# BASELINE BUILDINGS -REV2 EQUIPMENT SCHEDULE

## WATER-TO-AIR EQUIPMENT

| | | | | | | Cooling | | | | Heating | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Zone** | **Manufacturer** | **Model** | **Tons (nom)** | **QTY** | **Head Loss (ft $H_2O$)** | **Unit Flow (gpm)** | **$EAT_{db}$ (°F)** | **$EAT_{wb}$ (°F)** | **Air Flow (cfm)** | **Unit Flow (gpm)** | **$EAT_{db}$ (°F)** | **Air Flow (cfm)** |
| **ISC_Lib** | Waterfurnace | NB038 (ECM) | 3.00 | 20 | 7.9 | 9.0 | 80.0 | 67.0 | 1,250.0 | 9.0 | 70.0 | 1,250.0 |
| | Waterfurnace | NB049 (ECM) | 4.00 | 20 | 8.9 | 12.0 | 80.0 | 67.0 | 1,550.0 | 12.0 | 70.0 | 1,550.0 |
| | Waterfurnace | NB026 (ECM) | 2.00 | 25 | 6.4 | 6.0 | 80.0 | 67.0 | 900.0 | 6.0 | 70.0 | 900.0 |
| **YEL Buildings-Rev2** | Waterfurnace | NB049 (ECM) | 4.00 | 20 | 8.9 | 12.0 | 80.0 | 67.0 | 1,550.0 | 12.0 | 70.0 | 1,550.0 |
| | Waterfurnace | NB026 (ECM) | 2.00 | 25 | 6.4 | 6.0 | 80.0 | 67.0 | 900.0 | 6.0 | 70.0 | 900.0 |
| | Waterfurnace | NB038 (ECM) | 3.00 | 20 | 7.9 | 9.0 | 80.0 | 67.0 | 1,250.0 | 9.0 | 70.0 | 1,250.0 |
| **ORG Buildings-Rev2** | Waterfurnace | NB038 (ECM) | 3.00 | 20 | 7.9 | 9.0 | 80.0 | 67.0 | 1,250.0 | 9.0 | 70.0 | 1,250.0 |
| | Waterfurnace | NB026 (ECM) | 2.00 | 50 | 6.4 | 6.0 | 80.0 | 67.0 | 900.0 | 6.0 | 70.0 | 900.0 |
| | Waterfurnace | NB049 (ECM) | 4.00 | 50 | 8.9 | 12.0 | 80.0 | 67.0 | 1,550.0 | 12.0 | 70.0 | 1,550.0 |
| **RED Buildings-Rev2** | Waterfurnace | NB049 (ECM) | 4.00 | 55 | 8.9 | 12.0 | 80.0 | 67.0 | 1,550.0 | 12.0 | 70.0 | 1,550.0 |
| | Waterfurnace | NB038 (ECM) | 3.00 | 30 | 7.9 | 9.0 | 80.0 | 67.0 | 1,250.0 | 9.0 | 70.0 | 1,250.0 |
| | Waterfurnace | NB026 (ECM) | 2.00 | 80 | 6.4 | 6.0 | 80.0 | 67.0 | 900.0 | 6.0 | 70.0 | 900.0 |
| | | **Total** | 1,210.00 | 415.0 | | | | | | | | |

