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Consolidated Fuel Reprocessing Program

OPERATIONS MONITORING CONCEPT

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OPERATIONS MONITORING CONCEPT*

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Operations monitoring is a safeguards concept which could be applied in future fuel cycle facilities to significantly enhance the effectiveness of an integrated safeguards system. In general, a variety of operations monitoring techniques could be developed for both international and domestic safeguards application. The goal of this presentation is to describe specific examples of operations monitoring techniques as may be applied in a fuel reprocessing facility.

The operations monitoring concept involves monitoring certain in-plant equipment, personnel, and materials to detect conditions indicative of the diversion of nuclear material. An operations monitoring subsystem should be designed to monitor operations only to the extent necessary to achieve specified safeguards objectives; there is no intent to monitor all operations in the facility.

The objectives of the operations monitoring subsystem include:

- verification of reported data,
- detection of undeclared uses of equipment, and
- alerting the inspector to potential diversion activities.

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Achievement of these objectives will enhance the diversion detection capability of an operations monitoring subsystem. The monitoring function must be accomplished with minimal instrusion upon the operations of the facility. Once these objectives have been met, additional logic could be added to the operations monitoring subsystem to permit a graded response to an identified anomaly in facility operation. This graded response would not be acceptable for international safeguards but might be considered a viable domestic safeguards technique. Operations monitoring will function in an interactive mode providing other safeguards subsystems with data otherwise unavailable to them.

The operations monitoring concept can be applied to areas and operations within a reprocessing facility which are not amenable to other safeguards measures such as process monitoring (e.g., spent fuel pool, storage, vault, etc.). Operations monitoring techniques are particularly well suited to parts of the facility where item accountability techniques are employed. Nuclear material in these areas is in a form which can be readily manipulated by operational equipment. Signals from remotely operated equipment can be easily linked to a computer for analysis of the safeguards significance of each movement.

In general, penetration monitoring relies on a large number of functionally independent instruments; the integrity of this system is compromised by the failure of key penetration monitors. Application of operations monitoring and/or process monitoring to a facility would provide assurance that although the penetration monitors in a particular area are inoperable, the operations within that area are not indicative of a diversion. Thus, the redundancy contributed by operations monitoring would enhance the credibility of the penetration monitoring subsystem.

Operations monitoring would also be valuable in the separations area of the plant where nuclear material is in solution. It would complement the other safeguards subsystems in this area, for example, by indicating that process lines had been altered to by-pass the accountability tank. This internal diversion of material (that is diverting material from its declared use without removing the material from the facility) must be considered by the International Atomic Energy Agency in safeguarding future facilities.

Another feature of an operations monitoring system is a personnel access monitoring capability. In highly sensitive areas of the plant, this monitoring would detect undeclared personnel access and would provide an extra measure of personnel safety. Personnel access monitoring will help assure that only authorized employees are admitted to highly sensitive areas at authorized times:

One design feature of any containment/surveillance system should be a tamper indicating capability. An operations monitoring subsystem must incorporate this feature in its design at the outset to establish its credibility as a safeguards technique. Two methods which can be employed to accomplish this goal are:

1. installation of a tamper indicating device on the instrument and
2. correlating the signals from two or more instruments such that tampering with one is reflected in the output of the other.

Operations monitoring must be compatible with other safeguards functions and operations (i.e., process monitoring, penetration monitoring, and physical protection). A logical interface between operations monitoring and process monitoring would be in the separations area. In this area operations monitoring could assure that any changes to process lines would not compromise the process monitoring system. Similarly, the interface of operations monitoring with penetration monitoring would help detect the intentional neutralization of penetration monitors.

The operations monitoring system is responsible for events of safeguards significance during periods of plant operation including routing maintenance activities performed on-line. Facility operation will also be routinely shut down for preventive and restorative maintenance as well as for physical inventory taking. Unlike some of the other containment surveillance techniques, operations monitoring will be responsible for safeguards events during these shutdown periods.

Operations monitoring may be employed in all areas and activities in which nuclear materials are subject to item accountability. In addition, operations monitoring may be applied in separation areas to improve the effectiveness of other containment surveillance techniques.

Specific areas and operations in a future fuel reprocessing facility will be analyzed for possible application of operations monitoring techniques. Some examples of areas and operations to which operations monitoring might be applied are discussed in the next two sections. These two examples are in no way meant to be a complete list of the possible applications of operations monitoring.

Sampling Operations

Radiochemical plant process control and material accountability information is most frequently derived from the analyses of process vessel samples. The safeguards significance of this information requires the monitoring of sampling operations. The objectives of this monitoring are:

- to assure representative samples and
- to identify removal of undeclared samples.

Surreptitious manipulation of the sampling operation could be used to grossly understate the amount of material reprocessed. Material could then be removed from some other point in the process, defeating the material accounting system. The sampling operation could also be used to remove material directly from the process.

