GL01292

THE CHURCH OF JESUS CHRIST OF LATTER-DAY SAINTS

OPERATIONS AND MAINTENANCE DIVISION
50 East North Temple Street
Salt Lake City, Utah 84150

(MW) Schutty
Manning
Lamfell
Lewis
file B.8.2

September 28, 1979

Mr. H.R. Hilker
EG&G Idaho, Inc.
P.O. Box 1625
Idaho Falls, Idaho 83401

Dear Mr. Hilker:

I am attaching a copy of a news release which describes the general concept of our heat pump system and other pertinent information regarding our building. Also attached are sketches indicating the piping arrangements of our chillers, heat exchangers and well water distribution.

In answer to your questions regarding temperatures of the resource, flow rates, etc., I will address the following answers in sequence of your inquiry.

Temperature of the resouce is now 63°. The well water can be supplied from any one of the four wells into a distribution system which serves other areas besides the office building. Two wells were drilled to the depth of approximately 300 feet, the other two wells to approximately 700 feet (see attachment #1). The well water temperatures have risen since the original drilling in 1965 from 56° to 63°, depending on the well used. We attribute this to heat contamination from our own system as well as other similar equipment in the immediate downtown area. We discontinued returning our well water to the ground about a year ago because of the heat sink problem, and the temperature has stabilized from highs of 78° to the present 63°.

The flow rates from the well water pumps vary from a miximum of 2600 GPM to approximately 1800 GPM. Our operation dictates operating our 2600 GPM pump (#1) during the summer months when our loads are the greatest, and the 2000 GPM pump (#2) in the winter. The other 2 alternate between spring and fall. The original design of the complex required 4000 GPM, but we have found that 2600 gallons is sufficient in the peak season.

Attached sketch #2 indicates our present method of circulating the well water through the heat exchangers. The well water is circulated through the tube side which is not treated, and the building water through the shell and it is treated.

The heat pump system consists of three 800 HP 750 ton York centrifugal refrigeration units. Our well water pumps are Johnston vertical pumps, two are variable volume and two are fixed speeds. The impellers on all four well water pumps are at 200 feet and the static water level varying from 80-100 feet in depth. Pump down in each column is approximately 10 feet. The secondary pumps in the system are Aurora, split case, flat curve pumps. The capacity of these pumps are indicated on the drawing.

The summer/winter or heating/cooling cycle changes over at 55^{0} outside air temperature. A basic description of the 4 pipe building piping system is outlined in the attached article.

There is about 10^{0} temperature drop through the heat exchangers and approximately 6^{0} through each chiller. As you will note, the heat exchangers are parallel with the system. The chillers are in series. The water temperatures in the building system are controlled by an outside air sensor which resets the water temperature depending on the outside air temperature. On the cooling cycle, the water temperature varies from 56-42^{0}. On the heating cycle the temperature varies from 85-105^{0}.

The original design called for constant 42^{0} chilled water and 105^{0} hot water; after the change we achieved a cost cavings of $60,000 in operating costs. Mixed air temperatures in our fan coil units are very critical as is the control maintenance on the chillers in order for us to continue realizing these cost savings.

Our power bill for the chillers taken from actual meter readings for the eight months from January to August is 1,347,500 KWH. At approximately 60% efficiency for our refrigeration equipment, we estimate that our annual heating and cooling load is 4,135,477,500 BTU's. We have no convenient way of determining the percentage of what is heating or cooling because of the automatic switch over. In the winter time the heating is assisted by our lighting level which is about 3½ watts per sq. ft. We have 676,000 sq. ft. occupied area in the Church Office Building, therefore, it becomes difficult to determine the extent of heating which is achieved by the lighting and people load and which is done by the heat pump system. The reverse is true in trying to determine the cooling portions, as we use 100% outside air when the temperature is between 45-60^{0}.

We do not have firm figures to substantiate whether this type system is more economical vs the conventional boiler and chiller. We do feel, however, that it is more economical to operate because we do use heat which is normally wasted in the cooling tower in a conventional refrigeration system. Our total electrical costs for the high rise is about 3¢ per sq. ft., of which we estimate that approximately 50% is the lighting and the rest is mechanical equipment. We do not have any cost estimates of the initial heating system costs. The building is approximately 7 years old and much of that data is unavailable.

The well water system, as previously mentioned, is outlined on the sketch attached and has some limitations associated with it. The limitations are because of the two type pump systems, the variable speed and the constant speed, plus the fluctuating loads from hour to hour. When we use the constant speed pumps, it is difficult to anticipate the changes in system pressure and, therefore, excessive pressure as well as minimum pressure conditions occur.

