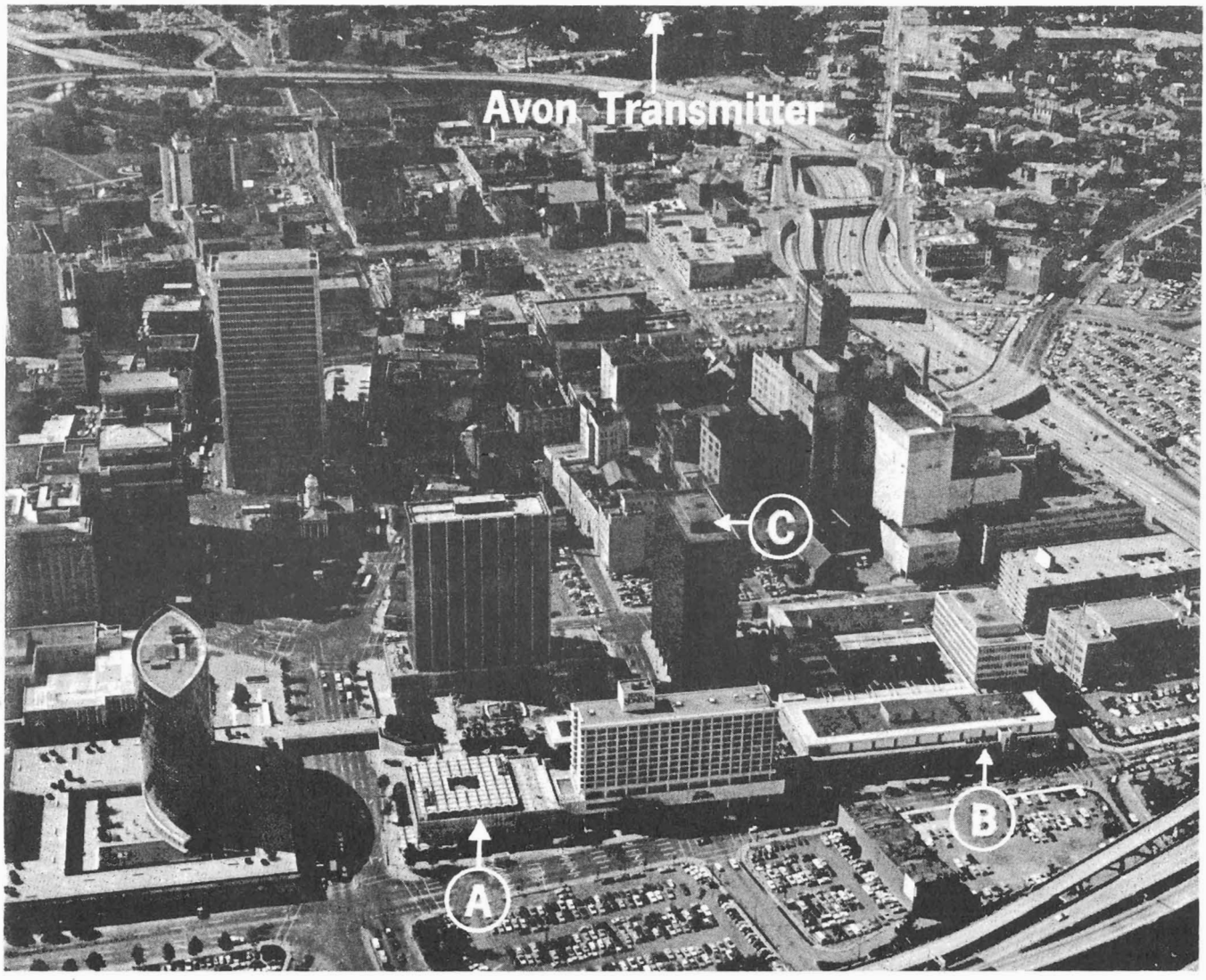

Fig. 1 Photo of downtown Hartford with WTIC-TV at "A", Travelers Weather Service at "B", and microwave receiver at "C" Avon, where the transmitter is located, is beyond the top of the picture.

