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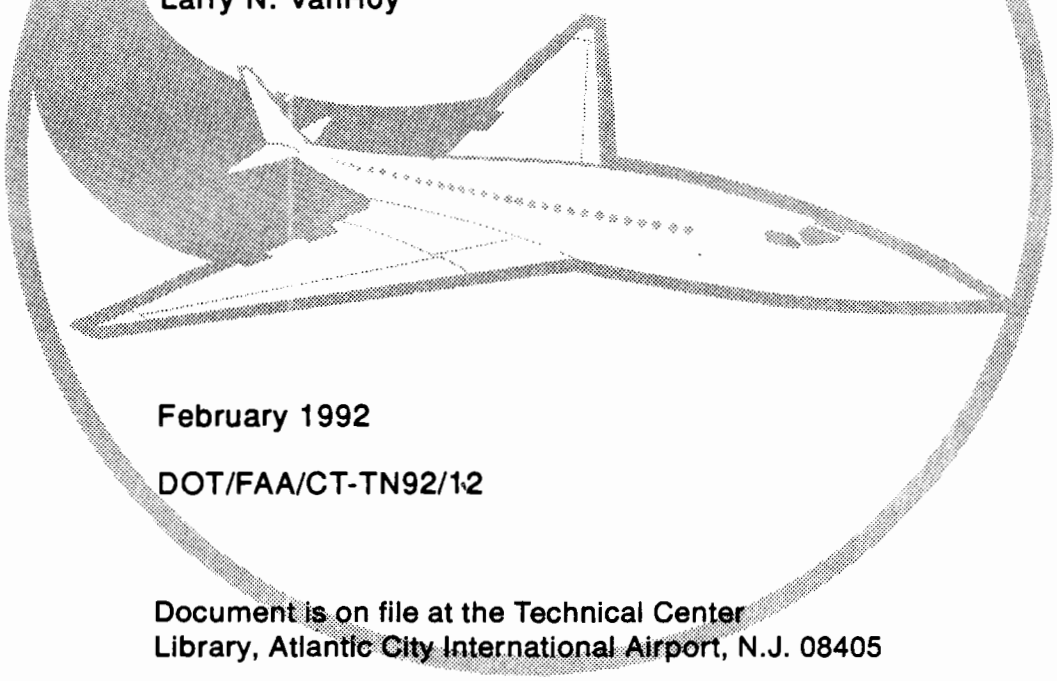
Airport Smart Power Lighting System

AVAILABLE IN ELECTRONIC FORMAT

Larry N. VanHoy



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16. Abstract

The Swedish Airport Smart Power (ASP) System has been installed at the Federal Aviation Administration Technical Center, Atlantic City International Airport, NJ (ACY). The purpose of this system is to provide control of individual lights on an airport from a remote location such as the Air Traffic Control Tower. A demonstration of the installed system's capabilities was conducted. Control of individual airport lights enhance the operation of systems such as hold-short bars, stopbars, wig-wag lights, taxiway guidance, lead-in lights, clearance bars, and control of lighted signs.

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EXECUTIVE SUMMARY

This project was initiated to test, evaluate, and demonstrate new available technology provided by the Airport Smart Power System for controlling individual lights on an airport. Control of each light is accomplished by superimposing a discrete control signal onto the existing airport power cable. Each light is then supplied with "reader" hardware to give individual control.

The reason for the need to control individual lights or small groups of lights on an airport is the emerging requirement to provide an increased margin of safety for taxiing aircraft and ground vehicles to prevent incursions and/or collisions, provide guidance to taxiing aircraft, and give pilots better information as to their location on the airport. There are many applications for this technology that may benefit from the use of controlled lighting. Some examples would include hold-short bars, stopbars, wig-wag lights, taxiway guidance, lead-in lights, clearance bars, and control of lighted signs.

INTRODUCTION

PURPOSE.

