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EFFECT ON RADIO CIRCUITS OF THE HIGH-ALTITUDE NUCLEAR DETONATION ON 9 JULY 1962

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ABSTRACT

This preliminary report covers the observations made on commercial and other radio circuits in New Zealand and the Pacific area after the high-altitude nuclear explosion over Johnston Island. Reports show that all circuits specifically observed were affected. The effects were widespread and began, as far as could be ascertained, at the moment of detonation.

INTRODUCTION

To assist in assessing the possible effect on commercial radio circuits, arrangements had been made, prior to each proposed high-altitude test, to extend the hours of operation of the Wellington (Himatangi)–London direct radiotelephone circuit from normal closing time, 1200 UT, to 1800 UT. The Wellington (Himatangi)–Vancouver radiotelephone circuit time was also extended from the normal closing time, approximately 1000 UT, to 1830 UT. During the extended hours, continuous tape loops were run, with frequent technical operator to technical operator contacts.

It was not possible to obtain other than qualitative reports from most of the observation stations, owing to the number of transmissions they were watching and to the short duration and unexpected nature of the immediate effects. Some reports in the form of SINPO* ratings were provided by Makara Radio.

Although Maximum Usable Frequencies (MUFs) are quoted it should be borne in mind that operating agencies use Optimum Working Frequencies (OWFs) in planning their frequency usage. The OWF is taken as 85% of the MUF (*see* Fig. 1).

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*SINPO is the name of a reporting code recommended for world-wide use by the C.C.I.R. (International Radio Consultative Committee) of the International Telecommunications Union (*Radio Regulations: Geneva 1959*, I.T.U., Geneva, 1959, p. 422). Five factors are reported, each on a scale of 1 to 5: *S*ignal strength; *I*nterference, degrading effect of; *N*oise, degrading effect of; *P*ropagation disturbance, effect of; *O*verall rating. X = not rated.