Operating Weather Radar by Remote Control

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Weather radar systems are appearing in more and more television stations around the country and are no longer a novelty. However, WTIC-TV in Hartford, Conn. has recently installed a system containing a number of unique and practical features which make it of interest to other stations planning the purchase of such equipment.

What is different about the WTIC-TV installation? The RF unit is separated eight miles from the control point and operated by remote control. It also has two control terminals. Furthermore, it is believed to be the only system of its kind in the world, and one of a very few remote-controlled radars outside government or military activities.

This multi-terminal arrangement is necessary because the studios of WTIC-TV are situated in a relatively low spot surrounded by taller buildings as shown in Figure 1. These would cause severe blocking of the radar beam in three directions. Consideration of all possible sites within reasonable distance disclosed that the WTIC-TV transmitter plant eight miles west in Avon, Conn. offered the most advantages. It is the highest point in the area with unobstructed views in all directions.

The main terminal is at the Travelers Weather Service, a commercial weather forecasting service and subsidiary of Broadcast-Plaza, Inc., licensee of WTIC-AM-FM-TV. It is indicated by B in Figure 1. A second terminal arranged for television use is in studio B at Broadcast House marked by A in Figure 1.

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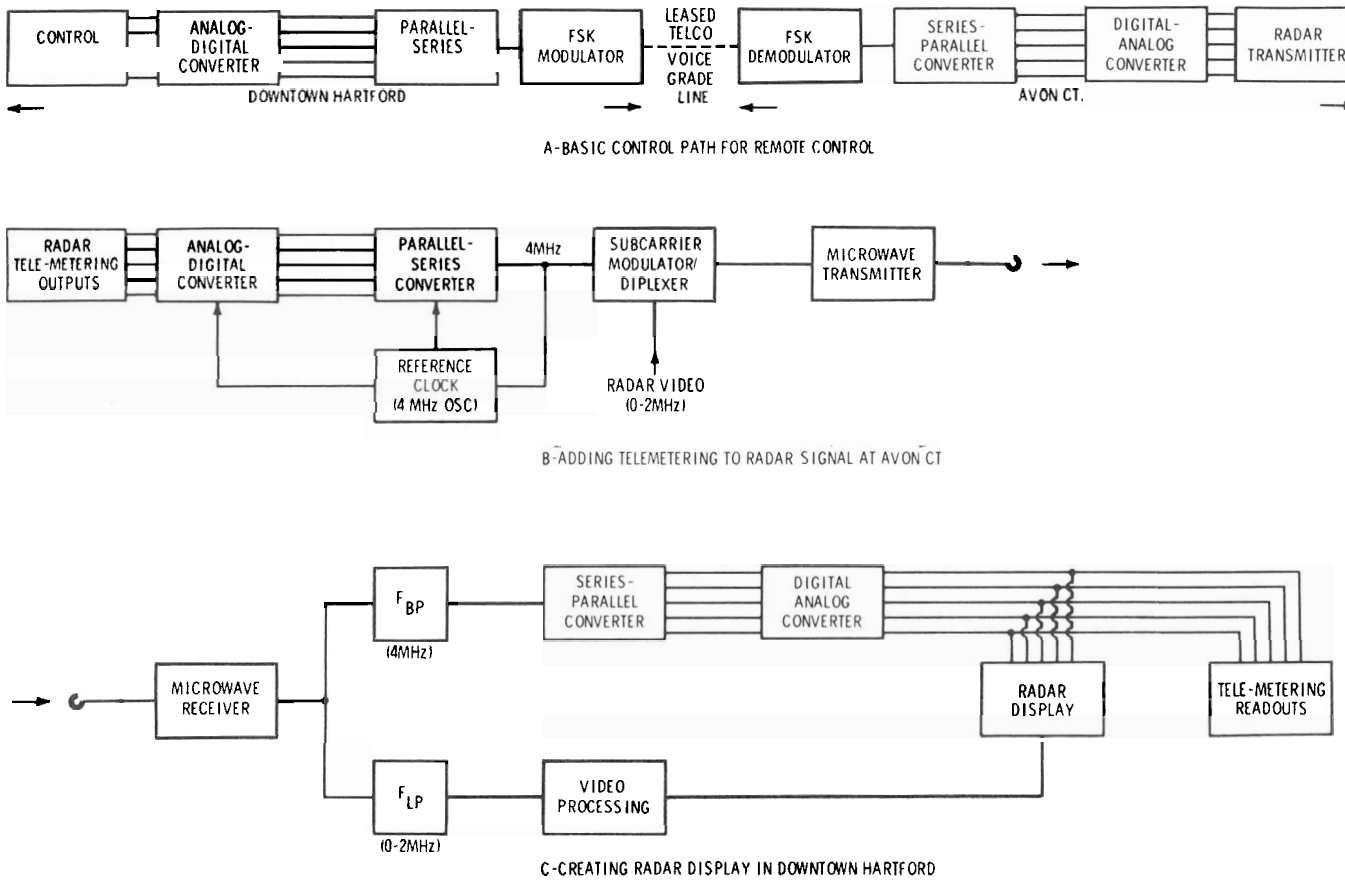