# BASELINE BUILDINGS -REV2 EQUIPMENT SCHEDULE

## WATER-TO-WATER EQUIPMENT

| | | | | | | | Cooling | | | | Heating | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Zone** | **Manufacturer** | **Model** | **Tons (nom)** | **QTY** | **Head $Loss_S$ (ft $H_2O$)** | **Head $Loss_L$ (ft $H_2O$)** | **Unit Source Flow (gpm)** | **Unit Load Flow (gpm)** | **$EWT_L$ (°F)** | **$LWT_L$ (°F)** | **Unit Source Flow (gpm)** | **Unit Load Flow (gpm)** | **$EWT_L$ (°F)** | **$LWT_L$ (°F)** |
| **ISC_Lib** | Waterfurnace | NXW120 | 10.00 | 5 | 4.9 | 4.4 | 30.0 | 30.0 | 56.0 | 44.7 | 30.0 | 30.0 | 115.0 | 119.5 |
| **YEL Buildings-Rev2** | Waterfurnace | NXW120 | 10.00 | 10 | 4.9 | 4.4 | 30.0 | 30.0 | 56.0 | 44.7 | 30.0 | 30.0 | 115.0 | 119.5 |
| | Multistack | MS050XN | 50.00 | 7 | 21.3 | 21.3 | 150.0 | 150.0 | 56.0 | 45.7 | 150.0 | 150.0 | 115.0 | 119.5 |
| **ORG Buildings-Rev2** | Multistack | MS050XN | 50.00 | 2 | 21.3 | 21.3 | 150.0 | 150.0 | 56.0 | 45.7 | 150.0 | 150.0 | 115.0 | 119.5 |
| | Waterfurnace | NXW120 | 10.00 | 4 | 4.9 | 4.4 | 30.0 | 30.0 | 56.0 | 44.7 | 30.0 | 30.0 | 115.0 | 119.5 |
| **RED Buildings-Rev2** | Waterfurnace | NXW120 | 10.00 | 10 | 4.9 | 4.4 | 30.0 | 30.0 | 56.0 | 44.7 | 30.0 | 30.0 | 115.0 | 119.5 |
| | Multistack | MS050XN | 50.00 | 6 | 21.3 | 21.3 | 150.0 | 150.0 | 56.0 | 45.7 | 150.0 | 150.0 | 115.0 | 119.5 |
| | | **Total** | 1,040.00 | 44.0 | | | | | | | | | | |

# FUTURE INDIVIDUAL BUILDINGS -REV0

## ENTERING WATER TEMPERATURES

The Entering Water Temperatures defined for all of the equipment operating in this Zone Group are as follows.

**$EWT_{min}$** 30 °F **$EWT_{max}$** 90 °F

## ZONE GROUP DESIGN DAY

The Zone Group Design Day is the aggregated load including all consituent zones and hot water elements in the zone group. The Zone Group Design Day is the loading profile for which the ground loop is sized.

| | Cooling (kBtuh) | Heating (kBtuh) |
|---|---|---|
| **8:00AM-12:00PM** | 13,412.3 | 20,165.4 |
| **12:00PM-4:00PM** | 15,866.0 | 17,553.5 |
| **4:00PM-8:00PM** | 14,750.7 | 17,732.1 |
| **8:00PM-8:00AM** | 9,768.9 | 18,897.7 |

## SPACE SENSIBLE HEAT FACTOR

The zone group space sensible heat factor is the weighted average space sensible heat factor for all zones in the zone group.

**Space Sensible Heat Factor (SHF)** 0.90

## ZONE GROUP CAPACITY

Zone Group Capacity is the aggregated equipment performance defined across all load elements in the Zone Group. These values represent the performance and efficiency of the entire system connected to the loopfield.

| | Cooling | Heating |
|---|---|---|
| **Total Capacity (kBtuh)** | 32,500.1 | 29,573.3 |
| **Sensible Capacity (kBtuh)** | 3,223.0 | --- |
| **Percent Total Sizing** | 204.8 | 146.7 |
| **Efficiency (EER/COP)** | 16.9 | 3.2 |
| **Demand (kW)** | 940.6 | 1,818.9 |

# FUTURE INDIVIDUAL BUILDINGS -REV0 ENERGY SUMMARY

## ANNUAL ENERGY REQUIREMENTS

The following table describes the annual energy requirements of the Zone Group organized by use.

| | Cooling | Heating |
|---|---|---|
| **Space Conditioning (kBtu)** | 24,492,096 | 18,838,760 |
| **Hot Water Generation (kBtu)** | --- | 0 |
| **Total (kBtu)** | 24,492,096 | 18,838,760 |

## ENERGY SOURCES AND SINKS

The following table describes how the annual energy requirements of the Zone Group are distirbuted across system sources and sinks.

| | Cooling | Heating |
|---|---|---|
| | | |
| **Ground Energy (kBtu)** | 24,492,096 | 18,838,760 |
| **Net Ground Energy (kBtu)** | 5,653,336 | |