Whether walking, driving a car, or flying an aircraft to get from one place to another a person must follow some sort of path. While flying, a pilot has a well defined route to follow which insures that he will not be in conflict with other aircraft. On the ground he must taxi by following the instructions of the Air Traffic Control (ATC) ground controller. In the air his task is made easier by sophisticated navigation equipment in the cockpit. Such cockpit guidance equipment is not yet ready for use on the ground. This means that the pilot must use visual cues outside the aircraft to negotiate a specific route from one place to another on an airfield. This task is not nearly as easy as it would initially seem. Several external factors such as unfamiliarity with a specific airport, nighttime conditions, weather, inadequate signage, and low visibilities may combine to make his job even more difficult. If lights on the airport could be controlled to indicate the desired taxi path, the task of taxiing an aircraft along a specific route could be made much easier and safer.

For some time the Airport Smart Power (ASP) System developed by Airport Technology of Sweden has been used successfully in Europe to control individual airfield lights. Their airport lighting systems are run with parallel circuits while the airports in the United States are run on series circuit systems. The Swedish system was redesigned (figure 1) for series circuit use and was installed at the Federal Aviation Administration (FAA) Technical Center for testing and evaluation.

OBJECTIVE.

This project was directed specifically toward testing and evaluating the Swedish ASP System which should:

1. Demonstrate compatibility with the constant current regulators (CCRs) and series circuits in the United States airport lighting systems.

2. Allow complete control of individual airport lights to include on/off functions, selection of step settings, and ability to flash.

3. Provide the ability to monitor the status of each light being controlled. This monitoring should be able to report command status, output current, and open circuits (burned out filament).

BACKGROUND.

The ability to control a remote light can be accomplished in one of three general ways. A light could be controlled by a dirct wire connection. An on/off/step/flash signal could be sent via a control wire or fiber optic cable to a relay which controls the light itself. This method would necessitate recabling of all lights which need to be controlled and would obviously be very expensive. Its use would cause a great deal of installation activity on the airport, possibly causing delays because of the construction. This choice does not appear to be an attractive one.

A second method would be radio control which avoids the need to recable the airport lights. The ATC ground controller could push a button that sends a radio signal to a receiver on the airport which in turn commands the appropriate light to the proper status. Frequency congestion and possible interference are possible drawbacks. This system is also relatively expensive.

The last technique, and the one being tested at the Technical Center, is the concept of superimposing the control signal on the power cable itself. The advantages are immediately obvious. No new wiring is necessary and radio frequency problems are not encountered. Until now this technology has not been available for airport circuits in the United States. The unusual waveform that is created by the CCRs at an airport has, until recently, presented difficulty to the emergence of this technology. The expense of this system would seem to be reasonable although the final market cost has not yet been determined.

SYSTEM DESCRIPTION

The system as installed at the FAA Technical Center consists of the following components:

Personal Computer (PC) - The PC acts as the interface for the human controller to initiate commands that control the desired lights on the airfield. This PC resides in the lighting vault, itself, and is physically connected to the loop modem. By trial and error it has been determined that a 386-type computer gives far better results than slower models.

Series Circuit Loop Modem (Figure 2) - The PC located in the lighting vault sends RS-232 command signals to the loop modem which converts the computer commands to signals to be placed onto the power cable via the signal filter. The prototype modem is powered by 220 VAC. Production models may be powered by normal line voltage. This device also takes the monitoring signals from the system and converts them to RS-232 to provide the PC with the ability to monitor the status of each light being controlled.

Signal Filter (Figure 3) - This component takes the power from the constant current regulator and the control signals from the loop modem and combines them to be sent to the lights in the field via the light control units (LCUs). Before the signal is inserted onto the power cable, the waveform of the CCR output is filtered to suppress signals that might disturb the communications on the loop in the field. This filter also prevents commands from spreading to other loops which may be powered by the same CCR. In addition, the signal filter picks off the remote monitoring signals from the LCUs in the field to be sent to the PC via the loop modem.

