

STEAM HEAT DEPARTMENT

*File
Steam Heat*

C-Steam

1. General History:

The history of the steam heat system in Denver begins with the corporate existence of the Denver City Steam Heating Company December 15, 1879. The Denver City Steam Heating Company obtained its first franchise January 5, 1880, which was amended May 17, 1881. This franchise was renewed October 18, 1901, and was amended June 16, 1902. The rights under this franchise terminated December 15, 1919. Since this date, the steam heat utility has been operated without a franchise.

The steam heat system was started specifically to furnish heat for the American House located at 16th and Blake Streets which was completed during 1869 by Mr. John W. Smith who was the first president of the steam heat utility company. The service area was soon expanded after the formation of the Denver City Steam Heating Company to include 15th Street to 18th Street between Larimer and Wynkoop Streets. The system was further expanded to keep pace with the growth of the business district toward Broadway in the years immediately following so that by 1909 it served an area bounded by Wynkoop Street and Tremont Street and 15th Street to 18th Street with mains extending toward 14th Street in Arapahoe, Curtis, Champe, Stout, Welton and Glenarm Streets and toward 19th Street in Lawrence, Curtis, California and Welton Streets.

The Denver City Steam Heating Company was purchased by Mr. Frank Frueauff November 23, 1909, and title was transferred to the Denver Gas and Electric Light Company November 29, 1909. During the years 1911 and 1912 extensive replacements and alterations were made in the steam distribution system. Six types of main construction were installed by various

contractors; however, it is not possible now to determine accurately the extent of replacements made. It is known that the Pierce Company installed 1273 feet of main, the American District Steam Company 1260 feet, the Central Station Engineering Company 1900 feet, the Schoot Company 1420 feet, the Evans Aimisill Company 1776 feet, and the Denver Gas and Electric Light Company constructed 2785 feet during this period. The diasystol construction of the Evans Aimisill Company has been since replaced to a large extent and the failure of most of the variators installed by the American District Steam Company has required replacement with slip-type expansion joints.

Prior to the 1911-1912 rehabilitation program steam was sold on an unmetered basis. A change of policy during this period required the metering of steam delivered to customers; however, it was not possible to immediately eliminate flat rate situations. Metering was accomplished by measuring the condensate thru conventional condensate meters, which is the present practise with a few exceptions where condensate cannot be returned for measurement at one point. In these situations shunt-flow meters are used.

It appears from available information, considered reliable, that the threat of isolated generating plants in the several new buildings being constructed or scheduled for construction during 1909 was one of the major factors which entered into the decision to purchase the steam heat utility. How well the idea that being then in a position to offer both steam and electric power succeeded cannot be determined; however, at least 18 isolated generating plants were installed in buildings constructed within the steam heat service area during the years 1909 to 1911. Most of these plants were operated at least 25 years and the last was not abandoned until the year 1949.

The Steam Heat Plant located at 19th and New Haven Streets near the Union Station was the only source of steam until September 1949. This plant is housed in a one story brick building which has been maintained in reasonably good condition considering its age dating back to probably 1878 or earlier. The original compliment of boilers probably included twelve 100 BHP Horizontal Return Tubular Boilers installed from 1878 to 1881 all of which have been replaced. During the period 1885 to 1889 three 400 BHP Hazelton "porcupine" vertical water tube boilers were installed. Two of these boilers were retired during the early thirties and the last was retired in 1941. Seven 150 BHP Heine Water Tube Boilers were installed during 1913 to 1915 all of which are still in service. These boilers had been used elsewhere and were probably originally installed new during 1890 making their age approximately 25 years when installed at the Steam Heat Plant. Three 436 BHP Heine Water Tube Boilers were installed during 1919. The compliment of boilers since 1941 has therefore consisted of the three 436 BHP boilers and the seven 150 BHP boilers; however, a used 30 BHP Torbett vertical flue boiler was installed during 1947 for start up purposes only. This boiler is used for heating and atomizing the fuel oil when starting up the plant.

The Steam Heat Plant was operated on coal, hand fired, until 1931 when the fuel was changed to oil with appropriate storage, handling and burner facilities. Fuel oil was made the standby fuel with the installation of facilities to utilize natural gas on an interruptible basis during December 1947.

