Final Commissioning (Cx) Retro-Commissioning (RCx) Policy

Final Policy

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1. Background

On September 4, 2012, the Norwalk City Council approved participation in Southern California Edison's Energy Leader Partnership Program designed to identify and address energy efficiency opportunities in municipal facilities, take actions supporting the California Long Term Energy Efficiency Strategic Plan and increase community awareness and participation in demand side management opportunities. The City applied for and received funding via the Partnership to implement the City of Norwalk's Strategic Plan Strategies Program, which enables the City to establish policies and programs that support energy reduction in municipal facilities and operations. The Strategic Plan Program includes a number of components, an energy benchmarking policy, procurement of a utility manager software program, development of an energy action plan and the implementation of a retro-commissioning (RCx) policy.

In promoting long-term energy efficiency and sustainability efforts in the community, the City of Norwalk is leading by example with their own municipal facilities by implementing a Commissioning (Cx)/Retro-Commissioning (RCx) Policy.

When a building is initially commissioned it undergoes an intensive quality assurance process that begins during design and continues through construction, occupancy, and operations.

Commissioning (Cx) ensures that a new building operates initially as the owner intended and that building staff are prepared to operate and maintain its systems and equipment (California Commissioning Collaborative) as originally designed.

Retro-commissioning (RCx) is a process that seeks to improve how building equipment and systems function together. Depending on the age of the building, retro-commissioning can often resolve problems that occurred during design or construction, and address problems that have developed throughout the building's life. In all, retro-commissioning improves a building's operations and maintenance (O&M) procedures to enhance overall building performance (California Commissioning Collaborative).

2. Purpose and Scope

2.1 Purpose

This policy establishes guidelines and procedures for Cx and RCx that the City of Norwalk will implement. Both Cx and RCx will enable the City to maintain the highest energy performance possible throughout the life of its facilities and energy systems. As a result of this policy, the City of Norwalk will reduce electricity costs, extend equipment life, improve indoor air quality, lower overall maintenance costs, and improve staff comfort and productivity. The City will utilize in-house maintenance and operations staff to complete the procedures corresponding with this policy. If the City should choice too, outside contractors may also be utilized to complete procedures.

2.2 Scope

The Commissioning (Cx)/Retro-Commissioning (RCx) Policy is limited to City-owned buildings or for buildings which the City regularly pays all or part of the annual energy bills as specified by the Public Services Department. In addition the policy is limited to facilities pre-qualified by the City noted in the eligible list noted below. The building systems under this Policy include:

- Central Plant
- Distribution Pumping and Valves
- Domestic Water Systems
- Airside
- Building Management Systems
- Lighting

Facility Name	Address	Square Footage of	Type of Use	Year Built
City Hall	12700 Norwalk Boulevard	38,300	Offices	1965
Arts & Sports Complex	13000 Clarkdale Avenue	26,700	Sports Center	1990
Cultural Arts Center	13200 Clarkdale Avenue	6,067	Recreational Center	1997
Senior Center	14040 San Antonio Drive	21,164	Offices - Meetings - Nutrition	1999
Social Services Center	11929 San Antonio Drive	9,171	Offices	1973
Transportation/Public Services Building	12650 Imperial Highway	20,705	Offices	1999

3. Commissioning (Cx)/Retro-commissioning (RCx) Policy Statement

The policy of the City of Norwalk is to ensure:

3.1 All new facilities, facility equipment, and energy systems are commissioned prior to being placed in service in accordance with the appropriate manufacturers' operations manuals and other appropriate standards and guidelines addressed in the Norwalk Cx/Rx Procedures Guide.

3.2 All existing facilities and/or energy systems are retro-commissioned in accordance with the appropriate manufactures' operations manuals and other appropriate standards and guidelines addressed in the Norwalk Cx/Rx Procedures Manual.

3.3 All facilities and equipment will undergo ongoing commissioning through the development and implementation of improved operations and maintenance procedures to be conducted by either City staff or maintenance contractors under the direction and supervision of City staff.

3.4 Training is made available to appropriate City staff to increase the necessary knowledge and skill sets to expand in-house capacity to participate in commissioning activities. Continuous training when available will allow City staff to have a greater understanding and ability to leverage enhanced operations and maintenance (O&M) practices to maintain facilities and energy systems at their optimum level of energy performance (hence lowest operational costs).

3.5 Periodically monitor and track Retro-commissioning/O&M activities performed on facilities through the use of the City's ENERGY STAR Portfolio Manager Took or the City's EnergyCAP Software System.

4. Policy Timeline and Frequency

4.1 Commissioning Timeline

Building commissioning shall be included in the design and construction processes of the building project to verify that the building systems and components meet project requirements, for new City-owned buildings consisting of 10,000 square feet and above. (See Section 5.410.2 Commissioning, 2010 California Green Building Standards Code in Guide)

4.2 Retro-commissioning Timeline

The City shall implement appropriate system modifications and energy efficiency projects identified in the policy into the existing eligible facilities within the next five (5) years, depending on funding and staff resources at the discretion of the Public Services Department.

4.3 Retro-commissioning Frequency

All facilities shall be retro-commissioned continuously through the implementation of enhanced O&M conducted by either City staff or outside contractors. Eligible City facilities shall be retro-commissioned at least every five (5) years, but it is recommended that retro-commissioning inspections be conducted annually to ensure systems are performing at optimum levels.

5. Cx/RCx Responsibilities

4.1 The Public Services Department is responsible for ensuring compliance of the Cx/RCx policy.

4.2 The Deputy City Manager/Public Services Director is responsible for management oversight of the Cx/RCx process and will ensure adherence to the policy.

4.3 The Public Services Department is responsible for managing the operational aspects of the policy and will ensure that:

4.3.1 Any additional City-owned buildings that the City of Norwalk acquires comply with the Cx/RCx Policy.

4.3.2 Appropriate staff are assigned to support Cx/RCx procedures and are adequately trained to perform the RCx procedures.

6. Commissioning (Cx) Procedures

6.1 Overview

The term commissioning comes from shipbuilding; a commissioned ship is one deemed ready for service. Before being awarded this title, however, a ship must pass several milestones. Equipment is installed and tested, problems are identified and corrected, and the prospective crew is extensively trained. A commissioned shop is one whose materials, systems, and staff have successfully completed a thorough quality assurance process.

Building commissioning takes the same approach to new buildings. When a building is initially commissioned it undergoes an intensive quality assurance process that begins during design and continues through construction, occupancy, and operations. Commissioning ensures that the new building operates initially as the owner intended and that building staff are prepared to operate and maintain its systems and equipment (California Commissioning Collaborative).

6.2 Applicable Cx Standards

The following commissioning documents provide the standards that guide the Cx/RCx Policy for commissioning activities and are provided in the Norwalk Cx/RCx Procedures Guide:

- ASHRAE.90.1.ip.2010.pdf
- CA_Commissioning_Guide_New Bldgs.pdf
- 2010 California Green Building Standards Code (CALGreen)

6.3 Procedure

Request for proposals (RFP) for design and construction teams for new facilities and equipment providers requires adherence with current Cx standards (See Applicable Cx Standards in Guide).

