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THE ACCIDENT SITE PORTABLE INTEGRATED VIDEO SYSTEM [1]

D. P. Jones
Sandia National Laboratories
Dept. 9616, MS 1125
P. O. Box 5800
Albuquerque, NM 87185-1125
(505)844-2912; fax (505)844-5946

D. L. Shirey
Sandia National Laboratories
Dept. 9616, MS 1125
P. O. Box 5800
Albuquerque, NM 87185-1125
(505)844-9790; fax (505)844-5946

W. A. Amai
Sandia National Laboratories
Dept. 9616, MS. 1125
P. O. Box 5800
Albuquerque, NM 87185-1125
(505)844-6698; fax (505)844-5946

ABSTRACT

This paper presents a high bandwidth fiber-optic communication system intended for post accident recovery of weapons. The system provides bi-directional multi-channel, and multi-media communications. Two smaller systems that were developed as direct spin-offs of the larger system are also briefly discussed.

I. INTRODUCTION

In responding to past accidents, the Accident Response Group (ARG) realized that receiving secure, reliable information in a timely manner, and at the same time reducing the number of personnel exposed to hazardous material, was a major concern. To remedy this situation a system was developed that would provide personnel, located a safe distance from possible hazards, with secure real-time visual and verbal information from the accident site.

The Portable Integrated Video System (PIVS) provides Multi-channel, two-way video, audio and computer data communication by way of a single four kilometer fiber-optic cable. The PIVS provides a safe and secure communications link between Accident Response Group (ARG) weapon recovery team members. The PIVS requires no destination-provided equipment and is sufficiently portable to be checked as normal baggage. Because the PIVS is portable, it is expected to accompany the first ARG responders.

This paper is organized so that in Section II the reader is presented with an idea of how the Portable Integrated Video System would be deployed at an accident. Next, in Section III, major components that make up the system are listed and described. A brief history of the system's development and evolution is found in Section IV. Finally, Section V discusses two related systems that have been developed as direct spin-offs of the Portable Integrated Video System.

II. THEORY OF OPERATION

Deployment

The PIVS is initially deployed as a seven suitcase system mounted on two luggage carts. Support equipment such as; spare fiber-optic cable, spare batteries, fiber-optic test and repair equipment would arrive at the accident scene when transportation becomes available.

The entire PIVS, shown in Figure 1, consists of the "Base Assembly" and the "Site Assembly." The base provides a safe area from which to communicate with the accident site. The two areas are connected by a fiber-optic cable that carries video, audio, and serial computer signals for communication.

