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Remote Surveillance System for New MOX Plant

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ABSTRACT

This report describes the results of project JD-12 including JD-9. The objective of this project is to develop a remote surveillance system with a trigger devices which consist of gamma ray monitor and electronic sealing switch. The concept of the system is going to be applied to an automatich storage of new MOX plant which is fully automated.

1. SYSTEM SPECIFICATIONS

1.1 Outline of System

This surveillance camera system is for application of safeguards.
If has tamper-proof nuattended monitoring functions.

(1) For application of safeguards, each component (cameras, image recorder, computer) is covered by the tamper-proof function. A tamper switch (for detecting door open, abnormal vibrations and abnormal temperatures) is installed in the central monitoring cabinet, and data from that switch are recorded.
Optical fiber is used for the transmission of video and tamper signals.

(2) The remote monitoring, remote operating and image recording functions are contained in the camera and in the central monitoring cabinet. The camera can be operated remotely from the central monitoring cabinet. The image from the camera can be stored in an optical disk file as necessary.

(3) Verification can be performed by using the frame memory of one screen image from the optical disk file while monitoring.

(4) System functions can be operated from the computer except setting the initial values of the video timer.

(5) Automatic control of the cameras allows the system to perform the unattended operations.

(6) Monitoring Pattern can be set by both input from external switches and commands from the computer program.

(7) A selection of power supplies from 100V, 115V, 200V and 220V can be made in the central monitoring cabinet.

1.2 System Configuration

The system consists of a surveillance camera and a central monitoring cabinet. These components are linked by optical fiber and control cables. Fig.1 is a block diagram of the system. The flow of signals in this configuration is described below.

(1) Both the title and time are superimposed on the screen of the video signal from the camera as one line containing a maximum of 16 alphanumerics and symbols and the time (Month-Day-Year, Hour:Minute: Second).

(2) When necessary (when directed by the CPU), the image of the surveillance

monitor is recorded in the optical disc file. When an image is to be verified, the CPU controls a freezed image through the frame memory on the verification monitor. Use of the frame memory allows for simultaneous verification and surveillance.

(3) Signals from the switches mounted in the surveillance cameras (case open, illumination detection, vibration detection signals) are input to SIF (2), and pass along fiber optic cables from the STU in the central monitoring cabinet to be stored in the CPU.

(4) Signals from the switches mounted in the central monitoring cabinet (door open, abnormal temperature, vibration detection and power supply failure signals) are input to SIF (1) (External interrupt signals from the pushbuttons are input to SIF (1) and are stored in the CPU from the STU).

(5) The camera pan heads and the zoom lenses are controlled by control commands from the CPU through metalic cables.

1.3 Functions

(1) Tamper-proof functions

All tamper data are collected in the signal interface (SIF-1) and is transmitted optically to the signal transfer unit (STU). The collected data is processed periodically by the host computer (CPU).

a. Tamper data input to the SIF inside the camera case are for camera case open, vibration detection and room illumination detection.

b. Tamper data input to the SIF in the central monitoring cabinet are for door open, vibration, temperature and power failure detection.

c. The SIF secret number (ID), the case open and equipment abnormal signals are transmitted to the STU as status signals.

d. The major video signals and temper signals are transmitted on fiber optic cables that cannot be removed from the outside.

e. Operating of the CPU are only effective when the secret code matches the recorded code. Inspectors set the secret codes.

(2) Monitoring, image recording and play-back functions

The (monochrome) image output from the CCD cameras is input to the video equipment in the central monitoring cabinet along fiber optic cables. Details such as the time and the surveillance area code can be inserted into the video signal for monitoring on the surveillance monitor TV. At

the same time, these signals are recorded on optical disc file under the comand of the CPU. The number of disc files remaining constantly appears on the CRT. Image recording is completely performed by the operation monitor program.

The play-back images can display on the verification monitor TV. The selection for play-back is made by using the index menu on the monitor display. During play-back, the system freezes one frame at a time in the frame memory, so surveillance and recording are not interrupted by the verification activity.