Light Control Unit (Figure 4) - The LCU acts like a small CCR to receive power and commands from the signal filter to provide the proper voltage to the lights themselves. The LCUs are placed in the hand-holds in the field and, in our system, replace the isolation transformers used in the standard lighting system. Two lights may be connected to each LCU and either or both can be instructed to respond. The LCU also detects problems (status, output current, or open filaments) in either light and sends this message to the signal filter.

The larger production system includes two more devices that are not installed at the Technical Center. One is the concentrator which acts as a meeting point for up to 15 loop processors. Up to 15 concentrators can be used on one host PC. The other component not installed is the loop processor which is similar to the concentrator. A loop processor is required for each loop containing LCUs. Up to 127 LCUs can be commanded from one loop processor. A microwave barrier detector is also available for stopbar and other applications. Figure 5 depicts the ASP system as installed at the FAA Technical Center.

In addition to the ASP system, a method of controlling the PC in the lighting vault from a remote location was needed for the evaluation. The natural choice was another PC and a modem to pass the instructions over existing telephone lines to the ASP computer. By using off-the-shelf communication software, the computer in the vault can be controlled remotely from any location via a normal telephone line. The software that was chosen for this purpose is pcANYWHERE IV. (DMA Inc., 1776 East Jericho Turnpike, Huntington, NY 11743). This software has proven to be excellent for this application.

TEST METHODS

Technicians from Airport Technology in Sweden came to the FAA Technical Center to install the hardware and software that comprises their ASP system. Because of the different lighting circuits (series versus parallel) found in the United States, the equipment was prototype equipment for testing purposes and not actual production equipment. Since the installation and operation tests were successful, full-scale production has been approved. The equipment was installed as shown in figures 1 through 5. The equipment was put in series with the airport lighting circuit #6 at the Atlantic City International Airport. Six LCUs were placed on that circuit approximately 5000 feet away from the lighting vault to determine if they could, in fact, be operated remotely. Via two-way radio, it was confirmed that the commands given on the computer in the lighting vault were actually producing the desired results in the field. These results were successful in all modes that the ASP system is capable of operating.

The next test was to see if the vault computer could operate the ASP system and the airport lights by using another computer in a remote location connected to the vault computer by a telephone modem hookup. This test was also successful using off-the-shelf software called pcANYWHERE. Now it is possible, and it is being demonstrated that a remote computer plugged into any telephone line can actually operate the PC in the lighting vault which in turn operates individual test lights at the Atlantic City International Airport.

SYSTEM APPLICATIONS

Any application on an airfield where it would be advantageous to be able to control individual lights would make the Airport Smart Power System an attractive candidate. A specific example would be stopbars. Stopbars are lights placed across a taxiway where it meets a runway. As an aircraft approaches the runway the stopbar lights are red, signaling stop. When verbal clearance is given, the controller also extinguishes the stopbar, turning the red lights off; and in some cases, green taxi-path lights are illuminated to additionally confirm the clearance. Recent incursion accidents could well have been prevented if a stopbar system was in place and operational.

Another application relating to runway incursion prevention would be the hold-short bar. The hold-short bar is a series of flashing white lights placed in the runway where two intersecting runways meet. The purpose of these lights is to give the pilot of the landing aircraft a visual cue as to where the effective end of his runway is located. This flashing sequence could be controlled from the tower using the ASP system.

In some areas enhancement of a warning area is desired. Wig-wag (alternate flashing amber) lights may be used to indicate to a pilot where a critical holding point exists. This demonstrates another control application.

For Category III low visibility landings, there is an increased possibility of a pilot becoming disoriented as to his location on the airfield. Controlled taxi centerline lights (Taxi Route Control) may be used to guide that pilot safely to his destination taxiing to or from the gate.

At large airports where there may be many gates used by the same airline another application of controlled lights may be to use them as lead-in lights to confirm an aircraft's gate destination. Quite often the gate designators are difficult to see or confusing to the pilot.

