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TV2GO - THE USE OF MINIATURE OFF-THE-SHELF CCTV DURING THE DECOMMISSIONING OF A CHEMICAL ENGINEERING BUILDING

E Abel, C Hamblin and A C Rose
AEA Technology[+], Harwell

SYNOPSIS

The 43 year old Chemical Engineering Building at AEA Technology's Harwell Laboratory is the subject of a decommissioning programme, with a scheduled green field end point in 1998. It has housed experimental and production plant covering the full spectrum of the nuclear fuel cycle. Clearance of the building is being accomplished using mainly hands-on methods. However, increasingly stringent legislation on topics such as manual handling, COSHH and workplace evaluation mean that every task has to be carefully planned and strictly controlled, with reference to a range of potential chemical and radiological hazards. Using techniques borrowed from remote systems technology, decommissioning operations now regularly employ Video and CCTV for inspection, surveillance, communication, record keeping, training and management control. This poster paper describes the use of miniature off-the-shelf colour CCTV systems that have been configured to meet a range of applications in the building. Because of their versatility, cheapness and the ease with which systems can be built quickly and made ready for use, they are known as TV2GO.

* Note: The submitted Synopsis (virtually identical to the first section) and pictures of the building surveillance cameras were added to this printed version in 1998, otherwise this version is as presented at the Conference Poster session.

[+] In 1995, UKAEA work was published under the AEA Technology banner.

BACKGROUND

The 43 year old Chemical Engineering Building, Building 351, has housed experimental and production plant covering the full spectrum of the nuclear fuel cycle. Clearance of the building is being accomplished using mainly hands-on methods. However, increasingly stringent legislation on topics such as manual handling, COSHH and workplace evaluation mean that every task has to be carefully planned and strictly controlled, with reference to a range of potential chemical and radiological hazards. Using techniques borrowed from remote systems technology, decommissioning operations now regularly employ Video and CCTV for inspection, surveillance, communication, record keeping, training and management control. Miniature off-the-shelf colour CCTV systems and 3-D TV have been configured to meet a range of applications in the building. Because of their versatility, cheapness and the ease with which systems can be built quickly and made ready for use, they are known as TV2GO.

SELECTION OF CCTV CAMERA

UKAEA have extensive experience in specialized CCTV design for the nuclear industry. Stereoscopic systems such as TV^3 have been used in reactors, decommissioning projects and non-nuclear applications. However for short-term exposure to radiation, especially at the levels where manual decommissioning teams will operate, radiation-induced degradation of CCTV electronics and optical systems is not normally a problem. The decommissioning tasks require a system that could be rapidly deployed or installed, would provide quality pictures and was robust. Video recording of the information and the ability to interface cameras with audio links was also important. For inspection purposes, colour was necessary because chemical residues and corrosion were likely to be found in many rigs, ductwork and installations throughout the building.

Table 1 - Details and Specifications of Chosen "Lip stick" Camera

Power Consumption	approx. 4 W
Device	½" CCD image area sensor, 579 x 583 pixels
Resolution	>370 lines(H), >420 lines(V)
Scanning Area	6.50mm x 4.85mm
Scanning	2:1 interlaced
Standard luminance	over 200 lux
Ambient temperature	-10°C to +40°C
Camera cable length	up to 30m
Weight	25g (head, without cable)
Pan (& tilt) unit range	340° (190°)
Pan & tilt unit weight	700g

The particular camera chosen was supported by a wide range of accessories. The camera control unit could be located up to 30m away from the head. Environmental and underwater housings were available, but for the mainly dry applications in this building they are not necessary. Contamination has been avoided by carefully double-wrapping the camera and cable in lay-flat plastic tubing. The camera was fixed to a miniature pan and tilt unit when used to observe work being carried out by decommissioning teams. The pan and tilt was either hung at height on a wall or mounted on a tripod that could be easily moved.

