

**THE ECONOMIC AND TECHNICAL ASPECTS
OF RADIO STATION KOAC**

by

Grant Stephen Feikert

A THESIS

submitted to the

OREGON STATE AGRICULTURAL COLLEGE

**in partial fulfillment of
the requirements for the
degree of**

ELECTRICAL ENGINEER

June 1, 1937

APPROVED:

Redacted for Privacy

Professor of Electrical Engineering

Redacted for Privacy

Chairman of School Graduate Committee

Redacted for Privacy

Chairman of College Graduate Council.

10/28/87

21.45

9/17

30 Sep. 87

"That wonder of the Age, the radio, ranks with the press in its potential power to extend the influence of an organization, to create public opinion, to induce public action.....Building public opinion and stimulating public action are the functions of all publicity devices, of all publicity technics. Without these devices and technics, organizations cannot achieve their objectives. With them they have the opportunity of influencing national character toward better thought and action."

Blanche Arter Buhlig
Christian Science Monitor

TABLE OF CONTENTS

<u>SECTIONS</u>	<u>PAGE</u>
Section I History of Radio Station KOAC.	1
Origin of Interest in Radio at Oregon State College	1
Origin of Broadcasting at Oregon State College	6
Radio Activities of Extension Service	12
Official College Station KFDJ	20
Dedication of College Radio Service	29
Station Call Changed to KOAC	31
Recapitulation for New Station	40
Installation of New Station	48
Decision on Future of KOAC	62
 Section II Present Status of Radio Station KOAC .	 72
 Section III Suggested Future Development Plan . .	 91
Proposals for Expansion	94
Discussion of Proposal I	95
Discussion of Proposal II	115

TABLES

<u>TABLE NUMBER</u>	<u>TITLE</u>	<u>PAGE</u>
I	Federal Radio Assignments to Oregon State College	68
II	Population and Radio Receivers Served by the Present KOAC	83
III	Summary of Educational Stations and In- stitutions According to Annual Expendi- tures for Radio	89
IV	Points of Origin of Letters to KOAC in 1935-36	90

ILLUSTRATIONS

<u>FIGURE NUMBER</u>	<u>TITLE</u>	<u>PAGE</u>
1	Early Wireless Station at Oregon State College	3
2a	KFDJ Transmitter Block Diagram	8
2b	KFDJ Microphone Response Compared with 1937 KOAC Microphone	8
3	First Oregon State College Band Broadcast over the State Owned Station KFDJ . . .	10
4	Reconstructed 500 watt Transmitter, KFDJ .	21
5	Original 500 watt transmitter, KFDJ . . .	21
6	Arrangement of Components in Class B Trans- mitter KFDJ-KOAC	22
7	KFDJ Studio	25
8	KFDJ Installation	25
9	KOAC Studio Constructed 1928	49
10	1000 Watt Installation 1928	49
11	Analysis of Listener Response to KOAC . .	69
12	Financial History of KOAC Showing Cost Per Hour	70
13	KOAC Transmitting Installation in 1937 . .	73
14	Block Diagram of Present KOAC Transmitter	76
15	KOAC Audio Frequency Diagram With Corres- ponding Audio Frequency Power Levels .	77
16	Audio Fidelity of Station KOAC	79
17	Field Intensity Contours of Station KOAC .	81
18	Points Reporting Reception from KOAC . . .	82

<u>FIGURE NUMBER</u>	<u>TITLE</u>	<u>PAGE</u>
19	Location of Transmitter House and Vertical Radiator on the Young Tract . .	97
20	Artist's Drawing of Transmitter Building .	98
21	Transmitter Building Floor Plan with Western Electric 5000 Watt Transmitter .	101
22	Federal Communications Commission Antenna Specifications	102
23a 23b 23c	Antenna Design Details	103
24	Dimensions of Vertical Radiator With Ob- struction Lighting Data	104
25	Field Intensity Contours With New 5000 Watt Station	107
26	5000 Watt Transmitter	112
27	Schematic of 5000 Watt Transmitter	113

T H E E C O N O M I C A N D T E C H N I C A L
A S P E C T S O F R A D I O S T A T I O N K O A C

I. HISTORY OF RADIO STATION KOAC

1. ORIGIN OF INTEREST IN RADIO AT OREGON
STATE AGRICULTURAL COLLEGE

The development of radio at Oregon State College was based upon the general interest of Dr. W. Weniger, and a demand on the part of five students for a course in wireless instruction.

A course was given during the year 1914-15 by Dr. Weniger of the Department of Physics. Members of the class equipped and operated a spark type transmitter on the Oregon State College campus. Previous to this time Dr. Weniger had done research at the University of Wisconsin on refraction of short radio waves through paraffin blocks. This course was terminated in 1916, when Dr. Weniger left the campus. He had been a student in the first radio course given in the United States. The course was given by Dr. Augustus Trowbridge at the University of Wisconsin in 1905-06. He used a text printed in Italian.

Professor S. H. Graf of Oregon State College in 1906-07 had successfully sent and received wireless messages in Corvallis using a spark coil transmitter and a coherer type detector for receiving.

Advent of Signal Corps Instruction (1916-18)

During the period of encampment of World War military forces on the State College campus, wireless instruction was given by Mr. Willis Duane Peasley of the Department of Electrical Engineering. This instruction was of a practical nature and consisted largely of code practice and operating procedure. After this wartime period, ending in 1918, no further instruction in the radio field was given until 1920.

Origin of Present Radio Courses (1920)

After the return of Dr. Weniger to Oregon State College in 1920, there was a demand from a number of ex-navy wireless operators enrolled at the State College for instruction in radio. Consequently a course was organized and given by Dr. Weniger in 1920-21, which was well attended. The following year, 1921-22, the course was assigned to Mr. Jacob Jordan, Instructor in Physics. This assignment was made as a result of Mr. Jordan's interest and experience in the field of amateur radio.

During this period (1920-22) a spark type transmitter was assembled on the campus and operated on a wavelength of 375 meters or 800 kilocycles, with a call of 7YJ. The operating license was issued by the Department of Commerce, Washington, D. C.

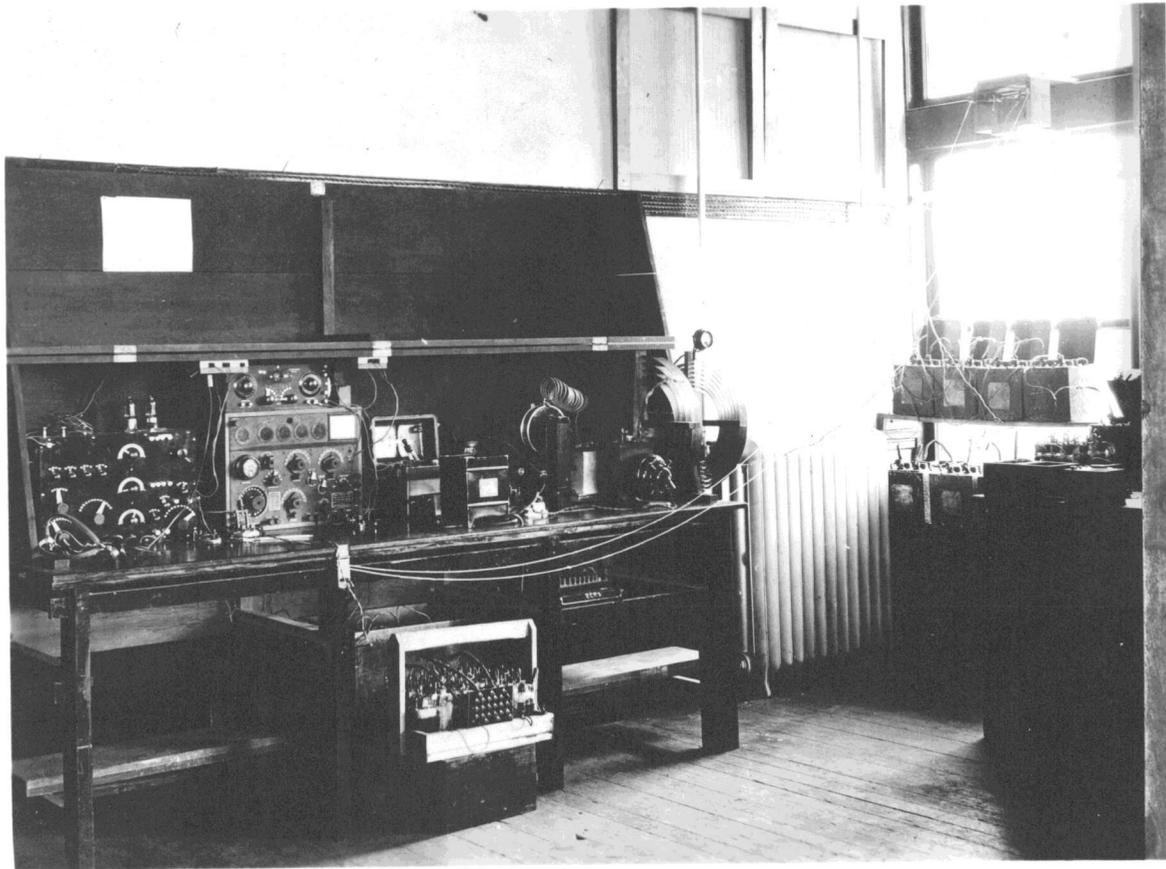


Figure 1 - Early wireless station at Oregon State College.

This transmitter was used for general communication with the amateur and other school-operated stations in the western section of the United States. The operation of this station was by army and navy trained operators who were attending Oregon State College as a result of government subsidy. Installation of this unit, under the direction of Mr. Jordan, was made in the north wing of the second floor of Apperson Hall. (Figure 1).

This station was placed in operation approximately October 8, 1921, and was of great assistance for emergency communication during the flood from November 11 to November 22, 1921, when Corvallis and the Pacific Coast was practically isolated by road washouts and demolished communication lines at Jefferson, Oregon. Numerous emergency messages were handled for the Pacific Telephone and Telegraph Company, The Western Union Company, President W. J. Kerr of Oregon State Agricultural College, and many Corvallis citizens.

A motion picture film was made of this station during emergency work with operator F. K. Johnson on duty. This film is now in possession of the State College.

Annual Engineering Show

It should be noted that the annual Engineering Show held in the early days of the engineering departments at

Oregon State Agricultural College, had a beneficial influence on the development of radio and the stimulation of technical interest along this line.

The O. A. C. Engineering Show was inaugurated in 1909 and was repeated annually until 1923 when other departments participated and the name was changed to the O. A. C. Educational Exposition.

The annual exhibits gave the public an opportunity to see the operation of various laboratories and to inspect the accomplishments of students of the various schools of the state college. It served to interest many technically inclined students in a college education, and gave the students who were then in college an opportunity to meet the public.

These annual shows were discontinued in 1932 when operation of the Oregon State College and the University of Oregon was united under the Oregon State System of Higher Education.

Military Communication Service Maintained by the Department of Physics (1922-23)

During the years of 1922-23 a military communication service was maintained between Oregon State Agricultural College and Vancouver Barracks, Washington. This service operated on a wavelength of 1060 meters, on which reliable communication was consistently maintained.

The equipment in use consisted of a standard portable unit of the United States Signal Corps and was operated by Mr. Grant Feikert. Daily schedules were maintained, but during this time several emergency messages were transmitted to the Presidio, San Francisco, on 600 meters through the Federal Telegraph Company station KKK in Portland, or through The Naval Radio Station NPE located at North Head, Washington. The equipment used for this purpose is also shown in Figure 1.

This communication service was arranged for, and operated under the direction of Colonel G. W. Moses, U. S. Army, who was stationed at Oregon State College as commandant of the Reserve Officers Training Corps.

Development of Radio Courses

During 1921 Mr. Jacob Jordan of the Department of Physics developed a two term course in the technics of radio. This course was broad in scope and, even though curtailed by the lack of available equipment, was a creditable asset to the state college.

2. ORIGIN OF RADIO BROADCASTING AT OREGON STATE AGRICULTURAL COLLEGE (1921)

Late in 1921, Mr. Jordan began a series of experiments on the transmission of speech and music by radio telephone. Due to the scarcity of equipment, because

practically no manufacturers were in the field at that time, much early work was done with signal corps surplus apparatus released to schools for experimental and instructional work. The early broadcasting experiments were made with a power of 50 watts. As a result of these early experiments a radiotelephone broadcasting station was developed.

The Advent of Radio Station KFDJ (1922)

The station KFDJ was licensed to operate with a power of 50 watts. The original broadcasting license was issued to the Oregon State Agricultural College by the Department of Commerce. Custody of equipment and responsibility of compliance with the license was vested in the Physics Department.

The transmitter, which was constructed in 1922 and used for experimental broadcasting that year, consisted of two type 203 tubes. These were built and sold by the General Electric Company. One tube was used as an oscillator feeding directly into the antenna. This oscillator unit was arranged in the characteristic Meissner circuit, and was modulated with a single type 203 tube operating through a Heising modulating circuit. Speech amplification was accomplished in a cascade arrangement of signal corps tubes, type VT2. A block diagram has been included (Figure 2a) to more clearly indicate the limitations

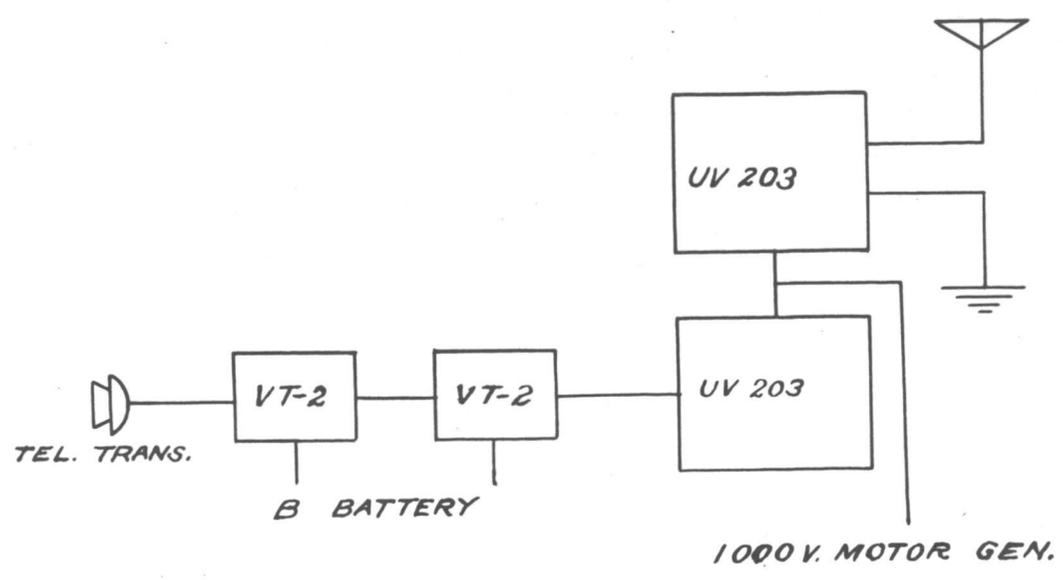


Figure 2a - First radio transmitter at Oregon State College which operated under call of KFDJ.

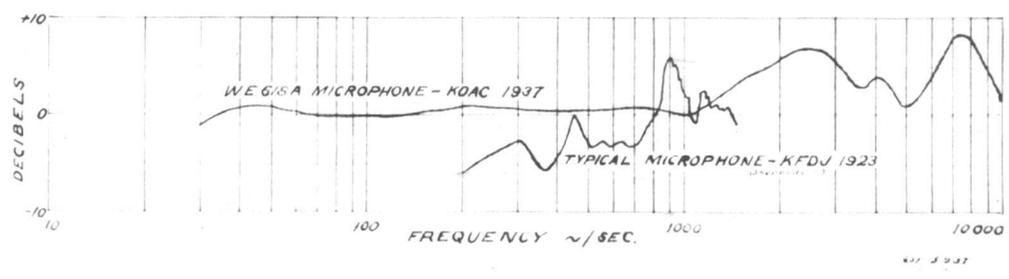


Figure 2b - The probable audio frequency response of the KFDJ microphone used for the band broadcast of figure 3 has been compared with that of the present KOAC microphones.

imposed upon fidelity by early types of component apparatus.

First Formal Broadcast Made from the Oregon State College Campus (1923)

The first broadcast from the state college campus was a musical concert and was presented through the college-owned broadcasting station KFDJ. This occurred on January 23, 1923, and was in the form of a concert played by the Corvallis High School Band. The first concert given by an Oregon State Agricultural College organization was played by the R. O. T. C. Cadet Band (Figure 3) under the direction of Captain Harry L. Beard on January 25, 1923. This early broadcast displayed the interest of the state college in radio and probably was the hub for early technical and program development.

As can be noted from Figure 3 no acoustic treatment was applied to the walls of Room 212 Apperson Hall, then used as a studio. The broadcast pick-up was made by using a single button carbon type microphone, designed for telephone use. In Figure 2b a response curve of this unit has been compared with that of a modern microphone. Attention has been called to the above details to indicate the numerous problems which early broadcast engineers were compelled to meet.



Figure 3 - First Oregon State College band broadcast over the State owned station KFDJ.

Using the technical facilities already described, the following programs were presented over the radiophone station KFDJ:

January	23, 1923	Corvallis High School Band
January	25, 1923	O. A. C. Cadet Band
February	2, 1923	O. A. C. Lyceum Club
February	6, 1923	Marguerite MacManus String Quartet
February	9, 1923	O. A. C. School of Music
February	16, 1923	Corvallis High School Orchestra
February	25, 1923	The Lorelie Club
March	1, 1923	O. A. C. Lyceum Club
March	6, 1923	O. A. C. Orchestra
March	15, 1923	Students of O. A. C. School of Music
May	3, 1923	Christian Church Bible School Orchestra

Broadcasting Through 1924

During the summer of 1923, Mr. Jordan was active in the reconstruction and improvement of the broadcasting equipment. In the fall of 1923 and throughout the school year 1923-24, Mr. Jordan with the cooperation of Dr. Weniger, continued to broadcast musical programs from KFDJ. During this period phonograph records were used only a

small amount of the time, and no set schedule of operation was adhered to. Many talks covering a wide variety of subjects were broadcast by staff members of the College.

3. RADIO ACTIVITIES OF THE OREGON STATE AGRICULTURAL COLLEGE EXTENSION SERVICE (1921)

The state college extension service first became interested in radio as a means of education in November, 1921, when Paul V. Maris, Director, conferred with officials of the United States Bureau of Agricultural Economics in Washington, D. C., relative to the value of this new method of disseminating marketing information. Literature relating to agricultural and radio broadcasting in general, was assembled and a special analysis of the material was conducted by Mr. F. L. Ballard, county agent leader.

That analysis was made public at the annual Extension Conference held in Corvallis, Oregon, in October, 1922. The study of assembled literature indicated that the Agricultural Extension Service should inaugurate a system of radio broadcasting in order to place at the disposal of the farm public in Oregon, agricultural information and market news.

Broadcasting Activity of the Agricultural Extension Service (1923)

Being interested in the latent possibilities of radio broadcasting and wishing to test a system of disseminating agricultural information, an arrangement was made with the Morning Oregonian Publishing Company to broadcast a series of programs over its station KGS at Portland. Therefore, beginning October 2, and ending December 18, 1923, representatives of the Extension Service gave one lecture each Tuesday evening at 8 o'clock from the Oregonian station KGW in Portland. Twelve such lectures were delivered in the above period covering subjects dealing with agriculture, marketing, city and town planning, and home economics.

Realizing that a short series of programs of this type would not in any way reveal statistics upon which future activities of the state college extension service could be based, it was decided to continue and to expand the Portland broadcasts. Therefore, arrangements were made with the Oregonian for the use of its station for the release of a series of programs to June 3, 1924. Fifty-four 15-minute talks were presented in the series, including a large number of subjects of interest to both the urban and rural population of the state. These talks by the state college staff members were received with so much interest by the people of Oregon that the management

of Radio Station KGW asked for an extension of time running into and through the month of June, 1924.

In determining the kind of lectures to be given from Station KGW, consideration was given the diverse character of the radio audience. For the first time at the state college a radio analysis was being conceived from the listener viewpoint. Educational lectures dealing with varied subjects were scheduled and the best campus talent drawn upon for presentation of these discussions.

As a mark of broadcast showmanship, the first lecture of this series was prepared and presented by Director Maris, and was entitled: "An Introduction to Seventy-Five Worth While Lectures".

A group of suggestions to broadcasting participants was prepared and distributed to scheduled program participants.

As a result of the studies made through station KGW, the extension service definitely decided to enter the radio broadcasting field. Therefore, when a questionnaire from the University of Wisconsin supplied the immediate motivating force, a conference was called between the state college physics department and the extension service. At that time the state college radio station which had constantly been technically improved was broadcasting programs approximately four nights each week. Music was

dominant in these programs.

Dr. Weniger of the Department of Physics expressed willingness to cooperate with the extension service in broadcasting programs of interest to the farmers of the state.

