# New Standard Frequency Broadcasts

Artist's conception of the antenna across Sunset Canyon for 20-kilocycle standard frequency broadcasts from Station WWVL. The copper-coated steel cable weighs more than a ton, stretches 3,400 feet from anchor to anchor, 900 feet above canyon floor.

THE BUREAU is now broadcasting a standard of radiofrequency from a new station in the Rocky Mountains at the very low frequency of 20 kc. Broadcasting began April 5 from Sunset Canyon, about 20 miles west of Boulder, Colo. Within their range, these signals will substantially increase the accuracy of the NBS standard frequency broadcasts.

Signals from the Sunset Canyon station (call letters WWVL) may reach as far as Hawaii—perhaps even to New Zealand—but they are not strong enough to provide good coverage over the entire globe. However, WWVL is only the first step toward eventually providing worldwide broadcasts at 20 kc.

Both time signals and the national standard of frequency are currently transmitted on a worldwide basis by the Bureau's two shortwave stations, WWV at Beltsville, Md., and WWVH on Maui, Hawaii. These signals are propagated by alternate reflections between the earth and the ionosphere to reach the receiver. But the height and density of the ionosphere change constantly and this creates small, erratic changes in the speed of the radio waves. Errors introduced by these changes were insignificant 10 years ago. Today, however, it is increasingly important to measure both time and frequency with greater and greater precision in order to coordinate the recordings of tracking stations for missiles and satellites, to measure minute quantities of electrical and radio energy in basic research, and to facilitate development in the field of electronics.

The low-frequency waves from Sunset Canyon will follow the curvature of the earth with the ionosphere and the ground acting as upper and lower limits of a gigantic duct to guide the signals over the globe. As the ionosphere will serve only as a boundary, not a direct reflector, it will have almost no effect on the speed of the waves. For this reason the 20-kc frequency will provide a much more stable transmission than the shortwave frequencies of WWV and WWVH.

The Sunset station is the result of several years of effort and several more years will be required before a true global transmitter is on the air.

Many investigations, by such men as J. A. Pierce at Harvard, have shown that very low frequencies can transmit standard signals over long distances wth great accuracy. A study in 1958 by A. D. Watt and R. W. Plush of the NBS Boulder Laboratories indicated that the 20-kc frequency was the most efficient to transmit a standard frequency on a global basis.

Radio waves, however, are not bound by international boundaries and use of the different frequencies must be approved by both national and international organizations. In January of 1959 the Bureau recommended that the 20-kc frequency be adopted by the U.S. group of the International Consultative Radio Committee (CCIR). CCIR adopted the proposal in April 1959 and in December 1959 the International Radio Conference at Geneva, Switzerland, adopted the 20-kc standard frequency band for the International Telecommunications Union (ITU).

In January of this year the U.S. Government's Interdepartmental Radio Advisory Committee (IRAC) approved a Bureau application to operate a 20-kc standard frequency broadcast and the new service was registered with the ITU. This action automatically placed a deadline into effect as international agreements specify that a valid registration requires a station to be in operation within 90 days after the application is approved.

To meet this deadline—and to rapidly and economically provide a better frequency standard for as large an area as possible—the Bureau modified an existing antenna in the Rocky Mountains.

The antenna was previously used for low-frequency ionospheric research, whistlers, and VLF emissions.

Although almost every division of the Boulder Laboratories was involved in determining the best frequency, obtaining the site, adapting existing transmitters to the job, and other tasks, prime responsibility for the Sunset development rested on a group headed by W. D. George, W. W. Brown, A. H. Morgan, and D. H. Andrews.

The antenna is a copper-coated steel cable stretching more than half a mile across the top of Sunset Canyon, more than 900 ft above the canyon floor. From the center of the cable another cable was dropped to a 20-kw transmitter at the canyon floor. This assembly forms a top-loaded antenna with the canyon walls acting as giant supports to hold the cables above ground. The tremendous size is necessary because of the great length of a 20-kc radio wave (each wave is almost 10 miles long, whereas television waves, by comparison, range from about 1 to 16 ft.)

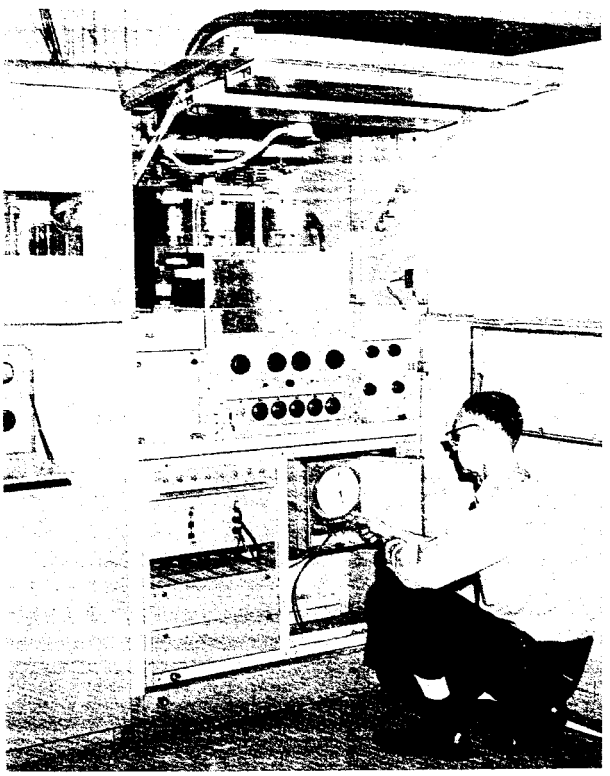
Currently, users of WWV can, in a few hours, use the shortwave signals to measure frequency to a few parts in $10^7$. Users within the range of the WWVL Sunset station (several thousand miles) will be able to make measurements about a thousand times better—to 1 part in $10^{10}$.

