Chapter VI

Beyond 100 Meters:

Vhf and Hf Developments

From work carried on in Germany and other countries, it has become known that prolonged exposure of the human being within an ultra-short wave field will produce sterilization.

- Francis R. McCabe (1934)

Now I find out!

- Guy V. Wood (1958)[1]

Selection of a frequency range occupied a significant portion of time in Dwight Beatty's 1928 and 1929 field experiments. Selecting a frequency directly affects battery power, antenna length, signal-to-noise radio, transmission characteristics, and other diverse needs. The time of day and the terrain also must be considered before a frequency range is selected. The scarcity of commercial components for sale restricted the scope of Beatty's experiments. If "an optimum frequency exists ... which will provide the best signal/noise ratio at the receiver under a given set of conditions,"[2] then the complexity of Beatty's task, and his preoccupation with frequency, may be better understood.

To insure the effective transmission of daytime signals in timbered and mountainous terrain, Beatty narrowed his frequency criteria to three: What frequency would be the least susceptible to interference under these conditions? What frequency would result in a radio set light enough to be carried? What available components could accomplish all of this without resulting in a set too sophisticated or delicate for adverse conditions? From his consultations with NBS, NRL, commercial manufacturers, amateurs, and his own experiments, Beatty selected the region of 100 meters (between 3 and 4 MHz) as the most promising. This band was used for the SP-1930, SP, P, and M sets.[3]

A worldwide interest in the lower end of the 10-meter, very high frequency (vhf), spectrum began to occur about the time of Beatty's earliest field trials. On March 7, 1928, the 28- to 30-MHz region was reserved and authorized for both code and voice amateur use, as it still is today, more than 50 years later.[4] Almost immediately, numerous reports of trans-Atlantic broadcasts and receptions were received.[5] In spite of the success experienced by "hams," vhf was found useful for consistent transmissions only over so-called "line-of-sight" distances. Transmission of these higher frequencies over the horizon is due to radio wave reflection, or "bounce," from the ionosphere. This process is highly vulnerable to sunspot activity; it was considered erratic and resulted in fading of signals and wide variations between the quality of day transmissions (often poor) and night transmissions (usually better). Signals received hundreds of miles away might not be detectable only a few miles distant. For these reasons, the vhf spectrum at that time found little favor with users needing consistent performance. Such Government agencies as the Weather Bureau and the Navy, which relied on long-distance (DX) broadcasts, left the development of early vhf largely to radio amateurs.[6]

Early Radio Laboratory interest in vhf development was due to a combination of circumstances. Harold Lawson and Foy Squibb were aware of the advantages and peculiarities of the 10-meter band through their professional involvements, which included Lawson's membership in the American Radio Relay League.[7] Gael Simson was in a position to recognize and encourage their field experiments and to secure operating frequencies. Because other Government agencies in IRAC found no useful purpose in vhf, Simson was able to acquire an abundance of these channels for use in the Forest Service.[8] Although his motives in acquiring a large number of 10-meter frequencies are not recorded, Simson probably recognized the relationship between line-of-sight transmission and its application to Forest Service use. Because National Forests were then covered by a network of fire lookout towers, each one usually in sight of several others, line-of-sight radio transmissions had the potential for useful application.

Another benefit, and perhaps Simson's primary consideration, was that vhf was above the frequency spectrum for electrical interference during lightning storms. If vhf (10 meters) could be developed in the same manner as hf (100 meters), its ability to provide static-free transmission during lightning storms would aid forest firefighters during conditions that produced static interference and forest fires.

In addition to line-of-sight performance and static-free reception, vhf offered several other advantages. Because shorter wave lengths require shorter lengths of antenna wire, a transmitter-receiver operating at 10 meters can use an antenna about one-tenth the length required for 100 meters. This shorter wire is also relatively simple to install, especially when it became possible to incorporate an antenna of this length (approximately 7.5 feet) in the set as a telescoping rod.

Because vhf also required lower levels of power for line-of-sight transmissions, a corresponding decrease in battery weight was possible. The lower battery drain meant the operator could leave the receiver on for standby operation rather than rely on intermittent schedules of operation that often had receivers "Off" when they needed to be "On."

A final advantage of vhf low-power requirements was the possibility for duplex operation, that is, transmitting and receiving simultaneously.[9] With this feature vhf could more closely approximate telephone performance, as well as function as a relay for the immediate transfer of messages from point A to point C via point B.

A major reason for the lack of commercial development in the 30- to 40-MHz region was the relative absence of components that could operate at these shorter wave lengths. Amateurs have traditionally considered this a challenge. A ham inclined to conquer unexplored horizons will find suitable components either by combining unusual parts into a unique design or by raiding the "junk box" of a fellow ham. The end result is usually a unique product too complicated in parts and labor for profitable duplication by large-scale manufacturers.

This tendency to produce a custom design worked to the advantage of amateurs and was a logical approach for the Radio Laboratory. In fact, Beatty, Lawson, and Squibb designed Forest Service radios as if they were one-of-a-kind units intended for their own personal use. In the best of amateur traditions, their experimentation was based on a few articles read here, a conversation with other hams there, a few of their own ideas thrown in for good measure, and a lot of work. Within the limitations of space and size, they sought to package a unique concept for a specific situation--fire fighting.

Viewed in retrospect, this approach precluded early involvement by manufacturers in the design of hf or vhf portable radios. The Forest Service market was at best to be only several thousand units. As in any new endeavor, the cost of research was considerable. The demands of consumers for other products such as broadcast radios, military transmitters and receivers, and large fixed-base communication systems was real. Major corporations are geared to mass markets; the techniques of amateur radio enthusiasts have no place in their board rooms, production lines, or sales territories. Firms like RCA, De Forest, Radio Telephone and Telegraph Co., Westinghouse Electric Corp., and Zenith Radio Corp. were hard-pressed to duplicate Forest Service units of comparable size, price, or function at a profit.

Work Begins on Vhf in 1932

The work on very high frequency (vhf) began at the Radio Laboratory in 1932, shortly after the move to Vancouver.[10] Following the successful 100-meter development plan, a high-power 10-meter transmitter was constructed for fixed-base use. A prototype portable design was installed at Wind River for field tests during 1933. These tests proved satisfactory and led to the production of a small number of portables that were distributed to selected Regional locations for intervisible communication, "one of the most intriguing uses of radio ..."[11]

A 5-meter set, designated type V (for Roman numeral five), was also completed in time for the 1934 fire season. Two units were shipped to Bill Apgar at Savenac Nursery. Apgar tested the equipment and found it lacking. "I eventually believe the equipment will be of use," he wrote of the 60-MHz set, "but in its present state of development and in view of its limitation, I should hesitate to acquire more than enough for experimental purposes."[12]

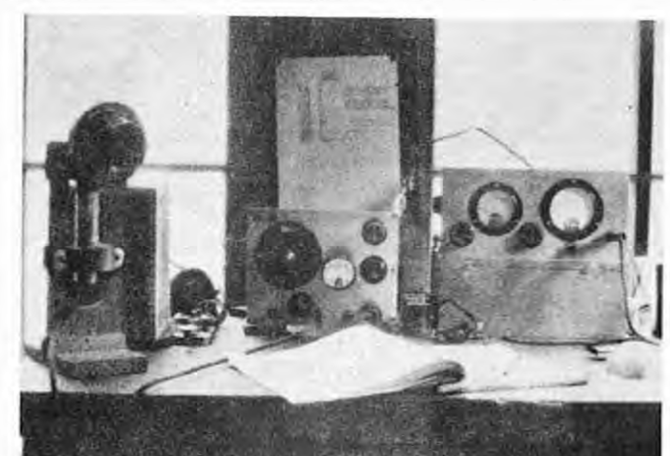


Figure 55. Photo at left shows an early version of Harold Lawson's 10-meter-band vhf portable radiophone, center, at Wind River Forest Experiment Station, Wash., 1933. Photo at right shows Harold Lawson testing a later version, also at Wind River. Note the absence of the panel meter that is on the front panel of the set in the photo at left. (Forest Service photos, History Section)

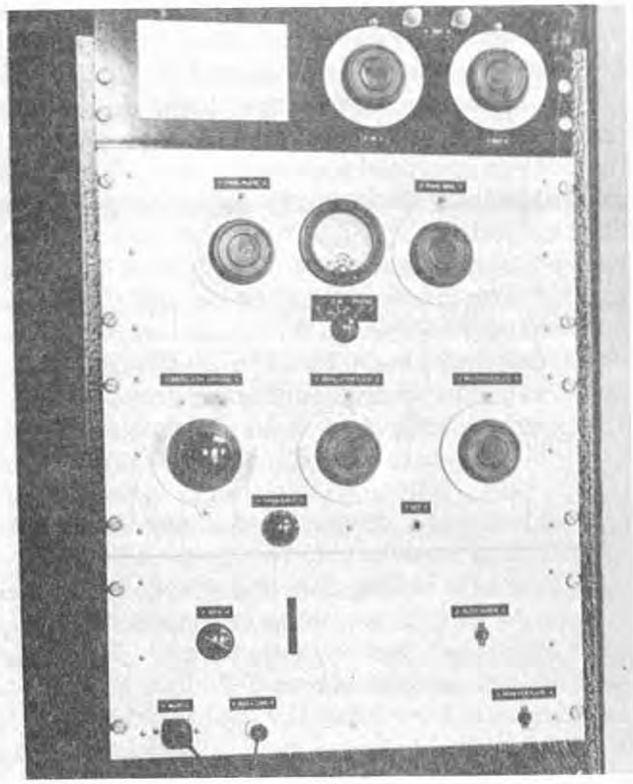


Figure 56. High-power, fixed-base vhf transmitter begun at the Radio Laboratory in Vancouver, Wash., in 1932 and installed at Wind River in 1933. (NA:95G-302664)

The type V failed to perform as expected largely because the receiver could not operate satisfactorily at 60 MHz.[13] An example of pushing components beyond their limits, it could not make the transition from test bench to field use, and the 5-meter band was abandoned for the less demanding range of 10 meters. With a triad consisting of portables, semiportables, and fixed-base radios, each phase of Forest Service vhf fire-radio needs would be met. The working plan for the 10-meter models was identical to that of the previously successful 100-meter units. By early 1934, Harold Lawson had completed the design of the portable type S set (superregenerator) and Foy Squibb, who had returned from field tests and installations, completed design of the semiportable type T sets (ten meters). Calling again for bids on working models, the Radio Laboratory had vhf units available for Regional testing by late 1934 and subsequently produced for the 1935 fire season.[14]

Like their 100-meter counterparts, these vhf units represented the best portable and semiportable design. The T set, for example, transmitted and received voice only and weighed between 30 and 100 pounds, depending on battery selection. It cost $50 to $60, was rated at a working range of 50 miles "over optical paths," designed for standby operation, and could be operated duplex.[15] While lacking the capability to operate duplex, the S set redeemed itself with a low initial price tag of $26 and a mere 10-pound weight. The set-up time of under 2 minutes provided smokechasers, scouts,

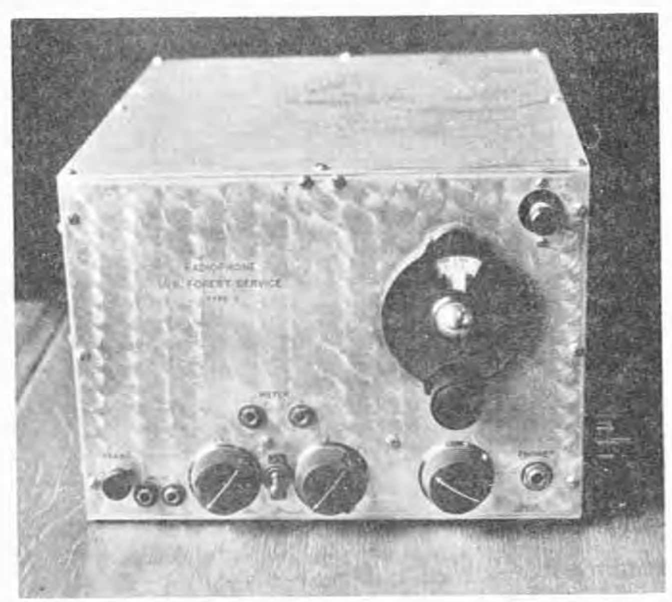


Figure 57. Experimental type V 5-meter-band radiophone field-tested during the 1934 fire season in Region 1 and found deficient because the receiver could not operate satisfactorily at 60 MHz. The 5-meter band was then abandoned for the less demanding range of 10 meters. (NA:95G-274974)

and fire chiefs with an adequate tool for ranges of 50 miles "over optical paths."[16]

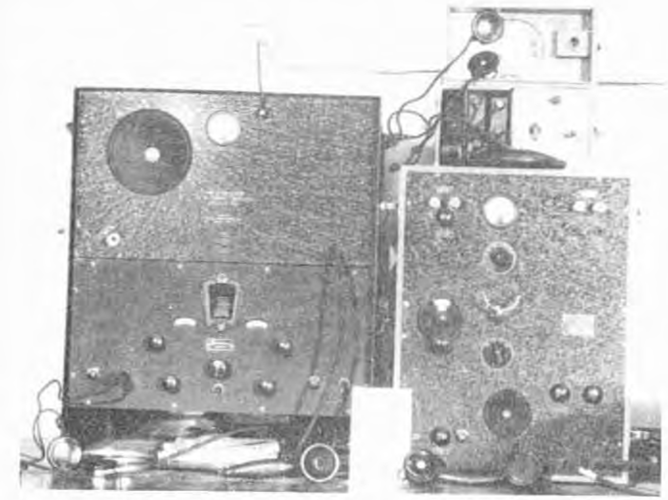


Figure 58. Type S (superregenerative) portable (10-pound) vhf set atop a later type T semiportable set, at right. Both of these 10-meter-band sets were designed and tested in the Regions in 1934. They were produced in volume for the 1935 fire season, when they received some mobile testing. Both were voice transmitter-receivers with a working range of 50 miles, line of sight. At left is a type M set mounted in a field cabinet. (NA:95G-362772).

