MASTER PLANNING and DECISION GUIDE for MECHANICAL SYSTEMS

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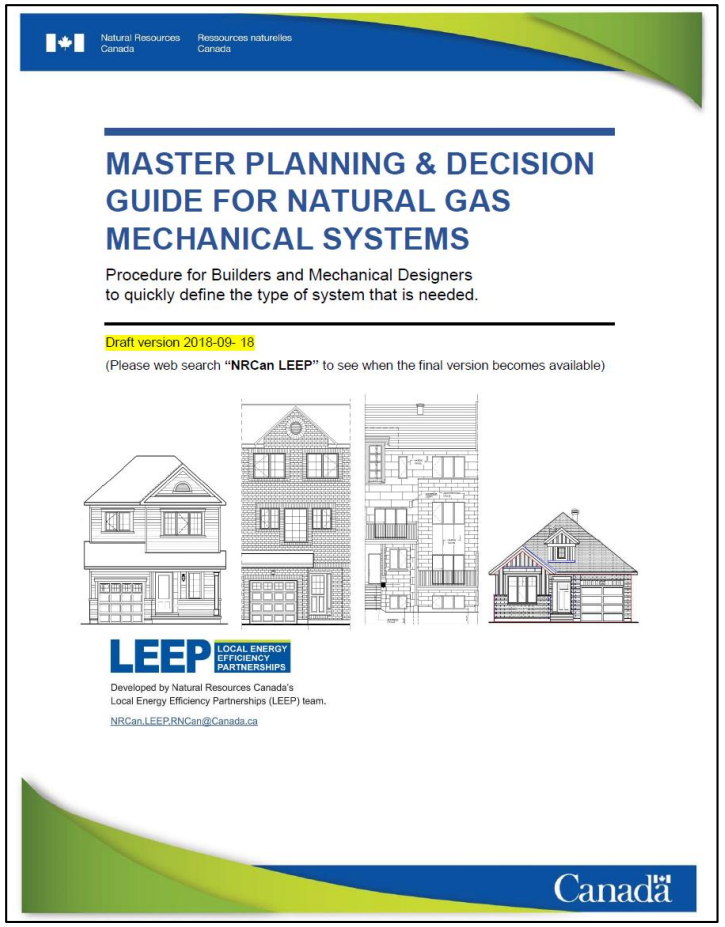
City of New Westminster's Builder & Designer Breakfast | March 21st, 2019

AGENDA

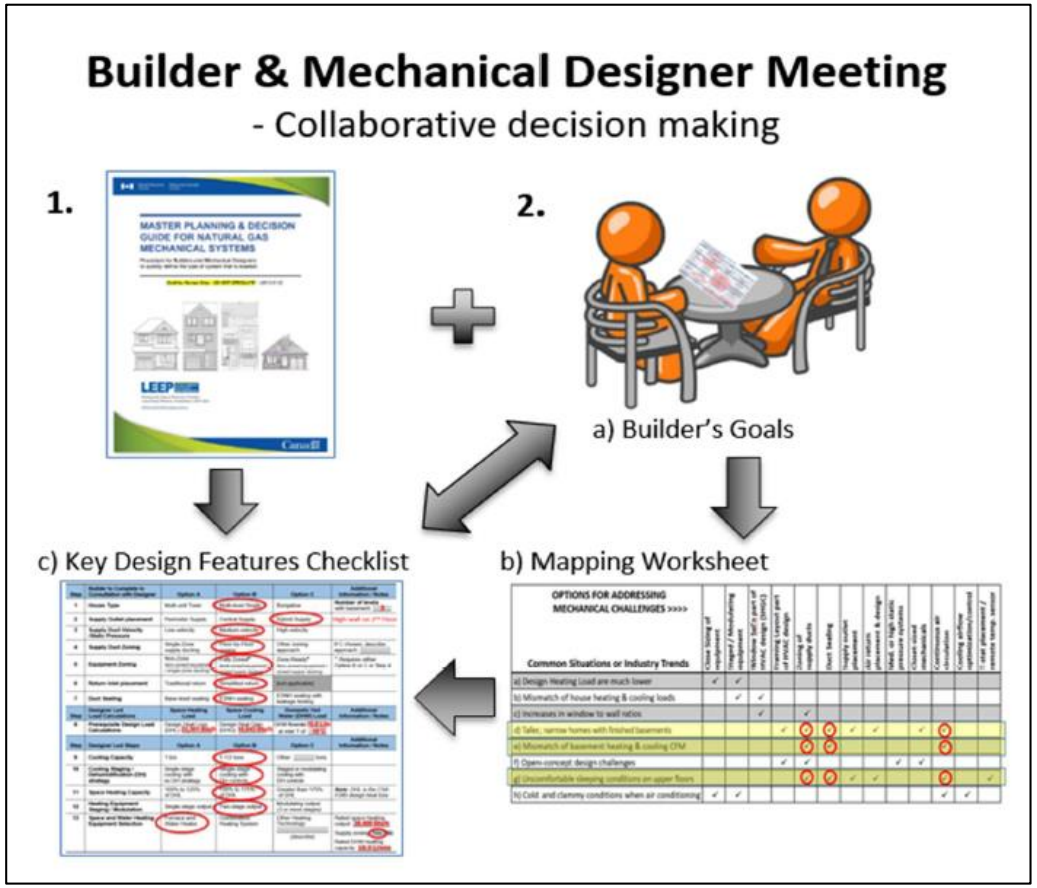
1. Introduction to the Mechanical Guide
2. Benefits of Mechanical Guide
3. Key Components & Considerations
    - Builder Consultation
    - Load Calculations
    - Mechanical Design
    - Verification of Performance
4. Case Study of Local Project
5. Key Takeaways
6. Q&A



