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The LASL Upgraded Alarm System Functional Requirements

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THE LASL UPGRADED ALARM SYSTEM

FUNCTIONAL REQUIREMENTS

by

B. L. Hartway and E. N. Shaskey

ABSTRACT

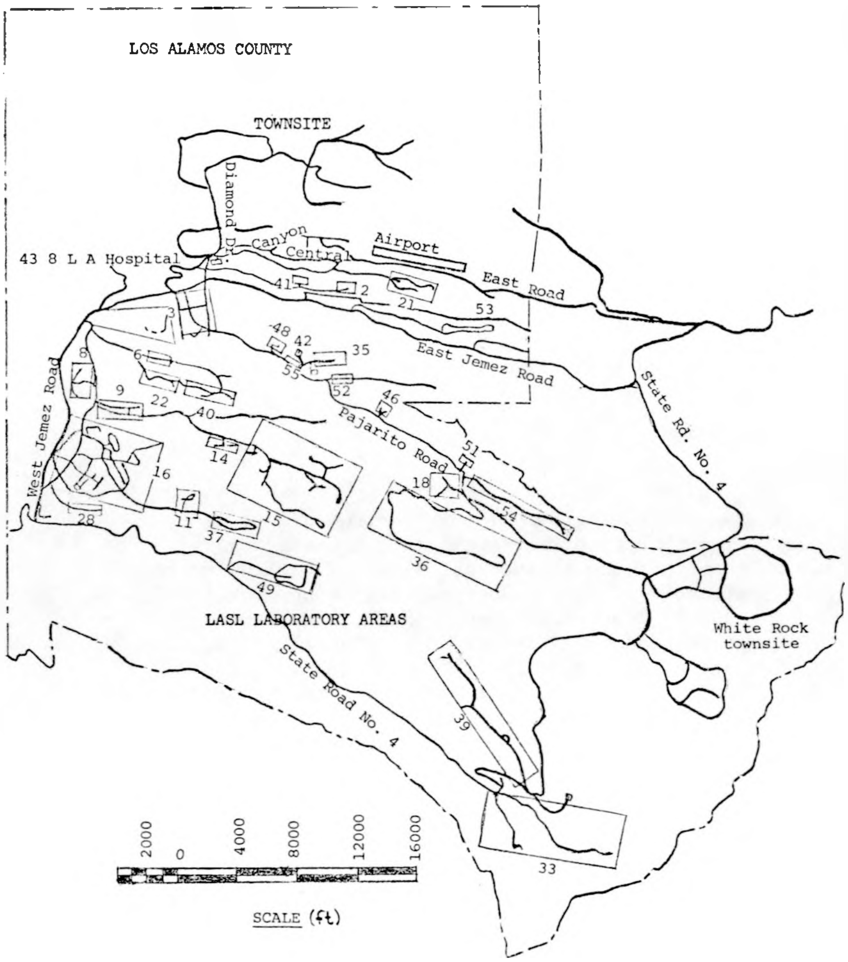
This document defines and describes the functional requirements to successfully provide Los Alamos Scientific Laboratory with a combined security and fire alarm system that will satisfy the operational needs of various users and provide compliance with applicable codes and Energy Research and Development Administration security and fire protection requirements. The four major subsystems of the upgraded Laboratory alarm system are field installation, data communications, central station, and remote operation station. Each field installation includes all of the intrusion detection sensors, fire alarm sensors, and all other sensors and controls directly connected to a remote terminal unit at each alarm protected area within the Laboratory complex. The data communications system provides multiplexed data between the remote terminal units and the central station computer, and between the central station computer and the remote display and control equipment for the fire and security response forces. The central station computer automatically processes, displays, and records the status, actions, and events of all alarm system equipment and response force personnel. Finally, the remote operating stations for both fire and security forces provide the following key features: real-time displays, hard copy printouts, keyboard access and control, microfiche-projector drawings and documentation, and data base interaction with displays of all equipment status changes and events occurring with the Laboratory alarm system.

I. GENERAL BACKGROUND INFORMATION

Los Alamos County encompasses approximately 259 km^2 of rugged mountainous terrain, at an average elevation of 2286 m, sectioned into strips of land alternating between mesas and canyons with elevation differences of over 122 m.

The county is divided into two entities. The first is the Los Alamos Scientific Laboratory (LASL), which is spread over about two-thirds of this terrain in clusters distributed over mesa tops and in remote canyon bottoms. The second entity is the community territories that are divided physically by the government lands, one part being the original townsite of Los Alamos, the second being the suburb of White Rock. The combined public community population is around 18 000.

The approximately 6500 people who are employed by LASL and its related functions work in the 571 buildings of the Laboratory. These buildings are grouped into 35 major clusters (called "sites") that are scattered over the terrain; most of the sites are separately fenced and secured from the surrounding wooded countryside. This geographical arrangement is shown in Fig. 1. The variety of work performed in these areas requires a mixture of security protection, since areas containing open- and international-access labs are in close proximity to highly secured areas. There are no common utility tunnels or data-communications systems tying these scattered sites together, and because of this, all of the present alarm systems utilize short-distance telephone lines in the form of dedicated and unconditioned dc circuits.



TECH AREA NUMBER	SITE NAME
TA-2	Omega Site
TA-3	South Mesa Site
TA-5	Beta Site
TA-6	Two Mile Mesa Site
TA-8	Anchor Site West
TA-9	Anchor Site East
TA-11	K-Site
TA-14	Q-Site
TA-15	R-Site
TA-16	S-Site
TA-18	Pajarito Laboratory
TA-21	DP-Site
TA-22	TD-Site
TA-28	Magazine Area A
TA-36	Kappa Site
TA-37	Magazine Area C
TA-39	Ancho Canyon Site
TA-40	DF Site
TA-41	W-Site
TA-42	Incinerator Site
TA-43	Health Research Laboratory
TA-46	WA-Site
TA-48	Radiochemistry Site
TA-49	Frijoles Mesa Site
TA-50	Liquid Disposal Site
TA-51	Radiation Exposure Facility
TA-52	Reactor Development Site
TA-53	Meson Physics Facility
TA-54	Materials Disposal Site
TA-55	Plutonium Facility

PERTINENT FACTS

(1) 100 sq mi area (259 000 000 sq m)
(2) Two communities
  - 18 000 total population
(3) Lab personnel ~ 6500
(4) Lab facilities
  - 35 clusters
  - 571 buildings with
  - total 4 340 000 sq ft (403 186 sq m)
  - $167 715 000 plant value

Fig. 1. LASL Technical Area Location Plan.

Security protection for LASL is provided by an Energy Research and Development Administration (ERDA) operated Protective Force that furnishes all manned guarding functions required. This guard force is distributed over LASL areas in the sense that each secured area of these geographically scattered sites is provided with either a manned security guard station, a roving patrol, or both. The central control and muster point for this guard force is in the ERDA Administration Building, which is a building separate from and outside LASL security areas. This building contains the present central alarm station for fire, ambulance, and security protection for LASL and, in addition, fire and ambulance protection for the Los Alamos and White Rock communities. (These communities are an outgrowth of the original Atomic Energy Commission housing of World War II and certain functions are still supported by ERDA subsidy.) The five fire stations in the county are also ERDA owned and controlled; they supply these communities and LASL with the required fire and ambulance protection.

Thus the "911" emergency telephone system used by both the community and LASL is handled by the guard force in the alarm center. They redispatch messages to the fire stations for fire and ambulance calls. Community police protection, separate and publicly operated, is not tied into the LASL alarm system. The police answer "911" calls in parallel with the ERDA guard force but interact only if the reported incident requires police action. LASL secured-area alarms also come into the alarm center and appropriate guard dispatching is provided by alarm center personnel.

The interrelationships of the present system are shown in Fig. 2 in pictorial form and in Fig. 3A in block diagram form. The interrelationships for the upgraded system are shown in Fig. 3B.

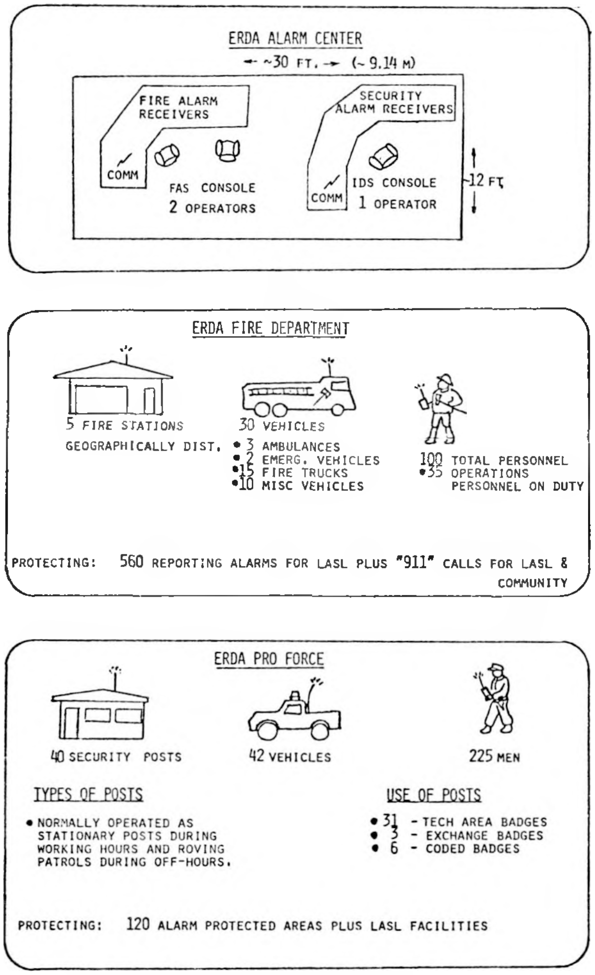


Fig. 2. Overall characteristics and interrelationships of LASL alarm systems.

II. OVERVIEW OF THE EXISTING LASL ALARM SYSTEM

A. *Description of Existing Alarm System Operation*

The present alarm center is manned by ERDA Protective Force personnel 24 h/day, 365 days/yr. It services approximately 120 security and 560 fire alarms for LASL, a few for the Los Alamos Area Office (LAAO), the Federal Bureau of Investigation (FBI), and other government agencies; in addition, it provides emergency "911" telephone service for the communities of Los Alamos and White Rock. Voice dispatch to the 5 fire stations and 40 security stations is provided at the alarm consoles by two-way radio, telephone, and leased-line services. Figure 4 shows the overall fire alarm system (FAS) and intrusion detection system (IDS) characteristics.

B. Present Security Alarm System (Fig. 5)

The American District Telegraph (ADT) IDS equipment consists of a manually operated receiver for

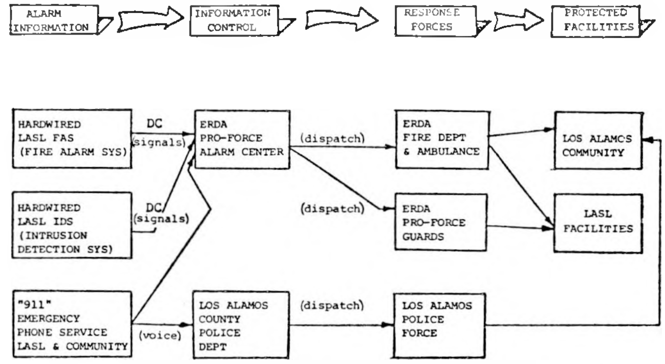


Fig. 3A. Present alarm system relationships between LASL and Los Alamos communities.