Attachment #3 is a copy of a portion of the water analysis on the four wells.

Basically, our heat pump system is a good system. It does have peculiarities which are different than that of other conventional systems. Primarily the low heat capability of the system requires more air in our air handling systems, and as a result, a chill factor condition occurs and requires some getting used to. I also mentioned previously the fact that the temperature controls require constant maintenance in order to achieve the economy the system was intended to be able to deliver.

I think to the best of my knowledge we have answered most of your questions. If additional information is needed, please feel free to contact us.

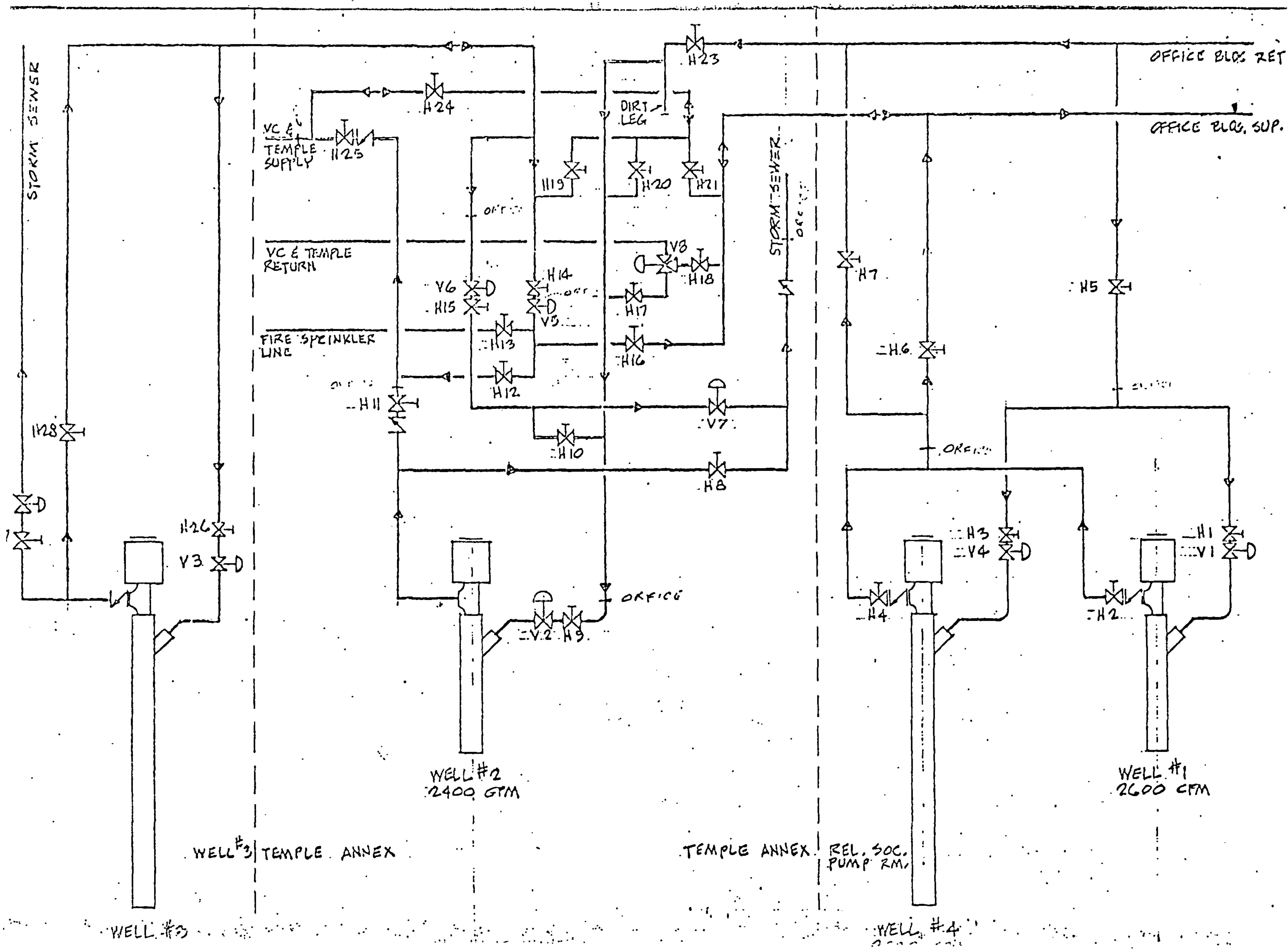
Sincerely,

John R. Ellingson, Manager
Headquarters Buildings Section

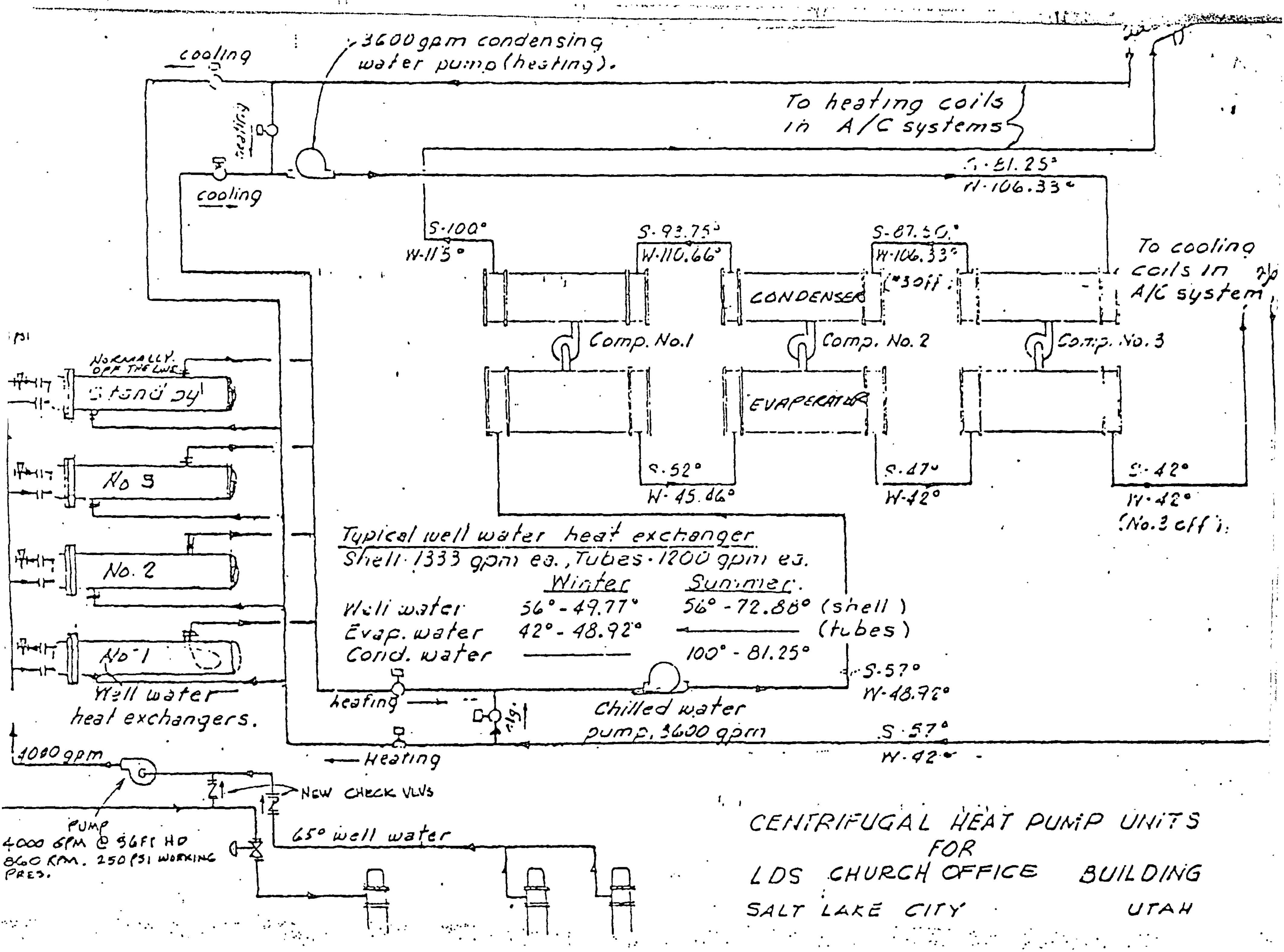
JRE/lb

Attachments

The Headquarters Building of the Church of Jesus Christ of Latter-day Saints (Mormon) is a 28-story structure in downtown Salt Lake City occupied in late 1972. The building has several energy-saving features including double-glazed windows, T-shaped exterior columns to help shade the windows, and a heat pump system to provide total heating and air conditioning year round. The heat pump consists of three 750-ton certrifugal refrigeration water chillers, and associated air handling equipment. The heat pump equipment can be related simply to a home refrigerator. The heat source comes from the condenser section which is the coil on the rear of