(3) Camera control functions

The camera head is controlled by command from the CPU. Position detection data (analog data) of the pan heads is processed in an A/D convertor before being transmitted to the central monitoring cabinet. The CPU processes this data and controls camera movement.

(4) Functions for creaing monitor programs

The operator can select the memu for creating the program menu monitor program. The operator set surveillance area (up to 10 locations), the monitoring interval (in units of 2-10 minutes when the cameras are moved, and in nuits of 1-10 minutes when the cameras are not moved), and the number of shots to be photographed (up to 11 shots for each external interrupt signal point). Up to 10 locations can be specified by each program, and up to 10 programs can be created.

The external interrupt signal selects the program and operates the system according to the shooting pattern described by the program. When no external interrupt signal is input, the system performs surveillance according to the internal shooting pattern.

(5) Search functions

Operator can search image records and event data.

a. The records of recorded images are classified into the same location, according to the external interrupt signal, or time, and can be played back in these categories.

b. Operator may randomly select and play back images.

c. Event data can be searched by displaying the details for each item on the CRT and this information by printing can be printed if

necessary.

d. The record data for recorded images and event data can be output for the contents of each register.

(6) Structure and other functions

a. The camera case is a simple dust-proof type. The tamper switch activates when the case is opened.

b. Cables are secured internally so that they cannot be removed from the out side without openning the case.

c. The door on the central monitoring cabinet is fitted with a lock. The tamper switch activates when the door is opened.

d. There are two openings on the central monitoring cabinet, at the front and the back. The back opening cannot be opened unless the front door is opened.

e. To improve operability, the mount for the primary equipment such as printers and keyboard can be pulled out towards the poerator.

f. When the temperature inside the cabinet exceeds a set level, a buzzer fitted to the cabinet's front door sounds.

g. Operator can select the power supply from 100V, 115V, 200V or 220V.

h. If a power failure is detected on the CPU, the emergency power supply acts as a back-up until the data have been saved. After that, the emergency power only supplies the STU and SIF so that tamper surveillance can continue.

i. When power supply is restored to the normal condition the system automatically returns to normal.

