UNITED STATES DEPARTMENT OF AGRICULTURE
Rural Utilities Service

BULLETIN 1751F-640

SUBJECT: **Design of Buried Plant - Physical Considerations**

TO: All Telecommunications Borrowers
RUS Telecommunications Staff

EFFECTIVE DATE: Date of Approval

EXPIRATION DATE: Seven years from effective date

OFFICE OF PRIMARY INTEREST: Outside Plant Branch, Telecommunications Standards Division

PREVIOUS INSTRUCTIONS: This bulletin replaces RUS Telecommunications Engineering & Construction Manual (TE&CM) Section 640, Design of Buried Plant - Physical Considerations, Issue 4, dated May 1973 and File With, dated June 1967.

FILING INSTRUCTIONS: Discard RUS Telecommunications Engineering & Construction Manual (TE&CM) Section 640, Design of Buried Plant - Physical Considerations, Issue 4, dated May 1973, and File With dated June 1967, and replace it with this bulletin. File with 7 CFR 1751 and on RUSNET.

PURPOSE: This bulletin provides RUS borrowers, consulting engineers, contractors and other interested parties with information on the design and construction of buried plant facilities.

Wally Beyer	3/3/95
Administrator	Date

TABLE OF CONTENTS

TABLES & FIGURES

INDEX:
Outside Plant
Design
Telecommunications

ABBREVIATIONS

BFC	Buried Filled Cable Assembly Unit
BFO	Buried Filled Fiber Optic Cable Assembly Unit
CATV	Community Antenna Television
LD	Loan Design
NEC	National Electrical Code
NESC	National Electrical Safety Code
P	Suffix for a Predesignated Area Assembly Unit
R/W	Right-of-way
RUS	Rural Utilities Service
SAVE	Serving Area Value Engineering
STMP	State Telecommunications Modernization Plan
TE&CM	Telecommunications Engineering and Construction Manual

DEFINITIONS

BFC: A buried filled cable assembly unit which includes all the material and labor costs to plow or trench and backfill 1,000 feet (304.8 meters) of filled buried copper cable.

BFO: A buried filled fiber optic cable assembly unit which includes all the material and labor costs to plow or trench and backfill 1,000 feet (304.8 meters) of filled buried fiber optic cable.

P: A assembly unit suffix which informs the contractor that installation in that particular area will be much more difficult

than normal because of the presence of underground facilities or severe right-of-way restrictions.

Loan Design: A comprehensive engineering plan for the project used to support a loan application to RUS.

Resident Engineer: The representative of the Engineer who is delegated full time "on site" engineering responsibilities for construction administration.

RUS accepted (material and equipment): Equipment which RUS has reviewed and determined that:

a. Final assembly is conducted within the United States, Mexico, or Canada or any of their territories and the cost of components within the material or equipment which are manufactured within the United States, Mexico, or Canada, or any of their territories, cost more than 50 percent of the total cost of all components utilized in the material or equipment, and

b. The material or equipment is suitable for use on systems of RUS telephone borrowers.

RUS technically accepted (material and equipment): Equipment which RUS has reviewed and determined that:

a. Final assembly is not conducted within the United States, Mexico, or Canada, or any of their territories, or the cost of components within the material or equipment which are manufactured within the United States, Mexico, or Canada, or any of their territories, cost 50 percent or less than the total cost of all components utilized in the material or equipment, and

b. The material or equipment is suitable for use on systems of RUS telephone borrowers.

1. GENERAL

1.1 This bulletin discusses in particular the design of buried plant using filled copper cables, filled copper wires, and filled fiber optic cables. The information and recommendations in this bulletin are advisory.

1.2 Buried plant refers to telecommunications copper cables, copper wires, and fiber optic cables that are buried directly in the ground by plowing and/or trenching.

