
THERMO KING
THE FUTURE OF
FUEL EFFICIENCY

History of Innovation

Fred Jones invents transport refrigeration unit

1938

Thermo King founded by Joe Numero

1955

Thermo King makes first HVAC system for Bus

1956

Thermo King builds first Marine container refrigeration unit

1962

Thermo King invents NWD 62, first to use diesel engine

1997

Ingersoll Rand adds Thermo King to its portfolio

Ingersoll Rand
Inspiring Progress™

Today

Over 10,000 people associated with the Thermo King brand

THERMO KING®

2013

THE FUTURE OF FUEL EFFICIENCY

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PRECEDENT

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The Making of Precedent – The Assignment

2009

Identify and analyze all available technologies that could be used for the purpose of transport refrigeration.

The Assignment - System Architecture

The team developed a matrix of unique criteria based on:

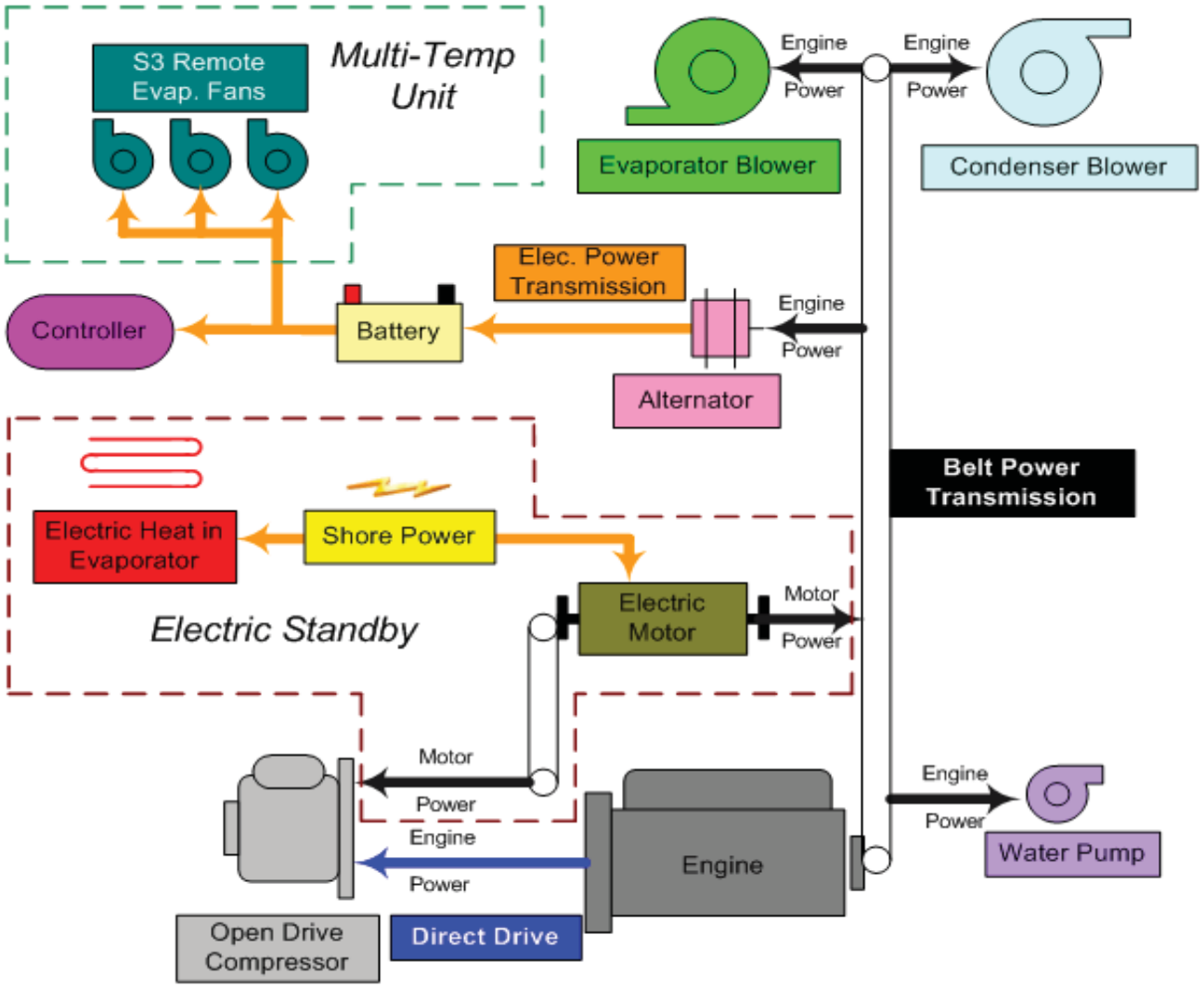
- Customer contextual interviews
- Primary and secondary VOC data
- Involvement and review with our dealer body (IDAC)
- Participation with our commercial sales and service teams

The team rationalized the design options to three:

- Direct drive compressor with a mechanically driven refrigeration system
- Direct drive compressor with a electrically driven refrigeration system
- Electrically driven compressor with a electrically driven refrigeration system

