BSR/ACCA 15 OBD – 201x Standard

On-Board Diagnostic Codes for HVACR Equipment

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To be added

Person; company; city, state

Person; company; city, state

Person; company; city, state

FOREWORD

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Modern heating, ventilation, air conditioning and refrigeration (HVACR) systems have become increasingly sophisticated, intricate, and complex (e.g., hybrid heating-cooling systems, variable-speed operation, variable-flow refrigerant, enhanced controls), which adds layers of complexity to equipment installation, servicing, maintenance, and problem diagnosis. On-board diagnostics (OBD) that incorporate a standardized set of fault and performance codes help technicians to properly install equipment, identify servicing problems, and return systems to proper operational duty.

A consistent OBD code nomenclature – applied across a wide platform of industry product offerings – can be an efficient way for the HVACR industry to reduce field installation and operational errors and better ensure that installed equipment capacity and efficiency are as designed. A consistent code nomenclature reduces the need for field practitioners to cross-reference multiple error code listings from within a manufacturer's lineup as well as across the spectrum of product producers. Reducing the opportunities to misconstrue error codes helps contractor operations, as well as reduces time and materials spent on misdiagnosed problems. In addition, when the system has outside communications capabilities, the service contractor can identify compatible replacement parts. This benefits not only the contractor, but the system owner as well.

That a code can be characterized by this Standard does not require any equipment manufacturer to support that specific functionality. It is not required or implied that equipment offerings from any manufacturer must have the capability (e.g., embedded controllers, sensors, switches, etc.) to provide any minimum set or level of on-board fault and / or performance code identification. This Standard supports code identifications without consideration as to whether (1) the needed sensors / controls / relays / switches / etc. are in HVACR equipment offerings, (2) whether said items are cost-effective to apply to HVACR equipment, and (3) whether such capability exists within the industry for application to HVACR equipment.

This Standard supports flexibility so that OEMs and aftermarket component producers can continue to offer unique attributes, characteristics, and other proprietary aspects that differentiate their brands. OBD codes may also expedite the requisite technician training for new equipment offerings, and allow technicians to successfully diagnose faults on a broader range of equipment types.

INTRODUCTION

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This Standard details a nomenclature naming schema for defining fault and / or performance codes and terminology associated with heating, ventilating, air-conditioning, and refrigeration (HVACR) equipment.

As defined and used in this Standard, the nomenclature naming schema standardizes codes based on *Component* (with a *Modifier*), *Mode of Operation*, *Process*, *Attribute Type*, and *Performance Descriptor*. The schema accommodates operating faults and / or performance characteristics that are commonly identified by today's equipment diagnostic capabilities, and that may need to be identified in the future as enhanced sensors and controls are applied to HVACR offerings. Additionally, this Standard supports the incorporation of proprietary, manufacturer-specific information that individual manufacturers may choose to make available to field practitioners.

The derived fault and performance codes indicate a suspected problem or problem area, and are not intended to be used as a directive to the proper service procedure. The standardized codes identify fault and/or performance situations within HVACR systems and permit field practitioners to focus on the area(s) and component(s) causing incorrect equipment operation or performance.

This Standard does not detail possible causes or diagnostic information associated with the fault codes and / or performance issues. Such prognosis / diagnosis / troubleshooting instructions are currently provided by the equipment / component manufacturer with their product documentation and servicing procedures.

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1.0 PURPOSE

This Standard details a nomenclature naming schema for defining fault and performance codes and terminology associated with heating, ventilating, air-conditioning, and refrigeration (HVACR) equipment.

2.0 SCOPE

This Standard applies to new HVACR equipment and components for use in new and existing residential and commercial buildings and commercial refrigeration applications.

Excluded are:

- HVACR equipment that do not provide fault / performance codes.
- HVAC equipment not designed / manufactured to support the naming schema defined in this Standard.

3.0 DEFINITIONS

The terms below are unique to this standard. See Appendix A ("Glossary") for definitions of other terms commonly used in the HVACR industry.

Air Movement System: The components within an HVACR system which facilitate or initiate the movement of air.

Attribute Type: Refers to the name of the specific operating element that a component subsystem or diagnostic program detects may not be in conformity with proper operation or for which performance information is being provided. See §4.5 for the Attribute Types supported by this Standard.

Combustion System: The components of a furnace or combustion system related to the burning of a fuel, providing combustion air, and venting of combustion products.

Component: The location or subsection/subsystem within the HVACR system where a code is being generated. See §4.1 for the Components/subsystems/systems supported by this Standard.

Component Modifier: Within the context of this standard, the designation of a stage within a multi stage component, or a multiple component within a system, or a specific position of (or within) a component. See §4.2 for the designations supported by this Standard.

