

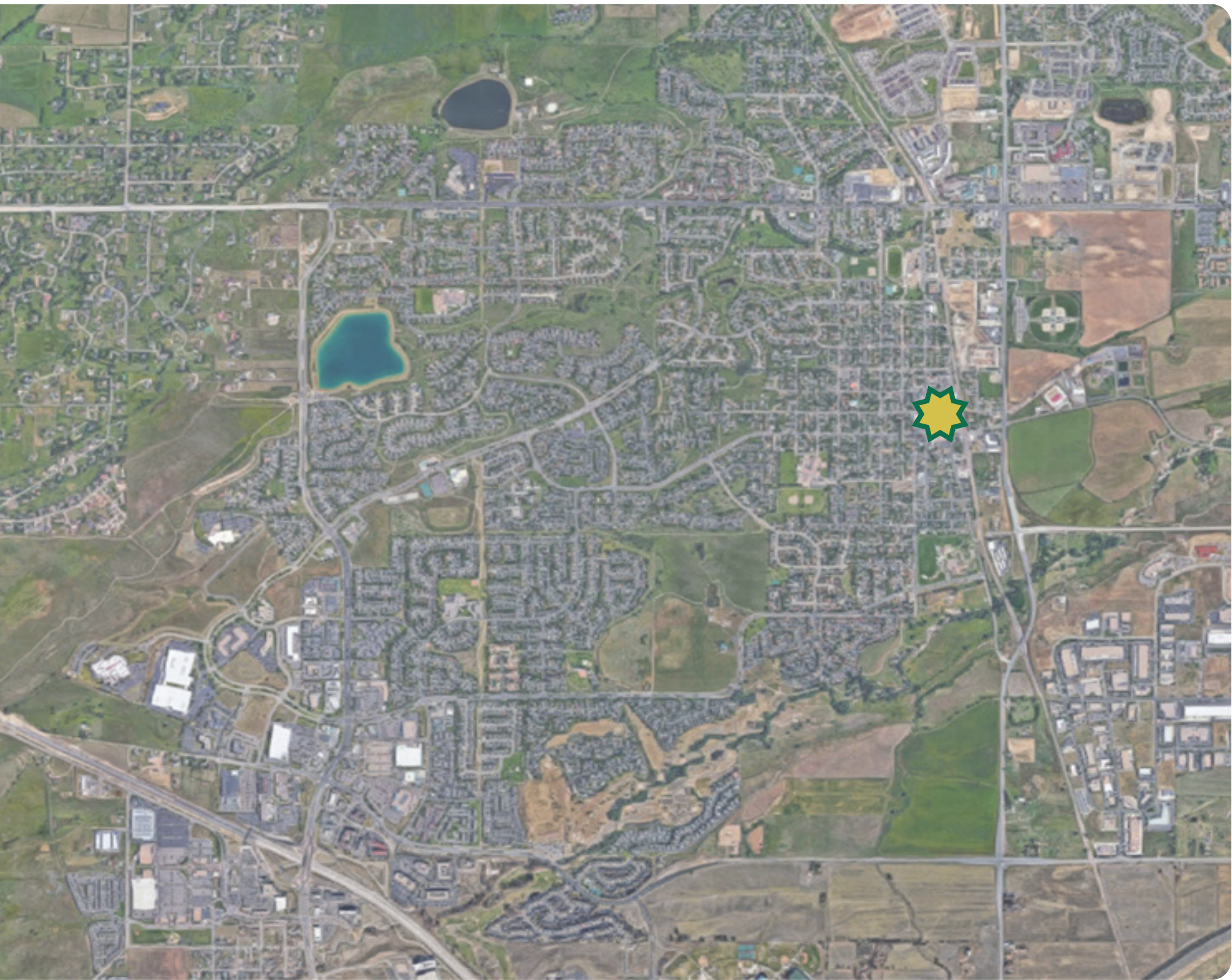
City of Louisville Internal Decarbonization Plan

CITY HALL & AUSTIN NIEHOFF DECARBONIZATION AUDIT REPORT

749 & 717 MAIN ST
LOUISVILLE, COLORADO
AUGUST 18, 2023



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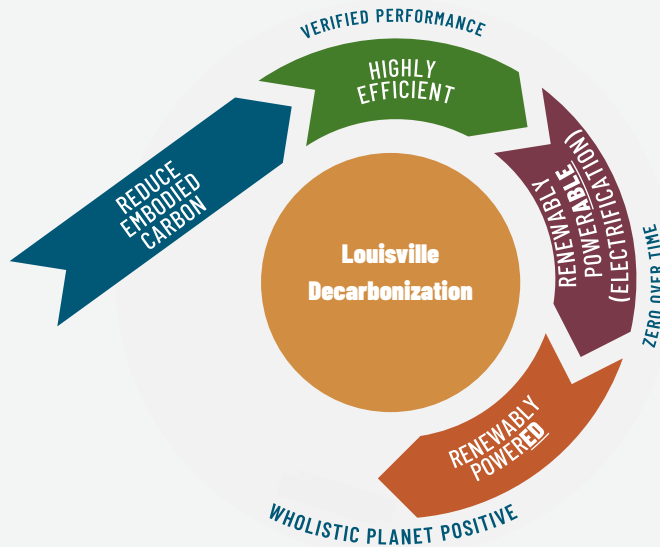
Date	Version History
8/18/2023	Version 1 - Issued to City

Background

In August of 2019, City Council passed Resolution 25, Series 2019, which set clean energy and carbon emission reduction goals for the municipality and larger community. This resolution sets goals to meet all of Louisville’s municipal electric needs with 100% carbon-free sources by 2025, and to reduce core municipal greenhouse gas emissions annually below the 2016 baseline through 2025. The City of Louisville has demonstrated its commitment toward creating a healthy and sustainable environment for its residents, evident through Resolution 25-2019 (Setting Clean Energy and Carbon Emission Reduction Goals), as well as their Sustainability Action Plan (adopted in October 6, 2020). In support of these goals, McKinstry was contracted to identify a strategic roadmap for electrification and decarbonization of all City buildings, fleet, equipment and operations by 2030, and recommend an alternative target if appropriate.

This is an interim report, providing initial directions, findings, as well as a draft set of detailed decarbonization approaches for City Hall and the adjacent Austin Niehoff building, the oldest structure in Louisville that was once home to the Niehoff family but has since been converted to house the Louisville Parks and Recreation department.

There are many possible pathways for decarbonizing Louisville. With guidance from City staff, this report focuses on identification of strategies that provide the highest value, most fiscally responsible path forward to achieve Louisville’s decarbonization goals.



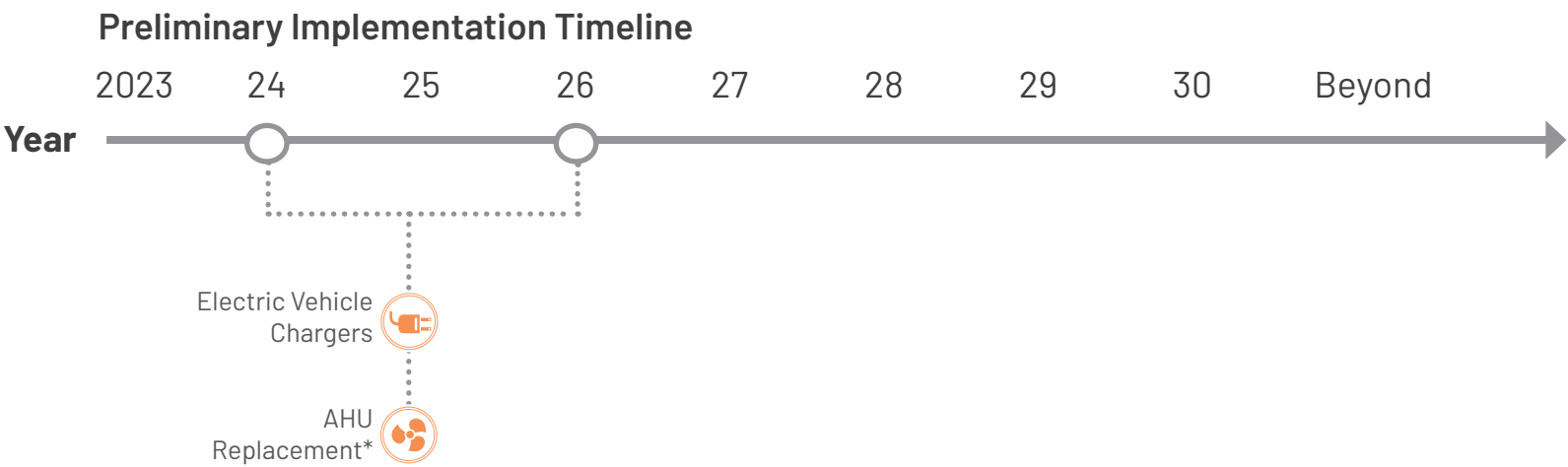
Decarbonization Recommendation

The table below outlines the findings of the study and highlights the opportunity towards a viable and cost-effective path towards carbon neutrality. The total cost is the total amount of money that will need to be allocated for budgetary purposes. The net cost is the total construction costs minus the replacement costs that would’ve been spent to replace the existing units with like-for-like fossil fuel units. The net cost represents the true cost of this decarbonization effort. All information included in this table is explained in greater detail in this report. **These are “all-in costs” and represent the total cost of construction. They are also Rough Order of Magnitude (ROM) numbers, with a +/-20% range.** See “Construction Pricing Context” section for more detail.

	Scenario	Life Cycle Carbon Reduced	Life Cycle Carbon % Reduction	Total First Cost	Net First Cost Over Business as Usual Cost
⚡	Full Electrification	1,000 tons	100%	\$1.9M	\$1.3M
⚡🔥	Hybrid Electrification	700 tons	70%	\$1.0M	\$360K
🚗🔌	EV Charging	N/A	N/A	\$240k	N/A

Implementation

A preliminary implementation timeline is shown below, based on the 2023 Capital Improvement Plan (CIP).



*Existing equipment was installed in 2006. Replace at end-of-life.

Baseline | Building Use & Energy and Carbon Analysis

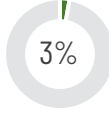
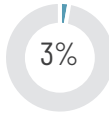
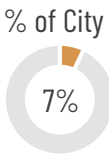
Baseline Building Use

Baseline Year
2019

Building Size
19,156 ft²

Building Energy
1,600 MMBtu

Building Carbon
75 Tons



Building Information

- City Hall for Louisville.
- Located at eastern border of the city.
- Open to public.
- Austin Niehoff building houses Louisville Parks & Recreation department.

Recent Renovations and Energy Improvements

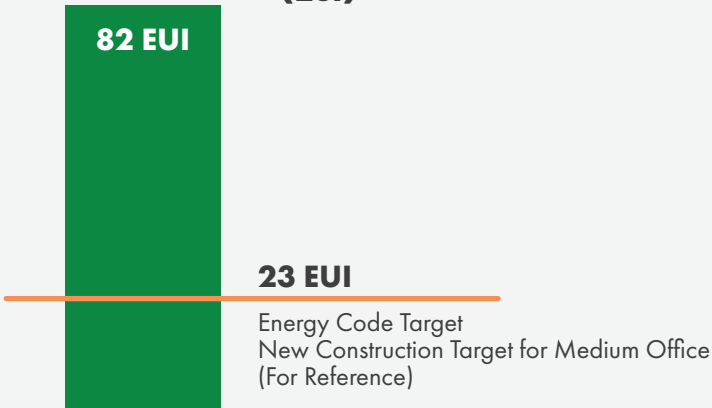
- Lighting upgrade to LED planned for August 2023.
- Fire notification system in 2023.
- Elevator modernization in 2023/24.



Baseline Energy Use

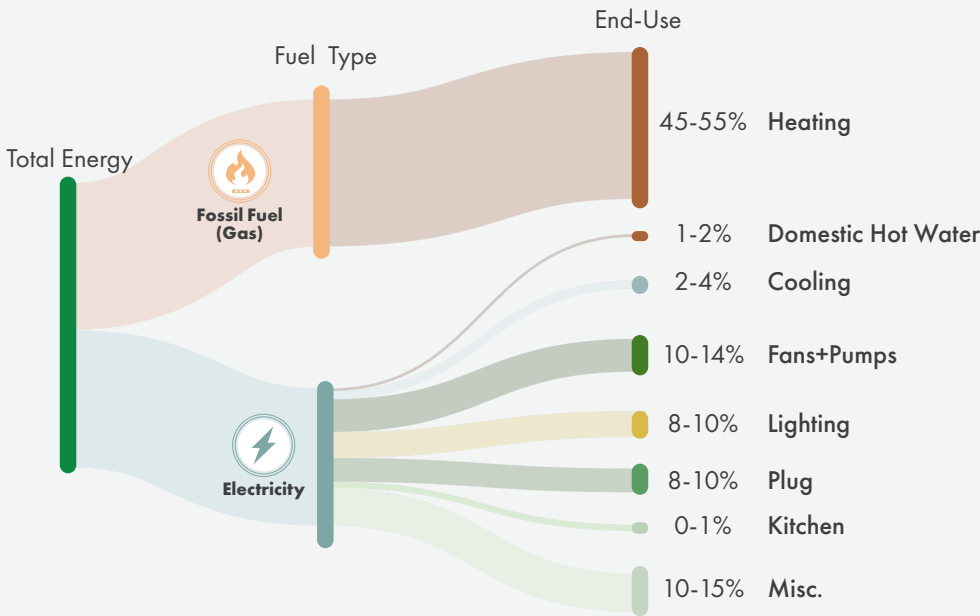
The City Hall performs poorly when compared to the new construction target for medium sized offices.

Baseline Annual Energy Use Intensity (EUI)



Baseline Energy End-Use

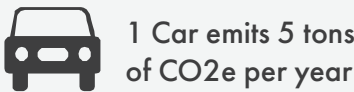
Energy end-use estimates are based on most recent available 2018 Commercial Building Energy Consumption Survey (CBECS) benchmarking data and site audit information.



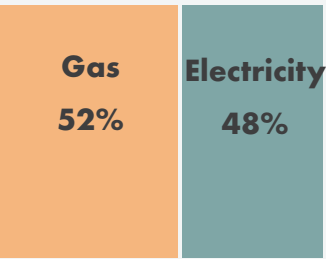
Baseline Carbon Use

The City of Louisville participates in programs to offset their existing electrical consumption with renewable sources. **Therefore, for the purposes of this study the total carbon emissions at Louisville will be solely driven by on-site fossil fuel combustion and emissions associated with electric consumption will be zero.**

The amount of electric consumption offset needed for zero carbon will be addressed in future phases of this study, and will be evaluated at the portfolio level. The offset will be a function of post-decarbonization electrical consumption considering carbon and load reduction measures, on-site renewable energy provided, and the grid emissions of Xcel Energy and zero-carbon utility subscription programs.



Baseline Energy



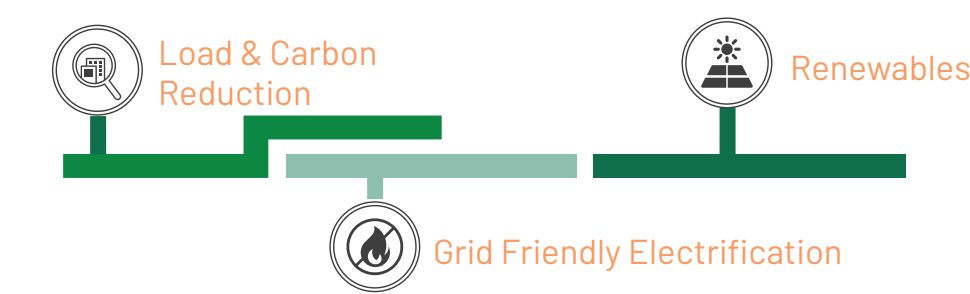
Baseline Carbon



Decarbonization Measures | Decarbonization Process, Load & Carbon Reductions

Decarbonization Process

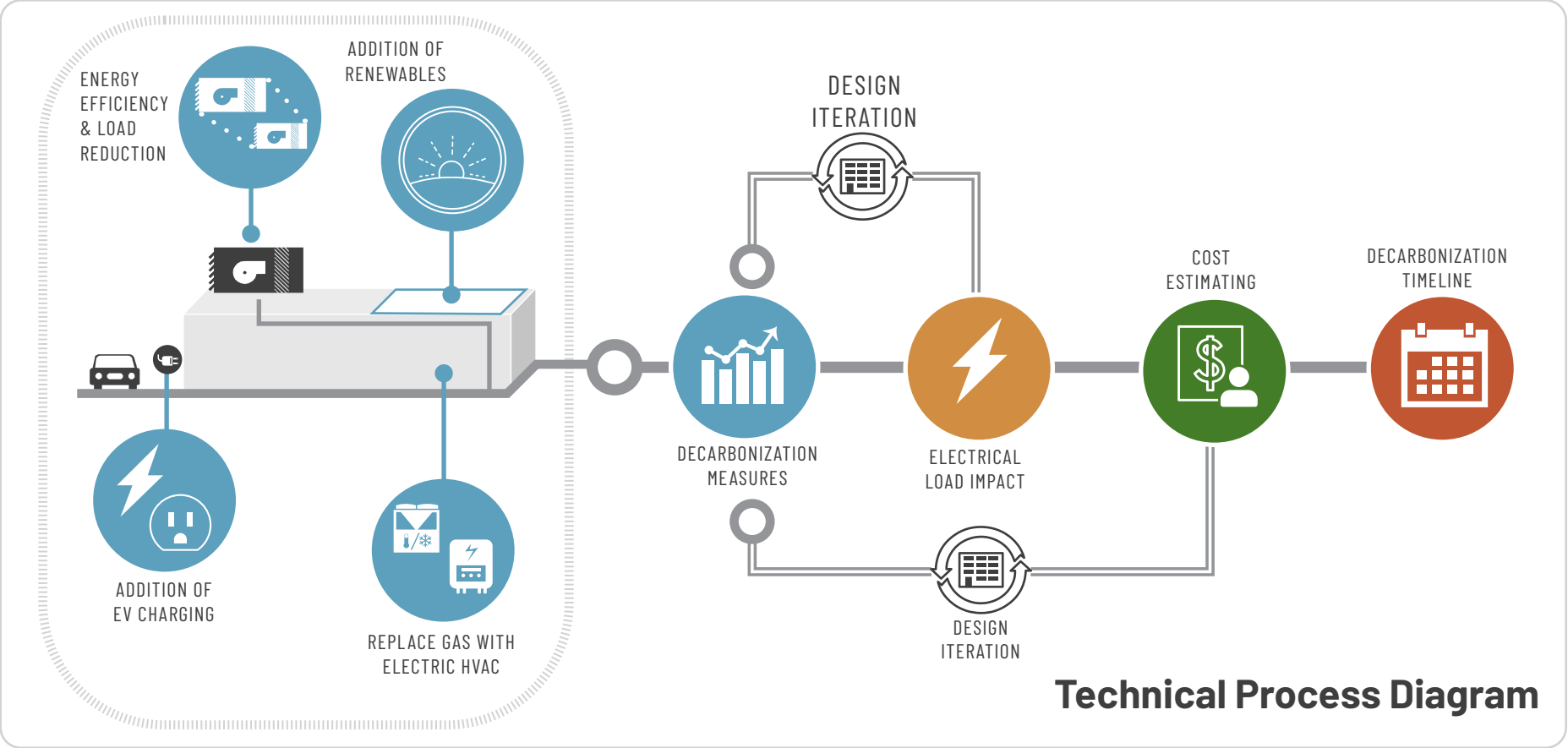
There are a host of measures to employ on the path of decarbonization, ranging from time-tested traditional energy efficiency measures to the more aggressive electrification measures. The key to decarbonization is finding the right balance between measures, as indicated by the graphic below. With this approach, Louisville will find the most cost-effective path to full decarbonization.



The decarbonization solution starts by identifying measures at the building, and continues with design iteration to arrive at the final timeline, as seen in the Technical Process Diagram.

Load & Carbon Reduction

The recent shift towards decarbonization still operates on the core foundation of reducing building's overall energy use. Measures can have two functions: reducing annual energy/carbon consumption and reducing peak building demand load. These measures are often incentivized by Xcel and may have shorter paybacks.

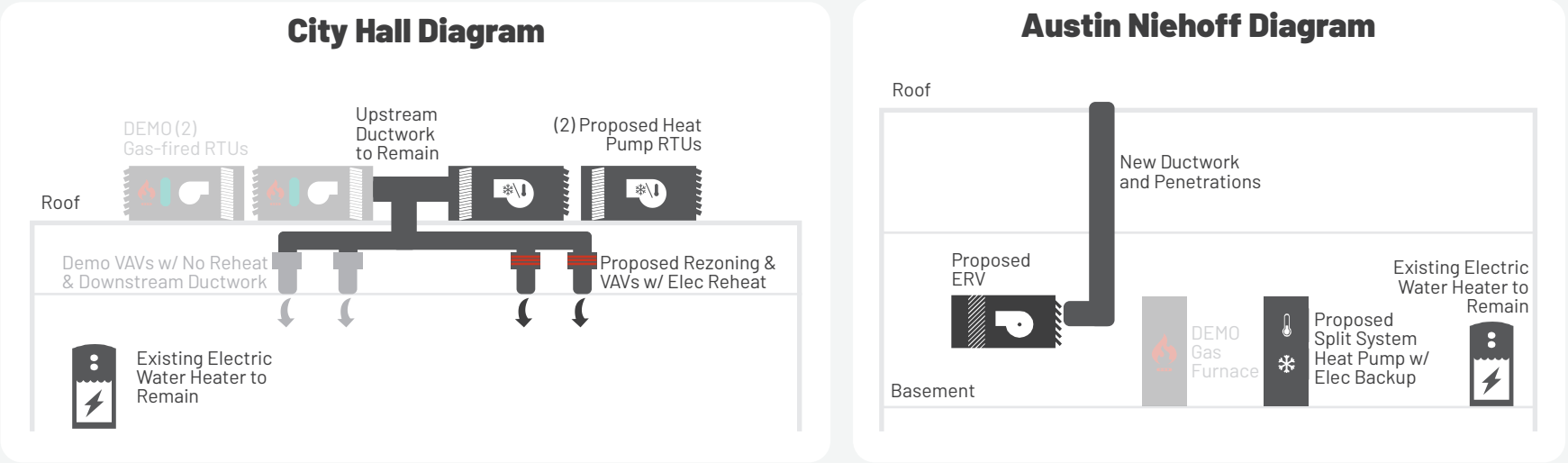


Load	Carbon	Measure	Description
		ENVELOPE AIR SEALING	Buildings are often remarkably leaky – the wall/parapet junction being a frequent culprit. Ensuring a building is tight and ventilated correctly is an effective efficiency measure that also has durability benefits (condensation often occurs at air leakage points) and improves air quality (mold reduction and limiting outside air infiltration during wildfire events).
		LIGHTING CONTROLS/VACANCY SENSORS	LED light replacements are typically the most cost effective way for saving electricity in the lighting arena, but adding lighting controls (which turn off lights with vacancy and vary based on available daylight) provide additional savings and better user experience.
		CONTROLS OPTIMIZATION/RETRO-COMMISSIONING (RCx)	Ongoing commissioning can help reduce energy use. This work focuses on identifying low- and no-cost opportunities to drive energy savings and optimize operational practices in the facilities. This is primarily accomplished through ongoing site audits, data analysis, training, and collaboration with the facility's operational team.
		WALL/ROOF INSULATION	Due to the age of this building, it was constructed with very little insulation. Additional wall insulation will reduce utility costs and provide better thermal comfort to the occupants of the building.
		ADVANCED PLUG LOAD REDUCTION	Items that are plugged into outlets -plug loads- often make up the single largest use of electricity in buildings, after heat pump heating and cooling. A dedicated, ongoing program for ensuring plug load items operating at maximum efficiency and/or appropriately switched is a great way to save electricity.

Decarbonization Measures | Mechanical Electrification

Proposed Electrification

The City Hall’s primary HVAC system is (2) gas/DX Rooftop Units (RTUs). The Austin Niehoff building’s primary HVAC system is a gas furnace. Simple diagrams of these systems and their proposed electrification measures are shown below.



AIRSIDE

City Hall contains (2) packaged gas/DX rooftop units for space conditioning and ventilation that is distributed through the building by terminal VAV boxes. As the office layout has changed over time, it is no longer aligned with the original mechanical zoning and since the system does not have reheat capabilities it has caused significant comfort issues. To decarbonize, replace the gas/DX rooftop units with heat pump RTUs with heat recovery wheels and full electric backup. As the RTUs are replaced with heat pumps, swap the terminal VAV boxes with similar units with electric reheat. All medium pressure ductwork between the rooftop units and the terminal units will remain, but the low pressure ductwork downstream of the VAV boxes will be replaced and rezoned for better energy performance and occupant thermal comfort.

Austin Niehoff contains (1) gas furnace for heating the building. The decarbonized solution would entail replacing the gas furnace with a heat pump, as well as providing an Energy Recovery Ventilation unit (ERV) for ventilation. ERVs introduce fresh outdoor air into the building and precondition/temper the air via the heat recovery coil. Emergency electric backup heat will be utilized during extreme winter days when heat pump operation is not optimal.