Radio Program Committee Appointed by Director Maris

As a result of this conference and the cooperation of Dr. Weniger, Director Maris appointed the following committee to consider the matter of broadcasting over the college radio station. The members of the committee were Professor G. R. Hyslop, F. L. Ballard, Jessie D. McComb, C. J. Hurd, George W. Kable, and W. L. Kadderly.

Radio Technical Committee Appointed by Director Maris
With Administrative Approval

In March, 1923, a radio technical committee was named by Director Maris, to investigate the technical phases of radio broadcasting. This committee also was charged with the investigation of the technical and economic practicability of a reasonably high power broadcasting station on the state college campus. The members of this committee were:

George W. Kable, Extension Service

A. E. Jensen, Farm Mechanics Department

Jacob Jordan, Physics Department

H. C. Seymour, Extension Service

F. O. McMillan, Electrical Engineering
Department

This Radio Technical Committee filed a report in
May, 1923.

Report of the Radio Technical Committee (May, 1923)

On May 25, 1923, the radio technical committee conducted an exhaustive research, both with persons concerned with the business of broadcasting and equipment manufacturers. As a result of the investigation the following recommendations were submitted:

- A. That a broadcasting station to qualify for a class B license be installed during the summer of 1923. (At this time when radio was administered under the Department of Commerce, Bureau of Navigation, a class B station was one which served a regional area such as the State of Oregon with interference-free reception.)
- B. That this station should have modulation and quality of transmission equivalent to other coast stations such as those owned by Hale Brothers of San Francisco (KPO), The Los Angeles Times (KFI), and the Morning Albertan of Calgary, all of which are heard clearly in this state at night.

- C. Provision should be made for remote control so that athletic contests, convocation addresses, and similar events, can be broadcast.
- D. The installation of the station should be contracted to some responsible builder who can guarantee quality of transmission.
- E. That the necessary funds be provided to build the station described above.
- F. That \$1,600 per year be provided for operation and maintenance exclusive of salaries.
- G. That some qualified faculty member or student be employed for one-fourth time to operate the station.
- H. That the station be built at once to enable the state college to secure the Class B license before the more satisfactory wave lengths have been assigned to other stations.

The report also discussed the radio question under the following heads:

- A. Present station inadequate.
- B. First class station warranted.
- C. Radio program possibilities.
- D. Reasons for Class B station

The report was transmitted to the state college executive office.

Continuation of Agricultural Extension Broadcasts Over
KGW (1924-25)

In the summer of 1923 and before the Radio Technical Committee recommendations had been considered, Mr. R. V. Haller, director of radio station KGW of the Morning Oregonian Publishing Company, asked the Extension Service to broadcast agricultural and home economics lectures from that station. His invitation was accepted, largely because KFDJ, the state college station, did not cover a large portion of the state.

The following lectures were given from KGW in Portland under the auspices of the Extension Service:

1923-24 Agriculture - 37 lectures between October 2 and July 1, 8 o'clock Tuesday evenings.

Home Economics - 37 lectures between October 12 and May 20, 3:30 o'clock Friday afternoons.

1924-25 Agriculture - 56 lectures between October 14 and May 26, 8 o'clock Tuesday evenings.

Based upon this series of lectures, the Extension Service conducted a survey in an effort to obtain information on the extent to which its programs were heard. In the fall of 1923, 110 responses were received from a

lecture by Mr. George W. Kable. In May, 1924, about 200 responses to an Extension Service questionnaire were tabulated. From these results it was decided that the Extension Service should have a campus radio outlet. Therefore, the director transmitted a letter to the administrative office stating that extensive studies conducted by that department had shown the need for a local, state-owned and operated radio station.

This letter, written by Director Maris to Executive Secretary W. A. Jensen, outlined the plans of the Extension Service in the field of radio program building and direction, and the need of the people of Oregon for a closer relation between the state agricultural college and their farm interests.

On February 26, 1925, a college radio committee was named by Secretary Jensen to consider the entire question of operating a station, to be owned by the state college. This committee consisted of:

Dr. W. Weniger, Chairman

G. W. Peavy

Paul V. Maris

J. T. Jardine

Ava B. Milam

E. T. Reed

J. A. Bexell

W. A. Kearns

Paul Petri

C. B. Mitchell

A. G. S. Bouquet

J. P. Brumbaugh

H. S. Rogers

This committee, in a meeting on May 5, 1925, agreed upon a favorable set of recommendations for the operation of the station which were forwarded to the executive office.

The recommendation placed the technical operation under the Department of Physics, while the program responsibility rested with the Agricultural Extension Service. With favorable reports being returned to the Executive office from all committees appointed to study radio broadcasting, development of a radio station at the state college took definite proportions.

4. OFFICIAL BROADCASTING STATION OF THE COLLEGE - KFDJ

As a result of the favorable report of the radio technical committee, the executive office in charge of President W. J. Kerr, ordered the construction of a 500 watt station. This unit was built by Professor Jacob Jordan in the Department of Physics during the summer of 1925.

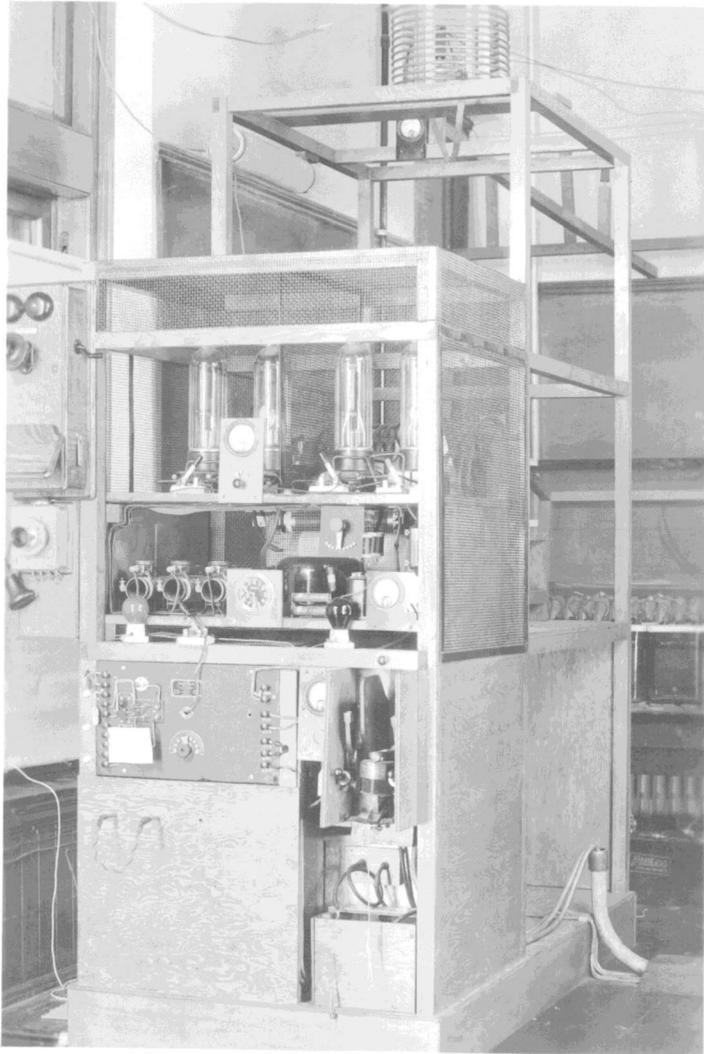


Figure 4 - Reconstructed 500 watt transmitter
KOAC as licensed for Class B operation.

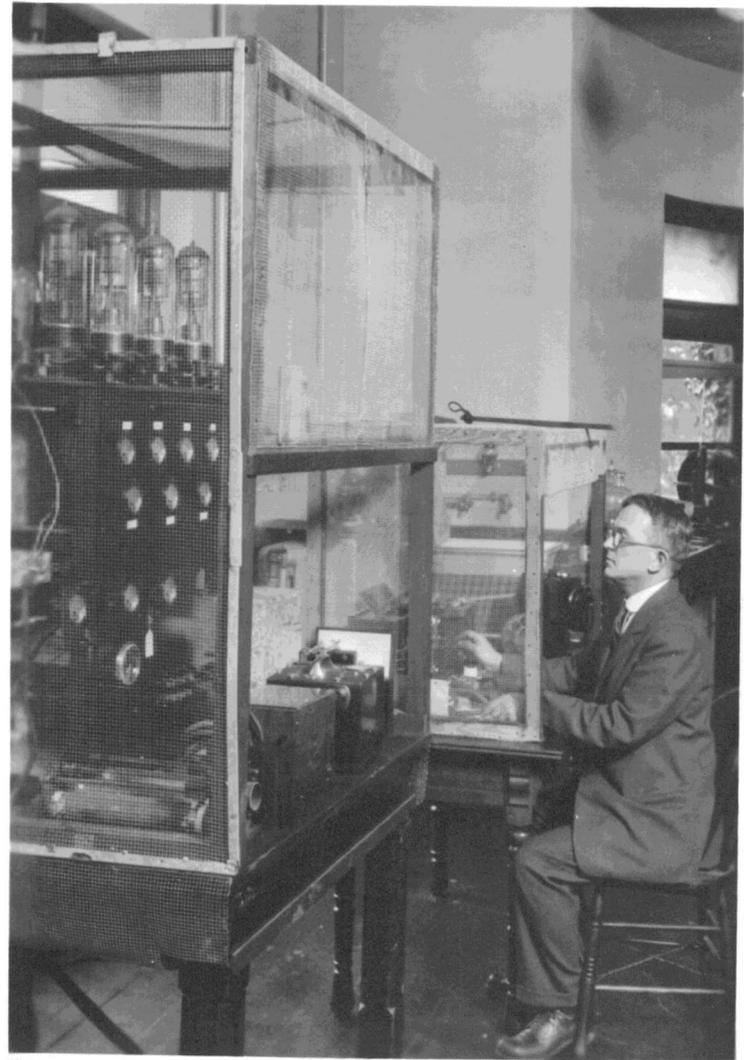
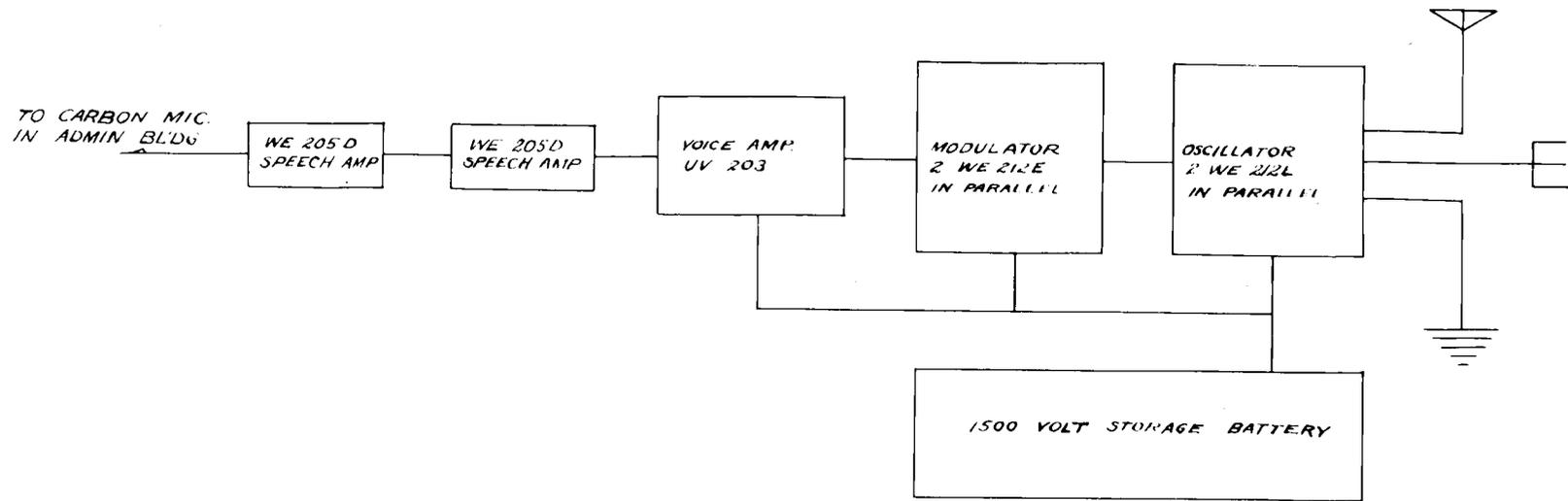


Figure 5 - First 500 watt transmitter, KFDJ.
Mr. Jacob Jordan, operating.



KFDJ-KOAC TRANSMITTER 1925-1929

Figure 6 - Arrangement of components in the Class B radio transmitter.

It was felt that the radio industry in 1925 was undergoing a process of rapid change in apparatus design. For this reason only, it was decided that a transmitter should be assembled locally that would enable the state to qualify for a Class B or regional broadcast license.

A license was obtained and the station was assigned to operate on a frequency of 1060 kilocycles, until it could be tested by the Federal Inspector for Class B rating.

The transmitter was built and operated by the Department of Physics, and was located on the second floor of Apperson Hall in Room 201.

Technical Description

Equipment as designed and constructed by Professor Jordan is shown in Figure 4. Figure 5 shows the same transmitter after reconstruction. The transmitter has been shown in block diagram form in Figure 6. The output of this transmitter was rated at 500 watts. This amount of power was generated by two Western Electric type 212D vacuum tubes operated in parallel. Modulation was accomplished in the oscillator unit. The speech amplifier system consisted of a type 24-A Western Electric audio amplifier of three stages, which was operated directly from a carbon microphone manufactured by the Western

Electric Company and designated as type number 387W. The microphone was remotely located in the studio. The audio frequency output of the commercial amplifier was fed into a speech amplifier using a Western Electric type 211-D vacuum tube. This audio voltage was then coupled into the grid circuit of two Western Electric type 212-D tubes operated in parallel as a modulator.

Power for the transmitter was supplied entirely from storage batteries. Filament heating current was supplied from a 14-volt Exide battery of 200 ampere hour capacity, which was charged from a mercury arc rectifier. Plate power and grid bias voltage were supplied from a Philco battery type UD44 consisting of 900 cells. This battery, along with general views of the radio transmitter, are shown in Figure 8. This battery was arranged to be switched into nine 100-volt banks for charging while 750 cells could be connected in series, giving 1500 volts for plate power. The remaining cells supplied 300 volts for the grid bias supply.

The antenna was located on the roof of Apperson Hall at a point directly over the transmitter, and was a "T" type supported on two 40-foot steel windmill towers. Between the towers a counterpoise was arranged with a lead running down the side of the building to the transmitter.



Figure 7 - The KFDJ studio located in the administration building.
Mr. W. L. Kadderly announcing a group of college musicians.

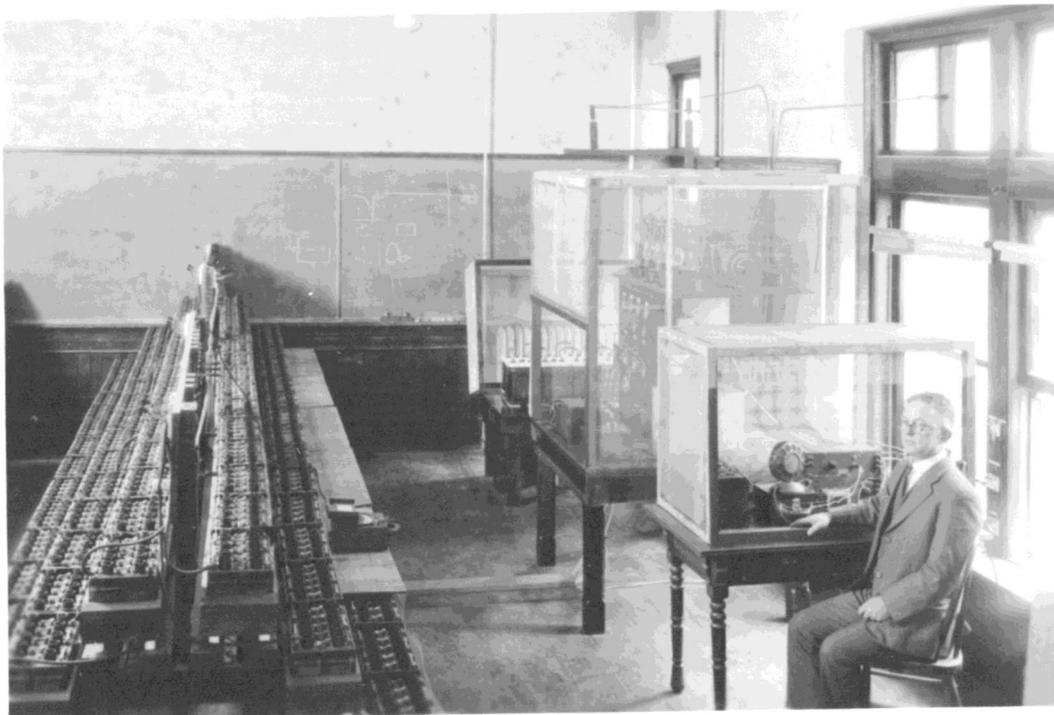


Figure 8 - KFDJ installation with Mr. Jordan operating.

A buried ground was also tuned into this radiating system and further helped to decrease the ohmic losses and to increase the power radiation coefficient.

A set of typical operating log readings has been included and appears as table 1.

The studio was located in one of the rooms occupied by the School of Music on the third floor of the Administration Building. The room was acoustically treated with Monks cloth to reduce the reverberation time to make it suitable for broadcast use. This is further exemplified by Figure 7.

The studio equipment consisted of only a carbon microphone which was supplied current from the Western Electric type 24-A amplifier located in the transmitter room in Apperson Hall. Studio connections between Apperson Hall and the studio were encased in lead cable under ground. A private telephone communication system was also installed under ground.

A program line system was also installed, connecting the following remote points with the transmitter for campus broadcasts:

Women's Old Gymnasium Auditorium

Men's Gymnasium Auditorium

Bell Field Athletic Stadium

This underground system consisted of four number 19 copper conductors with rubber insulation encased in a lead sheath. This was installed over most of the distance by being pulled into an abandoned wood water main.

Administration and Operation of KFDJ

After authorization to construct the station had been made, and after a committee report of the college broadcasting station had been submitted, the executive office issued under the date of June 11, 1925, the following statement:

"To Those Concerned:

Under date of February 26, the executive office appointed a special committee to consider the entire question of policy and organization for the handling and conduct of college radio broadcasting interests. This committee consisted of W. Weniger, chairman, G. W. Peavy, P. V. Meris, J. T. Jardine, Ava B. Milam, E. T. Reed, J. A. Baxell, W. A. Kearns, Paul Petri, C. B. Mitchell, A. G. B. Bouquet, J. F. Brumbaugh, and H. S. Rogers.

Under date of May 13, there was filed in the executive office a report of the above-mentioned committee. The following are the essential points contained in this report:

- A. That the operation of the broadcasting station shall rest with the Physics Department.
- B. That the direction of the radio programs be placed under the Extension Service, and that an advisory committee composed of one member appointed by each dean and director be delegated to cooperate with the Extension Service in this matter.

- C. That W. L. Kadderly, of the Extension Service staff, shall be placed in charge of the programs.
- D. That the station shall be operated regularly two nights a week to begin with, and that such additional programs as athletic games, forensic events, special addresses, and timely information be broadcast when desired, either in the evening or during the day.
- E. That for the time being Mr. Kadderly, as program director, shall act in the capacity of announcer, and that he will arrange for the training of several other staff members to act as alternate announcers in case of need.
- F. That in order to keep a complete record of all lectures and other informational material broadcast, a telegraphone be purchased and made available for this purpose, the understanding being also that the telegraphone may be used by the department of public speaking in connection with the instructional work of that department.
- G. That certain other equipment and operating expenses would be necessary, including draperies, storage batteries, etc.

In connection with the foregoing, you are advised that the executive office approves the report of the special committee above mentioned and summarized, and appropriated \$1500 for equipment (including the purchase of the telegraphone) and operating expenses for the fiscal year beginning July 1. The cost of telephone installation and connection will be cared for separately and in addition to the appropriation above mentioned.

As a matter of convenience in accounting

and record keeping, the executive office will make this appropriation subject to the requisition of the program director, Mr. Kadderly. In this connection, it is suggested that as a matter of institutional record, the interested parties compile and place in memorandum form for present and future record purposes, essential information regarding the history of the station to date, the cost of installations, etc.

Respectfully,

W. A. Jensen,
Executive Secretary"

A Radio Advisory committee was subsequently named as follows:

Commerce	Dean J. A. Bexell
Agriculture	Dean A. B. Cordley
Experiment Station	G. R. Hyslop
Engineering	Dean G. A. Covell
Mines	Dean C. E. Newton
Forestry	Dean G. W. Peavy
Pharmacy	Dean Adolph Ziefle
Physical Education	R. O. Coleman
Basic Arts and Sciences	Dean M. E. Smith
Home Economics	Dean Ava B. Milam
	Mrs. Jessie E. McComb
Vocational Education	Prof. J. F. Brumbaugh
Music	Paul Petri
Physics	Dr. W. Weniger
	Prof. Jacob Jordan
College Editor	E. T. Reed
Journalism	John Burtner
Library	Miss Lucy M. Lewis

Dedication of the New College Radio Service (1925)

With the sanction of the Radio Advisory Committee, and after construction and testing of the new KFBJ transmitter had been completed, a dedicatory program was officially presented to the radio audience on October 16, 1925. Members of the college board of regents participated.