7. Retro-commissioning (RCx) Procedures

7.1 Overview

Retro-commissioning (RCx) is the application of the commissioning process to existing buildings. RCx is a process that seeks to improve how building equipment and systems function together. Depending on the age of the building, retro-commissioning can often resolve problems that occurred during design or construction, or address problems that have developed throughout the building's life. Retro-commissioning improves a building's O&M procedures to enhance overall building performance

RCx identifies low-cost O&M improvements so that owners can achieve the building's original design and performance intentions. The benefits of RCx include the following:

- Increased asset value
- Reduced operational costs
- Advanced building performance
- Substantial energy savings

- Comprehensive building documentation
- Improved indoor environmental quality
- Expanded O&M staff capabilities and expertise
- Enhanced systems operations (beyond preventive maintenance)
- Improved equipment performance and extended life
- Identification and solutions to building systems, controls, and maintenance problems

RCx of building systems and controls enhances capital project delivery. This policy will reduce the facilities energy consumption and elongate the effective useful life (EUL) of the mechanical equipment in the buildings systems. This Policy is aimed to support the City's continued effort to increase energy efficiency in municipal stock and enhance their sustainability programs.

7.2 Applicable RCx Standards

The following commissioning documents provide the standards that guide the Cx/RCx Policy for retro-commissioning activities and are provided in the Norwalk Cx/RCx Procedures Guide:

- ASHRAE.90.1.ip.2010.pdf
- CA_Commissioning_Guide_Existing Bldgs.pdf
- RCx_PolicyManual.pdf

7.3 Procedure

The City shall determine which RCx measures are applicable for the facilities systems (refer to section 8, Retro-Commissioning Measures). These measures shall be implemented while adhering with current RCx standards (See Applicable RCx Standards in Guide). City staff or outside contractors shall perform functional tests on mechanical equipment to determine the current condition of the equipment.

8. Retro-commissioning (RCx) Measures

This report focuses on the six major areas that require retro-commissioning within a building.

- **Central Plant (Blue)**
- **Distribution Pumping and Valves (Purple)**
- **Domestic Water Systems (Green)**
- **Airside (Red)**
- **Building Management Systems (Gold)**
- **Lighting (Orange)**

Color coded for the convenience of the prospective implementer.

(See Staff Training Report for additional information on systems descriptions per facility, and see Norwalk Cx/RCx Procedures Guide for additional explanation on Procedures and for equipment checklists.)

8.1 Central Plant

This section is only applicable for buildings with central plants. The only existing facility with a central plant is City Hall which contains a York air-cooled chiller (See Staff Training Report for Procedures and Checklists). In the future, if the City acquires a building that contains a central plant and qualifies under the RCx eligible building criteria, the City will follow these measure procedures.

8.1.1 Chillers

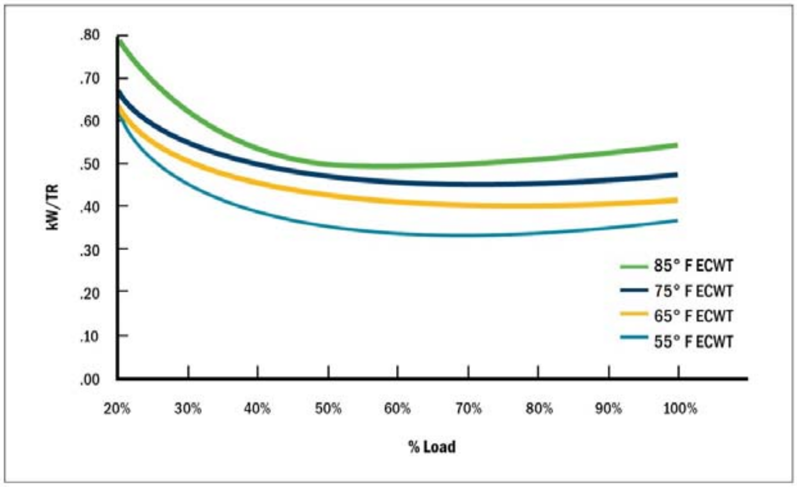
These measures are only applicable if the City acquires buildings in the future with the following systems.

8.1.1.1 Re-Sequence Chiller Operation

On average, central plants are designed with two chillers that have identical capacity/tonnage and operate in a lead/lag configuration. When the cooling load exceeds the capacity of a single chiller, as determined usually by the chilled-water return temperature, the second chiller is brought online.

Centrifugal chillers, especially machines with variable-frequency drives (VFDs), operate most efficiently at part loads ranging between 40% and 80% of their full load capacity. See Figure 5, reproduced from Johnson Controls HVAC&R Engineering Update 2009.

Figure 5. Average Water-Cooled Centrifugal Chiller Energy Performance



This measure recommends that the chiller operation sequence be revised so that both chillers are used whenever possible. When the load exceeds 60% of the capacity of a single chiller, the second chiller is brought online and both machines operate at 30% of their capacity. This proposed sequence will enable the chillers to operate at a more efficient point on their curve.

This control sequence will improve overall plant efficiency and provide significant energy savings.

8.1.1.2 Chiller Compressor

Chillers have a single centrifugal compressor with a constant-speed motor. Currently, at part load conditions, the chiller unloads by using its built-in inlet guide vanes which throttle the refrigerant flowing to the compressor. This reduces the operating efficiency of the chiller.

Retrofitting the existing constant speed compressor with a variable-frequency drive (VFD) allows the compressor motor to slow down at low loads while keeping the inlet vanes as open as possible to maintain a high operating efficiency. These operations allow the variable-speed drive chiller to be able to adjust to the varying load and will have improved part-load efficiency. During periods of low load conditions this proposed measure will save energy, especially in winter and at night.

8.1.2 Cooling Towers

These measures are only applicable if the City acquires buildings in the future with the following systems.

8.1.2.1 Cooling Tower Optimization / Re-Sequencing

This measure proposes to improve cooling tower sequencing to enable an additional cooling tower that is optimized for the given cooling load and ambient conditions. Implementation of an additional cooling tower allows the cooling tower fan VFDs to back-off, thus taking advantage of the favorable variable frequency fan motor power curve for net savings in cooling tower fan energy. Additionally, this will allow condenser water temperatures to be reduced (but not below chiller tolerances). The chillers take advantage of low condenser water temperatures that improve chiller efficiency. Condenser water temperature will be optimized by setting to the cooling tower approach temperature (about 5°F to 7°F) above the ambient wet-bulb temperature. This sets condenser water temperatures to as low as can be achieved given the ambient conditions.

Chiller efficiency improves significantly at lower condenser water temperature. By reducing the "lift" required by the compressors, chiller efficiency increases by approximately 1.5% for every 1°F reduction in condenser water supply temperature (CWST). This recommendation will be accomplished through a new sequence of operation programmed in the building management system (BMS). The BMS is equipped with all required control points to implement this strategy.

8.1.3 Waterside Economizer

These measures are only applicable if the City acquires buildings in the future with the following systems.

When a facility is located in a mild climate zone where there are a significant number of hours containing cool outdoor air temperatures the cooling tower is optimized to generate cold enough water (55°F and lower). Cold water is sent directly to the air-handler and fan coil unit, cooling coils for space cooling, bypassing the central plant chillers, and then a waterside economizer can be implemented.

This measure recommends that a Plate-and-Frame heat exchanger be installed on the condenser water between the cooling tower and the chiller. This waterside economizer shall be operated as the first stage of cooling. Also included in this measure is the addition of controls which can "lockout" the central plant whenever the outdoor temperature permits the use of the free cooling system.

