Use of CCTV in remote operations and remote support of oil and gas fields to improve safety and resilience

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Abstract. CCTV is increasingly used in the oil and gas industry to assist in remote operations and remote support. This is done to achieve safety and resilience. The CCTV system is a complex component, consisting of technology (screens, cameras, workplaces), humans (operators observing and analyzing information) and organizational factors (procedures, responsibilities, staffing). We have examined the use of CCTVs in three actual oil and gas installations on the Norwegian continental shelf, in order to identify the use and need for Human Factors (HF) specific guidelines. The scope of HF specific guidelines related to CCTV is ergonomic factors (i.e. size of screens), cognitive factors (i.e. situational awareness) and organizational factors (i.e. awareness of need, process to implement CCTV, and procedures of use). Available CCTV standards and guidelines were not known or used in the design process in the installations. In general, available CCTV guidelines are focused on security, and are not focused on safety and resilience of remote operations. The industry should use and explore the existing CCTV standards from the initial phase in order to build on existing research and good practices from the HF area. We argue that there is a need to develop improved CCTV guidelines and standards supporting HF, safety and resilience, especially in the oil and gas industry.

Keywords. Closed Circuit Television (CCTV), control centre, safety, HF Guidelines, remote control.

1. Introduction

Closed Circuit Television (CCTV) is increasingly used in the oil and gas industry in order to support remote operations with both low manning and no manning. In several installations (i.e. oil and gas platforms) between 200 and 80 CCTV cameras have been installed to give video coverage in a control centre or a support centre onshore or offshore. CCTV cameras (with microphones) can make a high quality multi media video-stream available anywhere. CCTV cameras with thermal sensors can also document temperature distribution and can identify unwanted incidents such as gas leaks. The availability of low cost CCTV cameras and data networks with high capacity has lowered the threshold for use of CCTV. It has been easy to demand a CCTV camera on an installation without a thorough analysis of the needs and requirements of use. The CCTV cameras can be used:

- proactive to control a process and mitigate unwanted incidents in advance
- reactive to mitigate an unwanted situation and recover
- to learn, by finding and analyzing a situation after the event

The CCTV camera is not just a technical component, the CCTV system is a sociotechnical component, consisting of technology (screens, cameras, workplaces for the operator fulfilling ergonomic requirements, usually in a control center), humans (operators having the cognitive ability to observe, interpret, plan and act based on information given) and organizational factors (such as procedures, responsibilities, staffing). Thus in order to ensure that the CCTV system is supporting the intended use, all these human factors issues must be specified and designed. Human factors issues are generally explored when designing a control centre in the process industry and oil and gas industry. This has been done through the use of recognized HF standards such as ISO 11064 "Ergonomic design of control centres" (2013) and exploring alarm standards such as EEMUA-191 (2013). In Keval (2009), it is estimated that five million CCTV cameras are in use today, but there has been little research to establish whether these systems are fit for purpose. The use of CCTV is poorly threated in ISO 11064 (2013), thus there is a need to use additional standards or guidelines.

Based on the expanding use of CCTV in the oil and gas industry there are several key issues that should be explored:

- What are relevant HF standards and guidelines of CCTV that should be used in the oil and gas industry in the control centres?
- What is the actual use of relevant HF standards of CCTV in the oil and gas industry?
- What should be covered in relevant CCTV standards and guidelines in the oil and gas industry?

2. Method and research

The research questions mentioned above have indicated the need for the following activities:

- Performed a cursory survey of existing CCTV standards and guidelines.
- Explored the use of CCTV standards and guidelines in new projects involving extensive use of CCTV in the oil and gas industry.
- Suggested the framework for relevant CCTV standards and guidelines.

We have performed a survey of existing CCTV standards and guidelines, in order to identify relevant issues based on using keywords such as "CCTV, Human Factors in CCTV, Safety and security in CCTV use". The identified literature has been reviewed in order to find often cited articles.

Our area of focus has been oil and gas installation where use of CCTVs has been extensive. We have explored the use of CCTV guidelines in projects designed for remote operations or remote support in three installations (through the development phases). The areas of exploration have been the control centers, being designed based on recognized human factors standards, such as ISO 11064 (2013), implying a task driven iterative design process. Our approach has been based on participatory action research (PAR); see Greenwood & Levin, (1998). PAR involves three basic elements – research, action and participation. PAR aims at creating a joint learning process between researchers and the various stakeholders holding interests in the problem under study. Thus the findings have been discussed with the involved stakeholders, which have helped prioritize the findings. The number of participants in the PAR meeting has varied from 23 to 4.