Descriptive Leaflet Series Originated

To assist in announcing the program plans for KFDJ an eight-page leaflet was prepared and distributed to a selected list of radio receiver owners.

A set of suggestions to help lecturers who were inexperienced in talking before the microphone was prepared and distributed. These were placed in the hands of all scheduled faculty members prior to the time of their radio talks.

Split Time Schedule with KFAU

After the broadcast license was granted to KFDJ in the name of the Oregon Agricultural College, the station was instructed by the Federal Radio Supervisor, Mr. O. R. Redfern, to split time with KFAU, owned and operated by the Boise High School. This station was located in Boise, Idaho. Due to the part time schedule normally used by the college this resulted in only one change in the time of presentation of programs.

Regular Hours of Broadcasting by the College Station (1925)

Regular hours of broadcasting were established on Monday, Wednesday and Friday evenings from 7:30 to 9:00 p.m. These hours were augmented with broadcasts of college convocations, athletic contests, and other features

of special interest.

Test Program for Class B License Rating

To test the ability of the station to serve an extensive listening audience a program was arranged and presented on August 28, 1925.

At the request of Mr. O. R. Redfern, Federal Radio Inspector for the seventh radio district, a test program was presented on September 26, 1925, as a part of the official inspection of the station following the application for a Class B license.

KFDJ Assigned to Operate on 1180 Kilocycles

With the approval of Mr. Redfern, assignment of the Class B license to the college was made. The station was instructed to operate on a wavelength of 254 meters or a frequency of 1180 kilocycles.

Station Official Call Changed to KOAC

In order to be significant of the radio station of the Oregon Agricultural College a special request was made to the Federal Radio Commission in Washington to change the call letters of the station from KFDJ to KOAC. This request was granted and the change was made officially, with the station putting into use the new call of KOAC on December 11, 1925.

Summary of Responses from Listeners

After programs were presented from the new Class B station during the period of October 2 to November 30, 1925, a tabulation of mail reports was made. The station was operated tri-weekly from 7:30 to 9:00 p.m. Listeners had responded with letters from the following points.

State of Oregon

Astoria	Halsey	Perrydale
Albany	Hermiston	Pilot Rock
Brownsville	LaComb	Prineville
Corvallis	LaGrande	Salem
Cushman	Lebanon	Umpqua
Elgin	McMinnville	Waldport
Greenleaf	Pendleton	Warren

State of California

Chula Vista	San Diego	Stockton
Long Beach	San Francisco	
Oakland	Santa Maria	

State of Idaho

Kellogg	Kendrick
---------	----------

State of Illinois

Chicago	Highland Park
---------	---------------

State of New Jersey

Bloomfield

State of Pennsylvania

Cornwells Heights	Philadelphia
Northampton	Souderton

State of Washington

Camas	Seattle
-------	---------

British Columbia

Cumberland

Fort Fraser

All of the above listeners reported hearing the 500 watt station of the college. This indicated that the transmitter was operating in an efficient manner. It should be borne in mind that the station was on the air three times weekly for one and one-half hours each period totaling only four and one-half hours per week.

These results also indicate that the designer and builder of the station, Mr. Jacob Jordan, had accomplished the construction of a satisfactory transmitter in spite of the limitations of equipment and the current lack of dissemination of engineering knowledge in the radio field at that time.

Broadcasting Summary Throughout 1925-26

Regular programs were broadcast each Monday, Wednesday and Thursday evening from 7:30 to 9:00 p.m. In addition to these evening programs a regular feature was presented during daytime from 12:30 to 1:00 p.m. from March 1 to May 24. This program was made up of agricultural material and was known as the "O. A. C. Lunch Box". A Women's Forum was presented each Wednesday and Thursday afternoon from 2:00 to 2:30 p.m. from March 11 to May 27.

During the fiscal year 1925-26 broadcasting allocation of time was as follows:

Total number of faculty members participating	119
Total times station was on the air	361
Total broadcast time	81 hours 40 minutes

Included in the above time the following off-campus people contributed or participated in the programs:

State Game Commission
 United States Forest Service
 United States Biological Survey
 Portland Better Business Bureau
 Visiting Summer school faculty members
 U. S. Department of Agriculture Radio Service

Investment in KOAC, March 1, 1926

Transmitter and associated apparatus	\$4806.65
Studio	517.96
Antenna and auxiliary equipment	<u>857.64</u>
Total Investment	\$6182.25

Wavelength Changes Made by KOAC

The college was assigned to operate on a frequency of 1180 kilocycles or a wavelength of 254 meters. This wave was used up to and including September 1925. The station was then assigned to operate on 1060 kilocycles or 282.5 meters. This wave was used until in April, 1926, when the station was again changed to the frequency of 1070 kilocycles or a wavelength of 280.2 meters.

These changes were significant of the congestion which prevailed on the broadcast frequencies at that time. Director Maris of the Extension Service therefore appointed a committee to study the allocation of broadcast facilities. The committee was appointed as follows: Dr. W. Weniger, Professor Jacob Jordan, Mr. W. L. Kadderly.

The committee was named by Director Maris to study the congested situation and report on the possibility of relief. The committee reported that a wavelength of 374.8 meters might be available. Mr. Kadderly did not sign the report because he felt that a full statement of interferences with KOAC programs should have been presented to Department of Commerce officials. No action was taken on the report of the committee.

General Commercialization of Radio Channels

The general trend in 1925-26 was toward the commercialization of available radio facilities, which might have been suitable for educational use. During this time when the college station was under process of development and while it was not assigned to a regional channel, the wavelength was constantly being shifted to more undesirable spots. The conclusion to be drawn from the above facts is that any station can not be operated for educational purposes without keeping pace with commercial

interests. This is true especially with respect to time of operation on the air and modernization of equipment.

Analysis of Listener Response to the Station (1926)

In connection with the home interest programs a radio cook book was to be given to all those people writing the station giving data on reception. Advantage was taken of the book distribution to tabulate listener distribution.

During October, November and December, a total of 187 requests were received, originating as follows:

Within 25 miles of the station	57	or	30%
25 to 50 miles of the station	43	or	23%
50 to 75 miles of the station	13	or	7%
Over 75 miles of the station			
but in Oregon	11	or	7%
Out of state	<u>63</u>	or	<u>33%</u>
	187	or	100%

Brief Protesting Against Application of KLDS for

Additional Power

Station KLDS at Independence, Missouri, operating on the same frequency as KOAC (1060 kilocycles) filed with the Federal Radio Commission an application to increase its power to 5000 watts. On September 23, 1926, a brief was prepared by the program director, Mr. W. L. Kedderly, protesting that such increase would further interfere with

broadcasts from this station. Some weeks later notification was received by the station that the application of KIDS had been denied by the Federal Radio Commission.

Summary of College Radio Broadcasting (1926-27)

The station was operated with practically the same technical set-up which was employed the preceding year. Operation was at a frequency of 1110 kilocycles, or 270.1 meters.

Programs were regularly presented three evenings per week on Monday, Wednesday and Friday. These were augmented after September 23, 1926, by the addition of farm programs to make the schedule continuous throughout the week during the evening periods.

In addition to the regular program schedule the station went on the air thirty-seven times for extra broadcasts. These were composed of convocations, athletic contests, banquets, and the annual college baccalaureate and commencement exercises.

The station was operated 203 times during the year. It has been found impossible to obtain the exact number of hours of operation.

In order to check the response of the station's audience a tabulation of correspondence was made. Letters received during October, November, and December, 1926,

indicated the following:

94 letters originating within 25 miles of the station

29 letters from 25 to 50 miles from the station

27 letters from Oregon points beyond 50 miles from
the station

93 letters from other states

License Application Brief (March, 1927)

Under terms of a new Federal Radio Law enacted by Congress and approved February 23, 1927, creating the Federal Radio Commission, a brief was prepared showing interference with the college programs within the service area of KOAC. From correspondence and observations the following interference was noted. This was wholly in the form of program heterodynes.

KFWI - 27 times KGEF - 4 times

KFAB - 8 times KPSG - 3 times

KSMR - 7 times

These data have been submitted to further show the congestion which existed before KOAC was given its present assignment.

Summary of Radio Broadcasting Activities (1927)

1927 marked the first year of a complete radio service to the people of Oregon from The Oregon State Agricultural College. The station was operated in a noncom-

mercial manner throughout the year on Monday, Wednesday and Friday evenings. During the regular school year, a daily evening schedule of programs was observed during the evening hours only.

Innovations of this year of broadcasting marked the use of phonograph records by KOAC. The method used consisted of playing the records on an orthophonic Victrola and picking up the music acoustically on a microphone placed in front of the sound chamber.

Associated Press news service was first extended to the public from KOAC during this year.

Technical Facilities Limited During 1927

Very few changes were made in the technical facilities of the station during this time. Since the transmitter was entirely operated from storage batteries, the operation was consigned to periods of limited duration. The broadcast schedule and the demand by the public for a more complete service had made the college Extension Service supply a constantly enlarging service. This entailed the necessity of staying on the air for long periods of time.

Limitations of Present Equipment Become Acute (1928)

Due to the inability of the storage battery operated transmitter to perform under long periods of broadcasting the station was closed down on June 25, 1928

Last Date of Operation of the KOAC Transmitter

The KOAC transmitter, located in Apperson Hall with the associated studios located in the Administration Building on the Oregon State College campus, was closed down for the last time on July 31, 1928, by the operator, Grant Feikert.

This transmitter, operated on a band of undesirable wavelengths, assembled at a small outlay of money, and installed in a location which was not surrounded with physical factors conducive to radio transmission, had performed in a favorable manner. It had been in operation for three years, and had given to the state a just return for the money spent for its construction. The design and construction had been accomplished by Professor Jacob Jordan of the Department of Physics.

Recapitulation by College Administration

In negotiations with the Federal Radio Commission beginning in December, 1927, an official representative of the college had said that if the Commission would assure KOAC a wavelength free from interference and adaptable to coverage of the State, the college stood ready to install a 1000 watt Western Electric station.

Acting upon the above fact, and learning that Mr. Harold A. Lafount, newly appointed Federal Radio

Commissioner for the western district, was to make a tour of the Oregon district, arrangements were made by Mr. W. L. Kadderly to confer with him on December 31, 1927, in Portland. Prior to that meeting conferences were held by Mr. Kadderly with Dr. Weniger, Mr. Jordan and Director Maris to consider the need for more power and a more suitable wave length for KOAC. A brief was prepared by Mr. Kadderly, Director Maris, and Dr. Weniger showing the background of radio at the college, and the interference existing with the educational broadcasts, and the constant wavelength shifting of the college station. This brief, presented to Mr. LaFount, contained the statement that the college stood ready to install a 1000 watt Western Electric station.

Steps Taken in Obtaining a Suitable Wavelength for KOAC

In order to allow the reader to more easily comprehend the economic and political negotiations necessary to obtain a suitable regional broadcast assignment for the college, the negotiations with the radio commission have been briefly summarized as follows:

1. Application for construction permit for a 1000 watt Western Electric installation was sent to the U. S. Radio Commission under date of January 4, 1928.

2. Letter from Commissioner Lafount dated January 21, 1928, saying that application for radio station

construction permit had been received and would be given attention as soon as the Senate confirmed appointments of members of the commission.

3. Telegram signed by President Kerr, February 17, addressed to Mr. Lafount calling attention to the fact that certain Pacific Coast stations had been given power or wave length adjustment and asking him whether or not action on KOAC's application would follow.

4. Letter from Mr. Lafount to Dr. Kerr, February 18, explaining adjustments mentioned in telegram from President Kerr.

5. February 27, letter from O. R. Redfern transmitting construction permit dated at Washington February 18, authorizing 1000 watts power, date of commencement March 1, 1928, date of required completion of construction September 1, 1928, time of operation daily to 8 p.m. on 270.1 meters or 1110 kilocycles.

6. Telegram from Commissioner Lafount dated at Washington February 25, instructing KOAC to divide time with KMED at Medford.

7. Night letter sent Lafount by Kadderly February 28, advising that on March 1, KOAC would go to new schedule operating from 12:30 to 1:15 p.m. daily except Sunday and 6:30 to 8:00 p.m. daily except Sunday.

8. Letter from Mr. Lafount dated February 29, saying that ICFTD had been advised of KOAC's requirements and explaining that the commission believed there should be no interference from KEX, adding that he, Lafount, "is trying to get a good assignment for KOAC".

9. Telegram signed by President Kerr addressed to Mr. Lafount dated March 1, renewing application for 830 kilocycles or other frequency between 500 and 1000 kilocycles that will permit reception of KOAC's programs without interference. In this wire attention was called to the further congestion created near the wave length by assignment of KEX to 1080 kilocycles.

10. Telegram from Lafount dated March 5, saying that commission feels that KOAC would not benefit by assignment to 830 kilocycles, adding statement that "there is absolutely no reason why your programs should not be heard all over Oregon...I am doing everything in my power to secure better wave length".

11. Radio statement for President Kerr. In conference with Dr. Weniger and Mr. Jordan following telegrams and letters received from the radio commission in late February (see above) it was decided that we should enlist the support of our Congressmen in obtaining from the Federal Radio Commission favorable action on our request for a wave length to relieve us from existing

interference. The situation was laid before President Kerr in a brief conference on February 28, and a later conference was held on March 3. In the meanwhile a statement had been prepared for President Kerr under date of March 2, in an effort to prove to him that aid from senators and representatives was called for.

12. Brief for Congressmen. As an outgrowth of the March 3 conference with President Kerr, Mr. Kadderly prepared a brief to support the petition of the college for a wave length to permit reception of KOAC's programs without undue interference. This brief is on file. Six copies were sent to Director Maris with a letter dated March 14.

13. Letter advising procedure regarding wave length. March 7, Mr. Kadderly wrote Director Maris advocating that either we be content with our present wave length (270.1 meters) and fight vigorously to have it cleared of interference or that we continue our request for a higher wave length, demand a hearing as specified in the radio law and prepare to defend our request against opposition of stations affected.

15. In last September Mr. Kadderly conferred with C. R. Hunt of KXL regarding time sharing and said KOAC required, as a present minimum, the hours 12:00 to 1:00 p.m.; 2:00 to 4:00 p.m.; and 7:00 to 8:00 p.m.

16. Under date of October 1, 1928, Director Maris transmitted letter prepared by Kadderly to Commissioner Lafount analyzing KOAC's new wave length, calling attention to interference bound to be encountered, and suggesting that KOAC be permitted to operate on 740 kilocycles, with WSB of Atlanta.

17. On October 12, telegram was received from Senator Steiwer saying he understood KOAC was not satisfied with split-time arrangement and expressing desire to be of assistance.

18. On October 12, telegram was dispatched to Senator Steiwer saying KOAC was not objecting to split time arrangement but that our problem was one of certain interference from other stations on 1250 kilocycles, and that on that frequency we could not get into Portland.

19. Telegram was received from Commissioner Lafount October 13, assigning KOAC to 560 kilocycles with unlimited time on the air.

20. On October 15, letter and wire were sent Senator Steiwer saying that new assignment was very satisfactory unless other stations also were changed to thereby create interference with KOAC.

21. On November 9 Commissioner Lafount wired that license was being issued KOAC to operate on 560 kilocycles with 500 watts. On December 1, 1928, power was authorized

at 1000 watts.

Assembly of 1000 Watt Transmitter (1928)

The radio construction permit which was received from the Federal Radio Commission covered a change in the location of the station from Apperson Hall to the new Physics Building, and a change in the power from 500 to 1000 watts. At the request of the administration Dr. Weniger assembled cost data on both a composite broadcast transmitter and a manufactured installation. The construction permit stated that it would be automatically revoked if the 1000 watt set was not in operation by September 1, 1928.

The comparative costs, based on current quotations were as follows:

LOCALLY ASSEMBLED UNIT

Composite or locally assembled transmitter with associated speech input equipment	\$12,481.00
--	-------------

MANUFACTURED UNIT

Western Electric 1000 watt set f.o.b. Philadelphia	\$18,450.00
17B Amplifier (for remote control programs)	650.00
Freight and Express	200.00
Installation, 8 days @ \$40.00	320.00
Conduit, wire and labor	300.00
Miscellaneous	80.00

Condenser Microphone and Amplifier	\$400.00
Mixing Panel	<u>200.00</u>
Total	\$20,600.00

Recommendation of Dr. Weniger

The following is quoted from a letter from Dr. Weniger to Dr. Kerr concerning the above purchase: "These costs do not tell the whole story. The Western Electric set includes spare tubes, coils and condensers; the last mentioned are parts that cannot be purchased by others than owners of Western Electric sets. The set contains several safety devices of complicated design and construction that protect the tubes and other delicate parts against unusual electric disturbances. These cannot be purchased separately, nor can they be made here. Their absence will probably cause occasional tube failures and consequent interruptions in service as well as an increased operating cost. The quality of the programs given by the purchased set will be good from the start; an assembled set will have to be modified as experience dictates after it is in use. The design and construction of the necessary chokes and condensers is a long and tedious piece of work, as there are no data available. Mr. Jordan would have to spend a great amount of time in investigating these problems before beginning construction. He would have to start this immediately, as there is not time for

it between the close of school in June and September 1st. The purchase of the Western Electric 1000 watt set is recommended."

New KOAC Installation (1928)

The new transmitter was installed on the third floor of the new Physics building on the campus. Studios were installed immediately across the hall from the transmitter. The new station began operation on 560 kilocycles with unlimited time on November 19, 1928.

The program schedules were as follows:

12:00 to 1:00 p.m.)	} Daily except Sunday
2:30 to 4:00 p.m.)	
7:00 to 8:00 p.m.)	

Description of Transmitting Installation

The transmitter installed at KOAC was manufactured by the Western Electric Company as a result of development work done in the Bell Telephone Laboratories. The unit was shipped to the college as a self excited transmitter of the 6A type and was converted for crystal control operation during installation by Mr. W. L. Tearney, Engineer for the Western Electric Company. He was assisted in this by Mr. Jordan and Grant Feikert.

The main installation of the station was made during the summer of 1928 by Professor Jacob Jordan of the Physics



Figure 9 - The main KOAC studio as constructed in 1928.

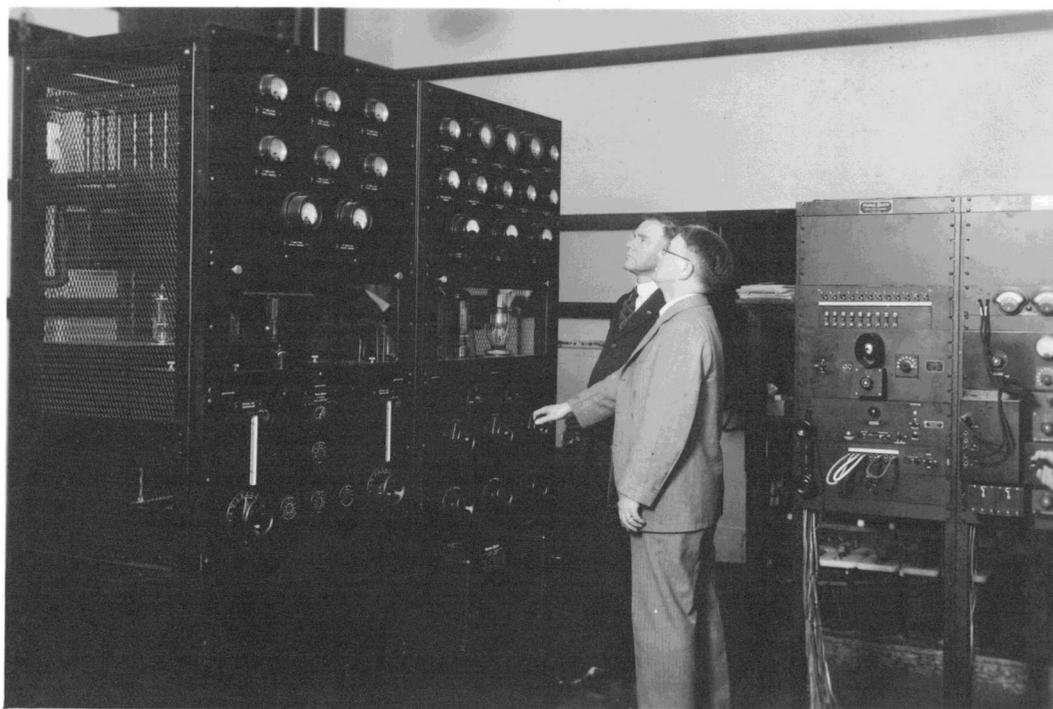


Figure 10 - 1000 watt installation in 1928.
Mr. Jordan and Dr. Weniger.

Department. The transmitter as installed has been shown in Figure 10.

Antenna and Ground Installation

Due to the fact that the station was assigned to operate on the frequency of 1110 kilocycles when it was purchased, an antenna system was installed with two 80 foot steel towers placed over the stair wells on the Mines and Engineering Laboratory Buildings respectively. Between these towers a "T" type antenna was erected with a vertical cage lead in.