DOMESTIC HOT WATER

DHW in both City Hall and the Austin Niehoff building is currently served by existing electric water heaters, to remain as they are.

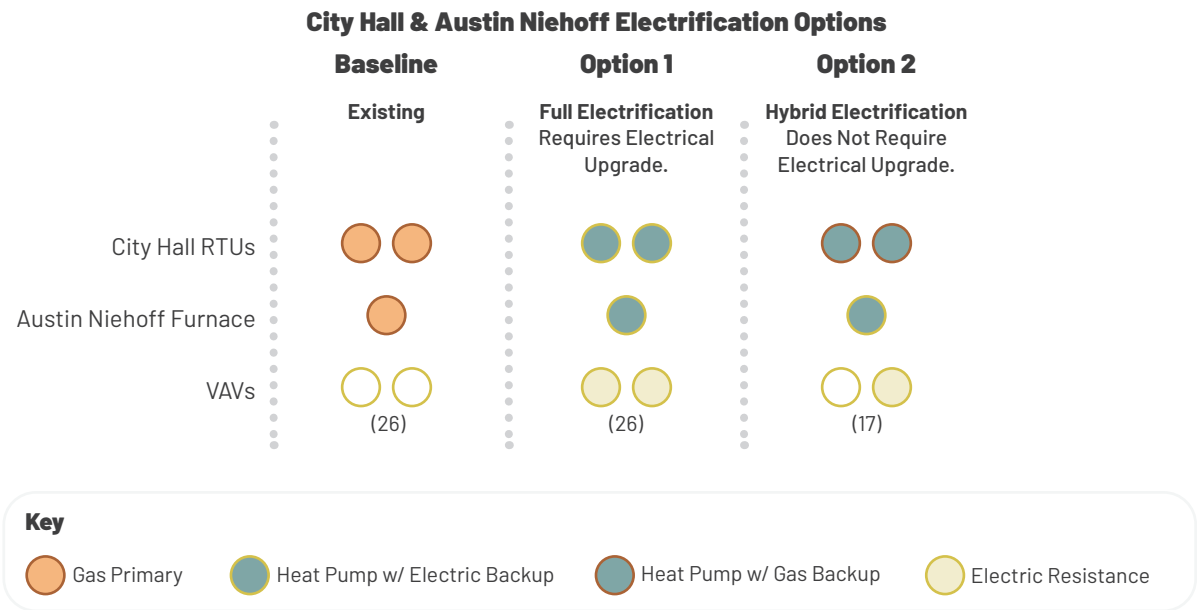
FUTURE MECHANICAL SYSTEMS FOR CONSIDERATION

Another option would be to completely redesign the mechanical systems in City Hall. Variable Refrigerant Flow (VRF) systems are very energy-efficient and allow for energy sharing between building zones, making them one of the best for occupant thermal comfort since different areas of the building can be heated or cooled at the same time. An alternate design could include a Dedicated Outdoor Air System (DOAS) for ventilation combined with a VRF system for space conditioning.

All Electric vs Hybrid Systems

Hybrid systems are a useful tool for **sensible and cost-effective decarbonization**, as they strike a balance between carbon reduction, construction costs, and utility demand costs. In general, it can be expensive to electrify the “last 10%”, because the system is sized for the coldest day of the year, which rarely occurs. In many cases, using gas as the peaking fuel source on the coldest day will mitigate need for an electrical upgrade while still achieving significant carbon reductions.

The Hybrid system for the City Hall was designed to stay within the existing electrical service capacity and avoid an electrical service upgrade. Based on the sizes of the mechanical equipment and the load profiles of the buildings, the Hybrid option for City Hall would be similar but use gas backup for the RTUs instead of electric. The Hybrid option also provides less VAV boxes than the fully electrified option. While this option begins to address comfort issues, it may not provide the same level of comfort control as the fully decarbonized system. As described in the electrical impacts section, full electrification would require an electrical service upgrade.



Beneficial Electrification

Electrification of mechanical systems provides value beyond energy and carbon savings. Additional benefits include, but are not limited to:

- Added cooling to the building with the new split system heat pump
- Enhanced ventilation control (outside-air supply, CO₂ Control, etc.) with new RTUs
- Improved thermal comfort with right-sized equipment and updated controls
- Improved resiliency of newer units

Decarbonization Measures | Renewables & Electric Vehicle Chargers

Renewables

AVAILABLE SPACE & RACKING MODALITY

The first constraint on system size is the available space on the property. Unfortunately at City Hall & Austin Niehoff, the roof had less than needed area in order for solar to be viable. There was not an opportunity for a ground mount or carport installation at these facilities.



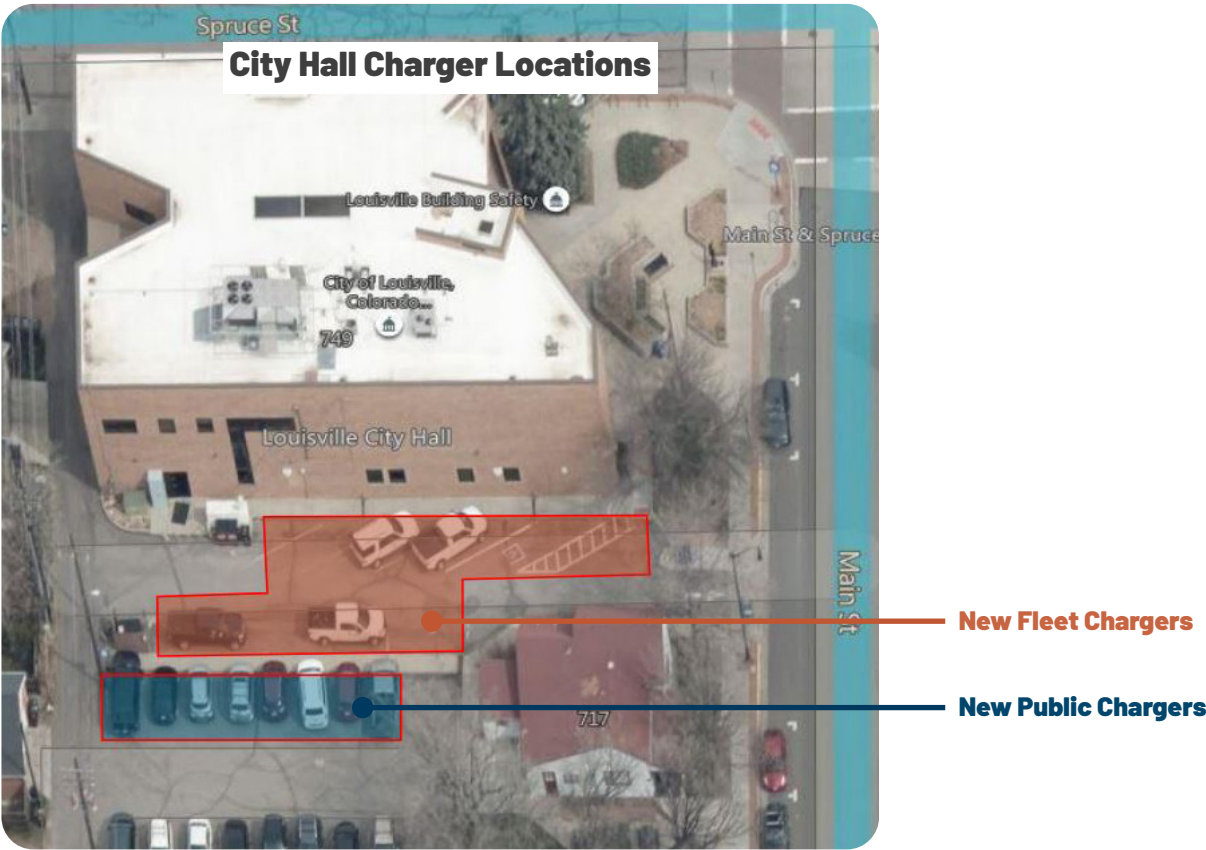
Electric Vehicle (EV) Chargers

City Hall stores 2 vehicles onsite and both are passenger vehicles.

Make	Model	Qty
Chevy	Bolt	1
Chevy	Impala	1

We recommend installing 7 chargers and the associated electrical scope to support them. 3 of the chargers will be for fleet vehicles and 4 of the chargers will be publicly available for the city residents.

Existing Public Charging Stations	Existing Public Charger Level	Quantity of New Level 2 Public Chargers	Quantity of New Level 3 Public Chargers	Quantity of New Level 2 Fleet Chargers	Quantity of New Level 3 Fleet Chargers
0	N/A	3	1	2	1



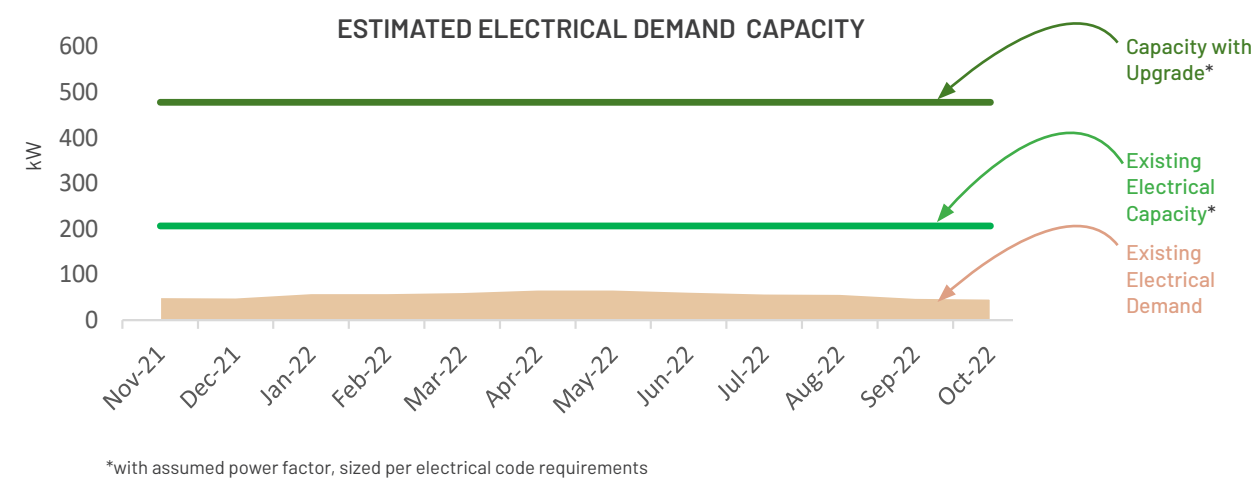
Decarbonization Measures | Electrical and Structural Impacts

Electrical Impacts

CITY HALL

The existing service to the City Hall is 208 Volts (V), 3-phase, 800 Amps (A).

Utility data was analyzed for the date range 11/2021 – 10/2022. This data shows the existing annual maximum demand of the City Hall is 64kW and 60kW during heating season. Accounting for demand factor adjustment, only 230A of winter demand is utilized on the existing 800A service, leaving 570A of extra capacity for new mechanical electrification and EV charging loads.



A significant proportion of the proposed load addition is heating, so we can utilize the winter demand as the base case. It should be noted that future changes in building occupancy or consumption patterns from the date range where data was provided may impact the service demand and available capacity for electrification.

The City Hall has an existing natural gas backup generator of unknown size. Generator capacity will be assessed during the next stage of design.

In Option 2, the existing service remains and new electrical distribution equipment is added upstream of the existing ATS to serve mechanical and EV load as well as a possible PV array. This option retains the existing generator and assumes that there is at least 26kVA of spare capacity.

In Options 1 and 3, the existing service is demolished and replaced with a 480 Volt (V), 3-phase, 800A service. The existing natural gas generator and ATS are replaced with a new diesel generator and ATS to provide partial backup to some mechanical systems. The design is intended to minimize disruption to the existing facility by allowing installation of most of the new equipment prior to decommissioning and demolition of the old equipment.

AUSTIN NIEHOFF

The existing service to the Austin Niehoff building is 240/120 Volts (V), single-phase, 200 Amps (A).

Existing load is unknown. It is assumed that the service is fully rated at 200A. Mechanical scope is very simple and consists of converting an existing gas furnace to a residential heat pump with full electric resistance backup and an energy recovery ventilation unit. Added load requires ~122A of capacity under the assumption that the heat pump and resistive backup loads can operate concurrently.

Based on the small size and quantity of equipment served in this building, it is possible that the existing demand load could be below 60A, as would be required to justify this load addition without a service upgrade. However, it is more likely that the new load addition will necessitate a service upgrade to 300A. It may be possible to avoid the service upgrade by performing metering in the future.

Structural Impacts

Option 1- No structural upgrades are anticipated for rooftop mechanical equipment replacements at existing RTU-1 location. The original supporting roof trusses were designed for rooftop mechanical equipment of similar size.

Option 2- No structural upgrades are anticipated to underlying trusses at RTU-2 replacements, however, flat oriented steel channel is configured to support significantly heavier RTU-2 replacement and distribute gravity load to more underlying support trusses.

Option 3- No structural upgrade is anticipated at new DOAS unit to be located at existing RTU-1 unit location. For new rooftop VRF condensing units, structural upgrade and rooftop mechanical equipment supports will be required. In order to support the new equipment, the underlying bar joists will need to be structurally reinforced. Truss reinforcing will consist of top and bottom chord reinforcing, web reinforcing along with truss panel point reinforcing. In addition, at some locations, added steel framing is to be configured above the roof deck to distribute the weight of the overlying mechanical units to engage more truss support framing.

Decarbonization Measures | Proposed Electrification

Electrification Options



FULL ELECTRIFICATION – Full electrification at the City Hall, including heat pump RTUs and electric VAV reheat. EV charging costs are not included in this option. **This option requires significant electrical and generator upgrades.**

	Load & Carbon Reduction	Grid Friendly Electrification
	Envelope Air Sealing Lighting Controls LED Upgrades	Electrification Hybrid Electrification Full
Total Cost	\$20k	\$1.9M*
Base Cost	N/A	\$660k
Net Cost of Electrification	N/A	\$1.3M*



HYBRID ELECTRIFICATION – Hybrid electrification at the City Hall, including heat pump RTUs with gas backup. Only some VAVs will have electric reheat in this option. EV charging costs are not included in this option. **This option does not require significant electrical and generator upgrades.**

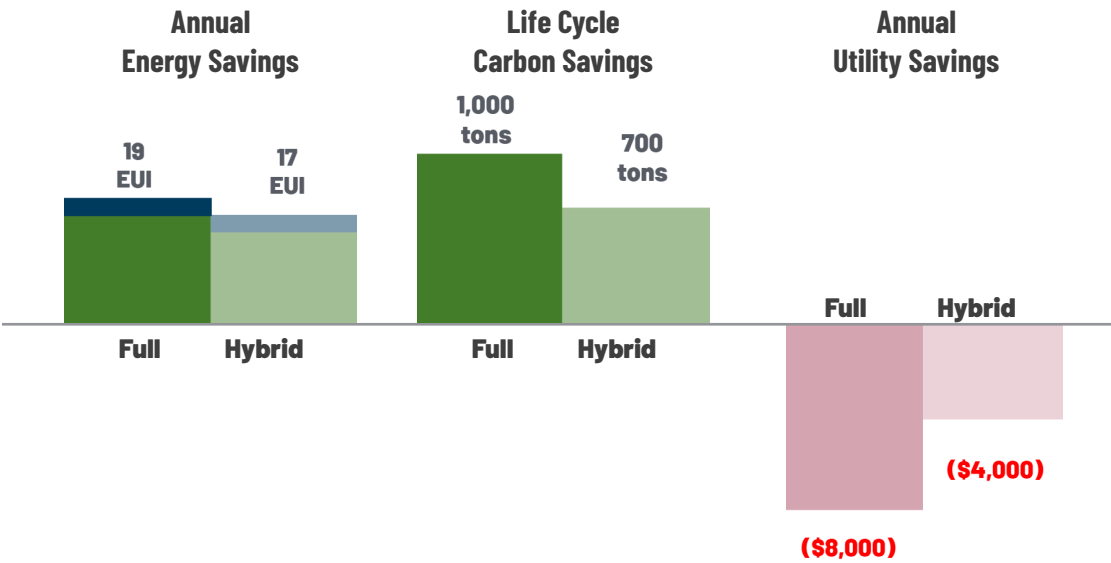
	Load & Carbon Reduction	Grid Friendly Electrification
	Envelope Air Sealing Lighting Controls LED Upgrades	Electrification Hybrid Electrification Full
Total Cost	\$20k	\$1.0M*
Base Cost	N/A	\$660k
Net Cost of Electrification	N/A	\$340k*

*Costs subject to further evaluation of generator requirements.

Proposed Annual Measure Savings

Energy, carbon, and utility cost savings of the proposed options are shown here. The full electrification option is roughly equivalent in energy savings. Conversion from gas to electricity does provide additional carbon savings.

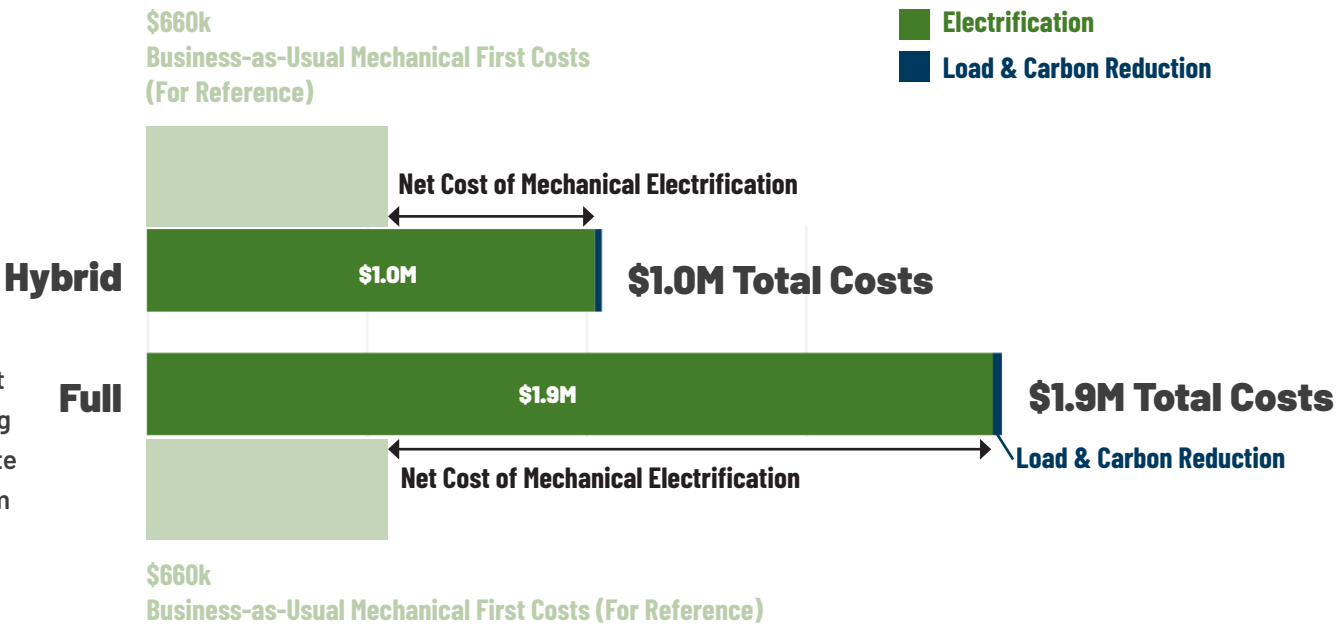
- Electrification
- Load & Carbon Reduction
- Cost Savings
- Cost Penalty



Proposed Total Measure Costs

Proposed measure costs are shown below, including any structural and electrical upgrades needed for each option. They are also Rough Order of Magnitude (ROM) numbers, with a +/-20% range.

The total cost is the total amount that will need to be allocated for budgetary purposes. The net cost represents the total cost minus the replacement cost that would've been spent to replace the existing units with like-for-like fossil fuel units. Note that there is a significant net cost premium for full electrification due to electrical upgrades.



Decarbonization Measures | Construction Pricing Context & Constructibility

Construction Pricing Context

The MEP scope narratives described in previous sections and included in the appendices were used by McKinstry’s construction division to provide Rough Order of Magnitude (ROM) pricing. This early ROM budgeting process sought to be reasonable but conservative wherever possible. **Typically for ROM-level pricing a range of +/- 20% is applied to the total construction and start up costs.** This range can be reduced, and the pricing further refined, via a deeper understanding of existing building conditions and detailed design. Note this does not account for escalation, which is addressed separately. This pricing represents the total construction and startup cost to Louisville, including:

- General contractor markup
- Design fees
- Engineering energy analysis
- Controls
- Equipment startup, commissioning, testing, and balancing
- Placeholders for miscellaneous trades (e.g. carpentry).
- Allowances specific to each building for construction conditions (e.g. crane time)

All construction costs are in 2023 dollars unless noted otherwise.

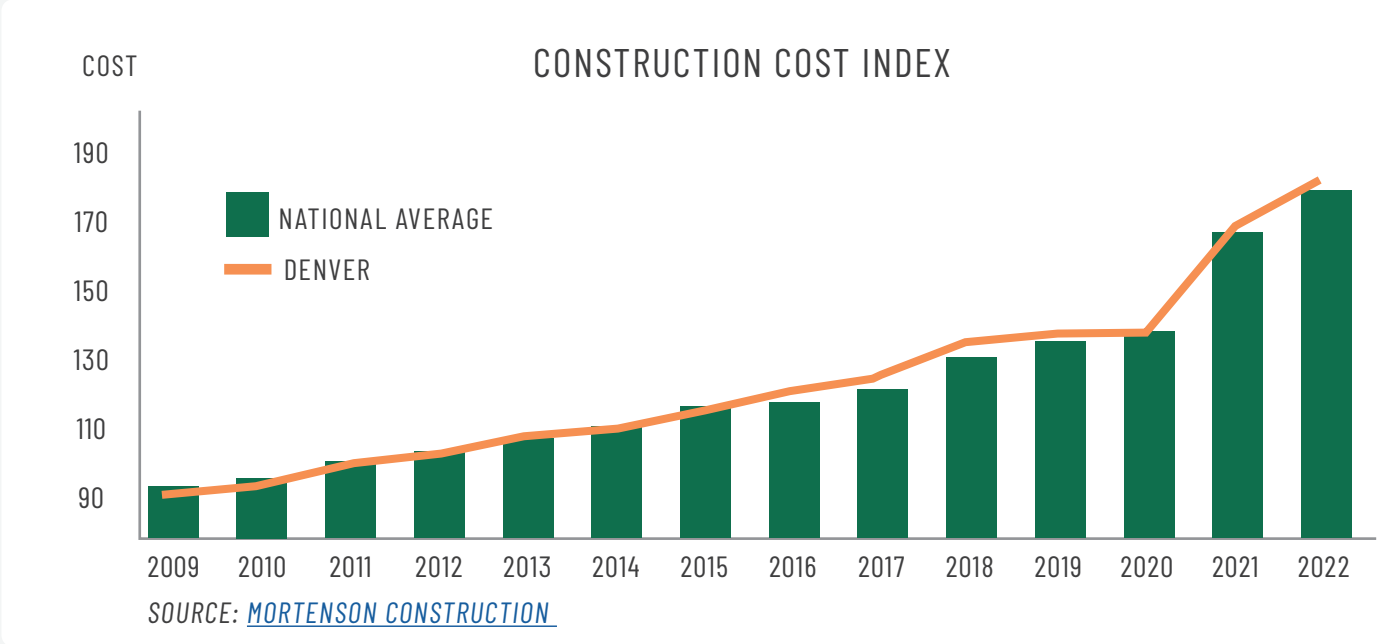
Using These Construction Costs

Throughout this report, differentiation is made between “total construction costs” and “net cost over business-as-usual fossil fuel systems”The distinction between the two is:

- Total costs: these are the total construction costs. This is the total amount of money that will need to be allocated for budgetary purposes.
- Net Cost: these are the total construction costs minus the replacement costs that would’ve been spent to replace the existing units with like-for-like fossil fuel units. These numbers represent the true cost of this decarbonization effort.

Note the numbers in the 2023 City Budget are budget numbers, and do not represent all costs for replacing the existing units. As such, they should not be used when determining the costs of decarbonization. In addition, the cost estimates in this report assume miscellaneous equipment (e.g. expansion tanks, domestic hot water storage tanks) need to be replaced. This assumption should be validated in detailed design, and could result in the total construction cost being lower if equipment can be reused.

As shown in the graph by the Mortenson, construction costs have been steadily rising since 2009. However, costs rose drastically from 2020 to 2022 (approximately 35%) due to global supply chain issues and unforeseen consequences of the COVID-19 pandemic.



Constructibility

Recent upheavals in the global supply chain and labor workforce have caused uncertainty in the construction market. Our construction teams are seeing the following trends as of March, 2023:

ELECTRICAL LEAD TIMES:

- Most commodity items, such as conduit, wire, fittings, etc. are readily available.
- Lead times for Switchboards are being quoted 50-80 weeks. Panel-boards can be 20-40 weeks depending on complexity.