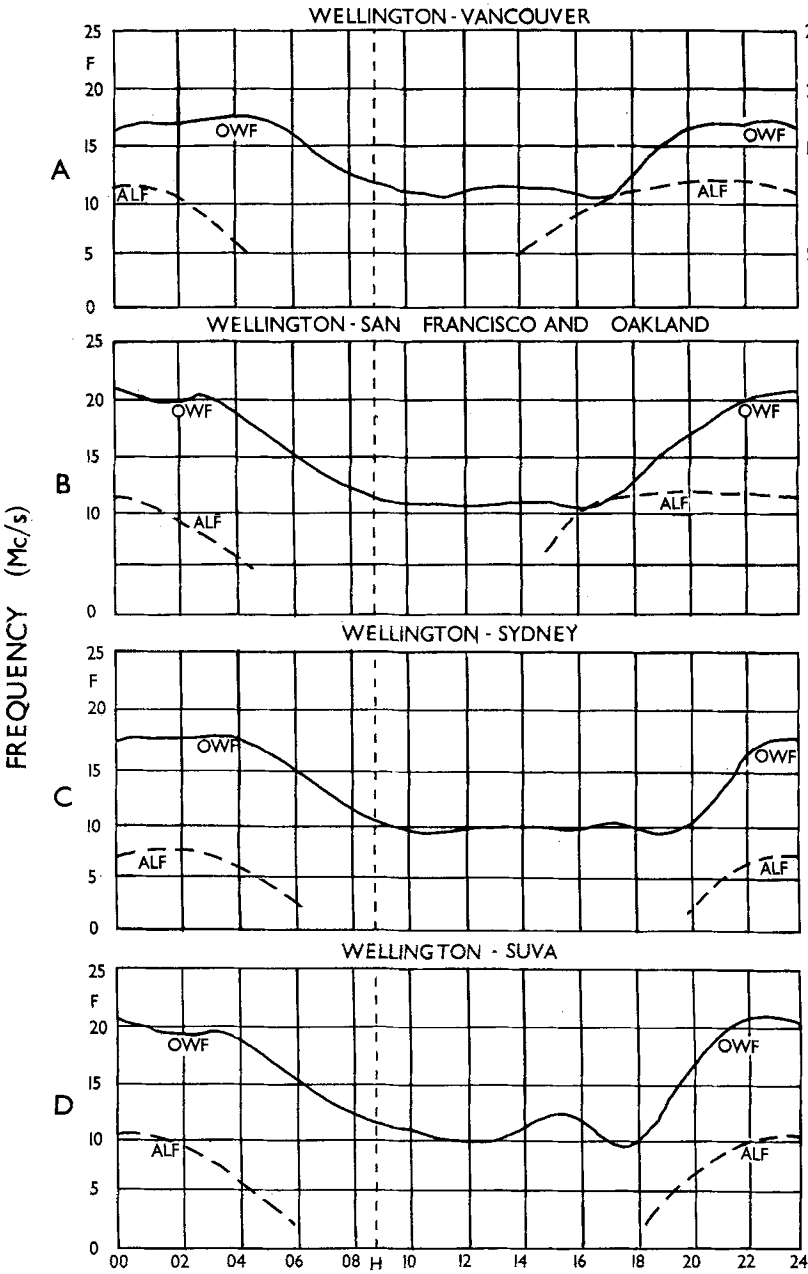

FIG. 1—Frequency prediction curves for July 1962. OWF = Optimum Working Frequency. ALF = Absorption Limiting Frequency.

COMMERCIAL RADIO OBSERVATIONS

Observations at Makara Radio, Wellington

(1) *Vancouver–Wellington Radiotelephone (Part of Composite Emission)*

Frequency 9820 kc/s. An abrupt fadeout occurred at 0900 UT (the detonation time), lasting three minutes. From 0903 UT to 0920 UT the reception was only strength 1. From 0920 UT to 0945 UT the circuit gradually improved to strength 3. By 1000 UT the signals were normal. Rapid fading was a feature of the recovery. Conditions remained normal on this circuit (including telegraph, section 2) until 1630 UT when 9820 kc/s became unusable. Tests on 11538 kc/s and 15563 kc/s were unsuccessful and it was finally necessary to use 19752·5 kc/s. Difficult working conditions and a change to a higher frequency are normal at this time of day and at this phase of the sunspot cycle. The Absorption Limiting Frequency (ALF) also approaches the Maximum Usable Frequency (MUF) at this time. However, it is notable that the change in this case was to a frequency higher than normally used and one that was above the predicted MUF. The predicted MUF at 1630 UT was 12500 kc/s rising to 19500 kc/s at 200 UT (Fig. 1A).

(2) *Vancouver–Wellington Radiotelegraph Circuit (Part of Composite Emission)*

Frequency 9820 kc/s. Coincident with the detonation, signals faded out. abruptly. At 0903 UT signals started to recover but were barely audible. At 0920 UT signal strength was normal with pronounced flutter, and at 1000 UT the flutter had modified to occasional rapid fading.

This circuit uses error detecting and correcting telegraph equipment and this, along with the fact that narrow-band telegraph emissions tolerate poorer circuit conditions than does a 3-kc/s-wide telephone emission, accounts for the differing reports on the components of the single composite transmission.

The SINPO reports were as follows (X indicates no assessment made):

Time UT	*SINPO*	*Time* UT	*SINPO*	
0830	35434	0910	35432	
0900	Nil	0920	35433	(Normal strength with flutter)
0902	1XX11	0930	35433	(Occasional rapid fades)
0903	25422	1000	35433	
		1030	35433	

(3) *San Francisco – Wellington Radiotelegraph Circuit*

Frequency 9390 kc/s. An abrupt fadeout occurred at 0900 UT. By 0905 UT signals regained normal strength with flutter. This circuit operates on short schedules so that complete observations were not possible.

(4) *San Francisco – Wellington Radiotelephone Circuit*

Although no observations were made on this circuit as it was not in operation at the time of the nuclear detonation, it was reported that at 1900 UT the normal opening frequency 15580 kc/s was unusable and it was necessary to use 20930 kc/s. Conditions on this circuit and the Vancouver composite circuit (sections 1 and 2) were partly disturbed most of the time until approximately 2359 UT. The predicted MUF at 1900 UT was 17500 kc/s (Fig. 1B).

(5) *London–Wellington Direct Radiotelephone Circuit*

Frequency 14945 kc/s. London was barely audible at 0900 UT, but regained strength at approximately 0945 UT. Effects were masked by currently poor performance of this circuit, a normal feature of the sunspot minimum period.