Installed Antenna Too Small After Frequency Change to 560

Coincident with the time that the installation of the antenna was completed, a telegram was received from the Federal Radio Commission stating that KOAC had been assigned to the frequency of 560 kilocycles. The antenna which had been erected was subsequently taken down and reconstructed by lengthening the electrical portion as much as possible. However, it was found that the antenna could not be made efficient for a frequency lower than about 830 kilocycles.

As a result the antenna which was finally installed and operated on 560 kilocycles was much too small and the efficiency was found to be about 50%.

Cost of Operation of the 1000 Watt Station (1929)

One of the important questions which rose immediately was: What will the cost of operation of the new station be? A cost sheet has been included which also shows the loss of time from mechanical or electrical failures.

Cost of Operation of KOAC (1929-30)

During the period July, 1929 to June, 1930, KOAC was on the air 1416 hours. The budget for that year totalled \$12,185.36. Excluding depreciation the cost was as follows:

Cost per hour - \$8.53

Assuming \$2000 depreciation (for one year)

Cost per hour - \$10.02

Time Lost (1929-30)

Mechanical and electrical difficulty

(including power failure) 3 hours 6 min.

Personnel losses 28 min.

Total broadcast time lost

through shutdowns 3 hours 34 min.

Complete Market Report Service Inaugurated (1929)

On August 19, 1929, after arrangements had been completed between Mr. L. R. Breithaupt, Extension Economist, and the United States Bureau of Agricultural Economics,

KOAC began the twice daily broadcasting of current market quotations on farm commodities. The market reports were taken directly from a leased wire maintained by the Bureau of Agricultural Economics and edited for immediate presentation over KOAC. This service has been continuous to 1937 and has been augmented with numerous timely summaries and outlook reports by Mr. Breithaupt. KOAC has been recognized as maintaining one of the most complete non-commercial market report services in the United States.

Maintaining the KOAC Unlimited Time License (1931)

The year 1931 marked a crucial stage in the history of KOAC. The following is a chronological record of the circumstances which have influenced the development of the station:

- A. Commercial application filed on the state-owned station.

Station KTFI, Twin Falls, Idaho, filed application for the use of KOAC's unused time. Harry B. Read, Portland, filed application for a new 250 watt station to be installed in Salem, and for use of the KOAC unused time.

- B. Action on Applications

Both of the above applications were set for hearing by the Federal Radio Com-

mission on January 29, 1931.

C. Results of Applications

Examiner R. H. Hyde for the Federal Radio Commission, recommended against Harry B. Read and KTFI. His recommendation was officially tendered to the Commission and transmitted to the college under date of June 4, 1931.

D. Exceptions Filed

KTFI filed exceptions to Mr. Hyde's report. Under date of September 11, 1931, the Federal Radio Commission overruled the exceptions and denied the applications of Harry B. Read and KTFI.

Ruling of the Federal Radio Commission for Unlimited Time Stations

General Order No. 105 was issued by the Federal Radio Commission to become effective on May 1, 1931. The order required that all stations assigned the privilege of an unlimited time license were required to operate two-thirds of the broadcast day exclusive of Sunday. This applied to KOAC and meant that the station was required to approximately double the number of hours of operation per day. The minimum schedule time was to be 12 hours per day.

Time on the Air Previous to Compulsory 12 Hour Schedule

During the time from September through October, 1931, the station was operated 1579 hours, 30 minutes. This did not comply with Rule 105 of the Federal Radio Commission. The distribution of programs was as follows. Programs being broadcast on 310 different days. A total of 205 remote control programs were broadcast.

Women's Old Gymnasium	10
Bell Field	9
Memorial Union	5
Men's Gymnasium	8
Whiteside Theatre	<u>173</u>
Total	205

Percentage of time devoted to various classes of program materials:

Farm talks and service	16.4 per cent
4-H Club programs	2.2
Homemaker programs	10.2
Other talks and service	<u>12.6</u>
Total for all talks and service material	43.4
Musical entertainment (live talent)	12.6
Phonograph records	34.0
Athletic contests	<u>3.3</u>
Total entertainment	49.9
Miscellaneous	<u>6.7</u>
Total time	100.0 per cent

Procedure of the College in Complying with Rule 105

A budget estimate submitted to the administration by

Mr. W. L. Kadderly estimated that the station would require \$36,000 annually to operate 12 hours per day.

Therefore the following action was taken:

- A. KOAD did not comply with the ruling on the date of its enforcement which was May 1, 1931.
- B. Legislative action was taken on the station as follows: Senate Joint Memorial No. 13, asking the Federal Radio Commission to exclude KOAD from the provisions of General Order 105, was passed and sent to the Federal Radio Commission.

Senate Joint Resolution No. 25, empowering the State Board of Higher Education to provide for use of KOAD by the state boards, commissions, officers, etc.

Under this resolution date were assembled on the coast of establishing remote control studios at Salem and on the University of Oregon campus.

Conference with Radio Commission Member

On July 14, 1931, a meeting was arranged between Federal Radio Commissioner Lafount, Governor Meier, and members of the State Board of Higher Education. The meeting was attended by the following people assembled in Governor Meier's office at Salem.

From the State Board of Higher Education

C. L. Starr, Chairman

E. C. Sesmons, member

Dr. E. E. Lindsay, Secretary of the board

From the University of Oregon

President A. B. Hall

Alfred Powers, Dean of General Extension

From Oregon State College

President W. J. Kerr

Director Paul V. Maris, Agricultural Extension

Dr. W. Weniger

W. L. Kadderly

From the Oregon Normal Schools

President J. S. Landers

Others present

E. P. Carleton, Secretary, State Teachers

Association

Charles Pray, Superintendent of State Police

Senator Charles McNary

J. M. Burgess, State Department of Education

As a result of this conference the following statement under date of July 16, 1931, was forwarded to the Federal Radio Commission:

"To the Honorable Federal Radio Commission
Washington, D. C.

Gentlemen:

We, the undersigned, in behalf of the State of Oregon, respectfully request that radio station KOAC be granted an extension of one year in which to comply with the provisions of your order number 105, effective May 1, 1931, requiring all stations operating under a full time license to be on the air a minimum of twelve hours per day, exclusive of Sundays.

At a conference held in the office of the Governor of Oregon on June 14, 1931, it was our privilege to present to Mr. Harold A. Lafount, your member representing the Fifth Radio Zone, the facts supporting this request. We feel that Commissioner Lafount understands the circumstances compelling us to appeal for additional time, and that he will be able and ready to confirm the claims, herewith submitted, that such action will contribute to the public interest, convenience and necessity.

We pledge our united efforts to consummate at the earliest date possible an expansion program already formulated. This program contemplates:

1. Immediate expansion of the present broadcasts over KOAC from five hours to six hours per day. The budget for the fiscal year beginning July 1, 1931, approved by the Oregon State Board of Higher Education, will meet the cost of this expansion.

2. Daily, except Sunday, broadcasts from the campus of the University of Oregon, at Eugene, by means of remote control facilities.

3. Daily, except Sunday, broadcasts from the State capitol at Salem, to be participated in by numerous State offices and commissions, such as the Governor, secretary of State, State treasurer, State superintendent of public instruction, librarian, department of agriculture, department of police (for educational purposes only, not including apprehension of criminals), highway com-

mission, industrial accident commission, State forester, fire marshall, corporation commissioner, public service commissioner, department of vocational education.

4. Participation by three State normal schools, and, if desired, by Willamette University, a privately endowed Methodist college located at Salem.

The combined program resources of the educational institutions and public agencies enumerated above, including the leased wire connections with the market news service of the United States Department of Agriculture, will permit full compliance with the twelve hour minimum program service required in your order number 105, and provide the citizens of the State of Oregon with an educational and service program of inestimable value.

KOAC is wholly dependent upon public funds or private donations for support. It was established in 1922, when a 50 watt transmitter was built by the State College Physics Department. In the fall of 1925 a 500 watt transmitter was placed in operation and the program enlarged. In the summer of 1928 the present modern Western Electric equipment was purchased and installed in the new Physics Building on the campus. The station and studio equipment, exclusive of the building in which it is housed, represent an investment of approximately \$35,000.

It is our purpose to comply with your order number 116 and install, prior to June 22, 1932, the necessary device for limiting to 50 cycles, plus or minus, the deviations from our assigned frequency (550 kilocycles).

(More modern frequency control equipment was to be required on June 22, 1932.)

These facts are cited to indicate that the station now meets, and it is our purpose that it shall continue to meet all the requirements as to technical efficiency imposed by you.

Twenty per cent of Oregon's radio audience is within a radius of fifty miles of KOAC; 76 per cent

of the State's radio audience is within a radius of 75 miles of the station, and 85 per cent is within a 100-mile radius. This includes the city of Portland, over the larger portion of which KOAC is well received. Excluding Portland from the consideration altogether, 41 per cent of the State's radio audience remains within the 100-mile radius from the station.

Reliable checks indicate that the daily farm broadcasts, the market news reports, the homemaker hour, the 4-H Club programs, the business reviews, the special lecture courses on various subjects and other program features are widely received and greatly appreciated by the people of the State.

As the above statements indicate, the record of the station is one of progress. Notwithstanding large reductions in contemplated expenditures for other higher educational activities, a fifty per cent increase is contemplated for the maintenance and operation of KOAC for the year beginning July 1, 1931. In view of the number of persons reached education by radio is relatively inexpensive.

It is contemplated that the programs herein suggested shall be of special interest and benefit to the citizens of Oregon. Their local application, which adds to their value, tends in fact to render them inappropriate for chain broadcasts covering groups of states. It is our experience and judgment that it is only by owning and operating its own broadcasting station that the State of Oregon can best be served with educational programs such as those contemplated in plans for expanding the scope of KOAC's schedule.

Loss of any part of the time now assigned to the station, or any other circumstance preventing the final consummation of our objectives, will be distinctly against the public interest, convenience and necessity which Congress, by its enactments, has sought to safeguard.

The Oregon legislature will not convene again in regular session for a year and a half (January, 1933). In the meantime we shall be diligent in our efforts to secure in any manner open to us the funds

required for the expansion outlined in this statement.

We therefore bespeak your favorable consideration of our request for tolerance and discretion in the enforcement of Section 3 of General order number 105 as it applies to station KOAC with regard to the twelve hour minimum broadcasting schedule."

Federal Radio Commission Cites KOAC to Hearing on Renewal of License (1931)

Even though the foregoing memorial and statement were transmitted to the Federal Radio Commission, the gentlemen of the Commission did not feel that the state should be allowed to operate without complying with the rules and regulations which the Commission had stipulated.

On August 25, 1931, the Federal Radio Commission decided to renew the KOAC license for 90 days, pending consideration of the petition for a year's time in which to meet the provisions of General order 105.

Denial of Petition

On September 1, 1931, the Commission denied the petition and cited KOAC for hearing on October 13, to pass upon application for renewal of license.

KOAC Assumes 12 Hour Schedule with Authorization to Commercialize

Upon danger of denial of renewal of the license of the radio station to the state, the State Board of Higher

Education executive committee authorized the station to go to a 12 hour schedule and simultaneously authorized the commercialization of KOAC to the extent necessary to maintain a 12 hour schedule.

Commissioner Lafount stated that he felt it would be disappointing for a station with the purpose and activity of KOAC to be forced to turn to commercial operation.

Activities of KOAC (1931-32)

12 Hour Broadcasting Schedule - On September 21, 1931, the station increased its operation from approximately six and one-half hours per day to twelve. This brought the station into conformity with the regulations of the Federal Radio Commission and the license was renewed for the customary period of six months.

Time of Operation and Cost Per Hour with 12 Hour Schedule - Between June 29, 1931, and July 2, 1932, KOAC was on the air 2980 hours and 12 minutes. Costs were as follows:

<u>Department</u>	<u>Total Cost</u>	<u>Cost per Hour</u>
Operating (including power and transmitter parts)	\$6,937.59	\$2.33
Program	<u>15,375.99</u>	<u>5.14</u>
Total	\$22,313.58	\$7.47

5. STATE BOARD OF HIGHER EDUCATION CONSIDERS THE FUTURE OF KOAC

Early in March, 1932, the station was told that the State Board of Higher Education had assigned to its finance committee the responsibility of investigating the value of KOAC and the possibilities of continuing the station from the financial standpoint. This committee asked that President Kerr and representatives of the station meet with it in Portland, March 17, with information on the extent to which the station is heard in the state and the value placed upon the programs by listeners.

Expression of People of Oregon Concerning KOAC

Director Maris called a conference on Sunday, March 13, 1932, of H. C. Seymour, L. R. Breithaupt, Miss Claribel Nye and Mr. Kadderly to determine details in going direct to the radio audience for answers to the above questions. Authority for the procedure had been obtained by President Kerr from G. L. Starr, chairman of the board.

Subsequently statements were prepared and broadcast on the two following days only. These statements asked for an opinion of the listeners concerning the worth of the station to them.

The response was immediate and almost unanimous. It was immediate in that 986 letters and postcards flooded

the station in one day following the first announcement of the desire of the Board of Higher Education to know what the public thinks of the activities of the station. It was almost unanimous in the final count, which was:

Continue the station	2898
Discontinue the station	<u>6</u>
Total	2904

Note: Of the six who did not wish the station continued five were from Corvallis and were being interfered with.

Action of the Board

After President Kerr and Mr. B. F. Irvins, member of the board, had made a plea for the station, Mr. Pease, chairman of the finance committee stated that the station would be financed on the basis of \$36,000 per year for 12 hours per diem operation.

Diversion of Funds from State Boards for Radio

Since the Oregon senate had authorized the use of KOAC for general dissemination of state business in Senate Joint Resolution No. 25, the station was authorized by the Governor to obtain budget funds from other state boards and commissions wherever possible. The Oregon State Board of Forestry and The State Board of Mental Examiners were the only ones who were in a position to

use and contribute toward the operation of the station. Contributions were made by those two boards and as a result both organizations used the station extensively for a contact with the public. The station was used for the distribution of the daily fire weather forecast by the Forest Service.

Operation of KOAC Compared with that of KEX and KOIN

A survey was made through the cooperation of two radio stations in Portland. The purpose of the survey was to compare the operation of these stations with KOAC. The staff of KOAC was found to be composed of substantially the same number of persons as the staffs of the other stations, KEX and KOIN, considering the time on the air for the three stations.

Plans for Continuation of KOAC (1932)

At the request of the Board of Higher Education all alternate future plans for operation or disposal of the station were presented. After conference with staff members concerned, Dr. Kerr presented the following alternatives to the Board of Higher Education:

- A. Establish remote control facilities at Salem and Eugene. This was recommended as the most desirable of the various alternatives, greatly increasing the value of the station to the

state and creating a relatively inexpensive educational service.

- B. Maintain operation of the station at Corvallis on a 12 hour basis as it was operating at that time.
- C. Lease station with attempt to reserve time required for educational broadcasting. Attention was called to the fact that the Federal Radio Commission would require notification 60 days prior to the contemplative date of transferring control of the station.
- D. Operate the station on a reduced time basis, thereby sacrificing the full time license.
- E. Close station and sell equipment.

Decision on Plans to Continue KOAC

After much discussion and investigation the Board decided to proceed with the operation of the station in compliance with the second recommended alternate given above. Under this plan the station was to be operated 12 hours per day on a noncommercial basis.

Creation of Radio Broadcasting Department

Under the general reorganization of the State College, the University of Oregon, and three state normal schools, the radio station was transferred to the General Extension

Division. This division was administrated by Alfred Powers, Dean and Director, located at 814 Oregon Building, Portland, Oregon. Mr. W. L. Haddenly was named manager of the station at Corvallis. It was felt by the board that under this organization the station could be used to greater advantage by the Oregon State System of Higher Education as a whole.

Broadcasting Activities During 1932-33

During this period the station was operated 12 hours per day exclusive of Sunday. Program features were added and numerous regular features of the station were expanded. By means of special authorization from the Federal Radio Commission, the station was given permission to reduce its hours of operation from 12 to 8 per day during the months of April and May. During this period Mr. W. L. Haddenly resigned as manager of the station to accept another position. He was succeeded in this position by Mr. Luke L. Roberts.

Station Activities 1933-36

During this time the program service was greatly expanded. With the advent of the station being operated to serve the State system in general, a number of programs were supplied from the University of Oregon and

the State Normal School at Monmouth.

Numerous home economics clubs were organized throughout the state and a solid response was received through the formation of listening groups.

A school of the air was organized and presented by Mr. Alexander Hull of the station staff. Courses were offered in Elementary Spanish, Elementary German, Music Interpretation, History of Music, Elementary Play Writing. The time of presentation of these courses was set cooperatively with the schools which were using the material to supplement resident instruction.

Bulletins scheduling the programs from the station were printed and mailed to a selected list of interested listeners.

TABLE I
 FEDERAL ASSIGNMENTS TO THE OREGON STATE
 AGRICULTURAL COLLEGE

<u>Date</u>	<u>Meters</u>	<u>Kilo- cycles</u>	<u>Watts</u>	<u>Call Letters</u>
Dec. 1922	260	856	50	KFDJ
Jan. 14, 1925	254	1180	50	KFDJ
Oct. 2, 1925	254	1180	500	KFDJ
Nov. 11, 1925	282.5	1060	500	KFDJ
Nov. 26, 1925	280.2	1070	500	KFDJ
June 15, 1927	270.1	1110	500	KOAC
Nov. 12, 1927	534.5	560	1000	KOAC
Sept. 3, 1929	545.3	550	1000	KOAC

The operation from September 3, 1929 to March 31, 1937, has been on the frequency of 550 kilocycles, unlimited time, with a power of 1000 watts.

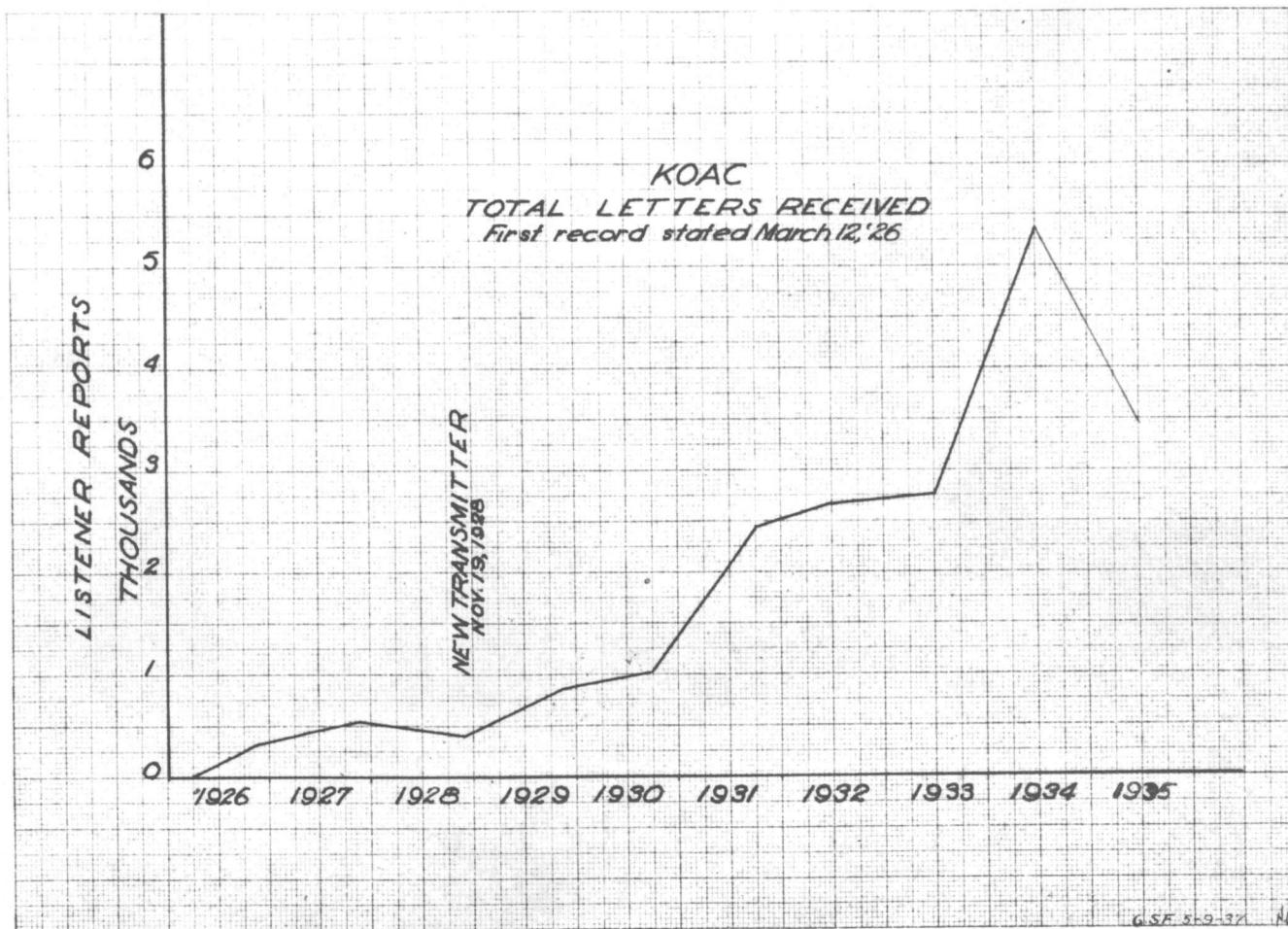


Figure 11 - Graphic analysis of listener response to KOAC programs. The peak of 1934 was caused by the distribution of a bulletin advertising the programs.