MECHANICAL LEAD TIMES:

- Equipment needs to be ordered earlier in detailed design process to accommodate long lead times. Requires additional coordination earlier in design.

In order to combat these lead time challenges, design teams may need to be flexible with their specifications and the products/manufacturers they are selecting.

LABOR MARKET:

While we are seeing a general relaxing of labor shortages in other markets around the country, the contractor and labor shortages continue to persist in the Denver market.

Next Steps | Implementation

Implementation

A preliminary implementation timeline is shown below, based on the 2023 Capital Improvement Plan (CIP). Given the CIP replacement schedule, the City Hall will likely implement measures beyond 2030, at equipment end of life. The summary below is the implementation recommendation based on age of equipment as well as additional thoughts on emerging technologies and sequence of upgrades.

AIRSIDE

- As RTUs reach end of life, replace with all-electric heat pump alternatives.

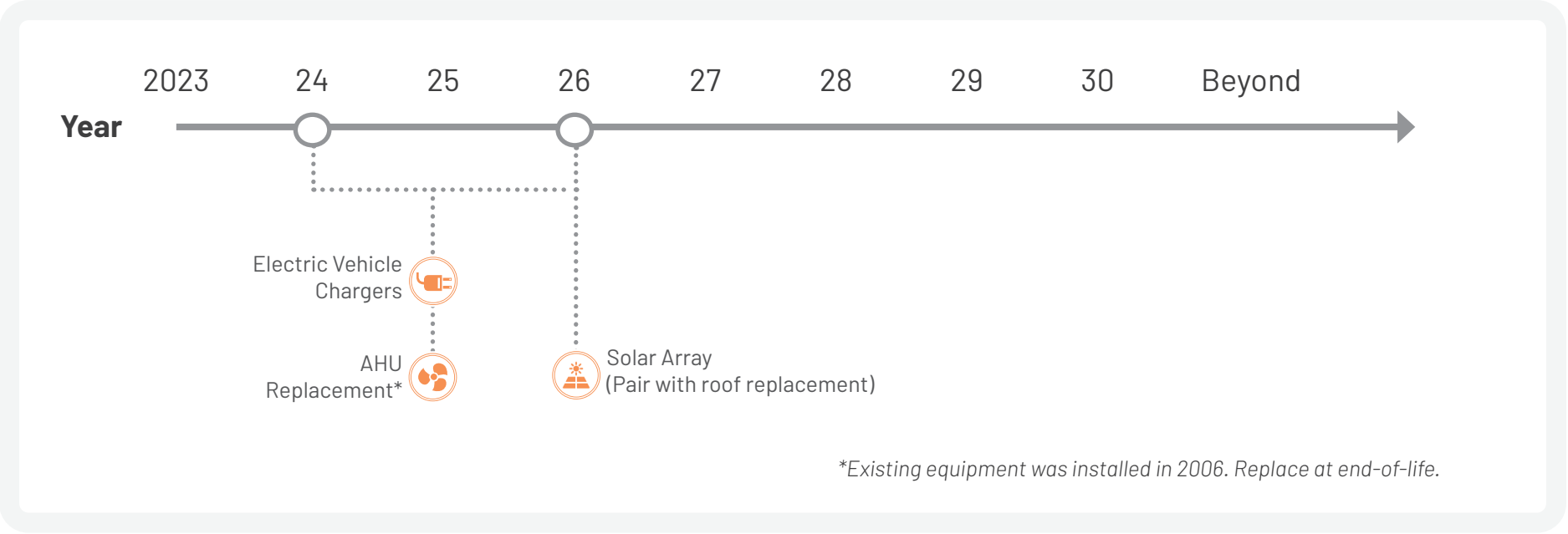
FURNACE

- As furnace reaches end of life, replace with heat pump and energy recovery ventilation unit.

ELECTRIC VEHICLE CHARGER

- Provide 3 EV chargers for fleet and 4 EV chargers for public

Preliminary Implementation Timeline





Appendix

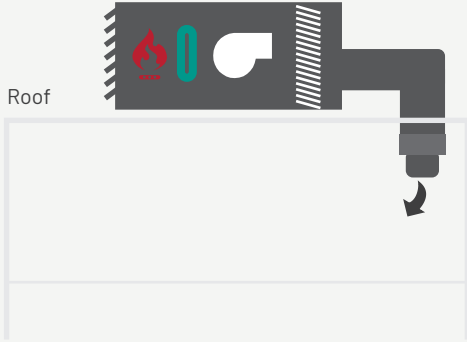
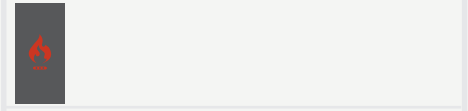
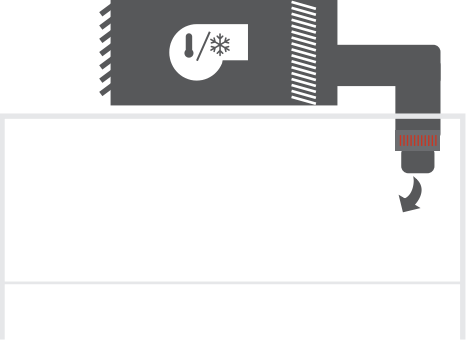
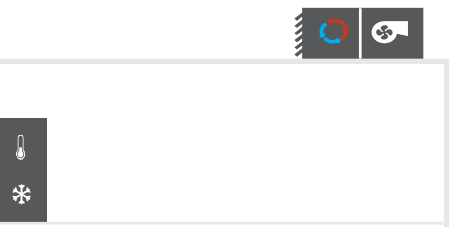
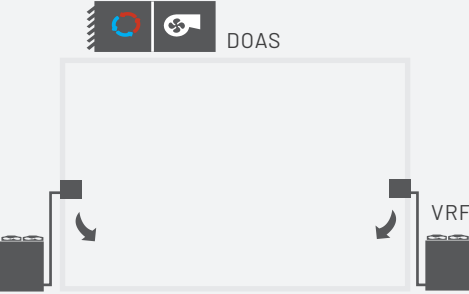
1. Mechanical System Matrix Options
2. Mechanical Decarbonization Scoping
3. Electrical Decarbonization Scoping
4. Structural Scoping
5. Electric Vehicle Charging Narrative
6. Renewables Scoping
7. Cost Estimating



Appendix

1. Mechanical System Matrix Options
2. Mechanical Decarbonization Scoping
3. Electrical Decarbonization Scoping
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5. Electric Vehicle Charging Narrative
6. Renewables Scoping
7. Cost Estimating

HVAC System Matrix: City Hall & Austin Niehoff

	City Hall: Existing System	Austin Niehoff: Existing System	City Hall: Recommendation	Austin Niehoff: Recommendation	City Hall: New Construction Alternate
General	Gas Rooftop Units	Gas Furnace	Rooftop Heat Pumps	ERV+ASHP	DOAS + ACVRF. Full system replacement
					
Plant Equipment	-	-	None	None	Air-cooled VRF condenser farm located on ground next to City Hall.
			None	None	See Above
Extent of Retrofit	City Hall has known occupant comfort and control issues. An extensive retrofit is likely required to rectify these.	-	Extensive Proposed rezoning of terminal VAV boxes will require entirely new low pressure ductwork and added electric reheat coils. Attempt to reuse existing medium pressure ductwork.	Medium Energy Recovery Ventilator (ERV) will require new ductwork and penetrations to the exterior for outdoor air and exhaust air.	Potentially Substantial & Invasive Attempt to reuse existing medium pressure ductwork. VAV Box Replacement
Electrical Impacts	-	-	Upgrade Potentially Needed. Can be a component of system mix and match to avoid electrical upgrade. Demo/replace existing nat gas generator with diesel generator.	Upgrade Potentially Needed. There is very little electrical information available about this site. Will likely require a service upgrade, but actual existing service size is unknown.	Upgrade Potentially Needed. Can be a component of system mix and match to avoid electrical upgrade. Demo/replace existing nat gas generator with diesel generator.
Limiting Factor	-	-	None	None	High First Cost
Verdict	-	-	Proceed w/ Detailed Scoping	Proceed w/ Detailed Scoping	High-Level Consideration



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City Hall – Mechanical Scope Narrative

Option 1 – Full Electrification

Demo Scope of Work:

- Includes removal and disposal of (2) RTUs
 - Assumes cut, cap and make safe gas piping from each RTU
 - Includes removal of (26) terminal VAV boxes and downstream LP ductwork

New Scope of Work:

- Includes (2) new air to air heat pump RTUs, (1) 31ton and (1) 10ton, with 36kW electric backup
 - Includes new curbs
 - Assumes existing MP ductwork and any sound attenuation to remain and be reused
 - Assumes any condensate off RTUs may drain to existing roof receptors
 - Includes (26) new terminal VAV boxes with electric reheat and downstream LP ductwork, rezoned

Option 2 – Hybrid Electrification

Demo Scope of Work:

- Includes removal and disposal of (2) RTUs
 - Assumes cut, cap and make safe gas piping from each RTU
 - Includes removal of (9) terminal VAV boxes and downstream LP ductwork

New Scope of Work:

- Includes (2) new air to air heat pump RTUs, (1) 31ton and (1) 10ton, with gas backup
 - Includes new curbs
 - Assumes existing MP ductwork and any sound attenuation to remain and be reused
 - Assumes any condensate off RTUs may drain to existing roof receptors
 - Includes (17) new terminal VAV boxes with electric reheat and downstream LP ductwork

Mechanical General Inclusions, Clarifications, & Exclusions

- Includes allowance for crane/rigging
- Includes allowance for permits
- Includes allowance for carpentry
- Carrying Seattle labor rates
- Pricing in today's dollars
- Excludes temp HVAC and plumbing
- Excludes overtime work
- Excludes parking
- Excludes any new sound attenuation scope. Assumes ductwork and existing sound attenuation to remain.
- Excludes duct smoke detectors and wiring
- Excludes any heat tracing
- Excludes good faith survey
- Excludes demolishing gas distribution lines/piping back to meter
- Excludes condensate drain piping to roof drains. Assumes piping directly down onto roof.



Austin Niehoff – Mechanical Scope Narrative

Option 1 – Full Electrification

Demo Scope of Work:

- Includes removal and disposal of (1) gas furnace
 - Assumes cut, cap and make safe gas piping from furnace

New Scope of Work:

- Includes (1) new 2-ton residential-style air-source heat pump
 - Located in basement in approximately same area as existing gas furnace
 - Includes auxiliary 15kW electric coil for 100% electric backup capabilities
- Includes (1) new 200 cfm ERV with heat wheel
 - Located in basement in approximately same area as existing gas furnace
 - Includes new supply and exhaust ductwork to exterior
 - Includes roof penetrations for new ERV ductwork
 - Includes 2kW duct heater downstream of unit for additional capacity

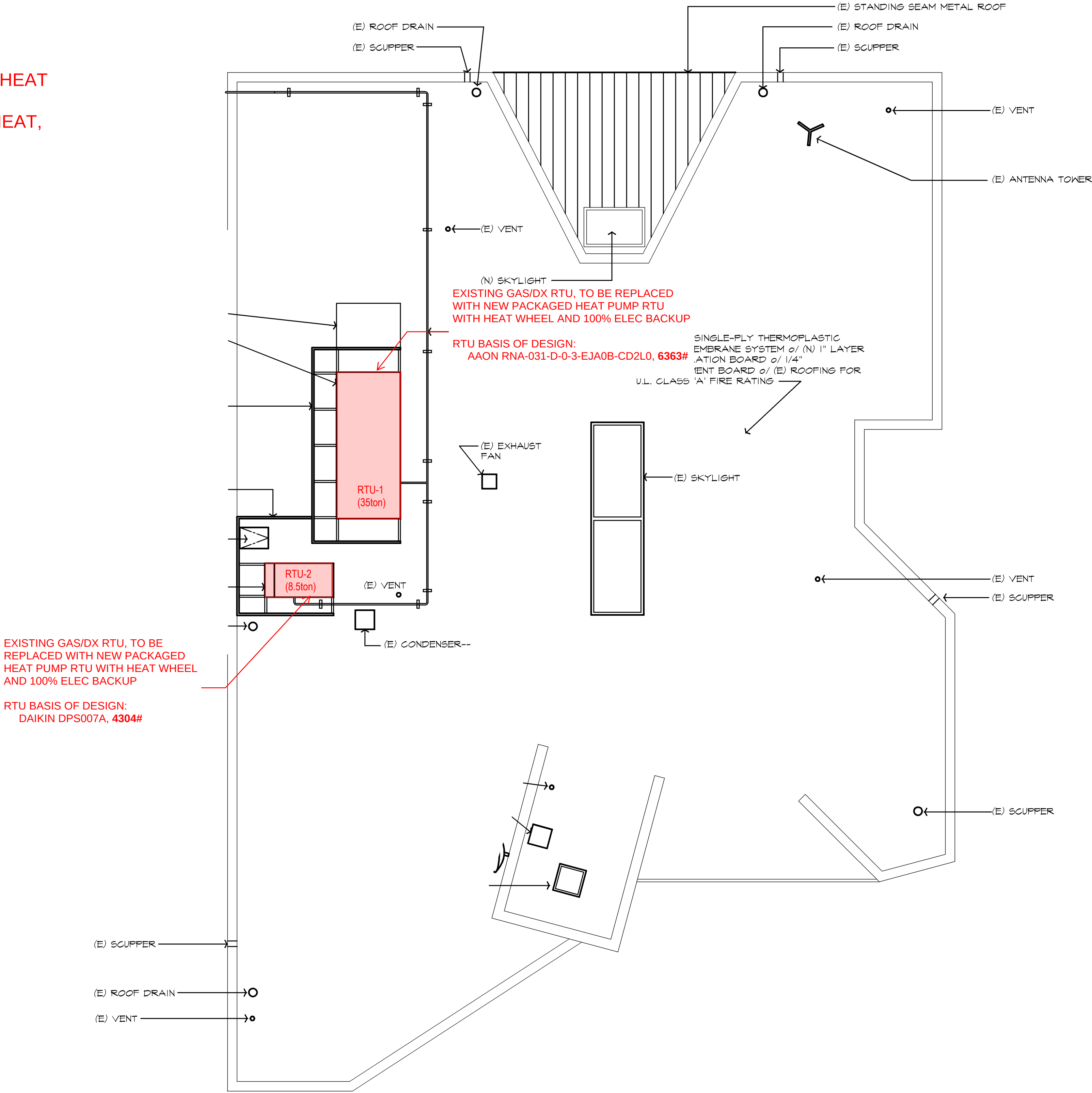
Mechanical General Inclusions, Clarifications, & Exclusions

- Includes allowance for crane/rigging
- Includes allowance for permits
- Includes allowance for carpentry
- Carrying Seattle labor rates
- Pricing in today's dollars
- Excludes temp HVAC and plumbing
- Excludes overtime work
- Excludes parking
- Excludes any new sound attenuation scope. Assumes ductwork and existing sound attenuation to remain.
- Excludes duct smoke detectors and wiring
- Excludes any heat tracing
- Excludes good faith survey
- Excludes demolishing gas distribution lines/piping back to meter
- Excludes condensate drain piping to roof drains. Assumes piping directly down onto roof.

LOUISVILLE CITY HALL - MECHANICAL PRICING DOCUMENT

OPTION 1 - FULL ELECTRIFICATION

NARRATIVE:
-FULL ELECTRIFICATION OF THE BUILDING BY REPLACING ALL GAS-FIRED EQUIPMENT WITH NEW ELECTRIC-ONLY EQUIPMENT; WILL REQUIRE AN ELECTRICAL SERVICE UPGRADE
-(2) EXISTING GAS/DX ROOFTOP UNITS TO BE REPLACED WITH PACKAGED ROOFTOP UNITS WITH HEAT WHEELS AND 100% ELECTRIC RESISTANCE EMERGENCY HEATING CAPABILITY
-REUSE EXISTING MEDIUM PRESSURE DUCTWORK. PROVIDE (26) 8" VAV BOXES W/ ELECTRIC REHEAT, ESTIMATED AT APPROXIMATELY 6KW PER VAV. REZONE AND REPLACE ALL DUCTWORK DOWNSTREAM OF VAVS
-EXISTING ELECTRIC DOMESTIC WATER HEATER TO REMAIN AS IS



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STAMP

CONSULTANT

PROJECT TITLE

**LOUISVILLE
CITY HALL
REMODEL**

**CITY OF LOUISVILLE
749 MAIN STREET
LOUISVILLE, COLORADO
80027**

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ISSUE LOG

1 06APOS - ISSUE FOR PRELIM ESTIMATE

2 10APOS - 50% DESIGN DEVELOPMENT

3 06JN06 - PRELIMINARY ESTIMATE #2

4

5

6

7

8

9

SHEET TITLE

ROOF PLAN

PRINT DATE

06JN06

PROJECT NUMBER

0411

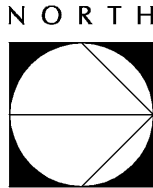
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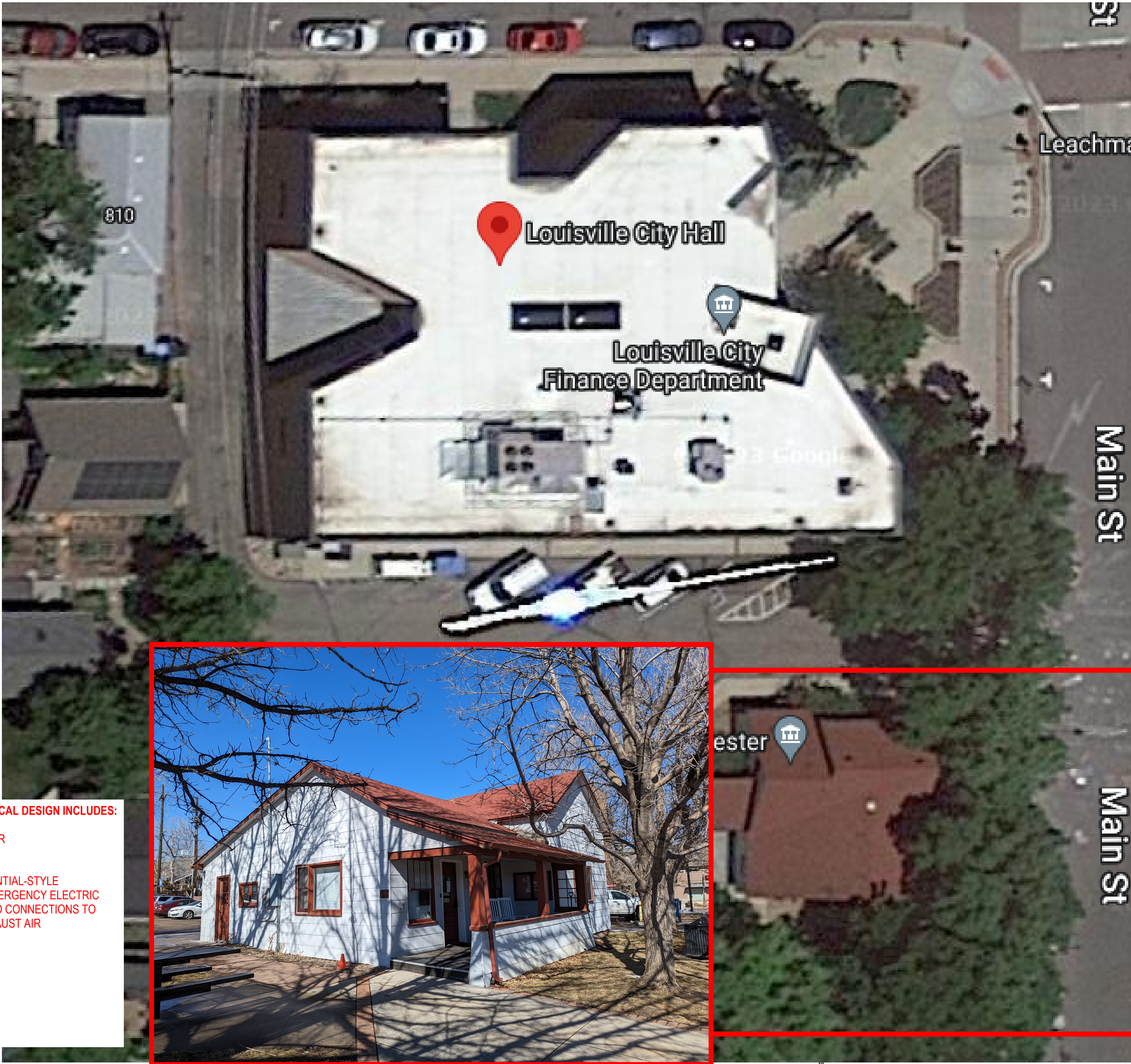
SHEET NUMBER

M3

A **ROOF PLAN**
1/8" = 1'-0"



LOUISVILLE AUSTIN NIEHOFF - MECHANICAL PRICING DOCUMENT
BASE OPTION - FULL ELECTRIFICATION



CURRENT AUSTIN NIEHOFF MECHANICAL DESIGN INCLUDES:
- (1) GAS FURNACE
- RESIDENTIAL ELECTRIC WATER HEATER

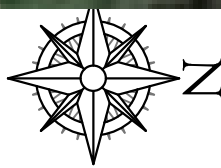
BASE REPLACEMENT OPTION:
- REPLACE GAS FURNACE WITH RESIDENTIAL-STYLE AIR-SOURCE HEAT PUMP WITH 100% EMERGENCY ELECTRIC REHEAT AND INDOOR ERV WITH DUCTED CONNECTIONS TO EXTERIOR FOR OUTDOOR AIR AND EXHAUST AIR

ASHP BASIS OF DESIGN:
GOODMAN GVZC200361, 318#

ERV BASIS OF DESIGN:
GREENHECK MINIVENT-450-VG, 160#

- LEAVE ELECTRIC WATER HEATER AS IS

1 Main Floor Plan
Scale: 1/4" = 1'-0"





Appendix

1. Mechanical System Matrix Options
2. Mechanical Decarbonization Scoping
3. Electrical Decarbonization Scoping
4. Structural Scoping
5. Electric Vehicle Charging Narrative
6. Renewables Scoping
7. Cost Estimating

City Hall – Electrical Scope Narrative

Option 1 – Full Electrification

- General: Electrification of HVAC equipment (RTU's + VAV) and addition of L2 & L3 EV chargers. Requires service upgrade to 480V and also generator replacement. To minimize disruption, a new utility transformer location has been selected to allow installation of the bulk of the new infrastructure prior to demolition of the existing service.
- 30 Day Metering: None required. Utility data is sufficient and spare capacity will be provided.
- Electrical Demo:
 - Demolish existing natural gas generator
 - Demolish existing ATS
 - Demolish existing NEMA 1 800A MDP & utility metering section in electrical room
 - Demolish feeders to RTUs
 - Retain conduit to RTU-1, for reuse for new 480V RTU
 - Retain all other 208V sub-distribution conduit and wire from location of existing MDP. Conduit and wire will be reused where possible, new wire shall be run where required.
- Electrical New Work:
 - New utility service:
 - Provide precast or poured in place pad for 500kVA utility transformer, per Xcel specifications
 - Protective bollards.
 - Provide 800/4 feeder to new NEMA 3R CT metering enclosure, with adjacent meter socket and 1" C.
 - Provide 800A NEMA 3R busfed gutter and enclosed circuit breakers as shown.
Alternate, at contractor's discretion – provide 800A NEMA 3R distribution panelboard with 800A main
 - New key distribution system equipment:
 - Provide L2 EVSE equipment, including feeders, 75kVA transformer, 250A MCB NEMA 3R 10kAIC 24 pole distribution panelboard.
 - Provide feeder and new 250A MLO NEMA 1 PNL VAV, located in storage closet.
 - Provide feeders to and associated with new ATS, and new equipment:
 - 400A MLO panel 4PNL1 (NEMA 3R, 35kAIC)
 - 112.5kVA transformer
 - 400A MCB panel 2PNL1 (NEMA 1, 10kAIC)
 - New generator and ATS:
 - Concrete pads, as required.
 - Protective bollards.
 - 300kW Diesel generator with L1 sound attenuated enclosure, on board circuit breaker and 17hr fuel tank (Generac SD300 as basis of design)
 - New 400A 3P ATS, NEMA 3R.
 - New equipment feeders and circuiting:

- PNL-VAV
 - 26 runs of 30/2, assume 75' per run.
- PNL-4PNL1
 - RTU-1 feeder (225/3, existing conduit may be available for reuse)
 - RTU-2 feeder (90/3, new conduit)
- PNL-2PNL1
 - Refeed the 6 loads removed from the demolished 208V MDP

Option 2 – Hybrid Electrification

- General: Electrification of HVAC equipment and addition of L2 EV chargers staying within the limits of the existing electrical service. Will utilize gas backup in the RTU's.
- 30 Day Metering: None required. Utility data is sufficient.
- Electrical Demo:
 - Demolish feeders to:
 - RTU-1, disconnect only, retain existing circuit breaker, conduit and wire for reuse. Verify existing wire size.
 - RTU-2, demolish feeder. Assume new circuit breaker, conduit and wire for replacement RTU-2
- Electrical New Work:
 - Add feeder tap, 600A disconnect and new power distribution
 - Provide feeder tap from existing ATS (as shown in drawings) to new 600A NEMA 3R fused disconnect. Assume 15' of conduit and 20' of wire to route to other side of entry door.
 - Provide feeder (tap) and PNL-EV (225A MCB NEMA 3R), located adjacent.
 - Provide feeder (tap) and PNL-VAV (400A MCB, NEMA 1) located in storage closet immediately inside of fused disconnect.
 - Additional feeders and circuiting:
 - Provide new 125A, 3P circuit breaker in MDP and new 125/3 feeder to new RTU-2.
 - Reconnect existing 300/3 feeder to new RTU-1.
 - Provide new 30/2 feeder circuits to distributed VAV boxes (qty 26). Assume average circuit length of 75'. Assume individual circuits for each box.
 - Provide (qty 5) pedestal type dual port L2 60A EVSE's. ZEFNET-60-CPD or approved equivalent.
 - Provide (5) new 60/2 feeder circuits to L2 EVSE's, pedestal type dual port 60A. See marked up image – approx. 60' average feeder length.