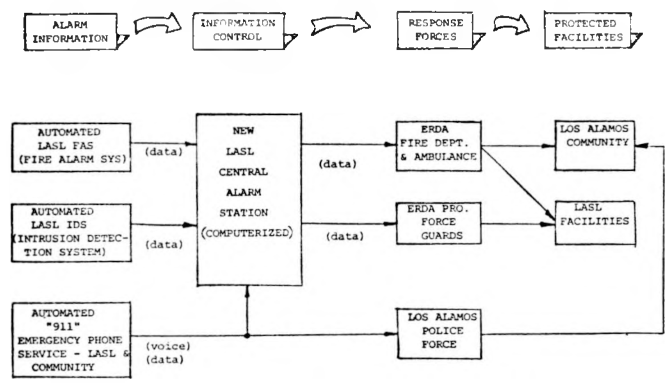


Fig. 3B. Future alarm system relationships between LASL and Los Alamos communities.

every alarm "drop." The design of most of these receivers is nearly 30 yr old, and even recently purchased solid-state units are operated by the same method. Because of the large physical layout required of the LASL alarm system and the age of the present equipment it is desired to modernize the

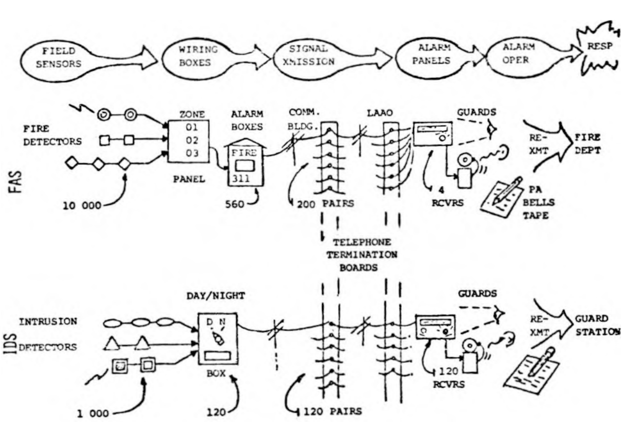


Fig. 4. LASL alarm systems.

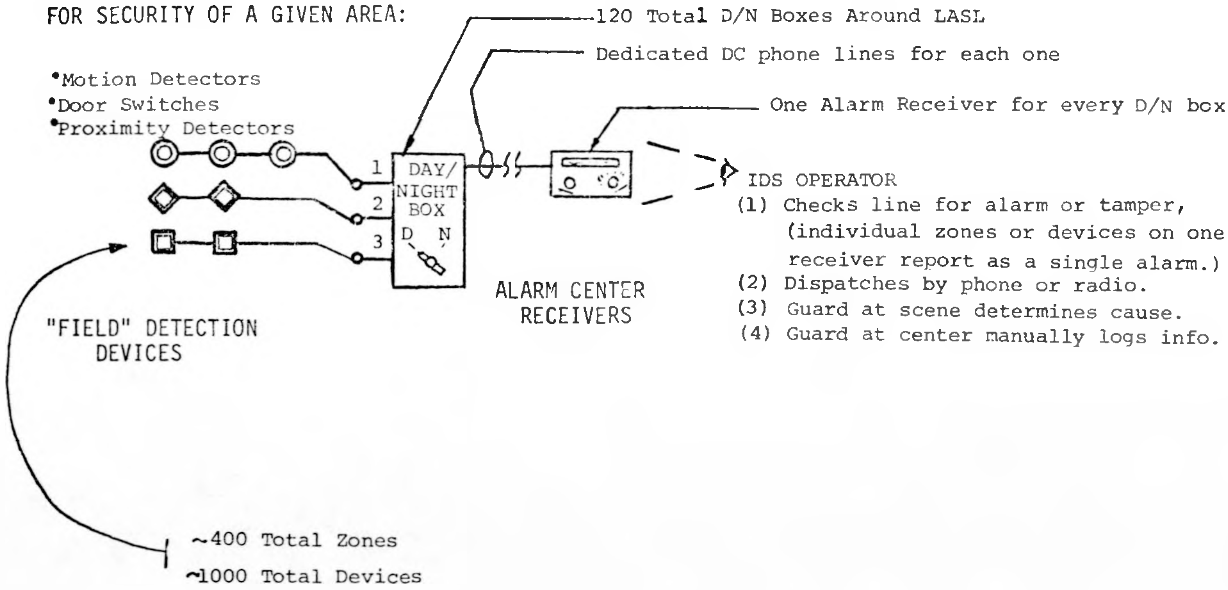


Fig. 5. LASL intrusion detection system.

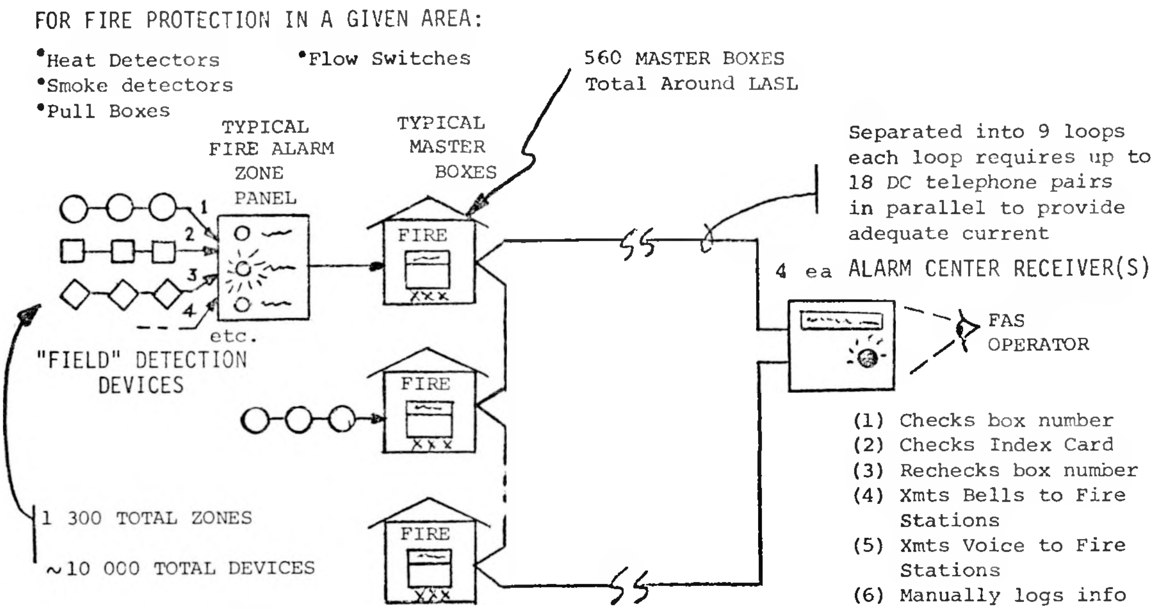
system using a digital multiplexing system. The alarmed areas are equipped with sensors selected according to ERDA Manual (ERDAM) Chapter 2401 requirements for both equipment and wiring techniques and installed by the government. The ADT transmitters in the alarmed areas, called day/night boxes, are of the same vintage as the alarm-center receiving equipment and are to be replaced with new digital multiplexors. The present system utilizes large numbers of metallic-circuit telephone lines and it is desired to eliminate this requirement by utilizing a modern digital multiplexing system that will only require voice-grade circuits. System maintenance is difficult and costly because of awkward liaison with the common-carrier utility (Mountain Bell Telephone Co.) and age of the equipment.

C. Present Fire Alarm System

The FAS equipment shown in Fig. 6 consists of outmoded Gamewell "municipal" fire alarm boxes and more recent ADT "central station" boxes. The Gamewell system is misapplied because it uses multiple-paralleled metallic-circuit telephone lines instead of the heavy-gauge wire it was designed for. Several of the Gamewell units are obsolete and parts are hard to obtain. The ADT equipment, although newer, is a type that will not allow near-simultaneous alarms without circuit interference; the result is lost information during such events. The fire alarm receivers in the alarm center require manual operation and logging and voice retransmission of alarm information to the outlying fire stations. This operation is prone to human error which causes delays and lost information. The wiring of Laboratory areas is, for the most part, obsolete with little "as-built" documentation. There is a confusing variety of alarm sensors in the field because of the nature of the 30-yr history of the LASL's building construction. (For example, several buildings constructed 20 to 30 yr ago as "temporary," for whatever purpose, are in use today and for entirely different purposes--often resulting in inadequate fire protection arrangements.) Because of a shortage of adequate quality metallic-circuit telephone lines, several existing areas are not provided with FAS protection and it is difficult to provide service to new areas. Several master alarm boxes are overloaded with zones, requiring excessive field response by the Fire Department in order to insure adequate protection. Maintenance of this system is difficult and costly because of awkward liaison with the common-carrier utility (Mountain Bell Telephone Co.), lack of as-built drawings, age and variety of the equipment, and poor availability of replacement parts.

D. Present Alarm Center Facility

The alarm center is a 37-m^2 room in the unsecured ERDA building. Because it is used for fire,



PROBLEMS:

(1) DC telephone line transmission is:
  a. prone to noise, false alarms, outages
  b. scarce or unavailable in some areas due to lack of adequate dc circuits.
(2) Inadequate information in alarm center as to type of alarm and cause of alarm.
(3) Manual retransmission and logging prone to errors and unnecessary delays.
(4) Fire detection devices, zone panels, master boxes are of a variety of styles, ages, configurations, and prone to failure or misbehaving.

FIRE STATIONS:

(7) Firemen check at watch desk
  •Index Cards •Status board
  •Punched Tape •Status notes
(8) Roll to scene, check cards
(9) Check zone panel, if any
(10) Check out area to determine cause of alarm

Fig. 6. LASL fire alarm system.

security, and community protection, it is required to meet ERDAM 2401, National Fire Protection Association (NFPA) Chapters 71, 72D, and 73. Because of its location and construction, it cannot be easily modified to meet the new requirements for central alarm system facilities on account of the lack of adequate expansion or renovation space.

E. On-Going Operations of Present IDS, FAS

Expansion of LASL operations requires the present systems to be in a continuous state of growth. Because of the problems outlined above, large amounts of money and manpower could be needlessly expended on expansion of the present alarm system and considerable waste of manpower for maintenance and operation will be unavoidable unless a change is made soon. However, because of the requirements for continuous alarm service and maintenance of the present system until a new system is operational, the manpower and equipment scheduling problems to accomplish a coordinated upgrading program are formidable.

III. EVOLUTION OF THE ALARM SYSTEM UPGRADING PROGRAM

The ERDA Albuquerque Operations Office (ALO) has requested that LASL modernize and improve its security alarm protection system and that funding be made available to accomplish this task. Because the security alarm system upgrading will require the development of a more secure, more highly automated and effective central alarm station concept, ERDA has asked LASL to implement a plan that will also include capability for this new center to accommodate an improved fire alarm system. Although initial funding will be used for an improved IDS, the central station will therefore be designed for combined operation of an automated FAS and IDS. The actual fire system field upgrading will be accomplished under a coordinated but separately funded program.