bulletin advertising the programs

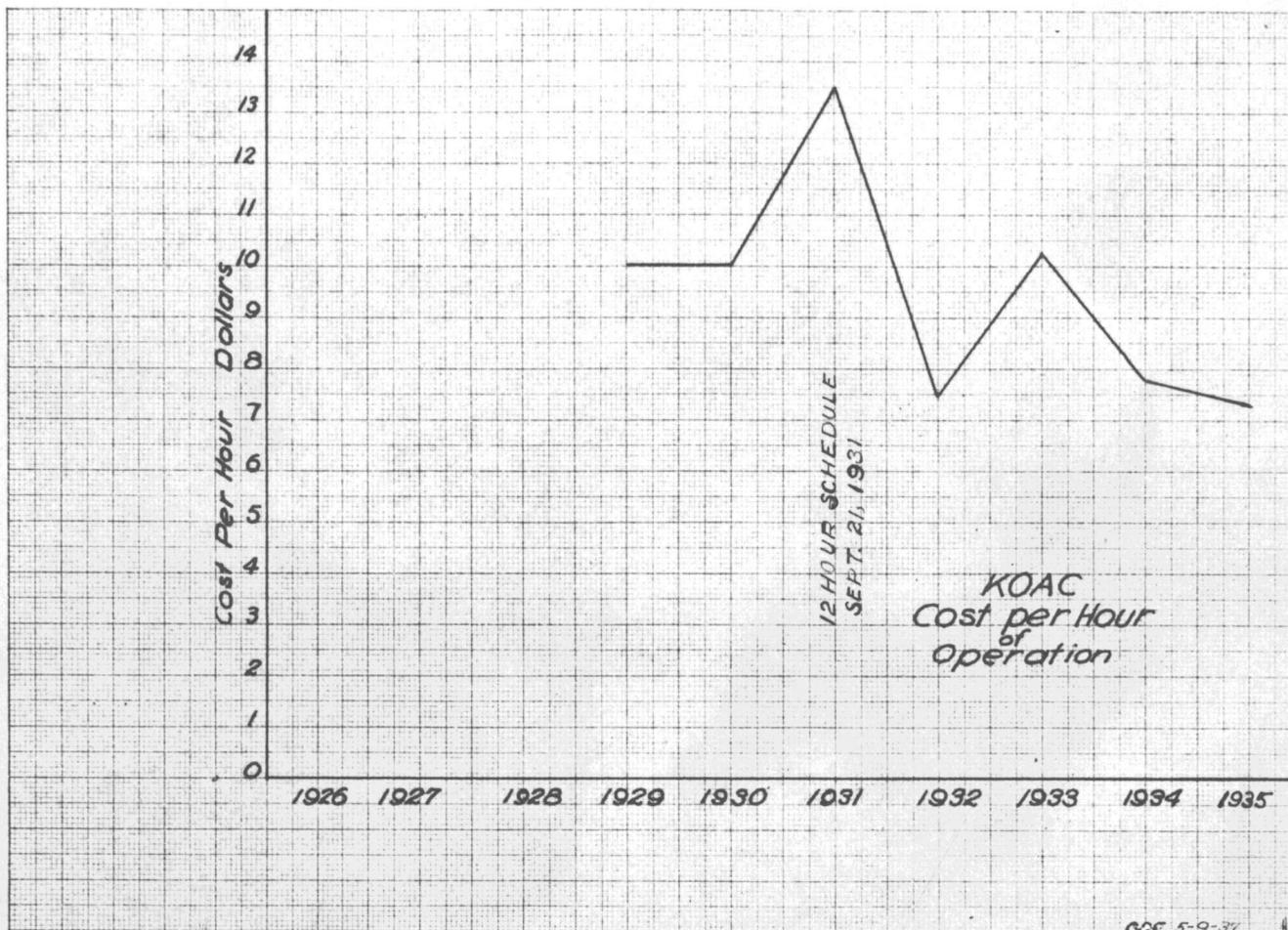


Figure 12 - Financial history of KOAC showing total cost per hour of operation.

**PRESENT STATUS OF
RADIO STATION KOAC - 1937**

I. PRESENT STATUS OF RADIO STATION KOAC - 1937

Radio Station KOAC is fully equipped with a Western Electric D-96020 Radio Transmitter, and attendant speech input and monitoring units.

A photograph has been included (Figure 13) showing the equipment as it is arranged for use at the present time. The transmitter has been converted for operation at 100 per cent modulation and its performance is comparable to that of the most recently developed equipment of the same type. A modern speech amplifier has been added along with suitable measuring equipment for carrier stability, carrier shift, and modulation percentage. An oscilloscope for interstage checking of circuit adjustment is also available. This use of storage batteries has been brought to a minimum by the conversion of existing speech amplifiers to alternating current operation, and the installation of the latest type speech amplifier which is connected in the main program line.

Transmitter

The transmitter now in use is a product of the Western Electric Company, and was sold to the State of Oregon in 1928. It has been in continuous service since that time. For modernization this transmitter has undergone



Figure 13 - The KOAC transmitting installation as it is installed
in 1937.

two major conversions as follows:

1932 - Converted, by Mr. B. H. Cole of the Bell Telephone Laboratories, by the addition of a system of frequency control to hold the station within the plus or minus fifty cycle deviation as required by law.

1937 - Converted by Mr. Tom B. Wagner and Mr. Grant Feikert to increase the modulation capability from 50 per cent to 100 per cent. This conversion included the installation of a 5000-volt mercury vapor rectifier. The unit replaced the 4000-volt motor generator set. A conversion also was made on the modulated amplifier, with the installation of an improved neutralizing bridge arrangement in the power amplifier circuit.

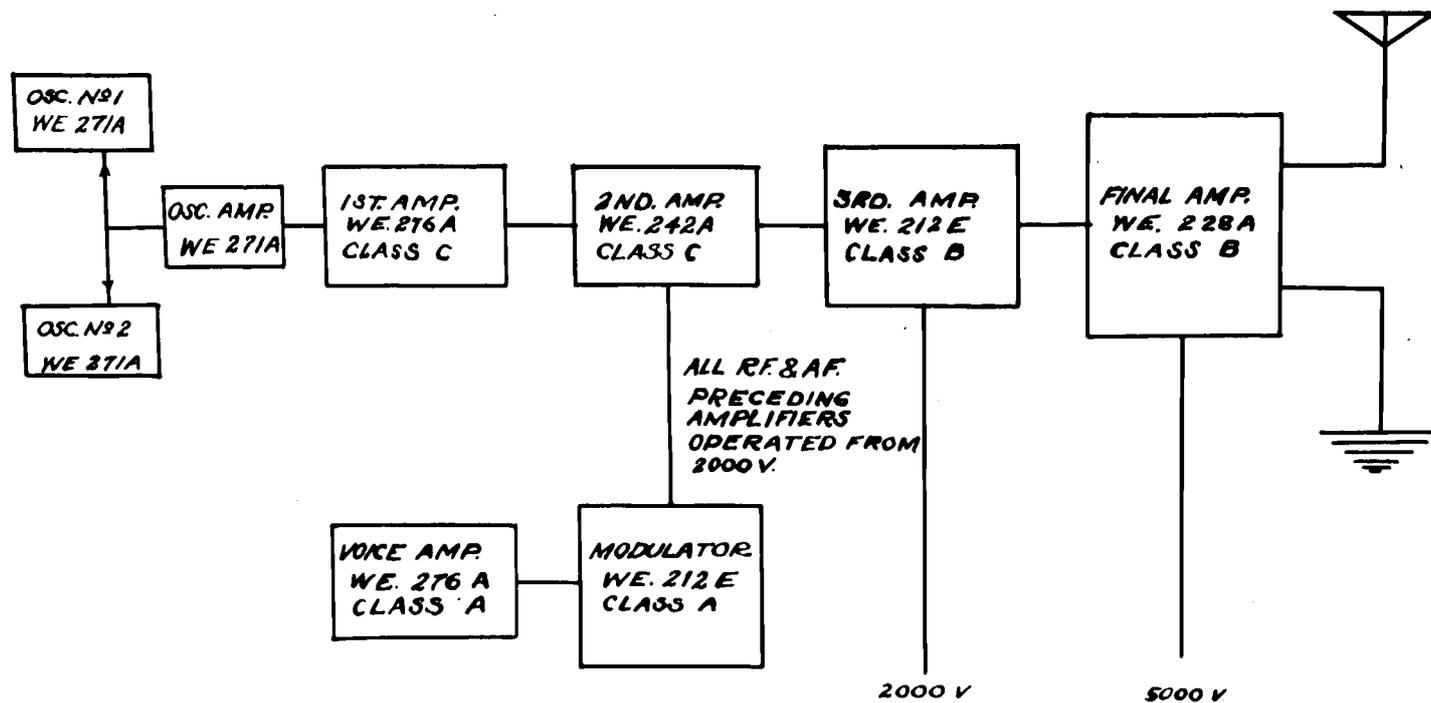
By means of these major conversions, supported with a large number of smaller conversions and improvements, the station has kept abreast of apparatus development in the broadcast field in a respectable manner.

A strict routine of maintenance procedure, patterned after that practiced in the organization of The Pacific Telephone and Telegraph Company, has reduced to a minimum the loss of program time due to mechanical and electrical failures.

A block diagram of the equipment as it is installed at the present time (W. E. D-96020) has been included, and is shown in Figure 14. The crystal temperature control tubes have been omitted as has the audio monitor rectifier. Figure 14 has been included mainly to show the arrangement of the oscillator isolation or buffer stages, the point at which modulation takes place, and the arrangement of the linear amplifiers. Each vacuum tube has been labeled with the characteristic class of operation into which it falls.

The audio frequency circuits have been shown in block form in Figure 15. On this diagram the impedance of the connecting circuits has been indicated since the voltage across the circuit for a given level is a function of the impedance across which it has been calculated. Immediately below each unit the characteristic audio frequency level in decibels has been plotted. Where an attenuator or monitoring control has been introduced the attenuation range of the control has been indicated graphically.

Figure 16 has been included to show the audio frequency response of the station. This usually is termed the audio fidelity of the system. Curve A was taken only with the audio frequency speech input equipment. Curve B is the response of the entire system from the microphone



BLOCK DIAGRAM WESTERN ELECTRIC D-96020 RADIO TRANSMITTER

Figure 14.

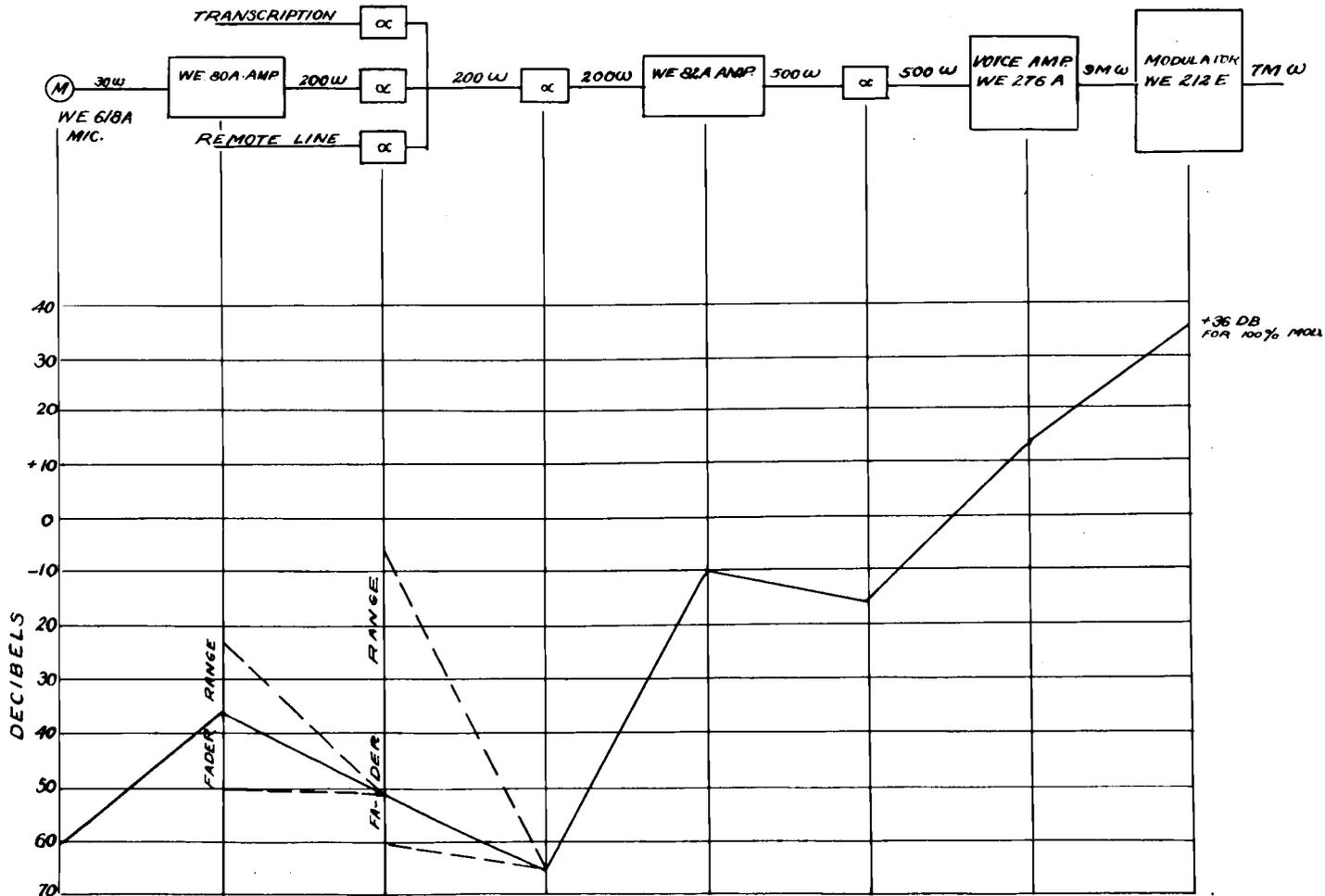


Figure 15 - KOAC audio frequency diagram with corresponding audio frequency power levels. Output impedance is 7000 ohms.

input terminals through the transmitter, including the modulator, the modulated amplifier, and the two linear power amplifiers. This curve is as near to the overall response as it is possible to obtain by conventional methods. It indicates the audio frequency range that can be transmitted to the listener's radio and it should be noted that the audio response of the present KOAC transmitter is constant within plus or minus two decibels from 30 to 8000 cycles per second.

No measurements of the audio harmonic distortion are available at this time; it is felt, however, that the total audio harmonic voltages generated in the system will add to a sum well below the 10 per cent value specified by the Federal Communications Commission.

Present Coverage of KOAC

During the spring of 1935 a survey of the KOAC service area was made by Mr. D. D. Perkins, a member of the technical staff. A contour map showing field intensities has been included as Figure 17. From this map and from published census data the population and the number of radio receivers within the service area of KOAC have been tabulated and are included as Table 7. A map showing the distribution of listener reports has also been included as Figure 18.

FREQUENCY RESPONSE OF STATION KOAC

A- STUDIO MIXER-TERMINATED IN 62 A AMPLIFIER
B- WE D-94993 TRANSMITTER, W.E. 62 A AMP. & STUDIO MIXER,
RESULTING IN OVERALL AUDIO RESPONSE

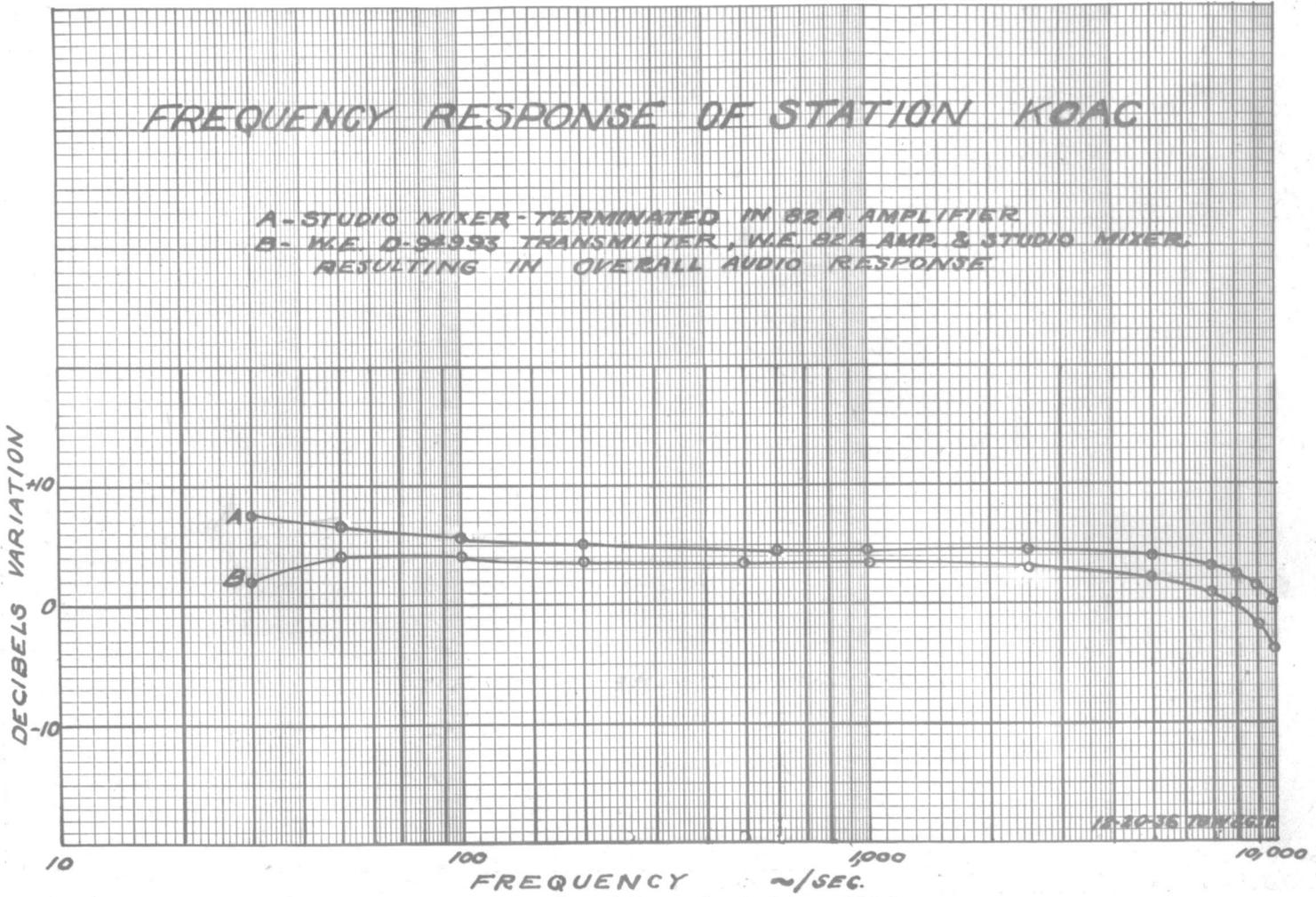


Figure 16 - Audio fidelity of station KOAC.

A study has been made at Corvallis of the fading of radio signals with respect to frequency assignment. It has been found that radio transmission is much more stable on the lower frequencies (550 kilocycles) than it is on the higher frequencies (1500 kilocycles).

This indicates that KOAC, now on 550 kilocycles, enjoys transmission which is more fading-free than that of many other stations. Signal graphs of KGW, KOIN, KEX, and KWJJ are available in support of the above statement.

It has also been determined that transmission takes place with less attenuation on the low frequencies. In support of this a table is submitted that indicates the power necessary to produce consistent ground wave, primary coverage at a distance of 75 miles. Frequencies being used by the various Oregon stations were assumed as a basis of calculation. Typical Willamette Valley conditions were also assumed.