Level 2 & 3 EV Chargers and Supporting Infrastructure

- General: Installation of (5) dual port pedestal type EVSE's.
- Electrical Demo: None required.
- Electrical New Work:
 - Level 3 Charging:
 - Install (3) 60A 208V dual port pedestal type EVSE's. Zefnet-60-CPD or approved equivalent
 - Install (3) 60A/2P circuit breakers in existing panel EP-2. Move existing circuit breakers as needed to ensure the new EV load is balanced.
 - Install 1 1/4" – 6#6, 1#10G from EP-2 to location of EVSE's as shown on plan. Provide pull-box / junction box to split the (3) 208V circuits to each EVSE.
 - Level 2 Charging:
 - Provide (qty 5) pedestal type dual port L2 60A EVSE's. ZEFNET-60-CPD or approved equivalent.
 - Provide (qty 5) new 60/2 feeder circuits to L2 ESVE's, pedestal type dual port 60A. Approximate 75' average feeder length.

Electrical Exclusions

- Applicable sales, use and B&O tax
- Performance and Payment Bonds
- Utility company charges.
- Refurbishing existing lighting (cleaning, re-lamping, re-trimming, repair, restoration).
- Roof and building envelope penetrations, waterproofing.
- Moving, placing and (re)-calibrating owner equipment.
- Mechanical and plumbing control devices, including wiring, conduit, and components.
- Correcting existing code violations
- Hidden conditions.
- Removing, re-installing and replacing ceiling tiles.
- Opening and repairing walls and ceilings for electrical work.
- Patching and painting.
- Access panels.
- Temporary power and lighting
- Handling hazardous material including but not limited to asbestos, lead and PCB's.
- Overtime and shift premiums.
- Work stoppages, hindrances, multiple trim passes and out-of-sequence installation.
- Electrical engineering, calculations, drawings, peer review services.
- Structural and Seismic Engineering
- Material cost escalation.
- Plywood and specialty backing.



-
- Low voltage systems (telecom, CCTV, access control, audio visual, etc.).
 - Any work not specifically included in this proposal.
 - No thermostat relocations are included



Austin Niehoff – Electrical Scope Narrative

Full Electrification – Admin Building

- General: Added load requires ~122A of capacity under the assumption that the heat pump and resistive backup loads can operate concurrently, as advised by the mechanical engineer. The load on the existing service is unknown. Based on the relatively low amount of equipment served from this building, it is possible that the existing demand load could be below 60A, as would be required to justify this load addition without a service upgrade, however most likely a service upgrade to 300A will be required. Given the uncertainty, the service upgrade option has been scoped.
- Electrical Demo:
 - Demolish existing meter base. Retain mast (conduit appears to be 2 ½" and is sufficient for an upgraded 300A service)
 - Demolish service conductor
 - Demolish main load center, 40 pole 200A NEMA 3R
 - Retain existing branch circuits and feeders for reconnection to new load center at this location
- Electrical New Work
 - New 300A service option:
 - Provide new 400A meter base.
 - Provide new 300A service conductors 4#2/0, 1#4/0N to mast per utility requirements.
 - Install new 40P 400A, 300A MCB NEMA 3R service panelboard at location of demolished loadcenter
 - Panel shall contain:
 - (qty 1) 80A 2P
 - (qty 2) 30A 2P
 - (qty 2) 20A 2P
 - (qty 16) 20A 1P
 - (qty 4) spare 20A 1P
 - Allow for provision of new ground rods and GEC.
 - Refeed existing loads from supplied circuit breakers.
 - Provide new branch circuiting and equipment disconnects for HVAC equipment:
 - (qty 1) 80/2, allow for 40'
 - (qty 1) 30/3, allow for 40'
 - (qty 2) 20/2, allow for 40'

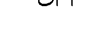
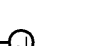
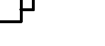
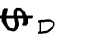
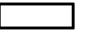
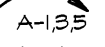
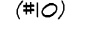
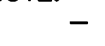
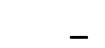
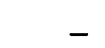
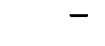
Electrical Exclusions

- Applicable sales, use and B&O tax
- Performance and Payment Bonds
- Utility company charges.
- Refurbishing existing lighting (cleaning, re-lamping, re-trimming, repair, restoration).



- Roof and building envelope penetrations, waterproofing.
- Moving, placing and (re)-calibrating owner equipment.
- Mechanical and plumbing control devices, including wiring, conduit, and components.
- Correcting existing code violations
- Hidden conditions.
- Removing, re-installing and replacing ceiling tiles.
- Opening and repairing walls and ceilings for electrical work.
- Patching and painting.
- Access panels.
- Temporary power and lighting
- Handling hazardous material including but not limited to asbestos, lead and PCB's.
- Overtime and shift premiums.
- Work stoppages, hindrances, multiple trim passes and out-of-sequence installation.
- Electrical engineering, calculations, drawings, peer review services.
- Structural and Seismic Engineering
- Material cost escalation.
- Plywood and specialty backing.
- Low voltage systems (telecom, CCTV, access control, audio visual, etc.).
- Any work not specifically included in this proposal.
- No thermostat relocations are included

UPON ACCEPTANCE OF THIS DRAWING OR OTHER DATA OR AN ELECTRONIC MEDIA GENERATED AND PROVIDED BY PREPARED ENGINEERING, INC. THE RECIPIENT COVENANTS AND AGREES THAT ALL SUCH DRAWINGS, DATA, AND INSTRUMENTS BE SERVICE AND BELONG TO PREPARED ENGINEERING, INC. AND THAT THE RECIPIENT SHALL NOT REPRODUCE, COPIY, OR OTHERWISE DISSEMINATE THESE FILES OR THE DRAWINGS, DATA, OR INSTRUMENTS WITHOUT THE WRITTEN CONSENT OF PREPARED ENGINEERING, INC. ANY REUSE OF THESE FILES OR THE DRAWINGS, DATA, OR INSTRUMENTS WITHOUT THE WRITTEN CONSENT OF PREPARED ENGINEERING, INC. SHALL BE AT THE RECIPIENT'S SOLE RISK AND WITHOUT LIABILITY TO PREPARED ENGINEERING, INC. FOR ANY DAMAGE, LIABILITY, OR COST OF DEFENSE, INCLUDING ATTORNEY'S FEES AND COSTS OF DEFENSE, ARISING FROM ANY CHANGES OR REUSE OF THESE FILES OR THE DRAWINGS, DATA, OR INSTRUMENTS WITHOUT THE WRITTEN CONSENT OF PREPARED ENGINEERING, INC.

LEGEND	
	DUPLEX RECEPTACLE MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED
	48" - MOUNT AT 48" A.F.F.
	48" - MOUNT AT 6" ABOVE CONTERTOP
	GFI - GROUND FAULT INTERRUPTER
	SINGLE RECEPTACLE MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED
	DUPLEX I.G. RECEPTACLE MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED
	FLUSH FLOOR MOUNTED DUPLEX RECEPTACLE - USE BRASS COVERPLATE
	4-PLEX RECEPTACLE MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED
	208V RECEPTACLE
	JUNCTION BOX NOTE: MARK ALL J BOXES WITH BRANCH CIRCUIT PANEL DESIGNATION & CIRCUIT NUMBER(S)
	WALL MOUNTED JUNCTION BOX
	TELEPHONE OUTLET MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED - STUB 3/4"C. INTO ACCESSIBLE LOCATION ABOVE CEILING. PROVIDE BLANK COVER PLATE. 2D=DOUBLE
	FLUSH FLOOR MOUNTED TELEPHONE OUTLET - USE BRASS COVERPLATES - STUB 3/4"C. INTO ACCESSIBLE LOCATION ABOVE CEILING
	DATA TERMINAL OUTLET MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED - STUB 3/4"C. INTO ACCESSIBLE LOCATION ABOVE CEILING. PROVIDE BLANK COVER PLATE. 2D=DOUBLE
	FLUSH FLOOR MOUNTED DATA TERMINAL - USE BRASS COVERPLATES - STUB 3/4"C. INTO ACCESSIBLE LOCATION ABOVE CEILING
	FUSIBLE DISCONNECT
	NON-FUSIBLE DISCONNECT
	COMBINATION DISCONNECT/STARTER
	MAGNETIC STARTER/CONTACTOR
	PANELBOARD -NOTE: PROVIDE TYPEWRITTEN DIRECTORIES AT COMPLETION OF WORK
	SWITCH MOUNT @ 48" A.F.F. UNLESS OTHERWISE NOTED
	D - DIMMER SWITCH
	3 - THREE-WAY SWITCHING
	K - KEYED
	M - MANUAL STARTER
	RECESS MOUNTED FIXTURE
	A - FIXTURE TYPE
	O - SWITCHING DESIGNATION
	RECESSED DOWNLIGHT
	SURFACE / CHAIN MOUNTED FIXTURE
	WALL / POLE MOUNTED FIXTURE
	AA - FIXTURE TYPE
	WALL MOUNTED EXIT SIGN
	ARROW INDICATED
	CEILING MOUNTED EXIT SIGN
	CIRCUIT HOME-RUN (ARROWS INDICATE NUMBER OF CIRCUITS)
	A=1,3,5 - PANEL A, CIRCUITS 1, 3, & 5
	(#10) - USE 10 GAUGE COPPER WIRE

- NOTE:
- NOT ALL SYMBOLS MAY APPLY TO ALL SHEETS
 - ALL WIRE SHALL BE COPPER (MIN. #12 AWG) UNLESS OTHERWISE NOTED.
 - FEEDERS SHALL CONFORM TO N.E.C. 215-2.
 - BRANCH CIRCUIT WIRING AND VOLTAGE DROP REQUIREMENTS SHALL CONFORM TO N.E.C. 210-19(a).
 - OUTLET MOUNTING HEIGHTS FOR RECEPTACLES, SWITCHES, SYSTEM INITIATING DEVICES, AND INDICATING DEVICES SHALL COMPLY WITH REQUIREMENTS OF THE (ADA) AMERICANS WITH DISABILITIES ACT.
 - COORDINATE MOUNTING HEIGHT OF ALL EXTERIOR LIGHTING FIXTURES WITH ARCHITECTURAL ELEVATION DRAWINGS.
 - ALL SUPPORTS FOR EQUIPMENT AND DEVICES SHALL CONFORM SEISMIC ZONE REQUIREMENTS AND LOCAL AUTHORITY HAVING JURISDICTION. LIGHT FIXTURES SHALL BE SUPPORTED IN ACCORDANCE WITH U.B.C. VOL. III, SEC. 25.213 and N.E.C. ARTICLE 300, AND SPECIFICALLY PARAGRAPH 300-11(a).
 - ALL DIMENSIONS ARE FROM FINISHED FLOOR OR FACE OF STUD TO CENTER OF DEVICE UNLESS OTHERWISE NOTED.

HR SCHEDULE FOR PANEL-IT	
#1	2, 4, 6 - 8, 10, 12
#2	14, 16, 18 - 20, 22, 24
#3	5, 7, 9 - 11, 13, 15
#4	25, 27, 29 - 31, 33, 35
#5	1, 3, 17 - 19, 21, 23
#6	26, 30

GENERAL NOTES

THE SUB-CONTRACTOR SHALL VISIT THE JOB SITE AND BECOME FAMILIARIZED WITH ALL REQUIREMENTS OF THE CONTRACT PRIOR TO SUBMISSION OF BID. THE SUB-CONTRACTOR SHALL NOTIFY THE ARCHITECT/ENGINEER OF ANY CONFLICTS PRIOR TO BID OR START OF INSTALLATION.

THE SUB-CONTRACTOR SHALL ARRANGE FOR ALL INSPECTIONS WHEN THEY BECOME DUE, AND SHALL NOT COVER ANY WORK UNTIL APPROVED BY THE INSPECTION AUTHORITY.

ANY AND ALL FEES ASSOCIATED WITH THE ELECTRICAL WORK, INCLUDING CONSTRUCTION AND INSPECTIONS SHALL BE PAID FOR BY THE SUB-CONTRACTOR IN ORDER TO DELIVER A COMPLETE AND FINISHED BUILDING, READY FOR OCCUPANCY AND 100% USAGE.

THE SUBMISSION OF A PROPOSAL WILL BE CONSTRUED AS EVIDENCE THAT THE SUB-CONTRACTOR HAS FAMILIARIZED HIMSELF/HIMSELF WITH THE PLANS AND BUILDING SITE. CLAIMS MADE SUBSEQUENT TO THE PROPOSAL FOR MATERIALS AND LABOR BECAUSE OF DIFFICULTIES ENCOUNTERED, WILL NOT BE RECOGNIZED IF THEY COULD HAVE BEEN FORESEEN HAD PROPER EXAMINATION BEEN MADE.

ANY COSTS DUE TO THE LACK OF COOPERATION AMONG TRADES SHALL BE BORNE BY THE SUB-CONTRACTOR.

THE INFORMATION PRESENTED ON THESE DRAWINGS IS DIAGRAMMATIC IN NATURE. IT DOES INDICATE THE GENERAL DESIGN AND ARRANGEMENT OF CIRCUITS, OUTLETS, EQUIPMENT, SYSTEMS, ETC. PROVIDE ALL MATERIALS AND LABOR FOR COMPLETELY FINISHED AND OPERATIONAL SYSTEMS. EXACT ROUTING MAY VARY AND MAY REQUIRE ADDITIONAL J-BOXES/PULL-BOXES AND/OR SPECIAL FITTINGS.

REFER TO LATEST ARCHITECTURAL DRAWINGS FOR: EXACT WALL LOCATIONS, DIMENSIONS, AND CONFIGURATIONS, DOOR SWINGS FOR SWITCH LOCATION VERIFICATION, REFLECTED CEILING PLANS FOR VERIFICATION OF LIGHT FIXTURE LOCATIONS.

ELECTRICAL CONTRACTOR SHALL FIELD VERIFY ALL ELECTRICAL EQUIPMENT LOADS PRIOR TO ROUGH-IN AND SHALL NOTIFY ENGINEER IF ANY DISCREPANCIES EXIST.

ELECTRICAL CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY ALTERATIONS REQUIRED BY THE OWNER, ARCHITECT OR FIELD CONDITIONS.

ALL EQUIPMENT SHALL BE NEW AND SHALL HAVE APPROPRIATE UNDERWRITERS LABORATORIES, INC. (UL) LISTING. ALL SHALL CONFORM TO LATEST INDUSTRY STANDARDS.

ELECTRICAL CONTRACTOR SHALL SUBMIT SCHEDULE OF EQUIPMENT INCLUDING: LIGHT FIXTURES, STATUS, WIRING DEVICES, ETC. FOR REVIEW/APPROVAL PRIOR TO BID. EQUIPMENT IS NOT TO BE ORDERED WITHOUT SUBMITTAL TO ARCHITECT/OWNER/ENGINEER.

ELECTRICAL CONTRACTOR SHALL MAINTAIN ALL WORKING CLEARANCES FOR ALL ELECTRICAL EQUIPMENT PER N.E.C. REQUIREMENTS.

ALL WORK SHALL COMPLY WITH LATEST FASCO ELECTRICAL CODE (N.E.C.) AND ALL LOCAL 800A ATS CODES AND ADOPTED ORDINANCES, AND R 208V 3 phase 4 wire UTILITY COMPANY.

ALL DISCONNECT SWITCHES SHALL BE HEAVY DUTY WITH DUAL ELEMENT TIME DELAY FUSES AS NOTED ON THE ONE LINE DIAGRAM. ENCLOSURE AND FUSE SIZE AS SHOWN OR AS REQUIRED TO MATCH INSTALLATION LOCATION AND LOAD CONDITIONS.

AT THE COMPLETION OF THE WORK, THE ELECTRICAL CONTRACTOR SHALL PROVIDE COMPLETE, ACCURATE, TYPED PANEL DIRECTORIES.

ANY DEVIATION FROM PLANS WITHOUT PRIOR APPROVAL OF THE ARCHITECT/ENGINEER SHALL BE CAUSE FOR REJECTION OF MATERIALS AND/OR METHODS AND ANY COSTS INCURRED TO CORRECT SUCH DEVIATION TO THE SATISFACTION OF THE ARCHITECT/ENGINEER SHALL BE BORNE BY THE SUB-CONTRACTOR.

EQUIPMENT STARTERS AND RELATED CONTROL AND WIRING SHALL BE SUPPLIED AND INSTALLED BY THE ELECTRICAL CONTRACTOR. OVERLOAD HEATERS SHALL BE INSTALLED IN ACCORDANCE WITH NAMEPLATE DATA ON EQUIPMENT. STARTERS SHALL BE INSTALLED AS DIRECTED BY THE MECHANICAL CONTRACTOR.

REFER TO MECHANICAL DRAWINGS FOR LOCATION OF THERMOSTAT(S), EXHAUST FAN(S), AND OTHER SPECIAL EQUIPMENT OR CONTROLS. ELECTRICAL CONTRACTOR IS RESPONSIBLE FOR INSTALLATION OF ALL CONDUIT, JUNCTION BOXES, WIRING, AND DISCONNECT SWITCHES AND THERMOSTAT JUNCTION BOXES.

ALL WIRING SHALL BE INSTALLED IN APPROVED RACEWAY SYSTEM IN ACCORDANCE WITH N.E.C. AND LOCAL ORDINANCES. THE USE OF TYPE MC CABLE SHALL BE INSTALLED IN ACCORDANCE WITH N.E.C. ARTICLE 334.

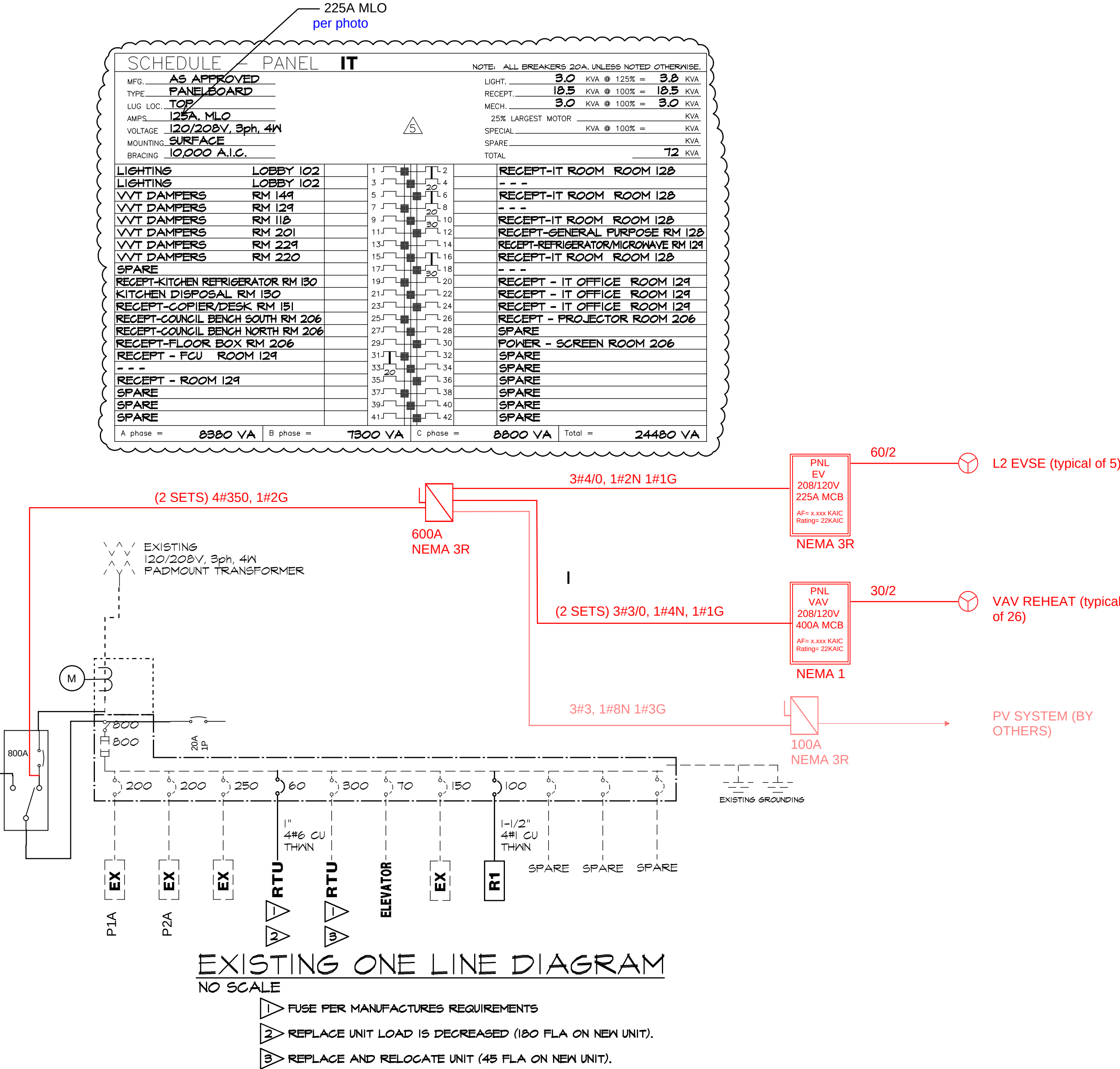
GROUNDING: SYSTEM GROUND SHALL BE IN ACCORDANCE WITH N.E.C. AND TABLE 250-122. THE SYSTEM SHALL BE FURNISHED WITH A CONTINUOUS GROUND FOR RECEPTACLES, LIGHTS, AND EQUIPMENT IN ACCORDANCE WITH N.E.C. TABLE 250-122.

ELECTRICAL CONTRACTOR SHALL CONTACT UTILITY COMPANY FOR METERING REQUIREMENTS AND SHALL INCLUDE ALL WORK IN BID.

ELECTRICAL CONTRACTOR SHALL PROVIDE ALL TRENCHING, BACKFILL, AND CONDUIT FROM POWER COMPANY TRANSFORMER TO C.T./METER.

CONDUIT RUNS INSIDE THE BUILDING SHALL BE CONCEALED, CONDUIT BELOW FLOOR SLAB SHALL BE INSTALLED BELOW THE SLAB AND INSTALLED PRIOR TO POUR. RUNS TO BE STRAIGHT AS POSSIBLE FROM POINT OF OUTLET TO POINT OF OUTLET.

ELECTRICAL CONTRACTOR SHALL MAKE ALL FINAL CONNECTIONS TO OUTSIDE EQUIPMENT, SIGNS, LIGHTING, ETC., PROVIDE DISCONNECT AT EACH SIGN LOCATION IN ACCORDANCE WITH N.E.C. PARAGRAPH 600-6.