The upgrading programs will require a master long-range plan spread over several years, which will eventually culminate in a new central fire and security alarm station that will also serve community needs for fire and ambulance protection. This will require that each upgrading step always be compatible with the long-range goal and at the same time provide a constant level of adequate protection. It was recognized early in this program that the unique situations of the physical size, arrangement, and terrain of LASL; the lack of adequate data communications other than telephone lines; the combined fire and security protection with fire and ambulance service shared with the community; the involvement of several organizations within ERDA and LASL who would have to work together for this common goal; the requirement for constant protection by presently obsolete but growing alarm systems; and the eventual smooth switchover to an entirely upgraded alarm system and alarm central station -- made the problem nearly unmanageable and unsolvable by any ordinary means.

Recognizing these aspects of the problem, LASL and ERDA administrators formed a Joint Committee to provide an overall program steering and guidance function for a specially selected group of technical specialists from each organization. This Joint Committee in turn appointed Security Alarm and Fire Alarm Task Forces, composed of actual working level personnel of the ERDA security and fire protection forces and LASL and Zia technologists involved in support of the present alarm systems. (The Zia Co. is an ERDA-contracted craft support group for LASL.) Early activities of the Joint Committee and the Task Forces included:

1. Reviewing the state of the art of the commercial alarm industry, manufacturers, vendors.
2. Bringing in consultants to review the LASL system and illuminate problem areas of the upgrading program.
3. Visiting several representative installations for comparison.

These activities have been supported by a full-time systems engineer provided by LASL and are resulting in a set of comprehensive alarm system upgrading program plans, functional definitions, and performance requirements.

This upgraded alarm system will utilize the best possible commercial technologies and be automated to the fullest practical extent to provide a highly efficient, effective alarm system. The plan will require modular, step-by-step upgrading to provide constant, uninterrupted protection while programmatically following the the long-range plan. This will allow smooth and uneventful switchover from the present expanding system to the ultimate planned solution without backtracking or reworking. The upgrading will be accomplished with existing LASL and ERDA administration and staffing by using the talents of people already involved wherever possible and changing their mode of operation only as it evolves through their participation. Additional manpower will be required during construction development phases; these personnel will be retained to support the expanded roles of the new alarm system where necessary.

IV. ALARM SYSTEM UPGRADING PROGRAM PLAN

A program plan entitled "LASL Alarm System Upgrade Program for Combined Operation of the IDS and FAS (intrusion detection system and fire alarm system)," dated 24 March 1976 has been prepared by Raymond A. Gore and Bobby L. Hartway, LASL. It has been reviewed and approved by LASL and sent to ERDA for review and approval. An abstract of the goals and objectives as stated in this document follows, references cited in this report appear in the Appendix.

A. Major Objectives

The major objective of this effort is to successfully provide LASL with a combined security and fire alarm system that will satisfy the functional needs of various users and provide compliance with applicable codes and ERDA requirements, in accordance with an agreed upon schedule, predefined performance milestones, expenditure of funds, and allotment of manpower resources. The major constraints are as follows:

1. Adequate alarm protection must be provided throughout all phases of the program.
2. It must be compatible with existing alarm center and ERDA Protective Force and Fire Department operations personnel requirements.
3 It must meet minimum ERDAM 2401 or equivalent requirements.
4. It must allow for the continuous 5-yr upgrading plan without rework or wasted equipment wherever reasonable.

B. Major Performance Goals

Translated into a working system, the program objective requires accomplishment of the following performance improvements:

1. Provide an alarm system and an operations methodology that will result in more reliable and definitive alarm data so that appropriate security and fire protection personnel can make a quicker, more informed alarm response.
2. Provide more comprehensive documentation and standardization of systems components, so that operations and maintenance resources are more effectively utilized, thus increasing reliability and reducing maintenance costs.
3. Provide a convenient, effective method for updating and maintaining operational information for the system by instantaneous and distributed access to the data base from remote locations and users.
4. Provide data base integrity and security through controlled user-access methods and programming (software) techniques.
5. Allow for system growth in a nondisruptive, economical manner to accommodate future add-ons such as closed-circuit surveillance TV (CCTV) which requires wide-bandwidth transmissions.
6. Decrease human error and operational problems through proper selection and utilization of equipment and procedures.
7. Ease maintenance, training, and support problems through selection of broadly based (conventional) commercial equipment that is compatible with upgrading and growth over a 10-yr period.
8. Invest funds in future growth and needs by using high-technology multiplexing techniques to reduce cabling installation costs whenever and wherever possible.
9. Analyze, develop, and implement techniques to enhance the ratio of actual alarms to false/nuisance alarms.

C. Program Phasing

Program phasing for upgrading the LASL alarm system is shown in Fig. 7, which illustrates how the existing system is upgraded with an "interim" system immediately and at the same time a parallel effort is begun for the long-range upgrading plan. Then, when the new long-range system is operational, the interim system is phased out and operation is switched to the new system.

Critical factors of the upgrading plan are:

1. The need for continuous alarm protection.
2. The requirement for immediate programmatic expansion of the existing system.
3. No available space for such a programmatic expansion in the present alarm center.
4. The present system is to be replaced with new multiplexing equipment.
5. The new central alarm station to be provided by the long-range plan will not be operational for at least 2 yr. Thus, the interim system must be fully operational before the existing system is phased out of operation; in turn, the final system must be operational before the interim system is phased out of operation. These switchover problems can be minimized by proper selection of upwards-compatible equipment where

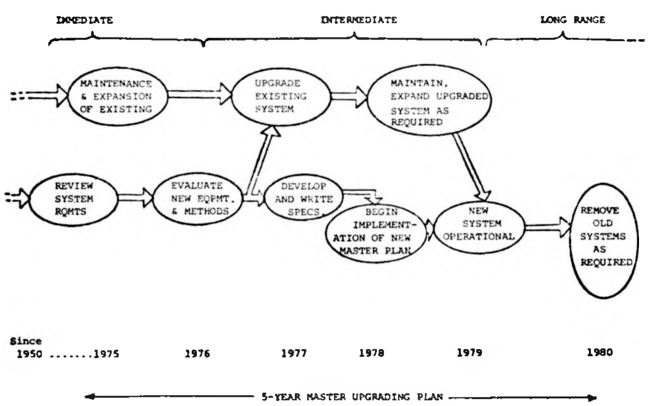


Fig. 7. Program phasing for upgraded alarm system.

feasible. If properly selected, field units of the interim system can be used in the final system, thus eliminating the need to wire alarmed areas twice. Likewise, the operator console of the interim system could possibly be used as an emergency back-up after the final system is operational. Actual results will depend on the system chosen.

V. FUNCTIONAL REQUIREMENTS FOR THE UPGRADED LASL ALARM SYSTEM

A. General Description

Figure 8 is a pictorial representation and Fig. 9 is a hardware/software overview of the upgraded LASL alarm system. The system is divided into the following major subsystems:

- Field installation
- Data communications
- Central station
- Remote station.

A brief description of these subsystems follows:

Each field installation will include all of the IDS sensors, FAS sensors, and all other sensors and controls directly connected to a specific remote terminal unit (RTU) at a given location within the LASL complex. In some cases one RTU can provide adequate alarm system control of an entire LASL site.

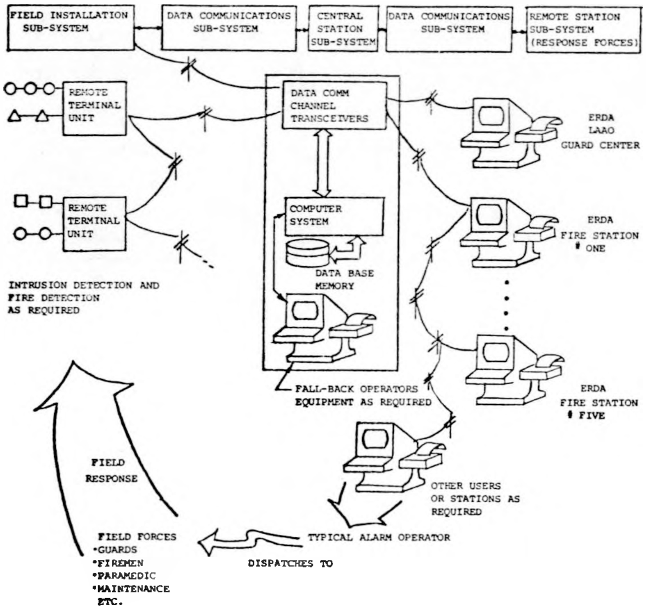


Fig. 8. Pictorial representation of the upgraded LASL alarm system.

Conversely, in some cases, for example LASL Site TA-3, several RTUs will be required to provide adequate control of the alarm systems within that site. Initially, there will be approximately 100 RTUs scattered among 35 to 40 LASL site locations. The total number of RTUs will, however, increase as new IDS requirements are identified and implemented and as the FAS is upgraded. These requirements will result from ERDA's safeguard vulnerability studies and LASL's long-term program for upgrading and integrating the fire alarm system. Additional long-range system growth is anticipated for CCTV surveillance and personnel-access controls.

The functional requirements of the RTU are shown in Fig. 10. The most significant RTU feature is its programmable controller (microprocessor), which will provide the flexibility to successfully adapt to either scheduled or unforeseen changes in alarm system requirements.

Data communications aspects of the upgraded LASL alarm system are shown in block diagram form in Fig. 11. This subsystem provides multiplexed data communications between the RTUs and the central station computer, and between the central station computer and the remote station display and control subsystems for fire and security response forces. Data communication paths will be provided by 256 isolated, digitally supervised, redundant carrier channels (RCC). Each RCC will be multiplexed to provide detailed status and control of every sensor in the LASL alarm system; that is, 15 000 to 20 000 devices scattered over 259 km^2. A significant advantage of the LASL upgraded alarm system architecture is that any data transmission media, that is, wire, radio, cable, or coax, can be successfully employed without affecting performance specifications of the alarm system. This is made possible by the flexibility of the RTU's data communications.