FINGAL INSPECTION AND DECOMMISSIONING

A deployment system for the lip stick camera was based on a 5m length of plastic conduit. The camera was wedged at one end and the control and signal cable run inside. A cut down plastic filter funnel was fitted to shroud and protect the camera head, and a halogen light was strapped to the conduit. The maximum width of the assembly was 75mm, compared to the plant bore dimension of 150mm. Camera parameters such as aperture and focus were set beforehand by a trial inspection of a (clean) soil pipe.

Working from the roof of the FINGAL Cell through the concrete shielding, a telescopic β/γ probe was used to map the radiation distribution of the furnace and two oven bores. The conditions of the inside surfaces were then inspected using the lip stick camera. High quality pictures of the bores showed that remarkably little debris remained and the furnace elements and ceramic bricks were mainly intact. This information strengthened the methodology proposed in the Decommissioning Safety Case. Correlation of the radiation measurements with the camera images clearly identified the location of the hot spots on specific areas above the furnace and ovens.

Two cameras were installed, one on a wall-hung pan and tilt unit within the Cell and one fixed to the inside of the MCS. The two viewpoints gave virtually total coverage of all areas. The control units were housed in a cabinet next to the change barrier in front of the MCS. A video switch allowed the supervisor to watch his team in either area on a TV monitor and record operations using the VCR. Two-way speech communications were possible through an audio system which was also patched to the VCR. The FINGAL Communications System worked without any problems during decommissioning operations.

At the end of the work the camera heads, lenses and cables were decontaminated and pronounced clear of contamination and will be used in other MCSs or containments built for decommissioning in different parts of the building. As expected, the microphones and speakers were not saved. An enhancement of the system components which uses leaky feeder cables as the transmission medium for voice, control and and video will allow greater variation in the types of respiratory protection that can be used by the decommissioning teams and make system deployment and installation simple.

UNDER FLOOR DUCT INSPECTIONS

The Ground Floor of the building is crossed by seven 0.9m x 0.6m under floor ducts, which run towards the pit. Each duct is 17m long and is clad with a stainless steel liner. They have housed all the building rig and laboratory active transfer and drainage pipework. Chemical contamination persists and spillage from rigs has resulted in corrosion of pipes and supports in the ducts. Contamination levels range to beyond 200 cps α and 3500 cps β/γ. Spectrometry of samples shows predominately U and Th contamination with Cs-137 and Ac-228. Significant Pu-239/240 and Pu 238/Am-241 levels are present in one specific duct and another contains the drain line for the U-233 separation pilot plant. The duct which contains the majority of Solvent Extraction Pilot Plant transfer pipework had accumulated radiologically contaminated debris soaked with the aggressive plant solvent, tributyl phosphate in odourless kerosene (TBP/OK).

An inspection programme was devised to establish the extent of the contamination and the status of pipework in the ducts. Each duct was covered by a series of interlocking steel plates (1.2m x 0.6) which each weighed approximately 170kg. In many places the ducts ran under internal walls and active cubicles and so direct access was impossible. A TV2GO camera was fixed to a set of rodding poles which could be progressively added as the camera was inserted

further into a duct. As with the FINGAL inspection, a halogen lamp was used. A more substantial shroud was provided so that the camera did not get trapped between duct obstructions. The CCU and VCR were mounted on a mobile trolley. Video and radiological records were compiled for each 1.2m section of each duct so that the eventual strip-out can be based on detailed knowledge of the ducts' contents.

VENTILATION AND EXTRACT DUCTWORK

The majority of the 4km of ductwork in the building is being removed in 1995/96. Inspection of the internal volumes of the ductwork has been carried out in 1994/95 so that records of accumulated in-duct debris, contamination levels and other information (such as the presence of asbestos and chemical corrosion) can be determined. Such information forms the basis of safety justifications for decommissioning. Initial trials have shown that for this building, at least, visual inspection is an easier alternative to investigative dismantling prior to ductwork strip-out, and is inherently safer.