8.1.4 Resets

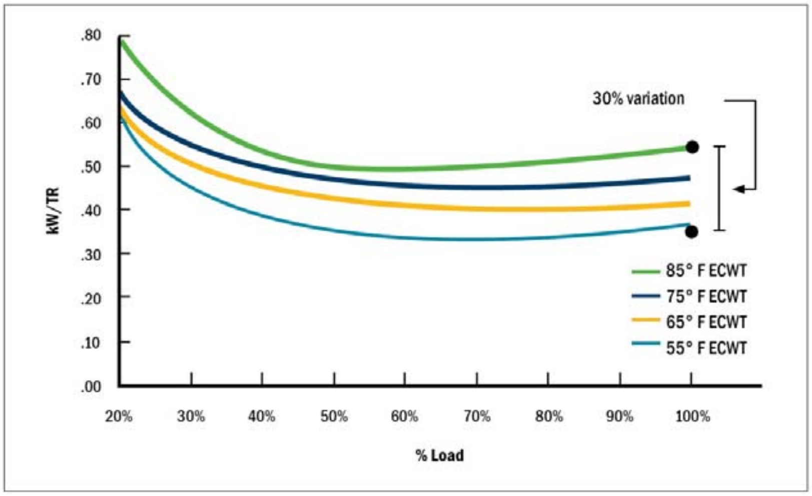
These measures are only applicable if the City acquires buildings in the future with the following systems.

8.1.4.1 Condenser Water Supply Temperature Reset

If the central plant chillers are water-cooled machines that use a cooling tower for heat rejection then a condenser water supply temperature reset strategy needs to be implemented. A performance characteristic of chillers is that they provide improved efficiency when condenser water is supplied to them at lower temperatures. The lower-temperature condenser water allows for improved heat rejection from the working refrigerant to the water.

This principle is shown clearly in Figure 6, from *Johnson Controls HVAC&R Engineering Update 2009*.

Figure 6. Chiller-Efficiency Changes with Variable



Head

The energy savings that comes from improving the chiller efficiency more than offsets the increased cooling tower fan energy use.

8.1.4.2 Chilled Water Supply Temperature Reset

Typical facility chilled-water central plants supply chilled water to support the air-handling units at a constant temperature of 45°F. At their discretion, the building engineers and operators may raise or lower the chilled-water supply temperature set point based on a specific need or to respond to an anticipated weather event.

This measure recommends that the chilled-water supply temperature be varied to reflect the actual building cooling demand. As the cooling load in the building varies throughout the day, and occupancy and equipment loads vary, the chilled-water coil valves modulate to allow for more or less cooling. This modulation can be used to approximate and understand the building cooling demand and, as the cooling demand increases, the chilled-water set point can be lowered. Further, as the cooling demand decreases and less cooling is required; the chilled-water supply temperature can be increased.

If this measure is implemented, the central plant water-cooled chillers will consume less energy by providing a higher chilled-water supply temperature, resulting in significant energy savings over the course of a year, and throughout its effective useful life (EUL).

8.1.4.3 Implement Heating Hot Water Supply Temperature Reset Strategy

Typical heating hot water boiler systems provide hot water for HVAC heating at a temperature of 180˚F. This measure recommends that the maximum heating hot water supply temperature of 180˚F be provided only when the facility is experiencing peak heating loads such as during winter and night time hours.

During the summer months and the shorter months of March, April, and October, the heating hot water supply temperature (HWST) can be decreased from a high of 180˚F to 140˚F on a sliding scale based on outdoor temperature (OAT). This proposed measure will provide energy savings at the HVAC heating plant.

The measure is implemented by including an additional logic in the existing BMS.

8.1.5 Boiler Circulation Pump

This measure should be implemented when a boiler has a circulation pump equal to or higher than 2hp. This measure should also be implemented on any existing pool or spa circulation pumps.

There are no facilities in the City of Norwalk eligible facilities list that have boilers with a circulation pump above 2hp. The Norwalk Aquatic Pavilion does have a 20hp circulation pool pump, but the Aquatic Pavilion is not on the eligible facility list. Therefore this is guidance for the City of Norwalk to consider for any circulation pump above 2hp for eligible facilities.

This measure recommends installing a variable speed driven pump or adding a VFD (variable frequency drive) to an existing pump, which can vary its output power to match the required flow rate and pressure, resulting in energy savings.

8.2 Distribution Pumping and Valves

These measures are only applicable if the City acquires buildings in the future with the following systems. There are currently no facilities on the eligible facilities list in Norwalk that qualify for these measures.

8.2.1 Chilled Water Pump (CHWP)

Primary pump VFDs are able to be controlled to reduce chilled-water (CHW) primary loop flow rates in response to cooling load and secondary loop flow rates. This measure reduces bypass of chilled water and mixing with return water. In addition to energy savings resulting from part-load operation of the primary chilled water pumps, higher CHW return temperatures back to the chillers improve their efficiency. To optimize the system, for example, one primary pump can operate up to 60% or 70% of full load, above which two pumps with VFDs will run simultaneously. When speeds of the two pumps reach 60% to 70%, the third pump with VFD will be enabled. The fourth pump without a VFD remains as back-up. This strategy takes advantage of the favorable VFD part-load pump power curve.

8.2.2 Condenser Water Pump (CWP)

The condenser water pumps VFDs will be controlled based on the chiller demand and minimum required condenser-water flow rates, within chiller condenser flow rate tolerances. Similar to the primary chilled water pump control sequence example, one condenser pump can operate up to 60% or 70% of full load, above which two pumps with VFDs will run together. When speeds of the two pumps reach 60% to 70%, the third pump with VFD will be enabled. The fourth pump without a VFD remains as back-up.

8.2.3 Hot Water Pump (HWP)

Implementation of variable-frequency drives (VFDs) on the hot water loop controls converts from the constant flow/speed operation to variable. The temperature differential between the heating hot-water supply water temperature and the return water temperature can be used as a control signal for the VFD. Energy savings will be realized during times when the building heating load is less than design heating capacity, allowing the pumps to provide reduced flow.

8.2.4 3-Way to 2-Way Valves

Three-way valves operate to bypass excess flow, which causes the pumps to circulate the same quantity of chilled water and consume excessive energy. Therefore, if you cap off one of the valves and have a two way valve that circulation is reduced and thus saves energy.

8.2.5 Control Shut-Off Valves

When there are no zone controls or shutoff valves installed at the heat pumps there is no control over water flow through their coils when off. Variable-speed drives are unable to vary the actual flow rate in the system.

This measure recommends that new zone control valves be installed at each heat pump. These valves will be connected to the heat pump and will close when the unit is off. It is also recommended that a pressure sensor be installed in the condenser water loop piping to provide a control signal to the existing variable-speed drive. The VSD can then be controlled to maintain a pressure set point and allow the pumps to adjust according to the building load. This will result in energy savings whenever the cooling load is at less than design capacity.

8.3 Domestic Water System

8.3.1 Domestic Water Booster Pumps (DWP)

This measure should be implemented when funding allows.

Installation of VFDs on these pumps with controls will modulate the pump speed to maintain domestic water system pressure and results in the pumps operating at reduced load rather than cycling and accumulating energy savings. There are no domestic water booster pumps in the eligible facilities list, therefore this measure is only for future Norwalk facilities.

8.3.2 Insulate Exposed Hot or Chilled Water Piping

This measure should be implemented where applicable when funding allows.

Insulating exposed hot water piping and/or chilled water piping will result in energy savings and improved building performance. When insulation deteriorates, or does not exist, additional gas usage is required at the heater to account for the losses, or additional cooling is required to account for the heat gain in pipes. If leaks are present, some of the heated water/steam is lost, requiring additional gas burned at the heater. Both issues lead to additional natural gas cost and excess electricity usage. It is recommended to insulate the hot water/steam piping to mitigate heat loss and leaks, or insulate the chilled water piping to mitigate heat gain.