The most significant improvement in the upgraded LASL alarm system is the incorporation of a dual computer-controlled central station that will provide a comprehensive data base containing detailed information on pertinent aspects of the total alarm system. It will automatically process, display, and record the status, actions, and events of both alarm system equipment and response force personnel. The computer will also be used to provide the critical and necessary system security for all alarm system

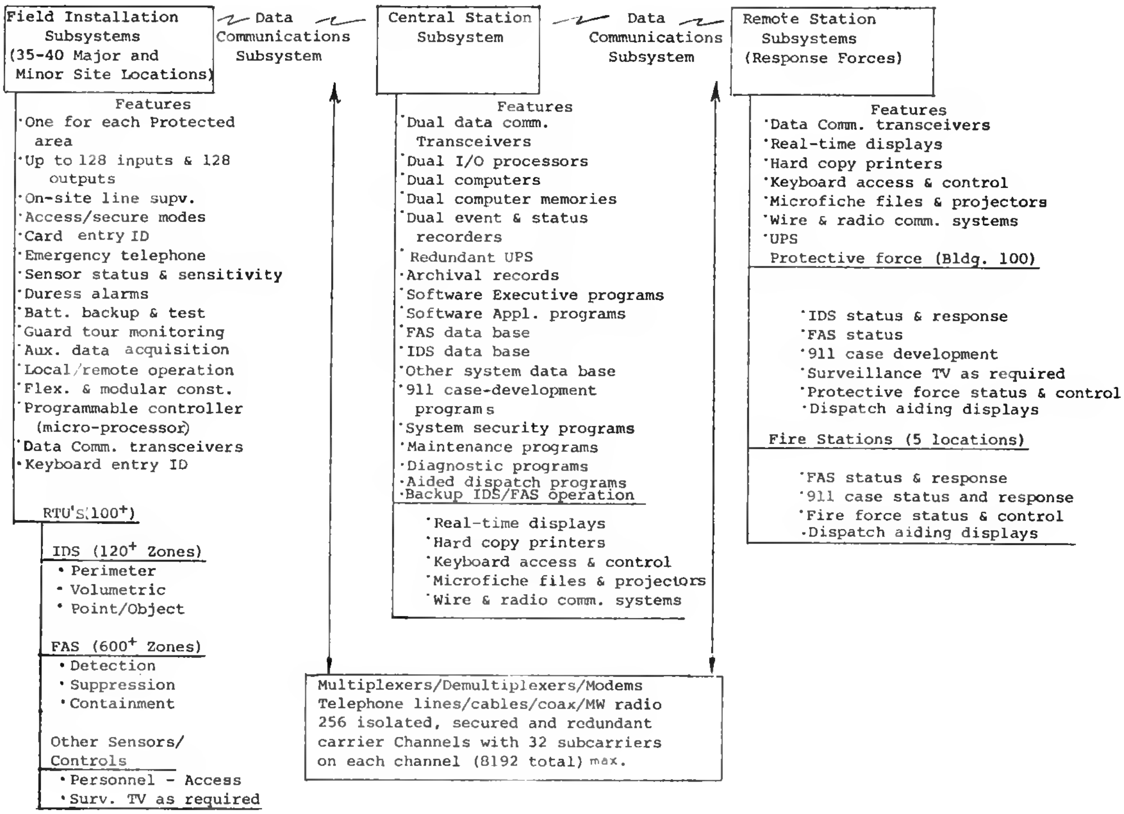


Fig. 9. Hardware/software overview of the upgraded LASL alarm system.

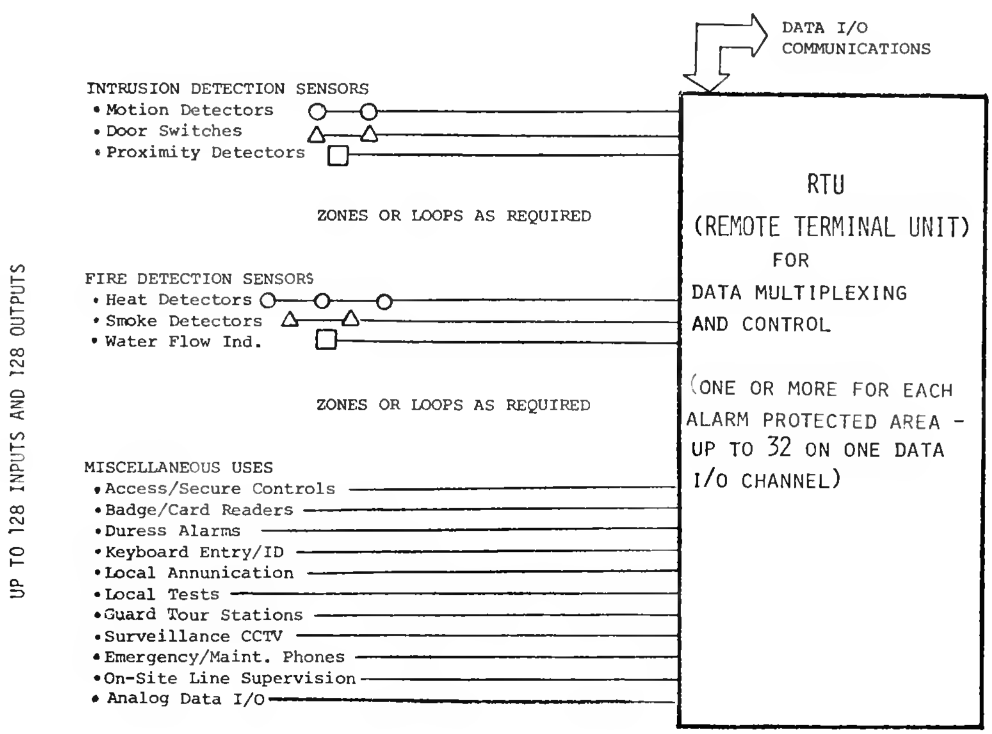


Fig. 10. Functional requirements for the remote terminal units.

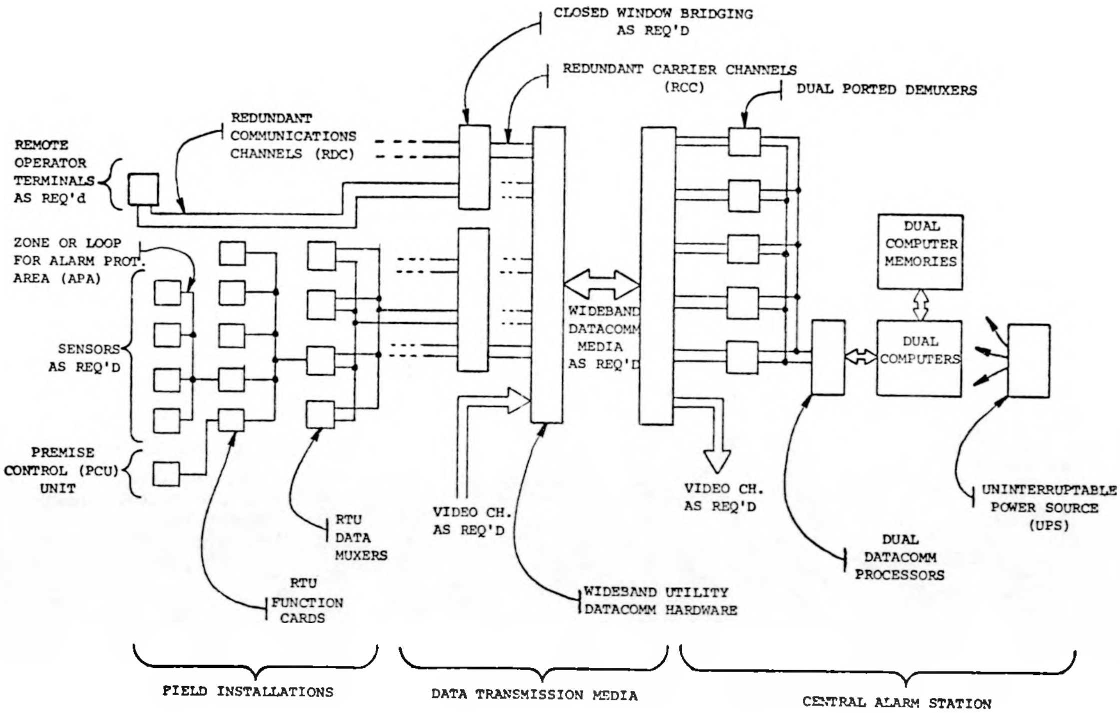


Fig. 11. Data communications aspects of the LASL upgraded alarm system.

data transactions. This is accomplished by software control of all alarm system activities; that is, data between the RTU and operators must first pass through the computer, regardless of direction of communication. The critical aspects of this central alarm station computer system are shown in simplified form in Fig. 12. All computer hardware and software will be implemented in redundant configurations for maximum system reliability.

The remote station subsystems consist of all those displays and operator terminals that are remote from the central station facility, such as the IDS alarm center in the ERDA building and the fire terminals in each of the five fire stations. The principal equipment required in the IDS alarm center is shown in Fig. 13, and equipment for the fire stations is shown in Fig. 14. Key features include real-time displays, hard copy printouts, keyboard

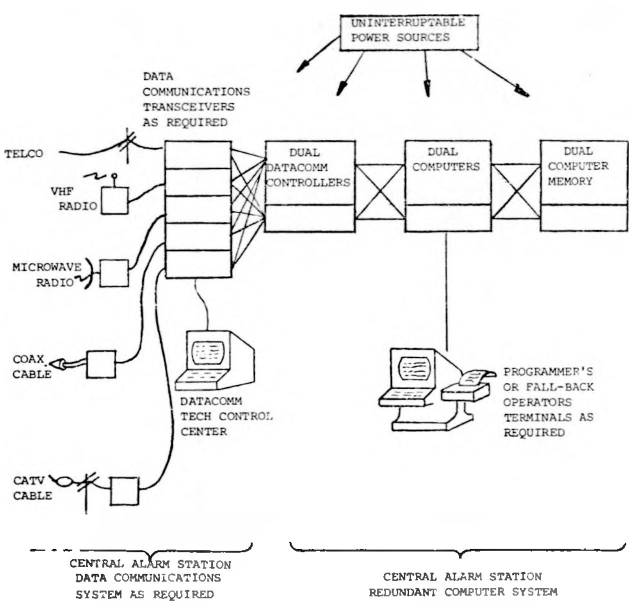


Fig. 12. Central alarm station computer system.

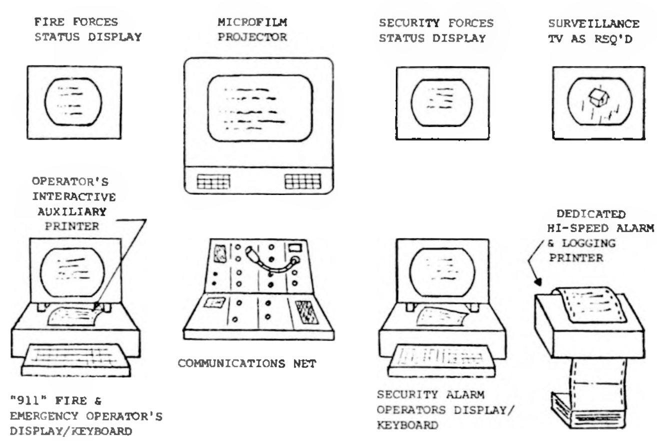


Fig. 13. Security guard's alarm station layout.

