621·397·823:621·332

Paper 37A

Television Interference

G. A. C. R. Britton, AMIEE

Senior Executive Engineer, Inland Radio Branch, Post Office Engineering Department

1. Introduction

In common with other systems involving the distribution and utilisation of electricity a high voltage electric railway system contains a number of potential sources of radio noise, which can cause interference with nearby wireless and television installations.

The purpose of this paper is briefly to outline the various likely sources of noise and to describe the experience gained to date on high voltage systems in Great Britain.

It is convenient to consider the sources under two main headings:—

(1) those associated with train equipment,

(2) those associated with the distribution system.

No mention will be made of interference from signalling circuits, etc., which is a problem common to all railways using electrical methods.

2. Train Equipment

Unless grid controlled rectifiers, which can give rise to steep fronted current pulses, are used to obtain the traction d.c. supply, there is little likelihood of excessive radio noise being produced by the traction equipment itself. Most heavy current devices are fairly innocuous in this respect. Noise can be expected from the control and operating circuits, however, which utilise relays, commutator motors, etc. The problem here is similar to that experienced with industrial equipment and well-known suppression techniques are available should they be necessary.

Sparking, as distinct from arcing, can occur at the current collector of an alternating current system if it is not in continuous contact with the conductor wire. No practicable form of suppression for the resultant noise would appear to be available.

The noise generated from passing trains is not likely to constitute a serious interference problem due to its short lived duration and suppression of the offending items will only be necessary if the train service is a frequent one.

3. Distribution System

A high voltage a.c. overhead power system has its own peculiar sources of radio noise and due to its physical character it provides an excellent radiator of radio frequency energy so that conditions are very suitable for causing interference. The main possible sources of noise are outlined below. It should be emphasised that the weather exerts a considerable influence on the resulting noise level and the presence of radio noise does not necessarily signify an incipient fault condition.

3.1 *Insulator Surface Leakage*

Under adverse conditions of pollution and weather (soot, damp, fog, frost), it is possible for localised voltage breakdowns to take place over insulator surfaces which can give rise to radio interference. The effect is minimised by using insulators which have a uniform voltage gradient and of a design which discourages the formation of localised pollution deposits. The application of an insulating grease to the surfaces of existing insulators will greatly improve their breakdown characteristics in conditions of pollution.

3.2 *Breakdown of Overstressed Airgaps*

Where insulators with a high self capacitance e.g., pin type, are used, the small airgaps between the conductor wire and insulator surface have sufficient voltage developed across them to cause sparking. Unless steps are taken to minimise this effect, radio noise fields will be generated. Reduction of the insulator capacitance greatly increases the discharge inception voltage and insulators such as the post type have much improved low noise characteristics. Alternatively, airgaps can be eliminated by coating those parts of a conventional insulator with a conducting medium, e.g., conducting glaze or by suitable mechanical design.

A build-up of high resistance deposits between adjacent metal components of a tension or suspension insulator set produces much the same effect.

Items of equipment which are within the electric field of the conductor wire have voltages induced in them and if conditions are suitable, sparking between adjacent metal items will take place. Electrical bonding of all metalwork is thus desirable.

3.3 *Corona Discharge*

Breakdown of the atmosphere in close proximity to a high voltage conductor can be expected under adverse weather conditions. Fortunately at the voltages under consideration (up to 25 kV) corona discharge even if it should occur is not likely to give rise to radio interference.

The degree of interference to be expected from an overhead HV system must obviously depend on the signal strength of the wanted signal. Due to the high signal/noise ratio (40 db) necessary to protect television services and the radiation characteristics of the HV systems at television frequencies, the bulk of the complaints of interference from this source are concerned with television reception in the 41-68 Mc/s frequency range.

This type of noise is inherently more serious than that due to train equipment since it can be continuous and it is very desirable for steps to be taken in the design stage to ensure that a line will be substantially ' noise free ' under operational conditions.

4. Service Experience

4.1 6 *kV System. Lancaster – Morecambe – Heysham*

Radio noise tests made when the Lancaster – Morecambe – Heysham 6·6 kV 50 c/s electrified scheme first came into operation in 1953 indicated that the only items of equipment carried by a train which caused significant radio noise fields were the current collector as it moved along the contact wire and the contactors of two auxiliary circuits. Since the train service was not a frequent one (two trains per hour) and since there was every possibility of the collector characteristics improving with use, it was considered that the possibility of serious interference being caused was remote. Little noise emanated from the overhead distribution system at this time.

Within a short time of the service becoming operational, however, the British Post Office received large numbers of complaints of power line type interference to Band I television from viewers living within 250 yards of the track. The trouble was continuous in dry weather and was proved to be due to the railway system. Joint tests by British Railways and the G.P.O. showed that the main source of the trouble was sparking between the catenary wire and the heads of its 50 years old supporting pin type insulators (this type is no longer used in British Railway Electrification). A temporary solution was made by tightening all binders and stirrups securing the catenary to the insulators and by eliminating the residual airgaps with a conducting graphited grease which was forced into the interstices. All insulators of the offending type within range of viewers were so treated and the work extended over some half a dozen miles of double tracks and included the fairly extensive network in the vicinity of Morecambe (Promenade) Station. A permanent remedy was provided when British Railways replaced the catenary supporting insulators by ones with a metal head to which the catenary wire was clamped, thereby eliminating the possibility of poor contact.

