

SUTTON MECHANICAL & ENVIRONMENTAL

Mechanical Engineering Design Services

HVAC Load Calculation Report

Project: FarmWild Orangery (2026-12) | Client: FarmWild | Date: 2026-09-30

Design Criteria

Field	Value
Indoor Design Temp Summer (F)	80
Indoor Design Temp Winter (F)	60
Outdoor Design Temp Summer (F)	92
Outdoor Design Temp Winter (F)	-4
Ventilation Standard	ASHRAE 62.1
Cooling Safety Factor	1.15
Heating Safety Factor	1.25
Elevation (ft)	3570
Location/City	Hamilton, MT
Electrical Service Spare Capacity (%)	
Electrical Feeder VD Limit (%)	
Roof Live Load (psf)	
Snow Exposure Factor Ce	

Energy Model Input Basis (building.yaml)

Site & Design Days

Parameter	Value
Location	Hamilton, MT
Latitude / Longitude	46.25 / -114.16
Site Elevation	3570.0 ft (EnergyPlus pressure-corrects air density to this elevation)
Summer Design Day	92.0 F DB / 62.0 F WB (ASHRAE 0.4%-style cooling design condition)
Winter Design Day	-4.0 F DB (ASHRAE 99.6%-style heating design condition; no solar at the pre-dawn heating peak)

Envelope Constructions

Scope	Construction Basis
Global	Wall R-17.0 / Roof R-30.0 (ft ² -F-h/Btu); window U-0.29, SHGC 0.27; WWR 0.0
HALL	override: wall R-3.4 / roof R-17.0; explicit S-facing window, 75% of that wall (global window U/SHGC)

Zone Model Inputs

Zone	Area (ft ²)	Floor	Space Type	ft ² /person	LPD/EPD (W/ft ²)	Clg/Htg SP (F)	OA (cfm/persons + cfm/ft ²)	System
HALL	1800	MAIN (h=12.0 ft)	multius e_assembly	18.2	0.7 / 0.3	80.0 / 60.0	7.5 + 0.06	IR-1/2
TR1	50	MAIN (h=12.0 ft)	toilet_room	50	0.8 / 0.2	85.0 / 65.0	0.0 + 0.0	EWB
TR2	50	MAIN (h=12.0 ft)	toilet_room	50	0.8 / 0.2	85.0 / 65.0	0.0 + 0.0	EWB
TR3	50	MAIN (h=12.0 ft)	toilet_room	50	0.8 / 0.2	85.0 / 65.0	0.0 + 0.0	EWB
MECH-JAN	45	MAIN (h=12.0 ft)	janitor	45	0.6 / 2.0	90.0 / 50.0	0.0 + 0.0	EWB
STAGING	255	MAIN (h=12.0 ft)	kitchen_commercial	42.5	1.0 / 20.0	85.0 / 60.0	7.5 + 0.18	EUH-1

Internal gains (people, lights, equipment) follow a weekday occupied schedule of 12:00-23:00 local standard time at full load, 10% minimum otherwise; design days are modeled as weekdays. Outdoor-air rates above are delivered and conditioned by each zone's ideal-loads system, so reported loads INCLUDE ventilation/infiltration conditioning energy.

Zone Load Summary

Zone ID	Name	Area (ft ²)	Occupancy	Cooling Load (Btuh)	Heating Load (Btuh)	Supply CFM	OA CFM	System
Z01	HALL	1800	98.9	42460	92640	1325	850	IR-1/2
Z02	TR1	50	1	732	1631	46	0	EWB
Z03	TR2	50	1	734	1632	46	0	EWB

Z04	TR3	50	1	734	1633	46	0	EWH
Z05	MECH-JAN	45	1	816	1149	34	0	EWH
Z06	STAGING	255	6	20336	9337	808	91	EUH-1

System Totals

System ID	Type (RTU/Split/AHU/VAV/Chiller/Boiler/EF...)	Serves Zones	Total Cooling (MBH)	Total Heating (MBH)	Total CFM
IR-1/2	Gas IR Tube Heater	HALL	42.5	92.6	1325
EWH	Electric Wall Heater	TR1, TR2, TR3, MECH-JAN	3	6	171
EUH-1	Electric Unit Heater	STAGING	20.3	9.3	808