In addition to experimenting with the S and T sets in mobile communications during 1935, the Radio Laboratory also worked to complete a vhf/lf receiver-transmitter for airplane use. The result was the type A (Airplane) designed for quick installation and capable of sending and receiving "...satisfactorily from plane to ground, even in unshielded planes."[17] It weighed about 25 pounds, and operated from a 6-volt battery that also lent itself "...to automobile installation for two-way communication from moving vehicles under favorable topographic conditions."[18]

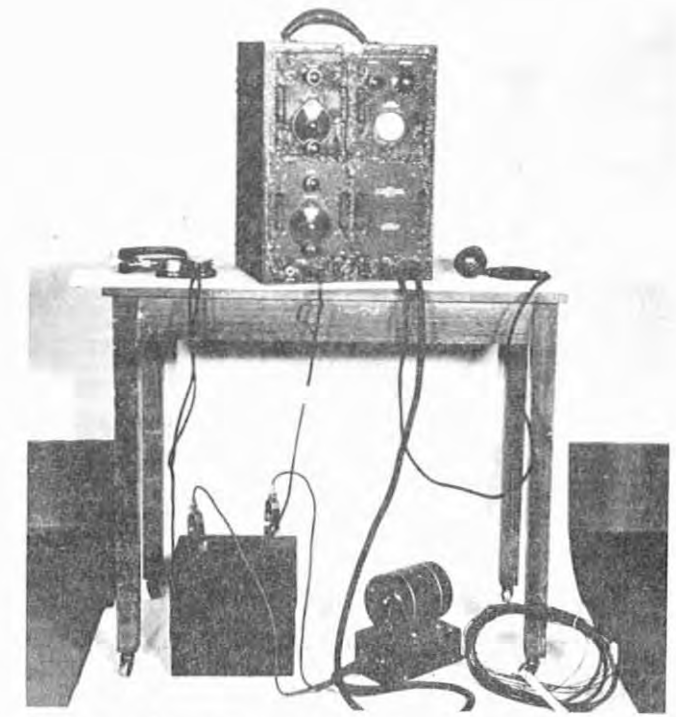


Figure 59. Type A set, a vhf receiver-transmitter, was designed for use in airplanes for air-to-ground communication, but was also operable in moving automobiles. It became available early in 1936. (Forest Service photo, History Section).

Spokane Firm Gets Contract

The workload at the Radio Laboratory was heavy, so Simson decided to have the initial model of a fixed-base, vhf transmitter constructed by an outside source. Preliminary schematic drawings had already been completed by Lawson. Spokane Radio Co. was low bidder for building the set.

SRC, of course, had "manufactured" the first eight sets of Beatty's SP--1930. The firm had also successfully bid on other units and played a significant, advisory role in the Forest Service program between 1931 and 1934.[19] Started as a local parts and repair facility for commercial radios, it had entered a wide range of electronic activities. The founder was Morris Willis. With his uncle, A. F. "Speed" Horton, and Frank Prince and Ted Young as engineers, plus a handful of regular and temporary employees that included Foy Squibb in 1930, Willis made SRC one of the more successful electronics firms in the Pacific Northwest.[20]

Working with Lawson's drawings for a moderate-power 10-meter set, Prince, Young, and a new employee, Logan Belleville, began to experiment with circuits that "...were a little bit of this and a little bit of that."[21] Belleville assumed the major share of the design, and the U set (for UHF) began to take shape.

In its final form, the type U was enclosed in a 4-foot, 9-inch console and weighed about 300 pounds. Like its hf counterpart, the M set, it used a commercial receiver, a National SW3 superregenerative. With an output power of 20 watts, the type U, priced at $400, rounded out the vhf triad.

Because of Belleville's knowledge of vhf and acceptance of the U set, Simson arranged to borrow Belleville from SRC during August 1936. He was placed temporarily as a junior radio engineer, and paid out of CCC and WPA (Civilian Conservation Corps and Works Progress Administration) funds. Belleville later achieved permanent Civil Service status.[22]

Logan Belleville had acquired radio background much as Lawson and Squibb had. As a young boy in Twin Falls, Idaho, he "was kind of a loner;" he did not get along easily with most others of his age. Instead of conventional youthful activities, he found tinkering in electronic communications exciting. With a young friend down the street, using cracked-off bottle tops for insulators, salvaged wire, and whatever parts that could be found, he devised a workable communication device between their two homes. Later, Belleville decided to attempt the same feat with wireless. He learned what parts he needed for an amateur set from library books. His product, though workable, could receive only a local amateur because the electric power lines into Twin Falls passed directly over the Belleville home.[23]

Figure 60. Logan Belleville, who designed it at the Radio Laboratory in 1936, is at the controls of a type U-30-25 fixed-base vhf radiophone with output power of 20 watts, in the Region 6 headquarters in Portland, Ore. (Forest Service photo, History Section).

Encouraged by his father, who gave him a vacuum tube for his birthday and a set of double earphones for his success in using the tube, Belleville became an astute follower of radio developments. With the attitude that "...if it ever worked, I could make it work again," he started to repair broadcast radios for the local residents.

A year after high school graduation, Belleville caught a ride to San Francisco, where his repair experience landed him a job with a local radio company. Duties included service calls "from Chinatown to out in the ocean," but he returned to Twin Falls after becoming homesick.

Spirits refortified several weeks later, Logan decided to try his fortune in Los Angeles. His first job was as a department store technician repairing sets before they went on the shelf. Next he worked at the service desk for a major radio manufacturer, repairing sets that dealers could not fix. At his third job, identical to the one in San Francisco, he again found the lure of home irresistible.[24]

Belleville found employment as a radio announcer back in Twin Falls. Encouraged by the station owner, he obtained a commercial first-class radio license and an amateur license (W7CFX). He operated a radio repair shop during off hours. At the shop he came into contact with A. F. "Speed" Horton, who was on the road selling electronic components for SRC. Because of Belleville's demonstrated knowledge of radio, Speed put him in contact with Morris Willis who put him on the SRC customer service desk. There, Willis recognized Belleville's potential and promoted him to help develop the Forest Service type U set.[25]

Before Belleville came to the Radio Laboratory, Gael Simson had obtained authorization to add a few other employees to the staff. He hired Ralph H. Kunselman before the move to Portland. Carl B. Davis joined the staff a year later. These two technicians constructed the prototype of most Laboratory sets. About this same time, Foy Squibb was temporarily assigned to install a number of his type T sets on the Cumberland (now Daniel Boone) National Forest in Kentucky. Lack of funds prevented his return to the Radio Laboratory after the installation was complete.[26]

In an effort to overcome the inability of the M sets to perform on the Forest Service patrol boats along Alaska's southeastern coast, Harold Lawson offered Wilbur "Bill" Claypool temporary employment. Claypool accepted, and the personnel count at the Laboratory remained near six through 1936.

Bill Claypool came to the Forest Service from a job as regional service manager for a Portland firm handling Stewart-Warner refrigerators and radios.[27] He had been familiar with Lawson's radio work for some time. He had acquired his amateur license in high school (9DDV, and then 7UN, NU7UN, W7UN, 3UN, XEUN and, "hopefully," XE1UN) and had "ham sessions" with Lawson in 1931 when the PCL-1 was under test.[28] In 1936, Lawson and Claypool became closely acquainted while serving with six others on the organizing committee for the American Radio Relay League (ARRL) convention in Portland.

B2 Set Designed for Alaska

Claypool suspected that the failure of the Alaskan type M was due to the 100-meter frequency selection and a low power output. To test his theory, he drew up plans for a dual-channel transmitter that would operate above and below the 3-MHz type M. After beefing up the output by a factor of 10 and adding a Hammarlund Comet Pro receiver, Claypool dubbed the new design the type B2 (Boat) and headed for Alaska. He discovered almost immediately that the 200-watt B2's were enough to make "the sparks begin to fly."[29]

Without an effective gound system, however, everything on the patrol boats was "hot"--the power shaft, propeller, and control room. After drydocking the boats, Claypool had large copper plates installed on the bottoms and then insulated the antenna footings. This cured the problem and the B2 set, operating at 2.3 and 4.6 MHz (130 and 64 meters, respectively), provided adequate communications until a small 100-watt version was completed a few years later.[30]

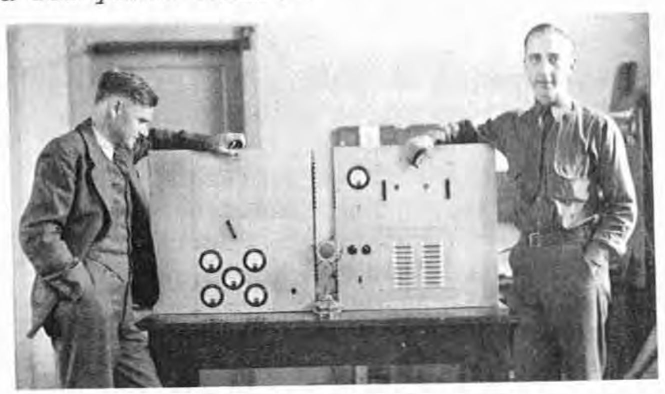


Figure 61. The B2 200-watt, dual-channel transmitter (130 and 65 meters), designed by the Radio Laboratory, worked well for forest patrol boats in the Alaska Region. Builder Wilbur Claypool of the Laboratory is shown on right and Gael Simson on left. (NA:95G-305778)

Other experiments in vhf were also conducted during this phase of Laboratory work. In an attempt to determine the relative performance of various vhf operating frequencies, Simson, long a believer in the utility of establishing a Servicewide radio network, traveled the country with the soon-familiar "Simson's Suitcase" built at the Lab. With the suitcase, he could effectively test four channels. It started on a fundamental frequency; then the press of a button would give the second, third, and fourth harmonic (the fundamental x2, x3, x4). Morning and evening, no matter where he was, he would try to contact Portland. (By 1941, Simson was up to 4.5, 9.0, 13.5, and 19.1 MHz, respectively, but he never succeeded in finding a satisfactory all-Service frequency.)[31]

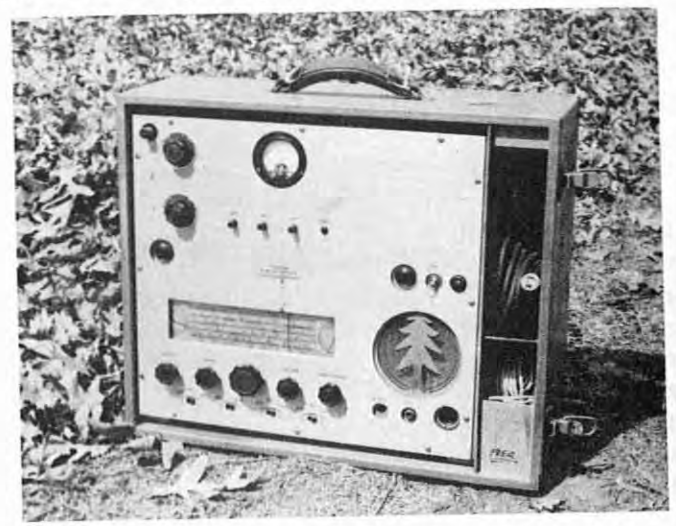


Figure 62. "Simson's Suitcase," which was carried around the country by its builder, Gael Simson of the Radio Laboratory, in an unsuccessful effort to find an optimum Servicewide frequency channel for a potential national radio network for the agency. (Forest Service photo, History Section)

The Radio Laboratory's progress in producing up-to-date radios was paralleled by physical improvements to the facilities. The brick exterior got a fresh coat of paint and a new addition put on the rear of the building. The appearance of a more modern facility was heightened inside, where the changes were equally impressive, with a separate room set off for communications. Here Logan Belleville led the group in designing a 250-watt transmitter--"a beautiful thing"--that kept KBAA at the Laboratory in contact with the men while they were on various assignments around the Pacific Northwest.[32]

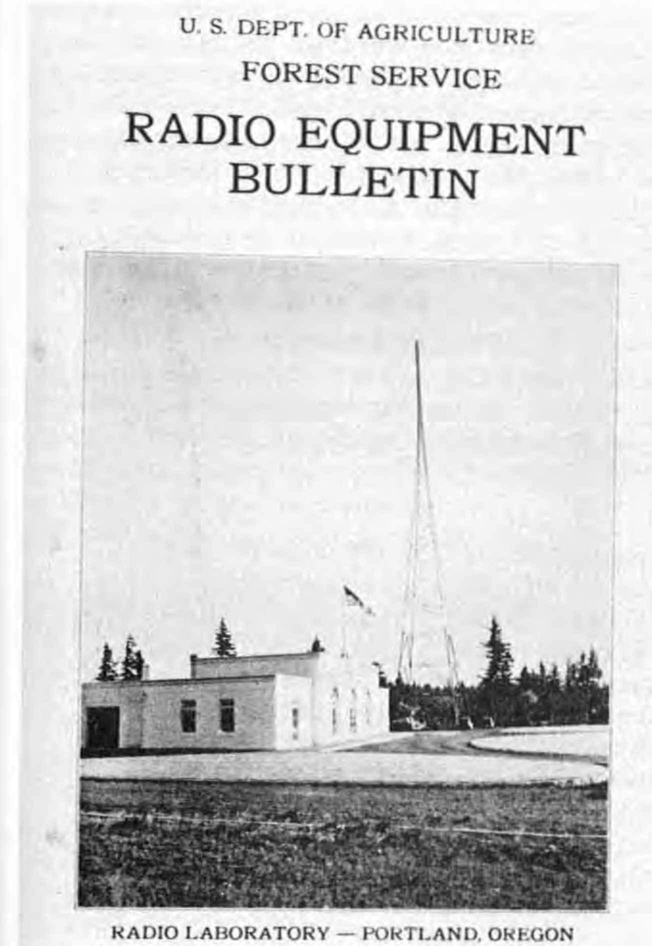


Figure 63. The Forest Service Radio Laboratory at Portland, Ore., in 1939, appeared on cover of "Radio Equipment Bulletin." (Forest Service photo, History Section)

