Evaluation of Closed-Circuit Standard Television for ARTC Sector Coordination

By

Russell M Andrew
Thomas S Wonnell
Fred S. McKnight

Navigation Aids Evaluation Division

TECHNICAL DEVELOPMENT REPORT NO. 307

CIVIL AERONAUTICS ADMINISTRATION
TECHNICAL DEVELOPMENT CENTER
INDIANAPOLIS, INDIANA

October 1958

U. S. DEPARTMENT OF COMMERCE
Sinclair Weeks, Secretary

CIVIL AERONAUTICS ADMINISTRATION
James T. Pyle, Administrator
D. M Stuart, Director, Technical Development Center

TABLE OF CONTENTS

	Page
SUMMARY	1
INTRODUCTION	1
TEST ENVIRONMENT	1
EQUIPMENT	1
OPERATIONAL TESTS	4
CONCLUSIONS	5
APPENDIX A	6

This is a technical information report and does not necessarily represent CAA policy in all respects

EVALUATION OF CLOSED-CIRCUIT STANDARD TELEVISION FOR ARTC SECTOR COORDINATION*

SUMMARY

This report describes evaluation tests of an industrial-type closed-circuit standard television system for data transfer and controller coordination in the Indianapolis Air Route Traffic Control Center The equipment permitted a controller at one sector to view fix-posting strips for an adjacent fix which were posted on a sector board located across the control room A maximum of five strips in one bay could be read at one time Because of limitation in system resolution and sensitivity, the equipment was not satisfactory for traffic-control purposes.

INTRODUCTION

During an air traffic controller's conference held at the CAA Technical Development Center (TDC) in Indianapolis from August 21 to 23, 1956, several possible improvements in traffic control methods were suggested Among the techniques suggested was the use of closed-circuit television for coordination It was believed that such a system might be used for transferring flight data and for controller coordination between sectors within an Air Route Traffic Control (ARTC) Center, between two or more Centers, and between Centers and control towers

Because TDC had available industrial-type closed-circuit television equipment, arrangements were made with the Indianapolis ARTC Center to conduct an in-service test in the operating Center The equipment was installed and operated for approximately 90 days, starting in September 1956

TEST ENVIRONMENT

Discussions with Indianapolis ARTC Center personnel indicated that one of their data-transfer and coordination problem areas results from Sector 7 (Evansville Sector) being located across the room from Sector 12, (Louisville Sector) The portions of the Indianapolis ARTC area controlled by these two sectors are adjacent, but due to physical limitations in the Center quarters, the controllers cannot be placed in close proximity or adjacent to each other As a consequence, it is necessary to use interphone or to hand-carry flight strips from one sector to the other to pass flight data In addition, coordination is required on almost all flights operating between the two sectors The problems involved and the physical arrangement of the sectors appeared to offer an excellent environment for testing an intracenter television system Accordingly, a one-way closed-circuit television system was installed.

EQUIPMENT

The camera system used for the data transfer tests consisted of an industrial television camera, Model PD-150, manufactured by the General Precision Laboratory, Inc , of Pleasantville, New York The equipment consisted of two units, a camera and a control unit, with the following manufacturer's specifications

System	525 lines, 60 fields interlaced
Resolution	500 lines
Signal Outputs	Composite video, 1 4 volt peak-to-peak across 75 ohms
	Modulated r-f 0.1 volt across 75 ohms
Power Requirements	105 to 125 volts a-c, 60 cps, 180 watts

---

*Reprinted for general distribution from a limited distribution report dated April 1957

Fig. 1 Vidicon Television Camera Installation

Weight	Camera, 5 pounds, control unit, 26 pounds	
Dimensions	Camera, 9 by 5 1/4 inches, control unit, 17 1/2 by 14 1/2 by 8 inches	
Tube Complement	8 - 6U8	1 - 6AQ5
	4 - 12AU7	1 - 6BQ7A
	3 - 12AT7	1 - 0A2
	1 - 6AL5	1 - 6198 Vidicon

Figure 1 shows the camera installation above the flight progress board used to scan the Evansville fix postings The composite video and sync output of the television camera equipment was transmitted to a studio-type television monitor by use of a coaxial cable

Figure 2 shows the monitor installation at the Louisville Sector The monitor was a Conrac television monitor, Type CB17A, manufactured by Conrac, Inc., Glendora, Calif. The CB17A monitor is a complete, self-contained television monitor using a 17BP4 kinescope which may be operated from a single coaxial cable carrying composite video and sync, or from two separate lines, one carrying video and one carrying composite sync. The monitor is constructed for standard rack mounting, and all controls and operating adjustments are accessible from a front panel through a trap door Technical features of the monitor are

