Automatic Multiple Tritium Sampler

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I Characteristics of CANDU Reactor and Tritium

Characteristics of CANDU Reactor

▣ Natural Uranium Fuel contains 0.7% of U-235

▣ Use of the Heavy water (D_2O) as Coolant and Moderator

▣ The interactions of neutrons with Heavy water
→ Tritium Occurrence

▣ CANDU Reactor in Korea → Wolsong Plant 1 & 2

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I Characteristics of CANDU Reactor and Tritium

Characteristics of Tritium

▣ Hydrogen with 2 neutrons exists gas or vapor status.

▣ Pure Beta-emitting radionuclide, Half-Life : 12.3 years .

▣ Maximum Energy : 18.6keV , Average Energy : 5.6keV

▣ Internal exposure is the more harmful to the body via inhalation or wounds.

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Ⅲ Tritium Measurements

Methods of Tritium Measurement

▣ Use of the Fixed Tritium Air Monitors (FTAM)





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Ⅲ Tritium Measurements

Methods of Tritium Measurement

▣ Use of the Portable Tritium Meter



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Ⅲ Tritium Measurements

Methods of Tritium Measurement

▣ Use of the Liquid Scintillation Counter





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Ⅲ Tritium Measurements

Methods of Tritium Measurement

▣ Use of the Fixed Tritium Air Monitors (FTAM)

- ❖ ΦΤΑΜ ισ φιξεδ ανδ ινσταλλεδ ατ τηε ποσιτιον οφ σπεχιφιχ αρεα.
- ❖ Τηρουγη 24 σαμπλινγ πορτσ λινινγ ωιτη μεταλ πιπεσ, σελεχτ ονε πορτ το σαμπλινγ βψ συχτιον πυμπ.
- ❖ Υσινγ τηε ιον χηαμβερ δετεχτορ το μεασυρε, Γοοδ ρελιανχε οφ Μεασυρεμεντ .



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Ⅲ Tritium Measurements

Methods of Tritium Measurement

▣ Use of the Portable Tritium Meter

- ❖ Εασψ το χαρρψ–ον ανδ χομφορταβλε το υσε.
- ❖ Σιμυλτανεουσλψ, συχτιον ανδ μεασυρεμεντ οφ τηε σαμπλινγ γασ.
- ❖ Υσε οφ τηε ιον χηαμβερ δετεχτορ το μεασυρε, βυτ ρελιανχε οφ μεασυρεμεντ ισ νορμαλ.



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Ⅲ Tritium Measurements

Methods of Tritium Measurement

▣ Use of the Liquid Scintillation Counter

❖ **Ωιτη τηε σιμιλαρ χηεμιχαλ προπερτιεσ, Τριτιυμ χαν δισσολωε ιντο τηε ωατερ .**

❖ **Αιρ συχτιον ωιτη τηε τριτιυμ □ Βυββλερ**

□ Σαμπλε βοττλε [100χχ] □ Σαμπλε ϛολυμε φορ μεασυρεμεντ [10Λ]



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Ⅲ Tritium Measurements

Methods of Tritium Measurement

▣ Use of the Liquid Scintillation Counter

- ❖ Χολλεχτεδ τριτιυμ σαμπλεσ(1χχ) ανδ φλυορεσχεντ σολυτιον (10χχ) πρεπαρε βψ μιξινγ
- ❖ Μεασυρε τηε σαμπλε ωιτη τηε σχιντιλλατιον χουντερ
- ❖ Υσινγ τηε σχιντιλλατιον δετεχτορ το μεασυρε, γοοδ ρελιανχε οφ μεασυρεμεντ.



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Ⅲ Tritium Measurements

Status of Tritium measurements

▣ Observations of radiation for several areas in Radiation zone with the routine [*1) tritium sampling and analysis

Sampling	NPP#1		NPP#2		TRF [*2)	
	Positions	Times	Positions	Times	Positions	Times
Days	10	30	9	27	6	18
Weekly	3	9	3	9	2	6

[*1) 3 shift operators on duty

[*2) TRF(Tritium Removal Facility)

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Ⅲ Tritium Measurements

Status of Tritium measurements

- ▣ At the abnormal situation(Tritium concentration rising), add the sampling points around the suspicious leakage area.
- ▣ At the leakage situation of Tritium, add the additional sampling and measurements of Tritium concentration.
- ▣ One sample with a Bubbler.

