ATTACHMENT 1

MGBA
ARCHITECTURE + INTERIOR DESIGN

CROFTON FIRE HALL ADDITION AND RENOVATIONS ENERGY STUDY

Prepared for: Municipality of North Cowichan

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SUMMARY FINDINGS

This report is issued in response to a request from the Municipality of North Cowichan for the design team to provide an analysis of the energy and emissions impact of the current design of the "Crofton Fire Hall Renovations and Addition" project. Specifically, to analyze the alignment of the building addition project with the January 2022 North Cowichan Climate Action and Energy Plan (CAEP) paying special attention to PART 3: "GOAL 4: Achieve Net-Zero emissions in Municipal buildings by 2030" and "GOAL 10: Starting in 2030 at the latest, install net metered solar photovoltaic (PV) systems on all new buildings, supplying at least 10% of their electric load."

The energy study findings in the AME Group report are very positive for this project. The current design is found to be 70% more efficient than a baseline code compliant air source heat pump, with a similar reduction in greenhouse gas (GHG) emissions. For informational purposes, a code compliant gas fired heating design was also run as a baseline, to show how much less energy use and emissions an air source heat pump system utilizes even at the minimum code requirements. The current design utilizes many high-performance best practice strategies to achieve this, including the building envelope design and insulation, LED lighting and a high efficiency all electric HVAC design.

Seven potential additional energy conservation measures (ECMs) were identified by the design team for consideration as providing a superior level of performance based on industry standards. Due to the nature and character of the new addition, many of these proved to be only 1% to 2% energy savings over the current design. Changes to the mechanical systems show the greatest impact with improved Demand Controlled Ventilation (DCV) systems showing the highest returns with an additional 6.4% improvement over the current design and a 33% improvement in GHG Intensity. If all the best options were combined, they would result in an energy performance 38% better than current design. The analysis of these additional energy savings options demonstrates that the building envelope performance options (1-4) will have very little impact on their own, but they have a greater impact when combined with additional mechanical systems improvements.

A study of a potential solar photovoltaic (PV) system on the roof area of the new addition indicates that the stated CAEP goal could be met. "GOAL 10: Starting in 2030 at the latest, install net metered solar photovoltaic (PV) systems on all new buildings, supplying at least 10% of their electric load." In fact, it could generate enough to offset as much as 70% of the energy usage of the current design and 100% if all additional conservation measures were implemented.

In each report the existing apparatus bay building is identified as an area that would benefit from significant energy performance improvements. This is beyond the scope of the current building addition project and should be considered for a future project. The existing building does not have a well-insulated building envelope and utilizes gas fired heating equipment. This is very inefficient and has a very high GHG intensity compared to the new systems in the adjacent building addition and does not currently meet the CAEP goals. This building will be subject to CAEP "GOAL 3: The existing building stock is retrofit for 50% increased energy efficiency by 2040 and large buildings are routinely recommissioned."

Long term, to bring the entire site in alignment with the CAEP goals the team would recommend recladding the existing apparatus bay building in an insulated panel system with integral air and vapour barrier. This will dramatically improve the heat retention of the building compared to the uninsulated masonry block of the existing wall assembly. The heating and cooling system in this existing building should be replaced with a new high efficiency system and additional solar panels will be needed to meet the offset goals of the buildings combined. The existing roof is not designed for the additional weight load of added insulation and solar panels and will require a structural upgrade to the roof structure to allow for the installation of more solar photovoltaic panels. Additional electrical upgrade improvements are recommended to support these new and improved systems. These all have significant cost implications that should be taken into consideration when planning for a future project to improve the performance of the existing apparatus bays.

CROFTON FIREHALL ADDITION

Project No.: 296b-003-21
1681 Robert St, Crofton B.C.

Energy and Emissions Study

July 22, 2022

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EXECUTIVE SUMMARY

This report identifies energy and greenhouse gas strategies for the Crofton Firehall Addition. This project has goals that are indicated in the January 2022 North Cowichan Climate Action and Energy Plan (CAEP):

- Mechanical Energy Use Intensity (MEUI) < 30 $kWh/m^2/y$
- Thermal Energy Demand Intensity (TEDI) < 15 kWh/m2/y
- Minimum 10% of electricity produced onsite by solar PV
- Efficient fixtures with > 30% reduction in water use

Energy modelling for multiple options were completed, with results shown in the following table.

	Annual Energy Consumption (MWh)	Mechanical Energy Intensity MEUI ($kWh/m^2/y$)	Heating Intensity TEDI ($kWh/m^2/y$)	Greenhouse Gas Intensity GHGI ($kgCO_2$/m2)	Annual Energy Cost
Baseline Comparator – Gas fired heating	103.2	279.4	200.7	40.5	$ 6,895
NECB Reference – Air source heat pump	62.1	162.9	200.7	1.9	$ 8,692
Proposed Building – Air source heat pump	18.5	39.2	38.1	0.6	$ 2,585
1: Proposed + Roof R-50	18.2	38.4	35.7	0.6	$ 2,542
2: Proposed + Wall R-26	18.3	38.8	36.9	0.6	$ 2,563
3: Proposed + Glazing U-0.26 SHGC 0.30	18.2	38.4	37.4	0.6	$ 2,546
4: Proposed + Glazing U-0.15 SHGC 0.22	17.9	37.6	36.3	0.6	$ 2,504
5: Proposed + ASHP + FC 80% ERV	17.3	35.9	27.9	0.5	$ 2,422
6: Proposed + 30% low flow fixtures	17.8	37.3	38.1	0.6	$ 2,488
7: Proposed + Improved DCV	13.4	24.7	25.8	0.4	$ 1,869
8: All Combined	11.4	17.8	18.9	0.4	$ 1,597

Based on calculations provided by the project electrical consultant, a rooftop PV array can provide 13 MWh annually. For each of the studied options, 13 MWh is greater than 10% of the estimated annual energy. To offset 100% of the annual electricity, additional onsite PV systems may be required, depending on the proposed design, such as with an installation in an adjacent field or above the parking area. Including all measures, these preliminary calculations indicate the project may be able to generate all its electricity onsite with the rooftop array.

With all measures combined, the model results show that the proposed project is on track for compliance with the North Cowichan Climate Action and Energy Plan requirements, except for the TEDI target. The TEDI 15 target is quite aggressive for this project because the building is rarely occupied and consequently has few internal gains to contribute heat.