We have also asked about the need for standards and guidelines through a Norwegian human factors network, Human factors in control (HFC), consisting of around 400 stakeholders. Some selected key participants identified the need for standards. The positive response was based on involvement in relevant projects where remote operations and Human factors had been a key issue. The suggested framework for CCTV standards and guidelines are going to be explored and discussed in workshops and projects in collaboration with the Norwegian network, Human factors in control (HFC), see www.hfc.sintef.no and also the paper from Pikaar and Lenoir (2014).

3. Result – poor understanding and poor use of CCTV guidelines

In the following we have documented the results from out quick scan of relevant litterature and project involvement.

3.1 Scan of literature related to HF of CCTV

We have performed a cursory literature review of CCTV use in the process industry, looking for standards and guidelines covering both safety and security.

CCTV-systems are used in surveillance to achieve security, in traffic control and supervision; as a support tool in tunnel safety, to aid in the control of movable objects such as portals/doors, and in many other areas. There are several guidelines covering security, such as EN 50132-7 (2012) and Home Office (2009). The standards and guidelines suggest a context for implementation of CCTV. We suggest that such a context should be based on recognized HF guidelines such as ISO 11064 (2013). In addition, a CCTV specific operational requirement document should be produced. The standard EN 50132-7 (2012), suggests a comprehensive structure covering the following areas:

- General considerations (Needs for CCTV based on risk assessment); Operational requirements specifications; Equipment selection and performance; Image presentation; Transmission and video performance; CCTV Storage requirements; CCTV control room requirements (Number, size of screens); and Test plan (Factory Acceptance, User acceptance).

There are several publications discussing human factors issues when implementing CCTV. Key issues are human attention, which can be influenced by many issues. Unexpected events are often overlooked when observing on CCTV, as suggested by Simons and Chabris (1999), when they demonstrated that around 50% of observers fail to notice an ongoing but unexpected event while they are engaged in a primary monitoring task. One of the key issues is to focus attention, and thus get help by other means, i.e. alarms or safety systems, when engaged in primary observation activities. In a study of security cameras, Green M. W. (1999), also pointed out:

- "These studies demonstrated that such a task [manual1y detecting events in surveillance video], even when assigned to a person who is dedicated and well-intentional, will not support an effective security system. After only 20 minutes of watching and evaluating monitor screens, the attention of most individuals has degenerated to well below acceptable levels. Monitoring video screens is both boring and mesmerizing. There are no intellectually engaging stimuli, such as when watching a television program".
- Thus use of CCTV must be supported by procedures, and supporting systems, i.e.:
- The operator vigilance are impacted by attention – and systems should be designed to establish attention in advance of an unwanted incidents, such as through an alarm

- The work organisation and worker schedule should be adapted to the criticality of the task, i.e. if there is a critical task, several people should be involved, there should be breaks between observing CCTV screens after 20 minutes (depending on the scene that is watched)
- The resolution and size of the screens must be designed based on good practice guidelines such as suggested by Wood (2007).

The main result from our cursory survey was the missing availability of guidelines, standards and research related to safety and resilience when using CCTV use in process control. However a set of security guidelines existed that could be explored.

3.2 **Use of standards when implementing CCTV in remote operations and remote support of oil and gas fields**

The use of CCTV to support safety and resilience has been discussed in three large project covering remote operations and support of oil and gas installations. The discussion has been based on participatory action research (PAR); using a scenario approach both in the early design phase and in the detailed design phase when the requirements and design of the central control room was decided. A set of typical scenarios was explored in a group setting (i.e. workshop) order to focus on how to use the CCTV proactive, reactive and how to learn.

The groups varied from 23 to 4 people in a half-day workshop, performing a systematic exploration of scenarios involving CCTV. The scenario exploration was based on documenting events by involved actors in a STEP diagram, i.e. sequential time event plot, ref Hendrick and Brenner (1987). The scenario was analyzed to identify critical actions and exploring the cognitive issues of the operator, based on issues such as how to: observe, how to interpret, how to plan, how to perform actions. One of the scenarios was based on a gas leak and subsequent fire. The CCTV was used to confirm the gas leak when no field operator could check (since there are no field operators when the installation is not manned). There was need to have a microphone (to hear the sound) and possibility to observe temperatures (to confirm gas leak). In addition key issues have been discussed in interviews with four selected stakeholders involved in installation of CCTV.