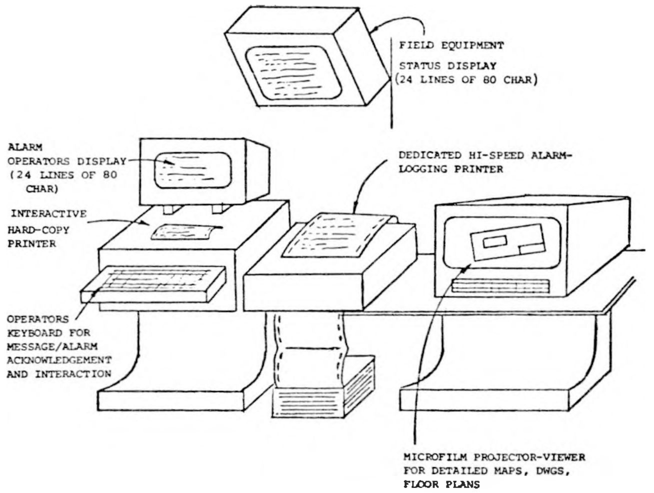


Fig. 14. Typical fire alarm station operator's terminal.

interaction and control, microfiche-projector drawings and documentation, and data base recording with display of all equipment status changes and events occurring within the LASL alarm system. Finally, since the upgraded system as discussed in this document represents an ultimate configuration, it must be stressed that all interim time-phased improvements must be upwards compatible with this ultimate configuration.

B. Alarm System Operation

The upgraded alarm system will utilize computer automation to the fullest extent. Alarm operations information processing presently performed by firemen and guards, such as logging and maintaining data files, monitoring the special status conditions of the alarm system, and dispatching field response units, will all be supported, if not wholly provided, by automated computer functions from the new central alarm station. A significant aspect of the new system is that although the new central station will provide computer automation of alarm signal processing, fire and security functions displays will be remoted from this alarm center to new terminals in each of the five ERDA fire stations for fire alarms and to the existing ERDA guard force alarm center for security alarms. The automated central station will presort all fire and security alarms automatically and route the alarm displays to the appropriate terminal. However, the guard force alarm center will continue to monitor alarm displays for fire because of their need to alert field security forces to the impending arrival of fire fighting forces. Also, the guard force alarm center will continue to handle "911" emergency calls, but the information will be entered into a computer-aided "fill-in-the-blanks" display controlled by the computer. While the guard types the information into the real-time display in response to the caller, the computer verifies any critical information such as street intersections, Laboratory areas, or building identities and simultaneously sends copies of this display to each of the fire stations. Furthermore, computer-automated call-tracing services are expected to be available from Mountain Bell at some future date. The result of such a service is that the telephone company can furnish the telephone number, name, and address (or Laboratory location) of the calling party automatically, in a few seconds, and provide this information to the alarm system operator. The computer forwards all of this information to the adjacent guard's display if the incident involves security, or to the fire stations if the incident involves fire or ambulance. This call routing is shown in Fig. 15. Thus, there will be less need for dispatches from the guard force alarm center to the fire stations, and the "911" service can provide significant security benefits as well.

C. Alarm System Data Logging and Display

Because all alarm system activities, information, and data transactions are controlled and monitored by the central station computer system, the upgraded alarm system will be capable of providing extensive data logging records and printouts.

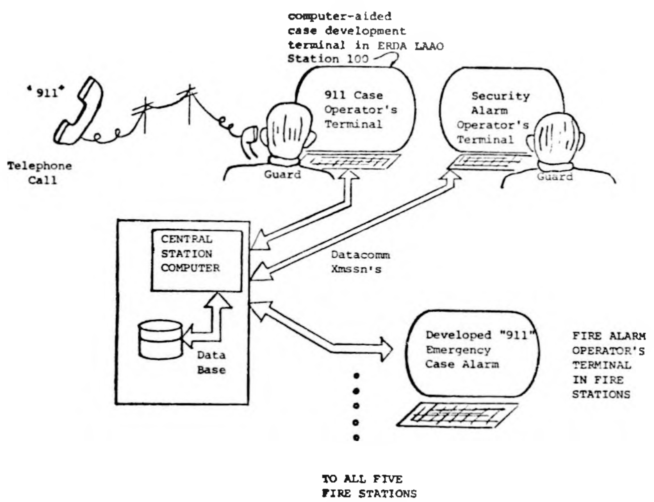


Fig. 15. Emergency "911" communications.

Whether the output is shown on a logging printer, displayed on a screen, stored in the working or archival memory of the computer, or all of the above, such records will require the support and use of an extensive information collection data base system. Such a data base is an integral part of the software of the proposed upgraded alarm system central station computer and is described in more detail below.

An example of data base use for plain English text on records, displays, and logs is shown in Fig. 16A for fire alarm use and in Fig. 16B for security alarm use.

The computerized operator terminals will be capable of automatically logging or printing hard copy of all automatic alarms, computer-aided alarms, and operator inquiry data to the extent required or desired and to the time resolution and accuracy required or desired.

D. Alarm System Data Base

Because of increased computer data-handling capability and remote field multiplexing of the new system, it will be possible to command a better grasp of alarm situations. However, to do so will

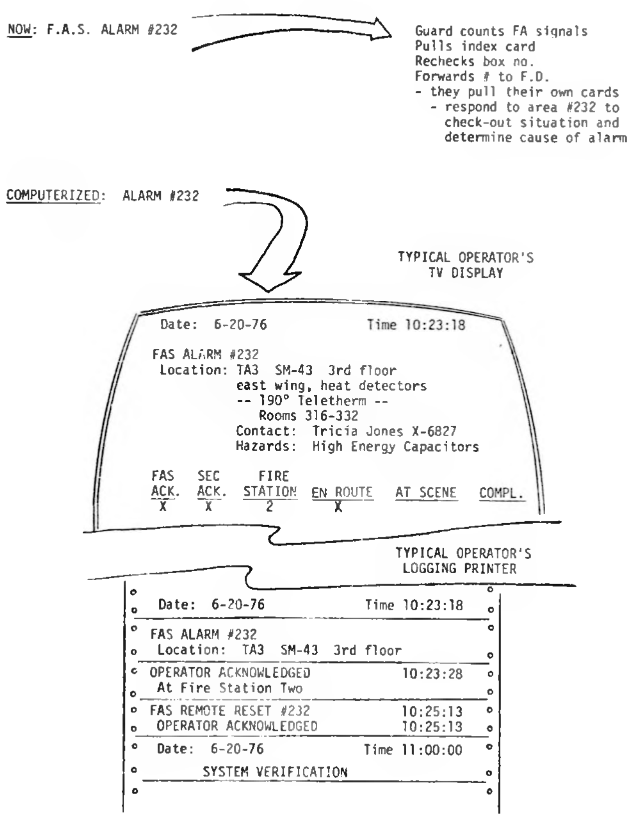


Fig. 16A. Data base use for fire.

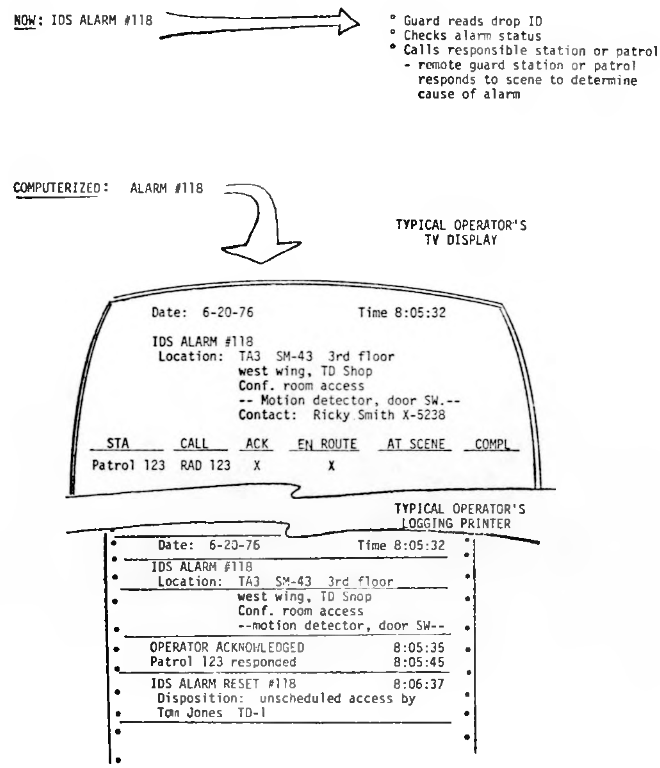


Fig. 16B. Data base use for security.

require development and continued refinement of a computerized data base. Such data are entered into the computer memory item by item, and although many of these data are entered before the computer is first on-line, changing field conditions and alarm system growth will require constant data base modification and updating. Operator access controls will be included in the new system so that an operator can enter a data change from his keyboard during actual operation and at his convenience or by a separately located data base clerk, or both. All such computer programming and system data base changes will be controlled by rigidly defined access-authorization codes or arrangements in order to prevent errors or unauthorized changes. One benefit of such a data base is utilization for comprehensive maintenance and operations logs and records, as well as for simple matters such as status summaries for between-shift operator changeovers. Because of the flexibility and power of the central station computer system, the data base can support English text to any extent required for records and displays. Another feature of the new system will be utilization of microfiche projectors capable of recalling maps,

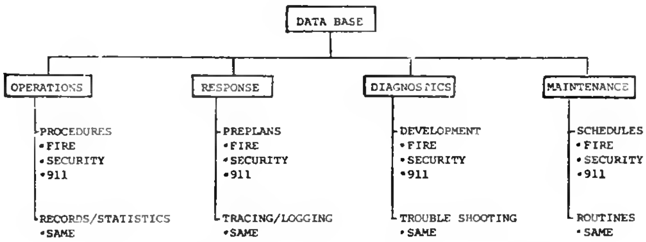


Fig. 17. Data base uses for LASL alarm system.

drawings, floor plans, and advance-prepared response "preplans" for fire and security response forces.

Figure 17 is an overview of data base uses, while Figs. 18A and 18B outline data base structures for the fire and security alarm systems.

E. Alarm System Time Response

The alarm system time response will be an order of magnitude faster (12 s vs 120 s) than the present system for fire alarm information to the Fire Department, and for security alarm information to the security alarm operator. This system time response is generally taken to be the longest delay between an alarm occurrence and full logging printout and display of all necessary information so that the operator can deal effectively with the situation. The largest difference will be English-worded printouts of extensive and supportive alarm data and associated field-status data as required. Equally

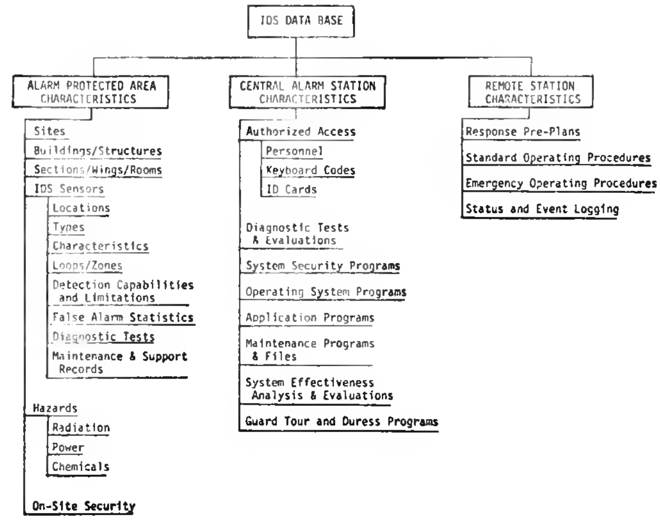


Fig. 18B. IDS data base structure.

significant will be the automatic logging of events and activities provided by the computer data base system.

