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Remote Video Assessment for Missile Launch Facilities

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Abstract

The widely dispersed, unmanned launch facilities (LFs) for land-based ICBMs (intercontinental ballistic missiles) currently do not have visual assessment capability for existing intrusion alarms. The security response force currently must assess each alarm on-site. Remote assessment will enhance manpower, safety, and security efforts. Sandia National Laboratories was tasked by the USAF Electronic Systems Center to research, recommend, and demonstrate a cost-effective remote video assessment capability at missile LFs.

The project's charter was to provide:

- system concepts
- market survey analysis
- technology search recommendations
- operational hardware demonstrations

for remote video assessment from a missile LF to a remote security center via a cost-effective transmission medium and without using visible, on-site lighting.

The technical challenges of this project were to:

- analyze various video transmission media and emphasize using the existing missile system copper line which can be as long as 30 miles
- accentuate an extremely low-cost system because of the many sites requiring system installation
- integrate the video assessment system with the current LF alarm system
- provide video assessment at the remote sites with non-visible lighting

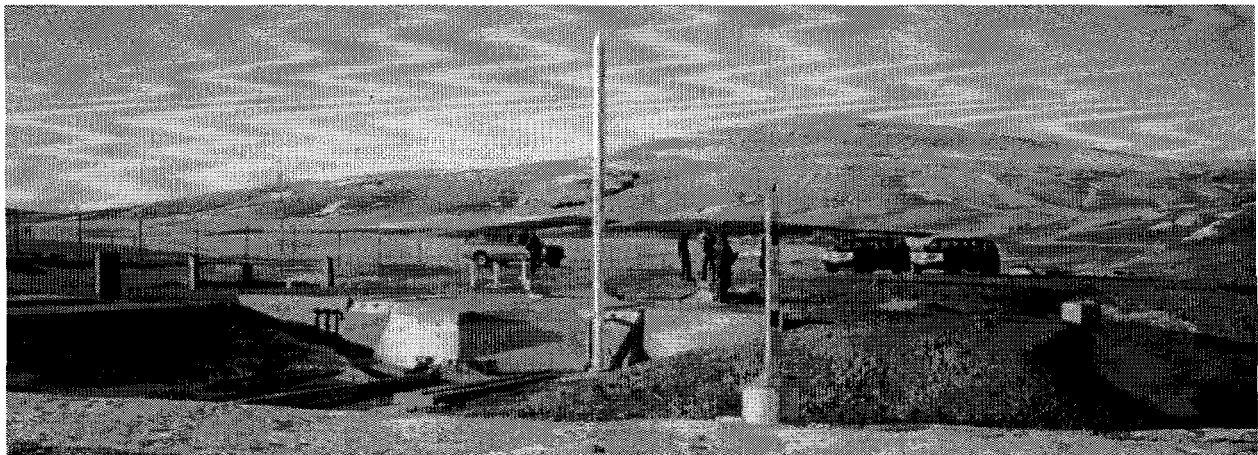


Figure 1. Typical launch facility site at Malmstrom AFB, Montana

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Introduction

The purpose of the project was to provide remote video assessment of the unmanned launch facilities (LFs) and to investigate the requirement that no visible lighting be used for nighttime assessment.

The location and environment of these facilities presented significant challenges to accomplishing these tasks. The areas chosen for the sites (which are usually remote), along with the lack of a dedicated video transmission medium, make it economically unfeasible for a video assessment system. Also, the site's camera and lighting equipment required the appropriate consideration for extreme temperature variations, severe wind conditions, and heavy precipitation.

The remote security center (Missile Alert Facility [MAF]), monitors the status of ten LFs as shown in Figure 2. The security police response time from an MAF to any LF may be as long as one hour depending upon terrain, weather, and road conditions.