Fig. 2 Block diagram of the basic elements in the radar remote control system at WTIC-TV.

The WTIC Radar System

The remote control system which makes operation of this widely separated equipment possible, is shown in simplified form in Figure 2. The technique is to convert all analog control functions to binary coded digital form. When put in serial form, these functions can be handled by narrow band interconnecting circuits. At the far end of the circuit, a digital-to-analog conversion occurs making the functions available for direct control use.

Primary functions such as power application, elevation, azimuth, scan rate and certain mode instructions originating at either downtown terminal are carried to the transmitter at Avon, Ct. as shown in A of Figure 2. The frequency-shift keyer utilizes 1100 Hz for a binary code "O" and 2300 Hz for a "1". The voice-grade telco line has a 1200-baud capacity.

Antenna position information and certain other servo values are telemetered from the transmitter to the downtown terminals as shown at B. Basically, this consists of a regular television microwave relay system in which radar video occupies the lower 2 MHz of the channel and the digital BCD train is used to modulate a 4 MHz diplexed subcarrier.

At C of Figure 2 is the method of creating the radar display. Filters separate the two portions of the signal after which they are processed for their respective uses. In the case of the BCD bits, they pass into Digital-Synchro converters which control the servo units and Digital-Sine/Cosine converters which operate Azimuth and Elevation indicators.

The microwave receiver is located on the 18th floor of a nearby building to provide path clearance from Avon and is marked as C in Figure 1. A co-axial cable connects that point with the Weather Service terminal. A similar cable plus DC control circuits carry on from there to the studio.

The radar system is a type MR781 manufactured by Vitro Services Division of Automation Industries, Inc., Fort Walton Beach, Florida. It operates in the range 5450 to 5825 MHz with a peak power output of 250 kW. The normal pulse repetition rate is 250 PPS, but it has been necessary to modify this somewhat to avoid interaction with the bit rate of the remote control system. Pulse width is 2 microseconds.

The antenna is a six-foot dish mounted atop an unused FM tower originally 200 feet high. Waveguide connects the antenna and RF unit which is housed in a small building at the base of the tower. This arrangement is shown in Figure 3.

The remote control sub-system

Fig. 3 Radar RF system at Avon, Conn. The radome had not been installed when this picture was taken.

