



REFRIGERATION

FLOATING SUCTION CONTROLS, MULTIPLEX

SWCR008-01

CONTENTS

Measure Name	2
Statewide Measure ID.....	2
Technology Summary	2
Measure Case Description	2
Base Case Description.....	2
Code Requirements	3
Normalizing Unit.....	3
Program Requirements.....	4
Program Exclusions.....	4
Data Collection Requirements	5
Use Category.....	5
Electric Savings (kWh).....	5
Peak Electric Demand Reduction (kW)	6
Gas Savings (Therms).....	6
Life Cycle.....	6
Base Case Material Cost (\$/unit)	7
Measure Case Material Cost (\$/unit).....	7
Labor Cost (\$/unit).....	8
Net-to-Gross (NTG).....	8
Gross Savings Installation Adjustment (GSIA)	8
Non-Energy Impacts	9
DEER Differences Analysis.....	9
Revision History	10

MEASURE NAME

Floating Suction Controls, Multiplex

STATEWIDE MEASURE ID

SWCR008-01

TECHNOLOGY SUMMARY

This measure pertains to suction pressure control retrofits on existing commercial multiplex refrigeration systems with fixed suction pressure controls. The two largest energy consuming components of a refrigeration system are the compressor(s) and the heat rejection fan(s). Critical processes in a refrigeration cycle are described as follows:

1. Refrigerant close to its saturated vapor state is compressed to a super-heated vapor state at a higher pressure and temperature.
2. The superheated vapor is fed to the fan-powered condenser where heat is rejected to the ambient via air for air-cooled condenser or the combination of air and evaporating water for evaporative condenser. The condenser is designed to cool the refrigerant to the saturated-liquid state by rejecting the refrigerant heat to the ambient at lower temperature.
3. Refrigerant at the exit of the condenser is then flashed to a lower pressure and temperature via an expansion valve which enables it to absorb heat from the refrigerated zones which are maintained at a higher temperature relative to the refrigerant. This heat absorption brings it back to the saturated vapor state at the start of the compression process.

The installation of floating suction pressure control reduces the compressor power draw by increasing the compressor suction pressure based on the worst-case zone demand. This measure allows the suction temperature to increase during periods of low fixture loads, which increases compressor efficiency.

MEASURE CASE DESCRIPTION

This measure entails adding controls to reset the suction pressure setpoint during periods of low loads based on zone temperature in a multiplex refrigeration system with an air-cooled condenser. The controls must operate the refrigeration system according to worst-case demand, and the maximum suction setpoint is 5 °F above the design temperature. The minimum is the same as the base case.

SWCR008 A - Floating suction pressure control for commercial air-cooled multiplex refrigeration systems

SWCR008 B - Floating suction pressure control for commercial evaporative-cooled multiplex refrigeration systems

BASE CASE DESCRIPTION

The base case is defined as a multiplex refrigeration system with an air-cooled condenser or evaporative-cooled condenser with saturated suction temperature (SST) controlled to a fixed setpoint.

CODE REQUIREMENTS

This measure pertains to Add-on Equipment (AOE) type measures for which savings are not determined relative to code standards. Thus, state and federal standards are not applicable (Table 1).

Table 1. Applicable State and Federal Codes and Standards

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20	None.	n/a
CA Building Energy Efficiency Standards – Title 24	Section 120.6(b)-Mandatory Requirements for Commercial Refrigeration.	1/1/2020
Federal Standards	None.	n/a

The 2019 California Building Energy Efficiency Standards (Title 24) ¹, effective January 1, 2020, Section 120.6(b)-Mandatory Requirements for Commercial Refrigeration, requires the following that are related to the measures in the worksheet.

- Air-cooled condensers shall use variable setpoint control logic to reset the condensing temperature setpoint in response to ambient dry bulb temperature
- Evaporative-cooled condensers shall use variable-setpoint control logic to reset the condensing temperature setpoint in response to ambient wet bulb temperature.
- The minimum condensing temperature setpoint shall be less than or equal to 70°F.
- Compressors and multiple-compressor suction groups shall include control systems that use floating suction pressure logic to reset the target saturated suction temperature based on the temperature requirements of the attached refrigeration display cases or walk-ins.

Title 24 started including commercial refrigeration and refrigerated warehouses from 2013 standards (Effective July 1, 2014). The code requirements remained the same until the latest version, Title-24 2019. Hence, this measure is only eligible for vintage 2013 and before.