System Architecture

Option 1. Direct Drive Compressor with Mechanical Refrigeration System



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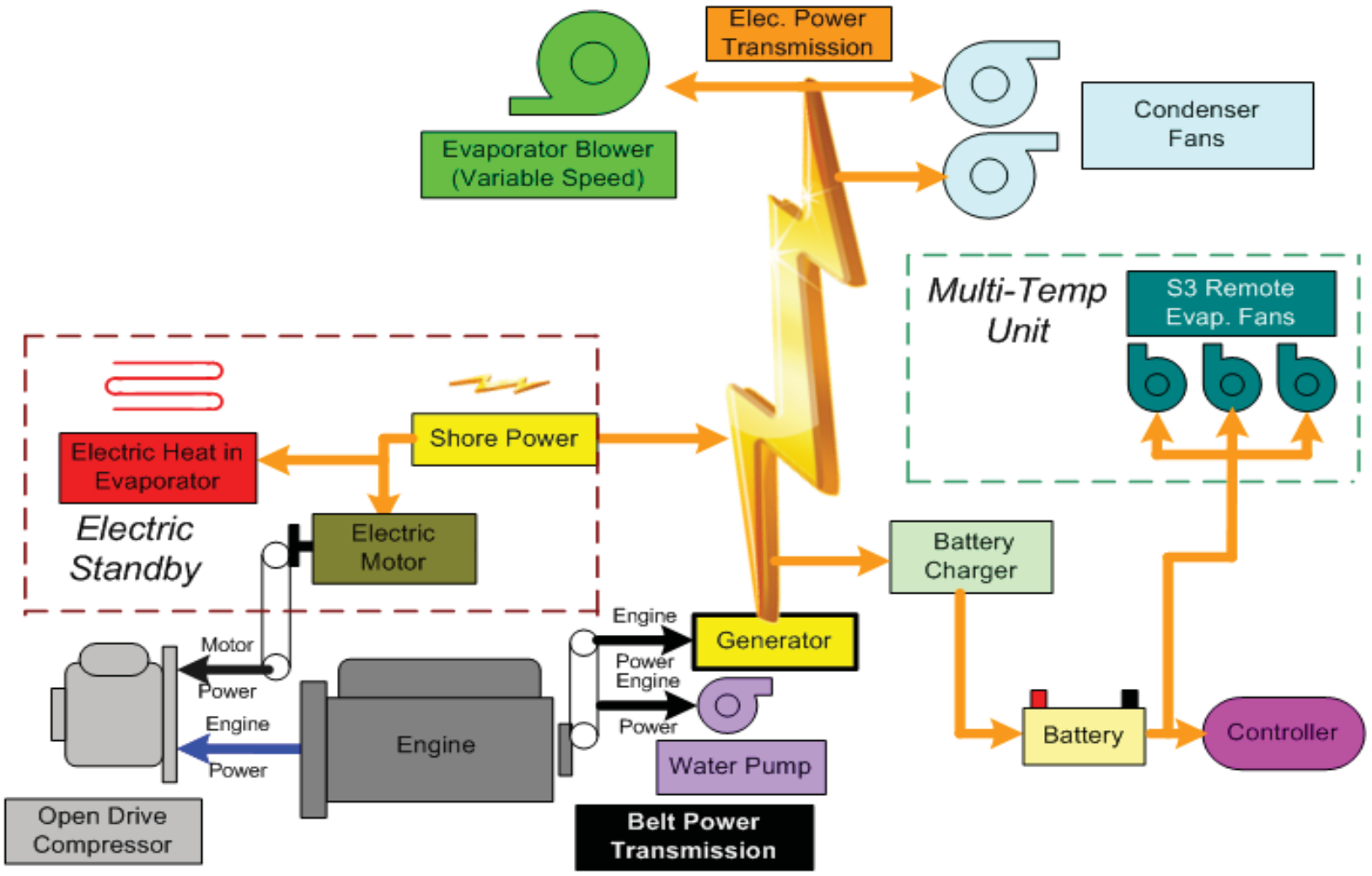
System Architecture

Option 2. Direct Drive Compressor with Electrical Refrigeration System



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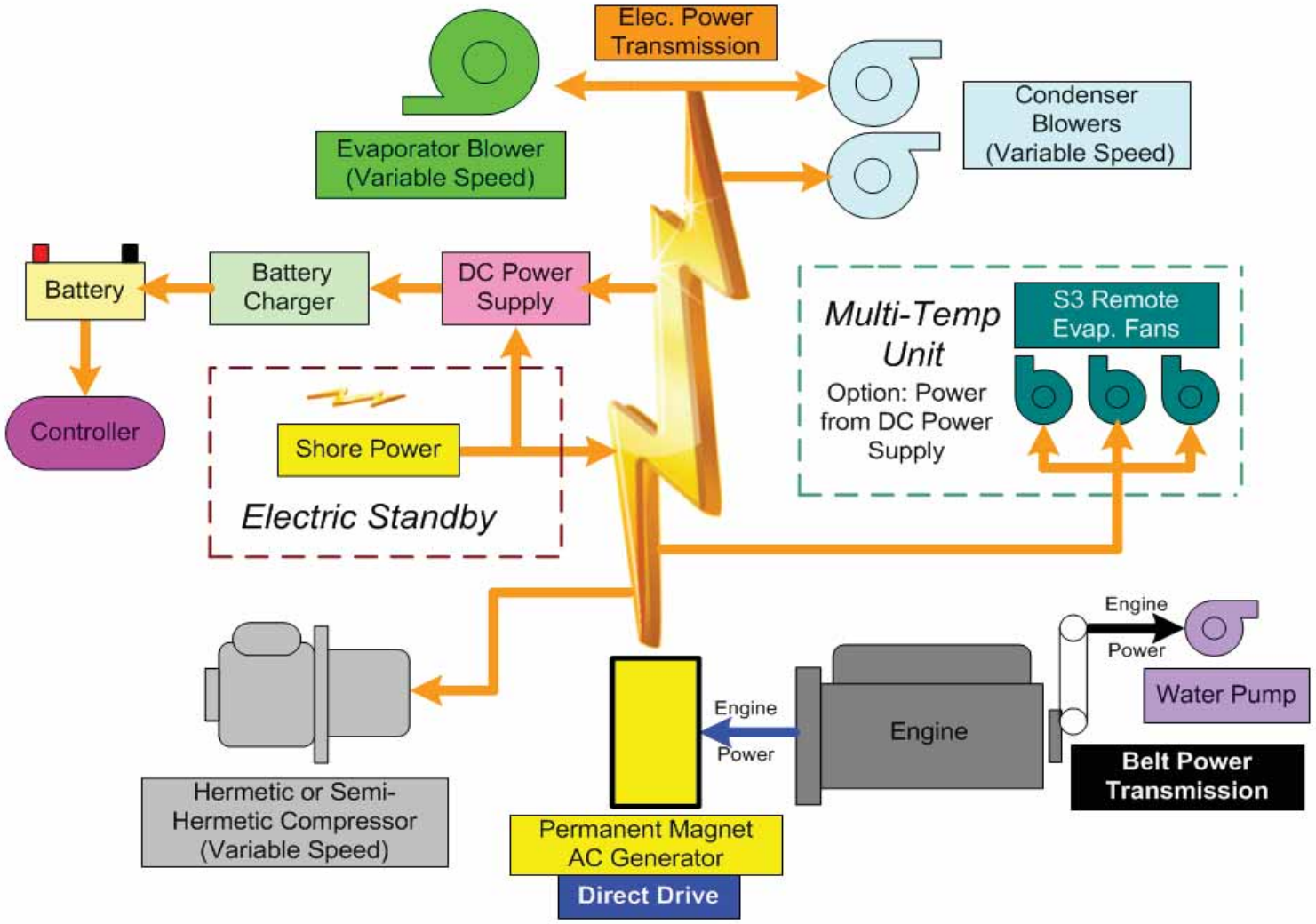
System Architecture

