§17. Conceptual Design of On-Site Monitoring Cart Available for Fusion Facility

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Fusion plasma experimental devices are sometimes opened and workers enter the device to carry out maintenance, improvements, and alterations. Before they enter, it should be confirmed that the radiation dose and radioisotope contamination do not exceed the legally prescribed limits. To ensure safe working conditions, immediate and precise on-the-spot measurements are desired. An on-site radiation monitoring cart has been conceptually developed to perform such measurements[1)]. The cart is movable, allowing it to be brought into a plasma device laboratory when the device not operating and to be removed from the laboratory before the device starts operating. This avoids adverse effects caused by the intense radiation and electromagnetic fields generated during device operation.

The present study determined the radiation systems required for radiation monitoring in a plasma device laboratory and whether these systems could be installed on an appropriately sized on-site radiation monitoring cart. Table I is a summary of the main systems to be installed on the cart, which were selected from commercially available equipments.

Figure 1 shows a picture of the cart with all these systems installed. These results demonstrate that all the necessary radiation systems can be installed onto a monitoring cart having dimensions of 164 cm (W) × 150 cm (H) × 80 cm (D). However, the large mass (728 kg) of the cart is a serious problem. Thus, to realize a practical on-site monitoring cart it is important to find ways to reduce the mass of the cart.

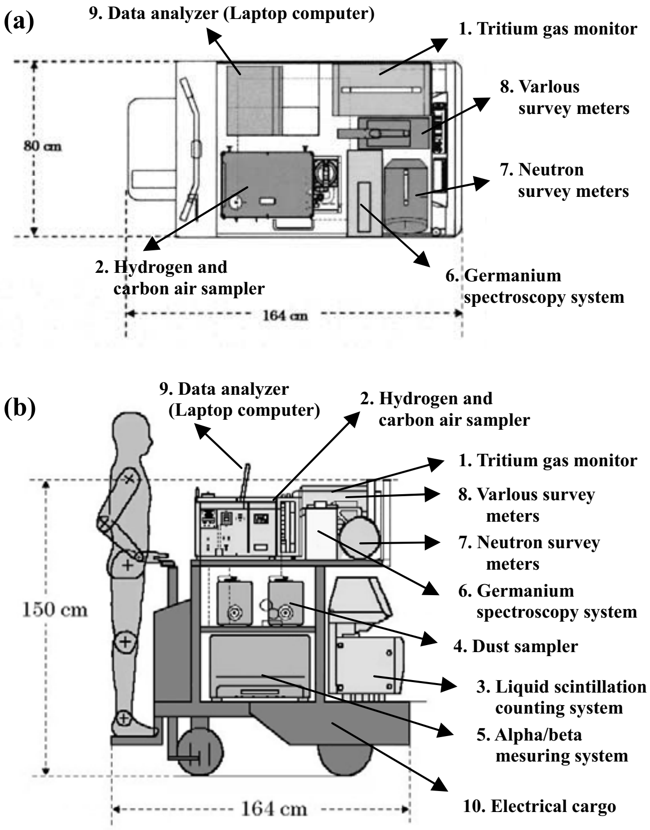

Fig. 1 Illustration of radiation moniroring cart.
(a) top view, (b) side view

Table I Main systems installed on an on-site monitoring cart.

Component apparatus	Model	Width×Height×Depth (cm × cm × cm)	Weight (kg)
1. Tritium gas monitor	DGM-233	24 × 35 × 48	15
2. Hydrogen and carbon air sampler	HCM-101B	59 × 37 × 30	25
3. Liquid scintillation counting system	LSC-6000	78 × 64 × 60	150
4. Two dust samplers	DSM-55	19 × 22 × 34	14
5. Alpha/beta measuring system	JDC-1351	55 × 34 × 64	200
6. Germanium spectroscopy system	Micro-Detective-HX	15 × 28 × 37	7
7. Neutron survey meter	TPS-451C	21 × 25 × 34	9
8. Various survey meters	General conventional survey meters		5
9. Data analyzer	Conventional laptop computer		3
10. Electrically-driven rover rack with battery	Special order	164×150×80	300
		Total	728 kg

From Table I, the heaviest systems are the liquid scintillation counting system, the alpha/beta radiation measurement system, and the electrically-driven rover rack. The mass of these three systems accounts for about 90 % of the total mass of the cart. One way for reducing the mass of the cart is to reduce the number of samples that are measured at the same time by the liquid scintillation counting system and the alpha/beta radiation measurement system. A second way is to reduce the mass of the shielding materials in the systems because, unlike environmental monitoring, extremely low-level radioactivity measurements are not necessary for radiation monitoring in a plasma device laboratory. For example, consider the concentration limits of tritium gas in air. According to Japanese law, the legal limit in a plasma device laboratory (10000 Bq/cm^3)) is about 140 times higher than that in the environment outside the radiation facility (70 Bq/cm^3). By employing these methods, it will be possible to both miniaturize the cart and reduce its mass, although further work is required to achieve this. A radiation monitoring cart will be realized based on the cart proposed in the present study.

1) Kawano, T., Nishimura, K.: 9th ISFNT Dalian Chine (2009) P2-145.