Frequency Kilocycles per second	Power necessary to pro- duce 500 Microvolts per meter at 75 miles	Station operat- ing in Oregon on this fre- quency
550	1.0	KOAC
690	2.3	KGW
940	10.0	KOIN
1060	29.0	KWJJ
1180	48.4	KEX
1500	89.0	KALB

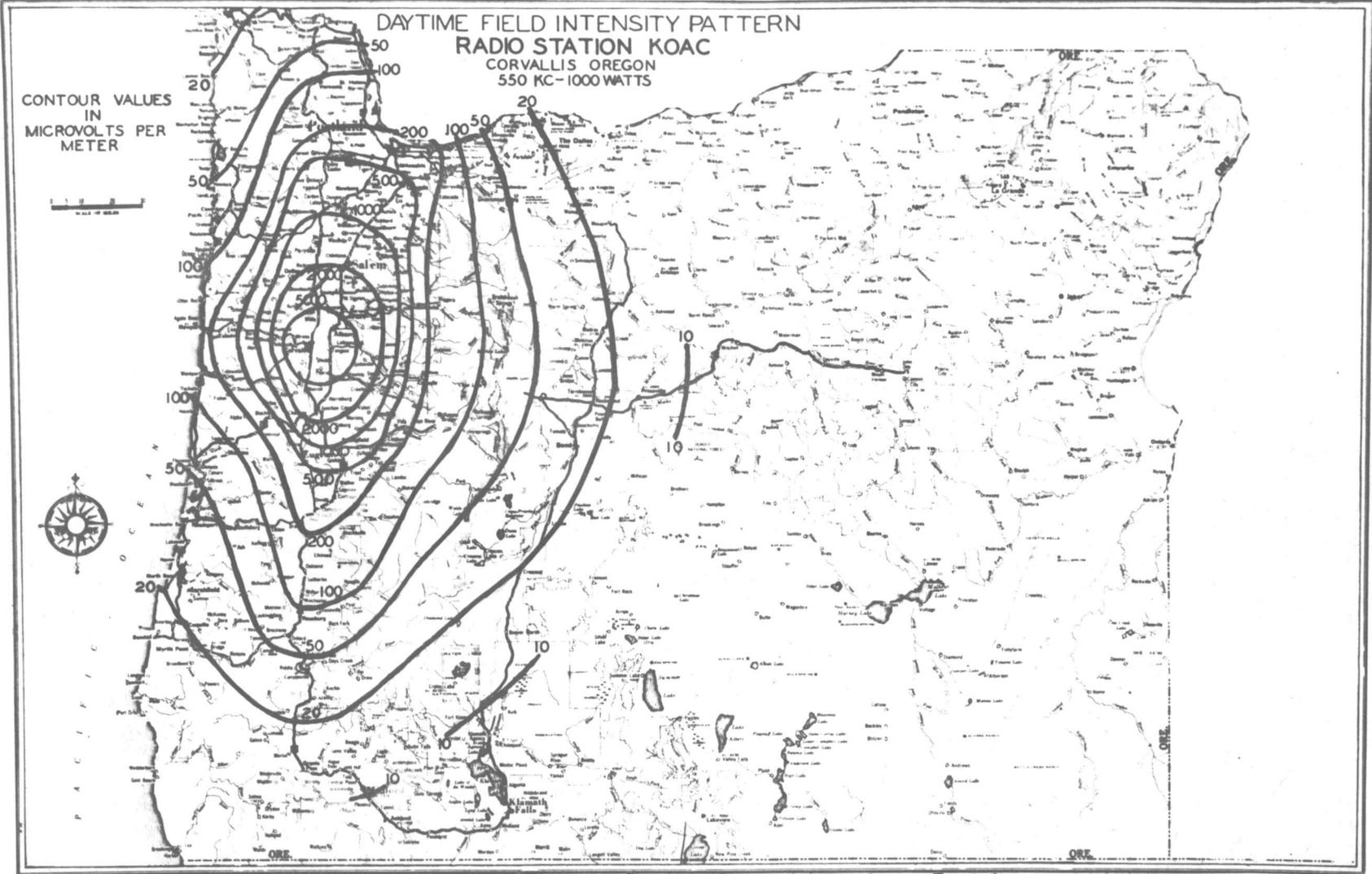


Figure 17 - Field intensity contours of station KOAC.

In computing this table a ground conductivity of $\epsilon = 0.6 \times 10^{-13}$ C. G. S. - E. M. U. and a $\frac{1}{4}$ wavelength antenna were used.

TABLE II
Data on Population and Radio Receivers
Within KOAC's Day Time Service Area
(1930 U. S. Census)

Area	Population	Families	Radio Receivers
Within 200 microvolt contour (9 counties: Clackamas, Multnomah, Washington, Yamhill, Polk, Marion, Benton, Linn, Lane)	609,904	172,877	85,518
Within 500 microvolt contour (7 counties: Clackamas, Yamhill, Polk, Marion, Linn, Benton, Lane)	241,388	66,728	26,134
State	953,786	267,690	116,299

Within the area served by KOAC with 500 microvolt daytime signal are:

- 25 per cent of Oregon's population
- 25 per cent of Oregon's families
- 22 per cent of Oregon's radio receivers

Within the area served by KOAC with a 200 microvolt daytime signal are:

- 64 per cent of Oregon's population
- 64 per cent of Oregon's families
- 74 per cent of Oregon's radio receivers

Present Status of the KOAC Programs

The programs presented over KOAC are designed to meet the varied educational demands of a noncommercial educational radio station. There are certain specified programs that throughout the year maintain regular hours of the day, for instance, the Homemakers' Hour at 9 o'clock every morning; the farm hours at 12:15 and 6:30 p.m. daily; 4-H Club programs at 7:30 p.m. every Monday. There are other programs, such as the news broadcasts given at 12 and 6:15 p.m. daily; weather broadcasts; visits with home economics extension staff members at 3 p.m.; music at regular intervals both morning, afternoon, and evening; the School of the Air at 11 a.m. daily, and many other important educational programs.

Detail of these various programs shows the wide range of service to the people of Oregon through their presentation. The broadcast of the Municipal Affairs program presents in cooperation with the League of Oregon Cities and the Bureau of Municipal Research and Service of the University of Oregon many interesting activities that deal with municipal government included on such a program. Also, in addition to government of municipalities, is the broadcast of news notices of particular interest to city government officials. There also is the broadcast at regular intervals of programs from independent colleges

throughout the State of Oregon. Through the medium of such a program these colleges are able to present talent and give a picture of their field of service, to the students of these institutions participating, a most valuable experience has been made available. Two of the programs of long standing on the schedule of KOAC are the two farm hours; the noon farm hour at 12:15 to 1 p.m. daily except Sunday; and the evening farm hour from 6:30 to 7:30 p.m. daily except Sunday.

These programs bring to the farmers of Oregon, and others as well, the latest developments of agricultural research and other important agricultural information of value to the farmers in the operation of their enterprises. Also on these farm hour programs is the presentation both noon and evening of a market report service believed to be unexcelled anywhere. This market report service furnishes spot market quotations at noon and spot market quotations and reviews in the evening. It is furnished over a government market news leased wire, and the information is prepared for broadcast by the agricultural economists in the office of L. E. Breithaupt, agricultural economist of the Oregon State College Extension Service. Every phase of agriculture is treated in the farm programs, and not only are the farm specialists of the State College included on the program but also

representative farmers and workers in farm organizations. These programs have proven of great benefit financially to Oregon farmers.

Two other important programs of long standing are the Homemakers' Hour at 9 o'clock a.m. daily and the daily program given at 3:00 p.m. The Homemakers' Hour presents many very interesting items of value and usefulness to the housewife both in the city and in the country. The presentation at 3 p.m. daily brings to the women of Oregon interviews with the Home Economics Extension specialists and many other programs of interest and usefulness to women.

Through the medium of two fifteen-minute news broadcasts daily from KOAC, many throughout the State of Oregon are made familiar with the details of the latest happenings in the state, national, and world-wide news. The full details of these news events can be learned from the press, but a definite service is established for the supplying of immediate news happenings.

A program that has been of considerable interest throughout its duration, and one that is regarded as one of the important ones over KMAC programs is the Garden Club broadcast. This program is broadcast in cooperation with the Oregon Federation of Garden Clubs and makes available the talents of specialists in the State College

when so desired.

The Business Hour broadcast in cooperation with the School of Business Administration of the State System of Higher Education is a new program inaugurated in 1937 that is being well received. This program brings to the microphone staff members from the State College and University, businessmen, and industrialists of Oregon. The Business Hour program presents material and talent in a manner designed to serve the best interests of Oregon business.

There are many other programs on the KOAC schedule that are more or less on the term basis, some of them being seasonal but all designed to meet a very definite demand and to serve the entire radio audience. As an illustration of some of the seasonal programs that are broadcast is the annual 4-H Club summer school held for two weeks on the campus of Oregon State College, attended by some 1500 to 2,000 boys and girls of the State. A very complete broadcast is made of this summer school, such as the daily assemblies, the evening broadcasts presenting various counties of the State, the Sunday religious service, and a final radio revue. This illustrates the nature and the completeness with which seasonal programs are administered. It is realized that the likes of all the people naturally vary, and it is

with this viewpoint in mind that a well-balanced program is the desire.

Present Status of KOAC Compared with Other Educational Radio Stations (1936)

In order to compare the activity, and the cost of operation of KOAC with that of other educational stations, a questionnaire was submitted to 38 educational stations. This questionnaire was arranged and distributed by Mr. Luke L. Roberts, Manager of KOAC. Thirty-one of these institutions replied and from the 18 stations operating transmitters, data have been tabulated to indicate the following:

1. Total hours on the air - - KOAC second
2. Annual expenditures - - - KOAC fifth
3. Actual cost per hour - - - KOAC sixteenth

A tabulation of the institutions covered by the survey has been included on the following page.

TABLE III
 SUMMARY OF STATIONS AND INSTITUTIONS ACCORDING
 TO ANNUAL EXPENDITURES FOR RADIO IN 1936

Station	Institution	Annual Expendi- ture	Total Hours on Air An- nually	Actual Cost per Hour
WHRF	University of Florida	\$38,100	4,700	\$8.10
WHA	University of Wisconsin	23,600	2,700	8.73
WOSU	Ohio State University	23,000	1,600	14.38
WOI	Iowa State College	20,955	3,000	6.97
KOAC	Oregon State System of Higher Education	19,000	3,550	5.34
WILL	University of Illinois	12,534	1,600	7.70
WEAR	Michigan State College	12,000	1,800	6.66
WCAI	St. Olaf College	10,000	500	20.00
WNSC	Washington State College	10,000	3,000	3.33
WLB	University of Minnesota	8,500	370	22.98
WCAT	South Dakota State School of Mines	8,000	216	37.00
WBAA	Purdue University	5,000	35 (per week)	
WCAD	St. Lawrence University	5,000	624	8.02
KFKU	University of Kansas	4,000	220	18.00
KSAC	Kansas State College	3,500	1,170	2.98
KFDY	South Dakota State College	3,500	468	7.20
KUSD	University of South Dakota	3,500	355	10.42
WHAZ	Rensselaer Polytechnic Ins.	3,000	260	11.52

*State of Florida provides an additional \$1,500 for preparation of programs broadcast over other stations.

TABLE IV
 Points of origin of all letters to KOAS
 from Oregon listeners by districts and Months
 July 1, 1935 to June 30, 1936

District	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Year Total	Percent of Year Total
Willamette Valley	165	167	102	391	372	370	480	356	315	190	65	103	3076	90.02
Coast	5	9	4	15	6	12	22	14	16	14		8	125	3.65
Southern Oregon	7	8	7	19	15	23	26	24	17	7	4	4	165	4.77
Columbia Basin	1			5	2	3	2	1	1	1	1		16	.44
Central Oregon				1	1	2	3	3	7			2	19	.56
Eastern Oregon			2	1	1	2	8	5					19	.56
TOTAL FOR OREGON	178	184	115	450	397	412	548	403	354	212	70	115	3416	100.00

FUTURE DEVELOPMENT

III. FUTURE DEVELOPMENT

The following section outlines a suggested technical expansion program for Radio Station KOAC.

INTRODUCTION

The suggested expansion program discussed in the following pages is pursued from the technical standpoint only.

Secondary state-wide coverage during daytime can be attained by KOAC with a logical and practical progression. This progression must be toward the goal of the ultimate in transmission efficiency as well as an increase in the power of the station.

In the data exhibited in this paper the term coverage implies only the availability of service. The term audience implies the interested listeners and is, of course, dependent upon program appeal.

Statistics on availability of program service are therefore based upon coverage. The engineering profession has divided coverage into four classifications:

1. Primary daytime
2. Secondary daytime
3. Primary night time
4. Secondary night time

In explanation, the primary coverage of the station embraces that area throughout which the station can be heard without objectionable interference practically all of the time the station is in operation. Primary coverage is a guaranteed coverage. The secondary coverage area of a station is that throughout which the station can be heard clearly part of the time, or embraces that area in which reception may be accompanied by disturbances or interference which tend to mar perfection. It is important that the present primary and secondary coverages for daytime and nighttime be determined for KOAC. These must be able to give the following information:

1. Coverage in square miles
2. Total population

During the last two years, engineering data have been taken to show that the present nighttime primary coverage of KOAC is substantially equal to that during daytime. (For daytime coverage see Figure 17.) The night limitation is due to interference and signal strength variations which are prevalent on account of the refracted sky waves. KOAC is, however, more immune to such disturbances than any other station operating with a regional assignment of higher frequency. This is due to the low frequency of transmission of 550 kilocycles.

Secondary nighttime ratings have not been given be-

cause of the freakish transmission phenomena caused by multiple refractions through the Kennelly-Heaviside layer.

Sufficient engineering experience has been gained and empirical data have been taken to make possible a prediction of primary and secondary daytime coverage ratings for KOAC on 550 kilocycles, if a program of technical expansion were undertaken.

It should be noted that the potential audience is greater than the actual audience. The actual audience is dependent upon program appeal and the effectiveness of programs can only be measured by a personal survey or a measure of what people do or do not do as a result of hearing the programs. Actual audience is not an engineering factor but is a program problem and will not be considered in this discussion. The program of expansion has for its goal the creation of a potential audience of 85% of the population of Oregon.

PROPOSALS FOR EXPANSION OF RADIO STATION KOAC

1. Modernize the transmitting plant of KOAC by installing a vertical quarter-wave steel tower in a suitable rural location. Erect a transmitter house of suitable style and dimensions, and install a 5000 watt transmitter of standard manufacture.

2. Extend the facilities of the station in behalf of the present potential audience by making direct broadcasting available from the University of Oregon at Eugene and the State Capital at Salem.

A DISCUSSION OF PROPOSAL I

Increase Power and Change Location of the Transmitter

The following section of this paper deals with the engineering aspects relative to the location and installation of a modern 5000 watt transmitting plant. This has been presented in the form of drawings and sketches in so far as this method could be conveniently employed.

The plan has been broken up into five sections as follows:

1. Location of the Transmitting Plant
2. Radiating System
3. Transmitter Specifications
4. Calculated Coverage
5. Cost Analysis

Location of Transmitting Plant

After an inspection of the terrain covering the available locations on property owned by the state college, it was decided to locate the transmitter southwest of the city on an area bounded by the north and south county roads running west of the state college and its intersection with

the Corvallis-Newport highway. As a further note on the station location, that section of the area known as the Young Tract was selected, which is bounded on the west by the county road, on the south by the Corvallis-Newport highway and on the northeast by Oak Creek.

This location was selected because of the damp character of the soil near Oak Creek, which would result in a low ground resistance. The total ohmic resistance of the system will thereby be lowered. This tract of land which would be occupied by the broadcasting plant, has been discarded as unsuitable for college farm use.

Power is readily available at the proposed location since it can be taken from the lines serving the city of Philomath. Water from the Corvallis Water Works System is available on the adjoining roadway. Communication and program lines to the studios in the Physics Building could be constructed at a minimum of expense, since a pole line is now available to the Poultry Building, which is approximately 1200 feet distant.

An analysis of the surrounding country has shown that no irregularities of terrain are close enough to influence the radiation pattern of the station. One hill of approximately one hundred feet higher than the base elevation of the 450 foot tower is located 1660 feet to the westward on the Hansen Farm. This hill is both too

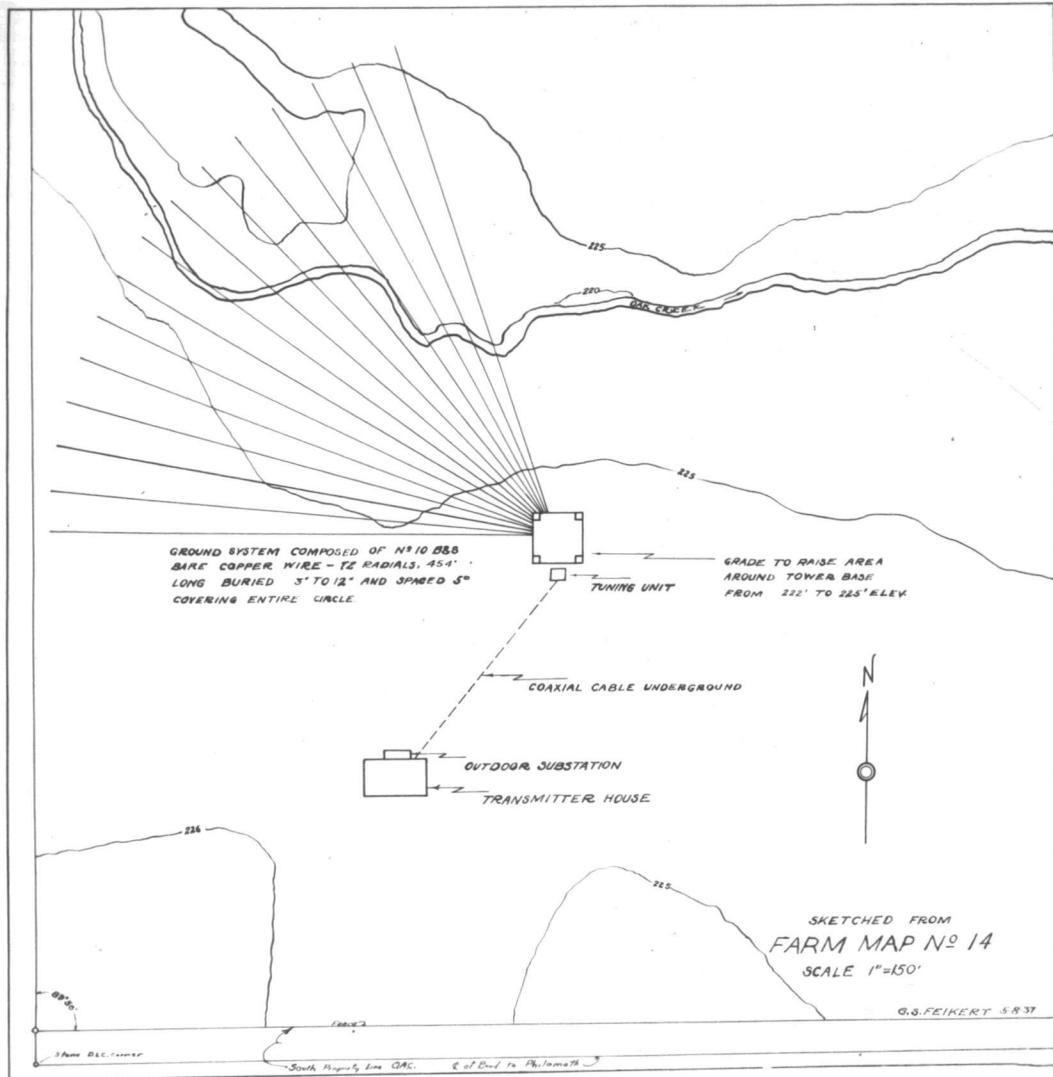


Figure 19 - Location of transmitter house and vertical radiator on the Young Tract, suggested grading and ground system specifications.