Option 3: Electrically Driven Compressor with Electrical Refrigeration System



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The Assignment - System Architecture

The team then investigated and analyzed the performance of a fully optimized design for each option. Using the matrix:

Performance was evaluated in a number customer criteria including:

Life Cycle Costs

- First Cost
- Operational Cost
- Maintenance Cost

Performance

- User Interface
- Cooling / Heating
- Environmental Sustainability

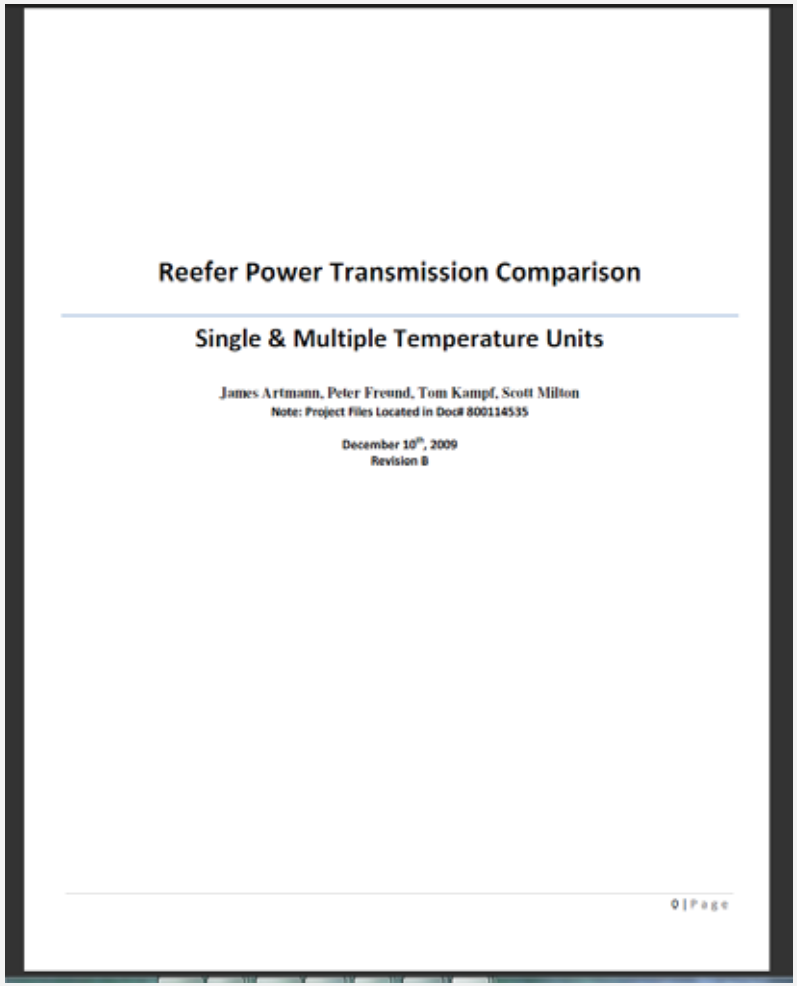
Performance was then weighted and scored across six market segments:

- Fleet Customers
- Owner Operators
- Leasing Companies
- Grocery Distribution
- Food Service Distribution
- Food Manufacturer

The Recommendation

The team's recommendation to leadership was for the development of design option 2.
A direct drive compressor with an electrical refrigeration system.

This recommendation was driven by option 2's performance in fuel efficiency, maintenance costs, unit operational flexibility and its adaptability to accept future design enhancements.


