Development and utilization of gamma-ray shielding suit excellent easy-to-wear

Tetsuo Itoh[1)], Hirokuni Yamanishi[1)*],
Tomizo Yamamoto[2)], Tatsuji Yamamoto[2)], Kodai Yamamoto[2)]

[1)] Atomic Energy Research Institute, Kinki University,
3-4-1 Kowakae, Higashi-osaka 577-8502, Japan

[2)] Yamamoto Corporation,
5-13-11 Nakagawa, Ikuno-ku, Osaka 544-0005, Japan

*corresponding author; yamanisi@kindai.ac.jp

A lot of radioactive substances were released by the accident of the 1st Fukushima nuclear power plant of Tokyo Electric Power Company. And those have contaminated the surface of every matter in the plant and circumference environment. When working in the environment polluted with the radioactive matter, we will take time, shield, and distance into consideration for radiation protection. Wearing a shielding suit is one of the measures. But, a gamma-ray shielding suit which is heavy and misery to wear reduces working efficiency. It brings long exposure hours for the same work. It is important to maintain easy-to-work. A gamma-ray shielding suit with sufficient shielding efficiency was developed and produced commercially. The main material is the rubber containing heavy metals, such as a tungsten alloy. That is sandwiched by the foaming structure rubber with feel nice and good flexibility. The suit contains two parts, a sleeveless jacket and shorts. The body trunk from a neck to a crotch was covered. 10% of gamma ray was shielded by the present material which has 4 mm thickness on the irradiation experiment using a cesium-137 gamma-ray source. In the preliminary result of experimental evaluation, the dose inside the gamma-ray shielding suit was reduces to 75 % of the dose outside the suit at a real work place of the quake-absorbing building in the power plant. At that place a lot of low energy photons were produced by scattering with building materials, as a result, it got high shielding efficiency. From now on, it will step toward utilization through the detailed shielding examination in the power plant.

Keywords: gamma-ray, shielding, suit, Cs-137, radiation dose

Introduction

A large quantity of radioactive material was released by the accident of the Tokyo Electric Fukushima first Nuclear Power Plant. The radioactive materials were deposited to the ground surface in the plant and outside the plant. The worker is exposed to the gamma-rays from every directions of the circumference. We have developed a gamma-ray shielding suit and sheet which reduce the dose of workers and which do not reduce work efficiency.

Shielding Material

The shielding material was a metal slab or a plastic resin which mixed metal with conventionally. When it is a rubber material, it has flexibility and is easy to install. The radiation shielding sheet of the development product is full of flexibility of the material in the special synthetic rubber of the independent air bubbles structure body. The sheet has multi-layer structure which is laminated the lightweight rubber and shielding rubber. The structure makes the sheet strong. Even if radioactive material attaches to the material surface, it can easily wash it away with water. Fig. 1 shows the photograph of the sheet.

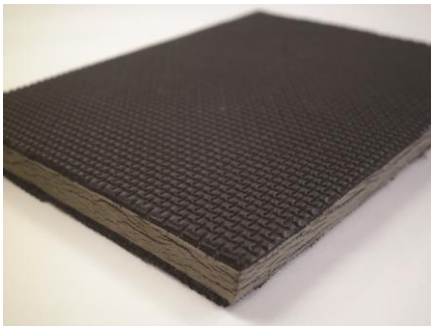

Fig. 1 WP16 sheet

In the case of a radiation shielding sheet, it has an ability to shield 90% of gamma-ray of the Cs-137 by only 6.6 cm thickness (ten pieces of superposition). This sheet has a very big sheet size, 75cm x 90cm, it has weight as 20kg. When matting the sheet to large area, it has a big benefit of workability and cost. Because the sheet can be winded it up into a roll, even worker alone has transportation easily. This sheet can shield 20% of gamma-ray of the Cs-137 on one piece of sheet with thickness 6mm. It is thought that it is effective for setting to inside of a cockpit to reduce the dose of a worker operating a heavy industrial machine in the plant.

Gamma-ray shielding suit

The gamma-ray shielding suit of the development product has superiority to other existing products so far all over the world. The shielding efficiency is about 50% in the site of the plant. As for the conventional radiation shielding suit, the upper body was shielded mainly. the center, and, , there was the lower part of the body only to a supporting thing. The development product covers the human trunk, and is comprised of a jacket and a pants. Fig. 2 shows the

suit WP16, and Fig. 3 shows the suit WP14. For the WP16 and WP14, the thickness of the suit and the shielding efficiency to Cs-137 gamma-ray is 1.38 mg/cm^2 and 10%, 0.72 mg/cm^2 and 4.4%, respectively. The neck parts is also ready to wear for the suit WP14.

Fig. 2 WP16 suit

Fig. 3 WP14 suit

The suit covers the genitals and the backbone which are needed to reduce the dose than other parts. Some additional parts are ready to add the suit for protection the important organs. The stabilizer pad which has three layer putting a wet suit material between radiation shielding material is adopted as parts of the disconnection part. Because of this part, for comfort to expand and contract in this stabilizer pad three dimensions direction when the worker move a body in right and left, top and bottom. The stabilizer pad also plays a role which disperses with the weight burden on shoulder on the part of a shoulder feeling weight most. The rubber

with stretch a lot to an anteroposterior heap part brings a high work efficiency. To a disconnection part, a hook and loop fastener is adopted. The surface of the main body of the suit is installed only an A side of the magic tape (the hard hook side). On the other hand, the B side of the magic tape (the tender loop side) is used for the both side of the stabilizer pad. When the B side deteriorates by long usage, by only changing the pad, the condition that is near to a new article can revivify the suit.

Several measurements were conducted in the plant. The personal dosimeters were used for the measurements. The dosimeters were set inside of the suit and outside. The shielding efficiency of the suit WP16 were ranged from 23% to 60%.

Conclusion

We developed radiation shielding sheet with laminating structure as a base with rubber. The gamma-ray shielding suit has ability to shield 10% of gamma-ray of Cs-137. The suit has larger shielding performance for the gamma-ray of the energy that is lower than it. Because a wet suit material was adopted for the suit, it is easy to fit a body. Since every worker feel comfortable to wear it, therefore it keeps the high workability.