INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
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A PROPOSAL FOR THE USE OF ROCKETS FOR THE STUDY OF THE IONOSPHERE.

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This report presents an idea for investigation of the characteristics of the upper atmosphere by the use of rockets. The IRPL does not contemplate any construction or investigation along these lines at present, since previous commitments fully occupy facilities and personnel. Nonetheless it is thought that the principles described herein should be disseminated, with the possibility of bringing them to the attention of agencies which may be interested.

In a classified report by Dr. G. P. Kuiper, OSRD (JX/WP 31 of the Combined Wave Propagation Committee of the Combined Communications Board) it was mentioned that the Germans had equipped rockets of the V2 type with certain scientific equipment (spectrographs, etc.) to obtain data on solar radiation in the upper atmosphere. No details were given, however, and the possibility of investigating the actual amounts of ionization present at various heights was not mentioned.

Since it is established that the German V2 rockets penetrate to the height of the E region, it seems likely that rockets could be used to study the physical and radio propagation properties of that region, and even of higher regions, if we assume that the apparatus load in the rocket used for ionosphere studies would be much lighter than the present load of explosives carried by the V2.

The proposed rocket could be equipped with containers for automatically taking air samples at designated heights, and with radio equipment for radio propagation studies.

In the interest of safety the experiments should be performed on a large desert area and in the interest both of safety and of saving the equipment and samples, means of parachuting the rocket, or of automatically guiding it to a good landing should be provided.

Since it is believed that frequencies in the vhf or uhf range would not suffer retardation in the ionosphere, the true height of the rocket at all times could be determined by means of observing the total time of arrival of a vhf or uhf pulse sent out from the ground and repeated in the rocket by the IFF technique used in radar.

(over)

If tropospheric effects caused a real retardation, or an effective retardation by bending the path taken by the waves, this would only occur over a relatively small part of the path of travel and below the region being studied.

The time of arrival of each return pulse could be recorded photographically in a plot which could be calibrated so that the ordinates showed height determined from the time of arrival and the abscissa showed time starting with the time of emission of the first pulse. It is likely that any tropospheric effects would merely cause a jog in the graph which could be corrected by a process of estimation or perhaps by comparing the effect of the troposphere on emissions on two different frequencies. In Fig. 1 is illustrated a conception of how such a plot would appear. Frequencies used in this part of the work are referred to hereinafter as pilot frequencies.

One way to study the effects of the ionosphere on high frequencies (hf) would be to emit simultaneously a group of say fifteen high frequencies from the ground in synchronism with the initial pilot frequency pulses. These would be received by fifteen fixed receivers in the rocket. The energy received could be used to trigger off fifteen fm transmitters in a part of the frequency spectrum near the pilot frequency. Their frequencies could be deviated proportionally to the received intensities of the hf emissions. On the ground these return pulses would be received on fifteen receivers with oscilloscopes whose sweeps were all synchronized with the initial pilot pulses. It is evident then that continuous records made of the time of arrival of the pulses corresponding to each hf emission could provide a measure of the retardation existing in the ionosphere on each frequency for transmission to a given height (see Fig. 2). Records of the received hf field intensity as determined in each of the fifteen fm receivers on the ground, possibly controlling the height of the oscillograph pips or perhaps being recorded separately, would show, in conjunction with the time of arrival:

a. Absorption on each frequency in transmission to given heights.

b. The virtual height for each frequency when the field intensity suddenly decreases. These could be reported as the ends of the graphs in Fig. 2.

c. The coefficient of reflection, by showing what percentage of the energy is still being received after reflection.

Temperature and pressure conditions could be recorded on instruments inside the rocket or transmitted by radio-sonde techniques. Cosmic-ray intensities, ultraviolet-ray intensities and other phenomena could be handled in the same manner.

Attached:
2 Figs.