Looking at the GHG performance of the overall building, including the new addition together with the existing apparatus bay that is to remain, improvements to the apparatus bay are also important to achieve overall low GHG emissions. Significant savings in GHG's can be achieved by switching from gas fired radiant tube heaters to an electric heating system.

1. INTRODUCTION

This report outlines the energy modelling analysis carried out for the Crofton Firehall Addition located at 1681 Robert St, Crofton, BC. The project is a renovation and addition to an existing Firehall building. The project is considering net zero emission targets, as outlined in the North Cowichan Climate Action and Energy Plan.

Figure 1 shows a rendering of the building, which is taken from the energy modelling software.

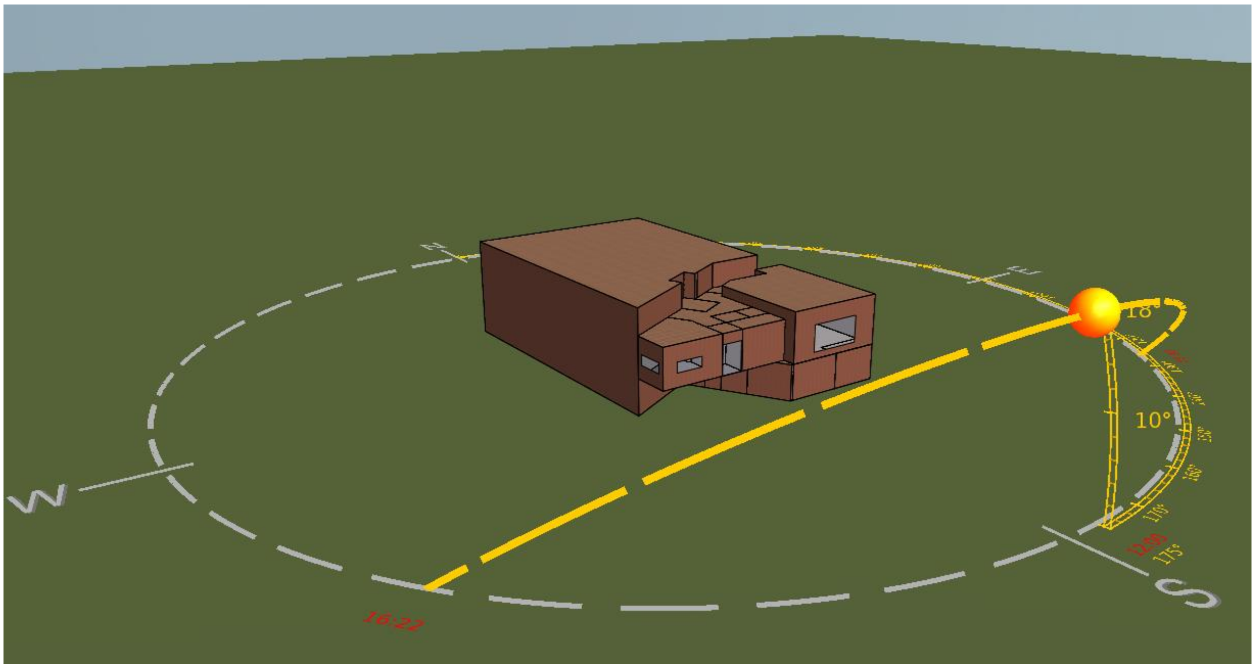


Figure 1: Energy Model Geometry

*This report has been prepared by the AME Consulting Group for the exclusive use of **Mallen Gowing Berzins Architecture** and the design team. The material in this report reflects the best judgement of the AME Consulting Group with the information made available to them at the time of preparation. Any use a third party may make of this report, or any reliance on or decisions made based upon the report, are the responsibility of such third parties. The AME Consulting Group accepts no responsibility for damages suffered by any third party as a result of decisions made or actions taken based upon this report.*

Energy modelling results will vary from the actual performance of the building after construction due to variations in parameters such as occupancy, building operation and maintenance, and weather conditions.

2. ENERGY MODELLING INPUTS

Energy model inputs are outlined in Table 1: Energy Modelling InputTable 1.

Table 1: Energy Modelling Input Summary Table

	Baseline Comparator	NECB 2015 Reference Building	Proposed Design ECM Options
General			
Project Name and Location	Crofton Fire Hall Renovation & Addition 1681 Robert St, Crofton, BC		
Building Type(s)	2 Floors, Firehall		
Modelled Floor Area	353 m^2		
Energy Performance Target(s)	Per North Cowichan Climate Action and Energy Plan, January 2022: • MEUI < 30 kWh/m^2/y • TEDI < 15 kWh/m2/y • Minimum 10% of electricity produced onsite by solar PV		
Modelling Software	ASHRAE Standard 140 Compliant (IESVE 2019.3.2.0)		
Climate Zone	NECB 2015 Climate Zone 4 HDD (Crofton)=2880 Jan 1%: -6°C July 2.5%: 28°C/19°C		
Weather File	CAN_BC_Victoria.Intl.AP.717990_CWEC2016.epw		
Envelope Performance			
Roof Effective R-value (h·ft².°F/btu)	NECB 2015 Table 3.2.2.2 for Climate Zone 4 R-25		Proposed design: R-30 ECM 1: R-50 ECM 2: R-30 ECM 3: R-30 ECM 4: R-30 ECM 5: R-30 ECM 6: R-30 ECM 7: R-30 ECM 8: R-50

	Baseline Comparator	NECB 2015 Reference Building	Proposed Design ECM Options
Above Grade Exterior Walls effective R-value (h·ft².°F/btu)	NECB 2015 Table 3.2.2.2 for Climate Zone 4 R-18		Proposed design: R-21.5 ECM 1: R-21.5 ECM 2: R-26 ECM 3: R-21.5 ECM 4: R-21.5 ECM 5: R-21.5 ECM 6: R-21.5 ECM 7: R-21.5 ECM 8: R-26
Below Grade Exterior Walls effective R-value (h·ft².°F/btu)	NECB 2015 Table 3.2.3.1 for Climate Zone 4 R-10		R-25
Slab R-value (h·ft².°F/btu)	NECB 2015 Table 3.2.3.1 for Climate Zone 4 R-7.5 for 1.2m		ASHRAE 90.1 F-factor Method R-15 slab fully insulated F-0.30
Overall Glazing Assembly U-value including frame (btu/h ft².°F), and Solar Heat Gain Coefficient (SHGC)	NECB 2015 Table 3.2.2.3 for Climate Zone 4 U-0.42 SHGC-0.40		Proposed design: U-0.35 SHGC-0.40 ECM 1: U-0.35 SHGC-0.40 ECM 2: U-0.35 SHGC 0.40 ECM 3: U-0.26 SHGC 0.30 ECM 4: U-0.15 SHGC 0.22 ECM 5: U-0.35 SHGC 0.40 ECM 6: U-0.35 SHGC 0.40 ECM 7: U-0.35 SHGC 0.40 ECM 8: U-0.15 SHGC 0.22
Fenestration and Door to Wall Ratio FDWR (%)	12.4%	40%	12.4%
Door R-value (°K·ft²/btuh)	NECB 2015 Table 3.2.2.4 for Climate Zone 4 USI-2.40		USI 2.40 (Same as baseline)
Air leakage / airtightness	0.20 l/s per m2 façade		