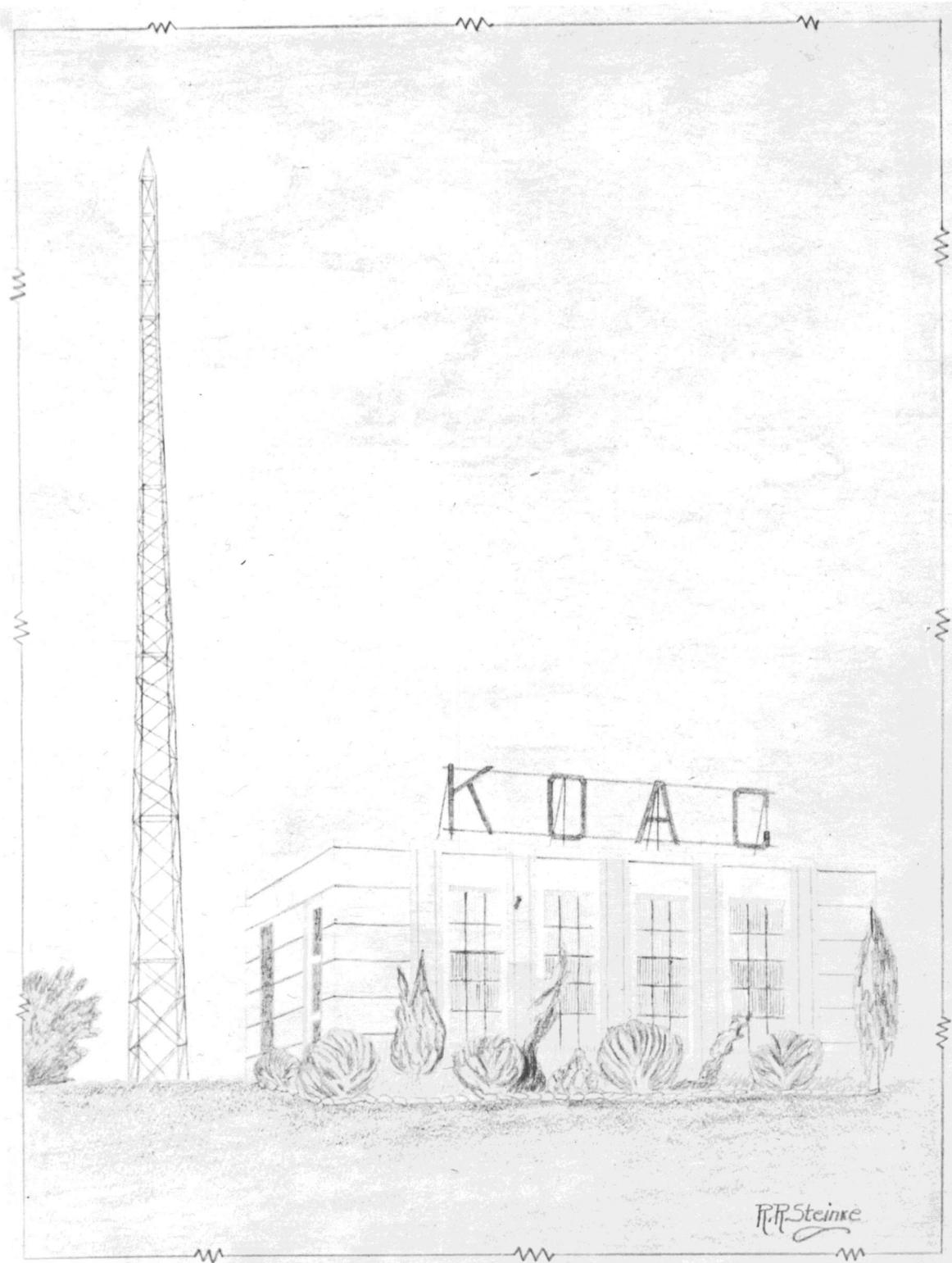


Figure 20 - Artist's drawing of transmitter building.

low and too remote to introduce a noticeable distortion to the circular radiation pattern of the antenna.

A map detailing the location of the tower and the transmitter building has been prepared and designated as Figure 19. Ground specifications, notes, and grading suggestions have been included on this map. The ground wires would extend across the creek bed but observation of flow in this stream during the recent flood stages has shown that this would not be disastrous. It has also been found from investigation that the area proposed for the station is not easily flooded, since flooding in this area could not be caused by a backwater from the Willamette River.

An artist's sketch of a transmitter building of compatible design has been obtained and included as Figure 20. This building would be of fireproof construction. Data exhibited in the attached cost summary have been based on the construction of tile walls with brick pilaster facings. The main structure would be covered with a good grade of cement stucco. Windows are to be equipped with steel sashes. The roof is to be of the characteristic tar and gravel construction.

The interior of the building would be of modernistic design with wood floors covered with a good grade of in-laid linoleum. The interior walls and ceilings would be

of the recessed type construction and would be covered with panels of decorative Celotex in the control room and office.

A floor plan for the structure has been prepared (Figure 21) indicating the placement of all apparatus attendant to the operation of a Western Electric 5000 watt transmitter. Arrangement has been based upon the use of the transmitter which has been detailed in the following pages.

Radiating System

During 1934 and 1935 the Federal Communications Commission carried out an engineering study of broadcast antennae. It was found early in the research that many stations had been licensed and were then operating with inefficient antenna systems. Since station location had been based on the population which could be served by the stations and since many were using inefficient radiators, it was imperative that definite antenna standards be established.

After a survey of existing stations and with consideration of good engineering practice, antenna standards were established as shown by the curves of Figure 22.

From these curves (Curve C) it was decided that a 454 foot vertical radiator should be installed for use by KOAC. After careful consideration of current distribution,

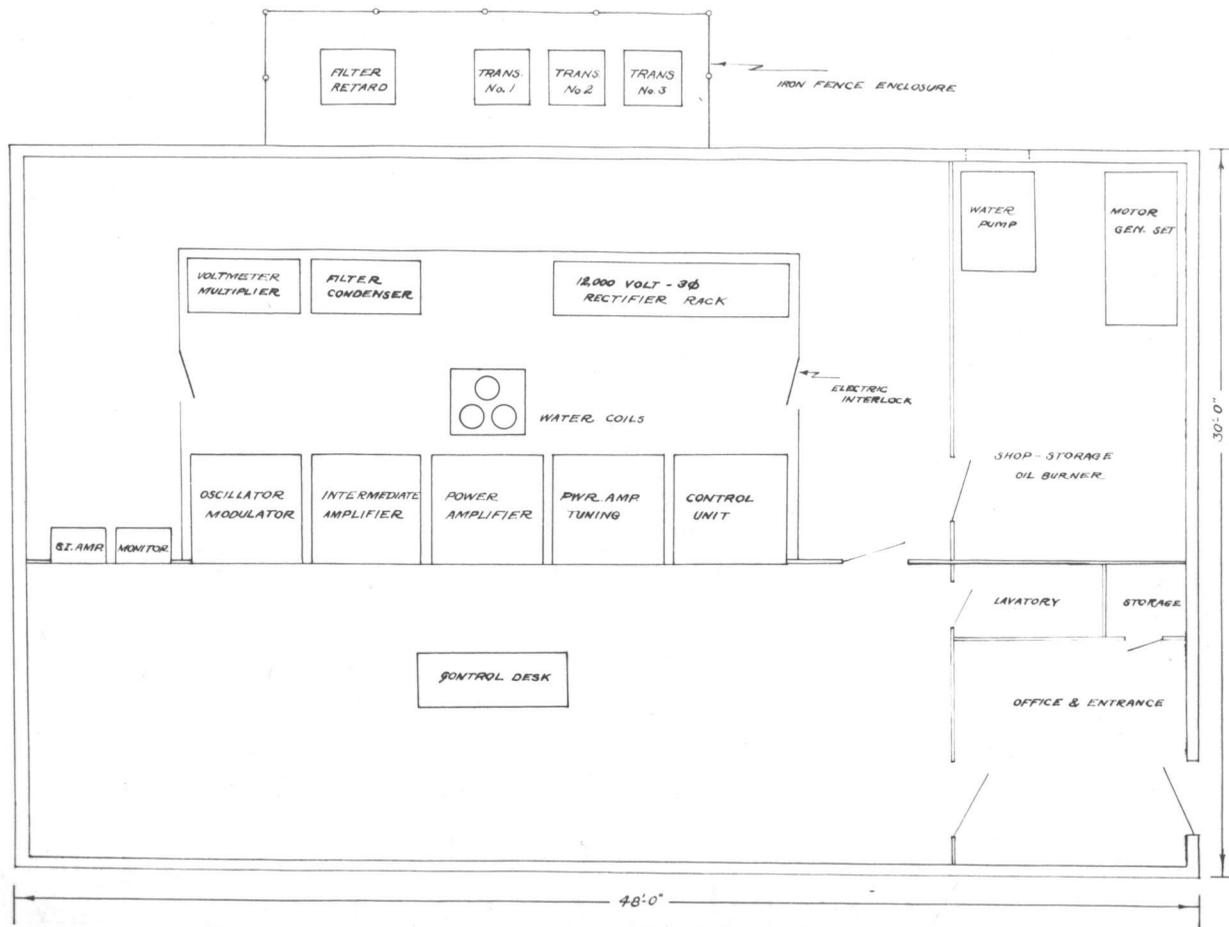


Figure 21 - Transmitter building floor plan with Western Electric 5000 watt transmitter.

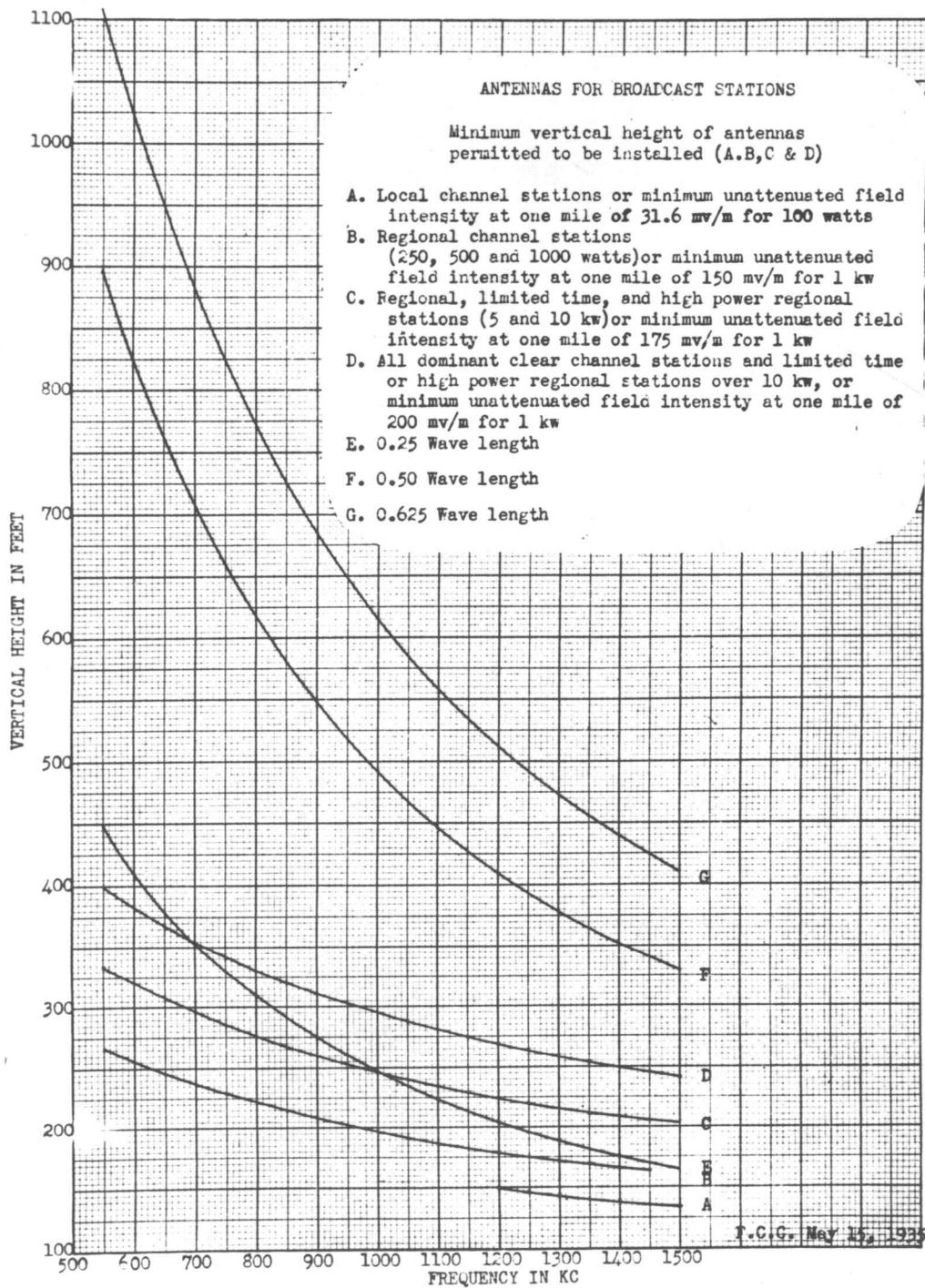


Figure 22 - Federal Communications Commission antenna specifications.

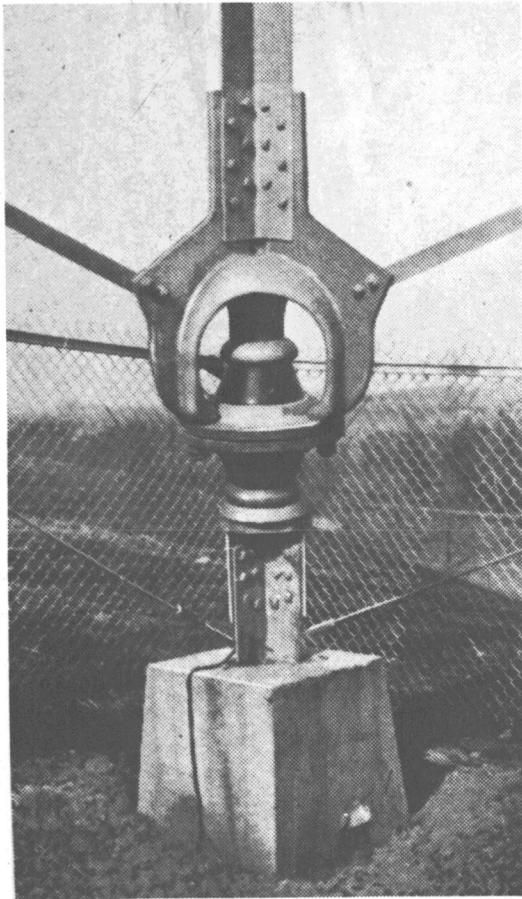


Figure 23a - Lapp base insulator installed at WHAM

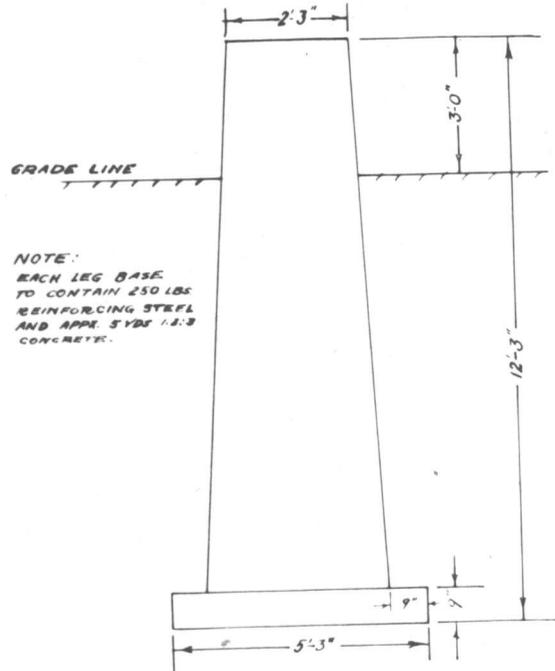


Figure 23b - Tower base detail for foundations on the Young Tract.

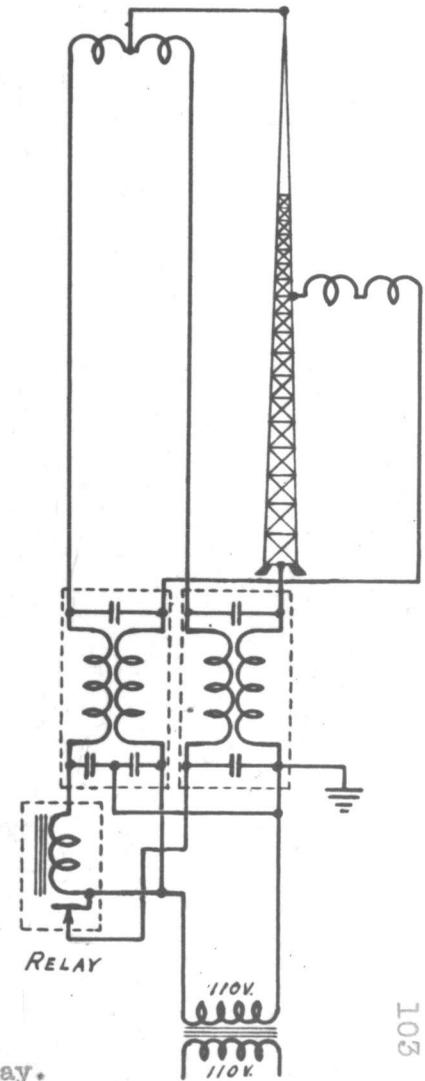


Figure 23c
Lighting filter and
auxiliary lamp relay.

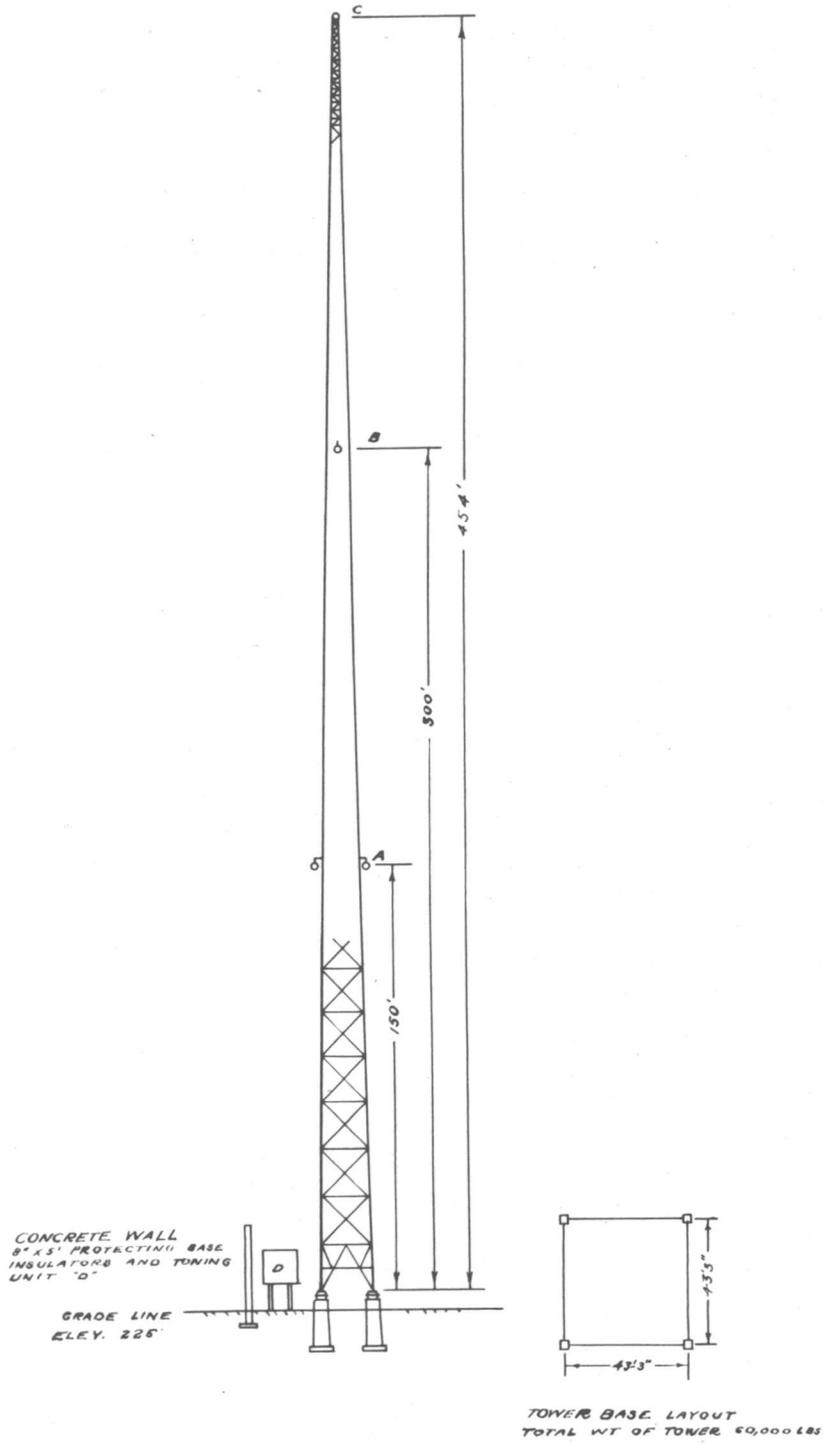


Figure 24 - Dimensions of vertical radiator with obstruction lighting data.

cost, and numerous electrical and mechanical details it was decided also that the most satisfactory structure would be hot-dipped galvanized, structural steel, with a base spread of 43 feet 3 inches. This tower would be supported on concrete piers as shown in the accompanying drawing. Each tower leg would be mounted on a Lapp push pull type insulator as shown in Figure 23a. The Lapp No. 9862 insulator has a minimum of 2 inches of porcelain between grounded and live metal parts. Each insulator has been tested under a 100,000 pound load. The weight of each insulator is 1,600 pounds.

The 454 foot self-supporting vertical radiator would have a total weight, exclusive of the insulators, of about 59,500 pounds. This tower would be made up of about 1,350 pieces and about 4,100 bolts. The heaviest single member would weigh about 450 pounds.

The foundations of the tower would require a total of about 18 cubic yards of concrete and about 1,000 pounds of reinforcing steel. One of the four foundations has been detailed in Figure 23b.

The lighting of the tower in conformity with the regulations of the Bureau of Air Commerce has been shown in Figure 24, with the lighting filter in Figure 23c.

The tower would be guaranteed by the maker, the Blaw-Knox Company, for a period of five years from date of

completion against direct loss or damage thereto caused by fire, lightning, floods, rising waters, ice, collision, explosion, strikes, riots, civil commotion, malicious damage, tornado, windstorm, earthquake, or collapse. The obligation of the Blaw-Knox Company hereunder is limited to repairing or replacing the physical loss or damage to the structure itself when occasioned within said five-year period by any one or more of the above causes. The foregoing is the full extent of the responsibility of the manufacturing company and in no event shall the company be liable for consequential damages or claims of any nature whatsoever arising from suspension of use or for loss of income, earnings or any remote loss.