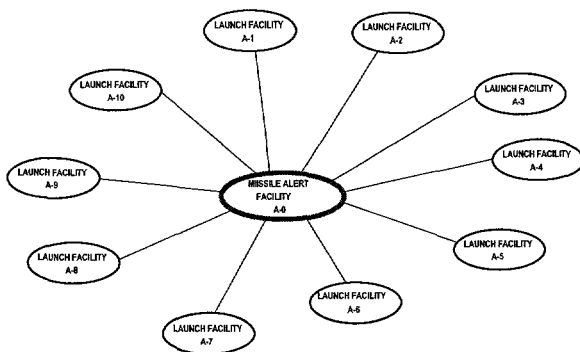


Figure 2. Launch Facility/Missile Alert Facility Concept

The basic concept was to enable the security police to visually assess an existing sensor alarm condition from a remote location. In theory, the system performs the basic security functions of assessment: distinguish valid alarms caused by actual intrusion, prioritize routing of response forces, and furnish timely information to approaching response forces as well as supplemental and commanding security forces. An example functional block diagram is shown in Figure 3.

Requirements

The requirements for the project originated from a USAF Space Command request for "instantaneous assessment of the actual cause for the activation of a sensor alarm by either direct visual assessment or with the aid of electro-optic equipment." This was to be accomplished without visible lighting and as inexpensively as possible; affordability was a top priority.

The project's functional specification was a significant early-project milestone; it established the functional performance, design, and development guidelines for the project. The outline of this functional specification is shown in Figure 4. Highlights of the functional specification topics are detailed below.

Assessment and Camera/Lighting

The requirement for the visual assessment area was defined as a radial pattern originating from the existing alarm sensor's antenna. This radial pattern (i.e., the camera coverage area and the infrared radiation (IR) illumination area) was the area needed to meet the requirement for adequate sensor alarm assessment.

Transmission

A requirement existed to provide a means of transmission that would use an effective and cost-practical transmission medium. The system must capture video assessment snapshots or repeated frame updates from the LF assessment area within 15 seconds of the existing intrusion sensor alarm or within 15 seconds of operator request. The transmission equipment must retain that video snapshot triggered by the alarm until a request is received from an operator. The system must receive and display the original video snapshot information from the alarmed area within 2 minutes of operator request. It must then be able to produce continuous updates of current video scenes upon operator request to determine if an intruder is present at the LF. The system must have the ability to be remotely called up at any time to visually assess any individual LF.

Interface

An interface with the existing alarm system was necessary to meet the requirement for instantaneous alarm assessment and video loss detection.

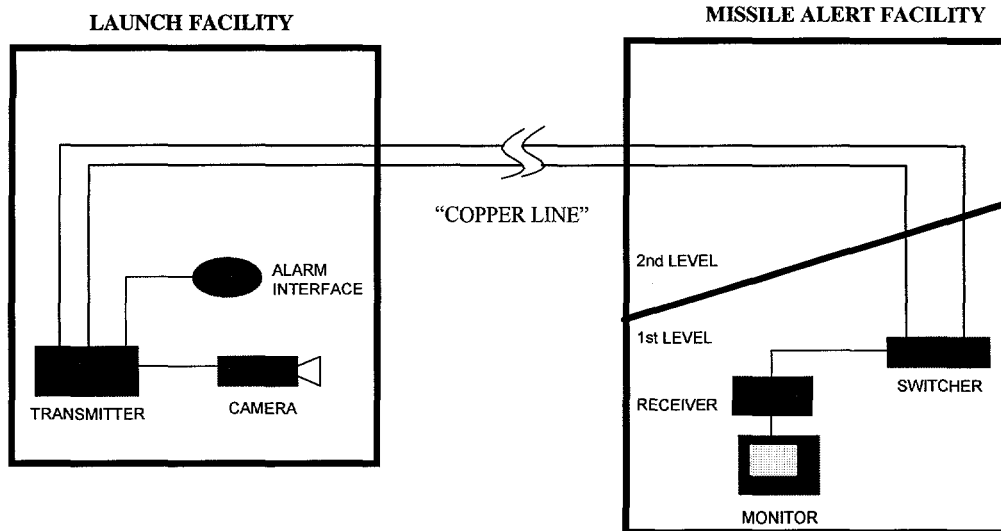


Figure 3. Launch Facility/Missile Alert Facility Functional Block Diagram

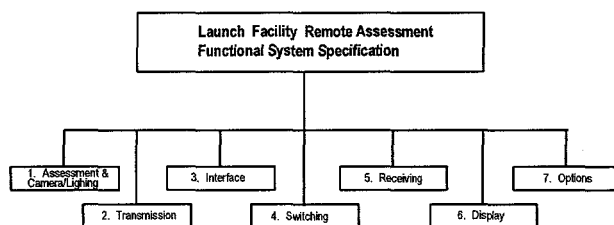


Figure 4. Functional Specification

Switching

The system was to be able to switch from one LF assessment scene to a subsequent LF assessment scene.