Fault Code: An alpha-numeric designator that indicates system problems as identified / stored / communicated by an on-board diagnostic system. The fault code identifies a particular problem area and are intended to provide the technician with information as to what type of fault(s) – and associated component location(s) – that might be occurring. Fault codes are to be used in conjunction with the OEM's equipment service manual to ascertain which systems, circuits or components are to be subsequently tested to fully diagnose the fault.

Lubrication System: The components that allow the lubricant to be managed throughout an HVACR system including oil pump, oil separator, oil filter, pressure differential valve(s), check valve(s), oil level regulator (mechanical or electronic), oil screen and "J-tube) and returned to the compressor.

Mode of Operation: The operating function of the equipment when the code is being reported. In the case of a heat pump system, various modes of operation and combinations of modes are possible; for example, heating, cooling, emergency heat, may be operating in conjunction with dehumidification, and humidification modes. See §4.3 for the Modes of Operation supported by this Standard.

Moisture Control System: A system, or components within a system, whose purpose is to control the moisture content of the conditioned air.

Performance Code: An alpha-numeric designator that indicates performance information as identified / stored / communicated by an on-board diagnostic system. The code provides operating characteristics of the system or component in terms of specific sensed / measured / calculated values such as amps, airflow, pressure, temperature, voltage, watts. The information is to be used in conjunction with the OEM's installation and service manuals to ascertain how the system is performing against OEM specifications.

Performance Descriptor: Indicates in what manner a specific attribute type is directly or indirectly sensed / measured / calculated (a) as being outside the limits expected for properly operating HVACR equipment (i.e., a fault code), or (b) for which an attribute's specific operating value is being provided (i.e., a performance code). See §4.6 for the Performance Descriptors supported by this Standard.

Power Production System: Any system whose purpose is to produce electrical power. This includes all the individual components, including but not limited to: generator, steam system including piping, fuel, combustion components, pumps, fans, storage cells, and wiring.

Process: The underlying system or subsystem activity that the code is referencing. HVACR systems are capable of undertaking multiple processes (e.g., air, refrigerant, water movements) simultaneously or sequentially. See §4.4 for the Processes supported by this Standard.

Refrigerant Movement System: Any system whose purpose is to transfer heat through the use of a refrigerant as a working medium. This includes all the individual components, including but not limited to: compressor, heating source, evaporator, condenser, refrigerant metering devices, and piping.

Water (or hydronic or fluid loop) Movement System: Any system whose purpose is to transfer heat through the use of water or a mixed water/glycol based medium. This includes all the individual components, including but not limited to: pumps, motors, fans, valves, and piping.

4.0 CODE FORMAT STRUCTURE

To be in compliance with this Standard, equipment manufacturers and suppliers shall convey fault codes and / or operating performance codes per the schema identified in this Standard.

- The fault code designation consists of two alpha digits, followed by a single numeric digit, followed by five alpha digits, optionally followed by an OEM-assigned, OEM-proprietary, four (4) digit designator that can be alpha-only, numeric-only, or alphanumeric.
- The performance code designation consists of two alpha digits, followed by a single numeric digit, followed by four alpha digits, followed by a "#" symbol, followed by four (4) numeric digits.

The assignment of the first eight (8) digits are determined by the area for that functionality; see §4.1 through §4.6. The alpha-numeric designators are straight forward since a particular code will arise due to the use of a specific sensor, relay or controller. The assignment of the additional four (4) digits are per §4.7. The code nomenclature schema is detailed below and is shown in Figure 1.

4.1 Component: The first and second digits detail the subsystem or component within the HVACR system associated with the encountered code:

AC = accumulator
AH = air handler
BS = boiler, steam
BW = boiler, water
CB = condenser, control board*
CC = condenser coil*
CE = condenser, expansion device*
CH = chiller
CN = contactor
CO = compressor
CU = condensing unit*
CR = capacitor, run
CS = capacitor, start
CT = cooling tower
DB = damper, bypass
DE = damper, exhaust
DO = dedicated outdoor air system
DR = damper, return
DS = damper, supply
EB = evaporator, control board*
EC = evaporator coil*
EE = evaporator, expansion device*
EU = economizer unit
FB = furnace burner
FC = fan, condenser*
FE = fan, exhaust
FR = fan, return
FU = furnace
FS = fan, supply (blower)
HR = heat reclaim
IT = ice tank (TES)
MB = motor, blower
MC = motor, condenser*
MI = motor, inducer
MP = motor, pump
PA = pump, absorber
PC = pump, condenser*
PE = pump, evaporator*
PG = pump, generator
RC = receiver
RD = return duct
RT = rooftop unit
SA = solar array
SC = sub-cooler
SD = supply duct
VB = valve, balancing
VG = valve, gas
VR = valve, reversing
VS = valve, split condenser
WD = wheel, desiccant
WH = wheel, heat

* For naming consistency, when heat pumps are operating in the heating mode, evaporator and condenser components remain as defined in the cooling mode.