INTRODUCTION TO GUIDE

- Aim of this publication is to provide builders and mechanical HVAC designers with a framework for collaboration on the type of mechanical design to use for individual homes and for larger developments.

- Guide provides a structured format to define, discuss and finalize key design features for forced-air heating and central cooling systems.



BENEFITS OF GUIDE FOR BUILDERS

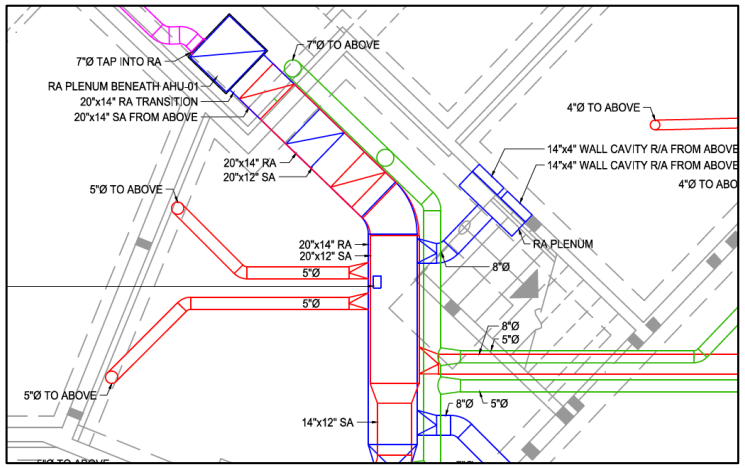
"The Guide is an important tool to help builders know what to do next with the HVAC system to improve comfort and efficiency, while maintaining affordability for homebuyers."

John Meinen, Builder
Pinnacle Quality Homes (Ontario)

What are the Guide's benefits for builders?

- ✓ Address changes in housing form, style, design and construction that have impacted the mechanical needs of today's housing.
- ✓ Improve homebuyer comfort and help manage their energy costs.
- ✓ Provide saleable benefits that are easy to understand.
- ✓ Help manage risk of call-backs while controlling costs associated with HVAC system design.

BENEFITS OF GUIDE FOR MECHANICAL DESIGNERS



"The Guide takes the guesswork out of offering better systems to my clients. At the end of the process, my client knows what to expect and I know what to design."

Dara Bowser, Mechanical Designer, Bowser Technical Inc. (Ontario)

What are the Guide's benefits for HVAC designers?

- ✓ Facilitate discussion and collaboration with builders to deliver HVAC system designs that address builder goals.
- ✓ Support HVAC system design from "business as usual" to new approaches that deliver enhanced benefits and value to the builder and homebuyer.
- ✓ Provides a structured review process to give the mechanical designer permission to make design changes that will improve home comfort, efficiency and aesthetics.

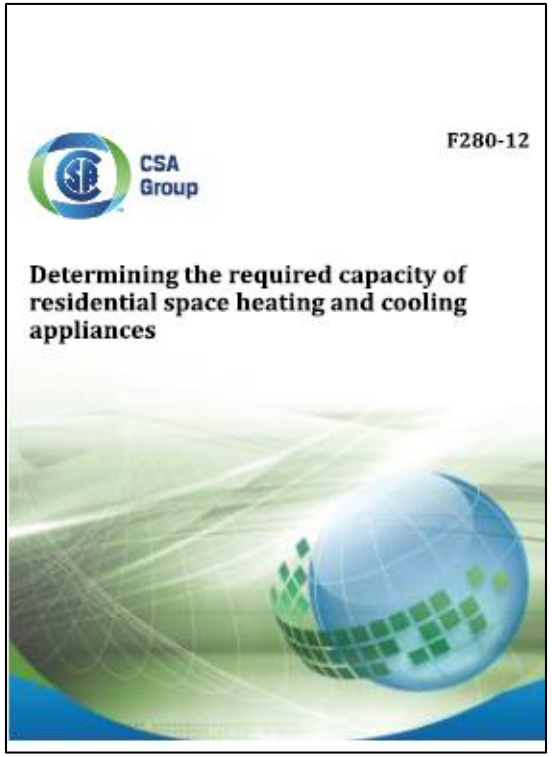
BUILDER CONSULTATION

- Ensure builder needs and project imperatives are established upfront. Consultation will help determine the most appropriate HVAC system for the project with respect to the following considerations:

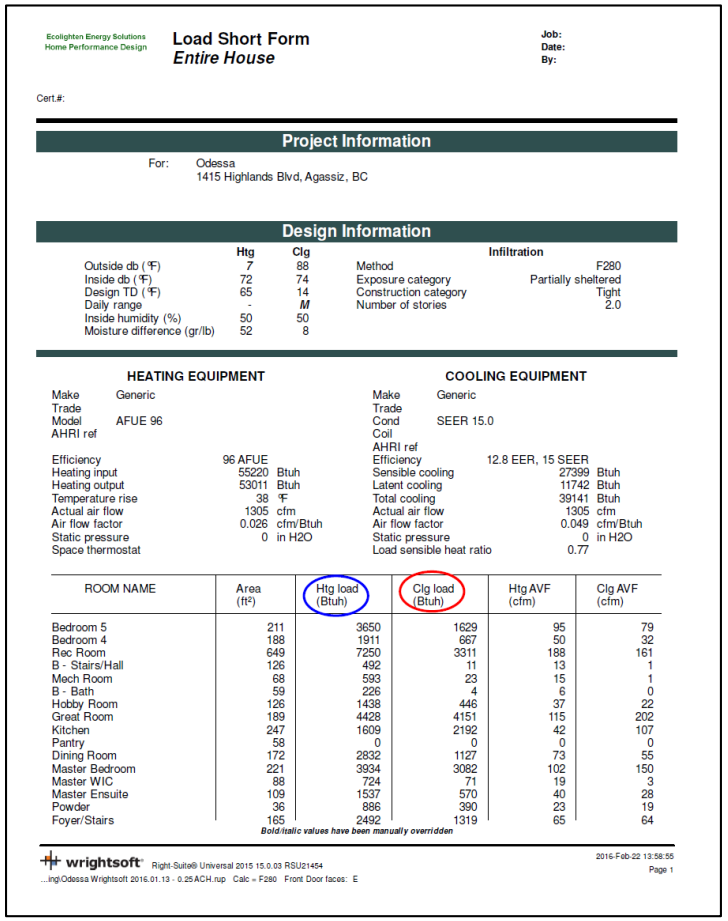
  - **Housing Type** – Low-rise attached houses and multi-level / single-storey houses.
  - **Financial** – Budgets, value and costs/benefit.
  - **Compliance Requirements** – Energy Step Code and HVAC design requirements unique to municipalities.
  - **Comfort & Health** – Occupant expectations, indoor air quality and humidity controls.
  - **Design/Construction Coordination** – Integrating HVAC with structural, architectural and interior design.
  - **Fuel Source & Systems** – Gas, electric and geothermal. Forced air, radiant or hybrid.

LOAD CALCULATIONS

- Carrying out CSA F280-12 heat loss/gain analysis will right size heating and cooling systems, improve comfort, and reduce your build cost.
- Room-by-room load calculations to CSA F280-12 is a code requirement under BC Building Code.
- Make sure your heat loss/gain is completed using a solution that conforms with CSA F280-12 (both software and experienced practitioner).
- CSA F280-12 standard helps builders avoid issues such as:
    - Drastically oversized heating equipment and undersized cooling equipment.
    - Poorly sized ductwork with too large and too many bulkheads.
    - Short cycling equipment.



WHAT TO LOOK FOR IN A LOAD CALCULATION



Ecolighten Energy Solutions
Home Performance Design

Load Short Form
Entire House

Job:
Date:
By:

Cert.#:

Project Information

For: Odessa
1415 Highlands Blvd, Agassiz, BC

Design Information

	Htg	Clg		
Outside db (°F)	7	88	Infiltration Method	F280
Inside db (°F)	72	74	Exposure category	Partially sheltered
Design TD (°F)	65	14	Construction category	Tight
Daily range	-	*M*	Number of stories	2.0
Inside humidity (%)	50	50		
Moisture difference (gr/lb)	52	8		

HEATING EQUIPMENT

Make Generic
Trade
Model AFUE 96
AHRI ref

Efficiency	96 AFUE	
Heating input	55220	Btuh
Heating output	53011	Btuh
Temperature rise	38	°F
Actual air flow	1305	cfm
Air flow factor	0.026	cfm/Btuh
Static pressure	0	in H2O
Space thermostat		

COOLING EQUIPMENT

Make Generic
Trade
Cond SEER 15.0
Coil
AHRI ref

Efficiency	12.8 EER, 15 SEER	
Sensible cooling	27399	Btuh
Latent cooling	11742	Btuh
Total cooling	39141	Btuh
Actual air flow	1305	cfm
Air flow factor	0.049	cfm/Btuh
Static pressure	0	in H2O
Load sensible heat ratio	0.77	

