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Description of the Map Board Portion of the Security Operations Center of the Plutonium Protection System

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Sandia Laboratories

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DESCRIPTION OF THE MAP BOARD PORTION OF THE SECURITY
OPERATIONS CENTER OF THE PLUTONIUM PROTECTION SYSTEM *

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ABSTRACT

This report describes the console map board which is part of the Sandia-designed Plutonium Protection System tested at the Hanford Works. The board displays areas under surveillance and contains alarm lights and switches for communicating with the system's computer.

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DESCRIPTION OF THE MAP BOARD PORTION OF THE SECURITY OPERATIONS CENTER OF THE PLUTONIUM PROTECTION SYSTEM

Introduction

This report describes the console map board which is part of the Sandia-designed Plutonium Protection System (PPS) which was field tested at the Hanford Works. A basically similar system (the Sandia Systems Integrated Laboratory (SIL)) was built and tested at Sandia at the same time; the two systems are electronically identical. The surveillance system is monitored at the Security Operations Center (SOC) (Figures 1 and 2).

The color CRT, located on the left-hand side of the console, presents a detailed map of one of three areas under surveillance by the system. Two options are continuously available for selecting the area map to be displayed. First, the operator can manually select an area for display. Secondly, the computer will automatically call up an area map whenever certain activities are sensed and will simultaneously write an instructive message on the screen.

Figure 1. Hanford Security Operations Center

Figure 2. Sandia Security Operations Center

The Hanford console map board (Figure 3) provides a back-up for the CRT if the CRT should malfunction. The board displays the areas under surveillance in much the same manner as does the color CRT; however, the board contains general area alarm lights rather than the detailed information presented by the CRT. The board contains buttons which indicate where the cameras are located and which particular camera has its display presented on the manually controlled screen. There are switches on the board which allow the operator to select detailed maps for display on the CRT. The computer can display questions on the CRT. The questions require yes or no answers, so switches labeled Yes and No are provided on the board for answering these questions. Computer-generated messages cause a buzzer to sound to alert the operator. A third button labeled Silence is used by the operator to acknowledge that the question has been received on the CRT and signals the computer to silence the buzzer. The board thus functions as an interface between the human and the computer.

Figure 3. Hanford Console Map Board

Design Goals

The design goals established for the system are listed below.

1. Manual control of cameras dedicated to one monitor.
2. Computer control of cameras on the other three monitors.
3. Computer override of the manual monitor under alarm conditions.
4. Buzzer to alert guard to observe CRT and monitors.
5. Operator response to computer-generated questions.
6. Ability to order computer to change map displayed on CRT.
7. Establish remote alarm box with buzzer alert signal.
8. Lights to indicate general area under alarm.
9. Display board to show the above functions within a general layout of the involved areas.

The majority of the design goals were met, although some were altered and numbers 3 and 7 were deleted because they were not essential in the present design. They can be easily introduced into the system if needed.

Description of Operation

Four basic functions are carried out by the lights and switches on the display board:

1. Camera Control,
2. Alarm Lights,
3. Map Lights, and
4. Yes, No, Silence.

The switch or switches and the lights that are involved with each function are shape- and color-coded to reduce the likelihood of the wrong switch being activated which in some cases might hamper operations.

Camera Control

The guard operator may have to use the manually controlled monitor when:

1. He desires to view a display by a camera whose picture was not being shown at that time.

2. A monitor or the computer control of a camera malfunctions. In this case, the manual monitor serves as a backup. The guard can select the camera which the computer normally would have called up and have its picture displayed on the manually controlled monitor. Thus, operations will not be significantly hampered while necessary repairs are being made.

The camera-control switch buttons are placed throughout the display areas and indicate the locations of the cameras (Fig. 3). These buttons are square in shape and white in color when lit. Pushing a button will cause that particular button to light and that camera to be displayed on the manually controlled monitor. WARNING: The internal timing of the circuitry requires that the button not be held down longer than approximately 2-1/2 seconds. The following situation may occur if the button is depressed too long: when the button is released the light will turn off and the picture will dissolve off the monitor. If this occurs the button should be pushed again and the light will turn on and the picture will return to the monitor.