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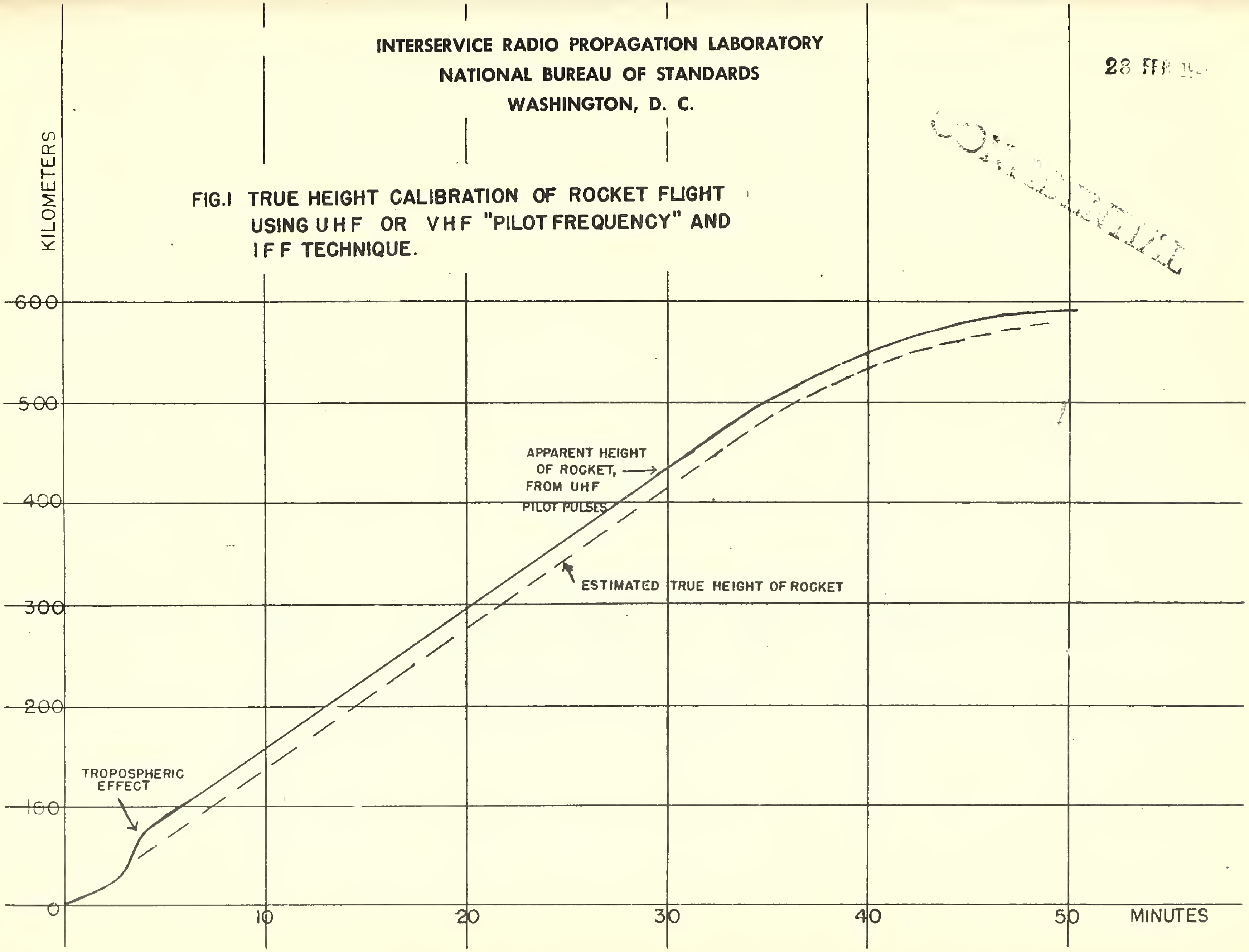

FIG.1 TRUE HEIGHT CALIBRATION OF ROCKET FLIGHT USING UHF OR VHF "PILOT FREQUENCY" AND IFF TECHNIQUE.

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FIG.2 PLOT OF VIRTUAL HEIGHT VS. TRUE HEIGHT OF IONOSPHERE FOR A GROUP OF FIXED FREQUENCIES RECEIVED IN A ROCKET.