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DISCLAIMER

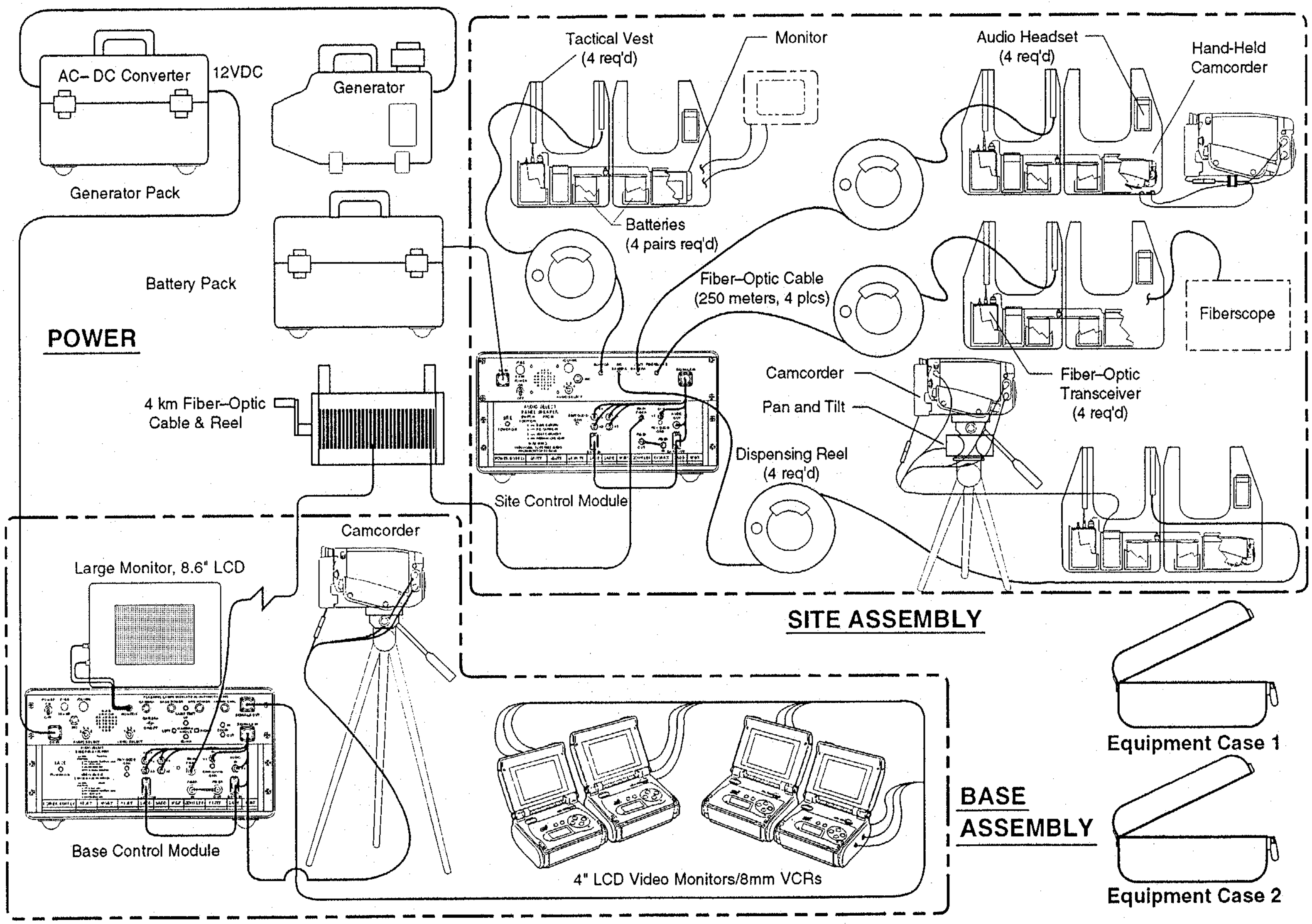

Figure 1. Portable Integrated Video System (PIVS)

Initial set-up

After arriving at the accident scene, both the Base Assembly and the Site Assembly are assembled for pre-operation check-out at the weapons recovery command post.

Accident Site Deployment

When it is determined that all components are functioning properly, the Site Assembly is transported to the accident site. While the Site Assembly is being transported to the accident site, the main fiber-optic cable is being unspooled.

At the accident site, the Site Control Module is placed at a location that is equal distance from all areas of interest. The remote control camera peripheral containing the camera mounted on the pan and tilt and tripod is located so that the operator at the weapons recovery command post can remotely view as much of the accident site as possible. When a weapon recovery operation is being performed, the hand-held camera peripheral is operated by one of the PIVS's team members. The fiberscope peripheral is used when it is determined that there is a need to view the inside of an area that can only be accessed with the fiberscope. The monitor peripheral can be used in support of fiberscope operation or if there is pertinent information that can be sent to the accident site from the weapons recovery command post.

Long Term Operation

During long term operation, maintaining power to the equipment becomes a major concern. Because many of the PIVS components rely on batteries as their source of power, a system of recharging batteries needs to be established if prolonged operation is anticipated.

Recharging cables that plug into the lid of the generator pack power supply are provided for the peripheral vest batteries. Because the fiberscope and monitor peripherals are not continuously operated, their batteries can be used as spares while the remote control and/or hand-held camera peripheral batteries are being recharged.

Normally the base control module is powered by the generator pack and the site control module is powered by the battery pack. When AC power becomes available at the weapons recovery command post, use of the portable gasoline generator can also be discontinued. The portable gasoline generator can be transported to the accident site and used to power the site control module and recharge batteries.

III. SYSTEM OVERVIEW

The PIVS is a communication system developed for the Accident Response Group (ARG). It is packed in suitcases and can be transported either commercially or by the military to an accident site. The system is deployed as shown in the schematic in Figure 1.

The *accident site* is depicted in the upper right area of the drawing. The *command post*, located in the safe zone, is in the lower left corner. The *safe zone* can be as far as 4 kilometers away from the communications equipment assembled at the accident site.