The sale of steam on an estimated use basis over the period of years prior to 1911 contributed to many abuses and diversions of steam. A survey and recommendations made during 1915 by engineers of Henry L. Doherty and Company corrected many of these situations and since that

time there have been relatively few unauthorized uses of steam which have not been metered. Prior to 1912 steam was supplied on a fourteen hour daily schedule during the heating season of approximately seven months with the steam heat plant closing down at 10:00 P.M. daily, regardless of weather conditions. With the beginning of the heating season in 1912 the steam heat plant was placed on a 24-hour schedule which was maintained during the heating season until the summer of 1950 when continuous year around steam heat service was made available.

The last 35 years of steam heat operations has been replete with economic studies investigating and recommending various plans for continued operation and abandonment. During 1920 an effort was made toward abandonment by suggesting to all steam customers that the Company would cooperate with resuming the use of their heating plants or with the installation of new boilers. The loss of customers over the years from 1920 to 1947 attests to this and another factor that of the competitive aspects of natural gas for space heating introduced in Denver during 1928. Changed economic conditions and real estate values in the lower section of the business district with the added trend in growth toward Broadway and to areas not served by the steam distribution system was also a factor contributing to the loss of customers.

Studies of these steam heat problems beginning in the year 1946 and extending intermittently thru part of 1948 indicated the economic desirability of utilizing bled steam from the 35,000 kw turbo-generator unit which was installed at Zuni in 1948 and which was equipped with a stage valve and provision for bleeding steam from the first and ninth stages for the steamheat system. Since condensate from the steam heat consumers is not returned to the system it was necessary to provide adequate water treatment facilities and segregation of feedwaters for

generating steam heat steam and turbine steam. Desuperheaters were provided to control the pressure and temperature of the steam entering the steam heat system. Adequate telemetering and automatic controls were installed so that labor and supervision expense at Zuni chargeable to steam heat could be kept to a minimum. A steam transmission line 8000 feet in length was constructed from Zuni to 14th and Stout Streets where it joined a header constructed in 14th Street connecting with the lateral mains extended to 14th Street in Curtis, Champa, Stout, California, Welton and Glenarm Streets completing a grid with the header in 18th Street. The first 7000 feet of transmission line nearest Zuni is 14-inch pipe and the last 1000 feet nearest 14th Street and the adjacent header sections to California and Champa Streets are 16-inch pipe; other sections of the 14th Street header are 14-inch pipe and the lateral mains connecting with this header are 12-inch pipe. Mains were extended in 18th Street to Broadway then in Court Place to 16th Street and in 16th Street toward Cleveland Place, all of 14-inch pipe. Rio-Wil prefabricated pipe and conduit construction was used throughout and the use of precast manholes containing slip-type expansion joints and anchors as a unit were installed where permissible.

All of the foregoing investment was predicated upon adding steam heat load to a maximum of 300,000 pounds per hour which was based upon the following coordinated factors:

1. The steam heat capability at Zuni from bled steam and supplemental live steam both as desuperheated is approximately 300,000 pounds per hour non-coincidental with the electric generation peaking capability.

2. The electric system and steam heat system annual maximum hour peaks are not coincidental either as to time of day or month.

3. The transmission pipe line was designed for an approximate capability of 300,000 pounds per hour recognizing reasonable steam pressures in the delivery to the 14th Street header.

4. The steam distribution system can receive and distribute approximately 300,000 pounds per hour of steam without incurring excessive steam pressures; however, large concentrated steam loads cannot be satisfactorily served at all locations within the steam heat service area without additional investment in major reinforcements.

5. The Steam Heat Plant aside from providing housing for the operating personnel of the Steam Heat Department is capable of generating approximately a maximum of 120,000 pounds per hour of steam on a stand-by basis at a penalty in production cost over Zuni during emergencies and to permit taking the transmission line out of service for maintenance during periods of light load on the steam heat system. It also provides additional reliability when Zuni has been called upon to meet unusual electric generation assignments and it permits certain sections of the distribution system to be taken out of service without necessitating interruption of steam heat service.

6. According to the surveys made in 1947^{of} additional possible steam heat loads, it was estimated that the 300,000 pounds per hour maximum system load necessary to justify the investment requirements, already described, could be attained in approximately five years after completing this construction in ~~the~~ time for the heating season beginning September 1949. The progress made to date in adding steam heat loads attests to the validity of this estimate.

7. Alternative plans examined to accomplish all of these purposes and to provide for the expansion of steam heat facilities to serve a steam heat load of 300,000 pounds per hour offered even less possibility of economic recovery and called for greater capital expenditures coupled with the necessity of operating a separate boiler plant on a continuous schedule at a sacrifice of steam generating efficiency and cost over the ~~steam generating efficiency and cost over the steam~~ costs presently realized.