A concrete wall surrounds the base of the antenna to protect it and the tuning unit from unauthorized persons.

Calculated Coverage

From measurements made by Mr. O. P. Perkins of the KOAC technical staff data have been obtained on the attenuation of radio ground waves. Typical attenuation data for Oregon are as follows:

Willamette Valley	0.6×10^{-13}	C.C.S. E.M.U.
Salapooia Mountains	0.2×10^{-13}	
Coast Range Mts.	0.2×10^{-13}	
Cascade Mountains	0.15×10^{-13}	

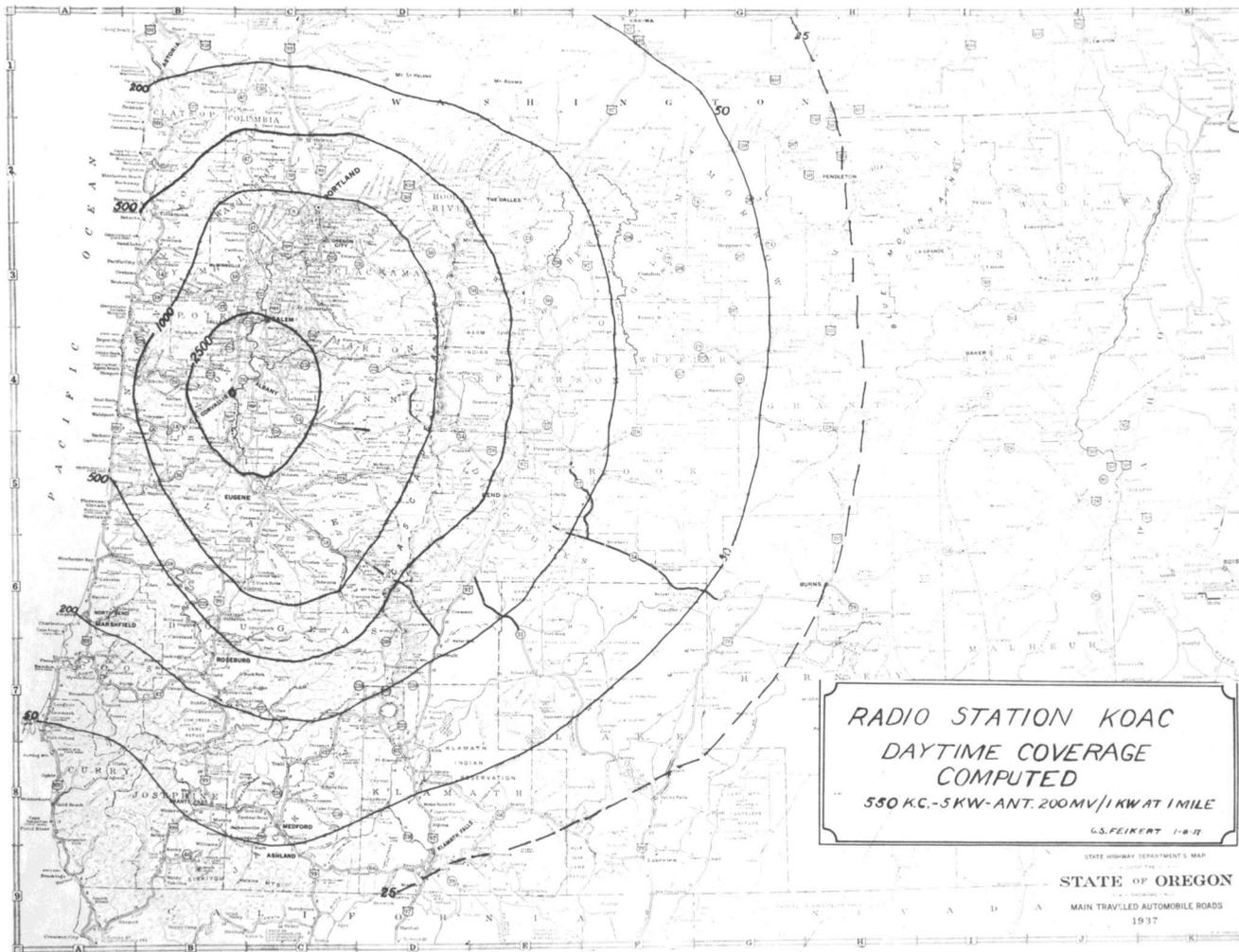


Figure 25 - Field intensity contours with new 5000 watt station.

From these attenuation data a map showing signal intensity contours for daytime coverage has been prepared (Figure 25). It should be noted that the computation was made with an antenna input power of 5000 watts. This was also based on the assumption that the antenna possess an efficiency sufficiently high to produce a field intensity of 200 millivolts for one kilowatt at one mile. This is the now generally accepted antenna standard and is slightly more efficient than that required by the Federal Communications Commission for a regional station. (See Curve D, Figure 22, showing 175 millivolts per meter.)

At a distance of approximately 175 miles from the transmitter, where the field intensity is in the neighborhood of 25 microvolts per meter, the contour has been indicated by a broken line. This has been done because it is felt that indirect radiation or sky wave may influence reception in that area.

Consultation of population distribution data has shown that the station would be heard by about 85 percent of the people of the state of Oregon.

The potential audience of the station would be between 800,000 and 900,000 people.

Transmitter

With the advent of higher fidelity response in radio receivers it has become imperative that the quality of a transmitted broadcast be as good as present equipment will produce. It has been found by experience among broadcasters that the station with the highest quality will have the largest number of listeners. This is, of course, based upon the assumption that all programs are acceptable.

The station should be equipped with a transmitter of recognized manufacture in the field of radio broadcasting. This transmitter should possess the following outstanding features:

1. One Hundred Percent Modulation

One hundred percent modulation of the carrier, corresponding to a peak power output of twenty kilowatts should be a capability of the equipment. This is based on the highest power rating of 5000 watts nominal unmodulated carrier power.

2. Audio Frequency Characteristic

The audio frequency characteristic of the equipment should be linear within plus or minus 1 decibel from 30 to 10,000 cycles.

3. Distortion Content

The absolute purity of the signal should be maintained in the process of modulation and amplification. The distortion contributed during the process of transmission must be less than five percent at one hundred percent modulation and less than two percent at the average level of program peaks. These will occur normally from six to eight decibels below constantly recurrent peaks in the audio frequency voltage.

4. Carrier Noise Level

The unweighted noise level must be at least 75 decibels below the signal at one hundred percent modulation of the carrier.

5. Carrier Stability

The carrier deviation from the assigned frequency must not be over plus or minus five cycles from the assigned frequency of 550 kilocycles. The Federal Communications Commission, at the present time allows a plus or minus 50 cycle shift as the upper limit of tolerance.

6. Carrier Harmonic Radiation

The harmonic radiation on any multiple of the

carrier frequency is to be at least 70 decibels below the carrier.

7. Other Factors

The transmitter must be fully equipped with electric interlocks on all doors and panels to comply with Rule 132 of the Federal Communications Commission. A magnetic switching arrangement incorporated in the transmitter must permit a change over from five to one or from one to five kilowatts without the loss of program time.

After a survey of available equipment meeting the above brief standards, it was decided to propose the installation of the Western Electric five kilowatt radio transmitter. This has been pictured as Figure 25 and Figure 27 which show the electrical arrangement of transmitting components. This transmitter will meet adequately all of the specifications and is well designed and excellently constructed, both electrically and mechanically.

Cost Analysis

The following cost data are based upon current quotations and estimates as of April, 1937.

It has been assumed that the station can be placed in the location indicated in the foregoing section on

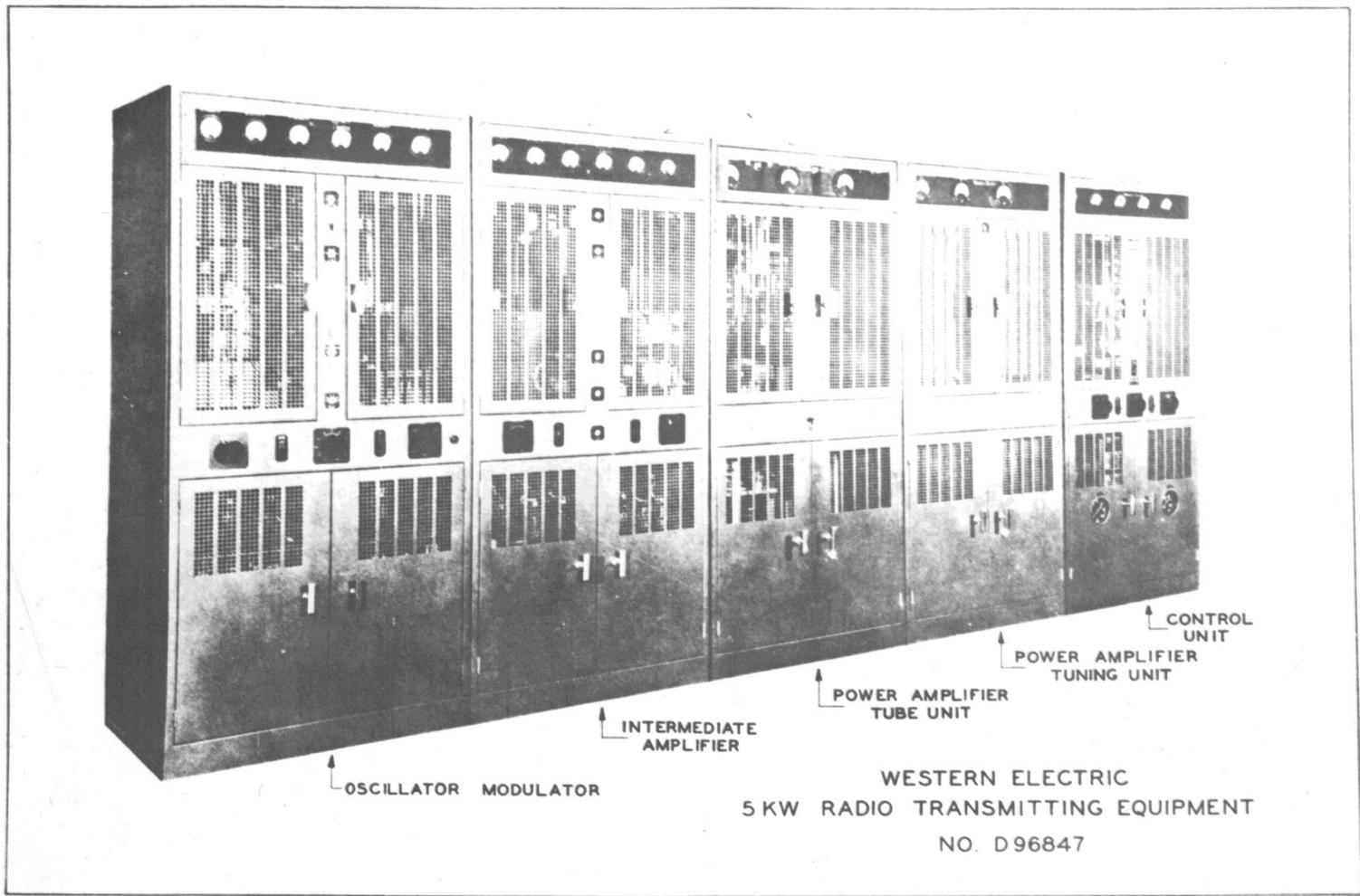
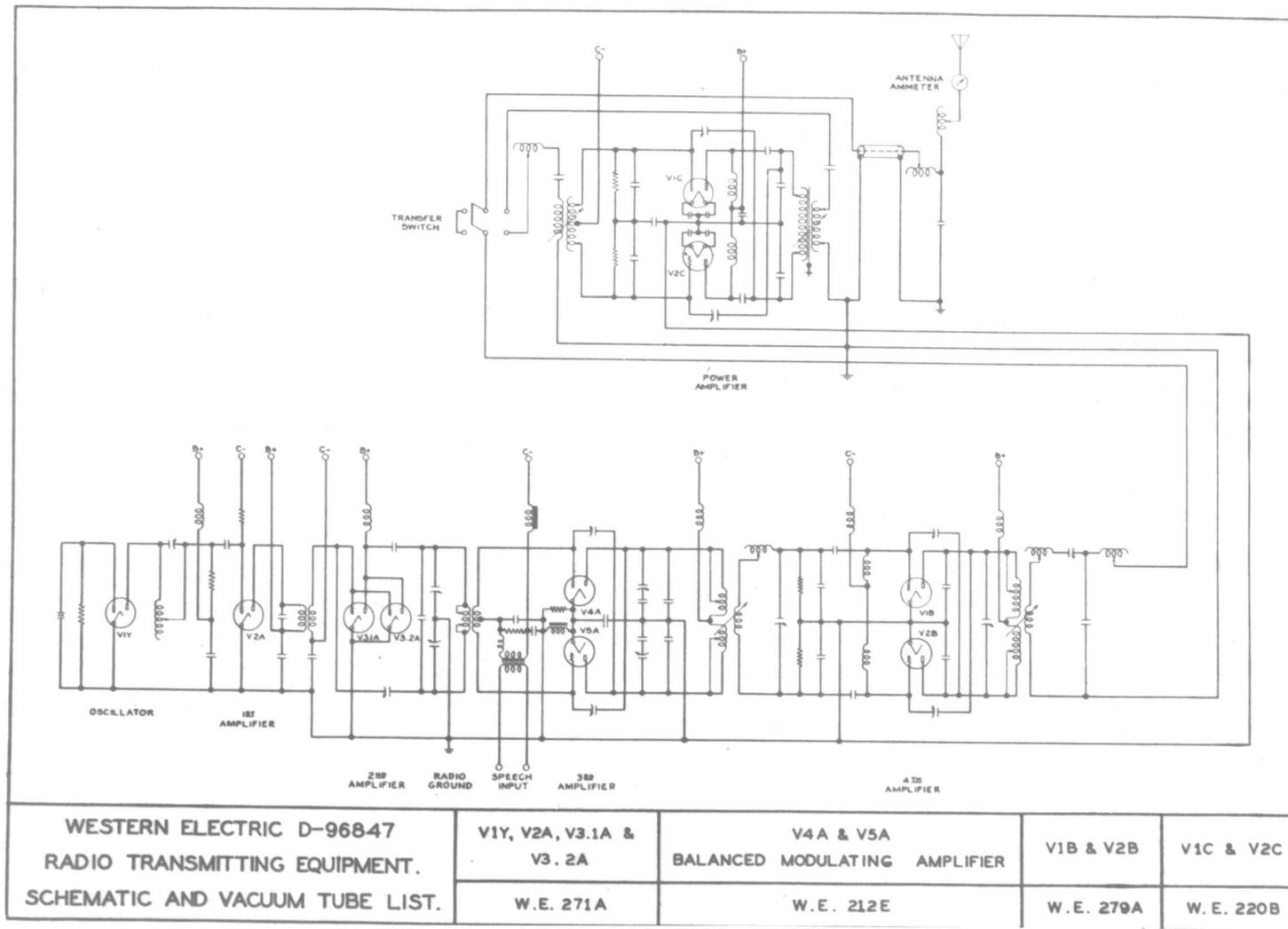


Figure 26.



WESTERN ELECTRIC D-96847 RADIO TRANSMITTING EQUIPMENT. SCHEMATIC AND VACUUM TUBE LIST.	V1Y, V2A, V3.1A & V3.2A	V4A & V5A BALANCED MODULATING AMPLIFIER	V1B & V2B	V1C & V2C
	W.E. 271A	W.E. 212E	W.E. 279A	W.E. 220B

Figure 27.

state college-owned property. No cost has been considered for a location site.

The fund entitled "contingencies" may not be used if all foundation areas are as estimated from inspection, and if water, power, and communication can be obtained from existing facilities.

COST ANALYSIS

500 Watt Transmitting Installation

RADIATING SYSTEM

454' Blaw-Knox Steel Vertical Radiator f.o.b. Corvallis, Oregon	\$5930.00
Foundations	60.00
Erection and Painting @ \$1.50/foot	685.00
Lighting	<u>350.00</u>
	\$7025.00

TRANSMITTER HOUSE

Fireproof construction	\$5000.00
Heating, Lighting, Ventilation, etc.	<u>750.00</u>
	\$5750.00

TRANSMITTER

Western Electric Type 5C 5000/2500/1000 watts	\$28,750.00
Installation Coaxial Cable, etc.	<u>1,250.00</u>
	\$30,000.00

Contingencies	<u>\$2,000.00</u>
TOTAL COST	\$44,775.00

A DISCUSSION OF PROPOSAL II

This section deals with the extension of the facilities of the station in behalf of the present potential audience by making direct broadcasting available from the University of Oregon at Eugene and the State Capitol at Salem.

Either proposal number I or proposal number II could be enacted individually. If proposal number II as outlined in the preceding section were developed simultaneously with or preceding the installation of the remote studios, a greater number of the people of the state could be reached.

University of Oregon Studio System

Location - The studio system at the University of Oregon would be tentatively located on the second floor of Friendly Hall on the campus. The rooms in that building, which would be converted over to use for the broadcasting studio suite, would be those now numbered from 212 to 217 inclusive. After building modification the studio suite would consist of two rooms, a control room, and a reception room. The control booth would be centrally

located with respect to the two broadcast studios. The walls between the control booth and the studio rooms would contain sections of double glass windows, allowing the control operator or announcer full view of each studio. The reception room would command a full view of each studio through sound proofed windows.

Acoustic Treatment - The walls and the ceiling of the studio rooms and the control booth would be covered with panels of acoustic celotex. The ceilings would be covered with type BB celotex. Wherever appropriate, the celotex could be stenciled with artistic designs. The floors could be covered with linoleum and rugs.

Studio Equipment - Each studio would be equipped with two 61BA type dynamic microphones with suitable cordage and stands. The control booth would be equipped with a Western Electric 23A Speech Input Control Cabinet. This unit is the latest development of the Western Electric Company and is assembled in an "organ console" type cabinet, low enough to be mounted on a table without obstructing the view of the operator. The equipment would present a combination of flexibility, simplicity of operation and high quality transmission. The frequency response of the amplifiers would be within plus or minus 1 decibel from 30 to 10,000 cycles per second. The equipment noise level, weighted as the ear would hear it,

would be 70 decibels below the program level. Switching would be available to connect any combination of transcription pick-up with either or both studios or a remote control point on the University campus with either or both studios. The amplifier would be capable of feeding into the line to Corvallis at a plus 13 decibel level at 500 ohms. A monitoring amplifier would be included to supply loud speakers in the control booth, both studios, and the reception room.

Campus Program Network - By means of underground cable broadcast circuits would terminate at Friendly Hall studios from McArthur Court, Hayward Field, the Music Building, and Gerlinger Hall. This underground program circuit would be paralleled with a communication circuit for telephone communication during broadcasts.

A suitable remote control amplifier would be stationed at the University studios for use in originating programs from any of the remote control points.

Provision for Radio Instruction - All studio equipment would be arranged so that it could be readily used for instruction in speech and broadcast technique while programs were not being broadcast through the transmitter at Corvallis. It is assumed that sufficient and satisfactory time could be arranged for the conduction of program auditions between programs.

Line from Eugene to Corvallis

A program transmission line would be leased from The Pacific Telephone and Telegraph Company for the transmission of the University programs to the broadcasting plant at Corvallis. The line would be equalized for transmission of all frequencies up to 5000 cycles, which would result in satisfactory program quality on speech and music.

COST ANALYSIS

Building alteration at Eugene (Friendly Hall)	\$1091.00
Western Electric Studio Speech Equipment	1500.00
Furniture and fixtures	600.00
Non-recurring telephone instal- lation charge	<u>25.00</u>
Total fixed costs	<u>\$3216.00</u>
Unlimited time high quality line per annum, Pacific Telephone and Telegraph Co.	<u>3600.00</u>
Total first annual cost exclusive of staff	\$6816.00
Future annual cost exclusive of staff and maintenance	\$3600.00

STATE CAPITOL STUDIOS AT SALEM

No detailed report has been included concerning the installation of studios at Salem.

The studio system at the State Capitol would be

presumably located in one of the state owned buildings at Salem. The studio suite would consist of an arrangement comparable to that outlined for the University of Oregon at Eugene.

Facilities could be available to enable the state owned station to broadcast sessions of the state legislature.

The equipment at Salem would be similar in design to that used at Eugene and would be connected to the station at Corvallis by means of a leased wire circuit.

While cost data have been assembled covering an installation of this type, they are similar to those covering the Eugene installation and have not been included here.

ACKNOWLEDGMENT

In the preparation of this paper the writer wishes to extend his sincere thanks to Mr. Burton Hutton, Director of Agricultural Programs at KOAC, for assistance in editing; to Professor A. L. Albert for guidance in writing; to Mr. Tom B. Wagner, Assistant Engineer at KOAC for suggestions; to Dr. W. Weniger for historic files and data; to Mr. Luke L. Roberts, Manager of KOAC; and to Miss Ruth Bellrood, secretary, who extended to the writer numerous annual reports containing data on the historic record of the station.