The Norwalk City Hall contains a central plant and therefore chilled water and hot water piping exist.

8.3.3 Replace Domestic Water Heaters with High-Efficiency Units

This measure should be implemented when a hot water heater is being replaced.

It is recommended that facilities containing hot water heaters approaching the end of their effective useful lives (EUL), be replaced with high-efficiency condensing-type water heaters. New units are capable of combustion efficiencies of 88% up to 97%; high-efficiency water heaters utilize effective internal heat exchangers and modulating burner firing rates to match domestic water load requirements and achieve higher thermal efficiencies.

The following facilities contain domestic water heaters; Arts and Sports Complex - NASC, Senior Center, and the Social Services Center. It is recommended that this measure be implemented in all eligible facilities, and if possible in any facility owned by the City of Norwalk.

8.4 Airside

The airside of a building can contain different types of HVAC (Heating Ventilation and Air Conditioning) equipment such as; Air Handling Units (AHUs), Package Air Conditioning Units, Package Terminal Air Conditioners (PTAC's), Package Terminal Heat Pumps (PTHPs), Split System Direct-Expansion Units with outside condenser, etc. See Staff Training Report, section 8, Various Types of AC Systems, for an explanation of each type of AC system.

All measures in this section shall be implemented if applicable to facility. (See Staff Training Report for description of Airside equipment per eligible facility, which contain more procedures and checklists)

8.4.1 Economizers

8.4.1.1 Repair/Replace Inoperative Economizer Dampers in AHUs

The use of free cooling through airside economizers is vital for energy efficiency and building performance. Airside economizers allow for the use of cool outside air to offset mechanical cooling for significant times during the day and throughout the year.

An economizer functions by introducing fresh outside air for cooling when outside air temperature is lower than indoor return air temperature. The existing system allows more energy to be used to cool the return air; therefore it is more efficient to introduce outside air.

However, this energy efficient system is dependent on the proper functioning of the outside air, mixed air and return air dampers. If any of these damper actuators are not fully functional then the economizer will not operate properly and may result in excessive energy use. As such, it is critical that any malfunctioning air-handling unit dampers actuators be repaired or replaced, and any damaged dampers be upgraded to ensure the full functionality of the economizer systems. Upgrading or repairing these dampers and actuators will provide significant energy savings.

The following Norwalk facilities have economizers; Arts and Sports Complex – NASC, and the Transportation Public Services Building specifically HP-1. No other eligible facilities have economizers.

8.4.2 Resets

The measures in this section will need further investigation to identify which airside units in eligible facilities will be suitable for these various types of resets.

8.4.2.1 Static Pressure

This measure calls for resetting the fan static pressure set point dynamically for the AHUs based on actual zone demands. In other words, the static pressure set point shall be adjusted to provide a signal to the supply fan to then vary its airflow. This signal may either be the damper signal if modulating actuators are used, or estimated based off damper position. Modulating actuators rely on zone level direct-digital-control (DDC) and feedback from the variable-air-volume (VAV) controllers indicating VAV box damper position. Otherwise the signal is an estimate of damper position based on timing open/close signals if floating actuators are used.

This measure is paired with having a VFD installed on the fan so that the VFD can ramp up or down depending on the demands of the zone. This information is fed to the VFD via the static pressure reset.

8.4.2.2 Supply Air Temperature

Unless overridden, the air handlers respond currently to cooling demand by supplying air at near design supply-air temperatures (SAT)— between 55°F and 60°F typically. The low cooling supply-air temperature of 55°F is needed only during design conditions where building zones are experiencing peak cooling loads. At other times, a SAT greater than 55°F is sufficient to meet the reduced cooling loads in the spaces. This measure recommends re-setting the supply-air temperature upward that is contingent on outside air temperature (OAT) and the schedule below, as well as providing SAT at 55F when peak cooling is required.

- Air handler SAT: 55°F when OAT is 80°F or above
- Air handler SAT: 65°F when OAT is 60°F or below

This revised sequence will provide significant energy savings with the benefit of steam savings from reduced reheat energy use, thereby improving overall building operation.

8.4.2.3 Air-Handler Optimum Start

An air-handler optimum start system determines the most appropriate time based on the current indoor temperatures in the various spaces. When conditions are met to enable the air-handling unit (AHU) it works to achieve the acceptable space temperature set points prior to occupancy.

A BMS can be programmed to shut down the AHU supply and return fans; when all zones supplied from a particular AHU are scheduled to be in unoccupied mode, if none of the zones are overridden to occupied mode by an after-hours occupant. An optimal start with morning warm-up/cool-down strategy can be programmed into the BMS to enable the systems to achieve the required space temperatures for morning occupancy. The start-times will vary based on ambient and interior temperatures. Mixed air dampers will be closed or shut during morning optimal start cycles, based on the ambient and interior space temperatures. Implementing an optimum start sequence minimizes the system's pre-occupancy operation time and saves energy.

8.4.2.4 Air-Handler Night Setback

For systems where the air-handlers are required to operate 24 hours a day, this measure calls for the AHUs temperature set point to be set back at night. Because cooling loads are lower at night, a simple adjustment of temperature set point will provide energy savings for the facilities.

8.4.3 Variable Air Volume (VAV) Boxes

8.4.3.1 Recalibrate VAV Box Dampers

It is recommended that all of the variable-air-volume boxes be reviewed on the controls system and their various parameters be investigated to identify any issues. If a lack of consistency is observed between the damper position signal and the actual measured airflow in cubic feet per minute (CFM), then the boxes will require recalibration to ensure their airflow output matches their damper position signal.

This measure would be easier to implement with a BMS. BMS are equipped to identify which VAV box dampers are not moving or are not at the correct position when a command is given to the box to either reduce or increase airflow to the space. Without a BMS this measure would need further investigation to identify which VAV boxes need recalibrating. This measure is applicable for any eligible facility with VAV boxes.

8.4.4 Variable Frequency Drives (VFD's) / Variable Speed Drives (VSD's)

If variable speed drives (VFDs), also known as variable frequency drives (VFDs), are installed on the air-handling unit (AHU) fans, they need to be checked to ensure units are working as intended, and reflect the actual varying of the speed of the fan.

The VFDs are controlled by a static pressure signal in order to vary fan speed. Recalibrating or replacing the static pressure sensors and re-commissioning drives on air-handlers that are not working as intended will reduce the overall airflow quantity and will provide significant energy savings.

No eligible facilities with VFDs were identified in Norwalk building stock; therefore this measure is for future installments of VFDs.

8.4.5 Filters

8.4.5.1 Proper Filter Replacement: Implement a Schedule

Filter replacement scheduling is important to track the replacement of filters before they become "dirty" (or surpass the filters lifespan) and help save energy. Dirty and clogged filters increase the static pressure drop experienced by supply fans causing them to deliver less airflow and use more energy. This measure recommends that filter replacement on all units be tracked and scheduled and that the schedule be followed to ensure that filters are replaced prior to their becoming listed as "dirty", at which point they are no longer effective.

This measure shall be implemented in all eligible facilities to develop and follow a filter schedule, based on the EUL of the filter per airside unit.

8.4.6 Fans

8.4.6.1 Supply Fan

This measure should be implemented on supply fans if and when funding allows at the discretion of the Public Services Department.

