MUNCH'S SUPPLY EST. 1956

Reference Guide

HYDRONIC FORMULAS

COMPUTING FLOW FROM BTU/h	
Simplified formula	GPM = BTU/h ÷ (Δt x 500)
Example: Determine the flow of 286,000 BTU/h at a 20°F differential temperature.	GPM = 286,000 ÷ (20 x 500) GPM = 286,000 ÷ 10,000 GPM = 28.6

CALCULATING ACTIVE LOOP LENGTH	
Note: The leader length must be added to the active loop length in order to obtain the total loop length.	Room ft^2 x 1.0 = active loop at 12" o.c. Room ft^2 x 1.2 = active loop at 10" o.c. Room ft^2 x 1.33 = active loop at 9" o.c. Room ft^2 x 1.5 = active loop at 8" o.c. Room ft^2 x 1.7 = active loop at 7" o.c. Room ft^2 x 2.0 = active loop at 6" o.c.

AMOUNT OF JOIST TRAK™ PANELS (A5080375, A5080500)
Active loop length x 0.2125

AMOUNT OF QUIK TRAK™ PANELS (A5060701) AND RETURNS (A5060702)
Room ft^2 x 0.386 (panels)
Room ft^2 x 0.386 (panels)

AMOUNT OF PEX CLIPS (F7060375, F7051258, F7057500, F7051001)
Active Loop Length ÷ 3

FLOOR SURFACE TEMPERATURE
(BTU/h/ ft^2 ÷ 2.0) + Room setpoint

SUPPLY FLUID TEMP. AFTER FIRST INJECTION POINT ON PRIMARY LOOP	
$(F_A \times T_A) + (F_B \times T_B) = (F_C \times T_C)$	
F_A = Primary flow rate after injection leg F_B = Flow rate for return injection leg F_C = Primary flow rate after return leg T_A = Primary temp. after injection leg T_B = Return temp. on return injection leg T_C = Primary temp. after return leg	
Example: Given the detail above, calculate the primary loop (boiler loop) temperature after the first injection location.	(7 x 180) + (3 x 160) = 10x 1260 + 480 = 10x 1740 = 10x The primary loop temperature after the first injection location is 174°F.

INJECTION PUMP FLOW RATES	
$F_V = (F_1 \times T_D) \div (T_1 - T_R)$	
F_V = Flow rate (injection loop) in gpm F_1 = Radiant (secondary loop) flow rate in gpm T_1 = Boiler (primary loop) supply temp. T_2 = Radiant (secondary loop) supply temp. T_R = Radiant (secondary loop) return temp. T_D = Radiant (secondary loop) differential temp.	
Example: If values at design condition are: F_1 = 30 gpm T_1 = 180°F T_2 = 130°F T_R = 120°F T_D = 10°F	Find the injection pump flow rate. F_V = (30 x 10) ÷ (180 - 120) F_V = (300) ÷ (60) F_V = 5 gpm

LOADED FOR MOTORIZED VALVE ACTUATORS (MVA) Computed at a minimum 10% line loss
MVA draw: 0.29 amps Amps x volts = current 0.29 x 24 = 6.96 VA per MVA
Example: 50 VA ÷ 6.96 VA = 7.18 x 0.9 = 6.5 (10%) 6 MVA per 50 VA transformer 40VAC transformer = 5 MVA 50VAC transformer = 6 MVA 75VAC transformer = 9 MVA 100VAC transformer = 12 MVA

LOADED FOR THERMAL ACTUATORS (TA) Computed at a minimum 10% line loss
TA initial draw: 0.1458 amps Amps x volts = current 0.1458 x 24 = 3.5 VA per TA
Example: 50 VA ÷ 3.5 VA = 14.29 14.29 x 0.9 = 12.83 (10% reduction) 12 TAs per 50 VA transformer 40VAC transformer = 10 TA 50VAC transformer = 12 TA 75VAC transformer = 19 TA 100VAC transformer = 25 TA

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Refer to manufacturer's instructions and local codes.

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HYDRONIC FORMULAS

Continued ...