Note that the manual control was not intended for rapid selection of cameras; therefore, the cameras should not be selected any faster than one camera-per-second. If this rule is violated, two cameras will be displayed on one monitor. In order to correct this situation, the guard must reselect the camera he wishes to monitor. Doing this will cause the correct picture to be presented as long as neither of the above warnings are violated again.

Alarm Lights

The alarm lights are round in shape and red in color when lit. The red color indicates that urgent response to that area is required. This color is also associated with the red screen that is projected on the color CRT in case of an alarm. These lights do not indicate which alarm was triggered but only the particular area that is under an alarm condition. Each area is separated by some barrier so each is independent of the other; therefore, a guard can quickly direct a response team to the area under an alarm. If more than one area is under an alarm, more than one light will be lit; therefore, the guard will have to direct the response team to the area which has the higher priority. The alarm lights are turned off by the guard after that area has been cleared, and the computers reset. When reset, the SOC computer will display, on the CRT, a message to the guard to reset the alarm lights. The guard will then push the lighted button(s) and the light(s) will turn off.

Map Lights

These lights indicate to the guard which area is presently being displayed on the color CRT. The switches are rectangular in shape and blue in color when lit. When it is desired to display another area, the guard may push that particular map button. When this request is processed by the computer it will turn on the light and display that particular area on the CRT. If the computer changes maps, it will also change the lighted button on the map to indicate the area being displayed.

There is a caution pertaining to the switching of the display maps. After a selection has been made, another map should not be selected until the previous selection is fully displayed on the CRT. If this is not done, two maps will be displayed, one over the other. To correct this situation, an unlighted map button must be pushed and the selection made again for the original map.

Yes, No, Silence

The Yes, No, and Silence buttons allow the guard to respond to the computer-generated questions. They are grouped away from the other switches to emphasize their importance. A wrong answer from the guard could cause unnecessary delays in the operation. The questions from the computer allow a Yes or No response. The first button in the group, which is green in color and square in shape, is for a positive response which will allow the operation to continue. The second button is for a negative response; it is red in color and round in shape. This response could halt the operations for an evaluation or stop it completely, thus generating an alarm condition; this would depend on the question the guard was asked. The third button is white in color and square in shape; it tells the computer that the guard has seen the message displayed on the color CRT and to turn the buzzer off. This button also serves more functions to the circuit internally and is discussed in detail in the next section.

Circuit Description

Camera Control

The design for the camera circuit requires that a direct current signal between 2 and 15 V be retained on an individual output line so that a commercial video switcher can switch the required camera to a monitor. Each output line connects an individual camera to a particular monitor; when the signal disappears from the video switcher input, the camera and monitor match will also vanish. In order to retain the decoded pulses that the computer gives the interface, a latch type circuit was used. The interface is a matrix type of arrangement in which a row and a column must be activated to latch a particular output circuit. Other circuits were required to erase previous pictures and to allow manual selection of a camera on one particular monitor.

A binary coded 16-bit word comes from the computer on connector P2 (Appendix A). The part of the word for the television portion is encoded in bits 10 through 13; bit 10 is the most

The circuits are defined on the following Sandia schematics:

 C47470 - SOC Interface, Appendix E.

 C47471 - SOC Interface CRT Display, Appendix F.

significant bit (MSB) and bit 13 is the least significant bit (LSB). The monitor code is in bits 14 and 15; 14 is the MSB and 15 is the LSB. When the coded word is received by the interface, these signals are split: one to decoder 2, which is for the television portion, and the other to decoder 1 which is the monitor portion. The number assignments of the binary coding of the camera numbers being used are given in Appendix B.