Base Assembly

The base equipment is shown in Figure 2 and includes the following items:

a. one large enclosure: base control module
   1. multiple channel fiber-optic transceiver
   2. auxiliary chassis
      a) audio amplification equipment
      b) interfacing devices and power supplies
   3. all the associated cabling required to connect the equipment
b. one 8.6-inch color LCD monitor
c. four combination LCD monitor/8mm VCR
d. one 8mm camcorder
e. one tripod
f. one microphone
g. generator pack housing a 350-watt generator and an AC-to-DC converter (can also be used at the site)
h. dark cloths to be used for shading video screens from bright sunlight

The base control module houses the multiple-channel fiber-optic transceiver and an auxiliary chassis containing audio amplification equipment and interfacing devices. These devices include switches and a computer that allows the operator to select video and audio channels and remotely operate site components.

The 8.6-inch color LCD monitor shown on top of the base control module gives bystanders a clearer image of the video information being received at the

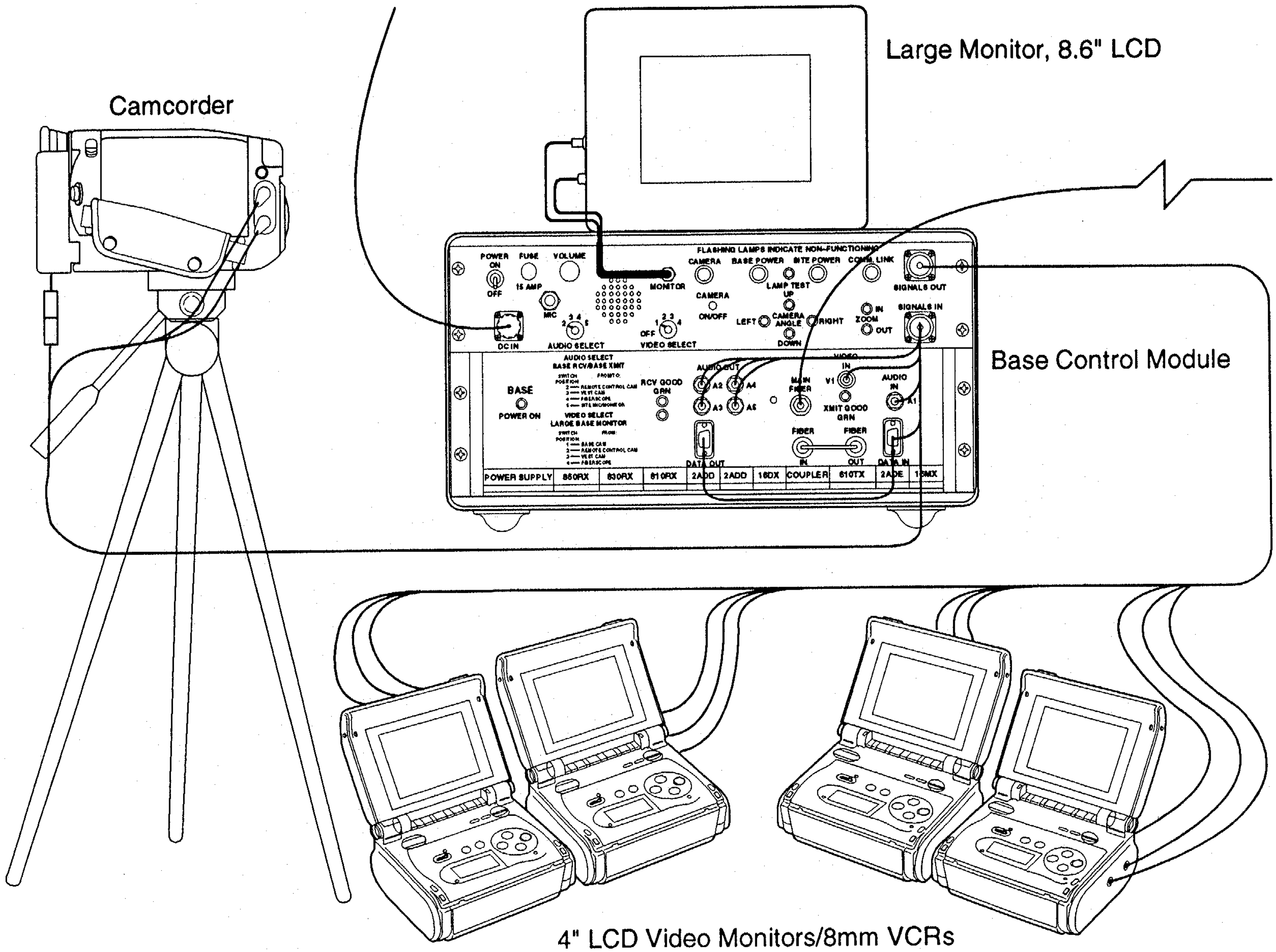

Figure 2. Base Assembly

base. The monitor can be switched to any of the four available video channels, one at the base (coming from the camcorder) and three at the accident site (the remote control camera, the vest camera, and the fiberscope camera).

The four smaller LCD monitors provide real-time audio and video as it is collected from the four video sources. Each monitor includes an 8mm video recorder (VCR) that enables the operator to record real-time audio and video throughout the accident scenario.

The camcorder, fitted with a tripod, supplies information from the base to the accident site. To supplement the camcorder microphone, a separate, switchable microphone is provided for private conversations.

All of these devices are carried in the base enclosure and in an auxiliary equipment suitcase (lower right-hand corner of figure 1).

Site Assembly

The site assembly, shown in figure 3, is located at the accident site and contains the following equipment:

a. one large enclosure: site control module
   1. multiple-channel fiber-optic transceiver
   2. auxiliary chassis
      a) power supplies
      b) audio amplification equipment
      c) interface for fiber-optic cables
   3. associated cables
b. two large equipment cases
   1. one monitor
   2. four fiber-optic cables on reels
   3. four peripheral vests