Some airports are installing clearance bars. A clearance bar may be found at a taxiway intersection where it is desirable to define a specific airplane holding limit and there is no need for a stop bar. ASP could be used to control these lights.

Finally, there may be reason for the tower ground controller to wish to light specific signs on the airport at different times. These signs are also candidates for control light technology.

RESULTS

The Swedish ASP controlled lighting system has been successfully installed at the FAA Technical Center at the Atlantic City International Airport, NJ. By using personal computers, control of the installed lights in the system is available from any location with the use of a normal telephone modem and a remote PC. Control includes off/on, step selection, and flashing functions. Additionally, remote monitoring of the light's status is being accomplished and displayed on the controlling computer.

A demonstration was held on January 29, 1992, for a group of lighting manufacturers, government representatives, and an international group of interested airport planners. Canada, Italy, and Sweden were represented as well as many parties from the United States.

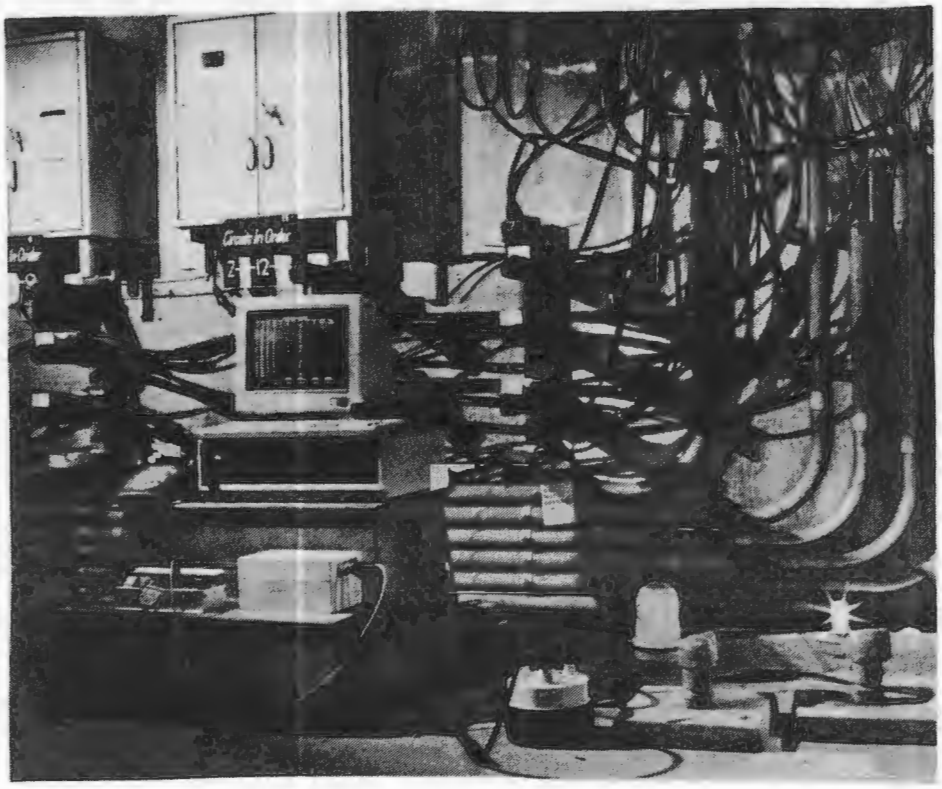
CONCLUSIONS

The Swedish Airport Smart Power System:

1. Was able to successfully demonstrate its compatibility with the constant current regulators (CCRs) and series circuits commonly used in the United States airport lighting systems. Original concerns that the noisy waveform of the CCRs might block the control signals proved unfounded.

2. Allows complete control of individual lights to include off/on functions, selection of step settings, and ability to flash.