Traditionally, sampling operations have been performed manually by an operator in a material access area (see Figure 1). Once material flow is established by proper valve and pump activations, a sample bottle is placed in the needle block of the station to be sampled. Vacuum and air lift systems are then manipulated to initiate material flow in the sample bottle. After a short time, the air lift is deactivated and the bottle removed from the needle block. The sample bottle is then transported usually by a penumatic tube system to an analytical laboratory.

A variety of signals from this operation could be transmitted to the safeguards computer for analysis by the operations monitoring software. The presence of personnel in the material access area where the sample station is located could be easily monitored by a device mounted on the door. This information would initiate the monitoring of the sampling operation.

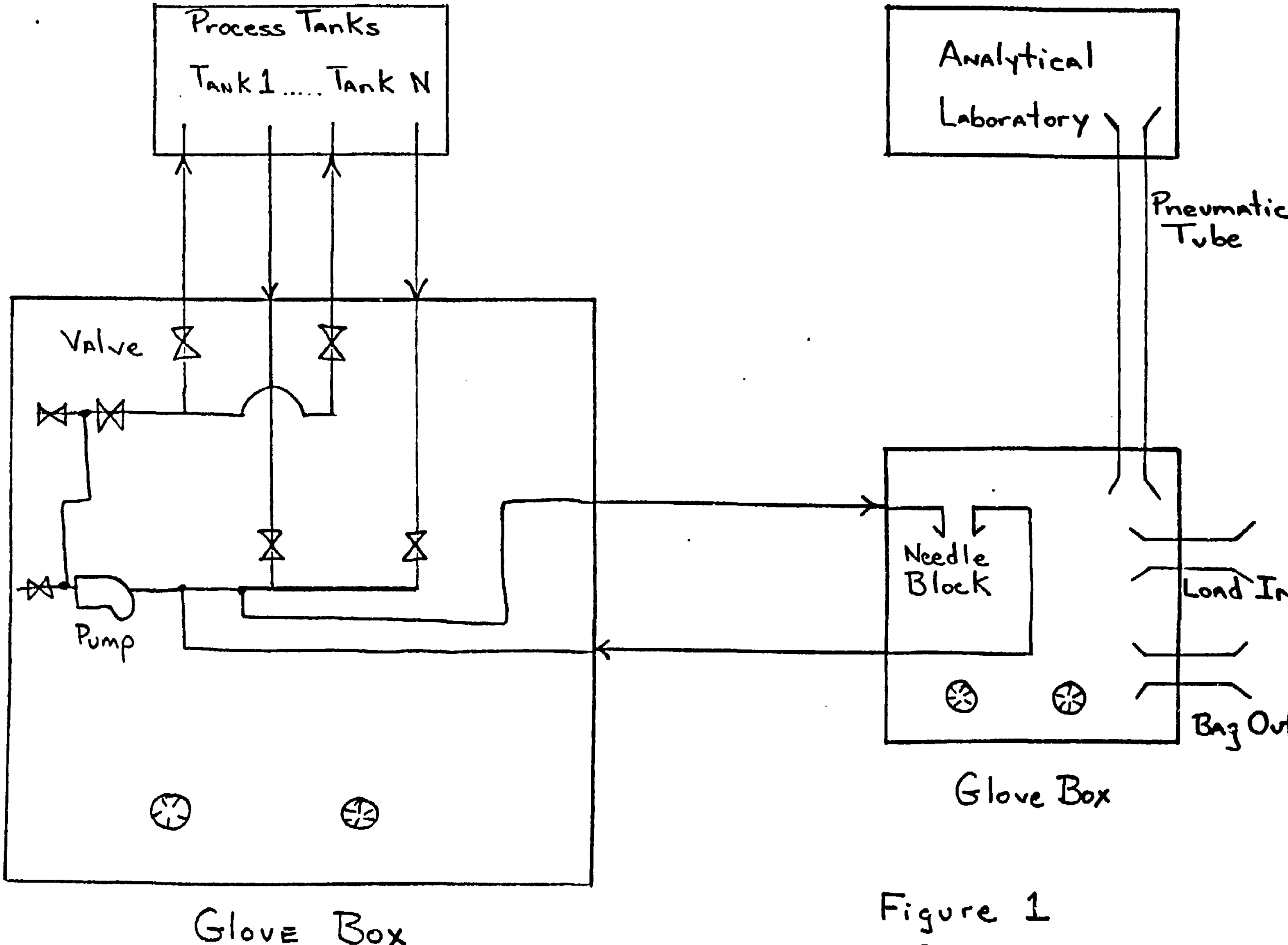

Figure 1
Typical Sampling System

Valve position indicators would signal the computer when the valves are aligned to permit sample circulation. This information would enable the operations monitoring software to determine which tank was being sampled. A signal indicating when the mixing pump was on could provide some assurance that the tank was mixed prior to sampling. During filling of the sample bottle, a bar code reader at the needle block would read a unique label from the bottle. The sample bottle label, tank name, and date and time would be stored in the safeguards computer for later verification of the operator's sampling plan. Monitoring of the sampling operation would be complete when a second bar code reader in the analytical laboratory reads the sample bottle.