Power	117 volts, 60 cps, 200 watts.
Video Signal Required	0 5 volt peak (minimum required for 50 volts at the kinescope grid)
Sync	Negative.
Separate Sync (if used)	1 volt minimum, sync pulses negative
Video-Input Impedance	1 High impedance for bridging--approximately 270,000 ohms in parallel with 15 micromicrofarad (mmfd).
	2 75 ohms terminating resistance, with switch on rear apron

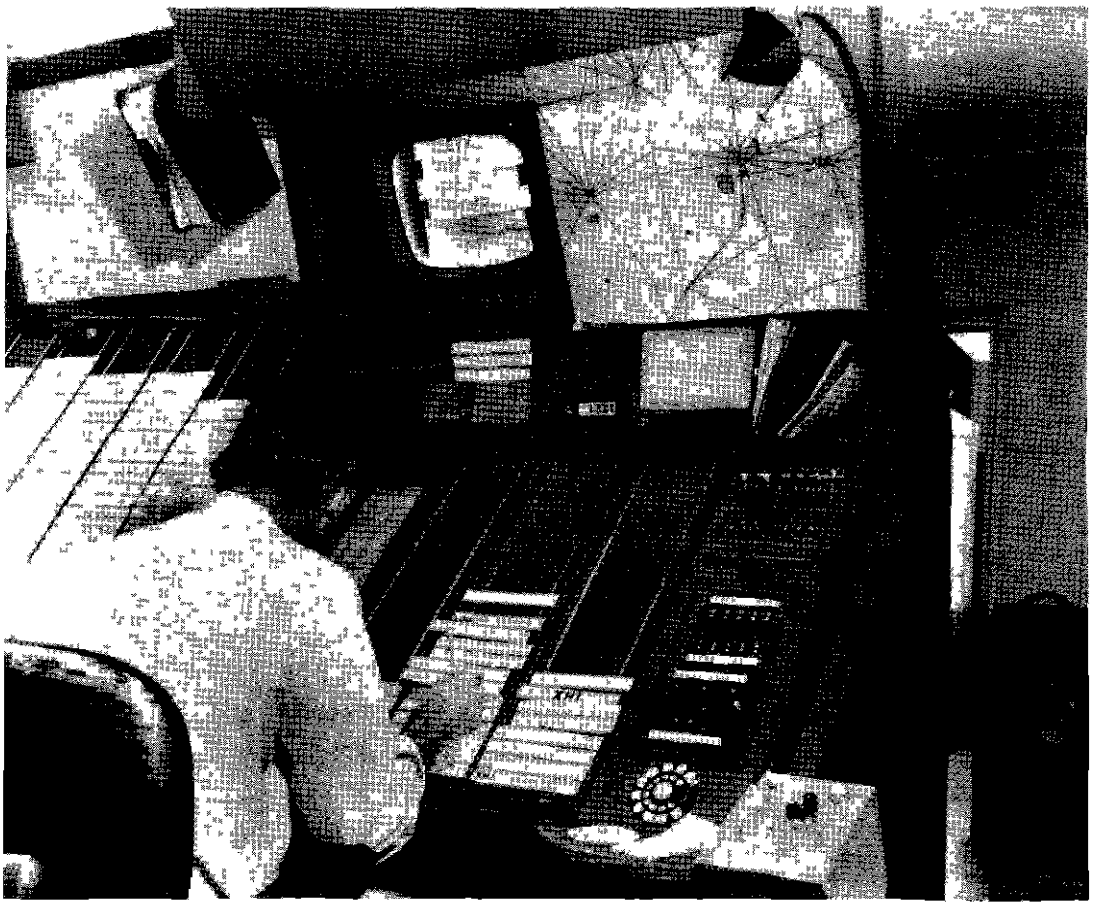

Fig. 2 Television Monitor Installation

Video-Frequency Response	Flat ±1 db to 6.5 Mc, with gradual roll-off characteristic.	
Tube Complement	2 - 6AU6	1 - 6AL5
	3 - 6SN7	1 - 6W6
	1 - 6BY6	1 - 6CD6
	1 - 6CL6	1 - 1B3
	1 - 5U4	1 - 6AU4

Because of limitations in resolution of the system, it was not possible to read more than five strips at one time During the early part of the test the camera was supported in a fixed position which permitted only the lower section of the Evansville board to be scanned It soon became evident that this arrangement did not provide sufficient coverage of the Evansville fix postings for the Louisville Sector. To overcome this difficulty, an elevation control system for the camera was installed. By means of a hand crank on a synchro mechanism at the Louisville Sector, the camera could be operated to scan the Evansville flight progress board in its entirety The Louisville controller usually was required to move the camera each time he desired to check information on the Evansville board.