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Ⅲ. Needs of the equipment development

Operator

- A variety of sampling point & how to sampling by each operator

Methods

- Bubbler can sample only one point with a bubbler
- Sampling during abnormal concentration rising are difficult.

Equipment

- Lack of sampling equipment holdings for emergency
- No record sampling times, No time reservations features
- The unexpected change of flow meter can cause the sampling volume.

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Ⅲ Needs of the equipment development

Methods

▣ Bubbler can sample only one point with a bubbler.

▶ Sampling of multiple points need with a bubbler.

▣ During the abnormal situation , Operator increase to sample because of the sampling interval time is shorter.

▶ During sampling at the same point, it needs a equipment that able to automatic sample with the setting time.

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Needs of the equipment development

Equipment

▣ Busy Outage and equipment contamination can cause a lack of equipment .

▶ Equipment needs multiple sampler line and requires a self-cleaning function.

▣ Equipment itself does not record the sampling time.

▶ Need the sampling time storage function .

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Needs of the equipment development

Equipment

▣ The unexpected setting change of flow meter(LPM)
can cause the sampling volume change.

▶ Need the automatic correction features in accordance with the change of flow rate(LPM).

▣ No Sampling reservation function.

▶ Need Sampling reservation function.

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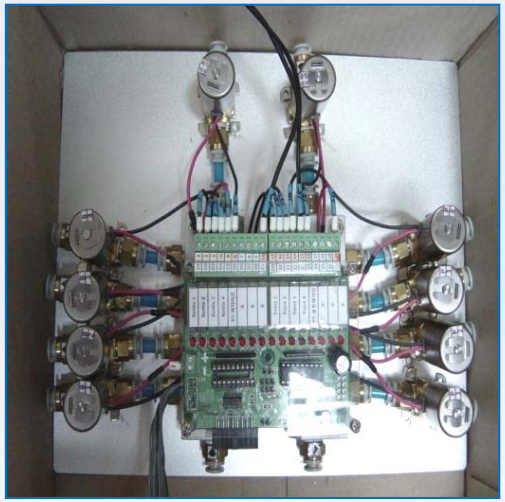
Ⅳ Automatic Multiple Tritium Sampler(AMTS)