Reefer Power Transmission Comparison

Single & Multiple Temperature Units

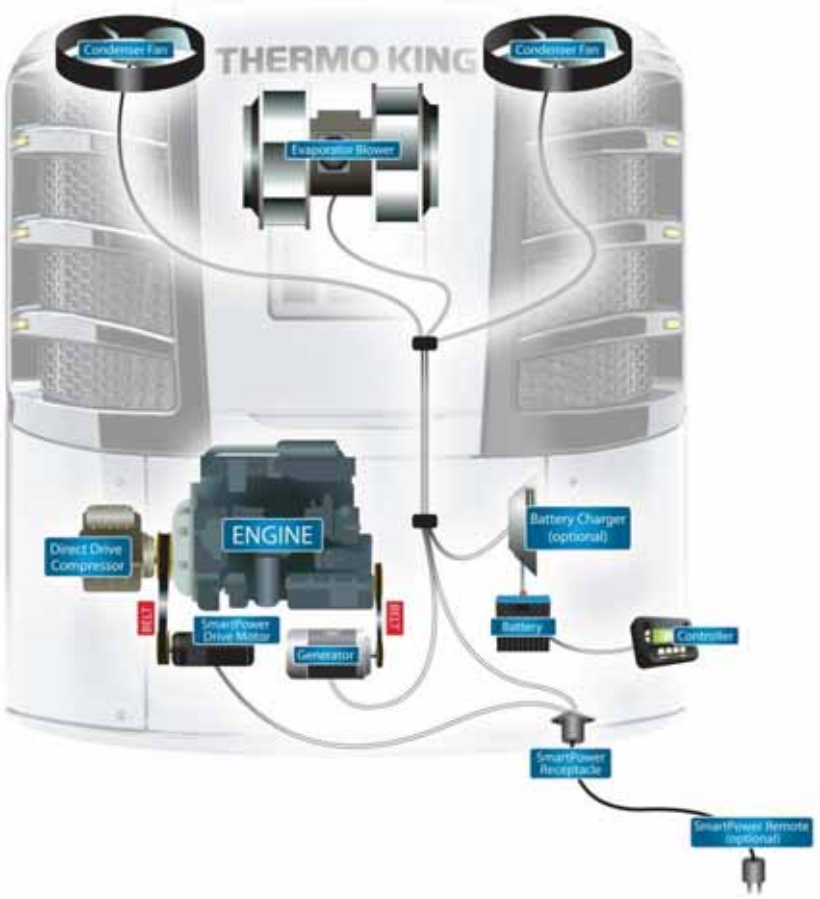
James Artmann, Peter Freund, Tom Kampf, Scott Milton
Note: Project Files Located in Doc# 800114535

December 10th, 2009
Revision B

0 | Page

Selected System Architecture

Diesel Direct Electric (DDE) Drives Optimum Efficiency



Precedent

A Look Inside

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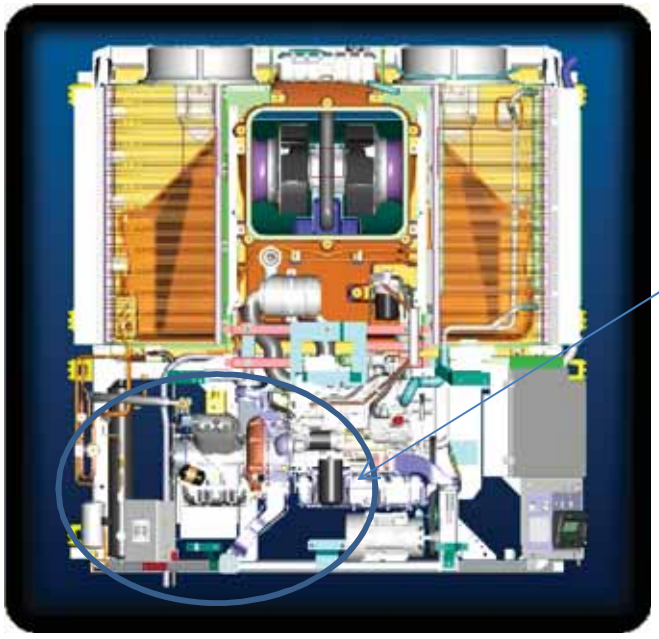
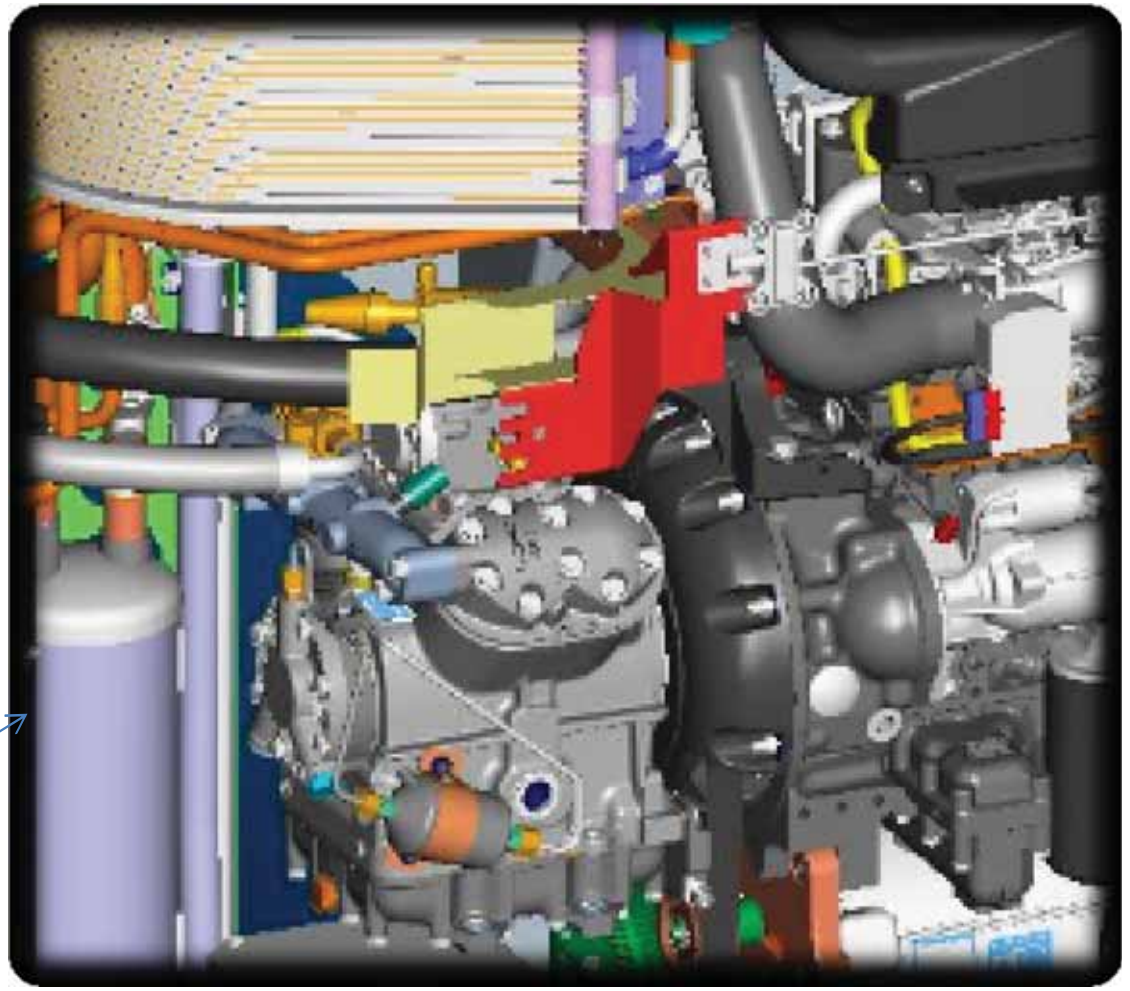
Precedent Compressor