4.2 25 *kV Test System. Bishopsgate* (1957)

Preliminary radio noise tests carried out on a test section of the overhead equipment which it was proposed to use for the National scheme, indicated that under conditions of heavy pollution the catenary supporting insulators could give rise to television interference in regions outside the primary service area. The application of silicone grease to the insulator surfaces reduced the generated noise level but it was not possible to determine the period over which the treatment would have remained effective.

4.3 25 *kV System. Manchester – Crewe – Styal Loop*

This section has been energised for 12 months and to date no reports of interference have been received.

4.4 25 *kV System. Colchester – Clacton Section*

Tests have been made on this section during March/April 1960, and formed part of the preliminary series of British Transport Commissions ' System Tests '. Test locations were situated at Thorpe-le-Soken, Alresford and Walton-on-the-Naze (see fig.3, Paper 2) and measurements made of continuous and impulsive noise on automatic recording equipment immediately adjacent to the line. The first two sites could be considered free from abnormal conditions other than from passing steam trains, whilst the latter site, a railway terminus including shunting yards, suffered additionally from the effects of salt-laden coastal atmosphere and pollution from steam trains. The insulators in this area had not been cleaned or greased since 3rd October, 1959.

The frequencies chosen for measurement were 0·22, 1·0 and 50 Mc/s, representative of long and medium wave 'sound' broadcasting and television reception.

Results shown in the table below have been adjusted to give the conditions of interference which would obtain had a viewer, or listener, been situated at each of the test points with receiving aerials 30 yards distance from the tracks and directed over the catenary towards the transmitter. This is considered a rational minimum distance at which aerials might be expected to be situated with respect to railway tracks and, in addition, conditions appropriate to distances of 60 and 90 yards have also been calculated for stated degrees of interference. The received signal level was considered to be equal to that at the limit of the service area of a transmitter, i.e., fringe area. Of the results obtained at Walton those shown in the table were obtained in conditions of high humidity and therefore show considerable interference. During conditions of low humidity interference-free conditions have been obtained.

Percentage of test period for which interference of varying levels was experienced at stated distances from track

Location	*Freq.* *Mc/s*	30 *yards* A	B	C	D	60 *yards* A	B	C	D	90 *yards* A	B	C
Thorpe	50	85	15	—	—	100	—	—	—	100	—	—
Alresford	50	98	2	—	—	100	—	—	—	100	—	—
Walton	50	25	44	16	15	69	16	9	6	85	9	6
Thorpe	1	97	—	3	—	100	—	—	—	100	—	—
Alresford	1	100	—	—	—	100	—	—	—	100	—	—
Walton	1	100	—	—	—	100	—	—	—	100	—	—
Alresford	0.22	64	14	12	10	90	10	—	—	100	—	—

Levels of Interference

A: interference free
B: just perceptible interference
C: moderate interference
D: severe interference

4.5 *Conclusions from Tests on Colchester – Clacton Section*

The table shows that where a television receiving aerial is situated 30 yards from the track and interference conditions are not abnormal then interference is just perceptible for 2 per cent. to 15 per cent. of the time. At a distance of 60 yards an interference free condition may be expected.

In abnormal conditions whereby one or more of the following factors apply:

(*a*) Insulators excessively contaminated by industrial or coastal atmospheres and/or smoke discharges from locomotives,
(*b*) excessive number of noise sources, e.g., multiplicity of gantries,
(*c*) excessive nearness to noise sources, i.e., receiving aerials tightly coupled to the catenary,
(*d*) abnormally low field strength of required signal, i.e., a fringe area,
(*e*) receiving aerials directed over the track towards the signal source,

then appreciable interference may be expected. Most of these conditions apply only to a small area close to Walton-on-the-Naze station and results show that continuous type interference in varying degrees may be expected for 75 per cent. of the time with receiving aerials situated at 30 yards distance from the track. At 60 and 90 yards this figure diminishes to 31 per cent. and 15 per cent. respectively. It should be noted, however, that in some cases at this location the distance between aerials and track is only 15 yards.

At 1 Mc/s (medium waves) continuous interference may be considered only slight, existing for 3 per cent. of the time at 30 yards and at 0·22 Mc/s (long waves) interference may prevail for 36 per cent. and 10 per cent. at 30 and 60 yards with complete freedom at 90 yards.

5. Conclusion

It is perhaps a little early to apply the conclusions of the Colchester – Clacton tests to the country as a whole, but it would seem that away from coastal areas and industrial polution in association with an abnormally low field strength of the wanted radio and television signals interference will be very slight.

Acknowledgements

The author wishes to thank the Engineer-in-Chief of the Post Office for permission to publish the paper.

SUMMARY

After describing that radio and television interference might arise from sources associated with (1) the train equipment and (2) the distribution system, for reasons which are given in some detail, the paper describes service experience with regard to radio and television interference on the 6.6 kV 50 cycle electrification brought into operation on the Lancaster – Morecambe – Heysham line in 1953, where some initial interference was eliminated by replacing out-of-date insulators by modern ones.