1.3 Additional information for the use in the design and construction of buried plant facilities can be found in following Rural Utilities Service (RUS) documents:

a. Telecommunications Engineering and Construction Manual (TE&CM) Section 116, Plant Engineering and Record System, (Proposed conversion to RUS Bulletin 1751B-101);

b. TE&CM Section 210, Telephone System Design - Sizing Criteria (Proposed conversion to RUS Bulletin 1751B-204);

c. TE&CM Section 218, Plant Annual Cost Data for System Design Purposes (Proposed conversion to RUS Bulletin 1751B-230);

d. TE&CM Section 219, Present Worth of Annual Charge Studies for System Design (Proposed conversion to RUS Bulletin 1751B-230);

e. TE&CM Section 230, General Principles of Feeder - Distribution Cable Engineering (Serving Area Value Engineering(SAVE)) (Proposed conversion to RUS Bulletin 1751B-230);

f. TE&CM Section 231, Design Techniques of Feeder - Distribution Cable Engineering (SAVE) (Proposed conversion to RUS Bulletin 1751B-230);

g. TE&CM Section 232, Transmission Design Cost Considerations of Feeder - Distribution Cable Engineering (SAVE) (Proposed conversion to RUS Bulletin 1751B-230);

h. TE&CM Section 424, Design Guideline for Telecommunications Subscriber Loop Plant (Proposed conversion to RUS Bulletin 1751B-101);

i. TE&CM Section 628, Plastic-Insulated Cable Plant Layout (Proposed conversion to RUS Bulletin 1751F-628);

j. TE&CM Section 629, Cable Plant Layout - Serving Area Concept for Rural Systems (Proposed conversion to RUS Bulletin 1751F-629);

k. TE&CM Section 641, Construction of Buried Plant (Proposed conversion to RUS Bulletin 1751F-641);

l. TE&CM Section 648, Serving Area Value Engineering (SAVE) (Physical Plant) (Proposed conversion to RUS Bulletin 1751F-648);

m. TE&CM Section 816, Electrical Protection of Buried Plant (Proposed conversion to RUS Bulletin 1751F-815);

n. RUS Bulletin 345-150, Specifications and Drawings for Construction of Direct Buried Plant, Form 515a (Proposed conversion to RUS Bulletin 1753F-001);

o. RUS Bulletin 344-3, "Buy American" Requirement, as amended by the North American Free Trade Agreement Implementation Act (NAFTA Act);

p. RUS Bulletin 1751F-642, Staking of Buried Plant

q. RUS Bulletin 1751F-670, Outside Plant Corrosion Considerations);

r. RUS Bulletin 1751F-801, Electrical Protection Fundamentals;

s. RUS Bulletin 1751H-601, Lightwave Fundamentals;

t. 7 Code of Federal Regulations (CFR) 1751, Subpart B, State Telecommunications Modernization Plan;

u. 7 CFR 1753.6, Standards, Specifications, and General Requirements; and

v. 7 CFR 1755.200, RUS Standard for Splicing Copper and Fiber Optic Cables.

2. APPLICATION

2.1 Buried plant facilities offer certain advantages over aerial and underground plant (in conduit) facilities, and are more economical on a first cost basis. Exceptions where this economic advantage may not be realized are in urban and suburban areas or extensive rock formations. In these areas, a combination of buried and aerial plant facilities may prove to be the most economical construction for the system. In certain situations, the use of underground plant facilities in conjunction with buried plant facilities may be advantageous. For these type

applications, refer to RUS TE&CM Section 643, Underground Conduit and Manhole Design and Construction (Proposed conversion to RUS Bulletin 1751F-643).

2.2 Since buried plant facilities are exposed to less physical damage than aerial plant facilities, fewer cable or wire faults are associated with buried plant facilities. This lower fault rate results in longer periods of maintenance-free operation and greater subscriber satisfaction. Buried plant facilities should be used in those areas susceptible to frequent ice storms and/or high wind velocities.

2.3 Permission from appropriate authorities should be obtained before burying copper cables, copper wires, and fiber optic cables in public and private right-of way (R/W). In most circumstances cooperation with appropriate R/W authorities can be obtained when buried plant construction techniques are fully explained. Low cost placement of cable or wire is obtainable when the burial depth of the cable or wire can be maintained throughout the public R/W. Use of private R/W for placement of cable or wire should only be considered if placement would be more economical than in the public R/W. If public R/W is to be used for placement of the cable or wire, a comprehensive investigation should be made as to possible highway improvements, such as widening or changing grade elevations, since these highway improvements may result in costly future rearrangements and rerouting. When installing buried plant facilities at railroad crossings, in navigable streams, and the crossing of facilities owned by other utilities, the need for permits should be thoroughly investigated.