The HF standard ISO 11064 (2013) was used as a basis and context of the projects. There was no reference or use of CCTV standards in any of the projects. Thus there is a need to raise awareness of standards and guidelines. Main areas of use of CCTV were related to reactively avoiding accidents and incidents. Suggested incidents were man overboard, evacuations, detection of gas, fire or detection of chemical release or use of CCTV to replace the field operator as an observer during remote operations or support.

The use of CCTV seems to be technology driven. CCTV was seen as an aid in proactive operations when handling “weak signals”, as an example during unmanned operation, if there was doubt about an alarm of gas leak, the CCTV could be used to confirm or check the possibility of a gas leak. The quality of the CCTV should be improved, with possibility to hear (with microphone) and possibility to detect temperature variations in environment (to detect gas leakages with high/low temperature). CCTV as a tool to resolve "weak signals" and help the operator reach a decision – could create the need for supporting information from the SAS system.

During the task analysis, the use of CCTV was discussed in more detail. The consequence of loss of CCTV was not elaborated or documented. However, the subsequent conclusion was that loss of CCTV was not critical, due to the alarms and operational information given by the process control systems – SAS (Safety and Automation Systems). So far the CCTV has not been categorized as a safety critical component, with a SIL level (i.e. Safety Integrity Level). A systematic assessment of criticality of CCTV should be performed, since some operators are implementing more than 100 CCTV cameras, in order to document need for resilience of the supporting infrastructure.

One additional issue that was poorly documented was the role of the humans as a key safety barrier in operations offshore. During not normally manned operations (NNM) when humans are not present and cannot detect gas leaks, discovering environmental leaks or detecting failures of equipment, (i.e. discovering maintenance issues) – how can the CCTV support the operator? What are the defined situations of hazard and danger that can be discovered on CCTV, and how can these situations or scenes be mitigated? Thus we see the need for exploration and documentation of when the human operator – with sight, hearing and perception has functioned as a safety barrier in operations. Such documentation can help us identify critical scenes of defined hazards that should be a part of CCTV design. There is a need to describe a set of critical scenes or scenarios – how they can be observed, interpreted and acted upon based on CCTV (in this context).

4. Discussion and conclusions

Our approach has been to explore the use of CCTV related to a barrier perspective:

- Proactive use, i.e. to control a process or mitigate unwanted events
- Reactive use, i.e. to mitigate an unwanted event and recover
- Learning, i.e. by analysing a situation after the event

Based on research findings, the CCTV system can be used proactively, reactively and to learn from unwanted incidents, but there has been little research to identify if the systems are fit for purpose (Keval, 2009). The implementation of CCTV must support the suggested barrier perspective, i.e. proactive use, reactive use and learning. A critical review of requirements for proactive use must be performed – what is the possibility of humans to observe, interpret, plan and act based on information given by the CCTV system? The criticality of the CCTV system must also be decided, i.e. if the CCTV is not working – is there a possibility for an incident/accident? What is the actual need for more than 100 CCTV on an oil and gas platform?

So far, it is assumed that CCTV implementation is based on existing ergonomics standard such as ISO 11064 (2013). Organizational factors and operator/user tasks are discussed in ISO 11064 (2013), part 1 and 2. In addition it is suggested to use existing CCTV security standards as guidelines for what should be documented. However there is a need to develop guidelines assessing safety and resilience. Building on EN 50132-7 (2012), the requirements should cover the following areas:

- General considerations (Needs for CCTV based on risk assessment); Operational requirements specifications; Equipment selection and performance; Image presentation; Transmission and video performance; CCTV Storage requirements; CCTV control room requirements (Number, size of screens); and Test plan (Factory Acceptance, User acceptance).

When looking at these standards and guidelines we have seen the need to cover the following additional areas in a requirement in the oil and gas industry:

1. Organizational factors, such as criticality of the CCTV, operating requirements, procedures, responsibilities, staffing guidelines in order to accommodate number of CCTV inputs.
2. Cognitive human factors (operators with cognitive abilities supported by solutions in order to observe, interpret, plan and act based on information given through

combination of screens and alarms..) and a set of defined hazard scenes that can be mitigated by CCTV

3. Ergonomic and technology requirements (screen size and position, camera resolution and quality, workplaces for the operator fulfilling ergonomic requirements based on ISO 11064.)

The use of guidelines and standards related to CCTV use has been missing in the oil and gas installations being surveyed on the Norwegian continental shelf. Thus it is suggested to develop a set of guidelines in collaboration with the industry, building on existing standards and guidelines as mentioned in this paper.

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