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Ph: (303) 773-8773 Fax: (303) 779-8333

PROJECT TITLE

LOUISVILLE CITY HALL REMODEL

CITY OF LOUISVILLE
749 MAIN STREET
LOUISVILLE, COLORADO
80027

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ISSUE LOG

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2 13JA06 - MODS PER PUBLIC WORKS

3 10AP06 - 50% DESIGN DEVELOPMENT

4 06JNO6 - PRELIMINARY ESTIMATE #2

5 22SP06 - REV PANEL SCHEDULE

6 08MAR07 - RECORD ASBUILT DWGS

MECHANICAL OPTION 2

SHEET TITLE

ELECTRICAL NOTES ONE LINE DIAGRAM

PRINT DATE

28JN06

PROJECT NUMBER

04303

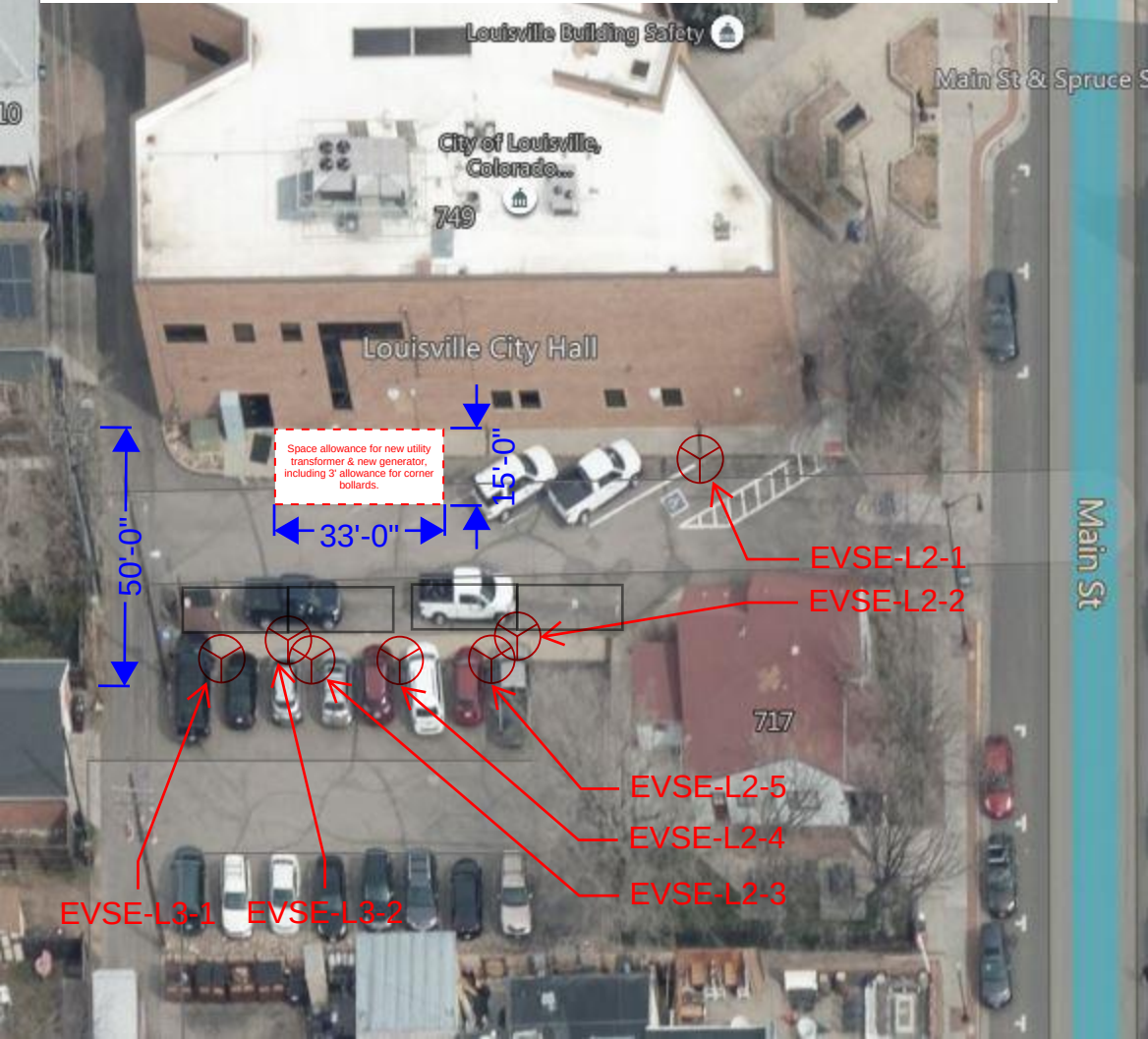
DRAWN BY/CHECKED BY

STAFF

SHEET NUMBER

E3

CITY HALL EVSE LOCATION AND REVISED SERVICE EQUIPMENT MAP



1. PROVIDE MOTION SENSORS FOR LIGHTING.
 2. VERIFY LOCATION BEFORE INSTALLATION.
 3. FUSE PER MANUFACTURERS REQUIREMENTS.
 4. CONNECT VVT DAMPERS, VERIFY LOCATIONS.
 5. LOCAL CONTROL TO CEILING FOR QUAD BOX.

- ☐ J - BOX
- ☐ HR HOME RUN BOX



HR SCHEDULE FOR PANEL-IT	
#1	2, 4, 6 - 8, 10, 12
#2	14, 16, 18 - 20, 22, 24
#3	5, 7, 9 - 11, 13, 15
#4	25, 27, 29 - 31, 33, 35
#5	1, 3, 17 - 19, 21, 23
#6	26, 30



E1

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LEGEND	
	DUPLEX RECEPTACLE MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED 48" - MOUNT AT 48" A.F.F. IG - ISOLATED GROUND 48" - MOUNT AT 6" ABOVE COUNTERTOP GFI - GROUND FAULT INTERRUPTER
	SINGLE RECEPTACLE MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED
	DUPLEX I.G. RECEPTACLE MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED
	FLUSH FLOOR MOUNTED DUPLEX RECEPTACLE - USE BRASS COVERPLATE
	4-PLEX RECEPTACLE MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED
	208V. RECEPTACLE
	JUNCTION BOX NOTE: MARK ALL J BOXES WITH BRANCH CIRCUIT PANEL DESIGNATION & CIRCUIT NUMBER(S)
	WALL MOUNTED JUNCTION BOX
	TELEPHONE OUTLET MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED - STUB 3/4" C. INTO ACCESSIBLE LOCATION ABOVE CEILING. PROVIDE BLANK COVER PLATE. 2D=DOUBLE
	FLUSH FLOOR MOUNTED TELEPHONE OUTLET - USE BRASS COVERPLATES - STUB 3/4" C. INTO ACCESSIBLE LOCATION ABOVE CEILING
	DATA TERMINAL OUTLET MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED - STUB 3/4" C. INTO ACCESSIBLE LOCATION ABOVE CEILING. PROVIDE BLANK COVER PLATE. 2D=DOUBLE
	FLUSH FLOOR MOUNTED DATA TERMINAL - USE BRASS COVERPLATES - STUB 3/4" C. INTO ACCESSIBLE LOCATION ABOVE CEILING
	FUSIBLE DISCONNECT ☒ NON-FUSIBLE DISCONNECT
	COMBINATION DISCONNECT/STARTER
	MAGNETIC STARTER/CONTACTOR
	PANELBOARD -NOTE: PROVIDE TYPEWRITTEN DIRECTORIES AT COMPLETION OF WORK
	SWITCH MOUNT @ 48" A.F.F. UNLESS OTHERWISE NOTED D - DIMMER SWITCH T - TIMER L - LIMIT 3 - THREE-WAY SWITCHING K - KEYED M - MANUAL STARTER
	RECESS MOUNTED FIXTURE A - FIXTURE TYPE o - SWITCHING DESIGNATION
	RECESSED DOWNLIGHT
	SURFACE / CHAIN MOUNTED FIXTURE
	WALL / POLE MOUNTED FIXTURE AA - FIXTURE TYPE
	WALL MOUNTED EXIT SIGN ARROW INDICATED
	CEILING MOUNTED EXIT SIGN
	CIRCUIT HOME-RUN (ARROWS INDICATE NUMBER OF CIRCUITS) A=1,3,5 - PANEL A, CIRCUITS 1, 3, & 5 (#10) - USE 10 GAUGE COPPER WIRE

- NOTE: - NOT ALL SYMBOLS MAY APPLY TO ALL SHEETS
- ALL WIRE SHALL BE COPPER (MIN. #12 AWG) UNLESS OTHERWISE NOTED.
 - FEEDERS SHALL CONFORM TO N.E.C. 215-2.
 - BRANCH CIRCUIT WIRING AND VOLTAGE DROP REQUIREMENTS SHALL CONFORM TO N.E.C. 210-19(a).
 - OUTLET MOUNTING HEIGHTS FOR RECEPTACLES, SWITCHES, SYSTEM INITIATING DEVICES, AND INDICATING DEVICES SHALL COMPLY WITH REQUIREMENTS OF THE (ADA) AMERICANS WITH DISABILITIES ACT.
 - COORDINATE MOUNTING HEIGHT OF ALL EXTERIOR LIGHTING FIXTURES WITH ARCHITECTURAL ELEVATION DRAWINGS.
 - ALL SUPPORTS FOR EQUIPMENT AND DEVICES SHALL CONFORM SEISMIC ZONE REQUIREMENTS AND LOCAL AUTHORITY HAVING JURISDICTION. LIGHT FIXTURES SHALL BE SUPPORTED IN ACCORDANCE WITH U.B.C. VOL. III, SEC. 25.213 and N.E.C. ARTICLE 300, AND SPECIFICALLY PARAGRAPH 300-11(a).
 - ALL DIMENSIONS ARE FROM FINISHED FLOOR OR FACE OF STUD TO CENTER OF DEVICE UNLESS OTHERWISE NOTED.

HR SCHEDULE FOR PANEL-IT	
#1	2, 4, 6 - 8, 10, 12
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#3	5, 7, 9 - 11, 13, 15
#4	25, 27, 29 - 31, 33, 35
#5	1, 3, 17 - 19, 21, 23
#6	26, 30

GENERAL NOTES

THE SUB-CONTRACTOR SHALL VISIT THE JOB SITE AND BECOME FAMILIARIZED WITH ALL REQUIREMENTS OF THE CONTRACT PRIOR TO SUBMISSION OF BID. THE SUB-CONTRACTOR SHALL NOTIFY THE ARCHITECT/ENGINEER OF ANY CONFLICTS PRIOR TO BID OR START OF INSTALLATION.

THE SUB-CONTRACTOR SHALL ARRANGE FOR ALL INSPECTIONS WHEN THEY BECOME DUE, AND SHALL NOT COVER ANY WORK UNTIL APPROVED BY THE INSPECTION AUTHORITY.

ANY AND ALL FEES ASSOCIATED WITH THE ELECTRICAL WORK, INCLUDING CONSTRUCTION AND INSPECTIONS SHALL BE PAID FOR BY THE SUB-CONTRACTOR IN ORDER TO DELIVER A COMPLETE AND FINISHED BUILDING, READY FOR OCCUPANCY AND 100% USAGE.

THE SUBMISSION OF A PROPOSAL WILL BE CONSTRUED AS EVIDENCE THAT THE SUB-CONTRACTOR HAS FAMILIARIZED HIMSELF/HERSELF WITH THE PLANS AND BUILDING SITE. CLAIMS MADE SUBSEQUENT TO THE PROPOSAL FOR MATERIALS AND LABOR BECAUSE OF DIFFICULTIES ENCOUNTERED, WILL NOT BE RECOGNIZED IF THEY COULD HAVE BEEN FORESEEN HAD PROPER EXAMINATION BEEN MADE.

ANY COSTS DUE TO THE LACK OF COOPERATION AMONG TRADES SHALL BE BORNE BY THE SUB-CONTRACTOR.

THE INFORMATION PRESENTED ON THESE DRAWINGS IS DIAGRAMMATIC IN NATURE. IT DOES INDICATE THE GENERAL DESIGN AND ARRANGEMENT OF CIRCUITS, OUTLETS, EQUIPMENT, SYSTEMS, ETC. PROVIDE ALL MATERIALS AND LABOR FOR COMPLETELY FINISHED AND OPERATIONAL SYSTEMS. EXACT ROUTING MAY VARY AND MAY REQUIRE ADDITIONAL J-BOXES/PULL-BOXES AND/OR SPECIAL FITTINGS.

REFER TO LATEST ARCHITECTURAL DRAWINGS FOR: EXACT WALL LOCATIONS, DIMENSIONS, AND CONFIGURATIONS, DOOR SWINGS FOR SWITCH LOCATION VERIFICATION, REFLECTED CEILING PLANS FOR VERIFICATION OF LIGHT FIXTURE LOCATIONS.

ELECTRICAL CONTRACTOR SHALL FIELD VERIFY ALL ELECTRICAL EQUIPMENT LOADS PRIOR TO ROUGH-IN AND SHALL NOTIFY ENGINEER IF ANY DISCREPANCIES EXIST.

ELECTRICAL CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY ALTERATIONS REQUIRED BY THE OWNER, ARCHITECT OR FIELD CONDITIONS.

ALL EQUIPMENT SHALL BE NEW AND SHALL HAVE APPROPRIATE UNDERWRITERS LABORATORIES, INC. (U.L.) LABEL AND SHALL CONFORM TO LATEST INDUSTRY STANDARDS.

ELECTRICAL CONTRACTOR SHALL SUBMIT SHOP DRAWINGS FOR ALL EQUIPMENT INCLUDING: LIGHT FIXTURES, ELECTRICAL APPARATUS, WIRING DEVICES, ETC. FOR REVIEW/APPROVAL (5) DAYS PRIOR TO BID. EQUIPMENT IS NOT TO BE ORDERED WITHOUT SUBMITTAL TO ARCHITECT/OWNER/ENGINEER.

ELECTRICAL CONTRACTOR SHALL MAINTAIN ALL WORKING CLEARANCES FOR ALL ELECTRICAL EQUIPMENT PER N.E.C. REQUIREMENTS.

ALL WORK SHALL COMPLY WITH LATEST EDITION OF NATIONAL ELECTRICAL CODE (N.E.C.) AND ALL LOCAL AND STATE BUILDING CODES AND ADOPTED ORDINANCES, AND REQUIREMENTS OF THE UTILITY COMPANY.

ALL DISCONNECT SWITCHES SHALL BE HEAVY DUTY WITH DUAL ELEMENT TIME DELAY FUSES AS NOTED ON THE ONE LINE DIAGRAM, ENCLOSURE AND FUSE SIZE AS SHOWN OR AS REQUIRED TO MATCH INSTALLATION LOCATION AND LOAD CONDITIONS.

AT THE COMPLETION OF THE WORK, THE ELECTRICAL CONTRACTOR SHALL PROVIDE COMPLETE, ACCURATE, TYPED PANEL DIRECTORIES.

ANY DEVIATION FROM PLANS WITHOUT PRIOR APPROVAL OF THE ARCHITECT/ENGINEER SHALL BE CAUSE FOR REJECTION OF MATERIALS AND/OR METHODS AND ANY COSTS INCURRED TO CORRECT SUCH DEVIATION TO THE SATISFACTION OF THE ARCHITECT/ENGINEER SHALL BE BORNE BY THE SUB-CONTRACTOR.

EQUIPMENT STARTERS AND RELATED CONTROL AND WIRING SHALL BE SUPPLIED AND INSTALLED BY THE ELECTRICAL CONTRACTOR. OVERLOAD HEATERS SHALL BE INSTALLED IN ACCORDANCE WITH NAMEPLATE DATA ON EQUIPMENT. STARTERS SHALL BE INSTALLED AS DIRECTED BY THE MECHANICAL CONTRACTOR.

REFER TO MECHANICAL DRAWINGS FOR LOCATION OF THERMOSTAT(S), EXHAUST FAN(S), AND OTHER SPECIAL EQUIPMENT OR CONTROLS. ELECTRICAL CONTRACTOR IS RESPONSIBLE FOR INSTALLATION OF ALL CONDUIT, JUNCTION BOXES, WIRING, AND DISCONNECT SWITCHES AND THERMOSTAT JUNCTION BOXES.

ALL WIRING SHALL BE INSTALLED IN APPROVED RACEWAY SYSTEM IN ACCORDANCE WITH N.E.C. AND LOCAL ORDINANCES. THE USE OF TYPE MC CABLE SHALL BE INSTALLED IN ACCORDANCE WITH N.E.C. ARTICLE 334.

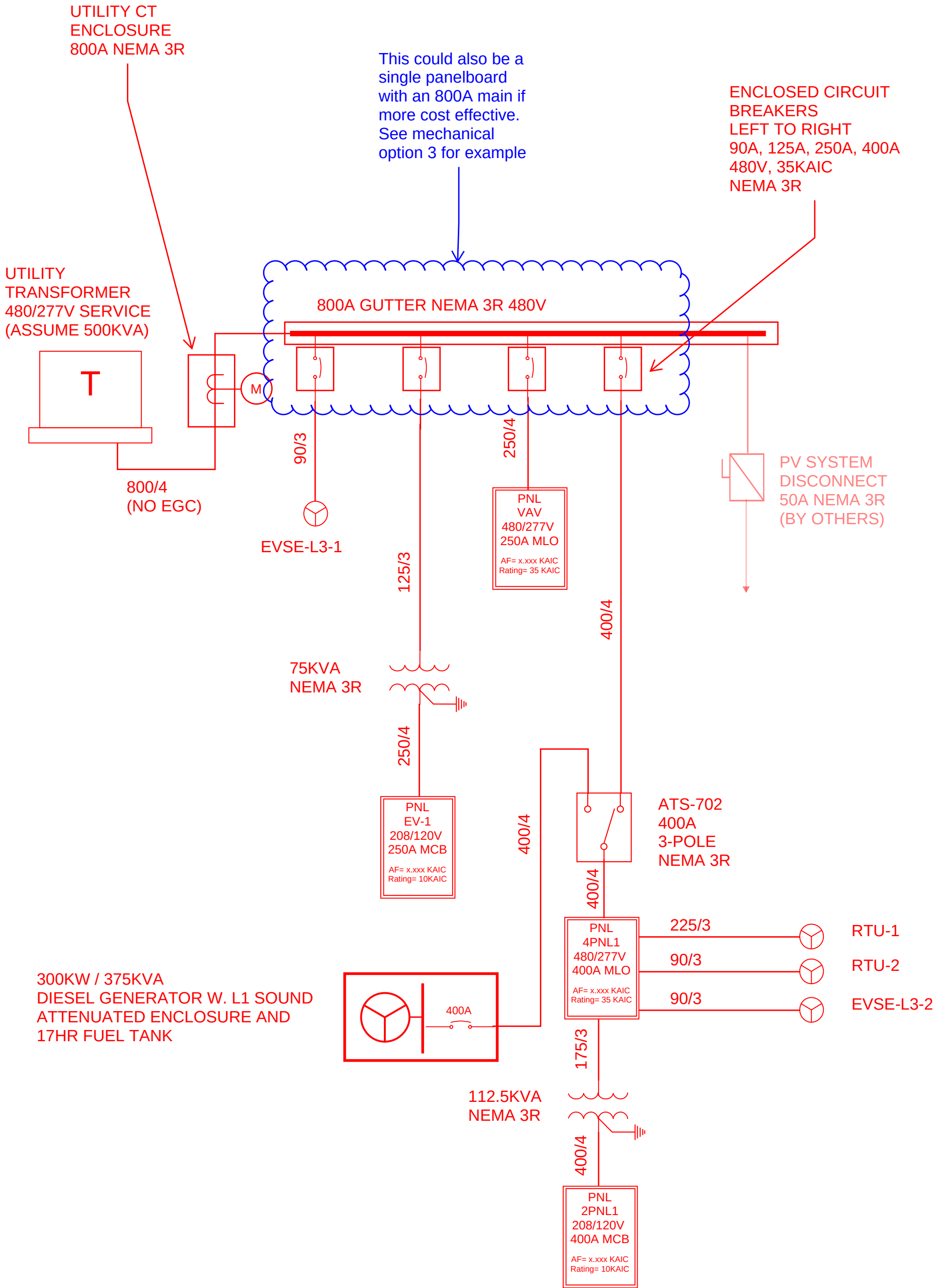
GROUNDING: SYSTEM GROUND SHALL BE IN ACCORDANCE WITH N.E.C. AND TABLE 250-122. THE SYSTEM SHALL BE FURNISHED WITH A CONTINUOUS GROUND FOR RECEPTACLES, LIGHTS, AND EQUIPMENT IN ACCORDANCE WITH N.E.C. TABLE 250-122.

ELECTRICAL CONTRACTOR SHALL CONTACT UTILITY COMPANY FOR METERING REQUIREMENTS AND SHALL INCLUDE ALL WORK IN BID.

ELECTRICAL CONTRACTOR SHALL PROVIDE ALL TRENCHING, BACKFILL, AND CONDUIT FROM POWER COMPANY TRANSFORMER TO C.T./METER.

CONDUIT RUNS INSIDE THE BUILDING SHALL BE CONCEALED, CONDUIT BELOW FLOOR SLAB SHALL BE INSTALLED BELOW THE SLAB AND INSTALLED PRIOR TO POUR. RUNS TO BE STRAIGHT AS POSSIBLE FROM POINT OF OUTLET TO POINT OF OUTLET.

ELECTRICAL CONTRACTOR SHALL MAKE ALL FINAL CONNECTIONS TO OUTSIDE EQUIPMENT, SIGNS, LIGHTING, ETC., PROVIDE DISCONNECT AT EACH SIGN LOCATION IN ACCORDANCE WITH N.E.C. PARAGRAPH 600-6.



SERVICE LOAD CALCULATION
UTIL METER DEMAND: 64KW (SUMMER), 60KW (WINTER)
X1.25 @ 0.9PF = 89 / 83.3 KVA

DEDUCT DEMOLISHED EQUIPMENT
RTU-1 176FLA @208V
RTU-1 45FLA @208V
TOTAL DEMO RTU DEDUCT = 221A = 80KVA

ADD NEW EQUIPMENT
RTU-1 191FLA @480V
RTU-2 65FLA @480V
TOTAL NEW RTU ADD = 256A = 212.8KVA

VAV REHEAT
QTY 26 X 6KW *1.25 (DEMAND FACTOR) = 195KVA

L2 EVSE (QTY 5)
60A, 208V
5 *60*208 = 62.4KVA

L3 EVSE (QTY 2)
63FLA @480V
(2)*63*1.25 (DEMAND FACTOR) =157.5A = 131KVA

EXIST DEMAND 83.3KVA
DEMO LOAD -80KVA
NEW LOAD 278.3KVA
NET DEMAND 604.5KVA = 727A @480V

SELECT 800A SERVICE. VAV REHEAT IS UNLIKELY TO OPERATE AT DESIGN. RTU STRIP HEAT IS UNLIKELY TO OPERATE AT 100% CONCURRENTLY WITH HEAT PUMPS. L3 EVSE'S ARE CONSIDERED CONTINUOUS LOAD BY CODE, BUT IN REALITY ARE NON-CONTINUOUS. THIS SHOULD REALISTICALLY ALLOW 20-30% CAPACITY FOR FUTURE EXPANSION.

GENERATOR LOAD CALCULATION
UTIL METER DEMAND: 64KW (SUMMER), 60KW (WINTER)
X1.25 @ 0.9PF = 89 / 83.3 KVA

DEDUCT DEMOLISHED EQUIPMENT
RTU-1 176FLA @208V
RTU-1 45FLA @208V
TOTAL DEMO RTU DEDUCT = 221A = 80KVA

ADD NEW EQUIPMENT
RTU-1 191FLA @480V
RTU-2 65FLA @480V
TOTAL NEW RTU ADD = 256A = 212.8KVA

VAV REHEAT
QTY 26 X 6KW *1.25 (DEMAND FACTOR) = 195KVA

L2 EVSE (QTY 5)
60A, 208V
5 *60*208 = 62.4KVA

L3 EVSE (QTY 2)
63FLA @480V
(2)*63*1.25 (DEMAND FACTOR) =78.75A = 65.5KVA

EXIST DEMAND 83.3KVA
DEMO LOAD -80KVA
NEW LOAD 278.3KVA
NET DEMAND 281.6KVA = 339A @480V

SELECT 300KW/375KVA (0.8PF) GENERATOR, 400A ATS.

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6 08MAR07 - RECORD ASBUILT DWGS

MECHANICAL OPTION 1

SHEET TITLE

ELECTRICAL NOTES ONE LINE DIAGRAM

PRINT DATE

28JN06

PROJECT NUMBER

04303

DRAWN BY/CHECKED BY

STAFF

SHEET NUMBER

E3

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LEGEND	
	DUPLEX RECEPTACLE MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED
	SINGLE RECEPTACLE MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED
	DUPLEX I.G. RECEPTACLE MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED
	FLUSH FLOOR MOUNTED DUPLEX RECEPTACLE - USE BRASS COVERPLATE
	4-PLEX RECEPTACLE MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED
	208V. RECEPTACLE
	JUNCTION BOX NOTE: MARK ALL J BOXES WITH BRANCH CIRCUIT PANEL DESIGNATION & CIRCUIT NUMBER(S)
	WALL MOUNTED JUNCTION BOX
	TELEPHONE OUTLET MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED
	FLUSH FLOOR MOUNTED TELEPHONE OUTLET - USE BRASS COVERPLATES - STUB 3/4"C. INTO ACCESSIBLE LOCATION ABOVE CEILING
	DATA TERMINAL OUTLET MOUNT @ 15" A.F.F. UNLESS OTHERWISE NOTED
	FLUSH FLOOR MOUNTED DATA TERMINAL - USE BRASS COVERPLATES - STUB 3/4"C. INTO ACCESSIBLE LOCATION ABOVE CEILING
	FUSIBLE DISCONNECT
	NON-FUSIBLE DISCONNECT
	COMBINATION DISCONNECT/STARTER
	MAGNETIC STARTER/CONTACTOR
	PANELBOARD -NOTE: PROVIDE TYPEWRITTEN DIRECTORIES AT COMPLETION OF WORK
	SWITCH MOUNT @ 48" A.F.F. UNLESS OTHERWISE NOTED
	D - DIMMER SWITCH
	T - TIMER
	L - LIMIT
	3 - THREE-WAY SWITCHING
	K - KEYED
	M - MANUAL STARTER
	RECESS MOUNTED FIXTURE
	A - FIXTURE TYPE
	O - SWITCHING DESIGNATION
	RECESSED DOWNLIGHT
	SURFACE / CHAIN MOUNTED FIXTURE
	WALL / POLE MOUNTED FIXTURE
	AA - FIXTURE TYPE
	WALL MOUNTED EXIT SIGN
	ARROW INDICATED
	CEILING MOUNTED EXIT SIGN
	CIRCUIT HOME-RUN (ARROWS INDICATE NUMBER OF CIRCUITS)
	A-1,3,5 - PANEL A, CIRCUITS 1, 3, & 5
	(#10) - USE 10 GAUGE COPPER WIRE

NOTE: - NOT ALL SYMBOLS MAY APPLY TO ALL SHEETS
- ALL WIRE SHALL BE COPPER (MIN. #12 AWG) UNLESS OTHERWISE NOTED.
- FEEDERS SHALL CONFORM TO N.E.C. 215-2.
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GENERAL NOTES

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REFER TO LATEST ARCHITECTURAL DRAWINGS FOR: EXACT WALL LOCATIONS, DIMENSIONS, AND CONFIGURATIONS, DOOR SWINGS FOR SWITCH LOCATION VERIFICATION, REFLECTED CEILING PLANS FOR VERIFICATION OF LIGHT FIXTURE LOCATIONS.