the unit and the cooling from the evaporator or interior where the food is cooled. The chillers supply both hot and chilled water through separate piping for simultaneous heating and cooling. Four deep-water wells provide a heat source or heat sink capability as required by the system. In the wintertime when the building is in the heating mode, the hot water (85°F to 110°F) generated in the chiller condenser section by the refrigeration process, is pumped to nine heating coils in various equipment rooms in the building. Air blown through these coils by fans is heated and distributed in ductwork throughout the building. The heating is also assisted by the lighting and body heat within the building. The unused and unneeded chilled water (42°F) which is generated at the same time in the evaporator section of the chiller, is diverted to four heat exchangers through which (68°F to 70°F) well water is pumped. Heat from the well water is transferred to the building chilled water, raising it's temperature to approximately 60°F. The warmed water returns to the evaporator to continue the cycle and the well water is returned to the ground. In the cooling cycle, the process is reversed. Separate water passing in pipes through the evaporator is cooled by Freon expanding from a liquid to a gas. The cooled water is then pumped to nine cooling coils adjacent to the heating coils. As in the case of the heating system, the air passes through the coils and is cooled, then distributed in separate ducts to areas within the building. The 110°F condenser water which is produced when the Freon is compressed back from a gas to a liquid, is diverted to the heat exchangers as indicated previously. The 110°F hot water gives up heat to the 68°F - 70°F well water in the exchangers and returns to the chiller at about 85°F to continue the cycle, and the warmed well water is returned again to the ground. Domestic cold drinking water and rest room hot water needs are met by utilizing the same type of heat pump system using smaller equipment. The building air handling equipment consists of two types of fan systems--the high velocity or interior system, and the primary air induction or peripheral system. The high velocity is a dual duct forced air system designed to convey both hot and cold air simultaneously to some 1650 zones in the building. The air leaves the heating and cooling coils in separate ducts, and is conveyed to various mixing boxes which are controlled by room or zone thermostats. The heat loss and heat gain through the outer walls is controlled by the primary air or forced air single duct system at the periphery of the building. The air leaving the main fan at between 60°F to 70°F blends with induced air at the reheat coils under the building windows. The blended air is then tempered with hot or chilled water in the reheat coil as needed to maintain comfort. This hot and chilled water is from the same source which provides water to the larger fan coils. Unlike other systems, the LDS Church Office Building requires no boiler or cooling towers.