Equipment Schedule (Draft Capacities)

Tag	Type	Description	Capacity	CFM	Electrical (V/Ph)	MCA	Basis of Design (Mfr/Model)	Weight (lb)	Notes
EF-1	EF	Exhaust fan serving TR1 -- 0.5 in wg	70 CFM @ 0.5 in wg	70	120/1	1			Sizing basis: 70 cfm/WC x 1 WC per ASHRAE 62.1 / IMC 403 toilet-room exhaust rates; interm

									ittent (occupancy/s witch) operation. [auto] (MCA est. per electrical_rules.yaml mca_estimate -- replace with vendor data)
EF-2	EF	Exhaust fan serving TR2 -- 0.5 in wg	70 CFM @ 0.5 in wg	70	120/1	1			Sizing basis: 70 cfm/ WC x 1 WC per ASHRAE 62.1 / IMC 403 toilet-room exhaust rates; intermittent (occupancy/s witch) operation. [auto] (MCA est. per

									electrical_rules.yaml mca_estimate -- replace with vendor data)
EF-3	EF	Exhaust fan serving TR3 -- 0.5 in wg	70 CFM @ 0.5 in wg	70	120/1	1			Sizing basis: 70 cfm/WC x 1 WC per ASHRAE 62.1 / IMC 403 toilet-room exhaust rates; intermittent (occupancy/switch) operation. [auto] (MCA est. per electrical_rules.yaml mca_estimate -- replace with vendor data)

EF-4	EF	Exhaust fan serving MECH -JAN -- 0.5 in wg	50 CFM @ 0.5 in wg	50	120/1	1			Sizing basis: 1.00 cfm/ft ² x 45 ft ² (janitor) per ASHRAE 62.1 / IMC 403 toilet-room exhaust rates; continuous operation. [auto] (MCA est. per electrical_rules.yaml mca_estimate -- replace with vendor data)
EF-5	EF	Wall propelled exhaust fan serving STAGING -- 0.1 in wg	400 CFM @ 0.1 in wg	400	120/1	2			[manual] Not a code exhaust, so the pipeline does not size it. Engineering

									judgm ent for holdin g- cabine t heat, about 20 air chang es in STAGI NG. Therm ostat 85 F plus manua l switch , wall sleeve and shutte r. Match es M-601 note 3. (MCA est. per electri cal_rul es.ya ml mca_e stimat e -- replac e with vendo r data)
IR-1/2	Gas IR Tube Heater	Gas IR Tube Heater -- heat only, 92.6 MBH peak x	2 x 57.9 MBH		120/1	5			(MCA est. per electri cal_rul es.ya ml mca_e

		1.25 heatin g SF = 115.8 MBH output requir ed over 2 units							stimat e -- replac e with vendo r data)
EWB	Electri c Wall Heater	Electri c Wall Heater -- heat only, 6.0 MBH peak x 1.25 heatin g SF = 7.6 MBH output requir ed over 4 units	4 x 1.9 MBH		240/1	12			(MCA est. per electri cal_rul es.ya ml mca_e stimat e -- replac e with vendo r data)
EUH-1	Electri c Unit Heater	Electri c Unit Heater -- heat only, 9.3 MBH peak x 1.25 heatin g SF = 11.7 MBH output requir ed	11.7 MBH		240/1	18			(MCA est. per electri cal_rul es.ya ml mca_e stimat e -- replac e with vendo r data)

Methodology

Zone and system peak heating and cooling loads were computed using EnergyPlus 26.1.0 design-day (ASHRAE-style) sizing simulations, run without a weather file (design-day-only

mode). Each zone was modeled as an independent rectangular envelope box with exterior walls, roof, and a ground-coupled slab floor, served by a ZoneHVAC:IdealLoadsAirSystem sized to include both the zone's own sensible/latent load and the energy required to condition outdoor ventilation air per the project's ASHRAE 62.1-style outdoor air rates. Reported Equipment Schedule capacities apply a Cooling Safety Factor of 1.15 and a Heating Safety Factor of 1.25 (per the Design Criteria tab) before rounding up to the nearest standard nominal equipment size. This is a first-pass design-day sizing study intended to establish equipment tonnage and airflow for schematic/design development; it is not a substitute for a full annual energy model or a detailed Manual J/N-style calculation, and simplifications noted in build_model.py (box-per-zone geometry, no shading, simplified slab-on-grade resistance) apply.