Prototype of the Sampler

Main controller



Sample selector



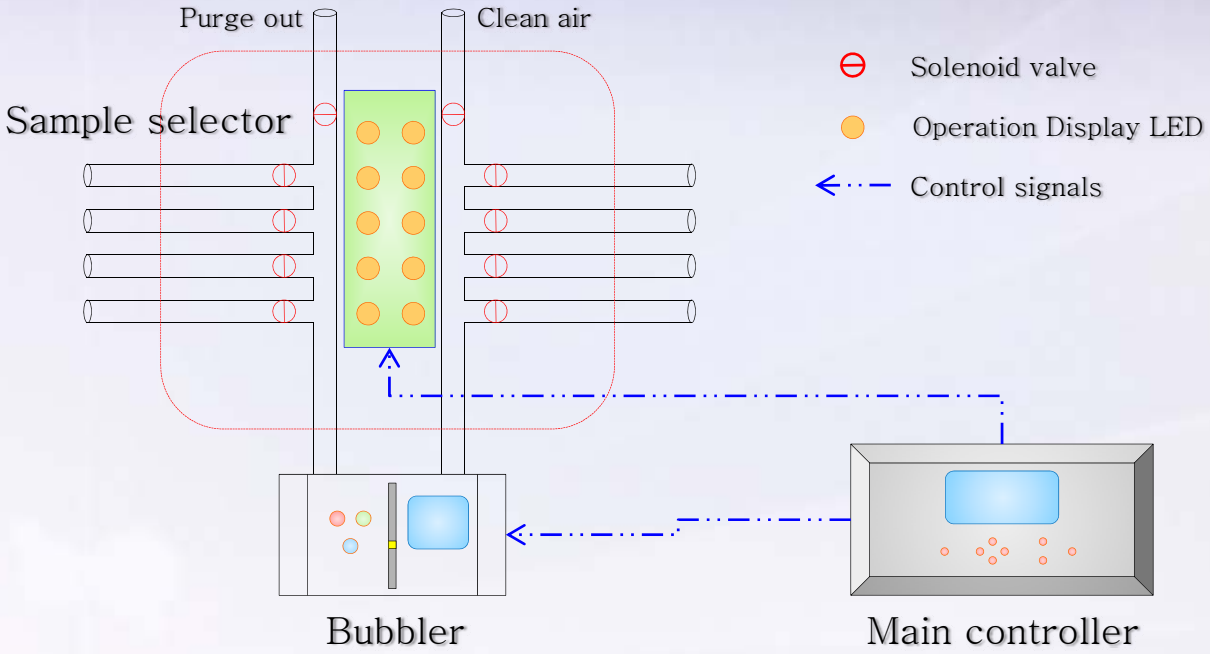
Bubbler



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Automatic Multiple Tritium Sampler(AMTS)