ROOM NAME	Area (ft²)	Htg load (Btuh)	Clg load (Btuh)	Htg AVF (cfm)	Clg AVF (cfm)
Bedroom 5	211	3650	1629	95	79
Bedroom 4	188	1911	667	50	32
Rec Room	649	7250	3311	188	161
B - Stairs/Hall	126	492	11	13	1
Mech Room	68	593	23	15	1
B - Bath	59	226	4	6	0
Hobby Room	126	1438	446	37	22
Great Room	189	4428	4151	115	202
Kitchen	247	1609	2192	42	107
Pantry	58	0	0	0	0
Dining Room	172	2832	1127	73	55
Master Bedroom	221	3934	3082	102	150
Master WIC	88	724	71	19	3
Master Ensuite	109	1537	570	40	28
Powder	36	886	390	23	19
Foyer/Stairs	165	2492	1319	65	64

Bold/italic values have been manually overridden

wrightsoft Right-Suite® Universal 2015 15.0.03 RSU21454
...ing\Odessa Wrightsoft 2016.01.13 - 0.25 ACH.rup Calc = F280 Front Door faces: E

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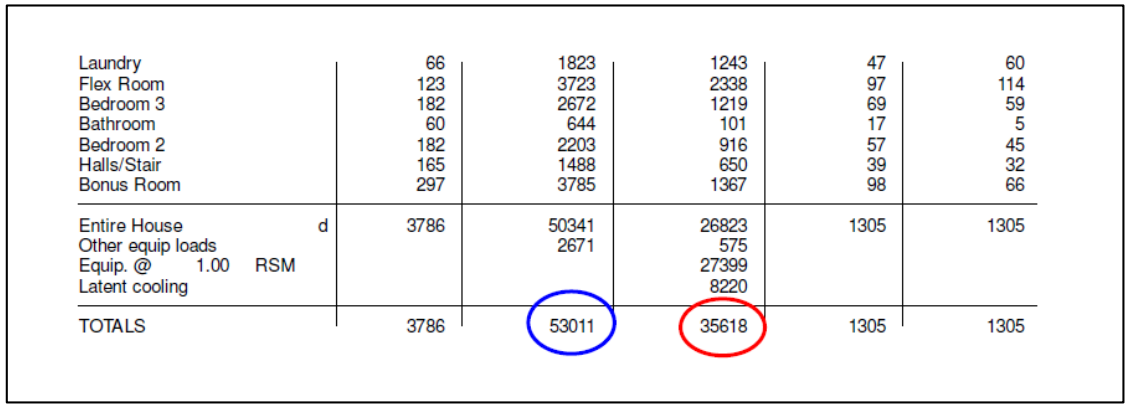


Laundry		66	1823	1243	47	60
Flex Room		123	3723	2338	97	114
Bedroom 3		182	2672	1219	69	59
Bathroom		60	644	101	17	5
Bedroom 2		182	2203	916	57	45
Halls/Stair		165	1488	650	39	32
Bonus Room		297	3785	1367	98	66
Entire House	d	3786	50341	26823	1305	1305
Other equip loads			2671	575		
Equip. @ 1.00	RSM			27399		
Latent cooling				8220		
TOTALS		3786	53011	35618	1305	1305

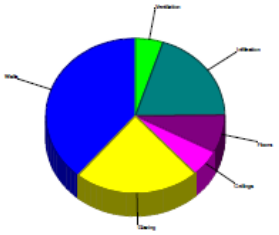
TIP 1

Review Total Heat Loss and Total Heat Gain to properly size equipment for heating and cooling capacity.

WHAT TO LOOK FOR IN A LOAD CALCULATION

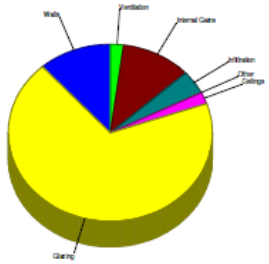
Heating

Component	Btuh/ft²	Btuh	% of load
Walls	1.6	20618	38.9
Glazing	20.6	12089	22.8
Doors	0	0	0
Ceilings	1.6	2949	5.6
Floors	2.3	4175	7.9
Infiltration	17.9	10510	19.8
Ducts		0	0
Hydronic		0	0
Humidification		0	0
Ventilation		2671	5.0
Adjustments		0	
Total		**53011**	**100.0**



Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	0.2	3169	11.6
Glazing	32.1	18843	68.8
Doors	0	0	0
Ceilings	0.3	583	2.1
Floors	0.0	8	0.0
Infiltration	2.0	1177	4.3
Ducts		0	0
Ventilation		575	2.1
Internal gains		3044	11.1
Blower		0	0
Adjustments		0	
Total		**27399**	**100.0**



Latent Cooling Load = 8220 Btuh
Overall U-value = 0.033 Btuh/ft²-°F

Data entries checked.