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EQUIPMENT STARTERS AND RELATED CONTROL AND WIRING SHALL BE SUPPLIED AND INSTALLED BY THE ELECTRICAL CONTRACTOR. OVERLOAD HEATERS SHALL BE INSTALLED IN ACCORDANCE WITH NAMEPLATE DATA ON EQUIPMENT. STARTERS SHALL BE INSTALLED AS DIRECTED BY THE MECHANICAL CONTRACTOR.

REFER TO MECHANICAL DRAWINGS FOR LOCATION OF THERMOSTAT(S), EXHAUST FAN(S), AND OTHER SPECIAL EQUIPMENT OR CONTROLS. ELECTRICAL CONTRACTOR IS RESPONSIBLE FOR INSTALLATION OF ALL CONDUIT, JUNCTION BOXES, WIRING, AND DISCONNECT SWITCHES AND THERMOSTAT JUNCTION BOXES.

ALL WIRING SHALL BE INSTALLED IN APPROVED RACEWAY SYSTEM IN ACCORDANCE WITH N.E.C. AND LOCAL ORDINANCES. THE USE OF TYPE MC CABLE SHALL BE INSTALLED IN ACCORDANCE WITH N.E.C. ARTICLE 334.

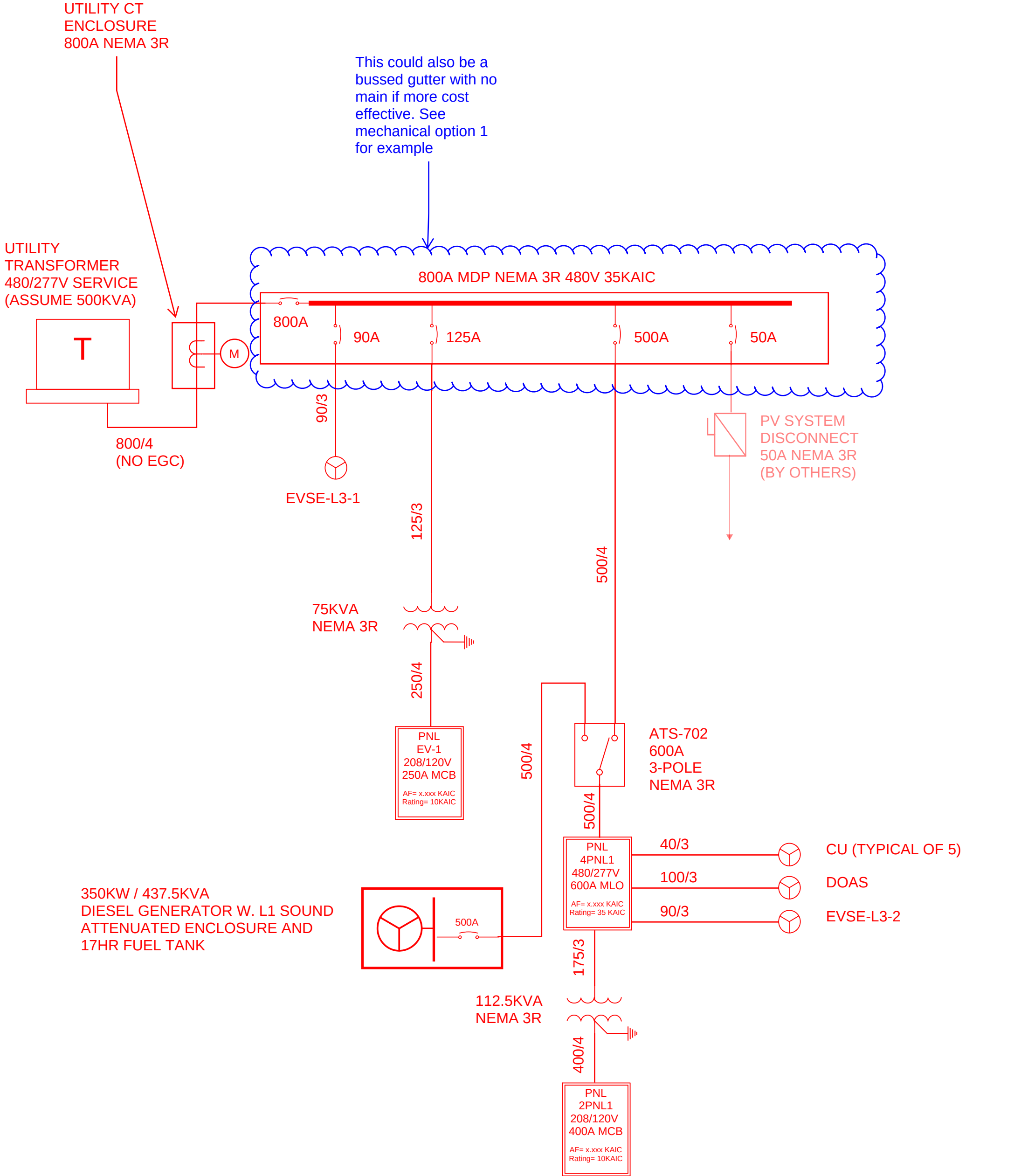
GROUNDING: SYSTEM GROUND SHALL BE IN ACCORDANCE WITH N.E.C. AND TABLE 250-122. THE SYSTEM SHALL BE FURNISHED WITH A CONTINUOUS GROUND FOR RECEPTACLES, LIGHTS, AND EQUIPMENT IN ACCORDANCE WITH N.E.C. TABLE 250-122.

ELECTRICAL CONTRACTOR SHALL CONTACT UTILITY COMPANY FOR METERING REQUIREMENTS AND SHALL INCLUDE ALL WORK IN BID.

ELECTRICAL CONTRACTOR SHALL PROVIDE ALL TRENCHING, BACKFILL, AND CONDUIT FROM POWER COMPANY TRANSFORMER TO C.T./METER.

CONDUIT RUNS INSIDE THE BUILDING SHALL BE CONCEALED, CONDUIT BELOW FLOOR SLAB SHALL BE INSTALLED BELOW THE SLAB AND INSTALLED PRIOR TO POUR. RUNS TO BE STRAIGHT AS POSSIBLE FROM POINT OF OUTLET TO POINT OF OUTLET.

ELECTRICAL CONTRACTOR SHALL MAKE ALL FINAL CONNECTIONS TO OUTSIDE EQUIPMENT, SIGNS, LIGHTING, ETC., PROVIDE DISCONNECT AT EACH SIGN LOCATION IN ACCORDANCE WITH N.E.C. PARAGRAPH 600-6.



NOTE. THE RTU TO VRF SYSTEM IS NOT LIKE FOR LIKE. FULL DEDUCT OF THE 80KVA REMOVED EQUIPMENT MAY NOT BE ACCEPTABLE. IF DEDUCT IS DETERMINED TO NOT BE PERMITTED, AN 800A SERVICE, 350KW GENERATOR AND 600A ATS WILL BE REQUIRED (DEPENDING ON FINAL CALCULATIONS). THIS HAS BEEN ALLOWED FOR IN THE DESIGN AND CAN BE REFINED AT A LATER DATE.

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STAMP

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PROJECT ENGINEERING, INC.
ENGINEERS
6909 South Holly Circle, Suite 304
Englewood, Colorado 80112
Ph: (303) 773-8773 Fax: (303) 779-8333

PROJECT TITLE

LOUISVILLE CITY HALL REMODEL

CITY OF LOUISVILLE
749 MAIN STREET
LOUISVILLE, COLORADO
80027

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ISSUE LOG

1 08AP05 - ISSUE FOR PRELIM ESTIMATE

2 13JAO6 - MODS PER PUBLIC WORKS

3 10AP06 - 50% DESIGN DEVELOPMENT

4 06JNO6 - PRELIMINARY ESTIMATE #2

5 22SP06 - REV PANEL SCHEDULE

6 08MAR07 - RECORD ASBUILT DWGS

MECHANICAL OPTION 3

SHEET TITLE

ELECTRICAL NOTES ONE LINE DIAGRAM

PRINT DATE

28JN06

PROJECT NUMBER

04303

DRAWN BY/CHECKED BY

STAFF

SHEET NUMBER

E3



Appendix

1. Mechanical System Matrix Options
2. Mechanical Decarbonization Scoping
3. Electrical Decarbonization Scoping
4. **Structural Scoping**
5. Electric Vehicle Charging Narrative
6. Renewables Scoping
7. Cost Estimating

CURRENT CITY HALL MECHANICAL DESIGN INCLUDES:
- VAV SYSTEM, NO REHEAT
- (2) GAS DX ROOFTOP UNITS
- RESIDENTIAL ELECTRIC WATER HEATER
- GAS-FIRED GENERATOR, BACKS UP WHOLE BUILDING

REPLACEMENT OPTION #1: HEAT PUMP + GAS BUP
- REPLACE LARGER GAS DX ROOFTOP UNIT WITH EQUIVALENT PACKAGED ROOFTOP UNIT WITH HEAT RECOVERY AND 100% EMERGENCY GAS REHEAT.
- REUSE EXISTING MEDIUM PRESSURE DUCTWORK
- PROVIDE (26) 8" VAV BOXES W/ ELECTRIC RH. SEE MEPS MATRIX FOR RH COIL KW.

RTU-1 BASIS OF DESIGN:
AAON RNA-031-D-0-3-EJA08-CD2L0, **6363#**
- REPLACE SMALLER GAS DX ROOFTOP UNIT WITH EQUIVALENT PACKAGED ROOFTOP UNIT WITH HEAT RECOVERY AND 100% EMERGENCY GAS REHEAT.

RTU-2 BASIS OF DESIGN:
DAIKIN DPS007A, **4304#**
- LEAVE ELECTRIC WATER HEATER AS IS

REPLACEMENT OPTION #2: HEAT PUMP + ELEC BUP
- REPLACE LARGER GAS DX ROOFTOP UNIT WITH EQUIVALENT PACKAGED ROOFTOP UNIT WITH HEAT RECOVERY AND 100% EMERGENCY ELECTRIC REHEAT
- REUSE EXISTING MEDIUM PRESSURE DUCTWORK
- PROVIDE (26) 8" VAV BOXES W/ ELECTRIC RH. SEE MEPS MATRIX FOR RH COIL KW.

RTU-1 BASIS OF DESIGN:
AAON RNA-031-D-0-3-EJA08-CD2L0, **6363#**
- REPLACE SMALLER GAS DX ROOFTOP UNIT WITH EQUIVALENT PACKAGED ROOFTOP UNIT WITH HEAT RECOVERY AND 100% EMERGENCY ELECTRIC REHEAT
RTU-2 BASIS OF DESIGN:
DAIKIN DPS007A, **2421#**
- LEAVE ELECTRIC WATER HEATER AS IS

REPLACEMENT OPTION #3: VRF + DOAS
- REPLACE (2) GAS DX ROOFTOP UNITS WITH DOAS + AIR-COOLED VRF SYSTEM

DOAS BASIS OF DESIGN:
(1) DAIKIN DPS007A, **2401#**
VRF CONDENSING UNIT BASIS OF DESIGN:
(2) DAIKIN RELQ240TATJA, **1587# EACH**
(1) DAIKIN RELQ096TATJA, **794#**
VRF BRANCH SELECTOR BASIS OF DESIGN:
(2) DAIKIN BSF4Q54TVJ, **49# EACH**
(3) DAIKIN BSF6Q54TVJ, **73# EACH**
VRF CASSETTE BASIS OF DESIGN:
(22) DAIKIN FxFQ24TVJU, **51# EACH**
(4) DAIKIN FxFQ12TVJU, **42# EACH**

VAV BOXES BASIS OF DESIGN:
(26) 4" Titus DESV boxes w/o reheat
- LEAVE ELECTRIC WATER HEATER AS IS

STRUCTURAL NOTES PERTAINING TO MECH SCOPE:

BASE MECH SCOPE:

1. (E) RTU-1 LOCATION:
OPTION # 1: HEAT PUMP + GAS BUP
OPTION # 2: HEAT PUMP + ELEC BUP
OPTION # 3: VRF + DOAS UNIT

ORIGINAL WT = 4,800#
OPTION 1 WT = 6363 #
OPTION 2 WT = 6363#
OPTION 3, WT = 2400# FOR DOAS, VRF = 4,800# WITH NEW STEEL FRAME.

--NO STRUCT UPGRADE ANTICIPATED AT RTU-1 LOCATION; UNIT IS SIM IN SIZE TO ORIGINAL AND (E) TRUSSES WERE UPSIZED FOR ROOFTOP MECH UNIT PER ORIGINAL DESIGN DOCS

2. (E) RTU-2 LOCATION:
OPTION 1: DAIKIN DPS007A, WT = 4304#
OPTON 2 : DAIKIN, WT = 2421#

--NO STRUCT UPGRADE ANTICIPATED AT RTU-2 LOCATION TO UNDERLYING BAR JOISTS; HOWEVER, MC 6x12 FLAT ORIENTED STRUCTURAL STEEL SLEEPER IS CONFIGURED TO DISTRIBUTE LOAD TO UNDERLYING BAR JOISTS.

-- SEE SK-1 FOR ADDITIONAL INFORMATION

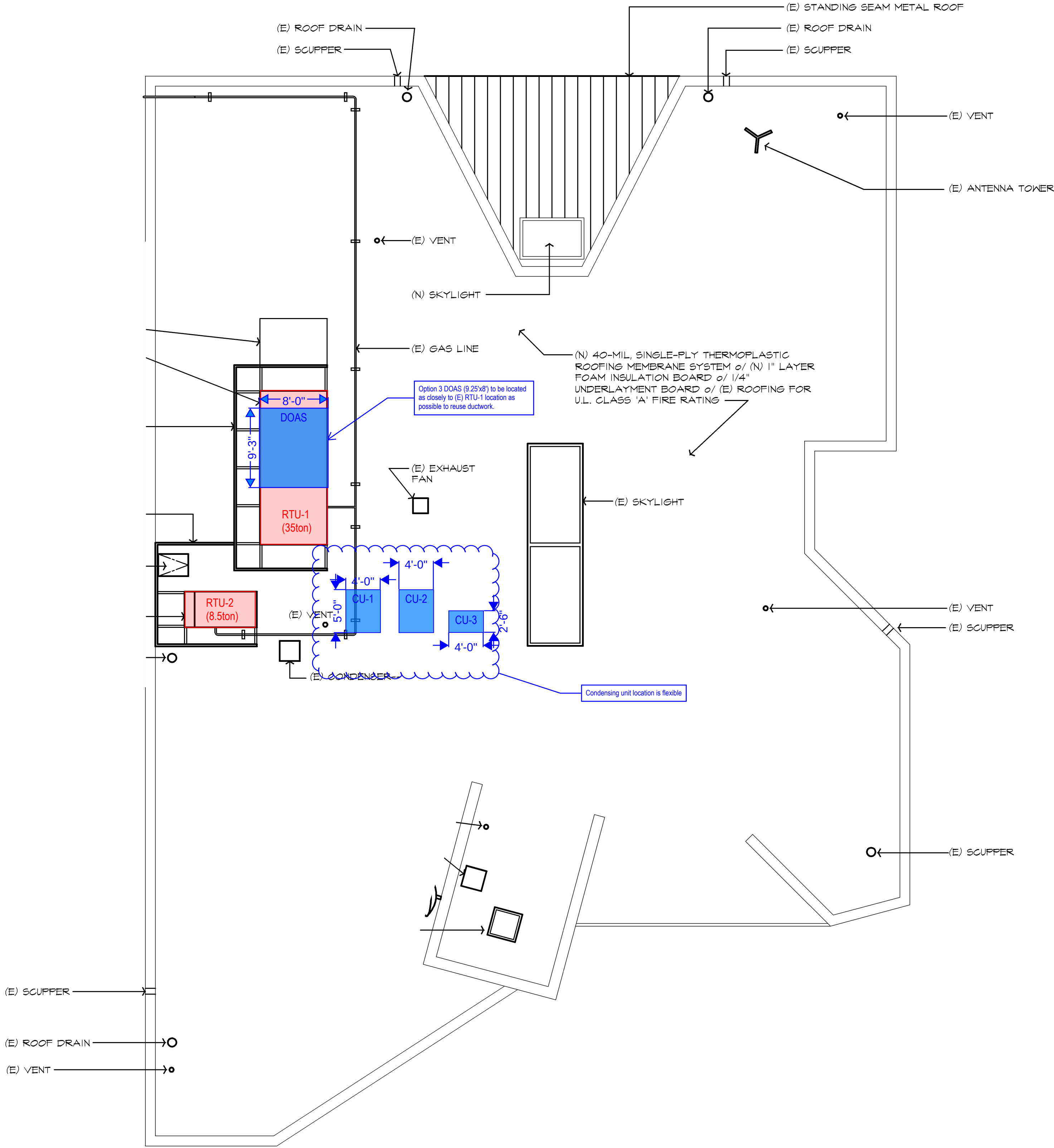
3. NEW ROOFTOP VRF CONDENSERS AT OPTION 3

--STRUCT UPGRADE TO UNDERLYING TRUSS FRAMING IS REQ'D FOR INCOMING VRF AND STEEL FRAMED EQUIPMENT SUPPORTS.

--SEE SK-1 FOR ADDITIONAL INFORMATION

4. INTERIOR VRF SUSPENDED EQUIPMENT AT OPTION 3:
A. CONFIGURE CABLE BRACE KITS AT VRF CASSETES (FC UNITS) AND SELECTOR BOX'S
B. WEIGHTS VARY FROM 42# TO 73#

C. PROVIDE CABLE BRACED CONNECTION PER DET 7;
--CABLES CONFIGURED FOR MAINTENANCE ACCESS AND ATTACHMENT TO STRUCTURE
-- FOR PRICING, ESTIMATE THE FOLLOWING:
--ATR = 1/4 AT EA CORNER, QNTY = 4
--SAMMY'S ROD HANGER 1/4" DIA X 2" THREAD, QNTY = 8 AT WOOD FRAMING
--CABLE = GRIPPLE GS-10, TYP AT EA CORNER, QNTY = 4



A ROOF PLAN
1/8" = 1'-0"

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itates

ecture
Planning

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STAMP

CONSULTANT

PROJECT TITLE

LOUISVILLE CITY HALL REMODEL

CITY OF LOUISVILLE
749 MAIN STREET
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80027