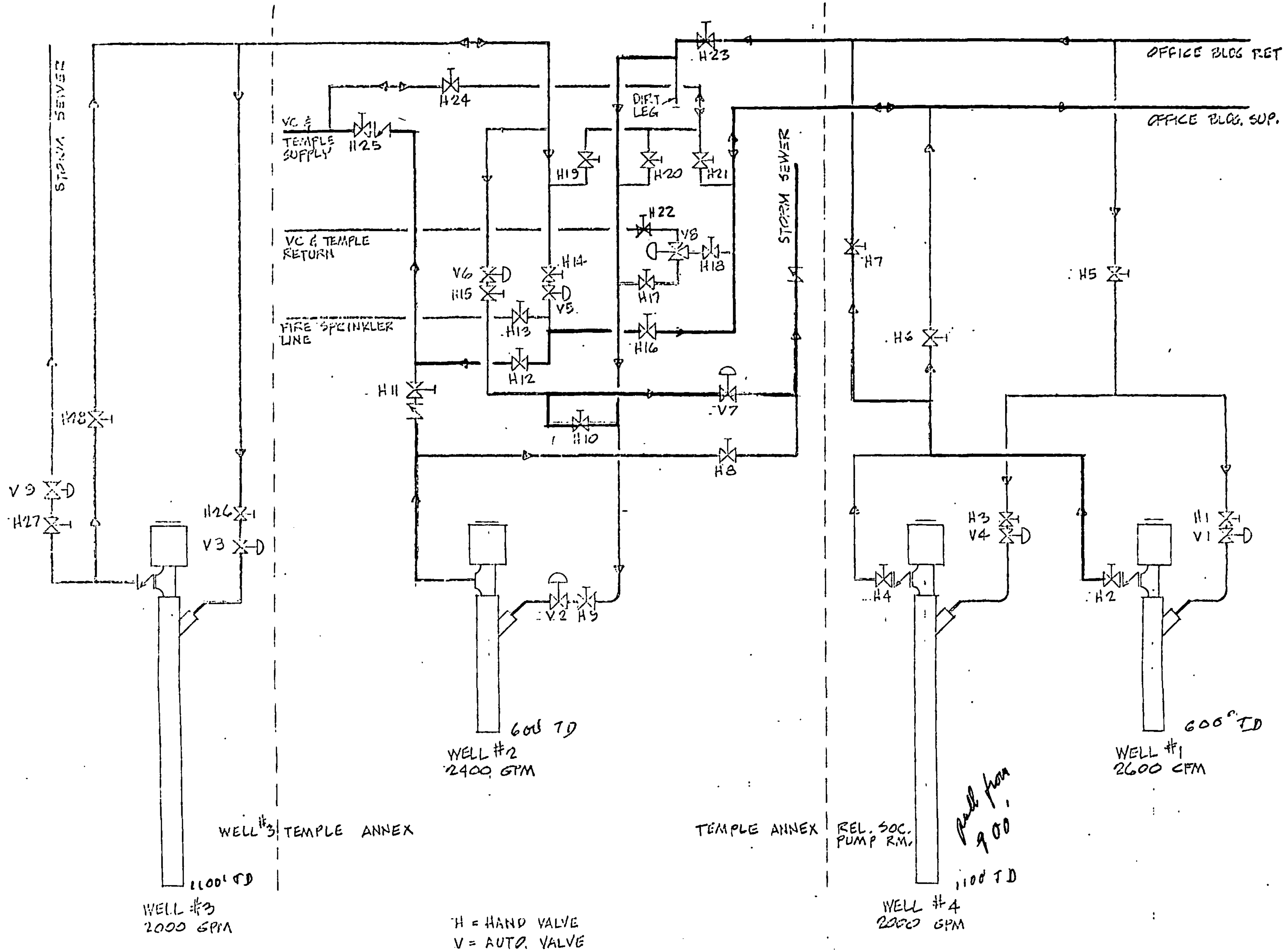
STORM SEWER
OFFICE BLDG RET
OFFICE BLDG SUP.
H23
H24
DIRT LEG
VC & TEMPLE SUPPLY
H25
H19
H20
H21
STORM SEWER
VC & TEMPLE RETURN
V8
H18
V6
H14
H15
V5
H17
H7
H5
FIRE SPRINKLER LINE
H13
H16
H6
H12
H11
V7
H28
H10
ORFICE
H8
H26
V3
H3
V4
H1
V1
ORFICE
H4
H2
V2
H9
WELL #2
2400 GPM
WELL #1
2600 GPM
WELL #3
TEMPLE ANNEX
TEMPLE ANNEX
REL. SOC. PUMP RM.
WELL #3
WELL #4



CENTRIFUGAL HEAT PUMP UNITS
FOR
LDS CHURCH OFFICE BUILDING
SALT LAKE CITY UTAH

Well No.	pH	Total Dissolved Solids	Bicarbonate (HCO_3^-)	Chloride (Cl^-)	(SO_4^{2-})	(O_2)	(SiO_2)	Carbonate $CACO_3$
1	7.60	641	327	68	192	2.7	18	420
2	7.46	547	332	46	154	5.8	18	420
3	7.86	682	371	82	184	7.4	17	456
4	7.25	830	347	74	194	---	19	430
Avg.	7.54	675	344	68	181	5.3	18	432