(6) *Sydney–Wellington and Melbourne–Wellington Telegraph Circuits*

Frequencies 7360 kc/s (Melbourne), 7435 kc/s (Sydney), and 9390 kc/s (Sydney). At 0900 UT no immediate effect on the two lower frequencies was observable. By 0905 UT, rapid fading and flutter were observed. Signals returned to normal at 1000 UT. The SINPO reports were as follows (X indicates no assessment made):

Frequency 7360 kc/s		*Frequency 7435 kc/s*		*Frequency 9390 kc/s*	
Time UT	*SINPO*	*Time* UT	*SINPO*	*Time* UT	*SINPO*
0830	3543X	0830	4543X	0830	3543X
0900	3543X	0900	4543X	0900	1542X
0903	3542X	0905	3542X	0905	3542X
0930	3542X	0930	4542X	0930	3542X
1000	3543X	1000	4543X	1000	3543X

The predicted MUF at detonation time was 12500 kc/s (Fig. 1C).

Preliminary Report from Civil Aviation Administration, Auckland

(1) *Fiji–Auckland Radiotelegraph Circuit*

Frequency range 5 Mc/s upwards. An abrupt fadeout occurred between 0900 and 0906 UT, with gradual improvement thereafter and reception fully restored by 0935 UT.

(2) *Nandi Aeradio Station, Fiji*

Nandi reported all communications were disrupted for periods of from 5 to 24 minutes. By 1000 UT conditions had returned to normal. Reception at Nandi of radiobeacon transmissions in the 200–400 kc/s band from other islands and from New Zealand was completely interrupted for approximately 8 hours, although reception is normally good during night hours. Reception of medium frequency (MF) broadcasting stations located in the Pacific area was similarly affected.

(3) *Musick Point Aeradio Station, Auckland*

This station reported that the 2945 kc/s Air-Ground-Air frequency was completely unusable for several hours after detonation. It also reported that abnormal reception of Nandi transmissions on 17496 kc/s occurred at 1400 UT. This transmission is normally unheard at that time. The predicted MUF was 14000 kc/s for this circuit at the detonation time and 13000 kc/s at 1400 UT (Fig. 1D).

Report from New Zealand Post Office Coast Station, Auckland Radio

From the instant of detonation most of the transmissions on the normally busy MF maritime mobile telegraph band disappeared for approximately 10 minutes. However, transmissions on 500 kc/s from Wellington Radio were received at normal strength. There was no background of weak signals. Australian stations started to be received at strength 1–2 at 0918 UT.

There was no noticeable degradation of reception on 2182 kc/s, although it is possible that transmissions from Cape Reinga may have been missed owing to the explosion between 0910 and 0930 UT. Propagation conditions were not good on 2182 kc/s over this circuit at the time.

Report from New Zealand Post Office Coast Station, Awarua Radio, Invercargill

This station reported that beginning at 0900 UT a complete fadeout occurred for a period of 15 minutes on the 2182 kc/s maritime mobile radiotelephone frequency and that other New Zealand coast stations' transmissions dropped noticeably in strength during the same period on the maritime mobile radiotelegraph frenquency (500 kc/s). Also, on 500 kc/s, Sydney Radio dropped noticeably in strength. Brisbane on 500 kc/s, normally strength 3, faded out completely for approximately three minutes after detonation. KFS, San Francisco, 8558 kc/s, normally well received on the 8 Mc/s maritime mobile band, exhibited a marked drop in strength for about 20 minutes after detonation.

Intercepted reports from ships in the general area 167°–176°W and 24°–32°S indicated complete interruption to telegraph transmissions from New Zealand on 4250 kc/s and 8702 kc/s maritime mobile bands until 0927 UT. These ships also reported that the effect on 2182 kc/s in the maritime mobile radiotelephone band was that signals normally heard weakly disappeared, and that there was a pronounced decrease in the level of atmospheric noise. Vessels also reported that the normally crowded MF broadcast band (525–1605 kc/s) became almost silent.

Report from Superintendent, Radio Nukualofa, Tonga

A complete fadeout of the Nukualofa–Nandi radiotelegraph circuit on 4595 kc/s occurred from 0900 UT till 1000 UT, when the circuit was restored but with weak signals. The frequency bands above 5 Mc/s appeared to be much less congested than usual with few strong signals. This condition lasted until approximately 2000 UT.

Immediately after the detonation, New Zealand MF broadcast stations became inaudible and Fijian MF broadcast stations dropped to their daylight strength. This condition lasted for the rest of the night. Next evening conditions had returned to normal.