TIP 2

Understand what has the most impact on your design heat loss (DHL) and design heat gain (DHG).

WHAT TO LOOK FOR IN A LOAD CALCULATION

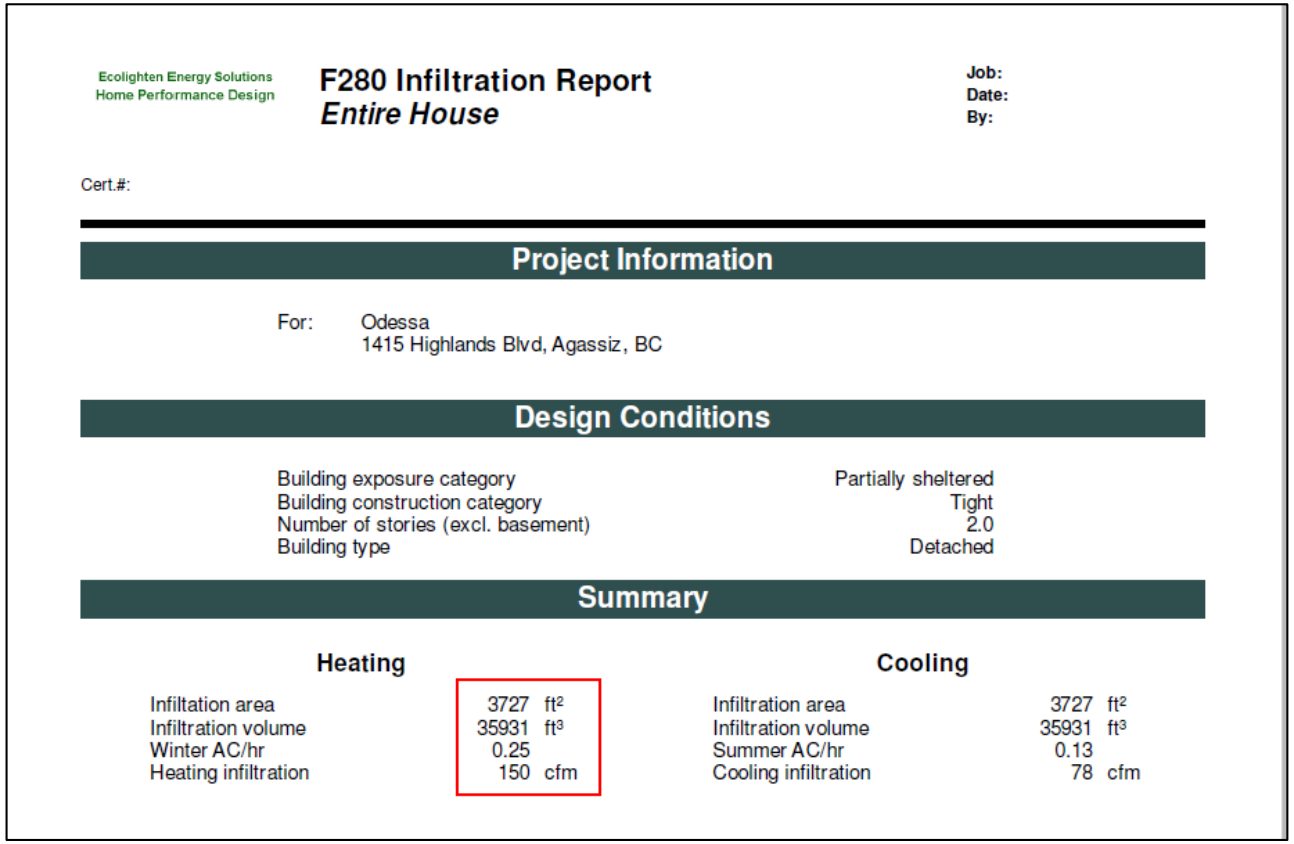
ecolighten

Construction descriptions	Or	Area ft²	R-value ft²-°F/Btuh	A/R Btuh/°F	Htg TD/R Btuh/ft²	Loss Btuh	Clg TD/R Btuh/ft²	Gain Btuh
Walls								
3A12: Frm wall, wd ext, 1/2" wood shth, r-21 cav ins, 1/2" gypsum board int fnsh, 2"x6" wood frm, 16" o.c. stud	n	328	13.3	24.6	4.87	1599	0.15	48
	e	193	13.3	14.5	4.87	942	0.90	174
	s	347	13.3	26.0	4.87	1691	0.37	130
	w	206	13.3	15.4	4.87	1002	0.90	185
	all	1074	13.3	80.5	4.87	5234	0.50	537
code min framed wall: R15.7 bcbc code min	n	840	15.9	52.9	4.10	3440	0.77	646
	e	810	15.9	51.0	3.90	3158	0.73	593
	s	839	15.9	52.9	4.10	3436	0.77	645
	w	865	15.9	54.5	4.10	3541	0.77	665
	all	3353	15.9	211	4.05	13575	0.76	2548
Partitions								
2A10: Frm wall, stucco ext, r-13 cav ins, 2"x4" wood frm, 16" o.c. stud		305	11.0	27.8	5.93	1809	0.28	84
Windows								
Code min glazing: u=0.317 SHGC=0.5; 6.9 ft head ht	n	16	3.2	5.1	20.6	330	19.6	314
	n	20	3.2	6.3	20.6	412	19.6	392
	e	14	3.2	4.3	20.6	278	50.6	683
	s	12	3.2	3.8	20.6	247	30.5	366
	s	53	3.2	16.8	20.6	1091	30.5	1616
	all	114	3.2	36.3	20.6	2358	29.5	3372
Code min glazing: u=0.317 SHGC=0.5; 1.5 ft overhang (4 ft window ht, 3.7 ft sep.); 6.9 ft head ht	n	20	3.2	6.3	20.6	412	19.6	392
	s	20	3.2	6.3	20.6	412	30.5	611
	all	40	3.2	12.7	20.6	824	25.1	1003
Code min glazing: u=0.317 SHGC=0.5; 19.5 ft overhang (6.7 ft window ht, 0 ft sep.); 6.9 ft head ht	n	18	3.2	5.7	20.6	368	19.6	350
Code min glazing: u=0.317 SHGC=0.5; 1.5 ft overhang (1.5 ft window ht, 0.8 ft sep.); 6.9 ft head ht	e	11	3.2	3.3	20.6	216	42.3	445
Code min glazing: u=0.317 SHGC=0.5; 1.5 ft overhang (4 ft window ht, 0.8 ft sep.); 6.9 ft head ht	e	20	3.2	6.3	20.6	412	47.5	950
Code min glazing: u=0.317 SHGC=0.5; 4.5 ft overhang (6 ft window ht, 0 ft sep.); 6.9 ft head ht	e	48	3.2	15.2	20.6	989	32.0	1537

TIP 3

Check that building assemblies and related R and U-Values make sense.

WHAT TO LOOK FOR IN A LOAD CALCULATION



Ecolighten Energy Solutions
Home Performance Design

F280 Infiltration Report
Entire House

Job:
Date:
By:

Cert.#:

Project Information

For: Odessa
1415 Highlands Blvd, Agassiz, BC

Design Conditions

Building exposure category	Partially sheltered
Building construction category	Tight
Number of stories (excl. basement)	2.0
Building type	Detached

Summary

Heating			Cooling		
Infiltation area	3727	ft²	Infiltration area	3727	ft²
Infiltration volume	35931	ft³	Infiltration volume	35931	ft³
Winter AC/hr	0.25		Summer AC/hr	0.13	