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ISSUE LOG

1 **06APOS - ISSUE FOR PRELIM ESTIMATE**

2 **10AP06 - 50% DESIGN DEVELOPMENT**

3 **06JN06 - PRELIMINARY ESTIMATE #2**

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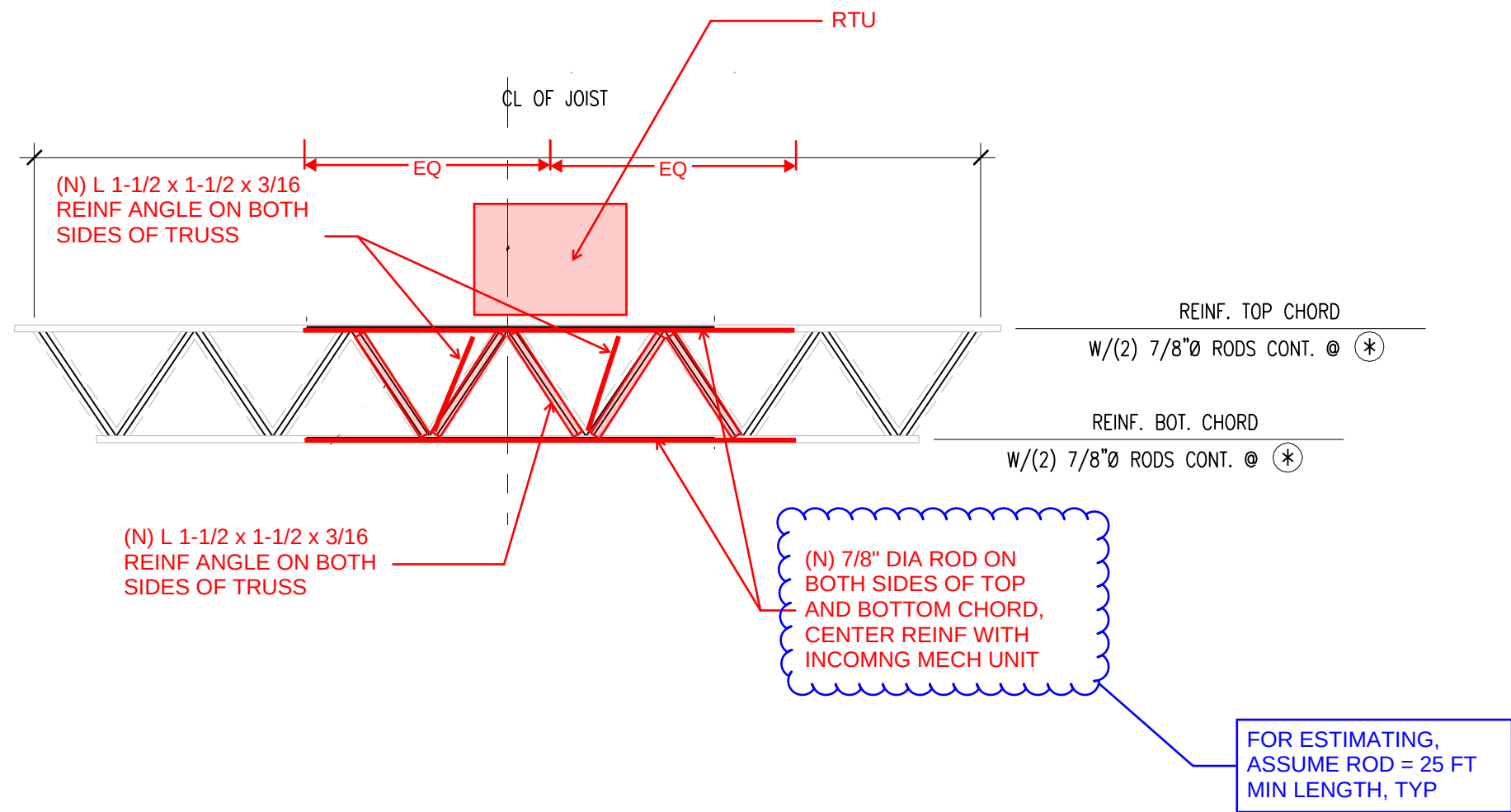
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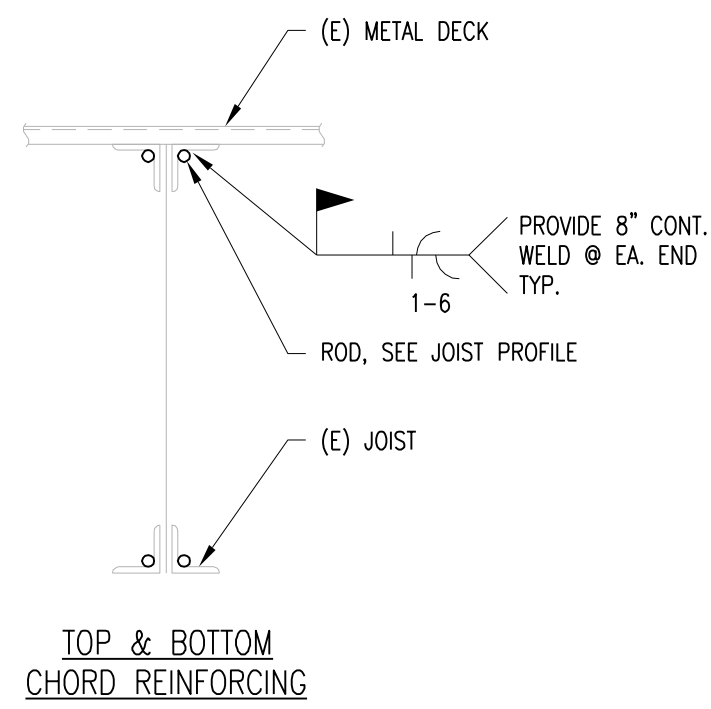
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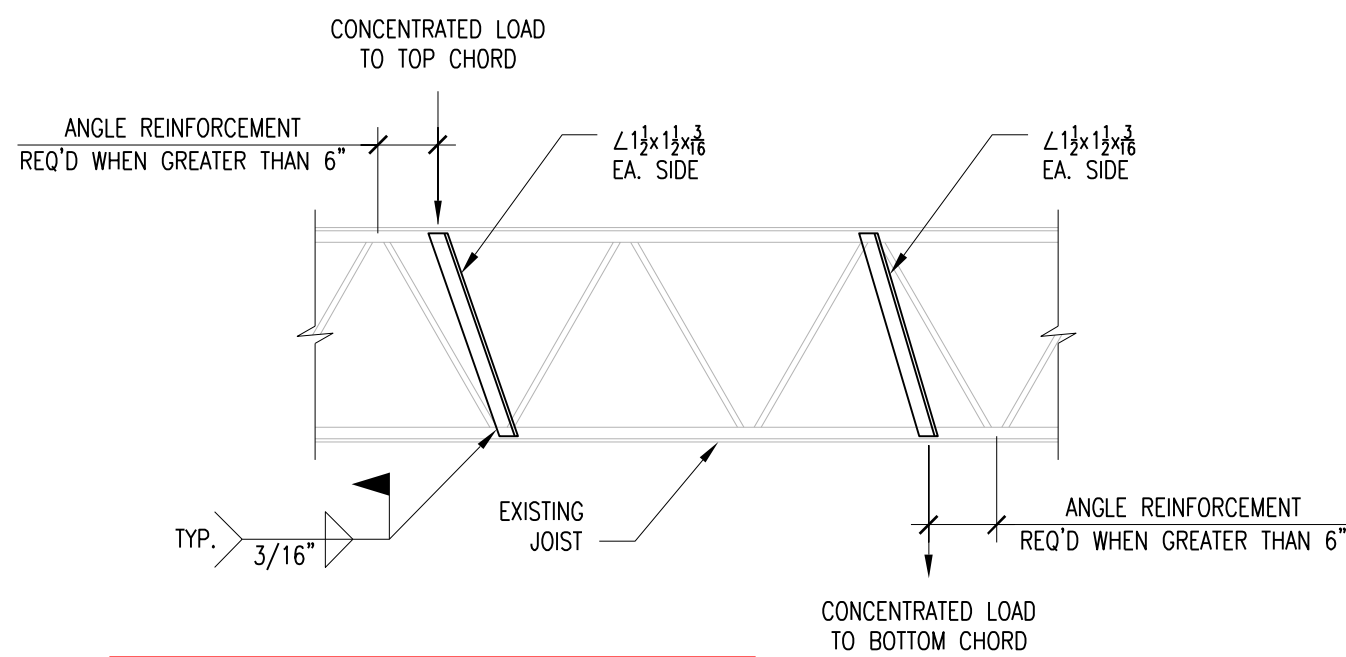
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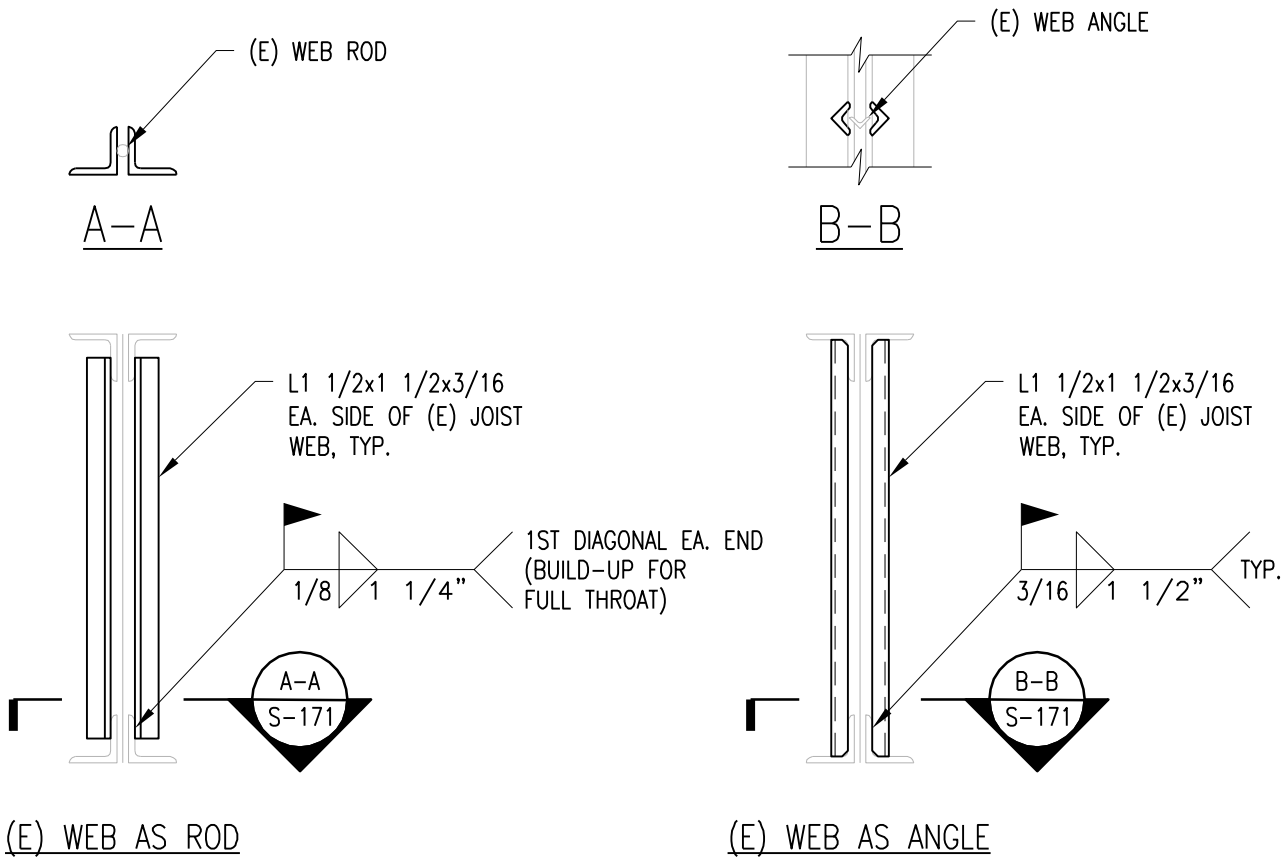
2 BAR JOIST REINF ELEVATION



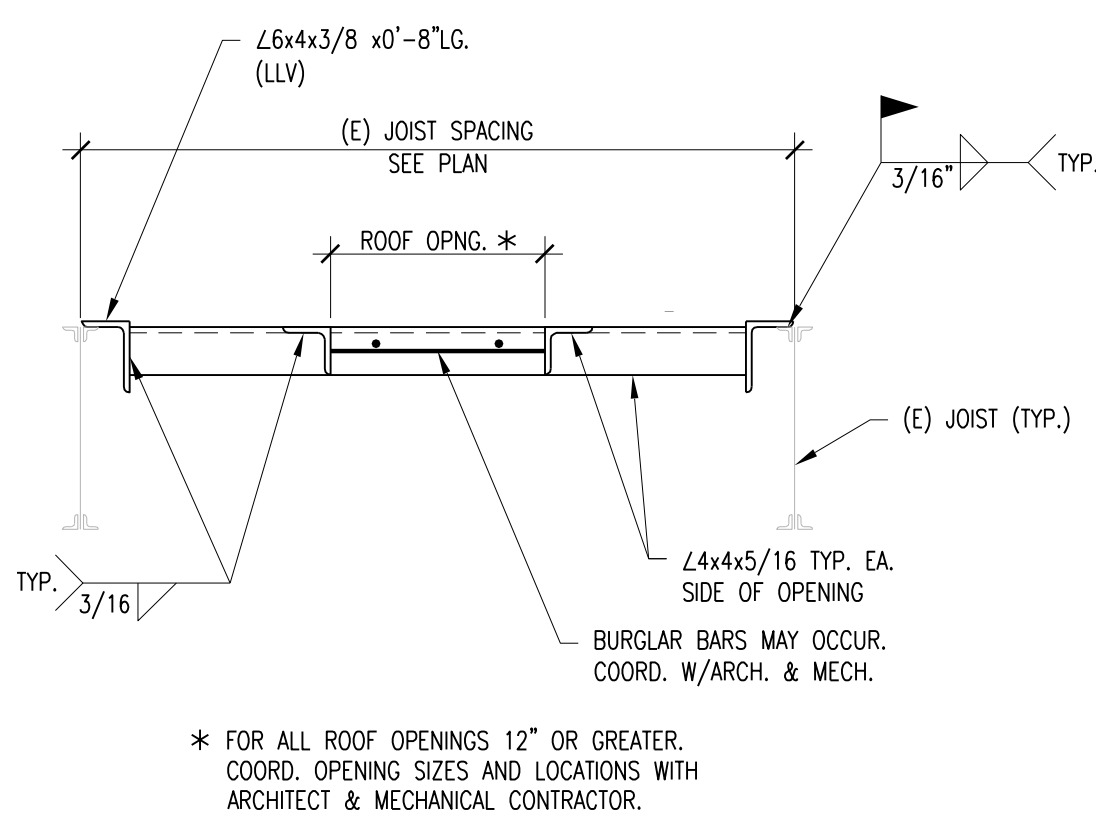
18 BAR JOIST CHORD REINF SECTION
3/4" = 1'-0"



6 BAR JOIST COMP CHORD REINF (TRUSS PANEL POINT) TYPICAL EXISTING JOIST REINFORCING DETAIL
3/4" = 1'-0"

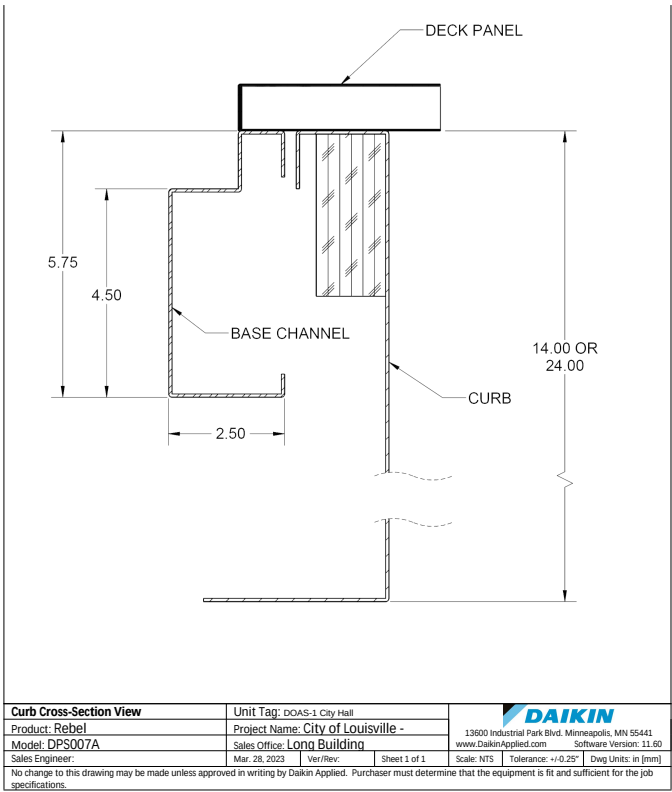
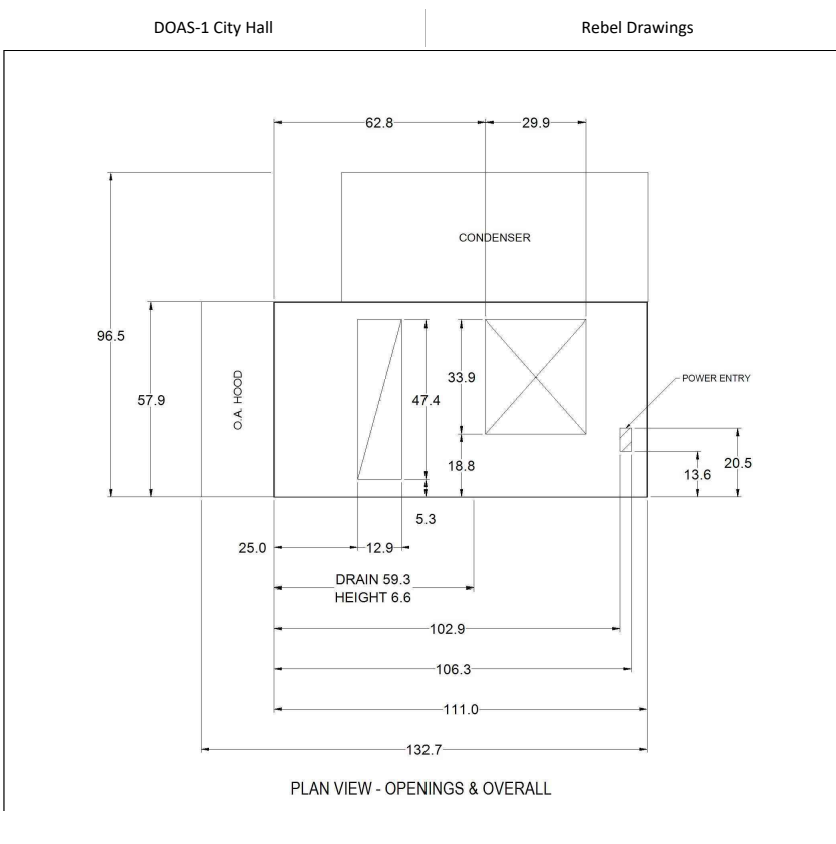
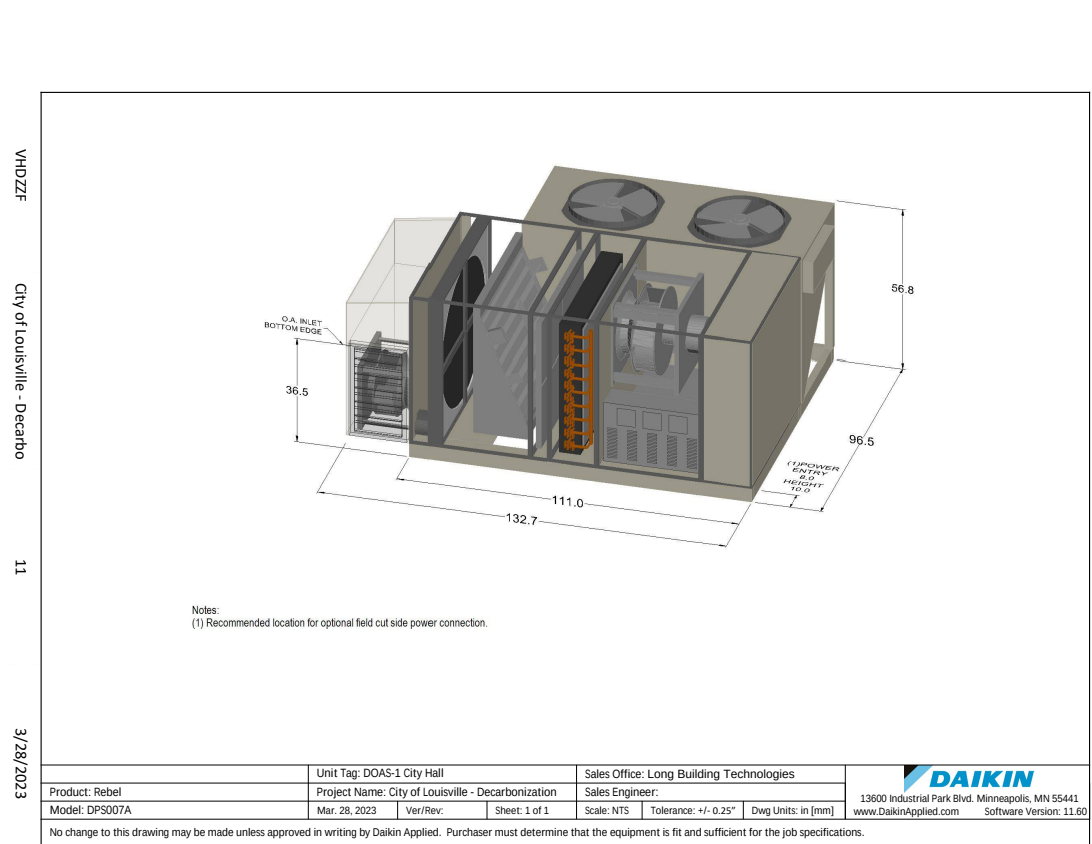


19 BAR JOIST WEB REINF SECTION
3/4" = 1'-0"



1 ROOF OPENING REINF TYPICAL ROOF OPENING DETAIL
3/4" = 1'-0"

Technical Data Sheet

[illegible]

wt's per 2007 MP
Drawings

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Submittal Data Sheet
20-Ton, 230V VRV AURORA HR - RELQ240TATJA
Project: Sample Submittal
Submitted by: Geoffrey McBride of LONG BUILDING TECHNOLOGIES INC on 3/4/2022
Submitted to: No Engineer Name Specified

- VRF Industry's first air cooled system that delivers heating down to -22°F (-30°C) as standard

- Dalkin's inverter based vapor injection compressor delivers high heating capacity of up to 100% of nominal at -18°C (-0°F), up to 85% of nominal at -13°C (+23°F) and up to 60% of nominal at -22°F (-6°F)
- Refrigerant-cooled efficient and stable inverter board operation, independent of ambient conditions
- Added peace of mind with Auto Changeover ability to back up (auxiliary) heat
- Year round comfort and energy efficiency delivered by combining VRV and VRF technologies
- Available in 6, 8, 10 ton single modules and 12, 16, 20 ton multi-module systems
- Compatible with the VRV-IV T-series Branch Selector Boxes
- Seamless connection to all VRV M, P and T-series indoor and air processing units
- Ships factory standard with coil guards
- Assembled in the US to increase flexibility and reduce lead times
- Standard Limited Warranty: 10-year limited parts warranty



Submittal Data Sheet
20-Ton, 230V VRV AURORA HR - RELQ240TATJA
Project: Sample Submittal
Submitted by: Geoffrey McBride of LONG BUILDING TECHNOLOGIES INC on 3/4/2022
Submitted to: No Engineer Name Specified

PERFORMANCE			
Outdoor Unit Model No.	RELQ240TATJA	Outdoor Unit Name:	20-Ton, 230V VRV
Type:	Heat Recovery	Unit Combination:	RELQ120TATJA/JA
Rated Cooling Conditions:	Indoor (°F DB/WB): 80 / 67 Ambient (°F DB/WB): 95 / 75	Rated Heating Conditions:	Indoor (°F DB/WB): 70 / 65 Ambient (°F DB/WB): 5 / 35
Rated Piping Length(ft):			
Rated Height Difference (ft):	0.00		
Rated Cooling Capacity (Btu/hr):	238,000 223,229 Btu/hr	Rated Heating Capacity (Btu/hr):	253,000 227,100
Nom Cooling Capacity (Btu/hr):	240,000	Nom Heating Capacity (Btu/hr):	270,000
Cooling Input Power (kW):	17.70	Heating Input Power (kW):	19.40
EER (Non-Ducted/Ducted):	12.30 / 11.70	Heating COP (Non-Ducted/Ducted):	3.7 / 3.5
IEER (Non-Ducted/Ducted):	21.10 / 18.60	Heating COP 1TF (Non-Ducted/Ducted):	2.2 / 2.1
		SCHE (Non-Ducted/Ducted):	24.90 / 20.80

Power Supply (VHzPh):	208/230/60/3	Compressor Stage:	
Power Supply Connections:	L1, L2, L3 Ground	Capacity Control Range (%):	4 - 100
Min. Circuit Amps MCA (A):	See SPPF Data Sheet	Capacity Index Limit:	168.0 - 312.0
Max Overcurrent Protection (MOP) (A):	See SPPF Data Sheet	Airflow Rate (H) (CFM):	8800±8800
Sound Pressure (H) (dBA):	67	Gas Pipe Connection (inch):	1-3/8
Sound Power Level (dBA):	87.5	Liquid Pipe Connection (inch):	5/8
Dimensions (Height) (in):	66-11/16	H/L Pressure Connection (inch):	1-1/8
Dimensions (Width) (in):	48-7/8±48-7/8	H/L Equalizing Connection (inch):	
Dimensions (Depth) (in):	30-3/16	Max. No. of Indoor Units:	41
Net Weight (lb):	793±793		

CURRENT AUSTIN NIEHOFF MECHANICAL DESIGN INCLUDES:

- (1) GAS FURNACE
- RESIDENTIAL ELECTRIC WATER HEATER

BASE REPLACEMENT OPTION:

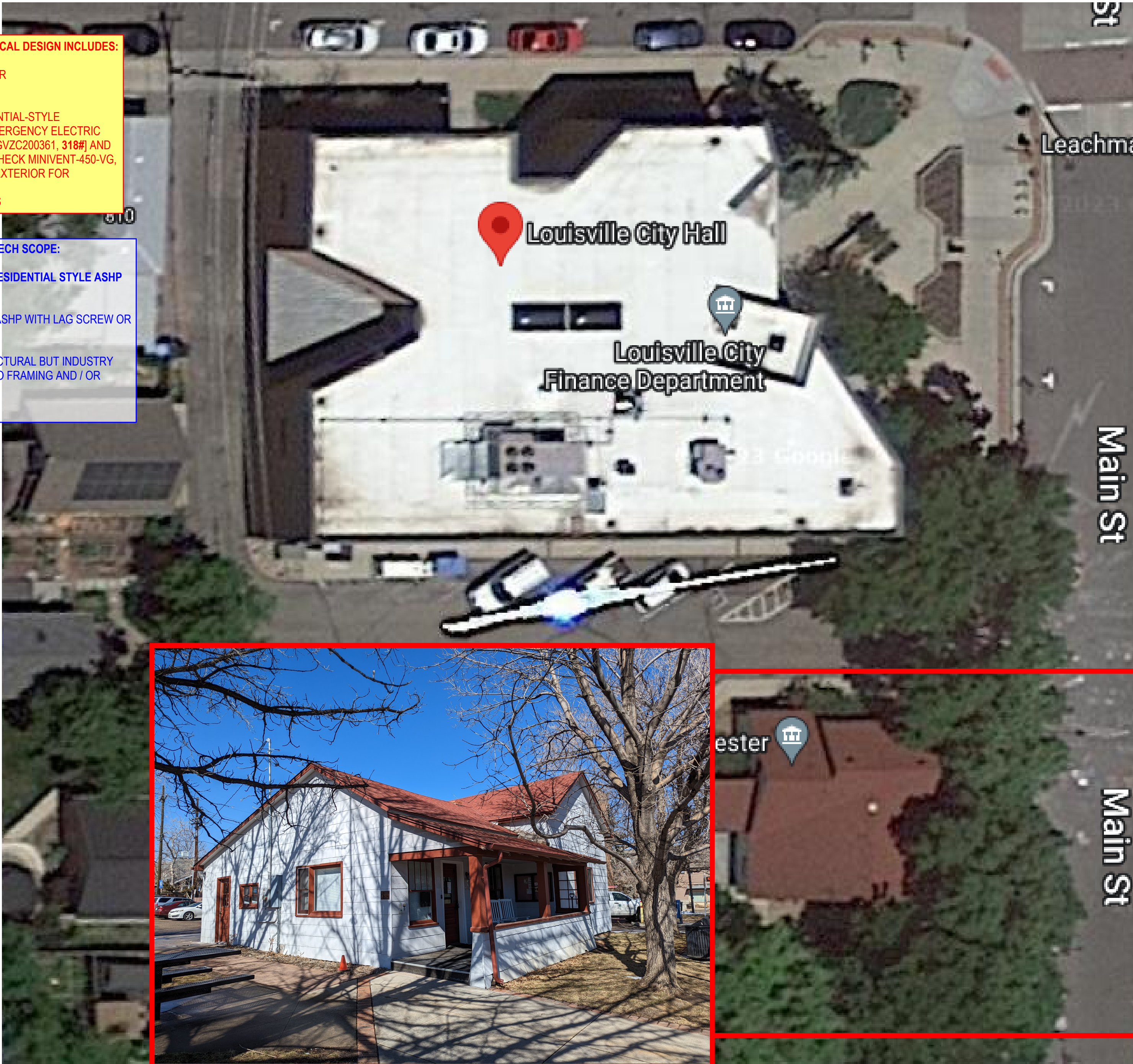
- REPLACE GAS FURNACE WITH RESIDENTIAL-STYLE AIR-SOURCE HEAT PUMP WITH 100% EMERGENCY ELECTRIC REHEAT [BASIS OF DESIGN: GOODMAN GVZC200361, 318#] AND INDOOR ERV [BASIS OF DESIGN: GREENHECK MINIVENT-450-VG, 160#] WITH DUCTED CONNECTIONS TO EXTERIOR FOR OUTDOOR AIR AND EXHAUST AIR
- LEAVE ELECTRIC WATER HEATER AS IS

STRUCTURAL NOTES PERTAINING TO MECH SCOPE:

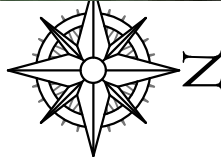
1. (E) GAS FURNACE REPLACED WITH RESIDENTIAL STYLE ASHP
--NO STRUCT UPGRADE ANTICIPATED.