4.2 Component Modifier: The third digit denotes, as applicable, whether the code applies to a multiple stage (e.g., stage one of a two-stage compressor), to a multiple component (e.g., the second compressor), or to a specific position within a component (e.g., furnace burner 2). The default value is "-" when there are only single stages, units, or positions.

4.3 Mode of Operation: The fourth digit details the function (mode of operation) that the HVACR equipment is operating in when the code is generated:

A = auxiliary heating mode
C = cooling mode
D = dehumidification mode
E = economizer mode
F = defrost mode
H = heating mode
M = humidification mode
P = purge mode
U = utility demand response power reduction mode
R= reheat mode

4.4 Process: The fifth digit relates to the underlying HVACR process / system to which the code applies:

A = air movement/system
C = combustion system
F = fuel movement / system
L = lubricant/oil movement system
M = moisture control system
P = power production system
R = refrigeration movement/system
W (or H) = water (or hydronic loop) movement/system

4.5 Attribute Type: The sixth and seventh digits relate to the element that is directly, or indirectly, sensed / measured / calculated within the HVACR system:

CA = capacity (e.g., mBTU/hr output)
CC = communications / controls
CD = carbon dioxide (CO_2) concentration (e.g., ppm)
CL = charge level
CM = carbon monoxide (CO) concentration (e.g., ppm)
CO = composition
EC = electrical current (e.g., amps)
FR = flame rollout
FV = flow volume (e.g., cfm, gpm)
MR = mass flow rate (e.g., lbs/hr)
NO = nitrogen oxide (NOx) concentration (e.g., ppb)
OX = oxygen (O_2) concentration (e.g., %)
PE = power, electrical (e.g., watts)
PR = pressure (e.g., psia for refrigerant, iwc. for air)
RH = relative humidity (e.g., %)
RS = rotational speed (e.g., RPM; revolutions per minute)
SC = subcooling (e.g. ºF)
SH = superheat (e.g. ºF)
SM = smoke concentration (e.g., ppm)
TE = temperature (e.g. ºF)
VE = flow velocity (e.g., fpm)
VO = voltage (e.g., V)

Note: For the Processes identified in §4.4, not all of the §4.5 Attribute Types apply.

4.6 Performance Descriptor: The eighth digit characterizes the operating performance of the system; either by indicating how an attribute is out of tolerance, or by indicating that an operating value for a specified attribute type is being provided.

4.6.1 Alpha-designation: When the eighth digit is a letter, said letter details what is incongruous with the Attribute Type when the code is encountered:

C = closed[1]
G = grounded
H = high
L = low
N = no signal
O = open[2]
P = polarity
R = out of expected range
S = shorted
T = tripped
X = lockout / manual reset
Y = lockout / automatic reset

Note: For the Attribute Types identified in §4.5, not all of the §4.6 Performance Descriptors apply.

4.6.2 #-designation: When the eighth digit is the "#" symbol, it alerts that the value shown in digits nine through twelve is a directly, or indirectly, sensed / measured / calculated operating value for the attribute type indicated in §4.5 above (see also §4.7.2).

= sensed / measured / calculated operating value

4.7 Additional Coding: Digits nine through twelve are reserved for coding that provides additional information.

4.7.1 OEM Proprietary Coding: When the eighth digit is an alpha character per §4.6.1, the value provided by digits nine through twelve contains optional, OEM-proprietary information that is created by the equipment manufacturer.[3]

4.7.2 Performance Operation: When the eighth digit is the "#" symbol per §4.6.2, the value provided by digits nine through twelve is the directly, or indirectly, sensed / measured / calculated operating value for the Attribute Type indicated in §4.5.[4]

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1 'Closed' is related to the sensor or relay. "Normally open" is considered the non-fault condition.

2 'Open' is related to the sensor or relay. "Normally closed" is considered the non-fault condition.

3 These optional digits, when provided, allow the OEM to communicate more detailed information or other information related to the fault situation. Such additional details can include proprietary information to further characterize the fault, the fault location, fault assessment, or to detail information related to such aspects as variable-speed motor control settings, variable refrigerant flow, etc.

4 These digits are in the units (e.g., for airflow, CFM or L/S) that are consistent in the manner that the OEM provides supporting engineering data.