With a full complement of vhf and hf radios in the portable, semiportable, and fixed-base classes, activities at the Radio Laboratory might have been expected to subside. This was not the case. In addition to improvements brought about "almost daily [by] new tubes, parts and technique..."[33] and the problems experienced with the commercial vhf receivers, the men recognized that their initial design efforts needed constant updating. "By modern standards," Harold Lawson was to recall, "we had some pretty sad pieces of hardware. For their day

Figure 64. Transmitting and receiving equipment at the Radio Laboratory's Station KBAA, Portland, Ore. A new 250-watt transmitter installed about 1939 kept the Laboratory in close touch with personnel on field assignments. (Forest Service photo, History Section)

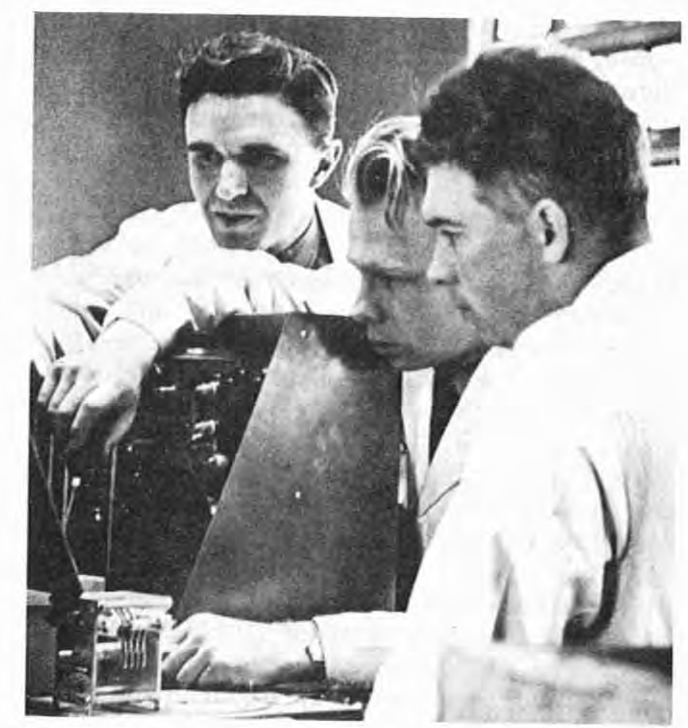


Figure 65. Checking the performance of a new vhf prototype at the Radio Laboratory. Left to right are Harold Lawson, Logan Belleville, and Carl Davis. (Forest Service photo, History Section)

most of them were pretty good, but we had a few 'dogs'..."[34]

Their desire to leave nothing to chance spurred them to tackle every identified problem. They experimented with variations that would improve the product and conducted studies on every new concept. For minor changes, a model change was made. For major changes, a new design was undertaken.

As a result, a significant number of Laboratory model changes were made before 1941. The M set, for example, went through variations that included the models B, C, and D. The T set had three model changes, the SPF and T/D each had five, the I had three, and the Relay Repeater Station (RRS) eventually had six variations.[35] Some of the changes involved only minor alterations intended as "fixes" for particular problems. In other cases, the modifications altered the physical appearance of the unit and changed the original function of the sets.

KA Model for Airplanes

After the Laboratory improved portable receiver design, the new M sets no longer included a separate Hummarlund or National receiver. Instead, each incorporated a receiver of Forest Service design. The end product not only changed the appearance but also changed the specifications so much that the M set could conceivably drop from the fixed-base class to that of the semiportable. Improvements found beneficial in a number of different sets were also grouped together with a few other new ideas in updated designs; this was reflected in the type KA (Kar-Airplane) in early 1940.

The type KA was intended to be the vhf (34.22-MHz) airplane counterpart of the S, T, and U sets. It incorporated circuits from the earlier mobile vhf version and was intended to eliminate much of the electronic noise associated with spark-type ignition systems. It had a new feature called the "squelch control" that the instructions pointed out did not contribute to sensitivity but merely relieved the constant hissing noise characteristic of this type of receiver. When it was set only to the point where the hiss disappeared, any signal strong enough to be heard above the squelch could be heard "full volume."

Improvements in the transmitting section of the KA incorporated features familiar to operators using other types of Forest Service radio equipment. Having learned through experience the tuning procedures most acceptable to operators, the Laboratory designed the front panel of the type KA to be similar "to the tuning procedures for the type M radiophone."[36] By assimilating the mobile concepts of the type K and operational features of the type M, incorporating new circuits, and designing from experience gained with the previous airplane type A, the staff was able to "invent" the new composite type KA.

With only minor staff changes between 1935 and 1941, the small Laboratory coterie was responsible for 9 entirely new types of radio equipment, some 27 model changes over the full complement of Forest Service radios, inumerable "fixes," and several types of unique hardware and test equipment. Although some may have "lacked refinements by modern standards," they had a decided effect on the adoption of electronic communications, fire-control procedures, and administrative management procedures in the Forest Service. They also affected the development and

design of radios in the military and private sectors.

The path to success, however, was marked by many trials and tribulations. As events were to indicate, the Radio Laboratory was more than a hobby shop.

Reference Notes

1. Francis R. McCabe, "The Use of Radio in Forestry," (Senior thesis, School of Forestry, Oregon State Agricultural College, 25 April 1934), p. 28; and penciled note in margin by Guy V. Wood, 28 January 1958, Gaylord A. Knight Collection.

2. Keith Henney, ed., *The Radio Engineering Handbook* (New York: McGraw-Hill, 1941), p. 538.

3. Wavelength in meters is found by dividing velocity in meters per second (300,000,000) by the frequency in cycles. Thus, 3,000,000 cycles, or 3 MHz, is effectively 100 meters. In the interest of clarity, 100 meters is used in the text to represent the general range of Forest Service frequencies below 4 MHz, and 10 meters for the range of 28.5 to 32.5 MHz actually used in this band by the Forest Service.

4. The classification of frequency ranges was shifted upward about the time of World War II. Hence, uhf was downgraded to vhf (30-300 MHz) and appears in more recent texts and articles as such. Because all Forest Service documentation prior to World War II used the older terminology of uhf for any frequency above 30 MHz, and vhf for the 10-meter band, a number of quotes in the text will not appear correct. The same confusion will appear over the later renaming of kilocycles (kc) and megacycles (mc) as kilohertz (kHz) and megahertz (MHz), respectively. However, in the interest of clarity, I have opted to use the present designations rather than expect the nontechnical reader to make a later transition. Where a quotation uses the older terminology the modern designation will be immediately braketed, e.g., [kHz], [uhf], etc.

5. Roland F. Spooner, "1978-Fifty Years of Ten Meters," *Ten-Ten Chapter News* 16, no. 2 (Spring 1978), p. 8.

6. L. S. Howeth, *History of Communications-Electronics in the United States Navy* (Washington, D.C.: Government Printing Office, 1963), pp. 387, 410.

7. Lawson was on the organizing committee for the ARRL convention in Portland in 1927. See Wilbur Claypool, interview with the author in San Antonio, Tex., July 1978.

8. Lawson and Squibb both agree that Simson had an "intuitive" feeling for vhf based on "inquisitiveness or foresight." Neither one recalls his own early interest, and both credit Simson with the initial impetus. See Harold K. Lawson, interview with the author in King City, Ore., May 1978, and W. Foy Squibb, interview with the author in Missoula, Mont., May 1978.

9. A. Gael Simson, "U.S. Forest Service Radio Equipment," 2 January 1935, mimeographed memorandum, p. 3, Gaylord A. Knight Collection.

10. William B. Apgar, "Report on Radio Activities at Savenac Nursery--1932," 30 November 1932, p. 9, Gaylord A. Knight Collection; and McCabe, "Radio," p. 28.

11. F. H. Brundage to the Forester, 26 January 1934, Gaylord A. Knight Collection.

12. William B. Apgar, "Radio Communications Report--1934," [nd],

[ca. late 1934-early 1935], typed copy, p. 8, Gaylord A. Knight Collection.

13. Lawson, interview with the author.

14. W. Foy Squibb, "Diary," 4 June 1934.

15. A. G. Simson, "Radio Equipment," 2 January 1935, p. 4, Gaylord A. Knight Collection.

16. Simson, "Radio Equipment," p. 4.

17. Simson, U.S. Forest Service Radio Developments," 10 April 1936, typed copy, p. 4, Gaylord A. Knight Collection.

18. Simson, "Radio Developments," p. 4.

19. Lawson, interview with author and Logan Belleville, interview with author in Saratoga, Calif., January 1978.

20. Belleville, interview with author, and Morris Willis, interview with author in Santa Barbara, Calif., January 1978.

21. Belleville, interview with author.

22. Belleville, interview with author.

23. Belleville, interview with author.

24. Belleville, interview with author.

25. Willis, interview with author.

26. Squibb, interview with author, and Lawson, interview with author.

27. Wilbur Claypool, interview with author in San Antonio, Tex., July 1978.

28. H. K. Lawson to W7ARZ [Wally Guthrie], Salem, Ore., 29 May 1931, Gaylord A. Knight Collection.

29. Claypool, interview with author.

30. Claypool, interview with author.

31. Frequency markings on the "Suit-case" now in storage at the Electronics Center, Beltsville, Md.

32. Lawson, interview with author, and various "Field Diaries" of Laboratory personnel.

33. U.S. Department of Agriculture, Forest Service, *Radio Handbook* (Washington, D.C.: U.S. Department of Agriculture, Forest Service, Division of Operation, circa 1938), p. 7, Mimeographed.

34. Lawson, interview with author.

35. See Appendix I; also chapter 7, pp. 106-108.

36. Forest Service Radio Laboratory, "Instructions for Operating Type KA Radiophone," 15 June 1940, Gaylord A. Knight Collection.

Chapter VII
Improved Designs:
Standards for the Future

Though the newspapers--and we ourselves--may be prone to treat them with no more than an off-hand respect, these sets are, even in a purely mechanical light, one of the outstanding wonders of the radio world. Improvement must still go on, but when viewed in a utilitarian way their worth--not only to the cause of conservation, but to society as well--already can hardly be evaluated either in dollars and cents or in words.

- Forest Service *Service Bulletin*[1]

By 1935, the rapid growth of radio use by Forest Service field units was complicating the administration and control of the radio project. The 700 radios available for operation, mostly in California and the Pacific Northwest, were congesting the limited frequencies allotted.[2] Using vhf had alleviated the problem somewhat by transferring part of the load to the 10-meter allocations, but the value of 100-meter radio was still important for nonline-of-sight transmissions. At a Forest Service communications conference in Portland in early 1935, "overcrowding" on the 100-meter band was discussed at length.[3]

To eliminate part of the congestion, the committee that planned the conference suggested that the Radio Laboratory staff design an intermediate-power transmitter of about 10 watts to fit between the 5-watt SP Special and the 20-watt type M.[4] The proponents argued this change '...will remove many more costly M sets from the air as well as reduce the interference between regions and forest on shared frequencies." Although "practically divided" on this point, the committee agreed "after rather exhaustive investigations" that "low power should govern" and that an improved receiver for the SP Specials would provide "adequate communication" in the semi-portable line. If this did not prove satisfactory, the committee requested that "...a new type set should be designed, but not until after an examination has been made by the technical staff at the Laboratory."[5]

The communications committee also reiterated the Forest Service policy of avoiding radio communications for all but fire control in an effort to further reduce inter-Forest, 100-meter interference. The practice of using the 3- to 3.5-MHz band for administrative business, or point-to-point communication, despite a prohibition, had been increasing steadily and was another cause of overcrowding. The committee cautioned that, "consistent with the agreement in effect between the A. T. & T system and the Secretary of Agriculture, we cannot ethically use radio for point-to-point communications where adequate private telephone facilities are available."[6]

The Laboratory staff set out to implement the conference mandate. In an attempt to provide a radio set of intermediate size and power, they sought (1) to improve the performance of the type PF (instead of that of SP Special as suggested) and (2) to lower the power of the type M.

In the meantime, Bill Claypool returned from Alaska to learn that the Laboratory temporarily lacked the funds to keep him on the payroll. He decided to open a marine radio sales and service shop in southeastern Alaska. While Claypool was in Portland to gather equipment for this venture, the financial situation improved, and Harold Lawson won him back with an assignment to improve the PF. (Claypool went back to Alaska later as an employee of the Forest Service.)[7]

The major problem with the type PF was its regenerative type receiver. It operated best when finely tuned to the point of breaking into oscillation. This made it a delight for experienced operators but proved difficult for the scarred and battered hands of a firefighter. Lacking the comfort and quiet of a lab or office, the harried men on the fireline had neither the time nor the patience to deftly locate the critical telltale hiss indicating regeneration.

Claypool set about designing a more acceptable receiver, assisted primarily by Lawson. For several months, he made many trips between books, drafting table, and workbench, attempting to master the fundamentals of superheterodynes. At one point, when neither Claypool nor Lawson could figure out the mathematics for a tracking oscillator in the 455-*if* stage, a traveling salesman came by. Learning of their problem, this graduate of "a prestigious school in the East" sat down and "whipped out" the answer for them.[8] The other circuitry was completed in due time and the newly designated SPF (Semi-portable phone) was ready for the 1936 fire season.

SPF Is Big Success

The success of the 2 1/4-watt SPF was immediate and it went on to become a legend. About one-half again as large as its predecessor, and weighing an intermediate 21 pounds, 6 pounds more, it was still light enough for smokechasers. With the kitbox, it was also hefty enough for temporary fire camps. Rugged in appearance and construction, it provided adequate service, amazingly, for 20 years after production stopped.