The monitor was installed originally on a small table adjacent to the Louisville flight progress board with the television monitor screen at the same level as the strips on the flight progress board. This location required the controller to turn his head away from the board whenever he scanned the television display. Controllers generally did not like this location An opening then was cut out of the map board and the monitor was moved to a position above the flight progress board This was considered to be a more desirable location by most of the controllers A lamp and switch system also was installed to provide an alerting and acknowlegment signal for new information to be transferred.

Periodic checks of the equipment twice a day, to peak the resolution and adjust the contrast of the camera system, and adjustment of the TV monitor display appeared to be inadequate because the monitor was readable only about 50 per cent of the time.

A measure of the ambient room lighting at the Evansville Sector indicated an average illumination of 14 5 foot-lamberts from blue strips and 18 foot-lamberts from the buff strips To overcome lack of system sensitivity and to improve contrast, control personnel were asked to use No 1 pencils for marking flight strips These are not satisfactory for normal use because they are too soft Supplemental flood lamps also were installed above the board for additional lighting, however, these were found undesirable because of the additional heat Both the darker pencil markings and the additional illumination improved system readability Even with improved contrast, the system resolution did not permit reading small characters written on flight strips if more than five or six strips were displayed.

OPERATIONAL TESTS

After the system had been operating for several weeks, a specific operational evaluation program was developed with the ARTC Center A memorandum was issued by the chief controller to Indianapolis ARTC Center personnel outlining the types of flight data transfer and controller coordination which could be effected by use of the television system

The Louisville Sector could obtain the following information by television from the Evansville fix postings for eastbound flights entering the Louisville Sector

1. New flight plans
2. Changes in Evansville estimates
3. Changes in altitude assignments.
4. Actual times of flights over Evansville with the Louisville estimate
5. Control release information authorized by the Evansville controller.

To alert the Louisville Sector to new information posted at Evansville, the following system was used

1 When a change was made on an existing Evansville strip, or when a new flight strip was added to the Evansville board, the Evansville Sector personnel would tilt the strip to the right and turn on the alert-signal lamps.

2. The Louisville Sector personnel would copy the revised data from the television monitor, turn off the signal lamps, then acknowledge the information via interphone in short form, such as "Roger, 5000 on Eastern 402" or "Roger, flight plan Air Force 1234."

3. After acknowledgment was received, the Evansville Sector personnel would align the strip.

In addition, the television system could be used to reduce certain controller coordination. After scanning the Evansville fix postings, the Louisville Sector controller could clear aircraft departing from Louisville to or over Evansville, or he could approve changes in altitude for westbound flights proceeding into the Evansville Sector, without prior interphone coordination with the Evansville controller In these cases, the Louisville controller scanned the Evansville fix postings with the television system to determine vacant altitudes at the time desired prior to taking such control action. Immediately after issuing the clearance, the Louisville controller would forward the new flight data or change in altitude by interphone to the Evansville Sector

From a safety standpoint, it was necessary that the Louisville Sector controller study all of the strip postings on the Evansville board before taking a control action affecting flights proceeding into the Evansville Sector. Several conditions slowed the study of these postings

1. Readability was generally poor on the monitor
2. At times, personnel working at the Evansville board blocked the viewing camera
3 Cranking the remote-elevation control was necessary when there were more than five strips posted on the Evansville board

These delaying factors required so much of the Louisville controller's time that the controllers believed prior coordination by interphone was faster and safer than using the television display

At the end of the 90-day test period, a questionnaire was circulated among the controllers of the Center Twenty-seven of the questionnaires were returned A copy of the questionnaire, with a breakdown of controller replies, is included in Appendix A. A brief summary of the results follows

1 Of the controllers answering the questionnaire, 79 per cent indicated that the closed-circuit television system tested was not adequate to obtain data on estimates, altitude assignments, actual "over-fix" times, control-release information, or new flight plans for eastbound flights from the Evansville Sector to the Louisville Sector

2 Sixty-one per cent of the controllers believed that the television system was not adequate for clearing westbound departures from Louisville over Evansville or for changing altitudes on westbound flights without prior coordination

3 The replies indicated that personnel were evenly divided in their opinions as to whether a perfectly readable system would be equal to or worse than the present interphone system for transferring flight data from one sector to another