	Baseline Comparator	**NECB 2015 Reference Building**	**Proposed Design ECM Options**	
	Electrical Inputs and Internal Loads			
Lighting Power Density (LPD) (W/m^2)	As per ASHRAE 90.1-2016 plus 10% savings. Lighting sensors included.			
Plug Loads	As per NECB 2015 Table A-8.4.3.2.(2)B Space Type			
Occupancy	Classroom/Lecture/Training: 20 people Others as per NECB 2015 Table A-8.4.3.2.(2)B Space Type			
Operating Schedules	Custom lighting, plug load, occupancy profile; See Appendix B: Operating Schedule 1219 Full load hours (FLH) per year			
Space Setpoints	18 C heating, 24 C cooling, fans operational 24/7			
	Mechanical System			
Heating/Cooling Plant	Single-zone RTU with DX cooling: Natural gas furnace for heating, 92% efficiency; DX cooling, EER = 11.5	NECB 2015 Baseline: System 3 Single-zone RTU heat pump; 3.3 COP @ 8.3 C and 2.25 COP @ -8.3 C EER = 11.0	Multizone heat pump units - air source heat pump with fancoil units	
Heating Fuel Type	Natural gas	Electricity		
Service hot water	Electric hot water heater and storage tank ECM 6: 30% flow fixture reduction, per CAEP			
Heat Recovery	None		60% sensible recovery effectiveness (SRE)	ECM 1: 60% SRE ECM 2: 60% SRE ECM 3: 60% SRE ECM 4: 60% SRE ECM 5: 80% SRE ECM 6: 60% SRE ECM 7: 60% SRE ECM 8: 80% SRE
Fan Power	640 Pa E.S.P over 40% total fan efficiency		Supply: 0.6 W/cfm Return: 0.4 W/cfm Fancoils: 0.3 W/cfm	

	Baseline Comparator	NECB 2015 Reference Building	Proposed Design ECM Options
Ventilation rate	As per ASHRAE 62.1-2001		
Demand Control Ventilation	None		ECM 1, 2, 3, 4, 5, 6: Recreation and training room with Minimum flow rate: 1.5 l/s/m^2 ECM 7 and 8: Recreation and training room with Minimum flow rate: 0.3 l/s/m^2 Area rate per ASHRAE 62-2010
Emission Factors	Gas 0.185 kg CO_2/ kWh Electricity 0.011 kg CO_2/kWh		
Utility Rates	Gas 0.185 kg CO_2/ kWh Electricity 0.011 kg CO_2/kWh		

3. RESULTS

Table 2 provides a comparison between the annual energy consumption, mechanical energy use intensity (MEUI), thermal energy demand intensity (TEDI), greenhouse gas intensity (GHGI), % improvement in energy over baseline, estimated annual utility cost and 10% PV offset requirement of the Baseline Design, NECB Reference, Proposed Design, and the various ECM options.

Table 2: Energy Model Results

	Annual Energy (MWh)	MEUI ($kWh/m^2/y$)	TEDI ($kWh/m^2/y$)	GHGI ($kgCO_2/m2$)	% Energy Savings over Baseline	Annual Energy Cost	10% PV Offset Achievable
Baseline Design	103.16	279.42	200.70	40.46	-	$ 6,895.21	Yes
NECB Reference	62.09	162.93	200.70	1.94	40%	$ 8,692.04	Yes
Proposed Design	18.46	39.22	38.07	0.58	82%	$ 2,584.62	Yes
ECM 1: Proposed + Roof R-50	18.16	38.36	35.75	0.57	82%	$ 2,542.19	Yes
ECM 2: Proposed + Wall R-26	18.31	38.78	36.89	0.57	82%	$ 2,562.95	Yes
ECM 3: Proposed + Glazing U-0.26 SHGC 0.30	18.19	38.45	37.43	0.57	82%	$ 2,546.45	Yes
ECM 4: Proposed + Glazing U-0.15 SHGC 0.22	17.89	37.59	36.30	0.56	83%	$ 2,503.96	Yes
ECM 5: Proposed + ASHP + FC 80% ERV	17.30	35.92	27.91	0.54	83%	$ 2,421.57	Yes
ECM 6: Proposed + 30% DHW	17.77	37.26	38.07	0.55	83%	$ 2,487.86	Yes
ECM 7: Proposed + Improved DCV	13.35	24.73	25.83	0.42	87%	$ 1,869.04	Yes
ECM 8: All Combined	11.41	17.84	18.92	0.36	89%	$ 1,596.74	Yes

The Baseline Design, NECB Reference, Proposed Design and all ECM options meet the requirement of minimum 10% annual energy consumption offset by PV. The calculation of PV energy offset is based on the PV Simulation Report of the new portion provided by SolarEdge. See **Appendix C** for further detail. As noted in the Appendix, Rooftop PV can generate approximately 13 MWh annually. The Proposed Design with all ECM options achieves a significant decrease in annual energy consumption over the Baseline Design.

4. CONSIDERATIONS FOR 100% EMISSIONS OFFSET

While the current PV design can meet the 10% offset threshold for the Proposed Design, additional PV panels may be needed if the project wants to completely offset the energy use and GHG emissions of the new addition. Alternatively, the project could choose to purchase renewable offsets to satisfy any certification requirements in offsetting GHG emissions. With all ECM's included, all the project's electrical energy is estimated to be accommodated by the rooftop PV array.