New Forest Service communication technicians continued to "cut their teeth" on the venerable SPF into the 1960's. Known on the fireline as the "short-peckered friend," it gained the respect of all who had to depend on it. Even Bill Apgar in Region 1, who found much to complain about, remembered that "those SPF's were a dream."[9]

Figure 66. Front view of SPF model set up for portable use. (Forest Service photo, History Section)

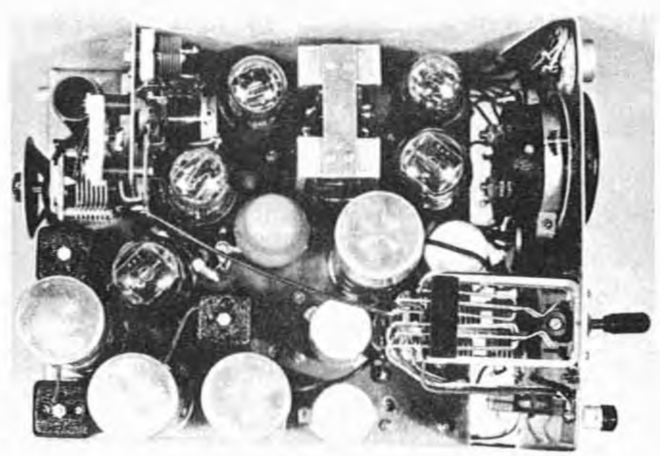


Figure 67. Interior view of SPF model. (Forest Service photo, History Section)

Figure 68. Smokechaser with SPF model set up for portable use on the Spud Hill fire, Columbia (now Gifford Pinchot) National Forest, Wash., 1937. (NA:95G-354925)

Figure 69. SPF model set up for semi-portable use at a Region 6 temporary base camp. (Forest Service photo, History Section)

The design of an intermediate-power, fixed-base, 100-meter unit followed that of the SPF. Based on the suggestions of the 1935 communications conference, the Radio Laboratory worked on altering the type M, now in its third modification, after abandoning the Hammarlund Comet Pro for the superheterodyne receiver of Claypool's SPF. Starting with the type M model D, the lower-powered version became the type I (Intermediate power). Virtually identical in appearance to the M, the type I weighed 66 pounds with all accessories, had a nominal output of 9 1/2 watts, and operated from batteries. Although the communications conference recommended it to reduce frequency crowding, its 20-watt predecessor outsold it 4 to 1.

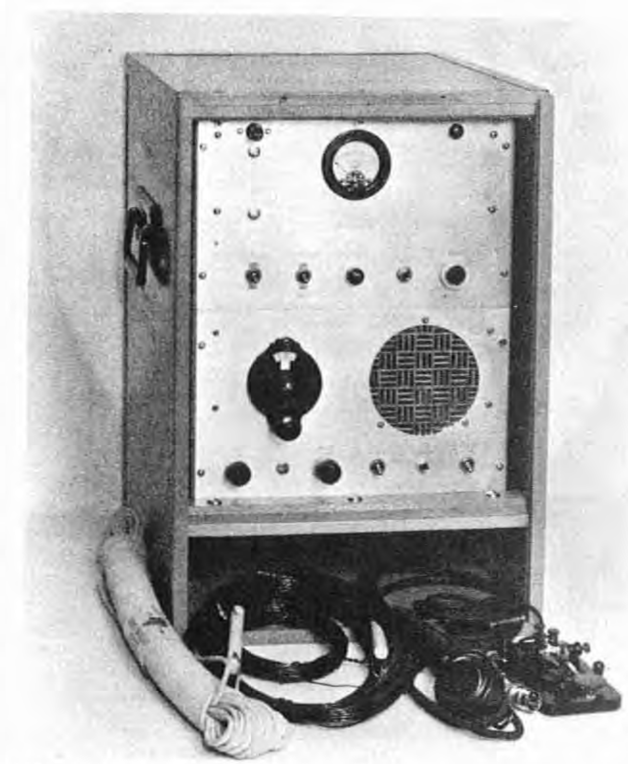


Figure 70. The type M, model D. The type I, model D, with the exception of a few switches, was identical in appearance. (Forest Service photo, History Section)

Improvements in the existing line of equipment followed a similar pattern. Criticisms had been leveled at the type S for its low power and frequently spurious signals, making it a prime candidate for replacement. Earlier changes in the type S model B had alleviated some of the problems of this 0.1-watt set, but even though over 780 sets were purchased by the Regions, the Laboratory decided to discontinue production. An updated version, the type SV (Superregenerative Variable frequency), with its output increased to 1-watt and separate oscillator circuits and tubes for both the transmitter and receiver, did not overcome all previous objections, however.

Figure 71. Type SV set at Mt. Hood, Ore., February 1941. (NA:95G-405143)

At an interregional radio meeting in Portland, January 4 to 12, 1938, a thorough review and analysis of Forest Service radio was again undertaken. Each set was evaluated on every aspect of construction and operation. Minor changes were recommended for most sets, but the type T set was subjected to major criticism. Over 35 changes were proposed. In addition to the need for greater receiver sensitivity, the conference requested crystal control for the transmitter, the use of a push-to-talk microphone, and a host of mechanical improvements.[10]

The Radio Laboratory had periodically subjected type T to model changes even before the conference. Early in its reconstruction, the T set was divided into two separate cabinets for duplex operation. With separate circuits for reception and transmission, the TH/TL (Ten-meter High frequency/ Ten-meter Low frequency) included many improvements.[11] But these modifications did not bring the type T up to the performance standards of the more successful Forest Service sets. It was "considered obsolete" following the 1938 communications conference, and was not included in later Radio Laboratory catalogs.[12] It was soon to be replaced by an improved model.

Figure 72. Type TH/TL in semiportable configuration for field use. See figure 97. (NA:95G-316855)

The naming of the type T, model D (T/D), was somewhat misleading. It was radically improved over the old type T. The type T/D incorporated "...the latest developments in ultra-high frequency [vhf] parts and material with a view to extending the usefulness of the ultrahigh frequency [vhf] spectrum..."[13] The major change in the T/D was in the receiver. The superregeneratives in the previous type T's were inherently noisy, making continuous standby nerve-wracking for the operators. This problem was eliminated by incorporating the superheterodyne in the T/D.

The T/D illustrates the number of complexities associated with the introduction of new Radio Laboratory ideas. Many older S and SV portables in the field faced obsolescence because the transmitters could not tune to the exact frequencies of the T/D. If a forest purchased the new units for lookout towers and sent smokechasers into the field with SV sets, there would certainly be many complaints. The master oscillators in the SV's simply could not hit the exact receiving location of the crystal-controlled T/D's--at least not without a number of frustrating failures.

T/D and SX/SXA Sets Are Versatile

The Laboratory staff was aware of this problem before completing the T/D design. To overcome objections, the men incorporated a bell into the circuitry of the new sets. This adaptation permitted S and SV operators to tune the dial of their sets across the full range of the T/D receiver while transmitting. When the two frequencies matched, the T/D alarm bell would sound. Returning to transmitting frequency, the S or SV operator would then continue to transmit until the type T/D operator located the calling station.

This strategy silenced charges of "planned obsolescence" against the Laboratory. But the staff went even one better. They saw the bell already in each T/D as presenting an option for a unique call system. If several T/D sets were ordered for a National Forest, the sender could activate the bell of a single receiver by using a code signal for that particular receiver in the system. This not only provided a degree of privacy but also meant that every lookout did not have to be disturbed when a message was relayed in the middle of the night.

The introduction of the T/D speaks well for the forethought and planning of the Radio Laboratory staff. In addition to extending the usefulness of the S and SV sets, the staff also made the T/D a less demanding tool. It could be left on, tuned to "standby" when necessary. With the set on standby, the lookouts or fire bosses could go about their other duties knowing that "the entirely foolproof" bell would notify them of incoming communications.[14]

Figure 73. Type T, model D, located in base of fire finder, Pepper Lookout, Mt. Hood National Forest, Ore., July 1940. (NA:95G-397920)

Development of a mobile set for use in Forest Service vehicles proved to be a more demanding job for the Laboratory than expected. The lack of adequate commercial sets, the bumpy roads, and the ignition problems made early development of mobile radio impractical. "I am afraid," wrote Gael Simson in early 1936, that, "the day when the Forest Supervisor can ride around in his car and listen to all his radio stations will have to be deferred for a long, long time. The Forests are too big, our transmitters too small, and roads too noisy."[15]

The Radio Laboratory's first mobile radio was an adaptation of the type I transmitter, with a commercial pushbutton receiver, in late 1938. This type I-Mobile found only limited acceptance. It was then modified and renamed the type K (Kar).[16] The type K was supplied in three packages --a receiver, transmitter, and power supply. It had an output of 9 1/2 watts and operated on 100 meters.[17]

To be successful, the type I would have to provide consistent performance under adverse conditions. Almost immediately, it was learned that this second-generation mobile was unsatisfactory because of the unstable commercial receiver. Having failed to wed an available product with a modified transmitter of its own design, the Laboratory staff was "forced to begin development" of its own mobile receiver.[18] Logan Belleville received the primary responsibility for this project.

The Radio Laboratory dropped its plan to supply a 100-meter mobile and instead considered a 10-meter model. Basing the transmitter on a scaled-down version of the original type U, the staff was successful in late 1941 in providing an acceptable mobile transmitter--the KU-T (Kar uhf-Transmitter).

The task of designing a mobile receiver was much more complex. There was, as always, the problem of automobile noise, and there was no existing set to provide a starting point. Undaunted, Belleville sought his answers in the Laboratory tradition. Using books, drafting table, and workbench, his solution some months later was both unique and extremely successful.

Belleville overcame the problem without spark-plug noise suppressors or other forms of common ignition noise treatment. He accomplished this by using a variation of the "Lamb Silencer," first outlined in a 1936 *QST* magazine article.[19] This technique was similar to today's squelch control that keeps the receiver off in the absence of a strong signal. Only transmissions above the squelch setting are heard by the operator.[20]

Lawson and Belleville believed this adaptation allowed the KU-R (Kar uhf-Receiver) to compete favorably with the newly developed, commercial frequency-modulated (FM) mobile sets, which were static-free. In addition, it extended the life of other amplitude-modulated (AM) mobile sets. In an article for *Electronics* magazine, they wrote that the modification was "...good enough so that many /AM/ communication systems now being discarded can be made to serve adequately."[21] Most important, the KT-T/KU-R had passed the tests which its predecessors had failed; its operation under adverse conditions far exceeded expectations. At the request of the Regions, the techniques used by Belleville were later applied to a vhf semiportable set--the U-T/U-R. While never substantiated, the word got around the National Forests that Motorola Inc. said they would have been "hard pressed" to equal the KU-R performance in the AM mobile field.[22]

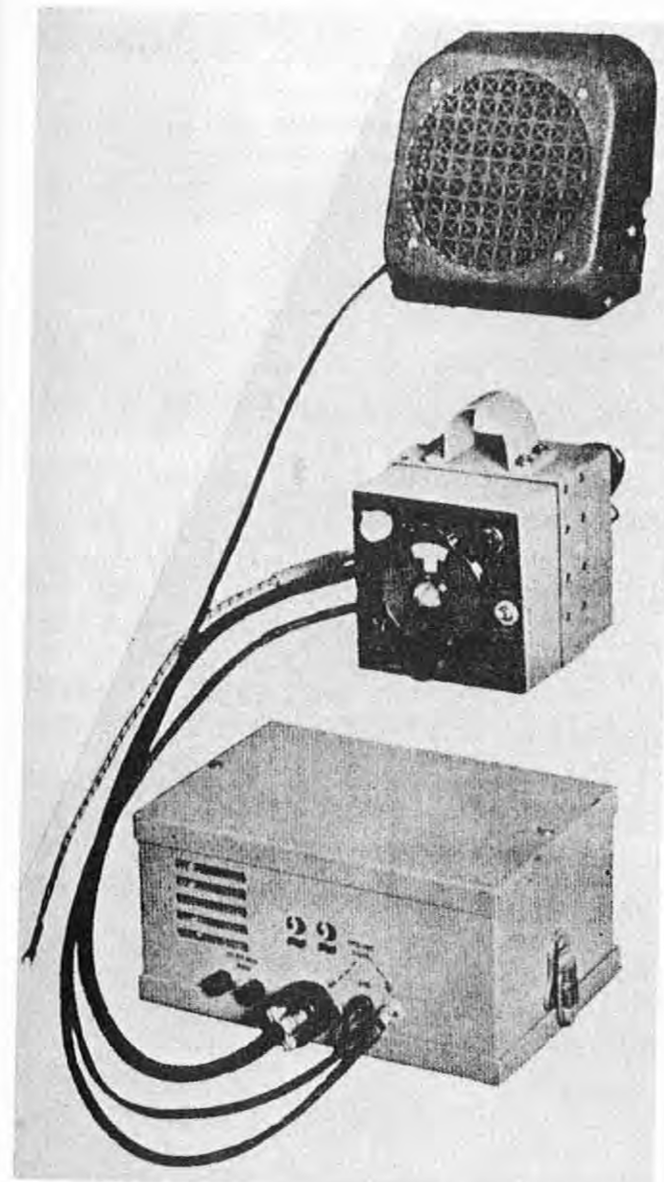


Figure 74. Type KU-R AM receiver, the Radio Laboratory's first fully successful mobile receiver. With its companion, the KU-T transmitter, it gave a high level of performance under adverse conditions. Receiver performance was assisted by a squelch control. The set competed favorably with new commercial FM sets of the time. See photo of combined unit in appendix I. (Forest Service photo, History Section)

Regional requests for an improved vhf portable/semiportable also led the Radio Laboratory to undertake a major modification of the type S/SV in 1940. The new type SX (Super-regenerative Crystals)[23] used three crystal-controlled frequencies in the 10-meter band at 1/4-watt power each. These were selected either by a switch or push buttons. With the purchase of a separate attachment (SXA), the unit could replace either the S or SV. The popularity of the SX led the smoke-jumper's school in Missoula to request an ultralight version. The type SJ (Smokejumper) represented the ultimate in size reduction; at 6 pounds, the compact set could fit in a special leg pocket of the smokejumper's outfit.[24]

Figure 75. Type SX (superregenerative, crystal-controlled frequency) lower set, shown here interconnected for operation with the SXA, top. The SXA was an audio amplifier used as a standby speaker with the SX transceiver. The SX proved a very popular, light, portable set. It was a successor to the S and SV sets. See circuit diagram in appendix I. (NA:95G-407251)

Figure 76. Type SJ set, developed as an ultralightweight model for smokejumpers, fitting into a special leg pocket and weighing only 6 pounds. Pencil gives an idea of its size. (Forest Service photo, History Section)

By early 1938, the staff at the Radio Laboratory was thinking of extending the effective operating range of the vhf semiportables.[25] In principle, vhf sets were limited to line-of-sight transmissions, but this could be extended if a third party relayed a message between two points not visible to each other. This concept might be thought of as a communication between a smokechaser and National Forest headquarters, with a lookout within sight of both parties retransmitting the smokechaser's message. The logical next step was to devise an "automatic relay."