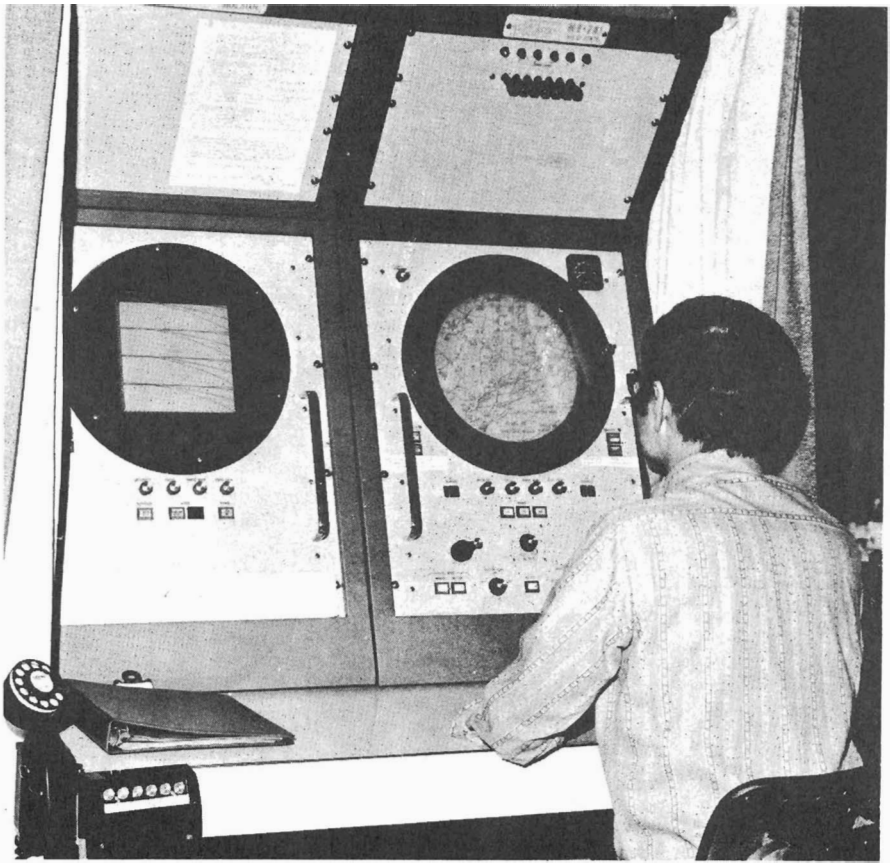

Fig. 4 Travelers Weather Service Terminal. Display at left is the Range Height Indicator (RHI) and at right is the Plan Position Indicator (PPI).

was designed and supplied by Mencom, Inc. of St. Petersburg, Florida, as a vendor to Vitro.

The main control terminal is shown in Figure 4. The right section contains the Plan Position Indicator (PPI) scope and the major operating controls. The left section has functions of special interest to the meteorologists. At top is the Amplitude Range Indicator and below it the Range Height Indicator. These two features allow investigation of specific weather phenomena useful in forecasting but which have no meaning to the television audience.

At Broadcast House the television terminal is built into the weather set in studio B as Figure 5 shows. Actually, only the control panel is visible since the PPI scope is concealed behind the set. This is possible because a vidicon camera is permanently attached to the PPI for conversion of the rho-theta ra-

Fig. 5 Studio terminal at right with camera monitor just above. The PPI and camera are behind the panel.