Directly coupled to engine, delivering most efficient transfer of power.

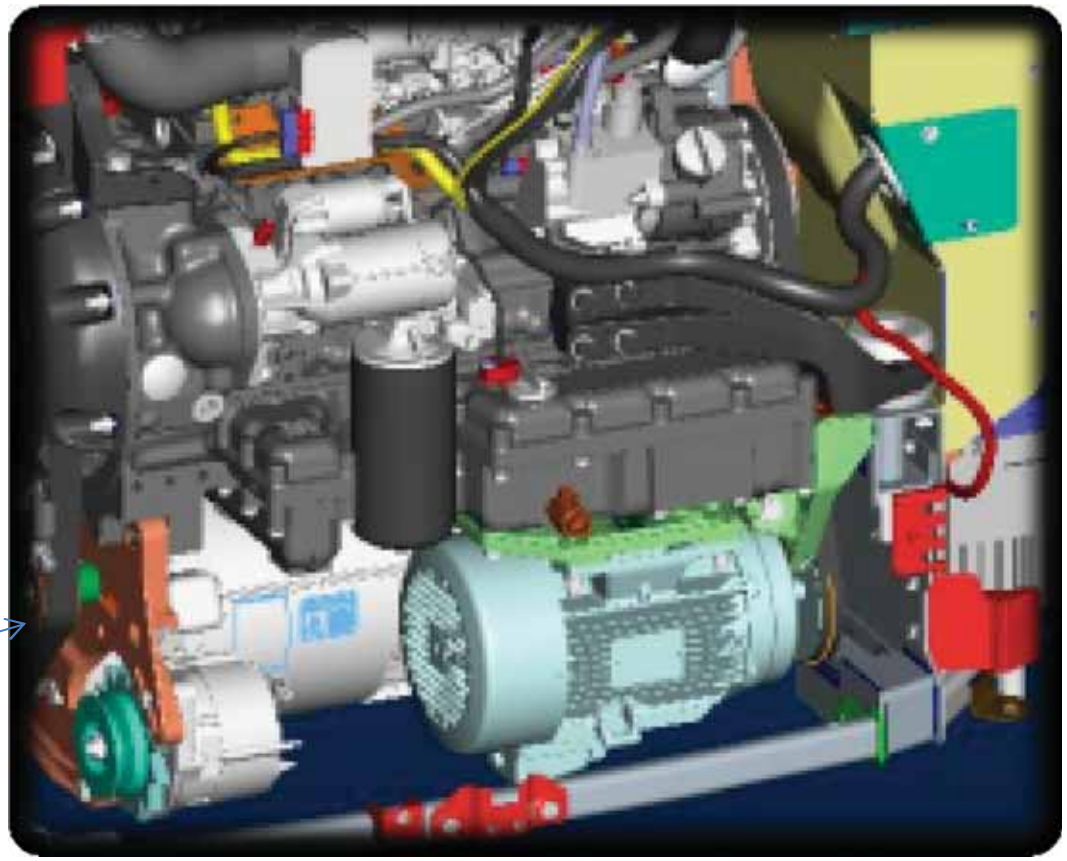




Precedent Generator

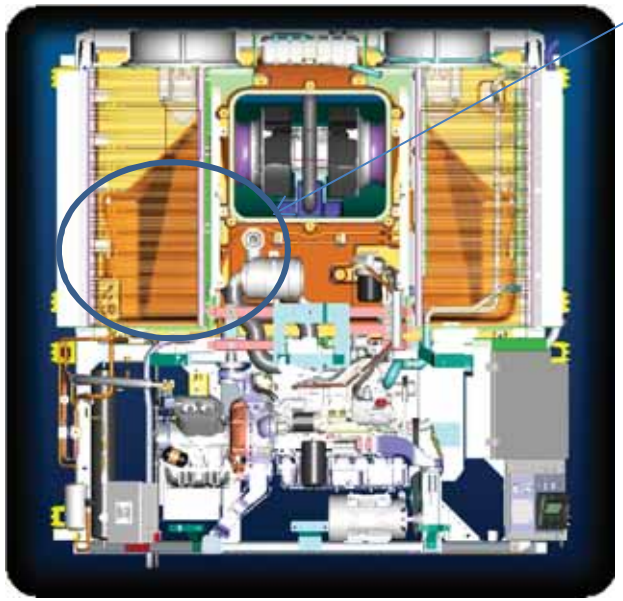
3.5 KW LS and 5.25 KW high-speed belt driven Permanent Magnet Generator.