5.0 CODE DESCRIPTIVE LABELS

5.1 Users of this Standard have the discretion to use plain-English descriptive labels associated with the §4.0 codes. When included, these plain-English descriptive labels are to[5]:

a. Use the wording as shown in Figure 1 in the exact order that the schema is ordered,
b. Utilize full words or industry-recognized abbreviations, and
c. Have the first letter for each word used from Figure 1 capitalized; the remaining words (sentence fillers) to be lowercase.

5.2 When plain-English labels are used, the code associated with the label(s) shall be included.

[5] See Appendix A for examples of plain-English fault code descriptors, as well as plain-English performance code descriptors, written per the §5 requirements.

FIGURE 1: CODE NAMING SCHEMA SCHEMATIC

Component (§4.1)

AC = **AC**cumulator
AH = **A**ir **H**andler
BS = **B**oiler, **S**team
BW = **B**oiler, **W**ater
CB = **C**ondenser, control **B**oard
CC = **C**ondenser **C**oil
CE = **C**ondenser, **E**xpansion Device
CH = **CH**iller
CN = **CoN**actor
CO = **CO**mpressor
CU = **C**ondensing **U**nit
CR = **C**apacitor, **R**un
CS = **C**apacitor, **S**tart
CT = **C**ooling **T**ower
DB = **D**amper, **B**ypass
DE = **D**amper, **E**xhaust
DO = **D**edicated **O**utdoor air system
DR = **D**amper, **R**eturn
DS = **D**amper, **S**upply
EB = **E**vaporator, control **B**oard
EC = **E**vaporator **C**oil
EE = **E**vaporator, **E**xpansion device
EU = **E**conomizer **U**nit
FB = **F**urnace **B**urner
FC = **F**an, **C**ondensor
FE = **F**an, **E**xhaust
FR = **F**an, **R**eturn
FU = **FU**rnace
FS = **F**an, **S**upply (blower)
HR = **H**eat **R**eclaim
IT = **I**ce **T**ank
MB = **M**otor, **B**lower
MC = **M**otor, **C**ondenser
MI = **M**otor, **I**nducer
MP = **M**otor, **P**ump
PA = **P**ump, **A**bsorber
PC = **P**ump, **C**ondenser
PE = **P**ump, **E**vaporator
PG = **P**ump, **G**enerator
RC = **R**e**C**eiver
RD = **R**eturn **D**uct
RT = **R**oof**T**op unit
SA = **S**olar **A**rray
SC = **S**ub**C**ooler
SD = **S**upply **D**uct
VB = **V**alve, **B**alancing
VG = **V**alve, **G**as
VR = **V**alve, **R**eversing
VS = **V**alve, **S**plit condensor
WD = **W**heel, **D**esiccant
WH = **W**heel, **H**eat

Component Modifier (§4.2): as applicable
[multiple stages / components / positions]
1 = First Stage (or, First Position, or First Unit)
2 = Second Stage (or, Second Position, or Second Unit)
...
n = "n" Stage (or, "n" Position, or "n" Unit)
– = default for base scenario

Performance Descriptor (§4.6)

C = **C**losed
G = **G**rounded
H = **H**igh
L = **L**ow
N = **N**o signal
O = **O**pen
P = **P**olarity
R = out of expected **R**ange
S = **S**horted
T = **T**ripped
X = lockout / manual reset
Y = lockout / automatic reset
# = Measured Operating Value

Digits	1	2	3	4	5	6	7	8	/	9	10	11	12
	A	H	–	C	R	T	E	H					

Mode of Operation (§4.3)

A = **A**uxiliary heating mode
C = **C**ooling mode
D = **D**ehumidification mode
E = **E**conomizer mode
F = de**F**rost mode
H = **H**eating mode
M = hu**M**idification mode
P = **P**urge mode
U = **U**tility DR power reduction mode
R = **R**eheat mode

Process (§4.4)

A = **A**ir movement / system
C = **C**ombustion system
F = **F**uel movement / System
L = **L**ubricant/oil movement/system
M = **M**oisture control system
P = **P**ower production system
R = **R**efrigerant movement / system
W or H = **W**ater (or **H**ydronic loop) movement / system

Attribute Type (§4.5)

