F.I.A.T. FINAL REPORT No. 287

QUADDED TOLL CABLES

Report prepared by
FIELD INFORMATION AGENCY, TECHNICAL
UNITED STATES GROUP CONTROL COUNCIL FOR GERMANY

BRITISH INTELLIGENCE OBJECTIVES SUB-COMMITTEE

LONDON—H.M. STATIONERY OFFICE

OFFICE OF MILITARY GOVERNMENT FOR GERMANY (U.S.)

Office of the Director of Intelligence

FIAT FINAL REPORT NO. 287 3 October 1945

QUADDED TOLL CABLES

BY

J. A. PARROTT

Technical Industrial Intelligence Committee

FIELD INFORMATION AGENCY, TECHNICAL

TABLE OF CONTENTS

Targets visited and personnel interviewed regarding cables (and some other matters).

Hamburg: No. 1 Toll Office, Local Central Offices, Reichspost and Reichspost direction office. British Signals Officers including Lt. Col. Harnden, Maj. Robinson and others, Reichspost engineers Huber, Schneider and others. Went over Reichspost direction technical library documents. Also interviewed Dr. Gruschke of Siemens and Dr. Hanau and Prof. Gladenbeck of AEG.

Lohbrugge: No. 3 Hamburg Toll Office (underground). Lt. Van Dyke of British Signals (a Holland repeater man who had worked in many stations under the Germans) and 3 or 4 German attendants at the office.

Luneburg: Underground Repeater Station. Questioned local personnel.

Harsten (18 km east of Hamburg: Unattended underground television repeater station. Lt. Van Dyke and Germans accompanying.

Minden: Underground Toll Office. Discussions with Brigadier Jones of British Signals and other officers as well as former Reichsposts men under their supervision.

Usingen: Underground Repeater Station. Interviewed attendant.

Furstenhagen: Interviewed Dr. Dull of Reichspost.

Hoohst: Discussed German communications with American Signal Officers including Col. Sutherlin and Maj. Cameron, and Jean Wolff, a Technical Observer formerly with Luxemburg Tel. Co. and who had worked under the Germans in the War.

Frankfurt: Toll Office, Main Railroad Office, SHAEF Document Section, Siemens and Signal Corps Cable Construction Company No. 1.

Frankfort (Cont.) : Interviewed Capt. Anderson and others at Toll Office, Lt. Moxan and others of the Construction Company, and German personnel at the Railroad Office. SHAEF Document Library had no technical communication information on file at the time, and Siemens was closed.

Nurnberg: Railroad Communication Office, Siemens Offices, Reichspost Office, Captured Enemy Equipment Depot. Talked to Enzerberger of Reichspost and 2 others, 3 Reichsbahn people (who were very helpful) and to Signal Corps people at the Depot.

Munich: Signal Corps 3rd Army Headquarters and Com. Eng. Section, Toll Office, Underground Repeater Station, Siemens factory (51 Hoffmanstrasse). Discussion with Signal Corps people including Maj. Harrington, Capt. Schoeneberger and several others. German attendants at toll offices were interviewed. At Reichspost Dr. Fuerer and Herr Mohr were questioned. Dr. Schreiderman and Herr Zaph were interviewed at the Siemens plant.

Condition of Targets

Good except for Hamburg upper floors partly bombed out, Minden and Frankfort toll stations partly damaged by Germans when evacuating, same for Nurnberg Railroad Communication Office. Siemens at Hamburg, Nurnburg and Reichspost people at Nurnburg and Munich had been bombed out and lost many records so they said.

Resume of Results

A number of practices are followed in the design, installation and maintenance of German communication cable plant which are different from American general practice. Among these are the use of aluminum wire, helical cord spacers on conductors, spiral-four (in some cases), styroflex insulation (to a limited extent), straight splices, underground repeater and terminal offices. Some of these measures were employed for other than commercial service or economical reasons, some have been known to the art for many years, and it is not of course the intent in mentioning these differences from the usual American practices to imply that they would be advantageous for general use in the United States. Some, however, may offer sufficient promise to warrant detailed studies of the advantages and disadvantages.

