NATIONAL PARK SERVICE

TM

"FROM GROUND WIRE TO MICROWAVE"

A CHRONICLE OF FIFTY YEARS OF TELEPHONE AND RADIO SYSTEM DEVELOPMENT IN OUR NATIONAL PARK SYSTEM

Compiled by
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DEDICATED

TO

ROBERT D. WATERHOUSE

Pioneer, "*Father*", and instigator of NPS radio

He gave me my first opportunity as an LEM in the CCC in April, 1934. My mentor for several years.

Ralph R. McFadden

TABLE OF CONTENTS

FOREWORD

Ralph McFadden was an engineer who left an indelible footprint on the National Park Service's telecommunications systems. During his employment, he wrote many documents that related to engineering of the Park Service's facilities. He has now turned to writing the history he recalls so well. Written with a keen love for the Service and with the experience of a lifetime of dedicated work on behalf of the Service, this volume should help you understand the background of the Park Service's telecommunications systems.

I had the privilege of being hired by "Mac" in 1964 and being able to work for him until his retirement from the Service in 1977. During those many years, numerous names and events he shares with us, the reader, were indelibly written in my own consciousness. Yet, without someone to document the development of telecommunications in the National Park Service, the pioneering efforts of Ralph, his predecessors, his associates and his supervisors would never have been known. For the historians, that would have been a tragic loss. For myself, I would have missed recalling the events paralleling the early days of my own career.

And so it was, when Ralph approached me with his idea shortly after retirement, I responded enthusiastically with my support. It was evident that we should not lose the opportunity to get the record written while we can get the historical facts straight (and while we can get them from one of the bonafide pioneers in this field). Ralph has written this entirely as a volunteer effort. He has received no remuneration and has had to fit the writing and the editing into his "free time" (which most retired people tell me is non-existent). I had the privilege of serving as proofreader and WordPerfect consultant to assist Mac in getting the document into print - "fretted" upon discovery of early computer network hardware "glitches" that at times gobbled up several pages of his efforts without backup. We readily learned the value of tape backups and archiving!

Agreeing that this was an effort worthy of support by the National Park Service, we approached management with the concept. The work that follows (over 107,000 words) justifies their enthusiasm as well. Now that Ralph has completed the work, we note that the year is that of the 75th anniversary of the National Park Service. Thus it is appropriate that this publication be one to herald that anniversary and to be released as part of the anniversary efforts.

This volume should bring enlightenment to the historian and anyone who is genuinely interested in the development of telecommunications in the early days of the Service. Ralph writes with personal vision and enthusiasm and shares his anecdotes to make this a truly interesting volume. I hope the reader will share in the enthusiasm I have had in reading this anthology on National Park Service telecommunications.

Frank P. Weed
Chief of Telecommunications Engineering
National Park Service
Denver, Colorado
April 26, 1991

INTRODUCTION

Realizing that the relatively new "wireless" method of communication might provide an invaluable service to isolated field personnel and fire crews, Bob Waterhouse (with help from other interested individuals), launched experiments to develop two-way radio equipment, and to determine its usefulness for NPS areas. Armed with parts and batteries, experimental radios were built which soon showed good possibilities.

This account is the story of the beginnings of telephone and radio communication in our National Parks, originating prior to the availability of commercial telephone and factory-made two-way radio units.

The story begins when experimental "portable" radio transmitter-receivers consisted of two or more boxes totalling 60 to 100 pounds in weight. The antenna was close to 100 ft in length and had to be erected by throwing lead weights and cord over tree branches. Developments in later years, spurred by NPS and USFS requirements, led to today's portables weighing less than two pounds. The period covered herein spans the time when there were no two-way mobile radios - to 1977 with its sophisticated two-way mobile systems.

Telephone lines at the beginning of this account were simple and fragile, but useful even without connection with the outside world. Their use began in the days of hand-cranks and shouting into a wall-mounted "transmitter" on a multi-party line, and leads up to the day of modern dial telephones and switching facilities.

My career embraced service at all levels, from park, to region, to WASO, to the Service Centers, ending as NPS Communications Officer. In the latter capacity the writer represented NPS to the Interior Department's IRAC member, and was in charge of all NPS communications engineering and operation. However, the writer's early duties were in the western parks, so he has had limited access to the early-period events occurring in the eastern United States. Therefore, pre-1950 experiences in that sector of the country may have been given short-shrift. Nevertheless, the events and experiences that are recorded herein can be considered as representing the historical development of NPS communication systems from the Service-wide perspective.

There were probably more than a dozen individuals who experimented with, or in some other way participated in the use or development of two-way radio for use in a particular park. It would not be fair to enumerate the names of those I know of and omit the names of others. Therefore names will be used only in reference to specific events.

This account is the result of personal experiences (during my 1934 to 1977 NPS Career), access to DSC files, assorted partial files from Mt. Rainier and other areas, publications pertaining to NPS and USFS history, and conversations with individuals having information on this subject.

I am indebted to the National Park Service's Washington Field Office (Branch of Telecommunications Engineering) in Denver for the encouragement they offered me to prepare this account, especially for their graciousness in providing access to information at their disposal. They also provided the clerical support in the early days before I learned to use their word-processing facilities myself. Without their support, the preparation of this account would not have been possible. I am especially grateful to Frank Weed of that office for the hours of personal time he has spent in assisting me with manuscript preparation and getting it into print.

I also wish to express my appreciation to many people, too numerous to mention here, for their help with personal experiences, files, and photographs and to many persons in the various parks who participated in conducting field surveys. I also wish to thank my wife and family for being understanding during my field trips, whether waiting at home or in a hot car in a parking lot while I "conferenced".

Special thanks to Aubrey L. Haines for the use of his extensive historical files on Yellowstone and other NPS areas.

It is hoped that this volume will be of value to readers that are interested in the National Park Service in general, or in its history, as well as to the technical reader.

Ralph R. McFadden
Lakewood, Colorado
April 26, 1991

CHAPTER ONE

EARLY BEGINNINGS

Prior to 1930

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GENERAL

Events leading to the development of modern communications took place in the latter part of the eighteenth century. As telegraph and telephone lines were established between cities following the settlement of the West, they were soon extended to remote areas, some of which later became part of the National Park System. But the unique conditions existing in these areas discouraged extension of commercial telephone lines into most parks. Government-built lines within the parks required special adaptations of customary systems and components.

As will be apparent to the reader, the National Park Service was a pioneer in the development of two-way portable radio. Commercial interests could not visualize the potential applications, so they were disinterested in developing suitable equipment for National Park Service (NPS) or U. S. Forest Service (USFS) use.

And so we begin the account of "From Ground Wire to Microwave".

TELEPHONE (AND TELEGRAPH)

The earliest development of telephone and/or telegraph facilities in most of the National Park areas is rather obscure. In many cases they were built for, and by, the concessioner or railroad rather than the Federal government, before the areas became part of the National Park System. In some cases they were preceded by telegraph facilities.

The earliest telegraph event in a (now) NPS area involved what is now known as Fort Laramie National Historic Site. "Fort Laramie served as a repeater station about midway between the ends of the Transcontinental Telegraph . . . The western [last] section . . . was finished by the Overland Telegraph Co. on 24 October [1861]. On that evening, the first messages were sent to President Lincoln. That from Horace W. Carpenter, president of the Overland Telegraph Co., read 'I announce to you that the telegraph to California has this day been completed. May it be a bond of perpetuity between the states of the Atlantic and those of the Pacific '. . . The Fort was essential, therefore to the successful transmission of transcontinental messages and also supplied vital information to the local area." *

* Institute of Electrical and Electronic Engineers Power Engineering Review July 1990, Page 24

Yellowstone National Park

The earliest known reference to telegraph facilities in Yellowstone was in 1882, only four years after the first telephone was installed at Bozeman, Montana.(1) Service (telephone or telegraph was not specified) at Bozeman was via a line that was extended to Bozeman from Salt Lake City, via Virginia City, Montana, and Helena, Montana, reaching Bozeman in 1871.(2) The Yellowstone Park Improvement Company was negotiating with the Secretary of the Interior for seven 640-acre tracts at various locations within the Yellowstone National Park for the purpose of "cutting timber for telegraph poles and fuel".(3) The intent was to acquire "telegraph privileges in the park".(4)

There is apparently no record as to whether the proposed telegraph lines were actually built. If they were, they had no connection with the "outside", since the Northern Pacific Railroad had only reached as far as Cinnabar (outside the northwest corner of the park) with their lines.(5) The latter, completed in July, 1883, was of little use that summer due to a nationwide strike of telegraph operators.

A proposed visit by President Arthur to Yellowstone in 1883 caused a flurry of concern about communication during the trip, and the financing thereof. A report, datelined Washington, July 9, indicated that the President had asked the signal office how long it would take to run a military telegraph line temporarily from the point nearest it on the Northern Pacific railway (probably Cinnabar) into Yellowstone Park. He had thought it would take a week and cost between $500 and $600. Evidently the president planned to pay for it himself. When he found that it would take more time and money, the President thought this "too high a price for a picnic among the geysers, and says he has deferred the trip until the summer of 1885".(6)

A later issue of the Livingston (Montana) Enterprise had another article, datelined Omaha, July 9, 1883, which was contradictory. It said General Howard "has completed arrangements for President Arthur's trip to Yellowstone National Park". The party "will leave the Union Pacific at Rawlins [Wyoming]**, travelling to Washakie [by wagon] where telegraphic communication was available." Couriers would be provided during the remainder of the trip to Yellowstone. (7)

The Arthur party left Rawlins in August, for Fort Washakie with 180 horses and no telegraphic facilities in the park. This lack was an embarrassment to H. W. Cole, electrician working to provide facilities for the party.(8) In 1884 the Daily Enterprise for July 10, 1884 reported that a line (presumably telegraph) was to be built by the Wakefield and Hoffman stage line extending the existing line at Cinnabar to Mammoth Hot Springs. There is no

** Brackets will be used to indicate author-inserted clarification within quotations.

evidence that it was built, probably because as reported in the January 17, 1885, Livingston Enterprise the Yellowstone Milling Company of Bear Gulch, was stringing a telephone line between Livingston and Gardiner (not far from Mammoth) via Cinnabar.(9)

Cooke City was an isolated community whose access was through the northern part of Yellowstone National Park. On November 21, 1883 the Livingston Enterprise announced "Cooke will soon be in telegraphic communication . . . George Norton has the contract and hopes to have the poles set and wiring strung by the middle of December." By November 28, 1883 the same paper announced that "C. T. Hobart has engaged Miss Lillian Pickering to manipulate the wires [operate the telegraph] at Cooke as soon as the line is completed . . . [she is] from Cincinnati, where she graduated in her profession . . ."

However, the Cooke City community's anxiety to communicate with the outside was thwarted by the weather as reported in the same issue of the paper: "George Norton and Ole Nord . . . driven in from their camp . . . snow so deep . . . impossible to plant telegraph poles."

On May 1, 1884, the Secretary of the Interior granted a permit to Eleanor N. McGowan, of Pennsylvania for "constructing and operating a line of telegraph upon that portion of the Yellowstone National Park lying . . . between Cinnabar [northwest of Mammoth, outside the park] and Clarks Fork, Montana Territory . . . for the period of ten years . . ." Permission was granted for cutting poles in the park as required for the portion of the line lying in the park. The permittee was required to "receive and to transmit over said line of telegraph, without charge therefore, all messages to or from any officer of the United States, relating to government business."(9) The permit was referred to in the Livingston Enterprise of June 13, 1884 which indicated Mrs. McGowan obtained the permit to "legalize the construction activities of the previous year by C. T. Hobart."

However, an article in the July 10, 1884 issue of the same paper reported "Wakefield and Hoffman's stages . . . Park . . . [will begin] regular trips next Monday . . . [the] firm to extend the telegraph line . . . Cinnabar to Mammoth . . ." Since Mammoth lies on the route from Cinnabar to Clarks Fork, it is not clear whether the line from Cinnabar is to be built by Wakefield and Hoffman or by George Morton and Ole Nord, or by C. T. Hobart. The relationships between these people, and between them and Mrs. McGowan are not clear from the information available to me.

While telegraph lines in the park were being built and/or considered in 1883, business interests visualized the future impact of the telephone for the communities in the states surrounding Yellowstone. On October 26, 1883 the Livingston Enterprise reported "Rocky Mountain Bell Telephone Company . . . [obtained] sole rights in the territories of Utah, Wyoming, Montana and Idaho . . . [to place] eleven exchanges and over 1000 new instruments in successful operation . . ."

Evidently the telephone was a curiosity which became the subject of a tongue-in-cheek article in the Livingston Enterprise for February 16, 1884 "Gardiner * [small town just outside the Mammoth entrance to Yellowstone] folks have a telephone line . . . Baronette, who brings the information, says it consists of one wire about 150 yards long . . . operators stand at the two ends and converse by the sign language . . . works very satisfactory . . . principle is entirely new . . ."

None of the foregoing mentions telephone line construction along any part of the Livingston-Cinnabar-Gardiner-Mammoth route. In fact it was as late as March 1, 1884 that the first telephone was installed in Livingston. (11) Nevertheless, as reported in the February 21, 1885 Livingston Enterprise "a prominent citizen of Livingston telephoned a friend at Gardiner . . . on Friday evening, [at] last the long expected news came to Livingston and the telephone to Gardiner was put into operation. For some reason it did not work well; the order to 'secure that horse' was indistinct and mixed." (This was about a scheme to use a coded message so certain individuals could acquire valuable property in the northern part of the park. The confused communication created a flurry of activity to accomplish this, whereas the truth was that the Congress was passing legislation which would retain the property as part of the park; thwarting the plans of the opportunists). "The wire was strung from the railroad terminus to Gardiner . . . [and] ended at Gardiner in a wall telephone in the new store of W. T. Hall."(12)

In the meantime, the right-of-way for the telegraph line from Mammoth to Cooke City was sold by Mrs. McGowan and was purchased by Mentor and Adolph Wetzstein.(13)

The telephone, being a new device, was frightening to Mrs. Lena Potter of Gardiner. She recalled "Well, that's the first place [Cinnebar] there was a phone. I remember that part and the man I was going with was up at Mammoth, and the agent down at Cinnebar, he . . . said 'Lena, you want to talk to your sweetheart?' and, oh, I wanted to talk so bad over it, but I was afraid to try it, and I begged off . . . That phone was just too much for me."(14) It was at about the same time (1885/1886) that "the Pacific Express Company had an office on the ground floor . . . where also is the office of the Western Union Telegraph . . ."(15)

No mention is made of the location or ownership of the telephone at Mammoth. Protection of the park was undertaken by a contingent of fifty Cavalrymen on August 13, 1886.(16) Evidently at that time a telephone line existed between Camp Sheridan * (Mammoth area) and unspecified points that were frequented by visitors.(17) It is known that by 1897 lines

* The spelling Gardner and Gardiner were used interchangeably for naming the town and river. Today Gardiner is the town outside the north entrance to Yellowstone National Park. The Gardner River flows through the town.

** The Mammoth area has been referred to as Camp Sheridan and as Fort Yellowstone in various references.

extended from Ft. Yellowstone to "soldier stations" at Lower Geyser Basin, Riverside, Soda Butte, Norris, and Mud Geyser. (18)

There is some confusion in the records that I had access to, as to whether certain lines were telegraph or telephone; and as to whether they were owned by the railroad, the concessioner, or the Army. Throughout this account of the development of wire communication in Yellowstone, I am using the word "telegraph" or "telephone", as used in the record.

Apparently the lines between Fort Yellowstone (Mammoth Area) and the "soldier stations" were "telegraph line[s] of the hotel keepers, which was the only remaining contact [in winter] with Fort Yellowstone."(19)

Telegraph "remained in use on the Parks interior lines up to WW I. Jack Haynes told me how he used the instrument at Old Faithful . . . he was a trained telegrapher as well as a photographer. . . to get through to Mammoth at the height of the 1910 fire which threatened the Old Faithful area (the Army sent out soldier fire fighters)." (20)

Arthur Mattoon, in the 1917 book "Yellowstone National Park . . . 1889" records that "All the hotels in the park are connected by telephone lines". This is in agreement with a letter from Mammoth, July 28, 1889 by Mary Reeves to her mother: "There is a telephone all through the park. We can not get away from civilization."(21)

Even in those days, the availability of the telephone was sometimes used to centralize authority and decision making. An interviewee recalls "When the soldier station [Gallatin] caught fire, the soldier in the building called Fort Yellowstone on the telephone and said 'The station's on fire, what shall I do?' the answer was 'save what you can'. He did - by jerking the telephone off the wall and saving it."(22)

One of the colorful early-Yellowstone characters was known as "Telephone Pete". Even in those days, the conflict between physical installations and the pristine setting was experienced: "The Golden Gate is a column of rock left standing by the engineers. It is striking bit of the scene; but a few weeks ago the representative of one of the highest achievements in modern science, a gentleman familiarly known as 'Telephone Pete', showed his contempt for the small achievements of which nature is capable by planting a telephone pole directly in front of the solitary gate-post."(23)

The rigors of Yellowstone winters have always been destructive to overhead telephone lines as noted by Yellowstone "scouts" (soldiers): "The windstorm of yesterday did a great deal of damage in the Gibbon Canyon to the telephone line; it is broken in about 25 places, and down for about 1/2 mile in some places, and there are at least 100 fallen trees across the road."(24)

As late as 1898 references were made to both telephone and telegraph. The May 1898 instructions to soldier stations directed "If the station is not in telegraphic communication with headquarters, the offending persons [violators of regulations] may be brought in to the nearest telegraph station, where report of the case will be promptly made."(25)

It is interesting to speculate how a cavalry detachment could build a telephone line from Lake to the Snake River entrance in just thirty days (Sept. 15 to Oct. 15, 1904), but they did.(26)

A 1904 report by acting Superintendent Pitcher clarifies somewhat the previous question of ownership. "The recent opening of the eastern entrance to the park . . . makes it absolutely necessary that a telephone line be constructed connecting that point [Sylvan Pass] and Lake Station. The distance between these stations is about 28 miles. At present nearly all telephonic or telegraphic communication with our stations is had through the wires belonging to the Yellowstone Park Association, and as these wires are frequently loaded with business pertaining to the hotel and transportation companies, it would be much better if the government would own its own line."

While the installation and use of telephone facilities was usually justified by administrative and management requirements, their usefulness in emergencies quickly became apparent. One such instance occurred in 1912 in which the soldiers at Old Faithful used telephoned instructions from the post surgeon at Fort Yellowstone (now known as Mammoth) to set the broken leg of the Old Faithful Inn caretaker. The latter had fallen off the roof while removing ice to relieve strain on the roof timbers.(27)

In order to maintain a proper time perspective, it should be noted that the Army's telephone system in Yellowstone, connecting the soldier stations, was in existence about 27 years before automobiles were admitted to Yellowstone and Yosemite National Parks.(28)

There are no details of the type of telephones and lines of that era. However, it can be safely speculated that the lines were single-wire-ground-return with iron conductors, using the hand crank type magneto telephones.

"In 1911, Ranger William Douglas (Forest Service) invented the split tree insulator [which was subsequently adapted by NPS for tree-supported lines). . . Its two parts were wired together so that the telephone line rode in an oval hole in the center. The ends of the wire binding the insulator together were bent into hooks and hung on a staple driven into the tree . . . The insulator let the telephone line ride free so that when a tree fell across it, the line seldom broke. Slack wire would be pulled from both directions to let the line fall to the ground with the tree . . . The maintenance men would cut the windfall off the line . . ."(29) allowing the line to operate without interruption. The wire, often being in poor contact with the ground under the windfall, did not usually ground the line sufficiently to prevent use of the line. See Fig. 1

Mount Rainier National Park

Mount Rainier National Park records include a letter from Superintendent Ethan Allan to the Tacoma-Eastern Railroad, dated April 29, 1911 stating that a fee of $25.00 per year would be charged for a "Commercial telephone line, approximately 22 miles . . . near the government road, from its western boundary, through Longmire Springs [site of present Longmire Inn], and Indian Henry's Hunting Ground [no longer used for concession purposes], to Paradise Valley [site of present Paradise Inn] such line to be connected to a main line to Seattle and Tacoma . . ." The line was to be placed on trees, with poles only where necessary. Care to prevent forest fires was required (the preservation of park values had been well established by this time). The location of telephones for the government's use was specified (presumably in addition to those that the concessioner would use) and required that the government be entitled to free intra-park calls and free calls to Seattle and Tacoma. The line construction was to be started within two months and completed in two weeks - a difficult undertaking even with today's mechanized equipment, especially when terrain and remoteness is considered.

Correspondence during 1913 between the Superintendent, Mount Rainier National Park and the Chicago, Milwaukee, St. Paul & Pacific Railroad (successor to the Tacoma Eastern Railroad) shows that misunderstandings existed as to the propriety of the connection of the government telephones to the line at Ashford, which was the terminus of the railroad.

It soon became evident that both concessioner and government could not function properly by using the same telephone line for intra-park and "outside" calls. So in 1913 Superintendent Hall asked for and received $750.00 to construct a government-owned line between the Nisqually Entrance and Paradise, with way-stations at Kautz River (now called Kautz Creek), Longmire Springs (now called Longmire), and Narada Falls. This "grounded line" was completed by September and was the first instance at Mount Rainier of government-owned communications facilities. They were expanded during the immediate ensuing years to provide service to Carbon River, Ohanapecosh (via a USFS line), and probably to White River (not verified). Including the hiring of pack animals, the construction cost for such tree-supporting lines, was about $40.00 per mile.

Bandelier National Monument

An interesting account of the early use of telephone in Bandelier National Monument appeared in the October, 1979 issue of the NPS Newsletter, the Courier. It quotes Evelyn Frey who operated the Frijoles Lodge, beginning in 1925. She said "About the only real conveniences we had at that time was a phone system of sorts. There was a phone line between the top of the canyon and the Lodge. When visitors arrived on the rim, they would give us a ring and we would send horses up to fetch them down. We also were connected on two party lines. One went to Santa Fe and the other was connected with Jamez Springs and the back country . . . I remember one winter the manager of the Valle Grande cattle ranch left a caretaker to look after the place. Well, that winter there was 8 feet of snow up

on the Valle and the caretaker could not even get out of the house. He called me on the phone one day and said that he was going crazy. The rest of the winter I called him every day and read all the articles in the newspaper that I thought might be of interest to him."

Yosemite National Park

While the foregoing developments were taking place, cavalry units of the Army were in charge at what was to become Yosemite National Park. A telephone line existed in 1902 between the Power House at Happy Isles(30) and "the junction of the roads, near the Lick house" (probably near Camp Curry). In 1908 a telephone line was erected "from the Yosemite Valley to Hetch Hetchy, connecting with three outposts, one at Crane Flat, one at Hog Ranch, and the other at Hetch Hetchy. This line was put up in an exceedingly short space of time by Captain Wells, of the Fourteenth Cavalry, he having completed the entire 35 miles within fifteen days."(31) The report mentions that the line has been beneficial in facilitating fire-fighting at Hog Ranch and Hetch Hetchy, as well as kept supervisors from San Francisco in touch while "they were inspecting the Hetch Hetchy as a possible reservoir site for a water system for San Francisco." The report also mentioned that the Pacific Telephone and Telegraph Co. (PT&T) had built a line from El Portal to the "Sentinel Hotel in Yosemite Valley."

Special Inspector E. A. Keys submitted the 1910 Superintendent's report(32) in which he indicated that PT&T had extended its line from the village (assumed to be the site of the previously-mentioned Sentinel hotel) to Camp Curry. The permit required that "all governmental messages shall be transmitted free."

The lines to Yosemite Valley were rebuilt in 1913.(33) This same letter states that the Hetch Hetchy outpost line (probably grounded) was maintained after October 23rd, so that "communication could be had with the rangers posted in the vicinity of Ackerson Meadows and Hetch Hetchy." It is also noted that a lineman was hired at $3.00 per day, a ground man (often called a "grunt") and a station operator were each hired at $2.50 per day. "One horse was used during the entire month to haul the light wagon used by this department."

It is interesting to note that areas like Yellowstone, Yosemite, and Glacier were labelled as parks even though they were managed by the army (reporting to the Secretary of the Interior) until the National Park Service took over the administration of Yosemite in 1915. Chief Electrician Jack Emmert (later Superintendent of Glacier National Park), Joe Jenkins (later Chief Electrician at Yosemite, and Regional Electrical Engineer, Region Four), and others at Yosemite "started to change out the old ground return to full two-wire metallic lines of #9 iron wire.(34) On the 5th of July of that year construction was started on the Soda Springs line, [now Tuolumne Meadows] via Yosemite Falls trail. The following year we built out to Hog Ranch Ranger Station [now Mather Ranger Station] and to Merced Lake. At night we slept on the ground, using fir or pine boughs for a mattress and as you know Jack they seemed mighty comfortable after a hard day's work."(36)

Supt Bell reported "The lines heretofore constructed have been of light wire . . . strung from tree to tree in many places and small limbs falling from these trees breaks the light wire in many places. Also the heavy winter snow each season breaks and throws down these lines so they have to be practically rebuilt . . . We have on it [the switchboard] 50 drops or 50 lines, and with a view of increasing business and service, I believe that this office equipment should be enlarged four times its present capacity . . . "(35)

The letter in reference 36 contains some personal reminiscences that are indicative of the times and dedication of NPS employees in those early days:

> "Remember when you and Henry Skelton used to scout and locate the routing of new lines through the mountains a couple of weeks or so before construction and maybe do a little fishing on the side . . .
>
> "Remember that day in 1916 when Marion Lewis came over Glacier Point [along] a #9 iron telephone wire and it took him about six hours during which time his clothes were torn to rags and he had to spend a couple of days in the old hospital recuperating from shock. He later said he saw many valuable cameras and other things on the ledge below the point but he was in no mood to become interested in them . . .
>
> "Remember when the Soda Springs line was being built and the several times W. B. Lewis and yourself came out for inspection purposes and had dinner with the crew and sat around the camp fire at night and swapped yarns with the men?"

Indeed, those were the days when there was no portal-to-portal pay, no overtime, no returning home each night, etc. What transportation was available was either walking, horseback, horse and wagon, or possibly a Model-T Ford.

Glacier National Park

Telephone lines in Glacier National park were first built in 1911.

> "The telephone lines built this season and in active operation are as follows: Belton [RR] Station [now part of West Glacier] to the temporary administration headquarters at the foot of Lake McDonald [now known as Apgar Village], 2 1/2 miles; Administration headquarters to ranger station at head of Lake McDonald, 12 miles;Administration headquarters to Logging Creek station [now known as Polebridge], 22 miles; Head of Lake McDonald to Sperry Glacier, 6 miles.
>
> "A total of 42 1/2 miles was installed at a cost of $1,400.37 including nine telephones. Telephones were installed in the residence of J. M. Gruber, and in the store of W. L. Adair, a rental fee of $4 per month that the phones are in use is being exacted therefore."(37)

From today's perspective it is inconceivable that labor and materials for a 42 1/2 mile grounded (single wire) line could be accomplished for such a small cost.

In 1915 the Superintendent reported "I earnestly recommend the construction of an independent telephone system for the Park Service. The telephone line(s) in the park east of the Continental Divide are owned by the Glacier Park Hotel Co., and are not connected with the park system on the west side of the park. Under the present conditions when it is necessary to send a message to any point in the park east of the main range it has to be telegraphed to Glacier park station [now known as East Glacier] and sent out over the telephone line from that place to its destination. During the season just closed the Glacier Park Hotel Co.'s telephone lines have been poorly maintained and as a result a great many times it has been impossible to transmit or receive messages of importance."(38)

Telephone Systems

This was an era when the work of the rangers was decidedly different from what it became in later years. This was particularly true for those "district rangers" serving the outlying areas of the wilderness parks. Their districts were not frequented by many visitors and there were often no visitors during the winter months. Their duties consisted essentially of "being there" for the purpose of visitor and wildlife protection. This included patrolling to apprehend "poachers" who were after meat in the days of financial depression, and maintenance of trails, water supply, care and use of stock animals, roads (often operating their own road grader), and protecting buildings (removing excess snow in winter), and repairing telephone lines.(39) The #9 iron telephone wire,being quite stiff, required the use of two linemen's pliers to properly make a "Western Union" splice (in later years it was replaced by splicing sleeves that were compressed onto the wire with a Nicopress tool). The ranger sometimes would discover a break in the single #9 iron wire at a time when the pliers were not in his pack. Without both pairs of pliers the wires of the hand-wrought splice could not be tightly wrapped around each other, and so the "ranger splice" was born which the professional linemen made much fun of. However, inefficient as the hand-wrapped splice was, the ranger splice often restored the line to use, albeit subject to scratching and/or interruptions when the wind shook the poorly-made splice.

The "grounded lines" built in Mount Rainier were typical of lines built in many park areas during the period of 1911 to 1920. These lines consisted of a single #9 iron wire draped through "bobs" or split-insulators in such a way that a tree falling on the line would pull slack from adjacent spans, preventing the wire from breaking, as previously described. The earth was used for the "return", taking the place of the required second wire to complete the circuit. When the line wire was pulled to the ground by a fallen tree, the resistance of the "ground" at that point would be high (probably in excess of 100,000 ohms in dry seasons) enough that the "shunting" effect was minimal. Oftentimes it was possible to talk 20 miles even if five or six trees lay across the line. On the other hand a poor ground at one telephone could prevent signalling to or from that telephone, although voices could still get

through if both parties were listening at the same time by coincidence or prearranged schedules.

Compared to modern wire communications facilities, the grounded lines seem rather primitive. However, they also had some remarkable properties, some of which were advantageous and some of which were detrimental to their performance.

The fact that the line wire was from ten to thirty feet above the earth which was used as a ground return, made it perform like a very wide-spaced transmission line or antenna which was susceptible to electromagnetic radiation (manmade and natural). If two grounded lines paralleled each other for any appreciable distance, at separations less than a quarter of a mile, "crosstalk" would cause both conversations to be heard on each line. Nearby AC power lines would induce enough 180-cycle harmonic to render the grounded lines useless, necessitating replacement with "metallic" (2-wire) circuits. Lightning strikes within one or two miles of the line would often cause the bells (properly called "ringers") to sound with a loud one-time clink for each strike.

The grounded lines did, in fact, receive static crashes from thunderstorms as far as fifty or more miles away.(40) Consequently, conversations during summer evenings were often difficult to understand due to the frequent "snap, crackle, and pop" sounds (for which a certain cereal is noted) caused by lightning in the region.. Experienced fire lookouts, by noticing increases in frequency of occurrence and amplitude of static crashes, could sometimes predict the likelihood of thunderstorms developing nearby. Such noises may or may not be accompanied by a whistling type of sound that starts as a rough sounding note in the 800-1500 cycle range, which decreases in intensity and frequency over a two to five second interval. Sometimes these "whistlers" happened so often that a new one began before the preceding one had finished. The whistlers were accepted without explanation until after World War II, when "whistlers" were studied in connection with low-frequency radio propagation.(41)

Postwar investigation by scientists has demonstrated that whistlers are the result of lightning flashes occurring at the antipodes (opposite side of the earth from the point that hears the whistler) being propagated by travelling along the Heavyside Layer of the atmosphere. Little did the early users of grounded telephone lines realize that their conversations were being impaired by atmospheric activities at the opposite side of the globe! Whistlers have been variously described as rushing noises, strange hisses, whistles descending in pitch, and even as a "dawn chorus" heard at sunrise, akin to the sound of birds at dawn.(42)

Another interesting effect was sometimes experienced when several grounded lines were terminated in a switchboard at a field station. If the ground for the switchboard was inadequate, damaged, or its effectiveness was reduced by drought, a ringing signal on one line would make the bells for all lines ring simultaneously. This phenomenon was the result of coupling through the ground connection, which was common to all lines. The "ground"

might be little more than a high resistance to ground. Obviously such a situation created havoc for the ranger or operator who would not know on which line the call originated.

Even when a switchboard had an adequate ground and such coupling did not exist, it was frequently a problem to determine which bell was ringing because of the similarity of the sound of the bells on each line. Ingenious solutions to distinguish between rings on different lines consisted of such techniques as sawing a slot in the bells for one line, sticking gum to another set of bells . . . to give each line a distinctive sound.

Many ranger stations were the termination point of more than one line. These "switchboards" often consisted of a group of double-pole knife switches. One for each incoming line, and a bell and/or howler for each line. This arrangement had evidently baffled the ranger(s) at Lincoln Ranger Station in Olympic National Park. In response to a complaint I discovered that each successive occupant rewired or added switches to suit his own fancy. The result was such a conglomeration of wires, switches, howlers, and batteries that the only way to correct the problem was to remove it all, and install and rewire new switches, properly labelled as to function!

While grounded lines are not very sophisticated by today's standards, they were economical and useful within their limitations. Ingenuity was often used to overcome some of these limitations. For instance; with good grounds at each telephone, and a line clear of contact with brush and trees, it was possible to ring with the hand generator (putting out about 80-110 volts, at about 20 cycles, capable of a powerful "ZAP" to anyone working on the line at the same time!) more than forty miles.(43) However, voice communication was possible up to eighty miles. In order to overcome the ringing limitations, the following procedures were sometimes used. If there was a manned intermediate station it was usually possible to ring that station and have its operator ring the distant station. If this was not possible, a predetermined time-schedule might be used to meet the distant station by voice, without ringing. In cases where long grounded lines were terminated at a operator- manned position, a "howler" might be installed with which the operator could hear rings from any distance over which voice communication was possible.(44) This howler was in reality a sensitive loudspeaker whose impedance matched the telephone lines (probably about 600 ohms). It also had other advantages; (a) when several lines were switched by an operator, the operator could hear when the voices stopped talking and did not have to ask "are you through?" before pulling the cord, (b) portable test sets used by linemen often used a buzzer rather than a hand generator for signalling. Thus the operator could hear the lineman's buzzer signals through the howler.

When testing a grounded line with a portable test-set, it was impractical to drive a ground rod for each test (in some locations a ground rod would be ineffective because of rocks or poor ground conductivity). However, if the operator's position was equipped with a howler, the lineman (oftentimes a ranger) could drive a staple into a tree and obtain sufficient ground from it to enable signaling the operator with test set-buzzer. The cambium layer of

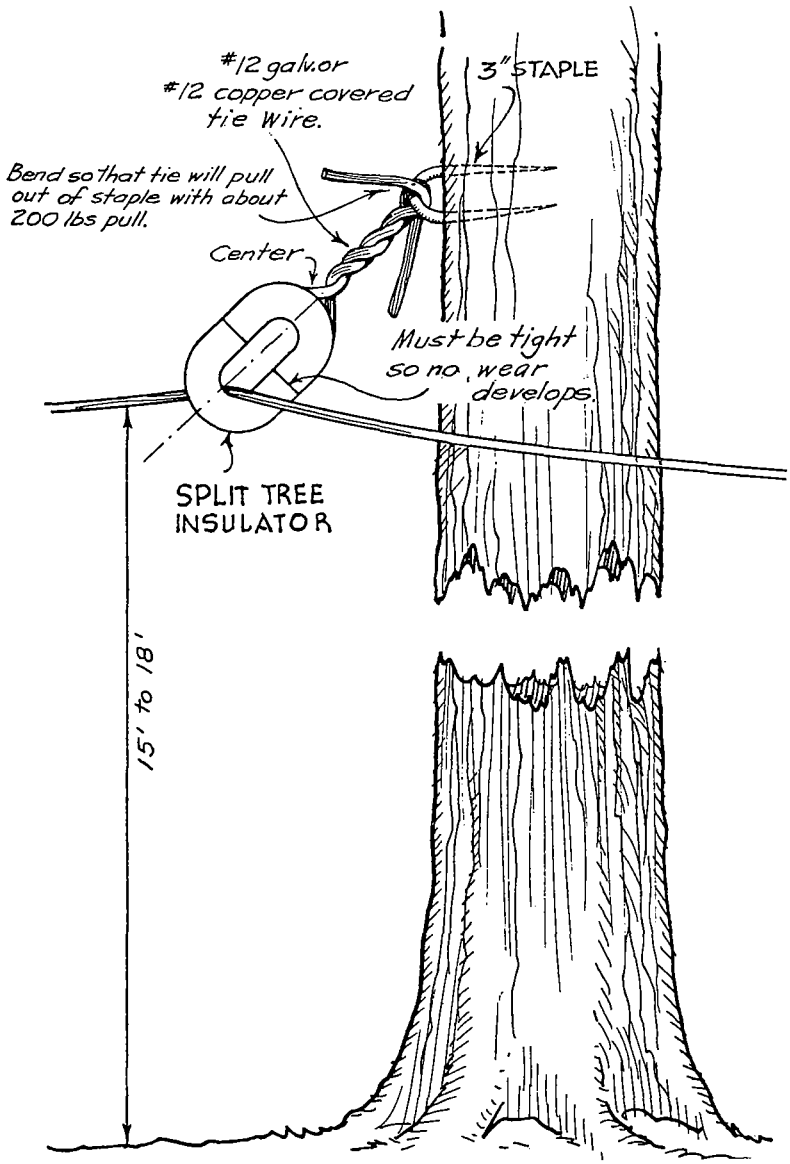

Figure 1

Tree Hanger for Grounded Lines

the tree provided a path to the root system, whose contact with the earth was an adequate ground for testing purposes.

Grounds used as the return path for grounded lines were of many types. The ideal was a coil of bare wire buried in moist soil 3′ or more deep, with rock salt placed over it before backfilling, but this was not always possible, hence ground resistance could be less than ten ohms in good situations to as much as two thousand ohms in poor situations. Since two grounds (one at each telephone) were involved in each communication it was possible that ringing (80 to 100 volts) current passed through in excess of 5000 ohms in addition to the ringer (bell coils). Standard 600-ohm ringers would not operate under such conditions, and it became necessary to purchase telephones with 2500-ohm ringer coils in order to signal over long distances.

As already explained, the grounded lines, being 15-30′ in the air were good "antennas", and could pick up a substantial "jolt" during nearby thunderstorms. Hence the telephones at lookouts were provided with a switchbox (built expressly for the Forest Service) that included a spark-gap and a switch which would disconnect the telephone from the line and ground the line side of the telephone. Because of possible hazard to lookout personnel, the switch was mounted outside the building and operated by means of a rope attached to the handle. Most lookouts would delay operating the switch until the storm moved close enough to "ping" the bell at which time he would begin use of his insulated stool and watch for cloud-to-ground strikes which may cause instant or delayed fires.

Batteries for magneto telephones were usually three #6 dry-cells which would last several seasons. Sometimes they would go dead at unexpected times, or run down because someone left the receiver off the hook or forgot to change them when needed. In such cases, it was possible to talk out by yelling into the receiver (fortunately it was on a separate cord in those days) once the other party had been raised. The reader can imagine the confusion that would result if a person had to yell "hello" in a receiver, and then quickly move it to his ear to hear the reply, continuing this manner through the entire conversation.

Telephone "transmitters" were actually microphones in which carbon granules were in an enclosure that permitted the diaphragm to compress the granules in a pulsing manner corresponding to the sound waves impinging themselves on the diaphragm.(45) After long periods of time, the granules sometimes became "packed" so that the diaphragm could no longer alter the granule's configuration. When that happened, no amount of yelling could be heard. If the user was aware of it,he (or she) could hang up the receiver and sharply rap the transmitter several times while the batteries were disconnected.(46) This would usually unpack the microphone so it could be used. If it did not, it was necessary to revert to the technique described in the preceding paragraph.

Some areas, like Yellowstone, where the snow did not have the moisture content of the west coast and the trees were smaller, were able to use their grounded lines throughout the year, in spite of windfalls laying on the wire.(47) The high resistance of trees leaning into the line

did not shunt the voice and ringing current enough to prevent use of the lines. However, the greater incidence of large and numerous windfalls with higher moisture content often rendered the grounded lines in parks like Olympic, Mount Rainier, and Crater Lake, impossible to maintain or use during the winter months.

RADIO

One of the very earliest uses of "wireless" was at an area that was not a National Park area at the time. "Thousands of tourists visit the site of the Marconi transatlantic transmitting station in Wellfleet, Massachusetts each year. All but the foundations of the transmitter house and parts of the concrete bases of two of the wooden towers has long since rotted or fallen into the sea owing to erosion. The National Park Service, however, has dignified the site with a facsimile of the original station.

"One exhibit at the site displays a copy of the first transatlantic wireless message, sent on January 18, 1903 from President Theodore Roosevelt to King Edward VII of England . . . in an adjacent display listing some of the equipment in the original installation, we find a 'Telsa transformer'. Yes, T-e-l-s-a,"(48). The correct spelling is TESLA.

The very earliest experimentation with radio in the National Park system is somewhat obscure.

"In 1919 . . . we installed the first wireless (radio today) transmitting set in Yosemite, one unit in the old Administration Building and the other in the Mountain House at Glacier Point. And it worked too (for a short time, 2 or 3 minutes until a condenser let go and replacements could not be obtained, it being an old deforest set which we obtained from the Army). That was the first and last attempt until 1934 when we installed the new short-wave equipment, which was fully developed at that time. This installation is also only a memory today, it being superseded by telephone company leased equipment in 1957".(49) This confirms the author's recollection of a private conversation with Joe Jenkins (now deceased), who was chief electrician at Yosemite with a total of 42 or 43 years NPS service.

There are purported to have been events in which WW I "Jennies" (aircraft) were used in unnamed parks to scout out forest fires. Communications was by means of CW (code).(50) The Forest Service was doing the same thing in 1920 over the forests of Washington, Oregon, and California.(51)

Finley Peak was a Forest Service fire lookout from 1919 to 1930, located very close to what is now Olympic National Park. "When Fred Briem was assigned here in 1919, the invention of radio was still a year away as far as the general public was concerned. Yet, the first fire report ever from a lookout via the wireless set might well have originated at this [Finley Peak] Cabin, had there been any to report. Finley was one of three lookouts (the only 3 in America) with a radio in 1919."(52)

In 1922 listening tests were conducted at Longmire and Paradise in Mount Rainier by a private party.(53) They "proved"that the mountainous terrain inhibited but did not prevent reception of broadcast, marine, and amateur stations up and down the coast. A quotation of $2500 was made for one 50-watt CW transmitter and three receivers; apparently assuming that one-way CW communication would be beneficial to the park. The latter was never carried out. The report is interesting for its terminology and description of the receiver "we used a Westinghouse RC2 set . . . one of the best possible for this experiment. All our receiving was very clear and was remarkable from the fact that our two amplifying tubes were not is use as the battery we had would not oscillate, so that all our receiving in park was done with only the detector." Probably a galena crystal used as detector, as distinguished from piezo-electric crystals used in later years for frequency control. "We also heard several small powered amateur stations came in with distinctness . . . Besides the many commercial code stations, both ICW and spark, we picked up what we thought was Portland [which had announced] 'the following will be played by Portland's finest orchestra.'"

This report by Mr. Cutler was followed by a proposal that illustrates what he was trying to promote in the park.(54) In the light of today's sophisticated equipment and licensing procedures, it is most interesting. "For one 100-watt CW broadcasting set, one code transmitter and three regenerative receivers including loud speakers that will fill with sound a hotel lobby, together with the installation, the cost will be $2800 . . . We find from the radio inspector that if the Rainier National Park Company operates the sending set two licenses would be needed, one for broadcasting and the other for transmitting paid code messages. However, if the government through your department, operates the sending set a naval call [can] be assigned the station and it will be taken out of the hands of the local inspector, thereby giving more privileges as to operation". Apparently the "system" was verbally described to Supt. Peters, since the proposal fails to indicate where the transmitter and receivers would be located, and what would b e accomplished with one-way CW transmissions to three receivers.

Licensing at that time was much different from present day methods. "At the urging of the U. S. Navy, Congress passed the Communications Act of 1912. This set aside certain frequency bands for commercial users and others for amateurs and required that all transmitters be licensed . . . It meant that individual operators could claim an operating authority within a band of frequencies . . . by obtaining a license. In effect, licensed operators 'owned' the frequency . . . People bought and sold licenses . . . This arrangement came to an end when Congress nationalized the airwaves in the Radio Act of 1927 . . . [President Coolidge appointed 5 commissioners to the Federal Radio Commission]. The final principle is that since specific users have been allowed to use 'public property', their use of it must be regulated. The Federal Communications Commission (FCC) like its predecessor, the Federal Radio Commission, took seriously its responsibility to regulate the use of the airwaves "in the public interest."(55) This quotation fails to specify the method of licensing government stations, which in early times was done through the Navy department as implied in the proceeding paragraph. Beginning in 1923 licensing of

government status was done through the Interdepartmental Radio Advisory Committee (IRAC) as described in a later chapter.

At this point in time, radio was considered mysterious. Yet it had been placed in service at sea and was instrumental in many maritime rescues. Radio broadcasting was being accepted and many homes proudly displayed a bakelite-panelled neutrodyne or "detector and two-step" receiver and either a large horn or cone loudspeaker. Yet there was skepticism that radio would penetrate the forests and mountains.(56) "The experts said that the timber canopy under which much of the operating would be carried on would result in destructive attenuation, and that the range . . . so limited as to be of little or no value."(57)

Individuals in the Forest Service began testing the possibility of using radio in 1919. R. B. Adams "was worried by predictions that radio would be adversely affected by the proximity of 'mineral zones', timber and terrain."(58) Even as late as 1928 there was skepticism in the Forest Service: "Some experts believed inexperienced personnel could not operate the sets, that low power would not read more than a mile, and that topography would cause a loss of radio energy. Others were sure that transmissions above 4000 kc * would be absorbed by timber." In 1930, Dwight L. Beatty (a Forest Service radio enthusiast) reported "It appeared that no attempt had been made to use lower power, short wave radio-communication in rough topography and green timber, and that there was no agency likely to initiate such a venture. Further, it was the majority opinion that the proposition was not feasible and the more optimistic termed it, at best, a gamble".(59) Evidently Beatty was not familiar with Waterhouse's efforts and tests as described herein, in addition, reference(60) seems to indicate that Beatty may not have known about some of other Forest Service tests and experiments.

During this period technological improvements in both broadcasting and receivers were rapidly appearing. The reader should note that in this, and other places in this book, the term "broadcasting" usually refers to broadcasts to the public by commercial stations in the 550 to 1500 (later, 500 to 1600) kc band. Some of these improvements were instrumental in getting two-way portable communications "off the ground". In the early twenties home broadcast receivers used 1.1 or 5-volts DC filament-type tubes for home receivers with the filament giving off a glow like an unfrosted 10-watt lamp. The filaments were operated from a battery, using a rheostat to regulate emission. A "portable" receiver, probably weighing sixty or more pounds, including batteries and a 3' loop antenna, was often taken to schools and other public places for public demonstrations.

By the late 20's vacuum tubes were developed with a cathode surrounding the filament, making AC operation possible, using 2.5 volts AC for filaments and a B-Battery eliminator for plate voltage. By the thirties, a series of 2-volt tubes (designated as types 30,31,32,33,

* kc and mc will be used instead of kHz and mHz in accounts that took place prior to the establishment of the new terminology.

and 34) was developed for portable sets with the idea of heating the filaments from one cell of a storage battery, drawing only 60 or 120 MA, (depending on tube type). These are the tubes which made reasonable-sized portables practical. Prior to and during WW II, 1.4 volt tubes of smaller size were developed, which further enhanced miniaturization. 1.4 volts was chosen because it allowed operating the filaments directly from 1.5-volt dry cells. Finally, about 1950 subminiature tubes (2E32, 2E36, etc) were developed and used in commercially-supplied "handy-talkie" radios. These were the ultimate until transistorized models became available. A later chapter will discuss the influence of semi-conductors on NPS communication.

During 1927/1928 R. D. Waterhouse (Bob), an engineer stationed at Mount Rainier entered the scene and on his own initiative based on his personal "ham" radio experience, began systematic experimentation and development of two-way radio units. This will be expanded upon in the following chapter. Bob had, coincident with but separate from the United States Forest Service, recognized the benefits which could be realized by forest protection forces if a truly portable transceiver were available. He was attempting to develop a portable unit weighing less than forty pounds, that would be capable of sending voice and code over a distance of thirty miles.(61) Of course, the fallacy of calling for a specific mileage range when using medium-frequencies was not realized. Later it became apparent that the vagaries involved in over-the-horizon propagation were so variable that one could not identify with certainty any specific range capability. By today's definitions the range would be specified together with a probable success-rate, which is more descriptive.

Waterhouse's personal dedication to development of two-way radio is evident in the following quote from reference (62) ". . . work was started in 1929 on a set to weigh not over 40 pounds. Progress was slow as all expense was carried personally by myself up to April, 1930 at which time Mr. Freeman of the Boeing Air Transport system took the work over . . . [he] reports that the set was finally worked down to a single case containing the complete set and with a weight of 32 pounds . . . It is the third set built personally."

In the same referenced letter Bob referred to the problem of funding his early experiments. "The fund as set up is not sufficient to do very much experimenting with and I have endeavored to get a workable set finished [using] private funds and then buy the finished product with this fund and adapt the set to our work as it is used under actual working conditions." His primary interest seemed to be to have a workable set for use in fire control, because the long runs of emergency wire necessary to bring telephone connections to fire camps were often either impractical or unworkable.

A Department of the Interior publication(63) reports that "in the next year [1928] the National Park Service established experimental radio stations at Mount Rainier National Park in the State of Washington." Activity of a permanent nature was evident in the early 1930's, as reported in the next chapter.

There is no doubt that some experimenting with radio had been done in other parks. However, they were not followed up with persistence and development. As will be seen in chapter two, it was Waterhouse's determination that resulted in the financing and development of two-way radio for NPS use.

It is an interesting coincidence that the Forest Service radio beginnings occurred about the same time and were also in the state of Washington, "Dwight Beatty, a self proclaimed mule-skinner . . . successfully demonstrated a small home built rig to a group of foresters near Missoula, Montana, in early 1927. Transferring his efforts to Tacoma, Washington, he made numerous tests in dense timber and mountain valleys. Hurrying in to a final design for the 1930 fire season set, came in four packages and weighed approximately 179 pounds."(64)

There was another test involving Mount Rainier about which I have been unable to get specific information, other than a reference to an article in the Sunday Oregonian (Portland, Oregon, date missing). "William S. Halstead and Royal V. Howard . . . designed and constructed a portable set weighing 60 pounds that was successfully demonstrated in 1928 on Mount Rainier for the National Park Service."(65)

CHAPTER TWO

GROWING PAINS

1930-1941

CHAPTER TWO

GROWING PAINS

1930-1941

GENERAL

The early 30's was an era that would not be recognizable to young people of today (in spite of the current emphasis and fads pertaining to antiques, beards, and longing for the "good old days").

As far as the planning and design of communication facilities and operations for NPS were concerned, there was little direction from the "top". Each superintendent and district ranger was largely on his own. Communication between park headquarters and the district rangers, such as it was (to be described later), was usually limited to information relative to the well-being of the ranger, travel and weather information, and to tell field personnel of impending events. Its availability also served as a "safety net" in case of the ranger's sickness or injury.

During this period, the possibility of using telephone and/or radio as an aid in combatting large fires became recognized. This led to the desire for communication between fire lookouts, district rangers, and dispatchers on a regular basis; and, in the event of "going fires," between these people and the men on the fire line.

Communication between the Superintendents and their Regional Director and/or the Director's office was largely by mail, with an occasional Army-handled telegram being the exception. Long distance calls were usually beyond the limits of economic propriety.

The Service was prohibited from purchasing passenger cars for any purpose other than the Superintendent's, meaning that everyone else had to use a truck or pickup which was not always suitable for certain activities. This limitation was sometimes circumvented by purchasing coupes to which a short bed and tailgate had been welded to the trunk, making it meet the "pickup" requirement. A few passenger cars were also obtained as a result of Government confiscation. Such cars were referred to as "bootlegger cars". Bootlegger cars were used for the first mobile radio tests conducted at Mount Rainier, as described in a following section.

TELEPHONE

Early Telephone Facilities

The period from approximately 1930 to the beginning of WW II was not noted for spectacular telephone developments. Rather it embraced many new systems but few new techniques.

For instance, not all grounded lines were replaced by metallic lines. The phenomenon and procedures described in the preceding section were still part of the scene. Since the traffic burden to fire lookouts was low and the lookouts were remote from interfering AC power lines, there was no incentive to metallicize those circuits, although there were cases where a grounded-line spur to lookout might be connected to a point-to-point metallic circuit serving other locations. This required installation of a "repeat coil" (actually a 1-1 transformer) to prevent unbalance of the metallic line.

Sometimes it was an advantage not to have all lines metallicized. A falling tree usually "shorts" a metallic line. But in heavily wooded areas a grounded line might be downed but not broken by falling trees as described in Chapter One. This still permitted talking, and sometimes ringing, although ringing was not always possible because the 20-cycle ringing current was more susceptible to the "grounds" on the fallen line. Many times radio was used to establish contact, after which the talking would be done on the downed line.

In 1932 the Superintendents of Lassen, Sequoia, and Yellowstone were concerned about communication to remote portions of their parks and inquired from Mt. Rainier about the feasibility of using radios to avoid the necessity of building telephone lines to those places. They were told that 70-pound battery-operated voice sets cost about $150.

Mt. Rainier's response was "The chief value of the present radio equipment is to provide emergency communication to points not accessible to wire lines and for short periods . . . [as to Mt. Rainier] we also require several additional telephone lines to distant points in the park to increase our protection efficiency . . . We also need two or three additional trunk lines to our newly opened Sunrise area for long-distance service . . ."(5)

Some telephone system developments were influenced by the introduction of AC power into developed areas. A report by the Superintendent, Mount Rainier (probably September 1933) stated "Great difficulty was experienced with the north side lines because of interference from the Sunrise Power Plant. Apparently it will be necessary to change all the lines in the Sunrise area to metallic circuits as the underground power distribution system in that area is grounded [probably 2400/4160 volts Y-connected] and greatly interferes with the operation of the telephone lines." At Olympic National Park, the CCC (discussed later) built a number of metallic circuits on cross-arms under a section of a 66-KV power line built by Crown-Zellerbach to deliver power from their generating plant at Lake Mills to their pulp plant in Port Angeles. The metallic circuits in turn fed grounded lines running to various areas in the park: i. e., Olympic Hot Springs, Hurricane Ridge, Low Divide and way-points. This section paralleling the power line required installation of special high voltage fuses and "repeat coils" to (a) isolate the line from high voltage if any power wires should become broken and (b) to minimize induced noise due to longitudinal currents.

Shortage of funds delayed replacement of many grounded lines with metallic lines. The master plan for Mount Rainier in 1932 showed grounded lines encircling the park. The only metallic line was between Nisqually Entrance and Longmire and Paradise which were the

only places requiring long-distance service on a regular basis, being the most visited points in the park. The line from Yakima Park (now known as Sunrise) to Carbon River was also metallic as far as Berkeley Park. This circuit was in a cable, buried simultaneously with the power and water lines that were laid when the Berkeley Park pumping station was constructed (to supply water for Yakima Park). Many of the grounded lines were replaced with metallic circuits by CCC crews as reported later in this chapter.

The dearth of appropriations for maintaining communications in the park areas was evidenced in many ways. The dedication of park personnel who worked long days, without overtime pay or compensatory time, oftentimes hiking through dripping underbrush at barely-above-freezing temperatures, or slogging across encrusted snowfields that would break through with each step, was phenomenal. The electrician's crew at Mount Rainier used a Ford Model A 1/2 ton truck that was loaded with what must have been more than a ton of tools, wire, insulators, etc, to the extent that it looked like an old-time peddlers wagon. It was so heavily loaded and had enough clearance that it could get traction in any depth of snow until the front bumper began to function as a snowplow, at which time the engine had insufficient power. Many times the drivers would drive the crests between the ruts on snow-bottomed roads to "help the road crew" - and help they did. If you were following, you could see a spray of snow and the ridges that had been left by preceding vehicles would nearly vanish.

Early telephones were of the separate transmitter and receiver type, with the transmitter either wall-mounted on the ringer-equipment box, or on an upright desk stand. The circuit design permitted a portion of the talkers voice to be heard in the receiver as a side-tone. Hearing one's own voice usually caused talkers to lower their voice level. In the early 1930's an anti-sidetone circuit, and the familiar handset were developed, which led to more voice power being transmitted to the distant telephone. The reduced "talk-back" encouraged talkers to "talk up" better. Many parks converted older telephones with the aid of conversion kits.(6)

In some parks, increased visitation required additional public, administrative and maintenance facilities which in turn required substantial expansion of telephone facilities and teletype facilities in special cases. Those needs included intra-area communications for both NPS and its concessionaires, as well as communication with the "outside world". Public pay telephones were also a necessity at developed areas, as were wayside emergency telephones for use by both the staff and public.

$9,000 was included in the preliminary estimates for Mt. Rainier for 1933, to provide for a telephone line between Longmire and Sunrise. This prompted the Associate Engineer to propose to Superintendent Tomlinson that the money be used for a radiotelephone link instead.(7) This was followed up in September, 1931 when Chief Engineer Kittredge requested radio-frequency assignments to Mount Rainier for a "duplex telephone service between Sunrise and Longmire."(8) It was claimed that $9,000 "will barely cover the cost of

providing a single-wire grounded circuit which cannot possibly be maintained during the late fall, winter, and early spring months."(9)

The proposed radio/telephone circuit was prompted by failure of the Bureau of the Budget to include $8,000 in the 1933 budget for telephone line construction. "Budget officials indicated that they desired further experimental work carried out to determine definitely the practicality of the use of radio phones. It was indicated that pending such determination, further telephone construction especially to outlying stations, would not be passed on by the budget."(10) But Waterhouse rejoined with the information that there was no money for radio tests.(11) Another letter clarified the Bureau of the Budget's position as not implying that the directive to proceed with experimental radio work was intended to meet the heavy traffic needs for communication between Longmire and Sunrise, but that there were inadequate treasury funds to finance the telephone line in the 1933 budget, and that the hoped-for substitution of radio for telephone was intended only for "outlying stations where the would be no volume of telephone communication and where the line was constructed solely for protection purposes." Because of the seemingly contradictory attitude of the Bureau of the Budget and the shortage of funds for continued development "it is thought that we might arbitrarily take a certain sum from each of the larger parks from the amounts granted for the purchase of equipment . . . perhaps some of the funds allowed for fire prevention equipment could be allotted."(12)

There were those, including this writer, who were so enthusiastic about the possibilities of radio, that they expected radio to replace telephone lines. This did happen, but only to a limited extent, where a radio-telephone might be used to replace a long (or difficult-to-maintain) telephone line that served only one or two remote points. The introduction of microwave circuits for telephone service is covered in later chapters.

Most park areas were usually remote from principal metropolitan areas, necessitating long trunk lines to reach them. By commercial telephone company standards, the density of telephones per square mile of area served was extremely low. The esthetics requirements of concealment of overhead lines and exposure to such hazards as falling trees, rock slides, etc., together with the low density of users, discouraged commercial utilities from providing service within most park areas. It was just not economically feasible for them. Consequently the telephone companies provided points of interconnection with government-owned lines(also concessioner-owned if there were any concessionaire's lines), treating the government and/or concessioner as an independent connecting telephone company. This required coordination of facilities and negotiation of a separations agreement for distribution of toll charges at many of the larger western (and some eastern) parks. (13) Most of these agreements were negotiated by C. D. Montieth, Utilities Engineer from the Washington office.

That operating the "independent telephone company" was a big job for an area whose main purpose is to serve and protect the public, is evidenced by an August 1956 report for Mount Rainier which indicated that were 266 circuit-miles in operation serving 171 telephones.

The operators (discussed in a following paragraph) handled 19,500 intra-park calls, 705 outbound long-distance calls, and 441 telegrams.

Chapter One detailed the early development of telegraphic and telephonic communication at Yellowstone National Park. The Park's connection with the "outside" was via facilities owned by the Northern Pacific Railroad (NPRR). The point of connection was evidently at Gardiner. However, in 1941, the Mountain States Telephone and Telegraph Company (MST&T) extended its lines to Gardiner and installed a "central" (exchange) south of the NP depot there.(16) At that time, both government and concessioner acted as independent operating companies.

Yellowstone had an extensive system throughout the park, with an operator on duty at all times at the switchboard at Park Headquarters in Mammoth. It was more extensive then the just-described Mount Rainier facilities. It was paralleled on most routes by concessioner-owned lines that interconnected most of the hotels and lodges. In parks where the concessions were operated by a railroad, telephone lines were operated for, and used by, the railroad/concessioner. Bryce Canyon, Zion and Grand Canyon were among the latter.

Maintenance

While most of the "front-country" telephone systems were being metallicized, and frequently more than one circuit was necessary between developed areas, remnants of grounded lines (some were ground-laid to lookouts) remained in service to fire lookouts and isolated ranger stations. The type of personnel selected for the latter were the self-reliant and adaptable type described in Chapter One.(17) Their attempts at placing a Western Union splice in a #9 iron wire were less than ideal because of lack of experience, proper tools, or just simply lack of patience. Thus the term "ranger splice" was derived as described in Chapter One.

It should be noted that, because it was desired to keep telephone lines out of the view of the public (often about fifty feet off the road right-of-way screened by timber and underbrush), construction and maintenance was more difficult and expensive than it would have been in non-park locations. Tools, materials, and equipment had to be toted in to the line route from the nearest suitable parking place for their trucks. Travel was up and down over brushy and/or rocky and/or marshy terrain without benefit of a trail. When it was necessary to erect poles, they were either dragged to the site by horse or carried by a crew of men using "swede hooks" - a tool that would be hard to find today. After holes were dug with hand tools, including rock-bars and long-handled "spoons" (sometimes after using "powder" to break up solid rock), the poles were "piked" into place by a crew using 15 to 20′ pike-poles - a procedure that OSHA today would probably outlaw - yet there were few injuries.

Maintenance of telephone lines during the winter months was virtually impossible in parks that experience heavy snowfall like Olympic, Mount Rainier, Crater Lake, Glacier and Lassen.

> "It seems to be impossible on account of snow, falling trees, blasting and weather conditions, to keep our round-the-park telephone lines working more than 80 percent of the time in the summer 6 months, and 10 percent of the time in the winter 6 months in normal years. And radio can be operative more than 80 percent of the time all year. Maintenance would favor the radio as the maintenance of the telephone lines is heavy.
>
> "The intermediate telephone stations in the patrol cabins will have to be maintained and the public will have to be accommodated over the telephone system, so that it may be said that radio will be a supplement to the telephone system in Mount Rainier in regard to the district ranger stations and Sunrise, and will be a very valuable primary source of communication for fire fighting camps."(18)

As an example of the difficulty in maintaining telephone lines in the heavily forested parks where trees often reach 200 feet in height, the following is a quote from a monthly report for May (probably 1931) by the Superintendent, Mt. Rainier: "At the end of the month [May] the inter-station grounded circuit telephone lines had been repaired and placed in operation. The seasonal repair and reconditioning work had been completed just before the wind storm of April 22-23 when it was damaged and remained out of order until the end of May. There still remains considerable repair work to restore this line to proper condition for summer operation. The park electrician employed a crew of about 12 to 15 men throughout the entire month repairing the metallic circuits connecting the commercial telephone company lines outside the park and the switch-board at Longmire [only about six miles!]. These lines had to be completely rebuilt in many places."

In spite of the tremendous job of maintaining the telephone lines in the park, only $7300 was programmed for 1932 FY. Yet the lines were kept open during the summers with much voluntary unpaid overtime. These were intrepid people!

At Mt. Rainier the crew employed by the Park Electrician worked mostly on lines in the south and eastern part of the park while rangers and/or CCC crews worked the lines in the remainder of the park:

> "I used to carry a 'connector' [Nicopress tool] and a large side-cutting plier for repairing line, that way neat, solid splices could be made on any gauge wire as the connector had the right slots for the wire gauge and a ring to lock it shut. Also carried a 'come along' for pulling enough slack to splice . . . I carried 'tree' spurs, not the short pole spurs. The whole outfit, with hand-axe and test phone, staples, a few insulators, and a few coils of wire, was a load . . . also carried a double-bitted axe in hand for chopping trees off the line .