CA = **CA**pacity (MBTU/h)
CC = **C**ommunications/**C**ontrols
CD = **C**arbon **D**ioxide (CO_2)
CL = **C**harge **L**evel
CM = **C**arbon **M**onoxide (CO)
CO = **CO**mposition
EC = **E**lec. **C**urrent (amps)
FR = **F**lame **R**ollout
FV = **F**low **V**ol. (CFM, gpm)
MR = **M**ass flow **R**ate (lbs/hr)
NO = **N**itrogen **O**xide (NOx)
OX = **O**Xygen (O_2) concentration
PE = **P**ower, **E**lectrical (watts)
PR = **PR**essure
RH = **R**elative **H**umidity
RS = **R**otational **S**peed (RPM)
SC = **S**ub**C**ool
SH = **S**uper**H**eat
SM = **SM**oke (ppm)
TE = **TE**mperature
VE = flow **VE**locity (FPM)
VO = **VO**ltage

Additional Characters (8th digit contingent)
Fault Code (§4.7.1): proprietary OEM coding (opt)
Performance Code (§4.7.2): actual attribute value

Fault Code Example Shown
A H – C R T E H = Air Handler, in the Cooling Mode, Refrigerant Temperature High

APPENDIX A | ILLUSTRATIVE EXAMPLES OF SCHEMA USE

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The intent of this Standard is that, to the extent that HVACR equipment and components communicate information regarding a fault situation or an operating performance metric, said information is identified by a standardized code as derived by the naming schema identified in Section 4.0.

A.1 Fault Code Examples: For illustrative purposes, the table below provides representative example fault codes for varied HVACR applications that are in accordance to this standard, along with a plain-English descriptive label for same. It is recognized that multiple system faults can be encountered due to a single system problem inducing responses from varied sensors[6] or due to multiple system problems related or unrelated to each other.

1	2	3	4	5	6	7	8	9	10	11	12
Component (location)		Component Modifier	Mode of Operation	Process	Attribute Type		Performance Descriptor	Reserved for OEM usage (optional)			
C	U	–	C	R	P	R	H				
Condensing Unit, in the Cooling Mode, Refrigerant Pressure High [CU-CRPRH]											
C	T	2	C	W	F	V	R				
Cooling Tower 2, in the Cooling Mode, Water Flow Out of Expected Range [CT2CWFVR]											
E	V	–	C	A	T	E	L				
Evaporator, in the Cooling Mode, Air Temperature Low [EV-CATEL]											
A	H	–	A	A	T	E	T				
Air Handler, in the Auxiliary Mode, Air Temperature Tripped [AH-AATET}											
S	D	1	H	A	P	R	R				
Supply Duct 1, in the Heating Mode, Air Pressure Out of Expected Range [SD1HAPRR]											

A.2 Performance Code Examples: For illustrative purposes, the table below provides representative example performance codes for varied HVACR applications that are in accordance to this standard, along with a plain-English descriptive label for same.

1	2	3	4	5	6	7	8	9	10	11	12
Component (location)		Component Modifier	Mode of Operation	Process	Attribute Type		Performance Descriptor	Sensed / Measured / Calculated Operating Value for the indicated Attribute			
A	H	–	C	A	F	V	#	1	2	6	0
Air Handler, in the Cooling Mode, Air Flow is 1260 [AH-CAFV#1260]											
S	D	1	H	A	T	E	#	0	1	2	2
Supply Duct 1, in the Heating Mode, Air Temperature is 122 [SD1HATE#0122]											
E	V	–	C	A	T	E	#	0	0	5	3
Evaporator, in the Cooling Mode, Air Temperature is 53 [EV-CATE#0053]											
E	V	–	F	R	P	R	#	0	4	2	5
Evaporator, in the Defrost Mode , Refrigerant Pressure is 425 [EV-FRPR#0425]											
S	D	1	H	A	P	R	#	0	0	5	0
Supply Duct 1, in the Heating Mode, Air Pressure is 50 [SD1HAPR#0050]											

[6] An example of a single problem causing multiple fault codes is: a clogged air filter in the indoor air handler results in a return air low pressure fault, low airflow fault, out-of-range air temperature sensor fault, low refrigerant temperature fault, low air handler amp draw fault, etc.

APPENDIX B | GLOSSARY

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As a convenience to the user, this Glossary provides descriptions for common, industry-recognized, industry-applied terms. These terms and definitions are not unique to this standard; they are common HVACR equipment and component terminology. See Section 3 of this Standard for terms whose definitions are unique to this Standard.

ACCA: Air Conditioning Contractors of America (www.acca.org).

Accumulator: A tank installed in the suction line on, or near, the compressor unit; designed to intercept liquid refrigerant before it can reach the compressor crankcase. Liquid trapped in the accumulator is then returned at a safe rate back to the compressor. On parallel compressor systems, the suction manifold is designed to serve this function. It also meters lubricant to the compressor on start-up.

Airflow: Volumetric flow rate for ducted flow, or for the flow through primary heating and cooling equipment, supply outlets, returns, etc...