NORMALIZING UNIT

Cap-tons (tons of cooling capacity)

¹ California Energy Commission (CEC). 2018. *2019 Building Energy Efficiency Standards for Residential and Nonresidential Buildings (Title 24)*. CEC-400-2018-020-CMF-Standards

PROGRAM REQUIREMENTS

Measure Implementation Eligibility

Table 4 specifies all measure application type, delivery type, and sector combinations that are established for this measure. Measure application type is a categorization based on the circumstances and timing of the measure installation; each measure application type is distinguished by its baseline determination, cost basis, eligibility, and documentation requirements. Delivery type is the broad categorization of the delivery channel through which the market intervention strategy (financial incentives or other services) is targeted. This table also designates the broad market sector(s) that are applicable for this measure.

Implementation Eligibility

Measure Application Type	Delivery Type	Sector
Add-on Equipment	DnDeemDI	Any
Add-on Equipment	DnDeemed	Any

Eligible Products

For adding controls to reset the suction pressure setpoint, the equipment must meet the following requirements:

- Convert the suction pressure controls of an existing multiplex system from fixed control to floating control.
- Adjust suction pressure to the highest point that can still maintain setpoint temperatures at monitored cases on the suction circuit.

Eligible Building Types

This measure is applicable to any existing building type, and the vintage categories listed below:

- Prior to 1978 ("1975")
- 1978 to 1992 ("1985")
- 1993 to 2001 ("1996")
- 2002 to 2005 ("2003")
- 2006 to 2009 ("2007")
- 2010 to 2013 ("2011")

Eligible Climate Zones

These measures are applicable in all California climate zones.

PROGRAM EXCLUSIONS

The following are ineligible:

- Projects that only reprogram a controller; new hardware must be installed.
- New construction installations.
- Floating suction pressure controls on refrigeration systems with variable speed evaporator fans.

- Any improvements which results in increased system energy use.
- Building vintage/ system vintage after 2013.

Additionally, calculation of the design cooling load (tons) is to be based on connected display cases, walk-in coolers and freezers, cooled storage, and prep areas only. Subcooler loads and air conditioning loads are ineligible for consideration.

Building vintage and refrigeration multiplex system vintage after 2013.

DATA COLLECTION REQUIREMENTS

The program should collect and verify the vintage of the building and the refrigeration multiplex system. The offerings are ineligible for multiplex systems majorly upgraded or installed after July 1, 2014 since the Title-24 code mandates the floating controls since July 1, 2014.

USE CATEGORY

Commercial refrigeration (ComRefrig)

ELECTRIC SAVINGS (KWH)

The measure offerings existed in previous version of Database for Energy Efficient Resources (DEER) as measure D03-220.² The original measures and energy models were created with DEER 2005, and measure information was updated in DEER 2008. These measures are not updated with DEER2020 release and the refrigeration end use in corresponding DEER prototypes (grocery building prototypes) has not been updated since DEER2005.

SCE undertook the task of updating the refrigeration end use in DEER prototypes and released the report³. The refrigeration end use did not require any updates for vintages 2011 and before. Since, the measure offerings are only eligible for vintage 2011 and earlier, the grocery prototypes from DEER2020 can be used without any revisions.

MASControl3, an updated version of the measure analysis software for DEER2020 is used to generate energy usage and savings for grocery building prototypes. MASControl3, released on 30 Sept 2018, uses the DOE-2.2-R52o simulation engine and provides processing scripts for computing DEER peak demand and applying vintage weights. Attributes of the modeled measures are noted below:

- Since nonresidential technology codes for these measures were not distributed with MASControl3, the following technology codes were created. These have the same effect as similar technology codes from DEER 2008.
 - GrocRefig-AirCool
 - GrocRefig-AirCool-FltSucPres-SSTReset
 - GrocRefig-EvapCool

² Itron, Inc. 2005. 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study - Final Report. Prepared for Southern California Edison.

See Section 6 for details of DEER Building Prototypes generated by DOE-2.2R. See Section 7.3 for general description for grocery refrigeration measures.