The following description is for the second monitor selected and the third camera. This description also applies to monitors 3 and 4 and any camera since the circuitry is the same. When a binary word is entered by the computer, the decoder selects one of four monitors; in this case, monitor 2. When monitor 2 is selected, pin 2 of decoder 1 goes low. The signal is split; one side goes to pin 9 of U5 and the other side to pins 3 and 4 of U34. When pins 3 and 4 go low, this generates a 30-nanosecond low-going pulse at pin 1; this is attached to the reset of the latch gates for monitor 2 and clears whatever picture was previously latched on this monitor. At the same time that pin 2 of decoder 1 goes low, pin 4 of decoder 2 also goes low; this is the camera selection for the third camera. This signal then goes to pin 9 of U24 where it is inverted on the output, pin 8. It then goes to four NAND gates (U25, U32, U35, U38), pin 10; these gates are then half activated and are waiting for the other half to activate. Since monitor 2 was selected by decoder 1, the signal from the output of pin 8 of U5 is the signal that will activate the other half of U32, pin 9. When both pins 10 and 9 are activated, as they now are, the output (pin 8) goes low; this sets U33's latch, and the output (pin 9) goes high. The 30-nanosecond pulse on the reset line has passed; therefore, the output (pin 9) of U33 is the only latch on the monitor line 2 that is latched. The output is then transmitted over J1 to the commercial video switcher to bring camera 3 on monitor 2. There are 48 latch circuits which means there are 12 possible camera selections for four possible monitors. The output of U34 is buffered by six gates to avoid a loading on the output; usually the expansion rate is ten gates but six were used in order to divide the load evenly. A buffer was inserted after U5 at the six-gate load point for the same reason that the buffers were inserted after U34. The present decoder can handle more monitors, but the latching circuitry would have to be added to accommodate the extra monitor lines.

When the circuit was first designed, the objective was that the monitors would be rotated as camera selections were made. Therefore, one could not choose a camera on a monitor and then choose another camera without changing the monitor and still expect the circuitry to function properly. After the circuitry was built, the computer program was changed so that a camera was always on a particular monitor. This could cause the circuit to misperform unless the program always changed the monitor number before putting a camera on any monitor or selected the monitors in a sequence to guarantee that they would always change monitor numbers. If the rotating of the monitors were not done properly, the result would be two images on one screen because the decoder 1 output would not cause the one-shots (U40 or U37 or U34 or U29) to trigger. This trigger generates a reset pulse to erase the previously selected camera; if the one-shot is not triggered, the previous picture is not erased and the new selection is added to the old, causing the double image. The interface circuit also was designed for dual control (manual control and computer control) and therefore additional circuitry was necessary for a monitor 1. The computer control was to override the manual control for approximately 5 seconds after an alarm; this override

feature was removed because the computer programming was changed to exclude computer use of monitor 1. The override feature was removed from the circuit to avoid any problems with the guards' control over the first monitor. This was done by eliminating bit 8 of the computer input. Although bit 8 was electrically disconnected, it will be discussed as if it were still in the circuit because the circuitry for the override is still shown in the schematics and is physically present.

Monitor 1 required additional circuitry because when no monitor is selected, monitor 1 would be activated. Therefore, an extra sensing circuit was needed to sense whether a camera was being selected for monitor 1 or one of the other monitors. In a quiet state the monitor line and camera line would have pin 1 low. Therefore, on decoder 1, pin 1 is low, and the signal goes through the U44 delay circuit to keep in time with the inversion time of U31, pin 3 and 4 from decoder 2. The U44 circuit keeps U44 pin 2 low, but the output is still high because the output from decoder 2 is inverted by U31. If a camera is now put on monitor 1, the output from U31 will go low, forcing U44 pin 3 low; this triggers the U24 one-shot which will reset the previously set latch so two images will not be projected on monitor 1. Now, if another camera is chosen without returning to the quiet state, the selection must go to a different monitor or two images will be projected. The switch signals for manual control come through U5 and go through an inverter. If the guard chooses camera 5, this inverter would be U12, pin 5. This signal is inverted and goes to U15, pin 1 which activates half of the NAND gate. The other half of U15 is always activated unless the override is in effect. Activation of the two inputs causes the output (pin 3) to go low which causes the latch U16, pin 4 to go high. At the same time that the switch is activated, a parallel signal is received at U43, pins 3 and 4; U43's output (pin 1) then generates an approximate 3-second pulse. This pulse is for switch bounce, both for the guard pushing and releasing the switch, and goes through pin 1 of U31 to trigger the reset pulse. Again, this pulse at U31 and the setting pulse at U15 can be overridden if the override signal is generated. If the override is given, U31 will not let the switch pulse through for the reset and will not let the set pulse pass through U15. The override will last for approximately 3.5 seconds or as long as U28 is set; since this can be adjusted, the override can be a longer or a shorter period of time. After the pulse is over, the manual switches will again trigger the correct circuitry to change the picture.