   4. eight batteries (four sets of two each)
   5. four fiber-optic peripheral modules
   6. two 8mm camcorders
   7. one pan/tilt mechanism and tripod
   8. four headsets
   9. one microphone
c. battery pack housing a 12-volt/60-amp hour battery, DC-to-DC converter, and an AC-to-DC converter (can also be used at the base)

The site enclosure is similar to the base enclosure, with a multiple-channel fiber-optic transceiver capable of sending four channels each of video, audio, and data to the base. It also can receive one channel of video and two channels each of audio and of data from the base.

The auxiliary chassis, housed in the site control module, contains the same audio amplification equipment as the auxiliary chassis in the base control module and provides an interface for the 250-meter single fiber-optic cables that go to each of the four peripheral devices. These cables are stored on plastic reels.

The site control module provides four separate capabilities through it's four peripherals. The peripheral components are contained in field vests that allow the operators to carry headsets, batteries, the fiber-optic peripheral modules, and the specific data-collecting items. In each vest are two 6-volt DC, 8-amp/hour sealed lead acid batteries wired in series to provide 12 volts DC. They can operate the equipment in the specific peripheral area for approximately 6 hours.

The optional headset gives the operator the capability of more intimate conversation. Camcorder operators may also speak into the camcorder's built-in microphone, while any of the peripheral operators may receive audio from a speaker located in the peripheral modules.

The peripherals communicate with the site control module using three different fiber-optic transceiver packages. The remote control camera peripheral uses a combination fiber-optic transceiver and remote control data processor package that transmits video from the site back to the base while enabling bi-directional audio and data communication.

The vest camera and fiberscope peripherals use fiber-optic transceivers without processors because no remote control functions are required of these peripherals; these are simpler, more compact components that transmit video signals back to the base while enabling bi-directional audio communication.

The transceiver package in the monitor peripheral is identical to the one in the vest camera and fiberscope peripherals, except that it receives rather than transmits video.