4 Almost one-half (48 per cent) of the controllers thought that the necessary scanning of the monitor required more time than interphone transfer of information Written comments indicated that during heavy traffic conditions, time did not permit the controller to scan another sector board on the television monitor and watch his own flight progress board also

CONCLUSIONS

The industrial-type, closed-circuit television system tried in the Indianapolis ARTC Center during the test was not satisfactory It is believed that standard television systems have inadequate resolution for this purpose

APPENDIX A

TDC/IND ARTCC

November 30, 1956

SUBJ Controller Questionnaire on Closed-Circuit TV Tests

Please indicate your opinion of the use of the closed-circuit TV system by answering the following questions

Your comments or recommendations are invited

1 Was the closed-circuit TV system adequate for transferring data in the following categories as listed in the Center Memo of October 15, 1956?

	(Number of Personnel Answering of 27 Replies Received) Adequate	Not Adequate
(a) Changes in EVV estimates.	4	20
(b) Changes in altitude assignments	4	19
(c) Forwarding actual time over EVV with the LOU estimate	4	21
(d) Transfer of control release information from the EVV sector to the LOU sector for flights landing at LOU	2	24
(e) Forwarding new flight plans posted at EVV	2	23

2 Was the closed-circuit TV system adequate for controller coordination between the LOU and EVV sectors as listed below (same Center Memo)?

(a) Westbound flights departing from LOU may be cleared to, or over, EVV by the LOU controller after he reviews the postings at the EVV fix without prior coordination with sector 7	5	16
(b) Westbound en route flights in the LOU sector may be cleared to change altitude by the LOU controller, after he reviews the EVV fix without prior coordination	4	17

3 If we had a perfectly readable system for exchange of data, do you think visual data transfer of information is better, equal to, or worse than voice data transfer and coordination used today?

Better	Equal	Worse
3	10	13

4. Do you feel the advantage of using this system to eliminate "waiting time" on the interphone, when the called sector is busy on another line, outweighs any disadvantages noted?

Yes	No
6	17

5 Does the periodic scanning of the Evansville board on the TV require more time than would be used with interphone?

13	10
Yes	No

6 When working the LOU sector, was the attention lamp and cocked strip on the EVV board for new or revised information adequate to call your attention to new information?

18	5
Yes	No

7 Is it feasible to transfer any type of control information on the TV without acknowledgment?

5	19
Yes	No

8 Would a signal light provide a satisfactory acknowledgment?

11	9
Yes	No

9 Did the TV display

(a) Have sufficient brightness?	15	8
	Yes	No
(b) Have sufficient contrast?	11	12
	Yes	No
(c) Have adequate readability for five or six strips?	4	17
	Yes	No

10 (a) Was the servo scanning device for the camera TV pickup adequate for scanning the EVV board?

11	14
Yes	No

(b) If answer is no, would a faster action scanning device be satisfactory?

8	4
Yes	No

(c) If answer to 10(b) is no, do you feel a view of all strips on the EVV board, without any scanning with the camera, would have made the closed-circuit TV system satisfactory?

6	8
Yes	No

11 Do you feel that the closed-circuit TV system was adequate for

(a) Light traffic?	15	6
	Yes	No
(b) Moderate traffic?	5	15
	Yes	No
(c) Heavy traffic?	0	18
	Yes	No

12 Have you any suggestions for other uses of closed-circuit TV in IND ARTCC?

Such as between, other pairs of sectors, Indianapolis and another Center, IND ARTC and IND approach control If so, please list suggestions on the attached sheet

(Of the personnel, 22 made no comment on this item The others made various comments, such as

"Not practicable
"Not until better equipment available
"I would suggest a camera at Patterson (Air Force Base) Approach Control and a monitor in the Indianapolis Center
"Indianapolis ARTC and Indianapolis Approach Control ")

13 If closed-circuit TV were to be installed between the IND Center and Approach Control, which of the following applications would you recommend.

Circle one or more

(a) Camera in Center viewing inbound strips Monitor in Tower 9

(b) Camera in Tower viewing approach fix and departure strips Monitor in Center. 3

(c) Both (a) and (b) 5

14 If it were possible by means of closed-circuit TV for you to view strips posted at several adjacent sectors, would you prefer to do this by using two or more TV monitors at your board (one for each pickup camera), or by using one monitor and a selector switch by which you could select any of the cameras?

(a) More than one monitor 3

(b) One monitor with switch 14

15 Please indicate any comments or remarks on factors not covered in the above questions on the attached sheet