> . . The Lake James line had nearly a mile of Army field wire laid on the ground through Windy Gap. I remember going up there and finding the whole line fried by lightning which had left a sooty-black streak on the rocks and ground. At Carbon [River], they [the CCC] cut a regular 'Canyon' thru the heavy timber up the valley from the entrance to beyond Ipsut campground. The idea was to install a metallic [two-wire] line in that 'slot' but it evidently didn't work out; we still had an old grounded line to the Ipsut cabin in '50 when I was briefly District Ranger . . .about the last use of telephone [radio system having been installed] in that corner of the park."(19)

Operators

In many areas, the traffic required installation of a magneto-ring-down switchboard and the services of one or more operators. These operators quickly ingratiated themselves to the park and concession staffs, and the public. Being the only operators in a small community they soon knew all the employees, their business, and usually their location hour-by-hour. Thus anyone could ring up "Myrt" (a character developed by Fibber McGee & Molly of radio entertainment fame) and ask her to get Joe, and she (there were no male operators in those days) knew just where to find Joe, whether it was at the carpenter shop, the fire shed, or at the wholesale house in the nearest town.(20) Night coverage was provided with a specially made patch cord (called a "rats nest") with enough plugs (usually 10 to 15) to connect all lines serving emergency personnel in parallel. In this way an emergency call would reach someone, it being unlikely for all personnel to be gone at the same time. Sometimes this loaded the lines too much for effective ringing.

The excellence performance of typical operators is recalled by an incident when a storm severely affected the Pacific Telephone and Telegraph Company (PT&T) toll lines throughout the Pacific Northwest. It had also caused considerable damage to buildings, roads, and facilities in Mt. Rainier National Park. The Superintendent was very anxious to report this to the Regional Director in San Francisco. The PT&T operators in Tacoma told the NPS operator at Longmire that there was no way for the call to go through. Elva Lewis, the NPS operator, used her knowledge and ingenuity and directed the PT&T operator how to get the emergency call through by bypassing the storm-affected area. The exact routing is not recalled, but it was as if she had told the Tacoma operator to reach the operator at Morton, who was to reach the operator at Yakima, who was to call Portland, who was to make the final connection to San Francisco "Where there is a will, there is a way" and the NPS operators were usually able to find a way.

The magneto ring-down lines had advantages that, if ordered today, would add considerably to the cost of service. "Conferencing" was a regular thing as long as those you wanted to "conference" with were on your line or the line of the party you were talking to. News was readily available if you were careful enough to cover your mouthpiece when "rubbering" on the calls on your line.

When I was stationed on the fire lookout at Mt. Fremont (Mt. Rainier) there were daily visits via phone with other lookouts, and sometimes with the telephone operator at Yakima Park (also known as Sunrise). One of the White River maintenance personnel who could be described as testily gruff, and cantankerous, delighted in discreetly eavesdropping on these visits. At a later time, he would embarrass us with comments or jokes concerning the conversations he had been rubbering on. We soon learned during our evening chats to listen carefully for changes in volume and/or background noise (when he took the receiver off the hook) and then talk about him, pretending we didn't know he was listening. We kept it up until he could stand it no more, and he would burst out with audacious retorts.

Besides meeting the necessities of communication for protection and administration, telephones were often a morale-builder for the fire lookouts. Often a week or more would pass without seeing another person. It was common for three or four lookouts on different lines to get the operator to connect their lines together for an hour or two each evening. If the operator (nearly always a female) was not busy she might join in on the conversation. Many of the lookouts were college students during the school year, so the evenings "visits" often involved discussion of college courses and life, in addition to exchanging recipes and experiences of the day. This was often the high point of the day for the lookouts when they could visit with their distant "neighbors" whose Coleman lanterns they could see if they looked carefully. Friendships were developed which sometimes continued through the year on the campuses. When the operator was able to join in, it became a fellowship event and morale builder. With the later replacement of grounded lines with radio this practice had to be restricted, since the entire park radio network would be tied up during such "rag-chewing". The battery drain of the tube-type radio equipment would not permit such extended use if one set of heavy-duty batteries were to last the season. By the sixties, many of these fire lookouts had been decommissioned in favor of aerial patrol of forested areas.

Providing telephone communication for fire lookouts was not always easy. Some of the problems have already been described. Most fire lookouts were on peaks that were above the timberline. The terrain consisted of either solid rock, lava, or shale, with very little soil for trees and/or vegetation. Whatever soil was available was granular and did not make good contact with ground conductors. However, the radial wires used for the lightning protection system were usually long enough to have a capacitive effect between the lightning protection system and the earth, making it possible for alternating current ringing signals and voices to pass through. Since the capacitive reactance (opposition to flow of current) decreases as the frequency is increased, this "ground" was more effective for voice frequencies than for ringing. There were three problems in connection with telephone lines to lookouts. First was the method of "stringing" the telephone line, since there were often no trees large enough to support on overhead line. The rock made it virtually impossible to erect poles. Even if an overhead line were possible, the weight of the wire would tend to pull the entire line down-slope, and winter snows would have a tendency to push poles over and/or pull the wire down from the supports. Consequently "emergency wire", consisting of a pair of seven-strand iron conductors insulated with rubber and cotton, was

Figure 2

Communications Center
Sequoia & Kings Canyon National Parks
1956

Telephone Switchboard is magneto ring-down. Typical of many of the larger parks until NPS-owned systems were sold to telephone companies. See text re "Myrt" and dial conversions. Radio remote control unit controlled one of the largest FM systems in use at the time.

laid on the rocks between the nearest overhead line (usually in a valley below the lookout) and the lookout. Since the telephone line was a grounded line, the two wires were connected in parallel to serve as a single conductor. The second problem was lightning, which was often intense near such lookouts. A special switch (designed by the USFS) was installed on the outside of the building which could be operated by the lookout (by means of ropes), to disconnect the lookouts' telephone from the line, and ground the telephone itself. The lookout could usually tell when the storm was close enough to endanger the telephone when he heard a "clink" of the telephone bells at the same time that lightning was observed. The third problem involved getting a ground-return connection as already described. The lightning-protection system ground was not always adequate for this purpose. When it was not, one of the lightning radials would be extended to a grassy place or clump of shrub-trees and a coil of bare wire buried in whatever soil or sand could be found.

The advent of the automobile into the parks drastically changed the methods and type of work of the park protection staff (rangers).(21) Road patrols (motorcycle until about 1936, then replaced with automobiles) became a necessity in order to discourage excessive speed which often resulted in accidents due to the visitor's unfamiliarity with the terrain, and to respond to emergency needs. However, the patrolling ranger had no way to request assistance. Neither did their headquarters have any way to dispatch them to emergencies. In order to help the situation,the larger parks installed roadside emergency telephones at intervals along the roads and, in some cases, alongside the trails.(22) During the post-war WW II era, two-way mobile radio displaced the need for wayside telephones, except where visitors might have need of them to report emergencies.

New metallic circuits in some of the heavily-forested northwestern parks were built with wires which were supported in a vertical position on trees. In those areas with open country, the metallic circuits were usually on poles with brackets or crossarms. Where there were several circuits hung in vertical configuration on trees, the effect was a "Paul Bunyan's banjo" as described by Thomas (Tom) C. Vint, Chief of Design and Construction, during a visit to Mount Rainier. Untangling six, eight, or ten of these wires which were often wrapped together after a winter's snow and heavy windfalls, made restoration a difficult job each spring.

The Civilian Conservation Corps

In spite of heroic efforts by park staff and CCC crews, it was not always possible to keep the lines working continuously during the summer season. The advent of two-way radio about 1934-36 was fortuitous in some cases. Sometimes it was possible to talk but not to signal ("ring") on certain lines. In such instances, the radio might be used to tell the distant party to get on the telephone line. Since continuous standby was not possible on the radio, sometimes the telephone was used to arrange a test with a distant radio.

The Civilian Conservation Corps (CCC) was inaugurated in 1933. It was a boon to those areas that needed new or rebuilt telephone systems. This "tree-army," created by President

Roosevelt to create employment, train and educate young men, and protect lands and forests, resulted in camps of about 200 men located in many of our national parks (as well as state parks and other public lands). The projects, many of which endure to this date, included construction of new and maintenance of existing lines, as well as roads, trails, buildings, soil conservation, etc. Without the CCC many of these facilities would not have been built. "John Schroeder referred to the CCC of young Americans as 'The Forgotten Men of Iron' in a feature story for the Arizona Republican Oct. 6, 1985 . . . work included the construction of the Trans-Canyon Telephone line . . ." in Grand Canyon National Park.(23) It is obvious that many CCC enrollees gained useful lineman's experience.(24) In addition the young men were introduced to the concept that National Park areas are to be protected and kept in their natural state. One of the popular comments was that if a trail was being built, and a tree was in the way, the trail must be rerouted to save the tree.

By 1940 the telephone traffic at Mount Rainier had developed to the point where two parallel metallic circuits were modified by CCC crews to provide a "phantom" circuit between Longmire and Paradise. Thus three conversations were possible with only two pairs of wires.

Records available to me are rather sketchy as to other NPS areas that benefitted from CCC work on telephone lines. In addition to areas already mentioned, Burton Appleton wrote "I could not fell burned out stands of lodgepole pine in New York City, or string telephone lines to remote areas, or do any of the other things that I did in Glacier National Park, what I could do is develop an appreciation for the natural beauties of our land . . ."(25)

Great Smoky Mountains National Park was authorized by a bill that was signed by President Roosevelt in 1934. "Many people say the CCC literally built the Great Smoky Mountains National Park. When the first [CCC] camp [there were twenty-two all told in the park] was established in 1933 the 'Park' was little more than a dream . . . The CCC helped make the dream . . . come true . . . the memory of huge fires following logging was fresh in people's minds. To be on the lookout for future fires, CCC crews built and manned fire towers. They also strung miles of telephone lines to enable quick communications between the various ranger stations and fire towers."(26)

The CCC also built a metallic line from Capulin National Monument headquarters to a point within a half mile of the small village of Capulin, New Mexico. The telephone service for Capulin residents was provided by a very small independent company owned, operated, and maintained by one man. The "switchboard" was in a residence and service was available at such times as "Myrt" (the operator) was on duty or not sleeping. When I visited the area, it was obvious that outages were frequent, and transmission was poor. It was hoped that the owner could be persuaded to turn over his facilities to MST&T so that the Monument could have more dependable service. MST&T officials were aware that the service was poor, but the small number of subscribers and their inability to pay for improved service was a disincentive for them to buy out the owner.

A June 1934 report on telephone line maintenance by the CCC Camp NP-1 Superintendent (Mount Rainier) is indicative of the nature of work done by CCC crews and benefits to the CCC enrollees:

> "On May 31, this project was started by Canty (Leader) and a crew of two men. Their work was to go over the existing line from Camp Tahoma Creek to Indian Henry's Hunting Ground and renew the old type of insulators with the new style. Also, to release the line in case branches or logs had fallen on it during the winter. In some places they cut out bad stretches of wire and put new material in their places. In fact, it turned out to be a job rebuilding the section from the forks of the Longmire and West Side roads to Indian Henry. The crew also cut a trail and stacked the brush under this line. On the 25th of June, Foreman Davis took over the telephone work and Canty acted as his leader. On this day, they started to rebuild and relocate lines 1 through 12, running from Longmire to National. This will include metallicizing of line 8 from Longmire to Tahoma Creek, and moving this line to the regular trail. Also changing No. 12 line from iron to copper and the re-routing of several lines at Sunshine Point. This work is the most popular in the camp program. It is also very good training for the boys and should benefit them later. Some days these crews take lunches and sometimes they are in locations where they can come in to camp for lunch. As it was found necessary to get leather gloves for the boys in this crew who were pulling line, the Captain secured them from Fort Lewis."(27)

During the thirties, park appropriations were very limited. Each superintendent and his staff avoided unnecessary expenditures. Long-distance telephone calls were just never made, except in dire emergency. However, mail was often too slow for some communications between the park and the outside world. Because of this, a number of parks arranged with the telephone company to install teletype machines in the park telephone operator's office to operate over NPS lines to the point of connection with the telephone company lines. Priority correspondence thus took place by means of teletype or by telegram, which was passed via Army Radio for forwarding as an economy measure.(28) The reference pointed out (Oct. 1941) that the imminence of war might end this arrangement.

About the same time, some of the parks were installing underground telephone cables to avoid the intrusion of open-wire pole lines in areas exposed to public view and/or heavy snow damage. In 1940, an underground cable was installed "at Fall River and Milner Passes" in Rocky Mountain National Park. Since the terrain involved is about 12,000 feet in elevation at the top of the Continental Divide, lightning protection was a concern.(29) Due to a snafu the bare copper conductors which were to be buried with the cable for "shielding" (from lightning) purposes were not received in time to be installed. No record could be found that would show whether the cable suffered damage or shield wires installed later.

A similar cable installation at Shenandoah which was provided with shield wires above, below, and at each side of the cable was considered to be the latest, most efficient type of installation for use in areas subject to heavy lightning. The shield wires were bonded together and grounded at intervals, section by section. In actual operation it did not always work as intended. In one case there were indications that a lightning strike to a nearby tree passed through the roots, travelled to the shield wires and along the shield wires to the arrestors at the end of that section. In cases where grounds at the arrestors was poorer than the grounds further down the line, part of the current would pass backwards through the second set of arrestors into the next section of line in order to reach the better ground! This was not intended and resulted in cable damage at certain places.

The proximity of park areas to lands administered by various other agencies often made it mutually expedient for park and other agencies to have rights to connect their telephones on lines of another agency. An example of this was a line built between the Bureau of Reclamations Grassy Lake Reservoir (Idaho) and an NPS line that ran between Bechler River Ranger Station and the South Entrance station, both in Yellowstone National Park. Both agencies were quick to terminate use of this line when no longer needed.(30)

RADIO

Pioneering by Waterhouse

Associate Engineer Robert D. Waterhouse of Mount Rainier became the motivating force in persuading NPS that two-way radio would be a useful tool. His earliest endeavors have been described in Chapter One. In addition to being a professional engineer, which was his work assignment with time divided between the park and NPS Field Headquarters in San Francisco, Bob was also a radio amateur with the call letters W7GY.

> "In the summer of 1928 several amateur radio operators built a portable radio set and brought it to Mount Rainier for a field test to determine if radio communication was practical from a forest fire fighting standpoint.
>
> "My personal radio station at Longmire was used as the base station and tests were made over several days between Paradise Valley, Anvil Rock and Longmire.
>
> "The portable set was equipped for voice transmission and my own set used code throughout the tests. The tests proved conclusively that radio was practical and possible."(31)

In notes that I made from Waterhouse's February 15, 1930 report (copy now unavailable) he stressed the possible benefits of two-way radio: "Great trouble we had with communication [on] our 1929 fire shows need for radio." Presumably his reference is made to an extensive fire on Klapatche Ridge.

His enthusiasm is further reflected in a report on additional tests made in 1931: "Communication has been carried on using voice only, at any hour of the day, and from all districts in the park. It was thought that the mountain and ridges would prevent communication but very satisfactory communication has been carried on proving the mountain, trees and ridges are no barrier to short-wave radio." He also reported that a radio link between Longmire and Sunrise was successfully used in a telephone call from Tacoma to Sunrise via a radio-telephone interface at Longmire.(32) The same report is not clear as to the frequencies used, but a later report says: "The tests were conducted on the 80-meter amateur phone band . . . and the same frequencies that the Forest Service [presumably outside the amateurs band] are using." A later report refers to 4135 kc as being used in 1931.(33)

It is appropriate at this time to recognize and pay tribute to amateur radio and its followers (sometimes called "hams"). This chapter cites several instances where civilian hams made tests and/or contributed to proving the usefulness of radio in the National Parks and Forests. Nearly all employees that worked with the early development of NPS radio were chosen because they had amateur radio and/or electrical engineering backgrounds. They are the people who initiated and persevered in proving that radio was practical for the NPS and the U. S. Forest Service, (and probably the Bureau of Indian Affairs). As hobbyists they performed experiments and propagation tests that were instrumental in proving the usefulness of the VHF portion of the spectrum. They provided a pool of highly skilled operators (mostly code) and technicians for the armed forces during WW II. Many of them were pressed into immediate service as instructors. These individuals, during the twenties and thirties did not resent the required code test - in fact they prided themselves on code ability. Most of their equipment was homemade and in some cases the individual parts were homemade. Many a housewife's aluminum pie pans disappeared, only to be found in a spaced stack with soda solution between the pie pans within the stack to constitute an electrolytic filter capacitor. Service shop's barrels of discarded tubes would often be ransacked by poverty-stricken hams until one or two tubes were found that were still usable. Tuning coils for receivers were sometimes wound on Quaker Oats containers, and hardly a ham station existed that did not have a transformer that was homemade or had been rewound from a commercial transformer made for other purposes. Experiments with antennas produced better understanding of their characteristics that enabled military and point-to-point radio to be more effective.

It is this "breed" of individual from which Bob Waterhouse and his early assistants came. It is their "ham" background that conditioned them to perform the pioneering efforts to develop radio as a useful tool.

The U. S. Forest Service's needs and progress paralleled those of NPS. By 1930, Mr. Beatty (referred to in an earlier chapter), had installed a base station at Hemlock, Washington in the Columbia National Forest. Their "portable" units weighted 75 pounds and were split into three units for pack-horse or backpacking. They were equipped to receive voice, but could only transmit code.(34)

Code transmitters were much simpler than voice transmitters which were similar to code transmitters with the addition of audio modulation apparatus. The latter results in a larger, heavier unit consuming more battery power and capable of only a fraction of the range over which code transmission is possible. But the difficulty of learning code made it urgent to develop portable voice transceivers: ". . . I used it with a telegraph key. Not knowing code well enough, I took it down [by copying the dots and dashes] and then painfully worked out the message. In sending, had to first put it [on paper] in code and then send. It got thru, but sure was rudimentary."(35)

As suggested in Chapter One, concurrently with Waterhouse's early experiments and tests, other individuals were doing the same thing for the U. S. Forest Service, also in the Northwest (apparently in Tacoma and Vancouver, Washington, and Missoula, Montana). In fact, there were occasional on-the-air contacts between Waterhouse and his assistants and the Forest Service station W7XAQ at their "lab" in Tacoma, Washington. There were also contacts with Forest Service stations at Vancouver, Washington; Mount Hood, Oregon; and an Idaho station(36) as well as personal exchanges between workers for both agencies, as will be noted in various sections of this report.

In June of 1930, $1000.00 was available to purchase "two radio telephone sets" and Bob was authorized to use his discretion in preparing plans and specifications.

> "The Park Service was fortunate in having a man of Mr. Waterhouse's ability along this line. His knowledge gained as an amateur and his training in investigational work along these lines, will be extremely useful to the Park Service in obtaining the best possible advantages in this proposed new method of communications.(37)
>
> "The object and purpose of the research work carried on in Mount Rainier National Park in 1931 [and earlier and later years,] was to determine the fitness of radio to take over part of the communication system and to supplement the telephone system during winter when wires go down and maintenance is heavy and more especially to furnish communication at fires and fire lookouts where the telephone lines are hard and expensive to build."(38)

Fortunately, Bob's activities were recognized by officialdom and recognition brought additional, but limited funding:

> "We think that it [radio] has very great possibilities for service in the various parks, especially in respect to fires and to winter service when telephones are more apt to be out of order.
>
> "I wish, however, to take this opportunity to call attention to the very fine work done by Mr. Waterhouse. He has been very much enthused over the possibilities of radios, especially in connection with fires, and he has devoted a great many nights and Sundays to this work for the last two years. In addition, he has spent a very

considerable sum of his personal money to carry on the original research work in connection with this development. To his knowledge of this type of engineering [and Superintendent Tomlinson's confidence] and his enthusiasm is due the success so far gained."(39)

Frequencies assigned for the development work were 3265, 3385, 3445, and 4135 kc, with 10-watts output, CW and phone. However, these were soon replaced by 2496, 3415, and 3445 kc. Until about 1930, the desired transmitter frequency was determined by tuned circuits which, due to temperature changes and variations in loading and/or plate voltage, might be anything within 5 or 10 Kc of the assigned frequency. Subsequently, frequency control by precision-ground quartz crystals was developed; a method still in use. Early crystals provided an accuracy of plus or minus .01% (100 parts per million). Improvements during the years led to accuracies as close as plus or minus .0005% (5 parts per million) by 1965.

Initial summer experiments began on 4135 kc in 1931 which was replaced by 3445 kc in the fall. They were summarized in R. D. Waterhouse's report(40) as follows:

"Work was conducted to determine the practicability of communication between Headquarters and District Ranger Stations, Fire Lookouts and Headquarters, and portable sets with any station within reach.

"Wave propagation, types of aerials, skip-distance, fading phenomenon, size and power of sets and receivers were all investigated with the results as set forth . . .

"It is proposed to tie the radio system into the telephone system so that a combination of the two communication systems can be used.

"Television [using a motor-driven scanning disk] can be utilized when it becomes possible so that a picture of any view from a fire lookout . . .

". . . our results have indicated the entire practicability of voice in the sets of as low as fifteen pounds . . .

"There is also the possibility of using frequencies of the order of 56 megacycles . . ."

The entire report and pictures would be most interesting to technically knowledgeable readers. Concerning the predictions the report said:

"Radio [usually microwave] is now being used as part of telephone systems. However, for NPS purposes, radio systems have usually served separate functions and are not used in combination with telephone (by interconnection).

"Television has been tested for fire lookouts, but the availability of air surveillance proved acceptable and less costly.

"Portable transceivers weighing as little as two pounds [one seventh of an earlier prediction] are in daily use.

"Frequencies are being used for portables in NPS systems as high as 420 mc in contrast to the predicted 56 mc."

As a result of a meeting with Messrs. Horton and Simpson of the Forest Service, in September 1931, it became apparent that the National Park Service in Mount Rainier and the U. S. Forest Service in nearby forests would have to have separate frequency assignments before further investment in facilities were made. (41) Waterhouse had recommended, in addition to medium and high frequencies (4020, 8040, and 12060 kc) for portable use, the frequencies 1692 and 1700 kc "for the duplex telephone service between Sunrise and Longmire."(42)

It has already been mentioned that Yellowstone and other parks were becoming interested in the possibility of radio "for use in fire fighting or for communication between Ranger Stations and Headquarters." In response to this interest Waterhouse prepared a detailed report for Supt. Tomlinson (Mt. Rainier) outlining (a) History, (b) 1931 program, (c)results, (d) forecast, (e) cost, and (f) conclusions.(43)

At the same time, the University of Washington, College of Engineering was interested in constructing a radio station to work with Mount Rainier in testing propagation and for other purposes. In return, they offered their calibration facilities for calibrating test equipment.(44)

"Another milestone in the NPS EMS [Emergency medical services] program also took place at Mt. Rainier in 1932 when initial efforts were made to develop field radio communications. Researchers from the University of Washington field-tested 150-pound 'semi-portable,' one-watt radios in the park, . . . they also stated that 'radio appears to be an excellent supplementary means of communications, and results justify continuation of this experimental work.'" (45) The "researchers" are known to have been the people mentioned in this chapter. They were not under contract to the Service, but were motivated by scientific and technical curiosity.

Acceptance of Radio

Funding the development work still remained a problem. In October 1931, Major Tomlinson* (Superintendent) was told "it probably will be necessary to take a small percentage of funds allotted for purchase of [non-radio] equipment and allot this to the Chief Engineer for expenditures on additional experimental work. It may be that we can call on a number of parks for a contribution to this work from their [non-radio] equipment funds so as to carry forward."(46) It was also suggested that fire prevention equipment funds might be used for this purpose.

This possibility was refuted by Chief Forester Coffman in March 1932, except for the possibility of obtaining funds by postponing the purchase of a fire truck for Colonial National Monument.(47)

There was, for a few months, extensive communication between Mr. Waterhouse, via the Superintendent of Mount Rainier and the Director of the National Park Service (which was depending on Waterhouse for technical advice and comments), and the Interdepartmental Radio Advisory Committee (IRAC) which makes frequency assignments and whose members were technically qualified. At the risk of oversimplifying, IRAC is the licensing authority for government stations, in the same manner as the Federal Radio Communications (FRC) - now called the FCC- licenses non-government radio stations. In response to Waterhouse's request of September 1931, IRAC attacked the 4020, 8040, and 12060 kc request as being too high in frequency for short-range use in the parks (later found to be true when 5287.5 kc was tried for local communication with mediocre results in some parks), and on the grounds that they are harmonically related and could only be used one at a time (a claim that was true only because equipment at that time was not adequately sophisticated). At the suggestion of the Army and Navy representatives, IRAC proposed 3415 kc because it could be used day and night (usually true, but occasionally "skip" created problems at night as will be noted in reports of rescues in later years). As to Waterhouse's request for 1692 and 1700 kc, IRAC indicated that they were in the then-assigned television band. (Remember the early sets with a 20" or 24" rotating scanning wheel in place of today's picture tube?)

They also criticized the 8 KC separation for duplex operation as technically unfeasible (49) and assigned one frequency, 2496 kc for this purpose. Waterhouse's response was to request an additional frequency (3445 kc) for fire and protection purposes "because with the breaking out of two [or] more fires (we have had 9 start in one lightning storm within 2 hours) more than one channel would be necessary to carry the traffic. There is a

* Major Tomlinson and Colonel White were so addressed as a result of their involvement in the Philippine insurrection in the early 1900"s. "Tomlinson and members of his mission . . . reformed the Ifugaos, who stopped removing heads and started playing baseball."(48)

tremendous amount of traffic from a fire and a ranger is almost constantly at a telephone [or radio] taking supply lists, payroll information, and assembling as well as giving information on movements of men, pumps, tools and kindred objects. With a fire going, the fire lookouts and trail crews in other parts of the park would have very little chance to break in and the time lost would be considerable."(50) He pointed out the desirability of being close to the 3415 kc frequency so that both frequencies would be within capabilities of a single half-wave antenna. He also asked for two frequencies in the 2000 kc band in place of his earlier request for 1692 and 1700 kc.

By the fall of 1931, Waterhouse had 2-tube code transmitters installed at the outlying stations using calls in the KGYA-KGYJ series. One entrance station had a privately-owned code-voice transmitter. All equipment was "home-brew". It can be imagined how reluctant the rangers would be to learn to send and receive code.(51) However, Superintendent Tomlinson's December 1931 monthly report proudly (we suspect) stated "Ranger Sedergren has become proficient in the use of code". Skip effects showed up at night during the winter months on the then-used frequency, 4135 kc, making short-range (between points in the park) transmission impossible . . . Plans were made to change to either 3415 kc or 3445 kc which required lengthening antennas 24 feet. This posed a problem in those instances where the support trees were too close together for the longer antenna.

Waterhouse obtained the intermittent services of Neal Frost, a University of Washington student who was also a ham, Phil Jacobson of the University of Washington engineering department, and Harry Kline, a commercial radio operator. He urged allocation of $8750.00 for manufactured (to NPS design) sets for a complete system.(52) He said "Private funds have done most of our development and loss of sleep by half a dozen of ourselves and friends went with this development, we have passed the development stage and are ready to shoot, but someone threw a monkey wrench" - referring to frequency problems.(53)

In one of his reports he complained that the Director's Office still considered radio as experimental and that they considered concurrent development of equipment by NPS and the Forest Service as duplication of efforts. "For some reason or other, Washington will gag at $2000 for development of something new and allow 10 times that much to be wasted elsewhere."(54)

The question of duplication of efforts by NPS and the Forest Service is covered in Mr. Coffman's report of a meeting of the Western Forestry and Conservation Association in early 1932. "They [FS representatives] stated that they had exchanged visits and ideas with Mr. Waterhouse last season and desired to continue such cooperative exchanges in the future so that each might benefit from the work of the other, but they believe there was sufficient difference in the objectives of the two projects to justify the continuance of the separate Park Service work. For instance, the Park project includes the establishment of radio communication between fixed points and the linking of the radio system with the telephone system so that a combination of the two systems may be used. This objective is not contemplated in the Forest Service radio project."(55) The Director was still

questioning apparent duplication of effort with the Forest Service and the Army as late as March 16, 1932.(56) The same letter admitted that radio is desirable "where wire communication is not practical in the parks," and indirectly commended Waterhouse's prosecution of development by saying "the information at hand indicates that our voice radio developments at Mount Rainier are in advance of those of the other services . . ."(57) This thought is further substantiated elsewhere in this chapter.

Coffman also cited the Forest Service objective as being the development of a smoke-chaser set to weigh less than ten pounds. The weight limitation precluded voice transmission, but was considered essential for forests in the Northwest where reaching a fire often entailed long hikes with an already-heavy pack without the radio. The Park Service considered the difficulty in teaching code, especially to seasonal help (including the famous "90-day wonders"), and the slowness of code transmission as justification for portable units capable of voice transmission, even if the weight were to be greater. The Park Service anticipated using their portable units for road and trail camps and rescues, as well as for fire fighting.(58)

While the Director approved development of radio, especially for fire protection,(59) funding of new radio units and maintenance was precarious. The Director felt that fire protection was the principle beneficiary of radio communication and suggested that the cost be distributed between the "fire parks" and did not favor diverting funds from fire truck allocations for Colonial and George Washington Birthplace.(60) Instead the Director suggested that Chief Forester Coffman might make not to exceed $1200 available from Fire Prevention funds "for servicing and purchase of radio equipment." He also recommended transfer of $500 from Mount Rainier's telephone appropriations and allotment of $300 "out of existing roads and trails allotments which have a favorable balance."(61)

Procurement of parts and supplies for assembling pilot models was difficult "It is simple enough to secure the best price . . . but quite a different matter to buy it and comply with Fiscal Regulations when one is limited to a $50 [open market] purchase [from] a single concern in a month."(62)

As mentioned in Chapter One, official IRAC records describe 1927/1928 activities. Subsequent events are included in its statement: "Activity of a permanent nature was evident in the early 1930's, particularly under the National Park Service and the Bureau of Indian Affairs. In December 1931, assignments for fixed and portable radio stations were made for Mount Rainier which set the pattern for a nation-wide development of National Park Service radio-communication facilities."(63)

In the fall of 1931 it was necessary to make an urgent request for the huge sum of $300 to keep three or four (exact number not specified) units in operation to continue the experiments.(64)

The experimental radios were in use at Longmire Headquarters and Carbon River, White River, Ohanapecosh, and Paradise Ranger Stations (as mentioned) in 1931, and 1932. During his employment Neal Frost, had equipped his amateur station in Seattle so it could be used on the park frequency, 3415 kc. During the winter of 1932-33 this station was instrumental in providing communications between headquarters and the outside while the long-distance telephone lines serving Longmire headquarters were out. The Seattle station relayed several important messages when lines to the "outside" were inoperative.(65) Later in 1937 "during the period when telephone communication was disrupted, emergency shortwave schedules are established with station KNDS, Seattle, [operated by Neal Frost's mother] enabling important messages and information to be delivered."(66)

Equipment Description

By today's standards the transmitters and receivers of that time were quite primitive. Few people would have the patience today to make the adjustments necessary to receive signals. Receivers were usually of the "detector-two step" type, meaning a regenerative detector and two-tube amplifier. These receivers were tunable, and resetability on a specified frequency was so uncertain, that the dial had to be touched up before and during each contact. The regeneration control had to be adjusted just below the threshold of oscillation in order to maximize voice signals. This was quite critical, and if the operator's hands were near the antenna, the critical setting might be lost by the movement of a hand while writing the received message. Some sets had "hand capacity", i. e., if the hands were removed from the dial after tuning in a station, the tuning would be changed and the incoming signal lost. Occasionally one of the tubes would be "microphonic", making a loud ringing sound whenever the table or radio were jarred. These problems were strong factors in the decision to use superheterodyne receivers exclusively in future production. It is interesting to note that as recent as the "late 1930's, the first Army walkie-talkie radio sets . . . [used] two-tube [regenerative] receivers." (67) Whether this was to minimize weight, or reluctance of the Signal Corps to use the superheterodyne is unknown.

Probably as part of his effort to keep abreast of the success of the Forest Service, Waterhouse purchased one of their ten-pound code units and a 50-pound voice unit (called SP for semi-portable).(68) The author used the latter for a week at a base camp in the 1934 Shriner Peak fire, gaining much useful information on propagation and application of radio to large fires.

The Forest Service had developed their "SP" (semi-portable) transceiver which consisted of two cases (radio in one, batteries in the other). It weighed fifty pounds and had a power output of 4.5 watts, and used earphones. The microphone was fastened to the door of the set, requiring acrobatics to reach it when the set was placed on the ground. It used a regenerative detector which required critical adjustment of a regeneration control at the same time as the tuning dial was adjusted, "to confound the men in the field. Accustomed to heavy work with their hands they did not have the patience to go through the tweaking and tuning required of regeneratives."(69) In the meantime, Waterhouse and his assistants

had developed the PTR-2D which weighed 37 pounds and had an output of 2 watts and used a convenient telephone type handset. There was also provision for an external loudspeaker. It did not require adjustment of a regeneration control. It had single-dial tuning. An attempt was made to simulate push-button tuning of the receiver. A notch was placed in the dial into which an arm on the tuning knob would fall. The receiver was not always stable enough for this to assure reaching the proper receive frequency. Users would have to call, and manipulate the knob in the vicinity of the notch to hear the reply. This inconvenience was insignificant compared with the touchy adjustment of regeneratives as has been described. The lesser transmitter output was not noticeable in communication range (the 4.5-to-2 watt ratio being less than 3 decibels difference). Soon after, the Forest Service began developing the SPF radiophone which was very similar to the PTR-2D, except as to physical shape. The prior development of the PTR-2D was an exception to the Forest Service claim that their "sets had no equals in their classes during the 1930's."(70)

As with any new idea or device this new communication tool was not always accepted. You can "sympathize with the ranger, who, while lighting his pipe, was receiving his first lesson in radio operation when a call came over the loudspeaker. Setting his pipe aside he picked up the microphone, touched the lighted match to his nose, and uttered an expletive that came in S-9 [very loud] back at headquarters.(71)

By 1932 other parks became interested in the use of radio, and since NPS did not have a contract for production of its PTR-2D model (PTR meaning portable transmitter-receiver), it was suggested that Lassen Volcanic National Park purchase SP sets through the Forest Service for about $150.00. Spokane Radio Company had the contract to produce the SP sets in quantity.(72)

By September 1932, Superintendent Toll of Yellowstone had arranged to borrow two of the Forest Service SP sets from Mount Rainier to test their practicality for remote stations and roving trail crews.(73) But the tests were unsatisfactory. A report(74) indicates that only a ten mile range was obtained with a "short" antenna. Presumably this was with a half-wave loaded Windom (off-center-fed Swf Hertz)(75) antenna. When the sets were returned to Mount Rainier, distances of 100 miles were reached with a fixed-station half-wave antenna. Superintendent Tomlinson was convinced that funds were justified to continue the development work.(76) "The experiment was continued at Yosemite, Rocky Mountain, Grand Teton and Death Valley in 1933, and Glacier, Yellowstone [described in a separate paragraph] and Great Smoky in 1934. Eventually radios would prove to be indispensable tools . . ." (77)

Technically inclined readers will be interested in Waterhouse's 1932 description of the headquarters station:

> "The main station at Longmire was constructed, consisting of a crystal controlled unit using a type 210 tube as oscillator, with this unit working into a second unit consisting of another type 210 tube and acting as a buffer stage.

> This unit in turn working into a third stage which consisted of a type 203-A tube capable of generating between 50 and 75 watts of radio frequency energy. The audio portion which consists of a double-button microphone, working into a type 227 tube, then by transformer coupling, into a type 245 tube, thence into a pair of 203-A tubes which act as high-level modulators, modulating the single type 203-A stage. The main radio control panel was rewired, so that the transmitter and receiver can be switched from code to voice, turned off or on, switched from send to receive, all with a minimum of motion. The high and low voltage power supply for the transmitting equipment was rebuilt so that the available voltage for the transmitter was increased, thus increasing the output of the equipment making it satisfactory for communication with any part of the park at any time." (78)

Almost concurrently with the aforementioned request for information from Lassen Volcanic NP, John R. White, Superintendent of Sequoia National Park wrote for a "personal opinion about the use of radio telephony to substitute [for] wire lines in the parks."(79) The response to this question was - not yet - "several years distant", but that radio can supplement telephone lines for emergencies and isolated points.(80)

On December 30, 1932, the Superintendent, Mount Rainier informed the Director that he had no objection to the Navy's use of 2604 kc in the Great Lakes area. Little did he know that this was a portent of impending shortages in the national resource known as the radio frequency spectrum.(81) Fortunately, as time passed, and new demands for frequencies developed, improved technological techniques (some of which are described in following chapters) opened up higher frequencies and also enabled users to operate on channels with less separation. This has enabled the FCC and IRAC to grant assignments to all the essential and some not-so essential services.

By March 1933, Glacier had experienced such good results with a Forest Service type SP set that they proposed to engage in further experimentation.(82) The Superintendent requested permission for several employees to place their personal amateur transmitters on the park frequency in order to expedite the tests. The dates of these references suggests that perhaps a Mr. Schneider's work for Glacier was 1932 instead of 1933 as he has written:"Vivid memories include the spring and summer when W7MZ and I built eleven stations each one including a one-tube transmitter and two-tube receiver for fire guards in Glacier National Park. We taught code during early spring, the guards paid for parts, and the Park Service hired us to do the building and serve as guards and radio operators during the summer. This was the first use of radio communication in the park."(83)

Glacier also maintained a twice-daily schedule with Mount Rainier. The superintendent also suggested that these contacts might be the first inter-park contacts on record.(84) Apparently Supt. Scoyen was so impressed with this that he had sent messages to the district manager of the Eleventh US Civil Service District in Seattle, Wash. via Mt. Rainier by radio. The latter then asked if "messages may be sent to you [Mt. Rainier] for

retransmission to Glacier National Park."(85) He was told that "While there appears to be no objection to occasional transmission of National Park Service messages between Mount Rainier and Glacier Parks there would be objection to the transmission of messages from other sources."(86)

The Director's office was constrained to advise Superintendent Scoyen that frequency assignments are specifically intended for intra-park use and that long-distance inter-park communication should be minimized.(87)

In passing, the same letter advised that the radio inspector had complained about the Mount Rainier station in Seattle being used for non-park business and engaged in "conversation that was both vulgar and belittling of another government department."

The early portable units experienced a number of problems that today are virtually non-existent due to improved components. Capacitors and insulation in transformers did not always withstand the B-battery voltage at elevations over 10,000 feet. Transformer breakdown was further enhanced due to the method of switching. Since the easiest way to turn a unit on and off, or from receive to transmit, was to switch the filaments (A-battery source) of the tubes, no switch was provided to remove the plate (B plus) voltage (135 or 180-volts) from the receiver/transmitter circuits when not in use. The continuous presence of the plate voltage encouraged electrolysis and/or corrosion in the insulation of transformers, causing them to fail prematurely.

Crystals for transmitter frequency-control were usually about 1+1/8" square, held in place between two flat brass plates by a spring. If the crystal was not perfectly flat (most weren't), they were sensitive to pressure and position of the upper plate which was held in place by a spring. Sometimes transportation by horse, hiker, or auto would shake the crystal into a position where it would fail to start, or the frequency would shift, making the transmitter unusable. In later years more expensive corner-clamp type holders became available that were not subject to this problem.

The earliest crystals also drifted in frequency over extended time periods because they were not x-ray treated. Whether the shift was higher or lower was determined by whether they were cut on the x or y axis. Fortunately most of them drifted higher in frequency which could be compensated for if the technician pencilled one side of the crystal - testing for frequency as the pencil marks were darkened.

During this period of "growing pains" in the use of two-way radio by the NPS, first-time management questions became apparent at Mount Rainier and probably in other NP areas. For example:

1. Could NPS use its assigned frequencies to relay snow, road, and weather information to the weather bureau, state highway department, radio broadcast stations, etc.?

2. Could a relative of a NPS employee operate a base station in town on government frequencies for the purpose of relaying this type of information?(88)

3. Could the Superintendent require the concessioner to either (a) install suppressors or (b) close down electrical equipment which interfered with reception at Headquarters station(s)?

By 1934 a prototype for the PTR-2D portable (often called the "mailbox" because its size and method of opening resembled the mailboxes used for rural delivery) was completed and specifications were prepared for bid invitations. "Old-timers" will be interested in the specifications for vacuum tubes which said "all tubes shall be equivalent to RCA or Cunningham manufacture." As is common with so many brand names, Cunningham disappeared as a tube brand sometime in the 1940's.

A more cumbersome model in the PTR-2_ series was the PTR-2C, classed as a "semi-portable radiophone". It was unique in that the antenna current (power output) was indicated by a "small lamp located near the top of the panel which is placed in the antenna circuit when the button next to it is pressed." (quote from instruction book)

The PTR-2D transceiver and its successors, were the most widely used high-frequency portables. They were capable of about two watts into a quarter-wave sloping-wire antenna (portable use) or a 600-ohm fixed station antenna. While it was heavy, 37 pounds, it could be split into two sections for easier transport. An external heavy-duty battery pack as available for extended fixed-station operation.

The "portable" high frequency radios really served both as portable and semi-portable units. Internal self-contained batteries were used for portable operation, making the complete transceiver weigh about 37 pounds. These batteries were good for about a week of operation with several contacts being made each day (receivers were turned off when not in use). For semi-portable use an external battery box, weighing about 65 pounds, would be used. The latter could last all summer on the same contact schedule as described for portables. The PTR-2D series also had a special tray for smaller batteries (making the weight 25 pounds). But the battery life was too short to be of much use. Several follow-up models in the PTR-2 series were procured (PTR-2G in 1937 and later the PTR-2K, both "mailbox" style of the same weight and configuration).

The 37# PTR-2D, E, G and K transceivers were also referred to as "Silver Sets" because of their color. They were purchased in quantities of 5 to 25, at an average price of about $140 between 1935 and 1939. Heavy-duty battery boxes and loudspeakers were evidently additional.

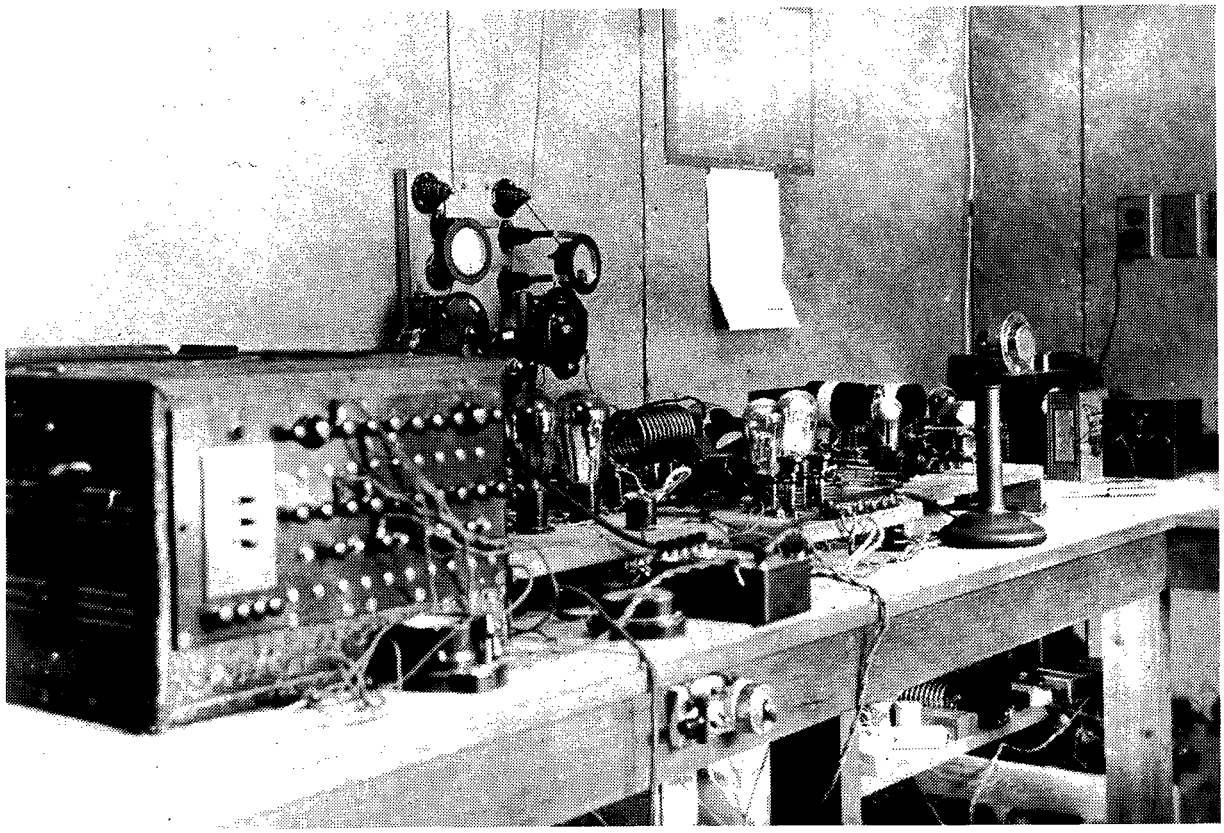

Figure 3

Headquarters Station
Longmire, Mount Rainier
1931

RF section at right - note final stage in center with copper tubing coils. Receiver not shown.

Telephone "transmitter" used as microphone.

Open-wire antenna transmission line connected to ammeters at center of photo.

The PTR-2D and its successor PTR-2G were the most-used of the PTR-2 series. "The price as quoted - $230.00 was the last [1937] price quoted by Northern Radio [PTR-2D]. The 39 sets [PTR-2G] manufactured by Technical Radio were bid at approximately $175.00 . . ."(89). These units were based upon replicating the above-described prototype designed and furnished by NPS. The Forest Service also used this procedure for procurement of their SP and SPF transceivers. Companies most interested in bidding included Technical Radio Co., San Francisco; Radio Laboratories, Inc., Seattle; Northern Radio Co., Seattle; Spokane Radio Co., Spokane; Radio Specialty Co., Portland; John M. Kaar Engineering Co., Palo Alto.(90)

The PTR-2 series transceivers were the "workhorse" of NPS radio communications during the late 30's and on into WW II. They were used as "portables" which entailed erecting a quarter-wave (about 60') sloping antenna supported by a string which was attached to a weight that was thrown over a tree limb. A ground or counterpoise wire was connected to the transceiver chassis. By using a reel to adjust the antenna length, and tuning the transmitter, (in effect the operator was tuning a pi-network to load the antenna) the operator could load the transmitter to two watts.

Transceiver type portable radios were switched from "receiver" to "transmit" by switching the filament of the tubes used for these functions. It was felt that such switching might shorten the life of the tubes, causing filament failure at a critical time. However, tests made by the US Forest Service (65,420 times) showed this fear to be unfounded.(91) In later years, concern developed about sorting out tubes whose emission and amplification characteristics had deteriorated. This is discussed in a later chapter.

These transceivers were also used as base-stations, usually with a single wire-fed half-wave (Windom) antenna, a set of heavy duty batteries, and an external loudspeaker. The antenna was usually strung between two tall (150 to 200') trees at about 80' height. It took care to provide enough slack to prevent snapping the antenna wire during windstorms when the trees might pull away from each other as they swayed. These antennae were very effective, providing high-angle radiation, which is required for short distances.

Ken Ashley has recalled using a PTR-2 series transceiver on snow-surveys in Tuolumne Meadows in Yosemite. The increased elevation at Tuolumne Meadows brought a surprise. Not only could they contact Yosemite headquarters as intended, but they could sometimes talk to Lake Mead, Grand Canyon, or Sequoia if they happened to be on the air at the same time. The receiver on the PTR-2 series was tunable with a notch to indicate when the pointer was set for the correct frequency. But this did not prevent the users from using the receiver for entertainment between schedules by tuning in ship-shore conversations between commercial fisherman and their wives or girl friends.

Figure 4

Ranger Rhumore checks in with Mount McKinley.
Communications with Headquarters using PTR-2D transceiver.
Winter 1939 / 1940.

While NPS was at the forefront in developing two-way radio for portable use, it was not alone, as already discussed. The US Forest Service was very active and, being a larger agency, their funds for development were greater, and their contracts were for many more radio units.

At this same period of time (1933) the matter of patent rights was raised in that it might inhibit the Service's ability to purchase the units to be made.(92) It was known that AT&T, RCA, Western Electric, and others held basic patents for circuits whose use could not be technically avoided at that state of the art.(93) After consultation with the Forest Service and the War Department, who had also decided to invite bidders to copy the models developed by them, they assumed that the patent holders would not sue the contractor or the government since "they must sue the government in the Court of Claims and can only get 7-1/2 percent of the amount anyway, under U. S. law, and consequently they have never sued (prior to 1933)."

Role of the Civilian Conservation Corps

During the period of 1933 to 1936 Waterhouse also took advantage of the federal emergency programs to further experimentation and development of radio at Mt. Rainier. During 1933 and early 1934 two members of the CWA (exact name of agency is uncertain) were employed for a short period, and in April 1934 two CCC enrolles were enlisted to continue the work. The scope of their work is indicated in the May 1934 report of CCC Camp NP-1, Tahoma Creek as follows:

> Though the Radio Detail is one of the smallest, it is one of the very important because of the nature of the program and the caliber of the two boys on it. Gene Piety is a graduate of the College of Puget Sound with the degree of Bachelor of Science and the other Ralph McFadden has had very good vocational training in electricity and radio engineering. This work includes several projects, namely; rebuilding the present high-power transmitter, care and upkeep of the transmitters located throughout the Park, building five-meter [transceivers] of suitable size to be used by rangers or fire fighting crews, engineering the possibilities of the same, building additional equipment for use at the Headquarters Station, KGYA, at Longmire, building a field strength indicator, and plotting the signal strength of the transmitters from any place in the park. Two five-meter sets have been built and are in operation at the present time. As it was found advisable to use a wave [length] of five meters, experiments are now being made to determine the shortest wave for suitable operation with portable equipment. This research is being made by McFadden. Work on the field-strength indicator is to be begin immediately and a trip around the mountains will be made by Neal Frost of the Park Service and one of the boys. (The project is being carried along with all the others. It is a study of the methods of eliminating the natural and artificial interference with reception. The latter is quite bad in this vicinity because of the many units of electrical equipment near by.)

The above-mentioned high-frequency tests from various parts of the park were attempted with a 15-watt PTR-15E transceiver installed in a 1932 V8 station-wagon. An alternator was installed on the front bumper. It was driven by the automobile's engine by coupling to the fitting normally used for hand-cranking the engine in cases where the starting battery is dead. "Jumper starts" were unheard of. No attempt was made to operate while moving (1) because no suitable mobile antenna had been developed, and (2) the varying speed of the engine would vary the alternator frequency. Even in fixed locations, with an antenna thrown over tree branches, the tests had to be cut short because the radiator boiled over when the engine was sustained at a speed necessary to maintain a frequency of 60-cycle power from the alternator!

The superintendent of CCC Camp NPS-1, Tahoma Creek, Mount Rainier included the following in his July (or August) 1934 monthly report.

> Radio Work: As no funds were allocated for the employment of Radio Operators it was necessary to place CCC members on duty to assist in maintaining communications with outlying Ranger Stations, lookouts,and fire suppression emergency stations. Work has been completed on the home transmitter, KYGA. It is now working and has one hundred watts carrier output. A smaller set for installation at White River has been completed and will soon be installed. A survey of field strength was started but bad weather prevented [permitted] but a few days work. A field strength indicator was constructed by the boys. Work was done with a portable set on Paradise Glacier in cooperation with KOMO for an NBC broadcast. The set at Ohanapecosh was made more permanent and a new set of batteries were installed. Some experimenting was done with antennas for portable sets but to date no definite conclusions have been reached. A small portable set of new design has been constructed. It is still being experimented with. We were very fortunate in getting two boys of good training for this work. Gene Piety is a graduate of the College of Puget Sound in Electrical Engineering and Ralph McFadden has had very good vocational training in radio and electricity. They were under the direction of Neal Frost, National Park Radio Technician and R. D. Waterhouse, Park Engineer.

Using qualified CCC enrollees as radio technicians involved situations which did not fit into the usual administrative procedures. It was necessary for the technicians to travel to different ranger stations to install and/or repair radio facilities. Procedures did not exist for issuing travel orders and per diem to enrollees travelling alone. On one occasion this writer was given a "Bootlegger" Model A sedan (no CCC vehicles were available) for transportation and given pocket change to pay for meals at the "zoo" with the concessioner's employees at Yakima Park (also known as Sunrise). On other occasions he simply walked into the nearest CCC camp and ate at its mess.

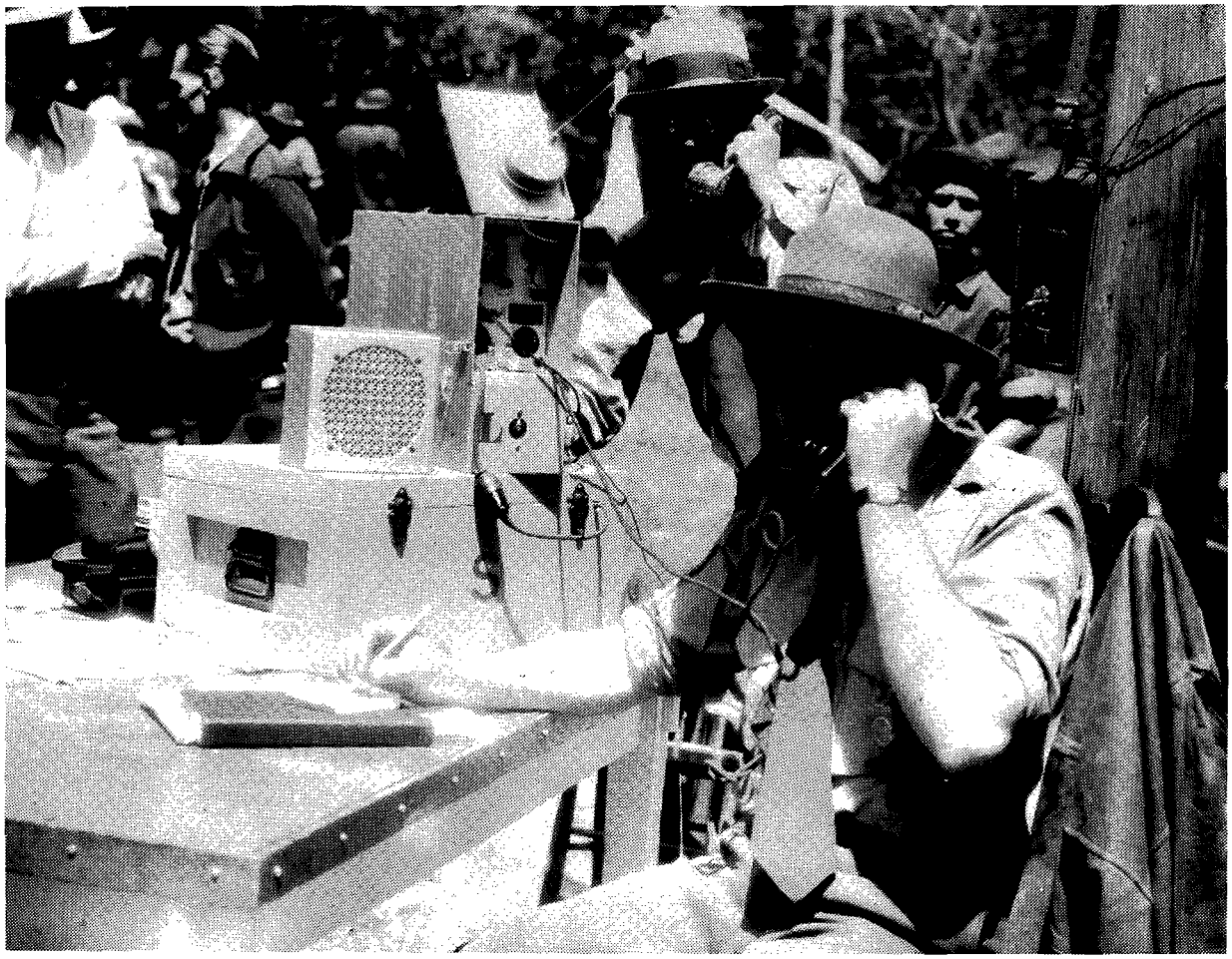

Figure 5

Fire training for NPS and CCC personnel.
Rocky Mountain National Park
circa 1937

Note PTR-2D radio, loudspeaker, and box with heavy-duty batteries on the table.
Field telephone hanging on pole.

During the summer of 1935 two radio technicians and the writer (as a CCC enrollee, a continuation of his 1934 enrollment, referred to an earlier pages) continued development of radio facilities under the direction of Waterhouse.(99) By this time, the Service had three types of commercially-built units, made to NPS specifications, portable units, the PTR-2D being the most practical. During that summer radio was used at the fire lookouts, CCC spike camps, and two forest fires, usually with good results. The reference describes these activities and provides recommendations. Their tests showed the superiority in performance and ease of operation of the superheterodyne receiver over the TRF/regenerative-detector type, which has already been described.

Further Use and Development

The radio broadcasting industry had become well established and the several networks were competing for special events which could be featured on the air. That summer, 1934, NBC arranged a broadcast from the ice caves in the Paradise Glacier in Mount Rainier National Park. After obtaining the necessary FCC and other permissions, an announcer with NPS assistance made a descriptive broadcast from within the Paradise ice caves. "Two Park Service portable sets were used in the nationwide broadcast . . . August 19. These sets were supplementary to the equipment of Totem Broadcasters and the National Broadcasting Company . . . materially aided the Broadcasting Company in setting up facilities for the unique broadcast."(94) A portable transmitter, using ski poles to support the upper end of the antenna, was received at the Paradise Ranger Station and from there telephone lines carried the broadcast to KOMO in Seattle which put it on the network. Another announcer, Hal Wolfe, located at Paradise provided additional color for the broadcast. The latter's distinctive voice has been heard from various stations since that time. The last time the author heard him was on KNBR, San Francisco in 1970.

As the use of two-way radio, mostly on frequencies like 2496, 2604, 3235, and 3415 kc, increased, both as to number of units and as to hours of usage, the vagaries of medium-frequency propagation became more apparent. Daytime communications was limited to distances less than 100 miles and was subject to fading, static from lightning storms, "blackouts" caused by sudden ionospheric disturbances (SIDs), and to manmade interference (power lines and electrical machinery). Equipment failures were sometimes claimed by non-technical users, that were actually due to SIDs. At Mt. Rainier I had difficulty explaining this to the rangers until I pointed out that heavy-users like the Washington State Patrol were also experiencing the same outages, which could last from a few hours to a few days. Most propagation was by means of the E-layer which disappears at night, forming into one or two F-layers at greater height in the daytime. This created two interesting situations - (a) at night it was not always possible to reach stations in the same park, due to "skip". Thus during the Fadden rescue (described later) a station in Seattle was pressed into service to relay stations 15 miles apart at Mount Rainier which could not talk to each other; (b) interesting long-distance contacts became possible at times, between Mount Rainier, Grant Grove National Park, Death Valley and Jackson Hole (before creation of Grand Teton National Park).

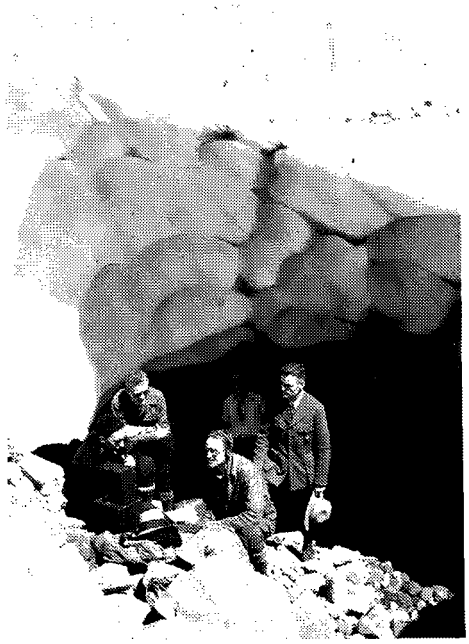

Figure 6

Setup for NBC broadcast from Paradise Ice Caves.
Mt. Rainier, 1934

Waterhouse's pioneering became known throughout the Pacific Northwest. His experience and expertise was beneficial to the State of Washington Department of Highways: "Your men rendered us a great deal of assistance both in extending use of equipment and information regarding radio communication."(95) Intercommunication had been established between the Naches Pass (now at Crystal Creek) maintenance station and Longmire for exchange of weather and road conditions.

The nature and location of the National Park areas often necessitates close cooperation between NPS and nearby agencies, such as law enforcement, rescue, highway, and land management (Forest Service, Bureau of Land Management, etc.) agencies. Frequently intercommunication with such agencies via radio was desirable because telephone service was often interrupted during storm conditions. Thus coordination of closures, forest fire fighting, apprehension of fleeing fugitives, etc. was arranged - usually by "cross-band" contacts. At Mount Rainier road and weather reports were made daily to be added to those of the Washington State Division of Highways for the rest of the state. The same capability was used at different times to coordinate emergency road closures and rescue efforts. In subsequent years (1960 and later) telephone service became reliable so that such interagency radio communication was usually limited to law enforcement activities when the park area has close proximity to and needed to cooperate with local police.

With NPS radio being an emergency facility, and with fire emergencies very often coincident with thunderstorms, reliability was very important. By memorandum of August 7, 1934, J. F. Maxwell described a double-horn-gap for use at the 10 and 50 watt fixed stations, with provisions for keeping snow from accumulating on the gap.(96) A vacuum-tube telephone type arrestor was recommended for 2-watt and receive-only installations.

The usefulness of two-way radios in the parks was officially recognized in a Department of the Interior news release in the spring of 1935.(97) In addition to citing its usefulness in forest protection and administration, it described how a car that was stolen in Glacier National Park was quickly recovered through the use of radio. In addition, "the Rangers in Rocky Mountain National Park have made use of the radio to a great extent in running down hunters who have killed deer illegally within the park boundaries." During the post-depression era, such "poaching" has not been such a great problem, nevertheless circumstances may cause a return of "poachers". If they do, current-day and future radios will be of great value in apprehending them.

This recognition of the usefulness of two-way radio by the National Park Service and Department of the Interior is in contrast to skepticism within the U. S. Forest Service at that time: ". . . total confusion over the apparent lack of acceptance as a Servicewide tool and the low expectations of the Washington office . . . I wonder if we should not face the fact that our radio sets are not rated as having much value, outside of Region 6? . . . Have we been all wrong in thinking we have developed a valuable and practical new tool . . .?"(98) These sentiments, expressed in 1934, were evidently soon dispelled, because a decade later the Forest Service was using thousands of radios, outstripping the National Park Service quantitatively.

Ever since the inception of use of radio into the park system many persons were under the impression that the radio frequencies being used were assigned by the FRC (and later the FCC). This is true for radios used by non-government (non-federal) users. Frequencies for NPS use and for other federal agencies were assigned by the Interdepartment Radio Advisory Committee (IRAC) which was composed of 11 member agencies and was created in 1922. Representation by the Interior Department is rotated between agencies. C. D. Monteith, a utilities engineer for NPS, served from 1938 to 1942.

Among the many functions of IRAC are the assignment of frequencies and the issuance of call letters. These important functions are necessary so that all licensed users can have reasonable assurance that they can use their radio facilities without interference from others and that their use will not interfere with other users. In spite of careful planning and technical standards, the possibility of interference always exists. It is because of the latter that proper use of call letters is important. Through an international registry at Berne, Switzerland and the registers of individual countries, it is possible to identify any interfering station, if the latter gives its call letters. The issuance of call letters is discussed further in a following chapter.

A later report by Waterhouse describes the installation of a 50-watt base-station at Longmire which replaced the 100-watt "home-brew" transmitter described on earlier pages. This is the same type of transmitter-receiver, built by Western Wireless, that was installed at a number of other park headquarters and ushered in an era of quite-reliable communication with the field units described above.

Beginning in 1934, Preston Macy was "custodian" of the new Mount Olympus National Monument and had frequent occasions to communicate with the Superintendent, Mount Rainier National Park who was his supervisor. Two-way radio was established between these areas on June 30, 1935.(100) Macy's transmitter-receiver was installed in an upper bedroom in his home. His wife, Esther, became "chief operator", providing contact for trail crews working in the interior of the monument. Shortly afterward the technicians improvised a "phone-patch" for the Longmire station so that Macy (as well as outlying rangers at Mount Rainier) could talk to the Superintendent, Chief Ranger, Chief Clerk, or Chief Mechanic at their own telephones. The technicians' report credits the "phone-patch" and radio link between Port Angeles Headquarters and Longmire with a considerable savings in toll calls. Such inter-park communication was not within the licensing authority and would be frowned upon today except in an emergency. The "phone-patch" concept was not utilized in later years, at Mount Rainier, or at other parks. There are three reasons for this: first, people naturally are more verbal when talking on the telephone, which might delay emergency radio calls from being received; second, more outlying stations were being equipped with radio, necessitating adoption of brief, concise radio operating procedures; third, some users of the phone-patch would forget they were "on the air" and use unacceptable language.

Because of the ultimate domination in the use of 3415 kc by Olympic National Park, an assignment of 2898 kc was made to Mt.Rainier and its equipment converted to the new frequency during the 1940 calendar year. This placed Mount Rainier on a different frequency from Olympic National Park, which had expanded its use of radio to such an extent that they often "clobbered" Mount Rainier communications.