2.4 In urban and suburban areas, other buried facilities such as water lines, gas lines, sewer lines, Community Antenna Television (CATV) lines, electric and/or telecommunications lines present obstacles to plowing or trenching. When the above buried obstacles are anticipated, detailed information should be obtained from the other utilities on present and proposed buried facilities locations. Where it is known that buried obstacles will be encountered during construction, those areas should be identified separately in the Loan Design (LD).

2.5 The buried filled copper cable and wire and buried filled fiber optic cable units for the areas containing the buried obstacles listed in the LD should be suffixed with the letter "P." The "P" suffix distinguishes these units from the normal "BFC" units for copper cable and wire and the normal "BFO" units for fiber optic cables in order that the higher cost associated with installing buried plant facilities in these congested areas will be included in the project cost estimate.

2.6 Physical Location

2.6.1 The location of buried copper cable or wire and fiber optic cable should be determined in conjunction with federal, state, county, and local authorities, and private interests as applicable. Special attention should also be given to the type and size of equipment that will be required to perform the installation.

2.6.2 Some of the considerations that can affect the physical locations of the buried plant facilities are:

a. Width of road shoulders;

b. Type of terrain;

c. Type of road;

d. Easements;

e. Fence locations;

f. Required number of buried outside plant housings;

g. Public and private R/W;

h. Type of drainage ditches;

i. Soil conditions;

j. Railroad crossings;

k. Navigable streams or other bodies of water; and

l. Environmentally sensitive areas.

2.6.3 When cable or wire is to be installed in public R/W, discussions with department of transportation authorities should be held to inform the authorities as to the location and depth of the buried cable or wire in the R/W, the placement of a buried warning tape above the cable or wire, and the placement of above ground warning and route signs as methods of protecting the buried plant facilities against damage.

2.6.4 The same procedure as outlined in Paragraph 2.6.3 should be followed in coordination with town and development areas where buried plant facilities are to be installed. Assistance should be given to town planning authorities, land, industrial, and commercial developers by either identifying on existing construction drawings or in the preparation of new construction drawings, the locations and depths of all buried plant facilities. Here again, these organizations should be informed

that the borrower will provide identification and location of its existing buried plant facilities when requested.

2.6.5 Proposed buried plant construction activities should be coordinated with other utilities. This coordination is necessary not only for joint occupancy construction, but also to properly develop a working relationship between the various utilities on future planning of all utility plant. Construction drawings of telecommunications plant to be constructed should be provided to each of the utility companies whose plant is, or may be placed, within the area of the borrower's telecommunication plant facilities.

2.7 RUS Bulletin 345-150, Specifications and Drawings for Construction of Direct Buried Plant, Form 515a, provides the minimum required depths for installing cable or wire in soil, at ditch crossings, and in rock. The resident engineer should determine the local conditions which would require the burying of cable or wire at greater depths than the minimum depths specified in RUS Form 515a. In areas where crop plowing or subsoil operations are preformed, burying the cable or wire at increased depths to protect the cable or wire from damaged may be necessary. The resident engineer should check with federal, state, county, and local authorities in regard to any existing and/or proposed land development programs which would require special design considerations.

2.8 In areas where frost heaving can be expected, the cable or wire should be buried below the frost line. Movement of outside plant housings due to frost heaving can cause damage to the insulated copper conductors, optical fibers, or loss of shield and/or armor continuity. In areas where movement of outside plant housings by frost heaving is encountered, the outside plant housings should be installed on stub poles. The stub poles should be set below the frost line and in accordance with the requirements of RUS Form 515.

2.9 In many areas of the United States a problem of general flooding should be considered in the design and construction of buried plant facilities. Flooding can also be a problem within specific areas of a system not included in the general flood areas. Particular attention should be given with respect to the routing and depth of the buried cable or wire in those areas subjected to flooding to prevent exposure of the cable or wire as a result of soil erosion. Another consideration in areas subjected to flooding is to mount outside plant housings onto existing or new poles above the flood water levels.