3. Provides the ability to monitor the status of each light being controlled. This monitoring is able to report command status, output current, and open circuits (burned-out filament)



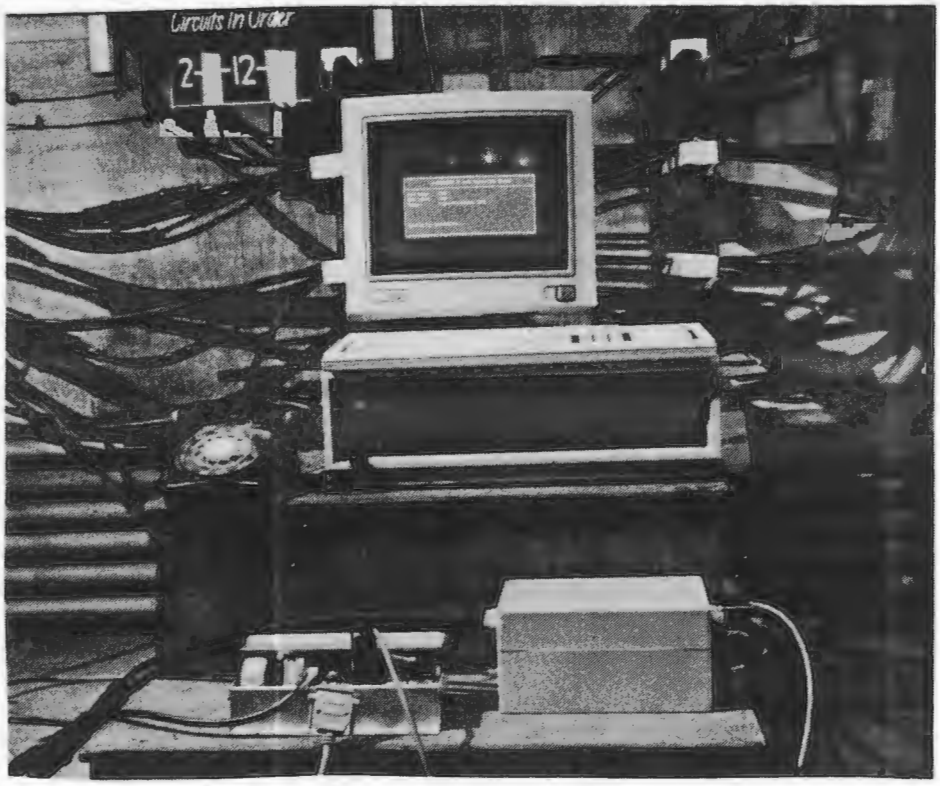


FIGURE 1. SWEDISH ASP EQUIPMENT INSTALLED AT THE FAA TECHNICAL CENTER

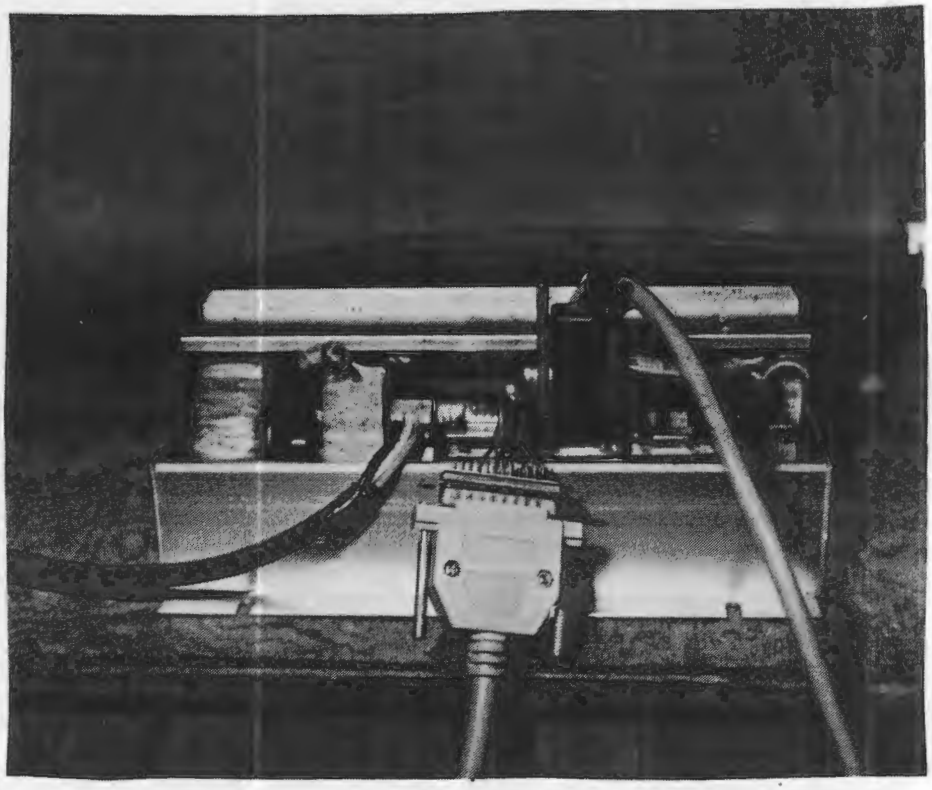


FIGURE 2. SERIES CIRCUIT LOOP MODEM