The AM radios used during this period were susceptible to both natural and manmade interference. Since the portable radios were low power, communication became difficult during the existence of either type of interference. Unfortunately most communications at forest fires occurred in midsummer when the afternoon and evening thunderstorms produced static crashes almost continuously. A call from a portable unit might only be discernable as a carrier, the voice being swamped with static. The control operators became innovative. Knowing that it was easier for field personnel to hear their higher-powered transmission, they would get the information from a field set by asking questions which could be answered by "yes" or "no" and asking for the reply to be repeated. It might go like this: "Jim, are you at the fire? Say 'yes' or 'no' three times." "Yes, yes, yes" "OK, Can you handle it yourself?" "No, no, no." "Will five men with tools help?" "Yes, yes, yes.", etc.

If the operators were unable to hear these words, they got the information by instructing the field unit to send one carrier burst for yes, two carrier bursts for no, the answer can be obtained. On AM it is often possible to hear a "carrier" when the voice is unreadable. When there is a will, there is a way!

Power lines, adding machines, and welders were among many of the man-made sources of intermittent interference which could not always be coped with even when using the above operating procedures. Some attempts were made to locate and eliminate such interference, but they were not usually successful. It was easiest to locate offending electrical machinery, but designing filters which would reduce their interference to the low level required to allow reception of weak signals was not always successful. Interference from primary power lines was almost impossible to locate, because of the "masking" of any one source by noise produced from other sources on the same line. Attempts to install remotely-controlled receivers placed at noise-free locations, were usually thwarted by insufficient funds. Fortunately in later years, when VHF-FM came into use, these noise sources had nearly negligible effect upon reception.

The history of radio, ever since the early discovery by Hertz, has been one of pushing the upper frequency limits of equipment. This evolution is largely motivated by two factors: (a) the need for more spectrum when existing bands are crowded and (b) natural curiosity of scientists and experimenters. Thus in the twenties the Department of Commerce relegated amateurs and experimenters to the frequencies above 1500 kc and later 3000 kc, thinking they were not suitable for any other purpose. During the thirties, experimenters and amateurs were exploring frequencies between 50 and 200 mc. With Bob Waterhouse's encouragement, experiments were conducted at Mount Rainier on 56 mc and about 1939 Mr. Hilgedick(101) constructed two super-regenerative transceivers for 200 mc and used them for tests in several western park areas.

Present-day emphasis on the nation's energy crisis includes encouragement and development of "renewable" energy sources, including solar and wind power. The National Park Service was an unheralded pioneer in both fields. The National Park Service conducted preliminary experiments with wind chargers in the 1934 - 1936 period at Mount Rainier, Glacier National Park, and Great Smoky National Parks. The Yellowstone wind charger was installed atop a 60-foot tower at Bechler Ranger Station. The Glacier unit was installed on the roof of the Waterton Ranger Station. The Great Smokies unit was side-mounted 2/3 of the way up the Frye Mountain lookout tower. Solar developments are described in a later chapter.

In 1936 a wind-charger system with 6-volt storage-battery and dynamotor, was installed at Mount Fremont Lookout in Mount Rainier. Reports from rangers and others predicted that the wind would be blowing continuously at the exposed 7200 foot elevation. If successful this installation would eliminate costly dry batteries and the problem of disposing of them when discharged. It would also enable the use of a 4-watt transmitter. The higher power would increase reliability in communicating with other stations. The writer was employed

as a fire lookout at this site and had the responsibility of care for the test installation. The wind-charger was expected to operate almost continuously. Actual observations indicated that enough wind to provide charging current occurred only about 5 percent of the time during the entire summer. With a maximum capacity of 20 amperes, there was not enough energy to operate a transceiver very long with a transmitter drawing 30 amperes. There were days (as many as six or more) when the propeller never turned! Sometimes when the wind did blow, it was so gusty that the governor operated, swinging the propeller to a horizontal position during gusts. One particularly violent thunderstorm was extremely gusty and the governor was keeping the propeller tilted to horizontal most of the time. My attention was concentrated on the eaves on the west side of the building, which had been tied down with #9 iron telephone wire (the roof had blown off in 1935), and to the corona glowing on the copper down-conductors at the corner of the building (the intensity of the glow served as an indicator of the imminence of nearby lightning strikes). Out of the corner of my eye, I became aware that something unusual was taking place. Suddenly there was no propeller! One end flew to the west and fluttered down like a leaf in the breeze into the valley 1500′ below. The other end fluttered onto the rocks some distance from the lookout building. The self-governing mechanism was inadequate for the sudden strong gusts of that storm. Thus ended wind charger tests at Mount Rainier. Full reliance fell onto the dry-battery operated radio.

Dry-cell batteries were the mainstay in powering portable units and fixed stations that did not have AC power. However, invitations-to-bid did not always result in delivery of reliable batteries ". . . Parks have mentioned in reports that when they advertise for bids on radio B batteries, they have received low bids on inferior brands of batteries. These batteries when put in service have not performed as long or as well as batteries of a better grade . . ." Associate Radio Engineer Hilgedick provided information to the field on April 1, 1938 as to how to include Federal Specifications No. W-B-101a in their invitations to bid. (102) Later problems with obtaining dry batteries under war-time conditions are described in Chapter 3.

Telephone lines to fire lookouts were not too reliable and the better radios installed at the lookouts for the first time (1935) filled the gap. The lookout radios also proved to be necessary to relay messages from (a) portable units installed at CCC "spike-camps"(103), (b) the Cougar Creek fire (Mount Rainier), and (c) at other fires in other parks. In August 1936, Waterhouse reported that transmission from all these locations was "favorable".

A report by Waterhouse also describes early tests at Mt. Rainier on 5 meters - probably the "grandfather" of the current "handy-talky" generation. The report suggests the possibility of duplex operation whereby the push-to-talk feature of simplex operation is eliminated. This is a concept that has never caught on, offering no real operating advantage, and requiring heavier battery drain and more components in the transceiver.

The writer recalls one of the 5-meter tests, from Ricksecker Point to Longmire; about a three-mile path which was slightly obstructed by the end of Tatoosh Ridge, of which Eagle

Peak is a part. This path was about the limit of range with battery-powered super-regenerative transceivers and non-directional antennas. During the test Superintendent Tomlinson had arrived at Ricksecker Point with several VIP's. After viewing the scenery, the party boarded their large sedan (a "bootlegger" vehicle, which had been confiscated and transferred to the National Park Service), and found it would not start. The embarrassed Superintendent, who had shown no interest in our tests previously, came over and asked if we could get a mechanic dispatched. Fortunately the test was successful, and a message relayed to the garage. The Superintendent and VIPs were impressed with the benefits of the two-way radio.

In April 1936, additional 5-meter (60 mc) tests were conducted between Longmire and Anvil Rock (9500'). Again, communication resulted only on line-of-sight, or very nearly line-of sight paths. This is very poor performance compared to what could be realized today with modern 5-meter equipment.

The equipment used for these early UHF tests (now known as VHF) was very mediocre by present-day standards. However, they foretold of the possibility that eventually frequencies in the 30-200 mc range might be used (a prediction which became fulfilled as reported on following pages) to relieve the burden on the lower frequencies. It was also apparent that their line-of-sight characteristic would eliminate some of the outages and other vagaries of the 2.5 - 5.5 mc band (5.5 - 30 mc was known to be nearly useless for short range use, since it propagated signals thousands of miles via reflections from the Heavyside layer). Unfortunately limited NPS funds prevented active pursuit of development of UHF equipment. In a later section it will be noted how the Service was able to benefit from the development of UHF by the U. S. Forest Service, amateurs, and eventually commercial manufacturers.

In August 1936, Isle Royale National Park had a bad forest fire. A telegram requested Waterhouse or Hilgedeck to hasten to the area to install one unit on the island and another on the mainland. Radio was now an accepted "tool".(106)

In the thirties, life was considerably different than it is today, with TV, good highways, and reliable telephone service. So it came as no surprise when, in January 1936, Grand Teton wrote Mount Rainier to make an 11 p. m. test between the two parks. (105) This was not just for "dx-ing" but was probably motivated by the winter hardships that would be experienced in setting up a portable unit for a test. Besides, Teton probably wanted a critical report from Rainier's technical personnel on the quality of their transmissions.

The PTR-2D transceiver was put to many uses, including communication for ski races at Mount Rainier. During the 1930's the famous "Silver Skis" race from Camp Muir (10,000') to Edith Creek Basin (5,700'), radio was used to coordinate the timing and to call for first-aid and/or other assistance. On one such occasion it was the writer's sad duty to relay a message that one racer was killed while taking a shortcut between rock outcropping on a snow-patch which had melted between his prior-days trial run and the running of the race.

Carrying the radios from Paradise (5,500′) to Camp Muir was most taxing physically. The return was also difficult for inexperienced skiers because the 37# radio had inertia that wanted to keep moving in spite of the carrier's efforts to slow or stop. In order to be set up in time for the race, the radios would be carried to the site the day before and buried beneath the snow in a tarpaulin. Often the temperature was so low that it was necessary to operate the unit for 15 minutes on receive in advance of the contact to be made. The receiver current would warm the batteries sufficiently to restore the batteries to normal voltage. Modern portable FM units are so small that the users can circumvent this problem by carrying the batteries and/or set inside their jackets.

While the AM transceivers worked fine at the ski races, problems were experienced in finding a location for the antenna (about 60′) where it would not be knocked down by the participants, bystanders, and officials. The officials usually insisted on doing their own talking, but were confused by the switch-to-talk feature which was new to them.(104)

Technically-inclined readers who are used to transistorized equipment and 12-volt vehicles may be interested to know that a 4-watt AM mobile transmitter required a 300-volt dynamotor that would deliver at least 100-ma. On a six-volt storage battery the current drain would be in the vicinity of 50-amperes. Imagine the problems that a cable-plus-contact resistance of say .05 ohms would cause! The voltage-drop would be disastrous. The cables and connectors had to be massive by today's standards. Receivers were usually powered by vibrator-type power supply, but vibrators were cantankerous - reluctant to start if the battery voltage was not up to par.

Metal tubes were introduced in 1935(107). They had 6.3-volt filaments which could be operated directly from an automobile battery (12-volt systems were not in common use at that time) for mobile receivers. They were not practical for portable equipment.

Radio at Mount Rainier was becoming important for mountain-top rescues of which there was one nearly every year. The 1936 recovery of the body of Delmar Fadden was the first such rescue in which radio played an important part. The author operated the headquarters base station and had a first-rate chance to evaluate the performance of the radios.

Fadden had attempted a solo summit climb from the east side in winter, bypassing the ranger at White River. Since a solo climb in winter would be extremely dangerous, the route had been closed. Had Fadden not by-passed the ranger station, the ranger would have prevented him from making the attempt. He had apparently completed the climb, having left markers during his ascent to trace his return route. At almost 12,000′ he lost a crampon, probably because he wore soft-soled boots to keep his feet from freezing, instead of the customary hard-soled boots which are used with crampons. He evidently lost his footing and slid face downwards and froze while unconscious. When he failed to return, Ome Daiber, a Seattle climber who had offered to help in the search, and NPS teams(109) began a search, but could not find him; the body evidently Having been covered by fresh snow. A few days later a plane spotted the body (wind having blown some of the snow

away), and a second rescue attempt was made. Radios were used at Starboe Cabin (high on the mountain), White River Campground (along the route), White River entrance, Longmire and Seattle (home of Mr. Frost, mother of Neal Frost who had worked seasonally as radio technician). Cross-band communication was also had with the Washington State Highway Department station in Seattle on 2490 kc. A detailed report(110) indicated that erection of antennas under winter conditions was very difficult, and recommended that patrol cabins and ranger stations be equipped in some manner for easy winter antenna erection, and a shelf for transceiver, located so that most of the antenna would be outside rather than inside (as would be required to extend from radio to point-of-entry). Communications at night were hindered by atmospherics and by "skip" effect, a condition that occurs on 3415 kc only during the low-activity portion of the 11 year solar cycle.

The dedication of the rangers, putting in long and hazardous hours on the search and rescue without any compensation other than regular pay, was exemplary. In addition, Frank Greer, one of the older rangers, stationed at Longmire, spent many hours with the author at the Longmire base station, maintaining the logs and keeping him company and bringing refreshments. Frank overlooked the formalities of wearing his full uniform as he accompanied the writer in the Longmire radio room - he shed his tie and boots and curled up on an unused desk while he napped between calls!

At that time it was considered that certain subjects were inappropriate to be shown in news photos. Publishing photos of a body, such as Fadden's, would not have been in good taste, but the rangers knew that a press photographer was waiting at White River to photograph the toboggan as the burden was to be transferred to a hearse. Since the rangers had learned that some newsmen were monitoring the communications, a system of double-talk was used to arrange for the rescue toboggan to bypass the waiting press, going through the forest until reaching a rendezvous point with the waiting hearse.

Another rescue illustrates the callous attitude of press reporters that existed at the time. Early articles on the rescue had reported that the rangers were assisting the CCC enrollees in the search and that the search was under the direction of Ome Daiber who was actually an enthusiastic volunteer who had no official responsibility. One newspaper referred to Park Rangers as Forest Rangers, another error that is still being made occasionally.

Discrepancies in press reports of previous rescues caused Superintendent Preston to insist that all information released to the press regarding this and later rescues be issued from his office. Nevertheless, reporters used various ruses to get a "scoop" before the Superintendent made his release. The Park was fortunate enough to have an amateur ("Ham") radio operator employed as a fire lookout. In an effort to prevent newsmen from misusing intercepted radio messages he was used as rescue-party operator so that code (CW) could be used to thwart the eaves- droppers. However, a newsman, accompanied by a sister of the victim, happened to locate the headquarters radio room just as the ham operator at the

Figure 7

Grand Teton National Park Headquarters Radio Station, circa 1936. The cavalry boots were the standard uniform of the early 30's. Antenna feed-through insulators below the window.

rescue site was tuning up. This was about 4 a. m. The standard procedure when turning up a portable unit was to send a series of v's (indicating test), followed by call letters. When the CW signals from the party began, the reporter appeared at a window with the victims sister urging that "you would not withhold any information from her, would you?" Actually no message, only tests, had been passed, but the reporter was not convinced! The newsman, not being able to read code, accused the operators of sending information that was being concealed, using the explanation of test signals as a coverup. This led to a heated exchange which did not help dispositions and the reporter was not endeared to Service personnel.

Other unusual situations came about as a result of the use of high-frequency AM radio. Many private "short-wave" radio receivers were capable of receiving such transmissions. The media and private citizens frequently monitored NPS transmissions from both Mt. Rainier and Olympic National Park (In spite of the secrecy provisions of the Communications Act of 1934). This became evident at Olympic National Park, during the period that the Coastal Strip was being managed prior to its official incorporation into the park. Many of the plots of land that had been purchased had residences and/or other buildings that were no longer occupied. These buildings became targets for nearby residents who might be in need of lighting or plumbing fixtures or other objects. Their problem was how to avoid being caught by the ranger that was based at Kalaloch Ranger Station. In due time they discovered that all the Olympic National Park rangers made a daily report at 8 a. m. giving their work-plans for the day. It was not long before they were pilfering on the north end of the strip on days that Ranger Dickinson was patrolling the south end and vice versa.(111) It eventually became necessary to use cryptic language when reporting one's expected patrol activities for the coming day--so that poachers or vandals would not know how to avoid being caught.

The concessioners in some park areas operated their own telephone systems. Usually, if NPS telephone lines were down, the concessioner was without communications also. Therefore, the question often arose whether the concessioner could either (a) monitor NPS and use weather and road reports(112), or (b) operate a transceiver as part of the local net during emergencies only?

In some cases the government-owned telephone lines furnished telephone connections with the outside world (including their home or "city" offices) for the concessioners, the concessioner would also be isolated during line outages. This meant that the concessioner(s) could not cancel or alter public bus and supply-truck schedules if the roads were blocked at the same time as the telephone outage. In the case of Mt. Rainier, Superintendent Tomlinson arranged an informal relay "plan for transmitting information from the park through Mrs. T. W. Frost's amateur shortwave station [actually on a NPS frequency, not on an amateur frequency] in Seattle to the Rainier National Park Company during the emergency while telephone lines are out of service."(113) This is the same station used in tests which have already been described.

While the expression "What you do not know does not hurt you" was true in the case of the early rangers who had to accomplish patrols under difficult conditions without radio,(114)

many difficult situations might have been avoided had portable radios been available. Reading about the work of the early rangers will convince most anyone that they were very intrepid people.(115)

Early uses of radio for point-to-point and for portable use(usually fire, sometimes for timing and control of ski races, and for rangers engaged in rescues and control of poaching) quickly proved its worth in spite of the temperament of equipment and its vulnerability to propagation vagaries, static, and other limitations. It was also recognized that mobile two-way radio, if available, would be a boon to maintenance and protection operations. Consequently many park areas endeavored to adapt or modify portable transmitter-receivers for mobile operation.

Radio Engineer Hilgedick of the Regional Office in San Francisco developed a top-loaded antenna which was superior to the usual base-loaded mobile antenna. In physical appearance it looked more like center loading, because the top whip was almost as long as the lower section supporting the loading coil. He took it to several areas for field tests. He and Jack Emmert ran tests in Yellowstone in August, 1939.(116) A report in the Old Faithful log for 1939 states that they "found area around Black Sand particularly favorable". Since this was in the Old Faithful log, we assume that the tests were between the mobile unit and a base station at Old Faithful.

During this period, reliability was a primary concern. Among the items that could cause failure were: tubes, microphones (carbon granules became "packed"), switch contacts, transformer breakdown due to electrolysis or high elevation. One cell within a battery or a set of batteries might discharge prematurely. Crystals would often fail to operate due to shifts of the pressure plates after rough handling of the transceiver such as being packed on a horse. The writer recalls making a field test to ascertain if a certain portable unit was ready for use. In this instance the unit did not work when set up. The 5-year old son of one of the maintenance personnel was observing the test and made the astute suggestion to "kick it" in the side and it will probably work. Sure enough it did; the shock shifted the pressure plates on the crystal sufficiently to establish operation.

Not every user of radio was happy with the new "gadgets". Whether it was reluctance to use something new, or the encroachment on one's independence and isolation (in the case of district and/or outlying rangers) and privacy is not known. Perhaps it was a little of each. It was quite common, when mobile units became practical, for rangers to drive with the antenna lowered under a clip on the rain gutter. The latter was necessary when the vehicles were placed in the garage. When asked why they didn't raise the antenna when leaving the garage, the reply was something like "What difference does it make? I can let it up anytime I want to talk!" Apparently they did not want a dispatcher or chief ranger to interfere with their day's work, by dispatching them to emergency or higher-priority work.

Early users of mobile radio were sometimes lukewarm to the extent that they would permit them to be installed in their vehicles but ". . . is rather rough on his radio equipment as he

let his baggage [in the trunk of the car] shear off the plug contacts on the chassis and do other damage. Incidentally the whip for the top of the can [antenna loading coil] was in the car all the time."(118) This writer experienced such skepticism on the part of a certain district ranger (at Mt. Rainier) whose radio usually "failed" at weekly intervals. Often there was nothing wrong other than a possible misadjustment or misunderstanding about schedule hours. On Dec. 26, 1940 ". . . the radio was installed at Carbon River Ranger Station. [To date, March 13] it has been necessary to make three trips over there to find why the ranger was not reporting, and remedy the trouble reported by him . . . In each case it was not the fault of the radio, but rather, lack of willingness to try to use the radio as instructed." (117) Since this person had a heart problem, such "failures" of the radio made the headquarters personnel very anxious about his well being. After several years of this, he became a "believer" when his daughter successfully used his radio to obtain medical instructions after he had a stroke.

In another instance, the same ranger involved began to suspect that the headquarters operator at Mount Rainier had ESP. It was after the morning check-in schedule for all stations that a carrier came on and stayed on. Obviously, one of the outlying rangers had returned his panel switch to SEND when he meant to turn it OFF (OFF being the center position). The headquarters operator could hear a man's voice and woman's voice faintly in the background, as they moved about the room in which the transceiver was situated. By knowing which rangers were married, and which transceivers were located in living quarters (the rest were in ranger's offices), the operator could determine that the station whose carrier was on was the one at Carbon River. It so happened that this ranger drove each morning about 15 miles to the Fairfax post office to pick up mail. Being a small post-office, it was a simple matter for the headquarters operator to telephone the postmaster and ask him to give the ranger a message when he picked up his mail. Imagine his surprise when the postmaster told him to turn off his transmitter when he returned to the station! Fortunately his batteries withstood the long period of heavy drain until the ranger returned to his station and turned it off! They were usable for several weeks thereafter.

Some parks were more reluctant to invest money and/or effort in utilizing the new tool such as the "old timers here [Yellowstone] have prevented any splurging like they did at [Mount] Rainier. Sets were purchased slowly . . . our radio system lethargic and unbalanced but it is useful . . . disappointed in the failure of our protection organization to try to use the high-frequency voice sets which the Forest Service made available for us last summer."(119)

During the same period, other government agencies were expanding the use of radio, requiring the assignment of more frequencies for their use. Sometimes this led to interesting situations such as occurred at Mount Rainier in the 1936-1941 period. Mount Rainier operated on 3415 kc without any interference except night-time "skip", already mentioned in a preceding paragraph. One day the operator heard a station testing and identifying itself as the Lighthouse Tender "Rhododendron" which appeared to be on the same frequency (actually it was on 3410 kc, but our receivers were not selective enough to separate them) and a two-way contact developed. The mood was like "welcome to the club."

Later, several lightships and other stations were established by the Lighthouse Service (superseded in 1939 by the Coast Guard) until the point was reached where it was difficult to conduct NPS communications because the 3410 kc operations were so extensive.

By 1940 UHF (now called VHF) equipment was becoming acceptable for certain uses. "Ultra-high-frequency sets . . . would be even more satisfactory than our [high-frequency AM] sets, providing excellent communication for scouting work [on large fires] . . . as it takes less than a minute to set up, report, and get moving again . . . One [proposal] uses 2770 or 2882 [kc] for winter ranger stations and ultra-high-frequency . . . for lookout and fire chaser use."(120) The same report predicted future use of automatic repeaters and cited advantages of VHF such as simpler antennas, lighter and smaller portable units, smaller power consumption, etc. The fulfillment of these predictions is described in following chapters.

The dangers associated with removing snow from highways where it can be as much as thirty feet deep, made it desirable to provide two-way radio for Sno-Gos. The pilot installation was at Mt. Rainier on a four-auger unit, with 20 foot digger-boom. An antenna which would withstand the rigors of flying snow and ice, as well as withstanding severe vibration and the possibility of being hit during snow slides was a necessity. After several types of antenna were tried the antenna consisted of an insulated street-car trolley, matched to the transmitter by a separate network. It was not very efficient due to detuning by changes in capacity between the trolley and Sno-Go cab as snow accumulated on the base during snow-blowing operations, but it was more practical than other types.

The choice of using a streetcar trolley for antenna was the result of numerous trials and tests. Earlier antenna types were abandoned as being either mechanically unsatisfactory or so inefficient as to be useless. Being the equivalent of the top end of a 68.5 foot vertical antenna, the trolley had to be well insulated, and a base loading circuit devised. "The original trolley-pole is used although it had to be cut off about 18 inches in order not to project beyond the end of the machine when in the down position . . . It was thought that the trolley would bounce and turn on its pivot as the Sno-go maneuvered, but it stands nearly straight up with no objectionable movement while under way. The moving parts of the base were shunted by a jumper made of woven [metal] braid . . . If a slide should hit the trolley when it is up it would probably cause it to turn on its pivot, but could not knock it down as it takes about fifty pounds pull on the end to pull the trolley down."(121) Flying snow piles as high as three feet atop the cab when Sno-go's are operating, and sometimes freezes in that position. Any lighter antenna would not withstand the shovelling required to clear snow from the roof of the cab.

There were several problems which had to be surmounted. Acoustical (the cab is very noisy under operating conditions) and electrical (two engines with high intensity truck type ignition systems) noise made reception in the rotary Sno-Go equipment very difficult. One engine was for traction. The other larger engine drove the 3 (some had 4) augers and the chute fan. The Sno-Go that had a 20-foot boom with diggers was used to bring the deeper

Figure 8A **Figure 8B**

Illustrating two types of antenna
for Sno-Go installations.

Figure 8A, collapsible one-turn loop of 1-1/4" brass tubing. Loop impedance was so low, it could not be properly loaded. Scheme was abandoned for trolley-type antenna in Figure 8B as described in the text.

snow (some cuts were 30 feet deep) down so the augers could handle it. If the volume was turned up enough for voices to be heard while "pushing" snow they would not be understandable due to loudspeaker distortion. It was necessary to cease plowing snow and slow both engines to an idle in order to understand received signals, and to reduce cab-noise so it would not blot out the voice while transmitting.

In May, 1940, Ranger Reino Sarlin and the author visited the Forest Service Radio Laboratory in Portland, Oregon. The purpose was to learn of their latest developments "as related to forest radio communications. It was felt that a visit . . . would prove beneficial in planning future [radio] development in this [Mt. Rainier] park . . . It was known that the Forest Service has used ultra-high-frequencies [now called VHF] with success for some time." The information obtained was considered important in determining whether to use the current medium frequencies or go to UHF in the future. (122)

In December 1940, a joint USFS, NPS, Indian Service, and State forestry, conference was held at the Forest Service Radio Laboratory in Portland, Oregon. Purpose was to "discuss technical phases of forest protection radio communication in order that there may be the greatest possible interchange of practical planning, application and maintenance information." That meeting was the precursor of the gestation period during which VHF was developed and eventually generally accepted in the 1950's. Preliminary models of portable VHF units were demonstrated that showed superior portability and ease of operation. Not having to stop to erect a long-wire antenna pointed to the possibility of talking while underway. That same meeting included a discussion of whether frequency-modulation (FM) should be used in the new VHF systems in place of then-used amplitude-modulation (AM). The conclusion "that its [FM] application to forest protection would be nil, because of the circuit designs complication not applicable to our use." That prediction proved to be false, since techniques developed during the WW II enabled FM to become far superior to AM: i. e., no change in audio strength as signal strength changes, less susceptible to ignition noise and static crashes, etc.

Another major subject at the meeting was the establishment and management of communication facilities for project fires.(123) These decisions might be considered to be the "seed" which eventually resulted in establishment of the Boise Interagency Fire Center (BIFC) at Boise, Idaho in (described in a later chapter).

By August of 1941, part of the world was already embroiled in battle, and the United States was preparing itself for possible entanglement in WW II. Even so, the parks were operational, and the Superintendent, Rocky Mountain National Park asked Superintendent, Mount Rainier for details on their Sno-Go radios, (described earlier) because of their concern for the safety of the operators of snow removal equipment, and efficiency of operations on the Trail Ridge road.(124) The reply indicated a single installation would cost about $600, but reminded them that under the "present emergency" conditions NPS might lose its high-frequency assignments making the Mount Rainier types of installation obsolete.(125)

The "National Emergency" also created concern about the need to "provide emergency radio communication between areas, and between areas and Regional Headquarters in the event of failure of commercial communications." This resulted in a proposal to modify each headquarters station so it could transmit and receive on 5287.5 kc in addition to its assigned frequency. The modifications were not easy. "That Sequoia set is a cranky son of a gun, while the Yosemite set is just as stable as an old cow and as easy to work with. You went to a lot trouble with the Longmire [Mount Rainier] set . . . At both Yosemite and Sequoia I shorted out part of the final coil to hit 5287.5 without changing the condenser at all, then changing taps with the second pair of relay contacts for properly loading the final."(126) Also certain headquarters would have receivers for the Forest Service emergency frequency 5902.5 kc and the Forest Service would monitor 5287.5 kc for cross-band emergency communication between parks and national forests. The Washington office also recommended conversion to UHF (now known as VHF) for intra-area use wherever possible, but no funds were provided for this purpose.(127)

There was much discussion as to how to implement the proposed emergency network and, as just indicated, several parks added the circuitry to operate on 5287.5 kc. Several tests were made, some satisfactory and some unsatisfactory, but the proposed network never materialized.(128)

There was also concern about the hinted possibility that NPS might lose it authority to use its HF assignments, which would virtually put an end to NPS use of radio. Since some areas were used for training mountain troops, it was hoped that special dispensation could be obtained for continued HF use in those parks. As discussed in the next chapter, this possibility (loss of HF assignments) never materialized, although operating requirements were very specific with limitations.

CHAPTER THREE

INTERRUPTION, WW II

1942-1946

CHAPTER THREE

INTERRUPTION, WW II

1942-1946

TELEPHONE

Even before the official entry into World War II, some National Park Service (NPS) workers were volunteering for the Armed Services. After declaration of war and implementation of the draft, this manpower requirement increased rapidly. The departing personnel left protection, maintenance, administrative and management positions. As a consequence there was much shuffling of remaining personnel to keep essential activities functioning. Less important activities were either treated minimally or omitted entirely.

There is not much in the way of records I had access to that show how this affected NPS telephone systems. However, it is known that preventive maintenance dropped to nearly zero, and only those lines that were critical were kept in usable condition. A few lines received priority because they served aircraft warning (AWS) posts under contract with the Air Force.

Involvement with Aircraft Warning Service

Because of the importance of military installations in the Puget Sound Area, particularly Bremerton Naval Shipyard and the Boeing Aircraft facility in Seattle, the Army desired an Aircraft Warning Service (AWS) network covering the Olympic peninsula in Washington State. Actually the Army (some sources use the term Air Force) wanted AWS coverage of the entire West coast. Because the majority of fire lookouts along the coast, which were ideal AWS sites, were on Forest Service lands, the Army designated the Forest Service (as coordinator) to activate and supervise those lookouts which were to be AWS stations.(1) The Forest Service was designated as the lead agency for establishing aircraft warning posts and their communication links with the Air Force's filter centers. The posts were to provide reports of movements and identification of aircraft to filter centers operated by the Air Force. It contracted with the agency-in-charge of non-Forest Service areas in which observation posts were desired. Husband-wife teams were hired to man approximately twenty strategically-located observations points on NPS, USFS, and state lands on the Olympic peninsula in the state of Washington. Other sections of the Pacific Coast were similarly equipped.

Through interagency cooperation thirteen NPS, USFS, and Washington State posts were set up for communication with the NPS radiotelephone operators at Port Angeles, Washington. Telephone was used when it was operable. Radio communication to these points was usually dependent upon radio maintained by NPS technicians from Olympic National Park.

"Operating fire lookouts in the winter was a new experience for Region 6. Ice and high wind plagued observers at elevations over 5,000 feet . . . Aircraft observers could not see or hear airplanes during inclement weather."(2) But the Forest Service FS-369 (see reference) description fails to indicate that nearly half of the AWS stations on the Olympic Peninsula were operated either by NPS or State Forestry agencies.

"Most AWS lookouts were atop peaks, above the fog. Hyas, North Point [FS lookout, radio maintained by NPS], Hurricane Hill [NPS lookout, radio maintained by NPS], Dennie Ahl, Jupiter, Zion . . . to name a few."(3) The narrative continues with a description of Striped Peak lookout which was a State Department of Forestry lookout, at which a Forest Service repeater was installed, and maintained by the writer. Access was via a dirt road across a private farm. This entailed opening and closing three dilapidated gates, usually in mud or water puddles, ignoring the heckling of some geese, and patiently encouraging one or more cows to leave the track.

> "The most significant change to the United States Forest Service (USFS) wrought by the war resulted from plans to protect its nation from attack."(4)

Telephone/radio switchboards which served AWS posts were placed in 24-hour service and operators instructed in procedures for handling "Army Flash" messages to the filter center. All AWS operations were to be treated as confidential. Changing from 40-hour weeks at the switchboards to 24 hr/day required recruiting additional operators, many of them housewives. Unfortunately, operator training had to be minimal and on a volunteer basis because Civil Service regulations prohibited paying two persons for being on the job at the same time. Hence there was no way for paying new employees during training. Because the switchboard at Olympic headquarters was the central link for thirteen AWS posts, some operators were concerned about their own security, especially when going on and off shift at night.

During proceedings to activate telephone lines to AWS posts in Olympic National Park it was necessary to make improvements in switching arrangements at some of the ranger stations. What was already at one station was a maze of wires and switches which were impossible to fathom. Evidently, during prior years, whenever trouble was experienced with the telephone system, the resident ranger did not understand wiring placed by previous occupants. The old system had grown like the proverbial "Topsy". Apparently this had happened more than once. The only solution was to tear out all the switches, wires, and bills, and rewire the system.

The AWS observers received training in aircraft identification and were occasionally visited by a representative of the filter center to be certain there were no "holes" in coverage of the Pacific coast. Many U. S. planes were reported routinely but one day a report was radioed in, which identified a plane as being Japanese. The Filter Center took the message, requesting the observers to continue to track the intruder. In response to a question, the Filter Center gave simply a "no comment" reply, indicating that all concerned should mind

their own business. A recent (probably 1978) article in Reader's Digest revealed that one or two planes from Japanese submarines actually did fly over our coastal area, but the military did nothing so that the Japanese had no way to tell if the U. S. defense system would be able to detect flight of their aircraft, if an attack was to be made.

A review of the Olympic National Park communications in 1944 included a detailed review of 1942 plans for a telephone system "division of the park into four large circuits by means of which any station in the entire park could be called direct from park headquarters." The review indicated "it is evident that heavily loaded circuits . . . would be unsatisfactory unless switching facilities were provided at certain points." A detailed description is included, describing additional lines, metallicizing of grounded lines and other changes that would be necessary to establish a viable system.(5)

RADIO

The entry into World War II, and emphasis on "national defense" placed the nation in a critical situation as far as supplies for civilian agencies were concerned. On August 2, 1942, some parks were advised to restrict operations so as to minimize the need for tubes, batteries, and other materials.(6) By August 29, Mount Rainier had advertised for bids for supplies for the coming year, anticipating that some items might not be available without a "priority" assignment. It was stressed that, without these materials, the fire lookouts would be unable to "keep daily reports of the passing of all airplanes, and report unusual movements by radio." Further justification for priority consideration was based upon the fact that "During the winter season the park rangers report the passing of army planes, by radio, and are solely dependent upon radio communication for aid in case of accident or emergency in outlying districts."(7) These concerns led to the establishment of the Aircraft Warning Service, already described.

During the first three or four years of the war, the AM medium-frequency equipment was pressed into service as backup for the telephone lines to the AWS stations that were in Olympic National Park. While very useful, these facilities were not too reliable. During the daytime, reflections from the F1 layer of the ionosphere were attenuated by absorption in the E layer, resulting in low signal strengths, sometimes below the level of the noise threshold. At night the signals would "skip" over and only distant stations were received (the F1 layer usually disappears or merges with the F2 layer at night). When signals were received they were often hindered by static crashes, making reception difficult.

At the beginning of the war Army and Navy laboratories obtained samples of the Forest Service SPF radios, which were very similar to the NPS PTR-2_ series) which contributed to the design of military portable models.

Concern about the security of the U. S. following the entry into WW II necessitated substantial changes in operating procedures, in order that there would be no possibility that medium-frequency transmissions could be used for direction-finding by enemy ships or

planes off our coasts or for obtaining useful information. (8) While the enemy had not penetrated to our shores, there was always the possibility that ships or planes could approach our coasts within receiving range of NPS and other transmitters located in the Pacific coastal states, using direction finders to pinpoint their own location (it has not been confirmed, but the author assumes similar precautions were necessary for park areas on the Atlantic seaboard).

The Army and the FCC had devised a plan (CONELRAD) whereby, in case of approach of enemy ships or planes, all radio users would be notified to cease normal transmissions. The plan was based upon the assumption that all radio users had the capability of continuously monitoring broadcast stations on 640 or 1240 kc to verify the non-existence of any alert before transmitting. A special procedure was developed to silence those operators of portables who did not have the 640/1240 monitoring capability, before their signals could be useful to an enemy direction finder. The AWS filter center (see following discussion) was concerned that CONELRAD alerts might prevent the forwarding of aircraft sightings ("FLASHES"). Therefore, provisions were made so that, in the event of aircraft reports or a dire need for communication during a CONELRAD alert, stations could use a secret call-letter which would render directional bearings taken by the enemy useless because they would not know the location of the station whose bearing they had taken.

In order to enable use of radio without jeopardizing the nation's security, various changes in operating procedures were established, similar to the following from Mount Rainier, which is quoted in it's entirety:

"EXCERPTS FROM REGULATIONS WHICH HAVE A BEARING ON THE USE OF RADIO FOR SILVER SKI'S RACES

"The Weather Bureau informed the conferees (NPS and forestry officials) that the word 'weather' was prohibited on the radio and any description of local weather was forbidden. The drastic action of closing down the station for duration would be taken against all offenders.

"Please advise all personnel using your radio transmitters to avoid mentioning weather in any form whatsoever.

"Several memoranda have been sent out over the past two years emphasizing the necessity of being brief, concise and not repeating call letters or station names once communication has been established. During war-time any order by the Army, Navy, or Federal Communication Commission is of course to be followed, such as the prohibition of putting weather information on the air, and observing radio silence when the key broadcasting station [CONELRAD] is off the air.

"Administrative heads of our areas will do well to closely guard all radio sets and parts in their custody during the war emergency.

"Various memoranda have been written from time to time on the necessity of brevity, conciseness and elimination of unnecessary conversation. The use of our radio system for personal conversation is now prohibited and other uses of radio should be kept to a minimum . . ."

On March 1, 1943, a Code of Wartime Practices(9) was issued "to coordinate to voluntary efforts of press and radio in the domestic field to keep dangerous information out of circulation . . . certain enumerated subjects be kept out of print and off the air." The code was voluntary and the Department of the Interior was specifically identified as one of many agencies to which it applied. It reminded radio users that "a radio signal knows no bounds, and that the enemy may be listening very near to the transmitter." This possibility was no illusion, since, as already mentioned, it has been reported in magazine articles(10) that Japanese aircraft did fly over some portions of the West Coast at that time.

The code included the following restrictions:

1. Weather data, amended later to prohibit only wind direction and barometric pressure when plain language is used.

2. Movement of military forces.

3. Ship information and movements, whether allied or enemy.

4. Aircraft movements (however, this did not prohibit forwarding of aircraft spotting "flashes" from AWS observers to the Filter center. Special secret arrangements were made to prevent identification by unauthorized persons during alerts when declared by the Military).(11)

5. Information concerning fortifications and defenses such as location of anti-aircraft guns, etc.

6. Production and communication facility details and locations.

The Code also stressed that measures be taken to assure that control of radio transmitters be available only to "a trusted and dependable employee."

In spite of the Code of Wartime Practices, some agencies failed to observe the restrictions. It disturbed the personnel of Olympic National Park very much, when they could hear Coast Guard stations in the Puget Sound area on 3410 kc (being higher-powered they came through the Olympic National Park receiver on 3415 kc as clearly as the park stations) in plain language dispatch boarding-boats to "that big black Russian freighter"and similar instruction with no regard for security.(12)

The possibility of the Japanese launching balloon-carried devices to start forest fires made it essential that west coast fire protection agencies continue to have access to fire-weather forecasts from the U. S. Weather Bureau's broadcasts on its frequency assignment. However, it was important that these broadcasts be conducted in such a way that they could not convey weather data to the Japanese. This was accomplished by transmitting the weather forecasts in coded form. Selected personnel were given access to decoding information which was changed form time to time. Of course, the coded weather forecasts were not to be sent during a CONELRAD alert, to prevent possible "homing" on the Weather Bureau station.

Olympic National Park was using 3415 kc and the Coast Guard was using 3410 kc (already mentioned). The latter's use of the frequency was almost continuous, wiping out most NPS communications.

In order to improve the use of its radios for AWS purposes, the writer was transferred to Olympic National Park. Steps were undertaken to reduce the interference from the Coast Guard:

1. Increase power at the most important stations, using wind power supplemented by a gas-engine-driven charger to charge storage batteries.

2. Improved antennas at certain locations.

3. Replacing or "doctoring" transmitter crystals to keep all transmitters closer to 3415 KC than they had been heretofore. Crystals which were too high in frequency could sometimes be "warped" to the correct frequency by coating the surfaces with lead pencil marks.

4. Establishing a 10-watt radio at Low Divide (ONP) in late fall required all the stamina that six men could muster. Their loads consisted of radio, a large truck battery, a gas-driven battery charger, and a wind charger, and gas for the generator, etc. There was about two feet of wet, heavy snow on the ground for the first four miles which made it difficult for horses. At that point a large blow-down area (made up of trees 150′ high and higher smashed in every direction due to a recent tornado) was encountered, making it necessary to traverse the remaining four miles on snowshoes, clambering over and around the fallen trees, a rigorous job for men with 50 to 120 pound packs on their backs.

5. Increasing the selectivity of the headquarters receiver to reduce interference from the Coast Guard. This was only possible after all outlying stations were brought closer to frequency by step 3. Because the headquarters transmitter output was 75-watts with an excellent antenna system, the field stations were not bothered so much by the Coast Guard and did not require changes in their receiver selectivity.

All agencies in the Northwest which were involved with AWS had difficulty at times in providing dependable aircraft-reporting via ground-return telephone lines and/or AM radio as already described. Therefore, several years into the war, the Forest Service undertook building AM base stations and repeaters, operating in the 30-40 MC band, for all AWS stations. The choice of AM over FM was apparently the conclusion of the aforementioned January, 1941 conference that "its [FM] application to forest protection will be nil, because of circuit complications not applicable to our use." Nearly 900 units were built for use under the aegis of the Forest Service at AWS stations on the Pacific Coast(13) during 1943. Installation on the Olympic Peninsula began in 1944. The earlier-mentioned network of thirteen FS, state and NPS AWS stations were equipped with the new 30-40 Mc transmitters and receivers and reported to the NPS operators at Port Angeles, Washington. They in turn used telephone to reach the filter center, presumed to be in Seattle.

The repeaters for this network were operated from huge banks of #6 dry cells which lasted about a month. They were connected in parallel for filament power, and in series for plate power. Replacing a set of batteries was time-consuming and monotonous, entailing the removal and replacement of about 240 terminal nuts.

Commercial manufacturers had not developed practical, low cost antennas for fixed stations in the 30-40 MC band. Therefore, a USFS-developed and manufactured monopole antenna with ground plane was used. For some locations it was necessary to build a "home-brew" phased array to achieve adequate signals to reach the repeater..

In late 1942, a meeting was held to consider adding "eight or nine more observer posts to be located in Olympic National Park, to fill certain gaps in the territory now covered. These stations will bring the total to over twenty stations which will be reporting [to the NPS Port Angeles operator] by either telephone or radio."(14) The additional stations never materialized. The meeting also expressed concern about the Army's occasional use of NPS and FS frequencies interfering with the expeditious forwarding of flashes (reporting of aircraft sightings).

Improvements in operating procedures, necessitated by wartime limitations, had been badly needed for some time. Operators would often do their thinking while on the air or would use lengthy expressions like "I got what you said but I did not get the license number" which could have been shortened to "Repeat license number." At the same way, once the off-frequency problems were corrected so that receiver tuning was unnecessary to bring in stations whose transmitter had drifted off-frequency, it was possible to simplify the calling and answering procedures like "five calling one", etc.(15)

The military apparently had authority to use any government frequency. In any case, during 1944 Mount Rainier was discouraged by interference such as: " 'Terrible calling Tiger' on 2898 [KC] has sure caused us a lot of trouble and now he has changed code and its 'Charcoal calling Purdue' 'I have bombing scores for you.' That goes on all day, Sundays

too and even at night. Can we do anything about it? I doubt it. Army, Navy stuff I suppose."(16)

The shortage of personnel during the war caused extreme measures to be taken to utilize their existing AM radios. At Mount Rainier National Park, one of the PTR-2 series transceivers was improvised into an automobile for use as a mobile unit. Ignition and generator noise precluded use of the receiver while underway, but the vehicle driver was enabled to stop his vehicle and make a call when necessary. It was used in an instance which illustrates the (unfounded) concern that prevailed about the possibility of sabotage by Japanese residents in the vicinity. District Ranger Rose was patrolling the West Side Road which permits viewing forest lands outside of the park. He sighted a series of smokes at intervals about one-quarter mile apart along a logging road. Surely this was sabotage, and the radio was used to alert the authorities. Excitement abounded; but alas, it was later determined that "chokers" (heavy wire rope devices to snag logs) had been dragged along the road. The forest was tinder-dry and the friction caused by the chokers had started the fires!

In another instance, a strange syllabic form of interference occurring routinely about 4pm every day, prompted park workers to suspect that a Japanese family living outside of Mount Rainier might be transmitting messages to enemy forces. The FBI and FCC were notified, but they failed to identify the source. But by being in the right place at the right time, I traced the interference to a faulty splice in the PA loudspeaker distribution system at the Sunshine Point CCC camp. Arcs within the splice created noise "splashes" which were being heard on receivers as much as a mile away. This made it appear that a transmitting schedule was being kept by the suspects! Actually the hour of operation was the leisure hour between the end of the work day and dinner when records were played over the PA system.!

One would think that under national emergency conditions the operating procedures of military stations would be exemplary and adhere, as a minimum, to the same requirements as demanded of NPS. However, this was not always the case. There was an instance at Mount Rainier where the Army was assisting with a rescue and had obtained permission to "work" the Mount Rainier stations on the NPS frequency. The Army sets, being VFO-frequency controlled, required considerable testing in order to get on the exact frequency. This sometimes blocked important NPS communications that were essential to the rescue attempt. Some Army operators, after exchanging good communication for a quarter or half hour would (for no reason at all) come on the air like "Test, one, two, three, four, five, Willie Jig Six, this is Able Fox Four Nine. Do your read? Do you read? over." To this day we do not understand why this unnecessary testing was practiced.

By mid-1942 "batteries are scarce. No stock in San Francisco. Ours came from the factory. Tubes and parts are nearly gone also. No receivers (HRO-Hammarlund-Hallicrafters) left in the San Francisco area either. Army and Navy got them all and want more." Priority numbers were required to purchase equipment, parts, and supplies. The NPS had very low

priority, even though we were under contract (through the Forest Service) to the Army for AWS stations. NPS requested assistance from the U. S. Forest Service in the hopes that they, being the lead AWS agency, would obtain priority treatment of orders for parts. Even so, delivery sometimes took more than six months. Batteries were critical items. Production inspection of batteries at the factory was evidently lax because some batteries would be delivered that had bad cells or broken internal connections. GSA required that purchase be made from their stocks, but the GSA shelf-life was sometimes so long that they could not be depended upon for full use. It was at this time that the benefits of cold storage were recognized and some parks began the practice of refrigerating batteries until they were placed in service.

With regard to frequency-control (item three above,) the art of Piezo-electric quartz crystals for frequency control left something to be desired. Crystals that were ordered for 3415 kc might end up as much as 3 kc away. In some cases a field station would be closer to the adjacent channel than it was to the proper channel. If the headquarters receiver selectivity were to be improved to reduce off-frequency interference (item 4 above,) such a field station would not be heard. Previously the off-frequency station might be heard in a distorted way by the operator who needed to manually tune to the off-frequency station in order to copy it. If the operator was careless enough to forget to retune the receiver he would most likely miss subsequent calls from any weaker on-frequency stations. It is interesting to note that the military avoided this problem by providing operators with a panoramic receiver with a scope on which they could see (and then tune to) all signals within a band several channels wide. Such receivers were financially beyond consideration by NPS.

Maintenance and installation of radio equipment by personnel with limited technical knowledge is not without difficulty. "Colonades [Mount Rainier] was a flop. Sent #5 [a PTR-2D 'Silver set'] up first and it cut out badly. Then sent #4 up and it was very weak but did not cut out. On #5 found two wires loose on the L2 coil. When Jones, Molineck and the lookout were packing out, the horses bucked everything off and wrecked #4. [The specifications for the PTR-2 series included a drop test, but who could anticipate this type of treatment?] Chassis all bent and do not know if the metal will stand straightening . . . At Ohana [Ohanapecosh] I connected the radio and tested it. It was very weak and the antenna current was only mere milliamperes. Well, it [a loading coil mounted below the window] was smashed this summer by a careless 90-day-wonder. So I removed it . . . and got 22 milliamperes. Then I thought I better check on the ground. Found it rusted off the water pipe . . . I ran a new ground . . . Longmire heard me swell and I heard them very fine . . . I have been having a rather tough time keeping various rangers and fire dispatchers from twisting dials on the receiver in the radio shack. Nearly always find the 'squelch' turned down too low."(17)

Not much information is available about wartime radio use by NPS on the East Coast. However, notes taken (but reference not copied) indicate that Blue Ridge Parkway had an extensive AM system completed on March 28, 1941. Base stations were installed in concrete

buildings and operated by remote control. On February 11, 1942 it was reported that one of the base stations was stolen. The park was advised to watch security, and keep an ear out for strange signals in case it would be used for subversive purposes.

By 1945 the Service was anticipating the cessation of hostilities and was establishing Project Construction Proposals (PCP's) for post-war needs to make the parks presentable and accessible for the public. The state-of-the-art was such that, while HF-AM radio was described in most proposals, it was anticipated that VHF may be more practical by the time funds became available. At Mount Rainier it was hoped that radio could be used to replace or supplant telephone at outlying stations. As reported elsewhere, heavy snows there (as much as 13′ on the ground in late March) caused most telephone lines to be useful only during the summer and early fall (subject to interruptions by blown down trees). In order to prepare reasonable estimates for PCP's, Chief Electrician Collens privately corresponded with the author (on leave to the U. S. Navy Radio and Sound Laboratory) to "pick his brains." The author was also consulted regarding problems the non-radio electricians were experiencing trying to maintain radios during this same period.(18)

A detailed analysis of the future radio and telephone needs for post-war was prepared by the author for Olympic National Park to assist them in preparing PCPs for post-war construction.(19)

The Service was not the only agency interested in preparing for the post-war period. In 1945 the Raytheon Company publicized their intent to "stake claims" for VHF repeater sites on many peaks in the Cascade and Sierra Nevada mountain ranges. The Service gave them a permit to test from Mount Whitney in Sequoia/Kings Canyon National Park. "Why not a repeater antenna instead of a station? Those poor easterners do not realize they can not get up to Mount Whitney for 9 months out of the year and for 8 or so to most of the other peaks either."(20) There is no record of such tests being actually made. Many microwave systems were subsequently built throughout the country using lower, but more accessible points which usually can be supplied with commercial power.

CHAPTER FOUR

A YOUNGSTER GROWS

1947-1960

CHAPTER FOUR

A YOUNGSTER GROWS

1947-1960

GENERAL

The two postwar decades gave birth to a period of trials, growth, and opportunity for the National Park Service. The neglect, due to shortages of personnel and funds during the war, had left many facilities in a precarious position for handling the increased visitation which began attending the National Park areas. This was apparent in roads, trails, campsites, museums, administration facilities, employee residences, maintenance and protection facilities, in addition to the communication facilities with which we are concerned.

The opportunities to correct the situation were fourfold: First, while Congress could not immediately increase appropriations, they did authorize the transfer of two million dollars worth of surplus military gear that was literally bursting the sides of warehouses, awaiting disposal by the War Assets Administration (WAA). Secondly, returning servicemen became a source of highly qualified personnel in such categories as military police (ranger potential), mechanics, electricians, telephone linemen, and radio technicians. Thirdly, because of the enforced neglect during WW II and the limited funds available after the war, the physical facilities could not withstand the "crunch" brought about by increased visitation after the war. The Congress, appalled by the inadequacy of run-down prewar facilities to handle record-breaking visitation, was sufficiently impressed to pass special legislation authorizing Mission 66 expansion and improvement of visitor services and facilities. This was a program of rehabilitation and redevelopment with the goal of meeting these increased needs by 1966 (hence the name Mission 66) Fourthly, the post-war circumstances stressed the need for re-evaluation and updating of management procedures and development of plans to meet post-war situations.

From the communications standpoint, this not only meant that radio and telephone facilities needed to be improved and/or replaced, but they had to be expanded as new sites and management plans developed, and as new park areas were brought into being. It also led to an examination of the possibility of obtaining communications from commercial suppliers rather than through use of government-owned facilities. These matters will be explored more fully in following pages.

The vast supply of surplus equipment available through the WAA was to become a source of fire trucks, Sno-Gos, hand tools, generators, office equipment in addition to all sorts of communications material. A task force was dispatched in January, 1947 to visit military depots throughout the west to identify and reserve specific items for NPS use. Under the leadership of Chief Engineer Paul Miller; A. C. Thuring (Park Engineer, Glacier National Park) specialized in road and fire equipment; Joe Jenkins (Chief Electrician, Yosemite

National Park), Lloyd Seasholtz (Chief Electrician, Yellowstone National Park), and Ralph McFadden (Radio-Mechanic, Olympic National Park) concentrated on electrical generators and telephone and radio needs. Depots in Nevada, Utah, and California yielded large quantities of various types of equipment.

The equipment obtained from WAA resulted in it being possible to establish communications to previously-isolated parks and/or locations. It also enabled improved radio and/or telephone or increased telephone service where it was badly needed, as will be described later. However, the equipment, being designed solely for military uses, required modifications and improvisations to adapt them to NPS use. Nevertheless, the surplus gear filled the gaps until state-of-the-art systems could be installed in the late fifties and ensuing years.

Radio systems were being modified, replaced or removed. Studies were made to determine the need for, and relationship between telephone and radio facilities in a number of parks.

In spite of the availability of surplus equipment and funding for the Mission 66 program, the needs were so great that there were only limited funds available for some operations of the National Park system, necessitating make-do and scrimping. At Olympic National Park I can recall the elation at being provided with a hand-me-down Dodge panel truck which eliminated the daily necessity of loading and unloading tools and test equipment from pickups borrowed from persons who were not going to be in the field on that particular day.

After several years of brake failures and other problems in my ancient Dodge panel truck, I was finally told to specify the appurtenances that I needed in a new vehicle. In its infinite wisdom GSA arranged for delivery from the low bidder in the east. When it finally arrived and after the freight bill had been paid, I learned that the local dealer would have supplied the same vehicle at a lower overall cost. To add to the insult, the new vehicle was supplied without a passenger seat alongside the driver and, after having driven it a few hundred miles, we learned it was delivered without grease in the transmission!

TELEPHONE

While the following discussion concerns mostly intra-park telephone facilities developments, it should be recognized that they were connected to the nation-wide telephone system on a "connecting company" basis. For the larger parks this entailed all the features of an independent telephone company requiring a point of interconnection for park facilities to telephone company facilities (either Bell System or an independent company) and a "separations agreement" for the prorating of toll-call charges between NPS and the telephone company. Also involved would be a switchboard operated by NPS employees, providing public pay stations, and sometimes a teletype. This meant that an employee had to be bonded in order to collect the coins in the pay stations. The Bell System engineers were usually generous in providing technical advice where needed to assure compatible operation between the two systems.

As always, NPS was under financial constraints in its effort to fulfill its mission. Efforts to economize frequently included restrictions in the use of long-distance telephone. Therefore in 1954 urgent written communication between areas and offices was accomplished via the Public Buildings Service (PBS) Teletypewriter Centers in place of long-distance telephone calls, wherever possible. The teletype was given to the nearest PBS operator via telephone. The addressee of the teletyped message was the PBS center nearest the destination. The text of the teletype included the destination address so that the distant PBS operator would know how to forward the message. Messages destined for Alaska were placed on the Army's teletype system by the Seattle PBS operator. Use of long-distance telephone was limited to only the most urgent business.(1) The PBS teletype system was later replaced by the Federal Telephone System, (FTS), operated by the General Services Administration (GSA).

Military telephone equipment available through WAA which proved most useful in the early post-war period included PBX switchboards and carrier equipment. The type-C carrier equipment was particularly useful in providing two or three additional circuits superimposed ("piggy-back" according to Tom Vint, Chief of Design) upon existing metallic circuits serving heavily-used routes. Glacier, Yellowstone, and Yosemite National Parks are known to have increased their circuit capacity by this means. The NPS telephone systems remained in use until contracts were established with commercial telephone companies which began serving within certain parks. *

With the cessation of WW II, some military facilities on, or near, park lands were no longer needed and were made available to NPS. Those known to the writer included a telephone cable used by the Coast Artillery on the Olympic peninsula. It ran between a site near Port Angeles, Wash. and a point on the coast in the vicinity of Neah Bay. It was not feasible to use this cable because of the expense involved in extending NPS lines to make connection with it. The Army also abandoned some telephone cables in the vicinity of Red Hill on the island of Maui. They were used by Haleakala National Park; however, the condition of the cable was so poor that only one pair of the multipair cable could ever be utilized.

In spite of the benefits derived from the installation of surplus equipment, there were instances during the 1950-54 period when telephone needs had grown so extensively that additions and/or new systems were necessary. A few examples will illustrate the problem:

1. Increased telephone traffic between various users at Giant Forest and Ash Mountain (Sequoia-Kings Canyon National Park) was overloading the circuits (5 or 6, I recall) between the two locations. A Project Construction Proposal (PCP) had been prepared, proposing the construction of more circuits between the two areas.

* Details of negotiations with commercial suppliers are given in a following section.

However, an analysis by WODC showed that most of the calls were between users (on different lines) within the Giant Forest area. This type of call tied up two of the lines to Ash Mountain which had to be connected by the operator there. A better solution would have been to install automatic switching equipment at Giant Forest, using the lines to Ash Mountain only for reaching points outside of Giant Forest. However, as recorded elsewhere, as a result of subsequent negotiations with Pacific Telephone and Telegraph Company (PT & T), it was not necessary for NPS to make the PABX installation.

2. Death Valley was operating with headquarters at Cow creek in the valley during the winter. The headquarters was moved to Wildrose in the mountains each summer because of the extreme heat in the valley. Operation of the headquarters there was difficult because there were no telephone facilities available. When communication was required, it was either by messenger or by AM radio to a person who remained at Cow Creek. This person then relayed messages to points outside of the Monument.

   In order to alleviate this situation, a two-channel FM radio- telephone system was installed in 1952 with the intention of connecting Wildrose with telephone lines at Cow Creek. It used 162-174 mc between Wildrose and a repeater at Augerrebery Point, and 408-420 mc between Augerrebery Point and Cow Creek headquarters. It was plagued with problems. Consequently when the technicians would go to the sites to repair the radio facilities they would often find that the overheating-detection devices had shut down the generators. Excessive heat, measured in excess of 160°F, in the steel equipment/generator buildings at Wildrose and at Augerrebery Point (a repeater site) affected the radio equipment and frequently caused the low-oil-pressure-shutoffs to stop the generators. Because it was necessary for the generators at Wildrose and Augerrebery Point to operate continuously, no electric starters had been provided. The one-cylinder, 720 RPM Witte units had massive flywheels, creating lots of inertia. It was virtually impossible for all but larger persons to spin the flywheel fast enough to carry the stroke through compression cycle for starting. After many such experiences, Ranger Matt Ryan developed a unique method of restarting the engines. One person would spin the flywheel as fast as he could (without compression). A second person would squirt aviation gas in the injector and quickly close the injector. The flywheel inertia, together with the more-readily-ignitable aviation gas, would enable the engine to start before compression slowed the flywheel. Probably this procedure did not help the cylinder-wall lubrication, but it did get the engines going again! The 400 MC radio equipment used for the Cow Creek-Augerrebery Point portion of the circuit was of recent design and was so unstable that the two telephone circuits were unusable. Subsequent changes in management plans abandoned Wildrose as a summer headquarters so the system was no longer needed.

In installing two 48′ towers at Augerrebery Point, they were located with the thought that a visitor would prefer looking under the guy wires at the scenic valley rather than having the towers themselves block the view. The view in the opposite direction including the Sierra Nevada mountains and Mt. Whitney was unobstructed. Years later the regional landscape architect proposed to move the towers so the guy wires wouldn't have to be considered in viewing the valley, but the view of the mountains would be obstructed. In such circumstances, it is impossible to please everyone.

3. In the early 50's a tornado in the Sunshine Point (Mount Rainier National Park) area smashed, twisted, and downed several acres of dense growth of Douglas Fir trees, many of them near 200′ in height, making an impenetrable mass of broken trunks and branches. Unfortunately this was astride the route of all the incoming telephone and power lines serving the park headquarters. Thus Tom Vint's (Chief of Planning, WASO) so-called "Paul Bunyon's banjo" became a mass of tangled wire and broken trees. Tom had bestowed the banjo name to this particular section of line because of the resemblance of the ten wires, vertically spaced about 16" apart on large supporting trees, to the strings of a banjo.

   Within a year of the tornado the Kautz Creek flood destroyed another mile-long section of the same telephone and power lines when it uprooted huge trees and deposited silt, rocks and debris for a depth of over 20 ft and a width of 1/2 mile at the confluence of Kautz Creek and the Nisqually River.

   A three-channel, plus teletype, radiotelephone system was then installed to replace the "banjo line".(2) The equipment was plagued with problems as a result of the manufacturer's inexperience with broadband equipment. The transmission path appeared to be such that it which would provide strong, reliable signals. In addition, when the equipment was installed it was also found that there were a myriad of reflective paths nearly as effective as the slightly obstructed short-line path. These paths were influenced by convection air-currents over the bed of the Nisqually River, changes in foliage on the trees, wind-currents through the trees and occasionally vehicular traffic. The multiplicity of paths and their combining with direct signal path resulted in continuous fluctuation of signal strengths from very strong to undiscernible. The equipment and propagation problems rendered the long-distance radiotelephone circuits unreliable. Because of this it was necessary to install an additional radio link between Nisqually entrance and Longmire for emergency use when the radiotelephone circuits were inoperative.(3) This situation continued until PT&T took over the Mount Rainier telephone system, using buried or ground-laid cables throughout the park, as described in a following section.

   While installing the radiotelephone system, the WASO technical staff spent a frustrating evening until 1 a.m. when the broadband receivers picked up spurious noises that rendered the radiotelephone circuits useless. All sorts of possibilities were thought of, including CW transmissions from distant stations, deliberate jamming

from unknown source, etc. After hours of probing and testing for the source of the noise, the interference suddenly stopped. The technician at the other end of the circuit was asked if the interference stopped there too. "You know what? I had to shut the cooling fan down for a moment, and the signal cleared up." It was a pair of very tired engineers who had learned that the transmitter crystals were microphonic, picking up the fan vibrations! The manufacturer was embarrassed, but agreed to supply a different type of crystal that did not have the microphonic characteristic.

4. Efforts to improve communications were not always welcome by local personnel who were used to doing things their own way. At Glacier National Park a two-channel radiotelephone system was to be installed between West Glacier headquarters and a new PABX switchboard to be installed at St. Mary, using a base station at Apgar Lookout to overcome the intervening mountains. Underground power and telephone cables were laid from the nearest overhead lines to the lookout to enable connection of the headquarters switchboard with the Apgar radiotelephone terminal. The power cable was a new (at that time) type of solid-dielectric cable with semi-conducting tape over the inner conductor and under the shield tape. The park's chief electrician insisted that "It won't work", "you have got to have two wires to get power up there" (even though the park electricians had had no trouble understanding ground-return telephone circuits). After the power cable was installed it did not work; that is, not until the writer remade each splice, taking care that stray strands of the semi-conducting tape did not create a short. I never learned whether the chief electrician made good on his bets with friends that the cable would not work. The telephone cable also didn't work until the connections were corrected at the junction points where someone had split the pairs when making inter-connections. Could this have been through carelessness or otherwise?

   Problems were also experienced with the 250-watt transmitters at the Apgar lookout and St. Mary's. They were standard units for intermittent push-to-talk two-way systems that had been adapted for the continuous-carrier operation needed for the two-channel telephone. When they were installed and tuned up they appeared to work fine but by the next morning they would be off-the-air. For more than two weeks this writer spent alternate days hiking to Apgar, and the in-between days driving to St. Mary, endeavoring to get the total system working. Eventually the manufacturer devised a special tuneup procedure that prevented this from happening.

   Fall came, before the PABX could be checked out, and the system was shut down for the winter. In the meantime, negotiations with Mountain States Telephone and Telegraph Company, by the Washington office, were consummated. The Company took over the facilities and used or replaced them as required to establish their service.

As noted in another section, there were several NPS–planned telephone installations that were not completed because of the replacement of NPS facilities with commercial telephone facilities. This was fortunate timing and avoided substantial investment in telephone lines and equipment. As recorded elsewhere, the timing occurred as the result of a shift in administration policy, which had stressed the desirability of using commercial services wherever feasible.

During this period, the Washington office insisted that radio installations at locations that also had telephone service must be justified. This resulted in two Recaps of Radio Communication Facilities for all Regions.(4) Some of the areas were of the opinion that nearby telephone lines would eventually be extended so that radio would no longer be necessary. Other areas needed to continue the use of AM radio for communication with other areas within a single cluster. A few areas reported that their telephone service was either unreliable or transmission was very poor. In such cases the area was usually served by an independent rural telephone company, whose switchboard and operator sometimes was located in the living room of the owner. There were some areas that decided to drop use of radio in favor of telephone; although in later years two-way systems were installed to facilitate management and protection required by increased visitation.