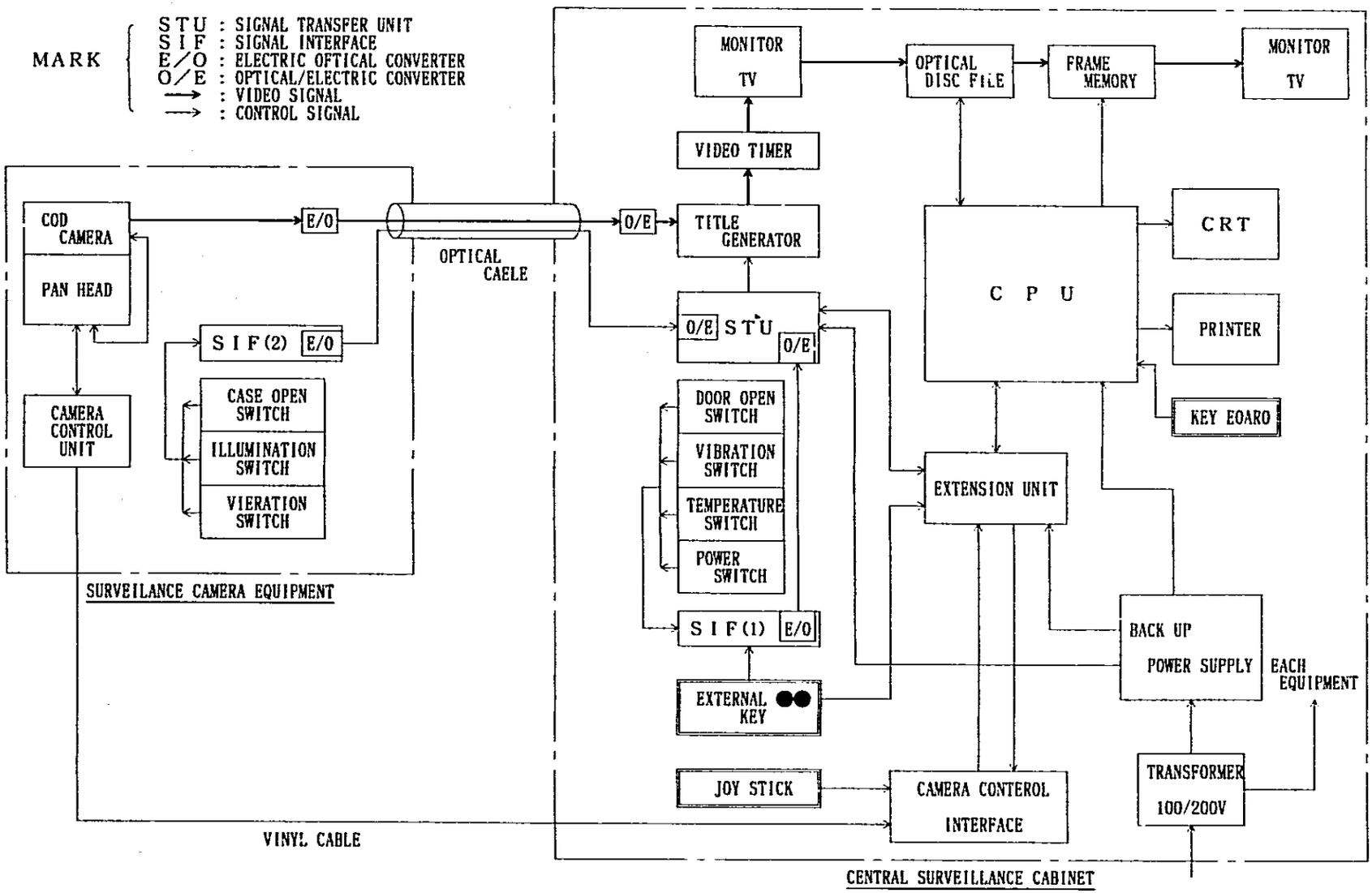


Fig. 1 SYSTEM BLOCK

2. SYSTEM MODIFICATION

As a result of evaluation of the running test, it was proved that the following points need to be improved from the viewpoint of the effectiveness and maintenance of safeguards.

(Improvement Points)

(1) Change the picture/recording time interval from every minute to every 10seconds to prevent a failure in monitoring any work contents.

(2) To improve the efficiency of using the limited recording capacity, enable the nighttime recording time interval after working to be automatically changed to every 20 to 30 minutes.

(3) Shorten the search file time for the inspection.

(4) Further improve the performance and reliability of each devices.

For improving the above points, both the hardware and software were modified to carry out the evaluation test of this C/S system in the assembly storage of the PPFF.

