

An Assessment of the Effectiveness of Personal Visual Observation as a Safeguards Measure in a Uranium Enrichment Facility

by

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Abstract

In a centrifuge enrichment facility, a cascade that produces low enriched uranium is composed of a large number of UF₆ gas centrifuges interconnected with pipes. It is possible to divert the cascade to the illegal production of highly enriched uranium (HEU) by changing the piping arrangement within the cascade. If integrated type centrifuges that contain a few tens of advanced centrifuges are introduced into the facility, the number of pipes will greatly decrease. The smaller the number of pipes, the less the labor required to change the piping arrangement. Because personal visual observation by an inspector is considered as one of measures against changing the piping arrangement, its effectiveness is assessed in this study.

First, a model centrifuge enrichment facility that has a capacity of 2,400 ton-SWU/y is designed. In this model facility, integrated type centrifuges that contain advanced centrifuges are installed. Second, the diversion path analysis is carried out for the model facility under the assumption that a facility operator's goal is to produce 75 kg of HEU with 20 % enrichment in a month. The analysis shows that, in our assumed diversion path, changes of the piping arrangement can be certainly detected by personal visual observation of a part of pipes connected with integrated type centrifuges that compose the cascade diverted to the HEU production. Finally, inspections in a cascade area are modeled as two-person noncooperative games between the inspector and the facility operator. As a result, it is found that all the cascades in the model facility will be investigated if the inspector can devote the inspection effort of 0.83 man-day per month to personal visual observation in the cascade area. Therefore, it is suggested that personal visual observation of the piping arrangement is worth carrying out in a uranium enrichment facility where integrated type centrifuges that contain advanced centrifuges are installed.

Keywords: Safeguards, Uranium enrichment facility, UF₆ gas centrifuge, Personal visual observation, Game theory

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