Table 3 summarizes the additional PV needed for each option. The current PV design utilizes 31 panels over a roof area of 200 m^2. Any additional panels would require a new location to be identified, such as installation in a nearby field or above an adjacent parking area.

Table 3: PV Panels needed for 100% offset

	GHGI ($kgCO_2$/m2)	Energy and GHGI offset by PV	Additional PV panels required for 100% offset	Additional PV area required for 100% offset (m2)
Baseline Design	40.46	12.6%	215	443
NECB Reference	1.94	20.9%	117	241
Proposed Design	0.58	70.4%	13	27
ECM 1: Proposed + Roof R-50	0.57	71.6%	12	25
ECM 2: Proposed + Wall R-26	0.57	71.0%	13	26
ECM 3: Proposed + Glazing U-0.26 SHGC 0.30	0.57	71.5%	12	26
ECM 4: Proposed + Glazing U-0.15 SHGC 0.22	0.56	72.7%	12	24
ECM 5: Proposed + ASHP + FC 80% ERV	0.54	75.2%	10	21
ECM 6: Proposed + 30% DHW	0.55	73.2%	11	23
ECM 7: Proposed + Improved DCV	0.42	97.4%	1	2
ECM 8: All Combined	0.36	100.0%	0	0

5. OTHER GREEN BUILDING STANDARDS

There are multiple green building standards that can be applied to projects, and each have specific performance requirements. As a rough comparison, Table 4 shows the Proposed Design compared to the CaGBC Zero Carbon Building standard version 2 and 3. Note this is not an exact comparison because the CaGBC standard has specific energy modelling guidelines that vary from the parameters noted in the Input Summary Table of this report.

Table 4: Proposed Design vs Green Building Targets

	TEDI (kWh/m²/year)	Savings vs NECB Reference
Proposed Design	38	70% Relative to NECB 2015
ECM 8: All Combined	19	82% Relative to NECB 2015
Zero Carbon Building Standard v2	30 Following ZCB modelling rules	25% Relative to NECB 2017
Zero Carbon Building Standard v3	N/A for projects with electric heat pump systems for space heat	25% Relative to NECB 2017

As indicated in this table, the project with combined ECM's is possibly compliant with CaGBC Zero Carbon Building standard's TEDI and energy performance requirements. Additional analysis would be required to confirm that the CaGBC's program requirements could be achieved by the project.

6. EXISTING APPARATUS BAY

The proposed design of the new addition greatly reduces the greenhouse gas emissions through use of electric heat pump systems for heating. However, the existing apparatus bay that is to remain currently uses natural gas for space heating with gas fired radiant tube heaters. A high-level analysis was completed to estimate the overall emissions of the new addition together with the apparatus bay. This analysis is a rough estimate only, however, because gas utility data is only available for the whole existing building, without breakout of gas use from the apparatus bay alone. Table 5 summarizes the results of this analysis.

Table 5: Estimated Improvement in Whole Building Performance

	Average Annual Electricity Usage (kWh)	Average Annual Gas Usage (kWh)	Total Annual Energy Usage (kWh)	Total GHG Emissions ($kgCO_2$)
Existing Building	74,600	106,121	180,722	20,453
Proposed Addition + Existing Apparatus Bay	57,628	56,373	114,001	11,063
% Reduction	23%	47%	37%	46%

The results indicate that the proposed addition would reduce the annual energy use and GHG emissions of the building. However, a significant amount of energy use and GHG emissions would still remain. Improvements to the existing apparatus bay could include:

1. Switching to an all-electric or heat pump heating system
   This will lead to a large reduction in natural gas consumption, lowering overall GHG emissions.
2. Installing a heat recovery ventilator (HRV)
   An HRV will recover heat from the exhaust air to preheat the incoming ventilation air, thereby reducing the net heating load on the space heating system.
3. Improving the building envelope
4. Installing/renewing sealing strips on exterior doors
   Improved seals will reduce annual energy consumption by increasing the airtightness of the heated envelope.
5. Installing high efficiency LED lighting

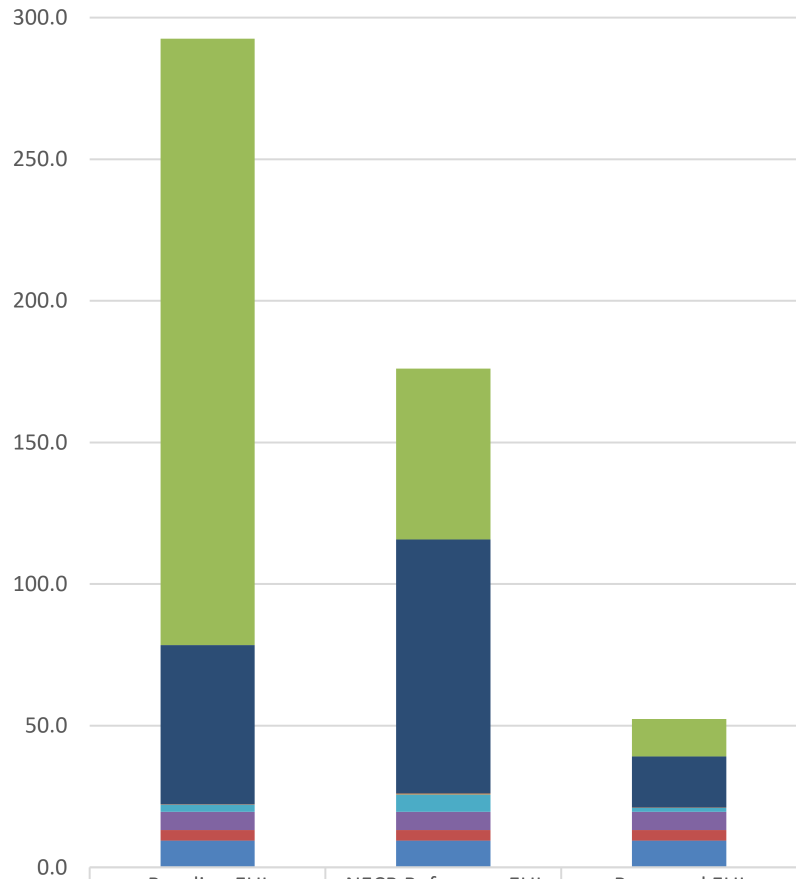
7. CONCLUSIONS

The proposed design for the Crofton Fire Hall was studied together with multiple energy conservation measures. With all measures combined, the model results show that the proposed project is on track for compliance with the North Cowichan Climate Action and Energy Plan requirements, except for the TEDI target. The TEDI 15 target is quite aggressive for this project because the building is rarely occupied and there are consequently few internal gains to contribute heat.