The supply fan pushes supply air from AHU to the occupied space. This measure recommends the installation of a VFD control to vary the fan's speed and thus power consumption; the fan will vary based on load in the zones it supplies. The VFDs are controlled by a static pressure signal in order to vary the fan speed. VFDs will reduce the overall airflow quantity and will provide significant energy savings.

8.4.6.2 Return Fan

This measure should be implemented on return fans if and when funding allows at the discretion of the Public Services Department.

Return fans pull air from the occupied space back through AHU. This measure recommends the installation of a VFD control to vary the fan's speed and thus vary power consumption. VFDs are controlled by a static pressure signal in order to vary fan speed and will reduce the overall airflow quantity and will provide significant energy savings.

8.4.6.3 Kitchen Exhaust Fan

This measure should be implemented on kitchen exhaust fans if and when funding allows at the discretion of the Public Services Department.

Kitchens with higher cooking hours should take priority over kitchens with lower number of cooking hours. If kitchens have low hours of cooking time, then this measure is simply a suggestion. Exhaust fans push unwanted air from a building to the outside environment, and prevents the reused o fair in airside equipment.

Fans used in kitchen exhaust hoods can have VFD controls attached that will allow the circulation of air while kitchen hood is in use. New variable kitchen-hood-control systems adjust the exhaust fan speed according to temperature, smoke and steam, increasing or decreasing fan speed according to cooking activity. These systems also connect to makeup-air (MUA) kitchen units to coordinate fan speeds and supply-air volume.

The longer a kitchen is in use and the greater the cross-sectional area of the hood(s), the more beneficial a variable-kitchen-hood control is. Implementing variable exhaust controls will achieve maintenance cost savings and improve kitchen indoor air quality. Installing VFDs will reduce the overall time that a fan runs based off kitchen hood usage providing significant energy savings.

8.4.6.4 Cooling Tower Fan

At this time, no eligible facilities with cooling tower fans were identified in Norwalk building stock; therefore this measure is for future installments.

The cooling tower fan is used specifically to cool the temperature of water in the cooling tower. This fan can have a VFD control attached; VFDs on fans are controlled by the condenser water supply temperature sensor signal in order to vary the fan speed and reduce water temperature to a desired set point. VFDs will reduce overall time that a fan runs based off of cooling loads and will provide significant energy savings.

8.4.7 Building Envelope

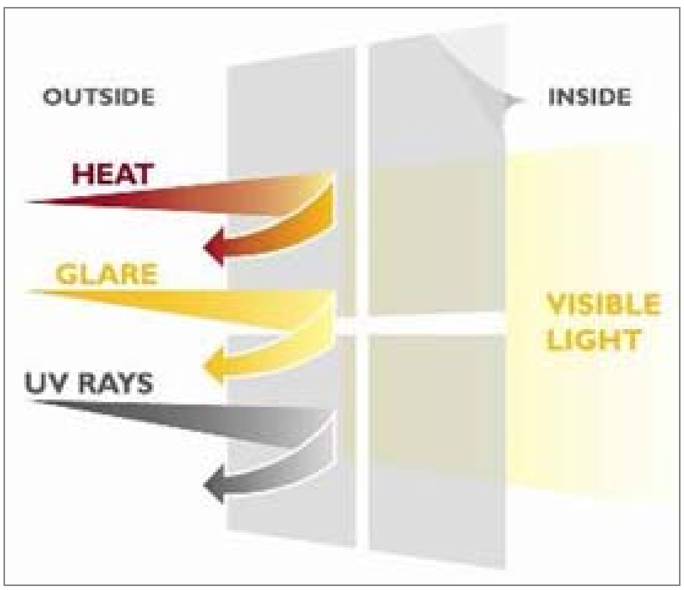
8.4.7.1 Install High-Performance Window Film

This measure should be implemented for windows if and when funding allows at the discretion of the Public Services Department.

The following facilities have window film the Senior Center, and the Transportation/Public Services Building. Window film should be replaced when a noticeable amount of heat is entering into the space through the windows resulting in the lack of effectiveness of the film when this is occurring then a tint with a higher solar heat deflection should be installed.

Building glazing (the use of windows in buildings) permits views and sunshine to enter facilities and reduce the need for artificial lighting. Under existing conditions daylight means more heat that requires cooling to keep occupants comfortable. Window film is one way to reduce solar heat gain and improve the energy efficiency of a building; solar control window film may be applied to the interior surface of the glazing to reflect the solar radiation that produces heat. Installing high-performance window film on the building's glazing will reduce solar heat gain. In addition to reducing the need for cooling, window film helps create an even, comfortable temperature throughout the building. High-performance window film will reduce the heat gain into spaces and results in reduced cooling loads.

Figure 11. Solar Heat Deflection with Window Film



8.5 Building Management System (BMS)

Implementation of a sophisticated Building Management System (BMS), also known as an Energy Management System (EMS), ensures that a facility is operating at its fullest potential and is equipped to realize the highest possible amount of energy savings. All mechanical devices, including VFDs/ VSDs, resets, sensors and controls in a building can be connected to a BMS.

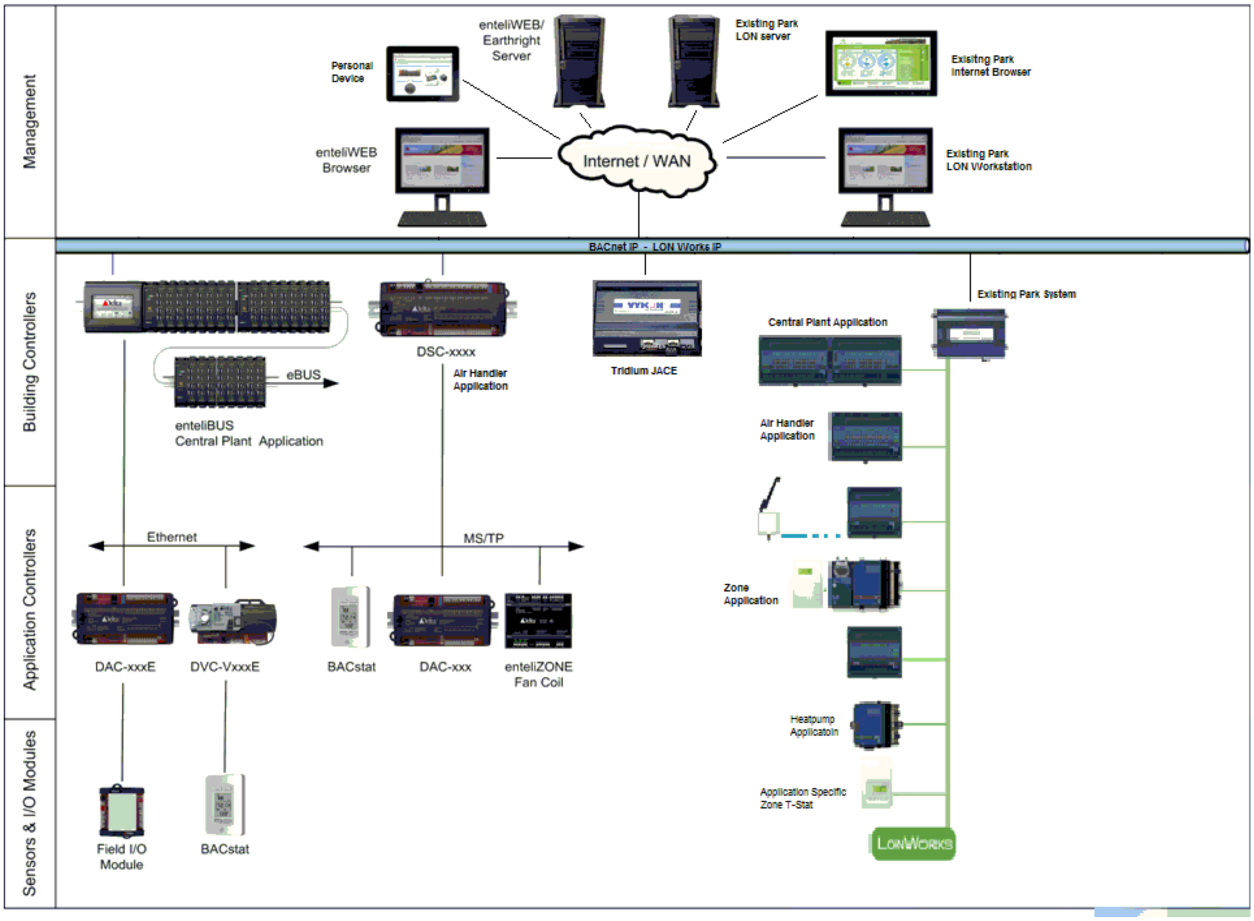
The following measures do not qualify under the list of eligible facilities (noted below), because none of the facilities contain a Building Management Systems (BMS). It is suggested that all eligible Norwalk facilities should consider the installation of a BMS when funding allows. This system will greatly increase energy savings for these facilities.

