Tungsten balls charge method radiation shield system

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In the periodical inspections at nuclear power plant, we try to reduce radiation exposure by installing shields in the work at places of higher dose.

Many of these shields consist of the sheets and plates of heavy metals, and it takes a longer time to install or remove them because heavy loads must be accompanied.

At our company, therefore, we have developed a tungsten balls charge method radiation shield system, and confirmed its effectiveness.

This system is capable of reducing the time of installing or removing the shields, and is expected to reduce radiation exposure. This is approx 1/10 or so in the area requiring the lead plate of 3 cm or equivalent.

Using tungsten balls makes the method lead-free, thus reducing harmful waste materials. Further by changing the structure of jacket, applicable place can be enlarged. This is one of the features of the system.

Concept of this new shield system is as shown below.

One is to reduce weight of shield container by employing the hollow jacket structure of specified thickness, so shields can be loaded to, or unloaded from the target objects more easily. By decreasing the number of parts of shield, work time is made more efficient. Also by charging tungsten balls to the jacket after loading helps reduce the handling of heavy loads.

Another is to charge and recover tungsten balls remotely. Max high/low difference of approx 20 m is supported.

Also from the viewpoint of not using harmful waste materials, it is specified that tungsten balls should be used.

As this system is developed, element researches are being carried out. One of them is the charge/recovery test of tungsten balls to/from jacket using the system shown in this drawing as an example. This will be introduced.（see figure 1）

This system consists of the tank storing water as a fluid transferring tungsten, Pump, Hopper, and Metal jacket.

Water coming out of pump, in the condition of single phase, Reaches the lower end of Hopper, and is mixed up with the tungsten balls loaded from such Hopper, and transferred to the metal jacket in the condition of two phases of water and tungsten balls.

Of the flow in two phases of solid/liquid so transferred, only the tungsten balls are held in the metal

jacket.

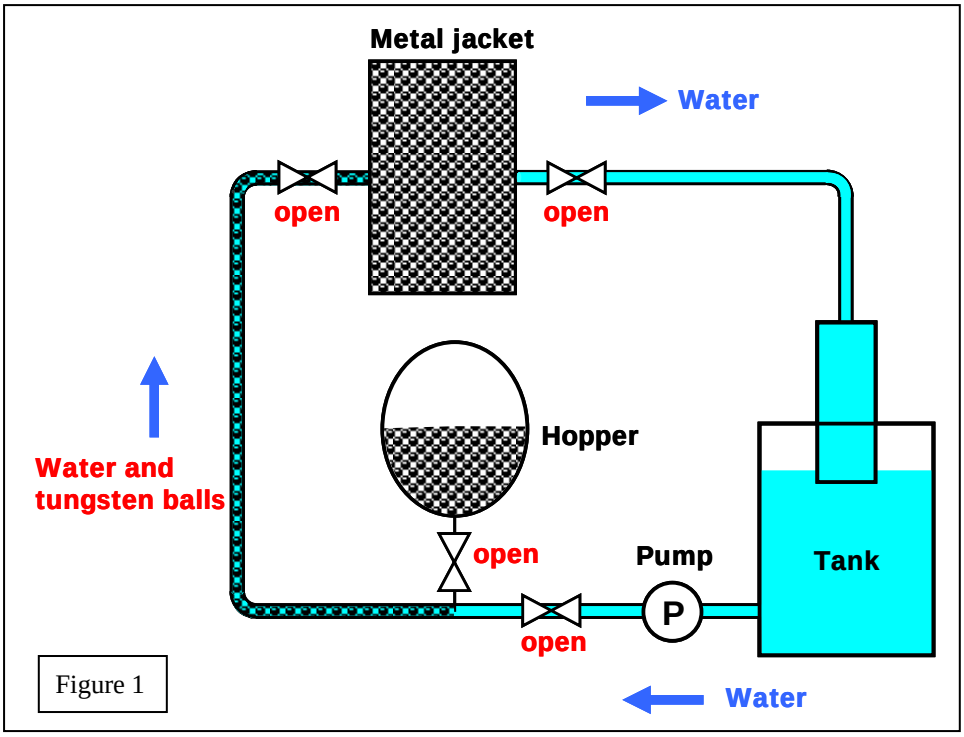


Figure 1

If only the water is allowed to drain in this condition, shields are completed. By using tungsten balls only in the isolated water path, tungsten balls themselves are not contaminated, and can be re-used, thus reducing the volume of waste materials.