Heating infiltration	150	cfm	Cooling infiltration	78	cfm

TIP 4

Set an infiltration target of air changes per hour.

MECHANICAL DESIGN

- Typical home design is done without anticipation or planning for the home's necessary HVAC system.

- Guide supports a coordinated design approach between builder and mechanical designer versus a coincidental design. HVAC design considerations within the Guide for forced air systems include:

    - **Supply Outlet Placement** – Perimeter supply, central supply and hybrid options that integrate with floor and wall framing plans.
    - **Ducting Options** – Duct sizing including low, medium and high velocity options.
    - **Zoning** – Houses with multiple floors, or distinctly different occupancy patterns on a single floor may benefit from supply ducting that is divided into a number of separate supply zones.
    - **Equipment Zoning** – Equipment delivers conditioned supply air to separate areas of the house, each controlled by an individual zone thermostat.
    - **Return Inlet Placement** – Traditional return system or simplified return system.

VERIFICATION OF PERFORMANCE

- Verifying in field HVAC system performance provides builders peace of mind knowing that industry regulations and standards of excellence will be met.

STEP 1

Mid-stage blower door testing to confirm air tightness targets will be met.

STEP 2

Duct sealing and visual inspection to confirm equipment installation meets design intent with appropriate standard of practice

STEP 3

Ensure start-up equipment procedures are followed and commissioning documented for homeowner.

CASE STUDY

WEDGEWOOD VENTURES

North Vancouver

- Multi-family townhouse project (8 units). 2 buildings with 4 units per building.
- Units 2,200 sq. ft., three floors with mechanical room in basement.
- City of North Vancouver development complying with Energy Step Code Level 3 requirements.
- Forced-air system selected to achieve mechanical energy use intensity (MEUI) target and provide cooling.
- Equipment selected include ducted heat pump with integrated HRV.

KEY DESIGN FEATURES CHECKLIST

- Builder and Ecolighten utilized Guide to support mechanical design considerations, including:
  - Coordinating design with structural, architectural, interior design and developer.
  - Support a design to contain the drop ceilings to a minimum for aesthetics.
  - Utilize hybrid perimeter and central supply ducting with ceiling grills.
  - Simplified return air approach.
  - Low velocity ducting.
  - Integrated heat recovery ventilation (HRV).
  - Quality assurance inspections for performance verification.