Attachment #3


OFFICE BLDG RET
OFFICE BLDG. SUP.
STORM SEWER
STORM SEWER
VC & TEMPLE SUPPLY
VC & TEMPLE RETURN
FIRE SPRINKLER LINE
DIRT LEG
H23
H24
H25
H19
H20
H21
H22
V8
H18
H14
V6
H15
V5
H17
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V7
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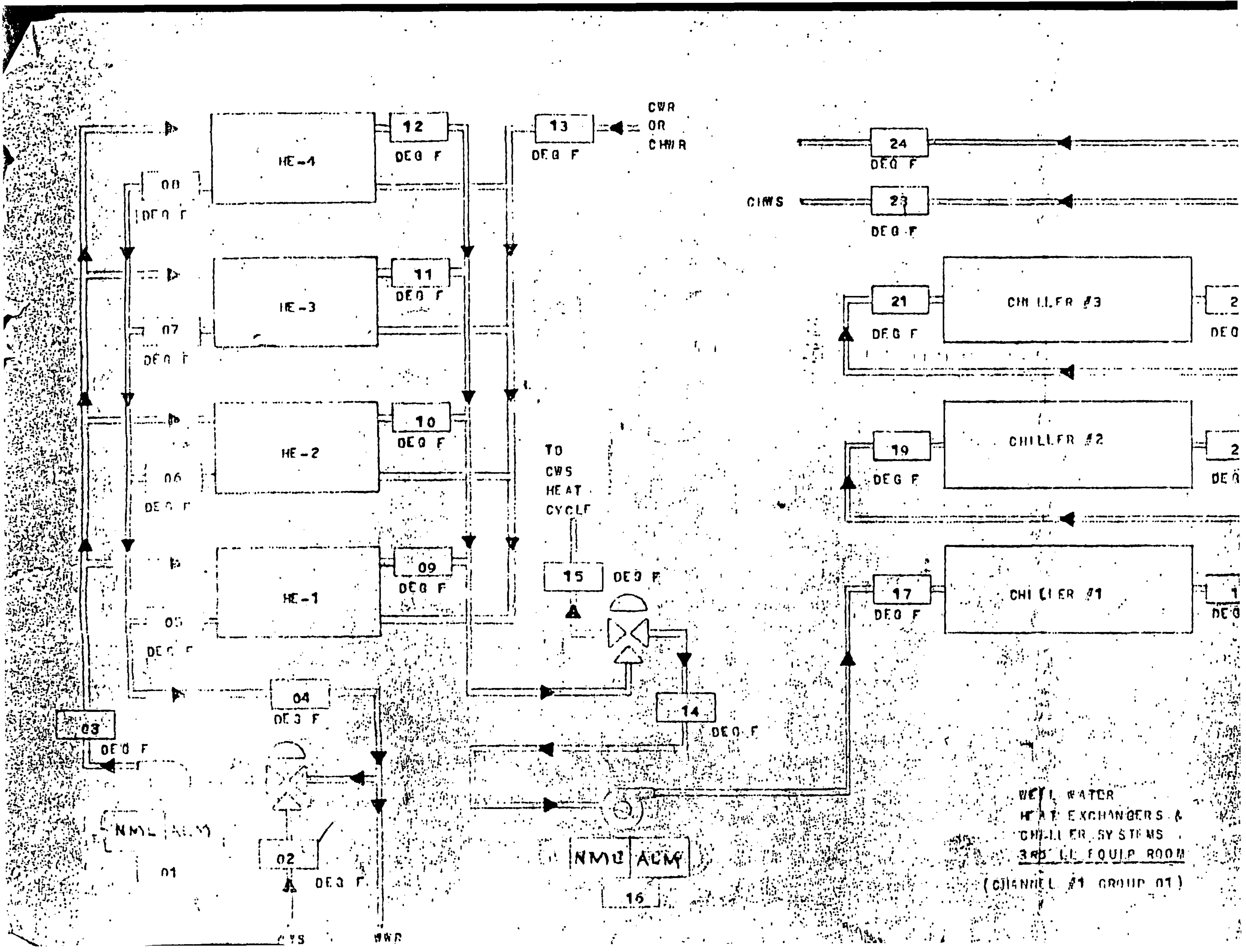
H5
H6
H28
V9
H27
H26
V3
V2
H9
H3
V4
H4
H1
V1
H2
600' TD
WELL #2
2400 GPM
600' TD
WELL #1
2600 GPM
WELL #3 TEMPLE ANNEX
TEMPLE ANNEX
REL. SOC. PUMP RM.
pulled from 900'
1100' TD
WELL #3
2000 GPM
1100' TD
WELL #4
2000 GPM
H = HAND VALVE
V = AUTO VALVE



HE-4
HE-3
HE-2
HE-1
12
11
10
09
13
DEG F
CWR
OR
CHWR
24
23
CHWS
21
19
17
CHILLER #3
CHILLER #2
CHILLER #1
08
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02
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14
15
16
TO
CWS
HEAT
CYCLE
NMU
ACM
WWR
WELL WATER
HEAT EXCHANGERS &
CHILLER SYSTEMS
3RD LL EQUIP ROOM
(CHANNEL #1 GROUP 01)

3 air handlers
6th, 17th, 22nd

provide hot or cold water to
These by 3 heat pumps

Hot 100-110
Cold 47-55

wells 67 hottest
55-57 coldest

wells
1 basement triple
1 N visitors center
2 basement Relief Society

200 HP pumps w/ variable speed

Wells only serve heat pumps