# FUTURE INDIVIDUAL BUILDINGS -REV0 ACTIVE GHEX

## VERTICAL BORE 1

**Active GHEX Type** Vertically Bored

### GEOMETRY

**Rows** 24 **Bores Per Row** 22 **Number of Bores** 528

**Average C-C Spacing** 20.00 ft

***Length Per Bore***

The required active length for each bore are calculated as follows. The design length is always the longest of the four.

| | Cooling | Heating |
|---|---|---|
| **Y1 LENGTH/BORE (ft)** | 498 | 461 |
| **Y25 LENGTH/BORE (ft)** | 528 | 431 |
| **DESIGN LENGTH/BORE (ft)** | 528 | |

***Length Total***

The required active total bore lengths are calculated as follows. The design length is always the longest of the four.

| | Cooling | Heating |
|---|---|---|
| **Y1 TOTAL LENGTH (ft)** | 262,835 | 243,313 |
| **Y25 TOTAL LENGTH (ft)** | 278,711 | 227,505 |
| **TOTAL DESIGN LENGTH (ft)** | 278,711 | |

### FORMATION PROPERTIES

**Deep Earth Temperature** 58.0 °F

**Thermal Conductivity** 1.40 Btu/hr ft °F **Thermal Diffusivity** 1.05 Btu/hr ft °F

## U-BEND CONFIGURATION

The U-Bend Configuration defines the number and position of u-bends within the bore.

**U-Bend Configuration** Single U-Bend Typical (B/C)

## BOREHOLE DEFINITION

**Bore Diameter** 6.00 in

***Design Path Piping***

The design path piping describes the defined type and size of pipe used within the active section of the ground heat exchanger design.

**Material** HDPE 4710 **Dimension Ratio** 11 **Nominal Diameter** 1.50 in

***Thermal Grout Conductivity***

The installed bore is assumed to have an annulus filled from bottom to top with a grouting material with the following thermal conductivity.

**Thermal Grout Conductivity** 1.20 Btu/hr ft °F

## TEMPERATURE PENALTIES

Temperature penalty describes the change in the deep earth temperature immediately surrounding the installed loopfield after extended periods of system operation.

**Y1 Penalty** 0.37 °F **Y25 Penalty** 2.05 °F

## CIRCULATING FLUID

**Antifreeze Type** Propylene Glycol **Antifreeze Concentration** 20 %

**Freezing Temperature** 19.4 °F

## OPERATING TEMPERATURES

**$EWT_{max}$** 90.0 °F **$EWT_{min}$** 30.0 °F

**$LWT_{max}$** 99.6 °F **$LWT_{min}$** 24.5 °F

## LOOPFIELD DESIGN FLOW

Future Individual Buildings -Rev0 assumes flow is based on Peak Block (Primary-Secondary). Which means, flow is a function of the block flow per ton and the aggregated peak block load for the entire zone group. The interior building loop will be decoupled from the exterior GHEX piping (i.e. - inside flow rate can differ from the outside flow rate).

**Block Flow Per Ton** 3 gpm

| | Cooling | Heating |
|---|---|---|
| **Total Loopfield Flow (gpm)** | 3966.5 | 5041.4 |
| | | |
| **Flow Per Path (gpm)** | 7.5 | 9.5 |
| **Velocity Per Path (ft/s)** | 1.3 | 1.6 |
| | | |
| **Reynold's Number** | 11,835 | 4,403 |
| | | |
| **Head Loss /100ft (ft)** | 0.57 | 1.23 |

A head loss table for a Step-Down Step-Up Reverse-Return (SDSU-RR) header is provided in the appendix.

