Two-Way Radio on Construction

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● SEVERAL YEARS AGO, it was anticipated what the impact of the accelerated highway program would be on the construction program of the Ohio Department of Highways. One of the measures to combat this was installation of a two-way radio system, the advantages of which are outlined herein. These advantages cannot be assigned to construction alone, however, as the system is equally important to maintenance and other phases of highway work.

With interstate highway construction, general construction, maintenance and improvements running at an accelerated pace, in addition to emergency operations emanating from adverse weather and road conditions, the two-way radio has proved invaluable.

Maintenance and adjustments of this system are the responsibility of the Bureau of Communication, which also is responsible for maintenance of the electronic units, teletype, telephone, etc.

In planning the radio system, the Ohio Department, like many others, was confronted with the scarcity of funds for such an installation and system, and the ever-present question or doubt as to whether or not the system would pay for itself, and if it would do the job for which it was intended. In fact, there was a three-phase construction and installation program, with the installation of radio equipment first in one county, later in 11 additional counties, and finally in the 76 remaining counties.

In 1951, radio equipment was installed in one county located in the snow-belt area of the state, consisting of a base radio station and 18 mobile units, to be used primarily in the snow and ice removal operations on a trial-and-error basis.

In 1954, the Construction Bureau requested the installation of a two-way radio system on a statewide basis. This request was made only after experience indicated that it would far more than pay for itself in a short period of time. The Maintenance Bureau was then called in for consultation, and indicated readiness to proceed.

After some discussion, $500, 000 was allocated for installation in the most critical areas, these to be determined by both Construction and Maintenance.

The heavy construction at that time happened to be in the heavy snow-belt area in northeastern Ohio, so there was no doubt as to where to start. This first installation comprised an 11-county area. The program then was to proceed to the next critical area for installation as the funds became available.

During this period, Civil Defense came into the picture. After several meetings with them, it was agreed that they would help finance the whole program on a matched-fund basis. This made it possible to proceed immediately with statewide coverage. In addition to the Department radio system, the network is also in direct radio contact with the headquarters and five area control centers of the Ohio Civil Defense Corps. It should also be pointed out that in the near future radio contact will also be established with the Ohio State Highway Patrol, this contact to be used for emergency purposes.

Without attempting to explain the many details encountered during the three different installation periods, mention should be made of over-all planning and operation of the system now consisting of 2, 112 mobile units in operation in all 12 divisions and all 88 counties of the state. Also in operation are 91 permanent base radio stations, antenna support structures and associated equipment located at each division headquarters and county garage, and the 72 portable base stations and the 72 portable telescopic towers which can be extended to 60 ft including the antenna. These portable radio stations and antenna support structures or towers are used by the Division of Construction and can be placed in operation on construction projects in a matter of hours. Due to the tremendous construction program, the portable radio equipment is being used in all 12 divisions.

The Ohio Department of Highways employs the use of leased private line teletype equipment, with contact between Central Headquarters and the U.S. Weather Bureau, and between Central Headquarters and Division Headquarters, as well as inter-division teletype contact over which is transmitted directives, instructions, lengthy messages of all types as well as weather forecast information used by all divisions in their year-round operations. The radio system was, therefore, designed to receive and transmit short messages and dispatches on a time necessity or emergency basis, according to the situation or the work at hand. Absenteeism, payrolls, sick leave, vacation information or records, material records, and other information not requiring immediate attention are transmitted by other means of communications. Although no claim is made to perfect operation procedures, a constant attempt is made to supervise and eliminate bad procedural practices.