The foregoing represents the salient historical facts relating to steam heat operations and directs attention to the present situation wherein it is evident that taxes and costs in general have increased substantially over those of 1947 on which estimates relating to the expansion of steam heat facilities were based. Many of these items although relatively insignificant per se when viewed as a part of total company expense have a very great economic impact on the Steam Heat Department.

2. General Description: Service Area - Rate H

Steam heat service is available in the business district of Denver from existing steam mains in an area bounded by 18th Street and 14th Street between Curtis and Glenarm Streets; on 18th Street from Glenarm Street to Broadway; on Broadway to 17th Street; on Court Place from Broadway to 16th Street; on 16th Street from Court Place one-half block toward Cleveland Place; on Tremont Street from Broadway to 17th Street; on Arapahoe Street 18th to 14th Streets; on Blake, Larimer and Lawrence Streets 18th to 15th Streets; on Market Street 18th to 17th Streets; on Wazee Street 18th to 19th Streets; on 19th Street Wazee to New Haven Streets and to the Denver Union Station. Service is available to consumers

located on both sides of the streets included in this description and to prospective consumers located adjacent to the existing main system which can be economically served by reasonably short service pipe or main extensions in accordance with existing policy governing the participation in the cost of such construction.

3. Source:

The sources of steam include both bled and live steam generated at the Zuni Power Plant of the Company located at 13th and Zuni Streets in Denver and from eleven small boilers of the Steam Heat Plant located at 19th and New Haven Streets in Denver. The combined sources provide a total coincidental capability of 420,000 pounds per hour; however, the Steam Heat Plant is recognized as reserve so that 300,000 pounds per hour available from Zuni is the nominal steam capability of these sources, due also to steam pressure tolerations on the distribution system.

Approximately 200,000 pounds per hour of steam can be bled from the first stage of the turbine at Zuni Plant under the most usual loading and operating conditions; however, this quantity can be increased 10% to 20% under specific conditions. The quantity of steam bled from the ninth stage is a maximum of 60,000 pounds per hour. Obviously steam for the steam heat system cannot be bled from both stages at the same time. Any supplemental requirement of steam on the steam heat system over the quantities of bled steam as desuperheated available at any time are made up with live steam from the boiler header desuperheated to the steam conditions required to maintain proper pressures and steam flows in the distribution system.

4. Customers - Pounds - Growth, etc. 1940-53-56:

	<u>1940</u>	<u>1953</u>	<u>1956</u>
Number of Customers (December)	55	160	170
Steam Sendout M. Lbs.	90,584	482,170	683,000
Steam Sales M. Lbs.	64,497	443,170	630,000

This does not agree with projected pro-forma figures stated in the office

5. Demands, Capacity:

Maximum Capacity M. Lbs. Per Hour (1953)	300,000
Maximum Capacity M. Lbs. Per Hour (1940)	100,000

Maximum Demand Lbs. Per Hour:

<u>Year</u>	<u>Actual or Estimated</u>
1940	59,760
1953	221,000
1956	300,000

6. Allocations - Capacity and Equipment:

While the allocation of capacity and equipment in a combined steam heat-electric generating plant is usually subject to opinion there are several factors related to the normal plant operations at Zuni which support the recognized dedication of plant equipment to steam heat; among these are the following:

1. The original Zuni plant and recent installations and additions all have been constructed without regard to providing separate steam generating sources for the steam heat system.

2. The electric system and steam heat peaks are not coincidental as to time of day or month.

3. Provision was made in the specification and design for the 35,000 kw turbo-generator installed in 1948 for a stage valve and for bleeding the first and ninth stages of the turbine for steam for the steam heat system. These turbine changes necessary to provide steam for the steam heat system are appropriately allocable to steam heat investment.

the steam supplied to the turbine should originate from condensate and condensate make up. In order to accomplish this and to at the same time supply steam for the steam heat system it was necessary to install two entirely separate feedwater systems. The cost of the second feedwater system is, therefore, an appropriate allocation to steam heat investment since condensate is not returned to Zuni from the steam heat system.

5. The installation of a feedwater treatment plant to handle the proportionate share of feedwater make-up represented by the steam heat sendout is another item appropriately allocable to steam heat investment; since it is assumed that the original water softening equipment associated with the boiler and turbine installation of 1948 could have met plant requirements if steam had not been supplied to the steam heat system.