GENERAL SURVEILLANCE OF OPERATIONS

TV2GO systems have been used to observe several other decommissioning operations where containment construction has prevented easy access by project management teams. 3D-TV has been used where the additional quality of information has been essential for the safe removal of the FINGAL Cell mass concrete shielding roof blocks. 3D-TV and lip stick cameras were placed inside the containment to monitor the progress of block lifting. The 20-tonne blocks had loose contamination tied-down onto their upper and lower surfaces. It was crucial for the safety of operators to see clearly the way in which the tie-down coating tore apart, sheared, delaminated and sagged, before the blocks were raised even a few inches. It would be impossible to get definitive, unambiguous visual cues using ordinary cameras. The stability of the supporting walls and the way in which the jointing cement (also contaminated) broke free had to be monitored remotely as the block removal progressed.

Success in using CCTV within the building will be extended to external decommissioning and final demolition. Steerable, mast or building mounted surveillance cameras will be used to watch, record and control operations. The data will be relayed to a central point in B351, then as the building is vacated prior to demolition, to an adjacent building which will house the Project Team.

CONCLUSIONS

The use of cheap, colour lip stick cameras in a Chemical Engineering Building have enabled decommissioning operations to be carried out safely and efficiently. A visual link between decommissioning team members allows rapid analysis of task complexities and helps in routine communication. The size and ease of deployment of camera systems means that high quality information can be obtained from plant without extensive alterations. This information can be successfully used as a foundation for decommissioning planning and safety assessment.

ACKNOWLEDGEMENT

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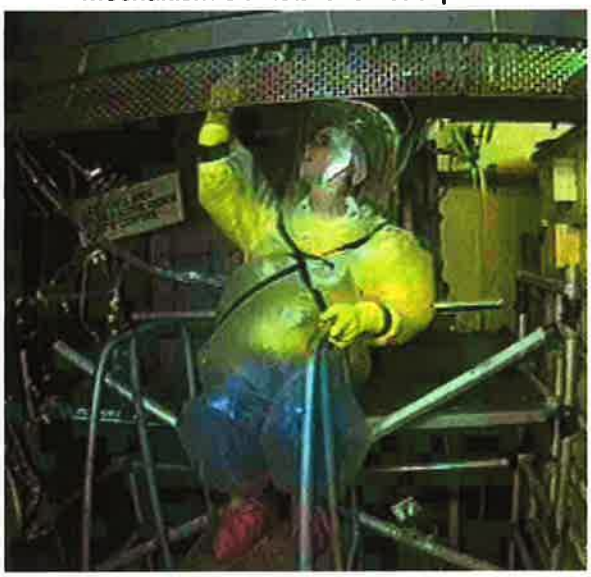
A lip stick camera

Camera plus simple shroud and light

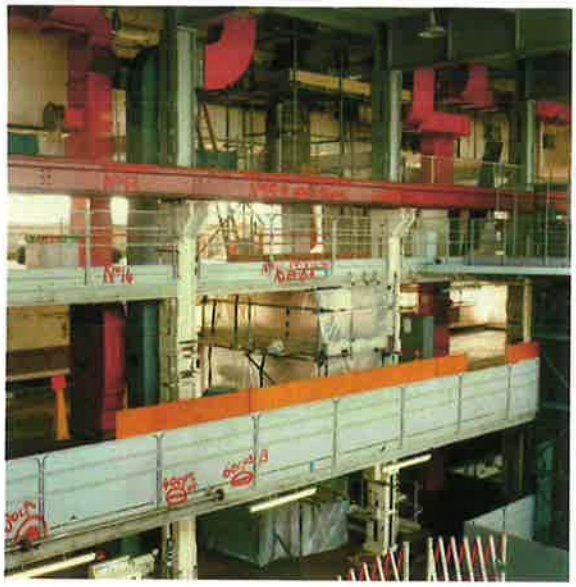
Camera and β/γ monitoring of FINGAL furnace

Microphone, speaker and camera with pan and tilt mechanism on installation backplate

Camera and communications control station



Inside the FINGAL Cell – lipstick camera image



Examples of building contaminated ductwork that was inspected before decommissioning

"TV2Go Kart" – trolley with camera, lighting and recording controls for use within Building 351

3-D TV camera head

3-D TV monitor

Building surveillance during decommissioning & demolition

Camera mast for surveillance of decommissioning & demolition