The two-way system affords station-to-station, station-to-car, car-to-car, and car-to-station contact. In Ohio this system is operated under the so-called "closed" or "controlled" radio net, with each county station requesting permission or "clear" from its respective division control station before transmitting during the period the division net is under the control of dispatcher personnel. Dispatchers are on duty at each division control station from 8:00 A.M. to 5:00 P.M., Monday through Friday — except in emergencies, when they return to duty; and except from December 1 to April 1, when the division nets are controlled 24 hrs daily during snow and ice removal operations. Each county radio station is operated by the county superintendent, the timekeeper, or by other county garage personnel. After the normal work day, the county mechanic, night watchman, or other assigned personnel on duty, will answer a radio call. Amplifiers and speakers have been installed in the main county garage area so that night personnel can carry on with their usual work, thereby eliminating the necessity of being at the immediate location of the control of the transmitting equipment. All personnel operating any type of radio equipment meet the license or permit requirements of the Federal Communications Commission. Dispatchers are on duty 24 hrs per day at the central control station in Columbus and can be contacted by radio, teletype, or wire phone for the immediate transmission or delivery of important information to staff personnel for decision or necessary action.

Surveys were conducted in all counties for the location of antenna support structures, base stations, and associated equipment; and proper papers were filed with the Federal Communications Commission. With a few exceptions due to surrounding terrain, nearness to airport facilities, or other restrictions, the support structures were installed on state-owned property. The Division Headquarters guyed-tower structures average 240 ft in height. The steel-pole antenna support structures at the county garage locations average 100 ft in height. Specifications were written for all support structures, base and portable transmitting stations, mobile units, antennas, transmission lines, remote control units, component parts, and associated equipment. It might be mentioned that all of the equipment is of the narrow-band type and meets the specifications of the Federal Communications Commission and the Federal Civil Defense Administration, except for the one base station and 18 mobile units installed in 1951, which have wide-band equipment, eventually to be modified or replaced.

Requisitions for the last installation covered 58 antenna support structures, 58 base stations and 1,350 mobile units, all to be installed under contract with the exception of 400 mobile units, which were installed by the Department's technical personnel. This installation period covered four months and four days of a seven-month time limit contract. An attempt was made to coordinate requisitions for equipment, so that delays would not be encountered. Antenna and transmission line delivery was coordinated with the arrival of the steel support poles, and were fastened by the Department's technicians to the poles while on the ground prior to their erection by the contractor, thereby eliminating the expense of steeplejack service.

Radio equipment installation was coordinated so as to complete one division at a time for the last seven divisions, with approximately eight base stations and 180 mobile units per division, under the supervision of the engineering staff to insure good workmanship and uniformity of installation.

Mobile radio units were installed in the cars of supervisory personnel, necessary maintenance trucks, construction trucks, station wagons, etc.

Much of this equipment is transferable. As the construction season slows down late in the fall, maintenance needs become greater with approach of the snow and ice control season. Radio-equipped construction trucks are then released to Maintenance for this period. Likewise, in the spring construction resumes and maintenance equipment is released to Construction.

Because Radio Operating Procedure Manuals were presented to the personnel who would operate radio station and mobile equipment ahead of the radio installations, with instructions to acquaint themselves with the contents of the manual, it was only necessary to hold short classes of instruction as each person presented his vehicle for installation. As each base station was placed in operation, instructions were given to county superintendents, timekeepers and other county personnel without taking them from their immediate duties. Although it was realized that these short periods of instruction would not be sufficient, they were followed up by the regular division radio personnel and are continuing, due to employment of additional personnel because of work expansion and normal employee turnover.

The mobile units are held to their own frequencies by a spring switch, thus assuring normal use only on the assigned frequency. To use the other frequency, they must hold the switch during this period; upon completion, the switch will automatically return to the proper frequency. By "designated" frequency, it is meant that approximately 1,500 maintenance vehicles are designated to use the 47.22-mc or Channel A frequency, whereas approximately 600 construction vehicles are designated to use the 47.34-mc or Channel 3 frequency. Because the assignment of vehicles to the two frequencies is out of proportion, the 47.34-mc frequency is also used for point-to-point operations. In tabulating the amount of traffic handled over each frequency, a difference of only 0.5 percent is noted for 1958. However, with the amount of equipment in operation, and with some possible expansion, a third frequency is highly desirable.