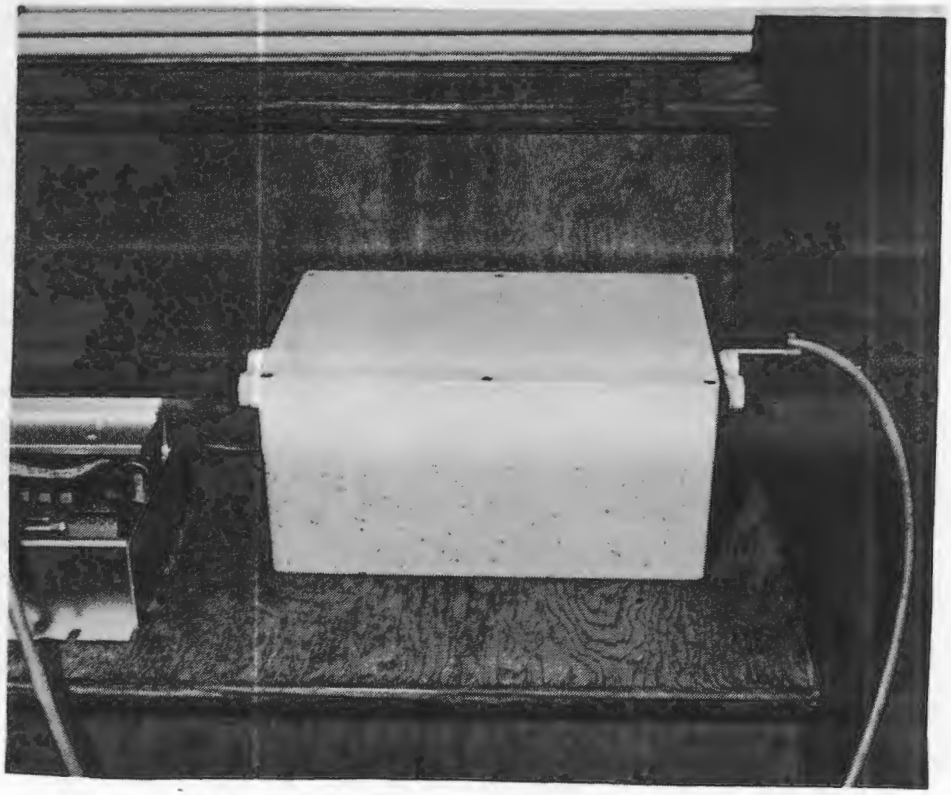


FIGURE 3. SIGNAL FILTER

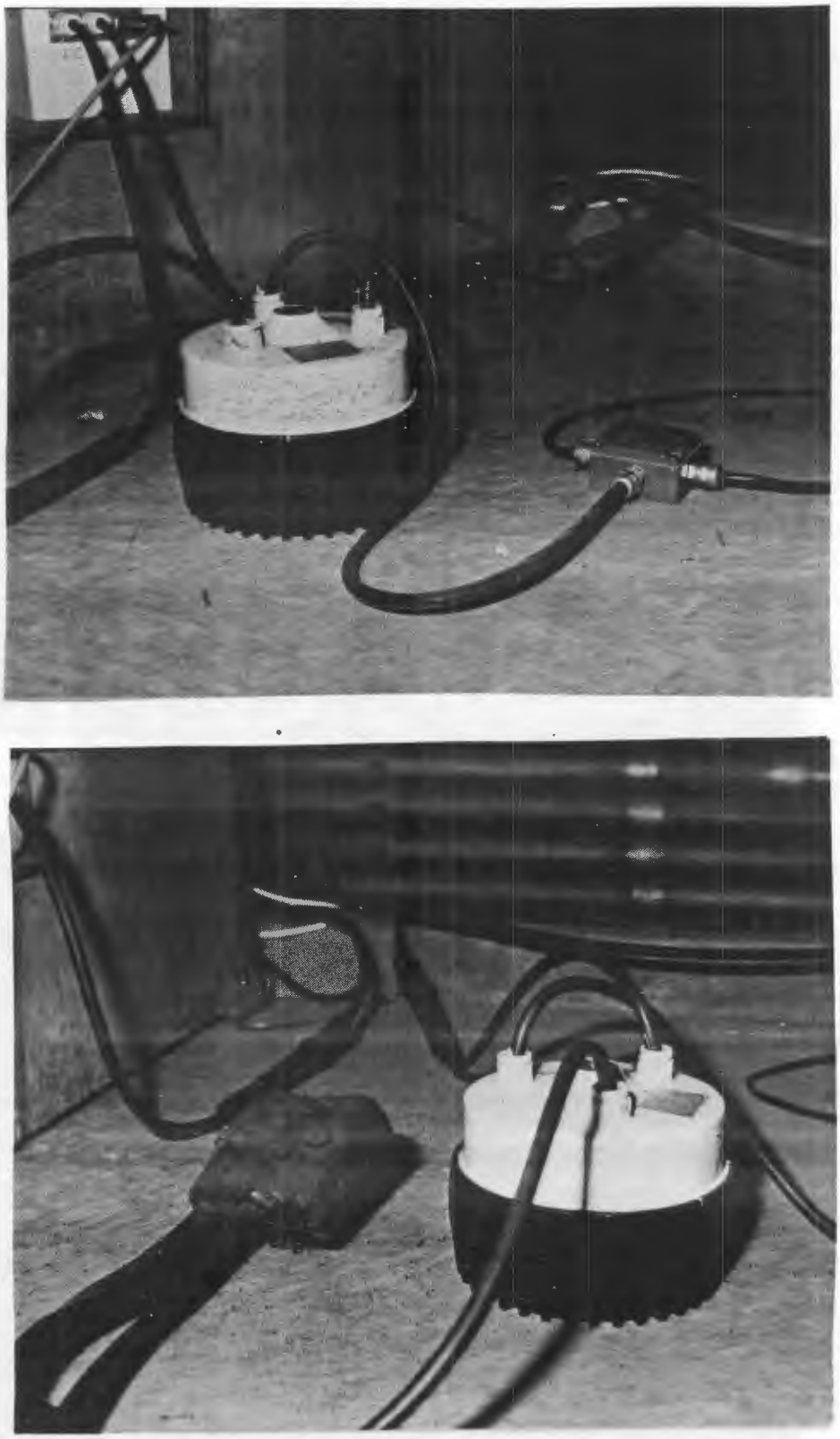


FIGURE 4. LIGHT CONTROL UNIT AND ISOLATION TRANSFORMER

FAA TECHNICAL CENTER INSTALLATION