The problems with telephone service from some small independent telephone companies are illustrated by these excerpts from a report on Lava Beds communications.(5) "The California-Oregon Telephone Company has been reluctant to enter into a service contract [to take over] for communications in this area. Unofficially, the company manager contends that assuming our deteriorated metallic circuits would increase their maintenance problem out of proportion with the revenue received. The Monument shares telephone service with seven other parties [on a single circuit]. Construction costs for a private line are prohibitive. As an alternative solution to the continued circuit disruptions from farming operations outside the park breaking the line, we suggest a radio-telephone circuit. This would reduce the party-line troubles and line breakage. I do not believe the California-Oregon Telephone Company could provide the [radio-telephone] equipment described."

Changes in policies relative to location of administrative offices (whether in or near the park area, or in nearby cities) have been covered in other sections. In instances such as Crater Lake it was necessary in the 1957/58 period to use radio for communication between the park and administrative headquarters in Medford, Oregon. At that time commercial telephone circuits were so poor as to be unreliable, and sometimes unusable even when they were not out of order.

Illustrative of the absence of telephone communication at remote points is a request from Carlsbad Caverns in regards to radio communication with the Rattlesnake Springs Pumping Station for maintenance purposes.(6) "We have been unable to establish telephone communication between the two points." This request was in addition to an "automatic [radio] transmitter which operates the Rattlesnake Springs Pumping Station equipment by remote control".

In the telephone systems which were owned and operated by many of the parks, emergency telephones were placed at strategic points so that park visitors could report emergencies and/or make requests for assistance. This was possible by the relatively simple expedient of installing a magneto-ringdown telephone in a weather proof cabinet, and extending a tap to the nearest line. Annual maintenance costs for such an installation were usually negligible.(7) When a telephone company took over the telephone system in a park, this arrangement became very costly. Their tariffs included a monthly charge for the telephone, plus an additional charge for the distance to the nearest base-rate-area boundary. Consequently each park area examined carefully the justification for wayside telephones. Negotiations for such wayside telephones also had to provide some way of preventing park visitors from making long-distance calls at the Park Service's expense. This was sometimes accomplished by substituting installation of pay-telephones, with the Service guaranteeing the monthly revenue in cases where public use did not cover the revenue required to justify the installation. This, in turn, raised the issue "what about the visitor in trouble that does not have a dime?" Because of this possibility when emergency calls needed to be made, it was necessary to insist that pay telephones be either post-pay, or be provided with a means to reach an operator without use of coins.

Frequently, government regulations which are well-intended become impossible when put into practice in certain situations. NPS had an example of this when it was operating its own telephone systems in various park areas. Many employees lived within the park area and were on 24-hour availability for emergency calls. Because of this it was necessary to install government-owned telephones in their homes. Since there were no commercial telephones within the area, the employees had to use the government telephones for their personal use, mostly for calls within the park but sometimes for long distance calls - all with the understanding that their personal use would cease in the event the line was needed because of an emergency. In the same manner, it was sometimes necessary to permit visitors to place emergency collect calls from government telephones. These circumstances resulted in a situation where insignificant tax payments were being submitted to the IRS for the few personal calls made from government telephones.(8) So the parks were notified of that which they already knew, that use of government telephones for private long-distance calls should be kept to a minimum.(9)

When commercial telephone service became available in most park areas, the problem of employees making personal calls from a government-assigned telephone in an employee residence, was solved by issuing the employees credit cards for which a fictitious personal telephone number was issued. It took some persuading of the Telephone Companies to get them to do this. In those cases where the visiting public had need of a telephone they are either referred to a public coin telephone or required to use a credit card, or call collect. Because the telephone company facilities have built-in expansion capability they were able to provide more public coin stations than the Service was able to provide with its limited plant capacity.(10)

As a result of installation of dial telephones (in place of the government-owned magneto ring-down telephones) by the commercial telephone companies, the Washington and regional offices encouraged those parks that were converted, to eliminate their telephone operator positions. Since each telephone had its own number and directory listing, it was easy to dial from any office to any other, and for businesses in nearby towns to dial the office they had occasion to reach. But a problem arose when persons not familiar with the park organization (especially those using long-distance, because they had no access to the directory) tried to make connection with a specific department or office. It became necessary to identify one telephone (usually the Superintendent's secretary) as Information in the directory. By having this line also appear as an alternate line on department-head telephones, the secretary could switch incoming calls to the proper department.

Telephone companies, by virtue of their monopoly in any given area, were consistently rigid in their policies concerning the types of service they would render, and were equally rigid in their refusal to permit connection of "foreign attachments" to their lines. Once they had installed a dial system in any park area, NPS switchboard operators were no longer necessary as we have mentioned elsewhere. Since there was no one employee on duty at night who could answer emergency calls from the public and/or concessioner, it was necessary to establish a hierarchy of home residence numbers to be called for assistance at night, in addition to the usual numbers for daytime emergencies. These numbers included ranger stations or offices that were attended during the day and several residences in which protection personnel lived. Each public telephone had to be equipped with a listing of the emergency numbers. The problem with this arrangement was that if it were to be effective, it would be necessary for at least one ranger to be at home during off-duty hours. Salary problems were involved. Was it necessary to pay overtime to guarantee that the emergency-listed telephones would be answered? In addition, the park communities being closely-knit socially, there were community occasions where no one wanted to remain at home. The ideal solution would have been to install a "call director" which could be programmed at the close of business each day to switch emergency calls to a telephone which has been designated for that night. However, the companies steadfastly refused to provide such equipment, even though it was already available from suppliers.) Repeated requests to furnish or allow the park to install such a call-forwarding device were denied by the telephone companies. Eventually the Service's requests, along with similar requests by other non-park users, were responded to by the FCC's Carterphone decision in 1968. "Under that decision, customer-premises equipment not made by the Bell System was permitted for the first time, provided that the connection to the 'foreign' equipment made with a 'protective connecting arrangement' designed by the Bell Laboratories to prevent the equipment from disrupting the network."(11).

During the years of government-owned telephone systems, most of them used protective devices similar to those used by the railroads on their lines. This included "grasshopper" fuses at switchboards and vacuum-tube lightning arrestors (with or without 7-ampere tubular fuses) at each telephone installation. This system of protection from lightning and power damage had been developed to maximize continuity of use without damage to the

telephones. It had been very effective. However, this method did not conform with Bell System practices. Because of this, when PT&T took over the Yosemite system, they removed the former protection devices and installed those meeting Bell System practices. But they were designed and intended for urban use. As a result, during the first year of PT&T operation in the park, several repairmen were on duty day and night cleaning carbon blocks and making other repairs caused by lightning. The reason? The function of carbon blocks, long forgotten by most telephone personnel, was intended to ground the telephone lines whenever they had been subjected to excessive lightning pulses. The grounding was considered necessary to cause the serviceman to check the telephone for damage at the same time that he cleaned the carbon blocks. Such a procedure is impractical in high-lightning areas and is unnecessary since if vacuum-tube arrestors are used they would provide adequate protection to modern telephone instruments.

Sometimes efforts to economize can, in the long run, be expensive. For instance, in all negotiations the telephone companies agreed that there would be no extension construction charge to provide telephone service at any location that was already being served by the government system. However, some parks, in trying to minimize monthly costs did not order telephones for every location (for example, a fire lookout for which radio was planned). Thus, when it was subsequently determined that a telephone was also needed at such a location, a healthy construction charge had to be paid to reinstate service.(12)

NPS Telephone Systems

Yellowstone National Park: Increased visitation and proposed Mission 66 developments prompted the initiation of a Project Construction Proposal (PCP U-55-3) in 1955. The proposal outlined modification and additions to the existing government-owned-and-operated telephone system to serve facilities in the "old" and "new" Canyon developed areas. A total of 45 additional telephones and four to six public pay-stations was envisioned by the park. They proposed that these be served by the installation of an additional copper circuit with a 6-channel J-carrier system from the Mammoth Switchboard. These circuits would be in addition to existing circuits from Canyon to Mammoth and existing C-carrier (3 channel) and metallic circuits from Mammoth to Lake and the South Entrance.(13) WODC recognized the inappropriateness of so many "trunks" to Mammoth, since most telephone calls between telephones on different lines within the Canyon area would tie up two trunks to Mammoth. WODC envisioned the possibility of one new metallic circuit with a 3-channel carrier to Mammoth, and the installation of an automatic dial PBX in the Canyon area. This would obviate the necessity for Mammoth operators to be involved with calls between telephones located within the Canyon area. (14) It would have cost less, converted the existing multi-party lines to one, two, or three party lines within the area and converted the lines to Mammoth into true trunk-type operation.

However, the proposed new facilities were never installed. This was a result of the new policy to utilize commercial services wherever possible (described in a subchapter on negotiations). Contract No. 14-10-243-261 was negotiated for the sale of the Yellowstone

government and concessioner-owned systems to Mountain States Telephone and Telegraph Company (MST&T). Contract No. 14-10-243-262 authorized the company to serve all government and concessioner facilities in the park. The appraisal for the sale of the facilities was completed on September 7, 1957 by an advisory appraisal board made up of government and telephone company employees. A contract had also been negotiated with Montana Power Company to build and operate power lines to serve the principle developed areas in the park.

MST&T established base-rate-areas (BRAs) and installed exchanges at Mammoth/Gardner, Old Faithful and Lake, which meant that toll charges would be applicable to calls between these exchanges and/or calls to the "outside". During the period of government-ownership of telephone lines, the Yellowstone Park Co. also owned telephone lines which were used for intercommunication between its facilities at Mammoth, Old Faithful, Lake, and Canyon. These were sold to Mountain States Telephone and Telegraph Company at the same time as the government facilities were sold. The facilities of both systems had been used for both official and public long-distance service outside the park. The government and concessioner had also been using their facilities extensively for intra-park communication to various points in the park.

There was a need for frequent calls by both NPS and concessioner between various points in the park. Therefore, in order to minimize toll charges and delays, "tel-pak" circuits were leased between the exchanges that were established. Authorized government and concessioner telephones were equipped with devices to enable use of the tel-pak lines. Costs for the tel-pak lines were prorated between government and concessioner, based on use. There was also a $.50 monthly charge for each telephone equipped to use tel-pak. The telephones which were using Telpak were wired so they could dial 7,8, or 9 to get into the desired exchange, obviating the need to compete with other users for connection, and the need for separate billing for each call between exchanges.

The takeover of government-owned lines in Yellowstone and other parks by the commercial telephone companies is interestingly described by Historian Haines' description of the takeover of the Yellowstone National Park telephone system by Mountain States Telephone and Telegraph Company,(15) when he says, "these antique installations, so typical of an earlier time, were replaced by a single modern system. Overhead wires gave way to buried cables, the switchboard (and the operator's cheery 'Number', please!) to a room full of clicking relays, and the hand-cranked phones to business-like dial models. The new system was more efficient, as all will agree who have strained their ears to make out a message between static crashes induced by summer lightning, but there was a cost beyond the fee charged for the service. Gone were those helpful operators whose switchboard was the Park's message center and whose voices doubled as the town crier for the headquarters settlement; also a switching relay does not crack a joke or show any interest in a sick youngster!"

The Yellowstone telephone system is probably the largest in any of our national park areas. While the other areas did not have as many facets to deal with, the negotiations for commercial service in Yellowstone and in other areas involved additional factors which are described in the section of this chapter devoted to Negotiations.

The contracts with the telephone and power company called for their joint use of rights-of-way. A conflict arose because the telephone company's practices would not permit them to place their lines on the 50-KV transmission lines built by Montana Power. The telephone company sought a payment of $331,000.00 ($310,000.00 in some correspondence) to cover the extra cost of placing their lines underground along the 50-KV power line rights-of-way. This was the subject of a high-level meeting in Washington, D.C., on October 4, 1957, with the apparent result that the telephone company would be reimbursed as requested.(16)

During the close of the period covered by this chronicle, long- distance service requirements had increased so much that a microwave system was installed to access the Mammoth/Gardner exchange from Livingston. A proposal also had been made, but not resolved, by MST&T to install microwave links to serve the Roosevelt Lodge and Tower Junction sections of the park.

Mammoth Cave National Park: Details of the Mammoth Cave telephone system available to this author are minimal. I have been told that prior to 1956, the park had a separate magneto ring-down system in the cave, with connections to telephone(s) in the headquarters building. This was separate from the "surface" telephone facilities (details and ownership missing), but it could be connected to the cave system by means of a switch if it were necessary to do so.(17)

Rocky Mountain National Park: Until the government owned telephone lines were sold to MST&T in 1956, the NPS operated an open-wire line from Estes Park headquarters to the ski area at Hidden Valley. In the Estes Park area, contact space was rented on MST&T poles. MST&T operated the government-owned lines after taking over the NPS facilities, but replaced them with an underground cable in 1964.

Wind Cave National Park: A 1953 memo from Chief of Design and Construction Ok'd the consummation of a telephone contract for Wind Cave with the Peoples Telephone and Telegraph Co. at Hot Springs, S.D., subject to making "provision to review the location of all pole lines, etc. by landscape representatives from your office."(18) "Your office" was the Regional Director, Region Two in Omaha, Neb. Dial telephones were installed in 1956, including several located in the cave.

Organ Pipe Cactus National Monument: Ever since its creation, Organ Pipe Cactus had been without telephone service. It's access to the outside was either (a) the 5150 kc Southwest Monument's radio net (described elsewhere) control station at Globe, Arizona;, or (b) a 30-42 mc FM link into Ajo, Arizona using a station on the Sheriff's frequency.

In early 1964 "Mountain States Telephone Company [MST&T] completed the installation of telephone and microwave equipment prior to receipt of authority from FCC to operate the system. Although a delay of several days use occurred, circuits were opened officially on Feb. 7."(19) The microwave terminal was installed near park headquarters. It served telephones in the headquarters area and the civilian community of Lukeville on the Arizona/Mexico border via an underground cable extension.

Alaskan Areas: Arrangements with the Alaska Communication System (ACS) permitted Sitka, Glacier Bay, and Mount McKinley to call "stateside" without charge for the Alaska-Seattle segment. "We have been informed that . . . 'collect' calls [from Sitka] to this office will be billed for the entire distance, whereas if we [Mt. Rainier] call Alaska 'collect'. . . we would pay commercial costs from here [Longmire] to Seattle only."(20)

Commercial Telephone Comes to the Parks

During and following installation of commercial facilities in a park area there was often a persuasion that the company could do no wrong. This assumption was based upon the conception that all companies were regulated in every aspect of their operations (discussed further elsewhere). This was evident in several ways:

(a) Equipment selection by park personnel sometimes included a "Cadillac" when a "Ford" would do the job (erroneously assuming that since the rates for equipment are regulated, this can't happen); (b) line crews were allowed to open access lanes that NPS crews would have been prohibited from doing; (c) allowing pay telephones to be installed in inappropriate places and/or with inappropriate style and color. In actuality, the contracts gave the Service full authority to control all aspects of the facilities. This was provided for in the requirement that drawings were to be submitted and approved prior to any construction. The understanding was that thecompanies would not be permitted to do anything that the Service would not do, if it were operating its own telephone system.

(b) Misuse (or non-use) of the Service's authority to regulate the construction within park areas occurred when commercial telephone service began in Carlsbad Caverns National Park. The company, looking for an opportunity to capitalize on the uniqueness of the Cavern lunch room, installed a bright red telephone booth in the most prominent position. Naturally, the novelty attracted visitors who lined up to call their friends from the cave. Lines of visitors were formed to ask "Mom, guess where I'm calling from?" But this was not commensurate with the setting and a change was ordered.

(c) In another instance PT & T received permission to install overhead cables from the Yosemite exchange to various locations in the valley. It had been assumed that the cable would be the customary dull, dark grey in color. At locations where only six or twelve-pair cable was installed it turned out to be a new type in which each pair

had distinctive, bright-colored insulation, each pair of a different color (prior cables had color-coded pairs, but they were contained within a nondescript jacket) for identification. The "bird wire", as it came to be known, stood out visually against the background and was incompatible with the landscape goals of the park.

Details of procedures and problems in negotiating for telephone service are described in a later section of this chapter and in chapter five.

RADIO

A Revival Begins

World War II resulted in an unprecedented surge of progress in technological development. "There the demoniacal demands of WW II, blacking out all cost figures, forced a dozen premature births, such as radar, sonar, the proximity fuse, remote-controlled missiles. Thus the present status of radio and electronics owes immeasurable debt to the two holocausts that have blackened the fair pages of the history of our [Institute of Radio Engineers] first half century."(21)

Up until the end of the War (WW II) there was insufficient market for manufacturers to develop and offer portable equipment suitable for the needs of NPS, USFS, and state forestry agencies.* During this period, it had been customary for each agency to design and build a prototype of the unit it needed. This prototype would become the model for the low bidders to copy in order to make additional units. "While this was not intended to work to the disadvantage of larger eastern manufacturers, it did, in fact, tend to favor the smaller companies in the vicinity"(22) of Mount Rainier and/or the Regional Office in San Francisco (both were duty places for Waterhouse), and the U.S. Forest Service radio laboratory in Portland, Oregon. Among the companies that supplied equipment under this procurement system were - Northern Radio Company (Seattle), Spokane Radio Company (Spokane), Radio Specialty Manufacturing Company (Portland), Western Wireless (San Francisco), Electronic Specialty (Seattle-USFS supplier only), Technical Radio (Palo Alto-NPS supplier only), Wunderlich (San Francisco- NPS supplier only). "It still took private enterprise 20 years to catch up with the [Forest Service] laboratory"(23) and Park Service designs. Had the NPS and USFS waited for the radio industry to develop suitable portable and semi-portable equipment, who knows how many lives would have been lost, acres of timber burned, and other effects?

> * "Prior to World War II, the civilian use of two-way radio for communications was in the main restricted to safety uses like police, urban fire control, aviation, and certain quite limited uses of a special emergency character . . . The numbers of land mobile stations was small and the field had nothing like this significance from a market standpoint that it does now."(24)

The development of NPS radio facilities was addressed by William Briggle, (then) Superintendent of Mount Rainier, to a Departmental Radiocommunications Workshop at Phoenix in 1978. (25) Some of his statements are appropo as an introduction to this section:

> "In 1948 we [Sequoia National Park] were working with the old 'Silver Sets' [PTR-2 series] and only a few vehicles were equipped with radios. There was an inadequate communication center that was manned only during emergencies, the ability of our units to perform was based on who had time to repair them, the users getting enough energy [and patience] to turn on the set and tune in the signal, and if out in the field, climb the nearest tree to string an antenna. The equipment was cumbersome . . . our radio system, while not always working, was at least understandable and very little training was needed to operate it. Then there were the men who maintained these systems . . . they also maintained the park telephone lines, switchboards, and did the electrical work. For us non-technical types it was easy to communicate with these old boys . . . They could fix most anything with electricians tape and spit along with a kick in the right place. Since rangers [who] occupied the remote stations in the park were required, more out of survival than anything else, to be able to change tubes and troubleshoot our radios . . . In early 1950's the first of the new FM systems began to show in the parks. This was the dawn of a new era . . . and those connected with servicing old systems soon became obsolete . . . By the early 1960's most Service areas of any complexity had a fairly reliable communication network. Also, we had branched out and were operating systems that offered travelers information [TIS, described later] via their car radios . . . [Concerning system planning] the superintendent must reconcile with the rangers among others who routinely expect every inch of ground and water has to be reached with a loud and clear signal . . . Moreover, it seems everybody needs a radio on his hip, in his car and at home. Not only was this impractical but the dollars to . . .[Meet the expectations] would have shot the project down."

A departmental publication(26) summarized the function of NPS radio in 1952 as follows:

> "In addition to providing fire protection and control, much of it in rugged and inaccessible areas, the National Park Service is responsible for the safety of field personnel and the considerable number of travelers (nearly 37 million in 1951) that visit the National Parks each year. Intra–park radio communication and communication to portable and mobile units are an integral part of the National Parks system."

During the war, manufacturers had developed the "walkie-talkie" and the "handie-Talkie" and improved mobile units, some of which became available (with other machinery and equipment) to NPS through a $2,000,000 authorization (Already described) to procure such devices via the War Assets Administration. However, being designed solely for military uses, many modifications and improvisations were required to adapt them to NPS use. Nevertheless, the surplus gear filled the gaps until state-of-the-art systems could be installed

in the late fifties and ensuing years. It was this equipment which enabled the Service to install medium-frequency AM equipment at locations that hitherto had no communication. It also enabled the first 30-42 MC FM installations to be made in some parks.

Placing these surplus (though new, in their difficult-to-remove overseas packaging) radio units into operation taxed the ingenuity of many technicians. Many of the units were intended for aircraft use, some of which operated from 28-volts DC and some of which operated from 400-cycles AC. Mobile units were designed to feed into a jeep antenna, which required modification in order to feed a half-wave antenna when used as an AM base station. The latter is best suited for the distances encountered in NPS medium-frequency operation. Some of the transmitters were not crystal-controlled, but had a "coffee-grinder" variable-frequency control. The latter was unacceptable for NPS operation because the transmitter could not be set within authorized limits of the assigned frequency. In military service during WW II this had been no problem because key receiving points had either panoramic receivers or schedules which enabled tuning to hear stations that were not exactly on the assigned frequency.

In addition to ingenious improvisations to utilize surplus military equipment for base station and mobile use, some areas were intrigued with the SCR-536 (sometimes called BC-611), a hand-held portable, and tried to put them to use "as is". The parks did not realize that many such units were equipped with crystals for the 75-meter "ham Band". That band had been closed down for amateur use for the "duration" so it could be used by the military. "In regard to the unauthorized frequency 3885 [in the ham band] . . . two 'handie-talkies' [had been] transferred . . . for use on special emergencies where light-weight equipment is required."(27) The parks were embarrassed to learn that the sets could not legally be used.

Nevertheless the Service obtained much use from other military surplus radio equipment. Reports were received from the field areas as late as 1954 that showed many areas were still using military AM and FM equipment with benefits, even if the benefits were not as great as those that could be obtained if new VHF-FM equipment were available.(28)

Because some of the surplus units used obsolete or hard-to-get tubes, areas continuing to use them obtained replacement tubes from other areas that had been able to replace surplus units with new modern equipment.

Congestion problems in the HF band were getting worse, making it imperative to convert to VHF-FM systems as soon as possible. "Aeronautical operations on 2429 kc are being implemented . . . we believe it desirable to take action at his time to place your operations presently on 2926 kc on a replacement frequency . . . the aeronautical mobile service has proposed operations on 3418.5 6A3 emission, 1-KW power . . . with the following locations involved: Chicago, New York City, Cleveland, Washington DC, Denver, Omaha, Atlanta . . . We propose that NPS operations on 3415 KC be transferred . . ."(29) Areas affected by this aeronautical use were Grand Teton, Dinosaur, Scotts Bluff, Fort Laramie, Olympic, Great Smoky Mountains, Lake Mead, Coulee Dam, Crater Lake, Millerton Lake (formerly

an NPS area in California), Olympic, Oregon Caves and Sequoia.(30) Crater Lake found it necessary to continue use of 3415 kc beyond Jan. 1954 and did not see any possibility of conflict with airline operations because of daytime-only use, and the distance from the park to Omaha and Denver.(31)

Looking back, it seems ironic that the aeronautical services should push the other services to VHF frequencies, since by 1970 almost all domestic aeronautical services themselves had been converted to VHF frequencies.

During the 1950's the FCC and IRAC, in their struggle to develop assignments for various users, modified their allocation plan for high-frequency assignments by changing from 5 kc to 4 kc spacing, with some "inserts" on a 2 kc basis.(32) This was necessary for those users that were unable to convert to VHF immediately. When they did convert to VHF-FM it turned out to be a "blessing in disguise." No longer would signals fade during transmissions, or be lost in static crashes from thunderstorms, or be blocked out during ionospheric disturbances. However, this is not to say that there were no problems with VHF-FM; some of which are mentioned in following discussions.

Post-war assistance by the military to park areas in rescue and fire situations created difficulties when Air Force or Army units attempted to work into HF NPS nets. The "coffee-grinders" in military planes would be set on frequency before they were airborne, but the frequency would usually drift outside the pass-band of the NPS receivers, resulting in loss of communication. Also the military procedures were often a hindrance because of their insistence on "long counts" and tests which blocked out reports by NPS personnel who had been trained in efficient message handling. It was amusing, but disruptive to hear military units that have been talking successfully for an extended length of time to stop and ask: "Bravo, this is Jerry;, do you read? Give me a long count."

Among the military equipment which became available were several types of exotic (exotic to NPS needs) equipment. A mobile facsimile system seemed to offer possibilities for a calling station to leave messages at ranger stations while the ranger was in the field, to be noted when he returned to the station. The messages would have been written (and reproduced at the distant station) on paper tape, about 1-1/4" wide (a primitive FAX system). The equipment was cumbersome and the requirement for DC power at AC-operated base stations precluded adaption of this form of facsimile.

Development of improved VHF equipment and antennas in the early post-war period soon dispelled the myth that VHF transmissions were possible only on line-of-sight paths. Until receivers were developed that had greater sensitivity to weak signals, it had seemed that signals beyond the line-of-sight were non-existent. However, with modern VHF equipment it became possible to take advantage of diffracted and/or reflected energy to extend radio paths into shadow areas. Since it was impossible to determine the net effect of the latter, the paths had to be tested (often called "surveyed")and proven before they could be depended upon. Because VHF above 100 mc is usually independent of the variations

attendant with the fluctuations of the Kennelly-Heaviside layer, long-term evaluation of the signals was not usually required. Several accounts involving field surveys are give in the following pages.

Technical development during the war had established that two-way FM equipment in the 30-200 mc range was feasible and reasonably reliable (but not nearly as reliable compared to modern solid-state equipment) and that, with the use of automatic repeaters, coverage of park areas might be possible. Furthermore, these higher frequencies were (1) less in demand than the high frequencies we had been using for AM radio, hence less subject to interference; (2) consistent (usually) in their propagation characteristics, giving better day-to-day communication; (3) it is not dependent upon the Kennelly-Heaviside layer which caused severe variations in day-to-night effects on the high frequencies. Therefore, whenever practicable, all new postwar facilities were to be FM types, operating in either the 30-42 or 162-174 mc VHF bands. Preference was being given to the use of the 162-174 mc band because it was not subject to long-range "skip" transmission. Also, since propagation does not require reflections from the Kennelly-Heaviside layer, the same frequency could be assigned to 4 or 5 operations within the U.S.A. This feature made it possible for IRAC to grant authorizations which were heretofore not possible. The first of the new systems were being planned in 1950-51 for Isle Royale, Glacier, Shenandoah, and Acadia.

Installation of surplus and/or early commercial VHF-FM units in patrol and maintenance vehicles was not easy. Nearly all transceivers consisted of separate transmitters and receivers, each measuring about 10" x 10" x 16". In the case of passenger cars, they were installed in the trunk, where luggage, fire tools, and work tools competed for space, often damaging the cable connectors to the units. The unit was remotely controlled from a control unit installed in the cab. Receiver drain was in the neighborhood of 10 amperes, which could not be handled (in addition to lights and heater) in some vehicles without a heavy-duty generator. Transmitter drain was usually in excess of 50 amperes, requiring the driver to accelerate the engine during transmissions if maximum range was expected. This current drain required the use of very large battery cables to assure that full battery voltage would be supplied to the dynamotor in the transmitter.

Some areas were already in the process of obtaining or installing FM systems, before the change from AM became necessary. Other less fortunate areas, operating on the proverbial "shoestring" hoped they could continue to use their HF-AM equipment if they vacated 2926 kc as requested by "obtain[ing] eight or nine crystals of that frequency [2558 kc] by transfer from other sources within the service, so as to reduce the cost of converting."(33) Such improvising and "horse trading" is typical of the effort taken by dedicated technicians to enable the Service to have the benefits of two-way radio communications. IRAC made allowances for delays in constructing FM systems by allowing Olympic to continue use of 3415 kc until November 1955.(34)

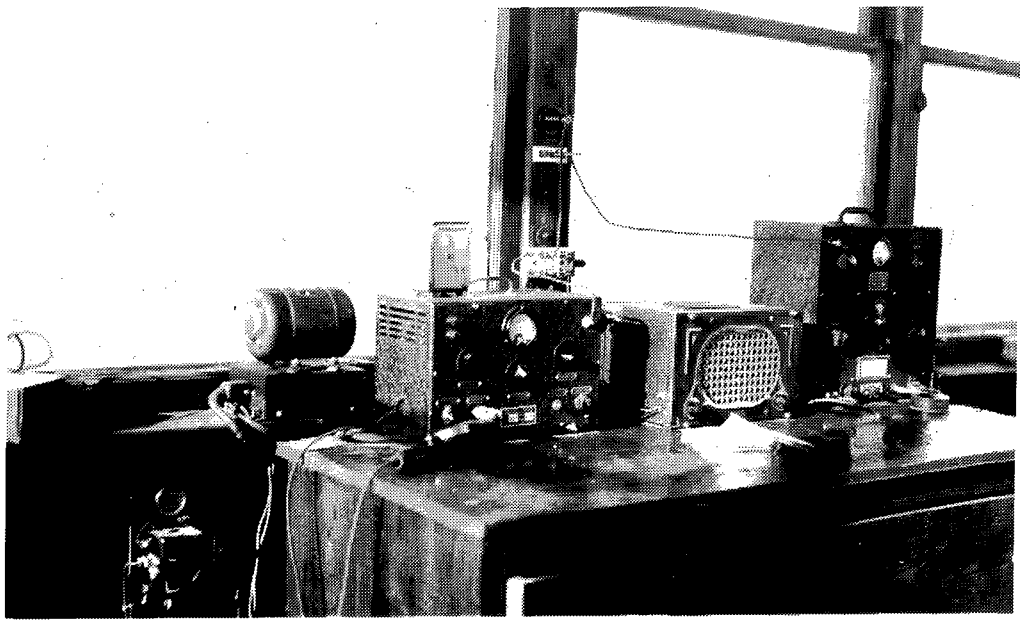

Figure 9

Frye Mountain Lookout Tower Radio Installation.
Vic. Great Smoky Mountains National Park.
Circa 1946.

Power - six volt wind generator and storage batteries. Surplus military equipment modified for lookout installation.

But conversion from HF to VHF was not a complete panacea for interference. The 30-42 mc band was capable of long-range propagation (even with low power) during portions of winter days during the 1957-58 sun-spot-cycle maximum. It became necessary to instruct field areas how to identify interfering stations so that they could be reported and traced, and in using good operating procedures to minimize the possibility of interfering with other stations.(35) Several instances of long-range "skip" interference are included in this and following sections.

In order to increase mobile VHF range where repeater coverage was inadequate, 30-42 MC mobile antennas consisted of a 1/4 wave whip, mounted in the center of the vehicle roof-top so as to get the best ground-plane effect. Being 6 to 8′ long, the whip often hit overpasses,

fluorescent lamps in service stations, tree branches, etc. making a horrendous crashing noise within the vehicle when the whip hit these objects. An alternate, but less efficient, location for the antenna was the rear fender or bumper. The rear-mounted antenna became known as a "cop stopper" because at that time only police vehicles used that type of antenna. However it was not as effective over long distances as the roof-top-mounted antenna.

For the 162-174 mc band, the best location for the 16" (more or less) antenna was in the center of the roof. However GSA did not permit drilling the necessary holes in vehicles from its motor pool. Various trunk mounts were used in that case, but the results were inferior and very directional. Larger park areas found it necessary to use base-loaded 30" high-gain (6 db) antennas to increase mobile coverage.

Early FM systems sometimes used military surplus equipment, adapted for use with many "jury-rigged" modifications. In heavily timbered parks like Mount Rainier (and Olympic) it was often necessary to raise the antenna as much as 60-100′ to get it into or over the tree-tops for stronger signals. Personal recollections bring to mind the instance where Chris Christensen was topping a 150′ tree at White River (Mt. Rainier) to install an antenna. While he was an expert lineman, it was his first experience of this kind. When he cut the top (about 40′ long) and it broke loose from the tree, the reaction of the tree was to sway about 20′ for three or four swings. Chris was unprepared for this and was suddenly seasick but he could do nothing but ride it out. When he reached the ground he was a bit "green about the gills."

The situation at Olympic required the installation of an 80′ pole which the park could not afford to purchase. After obtaining permission from Regional Forester, and accompanied by a well-known ranger (who shall remain nameless) I went to the west end of Lake Crescent, where excellent cedar abounds. When asked to select the cedar to be cut, the ranger said there were not any there, until the writer identified some for him. It was never determined whether (having recently come from a southern California park) he actually did not know the species, or whether he was attempting to discourage us from cutting one of the large trees.

The installation of low-band (30-42 MC) FM equipment soon after the war occurred at the same time that the solar cycle was near its peak. This meant that low-power transmissions from other stations on the same frequency could be received at distances of 2000-2500 miles in the daytime by means of reflection from the F2 layer in the ionosphere. Because of the use of the same frequency at Mount Rainier in Washington state, and by TVA in the Southeast U.S., the following experience occurred: One Sunday afternoon a snow avalanche buried a skier at Narada Falls in Mount Rainier National Park. Rangers saw the tracks entering the slide area, but there were no tracks leaving. Immediately a party was organized to probe for the body, using radio for coordination. However, at the same time, TVA stations (in Tennessee) were engaged in forwarding routine detailed reports "on the air", interfering with the Mount Rainier rescue operations. The Mount Rainier dispatcher contacted the TVA control operator, requesting that they postpone operation during the

search for the skier. The TVA operator evidently had never seen snow, and could not comprehend a person being buried by a snowslide. He let his curiosity get away from him and delayed the Mount Rainier operations with questions about the snow. It took a telephone call to his supervisor to get the TVA man off the air, so the search could be continued without interruption!

The late 40's and early 50's portable FM equipment consisted of the handie-talkie which was about nine pounds, with the transmitter, receiver, and battery pack supporting a bracket mounted on top which held a telephone type handset (500 series handset). Power output was 1/4 watt on the 162-174 Mc band and about 3/4 watts for the 30-42 Mc models. Each stage of the transmitter and the receiver were plug-in type with tiny vacuum tubes. Pack sets weighed about 12 pounds and were more bulky (about 15" high, 11" wide, and 5"thick). They contained a small loudspeaker and used a hand-held microphone. The transmitter and receiver were essentially the same as in the handie-talkie, except that the power output was greater.

These early portable FM transceivers used tubes that placed a heavy drain on the batteries that necessarily had to be small in order to keep weight down (nine pounds for a "handie-talkie" and twelve or more pounds for a "pack set"). Consequently it was important not to leave them turned on unnecessarily. However, since these units were equipped with a "squelch" control that made the receiver quiet except when signals are being received, it was easy to forget to turn them off. For this reason NPS included specifications for a device that would "break" the squelch at regular intervals to remind personnel that the receiver was still turned on. A forgetful user would be surprised at the squelchbreak "reminder" about the time he/she placed the unit on the shelf or laid it down in a vehicle. This device was not needed for hand-held units, because it was standard practice to turn them on only for the duration of a conversation, contrasted to the sometimes prolonged use of pack sets.

Another problem was experienced with early FM pack-sets provided by Motorola. Instead of a handset like the handie-talkie units used, a small hand-held microphone was provided. The voices received from rangers using the pack sets was found to be unusually weak, but the Motorola representatives insisted nothing was wrong. Eventually Motorola consented to send the design engineer to visit the NPS lab in Washington, D.C. concerning the problem. The instant he began talking into the microphone for a test, the answer was obvious. He had adjusted the modulation circuits for close-talking into the microphone, a technique for reducing noise in aircraft communications! When it was explained that the pack-sets were usually used by personnel who are experienced in mobile microphone techniques in which the microphone is held about three inches from the mouth, and that ranger's wives (with softer voices) occasionally used the pack sets, he agreed to a modification for units furnished to the NPS and the F&WS.

The availability of packsets enabled improved manpower utilization. Pack set reliability had reached a state whereby fire and trail crews that ordinarily had to stay near a telephone during periods of high fire danger so as to be available upon call, could be given job

assignments at various locations without interfering with their immediate availability for dispatch to fires or other emergency.

In the mid-50's a "handie-talkie" with two- frequency transmitter, one-frequency receiver cost about $350. A 50-watt FM mobile unit cost about $550, a 50-watt FM desk console cost about $700. A 30-42 mc repeater with one cavity cost about $1450. Mobile units now were about 18" x 15" x 6" leaving room in a trunk for other equipment, whereas the earlier models consisted of two units , already described, which, along with the spare tire, took practically all available trunk space. 50-watt base stations were available as (1) desktop consoles about 30" x 24" x 12"h. or (2)upright cabinets about 72" high, or (3) weatherproof cabinets which could be pole-mounted near the antenna. The latter were remote-controlled.

At this point in time, use of battery-operated repeaters in the back country was avoided if possible because of heavy dry- batteries that frequently had to be replaced, and the distances that had to be travelled by foot or horseback. However the vast area of Sequoia-Kings Canyon made it necessary to use many repeaters in the back country as described elsewhere. One set of batteries would entail up to twelve 8-pound "B" batteries and twenty-four two-pound dry cells. If it was a double (2T,2R) repeater, twice as many batteries would be required.

Some early systems were low-band (30-42mc) and depended upon AC-powered repeaters at sites where AC power was available, leaving "blind-spots" from which portables could not communicate. This was alleviated either by battery-operated repeaters or by using portables with a 3/4-wave flexible-wire antenna which could be supported from a tree branch, after using a rock and string to reach the branch. A 25-ft. coaxial line was used to connect the antenna to the portable unit. The range of communication was increased significantly over the 1/4- wave loaded flexible whip, which was normally used, but of course it did not permit rapid deployment for use.

Not everyone in management was amenable to the establishment of FM systems. During a visit at one regional office this writer called upon the assistant regional director to pay his respects. The latter was noted for his skepticism about new ideas and methods and he quickly displayed it to me. "The radios just do not work during lightning storms and the batteries always run down at the crucial moment. They are hard to understand, etc. etc." He mellowed considerably when he was reminded that he was 20 years behind the times- that VHF-FM antennas are grounded and that it takes a strong lightning strike in close vicinity to make a pop or squelch break, that newer sets were lighter, batteries lasted longer, etc. Evidently his recollection was only of the HF-AM radios which were rapidly becoming passe'.

Field Surveys

The use of VHF (30-200 mc) in NPS systems, coming about because of development of suitable equipment commercially, required a new concept in system planning based upon field surveys.

The medium and high frequencies, being propagated (except at extremely short distances and on over-water paths) by sky-wave reflections from the Kennelly-Heaviside layers did not require prior field testing when designing systems. The main requirements for these frequencies was frequency, proper siting, type of antenna, and local noise considerations. However, VHF transmissions were known to be propagated almost exclusively by direct-wave and/or surface-wave paths. It was also known that the waves could be bent (by diffraction or "knife-edge" effect) and reflected. How much bending and reflection, as well as attenuation, could only be determined by actual testing of each point-to-point path and mobile areas; hence the use of field surveys was necessary to determine if and where repeater stations were needed.

During the period 1950 to about 1955 the FM surveys were usually conducted by WASO engineers with a one-ton panel truck which would carry sufficient test equipment to the park to conduct the survey. After setting up base stations, the truck and other vehicles borrowed from the park were operated as mobile units to determine coverage capability from the base stations (or repeater sites under test).

Consideration was given to the possibility of using microwave transmission for radio and/or telephone in a few of the parks. This entailed a determination of line-of-sight between terminals. In the early 1950's I accompanied my "boss" to help in the determination of line-of-sight between certain points located in Shenandoah. Being a former fire lookout, the use of flashing mirrors was obvious to me. One path seemed to be nearly line-of-sight, but we did not know at what elevation an antenna had to be to overcome the lack. The use of a "Very" flare at night was an obvious solution, but no one reckoned with the intense heat of the flare when it returned to earth amidst some dry brush! We all did a lot of embarrassed skirmishing to put the fire out before it could become known to the park staff!

Developments in equipment, power supplies, solar cells and other devices caused an evolution in approaches to FM system planning and design for later areas. In the early fifties it was usually necessary to locate repeaters on or near the perimeter of the area, or roads within the area, so as to be accessible for maintenance and convenience to AC power. However, as transistorized equipment became available, and solar or thermo-electric power systems were developed, it was no longer necessary that AC power be available at a repeater site. Increased reliability of transistorized equipment made it possible to consider more remote locations which could be visited only 2 or 3 times a year. Later, availability of rotary-wing aircraft made it possible to utilize sites that are inaccessible by other means. With these developments it was no longer necessary to give priority to perimeter sites.

The problems with installations on private or other-agency land often required the technician (lacking the services of civil engineers and other specialists) to locate section corners and inspect courthouse records to determine landowners, and to use of a site and negotiate for a power line, etc. The procedures for obtaining use permits were unclear. Some NPS administrators insisted on proof that there were no suitable Federally-owned lands available that could be used; other administrators insisted that GSA must negotiate for the site. In my own experience while radio technician at Olympic National Park I had negotiated with a private party for use of a site outside the park for $10.00 per year. Several years later the chief clerk of the park asked me when we would receive a billing, since keeping the records open for a $10.00 obligation each year was "fouling up our books". The landowner had never sent a bill to the park. Being uninformed about fiscal regulations I said I would mention the matter to the land owner. "Oh, no you don't! - you never aid a person to make a claim against the government!" How did he expect to clear his books if the owner did not send a bill?

With the advent of VHF FM systems in the parks two major problems became apparent. First, how were we to install mountain top repeaters that would be usable but not detrimental to scenic and environmental values; second, how are we going to get qualified people to maintain them? Chief of Design Thomas C. Vint recognized the first problem and sought an answer by assigning a landscape architect to accompany the radio engineers during field surveys. In this way the landscape architects would become aware of the facilities needed for a successful system, and the radio engineers would be better informed as to techniques to make installations less obtrusive. At that time (1952/1953) it was usually necessary to use two antennas, separated by distances of about 75-100 feet. * As a result of this cooperation between engineers and landscape architects, antenna towers, when they could not be hid, were placed so as to be least obtrusive to viewers and photographers.

In planning FM systems for most of the larger parks, the distances and rugged terrain would have required an unmanageable (and cost-prohibitive) number of repeaters if coverage was to be adequate for portable units from any trail site or back-country problem (fire, rescue, etc.). Knowing this, portable units (during the decade of the 1950's) were supplied with the long-wire antenna which has already been described. The long-wire antenna was much more efficient and by exchanging it for the standard whip antenna could be used to "get out" of places where the whip was useless. Later, as transistorized, solar-powered, mountain top repeaters became feasible, greater coverage was possible without the use of long-wire antennas.

* About 1960 duplexers were developed which made it possible for repeaters to be designed for use with a single antenna.

"Because of reflection from buildings, lamp posts, utility wires, [mountains], and other obstructions, the signal may travel from the transmitter to the receiver by many different paths with different lengths . . . When one end of the channel is moving, . . . fading results because, in some relative positions, phases of the signals arriving from the various paths interfere distinctively, while in other positions the phases add, constructively." (39) Thus, in the mountainous parks the "picket fence" effect occurs frequently at the outer portion of the coverage area in which a completely readable signal occurring at one point would be "gone" in as short a distance as six inches, then reappear a short distance further. The cycle repeats so often that the cutting in and out of the voice reminds one of a stick held against a picket fence as one rapidly walks. This effect made it extremely difficult to define "mobile coverage" in specifications for systems that were to be designed and furnished by contractors. Tests conducted in 1954 by the Forest Service near Santa Barbara demonstrated that at 400 MC the "picket fence" effect was so rapid as to sound like ignition noise.(40) This author witnessed the test and was intrigued by the fact that, in a line-of-sight situation, each intervening palm tree would cause a remarkable drop in signal strength as the mobile unit passed along the palm-lined highway!

The topography of some park areas is such that base stations or repeaters can be more effective if placed outside the park. Consequently field surveys sometimes included tests from points not within the park area itself and in doing so some interesting experiences occurred. Probably every field survey has its difficulties and/or unusual happenings.

Sequoia & Kings Canyon National Parks: The survey at Sequoia & Kings Canyon in 1951 was most frustrating in that, after having three parties on horses at various test sites for almost a week, we learned that poorer-than-expected results had been experienced because one party had gone to the wrong mountain top! Each day seemed to have its problems. No amount of explanations could convince my packer-guide that I had to be at a certain location at a specific time, while the other two units were at their designated sites. One night the packer turned our horses out to graze, thinking the drift-fence would keep them close at hand. It caused a disaster. The horses penetrated the fence, and strayed away during the night. Fortunately one of the horses had been hobbled, keeping it close to camp. Even with this horse available for the pursuit, we did not retrieve the other horses and get started until 10:00 a.m. on a schedule that was to begin at 8:00 a.m. Naturally the test-site operators assumed that the area I was supposed to be in between 8 and 10 am was dead. It was another SNAFU test!

That survey was an introduction to different topography than I had been used to. (At Mt. Rainier the mountain prevailed over the entire vicinity.) Sequoia-Kings Canyon has a number of peaks over 14,000′ elevation, and many over 12,000′, with much up-and-down trekking over ridges and across low-elevation valleys. The helicopter today makes such horse travel unnecessary.

One of the dilemmas of designing FM radio systems in mountainous areas is in determining from which peaks to conduct tests. Time and cost does not permit testing every peak within

or near a given park. The peaks to be tested were usually selected after consideration of (1)map studies, (2)visibility maps and/or panoramic pictures taken from established fire lookouts, (3)evaluation of profiles of selected paths, using propagation nomograms(36), and (4)consultation with park staff to determine areas in which coverage is especially important., and (5)the relative accessibility of peaks under consideration.

The irony of this procedure is that, after a system is completed, (the Sequoia & Kings Canyon system was based on a survey that took three weeks with horses, mules, and numerous personnel involved) it sometimes is discovered that mountain tops which were not tested would have been more effective. This happened in the case of the first FM system, a low-band system, at Mount Rainier(37), and a low-band system at Sequoia & Kings Canyon(38). The Sequoia system that was designed, based upon the above-described field survey, involved a number of battery operated rep eaters which were necessary to cover the most-often-used sections of the Sequoia & Kings Canyon National Parks. They were nearly all on isolated remote mountain peaks. *

Great Smoky Mountains National Park: This was a period when there were still a few colorful "mountain men" and families living in remote areas near some of our parks who looked askance at "city slickers". When the field survey was being conducted for Great Smokies National Park some of the sites considered as possible repeaters were mountain tops outside the park. Of course, this required that the survey truck (which looked very official, being dark green, with a government license) traverse the very area where such mountain men were anxious about "revenooers" who might be looking for their stills. This led to one tense situation in which the truck was stopped by a mountain man with his rifle; no explanation being accepted without a prolonged parley which delayed the truck so it could not perform its part of the scheduled test! The story, as told to the author, did not indicate whether the test was rescheduled for another day or not.

Olympic National Park: Another survey which had its tense moments occurred at an isolated spot in the Hoh River Valley approach to Olympic National Park. Charlie Lewis, a local "mountain man"-type had spotted the test truck's tracks near his home. The tracks were the result of jockeying the survey truck back and forth (sometimes a six- inch change in position made the difference between no signal and a fair signal) to find a good spot. The procedure had been for the survey truck to move very slowly (low gear) while the driver repeats "Long call, please" as the vehicle moves. After about a minute of this, the truck is

* After the Rattlesnake and Park Ridge repeaters were installed, with the expectation of installing an intermediate repeater, Hannaford discovered that there was a "slot" through which signals between the two repeaters would pass. This was a 70-mile path that seemed inconceivable and was therefore not tested during the survey. This fortunate find eliminated the necessity for the intermediate repeater which would have added further to Hannaford's time in the saddle each summer. (details in a later section).

backed while listening for a reply. When a location is found at which the reply can be received, two-way communication can usually be established. After other tests had been made further up the road, and we retraced our route to head home, we were met by Charlie on his horse, gun pointed directly at us. It took much talking and an inspection of our panel truck to convince Charlie that the tracks which he had noted were not the results of an attempt to rustle one of his cows. He evidently had been sustaining losses recently. Since he didn't savvy the reason for the tracks our truck had made, he was very suspicious.

It is interesting to note what other people thought about the "locals" and their families that lived in remote valleys of the Hoh, Queets and other rivers along the Washington coast. During the same field survey, the writer and an assistant spend a night with District Ranger Dickinson at his station at Kalaloch near the oceanside. While we were there, a feature writer from one of the Seattle papers called on Dickinson to gather material for an article about the inhabitants of isolated sections of the Washington coastal area. She was told about Charlie Lewis, the Huelsdunk family and others, and then she asked "do you suppose the almost perpetual rain and isolation makes the coastal people a little 'teched'?" Dickinson's response was to the effect that he had lived there most of his life -"draw your own conclusion!"

"The climate [along the Washington Coast] has also bred some of the nation's hardiest people. When I asked a mental-health-service officer if winter rains produced an increase in psychiatric problems, he laughed. Anyone who has not learned to cope left long ago he said."(41) This phenomenon was the subject of an article in Modern Maturity magazine for June/July, 1984.

Yosemite National Park: The Yosemite survey was to begin in June 1952. After we had had inquired about specific communication needs, we described the proposed tests to the staff. They were to include testing from Double Rock, but the Chief Ranger advised us to postpone the tests for a month. Why? "Because of the late spring, there is too much snow for horses!" To the Chief Ranger's consternation, we made the survey on schedule, by walking - which was what we had expected to do in the first place!

When preparations for the Yosemite survey were complete, one of the older electronic engineers was sent from Washington to assist with the survey. When the survey was over he was to return to Washington while this writer went on to another project. One of the temporary Yosemite rangers was to drive the engineer to the airport. Being new to the area, the ranger asked the engineer to help him find the airport. After being directed by the engineer at various intersections in Fresno, the ranger/driver realized they were back where they started from. It was only then that they became aware that the engineer had arrived from Washington at the Merced airport and was using the Merced route to locate the Fresno airport! Needless to say, they had to make inquiry for directions and barely caught the plane!

Mount Rainier National Park: In connection with selection of repeater sites, a remarkable characteristic of Chief of Design and Construction Thomas C. Vint (late 40's and 50's) is recalled. He was decisive and had a fantastic memory. During this author's surveys at Mount Rainier, there was difficulty in selecting a site near Paradise for a repeater which would be most effective without imposing on the natural scene. It so happened that Tom visited Paradise with the Superintendent and others. While discussing the problem, Tom asked me what place would give the best results. He was told "on Alta Vista" (above the present visitor center). When the local personnel objected on the basis of the effect on the landscape. Tom said something like, "You want the radio system to work don't you? Put it there." The decision was made without further ado. However, later events and tests ruled out the Alta Vista site and the repeater was installed in the ski dormitory. Nevertheless, several years later when Tom and author happened to meet, Tom immediately recalled and asked about the Alta Vista repeater. With the myriad of design and development details for all physical developments in the parks on his mind, it is remarkable that he could retrieve such an incident rapidly from his memory.

Surveys in General: Developments in equipment, power supplies, solar cells and other devices caused an evolution in approaches to FM system planning and design. In the early fifties it was usually necessary to locate repeaters on or near the perimeter of the area, or roads within the area, so as to be accessible for maintenance and power. However, as transistorized equipment became available, and solar or thermo-electric power systems were developed, it was no longer necessary that AC power be available at a repeater site. Increased reliability of transistorized equipment made it possible to consider more remote locations which could be visited only 2 or 3 times a year. Later, availability of rotary-wing aircraft made it possible to utilize sites that are inaccessible by other means. With these developments it became no longer necessary to give priority to perimeter sites.

Most of the field surveys required the services of additional personnel so that tests can be made simultaneously from several locations and/or portable/mobile units. The rangers were usually available for this purpose, which they were glad to do since they were to become the major users of the systems. One ranger at Emigrant Ranger Station in Death Valley had had very little contact with other persons and was obviously lonely. During that survey he was placed on a mountain-top. However he was so voluble and detailed in his signal reports that there was not time to make tests at all the desired points with the mobile unit. His descriptions were so detailed, that he was still talking ten minutes after the tests were terminated and the mobile unit headed back to base! This, in spite of the fact that it had started snowing!

Radio Systems

Sequoia and Kings Canyon National Parks: Some of the experiences that occurred during the 1951 field survey are described in the section on Field Surveys. The park newsletter reported "The new communication system for Sequoia and King's Canyon is now [Sept.,

1951] in the engineering phase with Ralph McFadden, Electronic Engineer from the Washington Office, and Robert T. Steenhagen, Landscape Architect [In-service trainee from Region One], making tests . . . McFadden will work out of Cedar Grove covering points on a loop trip through Simpson Meadow, Deer Meadow, Upper Basin;, and Rae Lakes, testing through a set on Burnt Mountain operated by Dan Busby, F.C.A. [fire control aide] of the Ash Mountain Crew, and a mobile set operated from Park Ridge by Mr. Steenhagen. The last of the week Mr. Steenhagen will pack into Evolution Basin and test that area through the set on Burnt Mountain."(42) After the first test was completed, it was learned that Busby was on the wrong peak, but it didn't matter as will be apparent in the following discussion.

The state-of-the-art repeaters and the batteries used for power source were not very reliable by modern standards. The park technician, Jack Hannaford virtually lived on horseback en route to the repeaters almost daily during the summer season when the back country system was activated. "This location (Cahoon Rock) requires a three-day pack trip every four weeks for service, assuming no equipment failures were involved . . . They [the packsets used for repeaters] were not designed for continuous operation and . . . can be expected to fail in an average time of two weeks".(43) "In order that the technician can spend two hours maintaining a repeater, he must spend several days in unproductive travel. Travelling with him is a packer and of course, the horses and pack animals."

Hannaford related to me the technique and excitement involved in flying into the Kern Canyon (Sequoia/Kings Canyon National Park) to service the base station there. This was in the mid-50's before helicopters were readily available. Jack weighed around 200 pounds. He would have the contract pilot depart for Kern Canyon as early as possible to enable an earlier return when his work was be completed in the afternoon. The runway was short and surrounded by mountains with trees at the end of the runway. Therefore, an early afternoon take-off was necessary before the afternoon temperature caused the air density to drop too much to provide the necessary lift. The wind was usually gusty. In view of these conditions, when starting the return trip, the pilot would rev up the engine, with brakes locked, and wait until the wind-sock dropped and begin takeoff at that time! It was scary, but the pilot had observed the intervals between wind gusts and was taking advantage of them to reach the point at which maximum lift was needed at the same time as the wind returned. This procedure was needed to clear the trees at the end of the runway. The pilot's skill was successful!

The extensive FM system was completed in 1955 at a cost of $174,220. The Front Country portion of the system used AC-operated 50-watt equipment. "The Back Country stations use battery power, have power outputs of 1 watt, and are accessible only by horseback and pack animal."(44) When completed in 1955 the "system consisted of 9 repeaters (most of them served the back country), 11 base stations, 53 mobiles, 24 1-watt pack sets and 32 1/4-watt handie-talkies. This was a simplified version of the original design, the result of the discovery that there existed a very fine path from Rattlesnake Point to Park Ridge which eliminated the need for a repeater at Kaweah Gap and consequently at Bear Hill."(45)

Actually the 1951 survey was not directly involved in the design of the system. It was conducted in the 162 - 174 MC band. As the author learned during his back-country tests, the topography consists of many ridges with deep canyons or drainages between. This topography would have required an inordinate number of repeaters if the high-band were to be used. Consequently Vern Rowley (my boss) and I designed a 30 - 42 MC system while in a hotel room in San Francisco, making educated guesses about what signal paths would be usable, based upon the 162 - 174 MC tests.

> "All mobile and Front Country station [and] repeater equipment . . . are products of the General Electric Company . . . They have given very little trouble and are easy to maintain . . . The packsets used in this system are manufactured by the Radio Specialty Co., of Portland, Oregon. These are excellent units. The tube life has been good, and maintenance costs are low . . . The battery repeaters in use here are converted Motorola packsets. These units have given a great deal of trouble . . . Tube and component failures have been high, and intermittent operation has been the rule rather than the exception . . . The Handie-Talkies in use here are Motorola products . . . and since their function has not been the strategic importance of the battery repeaters, their failures have not been as costly. One additional deficiency of these units is that very little of the 1/4-watt of transmitter power reaches the antenna. Tests indicate that almost all of the output power is absorbed in the loading coil" (a device used to make a 30" whip load up the transmitter in the same manner as an 8′ whip. The latter is the most effective antenna, but is too long for portable use.)(43)
>
> This report and the report on the Glacier system are not to imply that all Motorola equipment had problems. Many systems, unreported in this journal, have used Motorola equipment with great satisfaction.

Yellowstone National Park: The first FM system at Yellowstone was leased. It was a discouraging experience. Field surveys in 1952 by NPS engineers indicated that a workable system could be designed around repeaters on Elephant Back near Lake and on Bunsen Peak near Mammoth. It was known that AC power would be essential on Bunsen Peak, but that constructing a power line to the site would be outside a radio contractor's expertise. The Bunsen Peak power line is unique in that it involves a 4300′ Catenary with about 1200 feet difference in elevation at the ends. Being exposed to high winds and lightning, special reinforcement and vibration dampeners were necessary. Even with the best lightning protection facilities available at the top, surges are carried to the power system at the reservoir below because of the better ground there. These surges "knocked out" the fuses so frequently it was necessary to replace the fuses with a recloser and additional lightning arresters. The counter on the recloser showed it operated many times each summer, indicating how often the line is struck by lightning. The fiberglass poles that were installed at the peak had to be replaced because there was no "spoil" to fill the hole, so rocks had to be used for backfilling. The stresses on the poles and vibration (during windy conditions)

caused the poles to wear against the rocks that were used for backfill. The wear was sufficient to reduce the 3/8" wall thickness to 3/16" in spots over a period of several years.

Bidders were informed that if they proposed an installation requiring AC power on Bunsen Peak, a handicap of $30,000.00 (the cost for NPS to build the power line) would be added to their cost when comparing their bids with bids not requiring power on Bunsen Peak. Land-Air (LA) was awarded a contract, and the power line was built by a contractor for the NPS. Land-Air installed a repeater on Bunsen peak which has been described: "From its peak, standing amid radio shacks and assorted antennae (very few peaks in the park are subjected to this; Bunsen is close to park headquarters)"(46) This description refers to more recent installations on Bunsen Peak.

Repeated attempts were made by LA to meet the performance specifications by experimenting with temporary installation of repeaters at different locations, one of which was on Elephant Back.(47) The writer personally made at least six "final" inspections, during which the contractor's representative "fished" for suggestions as to how they might modify the system to meet specifications. No technical assistance was given the contractor because the engineering and design was LA's responsibility.

Each "final" inspection required that the author drive the major roads, testing every mile to sample the mobile coverage to learn if it met the specified minimums. The rangers, hearing the tests, took great delight in clocking the tests, and reminding me of the speed limit. Well, perhaps I did exceed them when conditions permitted. The novelty of driving the "loop" had worn off, and delays due to visitor congestion sometimes required the assisting operators (as well as myself) to work long past the usual quitting time.

By 1958, the system was still not completed, so measures were under-taken to have the bonding company complete the installation for Land Air.(48)

In the meantime the park made payments to LA for rental of the mobile units, even though their usefulness was limited because the repeaters were not fully functional. The contractor did not have the impetus to expedite completion of the system that would have prevailed if payments had been withheld and liquidated damages charged as provided for in the contract. After limping along in this manner for nearly five years, Superintendent Garrison asked me if it really was possible to design a system that would meet specifications. He also asked if the telephone company (MST&T) with their extensive experience, couldn't do better than Land Air. I reminded him that our experience in other areas (reported elsewhere) has been less than satisfactory because the telephone company's radio experience was limited to urban situations. He was assured that if NPS had control of the design and installation it could be fully operational in six months. These difficulties prompted an ultimatum to be sent to Land-Air in June, 1962. The latter was to make a proposal for narrow-banding and demonstrate their capability of completing and maintaining the system. Due to inadequate response, representatives of the Regional Office and WODC met with the Park and Land-Air and the contract was terminated. ". . . it is planned to install a new

system with construction funds during the 1965 fiscal year. The latter will be narrow-banded. The Park needs additional funds to finance the termination charges payable to Land-Air but it will have to be administratively determined whether narrow-banding funds can be used for this purpose."(49) Ultimately, in 1963 the park bought out LA's interest, and a technician transferred from Sequoia to modify the system to make it fully operable. This was accomplished in about six months.

In the meantime during the construction period (1955) the frequency 40.97 mc was authorized for "portable radio equipment which might be leased for use during the fire season" by Yellowstone and Grand Teton.(49A)

While this was going on, plans were being made for the John D. Rockefeller, Jr. Memorial Highway linking Yellowstone and Grand Teton. In Feb.1957 WASO wrote Region Two concerning Grand Teton frequency assignments, suggesting consideration of using the same frequency for Yellowstone and Grand Teton.(50) The suggestion was never seriously considered because of practical problems that would be involved.

Olympic National Park: Immediately after the war, Olympic acquired surplus 30-42 mc equipment for a rudimentary FM system to serve the Lake Crescent and Heart O'the Hills areas without benefit of a repeater. Navy MN-5 (4-watt, marine/mobile) and SCR-628 (10-channel, 30-watt, for use in tanks) units were among those used. They did not get much actual use.

Later, one of the first FM systems using all commercially-available equipment in any park area was installed at Olympic National Park. Because of the extreme distances involved, three 3-KW 30-42 mc transmitters Motorola (Serial Nos. 1,2,3), were used to connect the west side (Quinault, Hoh, and other locations) with headquarters. The repeater at the former Quilayute Naval Air Station was the first repeater that Motorola had built using such large transmitters. Figure 10 shows Motorola engineer Fred Hilton tuning up the equipment. The decision to use 3-KW transmitters at Port Angeles, Quilayute, and Quinault was a calculated risk. The only available survey (field testing) equipment had 50-watt transmitter output, and tests showed that 50-watts would only cover a fraction of the distances involved (Port Angeles to Quilayute, Quilayute to Quinault). In order to have some feeling for the power necessary to cover the desired distance, the known distance covered with 50-watts was compared with the predicted signal (based on then-available nomograms) for the same distance to get a correction factor which was applied to the nomogram-predicted signal for the required distances. This procedure resulted in a prediction that 3-KW would give a usable signal if 6 DB gain antennas were used at each site. After the system was installed, it was found that 250-watts (the next lower powered, commercially-available units) would have been marginally satisfactory.

An undated tear-sheet from the Motorola Newsgram described the 3KW stations as follows:

> "After many months of continuous research, designing and engineering, a new remotely-controlled 2-way radio central station with a continuous power output of 3 kilowatts has been developed by Motorola.
>
> "Three of the powerful stations, which on intermittent operation are capable of 5-KW output, have been purchased by the Department of the Interior for the National Park Service, and already are installed near Olympic National Park in Washington.
>
> "Built as repeater stations, the units provide communications between Port Angeles, Washington, and United States Park Rangers in 2-way radio-equipped cars or trucks, or carrying Motorola "HANDIE-TALKIE' portable radiophones. The three stations are designated as Ediz Hook, Forks [actually Quilayute], and Quinault.
>
> "Any incoming signal on one of the frequencies used will automatically activate the 3-KW transmitters from which the signal will be rebroadcast.
>
> "The high power station is built in three individual cabinets to facilitate ease of handling and maintenance. The exciter cabinet houses a Sensicon receiver and a 60-watt transmitter which serves as the driver for the 3-KW amplifier. The second cabinet contains the high voltage power supply, screen supply, and relay and control circuits. The third cabinet contains the power amplifier which consists of a pair of 4-1000A tetrodes in a push-pull circuit. The tubes are forced-air cooled."