Looking at the GHG performance of the overall building, including the new addition together with the existing apparatus bay that is to remain, improvements to the apparatus bay are also important to achieve overall low GHG emissions. In particular, it is worth considering switching from gas fired radiant tube heaters to an electric heating system.

END OF REPORT

APPENDIX A: ENERGY BREAKDOWN OF BASELINE AND PROPOSED DESIGN



	Baseline EUI (kWh/m2/y)	NECB Reference EUI (kWh/m2/y)	Proposed EUI (kWh/m2/y)
Total	292.5	176.1	52.4
Space Heating	214.0	60.3	13.2
Fans	56.3	89.7	18.1
Heat Rejection	0.2	0.4	0.1
Space Cooling	2.4	6.0	1.3
DHW	6.5	6.5	6.5
Receptacle	3.7	3.7	3.7
Lighting	9.5	9.5	9.5

The Proposed Design demonstrates a significant decrease in energy consumption primarily due to the reduction of energy use in space heating and fans.

APPENDIX B: OPERATING SCHEDULE

The schedule used in analysis is shown in Table 6. This schedule is based on occupancy information provided by the client. There is training every Thursday from 6 pm – 10 pm with a capacity of at least 20 people. There is routine maintenance on the weekends. There are approximately 250 incident calls per year with each call approximately an hour in length. The firehall will operate under relaxed heating and cooling setpoints throughout the year.

Table 6: Operating Schedule

	Lighting	Occupancy	Plugs	DHW	Fan Schedule
Weekly Hours	23.4	23.4	23.4	23.4	168
Annual Hours	1219	1219	1219	1219	8760

APPENDIX C: PV SIMULATION REPORT

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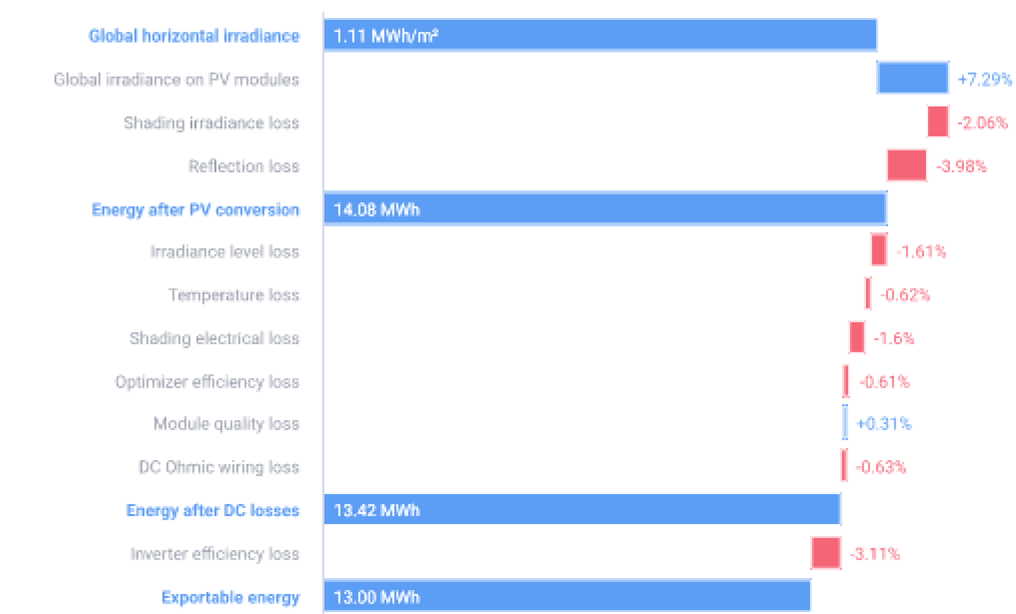
CROFTON FIRE HALL - 2022.07.12 - AHU CU
Robert Street 1681, Crofton, British Columbia, V0R 1R0, Canada | Jul 13, 2022

ELECTRICAL DESIGN

Inverters & Storage	Strings per inverter	Optimizers per string	PV modules per string
1 x SE14.4KUS 12.16kW | 84%	2 x strings	10 x P401	10
	1 x string	11 x P401	11

SYSTEM LOSS DIAGRAM



The PV Simulation Report provided by SolarEdge estimates an annual energy production of 13.00 MWh. This is sufficient to offset at least 10% of the predicted annual energy consumption of the Baseline Design, Proposed Design, and all ECMs.

O'M Engineering
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Permit to Practice: #1001261

Energy Model Electric Narrative

Electrical Narrative for	Project No.	Date
North Cowichan Crofton Fire Hall Upgrade - ECMs	21-331	July 26, 2022
Prepared for	**Authored by**	**Peer Reviewed by**
MGBA Architecture #300 – 7 East 6th Avenue, Vancouver, BC, V5T 1J3	Krishan Bhardwaj, EIT	Nav Patrola, P.ENG., P.Eng., PMP, LEED AP

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1.0 INTRODUCTION

O'M Engineering was appointed by MBGA to conduct a study and determine the electrical impacts of the Energy Conservation Measures (ECM) proposed by The AME Group.

The District of North Cowichan is redeveloping the existing Crofton Fire Hall located at 1681 Roberts Street, Crofton, North Cowichan, BC. The Fire Hall comprises of two buildings – an Apparatus Building and the original Fire Hall built in 1964. This older portion of the building is being demolished and a new building will be constructed in its place.

The AME group has identified six different ECMs for the new building and this report will consider the most electrically demanding ECM, which is noted as "*ECM 5: Proposed + ASHP +FC 80% ERV*" in AMEs report dated June 10, 2022.

A Photovoltaic offset of 10% is identified in AME's report which will be discussed below.

2.0 CODES AND STANDARDS

Although all existing installations would have been completed to applicable codes and standards at the time of installations, the electrical systems were reviewed in accordance with the intent of all current applicable codes, ordinances, bylaws, standards and regulations.