CFM: Cubic Feet per Minute (IP unit for volumetric airflow).

L/S: Liters per Second (SI unit for volumetric airflow).

Air Handler: An equipment cabinet that contains a blower (and other devices, such as coils and filters) that moves air through the air distribution system. (Note: A forced air furnace provides the similar air movement function.)

Amps (A): A unit for measuring the rate at which electric current flows.

Boiler, Steam: Vessel in which a liquid is pressurized and heated to produce a pressurized vaporization/steam.

Boiler, Water: Vessel in which a liquid is pressurized and heated without vaporization.

Carbon Dioxide (CO_2): A colorless, odorless gas produced by burning carbon and organic compounds and by respiration. It is naturally present in air (approximately 0.03 percent) and is absorbed by plants in photosynthesis. It can also be used as a heat transfer fluid in refrigeration equipment.

Carbon Monoxide (CO): Carbon monoxide (CO) is a poisonous, odorless and colorless gas which is created whenever a fossil fuel (such as wood, gasoline, coal, natural gas, kerosene, etc.) is burned.

Chiller: A machine that removes heat from a liquid via a vapor-compression or absorption refrigeration cycle. This liquid can then be circulated through a heat exchanger to cool equipment, or another process stream (such as air or process water).

Closed: Not open. As it relates to flow of a fluid - not allowing flow through a valve. As it relates to electricity – when a switch is closed, flow of electricity is enabled.

Combustion*: Chemical process of oxidation that occurs at a rate fast enough to produce heat, and usually light, either as a glow or flame.

Communication: The imparting or interchange of data or information within the system, as well as to outside communication hubs and devices.

Compressor: In refrigeration, the machine that compresses the cool refrigerant into a hot, high pressure gas so it can give off heat to the air or water being passed through a condenser.

Condenser: The device that exhausts the heat from a refrigeration system. The refrigerant turns from a gas into a liquid in the condenser, and is ready to begin the refrigeration cycle again. Condensers can be air-cooled, water cooled or a combination of both, called evaporative condensers or fluid coolers. Condensers may also be single circuited, multi-circuited, or split circuited.

Condenser, Control Board: An output board, connected to the main system controller, that as the algorithm instructs will control the components of the condenser, including but not limited to the fans, split condenser valve and flow control solenoids.

Condenser, Expansion Device: When a heat pump is in heating mode, the condenser (many times the outdoor heat exchanger) becomes the evaporator (many times the indoor heat exchanger). This heat exchanger requires a metering or expansion device which could be a fixed orifice device or a thermostatically controlled metering device to control the flow of refrigerant to the heat exchanger.

Condensing Unit: A package of refrigeration equipment generally consisting of a compressor, condenser (heat exchanger), condenser fan, controls, and associated hardware.

Contactor: An electrical load-carrying device, operated by a pilot circuit, which opens and closes the power circuit to start and stop compressor motors, condenser fan motors, or electric defrost heaters. A contactor is a type of relay. They are either General Purpose (GP) or NEMA rated.

Contractor*: The person or entity responsible for performing the work and identified as such in an owner-contractor agreement.

Control*: Device for regulation of a system or component in a normal and safe operation, manual or automatic. If automatic, the implication is that it is responsive to changes of pressure, temperature, etc.

Cooling Tower: A device which uses evaporative cooling to lower the temperature of water flowing through it.

Damper: A manually operated blade or louver or automatic throttling device used to adjust or block the airflow through a duct run, equipment cabinet, supply outlet, return grille or vent or chimney.

Bypass: A damper used in zone systems to relieve excess pressure in the air distribution system caused when one zone closes and the air flow exceeds the design static pressure of the open zone. These dampers usually employ a counter weighted arm that opens at a certain pressure (barometric bypass damper) or an air pressure sensor that opens the damper with a motor (motorized bypass damper).

Exhaust: Any blocking device placed in an exhaust ductwork to control the flow of air.

Return: Any blocking device placed in the return air ductwork to control the flow of air.

Supply: Any blocking device placed in the supply air ductwork to control the flow of air.

Dedicated Outdoor Air System: The components within an HVACR system which facilitate or initiate bringing outside air into the conditioned space.

Economizer, Air: A duct-damper arrangement, and automatic control system designed to supply outside air to reduce or eliminate the need for mechanical cooling during mild or cold weather.

Evaporator: The component of a refrigeration system in which the refrigerant absorbs heat and vaporizes. Usually a coil arranged from pipes or tubing and plates or fins. For air conditioners the evaporator coil is always in the indoor unit. For heat pumps the evaporator is the indoor coil in the summer, and reverses to the outdoor coil in the winter.