First Radio Relay Station

In July 1941, a battery-operated radio relay design was completed at the Laboratory and readied for installation on Mt. Diablo, near Oakland, Calif.[26] The RRS was a composite of earlier vhf sets operating on standby until a carrier frequency turned on both the receiver and transmitter. Its introduction heralded a new era in Forest Service communication planning.

Figure 77. The RRS (Radio Relay Station) installation atop Mt. Diablo, Calif., first field setup of the Forest Service, July 1941. It allowed the nearby Regional headquarters in San Francisco to establish point-to-point communication with any outlying vhf radio within visible range of the repeater. Esthetics required the RRS to be placed in a plain building that minimized environmental impact. (Forest Service photo, History Section)

Figure 78. Logan Belleville, standing, and Carl Davis, of the Radio Laboratory, at the RRS installation on Mt. Shasta, Calif. (Forest Service photo, History Section)

The selection of Mt. Diablo was significant. Located within communication range of Region 5 headquarters in San Francisco, the mountain gave the Regional office an opportunity to establish point-to-point communication with any outlying vhf radio within visible range of the repeater. If a system of strategically located repeaters could be placed throughout the State, it would eventually be possible for the Regional office to make contact with anyone in sight of a repeater. The Sequoia National Forest headquarters at Porterville, for example, might locate a repeater link on a point also visible to Mt. Diablo, bringing that office into direct contact with San Francisco. Similarly, if the Inyo National Forest could situate a repeater in line with the Porterville repeater, a 3-way link would be established between Bishop and the Regional office. The length of this daisy-chain communication system was limited only by an insufficient number of "intervisible" locations.

The RRS also had a significant impact on radio for the fireline aside from the inherent possibilities of vhf repeaters for administrative use. One criticism of vhf portable radio had been its inability to overcome the limits of intervisibility. A smokechaser who happened on a fire in a location where mountain ridges and the absence of a visible lookout tower hampered vhf communication was no better off than earlier smokechasers who had to rely on the telephone. To make contact, both had to leave the site. But with one or more vhf repeaters at strategic locations throughout a Forest, the smokechaser could now get his message out by sending his communication via the RRS link. This possibility was recognized by the Laboratory staff, who made plans to take full advantage of the technology.

Portable and semiportable sets were then designed with at least two transmitting channels. The first channel could be used on a Forest network when intervisible transmission was possible. The second channel would be the RRS link. Thus the anomalies of transmission would not keep fire crews, smokechasers, work crews, mobile units, or lookouts from establishing communications through one of the frequencies. This design virtually eliminated the last major objection to vhf use.

Two further advantages of the RRS are worthy of note. Its reliability made frequent maintenance inspections unnecessary; trips once or twice a year for adjustments and the replacement of batteries were usually the only attention required. This was in contrast to the annual chore of maintaining telephone lines and then repairing them after high wind, ice, and snow. The RRS also relieved overcrowding on the 100-meter channels for long-distance communication.

The way the Radio Laboratory staff coped with perceived objections provides insight into some of the guidelines they established for radio design. To be competitive with the telephone, the Radio Laboratory had to at least match the telephone's advantages, including ease of use, and relative simplicity. The simply constructed wooden box housing a Ranger's telephone was never shut off at the end of working hours; it always provided a silent communication hookup even if the many party line calls, which rang every bell on the party line, proved unnerving. Maintenance was inexpensive, and there was no battery drain during periods of standby.

On the a.c.-powered central station type U, the concept of standby, or 24-hour service, was touted as the "outstanding feature." The *Radio Equipment* bulletin pointed out that "when a call is received on the stand-by loudspeaker, it is only necessary to pick up the /telephone/ handset to answer."[27] This feature, matching one of the telephone's advantages, was improved in the battery-operated type T model D. The T/D, of course, incorporated a "silent stand-by calling system" that relieved the operator of the incessant background noise associated with the earlier receivers and "advised of incoming calls without the necessity of a loudspeaker in constant operation."[28] The relatively low battery drain of the T/D, like the telephone, made continuous 24-hour use possible.

Similarly, the duplex feature in Forest Service radio made it possible to interrupt conversations to ask questions. It also protected the communication system against inadvertent breakdowns. During the era of simplex operation, a radio operator under stress of an emergency, especially a fire fight, could neglect to throw the switch from "Transmit" to "Receive;" as a result, important incoming messages could be lost. By providing radio with duplex capability, the Radio Laboratory effectively silenced one more criticism.

A review of Laboratory literature also conveys an awareness of the need to provide a rundown of comparative costs by including an estimate of annual radio maintenance expenses in its catalog. A Supervisor could then easily calculate that if the initial cost of a semiportable set was listed as $100 and annual maintenance at approximately $20, the price of installing and maintaining a new 5-mile telephone line was much more.

Many Advantages Over Telephone

A number of other features extended the application of radio beyond that of the telephone; for example, the RRS repeater for long-distance transmissions; the Garco generator for extended, heavy-duty use in the interior; the quieter operation of vhf during electrical storms; and the mobile operation of KU-R/KU-T. Less apparent advantages over the telephone included comparatively private conversations as contrasted to multi-party lines made up of the Forest Service and numerous cooperators, elimination of the frequent delays caused by a backlog of calls at the local central, and freedom from the umbilical cord of the telephone. Thus radio was not only a supplement to the telephone, but also an electronic, primary communication device that eventually equaled and then surpassed the performance of its predecessor. The telephone spurred on the Laboratory staff to improve the radio.

Meanwhile, the administration of the Radio Laboratory continued along the lines established in 1932. Portland continued to determine the technical aspects of radio application, while the Washington Office "rubber-stamped" them into policy. As Regional interest in radio use grew, Earl Loveridge began to give serious consideration to the need for a separate radio section under the Division of Operation. Concerned that this would take time for approval, he once again turned to Jack Horton and the Radio Laboratory. "At present," he wrote in mid-1937, "the Section exists only in the formative stage,

hence I have to depend on you and Simson for considerable assistance in the radio activities of this office."[29]

By the end of the 1940 fire season, nearly 4,000 radios had been ordered by the Regions. Some 90 percent were in the portable class (under 21 pounds), and 2,000, or one-half, were vhf sets with only 1 percent over 2-watt output.[30] These figures reflect the successful accomplishments of the Radio Laboratory in its effort to design lightweight portables for the fireline during the relatively short period, 1933 to 1940.

By this time, it was also apparent that the SPF was "probably the backbone of the high-frequency /100-meter/ communication system."[31] In 1947, for example, it continued to lead the popular 10-meter SX by some 400 sets--1,200 to 800, respectively.[32] The development of vhf, originally accompanied by almost immediate obsolescence, had found considerable favor on the National Forests and was promising to become more popular as technological improvements tended to level off. "Within the last year or two," Simson wrote the Regions, "this process has slowed up markedly and it is not anticipated that the obsolescence factor will again be nearly so severe as it has in the past."[33]

The lack of adequate frequencies continued to limit the extension of radio into the National Forests. Because of Simson's IRAC activities, the Forest Service had a relative abundance of frequencies, at least when compared to the U.S. Weather Bureau which had to borrow a frequency from the Forest Service to get on the air.[34] The Forest Service authorization to use 25 frequencies in the 2,000 to 3,000 kHz band (100 to 150 meters) and 75 frequencies in the 30,000 to 40,000 kHz band (roughly 10 meters, actually 7.5 to 10.0 meters)[35] was not a significant allocation--given the promixity of Regions to each other, the number of National Forests, and the score of tasks that might have to be handled on any given day.

All the accomplishments of the Radio Laboratory staff were conducted despite a lack of adequate manpower. Before World War II, the Laboratory never had more than eight employees. Allowing for Lawson's contract employment, and Belleville's rather late appointment in 1936, the accomplishments appear even more staggering.

Similarly, at no time did the budget for the Laboratory go over $30,000. In fact, considering the benefits returned to the Forest Service, the allotments for fiscal year 1939 reflect rather miserly expenditures, with Belleville's weekly salary of $31.15 less than that paid the stenographer and draftsman. A breakdown follows in table 1.

Figure 79. Radio Laboratory personnel, ca. 1939. Left to right, Earl Schoenfeld, Gael Simson, Harold Lawson, Logan Belleville, Ralph Kunselman, and Carl Davis. (Forest Service photo, History Section)

Table 1.--Allotment estimate, Radio Laboratory, FY 1939[36]

Item	Amount	Total
Salaries:		
A. G. Simson, Radio Engineer	$4,600	
H. K. Lawson, Associate Radio Engineer	3,200	
Earl Schoenfeld, Assistant Radio Engineer	2,600	
L. M. Belleville, Radio Electrician	1,620	
Ralph Kunselman, Radio Electrician	1,620	
Carl Davis, Radio Electrician	1,620	
P. W. Snapp, Draftsman	1,800	
A. Pedersen, Stenographer	1,800	$18,860
Travel:		
A. G. Simson	1,500	
Other radio personnel	1,000	2,500
Miscellaneous Expenses:		
Fuel, electricity, water, telephone and telegraph, freight, and express		1,030
Parts and equipment		4,300
Complete house on tower		400
Total, all items		$27,090

In retrospect, the radio design accomplishments in Portland deserve very high marks. Only one decade had elapsed between Beatty's SP-1930 and the Laboratory RRS. Perhaps only those who have struggled with developing a single idea can appreciate the scope of this endeavor. It is no mean accomplishment to master the fundamentals of a design, test the innumerable variations, struggle with the gremlins that work their way into the circuitry, and then overcome the common "wisdom" that says if the prototype works, the final product won't. Though rewarding, the process is a highly personal endeavor that takes its toll, but it was repeated at the Radio Laboratory perhaps 100 times in a 10-year period.

In addition, the Radio Laboratory had responsibility for implementing a smooth transfer of this technology. Special projects, cooperation with other Government agencies, a great deal of travel and the expected bureaucratic administrative chores all combined to place additional demands on an already limited staff.

Reference Notes

1. U.S. Department of Agriculture, Forest Service, "Review Your Radio," *Service Bulletin* (1939): 6, p. 6, Gaylord A. Knight Collection.

2. U.S. Department of Agriculture, Forest Service, "Forest Service Communications Conference," Portland, Ore., 20 February to 3 March 1935, mimeographed summary, Gaylord A. Knight Collection.

3. The attendees of record were the personnel from the Radio Laboratory, William Apgar (R-1), Francis Woods (R-4), Fred Funk (R-5), and Leonard Blodgett and W. Holtz (R-6). Forest Service, "Communications Conference."

4. The SP Special (or SSP) was a "beefed up" 5-watt SP.

5. Forest Service, "Communications Conference," p. 2.

6. Forest Service, "Communications Conference," p. 3.

7. Wilbur Claypool, interview with the author in San Antonio, Tex., July 1978.

8. Harold K. Lawson, interview with the author in King City, Ore., May 1978.

9. William Apgar, interview with the author in Sun City, Ariz., January 1978.

10. U.S. Department of Agriculture, Forest Service, Radio Laboratory, "Technical Notes accumulated January 4 to January 12, 1938, at the Forest Service Radio Laboratory InterRegional Radio Meeting," typed copy, Gaylord A. Knight Collection.

11. A Gael Simson, "U.S. Forest Service Radio Equipment," 2 January 1935, mimeographed memorandum, Gaylord A. Knight Collection.

12. A. G. Simson, "Radio as a National Forest Protection Tool," *Journal of Forestry* 36, no. 4 (April 1938): 367.

13. A. G. Simson, "U.S. Forest Service Radio Developments," 10 April 1938, historical paper, including expected design changes, Gaylord A. Knight Collection.

14. Harold Lawson, "Memorandum for Mr. Simson," 26 October 1938, Gaylord A. Knight Collection.

15. A. G. Simson, "The Role of Radio in National Forest Communication," 11 April 1936, mimeographed copy, Gaylord A. Knight Collection.

16. The designation "type K" for "Kar" is only an educated guess, based on the method used to select other radio types. Neither Lawson, Belleville, nor Claypool could recall specifically why this letter designation was selected. Kar was considered an appropriate designation even though there was a commercial mobile radio produced by the Kaar Company at about this time.

17. U.S. Department of Agriculture, Forest Service, Radio Laboratory, *Radio Equipment Bulletin* (1939): 10.

18. A. G. Simson, "Memorandum," 27 January 1939, Gaylord A. Knight Collection.

19. H. K. Lawson and L. M. Belleville, "Mobile 30-40 Receiver for the U.S. Forest Service," *Electronics*, January 1942, p. 23.

20. Logan Belleville, interview with the author in Saratoga, Calif., January 1978.

21. Lawson and Belleville, "Mobile 30-40 Mc Receiver," p. 24.

22. Gaylord A. Knight, interview with the author in Atlanta, Ga., November 1977, February 1978, and April 1979.

23. In amateur radio parlance the word "crystal" is written "xtal," hence the SX designation.

24. S. R. Winters, "Radio Equipped Smoke Jumpers," *Radio News*, April 1942, p. 6.

25. Lawson and Belleville, "Mobile 30-40 Mc Receiver," p. 24.

26. Logan Belleville, "Field Diary, No. 4," July 1941 to December 1941, Gaylord A. Knight Collection, 7 July 1941.

27. U.S. Department of Agriculture, Forest Service, Radio Laboratory,

Radio Equipment Bulletin, October 1939. Looseleaf. Lifting the handset automatically turned on the transmitter.