OF THE AIRPORT SMART POWER (ASP) SYSTEM

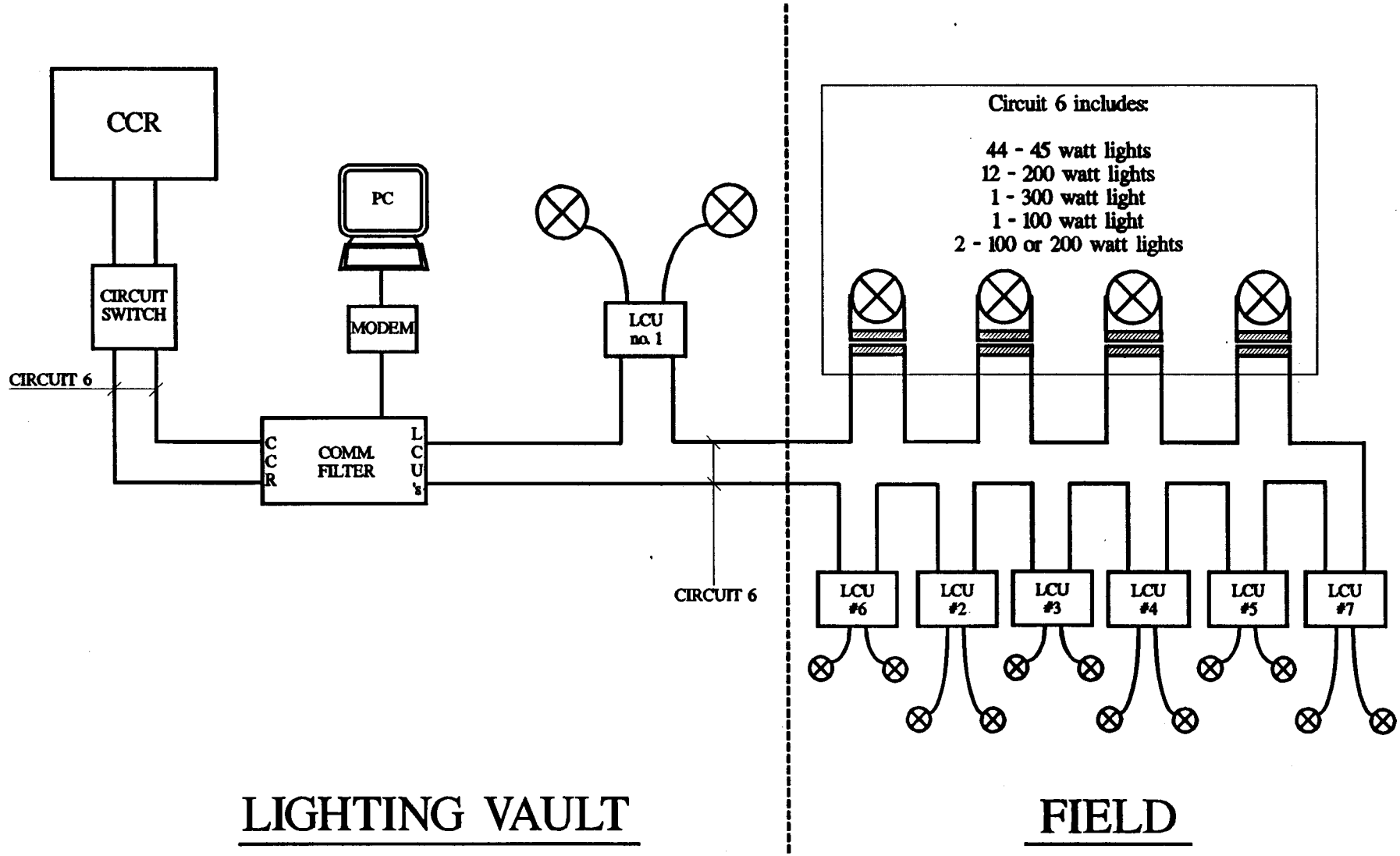


FIGURE 5. DIAGRAM OF DEMONSTRATION EQUIPMENT SETUP

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