The following list of applicable codes and standards for this review:

- 2018 British Columbia Building Code (BCBC)
- ASHRAE 90.1-2016
- Illumination Engineering Society of North America (IESNA)
- Applicable NFPA Regulations
- 2018 Canadian Electrical Code (CEC)
- Canadian Standards Association (CSA)
- Underwriters' Laboratories of Canada (ULC)

3.0 MECHANICAL LOAD ANALYSIS

Based on AME preliminary report and equipment selection, the mechanical equipment added as a part of ECM 5 is as follows:

New Mechanical Equipment	Electrical Information	Load in kW
FC-1	208V-1PH; 0.24 MCA	0.05kW
FC-2	208V-3PH; 34 MCA	0.6kW
DHWT-1	208V-1PH; 2.95 MCA	12.3kW
ERV-1	120V-1PH; 4.6 MCA	0.5kW
ERV-2	208V-3PH; 2HP	2.7kW
Heat pump	208V-3PH; 28 MCA	10.1kW

Table 1: Mechanical Equipment for ECM5

The total connected load of the proposed mechanical equipment is 26.3 kW. Using engineering best practices, an 85% diversity factor can be applied to the mechanical loads to bring the total calculated mechanical load to 22.4 kW.

4.0 IMPACTS TO ELECTRICAL DESIGN

The Electrical Schematic Design Report, dated April 8th, 2022, assumes a mechanical load of 80kW for the full electrification of the mechanical systems. Refer to load calculation below.

Load Calculation per CEC Section 8:

AREA:			
Total Area (approx.)	=	2150	sq.ft
		200	sq.m
LOAD CALCULATION:			
Basic Load @ 50 VA/sq.m	=	9987	VA
Mechanical Loads (electrified mech system - assumed)	=	80000	VA
LV EV Chargers - 20% of all stalls (12) = 3 Stalls	=	19968	VA
Misc (20VA/sq.m)	=	3995	VA
Sub-total	=	113950	VA
Deman Factor @ 90%	=	102555	VA
Amps @ 208Y/120V	=	285	A
Main Breaker Size	=	356	A

Thus, Main Breaker for new building will be 400A @ 208Y/120V

Since the proposed mechanical loads for ECM 5 are far less than what was allowed for in the preliminary load calculation, there is no impact to the service size or overall electrical design. However, the loads are not small enough to justify the next size down which would be a 200A service.

It should be noted that it is understood AME's ECMs only account for the new portion of the building. Should the ECMS be extended into the existing building, the service size will need to increase. This may require a PMT on site and will need to be coordinated with BC Hydro.

5.0 PHOTOVOLTAIC REQUIRMENTS

The Schematic Design Report assumes that there will not be a PV system on the roof. However, per AME's report, 10% of the energy will need to be offset by onsite PV.

The total annual energy usage for ECM 5 combined with the other ECMs, noted as ECM 6, is 16.22MWh. This equates to a minimum of 1.6MWh of onsite energy production required per annum.

This could be achieved with the installation of PV panels on the roof of the new building alone.

Refer to Appendix A for the full building PV simulation which would yield 13MWh of energy per annum.

6.0 CONCLUSION

In conclusion, the electrical loads associated with the ECMs can be accommodated within the proposed electrical service and design. In fact, there is room to add additional mechanical loads if needed.

Per AME's requirements, a photovoltaic system over the new roof will need to be considered to meet the minimum 10% threshold for onsite energy generation.

7.0 APPENDIX A // PHOTOVOLTAIC SIMULATION

CROFTON FIRE HALL - 2022.07.12 - AHU CU

Robert Street 1681, Crofton, British Columbia, V0R 1R0, Canada | Jul 13, 2022

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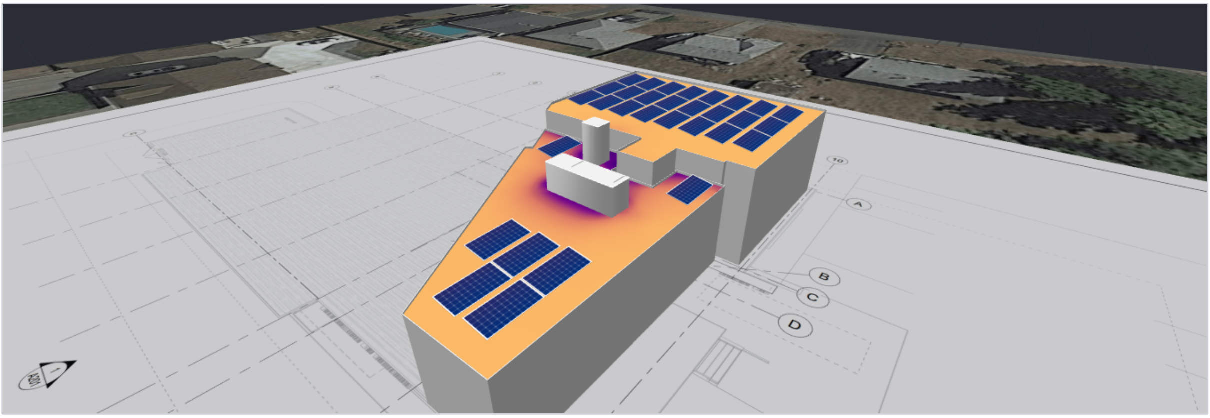
Electrical & Electronic Consulting Engineers



SYSTEM OVERVIEW

31 PV modules | 1 Inverters | 31 Optimizers

SIMULATION RESULTS

Installed DC Power	Max Achieved AC Power	Annual Energy Production	CO2 Emission Saved	Equivalent Trees Planted
12.56 kWp	12.16 kW	13.00 MWh	5.1 t	234