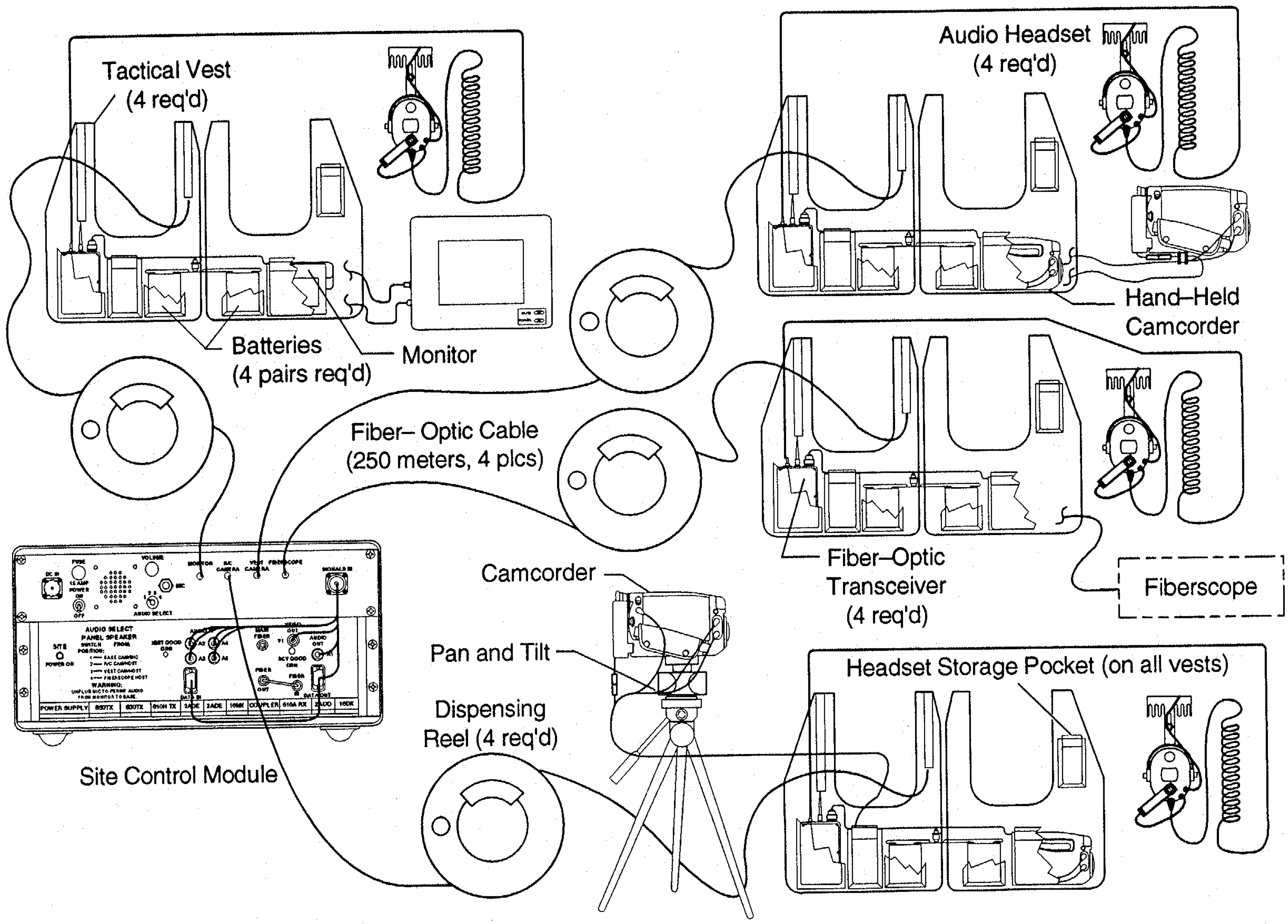

Figure 3. Site Assembly

Fiber-optic Cable and Reel

The main fiber-optic cable connects, and provides communication from, the base to the site and back. One single fiber-optic cable measuring about 2.5 millimeters in diameter carries one video, audio, and computer data signal from base to site, and simultaneously carries three videos, four audio, and one data signal from the site to the base. This 4 kilometer fiber-optic cable weighs 50 pounds and is carried on a 20 pound breast reel for manual deployment or retrieval. Shorter fiber-optic cables can also be used to reduce size and weight.

Power

Two power sources are available for the equipment assemblies: the battery pack and the generator pack, both of which can be used at either the base or site. Operators should consider that the battery pack is heavier than the generator pack, but gasoline may not be available at the accident site.

Battery Pack. The battery pack is housed in an aluminum case measuring 18 in. by 10 in. by 16 in. The pack can provide 12 volts DC power to the base control module, to the site control module, or to any of the four site peripherals; it has a capacity of 60 ampere hours, which will power the site control module for approximately 4 hours.