With consideration given to the monetary value of the radio system and the necessity of keeping maintenance costs at a minimum, the following program was instigated and placed under constant observation and supervision:

1. Uniformity of installations. A set pattern of installation is followed.
2. Uniformity of maintenance. The equipment is installed, maintained and repaired by schooled technicians of the Department. Altering or changing of radio equipment is not permitted unless authorized by the office of the Bureau of Communication.
3. Preventive maintenance. It is mandatory that all equipment be checked as completely as possible, at least every 120 days. The normal rough work encountered by highway department vehicles makes this type of operation a necessity.
4. Uniformity of operating procedure. A continuous program of instruction in operating procedure is maintained.
5. Cleanliness of equipment. In addition to radio equipment, a check is also made for the cleanliness of test equipment, tools, workshop, office, and motor vehicles, all of which are the property of the Department and the State of Ohio.
6. Uniformity of stockpiling of spare parts. Stocking of a reasonably safe margin of parts, no more, no less, is required. This requirement is given guidance by periodic inventories.

Although it is practically impossible to pinpoint the tremendous savings to the Department made possible by the use of radio, the following factors are given as being responsible for these savings:

1. Close and continuous control of all maintenance and construction.
2. Immediate contact between headquarters and division personnel, and between supervisory and subordinate personnel. At each division headquarters, both the Engineer of Maintenance and the Engineer of Construction have remote desk units, giving them immediate contact with their many projects and personnel.
3. Coordination and efficient utilization of all personnel and equipment.
4. Coordination of materials.
5. Prompt dispatch and constant contact with snow and ice removal equipment.
6. Constant flow of weather forecast and road condition information for departmental and public use.

7. Direction of and reports from personnel in the event of an emergency.
8. Immediate reporting of accidents, fires, plane crashes, flood conditions, etc., for immediate action or notification to proper authority.

The tremendously heavy construction seasons of 1957 and 1958 and the years immediately ahead have made it necessary for the construction field engineers and division construction and field engineers to conserve their time to the utmost in order that they may be where they are needed with the least lost time. Utilization of the short-wave radio in receiving reports and spotting personnel has been an invaluable aid in accomplishing this. From repeated observations, it is known to work like this:

The construction field engineer determines which division he plans to visit for a specified time. By radio, a message is immediately sent to the division construction engineer inquiring as to the best place to rendezvous. The answer is received enroute and a meeting place is arranged. The division base station contacts the project engineer to advise him of the proposed meeting and asking him to be present. In this manner, the three engineers are able to meet at the pre-arranged place with a minimum of lost time. Car-to-car contact is made as each approaches to make sure that no delay has occurred to anyone. It is amazing how closely a meeting can be coordinated by this method.

Where a number of projects are located in one area, a base station is set up at one of the project offices as near the center as possible. An office man, whose major assignment is the keeping of records, is on duty at all times. Contact between the various project engineers and inspectors is practically instantaneous. Field parties are moved in minutes as the need develops.

During the season when bituminous concrete is being laid, the use of the radio in placing and maintaining plant personnel is invaluable. The division construction engineer is contacted many times a day and is able to keep on top of the situation by radio enroute between projects, with a considerable saving of time. In some divisions, where ten or more bituminous concrete plants are in simultaneous production, contact by any means other than radio would be so time-consuming and restrictive as to be prohibitive.

Contact between the project engineers and the division construction engineer on any matter, particularly one requiring Central Office decision, is rapid and time-saving. If it is determined in the field that piling penetration specified cannot be obtained, the project engineer radios the data to the division. In a matter of minutes, this information is forwarded to the proper person in the Central Office, a decision is made, and the answer is relayed to the project through the division.

Test reports on material to be incorporated into the work are dispatched more readily. One could go on and on relating advantages; there seems to be no end.

These are but a few specific examples of the field use of two-way radio as a time saver. In order to utilize the limited number of personnel to the best advantage in administering the unprecedented volume of construction work, the radio is an important and necessary tool.

Two-way radio makes possible an increased volume of work and projects without correspondingly increasing the number of skilled and experienced engineers and personnel. One man can exercise efficient control over many more projects in a greater area with the use of radio than was previously possible.

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