APPENDIX C: Key Design Features Checklist for Natural Gas Mechanical Systems

Builder Name: Wedgewood Ventures

Designer Name: Ecolighten Energy Solutions

House Identifier: End Unit (North Vancouver, British Columbia)

The results are to be applied to:

☑ this specific home only, or
☐ subdivision of similar homes (mechanical designers to use their experience to modify to others homes as needed).

COMPLETION INSTRUCTIONS: Check one option per step; Provide additional information in shaded boxes.

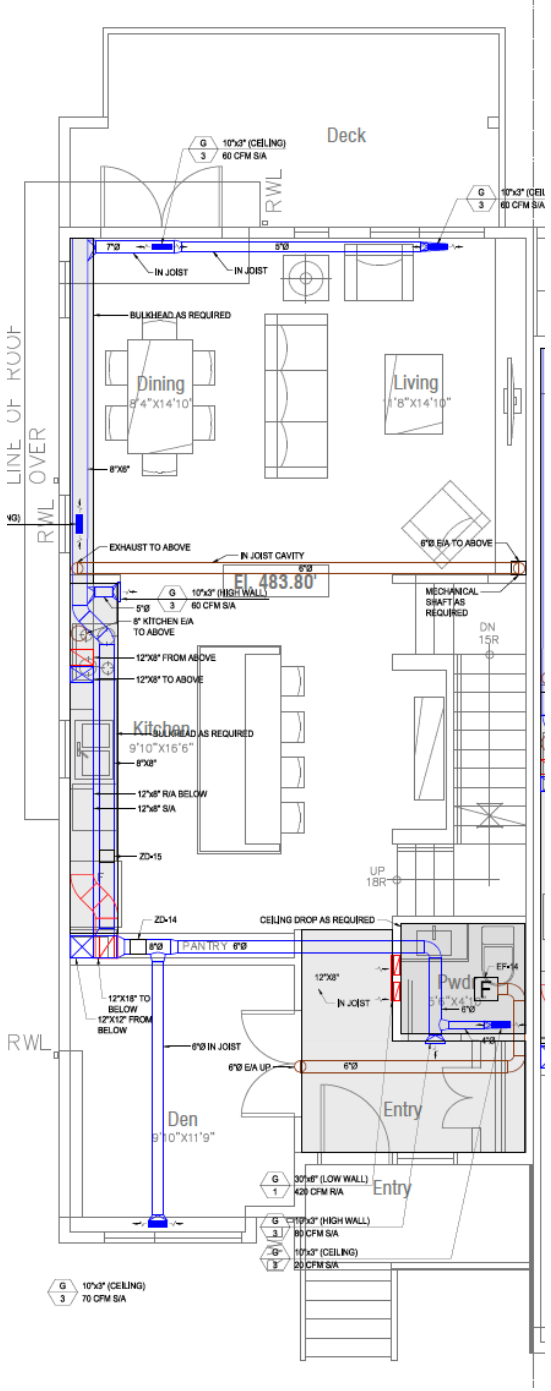
Step	Builder to Complete in Consultation with Designer	Option A	Option B	Option C	Additional Information / Notes
1	House Type	☑ Multi-unit Town	☐ Multi-level Single	☐ Bungalow	Number of levels with basement:
2	Supply Outlet placement	☐ Perimeter Supply	☐ Central Supply	☑ Hybrid Supply	Coordinated design.
3	Supply Duct Velocity /Static Pressure	☑ Low-velocity	☐ Medium-velocity	☐ High-velocity	Noise issues determined velocity.
4	Supply Duct Zoning	☐ Single-Zone supply ducting	☑ Floor-by-Floor zoning	☐ Other zoning approach	If C chosen, describe approach:
5	Equipment Zoning	☐ Non-Zone *Non-zoned equipment / single-zone ducting*	☑ Fully Zoned * *Multi-zoned equipment / zoned supply ducting*	☐ Zone-Ready * *Non-zoned equipment / zoned supply ducting*	* Requires either Option B or C in Step 4
6	Return Inlet placement	☐ Traditional return	☑ Simplified return	[not applicable]	Coordinated design.
7	Duct Sealing	☐ Base-level sealing	☑ ESNH sealing	☐ ESNH sealing with leakage testing	Visual inspection prior to cover-up no duct blasting.
Step	**Designer Led Load Calculations**	**Space Heating Load**	**Space Cooling Load**	**Domestic Hot Water (DHW) Load**	**Additional Information / Notes**
8	Prerequisite Design Load Calculations	Design Heat Loss (DHL): 18,028 BTU	Design Heat Gain (DHG): 23,726	DHW flowrate: N/A at inlet T of: N/A	F280-12 compliant.
Step	**Designer Led Steps**	**Option A**	**Option B**	**Option C**	**Additional Information / Notes**
9	Cooling Capacity	☐ 1 ton	☐ 1-1/2 tons	☑ Other: 3 tons	Effective equipment size.
10	Cooling Staging / Dehumidification (DH) strategy	☐ Single-stage cooling with no DH strategy	☐ Single-stage cooling with DH controls	☑ Staged or modulating cooling with DH controls	Variable refrigerant flow equipment.
11	Space Heating Capacity	☑ 100% to 125% of DHL	☐ 126% to 175% of DHL	☐ Greater than 175% of DHL	***Note:*** *DHL is the CSA F280 design heat loss*
12	Heating Equipment Staging / Modulation	☐ Single-stage	☐ Two-stage output	☑ Modulating output *(3 or more stages)*	Variable refrigerant flow equipment.
13	Space and Water Heating Equipment Selection	☐ Furnace and Water Heater	☐ Combination Heating System	☑ Other Heating Technology: Electric water tank *(describe)*	Rated space heating output: N/A Supply zoning: No Rated DHW heating capacity: N/A