This investigator wishes to acknowledge the considerable aid which was given by the British Signal and U.S. Signal Corps officers and enlisted men in gathering the information on which this report is based.

General

Since the end of the European War a larger number of German toll cable routes have been discovered that were not shown on the internationally published lists (Berne Lists) prior to the War. The sheath milage is at least 100 to 125 per cent greater than had been published. While placed and maintained by the Reichspost, the cables were very likely used mostly for circuits provided to the Wehrmacht as was stated by Reichspost people. These cables are underground as are also the majority of new repeater stations and many of the large terminal offices at large cities.

It is of course important in considering German cable systems and other communication systems to have in mind that a great many things which were done were not dictated by service or economy considerations but by military and critical material situations as well as the exploiting of communications for propaganda. The following is a quotation from the Reichspost ex-president, Dr. Ohnesorge, from the 1941-42 "Jahrbook des electrischen Fernmeldewesens":

"Since the transformation of the political scene in Germany we have turned more and more to the extension of the cable system. But whereas in earlier days we were concerned with the economic side of all these problems it is now the question of security which is primarily taken into consideration. This showed itself most clearly when the problem of the method of laying the cable was considered, when the Reichspost was given the task of relating the economic to the security side of the question, but another side, of great importance, was the technique of erecting lines of communication which would enjoy the greatest degree of security in time of war. For this reason, the repeater stations at the most vulnerable points in the line were placed underground and others were inserted which could be put into use in the event of the main ones being damaged. Lastly, the lines themselves were so closely enmeshed that it was an easy matter to switch from one part to another in the event of any section being destroyed by bombing. Over and above these, the

Two of the Reichspost engineers, Dr. Feurer and Herr Mohr, at Munich were of the opinion that the experience with aluminum has been sufficiently good to continue its use in peacetime in those countires where the relative costs of copper and aluminum make it economically attractive. Neither, however, had made any real study of the question, taking into account the other factors.

Helical Paper Insulators

Except for Dr. Gruschke of Siemens at Hamburg all those interviewed stated that only cables with helical spacers have been used for some years. All sample cables seen were of this type, and such translations as have been made of documents indicate the same. It is understood the Reichspost does not specify its use but only states the required electrical characteristics and the manufacturer might use any satisfactory design.

Several Army Cable Company officers and men who have had considerable experience with the cable in the Nurnburg area were of the opinion cables with this insulation are much slower to develop trouble due to leaks. This seems reasonable, but it, of course, does not necessarily mean the circuit troubles are less or the maintenance costs smaller, for cables not under gas pressure.

Spiral-Four

Spiral-four construction seems to have increased in usage since about 1935. Inspection of cable makeups indicates that its use either alone or in combination with quadded conductors was generally to fill the available layer space to the best advantage. Some of the Reichspost people mentioned this advantage and also pointed out the obvious disadvantage, viz. two types of facility to deal with in construction, maintenance and patching. Reichsbahn engineers at Nurnburg stated that they sometimes load and use the phantoms of the spiral-four conductors. This evidently is never done by the Reichspost.

Styroflex Spiral-Four

As an expedient during the War the Germans introduced 16 conductor, aluminum spiral-four cable with styroflex insulation, including styroflex helical cord spacers. This was available with either 1.55 mm or 1.15 mm conductors and was usually loaded with 1.75 MH coils at 281 to 284 meter spacing. The capacity being about 23 nF per Km, this provided channels suitable for frequencies up to 60 Kc for cable carrier systems. The MEK 8 carrier

equipment was usually employed as it permits pairing the terminal equipment in such a manner that the 6 to 60 Kc band can be transmitted on a pair from east to west in one cable and west to east on a pair in the other cable. This provides, therefore, 16 carrier channels on each two pairs of wires. Repeater stations would be 90 to 100 Km apart.

The only Reichspost installation in Germany which came to attention is between Munich and Buchloe and used 1.15 mm conductors. Only one 8 channel carrier system had been installed on this route, and it had only been in operation for a very short time before the end of the War. On this particular cable it had been planned to use 12 channel U systems but none were available. Most installations were understood to have been made in Russia.