Facility Name	Address	Square Footage of	Type of Use	Year Built
City Hall	12700 Norwalk Boulevard	38,300	Offices	1965
Arts & Sports Complex	13000 Clarkdale Avenue	26,700	Sports Center	1990
Cultural Arts Center	13200 Clarkdale Avenue	6,067	Recreational Center	1997
Senior Center	14040 San Antonio Drive	21,164	Offices - Meetings - Nutrition	1999
Social Services Center	11929 San Antonio Drive	9,171	Offices	1973
Transportation/Public Services Building	12650 Imperial Highway	20,705	Offices	1999

8.5.1 Controls

There are many different types of controls a facility may have, if possible all controls should tie into a BMS to communicate to the user how a building is operating. The following is an image showing the different levels of controls a building could have.

Figure 11. Solar Heat Deflection with Window Film



When controls tied to a BMS are not working effectively City staff should work with their controls contractor or manufacture and to address any issues.

8.5.2 Sensors

Building automation is only as good as the data it receives from controls and sensors, it is critical for facility maintenance for sensors to be in proper working order at all times. Sensors need to be recalibrated periodically to insure that they are working to their full potential as a means to achieve maximum energy savings. If a facility operates with a BMS, all sensors in the building should be connected to the BMS, if a malfunction occurs the system visibility may provide the user with an indication a sensor may not be working as intended. It is important all sensors working in conjunction with the BMS undergo calibration, recommended calibration intervals vary per equipment. The following measures are the various sensor types that are often tied to a BMS.

8.5.2.1 Recalibrate Temperature Sensors in Air-Handling Units

Temperature sensors and the readings they provide are the foundation for control in an HVAC system. The programmed controls logic relies on the sensor input values being reliable and consistent. This measure recommends that temperature sensors in the HVAC system be recalibrated to provide accurate and reliable readings. If the facility has a BMS all temperature sensors in the building should be connected to the system.

8.5.2.2 Recalibrate Relative Humidity (RH) or Enthalpy Sensors in Air-Handling Units

Temperature sensors and the readings they provide are the foundation for control in an HVAC system. The programmed controls logic relies on the sensor input values being reliable and consistent. This measure recommends that the Relative Humidity (RH) or Enthalpy sensors in the HVAC system be recalibrated to provide accurate and reliable readings. If the facility has a BMS all RH or Enthalpy sensors in the building should be connected to the system.

8.5.2.3 Recalibrate Differential Pressure Sensors in Air-Handling Units

Sensors need to be checked periodically to ensure they're working effectively, when sensors are not working correctly they need to be recalibrated. The static pressure sensors that are installed to provide a controls signal for the variable speed drives (VFDs) and also for the filter differential pressure, need to be inspected periodically and always working correctly. If they are not then the drives cannot run the AHU equipment adequately.

This measure recommends that the static pressure sensors in the AHUs be recalibrated if working inadequately to provide accurate and reliable readings. If the facility has a BMS all pressure sensors in the building should be connected to the system.

8.5.2.4 Recalibrate Demand Control Ventilation with Carbon Dioxide (CO_2) Sensors

This measure recommends assessing the efficiency of demand control ventilation strategy at system level, or recalibration of the CO_2 sensor in the AHU return ducts. Each sensor measures and monitors the CO_2 level within the building, and will vary the quantity of outdoor fresh air to maintain a space set point between 450–500 parts per million of CO_2 concentration. If the sensor appears to be working inadequately, it is recommended to review the current controls logic to integrate economizer and ventilation control properly. The logic can also be revised to include a space "flush-out" during unoccupied hours which will help to reduce the accumulated CO_2 levels daily. If the facility has a BMS all CO_2 sensors in the building should be connected to the system.

8.6 Lighting

These measures should be implemented when existing lights are no longer operational and need to be replaced throughout facilities when funding allows. These measures apply to all of City of Norwalk's eligible facilities, and are suggests for any facility owned by the City of Norwalk.

8.6.1 LED's

Light sources provided by LEDs (Light Emitting Diode) produce similar light output with notably less energy consumption compared to conventional lighting systems (less than 50% of the energy consumption). Additionally, LED technologies allow for lamps to operate up to and beyond 100,000 hours, which is roughly five times that of standard metal halide lamps. This translates to further savings realized through maintenance cost reductions. Savings are also realized by decreasing the fixture life-cycle cost.

8.6.1.1 Energy Star Certified Lamps and Fixtures

To qualify for incentives through utility incentive programs when replacing existing lamps with LEDs. The selected LED fixtures must be the approved product lists. Such lists are available from lighting industry Design Light Consortium, from the utility (SCE), or the federal Energy Star program. These lists are updated frequently and should be monitored for incentive availability and applicability.

8.6.2 Sensors

These measures should be implemented for all Norwalk facilities if and when funding allows at the discretion of the Public Services Department.

8.6.2.1 Occupancy Sensors: Motion Sensors and CO_2 Sensors

Occupancy sensors reduce energy usage by reducing the "on" time of the lights under their control. Sensors turn the lights on when they detect occupancy in an area (using motion sensors or CO_2 sensors) and turn lights off within a specified time after sensing the room is empty. These sensors are best suited in spaces that are used infrequently or unpredictably and can be mounted on walls or installed in ceilings.

For those facilities which currently have occupancy sensors installed, sensors should be tested to ensure that they are working properly. If sensors are not working properly they need to be repaired or replaced. For facilities which do not currently have occupancy sensors, sensors should be installed when funding allows.

Figure 16. Typical Occupancy Sensors

8.6.2.2 Daylight Harvesting Sensor: Photocell

This measure recommends that daylight harvesting controls be installed to take advantage of the natural daylight in any applicable occupied space throughout facilities; whether that is in offices and conference rooms, or lobbies and corridors. Photo-sensors would be installed within these spaces to detect the overall illumination levels within the space. Lights would dim and the natural ambient light entering the space would be available to maintain the desired illumination levels. Daylight harvesting sensors need to be tested periodically to ensure they are working properly. When sensors are not working properly, they need to be repaired or replaced.