2.1 Hardware modification

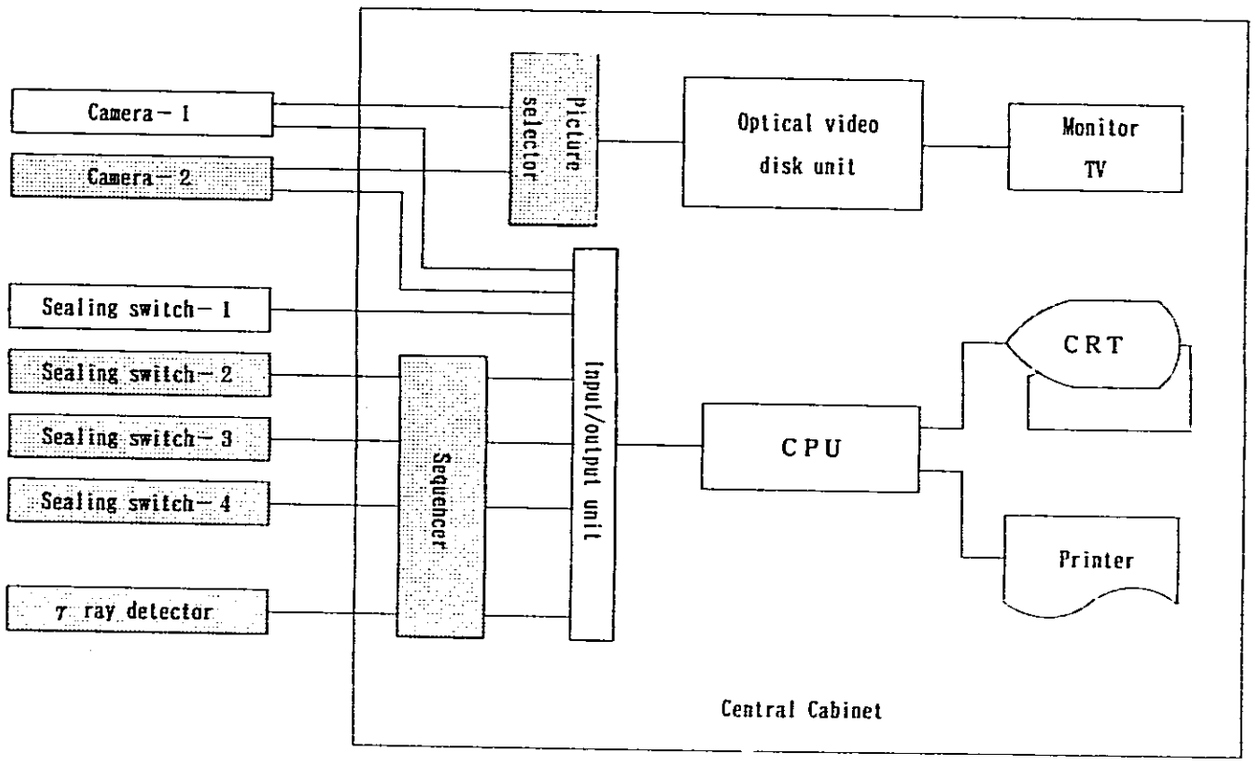
The CCTV camera and the trigger devices of the γ ray detector and electronic sealing switches are added to this system, and their accessory devices are mounted on the central cabinet. Figure 2 shows the system configuration diagram.

(1) Adding the CCTV camera

Both the newly to be made CCTV camera and the conventional CCTV camera are used to picture recording by selecting one of these two cameras with a timing signal from the external trigger device.

(2) Adding trigger devices

In addition to the conventional sealing switch, three sealing switches are newly added and a γ ray detector is built into this system. In addition, to apply this system to the assembly storage of PPFF, the input/output interface unit and the monitoring central cabinet are modified.



Each slanted line block indicates a newly added device.

Fig. 2 System Configuration Diagram

2. 2 Software modification

(1) Changing the picture recording process software

a. Monitoring pattern

The status signals input from the external trigger device are combined to classify the monitoring patterns (picture recording modes) and enable selection of one of the two CCTV cameras according to predetermined priority.

b. Picture recording pattern

In the monitoring pattern, the picture recording interval time can be input from the keyboard for picture recording at intervals and random picture recording.

(2) Modifying the inspection/confirmation program

To shorten the search time of picture data and event data, this software is modified to allow manual serach of bictures while the file structure is modified.

3. EVALUATION TEST

The modified system is applied to the fuel assembly storage PFEF and the evaluation test has been carried out for data collection and evaluation.

3.1 device layout

Figure 3 shows the conceptual diagram of the evaluation test device layout.