Report from Superintendent, Radio Niue

From the instant of detonation until approximately 30 minutes later the MF broadcast band reception ceased, except for ZCO Nukualofa, which is close enough to provide ground-wave reception. High frequencies appeared to be unaffected although reception of ZL7, operating on 6080 kc/s, was poor when the station opened at 1700 UT on 9 July (next day). Reception of this component of the Radio New Zealand HF Broadcasting Service to Pacific Islands is normally very good at this time.

Report from Superintendent, Radio Rarotonga, Cook Islands

A marked diminution in strength of high-frequency (HF) signals originating in Pacific coast areas and Australia was noted after the complete fadeout that occurred at detonation time. Signals observed before and after detonation were as follows:

20625 kc/s, NPG San Francisco.

7190 kc/s, VLG Melbourne

6980 kc/s, VKS3 Doonside, Victoria.

All these signals suffered approximately 20 dB drop in level immediately after detonation. The MF broadcast band suffered complete fadeout coincident with detonation, and recovery commenced about 30 minutes later, being almost complete by 1050 UT. Rarotonga also reported that the low-frequency end of the HF spectrum appeared to be most affected by the disturbance. A later report from Rarotonga reveals that on the night following the nuclear test New Zealand MF broadcast stations faded out completely at 0800 UT, although Australian and United States signals in the same band were normal. Two nights after the test, Australian and New Zealand MF broadcast stations again disappeared and United States stations were very weak. At the same time broadcasting stations in Fiji and Hawaii were of lower field strength than normal. The Superintendent attributes these two later fadeouts to longer-term effects of the nuclear detonation, as they are not part of the normal MF reception pattern at Rarotonga, nor were any naturally disturbed conditions predicted.

Report from Director, Posts and Telegraphs, Radio Apia, Samoa

This station observed a strong quick static burst on 500 kc/s and 2182 kc/s at detonation time followed by complete and abrupt fadeout with recovery commencing at 0920 UT. Communication with Nandi and with Wellington on 5750 kc/s was interrupted until 1000 UT and 1030 UT respectively. Short distance HF communications with Savaii, Tokelaus, and Pago Pago were not interrupted.

MISCELLANEOUS OBSERVATIONS

Automatic Recordings of Spectrum Occupancy, Mount Crawford, Wellington

Automatic chart records were made at the New Zealand Post Office Monitoring Station, of the occupancy of the nominal bands, 9400 kc/s to 10100 kc/s, and 12900 kc/s to 13100 kc/s, on 9 July. These showed that the nuclear detonation had the effect of reducing the number and strength of received signals for approximately 45 minutes after detonation (Figs. 2 and 3).

Although the charts show clearly the effect of the explosion, they are of only limited value in that there is no means of accurately identifying, before and after the detonation, all the incoming signals and their propagation paths. The station was not manned at the time, and even if it had been manned, identification is most time-consuming. Also the recording speed was such that it is difficult to fix exact times.

Report from a Private Observer, Wellington

Observations carried out privately in Wellington on reception of the "count-down" station "April Weather", transmitting on 12020 kc/s from Johnston Island, agree with other observations as to the suddenness of the