Alarm Lights

When the computer wants to light an alarm light on the display board, it will send a binary-coded word on its I/OIS (Input/Output Interface Subsystem) channel number 1 (physical slot 2). This word, which consists of a high true condition in bits 4 through 7, is received in the interface chassis through connector P2. Bit 4 in the word is the MSB, while bit 7 is the LSB; these signals go to the input of the decoder/multiplexer (D/M), labeled decoder 3 (CK-T47470). This D/M will decode the binary high signal to a single low output, one of eight; refer to Appendix C for alarm number assignments. This signal will then go to one of two quadruple set - reset ($\bar{S}$ - $\bar{R}$) latch chips (U41 or U42). When the low output of decoder 3 is received on the set ($\bar{S}$) line of the latch circuit, the output will go high and will remain there until the reset ($\bar{R}$) line receives a low signal. The output of the latch circuit going high will cause a Darlington transistor (A32) to turn on which will switch +28 Vdc to the light bulb through connector P5; this turns the light on. If the input is

now removed from decoder 3, the light will stay on until the light button on the display board is pushed. When the button is pushed, the signal to the reset ($\bar{R}$) line on the latch circuitry is pulled low, which resets the latch circuitry, thus turning off the transistor and switching off the +28 Vdc to the light bulb.

Map Lights

The map lights are controlled through two channels of the computer. One channel receives the input request; the other channel outputs the appropriate response according to the input received.

When a map button is pushed, a low true signal is sent through P6 to the interface chassis. This signal then goes to the input of U1, which is an $\bar{S} - \bar{R}$ latch chip. This low signal sets the latch, thus producing a high output through P3. This output is received by the computer's I/OIS channel 3 (physical slot 4). The computer interprets the request and displays the appropriate map on the CRT. The computer then sends a high signal back through J4 to the interface chassis; this signal then goes through a resistor to turn on a Darlington transistor (A32). This switches the +28 Vdc necessary to indicate the proper map. This same signal is also tied to an inverter chip, just before the resistor; thus, the signal is now low. This low signal goes to the reset ($\bar{R}$) side of the same latch circuit to reset the circuitry; thus, another button can be pushed. If the computer stops, the indicating light will also go out although the map will remain on the CRT.

Yes, No, Silence

Activating anyone of these switches causes the set line through P6 to go low which in turn causes one of the latch circuits of U3 to latch. The output generates a high signal, which is received by the computer through P3 at the I/OIS channel 3. Each switch represents a different bit on the channel; therefore, the computer will interpret which bit is set to determine which switch was pushed; for a breakdown on the channel bits refer to Appendix D. After the computer determines which bit is set it sends a reset pulse to all of the switches through J4.

If the computer determines that the silence switch has been activated, the computer not only resets the J4 lines but also zeroes its input to decoders 1, 2, and 3 through P2. This causes the interface to shut off the alert buzzer and allows the guard to turn off any alarm lights that are on. This also returns the circuitry back to the quiet state.

Buzzer

The buzzer signal is received through P2; it is then inverted twice by two of the circuits of U31. If the computer input is disconnected, the buzzer is activated and can only be turned off by shutting off the power or shorting an appropriate line to ground. (This could serve as a continuity line check on this cable.) The output of the last inverter goes through R44 which is a limiter resistor for the Darlington transistor (Q21). When the transistor turns on, the buzzer is grounded, activating it. The computer turns off the buzzer by changing the input to a low signal.

Conclusions

The present system provided reliable service during the field test. However, the reset part of the circuitry should be changed for the following reasons.