2.10 Large areas of the United States as indicated in Figure 1 are infested with gophers or other rodents which can damage buried plant cables and wires. This damage can lead to corrosion of metallic elements within the cables and wires, copper conductor insulation damage, broken optical fibers, loss of cable

shield and/or armor continuity, service interruptions, etc. RUS specifications for filled copper cables and wires, and the RUS specification for filled fiber optic cables includes designs that are recommended for burial in gopher and rodent infested areas. Although Figure 1 indicates areas with significant gopher infestation, the resident engineer should thoroughly investigate the project area and should contact the local agent of the U. S. Department of Agriculture, Animal and Plant Health Inspection Service, before determining if a rodent resistant cable or wire design is required for the project area.

2.11 One of the important responsibilities of the resident engineer in the design of buried plant facilities is the providing of above-ground identification of the buried plant facilities. This can be accomplished by the installation of warning and cable route signs along the construction route. The warning and cable route signs should provide information as to identification and proper instructions in order to avoid service interruptions. The resident engineer should provide information as to the number and spacing of signs along the cable route to clearly define the location of the buried plant facilities to the telecommunications company personnel and to the general public. The signs should be installed adjacent to the cable or wire along roads, railroads, pipe lines, streams, irrigation and drainage ditches, and at other locations where it is likely that excavation work may occur. In addition, the signs should also be installed at each change in route direction, at buried splice locations, etc. Where practicable, signs should be placed in fence lines or at other locations where they will not inconvenience the property owner on private R/W. The type of signs and examples of sign layout drawings are included in RUS Bulletin 345-150, Form 515a. In certain situations the resident engineer may require the installation of a brightly colored below-ground warning tape above the cable along with the above-ground identification to provide addition protection against service interruptions.

3. CONSTRUCTION MATERIALS

3.1 For all buried plant construction projects financed with RUS loan funds, RUS regulation 7 CFR 1753.6 requires that only RUS accepted materials be used.

3.2 RUS technically accepted, nondomestic manufactured materials, may also be used on buried plant construction projects.. Before technically accepted materials can be used on buried plant construction projects, permission is required from the

RUS borrower. In addition, borrower's are required to ensure that the cost of the technically accepted materials are at least 6 percent less than the cost of the RUS accepted materials, as specified in RUS Bulletin 344-3, "Buy American" Requirement, as amended by the North American Free Trade Agreement Implementation Act (NAFTA Act).

4. MECHANICAL PROTECTION GUARDS AND RODENT AND INSECT CONTROL

4.1 When the minimum depth of the cable or wire cannot be obtained as indicated in Paragraph 2.7, metallic or nonmetallic split "U" or spirally cut guards or preservative treated planks should be installed to provide mechanical protection to buried cable or wire, or direct buried splice cases and load coils.

4.1.1 The metallic or nonmetallic split "U" or spirally cut guards should be used to protect the cable or wire at the following locations:

a. Road, street, or highway crossings;

b. Open drainage ditch crossings;

c. Foreign pipe, cable, or wire crossings; and

d. Stream and river crossings.

4.1.2 The preservative treated planking should be used to protect the cable or wire at the following locations:

a. Parallel runs within highway R/W if required by regulations;

b. Within railroad R/W if required by regulations; and

c. In exposed areas susceptible to hand or mechanical digging.

4.2 Nonmetallic split "U" guards or small diameter conduits should be used at buried service entrance installations to protect the exposed portions of buried service wires from possible subscriber damage.

4.3 Preservative treated planks should be installed at direct buried filled splice case and direct buried load coil case locations to protect the splice and load coil cases from mechanical damage.

4.4 Rodent And Insect Control: Rodent and/or insect repellant should be installed in outside plant housing locations where

damage to copper conductors or fiber optic cable from mice, ants, termites, etc., could occur.

5. DESIGN CONSIDERATIONS

5.1 Buried plant construction should be the method of construction when the initial construction cost is equal or lower than the initial construction cost of aerial plant construction and when the annual cost of the buried plant facilities are lower than the annual cost of aerial plant facilities.

5.2 Buried plant construction should also be considered in areas which may have previously been assumed to be uneconomical because of costs, materials, construction techniques, etc., when such factors indicate that economical buried plant construction costs in these areas can now be achieved.