Load source: peak of the eplusout.csv "Zone Ideal Loads Supply Air Total Cooling/Heating Rate" timestep series per zone -- the TOTAL (sensible + latent) load the equipment must deliver, including outdoor-air conditioning (the .eio "Zone Sizing Information" sensible-only value would under-count equipment duty). Airflow (CFM) basis: peak CURRENT (site/local) density volumetric flow, computed from the ideal-loads supply-air mass flow rate and each timestep's actual supply air temperature at this site's elevation-corrected barometric pressure -- the reported CFM values are therefore already altitude-corrected and safe to use directly for fan and duct selection with no further density adjustment.

Equipment Sizing Basis & Trace

The values below reproduce the DESIGN.xlsx "Equipment Sizing" tab: every constant traces to a named key in design-tools\rules\equipment_rules.yaml or a Design Criteria tab override, and every Equipment Schedule capacity shows its inputs, the rule cited, and the intermediate arithmetic so any row can be hand-verified with a calculator.

Assumptions & Basis

Reference data source: C:\Users\mikes\OneDrive\Documents\Claude\design-tools\rules\equipment_rules.yaml *[Edit equipment_rules.yaml directly to change any conversion/tonnage-ladder/CFM-rounding assumption -- loads_to_schedule.py reads it fresh on every run.]*

Load source: eplusout.csv IdealLoads Supply Air Total Cooling/Heating Rate, PEAK over the design-day timestep series (IDEALLOADS_<zone> columns) *[This is the TOTAL (sensible + latent, including outdoor-air conditioning) load the equipment actually has to deliver -- NOT the .eio 'Zone Sizing Information' number, which is the zone's own sensible load only and under-counts OA conditioning in a dry/high-OA climate (see build_model.py Output:Variable comments).]*

W -> tons conversion: 3.412142 Btu/hr per W (equipment_rules.yaml w_to_btuh); 12,000 Btu/hr per ton (equipment_rules.yaml btuh_per_ton); equivalently 3516.85 W/ton (equipment_rules.yaml w_per_ton) *[tons = (peak_W * w_to_btuh) / btuh_per_ton = peak_W / w_per_ton (both paths give the same number -- listed both ways since "W/ton" is the more common shorthand in the field).]*

Cooling Safety Factor: 1.15 (Design Criteria tab) *[Design Criteria tab "Cooling Safety Factor" field, falling back to equipment_rules.yaml cooling_safety_factor_default if blank. Applied to raw E+ coincident peak tons before nominal-size rounding.]*

Heating Safety Factor: 1.25 (Design Criteria tab) *[Design Criteria tab "Heating Safety Factor" field, falling back to equipment_rules.yaml heating_safety_factor_default if blank. Reported alongside Capacity as MBH -- not currently applied to a separate heating-equipment nominal-size ladder (no gas-furnace-stage table in this codebase yet).]*

Refrigeration / product-pulldown allowance: Design Criteria tab "Product Pulldown Allowance (tons)" (project-specific -- see that tab's "Product Pulldown Basis" field for the derivation), falling back to equipment_rules.yaml product_pulldown_allowance_tons_default = 0 if absent *[Added on top of the safety-factored coincident cooling load ONLY for systems carrying a `plant:` block in building.yaml (chiller-plant aggregation) -- covers field heat from incoming product / defrost, which EnergyPlus's IdealLoads does not model.]*

Nominal tonnage ladder (single-unit systems): [1.5, 2, 2.5, 3, 4, 5, 6, 7.5, 10, 12.5, 15, 20, 25, 30, 40, 50] *[equipment_rules.yaml standard_tons -- raw tons (after Cooling SF) rounds UP to the smallest ladder entry >= the requirement. A requirement above the largest entry is FLAGGED, not silently truncated.]*