LOADED FOR THERMAL ACTUATORS (TA) Computed at a minimum 10% line loss
Fuel consumption based on degree day:

$$F = \frac{HL \times 24 \times DD}{E \times P \times TD}$$

HL = Heating load (BTU/h)

24 = Hours in a day

DD = Degree day

E = Boiler efficiency (AFUE)

P = Heating value of fuel (BTU)

TD = Temperature differential

F = Annual fuel consumption

Example: A 40,000 square-foot hangar in Bangor, Maine using an 82% AFUE oil boiler (Number 2 fuel oil). The heat load for the hangar is 1,288,128 BTU/h at design. Outside design temperature is -11°F with an indoor setpoint temperature of 65°F. Number 2 fuel oil is priced at $0.80 per gallon.

$$F = \frac{1{,}288{,}128 \times 24 \times 8{,}220}{0.82 \times 138{,}000 \times 76}$$

$$F = \frac{254{,}121{,}891.840}{8{,}662{,}480}$$

F = 29,335.93 gallons of fuel oil

F = 29,335.93 x 0.80 = $23,469/season

FUEL COMPARISON IN BTU	
Natural Gas	100,000 BTU per 1 CCF (1 therm.)
Propane	91,800 BTU per gallon
No. 2 Fuel Oil	139,000 BTU per gallon
Kerosene	134,000 BTU per gallon
Electric	3,412 BTU per Kilowatt Hour (KWH)
Wood	14,000,000 BTU per cord (mixed)

SUPPLY AND RETURN PIPE SIZING (AT A 10°F ∆t)

Tubing	BTU/h	GPM	Pipe Size (in.)
Copper	10K - 20K	2-4	¾"
	20K - 45K	4-9	1"
	30K - 80K	6-16	1 ¼"
	50K - 105K	10-21	1 ½"
	100K - 225K	20-45	2"
Multi-layer Composite (MLC)	10K - 20K	2-4	¾"
	20K - 45K	4-8	1"
PEX (Wirsbo hePEX™ and Uponor AquaPEX®)	2.5K - 10K	0.5-2	½"
	5K - 15K	1-3	¾"
	15K - 25K	3-5	1"
	20K - 45K	4-9	1 ¼"
	30K - 70K	6-14	1 ½"
High-density Polyethylene (HDPE)	75K - 205K	15-41	2"
	150K - 575K	30-115	3"
	250K - 1,125K	50-225	4"

BOILER MAIN PIPE SIZING (AT A 20°F ∆t)

Tubing	BTU/h	GPM	Pipe Size (in.)
Copper	20K - 40K	2-4	¾"
	40K - 90K	4-9	1"
	60K - 160K	6-16	1 ¼"
	100K - 210K	10-21	1 ½"
	200K - 450K	20-45	2"

HYDRONIC FORMULAS

ZONING MADE EASY

RULES OF THUMB

FLOW RATE

$$\frac{\text{NET BTUh LOAD}}{10{,}000} = \text{FLOW RATE}$$

MAXIMUM FLOW RATE

Pipe size (Copper)	Maximum Flow Rate
½"	1 ½ gpm
¾"	4 gpm
1"	8 gpm
1 ¼"	14 gpm

MAXIMUM FLOW RATE & HEAT CARRYING CAPACITY

Pipe size (Copper)	Maximum Flow Rate	Heat Carrying Capacity
½"	1 ½ gpm	15,000 BTUh
¾"	4 gpm	40,000 BTUh
1"	8 gpm	80,000 BTUh
1 ¼"	14 gpm	140,000 BTUh

(Based on 20°F temperature drop across the system.)

MAXIMUM LENGTH OF FIN-TUBE BASEBOARD LOOP

Baseboard Size (Copper)	Typical BTUh per Linear Foot	Maximum Length of Baseboard Loop
½"	600	25'
¾"	600	67'
1"	770	104'
1 ¼"	790	107'

(Based on 180°F average water temperature and a 20°F temperature drop across the system.)

MAXIMUM LENGTH OF FIN-TUBE BASEBOARD LOOP

1. Measure the longest run in feet.
2. Add 50% to this.
3. Multiply that by .04 ... and that's the pump head!

Bell & Gossett®

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