³ 2020 Commercial Refrigeration Prototypes Updates

- GrocRefg-EvapCool-FltSucPres-SSTReset
- The Grocery building type was selected for all climate zones (1 – 16) and for vintage codes 1975, 1985, 1996, 2003, 2007, and 2011.
- The base case is defined as a standard air-cooled or evaporative cooled multiplex refrigeration system with fixed SST control.
- The measure case is as defined in DEER 2008
 - SUCTION-GROUP:TEMP-CTRL = LOAD-RESET
 - SUCTION-GROUP:MAX-TEMP-SETPT defined by formula
 - SUCTION-GROUP:MIN-TEMP-SETPT defined by formula
- DEER2020 commercial vintage weights are applied to roll up the savings into “Ex” vintage
- The value of normalizing unit “cap-tons” used in the MASControl3 processing is the cooling capacities of refrigeration units (freezers and coolers) determined to be 17.55 tons. However, the cap-tons should be the rated capacity of compressors serving the multiplex system. This information is not directly available from DEER prototypes where the compressor capacity is in lbs/hr. The closest information to determine the compressor capacity from DEER prototypes is the peak load from .SIM files. The total peak capacity of all the compressors is compared with previous DEER measures normalizing units. While they are not same, they are of the similar magnitude. Since the previous DEER measures are peer reviewed, the capacity-tons from DEER measures which vary by climate zone are used to calculate the normalized savings.

Please refer to the folder⁴ for the workbooks and back-up folders required to enable the measures in MASControl3 and the eQuest .inp files generated by running the measures in MASControl3. Please refer to the calculation file⁵ for post processing analysis.

PEAK ELECTRIC DEMAND REDUCTION (KW)

MASControl3 provides processing scripts for computing DEER peak demand. The scripts for 4PM-9PM peak period is used to generate the peak kW savings meeting the DEER2020 peak period definition.

GAS SAVINGS (THERMS)

The therms savings are also generated from MASControl3.

LIFE CYCLE

Effective useful life (EUL) is an estimate of the median number of years that a measure installed through a program is still in place and operable. Remaining useful life (RUL) is an estimate of the median number of

⁴ SWCR008-01 eQuest Files.zip

⁵ SWCR008-01 Energy impact and cost calcs.xlsx

years that a technology or piece of equipment replaced or altered by an energy efficiency program would have remained in service and operational had the program intervention not caused the replacement or alteration. The RUL is only applicable to the first baseline period for a retrofit measure with an applicable code baseline.

The methodology to calculate the RUL conforms with Version 5 of the Energy Efficiency Policy Manual, which recommends “one-third of the effective useful life in DEER as the remaining useful life until further study results are available to establish more accurate values.”⁶ This approach provides a reasonable RUL estimate without the requiring any a prior knowledge about the age of the equipment being replaced.⁷ Further, as per Resolution E-4807, the California Public Utilities Commission (CPUC) revised Add-on Equipment (AOE) measures so that the EUL of the measure is equal to the lower of the RUL of the modified system or equipment or the EUL of the add-on component.”⁸

The EUL and RUL established for refrigeration case SST controls is specified in Table 2.

Table 2. Effective Useful Life

Parameter	Refrigeration Case SST Controls	Source
RUL (yrs) – SST controls	6.67	California Public Utilities Commission (CPUC), Energy Division. 2013. <i>Energy Efficiency Policy Manual Version 5</i> . Page 32. RUL = 1/3 EUL HOST capped at EUL of control based on 2015 SCE Ex Ante Adjustments ⁹

BASE CASE MATERIAL COST (\$/UNIT)

Insofar as these measures are Add on Equipment (AOE) measures, the base case costs are equal to \$0.00.

MEASURE CASE MATERIAL COST (\$/UNIT)

The measure case costs were drawn from the 2010-2012 WO017 Ex Ante Measure Cost Study, May 27, 2014, conducted by Itron, Inc.¹⁰ and applying an escalation factor determined by comparing the rates from RS Means 2013 and RS Means 2019.

The 2010-2012 Ex Ante Measure Cost Study provides the cost of controller per discharge group (whereas the normalizing unit for savings is per-ton of cooling capacity). Thus, it was necessary to develop cost per ton of cooling capacity.

⁶ California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 32.

⁷ KEMA, Inc. 2008. "Summary of EUL-RUL Analysis for the April 2008 Update to DEER." Memorandum submitted to Itron, Inc.

⁸ California Public Utilities Commission (CPUC). 2016. Resolution E-4807. December 16. Page 13.

⁹ 2015 SCE Ex Ante Adjustments-with Solution codes and WP number.xlsx

¹⁰ Itron, Inc. 2014. *2010-2012 WO017 Ex Ante Measure Cost Study Final Report*. Prepared for the California Public Utilities Commission.