Receiving

The system was to provide a means of receiving a video assessment transmission signal. The system must have the capability to receive and display the original video snapshot information from the alarmed area within 2 minutes of the initial sensor alarm.

Display

The requirement was to provide a means of adequately displaying video assessment snapshots or repeated frame updates from an LF location.

Options

The system was to provide a means of allowing

options to be incorporated into the video assessment system, such as video recording capability.

The market survey/technology search reports focused upon these functional requirements. These reports determined that a slow-scan video transmission system using existing copper line was the most affordable. The following transmission media options were investigated: telephone line, cellular coverage, fiber optic, radio frequency/microwave, and satellite. Because of their initial installation costs, none of these options were pursued at this time. The report also portrayed the latest, state-of-the-art IR illumination technology to be a key element worthy of serious project investigation due to their cost and projected reliability.

Candidate Video Transmission System

Several slow-scan video transmission systems were evaluated as commercial off-the-shelf systems. They were tested using the direct buried cable located at missile sites as well as under simulated conditions at a missile test facility. Modifications were made to the factory equipment to enable it to transmit video data over the 30-mile distance of #19-gauge copper line. A candidate system was then selected and installed at two missile launch facility demonstration sites.

The system was manufactured by Northern Information Technology of Chicago, Illinois. The

transmitter unit has one video memory used to store a video frame. The video input can be triggered by an alarm event to capture the scene and hold it in memory until an operator requests to transmit the video data. The data is transmitted as an audio signal within a 4K Hz bandwidth. This is an analog frequency-shift keying signal using 1200 Hz for the video synchronization signal, 1500 Hz for the black signals, and 2300 Hz for the white signals. An internal modem with adjustable output power is used to transmit the data across long lengths of unamplified copper line. The receiver has two memories each capable of storing a video scene. This allows the display of a stored picture as well as the current picture. The video scans down the monitor and the entire picture is displayed within 32 seconds. The system will produce 256 x 240 lines of resolution.

The operator transmits commands to the transmitter via touch-tone (dual-tone modulated frequency [DTMF]) signals. This requires a telephone line simulator to act as a carrier for the DTMF tones. A 660 Hz signal sent from the receiver will stop the video transmissions at the transmitter. The commands can then be sent to request an alarm picture, a current picture, or continuous updates.

The system operates on 110 VAC power. The transmitter can be mounted on a wall, and the receiver will fit in a standard 19-in rack shelf.

The complete system consists of the following elements:

- monochrome cameras housed in pressurized environmental housings with heaters and sunshades
- LED (light-emitting diode)-type IR illuminators with dusk-to-dawn switches
- video transmitter and receiver pair
- 10-position site selection switch
- 9-in monochrome display monitors

Refer to Figure 3 for the system design and Figure 5 for the topside layout.

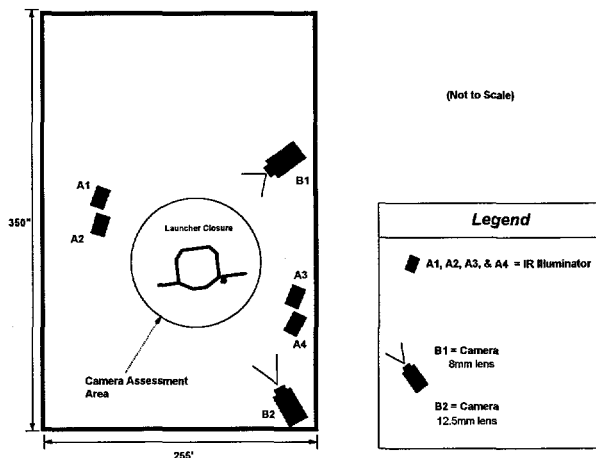


Figure 5. Generalized Site Layout

Results

The test results from the proof-of-concept demonstration at Malmstrom AFB in May 1995 concluded that the overall performance met, and in some cases exceeded, the requirement specification. The project was able to demonstrate and document a proof-of-concept system that would provide for remote video assessment of an LF to an MAF without using visible lighting.

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