- CCTV camera (1)

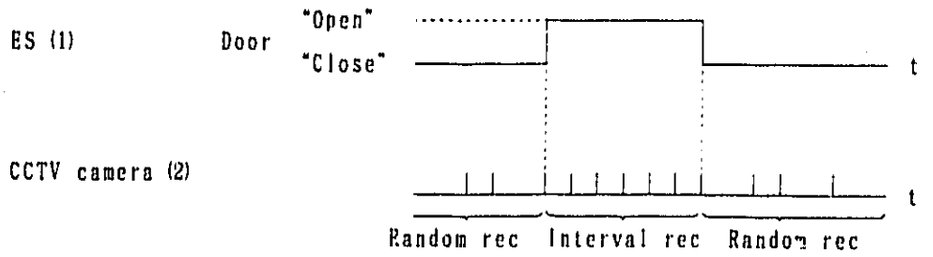
  This is installed in a place which enables monitoring of the entire storage pit area.

- CCTV camera (2)

  This is installed in a place which mainly enables monitoring of the entrance/exist door and the hatch area, but also enables monitoring of the maintenence area by manual remote operation if necessary.

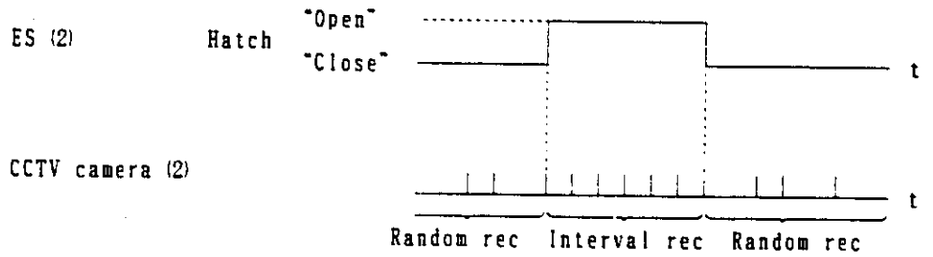
- Sealing switch ES (1)

  This switch is installed in a place which enables detection of open or close the entrance/exit door. The "Open" signal allows picture recording with the CCTV camera (2) in the following sequence:



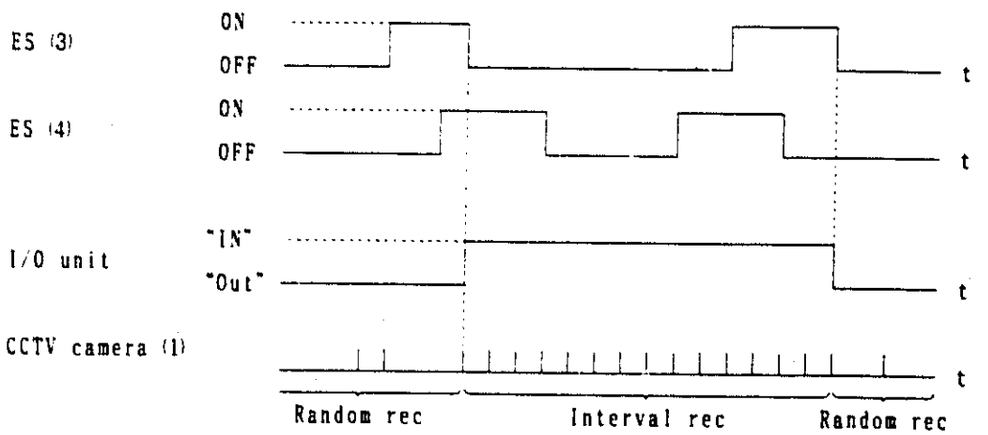
・Sealing switch ES (2)

This switch is installed in a place which enables detection of open or close the hatch door. The "Open" signal allows picture recording with the CCTV camera (2) in the following sequence:



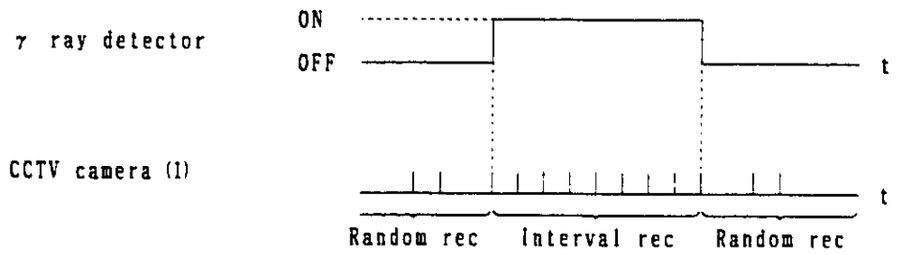
・Sealing switches ES (3) and (4)

Two sealing switches ES (3) and ES (4) are installed in places which enable detection of movement of the crane in the pit area. The crane pit area "In" signal allows picture recording with the CCTV camera (1) in the following sequence:



• γ ray detector

This is installed in a place which enables detection of assembly transfer the entrance/exit door and allows picture recording with the CCTV camera (1) in the following sequence:



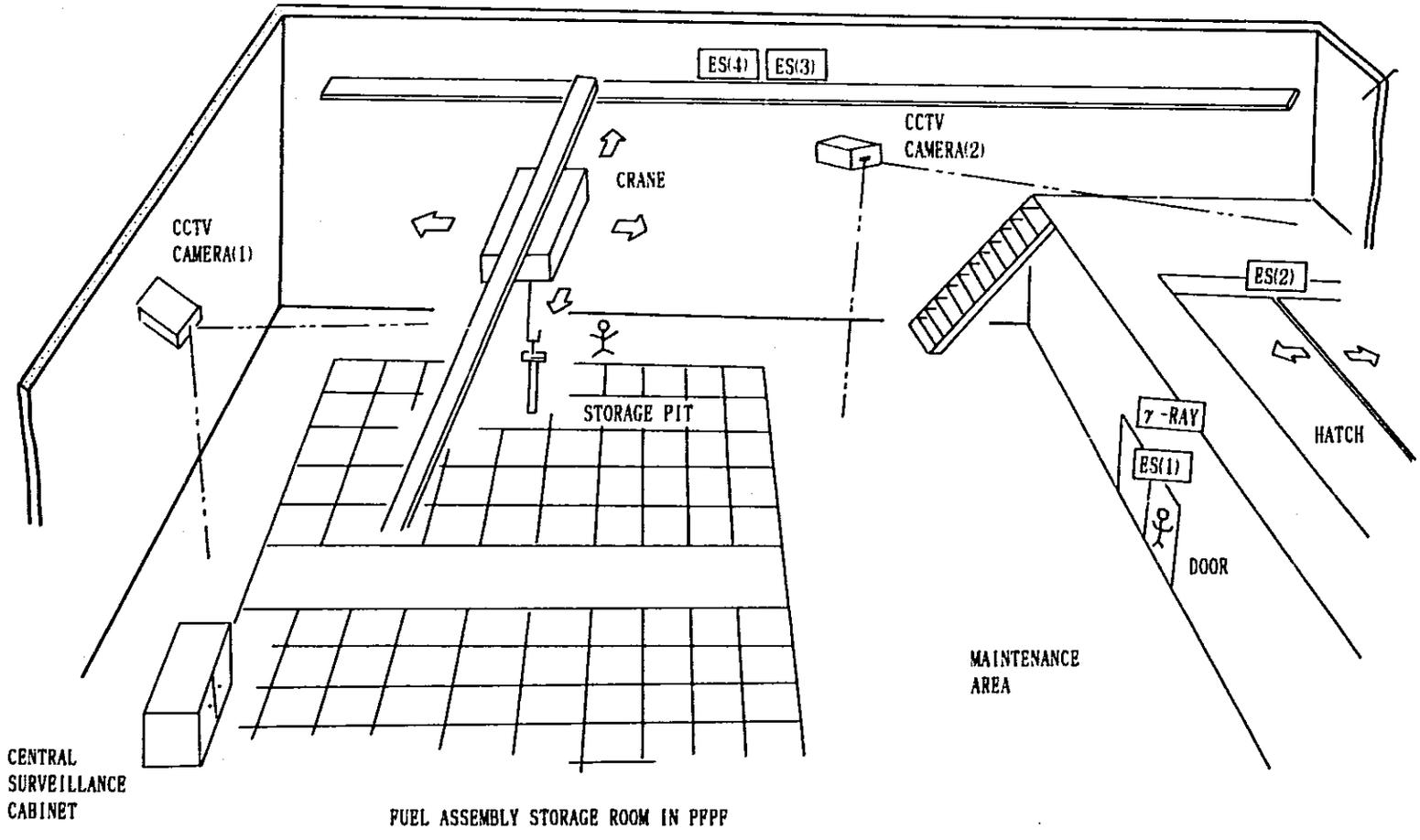


Fig. 3 Conceptual Diagram of Running Test Device Layout

3.2 Test Method

The evaluation test was carried out according to the procedure shown in Figure 4. During the evaluation test, the work contents monitored by recorded picture and the event data deeced by the trigger devices are compared with the data of the work report on the facility side for evaluation.

Based on the search time, the operability of each device was also tested.

3.3 Outline of Test Results

The evaluation test results are shown below.

(1) Detection ratio

a. Detecting the event signal from the trigger device

- The ratio of detecting the event signal from the sealing switches is 100%.
- The γ ray detector detected 100% of entry of fuel assemlies to the room. It was proved that even the entry of a small amount of nuclear material to the room can be detected up to about 100g of MOX if the parameters of this detector are set up appropriately.