To estimate the cost per ton, it is assumed that the design capacity of a discharge group is 34 tons. This assumption was derived as the weighted average of tons per discharge group, which accounts for the proportion of supermarket and grocery stores in the market, as well as the average number of discharge groups for each store type.¹¹ The cost per ton is calculated as cost per discharge group reported in the 2010-2012 Ex Ante Measure Cost Study divided by 34 tons.¹²

LABOR COST (\$/UNIT)

Labor costs were derived using the same methodology as measure case costs. See Measure Case Material Cost section.

NET-TO-GROSS (NTG)

The net-to-gross (NTG) ratio represents the portion of gross impacts that are determined to be directly attributed to a specific program intervention. The relevant NTG value for the refrigeration case SCT Control measures is specified in Table 4. These NTG values are based upon the average of all NTG ratios for all evaluated 2006 – 2008 commercial, agriculture, and industrial programs, as documented in the 2011 DEER Update Study conducted by Itron, Inc. This sector average NTG (“default NTG”) are applicable to all energy efficiency measures that have been offered through commercial, agriculture, and industrial sector programs for more than two years and for which impact evaluation results are not available.

Table 2. Net-to-Gross Ratios

Parameter	Refrigeration Case SST Controls	Source
NTG - Commercial	0.60	Itron, Inc. 2011. <i>DEER Database 2011 Update Documentation</i> . Prepared for the California Public Utilities Commission. Page 15-4 Table 15-3.

GROSS SAVINGS INSTALLATION ADJUSTMENT (GSIA)

The gross savings installation adjustment (GSIA) rate represents the ratio of the number of verified installations of the measure to the number of claimed installations reported by the utility. This factor varies by end use, sector, technology, application, and delivery method. The GSIA rate specific for refrigeration case SST controls is shown in Table 5. This GSIA rate is the current “default” rate specified for measures for which an alternative GSIA has not been estimated and approved.

¹¹ This weighting methodology was vetted during the California Technical Forum, Commercial Refrigeration Subcommittee Meeting #5 in September 2017.

¹² Southern California Edison (SCE). 2017. "SCE17RN023.1 Cost Calculation 2017.xlsx."

Table 3. Gross Savings Installation Adjustment Rate

Parameter	Refrigeration Case SST Controls	Source
GSIA	1.0	California Public Utilities Commission (CPUC), Energy Division. 2013. <i>Energy Efficiency Policy Manual Version 5</i> . Page 31.

NON-ENERGY IMPACTS

Non-energy impacts for this measure have not been quantified.

DEER DIFFERENCES ANALYSIS

This section provides a summary of inputs and methods based upon the Database for Energy Efficient Resources (DEER), and the rationale for inputs and methods that are not DEER-based.

Table 4. DEER Difference Summary

DEER Item	Comment / Used for Workpaper
Modified DEER methodology	Yes
Scaled DEER measure	No
DEER Base Case	No
DEER Measure Case	No
DEER Building Types	Yes
DEER Operating Hours	Yes
DEER eQUEST Prototypes	No
DEER Version	DEER2020
Reason for Deviation from DEER	DEER2020 does not have these measures. The offerings are added in MASControl3 and ran for grocery prototype
DEER Measure IDs Used	NA
NTG	Source DEER. NTG=0.60 is associated with NTG ID: <i>Com-Default>2yrs</i>
GSIA	Source DEER. GSIA=1.0 is associated with GSIA ID: <i>Def-GSIA</i>
EUL/RUL	2015 SCE Ex Ante Adjustments: EUL ID: <i>GrocSys-FISucPres</i> . EUL = 6.67

REVISION HISTORY

Table 5. Measure Characterization Revision History

Revision Number	Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision Effective Date and Approved By
01	3/31/2018	Jennifer Holmes Cal TF Staff	Draft of consolidated text for this statewide measure is based upon: SCE17RN023 Revision 1 (December 4, 2017) SCE17RN923 Revision 0 (December 9, 2016) PGE3PREF121 Revision 3 (January 1, 2016) Consensus reached among Cal TF members.
	4/26/2019	Akhilesh Endurthy Solaris-Technical	DEER2020 updates Update impacts using DEER2020 Grocery Prototypes Update costs Updated EUL to 6.67 years based on 2015 SCE Ex Ante Adjustments
	5/1/2020	Jesse Manao SCE	<ul style="list-style-type: none"> Split "Any" BT in the EnergyImpactExAnte. EnergyImpactExAnte savings updated to correctly reflect values in Measure Spec Data. Fixed Delivery Type misspelling in Implementation tab. Removed "SWCR008-01-Calc Template_Final.xlsm" (SCE Internal File)