# Future Individual Buildings -Rev0
# Appendix A: Equipment Schedules

# FUTURE INDIVIDUAL BUILDINGS -REV0 EQUIPMENT SCHEDULE

## WATER-TO-AIR EQUIPMENT

| | | | | | | Cooling | | | | Heating | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Zone** | **Manufacturer** | **Model** | **Tons (nom)** | **QTY** | **Head Loss (ft $H_2O$)** | **Unit Flow (gpm)** | **$EAT_{db}$ (°F)** | **$EAT_{wb}$ (°F)** | **Air Flow (cfm)** | **Unit Flow (gpm)** | **$EAT_{db}$ (°F)** | **Air Flow (cfm)** |
| **GRN Townhouses Future-Rev0** | Samsung | AM055KXW (VRF) | 5.00 | 27 | 8.4 | 15.0 | 80.0 | 67.0 | N/A | 15.0 | 70.0 | N/A |
| **YEL NH-North Future-Rev0** | Samsung | AM096HXW (VRF) | 8.00 | 18 | 5.0 | 18.0 | 80.0 | 67.0 | N/A | 18.0 | 70.0 | N/A |
| **ORG CHEM-Chemistry Future-Rev0** | Samsung | AM096HXW (VRF) | 8.00 | 7 | 8.9 | 24.0 | 80.0 | 67.0 | N/A | 24.0 | 70.0 | N/A |
| **RED Pantas-LJP Future-Rev0** | Samsung | AM096HXW (VRF) | 8.00 | 8 | 8.9 | 24.0 | 80.0 | 67.0 | N/A | 24.0 | 70.0 | N/A |
| **RED Dekalb-DKLB Future-Rev0** | Samsung | AM096HXW (VRF) | 8.00 | 7 | 8.9 | 24.0 | 80.0 | 67.0 | N/A | 24.0 | 70.0 | N/A |
| **ORG MACH-Machinery Future-Rev0** | Waterfurnace | NB026 (ECM) | 2.00 | 50 | 6.4 | 6.0 | 80.0 | 67.0 | 900.0 | 6.0 | 70.0 | 900.0 |
| | Waterfurnace | NB038 (ECM) | 3.00 | 20 | 7.9 | 9.0 | 80.0 | 67.0 | 1,250.0 | 9.0 | 70.0 | 1,250.0 |
| | Waterfurnace | NB049 (ECM) | 4.00 | 50 | 8.9 | 12.0 | 80.0 | 67.0 | 1,550.0 | 12.0 | 70.0 | 1,550.0 |
| **ORG ENG-Engineering Future-Rev0** | Samsung | AM096HXW (VRF) | 8.00 | 12 | 8.9 | 24.0 | 80.0 | 67.0 | N/A | 24.0 | 70.0 | N/A |
| **ORG ELJ-** | Samsung | AM096HXW | 8.00 | 8 | 8.9 | 24.0 | 80.0 | 67.0 | N/A | 24.0 | 70.0 | N/A |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Jones Future-Rev0** | | (VRF) | | | | | | | | | | |
| **ORG THRF-Thrift Future-Rev0** | Samsung | AM072HXW (VRF) | 6.00 | 3 | 5.2 | 18.0 | 80.0 | 67.0 | N/A | 18.0 | 70.0 | N/A |
| **ORG ISC Building Future-Rev0** | Samsung | AM072HXW (VRF) | 6.00 | 10 | 5.2 | 18.0 | 80.0 | 67.0 | N/A | 18.0 | 70.0 | N/A |
| **ORG LIB-Library Future-Rev0** | Samsung | AM096HXW (VRF) | 8.00 | 10 | 8.9 | 24.0 | 80.0 | 67.0 | N/A | 24.0 | 70.0 | N/A |
| **YEL MEM-Memorial Future-Rev0** | Samsung | AM072HXW (VRF) | 6.00 | 6 | 9.2 | 24.0 | 80.0 | 67.0 | N/A | 24.0 | 70.0 | N/A |
| **YEL SU-Student Union Future-Rev0** | Samsung | AM072HXW (VRF) | 6.00 | 6 | 9.2 | 24.0 | 80.0 | 67.0 | N/A | 24.0 | 70.0 | N/A |
| **YEL MAIN Future-Rev0** | Samsung | AM096HXW (VRF) | 8.00 | 12 | 8.9 | 24.0 | 80.0 | 67.0 | N/A | 24.0 | 70.0 | N/A |
| **YEL EAST Future-Rev0** | Samsung | AM072HXW (VRF) | 6.00 | 14 | 5.2 | 18.0 | 80.0 | 67.0 | N/A | 18.0 | 70.0 | N/A |
| **YEL SH-South Hall Future-Rev0** | Samsung | AM072HXW (VRF) | 6.00 | 6 | 5.2 | 18.0 | 80.0 | 67.0 | N/A | 18.0 | 70.0 | N/A |
| | | **Total** | 1,421.00 | 274.0 | | | | | | | | |