8.6.2.3 Time Clocks

There are numerous time clocks throughout Norwalk facilities which control exterior lights. These existing time clocks are set to have exterior lights turned on from dusk till dawn.

This measure recommends that astronomical time clocks be installed to control the exterior lighting in place of current standard time clocks. Astronomical time clocks are programmed to account for the changes in daylight/nighttime hours. In Southern California, the time from sunrise to sunset varies by about five hours per day during the course of a year. Therefore, current lights may be turned off for additional hours per year with astronomical clocks, than if left on a standard time clock. Utilizing astronomical time clocks would also reduce, or perhaps eliminate, the time necessary for employees to manually adjust the various time clocks on facilities throughout the year.

Standard manual time clocks and astronomical time clocks, need to be checked periodically to ensure they are working properly. When astronomical time clocks are not working properly they need to be repaired or replaced. All standard manual time clocks that do not have an on/off tab installed on timers need to be equipped with the on/off tab otherwise the time clock is unserviceable.

For facilities which are not outfitted with standard manual time clocks or astronomical time clocks, an astronomical time clock should be implemented for exterior lighting when funding allows, unless lighting throughout the building is connected to a BMS for maximum energy management.

Figure 36: Standard Manual Time Clocks

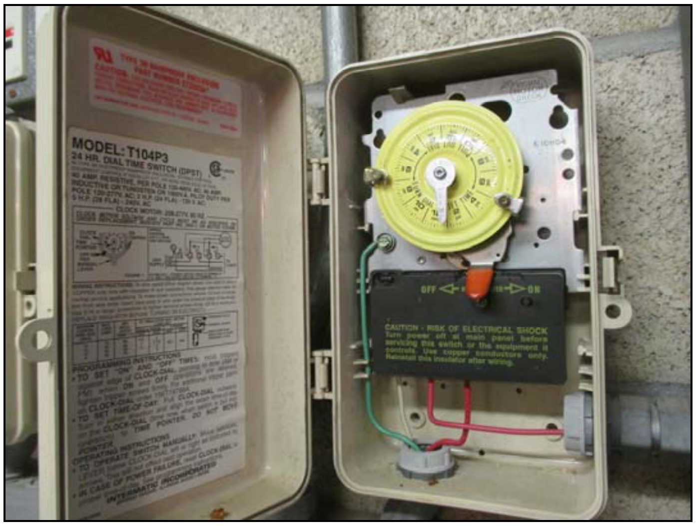


Figure 41: Astronomical Time Clock

9. Staff Training

The comprehensive training program for maintenance and operations staff is focused on specific equipment and systems. The facilities maintenance and operations supervisors and staff will undergo training and use resources provided in the Norwalk Cx/RCx Procedures Guide.

Training provides explanations on system changes performed by facility staff who are responsible for continued maintenance and operations of equipment and the derived savings which are realized after procedures are implemented. The training also provides staff with the best opportunity to learn about how issues are identified and remedied, as well as new potential sequences of operation for major systems that are in operation.

The City is advised to provide staff with continued training in the future for all aspects of building maintenance and operations. Proper training will ensure that facilities are operating in the way they were intended, and that the current needs of occupants are met by the available systems. Although, the implementation of this policy may have some future challenges such as meeting design standards, time limitations, availability of facility drawings, equipment information, budget constraints and limited staff resources; the benefits of continued improvements in O&M procedures significantly improve building performance and reduce overall energy usage.

9.1 List of Training Sessions and Topics

Staff training includes training on the following building systems:

- Central Plant
- Distribution Pumping and Valves
- Domestic Water Systems
- Airside
- Building Management Systems
- Lighting

10. References

- Johnson Controls HVAC&R Engineering Update 2009
- Project Basis, EUL-RUL, & Preponderance of Evidence_9_9_13.docx

11. Definitions

***American Society of Heating Ventilation Refrigeration (ASHRAE)*:** An international technical engineering society for all individuals and organizations interested in heating, ventilation, air conditioning, and refrigeration (HVAC&R)

Association of Energy Engineers (AEE): is a nonprofit professional society of over 15,000 members in 84 countries. The mission of AEE is "to promote the scientific and educational interests of those engaged in the energy industry and to foster action for Sustainable Development."

Benchmarking: is the ongoing monthly review of energy performance to determine if building performance is improving or declining in comparison to itself, and other buildings in the portfolio, and/or peers.

Building Commissioning (Cx): A systematic quality assurance process that spans the entire design and construction process. Building commissioning helps ensure that a new building's performance meets owner expectations by verifying and documenting that building systems and components are planned, designed, installed, tested, operated, and maintained to meet owner's requirements.

Building Commissioning Association (BCA): The BCA's goal is to achieve high professional standards, while allowing for the diverse and creative approaches to building commissioning that benefit our profession and its clients. For this reason, the BCA focuses on identifying critical commissioning attributes and elements, rather than attempting to dictate a rigid commissioning process.

Building Envelope: A building envelope includes all components of a building that enclose conditioned space. Building envelope components separate conditioned spaces from unconditioned spaces or from outside air. For example, walls and doors between an unheated garage and a living area are part of the building envelope; walls separating an unheated garage from the outside are not. Although floors of conditioned basements and conditioned crawlspaces are technically part of the building envelope, the code does not specify insulation requirements for these components.

Building Management System (BMS): is a computer-based control system installed in buildings that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems. A BMS consists of software and hardware; the software program, usually configured in a hierarchical manner, can be proprietary

California Commissioning Collaborative (CCC)**:** The CCC is a California nonprofit public benefit corporation. CCC's purpose is:

- To improve building and system performance by developing and promoting viable building commissioning practices in California.
- To facilitate the development of cost effective programs, tools, techniques and service delivery infrastructure to enable the implementation of building commissioning processes.
- To educate and inform concerning building commissioning processes.
- To identify opportunities, establish priorities and promote solutions relating to building commissioning processes in California.

Commissioning: is a process applied to new buildings. When a building is commissioned, it undergoes an intensive quality assurance process that begins during design and continues through construction, occupancy, and operations. Commissioning ensures a new building operates as designed and that building staff is trained and prepared to operate and maintain systems and equipment in a manner that continues proper and efficient operation.

Database for Energy Efficient Resources (DEER): is a California Energy Commission and California Public Utilities Commission (CPUC) sponsored database designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) all with one data source. The users of the data are intended to be program planners, regulatory reviewers and planners, utility and regulatory forecasters, and consultants supporting utility and regulatory research and evaluation efforts. DEER has been designated by the CPUC as its source for deemed and impact costs for program planning.

Direct Digital Control (DDC): a type of control where controlled and monitored analog or binary data (e.g., temperature, contact closures) are converted to digital format for manipulation and calculations by a digital computer or microprocessor, then converted back to analog or binary form to control physical devices.

Effective Useful Life (EUL) : – (definition excerpt from Project Basis, EUL-RUL, & Preponderance of Evidence_9_9_13.docx)

The Effective Useful Life (EUL) is an estimate of the median number of years that the measures installed under the program are still in place and operable. EUL values are for new equipment and are provided as years. This allows the EUL to be directly employed with CPUC authorized annual avoided costs and measure-specific energy savings to determine the lifecycle dollar benefits associated with a particular measure. Newly proposed measures may claim up to a maximum EUL of 20 years.