1. Because of the 30-nanosecond reset pulse and circuitry delays, the computer has to wait between camera selections; it cannot make the camera selections as rapidly as it should.
2. Because of bouncing switches, the one-shot had to have time delays built in; this causes the one-second delay between selections.
3. The one-shots for the reset are noise sensitive and could self-trigger in a noisy environment.

Although the present design is satisfactory, it could be improved. A storage register could accept the computer selections rapidly and then feed them to the circuit at predetermined time intervals, thereby freeing the computer for other activities. There also might be a commercially available product that performs this same switching function.

APPENDIX A

I/OIS Channel Breakdown (Hanford) for Alarms and CCTV Control

Date	2-22-77
I/OIS Channel Number	1
I/OIS Physical Slot Number	2
Function	Digital Output (TTL)
Card Model	1131

Channel Bits	Connected to Real World
1 MSB	Buzzer
1	Not connected at Interface
2	Not connected at Interface
3	Not connected at Interface
4	Alarm Number (MSB)
5	Alarm Number
6	Alarm Number
7	Alarm Number (LSB)
8	Override Pulse
9	Not connected at Interface
10	TV Number (MSB)
11	TV Number
12	TV Number
13	TV Number (LSB)
14	Monitor Number
15 LSB	Monitor Number (LSB)

APPENDIX B **TV Camera Assignments**

Binary input Bits 10-13	Decoder 2 Output Pin	Camera Number	Location
10111213			
0 0 0 1	2	1	Vault ICA corridor wall
0 0 1 0	3	2	Vault ICA-outer wall
0 0 1 1	4	3	Vault Holding Area
0 1 0 0	5	4	Vault ID Booth Wall
0 1 0 1	6	5	Vault ID Booth overhead
0 1 1 0	7	6	Vault corridor
0 1 1 1	8	7	MAC/MOC ID Booth
1 0 0 0	9	8	MAC/MOC Corridor
1 0 0 1	10	9	PIX Photo File
1 0 1 0	11	10	CRP Corridor *
1 0 1 1	13	11	CRP *
1 1 0 0	14	12	Not used

* Used in Hanford only

APPENDIX C

Display Board Alarm Light Assignments

Binary Input Bits 4 - 7	Decoder 3 Output Pin	Alarm Number	Alarm Area
4567			
0001	2	1	Vault personnel corridor and ID Booth
0010	3	2	Vault ICA
0011	4	3	Vault Control Room
0100	5	4	Vault Holding Area
0101	6	5	MAC Room
0110	7	6	MAC Room
0111	8	7	MAC/MUC corridor
1000	9	8	CMP ICA

APPENDIX D

I/OIS Channel Breakdown (Hanford)

Map and Operator Response Switches

Date	2-22-77
I/OIS Channel Number	2
I/OIS Physical Slot Number	3
Function	Digital Input
Card Model	1121

Channel Bits	Connected to Real World
0 MSB	CRT Display Switch Map 1 - Vault ICA
1	CRT Display Switch Map 2 - MAC/MOC
2	CRT Display Switch Map 3 - CMP ICA
3	Silence (Switch)
4	Yes (Switch)
5	No (Switch)
6	Not connected at computer
7 " " " "	
8 " " " "	
9 " " " "	
10 " " " "	
11 " " " "	
12 " " " "	
13 " " " "	
14 " " " "	
15 LSB " " " "	

Map and Operator Lights

Date	2-28-77
I/OIS Channel Number	3
I/OIS Physical Slot Number	4
Function	Digital Output (TTL)
Card Model	1131

Channel Bits		Connected to Real World
0 MSB		CRT Display "Light" Map 1 - Vault ICA
1		CRT Display "Light" Map 2 - MAC/MUC
2		CRT Display "Light" Map 3 - CMP ICA
3		Silence Latch Reset
4		Yes Latch Reset
5		No Latch Reset
6	Not connected at computer	
7	" " " "	
8	" " " "	
9	" " " "	
10	" " " "	
11	" " " "	
12	" " " "	
13	" " " "	
14	" " " "	
15 LSB	" " " "	

APPENDIX E

CK-T47470 -- SOC Interface

APPENDIX F

CK-T47471 -- SOC Interface CRT Display

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