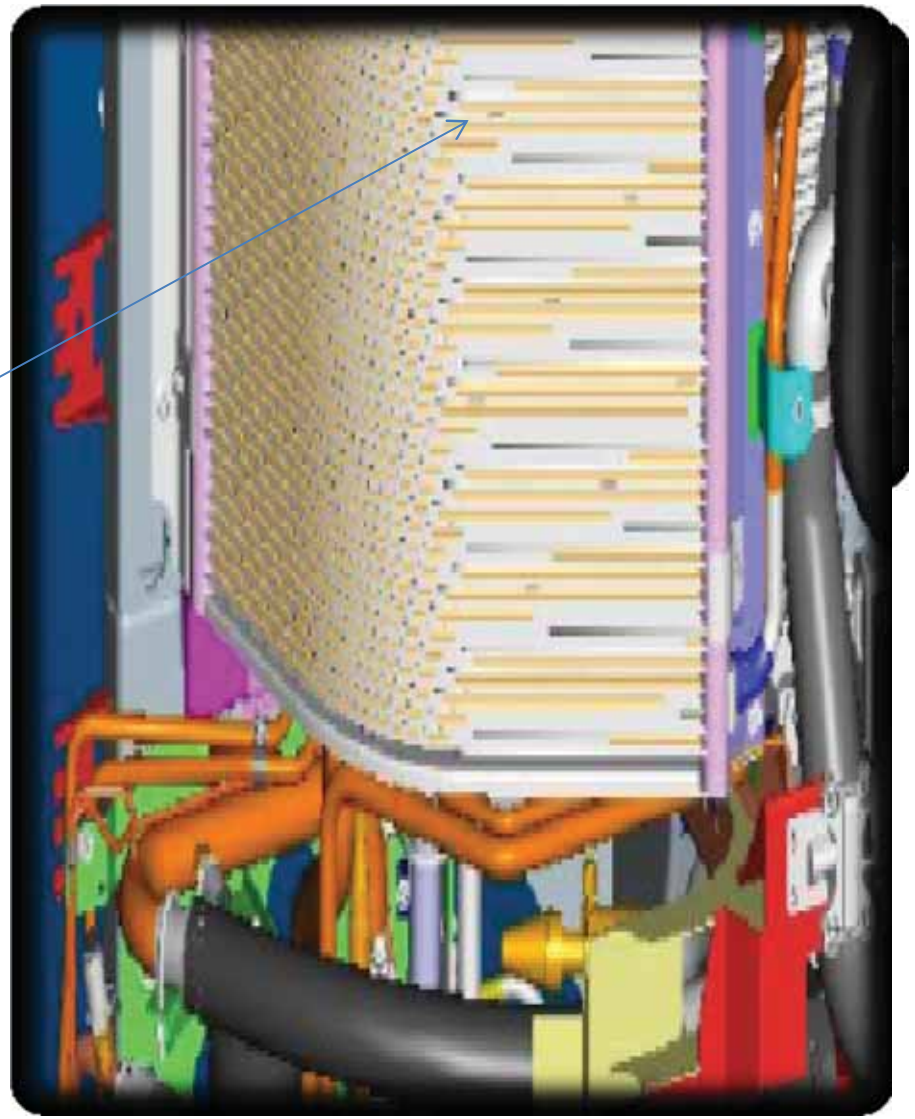
Belt driven generator allows the engine to be optimized to the compressor (primary draw) & generator – delivering maximum system efficiency.



Precedent Condenser Coils

- Dual extra-large microchannel condenser coils
- Superior high ambient performance
- Improves pull-down
- Reduces run time
- Maximizes efficiency, less fuel