This general type of cable with paper insulation was also available with 1.2 mm copper or 1.55 mm aluminum. The capacity of this cable is about 26.5 nf per Km. Loading with 1 mH spaced at 421 to 425 meters was proposed.

Several Reichspost and Siemens people mentioned cables of this type with only four pairs per cable.

Reichsbahn people at Frankfort stated they had also planned the installation of cables of this type. However, the cable sample seen had 7 spiral-four quads and the conductors were of copper enamelled and had two wrappings of styroflex. (No helical cord.)

Cable Splicing and Balancing

It is the general practice in Germany to splice toll cable quads straight through wire for wire. Each loading section is then balanced by the condenser method. The usual procedure is to balance the combinations in each quad mutually and to ground, and the adjacent quads. This of course materially simplifies cable splicing and restoration work. On the other hand, due to differences in mutual capacitances, substantially different characteristic impedances result and no single standard balancing network is used. The networks are assembled by individual singing point tests in the same manner as was used by the Reichspost for many years before the War. Information offered by German attendants at the Hamburg and Munich offices indicates that they usually secure balances from 25 to 30 db on the bare cable pairs. The trend appears to be away from 2 wire circuits of more than 3 repeater sections (450 Km).

Loading Systems and Quads Used

The normal loaded cable facilities are noted below, all of which use a 1700 meter coil spacing.

Conductor	Cap nf/km	Loading mH	Cutoff Kc	800 Cycle Atten. mn/km	Normal Use	VF Rept Spacing
.9 Cu or 1.15 AL	33.5 S	140 S	3.5 S	19.5 S	2 wire	70 Km
	54 P	56 P	4.4 P	19 P		
1.4 Cu or 1.8 AL	35.5 S	140 S	3.4 S	9.5 S	2 wire	140 Km
	57 P	56 P	4.3 P	9.5 P		
.9 Cu or 1.15 AL	33.5 S	30 S	7.75 S	39 S	4 wire	70 Km
	54 P	12 P	9.3 P	38.5 P		
1.4 Cu or 1.8 AL	35.5 S	30 S	7.25 S	16.6 S	4 wire	140 Km
	57 P	12 P	9.0 P	16.4 P		

Carrier Assignment to L Systems:

1.4 mm copper or 1.8 mm aluminum side circuits or pairs loaded with 3.2 mH coils were used for S systems (3 channel system using up to 14,700 kc).

1.4 mm Cu or 1.8 mm AL pairs loaded with 12 mH coils were used for program.

Non-loaded conductors were ordinarily employed for the U or 12 channel applications.

Two typical cable makeups with the facility assignments are noted below:

(a) Makeup

			Purpose
Core,	1 qd.	1.4 mm Cu 12 mH	Loading Program
Layer 1,	2 qds.	1.4 mm Cu 3.2/12 mH	" VF and S
	5 qds.	1.4 mm Cu 140/56 mH	" 2 wire VF
Layer 2,	12 qds.	0.9 mm Cu 30 /12 mH	" VF 4 W and L
	6 qds.	.9 mm Cu 140/56 mH	" 2 wire VF
	22 qds.	.9 mm Cu 30/12 mH	" VF 4 W and L
Layer 3,	2 qds.	.9 mm Cu 140/56 mH	" 2 wire VF

Shielded:

(b)

			Loading	
Core	4 pr.	1.8 mm AL	12 mH	Program
Layer 1,	10 qds.	1.15 mm AL	30/12 mH	VF 4 W and L
	4 qds.	1.15 mm AL	140/56 mH	2 wire VF
Layer 2,	14 qds.	1.8 mm AL	140/56 mH	2 wire VF
Layer 3,	24 qds.	1.15 mm AL	30/12 mH	VF 4 W and L
	4 prs.	1.4 mm Cu	3.2 mH	VF and S

Shielded

The quads used for the S system are usually separated by 2 or more intermediate quads. Those for opposite direction of transmission are on opposite sides of the layer. Actually only one such system is reported to have been made. This is between Berlin and Hanover and was put in for a trial.