F. Alarm System Reliability

The quantity, quality, and reliability of information will be improved in the new system owing to the utilization of RTU field electronic units that multiplex larger amounts of information onto digital data transmission lines. Unfortunately, physical constraints of the Los Alamos environment

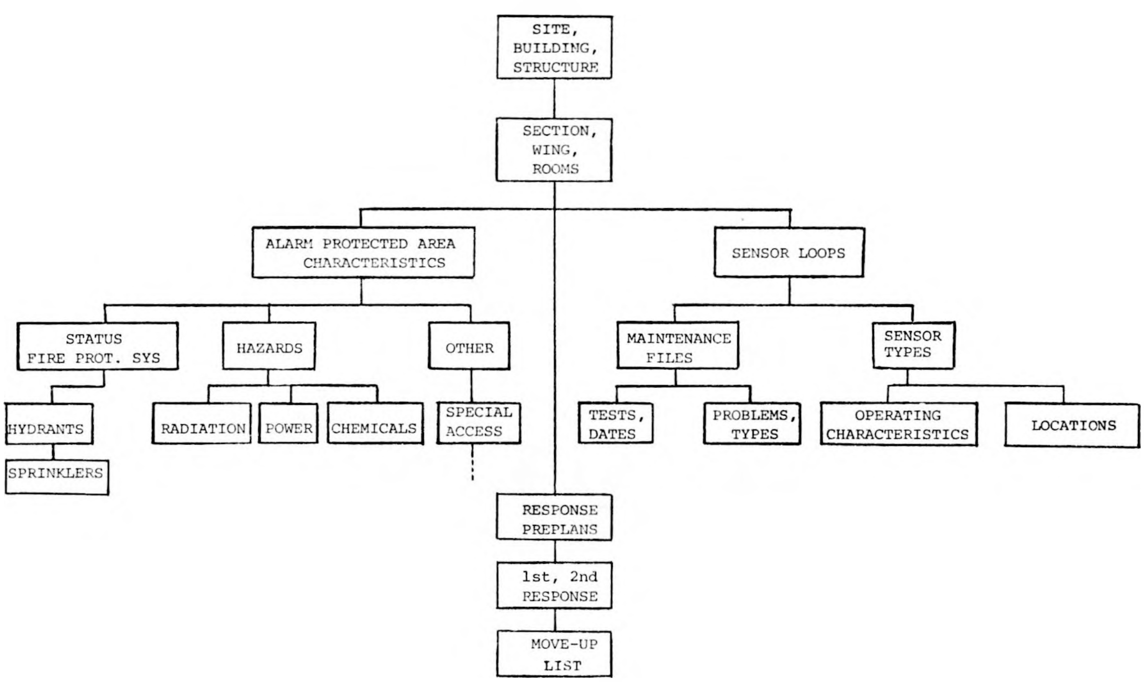


Fig. 18A. Fire alarm system data base structure.

will for several years limit transmission media to the telephone leased lines now in use. However, the new digital data communications method will use only the ac transmission characteristics of the telephone lines instead of the present dc characteristics. Also, the new digital multiplexing technique enhances the error detection and recovery mechanisms. Additionally, present system reliability problems related to catastrophic line failure are alleviated in the new system by using isolated redundant lines for every multiplexing channel used; if one line fails, the operation automatically switches to a backup line with 5 s, which is the RCC concept. Since the data transmission medium is transparent to the alarm system function when data communications other than telephone lines are provided, the RTUs and computer equipment will be compatible without retrofitting.

G. Alarm System Availability

In order to assure that continued operation of the new system is more reliable over a long period of time, the system employs redundancy and self-checking features at all levels from the sensors to the operator terminals. In the alarm-protected areas the sensors and field data multiplexers have failure detection circuitry and automatic battery-backup power. Transmission from the field units to the alarm center occurs over dual or redundant communication paths. The automated central alarm station features dual data processors for communications, dual computers, dual peripherals and memory, and dual power sources using battery and diesel generator back-up. A block diagram of this equipment configuration is given in Fig. 19. (The reliability of such computer installations is sufficiently high that no manual or hardwired back-up control is anticipated.) Furthermore, there are operator displays in the central alarm station that can duplicate the remote fire and security operator terminal functions and provide an emergency fallback capability. These terminals can also be used for system maintenance and training as well as for continued system improvement and development. The actual remote fire and security operator terminals are redundant in the sense that each of the five fire stations has its own terminal and communicates with every other fire station; in addition, there is a duplicate fire display in the guard alarm center. For IDS operation, should the IDS terminal fail, the

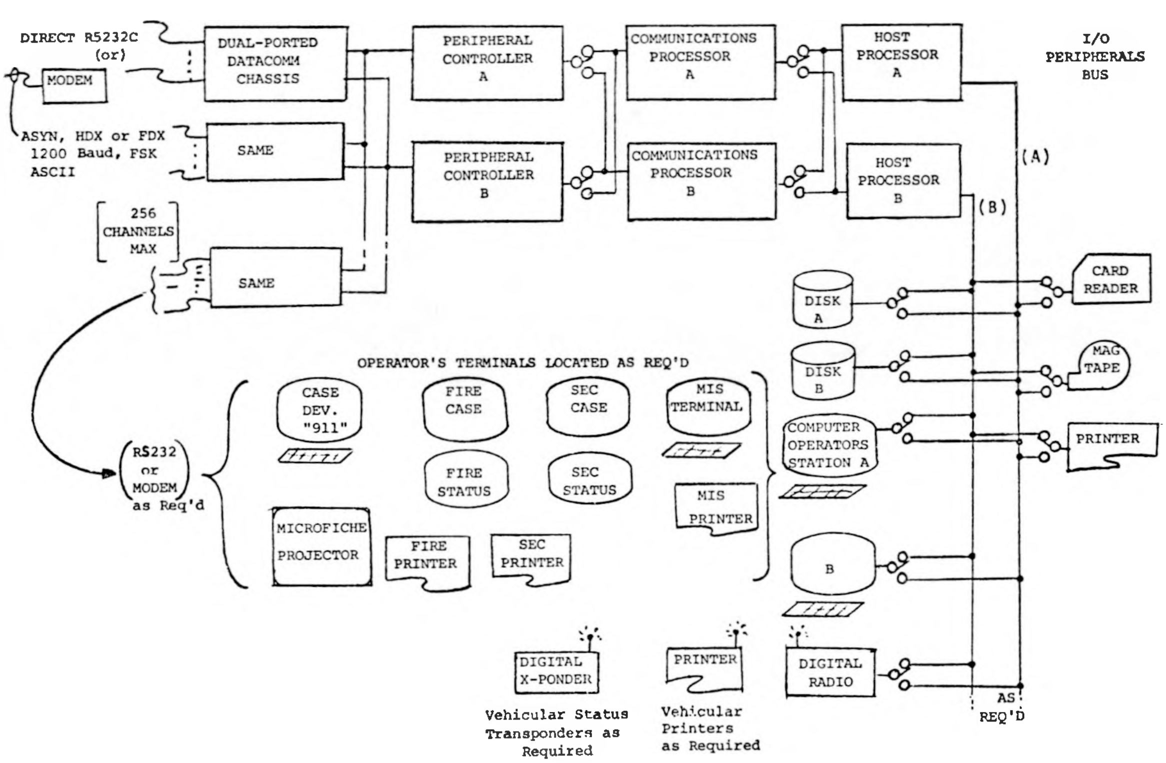


Fig. 19. LASL upgraded alarm system central station configuration.

guards can use the adjacent fire alarm or "911" emergency terminal as a fallback shared-mode operation or vice versa.

H. Alarm System Security

The alarm system security required for the IDS is provided at several levels throughout the upgraded alarm system. The specification and design criteria for system security are the most critical aspects of the upgraded IDS; therefore, they will be the first work undertaken in the upgrading program. The following discussion describes the system security measures in general terms only and in context with the theme of this document on functional specifications.

In order to insure adequate and proper IDS alarm system security, the new system will require several special and sophisticated features. These features, unique to the LASL system, are required because of the mixed varieties of security, the scattered facilities, the required transmission of alarm system data over essentially uncontrolled public domain territories, the initial reliance on ordinary telephone leased lines, the multiple and distributed use of the alarm system and alarm operator locations, and the impracticality of reducing or eliminating all of these problems before installing a new alarm system. The key elements of these security features will now be described.

Data communications capability, coupled with the computer, is the key to security problem solutions. This is accomplished by the ability of the computer to monitor and control all activities within the system since all data flows through the computer at each stage; that is, sensor to computer, computer to operator, operator to computer, and computer to premise control. The principle of utilizing redundant digital data communications for interconnecting all alarm system components and subsystems is also a key that provides the new alarm system with its power, flexibility, utility, and upwards compatibility with a master plan, while allowing an immediate start on a small scale.

The threat which the upgraded LASL alarm system must be protected against is defined below.

1. Alarm Security Threat. It shall not be possible to spoof or otherwise defeat the proper functioning of the alarm system by any of the following methods:

a. Cutting, shorting, loading, jamming, or otherwise interfering with or interrupting the flow of data on the sensor loops or on the transmission path.

b. Substitution of signals or data which are not precisely in sync and context with the scheduled and expected data flow on the sensor loops or on the RCC.

To achieve this, the alarm system design shall be such that the substitution of valid data shall require a minimum of all the following knowledge and conditions:

a. Knowledge of the protection arrangements of the alarm protected area (APA) as to the whereabouts, the physical arrangement, and the location of each of the two data channels which constitute the RCC serving this APA.

b. "Simultaneous" access to both channels of the RCC set, so that data control of the set can be passed between the two access points.

c. Knowledge of target alarm system data transmitter location, its data address, and command-code structure.

d. Electronic equipment capable of precisely emulating the data channels and their information and timing sequences.

e. A method of switching the complete RCC out of operation and switching substitution equipment into operation without causing anything more significant than a "statistical error" alarm (apparent only as noise).

f. Electronic equipment capable of sensing RCC signals without detection by the electronic and data supervision of the system.

g. Access to both channels of the RCC set between the target APA and the central alarm station.

h. Sufficient record of RCC data traffic to determine the timing structure and future behavior of the communications transactions in effect at that time and location in the alarm system.