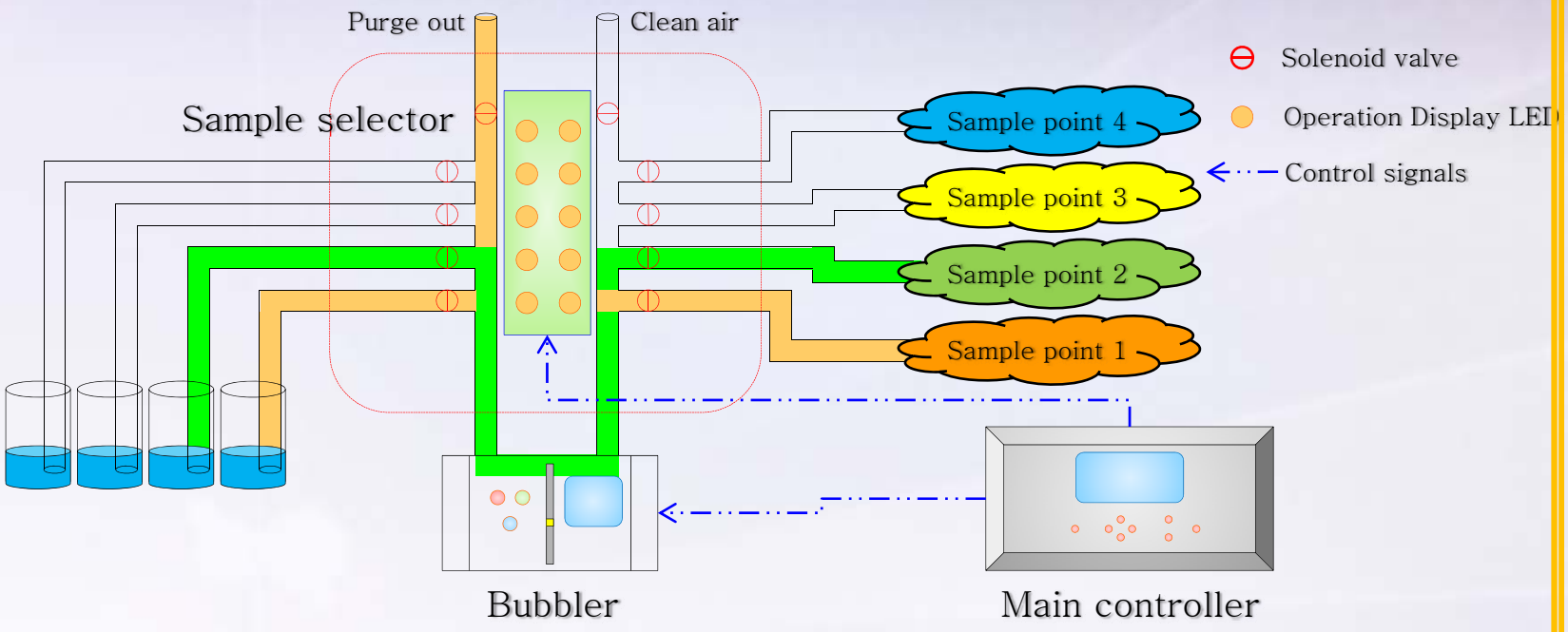
Configuration of the Sampler



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Automatic Multiple Tritium Sampler(AMTS)

Work flow of the Sampler



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Ⅳ Automatic Multiple Tritium Sampler(AMTS)

Specifications

Main Controller

- 8 Bit Microprocessor with Watchdog Timer
- 32 kbyte EEPROM, 8 kbyte SRAM
- 12 Bit A/D 4 Channel, 12 Bit D/A 2 Channel
- 8 key Input (cursor movement, decrease, return, action)
- 240 x 64 Pixel Graphic LCD with LED Back Light
- Real Time Clock Chip (Back Up Battery life 10 years)
- 10 Port Samples Selector Control (Power transistor driven by the relay)
- Bubbler Control of Photo Coupler
  (work orders, stop orders, work situation)

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IV Automatic Multiple Tritium Sampler(AMTS)

Specifications

Sampling Air Selector

- 4 Input Port + 1 Clean Air Port, 4 Out Port + 1 Purge Air Port
- Path selection by solenoid valves (DC + 24V powered)
- Power transistors, driven by a relay (10 Port)

Bubbler

- Photo Coupler automatically controlled by the Bubbler
- Subject made by the purge, stabilization, bubbling, automatically perform a clean operation
- 10 Liter Air Sampling (3 Liter Per Minute Sampling Speed)

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Ⅳ Automatic Multiple Tritium Sampler(AMTS)

Application Tests at Local Point

AMTS Test 1 – Continuous Measurements

▣ The time required for 4 points sampling with one Bubbler

(Sampling time = 10minutes / sampling x 4sampling = 40minutes)

◈ The necessary time applied with AMTS

(Sampling time = 6minutes / sampling x 4sampling = 24minutes)

▶ 16 minutes shorter

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IV Automatic Multiple Tritium Sampler(AMTS)

Application Tests at Local Point

AMTS Test 1 – Continuous Measurements

▣ The time required for 4 points sampling with two Bubbler

(Sampling time = 10minutes / 2bubbler x 4sampling = 20minutes)

◈ The necessary time applied with AMTS

(Sampling time = 6minutes / 1bubbler x 4sampling = 24minutes)

▶ Two bubbler effects

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Ⅳ Automatic Multiple Tritium Sampler(AMTS)

Application Tests at Local Point

AMTS Test 2 – Time settings

▣ To reduce Sampling Error – Sampling time

(Time on/off by operator – human error)

◈ AMTS sampling program

– Sampling start at scheduled time (30 minutes, 1 hour …)