FORCED AIR DESIGN

- Forced air heating system design informed by Guide for Wedgewood Ventures project includes:
  - Equipment summary with rated efficiencies.
  - A schematic arrangement of the forced air systems (i.e. fittings, air flow (CFM) per branch, total external static pressure, etc.)
  - Floor plans showing a detailed HVAC design of the mechanical room, duct routing and terminations, such as grille and registers with air flow targets.
  - System operation parameters including duct and pipe sizing, external static pressure and air flow per room.

1

MAIN FLOOR



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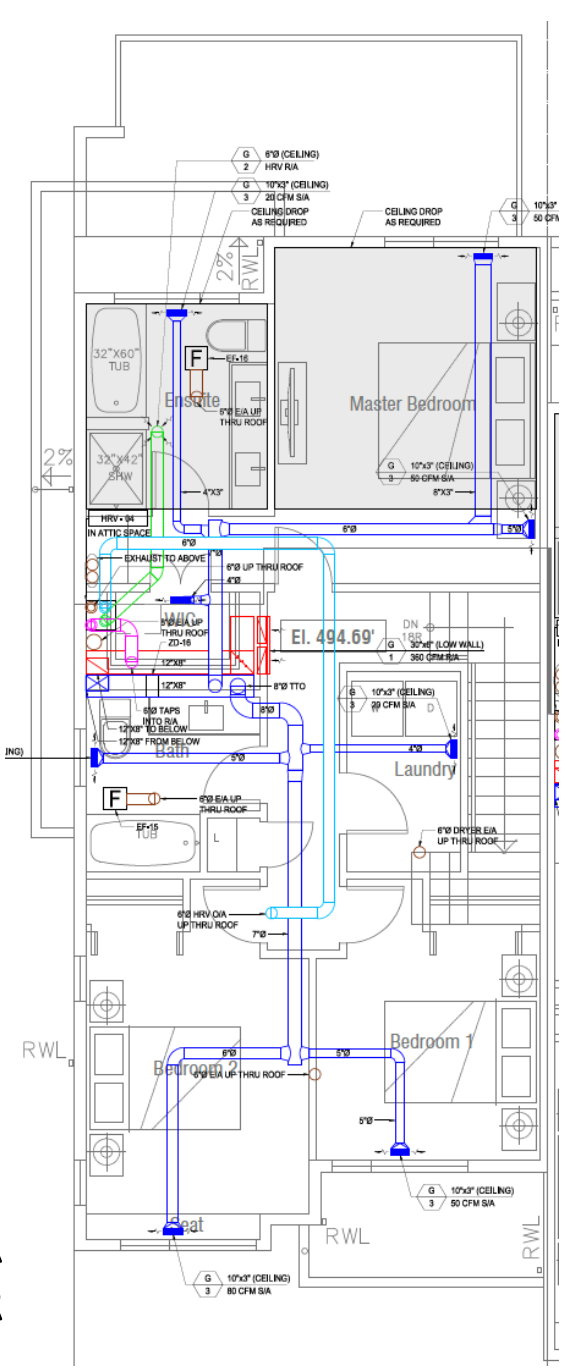
UPPER FLOOR



KEY TAKEAWAYS

1. **Changing Landscape** - HVAC design landscape is quickly evolving and driven by changes to regulation (e.g. Energy Step Code) and new technologies. Adapting to these changes requires better building/design processes.

2. **NRCan Guide** - "Master Planning and Decision Guide for Gas Mechanical Systems" is a fundamental tool supporting a more effective approach to HVAC decision-making between builders and mechanical designers.

3. **Importance of Fundamentals** – Code compliant F280-12 load calculations is the foundation on which all other HVAC decisions are dependent. Builders need to take ownership of their load calculations.

4. **Coordination of HVAC Solutions** – Improved collaboration and verification between builders and mechanical designers will optimize the HVAC system within the project requirements.

QUESTIONS?

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