This is an image showing the hollow metal jacket mounted on the pressurizer lower nozzle.(see figure 2)

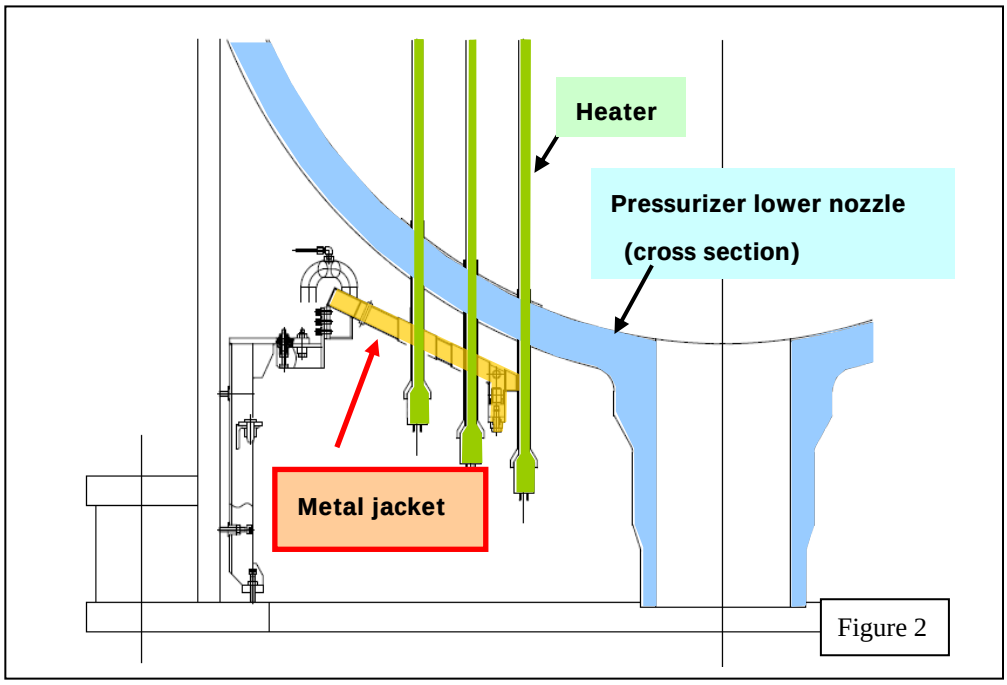


Figure 2

Metal jacket has holes to avoid the heater provided in the lower part of pressurizer, and provided at positions best to maintain work space and expect highest shielding effect.
Then, we compared, with the conventional type, the time required to install/remove metal jacket in this work and the amount of radiation exposure.
At the result, in the new shield system, however, it is 8 hours per worker. Compared with the conventional work method, time was able to be reduced to a half or so.
Amount of radiation exposure was 8 man・mSv in the including the installation/removal of jacket and the charge/recovery of tungsten. Amount of radiation exposure can be reduced to approx one seventh of conventional type. Initial targets were achieved; such as the reduced weight of shield container, reduction of man-hours, reduction of radiation exposure, and reduction of waste materials. According to these results, you will understand the efficiency of the tungsten balls charge method radiation shield system.

Next, an example application of this jacket will be introduced. This drawing shows the image in case the metal jacket introduced so far is applied for the regenerative heat exchanger. Also at the area where this system is installed, a very high dose is detected. So, we seek ways to reduce radiation exposure by making the shield container in the construction of this jacket. (see figure 3)