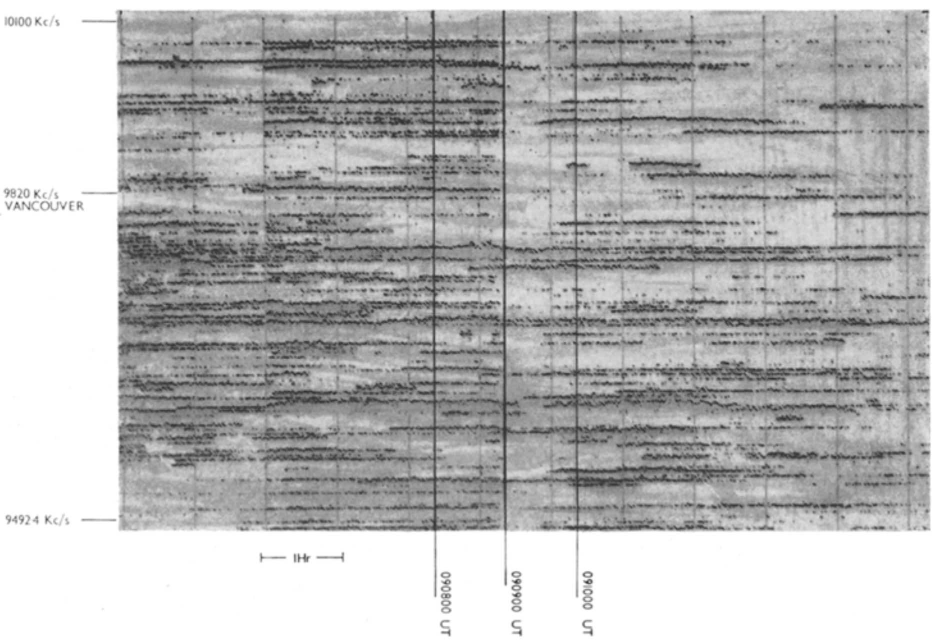

FIG. 2—Chart record of spectrum occupancy 9,400 kc/s to 10,100 kc/s, showing the marked diminution in the number of received transmissions immediately after the detonation. Original chart speed 1 in. per hour; reduced for reproduction.

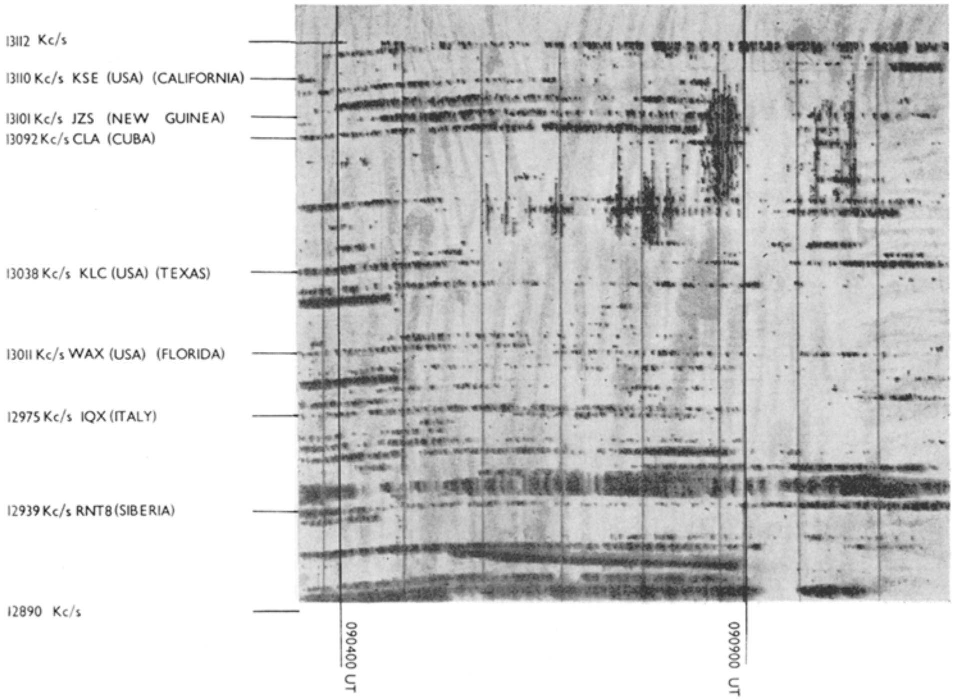

FIG. 3—As for Fig. 2, but for 12,900 kc/s to 13,100 kc/s.

onset of the fadeout. The short tone pulse indicating detonation time was clipped abruptly as detonation occurred. Simultaneously, signals abruptly disappeared from the 3500–3900 kc/s domestic amateur band, which had been occupied by numerous stations being received at good strength. Recovery commenced approximately 20 minutes after commencement of fadeout and restoration of normal conditions appeared complete by 1000 UT. During the recovery period all signals exhibited flutter, fading, and harshness of speech quality. Comments passed by amateur operators indicated that the phenomenon was observed throughout New Zealand.

Earth Currents, Invercargill

The New Zealand Post Office had been carrying out earth-current measurements between the telephone exchanges at Bluff and Invercargill. For some time before the nuclear explosion there had been no recorded earth currents. However, at 0900 UT on 9 July a deflection of 7 mA in a negative direction was recorded and this changed quickly to a positive deflection of 20 mA. The higher reading was recorded for about 5 minutes and then tapered off to zero in 30 minutes.

CONCLUSIONS

From the viewpoint of an operating agency the effect of the detonation was similar to that experienced under Sudden Ionospheric Disturbance (Dellinger) fadeout conditions, although normally this type of fadeout affects circuits lying wholly or partly on the daylight side of the globe.

ACKNOWLEDGMENTS

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