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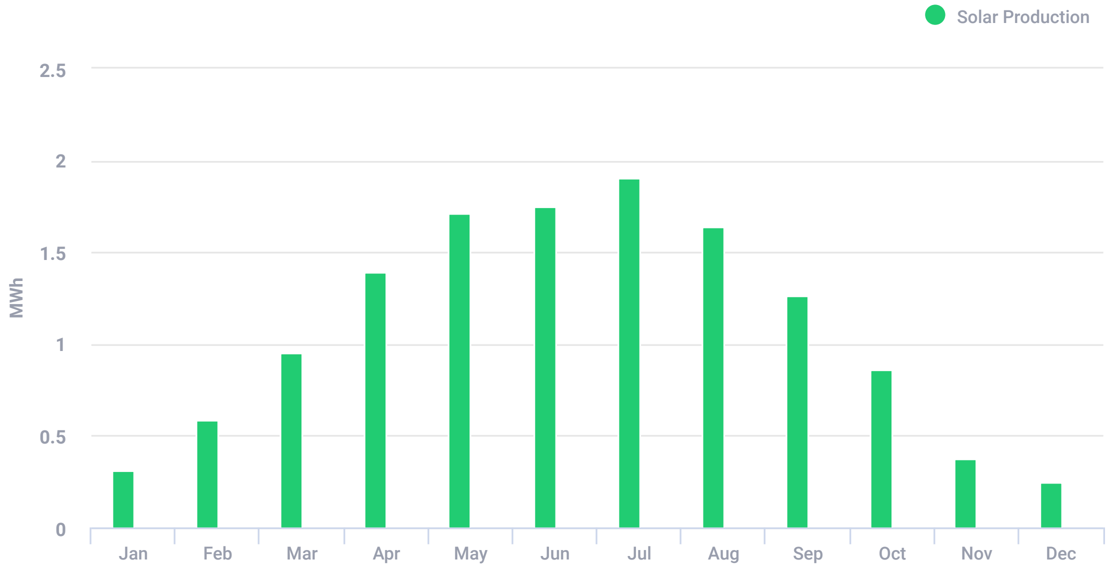
ESTIMATED MONTHLY ENERGY



Total clipped energy: 0%

PV MODULES

# Module	Model	Peak power	Racking type	Orientation	Azimuth	Tilt
24	Canadian Solar Inc., CS1U-405MS HiDM (1500V)	9.7 kWp			179°	10°
7	Canadian Solar Inc., CS1U-405MS HiDM (1500V)	2.8 kWp			180°	10°
Total: 31		12.6 kWp				

BILL OF MATERIALS (BOM)

Items	Quantity	Price (C$)	Total (C$)
SE14.4KUS	1		
P401	31		
CS1U-405MS HiDM (1500V)	31		

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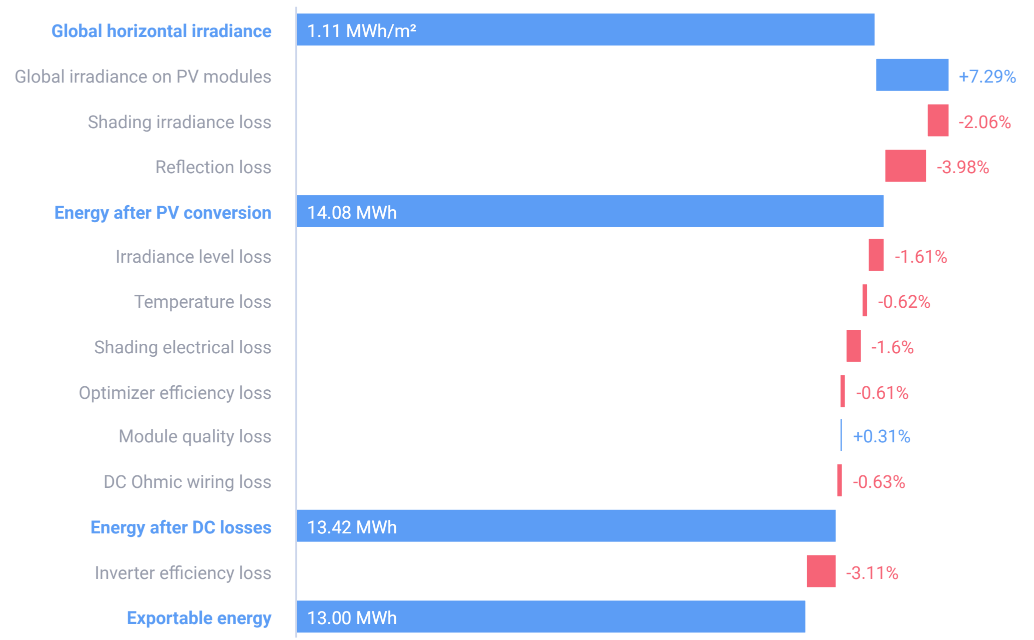
ELECTRICAL DESIGN

Inverters & Storage	Strings per inverter	Optimizers per string	PV modules per string
1 x SE14.4KUS 12.16kW | 84%	2 x strings	10 x P401	10
	1 x string	11 x P401	11

SYSTEM LOSS DIAGRAM



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SIMULATION PARAMETERS

LOCATION & GRID

Time zone	PDT (Vancouver)
Weather station	Cowichan Bay (14.6 km away)
Station altitude	62 m
Station data source	Meteonorm 7.1
Grid	208V L-L, 120V L-N

LOSS FACTORS

Near shading	Enabled
Albedo	0.20
Soiling/Snow	0%
Incidence angle modifier (IAM), ASHRAE b0 param.	0.05
Thermal loss factor Uc (const) Flush mount	20
Thermal loss factor Uc (const) Tilted	29
LID loss factor	0%
System unavailability	0%

PURPOSE / APPLICATION

INCREASING STRENGTH OF EXISTING OPEN WEB STEEL JOISTS FOR ADDITIONAL LOADS (TYPICALLY MECHANICAL UNITS AND/OR SNOW ACCUMULATION) .

WITH REFERENCE TO CROFTON FIREHALL ADDITION ENERGY AND EMISSIONS STUDY, IT WAS IDENTIFIED THAT ADDITIONAL PV PANELS ON THE APARATUS ROOF COULD BE EMPLOYED TO OFFSET THE ENERGY USE OF THE NEW ADDITION.
PVS CAN AFFECT THE DISTRIBUTION OF SNOW INCLUDING BUILDUP AT THEIR BASE, CAUSING LOCAL OVERLOADING OF THE STRUCTURE.
THIS DRAWING TAKES INTO CONSIDERATION THESE EFFECTS CONSIDERING THAT THE EXISTING ROOF STRUCTURE COMPRISING OF OPEN WEB STEEL JOISTS MAY HAVE TO BE STRENGTHENED FOR THE ADDITIONAL WEIGHT OF THE UNITS PLUS ANY POTENTIAL SNOW BUILDUP.
THERE ARE NO RECORD SHOP DRAWINGS TO IDENTIFY THE CURRENT STRENGTH OF THE EXISTING JOISTS, THEREFORE IN ABSCENCE OF THIS INFORMATION OR A DETAILED FIELD SURVEY, THESE DETAILS INCLUDE THE REINFORCING REQUIRED TO WITHSTAND THE NET INCREASE IN MEMBER FORCES DUE THE ANTICIPATED LOADING.
THE ANTICIPATED ADDITIONAL LOADING TAKES INTO CONSIDERATION ANY NET INCREASES DUE TO NEW BUILDING CODE PROVISIONS.
THE ANTICIPATED ADDITIONAL LOADING TAKES INTO CONSIDERATION THAT THE APPARATUS BAY WHERE THE PVS WOULD BE INSTALLED IS A POST DISASTER FACILITY AND THE APPROPRIATE IMPORTANCE FACTORS APPLIED.