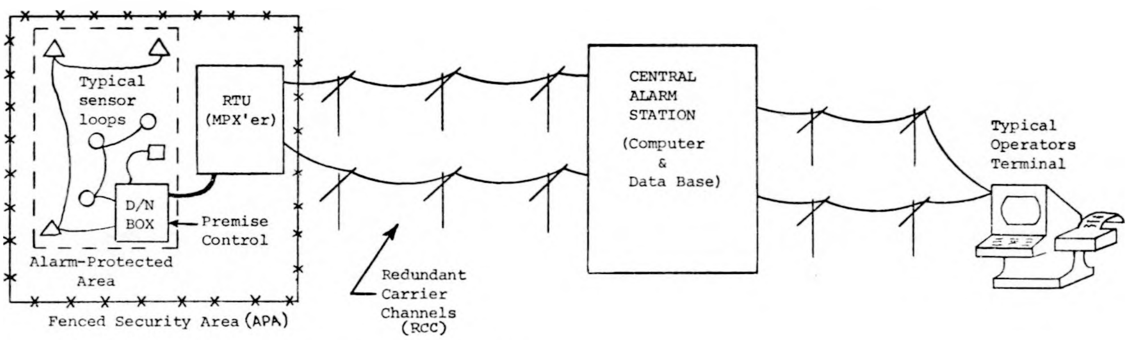
2. System Security Features. The security of the upgraded alarm system can best be described by Fig. 20, which shows how the security aspects of the system are divided into four distinct levels described below.

a. Security Level One. Field security of APAs is assured first by sensor selection from the ERDA-approved equipment list and second by sensor wiring using "tamper-proof" techniques or line-supervision signals in accordance with ERDAM Chapter 2401. The data from these sensors are collected by the RTU electronics. The circuitry, required to provide line-supervision signals on these sensor wires, and provide data on individual sensor activity, switch the sensor "zones" or "loops" between "access" and "secure" modes of operation, and to multiplex and protect these data during communication with the central station computer via the digital data links, is all contained within the RTU. A block diagram of the RTU is shown in Fig. 21 for reference. The figure also shows the RTU relationship to features and uses other than IDS, for example, the fire alarm system and possibly future CCTV.

b. Security Level Two. Data communications and control between the RTUs and the central alarm station, regardless of direction, location, method of transmission, and equipment used, is secured by three different techniques. In addition, alternate routing of redundant data communications channels is used. The three techniques are briefly described below and are illustrated in block diagram form in Fig. 22.

(1) Tactical Security. This provides detection of valid data loss in the system due to causes such as those listed under "Alarm Security Threat." It provides the operators with appropriate alarm notices and records of such events. This is accomplished by using interrogate-response communication techniques and rigid data-protocol timing requirements combined with the ability of the central station computer to precisely monitor all data transactions for conformity.

(2) Strategic Security. This provides sufficient coding complexity and corresponding verification techniques to detect attempts to "spoof" the alarm system by substitution of false alarm data signals. Appropriate alarm messages are provided for the operators. Such coding complexity is provided by the digital data rates, the multiplexing of several RTUs, and the use of two data paths with independent control over each path. Where necessary, the system can detect potential spoofing activities, invoke special requests for authenticators from the remote devices, and initiate evasive action. Such



LEVELS OF SECURITY OF THE UPGRADED LASL ALARM SYSTEM

LEVEL ONE

Methods of sensor installation
- selection of sensors
- wiring of sensors
- premise control
- tamper-proofing

LEVEL TWO

Methods of data XMSSN
A) Tactical Security
- interrogate/response
- tamper proofing

B) Strategic Security
- message complexity
- message integrity
- spoof-proofing

C) Command/Control Security
- message validity
- diagnostics

LEVEL THREE

Routing of data XMSSN
- alternate routes
- redundancy
- line-diagnostics
- failure recovery

LEVEL FOUR

Information Gathering
- zoning of APA's
- sensor assessment

Fig. 20. Levels of security of the upgraded LASL alarm system.

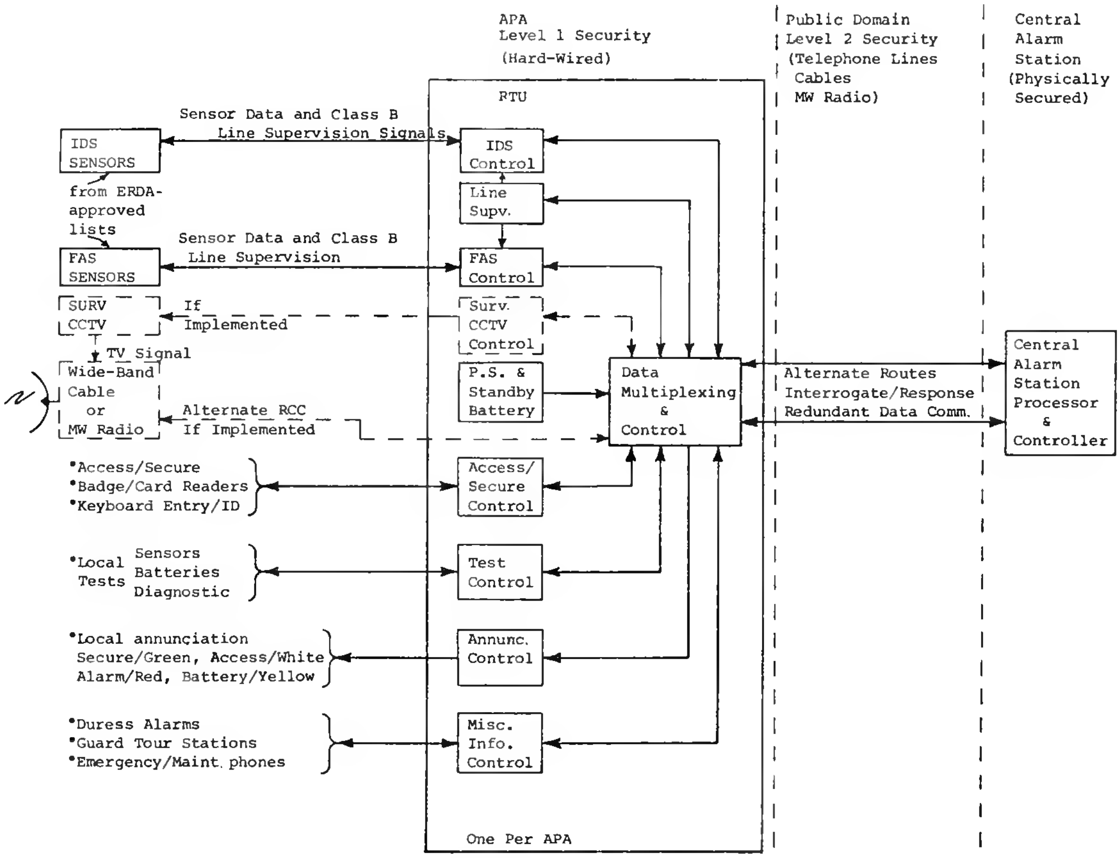


Fig. 21. Functional requirements for the remote terminal units.

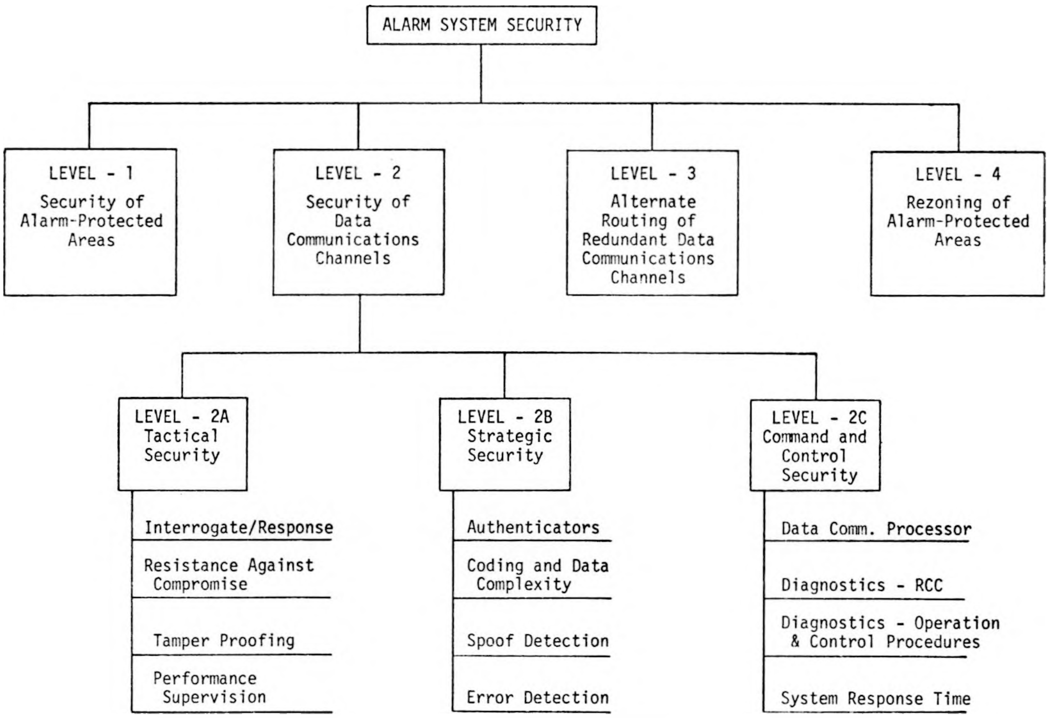


Fig. 22. Data communications security for the LASL alarm system.

evasive action might consist of intentional use of misleading data and messages, switching data lines, or other entrapment techniques. All of these methods and techniques are under the control of the central station computer.

(3) Command/Control Security. The proper origin and authenticity of data and operator actions are checked in terms of time, operational sequence or context, and standard or predefined Standard Operating Procedures (SOP). All proper and improper operations and sequences are automatically recorded and logged by the central station computer. The diagnostic capabilities of the dual computer and data communications processing equipment make such techniques possible. As an example, in the case of an automated access-secure implementation using magnetically coded badges and secret number entry at a remote keyboard, the computer would check the badge against lost or stolen badge status and check employee status in terms of whether or not the person is expected that day at that time. The computer would log the actual events of entry, and if abnormal, alert the operator. Abnormal events might be early arrival, late arrival, no arrival, or more than a certain number of attempts to get the number entry correct. Operator actions are monitored in a similar fashion. For example, missing alarm acknowledgment or acknowledgment later than at a prescribed time would be cross-checked by another operator station.

c. Security Level Three. The overall alarm system security depends on proper operation of the data communication system and appropriate use of the RCCs. The routing and RTU address assignments of the RCC must be carefully specified to accomplish proper modularity and function separation as required for system security.

Thus, the IDS installation will meet the fullest intent of a security alarm system, regardless of the factors of LASL environmental constraints and geographical configuration. For example, the number of alarm-protected areas per RTU data multiplexor will be limited to that number which can be safely covered by a dispatched security response guard force in the event of failure of that RTU. The maximum number of RTUs per RCC will also be chosen with similar constraints. In this way, a catastrophic loss of any of the major independent modules or parts of the data communications system will not exceed the security guard force ability to respond to the critical areas with on-site or dispatched guards. The concept of the RCC allows different routing of data channels for each of the two paths of data used for every communication in the security alarm system. To the extent that physical limitation can make this requirement impossible (for example, at LASL, where all telephone lines are a part of the same trunk line at various locations), then either the number of alarm-protected areas per RCC must be matched with the physical guard force, or else alternate data communications methods must be provided. This alternate route could be as simple as a new crosscut path in the telephone line or as complex as adding microwave radio links. In the LASL system, adding microwave links may be a desirable method for transmitting future requirements such as CCTV, used for security surveillance and alarm assessment. Thus, microwave radio links or equivalent methods are part of the long-range LASL alarm system planning consideration.

d. Security Level Four. To assure security of APAs protected by the IDS, the sensors used and their zoning or grouping in the APA must provide useful data to the IDS alarm operator. To accomplish this, sensor status in each APA can be individually collected so that in addition to an overall alarm signal, the operator can see exactly which sensors tripped in that area. Further information can be provided when necessary by using auxiliary sensors that provide additional data in support of the regular sensors. This supportive information will allow IDS alarm signal assessment. An example would be the use of CCTV to allow visual observation of the APA by the operator. Other techniques might include the use of complementary sensors, such as infrared or body-heat detectors in conjunction with regular ultrasonic or microwave motion detectors.