# FUTURE INDIVIDUAL BUILDINGS -REV0 EQUIPMENT SCHEDULE

## WATER-TO-WATER EQUIPMENT

| | | | | | | | Cooling | | | | Heating | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zone | Manufacturer | Model | Tons (nom) | QTY | Head $Loss_S$ (ft $H_2O$) | Head $Loss_L$ (ft $H_2O$) | Unit Source Flow (gpm) | Unit Load Flow (gpm) | $EWT_L$ (°F) | $LWT_L$ (°F) | Unit Source Flow (gpm) | Unit Load Flow (gpm) | $EWT_L$ (°F) | $LWT_L$ (°F) |
| **YEL DHW-Rev0** | Waterfurnace | NXW120 | 10.00 | 3 | 4.9 | 4.4 | 30.0 | 30.0 | 56.0 | 44.7 | 30.0 | 30.0 | 115.0 | 119.5 |
| **RED DHW-Rev0** | Waterfurnace | NXW120 | 10.00 | 12 | 4.9 | 4.4 | 30.0 | 30.0 | 56.0 | 44.7 | 30.0 | 30.0 | 115.0 | 119.5 |
| **RED Stabile-SBL Future-Rev0** | Multistack | MS050XN | 50.00 | 2 | 21.3 | 21.3 | 150.0 | 150.0 | 56.0 | 45.7 | 150.0 | 150.0 | 115.0 | 119.5 |
| | Waterfurnace | NXW120 | 10.00 | 2 | 4.9 | 4.4 | 30.0 | 30.0 | 56.0 | 44.7 | 30.0 | 30.0 | 115.0 | 119.5 |
| **GRN ARC Future-Rev0** | Multistack | MS050XN | 50.00 | 5 | 21.3 | 21.3 | 150.0 | 150.0 | 56.0 | 45.7 | 150.0 | 150.0 | 115.0 | 119.5 |
| | Waterfurnace | NXW120 | 10.00 | 5 | 4.9 | 4.4 | 30.0 | 30.0 | 56.0 | 44.7 | 30.0 | 30.0 | 115.0 | 119.5 |
| **RED Steuben-STE Future-Rev0** | Multistack | MS050XN | 50.00 | 4 | 21.3 | 21.3 | 150.0 | 150.0 | 56.0 | 45.7 | 150.0 | 150.0 | 115.0 | 119.5 |
| | Waterfurnace | NXW120 | 10.00 | 2 | 4.9 | 4.4 | 30.0 | 30.0 | 56.0 | 44.7 | 30.0 | 30.0 | 115.0 | 119.5 |
| **GRN DHW-Rev0** | Waterfurnace | NXW120 | 10.00 | 4 | 4.9 | 4.4 | 30.0 | 30.0 | 56.0 | 44.7 | 30.0 | 30.0 | 115.0 | 119.5 |
| **RED Pratt Studios-PS Future-Rev0** | Waterfurnace | NXW120 | 10.00 | 2 | 4.9 | 4.4 | 30.0 | 30.0 | 56.0 | 44.7 | 30.0 | 30.0 | 115.0 | 119.5 |
| | Multistack | MS050XN | 50.00 | 3 | 21.3 | 21.3 | 150.0 | 150.0 | 56.0 | 45.7 | 150.0 | 150.0 | 115.0 | 119.5 |
| **ORG** | Waterfurnace | NXW120 | 10.00 | 3 | 4.9 | 4.4 | 30.0 | 30.0 | 56.0 | 44.7 | 30.0 | 30.0 | 115.0 | 119.5 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DHW-Rev0** | | | | | | | | | | | | | | |
| **ORG MACH-Machinery Future-Rev0** | Waterfurnace | NXW120 | 10.00 | 4 | 4.9 | 4.4 | 30.0 | 30.0 | 56.0 | 44.7 | 30.0 | 30.0 | 115.0 | 119.5 |
| | Multistack | MS050XN | 50.00 | 2 | 21.3 | 21.3 | 150.0 | 150.0 | 56.0 | 45.7 | 150.0 | 150.0 | 115.0 | 119.5 |
| | | **Total** | 1,170.00 | 53.0 | | | | | | | | | | |