Evaporator, Control Board: An output board, connected to the main system controller, that as the algorithm instructs, will control the components of the evaporator, including but not limited to the fans, electronic expansion valve, defrost and flow control solenoids.

Expansion Device: A metering device that controls the flow of refrigerant to the evaporator. The device can be as simple as a sized orifice or tube that restricts the refrigerant flow. The mechanical valve version uses a sensing bulb attached to the refrigeration suction line, the bulb can sense temperature changes of the refrigerant leaving the evaporator coil. Based on the temperature of the leaving refrigerant the valve restricts or expands to ensure maximum heat transfer within the evaporator by optimizing refrigerant flow. The electronic valve version utilizes a temperature sensor placed in the airstream of the evaporator coil and in conjunction with an algorithm through an electronic controller opens and closes the valve to maintain a preset coil superheat.

Feet per Minute (FPM): The measurement of a fluid's (gaseous or liquid) velocity as it travels in piping or duct.

Flame Rollout: Burner flames discharge outside of the combustion chamber and possibly into the occupied space outside of a combustion appliance's cabinet.

Furnace*: 1. Part of a warm air heating system in which energy is converted to heat; **2.** Enclosed chamber or structure in which heat is produced, as by burning fuel, or by converting electrical energy.

Gallons per Minute (GPM): The measurement of a volume of fluid (e.g. water, oil, etc.) through a pump, or a closed or open system.

Grounded: Electrically connected to an electrical potential of zero volts, as referenced to the Earth.

Earth Ground: An electrical connection to the surrounding soil to maintain a zero electrical potential between the Earth and, typically, the equipment cabinetry**.** Refer to the National Electrical Code for proper use of grounding.

Heat Exchanger: The component in a heating or cooling system that adds or removes heat to an air stream or water stream. Heating mode examples include: a combustion chamber, electric resistance coil, or a coil with hot water or refrigerant (heat pump). A cooling mode example is a coil with cold water or refrigerant

Heat Reclaim: The heat normally rejected into the outside air by the condenser is used inside the store for heating purposes. The heat may be prioritized for hot water, or hot air for the store, or backroom.

High: Exceeding the system-designed degree or measure.

Humidity: Water vapor within a given volume, referenced to the air temperature within that volume.

HVAC: Heating, ventilating and air conditioning.

HVAC system*: A system that provides, either collectively or individually, the processes of comfort heating, ventilating, and/or air conditioning within, or associated with, a building.

HVACR: Heating, ventilating, air conditioning, and refrigeration.

Lockout: The ability to isolate and shut off – or disable – a system that has a fault so severe that running that system would be detrimental to human safety or the equipment's lifespan.

Low: Below the common degree or measure

Lubrication System: Components that provide a means to circulate lubricant/oil to those components within a system needing to reduce friction and/or heat.

Nitrogen Oxide (NOx): Any of several oxides of nitrogen (such as nitric oxide and nitrogen dioxide), most of which are produced in combustion and are considered to be atmospheric pollutants.

No Signal: Many electronic components require some means of communication. When the required signal is absent, it registers as a "no signal". For example, a pressure transducer relays a voltage or current signal to a communication board to advise the controller of its reading of pressure. When there is "no signal", this transducer circuit's lack of response implies that it is not functioning.

OEM: Original equipment manufacturer.

Open: Not closed. As it relates to flow of a fluid - allowing flow through a valve. As it relates to electricity – when a switch is open, electricity flow stops.

Out of expected range: The sensed value is within the normal operating range, but not correct for the operating conditions. It is used to indicate skewed values indicating poor performance of a circuit, component, or the system.

Oxygen: Oxygen is a chemical element with symbol "O" and atomic number of "8". It is a member of the chalcogen group on the periodic table and is a highly reactive nonmetal and oxidizing agent that readily forms oxides.

Polarity: 1. The relative orientation of poles; the direction of a magnetic or electric field. 2. The relative potential to earth ground of an electrical conductor.

Pressure:

Absolute – The sum of gauge pressure and atmospheric pressure.

Atmospheric – The pressure (weight) of the atmosphere, as indicated by a barometer. Standard atmospheric pressure at sea level is 76 cm or 29.92 inches of mercury at 32 degrees Fahrenheit (0 degrees Celsius). It is equivalent to 14.696 psia (14.7 psia) at 68 degrees Fahrenheit, and 101.325 kPa at 20 degrees Celsius.

Gauge – 1. That pressure measured by a gauge, which does not include atmospheric pressure. 2. The pressure differential between two pressure measurement points.

