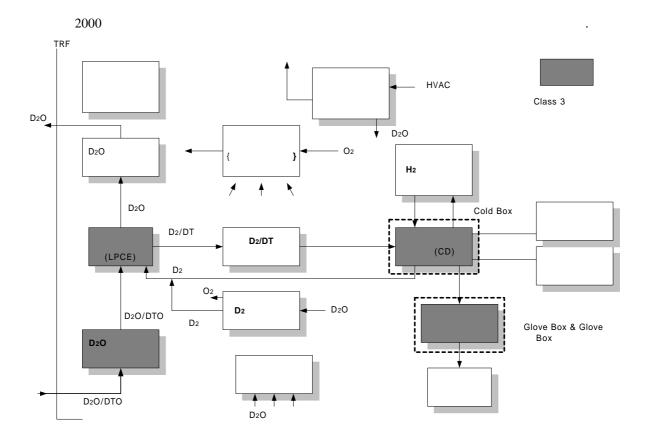
5.

(WTRF)

. (TRF)

•

가 가



1.

 $<sup>1.</sup> J.M.\ Miller, ``Technical\ Presentations\ To\ KINS\ on\ the\ Wolsong\ TRF\ and\ Darlington\ TRF",\ 2000$ 

- 2 . Wolsong Tritium Removal Facility Technical Description
- 3 . Do Hee Ahn, Han Soo Lee, et. al., "Optimum Design of the Wolsong Tritium Removal Facility", KAERI, 1996
- 4 . J.T. Shor, "Tritium Effluent Reduction at Oak Ridge National Laboratory" Chemical Technology Division, Nov. 1988
- 5 . DOE- HDBK-1132-99 " Tritium Removal System"
- 6. IAEA-CN-42/147 "Occupational Radiation Exposures at Canadian CANDU Nuclear Power Stations"
- 7 . R.B. Davidson, et. al., "Commissioning and first Operating Experience at Darlington Tritium Removal Facility", Fusion Technology Vol. 14, Sep.1988
- 8 . S.K. Sood and O.K. Kveton, "Tritium Removal Facility for Pickering",
- 9. Louis Fernandes,"The Management of Tritium Reduction at Ontario Hydro"
- 10 . W.J. Holtslander, " Recovery of Tritium from CANDU Reactors, its storage and Monitoring of its Migration in the Environment", AECL-6544, July.1979
- 11 . A. Busigin and S.K. Sood, "Optimization of Darlington Tritium Removal Facility Performance Effects of Key Process Variables", CNS 8th Annual Conference, 1987
- 12 . Ontario Hydro research division,"OH-85-279 –Tritiated Waste Conditioning Part III", Executive Summary, 1985
- 13 . J.P. Krasznai, V.S. Chew et. al., "Conditioning and Packaging of Tritiated Waste from Ontario Hydro's Tritium Removal Facility", Fusion Technology Vol. 21 Mar. 1992
- 14. INFO-0433, "AECB Staff Annual Report of Darlington NGS for the year 1991", AECB, Nov. 1992
- 15 . CA8507834, "Canadian Fusion Fuel Technology Project"
- 16 . J.S. Nathwani, A. Busigin, et.al, "Safety Evaluation of the Tritium Removal Facility at Darlington NGS", Fusion Technology Vol.14, Sep.1988