Many devices of the previous paragraph are currently available in reprocessing facilities; others would need to be installed. The technology behind these devices is well developed and relatively inexpensive, permitting early as well as frequent application. However, the output signal from all these devices will need to be linked to the safeguards computer for analysis.

Operations monitoring would assure representative samples through knowledge that:

- mixing had taken place prior to sampling and
- a uniquely identifiable bottle contained a sample from a specific tank.

The operations monitoring system would also serve to identify the removal of undeclared samples indirectly by comparison of its sampling data with the operator's sampling plan. A discrepancy between the two would be brought to the attention of an IAEA inspector for resolution.

Remote sampling is a more sophisticated approach to the manual sampling operation used in present-generation reprocessing facilities. A remote sampling vehicle collects and distributes sample containers from various sample stations and delivers the samples to the analytical laboratories. In fact, the remote sampling vehicle is a ready-made diversion apparatus. Its function is to divert material from the process lines to the laboratory for analysis. Such a system could be altered to withdraw samples of relatively high purity and unload them in inconspicuous places for later retrieval. A machine-assisted diversion such as the above would be difficult to detect without benefit of an operations monitoring system. A supervisory computer instructs the vehicle which stations are to be sampled. A wide variety of signals are transmitted between the supervisory computer and the sampling system. These signals could be easily linked to the safeguards computer for analysis by the operations monitoring software.

Spent Fuel Handling and Storage Area

The spent fuel handling and storage area of a fuel reprocessing facility would readily lend itself to surveillance by operations monitoring. The spent fuel pool contains large quantities of special nuclear material in the form of reactor fuel assemblies. Although this spent fuel is highly radioactive, assemblies could be easily removed with the aid of a crane. During normal facility operation a large number of assemblies will be added to and removed from the spent fuel pool. Under such dynamic circumstances, it would be possible to divert assemblies from a pool in which operations are not monitored.

The purpose of the monitoring in this area is to ensure that assemblies which are removed from the area enter the shear for subsequent reprocessing. A log of how many assemblies are removed from the pool which do not enter the shear should be maintained by the computer for an IAEA inspector.

Reprocessing facilities have a cask receiving area adjacent to the fuel storage pool for the purpose of unloading the shipping cask from the vehicle. The lock is designed to accommodate the vehicle as well as enough overhead clearance to permit a crane to move the cask from the vehicle to a cask cleaning cell. The spent fuel assemblies are removed from the shipping cask in this cell. After cleaning and assaying, the fuel assemblies are transferred by the crane to the spent fuel pool. After some time period in the pool, the fuel assembly will be transferred by crane to the fuel disassembly cell where the fuel is sheared and dissolved in acid.

A variety of signals from the cask handling system and fuel handling system could be transmitted to the safeguards computer for analysis by the operations monitoring software. The presence of a cask transportation vehicle in the cask receiving area would be indicated by a simple device on the doorway. The passage of a vehicle into the receiving area would initiate the surveillance by the operations monitoring system. A scale on the floor of this area would provide some information that the vehicle left the receiving bay lighter than when it arrived.

A weight sensor on the equipment which removes the assembly from the cask would signal that an object with a weight typical of a spent fuel assembly is picked up on the fuel cleaning cell. The operations monitoring system is not sure the crane holds a fuel assembly until the object is assayed. Once this assay is completed and the object is identified as an assembly, the operations monitoring system follows the movement of the assembly via a crane position monitor to the spent fuel pool.

After the assembly is lowered into its storage location in the pool, the movement of the next assembly is monitored until all the assemblies have been removed from the cask. The operations monitoring system maintains a record of what positions in the storage pool contain spent fuel assemblies. When the vehicle leaves the receiving bay, the operations monitoring of this operation is suspended until another vehicle enters the bay or a fuel assembly is picked up in the pool. In the latter case, the operations monitoring system follows the movement of the assembly to the fuel disassembly cell. Knowledge of the crane location which corresponds to the disassembly cell is maintained by the operations monitoring software. An attempt to unload the assembly in a location other than the disassembly cell or the storage pool would be cause for further investigation.

After an assembly is unloaded in the fuel disassembly cell, a device on the shear will indicate that an assembly is being sheared. Once the assembly has been sheared and no other assembly movements are indicated, the operations monitoring of this area is complete.

The purpose of these examples has been to examine how operations monitoring might be applied in a fuel reprocessing facility. Operations monitoring analyzes large quantities of diverse information with the ultimate goal of timely detection of an attempted diversion.