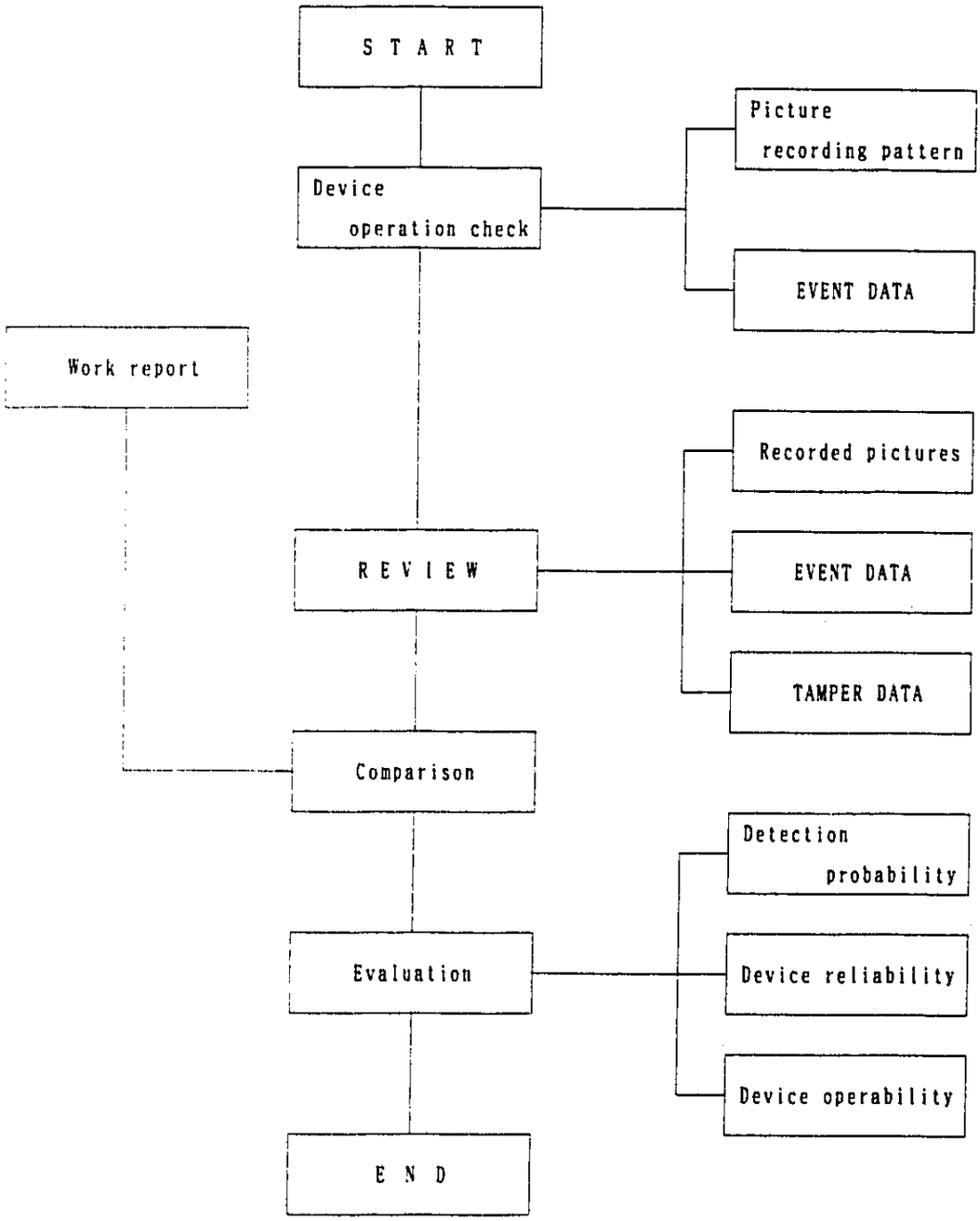


Fig. 4 Evaluation Test Flow

b. Monitoring work contents by picture recording

- The storage state of the fuel assemblies moved by the crane could be monitored at picture recording intervals of 20 seconds/frame without a failure.
- The transfer of assemblies to the room could be monitored at picture recording intervals of 10 seconds/frame without failure.
- The exit of fuel assemblies from the hatch could be monitored at picture recording intervals of 20 seconds/frame without a failure.
- It was proved that the entry/exit door of workers to/from the entrance/exit door could not be completely monitored unless the picture recording interval is within 5 seconds/frame.
  During working, the door is open.
  It is disagreeable to record pictures at intervals of five seconds for a fairly long time from the viewpoint of effective use of the picture recording capacity. From the viewpoint of the effectiveness of safeguards measures, it seems better to record pictures at random because the workers then feel like they are being monitored (However, it would be effective to record pictures at intervals (five seconds/frame) when the door is opened and closed.).

c. Device Reliability

During debugging, a part of camera (2) failed.
Other than this failure, however, all devices operated normally. Therefore, it was proved that these safeguards devices possess high reliability.

d. Device Operability

- Effective use of picture recording capacity