Nominal tonnage ladder (plant/aggregated systems): [20, 25, 30, 40, 50, 60, 70, 80, 90, 100, 120, 150, 200] *[equipment_rules.yaml plant_standard_tons -- used only for systems carrying a `plant:` block (whole-building coincident load, too large for the single-unit ladder above).]*

CFM basis: Peak of a CURRENT (site/local) density volumetric airflow computed from eplusout.csv IdealLoads Supply Air Mass Flow Rate [kg/s] / actual local air density (site pressure x actual supply air temperature, ideal gas law -- see parse_csv_peaks()/site_barometric_pa()), rounded to the nearest 50 cfm (equipment_rules.yaml cfm_round_to) *[Site elevation 3570 ft (building.yaml location.elevation_ft), barometric pressure 88918 Pa (same standard-atmosphere formula as build_model.py's SizingPeriod:DesignDay Barometric_Pressure field). NOTE: EnergyPlus's own 'Standard Density Volume Flow Rate' output (previously used here) is NOT a sea-level-uncorrected figure as once assumed in this codebase -- eplusout.eio confirms EnergyPlus computes 'StdRhoAir' from this SITE's actual elevation-adjusted pressure already (Site:Location line: Standard Pressure/RhoAir at Elevation), just at a fixed 20C reference temperature. So the only real gap between 'standard' and 'current' density here is TEMPERATURE (actual supply air T, ~55F cooling to ~105F+ heating, vs. the 20C/68F reference) -- a smaller correction (roughly 1.05-1.08x at this elevation) than the ~1.13-1.14x once assumed from the (incorrect) sea-level premise. This computed current-density CFM is the true site-corrected actual airflow and is safe to use directly for fan/duct velocity selection with no further manual correction. (Switched from Standard Density column to this computed Current Density value 2026-08-02; TONNAGE is unaffected since it derives from the density-independent Total Cooling/Heating Rate (W) columns.)]*

Glycol GPM per ton (plant systems only): 2.59 (equipment_rules.yaml glycol_gpm_per_ton_25pct_pg_10f_dt) *[25%% PG, 10F design dT -- used only for a plant system's pump GPM estimate; see design-tools\rules\pipe_rules.yaml glycol: block for the pipe-sizing use of the same convention.]*

Per-Equipment Derivations

IR-1/2 (Gas IR Tube Heater) -- serves HALL

Inputs: zone(s) HALL: eplusout.csv IdealLoads Total Heating Rate peak = 92.6 MBH

Rule / Basis Cited: building.yaml system heat_only: true, count 2; Heating SF 1.25 (Design Criteria tab)

Intermediates: $92.6 \text{ MBH} \times 1.25 = 115.8 \text{ MBH} / 2 = 57.9 \text{ MBH}$ output each

Result: **Capacity 2 x 57.9 MBH; Heating 92.6 MBH; (heat only -- cooling tonnage not scheduled (3.54 ton raw cooling peak is informational))**

EWB (Electric Wall Heater) -- serves TR1, TR2, TR3, MECH-JAN

Inputs: zone(s) TR1, TR2, TR3, MECH-JAN: eplusout.csv IdealLoads Total Heating Rate peak = 6.0 MBH

Rule / Basis Cited: building.yaml system heat_only: true, count 4; Heating SF 1.25 (Design Criteria tab)

Intermediates: $6.0 \text{ MBH} \times 1.25 = 7.6 \text{ MBH} / 4 = 1.9 \text{ MBH}$ output each

Result: **Capacity 4 x 1.9 MBH; Heating 6 MBH; (heat only -- cooling tonnage not scheduled (0.25 ton raw cooling peak is informational))**

EUH-1 (Electric Unit Heater) -- serves STAGING

Inputs: zone(s) STAGING: eplusout.csv IdealLoads Total Heating Rate peak = 9.3 MBH

Rule / Basis Cited: building.yaml system heat_only: true, count 1; Heating SF 1.25 (Design Criteria tab)

Intermediates: $9.3 \text{ MBH} \times 1.25 = 11.7 \text{ MBH} / 1 = 11.7 \text{ MBH}$ output each

Result: **Capacity 11.7 MBH; Heating 9.3 MBH; (heat only -- cooling tonnage not scheduled (1.69 ton raw cooling peak is informational))**

Hand-Verification Walkthroughs