Excitement reigned the day the Quilayute repeater was to be tested. It was located in an unused building on the inactive Naval Auxiliary Air Station (NAAS). It was one of those days when the clouds are solid, low, and drippy. Motorola's Field Engineer, Henry Gammel, a private pilot, had arranged to fly a photographer from Olympia, Washington to the site to take pictures at the Quilayute repeater. It was not flying weather on the flight path along the straits of Juan de Fuca and Puget Sound area, en route to Quilayute. The Port Angeles Coast Guard Station had advised against attempting the flight. Nevertheless, Hank, with his photographer, skimmed the white-caps on the Straits of Juan de Fuca, found the outlet of the Quilayute River, and followed the river to the air station, dodging tree-tops on the way. When he flew over the repeater, the plane bounced in the wind like a leaf, appearing like an apparition out of the mist and fog. He knew the field was officially closed at all times, but landed anyway with a very green-looking photographer, ready to take his "licks" from the Navy Chief who was caretaker of the field. However, at that very moment, the Chief was driving a jeep around the field, with a high-ranking officer from nearby Whidby Island Naval Air Station who was riding on the hood, shotgun in hand, expecting to bag

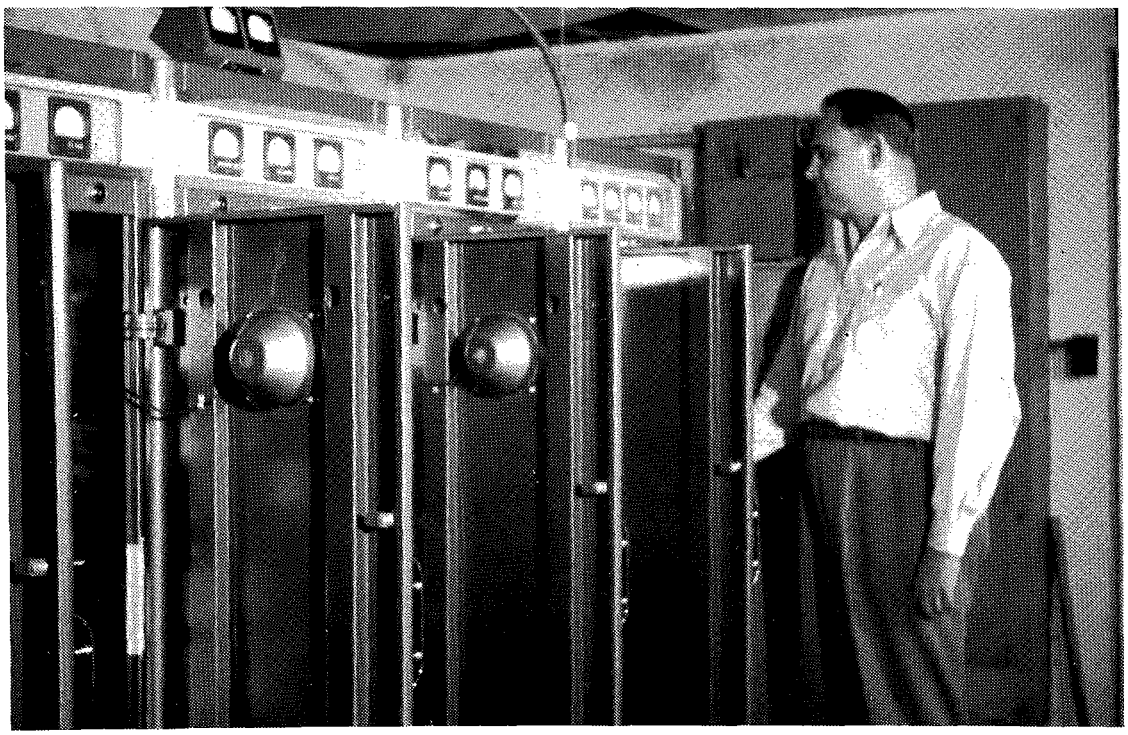

Figure 10

Fred Hilton, Motorola engineer, tuning up
3 KW, 30 - 42 mc repeater at Quilayute NAAS (inactive).

One cabinet not shown. Olympic National Park, 1950

ducks or geese. Needless to say, both parties were embarrassed and neither Gammel or the officer were in a position to have much to say to each other.

The east side of the park was covered by a high-band (162 - 174 MC) system using repeaters on Hurricane Ridge and on Toandos Peninsula (outside the park). The system had desensitization problems, mostly because the 162 - 174 mc units supplied by Link did not meet performance specifications(51) and because the 32-volt power supply at Toandos Peninsula was not a satisfactory power source (described under Power Supplies). Desensitization problems in the repeaters caused all but the strongest signals to set up a "chop-chop" cycle which resulted in inability to use them.. The difficulty was confirmed as an equipment problem, rather than an installation problem, by tests of the receivers made at the Forest Service Radio Laboratory in Portland, Oregon. (52) All of the receivers should have gone back to the manufacturer for correction, but the superintendent was so glad to obtain even limited use, that the equipment remained in place and attempts were made to modify them on the site with kits supplied by Link. The results were less than hoped for, but it led to implementation of a certification program (described elsewhere) to insure that in the future only technically adequate equipment would be bid on.

After the system was installed, another problem occurred which had not been anticipated. It had been assumed that the 30 - 42 MC band would be virtually immune from "skip" interference. However, during the 1957 - 1958 peak of the solar cycle and sporadically in other years, the super-high-powered transmissions of the military facilities in Greenland would lock on and block one or more of the repeaters for most of the daylight hours. The system was almost useless during these hours. It took several years to remedy the situation, through changes in frequency assignments arranged by IRAC.

While this was going on, the writer, stationed at Olympic National Park, was asked to supervise the installation of an FM system at Mount Rainier National Park. The latter was a "mix" of surplus military 30 - 42 MC equipment and new 162 - 174 MC equipment for repeater links. The equipment at that time was not as efficient or as immune from failure as the equipment which was installed later. This dual duty required frequent travel between the two parks, making it hard to keep both systems operational. The writer enjoyed a feature that was discovered during these many trips - that of being able to talk to Mount Rainier from selected spots in Olympic, and vice versa. By checking out these paths from his mobile unit he was able to ascertain the operating condition of both systems without depending upon someone in the distant area to call him via telephone. This capability also demonstrated the difficulties that would have been experienced if both parks had been on the same frequency.

Glacier National Park: In 1952 a comprehensive two-way FM system was installed, in addition to a two-channel radiotelephone system (which has already been described) to connect St. Mary area telephones with West Glacier headquarters.

Both systems involved base stations at Apgar Lookout. Difficulties with the telephone and power cables serving Apgar are described in the section on power supplies. The alternate-day hikes up to Apgar (occasioned by difficulties with the radiotelephone equipment, reported elsewhere)in the morning involved trying to pass a small lake without arousing the anger of the moose that was usually browsing in thickets alongside the trail. Fortunately the wind direction usually did not betray my presence as I passed.

Radio manufacturers had begun offering mobile and/or portable transmitter-receivers which could be used by the Service.(53) In many instances, models were designed with urban and suburban conditions in mind. Often they were not rugged enough for the extreme conditions experienced and required excessive maintenance and/or modifications. As mentioned elsewhere, this resulted in the Service joining with the Forest Service in preparing "specifications that are deliberately pegged at a level to encourage competition in a high quality radio."(54)

In their efforts to keep ahead of the competition by offering more advanced equipment, manufacturers sometimes supplied state-of-the-art equipment which was produced prematurely before they had been adequately field tested. The result was that the users experienced breakdowns and/or performance failures that were an embarrassment to NPS and to the suppliers. Thus, in 1953 a manufacturer supplied Glacier with receivers with a new guaranteed-for-life filter that was so sharp that transmitter and receiver frequency control had to be unusually precise. The filters were intended to reduce the susceptibility of the receivers to off-frequency interference; however, of those supplied for the Glacier system, a failure rate of one out of three occurred, requiring replacement by the manufacturer. But this was not the only problem with fifty mobile units which were installed, in which troubles showed up after a few weeks use. A field engineer from the factory determined that the new style crystals were not maintaining the frequency stability they were supposed to. All fifty crystals and the filters which proved defective were replaced by the manufacturer's field engineer.

It seemed as if manufacturers assumed that their equipment would be used in more accessible locations than our National Park areas where they could be easily repaired or serviced. For example, the repeaters and base stations installed in 1953 at Glacier experienced frequent fuse blowing. After the transmitters had been idle all night, the first transmission in the morning would often blow a fuse. A complaint to the factory brought the reply "Oh well, a fuse only costs ten cents!", oblivious to the 120 -mile, four-hour round trip to replace it! It was observed that the fuses blew after setting all night with only filament power supplied to the rectifier tubes. The filament coating would crack in such a way that when plate voltage was applied in the morning, a piece of the coating would come loose, fly to the plate, cause a momentary short, and blow the fuse.. When new tubes of the same type were offered by the manufacturer, we said "No way", reminding them of the distance and time (four hours each way when Logan Pass was closed) to get to the failed unit. Eventually the manufacturer furnished another brand of heavy-duty tubes that solved the problem.

Yosemite National Park: Yosemite National Park was considered to be a high-fire-risk park, but while the FM survey (already mentioned) was conducted in 1952, they had not installed a system as of 1954. As an interim measure, pending funding for a complete system, a portable repeater and 12 portables was rented from Pacific Telephone and Telegraph Company (PT&T)(the low bidder). They were to provide the engineering and technical work to design the equipment.(54A) It was apparent to the writer that the system design would cause it to "lock-on" and be unusable after the first call was made. After months of denial by the PT & T engineer, a test was made, and it was confirmed that the design and selection of frequencies for the repeater was indeed unworkable. The instant an incoming signal was detected, the repeater would lock on until the batteries ran down, or the repeater was turned off by someone visiting the site. This caused much consternation to the PT & T officials. Their engineers assigned to design the system were not knowledgeable about systems that were different from those used by PT&T in metropolitan area mobile telephone systems. Fortunately the units were not needed for emergencies. The park now has a modern, adequate FM system.

As late as 1954 the park still used 3437.5 kc for weather and fire traffic to the Forest Service as part of their cooperative agreements.

Rocky Mountain National Park: The first FM system at Rocky Mountain National Park was leased from MST&T. As confirmed when the system was replaced at a later date, the Continental Divide is a formidable barrier for communication between the east side (including headquarters) and the west side of the park. In order to overcome east-west propagation difficulties, the telephone company used one of their telephone circuits (land-line) to connect headquarters with a repeater on the west side. The results were disappointing because of unreliability of the land-line.

When it became necessary to narrow-band the system, the MST&T system was replaced with a system leased from Motorola in 1965. The earlier system used an AC-powered repeater on Prospect Peak which gave limited coverage of the east side of the park. Transistorized equipment and solar cell developments had progressed to the extent that a solar-powered repeater could be installed on Twin Sisters lookout, giving greatly improved coverage on the east side. The west side repeater was accessed from headquarters via a repeater link, replacing the land-line link used by MST&T.

Mount Rainier National Park: During the writer's 1948 to 1950 duty at Olympic National Park, he supervised the installation of a FM system at Mt. Rainier (already mentioned under Olympic), leaving instructions to the park technician for completion of the system. In June, 1954 Verne Rowley and this writer visited Mt. Rainier to investigate reports that the park had not completed the installation of that system. "The Park technicians had had insufficient time to properly maintain existing installations and complete additional installations at the same time . . . it was found that much of the difficulty . . . was due to one

or more of the following:(a)antennas cut for the wrong frequency, (b) transmitters overloaded, . . . (c) wrong coils in transmitters whose frequencies had been converted, (d)deviation set too low or too high, (e)transmitters off-frequency, requiring replacement of 13 crystals, (f) receiver oscillator tuned on wrong side of peak, (g) irregular line voltage, etc."(55) By hiring additional help to overcome these factors, the system was made operable.

In connection with this work it was noted that occasional lightning strikes had damaged radio or telephone equipment. Recommendations were made for better bonding and installation of air terminals.

For better maintenance, it was recommended that separate case-history cards be prepared and kept for each transmitter and receiver unit.

Systems for Alaskan Areas: The conversion from HF-AM to VHF-FM was several years later in Alaska than it was in the "lower 48" states. There were several reasons for this: the greater distances and rugged terrain were more suited to HF-AM until such time as accessibility and power-supply problems for VHF repeaters could be overcome; there was not the concentrated demand for additional frequencies in this less-populated area (although there were some problems in obtaining allocations as described later); radio was not used frequently and intensely enough to justify abandoning existing equipment as long as the HF could legally be used. In view of these factors IRAC extended the date for conversion to VHF in Alaska.

In the meantime, the need for light-weight high-frequency portable units was not being met. It was recognized that 25-pound AM (later SSB) "portable" units with the requirement of antennas over 60′ long were quite impractical in certain situations. Because of this three 1½ watt FM portables were purchased "on the 30-42 mc band for interim emergency use at Mount McKinley and Katmai".(56) Low-band units were used because the communication distance would be much more restricted in the high-band (162-174 mc) without the availability of repeaters.

A study made in 1957 stated that radio communication was still necessary between Katmai (which was under the administrative supervision of Mount McKinley) and Mt. McKinley. Drawing NP-McK-2044B shows the facilities that were built for this purpose.(57) The Superintendent of Mt. McKinley had the choice of using NPS frequencies or relaying via the radio facilities of the Alaska Communication System (ACS) to reach Katmai. The former had its limitations because of propagation vagaries, and the impracticality of maintaining 24-hour standby at Katmai and McKinley for this purpose. In either case he was still dependent upon HF AM radio for intra-area communication.

The ACS radio and telephone systems were owned and operated by the Signal Corps, and later by the U.S. Air Force. They were operated primarily for military purposes but,

because they were the only system available and there were so many Alaskan villages and outposts that had no communication, the Air Force also permitted civilian traffic.(58) However, the use of ACS facilities for this purpose was an imposition on ACS, to be avoided if possible.(59) Isolated NPS personnel couldn't rely upon their HF-AM transceivers on NPS frequencies for emergencies because of the limited monitoring hours at headquarters and the vagaries of HF propagation during SIDs (described elsewhere), but if their equipment had a second channel they could use the ACS "Bushfone" (radio) for emergency communication to the outside world(60) because ACS had a number of stations on 24-hour standby.(61) For this reason Katmai, Glacier Bay, and Mt. McKinley headquarters and field stations were authorized to use 3385 kc to work into the ACS Bushfone.(62) The latter consisted of a number of base stations which could provide a "patch" to long distance telephone lines. This was more satisfactory than two-station point-to-point links because of the erratic effects of Aurora Borealis on high-frequency transmissions, sometimes wiping them out for hours, sometimes days.

Further discussion of frequencies and system management in the Alaska areas is contained in the section on management and regulations.

The U.S. Army use of HF in Alaska was also a factor to be reckoned with. While they did not use Interior Department frequencies, their assignments were sometimes as close as 4 kc with power output of 3 KW compared to NPS use of powers 100 watts or less.(63) Before the Army use of near-NPS frequencies was authorized, NPS was given the opportunity to evaluate and comment on the likelihood of interference if the proposed frequency were to be authorized. If there was sufficient geographical separation, interference was usually negligible in the daytime. Since NPS seldom used radio at night, the inevitable interference at night (due to greater-long-distance capability at night) was no problem.

Additional discussion relative to management of the Alaska radio systems is described in the section on Management and Regulations.

Systems for Other Areas: In at least one case(64), access to some FM system mountain-top repeaters for maintenance was impossible during the winter (a problem that no longer exists with transistorized equipment whose power requirements can be met without requiring visitation during winter months). Because of this the Superintendent of Dinosaur, and probably a few other areas, requested and obtained permission to continue use of HF-AM equipment during winter months. However, this required changes in frequency to meet treaty requirements as outlined elsewhere.

A similar problem existed in other areas where heavy snowpack prevented activating FM tube-type repeaters in time for them to be useful to the protection forces during the early part of the fire/visitation season.

Beginning in 1956 a number of areas began renting or leasing radio systems. Experiences with these systems are described elsewhere.

Radio systems were being modified, replaced or removed. Studies were made to determine the need for, and relationship between telephone and radio facilities in a number of parks. A 1955 Tabulation of Southwestern National Monuments indicated that thirteen areas needed radio, but that radio can be deleted for eight areas. Fourteen park and recreation areas were to retain radio and nine areas will no longer need radio.(65)

It is not possible to provide a detailed account of all the activities of the 1950-1960 period. However, a few of the more significant events have been given which may be of interest to the reader.

Maintenance

The importance of maintenance was well-put in an address by W.S. Claypool of the Forest Service at a meeting of the IEEE Vehicular Communications Group in 1934: "It is recognized that the continued satisfactory performance of a radio system in a field service such as forestry requires that exceptionally good maintenance be given all of the equipment. Small portable sets have no reserve of power to allow for the normal degradation which would not seriously affect the higher power equipment types. Long pack trips into the wilderness to repair or replace a set [or repeater] which is ineffectively serviced in the shop is not only costly to do but may mean a lost fire [or a botched rescue]."(66)

Effective maintenance programs did not come about easily, since radio communication was a relatively new development. Management procedures were developed on an area-by-area basis. The technicians (sometimes called Radio Mechanic) often had difficulty convincing their supervisors (who may be the park engineer, park electrician, or, in some cases, the Chief Ranger) of the need for preventive maintenance, proper refrigerated warehousing for batteries, and an adequate supply of tubes and parts.

In the late 40's, telephone and radio expenses were both charged to account 209. The fiscal year ended on June 30. At Olympic National Park I endeavored to arrange a set-aside, so that in May I could purchase fresh batteries for the summer's use. To my consternation, I often found that the telephone crews had overdrawn their allotment, leaving no money for the necessary batteries. Ranger funds were reluctantly used to pay for the batteries in order to have the use of the radios for the summer. This is but one example of the in-house problems experienced by early technicians.

In 1951 - 1952 WASO made an attempt to meet the maintenance problem by "polling" the park areas for personnel who had had radio experience during WW II. A two-week training class for about 30 such persons was conducted in the Washington Office. Many of those attending were from the ranger ranks. Motorola, General Electric and RCA sent instructors to provide instruction for their equipment NPS personnel provided training in maintenance and operating procedures and other management matters.

While the training class was very effective and worthwhile, this writers' recollections include some unusual non-radio experiences: One of the attenders who was a capable technician who held to a long-disproved concept that the life of flashlight batteries could be enhanced by interchanging the cells so that the bottom one could be placed next to the lamp and vice versa. He took a lot of kidding, but remained adamant in his belief! On the last night of the class, all met together for dinner in a private dining room over a popular restaurant. All had a good time until the check was to be paid. The waiter was indignant at the size of the tip, insisting he could not feed his family if he did not get more. We reminded him that we could not feed our families if we had to live on the rate of per diem granted by the government at that time. The waiter was so belligerent that we half-expected the Mafia to block the doors until we "coughed up".

It is doubtful if any of the attenders that were not technicians previously became technicians for NPS. Recollection indicates that most of the ranger and naturalist types eventually became chief rangers, superintendents, or regional office personnel.

At the training class a committee, consisting of Glen Richie (Blue Ridge Parkway), Ron Richmond (Olympic National Park), John Rybon (Glacier National Park) and Louis Baronoski (Isle Royale National Park) derived a table of maintenance costs for various types of units.(65) They are substantially higher than the cost to maintain later-developed solid state equipment:

Handy Talkies	$55.25/yr. plus	5 hrs./yr.
Pack Sets	$67.37/yr. plus	8-1/2 hrs./yr.
Battery-operated Repeaters	$112.41/yr. plus	11.6 hrs./yr.
3 KW Base Stations	$480.00/yr. plus	24 hrs./yr.
250 Watt Base Stations	$107.50/yr. plus	20 hrs./yr
50 Watt Base Stations	$77.12/yr. plus	19 hrs./yr.
Mobile Units	$58.00/yr. plus	11.3 hrs./hr.

These costs did not include travel time. A footnote indicates that Messrs Richie and Richmond had independently arrived at an average cost of $43.00 per month per unit. This cost estimate included travel, vehicle rental, batteries, operator's salaries, remote control lines, and purchase of AC power.

At that time (1952 - 1953) it was usually necessary to use two antennas, separated by distances of about 75 - 100 feet. * As a result of previously described cooperation between engineers and landscape architects, antenna towers, when they could not be hid, were put in places so as to be least obtrusive to viewers and photographers. In more recent times (after about 1960) repeaters were installed with a single antenna in most cases.

Equipment manufacturers were not responsive to the need for special test equipment for maintaining government-owned facilities by the Forest Service and National Park Service. One of these needs was for battery testers; the ones offered on the market tested batteries which were used for receivers, but did not test batteries under load conditions that would be placed on them if they were to be used for transmitters (of which both agencies had many). Therefore, the Forest Service manufactured battery testers, which could be furnished to and used by both services. (68) This was only one instance of interagency cooperation which has existed between the technical personnel of both bureaus.

In spite of the 1952 attempt to recruit NPS personnel to serve as technicians, obtaining qualified radio technicians for the field areas was not easy. Many otherwise-qualified persons were not cut out for managing and maintaining a complete system by one's self. Others could not stand the strains of difficult hikes or handle horses to reach remote repeaters. Some objected to the necessity of extra unpaid hours. Those that stuck with it were highly motivated individuals, often being ham radio operators or ex-mobile servicemen. Such persons "grew up" with radio. It becomes their whole life. While the work is highly technical, the "hands-on" type of work did not appeal to degreed engineers. Al Loew of the Forest Service Washington Office agreed; ". . . believed these men [field technicians] knew more about radio than most graduate engineers."(69)

Maintenance procedures for newly-installed FM systems were determined by each technician. Many quickly learned that by monitoring their system while working in the shop, or while driving between sites, they could determine what stations (repeater, base, portable, or mobile) were not operating properly. To do this involved counting "squelch-tails"; determining if all base, portables and mobiles were distorted or noisy, or just certain ones; asking an operator of a certain unit to raise or lower his (or her) voice; and other ingenious methods of system analysis. Very often, such analysis, done while traveling between sites, would enable the technician to proceed immediately to correct the problem upon arrival at

* This separation was necessary to prevent the repeater-transmitter from degrading the receiver sensitivity (desensitizing). The result was reduced coverage and flip-flop (on and off) operation as the received signal energized the transmitter, only to be lost when the transmitter was activated. The transmitter would drop off and the signal would again be received, only to have the cycle repeated again and again, creating the chop-chop effect. By the 1960's duplexers were developed which enabled the repeater-transmitter and receiver to operate from one antenna without sacrificing performance.

a site. The author recalls one technician, however, who never turned on his mobile receiver whenever I rode with him. I asked him why he did not, thinking he could learn where and what system deficiencies existed. He replied he would not do this because "listening to all the talk disturbs me"! Consequently, that technician was not knowledgeable enough about operating procedures used by the personnel to give advice as to the best use of the system. Neither did he have a "handle" on the state of performance of individual stations. Performance of, and use of, his system was less satisfactory than other systems.

Throughout the period that tube-type equipment was in use, 1952 to about 1968, there were differences of opinions regarding tube testing. Some technicians were of the opinion that it was detrimental to remove tubes from their sockets for testing, deferring any action until meter readings showed a degradation of performance of the transmitter or receiver in which the tubes were placed. Other technicians would test tubes periodically, without any special procedures. Still others were more sophisticated. They used tube checkers, but tested each tube at a lower filament voltage (for instance a 6.3 volt tube would be tested at both 6.3 and 5 volts). It was contended that if there was an appreciable drop in mutual conductance at the lower voltage, the tube's performance was likely to deteriorate during the next several weeks (based on 24-hour operation).

A recap, made in January 1953, listed 80 NPS areas which had radio systems, of which 7 obtained their maintenance by contract and 73 were maintained by NPS personnel. Of the latter, 39 obtained "routine maintenance by NPS personnel. Emergency repairs and maintenance were obtained locally."(70) Notes attached to one of the references indicates that the cost of operating the Mount Rainier radio system in FY 1953 was $12,818.00.

Some of the problems with maintenance of leased radio systems are discussed in the section on negotiations.

Power Supply Problems

In chapters one and two we saw that NPS was on the forefront in the development and use of low-power two-way radio. In chapter two it was noted that NPS attempted to use wind power for certain installations. In this chapter are recorded early use of thermo-electric generators and solar energy for powering repeaters.

Until transistorized equipment became practical in the late 60's, power supply for tube-type repeaters was a problem. In some instances the source of power was more responsible for repeater outages than in the radio equipment itself.(71)

If AC power could be made available at a repeater site, it was to be preferred. Overhead or underground extensions of secondary lines were sometimes made for this purpose. However, early underground primary-voltage extensions were fraught with problems, both in plastic insulated non-armored cable reliability (manufacturers still had problems making fully reliable high voltage cables), and in their installation. Crews could be told to backfill

with "fines" directly over the cable, before backfilling with native rock and/or soil; however, they did not always fulfill the instructions, resulting in damage to the cable due to rocks. Electricians who had no experience with high-voltage cable requiring stress cones at terminations would treat the terminations with techniques suited to 600-volt cable. They didn't hold up very long!

The problems with the power and telephone cables to Apgar Lookout at Glacier National Park are good examples. The electrician was (1953) betting his friends that we would never get power to Apgar lookout because "you just cant push power through a single-conductor cable"(even though it was shielded, and was grounded at each end). Yet he had for years operated telephone lines with a single line wire and ground return. Well, we didn't get power at first and the primary fuse blew with gusto. Not until I personally had remade each splice in the power cable, replacing the 600-volt-type splices which had been made! The telephone cable didn't work either, until investigation revealed that the terminals were made up with split pairs.

Where it was not feasible to extend commercial power, and low transmitter power would be inadequate, several schemes of generating power were used. The problems in keeping 5 KW Witte diesel generators working in the hot weather at Death Valley have already been mentioned. Vibration problems were experienced with both Fairbanks-Morse and Witte single-cylinder generating units at Olympic, Mt. Rainier and Sequoia. These engines had massive flywheels to reduce speed fluctuations between power strokes, and called for large concrete base-blocks to further reduce vibration. Evidently at these areas the soil was spongy, permitting the generator unit and base block to vibrate excessively.(71A)

Another method was attempted to supply power at Dinosaur(72) and Olympic National Park by installing 32-volt batteries and a farm-type Delco or Kohler gasoline-driven charger which would charge the batteries whenever they reached a discharge point. The 32-volts were converted to 110-volts AC by a rotary convertor. The results were unsatisfactory because, whenever an incoming signal triggered the transmitters, the heavy current drain imposed by the convertor made the batteries appear to be discharged. Consequently the charger cycled every time the transmitter was keyed. The frequent cycling caused excessive gas consumption and did not allow the engine to reach full operating temperature. After a few days use the muffler and exhaust would be clogged with carbon and soot.(73)

At Joshua Tree, reasonable success was obtained with a thermo-electric generator. A propane flame provided the heat for the thermoelectric converter which in turn charged storage batteries. This arrangement furnished power for a 50-watt mobile unit which had been modified as a repeater. Thermo-electric generators were also used in conjunction with storage batteries for power sources at remote locations like Mica Mountain, Happy Valley Knoll, and Manning Camp in Saguaro National Monument.(74) Subsequent development of repeaters which required less power, and improvements in solar cell technology, resulted in the demise of thermo-electric generators as a viable power source.

Where low-powered repeaters (1 to 5 watts) could be used, dry-batteries were used. The early VHF-AM tube-type repeaters built by the Forest Service for wartime AWS stations (described elsewhere) used #6 dry cells in parallel for A battery and #6 dry cells in series for B power. It would take a technician most of a day to remove and make the multitude of screw connection on as many as 200 dry cells. Later repeaters used several large 3-volt A batteries in parallel and 45-volt B batteries in series-parallel. These batteries had plug-in connectors, making installation of new batteries a simple operation. Both types of battery systems involved disposal of the old batteries which could result in a sizeable heap after a few years operation. Most technicians, in true NPS tradition, were conscientious in finding a location for disposing of these batteries which was not aesthetically objectionable.

After WW II, nearly all mobile vehicles were furnished with 12-volt starting systems, replacing the former 6-volt systems, cutting the current-drain of electronic equipment (and sirens, flashers, etc.) in half. However, until transistorized transceivers became available, the auto charging systems were not always adequate for 50-watt transmitters:"Chevrolet cars equipped for taxicab service are provided with special generators that have a maximum charging rate of 40 amps at 22 mph . . . There is also a 50 amp generator available for state police 2-way radio which does not charge when idling, but reaches maximum charging rate of 50 amps at 26 mph."(108) However, GSA refused to order the large generators for vehicles, even where requested at the time the vehicles were requisitioned. Later, when transistorized units became available no special generators would be needed. In fact most recent users wire the power so that the radio unit is turned on any time the ignition is on.

While these developments were occurring, visionary engineers were recognizing the possibility of radically new techniques in system design, especially repeaters where commercial power sources were unavailable, Daniel Noble, "father" of Motorola two-way radio, predicted. "Either a sun-powered battery or an atomic battery to supply power for remote radio installations would be extremely useful. The low-power-demanding characteristics of a transistor provide new dimensions with which to work . . . It is easily possible to predict the use of such solar power conversion devices . . . for powering isolated radio reporting equipment, and particularly for the operation of forestry service receivers and transmitters, and automatic relay installations." (75)

Mr. Noble's prediction came true a few years later with NPS being among the first to adopt solar power for some radio repeater stations. Neither would it be long before transistorized portable units became available. Development of such portable units was "kicked off" by invention of the transistor in 1947 at the Bell Laboratories.

Relationships With Other Agencies

Chapters one, two, and three have already provided some examples of interagency cooperation. Intercommunication with other agencies has been a necessary function at many Service areas. This created problems at the time of conversion to VHF-FM at Glacier Bay. When the private and government vessels were required to replace HF-AM radio with

VHF-FM radio, communications with Coast Guard stations and private vessels were conducted in the 152 - 162 mc band, but the NPS frequencies were in the 162 - 174 mc band, requiring two separate transmitter/receivers. However, by the late 60's manufacturers had recognized and solved this problem by creating single broad-band transmitter/receivers that could operate on a number of frequencies anywhere between 152 and 174 mc.

Grand Canyon, in 1957 operated an AM station at its headquarters to provide an outlet for the Geological Survey's river-gauging station at Bright Angel.

The so-called "cooperation" by private boat operators (reported elsewhere) was in direct contrast with interagency and/or interbureau collaboration which was sometimes necessary where there were common areas of responsibility. One example was the Los Angeles Department of Water and Power whose vessel was authorized to use 2926 kc to contact Lake Mead National Recreation Area headquarters when necessary.(76)

Organ Pipe Cactus National Monument has a multiplicity of radio needs, brought about by its lack of telephone service. The 40.97 mc frequency used for its own needs, was impractical to reach either SWAC (5150 kc was used for this) or the coordinating superintendent at Saguaro (2770 kc was used for this). This still left the Monument without communication with nearby law/emergency authorities. Accordingly another transmitter/receiver on 39.18 mc was installed to communicate with the sheriff at Ajo, Arizona.

This period experienced a growth in use of VHF-FM radio by many established and new users: aeronautical, public safety, transportation, industrial and others. Some of these users established radio networks to cover vast areas or long routes, which resulted in pressure by these groups to establish repeater sites on strategically located mountain tops. The Service was not exempt from such demands.

The demands became insistent for use of sites at which the Service already had repeaters for its own use. The availability of electric power and/or 4-wheel-drive access made these sites especially attractive to other interests. Federal regulations were specific in that park lands could not be used (a) where land outside the park could be used, and (b) for purposes that are not related or necessary to administration and/or protection of the park area. Some of the more insistent applicants had to be shown locations outside the area which would be suitable. One example was an application by the Telephone Company for use of a site in Joshua Tree National Monument in 1953 for its mobile telephone service. With the aid of topo maps, the writer provided data whereby the Superintendent denied the application for a Special Use Permit on the basis that a mountain outside the park would service the Telephone Company's needs satisfactorily.

Another example of the pressures that can be exerted is that of Park Point Lookout in Mesa Verde National Park. Power, access road, and an excellent position for covering areas to the west, north, and east would have made this location ideal for many radio users in southwest Colorado. In about 1956, the writer inspected the leased FM system installed by the

Telephone Company for park use and learned that the REA power company, and a law enforcement agency already had repeaters there, justified by mutual concerns with the park. At that time there were several other companies and agencies interested in using the site. Again, the writer provided the Superintendent with data on another site outside the park that could be used by those desiring to use Park Point. He was also informed that the possibilities for interference to any of the repeaters goes up approximately as the cube of the number of stations involved. (77) Avoiding interference at a site with many repeaters is a prodigious job.

Not only does the law and Service policy require the Service to be extremely careful about use of radio sites for its own use, and to avoid issuance of Special Use Permits to other users (with a few specified conditions under which a permit can be granted), but the Sierra Club has monitored the Service's compliance from time to time.(78) The pressures for use of sites were cited to the Director "these implications involve not only the Telephone Company, the radio lessee, but Highway Departments and other agencies which have activities both within and without national park areas, community TV antenna installations or 'bouncing' apparatus whether to serve employee communities in the parks or for private individuals outside the parks . . . "(79) The same memorandum went on to discuss language in a typical Telephone Company contract regarding the buildings and rights of way intended for in-park use, but which might be used by the telephone company to become leverage for serving users outside the park from the same facilities if not carefully administered.

The Washington Office was also concerned that users, where authorized to use a common site do not "have two building and/or two sets of towers . . . it will be necessary for whichever organization is the latecomer from a contractual standpoint to make arrangements with the predecessor company for joint use of building [and] tower facilities." (78)

Operations and Interference

Over the years uses of radio (especially two-way) have been varied and are subject to many types of conditions, individuals, and interference. The following discussion will give the reader an overview of operating experiences and practices, and some of the problems experienced along the way.

Operating procedures evolved as transmissions progressed from the weak, noisy, oftentimes fading, and/or distorted voice signals to the clear, sharp, intelligible signals that developed as systems were improved. The improvements are primarily the result of using the VHF frequencies together with frequency-modulation (FM), but the latter were still vulnerable to interference which can happen in various ways.

Early call-up procedures would go something like "KGYA, Longmire, calling KGYC, Paradise (repeated several times), go ahead." The calling operator would then twist various knobs, attempting to tune in the reply. Sometimes the changeover from send to receive, or

vice versa, would involve operation of one or more knife type switches. If contact was established, each transmission always ended with "go ahead" since the background noise did not always change when the other station ceased transmitting. When FM systems were established, it was possible to drop the "go ahead" and most of the times it was only necessary to give the call-up once. It soon became more efficient to give the call of the desired station first in the call-up. Some areas changed to simple numbers or used names in the callup, giving the IRAC-assigned call-letters at the end of the conversation to meet IRAC/FCC requirements.

In the thirties, areas were assigned "blocks" of call letters to cover all their radio stations. For example KGYA through KGYI were assigned to Mt. Rainier, with the first call-letter being assigned to the headquarters station.

Periodically, as the number of both government and non-government two-way users increased, the FCC/IRAC revised the system of call signs. It is not known just when the first change in call letter systems was made, probably between 1938 and 1940. Again, four-letter calls were assigned, however only one call-letter was given to each park which was to follow the call-letter with either a location name or unit number. Thus Mount Rainier calls became KNJS-1,2,3,etc. This system avoided running out of call letters for the entire USA. It also permitted additional stations to be added without receiving out-of-sequence calls which would occur under the old system.

In the fall of 1951, the system was again changed.(81) This time (except for boats and mobiles) the calls consisted of three letters, followed by three numbers. Blocks of numbers were assigned to each area, presumably enough numbers to give one for each existing and future station. The letters for all users (including private services) were in blocks for specific sections of the country, and numbers were in blocks for different users or agencies. Thus Mount Rainier's calls KOD-715,716,717, etc., identified the stations as being Department of the Interior stations in the Pacific Northwest.(82)

Call letters for portable and mobile units, during the 1950's, were "two-four" calls, made up of two letters (K being the first letter, indicating USA), followed by four numbers. Attempts to have each mobile or portable unit recorded with serial and license numbers, and assigned its own call, ran into resistance. "Usually two of these units are held in reserve and used for replacements . . . to assign a specific call-sign to a radio unit which had to be used in a certain vehicle would certainly complicate maintenance for use . . . they may be removed from a vehicle and mounted on a packboard for portable use."(83)

A discussion of keeping radio logs is included in the section on Radio Management and Regulations.

During the early post-war-years, operations were peppered with military-style expressions and procedures. However, the gradual conversion from high-frequency AM to VHF-FM resulted in the decline of their use. Transmissions were more clear, and it was self-evident

when a transmission was completed, so it was unnecessary to use "over" "roger" "over and out", and the like. Instead, some areas commenced adopting a "10-code" similar to that used by police. This is a system whereby some transmissions could be shortened from a complete sentence to a number which carried the meaning of an entire sentence. It also achieved a level of confidentiality from casual listeners. However, some areas experienced problems in using the 10-code where large numbers of seasonal employees were using the radio systems. (the 10-code required memorization).

It may be surprising to the reader to learn that, in spite of the "wind-down" during the post-war period, CONELRAD (described in Chapter three) was required as late as 1954. The requirement was brought to the NPS attention when it could not be decided what to do about continuously-operating radio transmitters that were part of the telephone system at Mount Rainier. Compliance with CONELRAD during alerts would interrupt critical telephone service to and from Mt. Rainier National Park.(84) With the passage of time, less and less attention was paid to it. The last mention of it, was a test alert called on June 16, 1956. NPS stations were requested to submit reports on the test. A total of 78 park areas participated and submitted test results.

As VHF-FM came into its own as the basis for intra-park communications, the question arose as to low-power versus high-power for repeater links. High-power provided brute force which would cover greater distances, with the possibility that fewer repeaters would be required to cover a large park area. It would also avoid the problem of servicing and providing power for many mountain-top repeaters. Ultimately the advent of transistorized units, solar cells, and the availability of the helicopter resulted in the use of low-power repeaters located on higher peaks. This was a fortunate circumstance, because it enabled IRAC to grant low-power assignments on a single frequency to several widely-separated parts of the country. This would not be as feasible with high-powered repeaters which would add to the frequency "crunch".

A troublesome operational problem involved private boats and/or concessionaires on NPS waters. While the record cites incidents on Lake Mead, it probably has occurred on other waters such as Lake Powell. The problem is that NPS has had no authority to provide shore-station service on marine frequencies. Nevertheless, some boat owners managed to switch to a NPS high-frequency channel: "He called twice in the morning - wanting information on the weather and where the good fishing is . . . Then he would radio in (several times), saying that the lake was awfully rough; that the roof of the boat was leaking; and so on and on . . . We concluded he had some jittery passengers aboard. Finally, about 4:50 pm my patience was wearing pretty thin from hearing so many unnecessary calls. I said 'we can see that you are all right, and let's stop crowding the air'. He . . . wanting to know if we were going to be on the air at night . . . I said we are closing the station and this is KOD 759 signing off."(85) This was followed by a memorandum to the Regional Director, outlining the contacts made with the "Barvinhill", requesting that the owner remove the 2926 kc crystal from his transmitter. A letter had also been written to the registered owner of

the Barvinhill. The Region was advised to forward all information regarding this problem to the Director with request for action by the FCC and IRAC.(86)

This "cooperation" by private boat operators was in contrast with the efficient and proper cooperation exemplified by other government agencies as described in the section on relationships with other agencies.

Authorization for Department of the Interior radio stations are granted under specified circumstances(87, page 6) which does not provide for any situation where telephone is available (except when it is out of order). However, during the 1950's many of the smaller areas operated under a "mother area" administration arrangement and a few parks had administrative facilities outside the park. Under these conditions, and with severely curtailed appropriations, it was tempting to use radio between areas, and between areas and their remote headquarters. For instance "The Medford station is our principal means of contact between park headquarters and the fiscal and administrative operations at Medford . . . The Superintendent is kept informed of operations at the park and issues instruction or secures information for answering correspondence during the time he is residing in Medford. This station also links the Chief Clerk, the personnel and accounting sections with operations in the park . . . The only other means of communication between the two offices would be by long distance telephone toll calls. Substituting this means of maintaining contact would be very expensive and the service is very unsatisfactory and undependable."(88) This was in 1955 when Crater Lake maintained administrative headquarters in Medford, Oregon, but found that telephone lines were very unsatisfactory; so was AM radio. By borrowing FM units from Olympic they were able to establish interoffice communication. Appeals to the independent, telephone company were fruitless. It appeared that the financial condition of the company did not provide for investment in improved facilities.(89)

However, there are legitimate situations where radio must be used because of the absence of telephone lines. In addition, during the early post-WW II years, funds were not available for VHF equipment. The North Rim-to-South Rim needs at Black Canyon of the Gunnison was a typical example, when it was desired to continue use of 3215 kc because of lack of funds for a VHF system.(90)

The Forest Service, because of its more extensive forested areas, was also vitally concerned with communication facilities for large fires, including the possibility that large fires could occur in NPS areas as well as in FS areas. In 1947 "Region 1 [Forest Service] had been developing a Regional aircraft network for months. Separate application had been made to IRAC to include the National Park Service at Yellowstone and Glacier National Parks in the network. In consideration of Region 1 agreements with the Park Service which funded 12 smoke jumpers, the application was somewhat reluctantly approved. Maximum power was to be limited to 125 watts [HF AM]. Glacier was to communicate only with the Forest Service, and then only in an emergency jeopardizing life, public safety or important property under conditions calling for immediate communication where other means of communication do not exist or are temporarily disrupted or inadequate."(91) It is this type

of cooperation that would ultimately result in the creation of the Boise Interagency Fire Center (BIFC) described in detail in Chapter Five.

After WW II a number of small Southwestern National Monuments were coordinated with headquarters at Globe Arizona, now known as the Southwest Archeological Center (SWAC). Most were so remote that they did not have telephone lines. Their distance from Globe headquarters was too great for them to be reached by means of frequencies between 2.5 and 3.5 MC during normal working hours. A frequency of 5150 kc was assigned to this group. We have already described the devious means to improve surplus military equipment which was used by some of these areas for transmitting and receiving. An attempt was made to establish daily contact with all Southwest Monuments at 8:30 am, but it was not always successful.(92) The low-power radiated by the improvised transmitters, coupled with "skip" effects at times, meant that communication was only partially successful. Often one monument would have to relay another monument's transmission.

Interference from Mexican stations (nicknamed "Bean Bandits") and shrimp fishermen (from unknown country) was another obstacle to the use of 5150 kc by the Southwestern Monuments. Since the Spanish-speaking stations were very strong and voluble it was sometimes necessary to postpone contacts for a half-hour or more.

Throughout the development and maturation period of two-way radio, interference of one kind or another has been troublesome. Few people realize that the frequency spectrum is a resource that has limitations. Fortunately, through laws enacted by Congress, and regulations promulgated by the FCC and IRAC, a reasonable distribution of assignments has been made to various users, with priority being given to military, emergency, law enforcement, and safety activities.

As use of the radio frequency spectrum increased, the potentiality for interference on the high-frequencies became enormous, between different services, and over long and/or short distances. The western areas were supplied in 1954 with recommended precautions to prevent interference and suggestions for identifying sources of interference.(93)

Interference from stations operated by non-NPS users can occur by several methods and under various circumstances. Only a few are described in this journal. The simplest form of interference occurs when more than one agency is assigned to the same or adjacent frequencies in the same local area. This is usually avoided by careful coordination between the designing engineers and the IRAC/FCC authorities. This sometimes became difficult for agencies near the U.S. borders, because of the need for coordination with the Canadian or Mexican government, through the State Department.

On the high-frequencies, interference from distant stations can occur in the twilight and dark hours. The "skip" phenomenon develops during those hours due to changes that permit reflections by the Kennelly-Heaviside layer in the upper atmosphere. Very-high-frequencies are generally considered to follow line-of-sight paths, with bounce possibilities from local

terrain. Most of the time these frequencies are not reflected by the Kennelly-Heaviside layer. However there are occasional times when the "skip" effect on VHF will occur during daylight hours. It may happen at sporadic intervals of a few minutes or hours. When it does, it occurs in the lower portion of the VHF band rather consistently during the fall, winter, and spring months during the peak years of the 11-year solar cycle. Most of the VHF interference reported in this book happened during the 1957-1958 peak of the solar cycle. There was no way this interference could be prevented in those cases where the interfering station is co-channel.

Interference, particularly between different users or bureaus, is most often aggravating. In critical situations it can be disastrous, especially when interference is caused to aeronautical navigational aids. But in the day-to-day use of radio systems, the users are frequently oblivious to the possibility that their transmissions may be heard by other agencies, and that they may interfere with the other agency's use of their systems, whether over long and/or short distances.

It can sometimes have its humorous moments. One such instance is recalled in which propagation conditions "opened-up" for a few hours each day so that Mount Rainier National Park in Washington state and TVA in Tennessee stations could hear each other on their common frequency in the 30-42 MC band. One Sunday afternoon a skier was buried by about fifteen feet of snow in an avalanche at Mount Rainier. Communication between the rangers who were probing the snowslide to locate the victim was vital to coordinate the search efforts in their attempt to find and release the trapped skier. However, their conversations were blocked by TVA stations conducting routine business about time-sheets. A telephone call was placed to the TVA dispatcher to request that they postpone their traffic. When the dispatcher was told why the request was made, he was so enthralled by the reported snow (which he had evidently never seen) that he persisted in asking all sorts of questions, completely forgetting that the reason for the call was to request that TVA vacate the frequency to enable prompt rescue of the skier!

Unfortunately, through carelessness, bad planning, propagation anomalies, or similar circumstances, interference between various users does occur at times. Determination of the location and identity of interfering stations is often difficult. The "low band" (30-42 mc) repeaters at high elevations in Olympic, Mt. Rainier, Yellowstone, Blue Ridge, and others were particularly susceptible to mobile operations in areas which IRAC had thought to be adequately removed to be of no consequence. For example, military operations at Fort Lewis, Washington would "capture" the repeaters at Olympic and Mt. Rainier(94), breaking into the Park's operations.

The 1957-58 solar peak resulted in other situations where stations can be heard over a thousand miles away, a condition not normal; Sequoia and Organ Pipe Cactus were in contact on one occasion. On another occasion Yosemite was heard at Olympic National Park via a repeater at Mount Rainier.

Military interference was not always voice, some of it originating in teletype circuits in Labrador and Greenland.(95) Other examples are high-speed teletype from stations of the DEW-line network in the Arctic and the second harmonic of WAR (Army) teletype at Washington, D.C.(98)

During May, June and July, 1958, Mt. Rainier was plagued with interference from U.S. Army operations in connection with ship movements thru the Panama Canal. The Army replaced its equipment, but the interference persisted (being assigned 32.04 mc frequency).(96) In addition to the Army interference their log also shows interference from Sequoia National Park and from Lake Mead National Recreation Area.(97)

Military field operations often used tactical calls that were hard to trace, since they are usually determined by the area communications officer. They were particularly bothersome when they occurred on a frequency which resulted in the interference being broadcast (repeated) on all the repeaters through a large park system.(99)

Interference does not have any regard for international boundaries, although the U.S and Canada work together in an attempt to prevent it along their borders. However, it was not avoided when British royalty visited British Columbia in 1958. Being directly across the Straits of Juan de Fuca, Olympic's system was virtually useless during and following the visit of the Queen(100) and Princes Margaret.(101)

Even when a supposedly clear HF frequency assignment has been made by IRAC, there was always the possibility of proposed new or expanded operations by other users which would encroach upon it. In 1959 the Army proposed and was evidently authorized to"increase the power of their radio station from 0.5 KW to 3KW" on 3241 kc at Cold Bay, Alaska. This was only 4 kc from NPS frequency 3237 kc used in the Alaskan areas.(102) At the proposed power and frequency one would expect interference to NPS operations, but evidently the geographical separation and/or hours of operation were such that no report of interference was made by the Alaskan park areas, although Glacier Bay reported interference from the "Juneau Army Station which we presume is part of the same net."(103)

Another possible encroachment was the assignment of 3230 kc (7 kc from the Katmai and Mt. McKinley 3237 kc assignment) for "100 watts maximum antenna power for State of Alaska use at various locations."(104) It was expected that if interference occurred (none did), a change to single-side-band (SSB) would alleviate the problem.(105) This was the precursor of plans to eventually convert all Alaska HF operations to the SSB mode.

Low-band FM receivers were not as immune to electrical interference as high-band receivers. Automobile generators (which preceded the modern alternators) were a source of variable whine (its pitch depending on engine speed) usually in both transmission and reception. Special low-pass filters had to be installed to eliminate the whine. The receivers were also susceptible to interference from the vehicle ignition system. Spark suppressors and sometimes shielded or resistance - type spark plugs were needed. Stubborn noise

sometimes required special bonding of hood, motor block, etc. However, according to some mechanics, these devices were the "cause" of engine trouble and would be gleefully removed (or so it seemed to the radio technicians) as the first step in repairing or tuning up an engine.

Low-band repeaters installed in the vicinity of ranches sometimes experienced puzzling intermittent noises which could be traced to irrigation pumps. The steady pop-pop of an electric fence might disable a repeater at distances up to a mile away. In one case the fence acted as an antenna to radiate the noise a greater distance- reminiscent of the spark transmitters of the 1910's. Because of the higher frequency and technical developments in automobiles and in receivers, VHF-FM systems seldom experience the electrical interference just described.

Emergency Uses

The winter of 1953-1954 was a period of review of NPS's capability of dealing with emergencies, especially fire. A report "describes the very serious handicaps to effective action on fires where communication is inadequate. Similar serious problems are encountered in other areas where communication facilities are inadequate to meet recognized needs during critical emergencies, both fire and other." The Washington Office requested "top priority requirements to meet minimum communication needs, particularly in areas experiencing the most serious communication handicaps."(106)

There was concern about the Service's ability to provide adequate radio communications for large emergencies such as project fires, large rescues, and natural disasters. The Washington office (in 1954) became concerned about the availability of sufficient portables for this purpose and proposed the rental of emergency radios from manufacturers.(107) Each area had a limited supply of portables for their own emergency use; however, none of them could afford to stock, maintain, and keep enough radios and batteries that would be needed for a major disaster. Consideration was given to stocking crystals on home-park frequencies so that units borrowed from other parks could be used on the local park frequency.(108) This proposal had technical limitations and was objected to by the Superintendent Olympic because "in such an emergency we believe the Mount Rainier equipment would be of greater value to us if operating on Mt. Rainier's frequency. This would eliminate a part of the load that our frequencies will inevitably have in the event of such major emergency . . . Contact into our nets would be by manual relay at the fire camp or ranger station if needed."(109) Arrangements had also been made to lease a few low-band FM units. Because of the possibility of use in remote areas and/or aircraft, these units were supplied with 3/4-wave flexible antennas and aircraft noise-reducing headsets.(110)

Consideration was being given to "covering the more serious emergency conditions with a minimum of investment and probably this proposal anticipates obtaining equipment on a lease or rental basis . . . The proposal . . . has limited possibilities for initial attack on fires . . . the equipment to be obtained will be most useful during the peak activity and follow-up

stages . . . it may be more satisfactory to store standby equipment at this office [San Francisco] and/or some of the parks that have technicians who would be available to go with the equipment and establish the necessary stations and relay equipment"(111)

But this plan was not easy to put into effect. Any plan involving borrowing portable equipment from one park, to aid in large fire situations at another park would jeopardize the first park's capability. "The two radios assigned to trail crews could not be available until contact could be made and men sent out from the back country with the sets . . . eleven of these are distributed between districts, rescue caches, fire caches, lookouts, . . . It may be seen therefore that an adequate emergency network calling for the use of handie-talkies could not be provided on short notice."(112) The same memorandum points out, concerning storing equipment for emergencies at a central point: "The time required to move sets from the Region to Mount Rainier, for example, would remove such radios from the category of emergency equipment" and "The equipment would be of doubtful value unless extra crystals were available to fit these sets into the park's frequency." Also: "if the dispatched sets were of an entirely different frequency [band] . . . the communication network might be more complicated than relieved." (This is in contrast to Olympic's above-mentioned opinion that a separate frequency for use during fires is desirable.)

While there were a few instances of undocumented loans of equipment between some areas in special circumstances, no concrete plan was ever fully developed. It was concerns such as these that triggered the proposal that eventually caused the establishment of the Boise Interagency Fire Center, which is discussed elsewhere.

By this time airborne fire detection, search-and-rescue, and manpower movement operations had become an accepted practice. However, cabin-noise in aircraft often overrode voices when using portable units. This was overcome by using an aircraft headphone-microphone assembly made for this purpose. In those instances where metal fuselages prevented effective use on the antenna normally used with a pack set, a quarter-wave antenna was installed on the external members of the plane and a coaxial cable with plug was provided to connect the antenna to a pack set when needed. This enabled any portable unit to be installed on short notice.

Management and Regulations

Ever since the inception of radio use in the park system, many non-technical personnel had the impression that the radio frequencies being used were assigned by the FRC (later to be named the FCC). This is true for radios used by non-government (non-federal) users. The assignment of frequencies involves treaty agreements with members of the International Telecommunications Union, and complicated technical considerations which are discussed at appropriate times in this account. Frequencies for NPS use and for other federal agencies were assigned by the Interdepartment Radio Advisory Committee (IRAC) which was composed of 11 member agencies and was created in 1922. Representation by the Interior Department is rotated between agencies. C.D. Monteith, a utilities engineer for

NPS served from 1938 to 1942. A departmental publication(113) summarized the function of NPS radio in 1952 as follows:

> "In addition to providing fire protection and control, much of it in rugged and inaccessible areas, the National Park Service is responsible for the safety of field personnel and the considerable number of travellers (nearly 37 million in 1951) that visit the national parks each year. Intra-park radio communication and communication to portable and mobile units are an integral part of the National Parks system."

Among the many functions of IRAC are the assignment of frequencies and the issuance of call letters. These important functions are necessary so that all licensed users can have reasonable assurance that they can use their radio facilities without interference from others and that their use will not interfere with other users. In spite of careful planning and technical standards, the possibility of interference always exists. It is because of the latter that proper use of call letters is important. Through an international registry at Berne, Switzerland and the registers of individual countries, it is possible to identify any interfering station, if the latter gives its call letters.

In the section on radio systems there is a discussion of the development of the Alaskan area radio systems. During the development period, correspondence indicated that the Washington Office and the IRAC representative did not comprehend the need for Katmai to have a 3277 kc (an Air Force frequency) assignment to be used to communicate with the Alaska Communication System (ACS) station at King Salmon. They also questioned the need for a 3385 kc assignment for Mount McKinley headquarters to contact ACS at Anchorage.(114) These frequencies were the only means for Katmai and Wonder Lake (in Mt. McKinley) to communicate with the outside world and for Mount McKinley headquarters to reach the outside in the event of failure of the Alaska Railroad's telephone line, a not infrequent event. Eventually Glacier Bay, Wonder Lake, and Mount McKinley headquarters were authorized to use 3385 kc to work into the ACS "bushfone".(115) The latter consisted of a number of base stations which could provide a "patch" to long-distance lines. This was more satisfactory than two-station point-to-point links because of the erratic effects of Aurora Borealis on high-frequency transmissions, sometimes wiping them out for hours, sometimes days. At other times it might not be possible to contact a specific station on a point-to-point basis, but conditions sometimes permitted one station to contact one random station out of the many bushfone stations that may be listening.

Superintendent Pearson also included national defense as additional justification for the 3385 kc assignment at Mount McKinley.(116) An additional benefit from the 3277 kc assignment at Katmai was that King Salmon ACS would be able to connect Katmai with Superintendent Pearson (via ACS telephone), under whose supervision Katmai functioned. However, in 1957 Superintendent Jacobs (vice Superintendent Pearson) requested an NPS frequency for direct communication between Katmai and Mount McKinley headquarters.(117) He also pointed out that ranger stations at Eielson, East Fork, Moose

Creek, Toklat Flat, Lower Savage, Lower Windy, and Igloo should also have 3385 kc assigned so they can contact ACS for emergencies which might occur during hours that McKinley headquarters is not monitoring the NPS 3237 kc frequency.(118)

Because of the great distances and mountainous terrain that is involved in Alaska, the Service was allowed to continue use of high frequencies several years longer than the areas in the "lower 48". This was not without problems, however. IRAC authorized 5287.5 kc for communication between Katmai and Mount McKinley but the Interior Dept. representative suggested that NPS consider sharing the use of 5195 kc with the Bureau of Public Roads (BPR) instead. It was indicated that sharing of frequencies between the Bureau of Public Roads, Bureau of Land Management, National Park Service, and Fish and Wildlife Service would be advantageous (from the spectrum conservation standpoint). Acting Superintendent King's response was "After considerable monitoring of the Bureau of Public Roads 5195 kc frequency, we have no wish to attempt sharing this frequency as their [BPR] use of it [is extensive] and we feel certain that it would prove unsatisfactory to both agencies . . . There seems to be little question that we shall never be able to operate jointly with the BPR [the writer meant BLM] on the 5287.5 kc frequency . . . It was noted that the BLM had to be very restrictive in their use of this frequency because of the heavy traffic imposed on it."(119) In June 1957, the BLM had in excess of 70 going forest and tundra fires, tying up 5287.5 kc which they were sharing with Mount McKinley and Katmai. The Superintendent of Mount McKinley was embarrassed when it was called to his attention that his use of the frequency to work Katmai was authorized for emergency only.(120) When BLM objected to NPS use, a flurry of activity ensued in the search for another frequency for NPS use.

In the day-to-day use of radio systems, the users are frequently oblivious to the possibility that their transmissions may be heard by other agencies, and that they may interfere with other agencies' use of their systems. Even less thought is given to the existence of "policing" by the FCC. Occasionally an event would occur that would remind users of these conditions. Such as the time in 1953 when a "home-ground" crystal was prepared for 5150 kc use at Lake Mead, but it was not within regulatory tolerances. The infringement notice resulted in closing down the Lake Mead station until a new crystal could be ordered.(121)

Because of the long-range night-time transmission capability of frequencies between 2 and 10 mc, IRAC could not assign frequencies exclusively to individual users. There just weren't enough to go around. As a consequence many assignments to NPS areas were on a shared, secondary, or subject-to-coordination-with-other-users basis.

Logs of radio transmitter use were required from the earliest days of radio. This was not only required by IRAC/FCC, but it was a useful tool which could be used to determine which of several suspected stations were on the air at the time interference was experienced. This was an international requirement.

The original method of logging each contact became cumbersome as the use of radio increased. By the late 50's it became acceptable to log the time of beginning and ending of any series of transmissions with a listing of the call letters of all stations contacted during that series.

Beginning about 1954, the logs became important for another reason. Competition for radio frequency assignments had become so keen that non-government users were pressing the government to yield some of its frequencies for non-government use. "In order to protect [defend] and provide for Interior Department radio services . . . it will be necessary from time to time to call for frequency-usage data . . . Frequency usage and activity expressed in numbers of hours per month during which transmissions are actually made on the frequency."(122) The logs also proved very useful in post-mortem reviews of emergency operations.

As late as January 1960 there were still some HF frequencies assigned for AM use. At that time WASO questioned the need for 2770 kc, 5150 kc, and 34.78 mc at Saguaro, their hi-band system being operational. 2770 kc and 34.78 mc were canceled, but 5150 kc was still in use for contacting Chiricahua and Coronado, two areas which did not have reliable telephone service.

The conversion from HF AM to VHF-FM was several years later in Alaska than it was in the "lower 48". There were several reasons for this: the greater distances and rugged terrain were more suited to HF-AM until such time as accessibility and power-supply problems for repeaters could be overcome; there was not the concentrated demand for additional frequencies in this less-populated area (although there were some problems in obtaining allocations as already described); radio was not used frequently and intensely enough to justify abandoning existing equipment as long as the HF could legally be used. In view of these factors IRAC extended the date for conversion to VHF in Alaska.

During the 1946-48 period, there was inconsistency as to whether to use VHF or HF for new systems. A memo to the Director, dated Jan. 6, 1948 (signature and letterhead missing) proposed 30-40 mc surplus radios at Mt. Rainier "we will erect antenna poles in the vicinity of the utility area near the ranger stations . . . nearly as high as the surrounding trees." However, in the same year a HF AM mobile system was installed at Blue Ridge Parkway with "substation" houses built at Poor Mountain and Clingman's Dome per drawing PKY-PR-GEN-5374.

Changes in policies relative to location of administrative offices (whether in or near the park area, or in nearby cities) have been mentioned in other sections of this account. One example (Crater Lake) has already been reported.

A change in superintendents at Coulee Dam resulted in a statement that "there does not appear that there will be any requirement for such facility in the foreseeable future."(124), in spite of the fact that the previous superintendent has established a proposal for a $35,000

FM system to provide communication for water and highway patrols and rescues. The new superintendent was, in effect, reminded that his prejudices against radio should not deprive his staff of the use of a new system to better carry out their responsibilities(125) but offered to cancel all existing assignments if he still felt radio was of no use.

Planning and Procurement

During the early 1950's, the evolution of procedures for financing and implementing radio communications facilities was rather rapid.

The entry of major manufacturers into the production of portable and mobile units, and repeaters, eliminated the need for NPS and the Forest Service to provide pilot models for them to copy, as was the case in the period covered by chapter two.

At first, war surplus equipment was used, as already described, supplemented with equipment obtained under standard competitive bid procurement procedures. During the early fifties the equipment was usually installed by NPS personnel.

New FM systems were included in the 1952/1953 construction program for several areas. The funds scheduled in the Project Construction Proposal (PCP) for these areas evidently failed to include adequate funds for construction of buildings, erection of towers, etc. Rather than reduce the number of portable or mobile units to cover the missing costs, some areas elected (perhaps with a little persuasion from Communications Engineer Rowley) to do the required work with maintenance funds. In Death Valley they elected to do this so that even the garbage truck had a radio! Later it was determined to be unnecessary.

The 1949/50 experience at Olympic NP in which a manufacturer failed to meet specifications has already been described. Because of such bad experiences, both NPS and the Forest Service established specifications and testing laboratories to pre-certify equipment as being in compliance with those specifications.(126) The NPS laboratory was established in 1952. A general letter was sent to all interested manufacturers advising them that in the future bids could be submitted only on certified equipment. The NPS carried out the procedure (in varying degrees) until the late 1950's. However, when it was learned that the Forest Service was doing the same thing on a more extensive basis, an agreement was reached on June 3, 1956, whereby the certification tests would be conducted by the Forest Service radio laboratory at a cost of $2000 per year.(134)

In September 1953, specifications for a number of FM systems were issued. This was followed with an addendum "covering an alternate to provide for self-supporting towers in lieu of guyed towers and to provide for maintenance of the equipment with a further alternative being provided to permit leasing the equipment from some contractor in a similar manner to operation by the telephone company."(135)

Later in 1953 the Service's "policy of retiring from the utility business, reducing Government capital investment wherever possible and avoiding duplication of telephone and radio service" was stated.(127) The same reference also stated that radio facilities could obtained by (1)government-owned equipment with either government-maintenance or contract maintenance or (2)through leased services with commercial companies. Studies were initiated to explore these alternatives.(128)

With the beginning of negotiations in 1953-1954 for service and/or leasing radio facilities, several special circumstances surfaced. Two-way radio service companies based their charges on urban situations. It was necessary to negotiate surcharges because of the remoteness of repeaters and base stations. However, without some control, the Service could be "soaked" for an inordinate amount of travel costs if the serviceman was not thorough or was careless in carrying out the required preventive maintenance, resulting in additional service calls. To prevent this, the Western parks and contractors agreed to a surcharge based on a fixed number (usually 3 or 4 per year) of maintenance trips, with the Contractor responsible for any additional trips at no charge. In the same manner, the location and method of delivery of portable and mobile units had to be negotiated.(136) However, in practice some areas thwarted the intent of the contract, i.e., to persuade contractors to do a good job of preventive maintenance. This was the result of "saving" complaints and needed repairs until the next regular visit by the contractor. Of course this was not to the park's advantage and caused the "saved" units to be unavailable for emergency use, as well as permitting general deterioration of the system because of inadequate preventive steps by the contractor.

A March 19, 1954 directive from Washington asked all regions to submit an analysis of the overall communication requirements for each area and prepare recommended budgetary adjustments. This analysis was to reflect estimated budgetary changes as a result of converting some telephone systems to operation by a utility company and leasing certain radio systems.(123) This was part of the Office of the Secretary's continuing effort to get a "handle" on its communication facilities, initiated a "continuing study . . . for the purpose of improving the communications systems operated by the bureaus of this Department." A detailed format was specified that included inventories and location of equipment and spare parts, as well as the qualifications of the employees using and maintaining each system.(129)

The policy of retiring from the utility business (1953) referred to in the section on negotiations was modified in 1954.(131) A new directive from the Director emphasized that capital investments will not be made in radio and telephone facilities, except in exceptional situations. It also stressed that radio "should supplement, not supplant, existing telephone communications." It stressed that minimum necessary facilities should be installed and that annually-appropriated operating funds are only sufficient, Service-wide, to cover leasing and/or service costs for minimum facilities. Regions were urged to transfer funds between areas as necessary to provide minimum facilities. Available funds were to be augmented with reimbursements from the sale of government-owned utility systems.

A recap listed proposed radio projects for the 1955 FY for 30 areas for a total amount of $1,264,200.00.(132) Truly, radio has been accepted as a necessary tool! As will be evident in the following discussion, all of the 30 areas did not receive funds for their proposed systems.

An analysis made for Region Four indicated that a saving of $1940 for the region could be realized in 1956. An in-house note by J.R.P. of the Mount Rainier staff expressed indignation that this would reduce Mount Rainier's appropriation by $3000 "and giving it to Sequoia or one of the other areas."(130) This consternation was to be followed by changes in funding from a communications-account basis to a "benefitting user" basis.