Static - Force (per unit area) expended against the walls of a container such as an air duct. Commonly, force is measured in heating and air-conditioning in pounds per square inch, or inches of water column.

Receiver: A component of an air-conditioning or refrigeration equipment that is mounted in the liquid line between the condenser and the filter-dryer designed to hold the varying volume of liquid refrigerant resulting from changes in system operating conditions.

Refrigerant: **1.** In a refrigerating system, the medium of heat transfer which picks up heat by evaporating at a low temperature and pressure, and gives up heat on condensing at a higher temperature and pressure; **2.** (refrigerating fluid) Fluid used for heat transfer in a refrigerating system that absorbs heat at a low temperature and low pressure of the fluid and transfers heat at a higher temperature and a higher pressure of the fluid, usually involving changes of state of the fluid. 3. Glycol and other similar fluids that are used for heat exchange are not classified as refrigerants because they do not change state when adding or removing heat.

Relative Humidity: The percentage of moisture in the air measured against the amount of moisture the air could hold at a given temperature.

Return Duct: The conduit used to carry air from the conditioned space or the point of utilization back to the air handler.

Revolutions per Minute (RPM): A measure of the frequency of rotation, specifically the number of rotations around a fixed axis in one minute.

Sensor: A device that detects or measures a physical property. The specific input could be electrical, light, heat, motion, pressure, chemical, or other. Sensors may or may not include indication and/or recording capabilities.

Smoke: 1. The gaseous products of burning materials (especially of organic origin) made visible by the presence of small particles of carbon 2. A suspension of particles in a gas.

Sub-cooler: The component that allows additional heat rejection by refrigerant liquid beyond the condenser coil. Sub cooling can be viewed as the temperature of the refrigerant below its condensing point at its immediate pressure.

Subcooling: Heat rejection by refrigerant liquid. Sub cooling can be viewed as the temperature of the refrigerant below its condensing point at its immediate pressure. A small amount of sub cooling is necessary to prevent flash gas or bubbles in the liquid line which results in poor refrigerator performance. Additional sub cooling further increases refrigeration efficiency because: 1) there is less heat to be removed from the refrigerant in the evaporator and 2) condensing temperature (hence, discharge pressure) can be lowered. Two common methods of achieving sub cooling in supermarket refrigeration are ambient sub cooling and mechanical sub cooling (refrigerating the liquid).

Superheat: Heat absorbed by refrigerant vapor. Superheat can be viewed as the temperature of the refrigerant above its boiling point at its immediate pressure.

Evaporator - Evaporator superheat is calculated by taking the matching temperature from a temperature pressure chart for the pressure in the evaporator vs the actual temperature of the refrigerant on the outlet of the evaporator.

System – System superheat is calculated by taking the matching temperature from a temperature pressure chart for the pressure in the evaporator vs the actual temperature of the refrigerant on the inlet of the compressor.

Supply Duct: The conduit used to carry air from the air handler to the conditioned space or the point of utilization.

Temperature: A measure of heat intensity by the heat content of a substance, normally measured in degrees Fahrenheit (^{o}F) or Celsius (^{o}C).

Thermal Expansion Valve: A thermostatically controlled metering device to control the flow of refrigerant to a heat exchanger. The valve uses a sensing bulb attached to the refrigeration suction line. The bulb can sense temperature changes of the refrigerant leaving the evaporator coil. Based on the temperature of the leaving refrigerant the valve restricts or expands to ensure maximum heat transfer within the heat exchanger by optimizing refrigerant flow.

Tripped: To trigger a mechanism based on a designed level of input, such as temperature or pressure. Generally used in conjunction with disabling the mechanism for safety reasons.

Valve, Gas: A valve used with gas-fired furnaces that controls the flow of natural gas or propane to the burners. Normally controlled by a thermocouple and/or electronic control.

Valve, Reversing: A valve used with heat pumps that reverses the function of the evaporator (indoor coil) and the condenser (outdoor coil) to changeover between heating and cooling cycles. Also called a Four-Way Valve.

Valve, Split Condenser: A three way valve or a pair of motorized ball valves that allows refrigerant flow through a doublewide condenser with each side operating independently of the other, and each having its own fan controls.

Voltage: Electric potential or potential difference expressed in volts.

Watts (W): 1. A unit of electrical power that reflects the work done or energy generated by one ampere induced by an EMF of one volt ($P = EI = I^2R$). 2. A unit of heat flow equivalent to one Joule per second or 3.41 BTU/h. 3. A unit of mechanical power, where 746 Watts are equivalent to one horsepower.

* Definition adapted from ASHRAE Terminology of Heating, Ventilation Air Conditioning & Refrigeration Second Edition 1991.