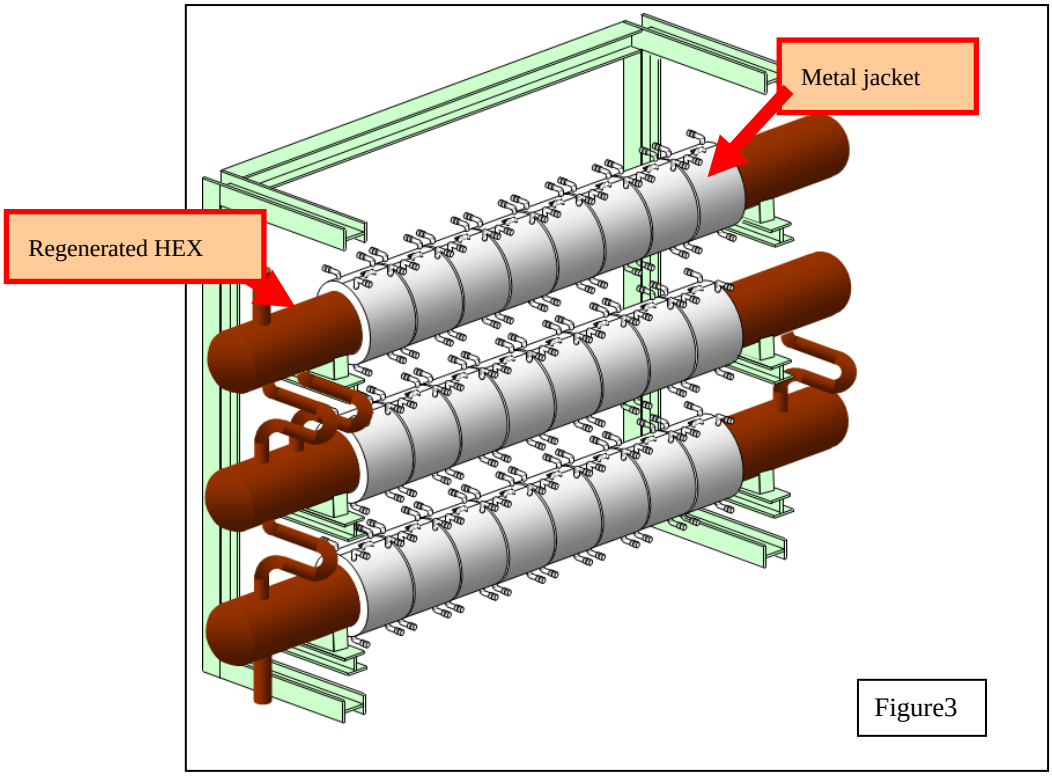
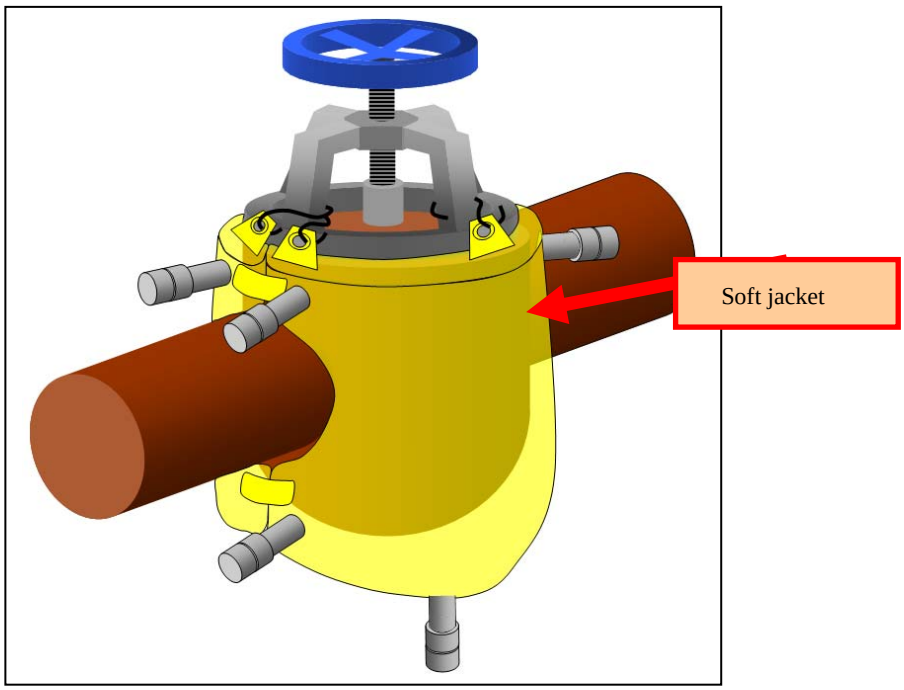


Figure3

Tungsten balls are charged into this jacket one by one sequentially this way, and recovered also in similar way one by one sequentially.
A soft jacket capable of dealing with complicated shapes is also under development, and we expect to see the followings if such a soft jacket is realized.



These valves will be able to be shielded easily.

Tungsten balls shielding system can reduce the exposure and workload of its installation/removal

Finally, We MHI will further promote various advanced techniques including Tungsten balls shielding technique to flexibly meet needs of operating plants based on the principle of ALARA .