Early attempts by the Service to use commercially available FM equipment were not without difficulty. We have already described problems with commercial equipment at Glacier and Olympic. Parallel with this NPS experience, the Forest Service "purchased 145 units in spring 1950 and distributed them to the field. Technical problems with the sets became evident almost immediately."(133) Their report elaborates on problems with other commercially-built equipment.

As more parks began to desire radio systems, it became necessary to require the contractor to furnish, install and (in some cases) maintain them. This procedure was soon followed by lease-and-maintain contracts. In preparing the lease-and-maintain contract it was necessary for the park superintendent and his/her staff to analyze and define their needs fully in a way that would enable a system to be designed to fit those needs.

Later there were attempts to acquire leased radio communication "service" by competitive bid. The intention was to have the supplier (instead of the Service) do the field surveys and engineering to design a system which would meet specified operating requirements. This arrangement had its difficulties in that it is very hard to develop a "yardstick" for portable or mobile coverage, and for point-to-point communication. Requiring "solid" mobile coverage might require an inordinate number of repeaters. Ninety percent of coverage is difficult to measure. If the signal drops out for a ten-foot interval, is the general vicinity dead, OK, or partly OK? If signals from a moving car fluctuate in and out rapidly, but the voice can be partly understood, is this "coverage" or not? If two fixed stations can talk together, but there is a lot of noise, is that circuit acceptable?

Nevertheless, leased contractor-designed systems were installed at Yellowstone, Saguaro, Wind Caves, Grand Canyon, Zion, Lake Mead, Great Smokies and other areas on this basis. Some of them worked well and some never worked satisfactorily. It looks easy to contract out or lease for services, but not so easy to obtain full satisfaction without adequate supervision and administration of contracts.

The growing pains experienced in the evolving from rather primitive (by today's standards) equipment to state-of-the-art facilities can be illustrated by Yellowstone National Park. To begin this story we must go back to about 1958. When it was determined that the Service

could not negotiate with MST&T for an integrated radio and telephone system, it was decided to lease a new FM radio system in which the contractor was to design a system meeting a performance-type specification. If the requirement had been limited to communication between field stations, it would have been relatively easy to develop a performance specification in terms of signal-noise ratio for a given percentage of time. However, it was desired to have portable and mobile coverage as part of the requirement. Because of the "picket-fence" effect where reflections from the mountains would often cause signals to (and from) a mobile unit to fluctuate between completely usable, to undetectable levels within a matter of inches, the mobile coverage performance specification had to be carefully spelled out. It called for a specified percentage coverage of specified roads, with no "dead spots" exceeding a specified distance. Portable coverage was not specified, it being assumed that if the mobile coverage requirements were met, 10-watt portables could be expected to "get out", provided the user maneuvered to reasonably located positions. The problems involved in getting the system installed and operational have already been described.

Up until 1957 the telephone companies had bid on installing and furnishing leased radio systems which were installed in places like Grand Canyon, Mesa Verde, Rocky Mountain, Grand Teton, Carlsbad Caverns, and Wind Cave. This practice was discontinued in response to the January 24, 1957 Consent Decree with the Justice Department which precluded them from furnishing private two-way systems. It "Limit[ed] the telephone companies affected by it to common carrier operations."(137) While the Bell System, with its Bell Laboratories for backup, did an admirable job providing its normal telephone services, there were difficulties when they attempted to provide radio systems to meet NPS specifications. Typical problems were:

1. Local Telephone Company maintenance personnel were sometimes too proud to admit they were "over their head," with the unique requirements imposed by NPS-type operations. In several cases after non-acceptance by NPS, their service personnel admitted their incompetency and reluctantly asked for engineering assistance from their state engineering offices. At Zion National Park the local manager covered up his staff's inability to make the base station operate correctly until NPS Engineer Hannaford stepped in and corrected the incorrect wiring.

2. At Colorado National Monument the base stations and repeater were maintained by the "long lines" people and the mobiles were maintained by the "exchange" people, resulting in confusion and buck-passing between the two groups until NPS demanded that a better procedure be developed for reporting and handling service problems.

3. At Mesa Verde the specifications called for 25-watts output from mobile transmitters. But during the final inspection they were found to be delivering only about four watts. The superintendent was happy with them the way they

were, since their daily use was on the paved roads where four-watts was adequate. He objected to the "punch list" calling for an increase to the specified 25-watts output, until it was explained that the latter would be needed if the mobile units were dispatched to an emergency in the "back country" or to areas outside the park where joint operations were called for. It was learned that the Telephone Company had been complying with Bell System practices which called for modification of 25-watt mobile units to about 4-watts output for continuous duty which is appropriate for urban mobile systems but did not meet NPS specifications. Their engineers were reluctant, but did finally restore the mobile units to meet NPS requirements.

4. At Grand Canyon, the maintenance personnel were capable in their maintenance of mobile and base stations. However, they were not trained or qualified for maintenance of the repeater at Hopi Tower. After several inspections by NPS engineers, the local telephone company manager finally conceded that the service of their Phoenix engineering department was required.

5. The specifications for a system at Yosemite included requirements that there be a portable repeater which could be moved to provide communication for emergencies in remote areas. Difficulties with the portable repeater which was furnished by PT&T have already been described.

About 1959 the Air Force developed a lease-and-maintain contract with Motorola, General Electric, RCA, and others. This was a unique opportunity for those areas without construction funds to obtain a radio system by using operating funds to lease equipment, and not involve the need for Service technicians for maintenance or the need to be involved with the bidding process. Because the prices were predicated on providing service at military bases that used large quantities of radios and were relatively close to metropolitan areas an adder was usually negotiated to cover travel costs to reach the park area. In order to apply persuasion to provide good preventive maintenance, the isolation factor usually included costs of a minimum number of emergency calls, with any additional calls being at contractor's expense. This is similar to the isolation surcharge already described in connection with the 1953/54 leasing program.

In the case of studies pertaining to use of the Air Force contract in the larger systems at Olympic, Mt. Rainier, and Sequoia-Kings Canyon, "An isolation factor was added to cover eleven trips annually (eight for preventive maintenance and three for emergencies) from the service facility."(138) Additional service trips were to be gratis as an incentive for the contractor to practice preventive procedures which would provide reliable performance from the tube-type equipment in use at that time. The studies indicated that continued government-ownership and maintenance was preferable for these areas.

Since Service operational requirements were sometimes more stringent and isolated than military bases, the Service continued to select only equipment that met NPS/FS certification standards when using the Air Force contract. In an effort to minimize the isolation factor charges, some areas mailed portable units to the contractor's shop for maintenance.

One of the problems in implementing radio systems is to determine how heavily to invest in portable equipment for emergencies. The problem is similar to flood-control planning or similar emergencies. Do you gear up for a once-in-ten-year or a once-in-a-hundred year occurrence? The NPS has never been supplied with an overabundance of funds, so most of its operations, including radio, is little more than "bare bones" in scope. Efforts to develop arrangements for coping with major emergencies have been described in the section on Emergency Uses of Radio. This was followed up in later years by more extensive agreements and eventually with participation in the Boise Interagency Fire Center, operated by BLM, together with representatives of the various cooperating agencies, including NPS and described more fully in Chapter Five.

The limited funding for two-way radio, together with development of smaller brick-sized portables, led to the multiple use of such units. Instead of buying (at around $1000 each) or leasing a mobile unit in each vehicle, a dash-mounted hanger was developed into which a portable could be placed. After connecting a roof-top antenna, the portable would serve as a mobile unit. The small speaker size precluded doing this in vehicles whose cab-noise was too high for incoming voices to be heard. It was also possible by using a fixed antenna and battery charger to use the same portable unit at base stations that were located where low-power was no handicap. This resulted in additional savings.

NATIONAL PARK SERVICE ORGANIZATION AND MANAGEMENT

Following World War II the supervision of design and construction of all NPS facilities was assumed by Chief of Design and Construction (D&C) Thomas C. Vint. His organization was broken into the Landscape Architecture, Architecture, and Engineering branches. While maintenance of NPS facilities was under the Chief of Maintenance, the D&C professionals were often called upon for assistance and/or advice when needed by the parks or regions. The only formal channel or assignment of responsibility for the technical design and supervision of radio and telephone facilities was to the Communications Engineer (and one or two assistants) in the Washington Office under Mr. Vint. Beginning in 1953 - 54 an Electronic Engineer (the writer) in Region Four was added. The planning, construction, supervision, and frequency-management of NPS radio systems were their responsibility for a number of years following World War II. Some areas had competent radio technicians and others were left to their own devices, or to request assistance if it was needed.

My transfer to Washington as a member of Rowley's staff in the fall of 1950 was with reluctance because I had not completed the installation of the Olympic system (described elsewhere). However, after refusing an earlier offer, and observing the incompetence of the person who took the job (and was later fired), it became evident that it was inconsiderate

to criticize WASO operations (as many field people did) if people with field experience fail to accept positions in the Washington office, leaving it to be staffed by people without knowledge of field conditions.

In 1954, offices of Design and Construction, were established in Philadelphia (EODC) and San Francisco (WODC) which were to provide many types of professional services to the field and regional offices. It is of historical interest to note that WODC's first quarters were in the old Cadillac dealership building at 1000 Geary St. in San Francisco. This spacious, high-ceilinged survivor from past years had an elevator which was large enough to move large Cadillacs from floor to floor. It was a real antique that creaked and groaned whether it slowly transported one or twenty persons from floor to floor. The building served as quarters for WODC until the new Federal Office Building at 450 Golden Gate Ave. was built.

This writer served as Communications Engineer for WODC, with several assistants. During following years WODC was reorganized and renamed DCSSC (Design and Construction, San Francisco Service Center) and later it became WSC (Western Service Center). Many of the activities of this period that are described in this book were personally experienced, or known to him while at WODC, DCSSC, and WSC (and later at the Denver Service Center).

After the D&C offices were established, they were to act as consultants to the regional offices and field offices. However, EODC did not establish an electrical or communications engineer position for this purpose, and frequently called upon Communication Engineer Sam Hoover from the Washington Office as needed.

Soon after creation of the Eastern and Western Offices of Design and Construction, intensive investigation of the possibility of leased "integrated" communications was begun. This is described in the section on Negotiations. The Western Office of Design and Construction (WODC) provided "professional service and other assistance as may be required . . . with direct consultation with Mr. Hill's office [WODC] for any professional advice."(139) The concept of using the various consultive professional services from other than the regional office was new to the field areas of the Service. Many superintendents were reluctant to take advantage of the services available from EODC and/or WODC. Even in the sixties it was noted that some field personnel preferred to either (1) put up with a problem (not necessarily a communication problem) or (2) refer the problem to the Regional office.

Not only were the 1950's a period of change and development as to communication. Changes in park management and in areas under NPS jurisdiction were also taking place. In the late 40's and early 50's the "cluster" concept was in vogue wherein a cluster of small or underdeveloped areas were under the supervision of the Superintendent of an older, larger park. This concept all but disappeared in later years when visitation and other problems necessitated that many small areas become independent, reporting directly to their

regional office. An example of this change was removing coordination of Colorado National Monument, Black Canyon of the Gunnison National Monument, and Mesa Verde National Park so that Colorado and Black Canyon became separately administered, but certain matters were handled by Mesa Verde acting as a finance office. Crater Lake had headquarters at Medford, Ore. and provided coordinating superintendency for Oregon Caves National Monument. Millerton Lake National Recreation Area was in the process of transfer to the State of California.(140)

The cluster concept created communication requirements between the superintendent and the areas within the cluster. In some cases commercial telephone was used. In other cases radio was used. Other examples were:

Area	Coordinated Area
Everglades	Fort Jefferson
Rocky Mountain	Shadow Mountain NRA 4 monuments (accounting)
Colorado NM	Black Canyon
Mesa Verde	Hovenweep
Wupatki	Sunset Crater
Zion	Cedar Breaks
Mt. McKinley	Katmai

A specialized type of cluster was created with the Southwest Archeological Center (SWAC) at Globe, Arizona as its administrative and control point. It served a number of smaller monuments in the southwestern USA, most of whom had no telephone communication. Communication was on a scheduled basis via radio as reported in another section of this chapter. The system functioned until the sixties when most areas had obtained telephone service.

There were no new government-owned telephone lines built during this period, so there was no requirement for telephone engineering other than the installation of switchboards and radio-telephone facilities described earlier in this chapter.

AN ERA OF NEGOTIATIONS

Introduction

Today very few National Park areas are more than an hour or two from fairly large cities and/or have "neighbors" nearby such as resorts, villages, mountain home developments, etc. It did not get that way until after WW II. Up to and including the 50's most park areas were considered too remote by commercial telephone and power companies for them to serve the park areas. In most cases they extended their lines up to a point (usually the boundary) and, in effect, they said "You are a utility. We will supply you the long-distance connections (or primary power connection), and you do the distributing." Thus, many parks found themselves in the utility business, saddled with the responsibility to build and maintain telephone and/or power lines, establish rates, collect coins from pay telephones, establish procedures for collections for long-distance calls to be prorated between the government and the telephone company. These responsibilities were "foreign" to an administrative organization whose primary function was to serve and protect the visiting public. Some of the problems encountered are reported elsewhere.

In 1952, the Eisenhower administration came into being. One of their campaign goals was "to get the government out of businesses that could be run by the private sector".* The "American Telephone and Telegraph Company . . . has stated that they desire to make a communication study of commercial service, in a number of the national parks . . ."(141)

The American Telephone and Telegraph Company (known as AT&T, or the Bell System) wasted no time taking advantage of the new "climate". The timing was also opportune for the National Park Service because of limited funding for construction projects. Telephone and radio systems were badly in need of rehabilitation or replacing. Other facilities, like buildings, roads, trails, campgrounds were still showing neglect from WW II and inadequate funding. Consequently, if there were some way that new telephone and radio systems could be obtained without capital investment by the Service, the Mission 66 effort could be concentrated on other facilities. Even though large sums of money became available under Mission 66, if radio and telephone construction projects had been necessary, it would have meant elimination of some other needed facilities.

In recognition of this situation, the Washington Office (on November 20, 1953) issued a directive that the intention was to get NPS out of the utility - telephone and power - business and on December 13, 1953 "directed that studies be made of radio and telephone communication requirements and facilities, with particular reference to the possibility of obtaining such facilities by lease arrangements."

> * This was fortunate timing because the government-owned, hand-crank-and-shout telephone systems would soon be passe' and there was little likelihood of funding for replacing them or providing expanded capacity to meet the increased visitation and need for modern facilities.

The November 20th directive was quickly interpreted by some field personnel as meaning that the "getting out" should be without regard to cost. The assumption was made that since utilities were regulated in most states, there would only be one supplier available and that its rates offered no alternative. However, more knowledgeable personnel questioned this assumption in view of the overriding government policy of obtaining supplies and services at the most advantageous cost. A year later a follow-up memorandum indicated that commercial services should be used when more economical than government owned facilities. In making an economic analysis to determine which method was the most economical,a host of questions arose, such as: Should Federal taxes paid by the utility be considered? Should NPS employee fringe benefits be included in the costs? What rate of interest is to be used when comparing the combined initial and future costs? Should comparisons be based on the present value of all costs or on an annualized basis? etc. These questions were eventually resolved by Bureau of the Budget (BOB) letter A-76 in 1966, but by that time many contracts had been negotiated for telephone and power.

The policy of retiring from the utility business (1953) was modified in 1954. The new directive from the Director emphasized that capital investments will not be made in radio and telephone facilities, except in exceptional situations. It also stressed that radio "should supplement, not supplant, existing telephone communications." It stressed that minimum necessary facilities should be installed and that annually appropriated operating funds are not sufficient, Service–wide, to cover leasing and/or service costs for minimum facilities. Regions were urged to transfer funds between areas as necessary to provide minimum facilities. Available funds were to be augmented with reimbursements from the sale of government-owned utility systems.(142)

One aspect of negotiations for utilities in some NPS areas was unique; i.e. that of PUC jurisdiction. Some of the early-established parks (Yellowstone, Yosemite, Mount Rainier and others) had exclusive jurisdiction, negating any control by state Public Utility (or Service) Commissions (PUC). If there was more than one company which was situated where it conceivably could serve the area, each had to be given a chance to make a proposal. Some companies chose to decline but were reluctant to put it in writing. When first approached, the utilities did not know how they could serve in a park where the state PUC has no jurisdiction. In those NPS areas the PUC-approved territorial extension would be to the boundary, with tacit approval being given to serve the park. The contract was usually submitted to the PUC as a matter of record and the telephone company had to convince the state Public Utility Commission that its service outside of the state-controlled territory would not be subsidized by customers located within the state–controlled territory. For example, after determining that there was no other nearby telephone company that was interested in serving Yosemite, it was necessary to assure the PUC that Pacific Telephone and Telegraph Company's customers in urban areas like San Francisco were not subsidizing telephone service for Yosemite or Sequoia Kings Canyon, but this did not bring actual PUC jurisdiction into the park. In order to do this the company kept separate books for the entire Yosemite operation. Later on this led to some interesting situations, such as the California tax man who thought he had caught PT&T with undeclared assets when he

discovered a PT&T building within Sequoia National Park that was not on their records for the company's California state-wide operations! He was not aware that Sequoia had exclusive jurisdiction.

In those areas where NPS did not have exclusive jurisdiction the park area, and often surrounding USFS areas, were oftentimes in "unassigned" territories as far as the state PUC was concerned. Unassigned areas are parts of the state (including National Park areas if the government does not have exclusive jurisdiction) in which there is no telephone company serving. In most cases, it was necessary to begin negotiations by determining what utility companies (often there was only one) would be interested in extending their service into the park. All nearby utilities were invited to make proposals, which would be contingent upon the PUC making appropriate territorial extensions. The company making the best proposal was encouraged to seek PUC assignment of the park territory, but the final decision as to which company would serve the park would be made by the PUC. After that a contract could be negotiated.

In order that the following discussions can be presented in an orderly manner, they will be grouped as (a) combined telephone and radio negotiations, (b) telephone negotiations, and (c) radio negotiations.

Combined Telephone and Radio Negotiations

The first effort to terminate the "connecting company" status of certain parks was initiated by AT&T in March, 1952.

> "Many of the National Parks have connecting agreements with telephone companies operating in their vicinity. Some of the agreements are antiquated and should be reviewed in view of modern technical developments and changes in operating policy and territory service by the companies.
>
> "Mr. Berrier, of the American Telephone and Telegraph Company, whose company is the parent company of the Bell Telephone System, has stated that they desire to make a study of communication service, in a number of National Parks, with the view of submitting a proposal to this office [WASO] for furnishing communication services for these areas.
>
> "It is their understanding that the studies will include consideration of all communications, both telephone (and radiotelephone) and radio to supply all administrative and protection functions.
>
> "No commitments have been made or are contemplated at this time."(143)

Until July, 1954 negotiations (with AT&T or other suppliers) for radio were considered separate from telephone. At that time: "It now appears that . . . integrating the radio system as part of the service furnished [by] a commercial company may be the most practical, effective, and economical method of obtaining complete communication services in most of the areas in Region Four.

> "By complete communication system, we mean an integrated radio and telephone facility that will use radio telephone for communication with outlying areas, such as ranger stations lookouts, and the like . . . and will have complete coordination of all radio and telephone units. This system will permit the connection of any call originating at any station (telephone, radio, console, mobile unit, pack set, or handie-talkie) to the headquarters exchange in a manner similar to that accomplished by picking up the telephone handset in your office or home."(144)

The attempt to obtain "integrated" communication services was discussed at the Washington level with Mr. Berrier of the American Telephone and Telegraph Company. At a July 2, 1954 meeting there surfaced a concern that Yosemite (which was to become its pilot contract) might be used as a "sounding board for furnishing communication services to portions outside the park and in the Valley." Mr. Berrier asserted that "it is not the intention of the Telephone Company to use the parks . . . for furnishing communication services to outside interests" which was considered to be in accordance with "Park Service policy that we generally take a negative attitude towards the construction of utility lines through the parks to service other than Service and concessioner facilities." An in-house determination was also made that only those contracts in excess of $50,000 annually would have to be cleared by the Washington Office.(145)

There was insufficient NPS engineering staff and construction funds to keep up with the need for additional radio facilities, therefore, the attempt to negotiate "integrated" radio systems which would be tied into the telephone systems(146) was considered advantageous. The thought was that one communications supplier could provide both telephone and radio service more efficiently and at lower cost than two separate systems, and that the technical expertise of the telephone companies could provide better-designed radio systems. The proposed integrated system was "explained further as follows: One of the advantages of obtaining communication from commercial sources is that very often dial switching can be arranged, obviating need for service operations . . . arrangements might be made for emergency radio calls to be made to the nearest telephone operator, during hours when the headquarters radio facilities are not manned, thus providing 24-hour coverage of all stations, radio and telephone."

These negotiations for radio and telephone services from the telephone companies generated concern to the technical personnel of the larger parks about the future of their employment. Parks in Region Four were reminded that requests for proposals were exploratory, that negotiations may or may not develop.(147) It was apparent that these parks could be without technical support and maintenance of the government-owned

facilities during the negotiating period. Superintendent Macy reminded the Mount Rainier technical personnel that negotiations would follow for an undetermined time frame after the telephone company had finished its three month study period to prepare a proposal. Then, "Company officials estimate that a minimum of one year's time will be required to complete the communication system integrating radio and telephone."(148) Unofficially the personnel were told that their assistance would be needed for at least another two years.

Some of the parks took issue with the premise that leasing radio and telephone facilities would be without "headaches" and necessity for operations and/or management type personnel. The statements by Superintendent Macy regarding Mount Rainier were typical: "serious consideration was given to a straight dial system for telephone type communication, but this lead to certain difficulties of incoming calls screening ["Myrt" would not be available] and transfer of calls which we believe to be intolerable. Also, in considering Group II [radio] type of communication, we feel the services of a day-time operator are essential. Furthermore, any system such as is herein proposed involves many toll calls * involving the listing and submission of bills by the telephone company, the correctness of which must be verified by checking in our office before payment can be made. For these reasons, we feel that the services of a clerk-operator, five days per week throughout the year, will be required to handle a PBX switchboard and radio and perform necessary clerical work. A relief operator will be necessary when the regular operator is on annual or sick leave and an emergency operator may need to be employed when emergencies require extra communication services."(149) After several meetings Mt. Rainier submitted a revised outline of radio and telephone requirements to PT&T on Aug. 25, 1954.(150)

The "integrated" concept was initiated by asking affiliates of the AT & T for proposals for integrated radio and telephone facilities. Several proposals were received, but it was soon apparent that (1) the companies did not really understand the nature and extent of radio communication requirement, (2) the "integration" of telephone and radio involved much more complicated and expensive equipment than was required for manually-operated radio systems.

In the case of Region Four, this was followed up with a list of nine areas proposed for "Integrated Radio and Telephone System;" four areas in Alaska proposed for "Leased Radio Services System, removal of radio systems at Oregon Caves and Medford (headquarters for Crater Lake at that time), three areas for which existing facilities were believed adequate and the no changes currently recommended." (151) As mentioned in a following section on negotiations, the integrated radio and telephone systems never materialized.

* Toll calls would be involved for many intra-park calls between districts, and between headquarters and outlying districts.

Several proposals were received from companies belonging to the Bell System, but it was obvious that their understanding of the radio requirements fell short. The minds and experience of the Telephone Company personnel were conditioned to the mobile telephone concepts they were offering the public.

In the meantime, experience with NPS-designed radio systems were not always up to expectations. This was due, at times, to inability of park staffs to fully analyze their needs during the planning/design process, and to the capriciousness of radio propagation. It took several years of experience to recognize that field survey results could not be extrapolated by saying that fair signals experienced at 20′ antenna height would become good signals at 40′ antenna height. The latter reasoning was the prevailing opinion of the technical journals, but it was based on rolling or flat-land typography and was not applicable in mountainous terrain. It was learned that multipath effects are most difficult to predict, and paths that were effective during one season could become ineffective when the foliage or ground cover changed.

The Washington Office was optimistic about the Service's ability to consummate negotiations for communications in many areas. An updated report listed nine areas "for which conversion from Government operated to leasing of commercial radio and telephone facilities will have been completed by the end of the 1958 fiscal year."(152)

Later a Field Order from the Director showed some rethinking about integrated systems and elaborated on procedures for obtaining communication facilities from commercial sources, including negotiated contracts, competitive bidding, GSA contracts, etc. After defining an "integrated" system it concluded "unless it can be conclusively demonstrated that it is administratively necessary to operate the radio and telephone systems as an integrated unit requiring a negotiated contract with the sole supplier (the telephone company) as opposed to an administrative desire to have the radio and telephone functions handled by a single company, it may be necessary to lease the radio services on a competitive basis."(153)

By November 15, 1954, there began to arise questions whether it was practical to integrate radios and telephone as originally intended. "His company [PT&T] . . . has been seriously concerned with the problem of working out a radio and telephone system which will be sufficiently integrated to meet negotiation requirements."(154) The question was whether using a common handset at certain points and a common PBX at certain points would meet the requirements. The "integration" of radio communication involved much more complicated and expensive equipment than was required for manually-operated radio systems.

Chief Forester Cook was concerned about "the current unsatisfactory local radio and telephone communication . . . a serious protection deficiency". He was disturbed by "lack of integration of the telephone-radio net and failure to include remote stations into a practical operation program."(155) He also pointed out that any conversion from

government-owned to commercial services should be accompanied by a distribution from the former communications accounts to the "accounts benefitted.

Several proposals for integrated communications were received, which were inadequate and therefore rejected. Thereafter, subsequent negotiations were carried out separately for telephone and radio.

Telephone Negotiations

To determine if the telephone companies could provide needed telephone service in the parks, negotiations were started in 1953 with Yosemite as a pilot project. The Telephone Company desired to furnish its services to the park, and NPS was anxious to have them do it so NPS could "get out of the utility business. It was an interesting experience trying to "marry" the goals of the Telephone Company (PT&T) with the goals of NPS. There were disagreements that had to be ironed out. With the Service's policies in mind, the NPS negotiators Sidney McClellan, Field Solicitor, and Ralph McFadden, Electronics Engineer, insisted that:

1. The Telephone Company not be permitted to "take the cream and leave the skim milk." In other words, in a given national park area they must serve all points requiring telephones, even those now served by grounded lines, and they must agree to serve the less-attractive park areas as well as the more lucrative ones. Neither would they be allowed to serve the larger profitable areas to the neglect of smaller, unprofitable NPS areas.

2. The Telephone Company will not be permitted to do anything that NPS did not permit itself to do. In other words, the Telephone Company must respect the same esthetics and environmental requirements as the Service did. This required prior review of all plans for construction of facilities.

3. Union contracts prohibited climbing trees (which requires "hooks" with longer points because of the thickness of the bark). Since trees were sometimes used for supporting lines in Yosemite, this problem had to be considered. Some union contracts limited the distance the lineman could be required to walk from their trucks. Because of this, PT&T proposed an aerial tram in Yosemite to carry maintenance crews 1/4 mile from the Wawona highway to their microwave terminal on Turtle Dome. They also proposed a pipe line to pump fuel for their standby generator at the microwave site. They were allowed a one-track, well-hidden access road instead. Both of these union rules could frustrate any attempt to operate and maintain telephone lines, especially in the wilderness parks. The companies were told bluntly that if their personnel were so encumbered with restrictions ("chintzy") we might as well terminate negotiations. These limitations had to be eliminated or it

would be impossible to use their services. The limitations were eventually resolved between the company and the unions.

4. The Telephone Company would be allowed to have only a minimum space for residences and buildings as demonstrated to be necessary for providing prompt repair service. All land for such purposes was subject to a fee which was established to discourage unnecessary construction of buildings and utility yards. The fee also served in lieu of a franchise fee for operation in the park. This was important because one of the favorite targets of visiting legislators are concessionaires and permitees, wanting to know "how much is the government getting for the privilege of operating in the park?"

The Telephone Company also had some requirements that, by the nature of their operation, had to be met:

1. In those park areas where NPS has exclusive jurisdiction (no regulation by state utility commissions) the rates must be adequate to guarantee that other customers in the same state will not be subsidizing operations within the park area. It was necessary to file a copy of each contract with the state PUC to assure the PUC that this was happening.

2. Some interesting developments occurred during these negotiations. Yosemite National Park lies in more than one county which presented the company with a labor problem. The union in each county did not want another local to cross-over into areas served by them. Eventually they worked out a method to overcome this objective.

3. The need for reliable communication emphasized the need for prompt maintenance and repair by personnel familiar with the park. In the case of Yosemite it required PT&T personnel to be located in the park in a continuous basis. The company was given a special-use-permit for residences (subject to restrictions described in another paragraph) for three technicians. This resulted in competition among PT&T personnel for the Yosemite assignment, it being a "prize" compared to working elsewhere.

By January, 1954 it was felt that "completion of contract with PT&T [could be] anticipated" for Yosemite, and a contract for Sequoia & Kings Canyon would follow soon thereafter. A proposal was also expected for serving Death Valley National Monument (table attached to reference 140).

As negotiations for Yosemite and other parks took place it became necessary for NPS negotiators, and park staffs to become familiar with telephone terminology, such as base rate area, suburban area, toll station, exchange area, etc.(156)

It was also apparent that in some cases, facilities installed inside a park could be designed in such a way that they could be used to serve outside-of-the-park customers. For instance, a cable from an exchange inside the park (there are a number of parks having one or more exchanges in them for exclusive use in serving the park) to a ranger station or visitor facility near the boundary could be installed which would have additional pairs that could be used for private homes or resorts located just outside the park. Any mountain-top microwave terminal in a park area could easily be equipped with an extra "dish" to serve points outside the park. These possibilities were additional justification for requiring approval of working drawings prior to construction. One special exception that was authorized, was for PT&T to use facilities servicing Sequoia Kings Canyon National Park to serve the community of Wilsonia which is surrounded by park lands.

At some of the larger parks the telephone company established base rate areas (BRA's) for the larger developments like Old Faithful , Giant Forest, etc., but they were reluctant to include specifics of the BRA's in the contracts. However, NPS needed assurance that the BRA's would actually be established as proposed; otherwise the Service's costs might escalate unreasonably. This dilemma was solved by a saving clause "which will provide that if the PUC's approval of the proposed operating boundaries is not obtained, the contract would be subject to renegotiation."(157)

In addition to Yosemite, larger parks like Yellowstone, Sequoia and some others, there were situations in which it was necessary for the telephone company to erect equipment buildings (and in some cases equipment yards and/or residences). Since the Service itself is reluctant to encroach on the natural scene by erecting additional buildings for its own use, a fee system was devised to serve as a determent which might encourage the telephone company to use locations outside the park where possible.(158) This policy has been extended to electric utility companies for the same reasons. In the case of Yosemite, this limitation was especially critical because the Service had recently moved some of its personnel and operations to El Portal (outside the Park) to reduce the impact of development on the valley floor. As already mentioned, the fee structure also provided a suitable response to visiting legislators who often asked "what are you getting from these utility companies" when they see utility vehicles traversing the park.

Three problems surfaced in discussions regarding emergency telephones at trail-heads and other strategic points. If the government arranged for a commercial telephone for public use to reports emergencies, there would be no way to prevent visitors from using the phone for toll calls at government expense. If pay phones were provided to avoid this, there might not be enough revenue to justify it (from the company's point of view) unless the Service made up the difference. At the time of the negotiations, pay telephones installed in park areas were of post-pay type, making it possible for a hiker to make an emergency call, even if the hiker did not have a dime. The telephone company agreed to continue this, but added that eventually they might install pre-pay phones, which would prevent the placing of emergency calls by persons without coins.(159)

Negotiations for conversion from government-owned to commercial telephone facilities also involved a determination of how to dispose of the government-owned facilities, some of which would be useful, and the remainder of which would not be useful to the commercial company. There were proposals to abandon, take down and bury some of the unused facilities in place, where the cost of removal might be great, yet the continued presence would be objectionable.(160)

During December 1953 there were in-house discussions whether unused government-owned telephone facilities at Yosemite should be removed by PT&T or the park. The unusable components were a liability,so it was necessary to remove them (also for esthetics reasons), but no funds had been appropriated for their removal. Eventually approval was obtained to use some of the money derived from the sale of usable facilities to reimburse the companies for removal of the unusable facilities. The cost of this was reflected in the sale price for the existing facilities.

The author, working together with Field Solicitor McClellan, negotiated telephone contracts for most of the major areas in Region Four. When WODC (later to be known as the Western Service Center) (WSC) was formed, the author participated in negotiations with the telephone companies serving areas in Regions Two and Three (mostly with Mountain States Telephone and Telegraph Company). After working with the Regional Solicitor McClellan and PT&T negotiators, it was quite an experience to go to a meeting with MST&T engineers, service representatives, and lawyers to be greeted by "Oh, you're the one we've heard so much about! We know all about you, your requirements, and your expectations." Evidently they had obtained information from their PT&T compatriots to help them prepare their strategy!

When negotiations were started in an area, it required a liberal interchange of ideas between the Service's negotiator and park staff. There were three reasons for this: first, the park staff was used to adding a phone to an existing government–owned line for incidental uses, such as a barn which was only used for a few weeks each year ("Why shouldn't we put one in, they only cost about $30.00"; not recognizing the additional loading on the line if they forgot to disconnect it when not in use); second, the park staff was not acquainted with the types and classes of service offered; third, the park was usually at a loss as to how to plan a system which would be usable without an operator such as they were used to.

The choice of type of service had to be carefully evaluated because the cost difference between various types of facilities could be quite substantial. However, each situation must be carefully considered. For example, if the less–expensive suburban service was chosen, and a private residence (outside the park) with a teenager was likely to be served by the same line, the results could be disastrous if the telephone were needed for an emergency.(161)

Even though the contracts that were subsequently negotiated for other areas gave the superintendents absolute control over these limitations, some superintendents were reluctant

to enforce them. Construction of some telephone lines was allowed to begin before the justification for them and the routes had been reviewed and approved. In one instance a telephone company installed a bright red telephone at a prominent visitation point, ostensibly to be available for emergencies, but undoubtedly to increase revenue. In Carlsbad Caverns a battery of telephone booths were installed in a prominent location with eye-catching signs, capitalizing on younger peoples' desire to call home and ask "Hey mom, guess where I'm calling from!" In both cases it was suggested that the superintendent learn and enforce the contract.

Two interesting developments occurred in connection with the sale of government-owned telephone facilities. Smaller parks, in which the government lines did not serve pay telephones and the visiting public, were considered as private telephone systems, for which it was standard practice to pay replacement-cost-less-depreciation for the usable components. This gave the government a cost break. However, the systems in the larger parks were considered to be "independent connecting companies" for which reimbursement was based on the original-cost-less-depreciation of usable components. The unusable components were a liability, but it was desired to remove them (also for aesthetic reasons) as already discussed.

The Washington Office required that the cost of telephone (or power) facilities sold to a utility company be determined by an Advisory Appraisal Board made up of members from the utility and NPS, which was to prepare a complete inventory, inspect the facilities, and recommend a fair evaluation.

Appraisals of systems sold to the telephone companies ranged from $2,725 for Crater Lake (1957) to $339,306 for Yellowstone (1957).

Sometimes efforts to economize can, in the long run, be expensive. For instance, in all negotiations the telephone companies agreed that initially there would be no extension construction charge to provide telephone service at any location that was being served by the government system. However, some parks, in trying to minimize costs did not order telephones for every location (for example a fire lookout, at which radios were also used). Thus, when it was subsequently determined that a telephone was needed at such a location, a healthy construction charge had to be paid to reinstate service.(162)

Yellowstone National Park: Events leading up to the replacement of government-owned and concessioner-owned systems in Yellowstone by MST&T have been described earlier in this chapter.

The Yellowstone telephone system is probably the largest in any of our national park areas. While the other areas did not have as many facets to deal with, the negotiations for commercial service in some parks involved one or more of these problems:

1. Type and location of lines or cables that would environmentally suitable (even taking into account possible damage to redwood trees by trenching too close to their root systems), but would be adequate for the needs of the Service, its concessionaires, and the visiting public.

2. Getting commitments to serve isolated field stations that had been served by the government-owned systems without the payment of costly line-extension charges that would apply to new line extensions.

3. Establishing base-rate-area boundaries which would encompass the developed sections in the park so that toll-free calls could be made within those base-rate-areas (Yellowstone has four base-rate-areas.

4. Providing dedicated trunks for government-only and/or concessioner-only use so that toll-free calls could be made between base-rate-areas within the same park area.

5. Minimizing use of park lands for residences, and/or exchange buildings, radio repeater sites, etc., without jeopardizing the telephone company's ability to provide adequate reliable service. The policy adapted for this purpose had to be adaptable to similar facilities when commercial power was being negotiated.

   In some instances the utility companies justified their need for housing certain of their employees in order to minimize outages. Such decisions were difficult to make, because it conflicted with Mission 66 goals of minimizing "crunch" on natural areas by moving non-essential government and concessioner-employee housing outside of the parks.

6. Insure that the Telephone Company does not use facilities within the park to serve other users that are outside the park.

7. Provide pay telephones that are adequate and convenient to the public without being out-of-tune with the surroundings. Examples have already been given.

8. Many coin telephones in other parts of the country are prepay type. NPS negotiations insisted that emergency telephones along highways and trailheads be the type which could not require a coin to contact an operator. It would

be a tragedy if help could not be obtained in an emergency, because the person making an emergency call did not have a coin.

Mount Rainier National Park: Problems with the government-owned telephone system have been described earlier in this chapter.

During the early 50's, exploratory negotiations were begun for Mount Rainier National Park with a request for a proposal from the Pacific Telephone Telegraph Company.(163) A copy of the preliminary draft of the proposed contract for Yosemite was provided for the park to review as to its suitability for Mount Rainier. It was noted that the 1953 FY costs of maintaining telephone service was $17,072 to serve a total of 137 telephones. This did not include the cost of long distance calls or cost of capitalization of facilities. Notes attached to reference 161 would indicate that operator's costs were included, but it is the writers opinion that they were not; the cost being too low, based on personal knowledge of the situation.

The proposal was to consider the possibility of eliminating the operators at headquarters. "This will be possible because of direct dialing between all offices, shops, and residences . . . each . . . telephone will be listed in the directory [enabling] most of the incoming long distance calls to [reach] the correct number. Arrangements will have to be made for a 'Longmire Information' listing . . ."(164)

The contract with PT&T was signed May 25, 1956. But "Mr. Conlin stated the Telephone Company was apprehensive about installing facilities for Longmire and Paradise which might be unnecessary due to [NPS thinking about] future changes in the developed areas."(165) It had been expected that PT&T would install a central dial exchange (CDO) in a "small central office building" at Longmire(166) with a base rate area (BRA) to include both Longmire and Paradise. However, "elimination of the Longmire CDO would not change the services or rates from the original proposal by PT&T. He said that this would be accomplished establishment of an 'island base rate area' to serve the Longmire area." (167) The latter was made possible by installation of a multi-conductor cable from their Ashford exchange outside of the park.

Because of heavy vegetation and extreme height of trees throughout the park "clearance of rights-of-way constitutes a greater problem than in other areas."(168) The cables were ground-laid in many places, becoming overgrown by vegetation in a short time.

PT&T plans to serve Ohanapecosh were complicated by the fact that the nearest exchange was owned by an independent company. At one time PT&T proposed to serve the area by cable extension from White River via Cayuse Pass which would not be maintainable in winter because of snow depths exceeding 20'.(169) The writer does not know how the area is now being served.

Delayed action by the telephone company had a disconcerting effect on the park's operations, and a letter dated December 9, 1957(170) stressed the urgency for PT&T to install its facilities with a request that the Longmire and Paradise facilities be operational within nine months. The reply, dated December 18, 1957 asked for patience.(171) Evidently the delay was based upon the previously-mentioned apprehension that Mission 66 plans for the Longmire-Paradise areas were not firmed up.(172)

The conversion from manually-operated telephones, with an operator available at any time (night hours from the operator's residences), to dial telephones necessitated revision of the fire alarm system in many parks. A typical solution is that developed for Mount Rainier: "A special fire alarm system comprised of five telephones in selected residences and one telephone in the Fire Shed is contemplated. From any telephone in the Longmire area a person discovering a fire may dial the fire number, in which event all six telephones will ring. The first person answering such a fire call will lift the instrument off the hook which stops the ringing, and raise a button which enables him to take the fire report. After taking such report he may, as the situation justifies, code the proper fire siren signal by manipulating the non-locking key on his telephone instrument. The first volunteer to arrive at the Fire Shed will pick up the telephone there and ascertain the location and other details of the fire - information which he will convey to others responding as they proceed to the scene of the fire."

This explanation neglected to state that (a) the fire telephones in selected residences were for fire use only, were on the same line, and were in addition to a standard telephone in each residence, (b) the first person that answers stays at his telephone until one of the volunteers arrives at the Fire Shed and comes on the line to get directions from the first person, (c) the person operating the siren would code it in one, two, or three repeated blasts to indicate the general location of the fire.

Crater Lake Telephone: "Crater Lake is still struggling with inadequate long distance facilities due in part to (a) condition of the National Park Service owned lines, and (b) condition of the West Coast Telephone Company's lines. We are endeavoring to make temporary improvements which will provide usable service for the summer. The Telephone Company's proposal is overdue, and it is presumed that the Park will request that it be expedited. In the meantime the Park has temporarily installed 50-watt Link units at the Post Office Building in Medford and the Rim Area within the park."(173) Upon receiving a request for frequency authorization for the latter, the IRAC representative took NPS to task. "please inform this office the authority under which the operation is being conducted."(174)

Negotiations for commercial telephone service at Crater Lake, and some other areas,was not always without difficulties: "both West Coast and Pacific Telephone and Telegraph have been contacted for proposals to provide all communication services within Crater Lake National Park, between the park and the adjoining Forest and Indian Services, as well as

Medford, Oregon Caves National Monument, and other long distance connections. The Pacific Telephone and Telegraph Company was advised that it cannot make an offer as long as the West Coast Telephone Company is in the picture [based on an earlier industry-wide agreement that the Bell System companies would not enter or take over territory serviced by an independent company, unless comparable Bell System territory was given up in exchange]. West Coast promised to submit a proposal by January 1, 1955. As of July 25, we dropped the effort to get a proposal from them because of their persistent procrastination. Ours is not an isolated instance with this company for the Oregon State Public Utilities Commission recently announced they could not approve rate increases requested by West Coast because of the inefficient and inadequate service being provided by the Company throughout the system."(175)

Other Area Telephone Negotiations: Before the Yosemite contract was consummated, I visited one of our major areas concerning radio problems. In those days it was customary for a member of the park staff to go to the airport to pick up officials who were to visit the area. In this instance the superintendent picked me up at the airport, and while enroute to headquarters he mentioned that he had a telephone problem. It turned out that the telephone company had "sold" the park a PBX switchboard, including a 5-year contract with termination charge. The superintendent pointed out that there was no way that outlying ranger stations or the public could reach headquarters or any of the park personnel at night when there was no attendant at the PBX! Similar problems were experienced in other park areas. The parks had unique problems that were not evident to most telephone companies, and the park staffs were not conversant with the alternatives available from telephone companies. As time went by it became apparent that there was a need for technical assistance for all areas planning commercial telephone facilities.

In some park areas, where there were insufficient numbers of telephones to justify establishment of a base rate are (BRA) which would include headquarters it was necessary to make a decision whether to order one, two, or four-part service (which required a mileage charge based on the distance to the BRA boundary); or to order suburban or rural type service; or to order toll-station service. Suburban service could be provided on a line which may have as many as eight telephones. The representatives of some companies were able to give the parks a verbal assurance (or prediction) that they would never allow suburban lines to serve that many telephones. In other cases a personal inspection would reveal that there just was not the potential need for that many telephones along the route. In both cases, suburban service might be satisfactory. Consideration of toll-station service required an estimate of outgoing calls to be made from the toll station. The choice of type of service then had to be carefully evaluated because the cost was quite different. However, it has already been mentioned that if the less-expensive suburban service was chosen, and a non-government residence with a teenager was likely to be served by the same line, the results could be disastrous if the telephone were needed for an emergency.(176)

Planning for commercial telephone service in the parks was a new experience for both the NPS and concessionaires and for the telephone companies. While it was the goal to obtain modern, efficient telephone service, it had to be within the context and confines of NPS practices, principles and regulations. Getting the viewpoints of supplier and supplyee to match required much discussion and "give and take".

One of the biggest adjustments after dial facilities were installed was how to direct calls from the "outside" to the proper telephone without the assistance of the beloved before-mentioned "Myrt." The telephone companies would have delighted to provide PBX service with extensions, which would still have required the services of an operator, making the cost more expensive than government-owned operation. Furthermore, telephone rates are predicated upon the existence of telephone- company owned switching facilities (central exchanges) which are included in the cost of telephone service, so why pay for additional switching facilities (either automatic PBX or manual PBX) and an operator?(177)

Anticipating the sad day when the park operator would be replaced by mechanical/electrical devices it was necessary to plan directory listings carefully, so outsiders could easily determine which number to call. It was also necessary to designate an "information" number, which could be accessed by five or six departmental telephones.(178) The latter would, in 95 percent of the cases, be able to answer any inquiry that the incoming caller might ask, without the necessity of making a second call. This was important because the caller, in many cases, would be calling via long distance. The larger concessions also had the same problems.

A telephone Service Contract for Shenandoah National Park was prepared and submitted for legal review in 1956.(179) The details are unknown to this writer.

In late 1953, negotiations were started with the Peoples Telephone and Telegraph Company for telephone service at Wind Cave National Park.(180)

During the appraisal of the Yosemite telephone lines to Pacific Telephone and Telegraph Company, it was noted that the poles on the line going to Hetch Hetchy were badly worn or eroded on one side, making them oval in cross section. The eroded side looked as if they had been sandblasted until almost of an inch of wood was gone, leaving the knots protruding. Investigation revealed that this particular line had been built by the CCC and that the poles had been floated in a log-boom down the coast, from a pole yard in Washington or Oregon, leaving the lower side saturated with salt. After the poles were in place, the porcupines learned of the salt and made a feast of the salty wood, creating the oval-cross section.

The PT&T plan for serving Yosemite's "back country" camps and Tuolumne meadows was to use 400 mc radio-telephone links between three selected points and Sentinel Dome which would be the tie into the Yosemite facilities. Tree-lines were to extend from the radiotelephone equipment at these three points to the various telephones at the High Sierra

camps. Problems with the radio equipment lines and/or the diesel generators resulted in eventual replacement with wire lines.

During this period the General Services Administration (GSA) was establishing area-wide utility contracts for government installations that were in or near large cities. It was readily apparent that the conditions of these contracts could hardly be applied to many Service areas, especially the more remote ones. On September 30, 1960, the Washington Office advised the Regional Director, Region IV (San Francisco) that a memorandum of July 22, 1953 was still valid, in that, because NPS telephone requirements are unique, the Service should negotiate its own contracts without referring them to GSA.

As indicated elsewhere, some telephone companies were reluctant to serve NPS areas because the revenue/investment ratio was too low. Part of the Service negotiator's job was to be familiar with the rate-of-return authorized by different PUC's. By knowing this, it was possible to analyze the utility's proposals for reasonableness. The analysis was sometimes the means by which the company could be persuaded that they could serve a given park without loss. In the case of Bryce Canyon their proposed service would have involved line extension charges for each one-party telephone to the nearest exchange in Panguitch. The resulting bill for NPS and the concessioner would have been prohibitive, so the Company was requested to consider a Bryce Canyon exchange, but they determined it would not be economically feasible. Further investigation revealed that if there were six additional telephones (above those actually needed) an exchange with a local BRA established would be feasible, and the cost to concessioner and NPS would be considerably less, even though the calls to Panguitch would be toll calls. Therefore, six additional telephones were ordered; an example in which strict application of the usual criteria would have been prevented establishment of a BRA, with higher annual cost as a result.

The telephone requirements for Yellowstone and Glacier National Parks were unique in that the volume of traffic (both government and concessioner) between developed-area exchanges was too great and too expensive to rely upon the customary long-distance service. The long-distance telephone companies offered "Telpak" service for use in such situations. It was an arrangement whereby a group of lines would be dedicated for calls between exchanges for which toll charges would not apply (cost being part of the charge for the Telpak service). Access to the Telpak circuits were restricted to specific telephones for which an access charge was applied. Yellowstone's Telpak arrangements have already been described. Glacier also used Telpak between West Glacier/Lake McDonald and East Glacier. Over the years a traffic congestion problem occurred, leading to a proposal by the park to increase the number of Telpak circuits at a substantial increase in cost. Investigation of the complaint revealed that both concessioner and NPS supervisors were competing to conduct most of their business at 8 a.m. each morning! By readjustment of timing of calls that were not critical timewise, the problem was solved without any need for additional Telpak circuits!

As noted in another section, there were several NPS-planned telephone installations that were not completed because of the replacement of NPS facilities with commercial telephone facilities. This was fortunate timing and avoided the government's substantial investment in telephone lines and equipment. The timing occurred as the result of a shift in government policy, which stressed the desirability of using commercial services wherever feasible.

During and following installation of commercial facilities in a park area there was often a persuasion that the company could do no wrong. This assumption is based upon the conception that all companies are regulated by a PUC or PSC in every aspect of their operations (discussed further elsewhere). This was evident in several ways:

> (a) Equipment selection sometimes included a "Cadillac" when a "Ford" would do the job (erroneously assuming that the rates for equipment being regulated, would prevent this from happening); (b) line crews were allowed to open access lanes that NPS crews would have been prohibited from doing; (c) allowing pay telephones to be installed in inappropriate places and/or with inappropriate style and color. In actuality, the contracts gave the Service full authority to control all aspects of the facilities. This was provided for in the requirement that drawings were to be submitted and approved prior to any construction. The understanding was that the companies would not be permitted to do anything that the Service would not do, if it were operating its own telephone system.

In another instance PT&T received permission to install overhead cables from the Yosemite exchange to various locations in the valley. It had been assumed that the cable would be the customary dull, dark grey in color. Where only six or twelve-pair cable was installed it turned out to be a new type in which each pair had distinctive brightly-colored insulation, each pair of a different color (prior cables had color-coded pairs, but they were contained within a nondescript jacket for identification. The "bird wire", as it came to be known, stood out visually against the background and was incompatible with the landscape goals of the park.

Frequently, government regulations which are well-intended became impossible when put into practice in special situations. NPS had an example of this when it was operating its own telephone systems in various park areas. Many employees lived within the park area and were on 24-hour availability for emergency calls. Because of this it was necessary to install government-owned telephones in their homes. Since there were no commercial telephones within the area, the employees had to use the government telephones for their personal use, mostly for calls within the park but sometimes for long distance calls - all with the understanding that their personal use would cease in the event of an emergency. In the same manner, it was sometimes necessary to permit visitors to place emergency collect calls from government telephones.

These circumstances resulted in a situation where minute tax payments were being submitted to the IRS for personal calls made from government telephones.(181) So the parks were notified, that which they already knew, that use of government telephones should be kept to a minimum.(182)

When commercial telephone service became available, in some park areas, this problem was solved by issuing the employees credit cards for which a fictitious personal telephone number was issued. It took some persuading of the Telephone Companies to get them to do this. In those cases where the visiting public had need of a telephone they are either referred to a public coin telephone or required to use a credit card, or call collect.

Because the telephone company facilities have built-in expansion capability they were able to provide more public coin stations than the Service was able to provide with its limited plant capacity.(183)

Even though many parks eventually had efficient commercial telephone service, some park areas were so remote that telephone communication was unavailable or unsatisfactory.

Radio Negotiations

The concept of leasing radio systems (1954) was considered by Washington Office personnel to be a remedy for problems which had been experienced with some NPS-designed-and-owned systems that were not adequately engineered. It was felt that the lessor could provide engineering designs that would meet the Service's requirements.(184) But this was not always true.

A number of leased radio systems were installed in the period from 1954 to 1958. Most were designed by NPS engineers, based upon field surveys. Competitive bids were solicited and some systems were awarded to Bell System companies. Problems with their systems have already been described.

The Anti-trust settlement in 1956 between the Justice Department and Bell System precluded the Bell System from further bidding on and furnishing leased radio systems to NPS.(184a) Contracts with them, existing at that time, were terminated when they expired.

In light of past experience, recorded elsewhere, the Service required that only radio equipment "which had been certified by the National Park Service radio laboratory as meeting NPS specifications to be furnished."(185) This was not only to assure reliability but to assure that the equipment would conform with IRAC regulations, and be reasonably immune to interference from other sources.

With the beginning of negotiations in 1953-1954 for service and/or leasing radio facilities, it was necessary to negotiate surcharges with contractors because of the remoteness of repeaters and base stations as previously described.

Later there were attempts to acquire leased radio communication "service" by competitive bid. The intention was to have the supplier, instead of the Service, do the field surveys and engineering to design a system which would meet specified operating requirements. This arrangement had its difficulties in that it is very hard to develop a "yardstick" for portable or mobile coverage, and for point-to-point communication. Requiring "solid" mobile coverage might require an inordinate number of repeaters. This problem of defining coverage has already been described.

Nevertheless, leased contractor-designed systems were installed at Yellowstone, Saguaro, Wind Caves, Grand Canyon, Zion, Lake Mead, Great Smokies and other areas on this basis. Some of them worked well and some never worked. It looks easy to contract out or lease for services, but not so easy to obtain full satisfaction without adequate supervision and administration of the contracts.

New FM systems were included in the 1953-1954 construction program for several areas. The funds scheduled in the Project Construction Proposal (PCP) evidently failed to included adequate funds for construction of buildings, erection of towers, etc. Rather than reduce the number of portable or mobile units to cover the missing costs, some areas elected (perhaps with a little persuasion from communication Engineer Rowley) to do the required work with maintenance funds. In Death Valley they elected to do this so that even the garbage truck had a radio - later determined as to be unnecessary.

CHAPTER FIVE

MATURITY

1961-1977

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MATURITY

1961-1977

GENERAL

In what direction would NPS communication development turn following the post-war years? Would telephone and radio become imbedded in the management and operations of the parks? Would they be superseded by newer developments? Would they grow and develop with more sophistication - perhaps as inspired by Buck Rogers?

What of the National Park movement itself? So far the Service and the areas entrusted to it had grown in size and maturity. Management and operational procedures were becoming standardized. Greater reliance was being placed upon two-way radio and by the close of the period covered by this book (1977) computers were being used extensively, both as separate systems, and as parts of a larger system linked by telephone lines.

Forest-fire-fighting techniques had been improved, using airborne detection and crews, new communication and other facilities. Interagency cooperation became standard procedure.

Radio-frequency channels were becoming clogged, once again forcing adoption of new techniques and frequency bands.

All of these developments required greater use of higher skilled technicians to maintain and operate the various communications devices.

The seventies brought on various attempts to "privatize" many functions of the Executive Branch including such functions as building and grounds security, architectural and engineering design, studies of all types, and even managerial functions. This chapter describes how these attempts were carried out in the telephone and radio services. It is to be noted that "privatizing" requires a very clear concept of the work to be done and the laws pertaining thereto. It also requires diligence and close attention by a government representative (usually a contracting officer and/or inspectors) to see that the function is fully carried out. Several instances of laxness pertaining to the latter are described in this chapter.

Because of the neglect during World War II and the limited funds available after the war, the physical facilities could not withstand the impact of increased visitation. They needed urgent attention. A program of rehabilitation and redevelopment to meet these increased needs was established, to be known as Mission 66, with the goal of bringing all facilities "up to snuff" by 1966.

One of the concepts developed during Mission 66 planning was that it would be desirable in some areas to remove support and administrative functions and related facilities outside the park, leaving protection and interpretation facilities to remain in the park. Yosemite and Mount Rainier(1) are among the areas in which this concept was eventually carried out.

In the mid-70's the Justice Department was gathering data that we were told was to be used to determine if AT&T and the Bell System companies were violating terms of the consent decree of 1957, and/or anti-trust regulations. In response to their request DSC prepared several large boxes of copies of records pertaining to telephone company involvement in providing radio facilities to NPS. Records pertaining to telephone contracts for many parks were also included. As of the close of the period covered by this narrative (1977) there had been no followup by the Justice Department.

TELEPHONE

The authority for the Service to negotiate its own contracts (without referring them to GSA) has been stated in Chapter Four.

In addition to the in-park telephone facilities which have been reported in Chapter Four and this chapter, the General Services Administration (GSA) established in 1967 a government-wide Federal Telephone System (FTS) throughout the country. This system was planned so that long-distance calls could be made at less cost by routing them through GSA-leased lines and operators. An identification code was required from callers to prevent use by unauthorized persons, and to determine traffic-use by the different agencies. Initially such calls could only be initiated from larger cities where FTS operators were located. Calls from outside these cities would require a toll-call to reach the FTS operation. It became incumbent on the caller to determine whether a toll-call to the FTS operator, or direct to the called party, would be the least expensive. The FTS system had no effect on within-park communications, but was usually used for communication between any headquarters and other headquarters, regional offices, or metropolitan areas.

Prior to the establishment of the FTS system, extensive use was made of the PBS teletypewriter centers described in Chapter Four.(2)

In connection with new areas being opened up for development, such as Wetherill Mesa in Mesa Verde National Park, consideration was given to joint use of rights-of-way with underground facilities. This joint-use could be either direct burial or in conduits for power and telephone lines in connection with (a) roadways being built, (b) water lines, or (c) sewer lines. This practice became feasible in the late 1950's with the development of lower-cost underground power and telephone cable.

North Cascades National Park

Stehekin is a ranger station in North Cascades National Park. It is at the head of long and narrow Lake Chelan in Washington State. Access is by boat from the town of Chelan, by float-plane from Chelan or more distant points, or by trail from distant trail-heads. It is manned by one or two all-year NPS personnel, supplemented by "seasonals" in the summer. There are a number of inholdings in which the owners live in their rustic homes. In 1968 the area was transferred by the U.S. Forest Service to NPS.

During the first few years of NPS management, a drowning and other emergencies in the Stehekin area impressed management with the importance of communication with the outside world. In one case, a congressional inquiry was made as to why immediate communication was not available to summons air transportation of a victim to a hospital.

About the same time, the preparation of master plans was under way for extensive visitor accommodations which would require telephone service. Accordingly, negotiations with commercial telephone companies were begun. Stehekin was outside of the "assigned" territory for any telephone company and at least 30 miles airline from the nearest point-of-service of any of three companies: Pacific Telephone, General Telephone, and United Utilities. Proposals were solicited from all three companies, any one of which would have had to use high-altitude microwave repeaters to reach into the isolated valley or an underwater cable laid the length of Lake Chelan. During the course of negotiations, it became apparent that any major development in the area would be far in the future, but the need for telephone service was urgent, since privately-owned CB radios could not be depended upon. Therefore, the requirement was scaled down to a single line for government use only, and a contract was signed with the General Telephone Company of the Northwest (GTE).(3) The circuit was to be provided by a VHF or microwave relay from the Company's facilities near Chelan. Due to the isolation of Stehekin and the need for providing solar electricity for the repeater, which was not easily accessible, the cost would be high ($550/month). Facilities were to be operational within a year. However, difficulties in locating a suitable repeater site and in getting environmental clearances from the Forest Service caused a delay of about two years, and an increase in cost to $1570/month with a nonrecurring charge of twice the original non-recurring charge ($33,000). Unfortunately GTE overlooked the fact that the contract price was fixed, and they should have indicated their problems in getting the necessary approvals, before obligating additional costs.

It is to be noted that the new costs exceeded the cost of a 6-pair submarine cable if it were to be laid in the water for the length of Lake Chelan to existing circuits (an alternative that originally was rejected as being too expensive). Had the actual cost of microwave been foreseen, and the cable laid instead, Stehekin would have had at least six circuits whereas only one circuit is available which must be shared by NPS, concessions and private residents. At the close of the period covered by this narrative, it was not clear how the contract and increased costs would be resolved.

Even at the original contract cost, it ended up with a high price for the taxpayers to pay for use of a environmentally questionable microwave site which would have been avoided if the facility had been accomplished by means of a cable in the lake. No evidence of its existence would have been noticed.

Alaska Areas

In Alaska, telephone communication, where it was available, had been provided by the Alaska Communication System (ACS) which was a branch of the U.S. Army (later the Air Force), as described in Chapter Four.

During the 1960's ACS facilities were sold to commercial communications companies. The sparseness of the population and the rugged terrain presented many problems not experienced in the "Lower 48". Prior to the takeover by commercial companies, Mount McKinley (now Denali National Park) headquarters was served by a single ACS line with five extensions in employee residences. At night, only one residence was able to receive incoming calls (at such times as that residence is occupied). The superintendent had a second telephone on a party line which was most always in use by others. The McKinley Park Hotel was served by two lines feeding into its "war surplus switchboard with antiquated telephones in some rooms."(4) There was concern about the difficulties in getting emergency messages out (or in) with the then-present facilities. (5)

After ACS began the process of turning over its non-military telephone services to commercial companies, the Alaska Public Service Commission (PSC) granted the Matanuska Telephone Company (MTC) operating rights (1967) to serve the headquarters vicinity and the settlement of Healy, among other territorial rights. Negotiations were begun by the San Francisco Service Center (DCSSC).(6)

At that time it was anticipated that an expansion of concessionaire facilities at McKinley Park Station would be in operation by 1970 or 1971. A proposal by MTC involving an estimated cost of $483.50 per month was recommended by the superintendent, but it was geared only to the concessioner's future needs and did not reflect the Park Service's or employee residence requirements. With all requirements considered, DCSSC proposed that a base-rate-area (BRA) be established to include the hotel, railroad, and government headquarters area (it would probably include the nearby Healy area as well).(7) The BRA possibility was not recognized by everyone involved in the negotiations. (8)

In late 1967, both the park (9) and the regional office (10) suggested negotiations with MTC be placed "on the back burner". There was also a misunderstanding whether the negotiations needed to be approved by GSA and the Bureau Telecommunications Coordinator but the services to be provided were not anticipated to be of the type requiring their approval.(11)

Bartlett Cove (the main point of interest and concession facilities in Glacier Bay National Park & Preserve) is about 5 miles from Gustavus Airport. The airport was developed during WW II for use during the ferrying of new planes from the United States to the USSR. The airport's telephone service was via FAA/ACS facilities. With increased tourism to Bartlett Cove in the late 1960's it became necessary to obtain telephone service there. A "ground-lay" cable was installed along the roadway shoulder by NPS crews. While the cable was intended for direct burial, trenching would have been too costly. So the cable was laid in the underbrush, realizing that it would be completely overgrown in a year or so. By that time RCA had taken over the ACS Alaska facilities, so service for Bartlett Cove was achieved by means of this cable, connected to RCA facilities at Gustavus airport.

Great Sand Dunes National Monument

The first attempt (in the fifties) to obtain telephone service at Great Sand Dunes (GRSA) was to rent a mobile telephone from Mountain States Telephone and Telegraph Company (MST&T) which was used as a fixed station to reach switching facilities at Alamosa, Colorado. At a later date, proposals were requested by the Denver Service Center from several telephone companies operating in the general vicinity of GRSA. The Colorado Public Utilities Commission (PUC) assigned operating rights to serve GRSA and its environs to the Columbine Telephone Company (CTC). The latter was a small independent company with headquarters in Montana. After negotiating line-extension charges with Columbine and installing on-site cables to different telephone locations, GRSA presumably had commercial telephone service. In actuality, service was so unreliable, and outages so long and often, that GRSA and other users appealed to the Colorado PUC for relief. The extent and condition of CTC facilities were beyond the capability of the one-man maintenance crew to provide effective service. It was hoped that another better-equipped and staffed company would be allowed to take over Columbine's operations. However, Columbine was still providing its unreliable service at the close of the period covered herein (1971).

General Experiences

Some National Park areas are ill-suited for installing telephone service via customary overhead or underground lines. For example, telephone service was badly needed for NPS-proposed developments at the Havasu Campground, in Grand Canyon National Park.(12) The nearest point with telephone service was served by an independent company, the Arizona Telephone Company. The only way to aesthetically install a line was to hang type "C" distribution wire on hangers along a cliff wall. The distances involved from the exchange required special line-extension apparatus for service to be satisfactory.