Initially the 20-kc signal will serve only as a frequency standard. Before the signal can be used to measure time intervals, such as a millionth of a second, new equipment must be built that will modulate the signal so that a particular wave can be identified at both the transmitter and the receiver. This is more difficult at very low frequencies because of the length of the waves involved. Research is being conducted to determine the best methods of cycle identification and time signal modulation.

The original signal will be used primarily by research organizations in studies to prepare for the eventual worldwide transmitter. Within a year the Bureau plans to build a pilot station (for the global transmitter) on the plains of Colorado and to transfer the Sunset equipment to the pilot site. The pilot station will be much more effective because it will be on the plains and will also have higher power, but will require the building of tall towers to support the antennas. In addition to the 20-kc signal the pilot station will also transmit a strong 60-kc signal.

To meet as many needs as possible for a better frequency standard within the United States, the Boulder Laboratories began broadcasting experimental, low-power, 60-kc signals in 1956. Because of their low power, these signals are not well received at distant points and their use is limited. However, more than 50 organizations, from coast to coast, have been using the signals during the past 2 years and have obtained from 10 to 1,000 times better precision than they received from the shortwave broadcasts. Because of the reliability and accuracy of these signals some organizations have been able to cancel plans for installing expensive atomic frequency standards within their own laboratories.

Both the 60-kc signals and the shortwave broadcasts will continue even after the global 20-kc transmitter is put in operation. The global station will provide standard time interval and frequency signals which will be accurate anywhere in the world to a few parts in $10^{10}$ for measurements made in a short period, and will thus serve U.S. possessions and bases overseas. The 60-kc broadcast, however—when its power is increased—should provide even better service within the United States (accuracies to a part in $10^{11}$). It is also relatively easy to modulate the 60-kc signals but this frequency is too high to be particularly effective beyond the continental limits of the United States.



**Howard Williams, who will operate the Sunset Canyon transmitter, adjusts the timer which controls the once-every-minute broadcast of the WWVL call letters.**

The range and accuracy of the 20- and 60-kc signals are critically needed by such groups as the U.S. Air Force; the National Aeronautics and Space Administration; the Atlantic, Pacific, and White Sands Missile Ranges; and the Smithsonian Institute (for satellite tracking). The special receivers, however, which are required to pick up these low-frequency broadcasts cost several thousand dollars.

For this reason, the shortwave broadcasts of WWV and WWVH will always be of value. They require only the simplest receivers and their accuracy is sufficient to meet the current needs of television and radio stations, electric power companies, amateurs, smaller businesses, and the general public.

In fact, the WWVH broadcasts should be improved by the initial Sunset transmissions. If the Sunset signal extends to Hawaii, as expected, it will be used to control the WWVH transmissions and thus increase their accuracy from ten to a hundredfold.

# Norton Wins Radio Award

KENNETH A. Norton, Chief of the Radio Propagation Engineering Division at the Bureau's Boulder, Colo., Laboratories has received the 1960 Harry Diamond Memorial Award of the Institute of Radio Engineers, the highest award offered to a government employee in the field of radio and electronics. He was cited for "contributions to the understanding of radio wave propagation."

Mr. Norton was presented with the award at the annual convention of the Institute in March. The award was named for the late organizer and first chief of the Bureau's Ordnance Development Laboratory, which is now operated by the Department of the Army as the Diamond Ordnance Fuze Laboratories.

This is the second year in succession that a Bureau scientist has won the award. In 1959, Jack Herbstreit, Assistant Chief of the Radio Propagation Engineering Division, was named.

Since he joined the Radio Section in 1929, Mr. Norton has been in the radio field continuously in various capacities. From 1934 to 1942, he was with the Technical Information Section of the Federal Communications Commission. He also served as consultant on radio propagation to the Chief Signal Officer of the Air Force and as a tactical counter measures analyst with the Eighth Air Force before rejoining the Bureau in 1946.

During the past ten years, Mr. Norton and his Division have played a major role in improving the use of radio for both communications and air navigation. The studies of the Radio Propagation Engineering Division are intended to promote and facilitate the more efficient use of one of the country's most precious natural resources, the radiofrequency spectrum.

In 1954, Mr. Norton received the Stuart Ballantine medal from the Franklin Institute. He was cited for "contributions over a period of 25 years in the field of radio propagation, through which our knowledge has been considerably increased by his measurments; our insight broadened by his theoretical work; our engineering calculations made easier by his charts, and our broadcasting frequency allocations above 50 Mc established more efficiently through his guidance."

Mr. Norton was born in Rockwell City, Iowa, and received his B.S. in physics from the University of Chicago in 1928. He has been a delegate to several international radio conferences, including the Provisional Frequency Board at Geneva, Switzerland, in 1948, and the High-Frequency Broadcasting Conference at Mexico City in 1948. He was vice-chairman of the U.S. delegation to the 1950 meetings of Study Group XI (Television Standards) of the International Radio Consultative Committee (CCIR). He was also a United States delegate to the Interim Study Group Meetings of the CCIR in 1958 and to the IXth Plenary Assembly at Los Angeles in 1959. Mr. Norton was a delegate to the eleventh general assembly of URSI at The Hague, Netherlands, in 1954 and was chairman of the Local Arrangements Committee for the twelfth general assembly of URSI held in Boulder in 1957.

He is a fellow of the American Physical Society, the American Association for the Advancement of Science, the Institute of Radio Engineers, and the American Institute of Electrical Engineers; a member of the Scientific Research Society of America, the American Geophysical Union, the American Mathematical Society, the Institute of Mathematical Statistics, and the American Statistical Association.