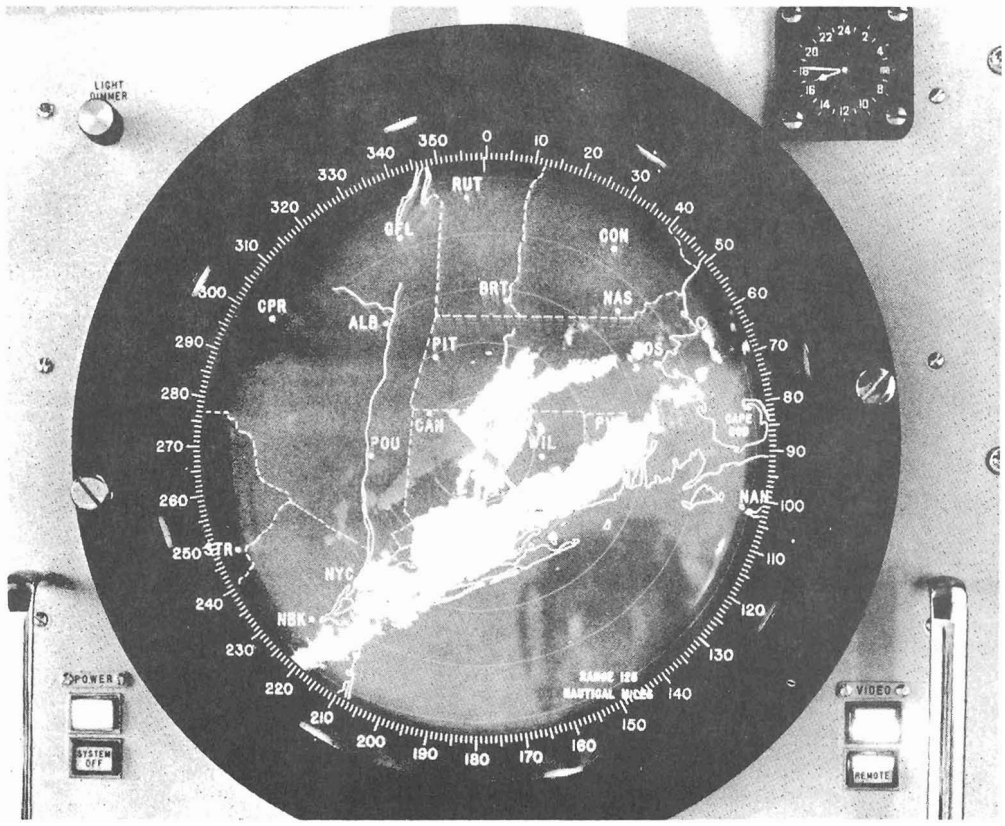

Fig. 6 Example of severe storm center displayed on PPI. The range was 125 miles.

dar scan to the X-Y television raster. The monitor visible in Figure 5 is fed from the camera output and is principally used by the forecasters in positioning a small white pointer in the picture for emphasis. The pointer, generated electronically, is controlled by a joy-stick on the panel and may be moved to any point the display requires.

Three overlays with maps outlining the area within 50, 125 and 250 miles are in place over both PPI terminals. Edge lighting illuminates the proper overlay automatically when the range selector is operated.

A recent storm center is shown in Figure 6 as it appeared on the PPI. A long persistence CRT is installed in the TV PPI terminal and a "sticky" vidicon in the camera for maximum retention of the image. Since the radar scanning rate is variable but usually between 4 and 6 RPM, it is a problem to maintain full video level for the 10 to 15 seconds between scans. Consideration is being given to using one of the high-resolution scan converter tubes available although this presents a problem with the overlays.

The FCC License

Weather radar stations are licensed by the FCC in the Industrial Radiolocation Service. Regulations for this service are contained in Subpart M of Part 91 of the FCC Rules and Regulations. Broadcast engineers faced with installing a radar should read Part 91 and Subpart M carefully because there are many differences between this part and the more familiar Parts 73 and 74.

FCC Form 400 is used to make application for the license. Since this form is used for all Safety & Special Services applications and does not pertain directly to radar installations, an engineering statement giving specific details must be supplied. Remote control features must be fully explained. If the equipment is not type accepted, additional information must be submitted.

Frequencies available for this service are listed in Section 91.604. All use is on a shared and secondary basis and every assignment by the FCC must be cleared by the Interdepartmental Radio Advisory Committee (IRAC). It would appear from our experience that an application specifying any frequency between 5600 and 5650 MHz has little chance of being granted because of primary government use.

Licenses are issued for a five-year period which is not concurrent with the broadcast license. Mark the termination date well so that renewal will not be overlooked.

The microwave station is licensed as an Intercity TV Relay. Application is made on Form 313, and about the only word of caution necessary here is that if the television station already operates an STL and one or more Remote Pickup Stations, selection of an additional frequency must be justified under the terms of Section 74.602. The emission designator for a radar with a control circuit subcarrier is F9.

Operator Requirements

Contrary to popular opinion, no Ship Radar Endorsement is required on the operator's license of the person doing the radar service for this class of station at this time. Section 91.154 (a) requires only that all transmitter adjustments or tests during installation, servicing or maintenance shall be made by the holder of a First or Second Class commercial license.

For routine operation, Section 91.154 (c) permits an unlicensed person to perform all necessary control actions such as turning power on and off, changing scanning patterns and similar functions as long as the operations do not affect power or frequency.

Section 91.160 concerns itself with Station Records and should be studied carefully to determine what kind of a log must be kept. Compared to the relaxed conditions found in some other parts of Section 91, this portion is quite strict.

The weather radar at WTIC-TV is the only one at this time in the northeast and it is proving to be a valuable device for meteorological forecasting and a TV attraction which has been enthusiastically accepted by the public. The difficulties of operating a radar by remote control under adverse conditions have been overcome and any station with a similar environmental problem may now consider the benefits of radar without concern.