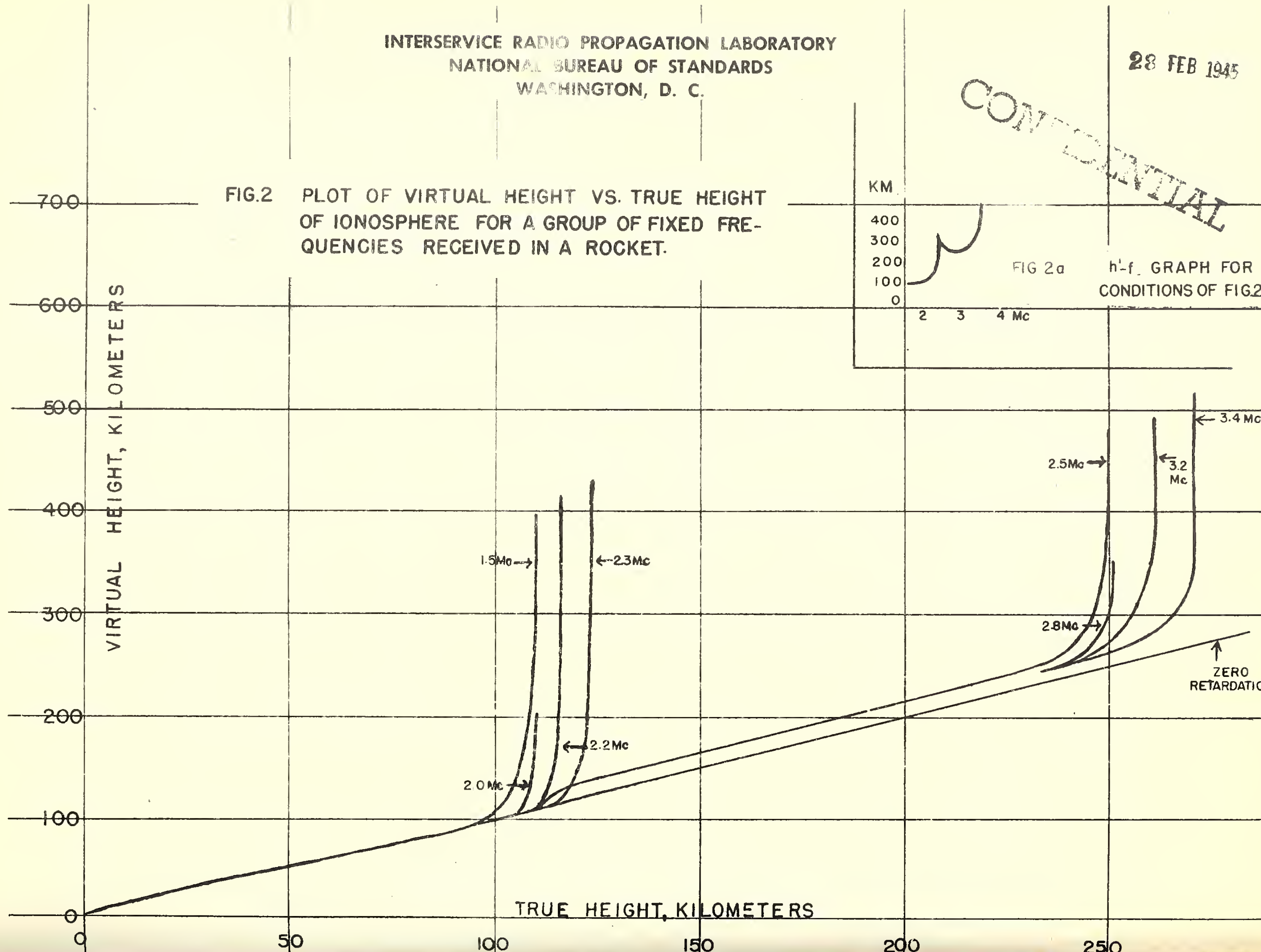

FIG 2a h'-f GRAPH FOR CONDITIONS OF FIG.2