Telephone companies, by virtue of their monopoly in any given area, had been consistently rigid in their policies concerning the types of service they would render, and were equally rigid in their refusal to permit connection of "foreign attachments' to their lines. Once they had installed a dial system in a park area, NPS switchboard operators were no longer necessary as we have mentioned elsewhere. Some of the consequences of such rigidity have

been described in Chapter Four. However, the general public and businesses having the need for services not provided by the telephone companies, and for interconnection of customer-owned equipment to telephone lines, were eventually responded to by the FCC's Carterphone decision in 1968. "Under that decision, customer-premises equipment not made by the Bell System was permitted for the first time, provided that the connection to the foreign equipment [was] made with a protective connecting arrangement designed by the Bell Laboratories to prevent the equipment from disrupting the network".(13)

Building-fire reporting presented a problem requiring special attention in many of the areas. Hotels and visitor facilities had their own internal detection and alarm systems. However, these did not automatically alert the fire department (NPS, concessionaire, or both). In all cases the "firemen" are trained employees who are working at their regular job when not actually responding to a fire call. Because of the exposure to pranks and/or malicious calls by the public, public alarm boxes are not usually provided in the developed areas. Instead, a special telephone number is listed on each public pay telephone which will reach a member of the protection force. This person can (a) determine if the reported fire needs response and (b) initiate the coded siren system to identify the fire location for the benefit of firemen (thus they do not have to go first to the firehouse, then to the fire). The solution to this problem was for a second telephone to be added at certain offices and residences of responsible firemen. The second telephones were placed on a common line with an unlisted number, which is posted at each pay telephone, hotel desk clerk, etc. A switch at each of the special telephones was provided for initialing the coded siren signal as indicated above. Mesa Verde, Mount Rainier (described in Chapter Four) and other areas used this type of system.

Throughout this period, government-owned overhead lines were often replaced with underground cables after contracts had been established for obtaining service from telephone companies. The same change was occurring throughout the countryside whenever overhead lines could be "vacated." Magneto ring-down telephones were being replaced by dial telephones (and in some cases touch-tone telephones). Opportunists were quick to recognize the possibilities of abandoned insulators and telephones as souvenirs. Many private museums display the various types of ceramic and glass insulators for use in different climatic situations. A genuine working magneto ring-down telephone is now a costly antique, and is the inspiration for modern telephones in antique-looking shapes. It is regrettable that NPS employees and individuals were unable to purchase the old magneto telephones for souvenirs before the telephone companies "trashed" them when they installed modern dial facilities.

By the close of the period covered by this chronicle, long-distance service requirements at Yellowstone had increased so much that MST&T installed a microwave system to serve the Mammoth exchange and the entire park system. A proposal also had been made, but not resolved, by MST&T to install microwave links to serve the Roosevelt Lodge and Tower Junction facilities in place of overhead and/or underground lines.

RADIO

As late as January 1960 there were still some HF frequencies assigned for AM use. At that time WASO questioned the need for 2770 kc, 5150 kc, and 34.78 mc at Saguaro, their hi-band VHF system being operational. 2770 kc and 34.78 mc were canceled, but 5150 kc was still in use for contacting Chiricahua and Coronado, two areas which did not have reliable telephone service.

By this time radio had become an accepted (and wanted) tool. Newer personnel (having grown up with dial telephones and being exposed to television and reading about Dick Tracy's wrist radio,) were quick to realize the advantage of communication to and from, and between field personnel.

In 1965, two-way FM radio became generally recognized as a useful tool to enable the limited manpower available to become more effective. Park areas which had not heretofore been interested in radio communications became anxious to get systems installed. This brought about exposure to new requirements and/or problems because many of these areas were located close to cities or suburban areas; whereas, the earlier park areas that had been using radio were in outlying or remote areas. A typical example is Fire Island National Seashore.(14) The repeater was installed at a high point near Farmingville at a site occupied by repeaters and base stations operated by local governments and private firms. In addition, an FM broadcast station is located at the site. Since interference between co-sited transmitters and receivers increases geometrically with the number of units, careful coordination was necessary to assure compatibility between systems. Similar installations at some other park areas have required expensive special cavity filters for this purpose. This type of installation requires negotiation for building and antenna space, sharing of costs of power, arrangements for access to equipment without interfering with the rights of other users of the site.

Like many other areas, Fire Island has cooperative agreements with civilian agencies for law enforcement and/or fire protection. Arrangements must be made for "cross-banding" or a "hot line" so that cooperating agencies can be called instantly. This requires special tone-controlled monitors, so that neither agency is subjected to non-related communications of the other agency, unless the other agency alerts them with its tone-control device. (Most 2-way systems are so active that dispatchers should only hear the operations pertaining to their own agency).

Manufacturers had, by now, recognized the advantages of developing radio equipment which was appropriate to the needs of the National Park Service and other forest and land-use agencies.

The introduction of transistorized VHF-FM portable units brought a number of advantages, of which reduced size and weight are the most well known. It also offered economy measures because it became possible to install antennas on boats or vehicles so that a single

hand-held or pack set could be used by ranger personnel whether walking or under way in a boat, automobile, or truck. In addition, by using the unit as a fixed station with a permanent antenna and battery charger, the need for base station equipment could be avoided. This possibility was further enhanced by the development of rechargeable nickel-cadmium (NICAD) batteries in sizes which could be used in hand-held and other portable transceivers. This, together with solid-state improvements resulted in the brick-shaped portables which could be dropped into a vehicle charger or ranger station charger when not in use. The need for frequent testing and disposal of dry batteries no longer existed. The nicad batteries were affected by extreme cold in the same way that dry batteries had been affected, but the size of radio and a spare battery became so small that personnel could carry them inside a jacket, using body heat to keep them ready for use, otherwise the battery voltage would be too low to operate the unit.

The development of solid-state equipment in the late 60's also revolutionized the power supply and physical size problem for repeaters and mobile units. It became no longer necessary to equip vehicles with special heavy-duty generators, and they took up much less trunk space. Repeaters could operate from solar-cell power with a storage battery to provide 24-hour operation during periods of darkness.

Many areas have had the problem of field stations not being able to reach anyone during hours that the headquarters base station is closed. Glacier Bay submitted a Project Construction Proposal (PCP) which proposed "it would be advisable to purchase marine band receivers for use in the rangers' residences. These would be very helpful in monitoring [progress of NPS and civilian vessels] after the office closes. During the summer, our boats should be operating after 5 pm."(15)

The same PCP said of their AM radios: "Our present [AM] portable units seem to do amazingly well for their 2-watt output. Our only problem is that we do not have enough to go around next year." This statement was intended to emphasize the need for additional portable radio units, not to promote continuation of AM mode.

Many parks were using leased radio systems, including maintenance, or were using contract maintenance. As mentioned elsewhere, there were sometimes deficiencies with this arrangement due to poor management. Often calls for maintenance were "saved up" or deferred, which had the effect of encouraging the contractor to be less diligent than he had contracted to do. Users continued to operate equipment which was not up to optimum performance without reporting it to the contractor. These practices led to recommendations that each radio system be managed by a single individual who was to be responsible for all phases of operation of the system (discussed further in another section).

This is not to say that all contractors "got away" with laxity. There were a few contractors whose personnel delivered sterling performance and sometimes went beyond the "call of duty " by providing system improvements and training of user personnel.

Many of the motor vehicles used by the parks were owned by GSA. Rooftop antennas were not allowed, making it necessary to use trunk-mounted antennas. But this resulted in markedly reduced coverage, which had to be taken into account during system design.

Chapter four referred to problems that occurred due to heavy battery-drain by tube-type mobiles in GSA vehicles. This was eventually eliminated by the chain of events in the automobile and communications industry. Auto manufacturers began furnishing larger-capacity generators and 12-volt systems in place of former 6-volt systems as standard equipment. The latter cut the current requirements in half for the same device. This voided the problem which was experienced because GSA had refused to order the larger generators for the 6-volt systems. And radio manufacturers began the production of solid state equipment which further reduced the battery drain so that it was no longer a problem.

Surveying, installing and maintaining radio systems within our National Park system was and is no job for the faint-hearted ("panty-waists"). Elsewhere I have described interesting situations that occurred during the field surveys at Olympic National Park and during the installation of a repeater at Haleakala National Park. These are but a few of the surveys that required ingenuity, ambition, and perseverance.

Winters at Mount Washburn in Yellowstone National Park are most severe. Several "heavy duty" antenna supports were destroyed by wind and ice.(16) They were replaced by a class-one (the heaviest commercially available) 60-foot pole, measuring 18" in diameter at the bottom. The antenna was enclosed in a fiberglass radome to eliminate angles and projections that would accumulate ice. Yet the next spring it was found to be broken off six feet above the ground line. It began to appear that antennas would have to be inside the building to prevent destruction during the winter!

Chapter four tells about the unique problem involved in accessing the Kern Canyon station in Sequoia/Kings Canyon National Park.

While checking a repeater at 9500′ in Sequoia/Kings Canyon with Ray Murry (park technician) I noted that the pilot did an almost-touchdown, then climbed again, and finally settled down for a landing. When I asked about this procedure Ray told about the pilot who failed to make this lift-off test, and had to set the controls for maximum lift, then push the chopper off the brink and hop in at the same time . It was necessary to do this so as to achieve lift capability to return and hover and pick up Ray. It sounds far fetched, but Ray is not known to exaggerate.

Radio Systems

Grand Canyon National Park: The FM system that was leased from the Mountain States Telephone and Telegraph Company (MST&T) was never completely satisfactory. The writer made five so-called "final" inspections, yet the system did not perform well. Instead of providing preventive maintenance as called for by the contract, only corrective

maintenance was provided. A check of the repeater at Hopi Lookout by the writer revealed that it had been installed and maintained by a technician whose training covered only mobile transceivers, but knew nothing about the intricacies of a repeater installation. At my insistence, an engineer was reluctantly dispatched from Phoenix to set up the repeater.

The result of these experiences was to replace the MST&T system with a new Motorola FM system under authority of the Air Force contract (described elsewhere). In addition to providing a better system and better maintenance, the Air Force contract had flexibility for additions and changes to the system as needed.

One innovation in the new system was the installation of a voice-operated tape recorder to be used for logging purposes. It proved advantageous also by providing a word-for-word recording of procedures and actions followed in critical circumstances such as fire and rescue. It is particularly beneficial for critiquing such operations.

Alaska Areas: Glacier Bay National Park, in the 1960's was staffed with very limited personnel so HF-AM radio was used for intra-monument communication. The most important radio installations were the Bartlett Cove HQ base station and the ship Nunatak. These stations used HF-AM to communicate between themselves, to communicate with patrol and research personnel who were using portable units, and communicate with the "outside world" via the "bushfone"(already described in chapter four) operated by the Alaskan Communications System (ACS) which was then part of the U.S. Air Force. They also operated on marine frequencies to communicate with ACS ship-shore stations and other vessels.

It has been pointed out in Chapter Four that special authority was give to the Alaska areas to delay conversion to VHF-FM, but about 1966, it became apparent that, while eventually Alaska communications should be converted to VHF, in the interim HF communications should be converted from AM to SSB. While radio was not being used as extensively by various users, as in the "lower 48", the long-distance capability of HF had the effect of creating a "crunch" on the available frequencies , which could be alleviated by conversion to SSB. Consequently, ACS in Dec., 1967, issued a public notice that the ACS "Bushfone" was to begin SSB operation (in place of AM) on July 1, 1968. Although ACS stations could handle AM after that date, they encouraged outlying stations (including NPS stations) to prepare to use SSB as soon as possible. This change did not relate to ship-shore operations, which were to continue on AM.(17)

For the NPS at Glacier Bay National Park this presented problems, because of different change-over dates assigned to the various agencies that NPS personnel had to communicate with. A proposal was made to install multiple transmitter-receivers and antennas at Bartlett Cove and on vessels which would be capable of SSB or AM for contacting the various agencies.(18) SSB transmitters of suitable power (around 100 watts) were only capable of about 12 watts when switched to AM, which was not sufficient for base station and marine

use. The situation was further complicated in that a vertical antenna for communicating with boats would be relatively ineffective as an antenna for communicating with aircraft, or portable units on land, or vessels beyond 200 miles. A horizontal dipole is best for the latter situations. Because of Glacier Bay's remoteness from communities and the U.S. Coast Guard stations, it was considered necessary to have the capability of communicating with the following(19):

NPS vessels
NPS portable units on land
Marine distress
Marine working (for private vessels)
Alaska Communication System
Alaska Coastal Airlines

Before the new system could be installed, the ACS announced that their land, (but not marine) facilities would be converted to SSB in 1968.(20)

While VHF-FM had been in use extensively in "stateside" areas, IRAC had authorized a delay in converting the land systems used in Alaska areas to VHF-FM (not to be confused with marine communications). Tests were made in 1968 to determine if FM could be used to meet the within-park needs of Mount McKinley National Park. It was obvious that at least one mountain-top repeater would be required. However, there was real concern whether dry batteries, solar power, or any other source of power would operate a repeater throughout the winter at the temperatures that exist. It was also noted that the manufacturers of radio equipment could not guarantee that their units would work at the extremely low temperatures to be expected.(21) During discussions of this problem in the San Francisco service center, several tongue-in-cheek proposals were offered, including: burning a candle inside the repeater during the winter months; installing thermal heat-storage units, which would reduce the chill in the building with heat which had been stored during the summer. Henry Oberg in his droll, poker-faced way suggested that providing some rabbits with enough food to keep them alive, the room would be warm enough to be above the lower tolerance limit of the radio equipment!

Until such time as the necessary tests could be made to determine if and how FM repeaters could be placed on mountain tops, and a system programmed for Mount McKinley and installed, arrangements were made to lease HF-SSB equipment from Motorola under the Air Force contract.(22) This was done only after the superintendent found that $2100, which was available, was not enough to make an interim purchase of 7 AM mobile units. He was most anxious to have radio communication as soon as possible. (23)

During this same period, it appeared to the State of Alaska, Dept of Fish and Game(24) that "benefits that could be derived by the joint use of a single radio communication frequency for ground-to-air and station-to-station use" in game and law enforcement. This opinion was shared by the Superintendent, Mount McKinley.(25) Base stations at

Headquarters, Wonder Lake and Camp Eielson were authorized to use 3231.5 kc for this purpose for communication with Alaska State Enforcement Agencies.(26)

In anticipation of the time when the use of HF in Alaska would be displaced by VHF-FM, PCP-proposal U-76 was made for a VHF-FM system to be installed to cover the northern part of Mount McKinley during the summer season, and an HF-SSB system to cover the southern portion of the park (an extension in boundaries to the south was anticipated) and to cover the northern part during the portion of the year that the VHF-FM repeater could not be used.(27) This redundancy in systems was important because of WASO/Senatorial concern over safety of visitors along the road to Wonder Lake, where the patrol ranger had no means of summoning assistance when needed. Field surveys for designing the new system were conducted in August 1965(28) and again in August 1968.(29)

An analysis made of the "comparative costs of a government owned vs. leased system showed that leasing ceases to be most economical when the leasing period is between three and five years."(30)

Great Smoky Mountains National Park: Great Smoky Mountains National Park has radio communication needs that are more extensive than many of the other parks. Following the original HF-AM system, a 30-42 mc HF-FM system was leased from Land-Air, Inc. which was installed in late fall, 1956. During the life of that system, IRAC had ordered all VHF systems be "narrow-banded" from +/- 15 kc to +/- 7.5 kc (described in a following section). The administrative and protection requirements had also outgrown the capabilities of the Land-Air system, making a new system preferable to narrow-banding the old system. Because of this, bid invitations were issued for a new leased system. An award was made to Motorola Communications and Electronics, Inc. Since the new system was to be installed during the 1965 busy season, there was concern about maintaining communication to outlying stations and mobile units during the transition period. It was determined that Motorola should install mobile and base stations first, so that mobiles could obtain a manual relay from the base stations to headquarters via the older Land-Air system. The "backbone" repeater system was to be installed later, at which time the Land-Air system could be withdrawn from service. It was stated that "it is essential that all mobile units used by rangers are capable of reaching at least one base station in order to meet the communication requirements relating to accidents, injuries, fires and other emergencies. Areas where these emergencies most frequently occur are on U.S. 441, Tennessee Highway 73, the Cades Cove Loop road and the Cosby Access Road."(31)

The new FM system was based upon field surveys and engineering provided under contract with Gantney & Jones, Communications Engineers. Specifications were on a performance-basis with a definition of areas to be covered. Design was to be by the contractor. Bid proposals for a leased system were received in early 1964. However, they were rejected because they exceeded the money available. They also exceeded Gantney & Jones Engineers' estimates. A protest by General Electric Company was denied by the

Comptroller General.(32) A negotiated contract with Motorola was signed March 18, 1965 for a 5 year lease, renewable for another 5 years. The system was accepted on December 1, 1965. Final service date for the earlier system which had been provided pursuant to Dynalectron's contract was November 18, 1965.(33) (The name Land-Air had been changed to Dynalectron Corporation.)

The new system was comprised of repeater stations at Mount Sterling in North Carolina; Clingmans Dome on the North Carolina-Tennessee line, and at Look Rock in Tennessee. The repeaters served twelve stations, 14 fire lookouts, and 48 mobile units.

There were many places within the park from which a mobile could reach more than one repeater. The signal received by one of these might be noisy. Therefore, a "voting" system was installed in which an analog signal, proportional to the received signal, was sent via the UHF (408 MC band) link, to the Clingmans Dome repeater station. A comparator would cause the Clingman's Dome receiver to respond to the strongest (and clearest signal). The mobile or base station operator can determine which repeater will retransmit his/her voice, by operating a switch which activates a tone that is coded to the desired repeater.(34) This voting method operates on a different principle than the one installed at Haleakala and described elsewhere, and avoids the problem experienced with earlier systems in which simultaneous transmissions by more than one repeater would result in bothersome beat-notes in areas where both transmitters are received with about equal strength.

During construction it was necessary for the contractor to drive over the foot trail in order to convey heavy equipment to the Clingmans Dome repeater. When the installation was complete, special procedures for maintenance were agreed upon in order to minimize the use of motorized vehicles, and to assure that such travel would be during hours when use by park visitors is minimal. The superintendent exercised close control over these activities in order to preserve the integrity of the park values. (35) Because the park lies within two states, Motorola designated its MSS in Asheville, North Carolina to serve the Southern District, its MSS in Knoxville, Tennessee to service the Northern District of the park, and the Cummins Diesel Sales Corporation, in Knoxville, Tennessee to service the diesel generating plant at Clingmans Dome.(36)

During the planning of this system it was necessary to evaluate the need for antennas at the repeaters that would be unobtrusive on the natural scene. The superintendent wrote the Director as follows concerning this: "As public use grew along with the possibility of forest fire it became eminently apparent that improved communications, to assist in emergencies involving human life, and emergencies involving the protection of the forest from fire, were needed. As a result of an extensive survey by one of the most competent radio engineering firms it was determined that there was no alternative, if coverage was to be adequate for basic protection needs, to the placement of an antenna in the Clingmans Dome area. Studies were made to locate this antenna in the least conspicuous location and still so located that it would provide the desired coverage."(37)

Mount Rainier National Park: In the NPS, it seems axiomatic that when administrative or department heads are replaced with new personnel, changes are made in policy, practice, and/or districts within the area. Sometimes they are predicated upon new visitation patterns or other factors. Sometimes these changes are made without determining whether the existing radio system can adequately serve the changed situation.

A VHF-FM system (PCP U-94, $155,000) was completed at Mount Rainier National Park in 1966. However, by 1968, correspondence indicated that there was dissatisfaction with the system. After inspection and tests by the regional communications engineer, the complaints were found to be the result of (a) improper and/or inadequate preventive maintenance, (b) changed communication requirements brought about by organizational changes, (c) inadequate training of the users of the system, and (d) power failures at the Crystal Mountain repeater. Carbon River was changing from a summer-use area to an all-year area. Repeaters at fire lookouts always experienced heavy snows which restricted accessibility by any means except expensive rental of helicopter at the very time the repeaters were needed for the early summer operations. In an effort to determine if the system could be redesigned to improve it, tests were made from Columbia Crest (on the 14,450′ summit of Mount Rainier) and Anvil rock at 10,000′. Both sites had been suggested as being ideal by many of the local personnel who had predicted complete coverage of the park. The results showed there was not enough coverage from either location to obviate the need for other repeaters. The existing system was so badly deteriorated that complete reconditioning to manufacturer's specifications (to be made by an outside contractor) was recommended.(38)

Later a computer-created (described elsewhere) study indicated that a minimum of six repeaters would be necessary to provide the desired coverage. The follow-up to this study occurred later, and is subsequent to the cutoff date of this account.

Haleakala National Park: The island of Maui is abundant with unique features, the Silversword, the crater, Seven Pools, and many other attractions. Haleakala National Park is also unique in many ways. The lava formations near the roads on the island cause unusually high attenuation of radio signals (even on the broadcast band, very noticeable in automobile receivers). The Kipahulu tropical forest with box rose, guava, large ferns of all types, and larger trees result in almost total VHF energy absorption. The growth and fallen trees are so dense that, during the field survey tests of the Kipahulu area, it was necessary to scramble from one deadfall to another without being able to walk on the ground which could not be seen through the undergrowth.

These factors made the field survey and system design difficult. Mount Kalipawili was chosen as the most likely repeater point to provide coverage of the Hana/Kipihulu area, but it did not cover the west and north slopes (and areas beyond in the same direction) of Mount Haleakala. Testing from that site went well until afternoon cloud-caps on other mountains nearby suggested the possibility of being stranded if we didn't scramble to the

road below to be picked up by helicopter. By that time it was obvious that if we had not done this we would have had the option of staying all night or walking back to headquarters.

Results of the test in the Kipahulu forest demonstrated that a high-gain directional antenna would be necessary at the Kalipawili repeater, and that pack sets (with higher power than hand-held portables) would be required if scientists working in the forest were to be able to communicate with headquarters.

As indicated by the tests, the park is large enough to require two repeaters, but the area covered by each repeater is broken up in such a way that in normal situations simultaneous transmission by both repeaters would be necessary. However, to do this without objectional beat notes when mobile or portable units are in a location at which both repeaters can be heard, it would be necessary for virtually identical frequencies to be produced by both repeater transmitters. However, this precision frequency control could not be achieved at the Kalipawili repeater because no AC power was available. (AC power is required to operate the thermostatically-controlled crystal ovens when the highest frequency-stability is called for).

In mobile operation, there were many areas where the Kalipawili repeater would be useful for a short distance (anywhere from ten feet to 100 ft or more) interspersed with dead areas of similar length, in which the House-of-the-Sun repeater usually was useful. In order to achieve continuous coverage, the receivers of the two repeaters were linked by a 400 mHz circuit. The best received signal was obtained by using a comparator which would compare the signals received by each repeater and select the received signal from the best repeater. A tone transmitted by the portable/mobile unit is used to determine which repeater transmitter would retransmit the selected receiver signal. It took practice for the users to learn that their tone determines which repeater retransmits his voice - hence determines which stations will receive his transmission.

Financial considerations dictated that portable units be used in the vehicles rather then mobile units, which would have greater "talk-back" range due to its greater power. However, the portable units, operated into a roof-mounted gain antenna, gave two-way coverage over most of the island's roads, except the west shore which was not an area of concern to the park operations.

Everglades National Park: Everglades is unique in that the customary FM system can be used for most of its management/protection functions, but additionally it must use high-frequency radio to reach Fort Jefferson and the vessels used in connection with it. The latter used AM until sometime between 1960 and 1965 when the equipment was exchanged for the SSB mode of transmission. The vessels were equipped with marine frequencies for contacting the Coast Guard, and other vessels, in addition to the NPS frequency for working Ft. Jefferson and Everglades. The flat nature of the terrain within the park necessitated

elevating the headquarters antenna. In 1971 it was moved to the tower of television station WCIX- channel 6.

Grand Teton National Park: Establishment of the John D. Rockefeller Jr. Memorial Parkway connecting the north end of Grand Teton National Park with the South Entrance of Yellowstone National Park requires cooperation and interaction between the protection forces of both parks. In 1976, it was proposed to install transceivers in four patrol cars with the capability of "working" both Yellowstone and Grand Teton control stations. This departure from the typical transceiver whose capability is limited to (a) direct unit-to-unit communication or (b) communication via a repeater, was the forerunner to more sophisticated systems that were developed subsequent to 1977. Details of the latter are not within the purview of this narrative.

General Problems and Developments: The Southwestern National Monuments 5150 kc (AM) net was terminated in 1962 with the cancellation of frequency assignments for Chaco Canyon (now Chaco Culture National Historic Park), Chiricahua National Monument, Wupatki National Monument, Southwestern Archeological Center (Globe, Arizona), Tonto National Monument, Great Sand Dunes National Monument, and Saguaro National Monument.(39) This action was predicated upon three developments: (1) Pressure from IRAC to discontinue use of HF to prevent radio interference to aeronautical radio and other needs; (2) improvement in telephone communications to many of these areas, and; (3) reorganization of the southwestern states area, in which field areas were to report to the Regional Office in Santa Fe instead of SWAC.

Management and regulatory problems with recently-developed frequency-synthesized portables are covered in the section on Radio Operations and Interference.

Narrow Banding

While the word "conservation" had been around a long time, the public's conception was that it pertained to natural resources; i.e., forests, soil coal, etc. The Civilian Conservation Corps created in 1933, was a classic example, in which the concept had been broadened into the concept of "conserving" the youth of America. In the same way, the "ether" (radio frequency spectrum) was considered limitless until the post-war period when users of radio were reminded that the radio-frequency spectrum was also a national resource to be conserved. Joint action by the FCC and the IRAC, and international treaties has pushed many users, NPS included, into the VHF spectrum as reported earlier. By 1960, the "crunch" on the VHF spectrum had developed to the point that something else had to be done, if police, taxis, mobile telephone and other needs were to be met. That "something" was narrow-banding conversion.

Up to this time, voice operations on VHF were almost exclusively FM, using a "spread" or deviation of plus or minus 15 kc. However, industry and regulatory agencies conducted tests to determine if a narrower spread could be used without sacrificing the distance-coverage and the noise-suppression of the then-used 30 kc spread. After development of improved equipment, it was demonstrated to FCC and the industry that plus or minus 7.5 kc could be used satisfactorily.

With this in mind, the Office of Civil and Defense Mobilization, acting through the IRAC, on January 14, 1959, issued an order that all government radio-telephone systems be "narrow-banded" with equipment either meeting or capable of being converted to meet narrow-band standards. Transmissions were to be limited to plus or minus 5 kc during modulation, and receivers selectivity was to be sharpened accordingly. Channel separations were to be reduced to 20 kc in the 30-42 mc band, 25 kc in the 162-174 mc band, and 50 kc in the 406-420 mc band. A date of November 1, 1963, was set, after which, if interference is experienced between two systems, the non-complying system must assume the responsibility for the interference.(40) The technical requirements were later incorporated into the Departmental Manual, part 313.511.

The Department required that all equipment procured after July 1, 1959, meet the new standards. They pointed out that the push for new frequencies was due to "a significant increase in the use of Very High Frequencies (VHF) for military, aeronautical and space services [which] emphasizes the need for government services to use the spectrum as efficiently as is feasible." Interior bureaus and offices were to have "already developed some plans for conversion to narrow-band or will have examined the situation".(41)

The narrow-banding requirements necessitated that all FM units in the 30-42 mc and 152-174 mc be ultimately narrow-banded. This requirement was placed upon both non-government and government users as a spectrum-saving effort, enabling more stations to be accommodated in these bands.

The requirement that all NPS FM units in the 30-42 mc and 152-174 mc band in the early 60's required planning and studies to determine which park systems were to be converted, and which were to be replaced. The narrow-banding program included a "mix" of narrow-banding modifications of existing systems, and replacing existing systems. The determinations whether to modify or replace and whether to own or lease replacement systems were made by detailed studies and consultation with park and regional personnel. It was also an opportunity to begin using some recently-developed techniques and procedures as well.

The Interior Department IRAC representative was diligent in his followups on NPS FM system narrowbanding progress.. A report to him, dated January 25, 1961 indicated that 12 of the 46 VHF-FM systems operated by NPS had been narrow-banded. Of the 34 which were not narrow-banded, 17 were Service-owned and in the process of narrow-banding either by modification or replacement. A request was made to extend the terminal date for

completing the changes from November 1, 1963 to January 1, 1966 to allow time for re-engineering and finding changes.(42)

In April 1962 a schedule for the Region Three areas was developed:(43)

1963

Bryce Canyon - replaced with leased or government-owned
Chaco Culture - replaced with government-owned
Chiricahua - replace with lease
Grand Canyon - modify existing system or replace
Organ Pipe Cactus - replace with lease
Saguaro - modify existing system or replace
Zion - replace with lease
Coronado - lease new system

1964

Bandelier - replace with lease
Lake Mead - modify existing leased system
Mesa Verde/Hovenweep - method to be determined
Canyon de Chelly - lease new system

1965

Carlsbad - replace with lease

Similar scheduling was developed for the other three regions. Grand Tetons narrow banding was completed in 1963.(44)

There was the probability that narrow-banding "results in a loss of coverage, and [where] existing coverage is marginal, system changes will have to be made to keep the system operating after the conversion [of existing equipment] to narrow band."(46) In many cases, west of the Mississippi, it was necessary for WODC to conduct field surveys to determine if system changes were necessary to overcome the anticipated loss of coverage due to narrow-banding. In those cases where 30-42 kc systems were being replaced, field surveys were necessary to determine whether they could be replaced with 162-174 mc systems. While the higher band practically eliminated the possibility of long-range (transcontinental) interference, the difference in reflection, diffraction, and attenuation characteristics between the two bands necessitated surveys to determine if the higher band could be successfully used.

Those areas which were narrow-banded by leasing new systems to replace government-owned systems faced funding problems. Most government-owned systems had been acquired with construction funds, but leased systems included the investment charges as part of the monthly rental charge. This required revision of funding programs.

In addition to the financial problems of converting existing systems (some systems costing over $6000 to convert), there was a technical problem in that portable equipment could not readily be converted. The IRAC representative also required that all new systems be in the higher-frequency bands wherever feasible. The latter was in "order to avoid long-distance sky-wave interference" in the 30-42 mc band, as reported elsewhere.(45)

Ignition noise was also a problem in certain vehicles after narrow-banding.

A preliminary study by WODC(47) showed that the costs of narrow-banding and/or replacing with narrow-band equipment, would cost about $67,700 in operating funds (for leased systems) and about $247,500 in construction funds for government-owned systems for those areas in Regions Two, Three, and Four (areas west of the Mississippi River). The timing posed a problem in programming funds because construction funds for the years through 1963 FY had already been scheduled for other projects. However, $67,500 was made available servicewide in 1963 FY for this purpose.(48)

Who should pay for the cost of narrow-banding leased systems? This question arose because the leasing contracts called for the lessor to keep the system in compliance with FCC/IRAC regulations. Since the change was mandated by IRAC, should the contractors not be obligated to make the change at no cost?(49) This matter was referred to the Regional Field Solicitor, Sacramento during 1961.(50) His opinion was that the contractor should not be required to stand the conversion costs, except in cases where the parts and labor are minor.(51) In most cases the Service did pay when existing systems were narrow-banded. However, the Mountain States Telephone and Telegraph Company agreed to do the work without cost for the areas in Region Two and Three served by them. "This work will be accomplished in so far as possible in connection with routing maintenance of the systems with the objective of having conversion completed by November, 1963."(52)

It was later learned that the telephone company only intended to narrow-band the transmitters, making them legal, but not narrow-banding the receivers. This would not pose a problem in those areas whose geographic separation precluded interference from other agencies on adjacent channels.(53)

Some of the telephone companies' in-house problems in providing leased radios have already been described. In connection with narrow-banding WODC advised "on Mr. McFadden's most recent trip he observed three telephone-company furnished systems and one Motorola-furnished system. The latter was satisfactory but in the other three areas the Superintendents [had] requested assistance in obtaining the type of maintenance the contract called for . . . that in most cases it will be advantageous to terminate leased radio contracts with the telephone company and either re-advertise or obtain future service under one of the Air Force contracts."(54) Subsequently the telephone companies voluntarily withdrew from offering to provide private radio systems. The latter resulted from a Consent Decree with the Justice Department in which certain functions were prohibited to AT&T and its operating subsidiaries.

During the narrow-banding operation there remained a question of government ownership versus leasing those systems which were to be replaced. WASO was recommending leasing of all systems but field areas and personnel sometimes felt that leasing did not provide the quality of service or appropriate savings, particularly systems based on a service requirement (where the lessor designs the system to meet specified service requirements).(55) This subject is further elaborated upon under the Maintenance heading.

Narrow-banding was accomplished for most areas in 1963 and 1964 FY. However, there were a few left to be completed in the 1965 and 1966 fiscal years.

Dates of actual conversion or replacement are not readily available except:

April 1964

Organ Pipe - converted
Saguaro - converted
Chiricahua - converted
Zion - converted
Bryce - converted

The "frequency crunch" which necessitated this program was not limited to frequencies below 200 mHz.* Plans to narrow-band equipment in the government 406-420 mHz band were held in abeyance several years because "it was difficult to achieve the requisite frequency stability with commercial equipment then available." However, in March 1968 the Departmental Communications Engineer advised "equipment that will meet the narrow-band standards is commercially available . . . accordingly . . . the IRAC proposes that government radiotelephone stations in the 406-420 mHz band be required to meet the same standards as for FCC-licensed stations in the 450-470 mHz band."(56)

Citizens Band

In the 1950's the FCC was involved in an extensive review of frequency allocations to non-government users. The FCC was being pressured to grant additional authorizations by many groups of users. "The principles resorted to by the Commission in setting up railroad, petroleum, forest products and special industrial services . . . [were based on] priorities of need. These priorities were equated with safety . . . and situations, such as non-urban location, where other means of communication tended not to be available. In the same determinations the Commission set up the Citizens Radio Service, freely accessible to those not given preferential private treatment, . . ." (57) The establishment of the Citizens Radio

* The terms kilocycle (kc) and megacycle (mc) were being replaced with kiloHertz (kHz) and megaHertz (mHz) during the late 60's.

Service applied only to civilians and there was initially no provision for government use of these frequencies. Citizen Band radio quickly became popular for truckers, boat owners, automobile owners, and individuals. Manufacturers vied with each other to create convenient, easy-to-use, low-cost units. Civilian CB users adopted specific frequencies within the CB band for calling and emergency uses.

It was not long before pressure was applied on certain park areas to provide CB base stations which could be contacted by private vehicles in need of assistance and/or information. A few rangers did operate their personal CB equipment (usually in their home) on an unofficial basis. Problems with this arrangement are discussed in a following paragraph.

Because of the low cost of the equipment (compared with FM equipment supplied for commercial/government uses, whose requirements were more stringent and required greater dependability), some parks that needed low-cost radio communication clamored for permission to install CB units for their own use. Ultimately pressure from the field and other agencies resulted in two regulatory actions.

Two frequencies, 27.575 and 27.585 mHz (called the Government Band, GB, adjacent to the CB band) were established for any government agency that desired to use them. Such use would be on a shared, non-interference low-power basis(58) Manufacturers were able to modify standard CB units to expand their range to cover these frequencies. In actual use, monitoring for calls from another station was usually accompanied by a bedlam of voices and heterodynes from other users. During sporadic E propagation conditions (described elsewhere) the bedlam might include stations located hundreds or a thousand miles away. As a result these units could only be used at distances where the desired station was strong enough to override the bedlam. Areas known to have used GB equipment includes(59): Cabrillo National Monument five units (1968) There undoubtedly were other areas, the details of which I did not have access to.

But another demand developed which was not met by the IRAC-assigned frequencies. Several NPS areas straddle heavily-used highways and/or include intensely-used marine activities. Many of the drivers and boat operators had CB radios with which they expected to contact NPS protection personnel in case of emergency. Concern arose because some rangers had used CB sets on a personal basis to respond to the calls. But serious concerns arose because if it was publicized that Dark Blue Marina (for example) was monitoring channel 9 during specific hours, and a CB'er called and got no answer, who could tell if:

(1) The CB-er transmitter was fully operational?
(2) The CB-er was within range of the unofficial (or later - official) NPS base station?
(3) The base station was manned?
(4) The base station volume was turned down, or the attendant was momentarily away from the base station?

(5) What would happen if there was an official NPS station established?

The possibilities for tort claims are many and varied.

The official response to this problem was the issuance of licensing instructions for NPS stations that might be installed to aid the civilian CB'ers. Special Directive 78-9 dated October 16, 1978(60) specified that only three channels could be used, and that no public announcements could be made that CB facilities are available. ". . . the FCC must concur with each proposed CB frequency assignment [in NPS areas] before the assignment can be authorized by the IRAC. To insure that Interior agencies have the capability to utilize CB frequencies when required to support other than Federal operations, the Department has negotiated with the FCC for their consideration of proposed CB frequency assignments for essential Interior operations requiring this service."

The Special Directive addressed the possibility of tort claims with the following instruction. "Parks should not consider it necessary to notify the public by posting or publishing notices of the availability of CB monitors within a park area. Since the effective capability of CB transmitters is limited, it would be impractical to suggest effective CB capability. There is also a potential for tort claims against the government if we fail to respond to an emergency call using a CB transmitter. While this potential is always prevalent, it would be much greater if we suggested that we have even limited capability to receive a call from the citizen in distress using a CB transmitter."

Travelers Information Stations and Unusual Uses of Radio

Older readers will recall an era where personal contact by rangers with the visiting public was more frequent and personal. At the park entrance the visitor was informed of important regulations, points of interest, and his questions were answered in an unhurried way. With the increased interest and attendance to our National Park Areas, this method of public contact has largely been reduced to the sale of an entrance permit, and the supplying of a brochure or folder. However, in addition to safety and protection of natural features, the Service is committed to making those features accessible and understandable to the visiting public. As the visitation load increased, the latter has been carried out by the ranger-naturalists and park rangers (usually in group situations), visitor center displays, information folders, and interpretive signs.

Interpreters were anxious for a radio system, which could reach visitors in their automobiles to point out points of interest and warning of hazards (animal, physical obstructions, or hazards). Protection people could see its usefulness for disseminating road information, especially as to closures and/or restrictions (i.e. chains,snow, ice, wind, etc.). However, there were no regulations permitting this type of operation.

The first known attempt, other than signs, at reaching motorists was a transmitter/message repeater which was placed in operation in Yellowstone National Park by the Museum

(or Interpretive) Branch in the 1960's. It was not an IRAC-authorized operation and I do not have access to further details about this test installation.

In the early 1970's, interest intensified and spread to other federal and state agencies who had similar needs. FCC Rule 15 permitted low-power transmission in the broadcast band, but the range was inadequate for reaching moving vehicles.

In 1975 - 76 representatives of the Division of Radiocommunications and Frequency Management (Department of the Interior) were active in meeting with the FCC and other interested users to develop "the conditions under which Traveler's Information Stations (TIS) could be established for government and non-government use." (61)

Largely through the "push" by S.L. Windes, Interior representative to IRAC, a temporary authorization was granted for the use of 1610 and 530 kHz. Final rules for use of these frequencies were established in 1977. But this was not without concern by the National Association of Broadcasters, who sent a delegation to the NPS Denver Service Center, indicating their concern about the proselytizing of park visitors from listening to their broadcast stations. They were informed that the severely restricted range of TIS would not seriously hurt their listening audience. Furthermore, in the case of NPS, BLM, and others, TIS would be used mostly in remote areas where reception of standard broadcast stations is only fair to non-existent.

The NPS and BLM Service Centers (in Denver) joined forces and took the lead in researching the distance-coverage possibilities within the limitations of the FCC rules, and in contacting manufacturers who could produce transmitters and message repeaters for TIS use. The latter proved to be the most frequent source of trouble.(62)

The interest had spread to some state and municipal agencies, NASA, DOD, FWS, Highway Department, airports, and others in addition to the various Interior agencies:

> "TIS units should be versatile so they can be utilized along roadways as well as in places such as parks, historical sites, marinas, tourist information centers, highway rest stops and campgrounds. TIS should prove valuable in disaster situations, highway accident control, and detour movements.
>
> "TIS benefits include improved public relations, interpretive messages, elimination of traffic bottlenecks, and the provision of safety messages to the travelling public . . . all accomplished without large signs or staffing."

In 1973 an exit-poll at Yellowstone NP indicated that 86 percent listened, or tried to listen, to TIS broadcasts at various locations where roadside signs called attention to the broadcasts. However, it was subsequently learned that some specific precautions must be observed if visitor interest and TIS credibility is to be maintained:

1. Signs informing the public of the desirability to tune to TIS must be located close enough to the transmitter to assure a field strength that most vehicle radios can receive the transmissions.

2. Signs must be promptly covered any time a transmitter/ message repeater is inoperative. Failure to receive a TIS station will discourage visitors from tuning to future TIS units. TIS credibility will be jeopardized.

3. Avoid trivia in messages. They should be useful and informative. They are not entertainment.

4. Provide preventive maintenance so that transmissions will be effective and clear. In 1975 a joint BLM/NPS report recommended interagency cooperation in adopting standard TIS signs, equipment standards, engineering standards.

Engineering studies conducted by the NPS's Service Center showed that a range of two to four miles could be expected on 530 kHz, depending upon soil conductivity and terrain. A range of three to four miles could be expected on 1610 kHz(63). Factors limiting the range also included 20′ antenna height limitation (FCC rule), and tuning and sensitivity limitation of vehicle receivers (some could not reach both 530 and 1610 kHz). A sampling of vehicles owned by the NPS service-center personnel resulted in establishment of receiver-sensitivity criteria, which was in turn used to determine the above-reported useful range. Many car radios could exceed these ranges, but the criteria was established to assure that 95% of the cars used by the public would be able to receive the TIS messages.

At the close of the period covered by this record, probably a total of 100 TIS installations were in the planning and/or procurement stage.

Other Uses of Radio

1. Early in the 1960's miniaturization of low-power transmitters had developed sufficiently that they could be installed in collars on larger animals, such as elk, deer, and bear. The animals could then be tracked by research biologists to study their daily and seasonal movements. This was soon noticed by the Department of Justice as having possible application to law enforcement.(64)

It was not long before further miniaturization permitted installation on birds and smaller animals. But there were not enough frequencies available to use a different frequency for

each animal. Various encoding schemes have recently been developed for identifying each creature which may be using a certain frequency.

By 1965 tracking of Grizzly bears was taking place in the Craighead study in the Yellowstones. Everglades began placing transmitters on crocodiles to study their movements and activities. By the early 1970's the size and weight of the wildlife-borne transmitter had been reduced sufficiently to be used in the study of Nene geese in Hawaiian park areas, and the study of sooty terns in Everglades.

2. Occasionally the characteristics of certain parks are ideal for scientific tests which cannot be conducted at less suitable locations. The Service usually cooperates if there is are no suitable locations elsewhere and the tests can be done without damage to the park and/or visitors. Such tests are usually for radio propagation or meteorological purposes.

3. By 1960, the popularity of television had progressed until employees in many park areas expressed a desire for it. In nearly all cases the residences were in mountainous areas at great distances from the nearest TV transmitter. Occasionally a barely-readable signal could be received with a high-gain antenna by picking up a bounce from a nearby mountain. In some areas tests were made from higher elevations with the thought of either a cable system or a translater to pass the signal to residences. Sometimes this was successful. Often it was not.

Management questions arose, which had to be faced. Among them were:

A. If a translator or cable system was installed, who would own and operate it? How would operating costs be collected from those benefitting from it?

B. If a translator is installed, what limitations should be placed on the antennas at the residences? Landscape and lightning hazard considerations were involved.

C. Should the Service participate in the cost, on the basis of employee morale?

Various solutions to the problem were developed, which are outside the scope of this book.

4. In addition to the common uses of telephone and\or radio that have been described, other not-so-common instances are:

A. Use of government-owned telephone lines and/or radio systems for special radio broadcasts. It is known that there have been several such uses in addition to the one reported in Chapter 2.

B. Glaciological research being conducted at Glacier Bay by the Institute of Polar Studies at Ohio State University began with the use of NPS-owned AM portables for communication between Bartlett Cove (Glacier Bay NM) and field teams. This was within NPS authority since the Service could terminate use of the portables if any untoward usage was experienced. A request was initiated for authorization to use more powerful University-owned transceivers in order to improve transmission and reception.(65) By reference to the Department's IRAC representative appropriate arrangements were made.

C. The Naval Underwater Systems Center petitioned the Service for use of sites for receiving tests in 1971 and 1972 on the island of St. John in the Virgin Islands National Park. St. John and St. Croix were thought to be ideal for freedom from manmade noise and RF interference which was required for propagation tests involving receiving a transmitter which was located in the Continental United States.(66)

D. In 1958 WODC prepared technical specifications for radio beacons and direction finders for an Archeological survey of Wetherill Mesa, Mesa Verde National Park. The terrain and heavily wooded mesa-top did not lend itself to rapid or accurate location of Archeological sites by other means. An article in American Antiquity credited the devices with facilitating the survey.(67)

E. Radar has been used in some park areas for navigational and anti-collision purposes on NPS vessels.

F. Radar has been used in some areas for traffic speed measurement, and law enforcement.

Maintenance and Power Supplies

"All of the government-owned and government-maintained systems in Regions Two and Four are reportedly working fine and it has been our Engineer's observation that the results are satisfactory. We cannot say this for leased radio systems at all . . . he observed three telephone-company-furnished systems and one Motorola-furnished system. The latter was satisfactory, but in the other three cases the Superintendents requested assistance in obtaining the type of maintenance which the contract calls for. In all such cases, it is not the contract that is at fault, but it is [the park staff's] failure to follow through [to require] that the services provided for by the contract are furnished."(68)

Concurrent with the narrow-banding program (previously described) it was apparent to WODC electronic engineers that, while technical advances were being made which resulted in two-way radio being a very effective tool, management and practices in the use of this "tool" were lagging. As a result many park areas were not realizing full benefits from their

systems. Where full-time employee or contractor personnel were available, the results were usually good because of the individual's pride in maintaining their systems and training NPS personnel in their use. In a few areas administrators put pressure on NPS technicians to neglect preventive maintenance by requiring them to do additional non-related duties. The poorest results were experienced with contractor-maintained systems that did not have a full-time technician assigned to the system. These results were usually because of poor contract administration. Most contracts were established on the basis of a fixed number of preventive checks per year, with the proviso that emergency calls would be made at no cost to the government. This arrangement was intended to motivate the contractor to perform effective preventive maintenance. In practice, however, when a unit failed, the park staff would very often manage without the unit, intending to have the contractor repair the unit during his next preventive maintenance rather than make a special trip to repair the unit. In other instances, users would tolerate substandard performance (usually in the form of noise, or reduced areas of mobile coverage) without requiring immediate restoration by the contractor.(69) This leniency toward the contractor was evidently due to unfamiliarity with the intentions of the contract; namely, that the contractor must perform effective preventive maintenance, and if he doesn't do it, he should be required to take emergency efforts to restore service at his own cost. It is this circumstance that prompted the recommendation that each park area have a single person responsible for all facets of their radio system operation (as discussed in the section on Radio Management and Regulations).

However, it was evidently too early in the Service's experience to realize that it was necessary to designate specific local personnel to monitor performance and use of the new communications tool. By 1977 this need became apparent and a start was begun by the establishment of Guideline NPS-15.(70)

Thermo-electric generators using "bottled" propane for fuel source were used in conjunction with storage batteries for power sources at remote locations like Mica Mountain, Happy Valley Knoll, and Manning Camp in Saguaro National Monument.(71) Subsequent development of solid-state equipment which use less power, and solar cells which can be used to charge storage batteries, made such cumbersome installations obsolete.

Almost simultaneously with the development of solid-state equipment, the modular concept came into popular use. Each stage or function would be contained in a separate module, enabling transmitters and receivers to be assembled to fit specific requirements. It soon became feasible to interchange modules rather than replacing the individual capacitor, resistor, or transistor that was defective.

The refinement of solid-state equipment in the late 60's revolutionized the power supply and physical size problem for portables (a 9-12 pound portable became less than 2 pounds), repeaters, and mobile units. Dry batteries for portable units have been improved through the years, but it is still necessary to carry them (or the radio with self-contained batteries) in user's clothing during extremely cold weather, Otherwise the battery output would be too low to operate the unit.

Relationships With Other Agencies

References and details have already been given pertaining to the NPS participation in the operation of the Boise Interagency Fire Center. This operation is one of the functions under the direction of the National Wildfire Coordinating Group. This group was the focal point for various teams including the Communications Working Team.(72) Meetings were held periodically to coordinate the management, financing, and technical features of communication needed for effective wildfire management. Members included personnel from National Park Service, Bureau of Land Management, Bureau of Indian Affairs, and U.S. Forest Service, plus representatives from a number of state forestry agencies. "The concept was also applied to radio inventories and resulted in the establishment of a broad Federal Government fire equipment warehouse at the Boise Interagency Fire Center (BIFC). It was made up of the National Oceanic and Atmospheric Administration, the Department of Commerce, Department of the Interior (NPS and BIA and BLM) and the [U.S.] Forest Service. Large-fire communication systems were made available on an as-needed basis to these three agencies."(73) Further details are given under Emergency Communications.

Rogers Peak in Death Valley is an example of the demand for use of sites on NPS land by others. (Such demands are further discussed elsewhere) Because of concurrent jurisdiction and mutual needs, Inyo County and NPS had built and constructed the building, access road, and generating facilities on Rogers Peak. This was accomplished in 1959. By 1961 the California Highway Patrol and the California Division of Highways were authorized to install repeaters at the site on the basis of interagency needs. BLM was granted use of the site in 1972. In the meantime two TV translators and a ham-radio repeater were installed. But interference to the communications repeaters necessitated closing down one TV translater and the ham-radio repeater (which was found by the FCC to being illegally used for business purposes, a practice prohibited to radio amateurs). The remaining agencies were required to install special equipment to help minimize interaction problems.

In 1968, mutual cooperation between Mount McKinley National Park and the State of Alaska, Department of Fish and Game produced evidence "of the benefits that could be derived by the joint use of a single radio communication frequency for ground to air and statio to station use."(74) The frequency of 3230 kc was proposed, after the FCC advised the Park to submit a request to them, through IRAC, to the FCC.(75)

Emergency Communications

As reported in preceding chapters, one of the prime justifications for two-way radio has been the importance of communication in fire-control and rescue operations. Several early attempts to provide sufficient radios for this purpose, without stocking large numbers of radios, have already been discussed. The creation and function of the National Wildfire Coordinating Group have been described already. Under the purview of this group, the Boise Interagency Fire Center was established to overcome this problem, which was

common to other agencies as well as the NPS. The Center constituted a cache for all types of fire suppression and communication equipment, and a dispatch center. The dispatch center was able to rapidly dispatch tools, radios, aircraft of all types and crews to any project-fire in the country. It even had a "hot-line" to several commercial airlines to arrange charter flights for moving crews rapidly to the airport nearest the fire. Agencies involved have various employees that are "carded" for certain fire-line and fire-support operations, including radio technicians and operators. BIFC has authority to call for carded personnel, as required, from any agency to meet the needs for a particular fire-fighting operation in any of the government-controlled lands.

In the early 1970's several events occurred which emphasized to the Washington NPS and Department of the Interior officials that there were still areas which did not have adequate communications to fulfill NPS responsibilities.(103) The Washington Office made a study and reprogrammed funds so that the Mount McKinley VHF-FM system could be completed in 1975.(76) This report included estimates of $1,000,000 for 9 new systems, and $800,000 to upgrade four major systems. "Our visitor safety program including search–rescue activities and law enforcement, as well as maintenance management, require efficient communications. We intend to move . . . high priority . . ."

With the increasing use of aircraft (both fixed-wing and helicopters for large fires and/or disasters) air-ground communication became essential. The aircraft, in addition to its own aviation requirements, needed to talk directly to, and receive instructions from ground crews and those in charge of operations. Some of the larger parks installed their radios in contract aircraft which were on-call during the primary fire/visitation season. This usually required special noise-reducing headsets for talking and listening, in order to reduce aircraft background noise (which could completely mask the transmission from the aircraft). A few areas installed antennas on contract aircraft with a flexible cable and connector for rapid connection to a hand-held unit or packset.

This still left the situation where non-contract aircraft could be pressed into service for use on larger conflagration. In 1973 the Interior Department's representative to IRAC negotiated with the FAA for an arrangement whereby such non-contract aircraft could use an easily programmable special frequency on the aircraft radio for communicating with NPS ground crews. The special frequency was to be arranged for each individual occasion by designated Department of the Interior representatives (NPS, BIA, and the Boise Interagency Fire Center) from designated FAA Frequency Coordinators.(77) This writer was one of the designates.(78) This, of course, would require rapid acquisition of an 116-136 MHz AM transceiver for use on the ground. BIFC was to stock such a unit which could be quickly installed in a base camp/headquarters. Fortunately, there were no situations in National Park areas requiring use of this arrangement during the period covered by this narrative.

As reported in Chapter Four, one of the problems of providing equipment for emergencies is that it ties down substantial investment. However, about 1976, VHF-FM portable transceivers became available which could "synthesize" any frequency in the 150-174 MHz

band. This is in marked contrast to earlier units which were locked on specific assignment by crystal control. This development would not have been possible without the simultaneous development of transistorized amplifier stages which were broad-banded (not requiring retuning whenever the frequency is changed) to cover the entire 150-174 mHz band. A portable unit could be loaned or sent to and operate with any area whose system operated on assigned frequencies within the 162-174 mHz government band. It even meant that the same unit could operate into systems of cooperating agencies, such as BLM, FWS, BIA, U.S. Forest Service, and even civilian agencies, by adjustment to proper frequencies by the user.This recent development permitted the Secretary's staff to purchase two such units which could be used on a trial basis with any high-band FM system (NPS or other agency) on short notice.(79) The problem of compatibility of borrowed equipment for emergencies could be circumvented if an adequate number of the 9600-channel units could be cached at suitable places. At the close of the period (1977) covered by this report, BIFC was considering acquisition of such units.

Operations and Interference

The use of the 9600-channel synthesized portables carries responsibilities and potential problems. It could very easily, intentionally or inadvertently, be changed to the transmitting (and/or receiving) frequency of any public safety (police and fire), mobile telephone, or other-user frequency. Such operation would be illegal and could result in delayed responses and/or other types of confusion. Because of its capability to operate on any frequency in the band(80), users must be carefully instructed as to what frequencies are authorized for the purpose it will be used.

Two National Radio Quiet Zones (NRQZ) were established in the 1970's. These zones were set up so as to regulate all radio emanations within the zone (by specifying frequency, power, and location) so they will not interfere with the performance of extremely sensitive devices at radio astronomy facilities. Shenandoah National Park lays within one of these zones, and special efforts were "made to achieve compatibility." The 10,000 square mile zones included parts of Virginia and West Virginia. (81) The second NRQZ is in the vicinity of Fort Huachuca in Arizona.

Interference quite often has the capability of becoming an adversary situation between interferer and interferee. Occasionally it occurs between "sister" agencies. One such incident occurred when the Bonneville Power Administration (BPA) installed a station near Driggs, Idaho on 172.525 mHz which was already in use by Grant Teton NP. It so happened that that frequency had been used in 4 states by BPA and was the only frequency that IRAC had available for that purpose, which was also cleared with Canada. (All VHF assignments in states bordering on Canada must be cleared with Canadian authorities through IRAC and the State Department) However, until the Driggs station was installed, there was no conflict between BPA and Grant Teton NP and/or Yellowstone NP. Because the Grand Teton use of the frequency was on a more limited basis than the BPA operation, it was anticipated that the NPS system frequency would have to be changed.(82)

Usually IRAC assigns frequencies in the 162-174 mHz band to two or more areas or Bureaus that are adequately separated geographically (under normal circumstances). But especially in the West, sometimes the two areas or Bureaus have operations at such high elevations that co-existence is impossible. Due to the shortage of frequencies, the IRAC representative usually demands use of directional antennas to overcome the problem.

As with everything else, radio operating procedures evolve; particularly as the facilities become more reliable and sophisticated. By the sixties, military-originated expressions like "OVER", "OUT", "ROGER", etc. had all but disappeared. With the capability of rapid changeover from send to receive (and vice versa), and clearer transmissions, it became possible to know when the other operator had released the push-to-talk switch without the necessity of saying "Go Ahead", or a similar expression.It became more common to say a sentence and pause for the reply, similar to face-to-face conversations (except that the talker could not be interrupted).

Calling another station could be reduced to a simple phrase like "Lincoln, this is Washington." By giving the name of the station or person being called first, other persons on the network would be minimally interrupted, since they had no interest in anything except the first word (except when it was they who were being called).

It was no longer required to use call letters in the call-up, although many areas still used the call letters or a variation of them, place names, or personal names. However, the call letters are required at the ends of a communication (or at intervals during an extended exchange). The reason, of course, is to enable any persons experiencing interference from a certain station to be able to identify that station.

From the inception of two-way radio, both IRAC and FCC required that station logs be kept by all fixed stations. This requirement was established so that, in interference cases, it would be possible to determine whether a specific suspected station was transmitting at the time of interference. Also, if improper emissions and/or procedural violations occurred it would be possible to determine the responsible operator. In addition, NPS stations were encouraged to log interference from other sources to aid in identifying and locating the source. The logs were also valuable for critiquing action taken on fires and/or other emergencies.

In 1965 some of the larger parks found log-keeping to be a chore, so they installed voice-operated recorders for logging purposes. They offered the advantage of an oral transcript of entire conversations. It now became possible to have a complete record of happenings, lists, or numbers that might need to be referred to. Since the recorder runs only during actual communications, it became necessary to transmit the time at the end of each exchange of traffic. Where such recorders are in use, they provide an excellent method of critiquing emergency and fire suppression actions.

Management and Regulations

Over the years, approximately one-half of the available frequencies in the spectrum were made available by the FCC for assignment to non-government users. The other one-half were assigned to federal agencies by IRAC. The non-government users, in their efforts to obtain more channels for their own use, frequently criticized the government's use of frequencies as being wasteful. Therefore, periodic reviews were being made to determine what government-assigned frequencies are actually being used, what for, and how often? As an example, in 1969 the Federal Agency Radio Frequency Usage Reporting Program required specific usage data from all agencies using frequencies between 4000 and 30,000 kHz.(83) In 1974 the Chief of Telecommunications staff Office (Office of the Secretary) wrote "the program (1968 review) has floundered for a number of reasons, . . . the update actions for your agency are seriously overdue . . . This is essential to protect NPS operations as well as those of other agencies on the same or adjacent frequencies . . . We urge immediate and effective action by your agency to avoid the need to place restraints on new radio system acquisitions or take other steps at Departmental level to resolve the situation . . ." Obviously the Department and IRAC were attempting to establish accountability.(84)

This "scolding" from the Secretary's office highlighted some of the existing misunderstandings by field areas and regional offices of the function of the DSC (especially the Communication Engineer's role). The Manager of the DSC reminded the Associate Director, Administration "our communications engineers are directly responsible to the Chief, Telecommunications Engineering, (Office of the Secretary) for proper control of NPS use of the radio spectrum." This was acknowledged by Mr. Cook's memorandum of December 19, 1973, file D5027, to all Regional Directors and Director, National Capital Parks. The Manager further stressed that "we must take immediate and effective action to review use of the radio spectrum to comply with OTP regulations." It will be necessary for the DSC Communications Engineers to "Monitor operations for compliance with part 313 of the Departmental Manual" and deal directly with the park areas, and that "the need for compliance is being emphasized at the Regional Radio Seminars our specialists are currently holding.

The DSC communications engineers had, for many years, stressed that one individual in each area having a radio system should have overall responsibility including that of directing users in the proper use and operation and compliance with regulations. The design, management and frequency assignments had been moved from WASO to DSC.(see section on NPS Organization) The DSC Manager stated further "many area radio managers are unaware of operational requirements of Part 313 and are unaware of the need to obtain support for frequency assignments as outlined in the OTP Manual . . ." and solicited cooperation in this matter.(85)

Two-way FM radio had become recognized as a useful tool to enable the limited manpower to become more effective. Park areas which had not heretofore been interested in radio communications became anxious to get systems installed. While this was happening, more

and more park areas were obtaining two-way radio systems (by lease or purchase). Systems were getting more sophisticated, using modern equipment, repeaters, automatic logging devices, etc. Licensing procedures became more complicated. Some areas were not insisting upon the quality of maintenance that they were paying for. It was obvious that the areas with radio systems needed help to manage them properly.

It eventually became evident that, for park areas to realize full benefit from their radio systems, it would be necessary to centralize the operation, maintenance, control and financing of each radio system under a single person called the Radio Manager (later changed to Radio Coordinator by NPS guideline 15). Without this supervision; contractors were not always being required to fulfill their obligations, operating procedures were sometimes ineffective, payments were sometimes rendered for unsatisfactory or not-furnished services. Once again a parallel with Forest Service is evident: "They began with the establishment of Regional communication positions and ended with a plea for taking radio out of the 'Jim Crack, the toy, the play thing class' in Forest Service communication systems."(86)

In 1974 the 5-year review required more specific details, which was in computerized form, with the addition "for systems with repeaters, a system map should be included showing . . . the transmit and receive frequencies for each station . . ." The required details included area of operation of portable and mobile units, type of antenna, and coverage area for base stations and repeaters.(87) The areas in the Rocky Mountain Region (and probably the others) were reminded of the need for "ready cooperation of the parks in assisting the Denver Service Center electronics staff in obtaining all necessary information essential for completion of the Departmentally-required review.(88)

By 1976 NPS had 693 frequency assignments which was more than any other Interior Bureau (19 percent of all Interior assignments).(89) The authority of the telecommunications staff in the Secretary's office was being strengthened, and it was necessary for the Service to organize itself to adopt appropriate procedures. "We must answer directly to the Departmental Telecommunications staff. We can do this only through orderly process and we can do this best through our own communication engineers at the Denver Service Center. Through the NPS Communications Officer, Ralph McFadden, we can maintain the required degree of compliance for changes accomplished or proposed in park communications systems." In addition: "A new system to monitor and measure government use of assigned frequencies, the Radio Spectrum Measurement System (RSMS) will take to the field soon. This mobile van system will move from area to area and will provide information on current use and compliance."(90) In other words, IRAC was setting up means of "policing" the use of government frequencies. The first NPS area where the van "conducted a field survey on frequency-spectrum management as practiced" was Lake Mead National Recreation Area. "The Assistant Director of OTP, commended the Department and the National Park Service for its frequency assignment and spectrum-management practices."(91)

Ultimately NPS Guideline NPS-15 was issued in 1976, setting up a management and procedural plan for establishing and maintaining two-way radio systems. That guideline made it clear that each area having a radio system must designate a "Radio Controller" who is to administer or monitor their contractors for maintenance, keep licenses up to date, monitor and train users in proper operating procedures. "Park controllers may need help in developing a radio coverage chart to check system efficiency . . . The fact that coverage is related to performance suggests establishing bench marks of performance from selected local points to periodically check each station's performance against the optimum."

This guideline also required regional offices to establish a position of "Regional Radio Coordinator" who is to supervise the work of the Radio Controllers, and screen proposals for new systems to see if they are justifiable and to aid in programming funds. They are to oversee area compliance with requirements established by the NPS and/or Departmental Communications Engineer.

The management of sites within parks and monuments which are of interest to other agencies as repeater sites has already been mentioned. Policies concerning this were covered in the NPS Administrative Manual "Organization" volume, part 5, page 9, and in the Land Management Handbook, Section 2, Chapter 3, page 1.

The pressure that can be exerted for use of strategically located and equipped [power and access] is illustrated by the following chronology of events pertaining to Hogback Mountain in Shenandoah National Park(92):

> Sept. 1963 Installations already in place include Virginia State Police, Virginia State Forest Service, General Services Administration, US Weather Bureau, National Park Service.
>
> Sept. 1963 Communications Engineer Sam Hoover (WASO) referred the Virginia Game and Fisheries Commission urging them to use Fork Mountain outside the park.
>
> Oct. 1963 The intermodulation effects created by the many transmitters caused trouble with acceptance tests of the new NPS system.
>
> Dec. 1964 A TV cable firm asked for a right-of-way through the park [not involving Hogback Mountain]. It was rejected because of other demands by private landowners.
>
> Nov. 1966 GSA applies to use Hogback Mountain as a repeater site - granted. [Apparently this formalized the installation reported in Sept. 1963.]
>
> March 1967 Shenandoah Education TV Corp asks for use of the site.

March 1967 There was talk about the possibility of installing all antennas on one tower, instead of many towers. (A tremendously difficult technical problem to avoid interaction between systems when the antennas are in close proximity.) It is not known if this was ever accomplished.

April 1967 A congressional inquiry was made on behalf of Shenandoah Valley Educational TV Association. NPS reply was that NPS is checking with other users to see if existing and requested installations could operate from a single tower.

July 1967 A.D. King and Associates made a study of possibilities of using a common tower, but did not include the Virginia Commission of Game and Fisheries (VCGIF) in the study.

Aug. 1967 On-site discussion of proposed common tower.

Oct. 1967 VCGIF asked for an antenna on the proposed tower, but was told there was no room for another antenna.