(c) (Coaxial Berlin Frankfort)

		Purpose
Core, 1 Coaxial unit, 5/19.5 mm Al.	B carrier and Telev.	
Layer 1, in rotation:		
1 pr. 1.8 mm Al	12 mH	Program
2 Spiral, 4 qds.	1.2 Cu NL	U Carrier
1 quad,	1.15 Al, 140/56 mH	2 Wire VF
1 Spiral, 4 qds.,	1.4 Cu, 3.2 mH	S. carrier
1 quad,	1.15 Al, 140/56 mH	2 Wire VF
1 Pr.	1.8 mm Al, 12 mH	Program
2 Spiral, 4 qds.,	1.2 Cu NL	U Carrier
1 quad,	1.15 Al, 140/56 mH	2 Wire VF
1 Spiral, 4 qds,	1.4 Cu 3.2 mH	S Carrier
1 quad,	1.15 Al, 140/56 mH	2 Wire VF
1 Spiral, 4 qd.,	1.2 Cu NL	U Carrier

The coaxial unit and facilities intended for S and U carrier systems operate on a 4-wire basis, the return path being in the other cables which is similar in makeup.

Miscellaneous.

It is of interest that the Germans are not using gas pressure on toll or other cables but rely solely on the older method of daily tests on a number of pairs to indicate troubles. They do, however, continue to utilize cables having one or two program pairs with individual lead sheaths. (The continuity of program service appears to be stressed in most all of the Reichpost's design and maintenance practices whereas regular message service is noticeably less protected.) Enameled pairs are often included to provide service over a few circuits in case of trouble and facilitate testing.

A number of cable designs seen do not contain a full layer of quads in the outer layer. When the unused space is small, however, paper fillers are used.

Underground repeater stations at Hamburg, Harsten, Luneburg, Minden, Usingen, Frankfort and Munich (2 offices) were visited. The following are the outstanding points of interest:

1. No moisture proofing was reported on any of the equipment. While air conditioning systems were installed at all stations, they apparently are seldom operated. Each structure had light and vent wells running along one wall. While well lighted and ventilated, repeater attendants at two stations expressed objections to working underground.

2. The stations were variously reported to have 3 to 8 feet of concrete above. They were all located in residential areas and disguised by typical dwellings above. No place visited had been damaged by bombs.

3. Diesel emergency power plants which could be started in a few moments were available at all offices. Large oil storage tanks were in place.

Unattended repeater stations for the television channel only were located about midway between the underground station of the type mentioned above. The one visited at Harsten was of interest in the following respects:

1. It consists of a steel cylinder about 12 to 14 feet in diameter and about 30 feet long. This is buried in the ground and has a 3 foot entrance tube with a steel cover above which is to all appearances a gardener's tool shed. The whole thing is on the side of a country residence under a vegetable garden.

2. The inside of the drum was divided into two compartments, a small entrance section containing the potheads and a small automatically operated air conditioning unit supplied commercial power. The latter had an alarm circuit extending to an attended repeater station.

3. The larger section was lined with pine and contained television amplifiers of the normal German design.

Discussions of electrolysis and lightning troubles with several of the Reichspost people at Hamburg, Nurnburg and Munich, and with Mr. Wolf of the Luxemburg Company indicated that considerable trouble is experienced with underground cables due to these sources as well as abnormals. No expert in remedial measures was located, and the only points of interest mentioned was that increasing attention is being given to better conductivity of the sheath or metallic wrappings under the sheath

in areas subject to lightning. Also much data were being gathered in the southern areas on storm paths with the idea of selecting cable routes less subject to trouble.

References:

Jahrbuch de elektrischen Fernmeldewesens 1940.

TFT Bd 30 H. 11, 1941
TFT Bd 31 H. 10, 1942

Verzeichnis de Deutschen Fernkabel.

Europaischer Fernsprechdienst Dec. 1941.

Verlegungs und Montagerorschriften for das Kabel Form 8 f/g

Verlegungs und Montagevorschriften for das Kabel Form 8 d/e

Mitteilungen aus dem Reichspostzentralamt 1940 contains article on aluminum for cables.

Veroffentichungen Nachrichtentechnik, Jan. 1940.