28. Forest Service, Radio Laboratory, *Radio Equipment Bulletin*, October 1939.

29. Earl Loveridge to the Regional Forester, Portland, 29 April 1937, Gaylord A. Knight Collection.

30. Lawson and Belleville, "Mobile 30-40 Mc Receiver," p. 24.

31. Simson, "Memorandum," 27 January 1939, p. 3, Gaylord A. Knight Collection.

32. D. S. Nordwall, "Memorandum for the Record--Radio Laboratory Inspection," 24 March 1947, p. 14, Gaylord A. Knight Collection.

33. A. G. Simson, "Memorandum," 27 January 1939, p. 3, Gaylord A. Knight Collection.

34. William P. Kramer, "Office Memorandum to Region 1," 29 July 1948, Gaylord A. Knight Collection.

35. Simson, "Memorandum," p. 5. In the 10-meter band the Forest Service actually used only the 28,200- to 32,500-KHz (28.5- to 32.5-MHz) range, or 9.23 to 10.53 meters.

36. Simson, "Memorandum," p. 5 (slightly edited).

Chapter VIII
Eat, Sleep, and Drink Radio:
Administration, Cooperation, and Special Tasks

> *(The radio operator) will guard his health and keep as physically fit as the job permits so that he will not fail in emergencies. By example, he will show that he can take it and come up smiling.*
>
> \- Forest Service *Radio Handbook*[1]

Men like Simson, Lawson, Squibb, Claypool, and Belleville came to radio development with a natural inclination, talent, and respect for the subject matter. By teaching themselves the basics and keeping pace with technological developments, they grew up with the subject while increasing their own self-confidence. As time progressed, the subject and individual merged into one. Logan Belleville willingly "ate, drank, and slept radio."[2] The net result was that the Radio Laboratory achieved its mission relatively quickly. It was staffed by highly creative men dedicated to their profession because of enthusiasm and free choice. The Washington Office could ask for an inch, expect a foot, and receive a mile.

Gael Simson quietly set the example for total commitment to the radio development program. As the principal administrator, his Portland location often placed him several thousand miles from many of his duties. He served both the Chief of the Forest Service and the Regional Forester of Region 6. His tasks, culled below from a memorandum from Earl Loveridge, encompassed a wide range of administrative functions and made him a well-traveled man.[3]

One of Simson's most important duties was his assignment to the IRAC. This assignment became his through a series of delegations, from the Secretary of Agriculture to the Chief Forester to Assistant Forester Loveridge to the Regional Forester in Portland, who passed it onto him. Each agency of

Chief, Forest Service	Regional Forester, R-6
(Simson's responsibilities through the Washington Office)	(Simson's and Lawson's responsibilities through the Radio Laboratory)
1. Formulate national policy.	1. Technical advice and recommendations in policy; technical application and administration of radio policies.
2. All Washington, D.C. contacts.	2. All field contacts, including technical and procurement.
3. Frequency allocations.	3. Technical assistance in frequency assignments.
4. Cooperation with State and Federal Agencies.	4. Cooperation with Regions.
5. Normal administrative management.	5. Administrative supervision of Radio Laboratory unit.
6. Field inspections.	6. Field inspections.

the Federal government, including the Armed Forces, was assigned a seat in IRAC. Along with E. C. Wagner, an attorney, Simson was responsible for respresenting the entire U.S. Department of Agriculture.[4] Because IRAC met as often as once a month, Simson frequently had to leave the Laboratory to attend meetings.

Cooperation with other Federal agencies and State departments of forestry also kept Simson on the road. One such activity was a three-point program to obtain vhf and hf frequencies for the States; another was the modification of IRAC regulations as applied to non-Federal forestry.[5] When the application and use of radio had to be demonstrated to State or Federal agencies, or sets had to be inspected, at locations where radio could be effectively used, Simson would travel to appropriate Forest Service Regional headquarters, pick up the Regional communication officer, and then go to the site.

The Laboratory would also inspect sets before delivery. Sales were made to such diverse agencies as the Navy; the Indian Service, National Park Service, Reclamation Service, and Grazing Service, all in the U.S. Department of the Interior; the Biological Survey and Weather Bureau in the U.S. Department of Agriculture; and the Bureau of Lighthouses in the Department of Commerce. So Simson's time was often at a premium.[6]

The Weather Bureau used the Laboratory more than the others did. The Forest Service began in the 1930's to prepare daily fire-weather summaries as indicators of forest fire danger in each Region. For this purpose, it depended largely on the Weather Bureau to supply it with data at frequent intervals at many locations --on temperature, humidity, wind direction and velocity, lightning, rainfall, atmospheric pressure, etc. The Forest Service combined such data with its own local observations and its measurements of the fluctuating moisture content of forest litter and dead branches and tree trunks to estimate the fire hazard from day to day during the fire season in its major forest areas, and later to calculate numerical fire danger ratings. The Laboratory, therefore, provided radio frequencies for joint use, sold sets to the Weather Bureau, and helped the Bureau develop mobile radio vehicles.

The success of the Radio Laboratory and the proliferation of Forest Service radios brought a measure of national renown to the work. At least once a year, an article had to be prepared for publication in a leading magazine or journal. Visits from news people and dignitaries took up additional staff time. One time,

Figure 80. Gael Simson in Arkansas for State forestry demonstration. (Forest Service photo, History Section)

Figure 81. U.S. Weather Bureau mobile radio van, 1938. (NA:95G-364875)

the National Broadcasting Co. (NBC) developed a radio script closely following the sequence of a real forest fire control operation. NBC requested that actual sites and equipment be used rather than duplicated in the studio. Under normal circumstances, this request was no problem, but a timed script required a great deal of advance preparation. Up until a few moments before the program went on the air, the telephone company was still frantically attempting to remove 60-cycle noise from the telephone line. Taking part at their posts were a smoke-chaser, two lookouts, a fire camp dispatcher, and Logan Belleville riding around in a pickup equipped with mobile radio. To the relief of all, the broadcast came off without a hitch. In the closing moments, the announcer asked Gael Simson if fire emergency work was the only use made of the radio system. The answer, which might have been predicted by those aware of the Forest Service's agreements with A. T. & T., was "Yes." Then Simson carefully added, "We do not use it as a substitute for our telephone system, but merely as an emergency device,..."

President Roosevelt's Visit

The visit of President Franklin D. Roosevelt to the Pacific Northwest in 1939, concerning the expansion of Olympic National Park in Washington at the expense of Olympic National Forest, also required a temporary diversion from the usual Laboratory duties. At the request of John Bruckart, supervisor of the Olympic National Forest, Simson and Belleville motored up to Tacoma to install a public address system for the scheduled speeches. After the program, Simson and Belleville quickly disassembled the equipment, loaded the Chevrolet panel truck, and hurried back to beat the traffic. As they sped along, crowds waved flags at them and the highway patrol motorcycle officers pulled out in pairs to escort them. Believing the Presidential party was just behind him, Simson did his best to keep out in front. Several miles later, the two men stopped for lunch and learned that the President was indeed some distance behind, led by an identical vehicle, and that the Washington State police had been confused.[8]

Further examples of cooperation with State and Federal agencies ranged from the simple to the complex. One particularly unique request for assistance came from the Portland Civil Service Board. The Board asked for a written examination that would test the skills and knowledge of applicants for radio operator and radio technician jobs. Lawson and Belleville put together a comprehensive exam and were subsequently thanked by the Board for their efforts. "We found," wrote the chief examiner, "that the radio sections of the examination had a remarkably high degree of reliability..."[9]

Special requests for electronic equipment to suit unusual applications also found their way to Portland. In the fall of 1938 a violent hurricane hit the coast of New England, with loss of life, property, and shattering of immense stands of timber. In response to numerous requests, the Forest Service was authorized to organize and operate the emergency Northeastern Timber Salvage Administration (NETSA) to reduce hazard of fire, insects, and disease, as well as to recover as much as possible of the great potential value of the lumber.[10] But the numerous nails, bolts, and spikes in the logs were raising havoc with the saw blades. Having attended a radio short course at the Lab, Leonard Blodgett, a timber specialist who was transferred from Region 6 to become a District Supervisor of the NETSA project, knew exactly where to turn. He wrote to Gael Simson to request that the Laboratory try to develop a metal detector.[11]

The Laboratory was unenthusiastic. Horton informed NETSA that "from a technical standpoint the problem you present is extremely difficult."[12] Blodgett, however, was not put off. Following consultations with Simson, who happened to be in Boston at the time, and Foy Squibb in the Eastern Region (R-7, now part of R-9), he prevailed upon Lawson to look into the matter further. For some months until September 1939, Logan Belleville struggled with a prototype.[13] He eventually completed the type X (Experimental) metal detector after devising an electronic bridge arrangement that became unbalanced in the presence of metal and, thereby, changed the frequency of an audible 1,000-Hz tone. The device was sent to NETSA. Judging from the queries on other possible uses, which ranged from ore exploration to the detection of metal in a cow's stomach, it received much interest from the general public. However, it was cumbersome and proved impractical, and there was no time to refine it further.[14]

A similar project evolved shortly after the beginning of World War II. The Army's request for an acute listening device to detect the approach of enemy bombers led the Radio Laboratory to build the type TE (Tin Ear). When preliminary tests demonstrated that "detection time by unaided ear [was]...30 seconds ahead of the simple 'Tin Ear,'" the project was abandoned.[15]

Regional assistance and cooperation also consumed a significant portion

Figure 82. Ralph Kunselman demonstrates the experimental type X metal detector developed by the Radio Laboratory, while Harold Lawson looks on. The gadget was designed to warn sawyers of nails, bolts, spikes, wire, etc., in logs they were processing after the New England hurricane of 1938. The work came under the timber salvage program of the Forest Service and cooperating States. (Forest Service photo, History Section)

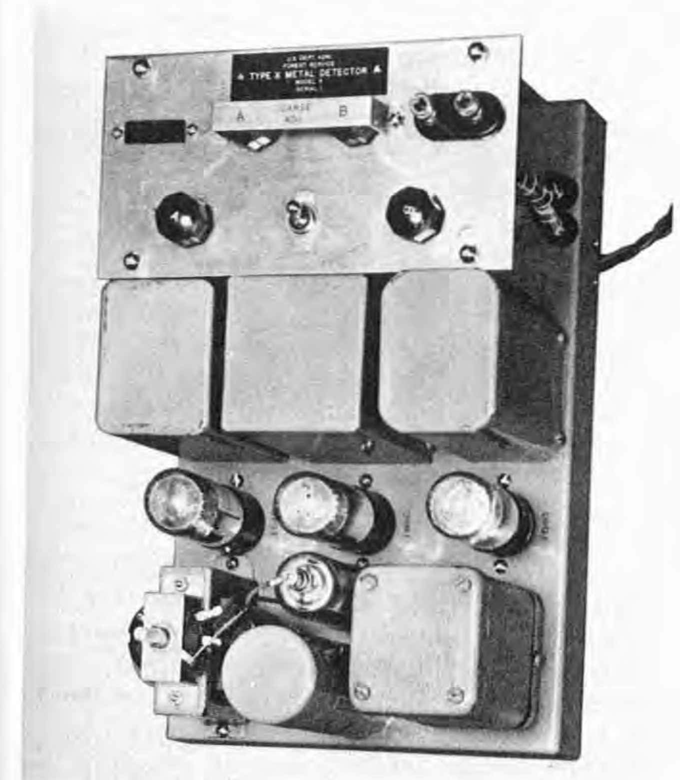


Figure 83. Interior layout of type X radio metal detector, an experimental prototype developed by the Radio Laboratory in 1939 to warn of metal in logs. (Forest Service photo, History Section)

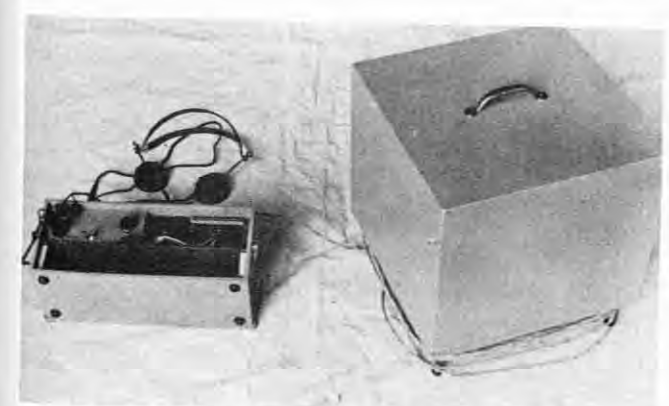


Figure 84. The "Tin Ear," type TE, a listening device created by the Radio Laboratory, at the request of the Army to detect approach of enemy bombers. (Forest Service photo, History Section)

of Laboratory time. Harold Lawson always had a backlog of Regional correspondence relating to technical problems, design improvements, and procurement, so Lawson and the staff spent a number of months accumulating materials and putting together an all-Service radio manual. Before then, a small pocket-size instruction book for the operators and working schematic drawings for the technicians had been inserted with each radio set shipped out. This practice had become a clerical problem for the Regions which struggled to keep pace with the paperwork for the many model changes and new products. When the *Radio Handbook* was published in 1938, it relieved the clerical situation greatly.

The *Radio Handbook*, bound in the traditional dark green of the Forest Service, dealt with all aspects of radio on the fireline. It gave the historical background of the program and went into the organization and policies of radio in the Service, use of radio in planning and application, and use of communication networks on large fires. It also outlined the proper Forest Service operating procedures and basic radio fundamentals. Several hundred pages of schematics, parts lists, circuit descriptions, and pictures were included to aid in servicing the sets. The 500 pages were removable and were frequently updated and circulated by the Laboratory.

The *Radio Handbook* was not only an organized compendium of Forest Service radio facts, but also an instructional device for technician training. It still left much to be desired, but now, theoretically, a person with previous experience in radio and assigned to a forest, could take the *Handbook* and one or two other recommended texts, and be successful in his job.