A. PROVIDE POSITIVE CONNECTION AT ASHP WITH LAG SCREW OR TAPCON CONCRETE SCREW.

B. POSITIVE CONNECTION IS NON-STRUCTURAL BUT INDUSTRY STANDARD FOR FASTING EQUIPMENT TO FRAMING AND / OR STRUCTURE.



1 Main Floor Plan
Scale: 1/4" = 1'-0"





Appendix

1. Mechanical System Matrix Options
2. Mechanical Decarbonization Scoping
3. Electrical Decarbonization Scoping
4. Structural Scoping
5. Electric Vehicle Charging Narrative
6. Renewables Scoping
7. Cost Estimating



City of Louisville
City Hall
Electric Vehicle Charging Narrative

Electric Vehicle Charging Narrative

Electric Vehicle Charging Narrative

Fleet or EV Charging

As part of the decarbonization study, the fleet vehicles were analyzed for replacement with EV equivalents. In addition, building electrical capacities were reviewed to determine if they have enough capacity to charge the fleet vehicles and if any electrical upgrades may be needed to the buildings.

EV Fleet Conversion

Based on current technology, transitioning from internal combustion engine (ICE) vehicles to EVs can substantially lower overall carbon emissions. A caveat to consider in assessing the environmental impact of EVs is the variation of electricity generation sources in a given area. The state of Colorado relies mainly on coal and natural gas. However, the share of these fuel sources as a percentage of total generation is decreasing. Alternative energy sources such as wind and solar are increasing rapidly. By using additional onsite renewable energy sources and phasing in vehicle replacement it will be possible for Louisville's fleet to be entirely carbon free.

In the current vehicle market mainly light duty vehicles are being produced. The battery technology is still being developed for heavy-duty vehicles. The market is rapidly changing so over the course of the next 5 years new innovation should allow heavy duty vehicles to be carbon free through either advanced battery technology or other yet to be determined technology.

EVs typically have a higher initial capital cost to purchase or lease when compared to ICE vehicles, EVs can cost less in the long-term due to lower fuel costs, different maintenance requirements, and longer vehicle lives. Therefore, it is important to consider the entire lifespan of a vehicle when investing in fleet vehicles. There are also limiting factors of EVs to consider, such as range and power needs of certain fleet vehicles, as well as the near-constant changes in the electric vehicle and infrastructure technology.

Charging Infrastructure

When planning for EV charging infrastructure, it is recommended to proactively plan for the number of charging stations needed by installing more electrical equipment (e.g. transformers and conduits) than is needed for the initial purchase of EVs. It is more cost effective to install excess electrical equipment during the initial installation than having to add electrical wires each time additional stations are required. This electrical equipment installation does not include purchasing all the charging stations that can fit with that equipment, but instead having the electrical capacity to purchase charging stations to meet future capacity needs without additional construction. The city has already thought about this and this report is the result of that forward thinking.

While there are three levels of EV charging infrastructure currently available, Level 2 charging is currently the most prevalent among them and requires electrical infrastructure upgrades to extend 240 volt AC service to locations where the EVs would charge. It charges at over twice the rate of level 1, adding 12 to 80 miles of range per hour charging. Level 3 charges are also becoming more common and can add from 80 to 500 miles of range per hour. Level 3 charging typically requires a 480 volt AC service. The level 2 and 3 chargers with the increased rate of charging can justify the costs to serve the needs of fleet management in a timely manner. Costs per unit can vary within these ranges depending on the installation and labor costs, warranties for equipment, and operation and maintenance costs for the equipment. Level 2 chargers provide good value for infrastructure investment when factoring in cost and time required to charge when compared to Level 3 chargers. Level 3 chargers can make sense when high use vehicles need quick recharging, though these chargers will cost more to install and incur a higher charging cost than level 2 chargers.

Electric Vehicle Charging Narrative

For the public chargers the City may want to consider charging a some type of fee for usage. Many charging stations charge a usage fee at some dollar per kWh of charging. This can help offset the peak demand that may be incurred by the city. Another option is to charge an idle fee. This type of fee encourages people not to leave there vehicle plugged in for long period of times once the vehicle has reached full charge.

Another consideration for charging infrastructure is the daily charging schedule. Most of the buildings reviewed for this study are on a secondary general rate schedule. This rate schedule does not have time of use rates for electrical consumption or peak demand. This means depending on when and how many vehicles charge relative to the buildings peak demand, it may increase the demand charges the city pays. Xcel Energy does offer a EV charging rate plan that incentivize the intentional reduction of electricity use during peak energy demand periods, such as during hot summer days. This rate plane does require a separate service for just the charging stations. Planning for fleet recharging during off-peak periods can add up to thousands of dollars in savings.

Battery capacity

Battery technology is changing rapidly, resulting in increased charge capacity and lower operating cost per mile. Many manufactures now offer eight year/100,000 mile warranties on their EV batteries (generally covering defects and workmanship), and some offers an eight year/100,000 mile warranty on battery capacity. Auto manufacturer warranties and charge capacity have generally reduced consumer concern about battery life and range. As a result, the analysis of total ownership cost does not account for the cost of EV battery replacement, assuming that municipal vehicles will be retired at the warranty expiration.

City Hall Site

City Hall has 2 vehicles that are stored onsite and both are passenger vehicles. See table XX below.

Use Type	Make	Model	Quantity
City Hall	Chevy	Bolt	1
		Impalla	1

We recommend install 7 chargers and upgrading the electrical infrastructure to support them. Four of the charger are will be publicly available for the city residents. Table XX below shows the number of recommended chargers.

Existing Public charging stations	Existing Public Charger Level	Quantity of New Level 2 Public Charger	Quantity of New Level 3 Public Charger	Quantity of New Level 2 Fleet Charger	Quantity of New Level 3 fleet Charger
0	N/A	3	1	2	1

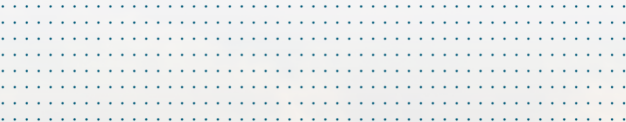
At this site the chargers were split into two groups, public and fleet. The number of fleet chargers selected to be installed here were based on the number of vehicles stored onsite plus one extra to account for visiting fleet vehicles. In addition, one of the fleet chargers was selected to be a L3 charger to allow for quick recharge of a fleet vehicle if needed. An example of such a use case maybe for the plow vehicle used to clear the parking lot.

The quantity of public chargers selected for this site was based on the parking spots south of the building and there proximity to the electrical services that will be in the area for the fleet chargers. More or less spots could installed or located in other areas but this will affect the cost. One L3 charger was included in the public area to allow a fast charging option for the public.



Appendix

1. Mechanical System Matrix Options
2. Mechanical Decarbonization Scoping
3. Electrical Decarbonization Scoping
4. Structural Scoping
5. Electric Vehicle Charging Narrative
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7. Cost Estimating



City of Louisville Decarbonization Study

Louisville City Hall

RENEWABLES SUPPORTING ANALYSIS

LOUISVILLE, CO

AUGUST 18, 2023

Together Building a Thriving Planet



Louisville City Hall

The Louisville City Hall is a candidate for a flat rooftop solar PV system. The available roof space would allow for a modest array and paired with a strong utility savings this makes the system advantageous to the City of Louisville’s Decarbonization Plan.

1. Proposed Solar PV System Overview

Below is a high-level summary of the proposed system specifications. Please note, specific equipment manufacturers and models may change depending on availability and market conditions at the time of construction.

SITE NAME	SITE ADDRESS	SIZE (KW-DC)	SIZE (KW-AC)	SYSTEM TYPE	YEAR 1 PRODUCTION (kWh)
Louisville City Hall	749 Main St. Louisville, CO 80027	27.5	20	Flat rooftop	39,569



Louisville City Hall

LOUISVILLE CITY HALL EQUIPMENT AND QUANTITY SUMMARY

QUANTITY	EQUIPMENT DESCRIPTION
51	JA Solar, JAM72D30-540 (540W) – Bifacial Mono PERC Half Cell Double Glass Modules
1	CPS SCA25KTL-DO/US-480 - Inverters
1	PanelClaw clawFR 10° Flat Roof Racking System Mix of ballast and mechanical attachments
1	AlsoEnergy Data Acquisition System (DAS) Package – PLCS400
1	Electrical Balance of Systems Package

AlsoEnergy Data Acquisition System (DAS) includes the equipment/functionality listed below.

- NEMA 4 Enclosure and Data Logger
- Cellular modem
- CT Based Revenue Grade Meter
- Inverter Direct Monitoring
- 5-year service plan
- A Meteorological Station consisting of the following:
 - Cell Temp Sensor
 - Pyranometer
- Publicly accessible web-based dashboard functionality

The Electrical Balance of Systems Package includes all components to create an electrically complete roof top solar PV installation. This includes grounding materials, wiring, conduit, MCT, panelboards/combiners, switchgear, fuses, and disconnects.

2. Production Modeling

Array layouts and system production are modeled in Helioscope, an industry-standard design and energy modeling software package with 3-dimensional modeling capabilities. Through Helioscope, we can incorporate site-specific characteristics of buildings and shade producing obstructions to determine their impacts upon system layout and production. McKinstry further applies our knowledge of codes and regulations, industry best practices, and professional judgment to ensure that designs are code-compliant and strike a balance across customer preferences, production, constructability, and price concerns.

Helioscope provides robust PV system output modeling capabilities. We use these in conjunction with Typical Meteorological Year (TMY) weather datasets, real-world equipment specifications, proprietary 3rd-party-engineered dust and snow soiling models, and professional judgment to determine a system's annual kWh production. For City of Louisville, we are using the TMY, DENVER INTL AP, NSRDB (tmy3,l) weather data set and soiling conditions from the DNV-GL NOAA Lafayette station. Annual production is estimated at 39,703kWh. Full Helioscope report below.

Louisville City Hall



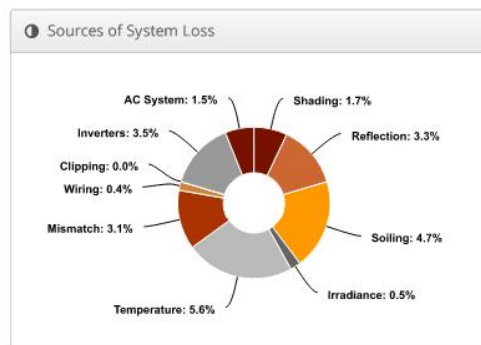
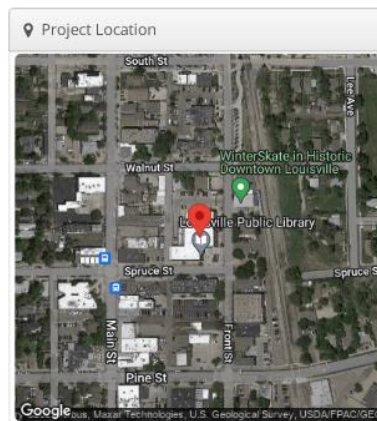
Annual Production Report produced by Mountain Bryan H

Cohort 3 - City Hall City of Louisville, 951 Spruce St, Louisville, CO 80027

Report

Project Name	City of Louisville
Project Address	951 Spruce St, Louisville, CO 80027
Prepared By	Mountain Bryan H bryanh@mckinstry.com

System Metrics	
Design	Cohort 3 - City Hall
Module DC Nameplate	27.5 kW
Inverter AC Nameplate	25.0 kW Load Ratio: 1.10
Annual Production	39.57 MWh
Performance Ratio	78.8%
kWh/kWp	1,436.8
Weather Dataset	TMY, DENVER INTL AP, NSRDB (tmy3, l)
Simulator Version	f1afba56bc-0d48734f56-22c03a577b-429aea41ae



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Annual Production Report produced by Mountain Bryan H

⚡ Annual Production			
	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,670.2	
	POA Irradiance	1,822.5	9.1%
	Shaded Irradiance	1,790.7	-1.7%
	Irradiance after Reflection	1,732.2	-3.3%
	Irradiance after Soiling	1,650.1	-4.7%
	Total Collector Irradiance	1,649.9	0.0%
Energy (kWh)	Nameplate	46,011.9	
	Output at Irradiance Levels	45,760.2	-0.5%
	Output at Cell Temperature Derate	43,175.1	-5.6%
	Output After Mismatch	41,817.3	-3.1%
	Optimal DC Output	41,629.1	-0.4%
	Constrained DC Output	41,628.3	0.0%
	Inverter Output	40,171.3	-3.5%
	Energy to Grid	39,568.7	-1.5%
Temperature Metrics			
Avg. Operating Ambient Temp		15.0 °C	
Avg. Operating Cell Temp		28.0 °C	
Simulation Metrics			
		Operating Hours	4513
		Solved Hours	4513

☁ Condition Set												
Description	Roof 10 deg											
Weather Dataset	TMY, DENVER INTL AP, NSRDB (tmy3, I)											
Solar Angle Location	Project Lat/Lng											
Transposition Model	Perez Model											
Temperature Model	Diffusion Model											
Temperature Model Parameters	Rack Type	U _{const}				U _{wind}						
	Fixed Tilt	20				0						
	Flush Mount	15				0						
	East-West	20				0						
	Carport	29				0						
Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D
	12	11	8	7	4	1	1	1	1	4	8	14
Irradiation Variance	3.5%											
Cell Temperature Spread	3° C											
Module Binning Range	0% to 2.5%											
AC System Derate	1.50%											
Trackers	Maximum Angle						Backtracking					
	10°						Disabled					
Module Characterizations	Module				Uploaded By		Characterization					
	JAM72D30-540/MB (JA Solar)				HelioScope		Spec Sheet Characterization, PAN					
Component Characterizations	Device				Uploaded By		Characterization					
	CPS SCA25KTL-DO/US-208 (2020) (CPS)				HelioScope		Spec Sheet					

📦 Components		
Component	Name	Count
Inverters	CPS SCA25KTL-DO/US-208 (2020) (CPS)	1 (25.0 kW)
Strings	10 AWG (Copper)	3 (141.3 ft)
Module	JA Solar, JAM72D30-540/MB (540W)	51 (27.5 kW)

🔌 Wiring Zones			
Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	17-17	Along Racking

🏠 Field Segments									
Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Landscape (Horizontal)	10°	179°	1.4 ft	1x1	38	38	20.5 kW
Field Segment 2	Fixed Tilt	Landscape (Horizontal)	10°	179°	1.4 ft	1x1	7	7	3.78 kW
Field Segment 3	Fixed Tilt	Landscape (Horizontal)	10°	179°	1.4 ft	1x1	6	6	3.24 kW

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3. Annual Utility Savings and Value of Solar Energy

To analyze utility bill savings, we utilize Energy Toolbase, an industry-standard bill modeling software package. Energy Toolbase estimates bill savings based upon a site's electric load characteristics, PV system production (imported from Helioscope or other sources), and local utility tariffs and net metering policies. Xcel Energy tariffs and Net Metering tariff adjustments used in this analysis are:

- Secondary General (SG)
- Secondary Photovoltaic Time-of-Use (SPVTOU)
- Net Metering Service (Schedule NM)

To properly calculate the annual utility savings associated with the solar PV, we need to analyze the building load after all electrification and carbon reduction measures are implemented. As noted in the Summary Report, there are three bundles of measures – Bundle 1 (Full Electrification), Bundle 2 (Hybrid Electrification) and Bundle 3 (High Performance Electrification). For this site we've included a Bundle 4 (Existing Conditions) to show the value of the solar system pre electrification measures. Each create a slightly different building load baseline. Therefore, all scenarios are listed below. Baseline utility year is 2019 and the assumed DOE building profile is Medium Office which models a 5 day a week daytime usage more closely representing the hours of City Hall.

OPTION 1 - ROOF MOUNT ONLY ESTIMATE WITH SPVTOU RATE SWITCH

SCENARIO	ANNUAL SAVINGS	ENERGY SAVINGS	DEMAND SAVINGS
Bundle 1	\$7,123	(-\$4,416)	\$11,539
Bundle 2	\$7,940	(-\$4,439)	\$12,379
Bundle 3	\$7,679	(-\$4,034)	\$11,713
Bundle 4	\$4,461	(-\$3,069)	\$7,530

All Bundles are modeled with a rate switch to SPVTOU. To qualify for a rate switch to SPVTOU, the building must have a minimum 30% load factor for the trailing 12 months and less than 500kW service demand. The average existing load factor for this site is above 40%, and the service demand is below 500kW.

Note the rate switch SPVTOU Energy Savings are negative. This means Louisville would pay more on the energy portion of their bill but save more on the demand portion of their bill due to the time-of-use rate structure.

4. System Price and Financial Results

There are two main avenues City of Louisville can choose to finance these projects – cash purchase or tax-exempt lease purchase (TELP). As a tax-exempt entity, City of Louisville is eligible for direct pay in Year 1 at Energy Investment Tax Credit (ITC) rates. These rates are 30% for cash purchase and 25.5% for TELP.

At this early feasibility study stage of a portfolio, we focus on simple payback to get a high-level look at the project economics. Our simple payback calculation is based on Year 1 solar production, Year 1 annual utility

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savings, and the Solar*Rewards C&I incentive program. Should any of these projects move into the next stage of development, McKinstry would develop more detailed proformas and cash flows to include items like solar degradation, Operations & Maintenance, discount rates, and more.

McKinstry aims to recommend solar systems that will pay back in the system lifetime, between 25-30 years. In all funding scenarios, this system would pay back within the solar lifetime.

BUNDLE 1 FULL ELECTRIFICATION	SYSTEM PRICE	ANNUAL SAVINGS	UTILITY INCENTIVE	SIMPLE PAYBACK (YRS)
Cash Purchase or Tax-Exempt Lease Purchase (TELP)	\$145,000	\$7,123	\$1,485	16.37
TELP with IRA	\$108,025			12.2
Cash Purchase with IRA	\$101,500			11.46
BUNDLE 2 HYBRID ELECTRIFICATION	SYSTEM PRICE	ANNUAL SAVINGS	UTILITY INCENTIVE	SIMPLE PAYBACK (YRS)
Cash Purchase or Tax-Exempt Lease Purchase (TELP)	\$145,000	\$7,940	\$1,485	14.96
TELP with IRA	\$108,025			11.15
Cash Purchase with IRA	\$101,500			10.47
BUNDLE 3 HIGH PERFORMANCE	SYSTEM PRICE	ANNUAL SAVINGS	UTILITY INCENTIVE	SIMPLE PAYBACK (YRS)
Cash Purchase or Tax-Exempt Lease Purchase (TELP)	\$145,000	\$7,679	\$1,485	15.4
TELP with IRA	\$108,025			11.47
Cash Purchase with IRA	\$101,500			10.78
BUNDLE 4 EXISTING LOADS	SYSTEM PRICE	ANNUAL SAVINGS	UTILITY INCENTIVE	SIMPLE PAYBACK (YRS)
Cash Purchase or Tax-Exempt Lease Purchase (TELP)	\$145,000	\$4,461	\$1,485	23.7
TELP with IRA	\$108,025			17.65
Cash Purchase with IRA	\$101,500			16.59

Please note that there is a proposed service upgrade for this site associated with Bundle 1 and Bundle 3. The cost of that upgrade is included in the Electrification scope of work. The full PV scope from the Point of Interconnection, to the Solar Disconnect, Solar Meter, AC Combiner, Inverters to Modules is included in the pricing below. Additionally, pricing below assumes Louisville moves forward with a system at the City Services building and Coal Creek Golf Course; there are cost efficiencies in material, installation, and construction management scopes using a portfolio approach.

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Another metric that may be useful as the City of Louisville considers the best way to decarbonize is levelized cost of electricity (LCOE). This is defined as capital cost divided by the estimated system lifetime production with units of \$/kWh. It can help the City of Louisville compare the value of owning onsite solar versus subscribing to renewable utility programs like Renewable Connect and Windsource. The table below shows LCOE with and without the Solar*Rewards C&I incentive.

BUNDLES 1-4	LCOE -	LCOE -
	NO UTILITY INCENTIVES (\$/KWH)	W/ UTILITY INCENTIVES (\$/KWH)
Cash Purchase or Tax-Exempt Lease Purchase (TELP)	\$0.146	\$0.095
TELP with IRA	\$0.091	\$0.064
Cash Purchase with IRA	\$0.085	\$0.059

5. Future Considerations and Next Steps

Should Louisville decide to move forward with the City Hall PV system, the first next step would be a more detailed structural capacity analysis and roof life assessment. While McKinstry believes there may be enough structural capacity to add solar without triggering upgrades, this needs to be confirmed. After this, next steps are a drone survey, development of racking and electrical bid sets, an interconnection application to Xcel, and a subcontractor RFP to get to final pricing.

6. Assumptions, Inclusions, and Exclusions

- Codes and Utility Standards:
 - NEC 2020
 - IBC 2018
 - IFC 2018
 - Xcel Energy Blue Book (7/31/2022 Version)
 - Xcel Energy DG Tech Manual (10/28/2021 Version)
- Tax-exempt
- Prevailing wage
- 10% mechanical attachment count
- No structural upgrades required
- The provided financial model projects that this site will qualify for SPVTOU rate class as its existing Load factor is over 40% (30% is the minimum required amount) and site demand is below 500kW.
- Pricing assumes a portfolio approach; Louisville will move forward with a solar PV system at both the City Services Building and Coal Creek Golf Course.
- Pricing includes payment & performance bond
- Terms & Conditions listed in the Xcel Energy Interconnection Agreement
- Current labor rates
- Modeling:
 - TMY, DENVER INTL AP, NSRDB (tmy3,l) weather file

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- Soiling data from DNV-GL
- Design Loads
 - Wind speed:
 - Risk Category II: 145mph
 - Exposure: C
 - Ground snow load: 30 psf
 - Risk Category II: 1.0 importance factor
- No interconnection upgrade costs
- No grounding transformers
- Major equipment warranties
 - Modules – 12 year Product
 - Modules – 30 year Power Output
 - Inverters – 10 years
 - DAS – 5 years
 - AC Combiners – 5 years
 - LEDs – 5 years
- No extended warranties
- No ongoing DAS Costs
 - Any ongoing fees beyond year 5 are excluded (both Cell Service and Data Subscription Monitoring fees).
- No reroofing or roofing repairs
- No backup generation
- 4' perimeter setback
- Xcel Energy Solar*Rewards C&I Incentives: Tier 1: <250kWac = \$0.04/kWh for 20 years



Appendix

1. Mechanical System Matrix Options
2. Mechanical Decarbonization Scoping
3. Electrical Decarbonization Scoping
4. Structural Scoping
5. Electric Vehicle Charging Narrative
6. Renewables Scoping
7. Cost Estimating

City Hall & Austin Niehoff Cost Estimates

Three sets of numbers are listed below:

1. Cost Delta of Decarbonization – These are the total construction costs minus the replacement costs that would've been spent to replace the existing units with like-for-like fossil fuel units. These numbers represent the true cost of this decarbonization effort.
2. Total Decarbonization Construction Costs – These are the total amounts of money that will need to be allocated for budgetary purposes. The delta between the above numbers and the below numbers represents the cost of decarbonization.
3. Baseline Costs - These are the costs that would be spent to replace the existing gas-based systems with like-for-like gas units.

All numbers are “all-in costs”, including all GC markups, permitting, etc. They are also Rough Order of Magnitude (ROM) numbers, with a +/-20% range. See the “Construction Pricing Context” section in the report body for more detail. All costs associated with the solar PV systems (including the electrical infrastructure to support these systems) are included in the Renewables costs as outlined in a separate section of the Appendix.

Cost Delta of Decarbonization

Decarbonization Delta Costs

City Hall + Austin Niehoff

Scope	Total Cost
Option 1 (Full Electrification)	\$ 1,272,562
Option 2 (Hybrid Electrification)	\$ 360,562

Total Decarbonization Construction Costs

Option 1 (Full Electrification)

Scope	City Hall	Austin Niehoff
	Total Cost	Total Cost
HVAC Ductwork	\$ 502,000	\$ 71,000
HVAC Piping	\$ 116,000	\$ 45,000
Plumbing	\$ -	\$ -
Electrical	\$ 1,085,000	\$ 112,000
Structural	\$ -	\$ -
Total:	\$ 1,703,000	\$ 228,000

Option 2 (Hybrid Electrification)

	City Hall	Austin Niehoff
Scope	Total Cost	Total Cost
HVAC Ductwork	\$ 468,000	\$ 71,000
HVAC Piping	\$ 100,000	\$ 45,000
Plumbing	\$ -	\$ -
Electrical	\$ 223,000	\$ 112,000
Structural	\$ -	\$ -
Total:	\$ 791,000	\$ 228,000

Electric Vehicle Charging

City Hall

Scope	Total Cost
EV Charging	\$ 238,000

Baseline Costs

Gas Like-for-Like Replacement

	City Hall	Austin Niehoff
Scope	Total Cost	Total Cost
Option 1 (Full Electrification)	\$ 598,416	\$ 60,022
Option 2 (Hybrid Electrification)	\$ 598,416	\$ 60,022