Mar. 1969 VCGIF was given a Special Use Permit to place an antenna on the tower used by the Virginia State Police.

Management Training and Conferences

Recognizing that there are managerial and technical aspects of radio communications that are not easily studied and disseminated by correspondence or manual, the Division of Radio Communications and Frequency Management (Secretary's office) (DRFM) sponsored a Departmental Radio Communications Workshop in Phoenix, on November 7, 1975.(93) This gave 100 representatives of nine Interior bureaus opportunity to discuss and solve mutual problems, and to learn what other agencies are doing that may be helpful.

Workshops were sponsored each year between 1975 and the mid-1980's by the Department, with scope being enlarged to telephone and data communications.

The rapid expansion of NPS responsibilities in Alaska and similar problems occurring in other Interior agencies led to a meeting in Anchorage, Alaska in February 19, 1976. Mr. Winter from DRFM met with representatives of the Interior bureaus "to complete the discussion on improving radio communications in Alaska . . ." An Interior Alaska Radio Communications Coordinating Group was established.(94)

Planning and Financing

During this period, the contracts that the U.S. Air Force had with Motorola, General Electric, RCA and others were convenient instruments for leasing NPS radio systems. The Air Force contractors had service shops throughout the country, but it was necessary to negotiate supplementary charges to cover the costs for the contractor to travel from the nearest shop to the facilities in the park. "An isolation factor was added to cover eleven trips annually (eight for preventive maintenance and three for emergencies) from the service facility."(99) As previously mentioned, additional service trips were to be gratis as an incentive for the contractor to apply sufficient preventive procedures to the tube-type equipment in use at that time. In an effort to minimize the isolation-factor charges, some areas mailed portable units to the contractor's shop for maintenance.

NPS required that only certified equipment be purchased (certification described in Chapter Four). Cost comparisons usually determined which supplier to order from, although the lowest-cost supplier was not used if that company did not have qualified service personnel within reasonable distance.

Prior to 1974, the determination whether an area needed a radio system was determined largely by the area superintendent. Occasionally a regional office would require justification or examine the need for a particular system. Eventually it became apparent that the investment in radio facilities was usually considerable, and a movement was started to look into the "cost effectiveness" of new systems. It was also noted that "area managers may be acquiring radio systems (or portions thereof) to provide communications between points which are now served by telephone, or could be served, if a modest investment were made to extend such service . . . Because of the diminishing number of frequencies available and the cost of acquiring and maintaining equipment you [regions and field areas] need to take a hard look at what type of equipment is being installed in your areas and determine its feasibility. The 'Guide' [a planning guide that was attached] is provided to aid you in these determinations." (95)

Procedures for planning and procuring radio systems in the past have been somewhat haphazard, without benefit of Master Plans or construction drawings, a necessity for effective contract administration. Most areas consulted with and used the services of DSC engineers, but there were a few that were influenced by sales personnel from the equipment manufacturers, particularly Motorola, and to a lesser extent General Electric.

By 1974 the General Services Administration (GSA) had established contracts, similar to the Air Force contracts that were previously used, with RCA, GE, Motorola, and several other companies. DSC received "many inquiries as to the use of [them]."(100) The Associate Director, Administration strove to establish procedures that would result in careful planning and orderly procurement. (96)(101) There were explicit instructions that "are effective immediately and shall apply equally to all qualified proposed suppliers." The instructions included the following: "Initial contacts with suppliers for such [new and

enlarged] systems shall be accomplished by the Service Center [rather than area personnel] . . . Procurement procedures set forth in FPMR-101-26.408 shall be followed in evaluating offerings for the best advantage of the Government, rather than preference on a selective personal basis . . . Orders for lease . . . may be placed only after a written determination has been made that the lease method of acquisition is to the best advantage of the Government." Instructions to the field were that orders shall be placed only after the manager has considered "all qualified prospective sources for the supplies/ services and have determined that the proposed supplier is the [best] source . . . on the basis of advantage to the government, price and other factors considered (qualified meaning being on GSA contract). Other requirements included:"only equipment which has been certified by the U.S. Forest Service Electronics Laboratory [under contract with NPS] may be acquired. . . . [subject to] acceptability . . . by the Communications Engineer, Denver Service Center" and that "radio accessory equipment orders in excess of . . . $2000 net worth must be reviewed and approved by the Communications Engineer . . .In making the choice of supplier to be used in ordering maintenance, three factors should be determined "in order of priority: (a) Price of Service, (b) Ability to respond to equipment failures in emergencies, (c) Proximity of the maintenance facilities."(97)

This is the first serious attempt to get a '"handle" on procurement procedures to assure that only necessary and suitable equipment would be purchased or leased at the most reasonable cost.

The Bureau of Standards had for many years been studying radio wave propagation with the goal of being able to predict whether communication was possible between fixed points, and the area of coverage in which mobile units could reach a fixed station or repeater. While their predictions were not always correct because it was impossible to factor in the multi-path "bounce" effects from off-path mountains, they were suggestive as to which points might be the best for testing during field surveys. It was also known that the Army Map Service had computer programs for making maps of the entire country. With this information, DSC engineers approached the Bureau of Standards to see if it were possible to "marry" their propagation prediction program with the map service so they could have predictions of usable point-to-point paths and portable-mobile coverage, before beginning their field surveys. The program worked out successfully, resulting in savings of time and cost in making field surveys. It is currently being used by DSC during early system planning, replacing the field survey pre-planning described in Chapter Four.

In the 30's and 40's, there had been very little record of the radio facilities except a tabulation of radio stations as part of the utilities section of the Master Plan and Development Outline (now replaced by a different record system). As already mentioned, construction drawings were made a part of the narrow-banding process. The newer master plans outlined the concept and operational details of radio systems and construction drawings made it clear as to what contractors were expected to install; i.e. the type and degree of grounding, the location and type of antennas and equipment.

Leasing equipment with contractor-furnished maintenance became the general policy, but there were some areas where the needs can be met with one or two portable units which were infrequently used. It seemed obvious that the most economical procedure in this case would be to purchase the units and mail them in to a service shop when needed. This would avoid the built-in routine maintenance increment of the leasing cost. There were administrative objections to doing this, in spite of the fact that savings would be realized because the remote-location surcharge would be avoided.(98)

The analysis of the cost of government-owned vs. leasing radio systems in reference ninety-nine is interesting for several reasons. The interest rate used in the present-worth method of comparing costs was 4 percent. As the reader is no doubt aware, interest rates have risen dramatically since 1963 and it is unlikely that we will see 4% interest rates in the foreseeable future.

The same analysis also illustrates the folly of attempting a carte blanche requirement to contract for maintenance in all areas. "Several firms, including General Telephone Company, RCA, and Motorola, have made inquiries of this office during the past six years, indicating an interest in leasing or maintaining the Sequoia/Kings Canyon radio system. All lost interest because of the remoteness and rugged terrain involved. While Olympic and Mt. Rainier do not have as many back-country installations, the need to keep certain ones operating during the winter creates a similar problem . . . with competent personnel, government-owned systems usually operate at peak performance more consistently than leased systems. While there are many reasons that are attributable to this situation, the most obvious is that, with leased systems, no one in the Park is responsible to call the contractor's attention to mediocre but usable performance. On the other hand, employee technicians will constantly have the system under observation and be able to take corrective action as required." All of the systems mentioned in that analysis have remained government-owned and maintained. (99)

A later instruction specified that where government-ownership is justified, the costs of acquiring a system should come from construction funds, but replacement units should come from operating funds.(102) However, the delays in programming and installing new systems with construction funds prompted many newly-established parks to seek leased systems to meet immediate needs.

There was concern in 1970 that Isle Royale National Park would have to convert the HF-AM radio equipment on their vessels to SSB operation. This conversion would mean the purchase and installation of new transmitters and receivers. However under a draft agreement (Oct. 22, 1970) between the USA and Canada "every vessel on the Great Lakes (with certain exceptions) shall have VHF radiotelephone equipment effective Jan 1, 1975. Although Government vessels not engaged in trade are exempt, it is planned that the Department of the Interior radio-equipped vessels will be required to comply for safety purposes, at least."(105) and in Jan. 1971 the Secretary's office issued a plan for Interior

stations operating on 2616 kHz. NPS fixed and maritime operations on 2616 kHz were to be converted to SSB by Dec. 31, 1971.(106)

On July 12, 1971 the Department of the Interior issued a timetable for converting Interior Department HF operations in Alaska to SSB. This was not simply a matter of establishing a single date ". . . a number of different dates of conversion has resulted from differing requirement and planning among the various radio services [i.e. marine, aeronautical, fixed and mobile services]. Equipment used by Interior agencies in Alaska is commonly multichannel, with operations . . . in a combination of different services . . . this plan provide[s] a realistic conversion program, taking these problems into account, and waiving, where necessary, the requirements of the Departmental Manual . . ." (107) SSB equipment had already been installed at Bartlett Cove at Glacier Bay National Monument. Other equipment had to be converted to coincide with changes made by the Coast Guard, Alaska Communication System, and the State of Alaska to their systems.

NATIONAL PARK SERVICE ORGANIZATION

After the Design and Construction (D&C) offices were established, they were to act as consultants to the regional offices and field offices as already described. However, EODC had not established an electrical or communications engineer position for this purpose, and frequently called upon Communications Engineer Sam Hoover from the Washington Office as needed.

In 1970, Sam Hoover, electrical engineer operating out of the Director's office retired. ". . . he was basically a 'one-man' operation. With increasing workloads . . . we believe now is an appropriate time to place responsibility for these activities in both the Eastern and Western Service Centers."(108) The same memo suggested that the Eastern Service Center represent both Service Centers in matters relating to radio frequency assignments. This was soon superseded by the establishment of the Denver Service Center and the establishment of its responsibilities as described elsewhere.

One of the concepts developed during Mission 66 planning was that it would be desirable in some areas to relocate support and administrative functions and facilities outside the park, leaving protection and interpretation facilities to remain in the park. This seemed to be a drastic move to employees who had enjoyed living in a park setting, but it was necessary in order to alleviate the crunch on the park environment due to greatly increased visitor utilization. Yosemite and Mount Rainier National Parks are among the areas in which this concept was eventually carried out, affecting communication requirements.

In the fall of 1971, the Eastern and Western service centers were formally merged into the Denver Service Center (DSC) to provide consultive service, design, construction and supervision of new facilities for all park areas, leaving the supervision of maintenance of physical facilities to be the responsibility of the regional offices. This was a new concept to the field areas and some of them expressed reluctance to use DSC's expertise, preferring

to seek technical advice and guidance from the regional offices. This reluctance was not limited to communications.

The announcement of the creation of DSC was made simultaneously to the two service centers on "Black Friday" in Oct. 1971 with the intent of being established by Thanksgiving. Actually it was mid-December before the office was established in a second-story loft above the Joslyn store in the Villa Italia shopping center in Lakewood (Denver), Colorado. Thus the rumor fabricators who had reported the move was to be everywhere from Portland, Oregon to Chicago, were silenced.

Since the design and management of radio systems and their frequency assignments was removed from WASO to DSC, it was necessary that the communications engineer at DSC be designated as the NPS Communications Engineer and have authority for direct communication and liaison with the Departmental Communications Engineer (S.L. Windes at that time).(109) It took almost a decade for some field areas to realize that a directive from the DSC communications engineer had the full authority and responsibility just as if it had come from WASO, and had the backing of the Departmental Communications Engineer. For example, in the Director's instructions regarding use of CB radios (previously discussed): "Therefore, applications submitted to the National Park Service Communications Engineer, Denver Service Center will first be carefully scrutinized at Regional and Washington office levels for proper justification before processing at DSC for Departmental consideration. "

The seriousness of management of radio systems and use of radio frequencies has been the subject of several warnings to NPS and to the field; "We must take immediate and effective action to review NPS use of the radio spectrum to comply with OTP regulations. (The OTP, of course is a special office responsible directly to the president.)"(110)

The Service (and other agencies) has had some form of student-trainee program nearly every year to give students experience in their chosen field. Sometimes the program was set up so as to give the student assurance of employment with NPS if certain academic standards were met. Beginning with the mid-fifties I was fortunate in having a number of student engineers working with the electrical/communications group at WODC and DSC. There were benefits to both the students and to those of us who were using them as assistants. Some episodes involving students appear elsewhere in this book. One of the NPS communication engineers today is a successful participant in the student-trainee program. It is rewarding to see young students, many of whom were provincialized in thought, training, and experience, develop as they gained experience and travelled with us to various installations.

Throughout its history, the Service has stressed and practiced protection of natural features in the national parks. Even during the buildup of facilities that occurred during the 30's, made possible by the availability of the CCC's, the construction was supervised by landscape architects. Susequently, the Wilderness Act was passed, requiring the establishment of wilderness areas (usually certain sections of a park area) which are to remain in their

pristine condition. The only exceptions are trails for the public. In special situations, if sites for radio repeaters are necessary for protection of the Wilderness Areas, they may be authorized.

It was during this period (1960 - 1977) that the Service "grew up" in size and sophistication. The trend shifted from the dedicated "family" organization toward a more complicated, cumbersome, and less personalized establishment. (Necessitated by the increase in number of areas, emphasis on environment and involvement of the public, and increased "red tape"). The waiver of park entrance fees to employees was replaced by a "you should be glad to contribute (entrance fees) to the support of the parks" attitude. No longer would employees be "entitled to reduced rates [from the concessioners when] accompanied by members of his immediate family."(111) when on an assignment in the parks.

EPILOGUE

So ends an era, a period in which the early beginnings were largely the results of experiments, investigations, and development by Service personnel with a pioneering spirit. World War II led to a significant change in which manufacturers and utilities began to see the communication needs (both telephone and radio) of the Park Service and other agencies as a viable market for their services. But the special needs of smaller NPS areas still required innovative solutions by Park Service personnel.

As the later years covered by this account neared, a new era opened. One in which microwave, satellites, multiplexing, direct-dialing, and computer interfacing are to become tools for managing the intensified visitation and its attendant problems (accidents, rescue, fire, crime prevention, and law enforcement). A new breed of managers, engineers, technicians, and providers has come into being who will be well-equipped to meet the challenges of this new era.

The dedication and inventiveness of most personnel (not only communications personnel) has been described. Fortunately, there are those in the new generation who are equally dedicated, but their functioning often seems to be handicapped by the "system".

The days when there was mutual respect and trust seem to be passe'. When Tom Vint put his approval on a development plan, it was respected as the best for the given situation, and was accepted Servicewide. It was trusted that drawbacks or shortcomings had been considered and compensated for.

Would progress have been made if Waterhouse had not charged some of the costs of tests and experimentation to non-benefitting accounts? Did I need to fear getting caught for getting a haircut while traveling through a town on government time? Not when I used the toilet seat in a motel as a desk, so I would not keep my family awake while I worked up my notes on the day's tests or meetings and did my "homework" in preparation for the next days activities, or worked six long days a week in order to keep up with the workload. More than once when on field assignments, Park personnel would say, "Hey, Mac, time to take a little time out for yourself, Let's go and wet a line . . ." Neither was there any need for feelings of guilt for taking my family along at no additional cost to the government.

But today, the adversarial tenor seems to prevail. The new generation of Service personnel have a myriad of regulations to observe. The planning process for any project is burdened with procedures and reviews that endanger creativity and load the project with planning and overhead costs.

While the technical efficiency of communications will be improved further, it is becoming depersonalized. Already automatic position reporting devices are being developed so that pilots and drivers do not need to verbalize their position or the location of an event. If a

mistake is made in dialing a telephone, a mechanical voice will tell you (sometimes in error) "deposit 45 cents" or "your identification number is invalid." Where is a real operator? Will the Smokey Bear hat someday include a miniature satellite dish?

It is going to be interesting to see what transpires in future years.

GLOSSARY

AM--Amplitude modulation, used on frequencies below 30 MHz

Area - A generic term for any (or all) park, monument, recreation area.

AT&T - American Telephone and Telegraph Company. The parent organization of the Bell Telephone System. Prior to recent divestment.

AWS - Aircraft Warning Service, established during World War II to track and identify all aircraft (both friend and foe).

Base Rate Area - An area, established by a telephone company, within which rates are standardized and no charge is made to extend lines to any customer.

Bell System - An aggregate organization of telephone companies, operating (prior to recent divestment) under the aegis of AT&T.

BIA - Bureau of Indian Affairs, a Department of the Interior Agency.

BIFC - Boise Interagency Fire Center. A central manpower and equipment supply and dispatch organization for fighting and control of wildfires that individual areas cannot handle. A cooperative effort of Interior and Agriculture Department agencies.

Bootlegger Car or Truck - A vehicle confiscated from illegal rum-running or hard-liquor stills. Confiscated property, vehicles, guns, etc. were transferred to various agencies for their use.

Break (Squelch) - An incident in which the audio system of a receiver is opened from the normally off position. It may be caused by an on-frequency carrier, splatter from adjacent channels, lightning, etc.

Bushfone - A network of radio stations in remote settlements in the Alaskan "bush" that can be connected with commercial telephone lines by ACS base stations.

Call-up - The procedure whereby a radio operator calls and identifies a station (or stations) that the operator wishes to communicate with. It usually consists of "... (call letter or name of desired station), this is ... (call letter or name of operator)" wishing to talk.

Carrier,radio or telephone - The high-frequency energy from a transmitter used to convey intelligence to a distant receiver. It may be interrupted to produce code, or modulated to produce voice or video. On telephone lines it is used to provide additional ciruits on one pair of wires.

Circuit - 1. The way in which components of a radio or telephone device are interconnected.

2. The combination of transmitting and receiving equipment and the intervening medium to establish communication between separate points. May be telephone, telegraph, or radio.

CONELRAD - A system devised by the military and FCC during World War II to cause all radio transmissions to cease, during an alert. Special transmissions by key stations on 640 and 1240 kc would alert the civilian population and operators of radio transmitters, to prevent possible use by Japanese planes or ships for navigational purposes.

Connecting Company - An independent telephone company that interconnects with the Bell or other long-distance company.

Contact Space - A term given to space on a power pole for installation of a telephone line or cable.

Copy - To understand and note the contents of a transmission or message. Also referred to as to "read".

Corona - A glow-like appearance on conductors which are stressed at a high potential, in this reference due to static charges in the vicinity of thunderstorms.

Coverage - The area in which two-way communication can be had from a specified station.

CW - Continuous wave (or carrier), broken into dots and dashes, also referred to as "code".

DRFM - Division of Radiocommunication and Frequency Management (within Department of the Interior).

Duplexer - A device to direct transmitter power into its antenna without allowing that energy to enter the receive, enabling transmission and reception from the same antenna.

Dynamotor - A motor-generator on a common shaft with common field coils. Converts DC (usually 6 or 12-volts) to higher voltage DC (often 300 or 500 volts). Now obsolete for 2-way mobile units.

Emergency - As applied to NPS radio - fires, rescue, lost persons, disaster, etc.

Exchange - A switching facility to enable telephones to talk to other telephones.

FAA - Federal Aviation Administration.

FCC - Federal communications Commission. Successor to the FRC.

Foreign Exchange - Connection service to another exchange outside of the users exchange area.

FRC - Federal Radio Commission. Superseded by the FCC.

FTS - Federal Telecommunications System. An assemblage of facilities and circuits for government agencies to use instead of making standard toll calls.

FWS - Fish and Wildlife Service, Department of Interior

Grounded line or ground-return line - A single-wire telephone line, often number 9 iron, and supported upon trees, using the ground for the return in lieu of a second wire.

GSA - General Services Administration

Half-Wave - A length of antenna which resonates at a given frequency.

Hand-held - Also called handi-talkie. A portable radio that can be held in the users hand while it is being used.

HF - High frequency, between 2 MHz and 6 MHz. Used for SSB or AM.

High-Band - 162-174 MHz. Usually used for FM. Also for telemetry and animal tracking. Early usage identified it as UHF, now identified as VHF.

Hooks - Climbers used by linemen for climbing power or telephone poles.

Howler - A very simple loudspeaker, matched to and connected permanently to the telephone line. Enables an operator to determine if a line is busy without "going in on the line".

IEEE - Institute of Electrical and Electronic Engineers, successor to the IRE

Instrument, Telephone - Often referred to as the "telephone". Includes transmitter (microphone), receiver, dial or magneto, and bells.

IRAC - Interdepartmental Radio Advisory Committee. The governing agency for radio use by all federal agencies.

IRE - Institute of Radio Engineers, superceded by the IEEE

Kennelly-Heaviside layer - an ionized layer (or layers), 60 miles or more above the earth, that reflects radio waves back to earth, sometimes interrupted by solar flares.

Land Line - A telephone line, may be a grounded or metallic line.

Line - Can be either (a) telephone line or (b) a coaxial antenna lead-in.

Magneto Ringdown - A type of line or system using telephones that generate a 20-cycle ringing signal by the user turning a crank, often in coded sequences, causing the switchboard "drop"(or marker) to fall, showing the operator on which line the call originated.

Magneto Telephone - Obsolete type of telephone that used a hand-cranked generator (magneto) to produce signalling current to signal an operator or another telephone.

Metallic Line - A telephone line using two wires, as contrasted with a single wire used with ground return (grounded line).

Microphone - The device that converts the audio voice into electrical impulses. Usually called the transmitter in telephone parlance.

Mission 66 - A program of rehabilitation of and construction of new visitor facilities throughout the National Park system, with the goal of completion for 1966.

Myrt - A fictitious telephone operator in the Fibber McGee comedy radio program of the forties.

Narrow-Banding - The conversion of FM radio systems from "broad-band" (± 15KC deviation) to "narrow-band" (± 7.5KC or less deviation), during modulation.

Ninety-day-wonder - Seasonal employee

On the Air - May mean either, (a) a radio transmission is in progress, or (b) a system or station has been developed or constructed so as to be operable.

Pack Set - A radio transmitter receiver that is too heavy or large to be classed as a hand-held unit, but readily transportable - in the ten to 20 pound range. Sometimes called a portable.

PBS - Public Buildings Service, part of the General Services Administration.

Park Area - A unit of the National Park System which may be a National Park, Historical Area, Recreation Area, Seashore, etc.

Patch - The process and/or equipment to interconnect a telephone with two-way radio facilities.

PCP - Project Construction Proposal. The document initiating the intention to construct a new or an addition to a facility.

Phantom Line - The telephone circuit derived by using a neutral mid-tap to form a third circuit from two metallic lines. connectors from two metallic circuits.

PSC or PUC - Public Service Commission or Public Utility Commission. A state regulatory body, regulating a variety of utilities which includes telephone.

"Raised" - The accomplishment of raising or reaching a desired radio station.

Ranger Splice - A splice in a telephone wire made by personnel that did not have the tools necessary to produce the customary Western Union splice.

Read/Readable - A term meaning that the transmissions referred to can be "copied", i.e. are understandable.

Regions 1, 2, 3, 4 - NPS regional designations prior to the 1970's. One being the Northeast, two being the north central, three being the south central, and four being the Western states.

Repeat Coil - An audio transformer used to match an unbalanced (grounded) telephone line to balanced (metallic) line, or to derive the mid-tap for a phantom line.

Ringdown - Used to describe the fact that magneto type telephones cause a flap on the operators switchboard to fall or drop whenever it is desired to call the operator.

Rubbering - The act of listening or eavesdropping on a telephone line without the persons using the line being aware of it.

Secretary - The Secretary of the Department of the Interior.

Service - Sometimes used to refer to the National Park Service.

Signal - May be either; (a) an actual signal or code, such as 1-long, 2-short rings, or (b) an actual radio transmission.

Single Sideband - Voice transmission in which the carrier and one sideband of AM transmission is suppressed.

Skip - The phenomenon whereby radio signals beyond the ground wave range are not heard until they are reflected to earth by the Kennelly-Heaviside layer some distance away.

Single-Wire fed antenna - Also called a "Windom" antenna after its originator. A half-wave horizontal antenna tapped at a single point with a single lead-in wire, which results in approximate 600 ohm impedance referred to ground. Radiation from the single wire is minimal.

SNAFU - Situation normal, all fouled up

Squelch - The removal of normal background noise from the audio system of a receiver during periods in which no radio signals are received.

Squelch-break - An opening of the receiver to audio. A short burst of lighnting or carrier may result in a squelch-break.

SNAFU - A World War II term - Situation normal, all fouled up.

Solar Cycle - A cycle in the variation of solar phenomenon, including sun spots. A complete cycle lasts about eleven years, but there is evidence that there is also a hundred-year variation.

SSB - See Single Sideband

Sunspot Cycle - See solar cycle.

Supervisory Equipment - Telephone devices whereby an operator or automatic exchange can determine if a telephone line is busy or out of order The devices may be indicator lights or "drops"..

SWAC - Southwest Archeological Center,(NPS)

Talk-out - The range at which two-way communications is possible.

Tariff - The schedule of rates which a public utility files with the regulatory authority

Telephone Instruments - Sometimes used to identify a "telephone", consisting of bells, magneto or dial, transmitter and receiver (sometimes combined into a handset).

Tel-Pak - An arrangement of a line or group of lines (Usually 6 or 12) that is used to by-pass toll circuits so that specified telephones can call telephones in a distant exchange without toll charges.

Toll Circuits - Telephone circuits between exchanges that are sufficiently far apart to require payment of a toll charge for their use.

Traffic - May be either (a) the existence of messages to be transmitted; i.e., "do you have traffic for me?" or (b) the frequency or length of time that a radio or telephone line is in use.

Transceiver - A self-contained radio device including transmitter and receiver.

Transmission - The actual sending of a message or the turning on of an unmodulated carrier.

Transmitter, Radio - The device used to broadcast code, voice, video or other intelligence to a distance receiver.

Transmitter, Telephone - See microphone

Trunks (telephone) - Mainline circuits between switchboards or exchanges. See toll circuits.

TRF - Tuned radio-frequency type receiver, usually consisting of radio and/or audio-frequency amplifiers and a detector.

Unassigned territory - Territory lying outside the domain of telephone companies as determined by the Public Utility (or Public Service) Commission.

VFO - Variable frequency oscillator. Takes the place of crystals for frequency control.

VHF - Very high frequency radio. Covers 30-300 MHz band. Originally considered UHF.

Windfalls - Trees that have fallen due to extreme winds.

"Worked" - Made contact via radio.

World War II - World War II - 1941 to 1947

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John Davis, Chief Ranger
Bill Butler, Ranger
Arthur Collens, Chief Electrician
Don Luerke, Equipment Operator
Larry Jensen, Seasonal Ranger
Charles B. Browne, District Ranger

Non-National Park Service Personnel:
Ome Daiber
Eastwood
Bushman
Paul Gailbreth
Drysdale
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3-20 R.D. Waterhouse, June 18, 1945 letter to the author.

CHAPTER 4

4-1. An example of PBS teletype procedure. Teletype to Public Buildings Service Teletype Center, dated June 23, 1954 from Skinner I-NPS.

4-2. Drawing NP-RAI-6002, April 11, 1949. The Longmire to Paradise circuits shown on the drawing were never built.

4-3. a. Superintendent, Mount Rainier, September 24, 1954 to Chief, Western Office, Division of Design and Construction, subject: (WODC) FM Radio System.

b. Acting Chief, Western Office, Division of Design and Construction, October 8, 1954 to Superintendent Mount Rainier National Park. Subject: FM Radio System.

4-4. a. Undated Analysis of Recommended Radio Communication Facilities, Region One, Two, Three, and Four. References to memorandum suggests February 1954 as issue date.

b. Chief, WODC July 13, 1954 to Regional Directors, Regions, Two, Three, and Four. Subject: Negotiations for Communications Services.

4-5. Study of Communication requirements, Lava Beds National Monument, January, 1954.

4-6. Reference mislocated.

4-7. Superintendent, Olympic National Park, September 9, 1954 to Chief, WODC. Subject: U-28, FM Radio System Completion and communications. See section entitled, other Facilities.

4-8. Chief, Accountant Douglas, Washington, March 16, 1950 to Regional Director, Region Four, File F5027MUIR. Subject: Refund of tax to the Collector of Internal Revenue, with enclosure.

4-9. Administrative Officer, Regional Four, San Francisco, December 11, 1953, file D5027, Subject: Furnishing Telephones in Residences of Key Personnel. Refers to Reference 4-8.

4-10. Acting Assistant Regional Director, Region Four, December 15, 1953 to Superintendent, Mount Rainier, D5027, particularly Item No. 9.

4-11. Spectrum (Institute of Electrical and Electronic Engineers), November 1985, Page 58.

4-12. Macy (Superintendent, Mount Rainier) handwritten note April 14, 1954 to Messrs. Skinner, Pritchard, Bremer, Rylon, Rose. Subject: Telephones.

4-13. Acting Superintendent, Yellowstone, January 19, 1956 to Chief, WODC. Subject: Canyon Area Telephone System.

4-14. Sketch from project file, entitled Western Office of Design and Construction Proposed Plan, January 25, 1956.

4-15. A.L. Haines, The Yellowstone Story, Volume Two, Page 378.

4-16. Associate Director (name not discernible), October 14, 1957 to Director, National Park Service. Subject: Meeting to Discuss Power and Telephone Contracts, Yellowstone, with draft of a proposed letter to MST&T from Secretary of the Interior.

4-17. Ed Clancy, now retired, verbal discussion.

4-18. Chief of Design and Construction, November 4, 1953 from Regional Director, Region Two. Subject: Telephone Requirements, Wind Cave National Park.

4-19. Organ Pipe Cactus National Monument, March 12, 1964 Report Design and Construction, (regarding report on radio and telephone facilities).

4-20. Chief Clerk, Mount Rainier, June 3, 1954 to Superintendents Sitka and Glacier Bay and Mount McKinley. Subject: Telephone Calls over ACS Network.

4-21. Lee de Forest editorial in Proceedings of the I.R.E., December, 1950 A Half Century.

4-22. Gary C. Gray, Mobiltimes, May 1979 Forest Service Radio, the Beginnings.

4-23. Forest Service Publication FS-269, Radio for the Future, Page 250

4-24. Lester W. Spillane, address delivered to mobile communications section of the Institute of Radio Engineers (now IEEE), date missing, circa 1957. Crossroads for the Mobile Services.

4-25. William Briggle to USDI Radiocommunications Management Workshop, Phoenix, Arizona, October 1978, Park Radio Systems - Are there Breakdowns in Communications?

4-26. Booklet, Administration and Operation of Radio Communication Services of the United States Department of the Interior, March 1952, Pages 3, 5.

4-27. Superintendent, Grand Canyon National Park, January 14, 1954 to Regional Director, Region Three. Subject: Radio Frequency Assignments.

4-28. Superintendent, Wind Cave National Park, May 27, 1954 to Director. Subject: Government-owned Radio Facilities Located at Wind Cave National Park and Jewel Cave National Monument

4-29. Interior of Department Representative (to IRAC), December 21, 1953 to Chief, Communications and Electrical Branch (NPS). Subject: NPS use of Radio Frequencies 2926 and 3415kc.

4-30. Acting Chief of Design and Construction, December 28, 1953 to Regional Directors, Regions One, Two, Three and Four. Subject: Radio Frequency Usage.

4-31. Superintendent, Crater Lake, January 26, 1954 to Regional Director, Region Four. Subject: Use of Radio Frequencies 2926 kc and 3415 kc.

4-32. USDI frequency assignment #54-NP-31 for Mount McKinley National Park. Replacing 3235 kc with 3237 kc.

4-33. Superintendent, Lake Mead National Recreation Area, January 29, 1954 to Regional Director, Region Three. Subject: Radio Frequency Assignments.

4-34. Acting Chief, WODC, April 20, 1954 to Chief, Division of Design and Construction. Subject: Frequency Authorizations, Olympic National Park.

4-35. Chief, Western Office, Division of Design and Construction, July 19, 1944 to Regional Directors, Regions Two, Three, and Four. Subject: Radio Operations.

4-36. Technical Manual TM-487.

4-37. Regional Engineer, Region Four, December 9, 1953 to Superintendent, Mount Rainier National Park. Subject: FM Radio System.

4-38. John C. Hannaford, February 27, 1956, Completion Report, FM Radio System, Sequoia and Sequoia Kings Canyon National Parks.

4-39. Institute of Electrical and Electronics Engineers "Spectrum" June 1983. Side-bar, Page 32 Mobile Radio Channel is Beset by Problems.

4-40. Electronics Engineer, Region Four, April 15, 1954 to Regional Engineer, Region Four. Subject: Report 400Kc Propagation Tests Conducted by U.S. Forest Service.

4-41. Modern Maturity, June-July, 1988, Page 70.

4-42. The GIGANTEA, (Sequoia Kings Canyon National Park) September 6, 1951. Subject: Survey of Radio System, Page 4.

4-43. Loc sit reference 4-38.

4-44. Loc sit reference 4-38.

4-45. Loc sit reference 4-38.

4-46. Mountain Time, Paul Schulley, Nick Lyons Book/Schocker Books, 1984.

4-47. Chief, Western Office, Design and Construction, September 14, 1962 to Assistant Director, Design and Construction. Subject: Narrow-Banding FM Radio Systems with enclosure listing Region Two radio systems.

4-48. Crowley, Acting Supervisory Engineer, WODC, July 30, 1958 Teletype to Superintendent Yellowstone NP.

4-49. Acting Chief Engineer, WODC, October 17, 1962 to Assistant Director, Design and Construction. Subject: Radio Narrow-Banding Programs.

4-50. Chief Engineer, February 8, 1957 to Regional Director, Region Two. Subject: Radio Frequency Assignment, Grand Teton with reference to the footnote directed to Chief, WODC.

4-51. H.K. Lawson, Radio Engineer (USFS), October 3, 1950 to the author, reporting on desensitization tests of one of the receivers provided by Link.

4-52. Ibid.

4-53. Paper - Portable Equipment in the Communication System by W.J. Weisz, Motorola, Inc. delivered to IEEE professional group on Vehicular Communications, date uncertain, Probably 1953.

4-54. Bill Morton (United States Forest Service) (USFS), Mobile Times, May 1979, Page 50. Land Mobile-Keep Rushing the Art.

4-55. Ralph R. McFadden, Electrical Engineer, September 28, 1954 to Acting Supervisory Engineer WODC. Subject: Communications Systems - Engineering and Installation, July 29 to August, 1954.

4-56. Maier, Acting Regional Director, July 20, 1956 teletype to Director, NPS.

4-57. "AM Radio System" drawing NP-Mck-2044B dated April 16, 1956.

4-58. Institute of Electrical and Electronics Engineers "Spectrum" July 1983. Hills - Alaska's Giant Satellite Network.

4-59. Acting, Supervisory Engineer, WODC June 27, 1957 to Director. Subject: Radio Frequency Assignment, Mount McKinley National Park.

4-60. Acting, Supervisory Engineer, WODC July 9, 1957 to Director. Subject: Radio Frequency Assignments - Mount McKinley National Park and Katmai.

4-61. H.L. Crowley, Regional Engineer, February 11, 1954 to Director. Subject: Radio Frequency Assignments and Call Letters, Mount McKinley.

4-62. S.L. Windes, Office of the Secretary, June 24, 1957 to Chief Engineer, National Park Service. Subject: Radio Frequency Assignments, Mount McKinley.

4-63. Various memoranda between Acting Chief Engineer, Regional Director, Region Four; Chief Engineer; Supervisory Engineer, WODC; Chief, Division of Design and Construction, May 11, 1959 to October 5, 1961 - all pertaining to assignment of frequencies to U.S. Army and State of Alaska.

4-64. Superintendent, Dinosaur National Monument, April 28, 1954 to Regional Director, Rocky Mountain Region. Subject: Radio Frequency Dinosaur National Monument.

4-65. Table Point-to-Point Radio Communications, Southwestern National Monuments, April 24, 1955

4-66. W.S. Claypool, Forest Service Radio Laboratory November 12, 1954 address before the Vehicular Communications Group (IEEE) in Boston; Mobile System Performance in the United States Forest Service.

4-67. Report of Average Estimated Radio Maintenance Cost For Year of 1952. Travel Time Not Included.

4-68. Leonard Hohl, Acting Regional Engineer, November 27, 1953 to Region Four Superintendents, File D5027.

4-69. Radio for the Fireline, USFS publication FS-369, Page 239.

4-70. Chief, Communication and Electrical Branch, January 7, 1953 to Regional Directors, Regions One, Two, Three, and four. Subject:

Booklet, Administration and Operation of Radio Communications Services, data obtained from attachment.

4-71. Superintendent, Dinosaur National Monument, March 31, 1954 to Regional Director, Region Tow. Subject: Radio Frequency Assignment,DNM.

4-72. Same as 71 (Ibid)

4-73. Author's recollection.

4-74. Chief, WODC, May 16, 1963 to Regional Director, Southwest Region. Subject: Narrowbanding FM Radio Systems, 1963 Fiscal Year.

4-75. Daniel Nobel editorial, Motorola Newsgram July-August 1954.

4-76. Chief Electrical engineer, Los Angeles Department of Water and Power, November 19, 1954 to Charles A. Richey, Superintendent Lake Mead National Recreation Area. Subject: Authorization to use 2926kc.

4-77. Authors recollection, Dates and names of applicants for use of Park Point Lookout site are obscure.

4-78. Richard Leonard, President, Sierra Club April 16, 1954 to Superintendent Preston, Yosemite National Park. Subject: Radio Relay Stations.

4-79. Regional Director, Region Four, May 5, 1954 to Director. Subject: Telephone Service Contracts as related to Service Policy on Location of Radio Repeater Stations and other Structures.

4-80. Acting Chief of Design and Construction, April 19, 1954 to Regional Directors, Regions One, Two, Three, Four and Superintendent, Hawaii National Park. Subject: Repeater Stations.

4-81. Interior Representative IRAC, October 11, 1941 to Director, NPS. Subject: Allocation of Radio Call Signs.

4-82. Regional Director, Region Four November 30, 1951 to Region Four Field Offices. Subject: Allocation of Radio Call Signs.

4-83. Superintendent, Yosemite, May 4, 1953 to Regional Director, Region Four. Subject: Assignment of Call Signs for all Mobile and Portable Radio Equipment.

4-84. Ralph R. McFadden, Electrical Engineer, September 9, 1954 to Supervising Engineer WODC. Subject: Conelrad Requirements Mount Rainier Radiotelephone.

4-85. Ranger Leicht, January 18, 1954 to District Ranger, Boulder District (Lake Mead National Recreation Area). Subject: The Barvinhil Radio, WD3278.

4-86. Superintendent, Lake Mead National Recreation Area, January 20, 1954 to Regional Director, Region Three. Subject: Infringement on Radio Frequency assigned LMNRA.

4-87. Booklet: March 1952 Administration and Operation of Radio Communication Services of the Untied States Department of the Interior.

4-88. Superintendent, Crater Lake National Park, January 20, 1954 to Regional Director, Region Four. Subject: Report on Radio Frequency Usage.

4-89. Superintendent, Crater Lake National Park, August 25, 1955 to Regional Director, Region Four. Subject: Radio Frequency Assignment.

4-90. Interior Department Representative, IRAC, March 8, 1955 to V. E. Rowley, Supervisory Electronic Engineer, National Park Service. Subject: Radio Frequency Assignment Black Canyon of the Gunnison, Colorado.

4-91. U.S. Forest Service publication FS-369 Radio for the Fireline, Page 225.

4-92. Acting, Regional Chief of Operations (R-3) April 11, 1958 to Director. Subject: Frequency 5150 kc, Coronado National Memorial.

4-93. Acting, Regional Director, Region Four, July 20, 1954 to Region Four Superintendents. Subject: Radio Operations.

4-94. Herbert Arlowe (FCC), November 10, 1954 to Curtis K. Skinner, Acting Superintendent (Mount Rainier National Park) regarding military interference.

4-95. Landsbury, (FCC), January 21, 1958 to Superintendent, Mount Rainier National Park. Telegram regarding Canadian interference.

4-96. Miller, Chief Engineer, May 28, 1958 to Chief, Western Office, Division of Design and Construction. Telegram regarding interference from Army in the Canal Zone. Also: Macy August 24, 1954 to Public Buildings Service Teletype Center. Group of memoranda and telegrams over several month period concerning military interference at Mount Rainier National Park.

4-97. Preston P. Macy, Superintendent, Mount Rainier National Park, July 21, 1958 to Chief, Western Office, Design and Construction. Subject: Radio Interference with copy of log.

4-98. Author's recollection.

4-99. Same as 94.

4-100. Acting, Chief Engineer, October 13, 1958 to Chief, Western Office, Division of Design and Construction. Subject: Radio Interference, Frequency 164.475 mc/
s, Olympic National Park.

4-101. Supervisory Engineer, WODC, January 29, 1959 to Chief, Design and Construction. Subject: Radio Interference, 164.475 MC, Olympic National Park.

4-102. Acting, Chief Engineer, May 11, 1959 to Regional Director, Region Four. Subject: Radio Power Increase, Cold Bay, Alaska, Army Installation.

4-103. L.J. Mitchell, Superintendent Sitka National Historical Park and Glacier Bay National Preserve, June 2, 1959 to Regional Director, Region Four. Subject: Radio Power Increase, Cold Bay, Alaska, Army Installation.

4-104. Miller, Chief Engineer, September 20, 1961 to S.A. Hoover. Telegram regarding proposed State of Alaska frequency.

4-105. S.L. Windes, Communications Engineer (USDI) October 5, 1961 to Chief Engineer National Park Service. Subject: Non-Government Frequency Assignment 3230 kc/s

4-106. Assistant Director, February 11, 1954 to Regional Directors, Regions One, Two, Three, and Four. Subject: Radio Equipment Needed to Handle Emergencies.

4-107. Finance Officer, May 20, 1954 to Regional Directors, Regions One, Two, Three, and Four. Subject:Financing Rental of Emergency Radio Equipment.

4-108. Acting Superintendent, Mount Rainier National Park, April 29, 1954 to Superintendent, Olympic National Park. Subject: Exchange of Radio Sets During Emergencies.

4-109. Superintendent, Olympic National Park, May 24, 1954 to Regional Director, Region Four. Subject: Radio Equipment for Emergencies.

4-110. Regional Director, Region Four, March 12, 1954 to Director. Subject: Radio Equipment Needed to Handle Emergencies listing needs area by area.

4-111. Assistant Regional Director, Region Four, February 18, 1954 to Region Four Superintendents. Subject: Radio Equipment Needed to Handle Emergencies.

4-112. Superintendent, Mount Rainier National Park, March 1, 1954 to Regional Director, Region Four. Subject: Radio Equipment Needed to Handle Emergencies.

4-113. Booklet, Administration and Operation of Radio Communication Services of the United States Department of the Interior, March, 1952, Pages 3 and 5.

4-114. Chief, Western Office, Division of Design and Construction, March 9, 1955 to Chief, Division of Design and Construction. Subject: Radio Frequency Assignments Mount McKinley/Katmai.

4-115. Same as 62.

4-116. Supervisory Electronics Engineer, March 28, 1956 to S.L. Windes, Interior Representative, IRAC. Subject: Radio Frequency Assignment, Mount McKinley National Park with incoming memorandum attached.

4-117. Same as 59.

4-118. Same as 60.

4-119. Same as 61.

4-120. Superintendent, Mount McKinley, June 20, 1975 to Regional Director, Region Four. Subject: Radio Frequency Assignment.

4-121. Acting Superintendent, Lake Mead National Recreation Area, September 2, 1953 to the Director. Subject: Frequency Infringement, Lake Mead NRA.

4-122. Acting Regional Director, Region Four, January 6, 1954 to All Region Four areas Utilizing Radio Communication. Subject: Maintenance of Adequate Radio Log Books.

4-123. Acting, Chief of Design and Construction, April 2, 1954 to Regional Director, Regions One, Two, Three, and Four and Superintendents National Capital Parks and Hawaii National Parks. Subject: Government-owned Radio Facilities with attachment detailing Mount Rainier radio equipment.

4-124. Superintendent, Coulee Dam, January 13, 1954 to Regional Director, Region Four, copy not available, referred to in reference 125.

4-125. Acting, Assistant Regional Director, Region Four, January 15, 1954 to Superintendent Coulee Dam. Subject: Communications Facilities, Study of.

4-126. Demaray, Acting director, undated letter to Radio Manufacturers with specifications.

4-127. Director, December 14, 1953 to Regional Director, Region Four. Subject: Communications Facilities, All Region Four Areas.

4-128. Acting, Assistant Regional Director, Region Four, December 23, 1953 to Region Four Areas. Subject: Communication Facilities, Study of.

4-129. Same as 123.

4-130. Regional Director, Region Four, May 13, 1954 to Region Four Superintendents. Subject: Review of Communications Requirements and Means of Financing.

4-131. Director, March 19, 1954 to Regional Directors, Regions One, Two, Three, and Four, Superintendent of Hawaii National Park, and Superintendent of National Capital Parks. Subject: communication Facilities.

4-132. Reference missing.

4-133. USFS Publication FS-369, Radio for the Fireline Page 229.

4-134. Acting Chief, Division of Design and Construction, July 11, 1956 to Chief, Eastern and Western Offices, Division of Design and Construction,; subject: Weekly report.

4-135. Acting, Chief of Design and Construction, October 1, 1953 to Regional Directors, Regions One, Two, and Four. Subject: Addendum No. 1 the Radio Specification NPS-7-54.

4-136. Electronic engineer, Region Four, January 18, 1954 to Regional Engineer, Region Four. Subject: Computation of Radio System Lease Costs.

4-137. Author's recollection.

4-138. See 4-136.

4-139. Assistant Regional Director, Region Four, July 19, 1954 to Region Four Superintendents. Subject: Communications Facilities in Region Four Areas.

4-140. Assistant Regional Director, Region Four, January 27, 1954 to Region Four Areas. Subject: Communication Studies, Region Four Areas. See attachments.

4-139. See 138, 126, 127.

4-140. See 4-65?.

4-141. Director, April 1, 1952 to Regional Directors, Regions One, Two, Three and Four. Subject: Commercial Communications Studies in the National Parks.

4-142 See 4-130.

4-143 See 4-141.

4-144. Director, July 6, 1954 to Regional Director, Region Four. Subject: Communication Facilities in Region Four Areas.

4-145. Chief Engineer, July 9, 1954 to Director. Subject: Communication Facilities.

4-146. See 4b.

4-147. Regional Director, Region Four, January 27, 1954 to Superintendents, Olympic, Mount Rainier, Sequoia and Kings Canyon, Death Valley. Subject: Communications Maintenance Personnel.

4-148. Superintendent (Mount Rainier National Park), June 29, 1954 to employees. Subject: Negotiations for Communication Services.

4-149. Superintendent (Mount Rainier National Park), July 14, 1954 to Chief, Western Office of Design and Construction. Subject: Communications Requirements - Mount Rainier National Park.

4-150. Acting, Superintendent, Mount Rainier National Park, September 2, 1954 to Regional Director, Region Four. Subject: Communications Services.

4-151. June 18, 1954 Radio Communication Proposals, Region Four, a table.

4-152. Undated Tabulation: Status of Conversion from Government Operated to Leasing of Commercial Communication Facilities.

4-153. Director, October 21, 1954 to all field offices. Subject: Communications Facilities Contract Procedure.

4-154. Superintendent, Mount Rainier National Park, November 15, 1954 to Chief, WODC. Subject: Negotiations with Telephone Company.

4-155. Mr. Cook (WASO), May 5, 1955 to Mr. Garrison and Mr. Kenner. Subject: Protection Communication's in the Parks.

4-156. Acting, Assistant Regional Director, Region Four, December 14, 1953 to Superintendents Yosemite, Sequoia and Kings Canyon, Mount Rainier. Subject: Telephone Contracts - Terminology and Practices.

4-157. Regional Director, Region Four, March 9, 1954 to the Director. Subject: Negotiations with the Pacific Telephone and Telegraph Company, for Telephone Service, Yosemite National Park.

4-158. Ibid

4-159. Ibid

4-160. Regional Director, Region Four, December 15, 1953 to Director. Subject: Sale of Telephone Facilities, Yosemite National Park.

4-161. Author's recollection of a similar situation at Lava Beds National Monument.

4-162. Same as 12.

4-163. Assistant Regional Director, Region Four, December 4, 1953 to superintendent Mount Rainier National Park. Subject: Sample of Contract for Telephone Service.

4-164. Acting, Assistant Regional Director, Region Four, December 15, 1953 to Superintendent Mount Rainier National Park. Subject: Telephone Service Recommendation Presented by the Telephone Company.

4-165. Supervisor, Communication Section, WODC, September 5, 1957 to Superintendent Mount Rainier National Park. Subject: Negotiations for Telephone Service.

4-166. Superintendent, Mount Rainier National Park, January 13, 1954 to Regional Director, Region Four. Subject: Communications Facilities, Study of.

4-167. Same as 165.

4-168. Assistant Regional Director, Region Four, March 2, 1954 to Director. Subject: Communication Study, Mount Rainier National Park, with attached report by Electronics Engineer, Region Four.

4-169. Ibid.

4-170. Supervisory Engineer WODC, October 24, 1957 to Superintendent Mount Rainier National Park. Subject: Negotiations for Telephone Service enclosing draft of letter to be sent to PT&T.

4-171. Vice President and General Manager, PT&T, December 18, 1957 to Preston P. Macy, Superintendent Mount Rainier National. Reply to letter based on 4-168 draft.

4-172. See 165.

4-173. Chief, Western Office, Division of Design and Construction, March 1, 1955 to Chief, Division of Design and Construction. Subject: Radio Frequency Assignment, Crater Lake National Park.

4-174. Interior Department Representative, IRAC, April 4, 1955 to Supervisory Electronics Engineer, NPS. Subject: Radio Frequency Assignment, Crater Lake National Park.

4-175. See 89.

4-176. See 160.

4-177. Acting, Assistant Regional Director, Region Four, December 15, 1953 to Superintendent Mount Rainier National Park. Subject: Missing, file D5027.

4-178. Acting, Assistant Regional Director, Region Four, December 14, 1953 to Superintendents Yosemite, Sequoia and Kings Canyon, and Mount Rainier National Park. Subject: missing, file D5027.

4-179. Chief Engineer, NPS June 29, 1956 to Acting, Assistant Solicitor, Parks. Subject: Proposed Telephone Communication System Contract, Shenandoah National Park.

4-180. Authors recollection.

4-181. Same as 8.

4-182. Same as 9.

4-183. Same as 177.

4-184. Same as 140.

4-185. Sanford Hill, Chief WODC, July 21, 1954 to Pacific Telephone and Telegraph Company regarding type approval for radios to be furnished to Mount Rainier National Park.

4-186. See 136.

CHAPTER 5

5-1 Assistant Regional Director, Region Four, March 2, 1954 to Director. Subject: Communication Study, Mount Rainier National Park, with attached report. By Electronics Engineer, Region Four.

5-2 Smith, Chief Engineer WODC, July 18, 1963 to Assistant Director, Design and Construction. Example of teletype sent by PBS.

5-3 Draft of memorandum to Pacific Northwest Region concerning contract CX-9000-6-9015.

5-4 Superintendent, Mount McKinley, September 26, 1967 to Regional Director, Western Region. Subject: Telephone Service - Mount McKinley National Park.

5-5 Supervisor of Electrical/Mechanical Engineers, DCSSC, August 12, 1968 to Chief, Design and Construction, SSC. Subject: Report on Telephone Negotiations, Mount McKinley National Park.

5-6 Acting, Chief Engineer, DCSSC May 4, 1967 to Regional Director, Western Region. Subject: Improved Telephone Communications of Mount McKinley National Park Headquarters Area.

5-7 Same as 5-5.

5-8 Ralph R. McFadden, November 13, 1967 to Sam Hoover, WASO. Subject: Telephone Service Mount McKinley National Park.

5-9 Superintendent, Mount McKinley, November 6, 1967 to Assistant Regional Director, Operations, Western Region. Subject: Telephone Service, Mount McKinley National Park.

5-10 Acting, Assistant Regional Director, Operations, Western Region, October 31, 1967 to Superintendent Mount McKinley. Subject: Telephone Service, Mount McKinley National Park.

5-11 Chief Engineer, Division of Project Design, DCSSC August 12, 1968 to Regional Director, Western Region. Subject: Negotiations for Telephone, Mount McKinley National Park.

5-12 Contract for Telephone Service, Havasu Campground, Grand Canyon National Park, June 22, 1971.

5-13 Article in IEEE Spectrum, November 1985, Page 57.

5-14 Electrical Engineer, EODC, April 5, 1965 to Chief Engineer, EODC. Subject: Proposed Radio System, Fire Island National Seashore.

5-15 Regional Programs Officer, Western Region, December 1, 1966 to Chief, Design and Construction, SSC. Subject: Project Construction Proposals - Glacier Bay.

5-16 P.E. Smith, Chief Engineer, WODC, August 22, 1963 letter to tower and antenna manufacturers.

5-17 Department of the Air Force, Seattle, Washington, December 21, 1967 to Jerry Riddell, NPS (WODC). Subject: Single Sideband Implementation.

5-18 Superintendent, Sitka and Glacier Bay, November 8, 1966 to Regional Director, Western Region. Subject: PCP U-33, Reconstruction of Radio System.

5-19 Chief Engineer, Division of Project Design, DCSSC, August 18, 1967 to Superintendent Glacier Bay. Subject: Separate PCP U-33, Reconstruction of Radio System, Glacier Bay.

5-20 See 5-17.

5-21 Ralph R. McFadden, October 29, 1968 handwritten notes. Subject: Mount McKinley Radio System.

5-22 Assistant Regional Director, Operations, Western Region, November 14, 1968 to Superintendent Mount McKinley. Subject: Single Sideband Radio Equipment.

5-23 George A. Hall, August 19, 1968 to Ralph R. McFadden DCSSC. Subject: Radio Communications - Mount McKinley, interoffice memorandum, including reply.

5-24 State of Alaska, Department of Fish and Game, February 24, 1969 to Wayne Merry, Assistant Superintendent, Mount McKinley National Park regarding Cooperative Radio.

5-25 Superintendent, Mount McKinley, March 12, 1969 to Regional Director, Western Region. Subject: Joint use of State Radio Communication Frequency.

5-26 Utilities Engineer, May 20, 1969 to Regional Director, Western Region. Subject: Radio Frequency Assignments, Mount McKinley National Park.

5-27 Acting, Chief Engineer, Division of Project Design, DCSSC October 15, 1968 to Regional Director, Western Region. Subject: Radio System, PCPU-76, Mount McKinley National Park.

5-28 P.E. Smith, Chief Engineer, WODC August 30, 1965 to Assistant Director, Design and Construction telegram advising dates of survey for Mount McKinley National Park.

5-29 Chief of Project Design, DCSSC July 19, 1968 to Assistant Director, Design and Construction. Subject: Radio Survey, Mount McKinley National Park.

5-30 Chief Engineer, Division of Project design, DCSSC, June 20, 1969 to Regional Director, Western Region. Subject: Radio System Mount McKinley National Park.

5-31 Assistant Superintendent Great Smoky Mountains National Park, May 25, 1965 to Motorola Communications and Electronics.

5-32 Comptroller General of the U.S., October 30, 1964 to Secretary of the Interior.

5-33 Superintendent Great Smoky Mountains National Park, August 30, 1965 to Dynalectron Corporation.

5-34 Acting Superintendent, Great Smoky Mountains National Park, April 15, 1965 to Director. Subject: Radio System, with attachment describing system operation.

5-35 Contracting Officer, Great Smoky Mountains National Park, November 30, 1965 to Motorola Communications and Electronics.

5-36 Motorola Communications and Electronics, November 16, 1965 to Superintendent, Great Smoky Mountains National Park.

5-37 Superintendent, Great Smoky Mountains National Park, October 8, 1965 to Director. Subject: Installation of Radio Antenna, Clingmans Dome, also summarized in a news release, dated March 25, 1965.

5-38 Ralph R. McFadden, September 1969 Report Re-evaluation, Mount Rainier National Park Radio System.

5-39 Assistant Regional Director, Region Three, July 3, 1962 to the Director. Subject: Discontinuance of Am Radio-Region Three Areas.

5-40 Office of Civil and Defense Mobilization, January 14, 1955 to All Federal Users of Radio. Subject: Narrow-band FM Operations in Certain Government Radio Frequency Bands.

5-41 Interior Department Representative to IRAC, September 24, 1959 to Bureau Heads. Subject: Implementation of Narrow-Band Radio Frequency Assignments.

5-42 Chief Engineer (NPS) January 25, 1961 to Communication's Engineer, Department of the Interior. Subject: Implementation of Narrow-Band Radio Frequency Operations.

5-43 Chief, WODC, April 11, 1962 to Regional Director, Region Three. Subject: Narrow-Banding FM Radio Systems.

5-44 Acting Chief Engineer, WODC, December 5, 1963 to Assistant Director, Design and Construction. Subject: Radio Frequency Assignments, Grand Teton National Park.

5-45 Communications Engineer (USDI), April 11, 1960 to Bureau Heads. Subject: Implementation of Narrow-Band Radio Frequency Operations.

5-46 Supervisory Engineer, WODC, July 20, 1961 to Chief, Division of Design and Construction. Subject: Narrow-Banding FM Radio Systems.

5-47 Acting Supervisory Engineer, WODC, December 13, 1960 to Chief, Design and Construction. Subject: Narrow-Banding FM Radio

5-48 Chief Engineer, March 16, 1962 to Chief, WODC. Subject: Narrow-Banding FM Radio Systems.

5-49 Acting Regional Director, Region Four, August 15, 1961 to Director. Subject: Narrow-Band Conversion of FM Radio Frequency Operations.

5-50 Acting Supervisory Engineer, WODC August 11, 1961 to Regional Director, Region Three. Subject: Narrow-Band Conversion of FM Radio Frequency Operation item nine.

5-51 Field Solicitor (San Francisco), August 24, 1961 to Chief, WODC. Subject: Leased Radio Contracts, National Park Service, Western Areas.

5-52 Mountain States Telephone and Telegraph Company, February 14, 1962 to P.E. Smith, Chief Engineer WODC.

5-53 Chief, WODC, March 20, 1963 to Regional Director, Midwest, Southwest, and Western Region. Subject: Funds for Narrow-Banding FM Radio Systems.

5-54 See 5-46

5-55 Chief Engineer, WODC February 10, 1965, to Assistant Director, Design and Construction. Subject: Narrow-Banding Radio Systems, 1964 Fiscal Year and Tentative 1965 Fiscal Year.

5-56 Communications Engineer (USDI) March 2, 1968 to Sam Hoover, Electrical Engineer, NPS. Subject: Conversion to Narrow-Band, 406-420MHz.

5-57 Source of quotation missing.

5-58 Communications Engineer (USDI) January 23, 1962 to Heads of Bureaus and offices. Subject: Provision for Short-Distance Low-Power Radio Service.

5-59 Acting Assistant Regional Director, Operations, Western Region, July 8, 1968 to Director. Subject: National Park Service Radio Station Guide, 1968.

5-60 Acting Director, October 16, 1978 to Directorate, Field Directorate and all Park Superintendents. Subject: Official use of Citizens Band Radios.

5-61 Annual Report, Division of Radiocommunications Management (USDI), Fiscal Year 1976.

5-62 The Development of Low-Power Broadcast Transmitters for a Travelers Information Service, March 1975 by Alan Smith (BLM) and Ralph McFadden (NPS).

5-63 Travelers Information Station Planning Handbook, NPS December 1978

5-64 S.L. Windes, Communications engineer (USDI), May 19, 1965 to Sam Hoover, NPS Interoffice memorandum.

5-65 Chief of Project Design, DCSSC April 11, 1966 to Assistant Director, Design and construction. Subject: Regulations Governing use of NPS Radio Frequencies by Scientific Organizations and attached March 25, 1966 memorandum from Sitka/Glacier Bay National Monument.

5-66 Naval Underwater Systems Center, January 7, 1971 to William Bromberg, Superintendent Virgin Islands National Park.

5-67 American Antiquity, Volume 27, No. 1, July, 1961 - Reprint: Finding Site Locations by Radio-Direction Finder at Mesa Verde

5-68 See Reference 46.

5-69 Chief, WODC, probably 1962, to Regional Directors, Regions Two, Three, and Four. Subject: FM Radio Systems. Draft of a memorandum that was never sent to addresses.

5-70 NPS Guideline NPS-15. Radio Facility Management and Use.

5-71 Chief, WODC, May 16, 1953 to Regional Director, Southwest Region. Subject: Narrow-Banding FM Radio Systems, 1963 Fiscal Year.

5-72 Chairman, National Wildfire Coordinating Group, February 11, 1981 to Ralph R. McFadden. An appreciation letter.

5-73 USFS Publication FS-369 Radio for the Fireline, Page 246.

5-74 Reference not available.

5-75 Federal Communications Commission Anchorage, Alaska, December 3, 1968 to Wayne P. Merry, Acting Superintendent Mount McKinley National Park.

5-76 Director, NPS October 25, 1973 to Assistant Secretary for Fish and Wildlife and Parks. Subject: Radio Systems.

5-77 S.L. Windes, Interior Department Representative IRAC, May 31, 1973 to Gordon T. Henderson, Chief Frequency Assignment Statt (FAA).

5-78 Communications Engineer (USDI) June 12, 1973 to Ralph R. McFadden, Communications Engineer NPS. Subject: Coordination of Aircraft Radio Frequencies with Federal Aviation Administrator.

5-79 Same as 5-61 Page 7.

5-80 Brochure RT-9600 VHF FM Transceiver from Wulfsberg Electronics, Inc.

5-81 Same as 5-61 Page 10.

5-82 Bill Baker (USDI) October 8, 1975 to Ralph R. McFadden, NPS log of telephone conversation regarding radio interference.

5-83 Communications Engineer (USDI) December 18, 1969 to Sam Hoover, Electrical Engineer, Design and Construction, NPS. Subject: Frequency Usage Reporting Program (First Quarter 1970).

5-84 Chief, Telecommunications Staff Office (USDI) February 27, 1974 to Ralph R. McFadden, Communications Engineer, NPS. Subject: 5-Year Review of Frequency Assignments.

5-85 Manager, Denver Service Center, March 28, 1974 to Associate Director, Administration. Subject: 5-Year Review of Radio Frequency Assignments.

5-86 USFS Publication FS-369, Radio for the Fireline, Page 205.

5-87 Communications Engineer, Telecommunications Staff Office (USDI) May 6, 1974 to Ralph R. McFadden, Communications Engineer, NPS. Subject: Frequency-Assignment List for 5-Year Review.

5-88 Associate Regional Director, Park System Management, Rocky Mountain Region, April 12, 1974 to all Superintendents, Rocky Mountain Region. Subject: Denver Service Center Radio Systems Frequency Review.

5-89 See 5-61, Page 18.

5-90 Associate Director, Park Systems Management, December 19, 1976 to all Regional Directors and Director, National Capital Parks. Subject: Planning and Management of Radio Systems and Devices.

5-91 See 5-61, Page 10.

5-92 This chronology was recorded earlier by the writer after reviewing assorted files and reports, the location of which is not recalled.

5-93 See 5-61, Pages 4 & 6.

5-94 Ibid, Pages 4 & 6.

5-95 Associate Director, Park Systems Management, April 1, 1974 to all Regional Directors and Director, National Capital Parks. Subject: Planning Guide.

5-96 Ibid.

5-97 Ibid.

5-98 See 5-71.

5-99 Chief Engineer, WODC, July 25, 1963 to Regional Director Western Region. Subject: Analysis, Government-owned v.s. Leased Radio Systems, Olympic, Mount Rainier, and Sequoia-Kings Canyon.

5-100 Manager, DSC, February 8, 1974 to Associate Director, Administration. Subject: Purchase, rental, and maintenance of radio equipment using basic GSA contracts.

5-101 Associate Director, Administration, February 28, 1974 to Regional Directors, Director, National Capital Parks, and Manager, Denver Service Center.

5-102 Associate Director, Administration, May 23, 1975 to Manager, Denver Service Center. Subject: Information: Financing Radio Systems.

5-103 Author's recollection.

5-104 See 5-76.

5-105 Communications Engineer (USDI), December 7, 1970 to James M. Stump, Communications Engineer (NPS). Subject: Conversion to SSB/VHF, Great Lakes.

5-106 Communications Engineer (USDI), January 25, 1971 to James M. Stump, Communications Engineer (NPS). Subject: Conversion to SSB on 2616kHz.

5-107 Office of Management Operations (USDI), July 12, 1971 Alaska Plan for conversion to SSB on Frequencies Below 27500kHz.

5-108 Associate Director, Professional Services, August 14, 1970 to Directors, Eastern and Western Service Centers. Subject: Establishment of positions to handle utilities and communications negotiations Servicewide.

5-109 See 5-84.

5-110 See 5-85.

5-111 Grand Canyon National Park, January 25, 1966 Authorization for Reduced Rates.

I N D E X