5.3 Joint burial of electric and telecommunications cables should only be considered when required by local, State, or Federal ordinances or regulations. When joint burial of electric and telecommunications cables is considered, the design and construction of the joint occupancy facilities should be performed in accordance with the latest editions of the National Electrical Code (NEC), National Electrical Safety Code (NESC), local or State regulations, or Federal regulations. When the local, State, or Federal regulations are more stringent than the NEC or NESC codes, the more stringent requirements should be observed. When joint burial is necessary, every effort should be made to limit the length of exposure to 1/2 mile (0.8 km) to minimize the possibly of induction of power line harmonics in telecommunications circuits which may create objectionable noise conditions for telecommunications subscribers.

5.4 For outside plant buried facilities using copper cables, circuit requirements should be thoroughly evaluated to provide sufficient margin in the sizing of both buried distribution and feeder cables. The sizing of the copper cables should be based on the recommendations listed in RUS TE&CM Section 210, Telephone System Design - Sizing Criteria. The assigning of cable pairs should be based on the recommendations included in RUS TE&CM Section 629, Cable Plant Layout - Serving Area Value Engineering for Rural Systems.

5.5 For outside plant buried facilities using fiber optic cables, circuit requirements should be thoroughly evaluated to provide sufficient margin in the sizing of the cables. The sizing of the fiber optic cables should be based on circuit requirements of the LD plus the number of circuits needed for future growth.

5.6 Serving additional subscribers not anticipated at the time of construction may be more of a problem in buried plant than in aerial plant. Therefore, thorough planning is of the utmost importance. Long range subscriber estimates should be made prior to the preparation of the LD. The estimate should take into account the upgrading of existing services and the addition of new subscribers.

5.7 Local characteristics of the project area should be thoroughly studied to determine whether normal or extraordinary construction conditions exist before making comparative cost studies. In addition, the determination should be made as to whether special cable or wire shielding or other protection methods would be required for rodent control so that the increase in the incremental cost associated with the rodent control protection methods can be evaluated.

5.8 For copper buried plant, the design should provide for the optimum use of fine gauge cable (22 and 24 gauge conductors). Care should be exercised in the design to ensure that transmission requirements will be met and that high lightning areas are considered.

5.9 For copper buried plant, the choice of the proper gauge conductors should depend on the transmission and signaling requirements. Care should be exercised in selecting the cables since initial cost differentials between the various cable types, sizes, and conductor gauges can be appreciable. Where economic costs indicate the use of digital carrier and other types of electronic equipment over physical circuits, the electronic equipment should be designed.

5.10 For optical fiber buried plant, the design should provide for the use of either dispersion-unshifted single mode fibers (operate at both the 1310 and 1550 nanometer windows) or dispersion-shifted single mode fibers (operate at the 1550 nanometer window). The choice as to which single mode fiber to use should depend on the optical system's length and the transmission and signaling requirements.

5.11 The design should be prepared in accordance with the recommendations in RUS Bulletin 1751H-601, Lightwave Fundamentals.

5.12 Economic and/or operating advantages may often be realized by extending or reducing cable lengths to eliminate splices or outside plant housings which may provide savings in cable reel length purchases. Such considerations should be made with careful evaluation of shield and/or armor grounding requirements.

6. ECONOMIC CONSIDERATIONS

6.1 The decision to construct in a project area using buried plant facilities should be based on an economic analysis using the recommendations referenced in
RUS TE&CM Sections 218, Plant Annual Cost Data for System Design Purposes and 219, Present Worth of Annual Charge Studies for System Design.
6.2 If the economic analysis indicates that the project area should be constructed using buried plant facilities, a decision should then be made regarding the design of the project area using either an all copper design or a combination copper/fiber design.

6.3 Selection of either the all copper design or the combination copper/fiber design should be based on a ten-year economic plan, good engineering judgement and consideration of the State Telecommunications Modernization Plan. The initial and annual cost data should be used as economic guidelines to supplement and support engineering judgements and decisions. The objective is to choose the most suitable elements of the new plant facilities. In general, the design with the lowest annual cost should be selected. However, other considerations such as reliability and quality of service, connecting company arrangements, flexibility for meeting unforeseen conditions, or other effects on system operation may outweigh annual cost considerations.

6.4 Local characteristics of the project area should be considered so that such factors as the adaptability of the soil conditions to buried plant construction are known before comparative cost studies are commenced. It should also be determined if special types of equipment or cable are required so that the added expense can be evaluated.

FIGURE 1

Gopher Infested Areas