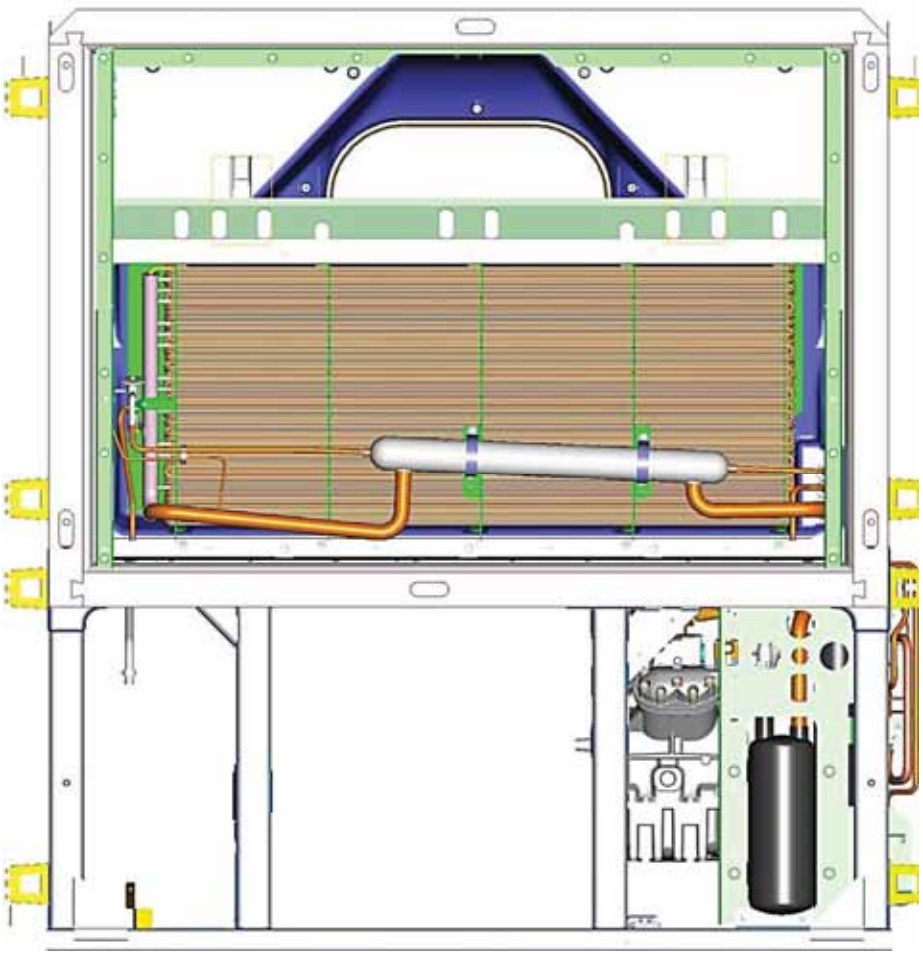


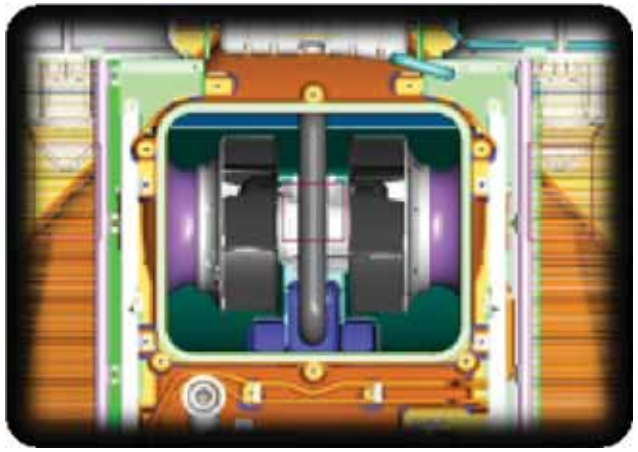


Precedent Condenser Fans

- Dual electrically controlled induction condenser fans
- Flexibility to meet broad spectrum of load conditions
- Optimize fuel consumption while meeting refrigeration demands
  - Both off
  - Both on
  - One off, one on

Precedent Evaporator

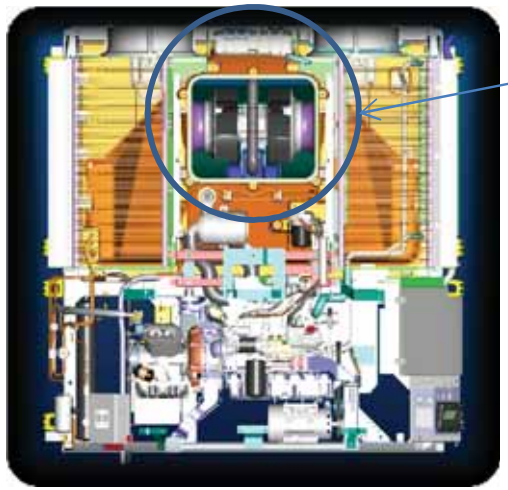


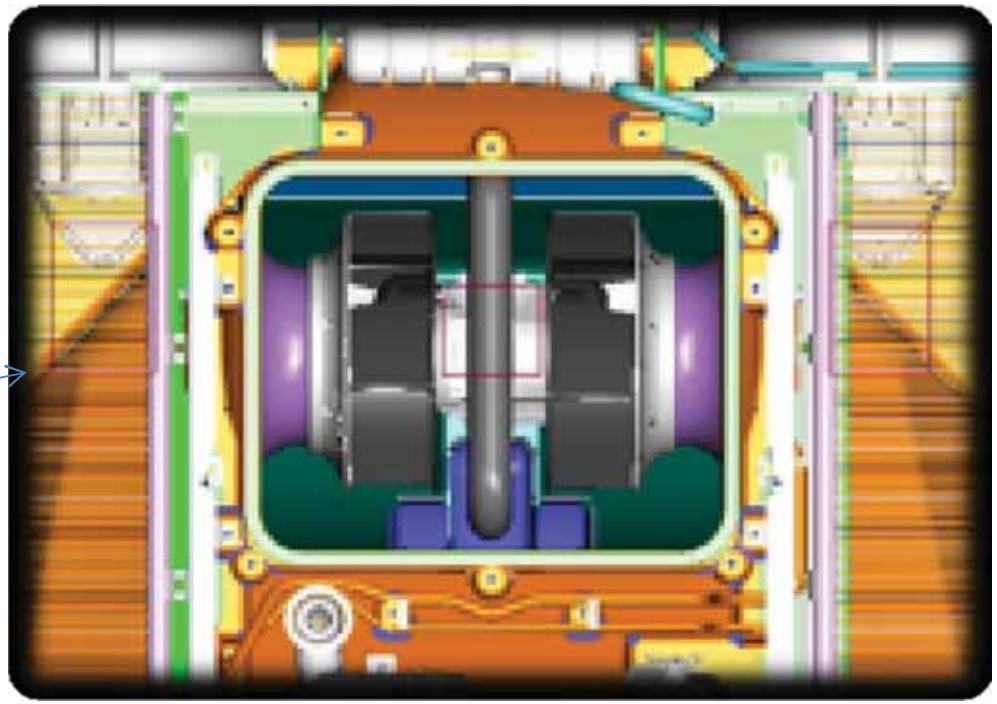


- Full width evaporator provides maximum coil surface area
- Maximizes performance
- Centralized air-discharge for optimal air delivery into trailer