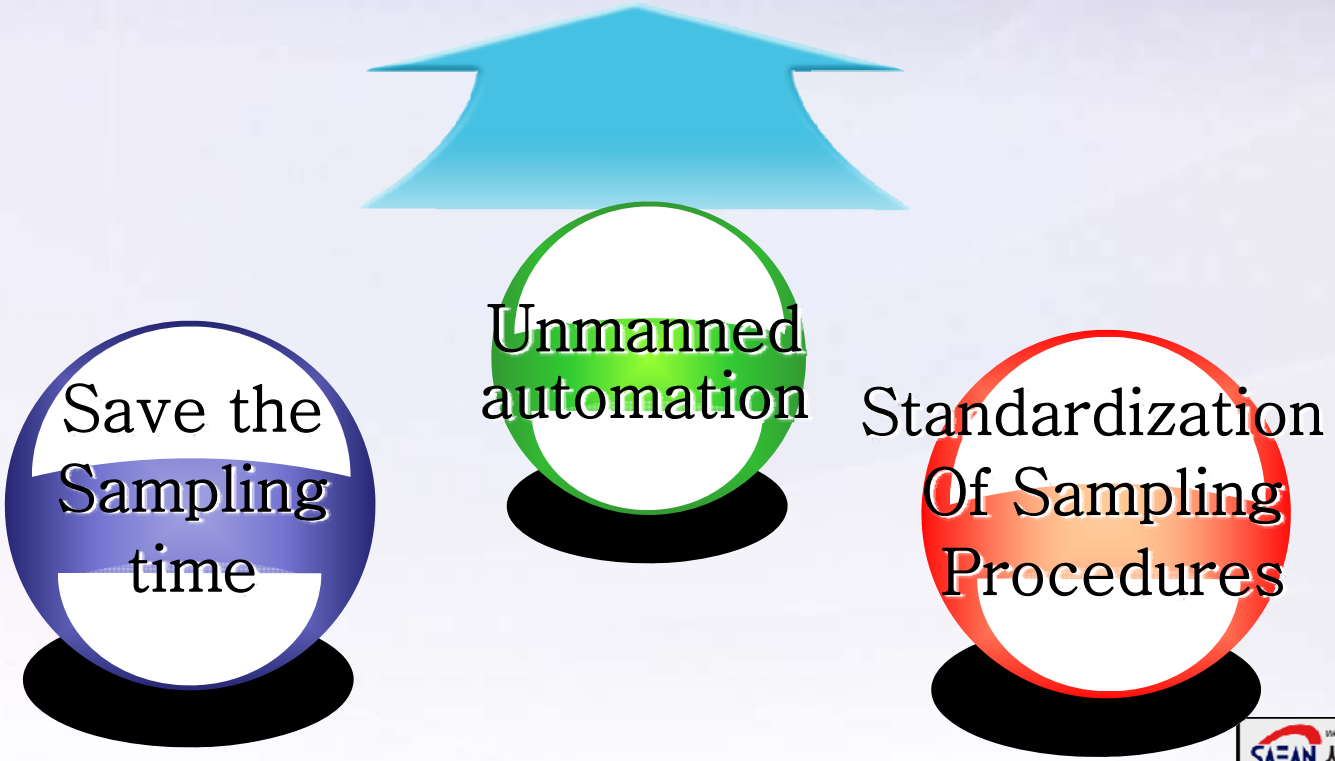
→ Automatically purge and self-cleaning

▶ Realization and reliability of unmanned automated collection

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Ⅳ Automatic Multiple Tritium Sampler(AMTS)

Unmanned automation and standardization of Sampling depending on reliability improvement



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V Conclusions & Expectations

- When tritium sampling at the several area in Radiation Control zone, it expects the shorter time to sample with the AMTS.

- More then 2 sampling positions can concentrate a sampling position. The more effects the tritium concentration surveillance .

- With the reservation function of AMTS, it is possible to sample and to purge periodically according to the setting time and the setting procedure.

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V Conclusions & Expectations

- When heavy water leakage breaks out, it can sample on the various areas within the shorter time, takes any actions quickly for emergency situation.

- After the outage, it is possible to observe quickly around the suspected heavy water leak area during the reactor start operation.

- After the outage of Wolsong Unit #1, it is possible to observe quickly around the suspected heavy water leak point.

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VI Future Plans

Improvements

Simultaneous function	Portable function	Storage function
AMTS has a sampling pump , sampling can not be done more than 2 points simultaneously.	Consists of the three separated elements, it is difficult to carry on and movement.	At the abnormal loss of power, it can be lost all of sampling data.

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VI Future Plans

Simultaneous function

Improve the equipment to sample more than 2 points at the same time.

Portable function

Improve the equipment All- in-one and portable.

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VI Future Plans

Storage function

Improve the program to store the sampling status automatically.

TAM function

Apply TAM function to portable tritium measurement.

⇒ Unmanned automatic tritium measurement.

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