  During normal operation of the fuel assembly storage of PFFF, the monitoring pattern used for this system has picture recording capacity sufficient for monitoring for a month and a half. Therefore, the picture recording capacity could be effectively used.
- Search time
  It was proved that the modified system enables data search in approximately 1/3 of the time required for the conventional system.
- Operability
  It was proved that the modified system could be easily operated even by the operators (such as inspectors) who were not accustomed to operating the CPU.

4. CONCLUSIONS

It was confirmed from the evaluation testing that this system was satisfactory from the viewpoints of effectiveness and the operability of the safeguards, and application to the larger MOX storage facility was confirmed. The concrete results were as follows:

(1) The operation in the assembly storage facility carried out by the crane, carrying in SNM, and entrance and exit door opening and shutting could be monitored and the operation could be evaluated.

(2) All operations in the storage facility could be recorded on videodisc, no matter what work was done, by switching the recording system with the outer trigger devices and by making the recording interval variable. As a result, recording on an optical disc of limited capacity was confirmed to be effective and therefore, a longer period of recording became possible.

(3) Retrieval time for recorded pictures and retrieval time for operation data of apparatuses could be shortened.

(4) From the long term proof test results in the fuel assembly storage facility, it was verified that the trigger apparatuses set in the facility and equipment on the monitoring cabinet were sufficiently reliable.