6. So that the steam conditions as to pressure and temperature can be ^{varied} ~~varied~~ to meet the changing requirements of the steam heat system at the inlet at Zuni, it was necessary to provide additional desuperheater stations over those already installed to permit the comingling of steam from the 265 psig. and 850 psig. headers representing plant operations during 1948 to 1952. These additional desuperheater installations are also allocable to steam heat investment.

7. In harmony with the compliment of modern control equipment and methods associated with the installation of 1948, it was desirable to provide a system of automatic controls for the steam heat system at Zuni along with associated telemetering equipment. The cost of this control equipment which is solely associated with the supplying of steam and desuperheating of steam for the steam heat system is properly allocable to steam heat investment.

Allocation of Production Expense:

1. The allocation of production expense at Zuni is explained in the following procedure which was made effective as of January 1952:

The cost of steam to the Steam Heat Department for steam produced at Zuni and delivered into the steam distribution system at the metering point in the Zuni Plant shall include the allocated proportional total cost of fuel as determined by the ratio of heat inputs method plus-the proportional cost of water and water treatment based on steam heat sendout - plus the proportional cost of boiler plant maintenance based on the ratio of heat inputs.

(For purposes of interpretation, the cost of water and water treatment shall mean charges to Account 704 and the cost of boiler plant maintenance shall mean charges to Accounts 708-1, 708-2 and 708-3; the proportion of water costs representing cost of water only to be allocated to the Steam Heat Department shall be the ratio of steam sendout converted to gallons of water to the total number of gallons of water consumed at Zuni Plant, less appropriate adjustments; and the proportion of other water costs shall be the ratio of steam sendout in gallons of water to the total number of gallons of water to the hot process water softener; the proportion of boiler plant maintenance costs to be allocated to the Steam Heat Department shall be the ratio used in the allocation of fuel costs.)

2. Over the past several years construction work has been in progress at Zuni Plant which has frequently necessitated the operation of the Steam Heat Plant on a stand-by and emergency basis. The prime obligation to supply steam to the steam heat system since the fall of 1949 has been assigned to the Zuni Plant. The occasions for operating the Steam Heat Plant were principally due to changes in equipment, piping,

etc. required during the process of construction which interfered with either the total or partial supplying of steam to the steam heat system. Also there have been situations when it has been desirable to utilize the electrical generating capability at Zuni to the fullest extent and during these times the Steam Heat Plant has been operated to supplement the supply of steam available from Zuni.

The method of allocation of production expense at the Steam Heat Plant is to charge the Electric Department with the excess cost of producing steam over that cost for the same quantity which would have been realized and chargeable to the Steam Heat Department if all of the steam had been generated at Zuni Plant.

7. Gross Additions:

Several improvements in the steam distribution system are necessary or desirable regardless of the growth or loss of steam heat load over the period of the next three years ending with the year 1956. Among these are the building of a main extension in ~~the~~ 16th Street connecting the existing mains on or crossing 16th Street at Court Place and at Glenarm Street to provide reinforcement for serving relatively large loads concentrated near 17th Street and Broadway which are now served only thru the main in 18th Street. This two-block extension falls into the category of necessity to provide for reliability in a heavily loaded area.

It would be desirable to construct also a main extension from 14th Street and Glenarm Street in 14th Street to Tremont Street and in Tremont Street to 16th Street to connect with the aforesaid main extension in 16th Street. This construction would relieve the relatively high operating pressure situation prevalent on the steam distribution system under peak load conditions and would provide reinforcement for a heavily loaded area.

The main header in 14th Street should be provided with valves at each side of the intersection at 14th and Stout Streets so that the 14th Street header can be sectionalized for maintenance and so that it will not be necessary to take the entire 14th Street header out of service for any work required on it. A manhole has been constructed to provide access to an expansion joint adjacent to this intersection toward California Street into which a valve might be installed. The second valve will require the construction of an additional manhole. These valves also fall into the necessity category.

Steam service pipes and metering equipment required to serve new customers will require nominal essential expenditures.

These items are summarized in the following:

Main Extension 16th Street Court to Glenarm	\$38,000
Main Extension 14th & Glenarm to 16th & Tremont	70,000
Valves at 14th and Stout:	
In existing manhole	1,000
Manhole and valve	2,500
New Service pipes	10,000
Metering Equipment	<u>5,500</u>
Total Capital Expenditures:	\$127,000

8. Operating Expenses - 1953 - Generation - Distribution:

Operation and maintenance expense for the year 1953 are classified in the following:

Total Steam Heat Production Expense	\$114,348.43
Total Steam Heat Distribution Expense	21,564.51

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