In summary, the modularity, redundancy, and security supervision of the upgraded IDS will be specifically chosen to assure against any loss of alarm protection that would exceed the manning and response capabilities of the security guard force. It is worth re-emphasizing that all data communications line supervision techniques are implemented at the secured computer end of the data communications system and are immune or transparent to the methods of data transmission between the central station and the outlying system areas.

I. Alarm System Maintenance

To assure availability of equipment for proper operation in the new system, maintenance personnel must be provided with adequate documentation, spare parts, test and diagnostics equipment, spare equipment, and appropriate operations bases and logistics support. In the central alarm station floor plan, Fig. 23, sufficient office space has been provided for any required engineer, programmer, or operations/maintenance personnel who will provide system preventative maintenance. These personnel will in turn be supported by an adjacent electronics lab that will provide diagnostic and repair work, spare parts and equipment, field equipment, and specialized rack-mounted equipment which are integral parts of the central alarm station. The central station data communications termination room will provide sufficient electronic cross-connect or patching equipment and facilities, as well as built-in diagnostic electronic gear, so that all kinds and magnitudes of data communications failures can be smoothly handled. The central station can provide 24-h support function service because of the features built into it such as emergency power, lunch room/conference area, restrooms, and so forth. Also, in the event of unusual emergencies, the office and backup control room area of the central station can be used for an emergency planning operations center with full supplies of power, parts, and resources as required.

J. Alarm System Flexibility

Because of the need for continuous alarm coverage throughout the upgrading program and since this period may be several years, implementation methods will be selected so that sufficient flexibility is an integral part of the alarm system design. This flexibility will be most evident in the functional modularity of the system; this modularity will be a combination of hardware and software features. For example, the APAs are all universally served by the RTUs, which are really standard data multiplexors utilizing standard commercial data communications techniques. These data multiplexors can be installed during the first stage of the upgrading and remain compatible with the system as it is upgraded. Furthermore, they are all connected to the central alarm station over ordinary data communications links.

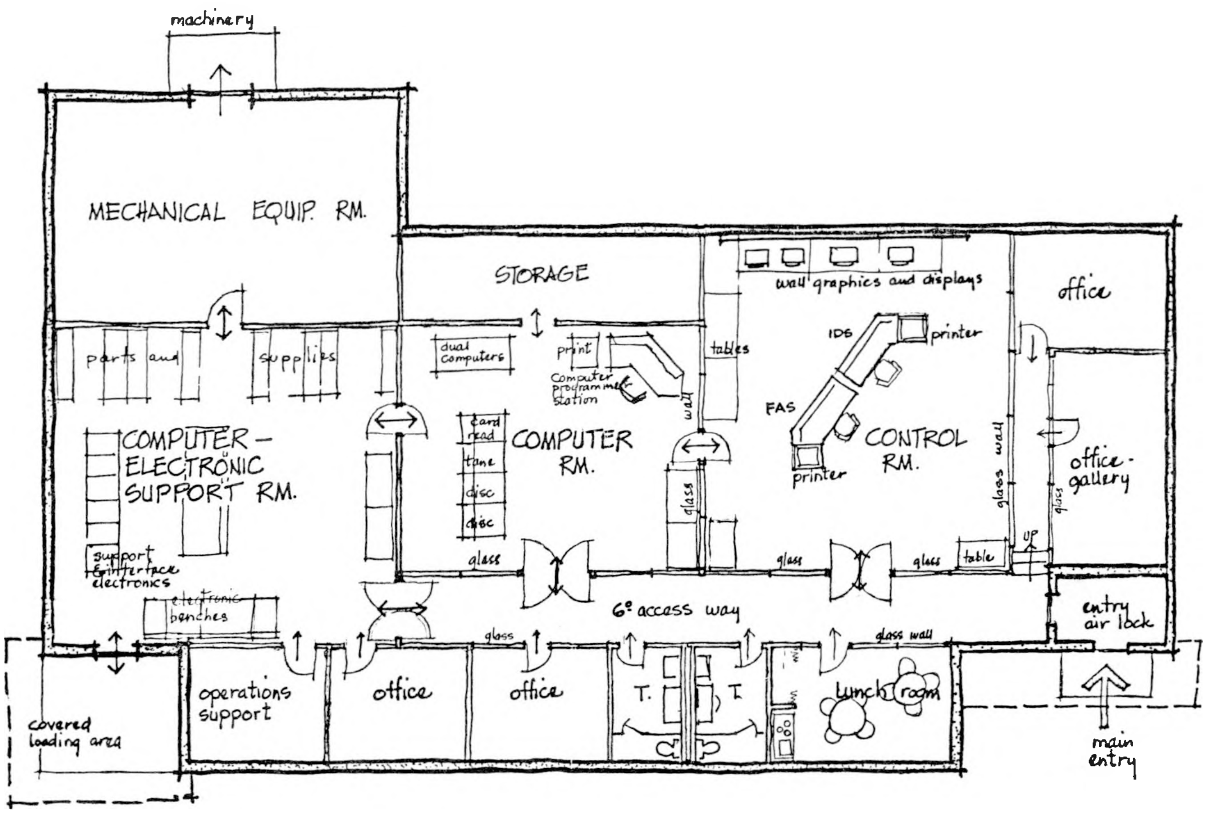


Fig. 23. Central alarm station floor plan layout sketch.

The nature of these links has no effect on alarm system security because security depends only on coding and protocol of data communications messages and not on transmission paths or links. This feature allows future transmission link changes to be made. For example, higher bandwidth for CCTV can be added without affecting any parts of the alarm system. Another example of the functional modularity of the upgraded alarm system is the use of commercial data communication operator terminals and operation of these terminals over the same transmission system already described. This allows operator terminal location to be independent of other features of the alarm system since they can be located literally anywhere on the data transmission links. The terminals consist of TV display/keyboards combined with high-speed printers. They are reasonably standardized and available from many sources in the data communications industry. Specialized use of such terminals for fire, security, or maintenance, is accomplished in the software programming of the computer system. The use of such terminals, their physical makeup and location are all independent functions from the rest of the system. Because of this modularity and flexibility, maintainability of the system becomes much more efficient and allows higher levels of reliability and availability.

K. Upgrading Benefits

The major benefits expected from this upgrading program are higher security capabilities and effectiveness of operations (Fig. 24). The higher security level can be obtained because the upgraded alarm system can provide faster and better data, higher reliability, freedom from unexplained false alarms, better records, and computer-aided support to speed up dispatching operations as well as keep track of field force status. In some circumstances, these features can trim minutes off of the response time. These same features will allow equivalent improvements in the fire alarm system for the same reasons and with even more dramatic results because the two-staged alarm reporting and dispatching arrangement now used will be eliminated. Increased effectiveness can be accomplished because the new system will reduce the required operator interactions in recording and tracing occurrences and correlating auxiliary data with alarm events. For example, on the security or fire alarm system critical field response, equipment or vehicles may be out of service and alternate plans must be invoked. These alternate plans would automatically be provided by the computer system data base for response pre-plans and would be provided in a manner that always matches this auxiliary data with the need to know, rather than presenting it all the time. Effectiveness is also enhanced because of higher reliability coupled with reduced maintenance time, giving better system availability. The reduced maintenance time is due to the better data collection, data recall features, and automated diagnostic capabilities of the computerized system.

Because of the modularity, flexibility, and standardization of the upgraded alarm system

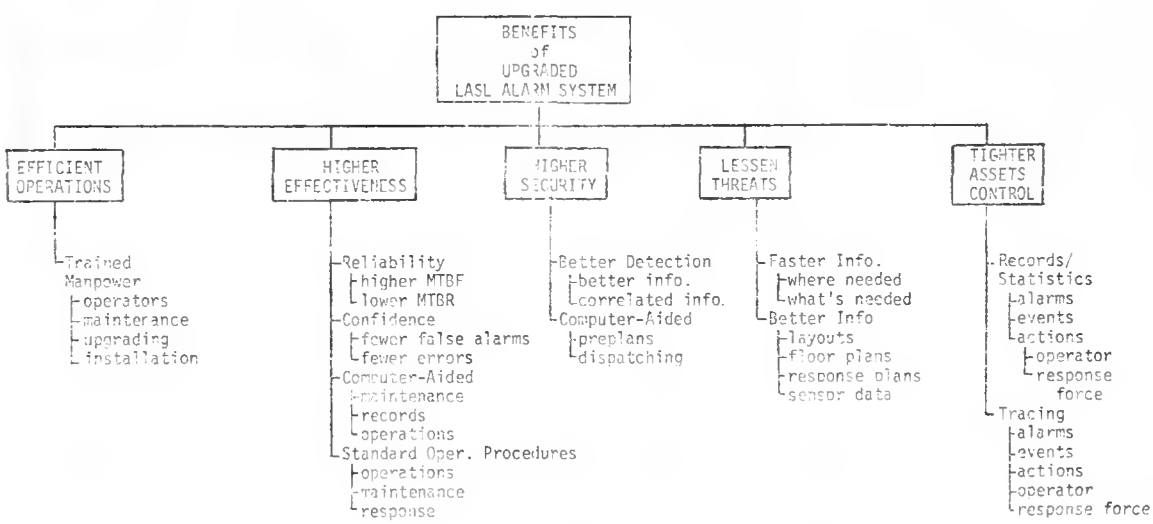


Fig. 24. Benefits of upgraded LASL alarm system.

components and the fact that the majority of these are commercially available from a broad range of manufacturers, the availability of spare parts, test equipment, corresponding training, and use of maintenance and support techniques become commonly available and therefore, efficient and economical. The mortality of the resulting system, its component parts, and its corresponding supporting services thus become much more immune to the inevitable changes that upset and eventually degrade systems of lesser flexibility, modularity, and standardization.

L. Future of the LASL Alarm System

Long-range plans for the LASL upgraded alarm system allow for future accommodation of equipment such as CCTV, vehicular displays or printers in key fire and security vehicles, local displays at key or critical guard post stations, automatic personnel identification for computer-aided access/secure premise controls, and possibilities such as automatic tracking of response force personnel and vehicles.

It is worth mentioning that because of the system architecture and its reliance on commercial data communication concepts, the system can withstand drastic rearrangements of operator terminal locations, procedures, and overall alarm system growth and rearrangements that may be required.

APPENDIX

APPLICABLE DOCUMENTS AND MAJOR REFERENCES

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NFPA No. 71	Central Station Protective Signaling Systems
NFPA No. 72A	Local Protective Signaling Systems
NFPA No. 72B	Auxiliary Protection Signaling Systems
NFPA No. 72D	Proprietary Protective Signaling Systems

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