DEER provides estimated EUL values for many different measures to utilize in cost effectiveness calculations. These are typically based on EM&V studies called retention studies that use measure equipment failure data to develop measure survival curves and hence, statistically determine the median life of a measure. EUL values should be taken from DEER when available. When EUL data is not available in DEER, additional studies, manufacturer data, or past maintenance records may be utilized to justify a proposed EUL for a measure and will be subject to review.

New construction measures that combine multiple measures into a single line item (such as the whole building approach) are to claim the average EUL of the combined measures. Measures that consist of both mechanical and electrical components with varying EUL values shall claim the lowest EUL value for the overall measure. Finally, the EUL claimed for a measure installing used equipment should equal the new equipment EUL minus the number of years that the used equipment was operated previously.

Energy Efficiency Measure (EEM): Any type of project or technology implemented to reduce the consumption of energy in a building without impacting operations.

Functional Tests/Testing: Tests that evaluate the dynamic function and operation of equipment and systems using manual or automated monitoring methods and either passive observation or active testing of operation. Functional testing is the assessment of the system's ability to perform within the parameters described in the design.

Heating Cooling and Air Conditioning (HVAC): is technology of indoor and automotive environmental comfort. HVAC system design is a major sub discipline of mechanical engineering, based on the principles of thermodynamics, fluid mechanics, and heat transfer.

Indoor Air Quality (IAQ)*:* The characteristics of the air in the indoor environment, including gaseous composition, temperature, relative humidity, and airborne contaminant levels.

International Performance Measurement and Verification Protocol (IPMVP): provides an overview of current best practice techniques available for verifying results of energy efficiency, water efficiency, and renewable energy projects

IOU: Investor Own Utility

Measurement and Verification (M&V): The process of verifying the equipment operation and energy savings associated with system upgrades and new energy efficiency measures.

Operations and Maintenance (O&M) Manuals: Written documents that provide all the information necessary for operating and maintaining installed equipment.

Professional Engineer (PE): A registered or licensed engineer in the United States who is permitted to offer professional services directly to the public.

Commissioning or Retro-Commissioning (Cx/RCx) Service Provider: The person or firm selected to execute the retro-commissioning projects. The commissioning Service Provider should have experience and up-to-date technical knowledge in the related fields of design, construction, and building operations. The commissioning lead should also have extensive and recent hands-on field experience in all aspects of the retro-commissioning process. The commissioning lead can employ or partner with technology specialists who have expertise in systems where the commissioning lead lacks experience. The Cx/RCx Service Provider shall have a good technical knowledge of the fundamental, design, and operation of the HVAC system and the implementation of controls systems.

Retro-Commissioning (RCx): The process of tuning-up an existing buildings in order to ensure proper operation of major equipment, proper indoor air quality, desired occupant comfort, and optimum energy consumption of existing equipment. Retro-commissioning is a process that seeks to improve how building equipment and systems function together. Depending on the age of the building, retro-commissioning can often resolve problems that occurred during design or construction, or address problems that have developed throughout the building's life. In all, retro-commissioning improves a building's operations and maintenance (O&M) procedures to enhance overall building performance.

Simple Payback: An energy investment's Simple Payback Period is the amount of time it shall take to recover the initial investment in energy savings, dividing initial installed cost by the annual energy cost savings.

Systems Manual: A system-focused composite document that includes the O&M Manuals and additional information of use to the owner and building staff in operating and maintaining the facility. This document is not typically part of a new construction project unless specified.

Southern California Edison (SCE): Electric service provider in Southern California and a partner in the Green for Life Program

Variable-Air-Volume (VAV) system: HVAC system that controls the dry-bulb temperature within a space by varying the volumetric flow of heated or cooled supply air to the space.

12. List of Eligible City Facilities and Criteria

Commissioning (Cx) and Retro-Commissioning (RCx) programs have been established for buildings over 5,000 sq. ft.

The City may consider RCx based on benchmarking results for facilities that score under 75 out of 100 points.

Buildings are only exempt from this Cx/RCx Policy if:

1. The City is not directly responsible for the energy bills.
2. The landlord is responsible for the O&M of the systems in the building.

12.1 Full List of Norwalk Facilities and Parks

No.	Facility Name	Address		Type of Use
1	Alondra Library	11949	Alondra Blvd	Library
2	Aquatic Pavilion	12301	Sproul Street	Pool - Showers
3	City Hall	12700	Norwalk Blvd	Offices
4	Arts and Sports Complex - NASC	13000	Clarkdale Avenue	Sports Center
5	Community Meeting Center - Sproul	13000	Clarkdale Avenue	Meetings
6	Cultural Arts Center	13200	Clarkdale Avenue	Recreational Center
7	Cultural Arts Center - MPR	13200	Clarkdale Avenue	Multi-Purpose
8	Gerdes Park	14700	Gridley Road	Reception Area
9	Glazier Park	10810	Excelsior Drive	Park
10	Hargitt House Museum	12426	Mapledale Street	Historical House - Tours
11	Hermosillo Park	11959	162nd Street	Meetings
12	Holifield Park	12500	Excelsior Drive	Park - Reception Area
13	Lakeside Park	11620	Studebaker Road	Park - Snack Bar
14	New River Park	13432	Halcourt Avenue	Park
15	Ramona Park	13244	Mapledale Street	Park
16	Robert White Park	12120	Hoxie Avenue	Park
17	Sara Mendez Park	11660	Dune Street	Meetings
18	Senior Center	14040	San Antonio Drive	Offices - Meetings -
19	Social Services Center	11929	Alondra Blvd	Offices
20	Sproul Museum	12203	Sproul Street	Museum
21	Sproul Reception Center (Barn)	12239	Sproul Street	Reception Area
22	Teen Center	12305	Sproul Street	Multi-Purpose
23	Transportation/Public Services Building	12650	Imperial Highway	Offices
24	Vista Verde Park	11459	Ratliffe Street	Park
25	Zimmerman Park	13031	Shoemaker Avenue	Park

12.2 List of Eligible Norwalk Facilities

Facility Name	Address	Square Footage of	Type of Use	Year Built
City Hall	12700 Norwalk Boulevard	38,300	Offices	1965
Arts & Sports Complex	13000 Clarkdale Avenue	26,700	Sports Center	1990
Cultural Arts Center	13200 Clarkdale Avenue	6,067	Recreational Center	1997
Senior Center	14040 San Antonio Drive	21,164	Offices - Meetings - Nutrition	1999
Social Services Center	11929 San Antonio Drive	9,171	Offices	1973
Transportation/Public Services Building	12650 Imperial Highway	20,705	Offices	1999

12.3 List of Eligible Norwalk Facilities Building Intensity's

Facility Name	Year	Annual Usage (kWh)	Bldg Size (Sq. Ft.)	Bldg Intensity (kWh/sq. ft.)	Bldg's Annual Cost for Electricity	Bldg's Rate ($/kWh)
Standard Office Building Per SCE	2013		6,000	**13.25**		
City Hall	2013	553,987	2,890	**14.46**	$ 95,836	$ 0.17
Arts & Sports Complex - NASC	2013	623,621	38,300	**23.36**	$ 104,030	$ 0.17
Cultural Arts Center	2013	74,477	26,700	**12.28**	$ 16,088	$ 0.22
Senior Center	2013	290,344	1,800	**13.72**	$ 51,844	$ 0.18
Social Services Center	2013	159,128	6,067	**17.35**	$ 25,255	$ 0.16
Transportation/Public Services Bldg.	2013	836,210	2,400	**40.39**	$ 97,483	$ 0.12