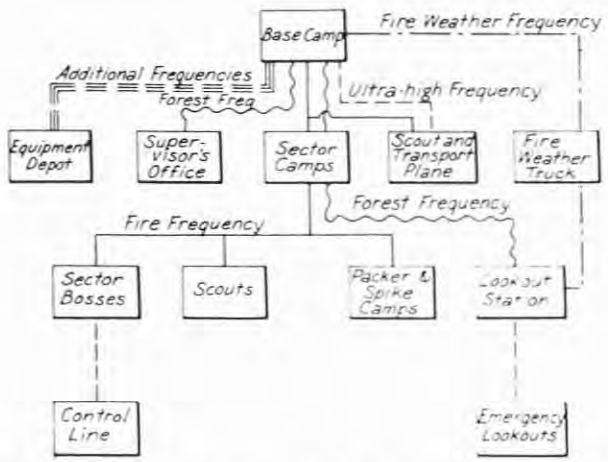


Figure 85. Suggested plan for radio network on "conflagration" fires, from the Forest Service Radio Handbook. (Forest Service photo, History Section)

Trips to Assist the Regions

From time to time, the Radio Laboratory staff had to travel to adjacent Regions to make technical inspections and installations. This experience often provided them with firsthand knowledge of Regional communication problems and allowed them to answer specific questions. The men went by automobile, boat, airplane, and horse, doing their best to smooth the transition of Forest Service personnel from telephone to radio. One entry in Foy Squibb's diary reflects the effort and time required. On a trip through Oregon, he spent Friday, July 21, 1933, traveling to and from an installation on Pearsol Peak. That night he recounted the day's work that had taken him 30 miles by car and 14 miles on horseback:

> Left 7:00 am with Blair for Pearsol Peak--arrived 10:30--changed directions of antenna to get feeder at right angle to it. Checked set and found oscillator condenser out of adjustment so set wasn't putting out a signal. Contacted Stove Gulch, Bald Mtn., Tennessee Mtn., and Bolan Mtn. for check on set. Results not so good at distance of 10 miles but fine for distances greater or less than 10 mi.
>
> Left Pearsol 1:00 pm--arrived Anderson Ranch 3:15 pm--Rode with Blair in govt. truck to Redwood R. S. /Ranger Station/--arrived at 6:00 pm[16]

Regional trips also gave the staff an opportunity to attend communication meetings and to discuss particular Laboratory design problems with authorities in the electronics field. Logan Belleville once logged a 12-day automobile round trip between Portland and Los Angeles. The diary entries, summarized below, reflect the value and the pace of such ventures away from the Radio Laboratory:

> Oct. 11, 1939
>
> Left Portland in company of H. K. Lawson in government car at 7:30 a.m. Arrived at Yreka, Calif., at 5 p.m. and contacted "Windy" Miller, forest radioman, and discussed general radio matters.
>
> Oct. 12, 1939
>
> Left Mt. Shasta in a.m., arrived in Vellejo, Calif., in p.m. After dinner went with Lawson and Squibb to A.I.E.E. /American Institute of Electronics Engineers/ meeting in San Francisco. F. E. Terman discussed directive antennas.
>
> Oct. 14, 1939
>
> Saturday. Visited Government Island. In p.m. visited ________ /undecipherable/ and returned to Vallejo where visited with Squibb.

> Oct. 15, 1939
>
> Sunday. Traveled from Vallejo to San Francisco.
>
> Oct. 16, 1939
>
> Met Fred Funke at Regional Office. Visited Bud Baine at Technical Radio. Visited Eimac tube plant. Visited Stanford University where saw F. E. Terman--discussed S set problems with him, saw Klystron working and met Morgan with whom discussed mobile antenna report of Dept. of Interior.
>
> Oct. 17, 1939
>
> Met Fred Funke in Oakland with whom started trip south. Went through Yosemite. Visited North Fork supervisor's head-quarters on Sierra and discussed general radio problems. Continued on through Fresno and visited Bakersfield.
>
> Oct. 18, 1939
>
> Arrived at Pasedena USFS office. On to USFS radio shop in Arcadia where went over specific radio problems. Visited Monitor Piezo Products Co. to discuss several problems with crystal oscillators.
>
> Oct. 19, 1939
>
> Made transmission tests at Arcadia. Left about noon on way north. Stopped at Santa Barbara to look at antenna problem. Continued north to San Luis Obispo.
>
> Oct. 20, 1939
>
> Continued north looking over topography and making transmission tests. Arrived in Oakland.
>
> Oct. 21, 1939
>
> Saturday. Government Island. Talked with Hanney, Funke and Crabb. Left for Modoc National Forest.
>
> Oct. 22, 1939
>
> Drove through Lassen National Forest. Visited Ranger station at Fall River Mills. Drove on to Klammath /sic/ Falls, Oregon.
>
> Oct. 23, 1939
>
> Arrived back in Portland.[17]

During the years immediately preceding World War II, the Portland staff personally handled a number of requests from the Regions, including special one-of-a-kind projects dealing with unique communication applications. Because Region 6 was close to the Laboratory, its requests ranged from modifications of communication sets to the construction of a radio trailer.[18] In search of a package that would allow smokejumpers to parachute radios to the fireline, Region 1 asked the Laboratory to experiment with various shockproof devices, including loaves of bread.

Installation of Regional systems and the inspection of communication applications also took the staff away from Portland. Perhaps the most extended trip was made by Bill Claypool in 1936 to the Caribbean National Forest in Puerto Rico. Claypool first traveled by rail to New York City to board the ship. He detailed the New York experience for Harold and Bee Lawson in a lengthy letter from Rio Piedras. A short excerpt from his letter reflects the interests of the men associated with the Portland Radio Laboratory:

Figure 86. Parachute experiment with radio package. Note the loaves of bread on top of the package. One of a series of experiments conducted for Region 1 in the late 1930's to find a way of shock-proofing radios parachuted to smokejumpers on a fire. (Forest Service photo, History Section)

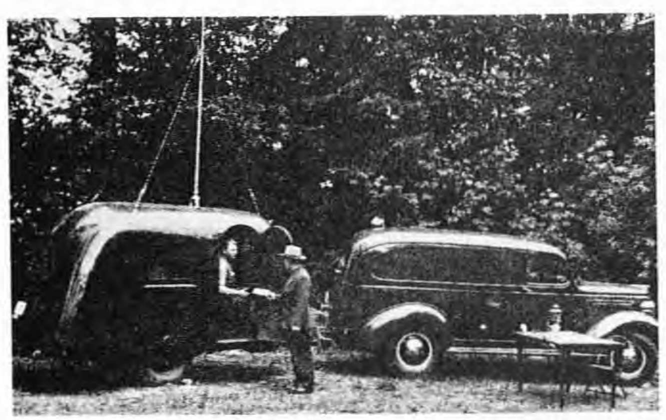


Figure 87. Radio trailer of Pacific Northwest Region (R-6) in 1939. (Forest Service photo, History Section)

> Radio City held so many attractions that I could not see the previous day that I returned the next morning early and spent several hours in the New York Museum of Science and Industry. And there, Harold, you would find things that would interest you so you would never want to leave. For example every sort of electrical principle such as capacitive, inductive, and resistive reactance and combinations are displayed in working form so simple that the layman can even understand the underlying facts. All sorts of electrical gadgets that perform unusual tricks with explanations of all. Every kind of scientific subject was displayed even to working models of wind tunnels that showed the effects of streamlining and aircraft construction and design. The Holland tunnel in miniature complete even to the automatic gas content analyzer...[19]

Designing a Testing Set

The Radio Laboratory staff always tried to keep radio costs to a minimum because the cost of a communications system was a financial burden for the Regions. They designed alternatives less costly than commercial test equipment. One of these, the type A test set, became a Laboratory catalog product. It served many functions: a grid-dip oscillator, a modulated oscillator, and a rectifier wavemeter. It was originally conceived by Logan Belleville for use in his Twin Falls radio shop. Along with the type D test set (for supplying a frequency-modulated test signal in visual alinement of wideband *if* amplifiers), it served as a functional, economical testing device in many Forest Service radio repair shops.[20]

Annual meetings furthered interregional cooperation. Radio Laboratory staff and the Regional communications personnel would discuss and analyze each set in detail and suggest improvements and modifications. Sometimes these recommendations involved entirely new projects. Because of

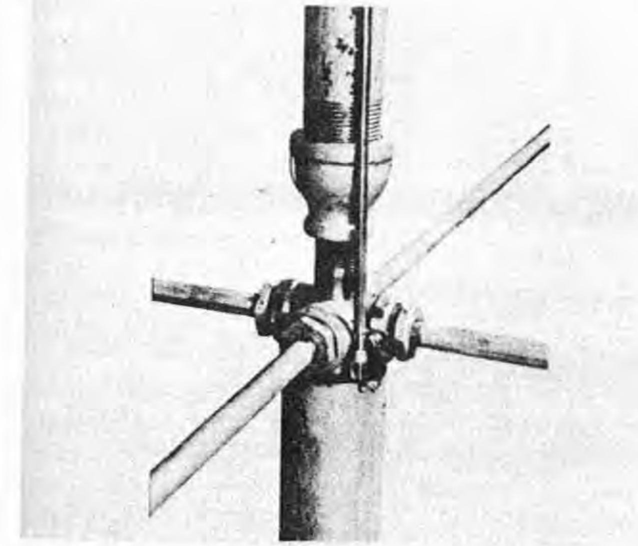
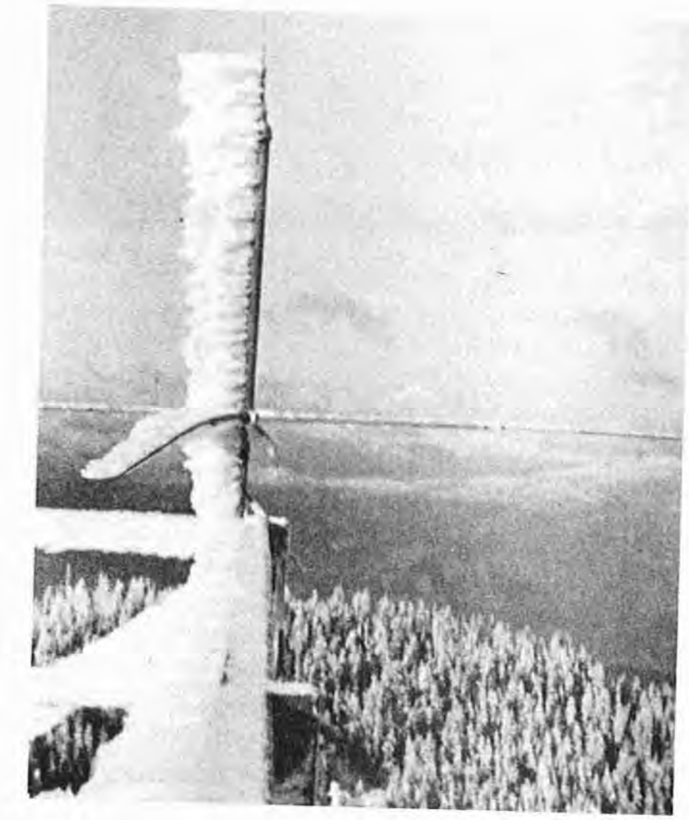


Figure 88. "Plumber's Delight" antenna, a creation of the Radio Laboratory. Photo at left shows details of the radial supports. Photo at right shows an installation on a Forest Service lookout station in Region 6, covered with rime ice. (Forest Service photos, History Section)



concerns voiced over the inability of the ground-return Forest Service telephone lines to handle additional traffic, the 1938 conference suggested that the Radio Laboratory look into carrier telephones, that is, telephone wires used for the transmitting medium; several test sets were constructed in Portland. In technical terms, the project was unsuccessful because of the inability to predict the transmission distance over any given line and the rather low-grade performance of a ground-return system.[21] Belleville, who looked back on it with a smile, thought the project was unofficially dropped because the staff had completely overlooked the fact that "...the unbalanced telephone line made a very effective antenna for lon-wave radio from as far as the East coast, and the interference was R9 /perfect/."[22]

Continual improvement and updating of antenna design was another Laboratory requirement. Antennae, which may determine the success or failure of any radio, were important factors in set-up time, reception, transmission, and maintenance. On interregional trips, the staff would often find time to stop at manufacturers' plants and universities to review recent developments in tubes and components, and to discuss the intricacies of particular configurations of antenna construction. Sometimes this brought them into disagreement with F. E. Terman, now commonly referred to as the "Father of Silicon /transistor/ Valley," and his staff at Stanford University.[23]

Antenna design, however, was not always so well-studied or esoteric. After RCA came out with a particularly effective vhf rod-type antenna at what Forest Service circles considered a very high price, Belleville suggested they "turn it inside out" for their production and use.[24] The result was a collection of pipes that could withstand the vagaries of wind, snow, and ice. Known as the type PD (Plumber's Delight), it served admirably at many remote Forest Service locations.

The most time taken from radio design was for the model-bid-construction practice. The Radio Laboratory had adopted the procedure because the staff lacked the test equipment to specify precisely the exact electrical performance of their designs. Potential bidders could determine production expenses by costing out the parts and labor necessary to duplicate the laboratory model. This practice was usually very successful, and awards went to manufacturers willing to work closely with the Laboratory.

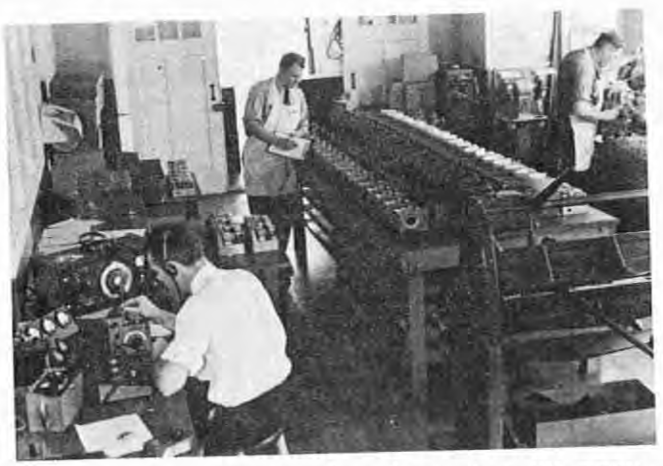


Figure 89. Inspecting incoming SV sets from the manufacturer at the Radio Laboratory, before reshipment to the Regions. Left to right, Charles McPherson, Carl Davis, and Ralph Kunselman. (Forest Service photo, History Section)

Actually, one staff member always seemed to be on temporary detail for preliminary acceptance tests of the sets at a manufacturer's plant, where any needed minor modifications were to be identified as sets came off the production line. This usually involved substitution of a resistor or capacitor--a practice that often left the Laboratory with an abundance of short-lead components[25] --and greatly facilitated the final inspection process in Portland before filling the Region orders.