After a brief reference to some tests made at Bishopsgate in 1957, it records that up-to-date no reports of interference have been received arising from the electrification of the Styal loop of the Manchester – Crewe line which has been energised for 12 months.

It then records in some detail tests made on the Colchester – Clacton section where television interference has been experienced on some receivers which are very close to the line over a limited portion of it in an area where the signal strength is low.

The tests made permit certain generalisations which are summed up in the Conclusion, that it would seem that away from coastal areas and industrial pollution in association with an abnormally low field strength of wanted radio and television signals, interference will be very slight.

RÉSUMÉ

Après avoir rappelé que les perturbations sur la radio et la télévision peuvent provenir des sources qui résident dans l'équipement moteur et la distribution de l'énergie, l'exposé décrit au sujet des perturbations sur la radio et la télévision l'expérience acquise en service sur la ligne Lancaster – Morecambe – Heysham électrifiée en 6,6 kV, 50 Hz, et inaugurée en 1953. Sur cette ligne certaines perturbations du début avaient été éliminées en substituant aux isolateurs démodés des isolateurs modernes.

Après un bref renvoi à quelques essais effectués à Bishopsgate en 1957, l'exposé remarque que, jusqu'à présent, aucune plainte de perturbations n'a été reçue sur l'électrification de la dérivation Styal de la ligne Manchester – Crewe qui a été mise sous tension il y a un an.

Le rapport décrit alors en détails des essais effectués sur le tronçon Colchester – Clacton où des perturbations sur certains appareils de télévision situés à proximité de la ligne ont été perçues sur une partie limitée de la ligne et dans une zone où l'intensité du signal est faible.

Des essais effectués permettant quelques généralisations qui sont résumées dans la conclusion, il ressort que loin des régions côtières et de la pollution industrielle associées avec une intensité faible des signaux de radio et de télévision, les perturbations seront très faibles.

ZUSAMMENFASSUNG

Zuerst werden die Ursachen der Radio- und Fernsehstörungen, welche (1) von der Zugausrüstung und (2) vom Verteilungsnetz herrühren könnten, ziemlich ausführlich beschrieben. Der Bericht erörtert dann die in Hinsicht auf Radio- und Fernsehstörungen gemachten Betriebserfahrungen mit der 6,6 kV, 50 Hz, Lancaster – Morecambe – Heysham Linie, auf welcher der elektrische Betrieb in 1953 aufgenommen wurde. Anfängliche Störungen auf dieser Linie wurden durch Ersetzen der alten Isolatoren eliminiert.

Einige in Bishopsgate in 1957 ausgeführte Versuche werden kurz erläutert; weiter wird erwähnt, dass bis heute keine Störungsmeldungen der nun seit 12 Monaten elektrifizierten ' Styal loop ' der Manchester – Crewe Linie eingegangen sind.

Der Bericht beschreibt ferner im Colchester – Clacton Abschnitt ausgeführte Versuche, wo Fernsehstörungen in einigen Empfängern bemerkt wurden. Es handelt sich dabei um Empfänger, die sehr nahe der Eisenbahnlinie und in einem Gebiet, wo die Signalstärke schwach ist, aufgestellt sind.

Die gemachten Versuche erlauben gewisse Verallgemeinerungen, die in den Schlussfolgerungen zusammengefasst sind. Es scheint, dass die Störungen sehr gering sind in Gebieten, die nicht an der Küste liegen und die nicht starken Luftverunreinigungen ausgesetzt sind, vorausgesetzt dass die Feldstärke für das Radio- und Fernsehsignal nicht ungewöhnlich schwach ist.

RESUMEN

Después de describir cómo se pueden producir interferencias en la radio y televisión procedentes de (1) el equipo del tren y (2) el sistema de distribución, por razones que se exponen con cierto detalle, el documento se ocupa de la experiencia cosechada en servicio acerca de las interferencias en la radio y televisión producidas por la red de electrificación de 6,6 kV, 50 ciclos instalada en la línea Lancaster – Morecambe – Heysham en 1953, en la que se logró suprimir un cierto grado de interferencias iniciales al substituir los aisladores anticuados por otros más modernos.

Tras de referirse a algunas de las pruebas realizadas en Bishopsgate en 1957, señala que hasta la fecha no se han tenido noticias de haberse producido interferencias como consecuencia del sistema de electrificación instalado en la vía de circunvalación de Styal derivada de la línea Manchester – Crewe, que ha estado prestando servicio desde hace 12 meses.

A continuación, pasa a enumerar detalladamente las pruebas llevadas a cabo en la sección Colchester – Clacton en donde se han registrado interferencias en ciertos receptores de televisión muy próximos a la línea a lo largo de un sector limitado de ésta en la que la señal es demasiado débil.

Las pruebas efectuadas han permitido hacer ciertas generalidades que se resumen en la Conclusión. Al parecer, las interferencias apenas se dejan sentir en los lugares alejados de las zonas costeras e industriales en donde se den, además, señales de radio y televisión con una intensidad de campo anormalmente baja.