THE LOADING USED IN THIS REVIEW IS AS FOLLOWS:

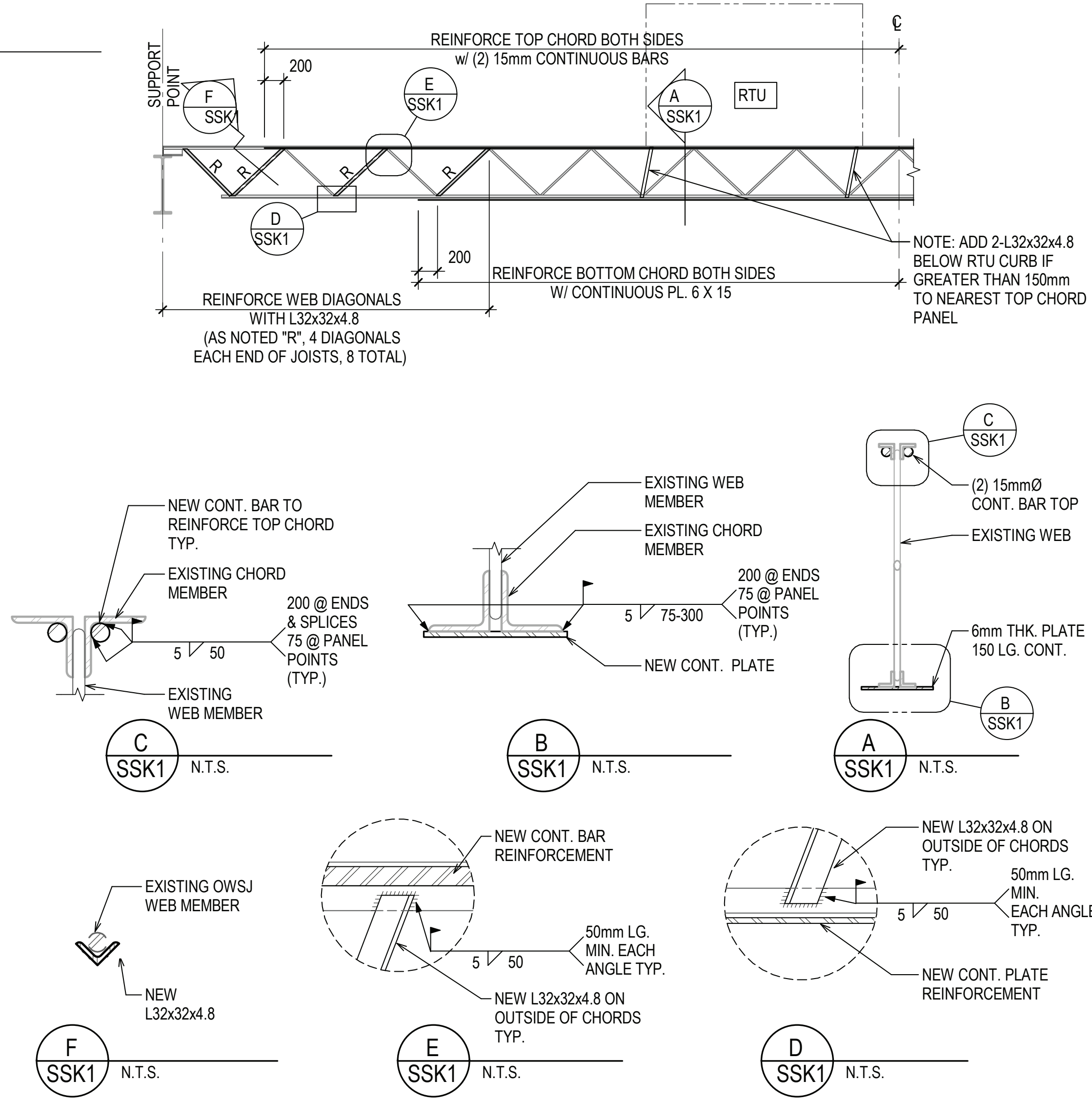
ORIGINAL ROOF DEAD LOAD : 0.75 kpa
ORIGINAL UNIFORM SNOW LOAD: 1.85 kpa (ULS)

ANTICIPATED ROOF DEAD LOAD ASSUMING A NON-BALLASTED PV SUPPORT SYSTEM : 1kpa
ANTICIPATED EQUIVALENT UNIFORM SNOW LOAD ALLOWING FOR NOMINAL DRIFTING: 2.7 kpa

ANTICIPATED FACTORED LOAD INCREASE DUE TO SNOW DRIFT AND WEIGHT OF PANELS = 44%

EXISTING ROOF DECKING COMPRISING 38MM DEEP PROFILED DECK GRADE 230, 0.76mm

THE DETAILS PROVIDED ON THIS SKETCH ARE PRELIMINARY AND NEED TO BE VERIFIED AGAINST SPECIFIC PV'S AND PANEL LAYOUT WHEN CONFIRMED. A DETAILED FIELD REVIEW WILL BE REQUIRED TO CONFIRM EXISTING OWSJ DIMENSIONS AND COMPONENTS.
EXISTING INFORMATION WITH RESPECT TO STRUCTURAL LAYOUTS AND ORIGINAL LOADING WAS BASED ON DRAWINGS S01 TO S04 TITLED CROFTON FIREHALL PROPOSED BUILDING ADDITION 4 BAY BUILDING ADDITION, DATED 08 MAY 2002 BY HEROLD ENGINEERING LIMITED.



Applicable Code
NBCC 2015
Applicable Material Code
CSA S16
Applicable Seismic Category
Rd*Ro <=1.5*1.3

rjc Engineers

Project Name	CROFTON FIREHALL	Dwg. Ref.	N/A
		Scale	As indicated
		Date	2022-08-09
Sketch Title	OWSJ REINFORCEMENT DETAILS	Project No.	VIC.131201.0001
		Sketch Number	SSK1
		Rev.	