With the battery pack, one can either use the internal battery directly or use external AC power in the form of either 220-volt/50-cycle or 110-volt/60-cycle through the AC-to-DC converter in the pack. The converter output may be selected to provide 12 volts DC out or charge the internal battery. The battery may also be charged with an external DC input of 12 to 24 volts DC.

Generator Pack. An aluminum enclosure similar to the battery pack houses a 350-watt, gasoline-powered electrical generator that produces 120 volts AC. The lid of the generator package houses an AC-to-DC converter that provides the 12 volts DC power required. Like the battery pack, outside AC power of either 220-volt/50-cycle or 110-volt/60-cycle power may be used to power the lid of the generator package. An in-line GFI device protects operators from accidental electrical shock, and a three-prong electrical cord completes the circuit to the input of the AC-to-DC converter.

The generator pack can supply power for 2 to 4 hours on one tank of 50:1 gasoline-to-oil mixture. Two-stroke oil is provided with the generator to mix with the gasoline, should it become available.

External Power Sources

Both the base and site enclosures may be powered by external DC sources other than the battery pack or the generator pack; these DC sources may vary in input voltage from 12 volts DC to 24 volts DC. The current requirement at 12 volts DC for the site equipment is approximately 8 amperes; the current requirement for the base equipment is about 10 amperes. In addition to operating the site or base assembly, the power packs can provide power to any one of the peripherals. Each of these peripherals requires approximately one and one-half amps at 12 volts DC.

IV. SYSTEM EVOLUTION

The PIVS Project began in April 1991, with the creation of a Phase 1, proof-of-concept system. The Phase 1 PIVS was demonstrated during an actual ARG training mission called "Midget Digit III" conducted at Concord, California in September 1991. Later, in February 1992, the system and development team acquired more experience by participating in a Navy Explosive Ordnance Disposal (EOD) training exercise held at Fort Ord, California. On both occasions, the equipment performed as designed and without failure. With the experience gained during the development of the initial set of equipment, an improved, Phase 2 version was planned.

In April 1992, the Phase 1 PIVS was demonstrated to a Russian delegation associated with the Safe and Secure Dismantlement Technical Exchange (SSD). The Russians requested four Phase 2 Portable Integrated Video Systems to aid in their Nuclear Safety and Dismantlement program. On October 6, 1993, four complete sets of Phase 2 PIVS, with spares, were shipped to the Russian Federation. On April 15, 1994, ARG team members and their equipment, including the PIVS, were deployed by way of two C5 aircraft to the United Kingdom. During this deployment a four day joint USA and UK exercise designated "DIVER MIST "was conducted.

An abbreviated version of the PIVS has been designed and fabricated. This system, designated MiniPIVS, is a single channel system that incorporates many of the features of the PIVS. This system was field tested during an exercise called "MATEA" held in October 1992.

V. RELATED SYSTEMS

MiniPIVS. MiniPIVS is a smaller, two suitcase system utilizing many of the features found in the larger PIVS.

MiniPIVS is a single channel communications system that provides a single tripod mounted remotely controlled camera and vest assembly that can be deployed up to one kilometer from the base control suitcase. Control of the remotely controlled camera as well as observance of the remotely controlled camera's video is performed at the base control suitcase.

The remotely controlled camera and vest assembly from the MiniPIVS is fully compatible with the PIVS and can be connected to one of the PIVS's video channels and operated as a remotely controlled camera.

MicroPIVS. Another spin-off of the PIVS is the MicroPIVS. By connecting the PIVS's monitor vest assembly and the hand-held vest assembly, via fiber-optic cable, it is possible to formulate a simple single channel system capable of sending video from the camera vest assembly to the monitor vest assembly. Used in this configuration the operators may communicate up to a distance of one kilometer.

VI. SUMMARY

The Portable Integrated Video System has developed into and proven itself to be a valuable tool used by the Accident Response Group. By providing bi-directional video and audio communications between the accident site and a safe control area, the Portable Integrated Video System allows the On-Scene Commander and accompanying personnel to make more informed decisions and also to observe (in real time) the actions taking place based upon those decisions.

VII. ACKNOWLEDGMENTS

The Portable Integrated Video System has been developed by the Advanced Vehicle Development Department at Sandia National Laboratories (SNL) for the Department of Energy's Accident Response Group.

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