Some Problems with Suppliers

Sometimes, however, this procedure did not work, especially when the Forest Service rushed to get additional units into the field in time for a fire season. Once, when contracts for some type T sets were awarded, the Laboratory hastily provided a model that lacked cabinet, antenna, instruction manual, and nameplates --exclusions covered either as exceptions or as special items that were to be identified after the contract award; the potential bidder could set a cost for the items based on previous experience, go ahead with the other tasks, and then call for the specifications at an appropriate point in the construction.

The Laboratory expected contractors to order parts as soon as verbal notification was received so that construction could start quickly after written notification. Western Wireless, Ltd. of San Francisco was awarded such a contract for 130 type T sets when it was already "strapped" for adequate personnel on a contract for Forest Service type M and S sets. Charles Watson received a telephone call in June 1936 that his company had won the bid, but he did not proceed to order parts in advance. A newcomer to this volume of business and lacking adequate labor or physical plant and financial resources, he later said, "...it was thoroughly inadvisable for us to borrow the necessary money on the strength of an order which, in fact, was not [yet] an order.[26]

This hesitancy, though technically legal, placed additional pressure on Western Wireless. Because he could not move into production quickly, Watson used up any grace period that might have been extended to the company if legitimate problems arose during the 45-day contract schedule.

The problems of Western Wireless soon began to snowball. When the September 2 contract deadline passed, Watson asked Gael Simson for an extension based on a number of "unforeseen circumstances" due to not receiving Kellogg handsets, the inevitable (and from the Laboratory's point of view, predictable) failure of suppliers to deliver parts on schedule, as well as some "problems" created by the Radio Laboratory. These last alleged problems were as diverse as failure to specify nomenclature on nameplates and to authorize the substitution of a five-position rotary meter switch for a double pole-double throw switch, failure of the original sample to work properly, and need to rewire the receiver decks because of a change in the hook-up of the quench coil.[27]

Harold Lawson responded to Watson's complaints with an onsite inspection. He found Watson's complaints unjustified. Receiver and transmitter decks were not yet completed. Panels, brackets, and shield cases were not drilled, tapped, or mounted. Watson's contention that the lack of handsets and nameplates was holding up production was specious. Even if they were on hand, they could not be used until construction was complete. "It would appear that a large part of this delay is due to the use of insufficient labor and the employment of unskilled men, Lawson concluded.[28]

Lawson also dismissed the complaints that the Radio Laboratory had not supplied a draft of the instruction manual and antenna specifications. Western had previous contracts with the Forest Service requiring the company to supply these items. Irritated by what he viewed as intentional delays, Lawson charged that the "...failure on the part of Western Wireless to call for antenna specifications or instruction manual copy was merely a method of evasion or an attempt to obtain contract time extension from the Forest Service on the basis of failure to supply [a] complete model."[29]

By this time, Watson realized that his relationship with the Radio Laboratory was suffering. He wrote Regional Forester C. J. Buck in Region 6 in expectation of sympathy for his campaign from higher echelons. He recounted his original complaints and charged that additional delays were warranted because the Radio Laboratory sample, on which his bid was based, "was far from complete."[30] But if Watson thought the Regional office was not aware of the unique bid status of the contract or would be swayed by a divide-and-conquer approach, he did not understand the Regional administrative structure or the relationship between the Radio Laboratory and a Regional office. Rather than a willing ear, Watson received a one-sentence reply from M. L. Merritt, Acting Regional Forester. He bluntly called Watson's attention to a memorandum from Lawson in October that he attached to his reply. It outlined Laboratory criticism after a preliminary inspection of set TL-100 sent to Portland by Western Wireless.[31]

In the normal chain of events, Forest Service contractors shipped a preliminary sample radio set to the Laboratory for approval before an inspector visited the contractor to certify compliance of the remaining sets. In this way, minor necessary modifications could be identified before the Laboratory spent money on an onsite inspection; the contractor, in turn, would be certain that modifications would have a minimal impact on final production costs. The financially pressed Watson had ignored the Laboratory evaluation.

The required modifications were minor, but time-consuming. New meter faces at 50-mA scale rather than 25-30 mA, and additional shunting of the meter grid current were necessary to keep from driving the meter off scale. Other modifications were less time-consuming, e.g., clarification of labels, switching of two leads, soldering, cabinet stenciling, and comments on the panel hinges.[32]

Perhaps of less concern to Watson, but more important, was that the T sets were no longer needed. Unintentionally, this made for further delays. No longer pressed to get the T sets on the fireline and involved with other assignments for the upcoming 1937 fire season, the Radio Laboratory was not about to drop everything in order to accommodate Mr. Watson. Believing Watson had brought the problem upon himself and constrained by limited staff and an ever-present scheduling problem, Simson and Lawson simply let the matter fit into whenever time was available.

Watson corresponded regularly with Simson and Buck during October. He made very plaintive and frequent pleas for payment, even partial payment, never wavering from his position that outside vendors and the Radio Laboratory were responsible for his plight.[33] The Region 6 office steadfastly supported the Laboratory and replied that it would "...arrange to have the type 'T' sets inspected when all are complete."[34] This, of course, included all antennae, handsets, and modifications to the original.

Watson then sent separate letters to Simson and Buck. By this time, he was walking the thin line between contract concellation for noncompliance and Western Wireless's need for some financial assistance to complete the modifications. Although still holding to his original argument, Watson did admit that modifications from the original sample were not yet complete, coming as close to demanding an inspection as possible.[35] Simson responded with the following radio message: "BELLEVILLE WILL ARRIVE IN SAN FRANCISCO NOVEMBER THIRD ONE FIFTY PM TO INSPECT T SETS."[36]

Watson met Logan Belleville at the San Francisco airport on the appointed date. By November 11, eight days later, Belleville had made little progress. While this was primarily due to a mixup by the express company in shipping test equipment, Belleville had also found several variations in the T sets. These included lack of adjustment in RF coils, a shortage of handsets, absence of switches, no cabinets, and incomplete testing.[37] He told Watson that the sets had to be completed for inspection.

Meanwhile, for lack of work and the frequent absence of Watson, Belleville took most of the next day to visit Fred Funke who supervised radio in Region 5. Returning to Western Wireless in late afternoon, he found "much activity towards getting [the] sets ready.[38] The following day Belleville also noted the "place cleaned up and work progressing satisfactorily," but very few sets were being completed.[39] With this in mind, the possibility of having to wait 2 more weeks for all sets to be completed, plus a telegram from Simson suggesting, "IF INSPECTION BEING DELAYED ACCOUNT SETS NOT READY SUGGEST RETURN PORTLAND YOUR JUDGEMENT [sic] SATISFACTORY,[40] Belleville confronted Watson and "Gil" Gilbertson, the radio engineer for Western Wireless. Realizing that it might take a supreme effort to arrange another inspection, Watson secured telephone permission from Lawson to continue work through the following week.[41] Three days later, but still facing 100 incomplete sets, Belleville's frustration was reflected in his field diary. "Whoopee!" was his final comment for that day.[42]

Belleville continued to run into problems with adjustments and component substitutions that commonly occurred between Laboratory prototype and finished product. Such delays were usually worked out after consultation with Lawson over KBAA, telegram, or telephone. But these problems were complicated at Western Wireless by Watson's attempts to economize. Belleville had to reject units several times because tacks were substituted for screws, even the best cabinets were substandard, and not all components were available.[43] The most frustrating problem, however, was Western's inability to cut the antennae to the proper length. After Belleville discovered that the wires were considerably too long, Watson apologized and placed another man on the job. A few days later, Belleville learned to his dismay that the antennae were still too long. Checking further, he discovered that the measurements were made on a pattern maker's shrink rule, which was 3/16 inch longer per foot than standard.[44] After a third attempt, each wire was cut to the proper frequency.

On November 26, after putting in double time for several days, Belleville completed the inspection of the last T set and departed for Portland. He left behind a very relieved Charles Watson and the impression that the Radio Laboratory would expect strict contract compliance in future dealings.

Thus, throughout the 1930's the Radio Laboratory staff were involved in a number of activities that speak well for their work. But the success of the radio development program cannot be measured solely by their effort and output. Radios were intended for the fireline. Their acceptance in remote areas of the National Forests is the final measure of the Radio Laboratory's accomplishments.

Reference Notes

1. "Operators and Operating Practices," *Radio Handbook* (Washington, D.C.: U.S. Department of Agriculture, Forest Service, Division of Operation, ca. 1938), sect. B7.1, pp. 14-22.

2. Wilbur Claypool, interview with the author in San Antonio, Tex., July 1978.

3. Loveridge to Regional Forester (R-6), 29 April 1937, Gaylord A. Knight Collection.

4. Simson's brother was the representative for the Department of Commerce.

5. Simson, "Memorandum," 27 January 1939, Gaylord A. Knight Collection, p. 5.

6. Simson, "Memorandum," p. 3. The Weather Bureau was transferred to the Department of Commerce June 30, 1940.

7. National Broadcasting Company, "Script for Forest Service Radio Communication Demonstration," 10 May 1939, mimeographed, Gaylord A. Knight Collection; Harold K.

Lawson, interview with the author in King City, Ore., May 1978; and Logan Belleville, interview with the author in Saratoga, Calif., January 1978.

8. Belleville, interview with author.

9. Roger W. Reynolds to Harold Lawson, 10 July 1939, Gaylord A. Knight Collection.

10. Walter Wesselius, "Experience from the New England Hurricane," *Electrical Engineering* 58, no. 3 (March 1939): 99-101. See also Earl E. Peirce, *Salvage Programs Following the 1939 Hurricane* (Berkeley: University of California, Bancroft Library, 1968).

11. L. D. Blodgett to A. G. Simpson [sic], 25 March 1939, Gaylord A. Knight Collection.

12. F. V. Horton to Director, NETSA, 6 April 1939, Gaylord A. Knight Collection.

13. Belleville, interview with author.

14. Belleville, interview with author, and George Vitas, telephone conversation with Frank Harmon, History Section, Forest Service, 25 March 1981.

15. F. H. Brundage to Regional Forester (R-5) 23 April 1942, Gaylord A. Knight Collection.

16. W. F. Squibb, "Diary-June 23, to Sept. 29, 1933," Gaylord A. Knight Collection.

17. Belleville, "Diary #3," October 1939, Gaylord A. Knight Collection.

18. W. S. Claypool, "Memorandum for Mr. L. K. Mays," 28 September 1939, Gaylord A. Knight Collection. This memo describes the major Forest Service radio equipment included in the trailer.

19. Bill Claypool to Harold and Bee [Lawson], 19 October 1936, Gaylord A. Knight Collection.

20. See Appendix I for details on the types A and D test sets.

21. H. K. Lawson, "Memorandum for Files," 15 November 1938, Gaylord A. Knight Collection.

22. Belleville, interview with author.

23. Belleville, interview with author, and "Field Diaries," *passim*, Gaylord A. Knight Collection. Other visits were frequently made to such manufacturers as Hewlett-Packard and Eimac (Eitel-McCullough).

24. Belleville, interview with author.

25. Logan Belleville to Harold Lawson, 13 June 1939, Gaylord A. Knight Collection.

26. Charles L. Watson to Gael Simpson [sic], 12 August 1936, Gaylord A. Knight Collection.

27. Charles L. Watson to Gael Simpson [sic], 4 September 1936, Gaylord A. Knight Collection.

28. "Memorandum for the Files," Harold K. Lawson, 14 September 1936, Gaylord A. Knight Collection.

29. Lawson, "Memorandum for the Files," 14 September 1936.

30. Charles L. Watson to Shirley Buck, 21 September 1936, Gaylord A. Knight Collection.

31. M. L. Merritt to Western Wireless, Ltd., 3 October 1936, Gaylord A. Knight Collection.

32. Harold K. Lawson, memorandum, per A. G. Simson to Mr. B.

Gilbertson, Western Wireless, [n.d.], Gaylord A. Knight Collection.

33. See Charles L. Watson to Gael Simson, 5 October 1936; M. L. Merritt to Charles L. Watson, 8 October 1936; A. G. Simson to Charles L. Watson, 10 October 1936; Charles L. Watson to C. J. Buck, 13 October 1936; Charles L. Watson to A. G. Simson, 23 October 1936; and F. H. Brundage to Western Wireless, Ltd., 26 October 1936--all Gaylord A. Knight Collection.

34. *Ibid.* and F. H. Brundage to Charles L. Watson, 26 October 1936, Gaylord A. Knight Collection.

35. Charles L. Watson to C. J. Buck, 27 October 1936, Gaylord A. Knight Collection, and Charles L. Watson to "Gael" [Simson], 27 October 1936, Gaylord A. Knight Collection.

36. A. G. Simson to Western Wireless, 2 November 1936, radiogram, Gaylord A. Knight Collection.

37. Logan Belleville, "Field Diary and Travel Record," 11 November 1936, Gaylord A. Knight Collection.

38. Belleville, "Diary," 12 November 1936.

39. Belleville, "Diary," 13 November 1936.

40. A. G. Simson to Logan Belleville, 13 November 1936, telegram, Gaylord A. Knight Collection.

41. Belleville, "Diary," 13 November 1936.

42. Belleville, "Diary," 16 November 1936.

43. Belleville later learned that the supposed shortage of Kellogg handsets was due to the express office's refusal to release them to Watson, as they were shipped C.O.D. It was also Belleville's understanding that Watson got these out of hock after a phone call to Herbert Hoover, Jr., his brother-in-law. Belleville, interview with author.

44. Belleville, "Diary," 19 November 1936.