Precedent Evaporator Fans

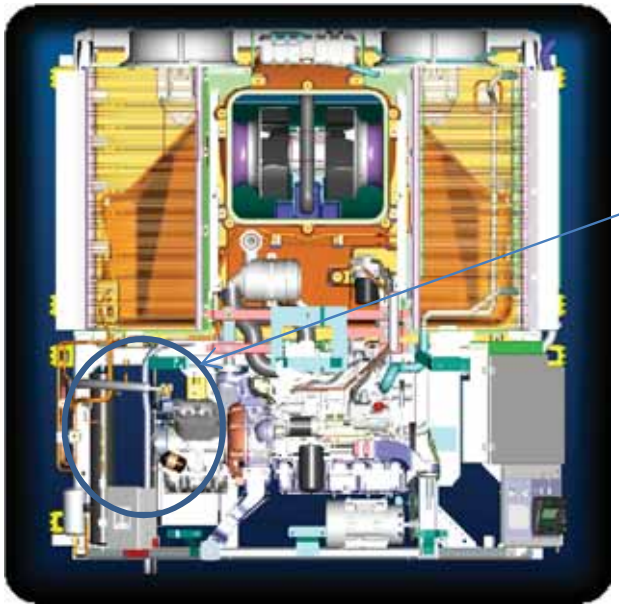
- Dual speed induction fan allows maximum air flow at both low and high engine speeds
- Improves fuel economy
- Performance advantages in certain fresh product applications
- Service access from front of trailer

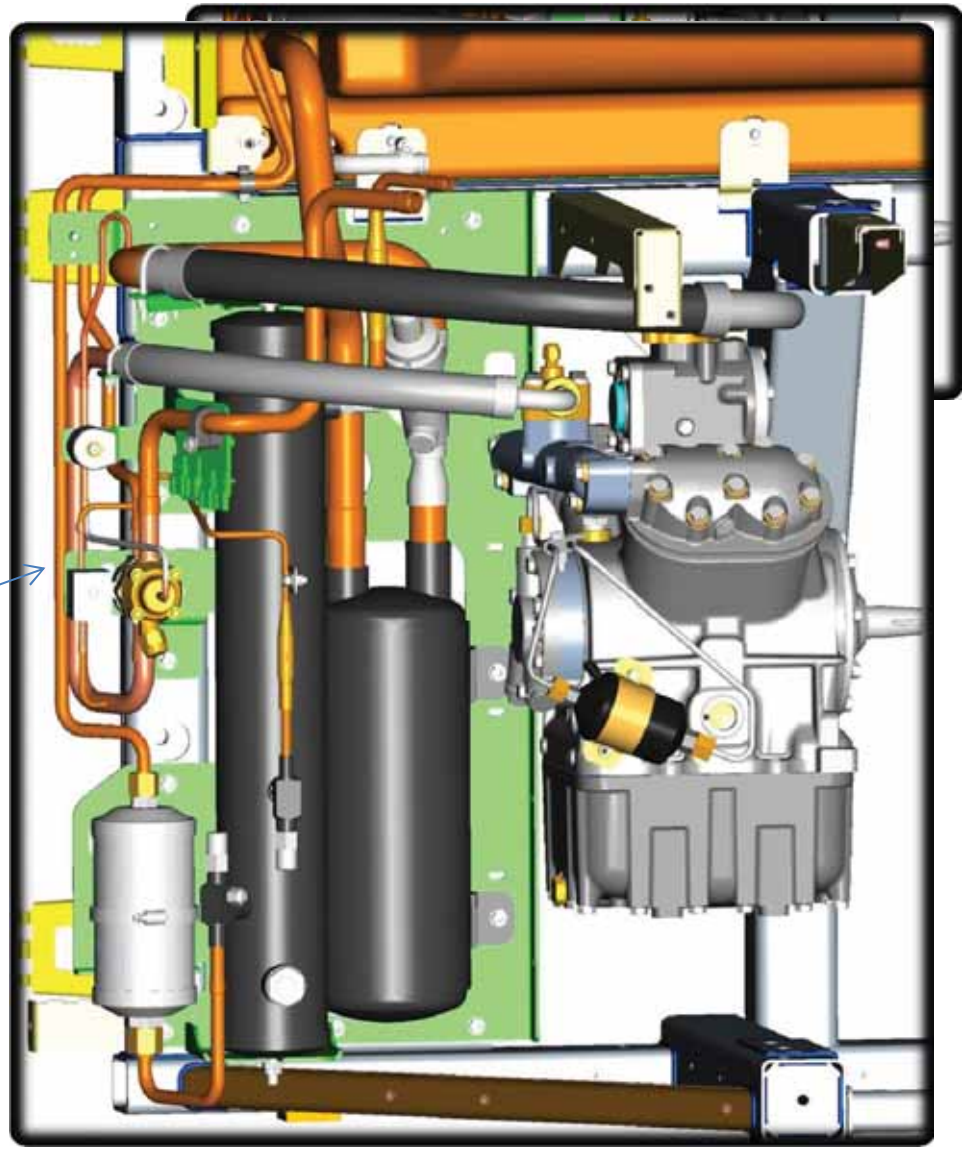




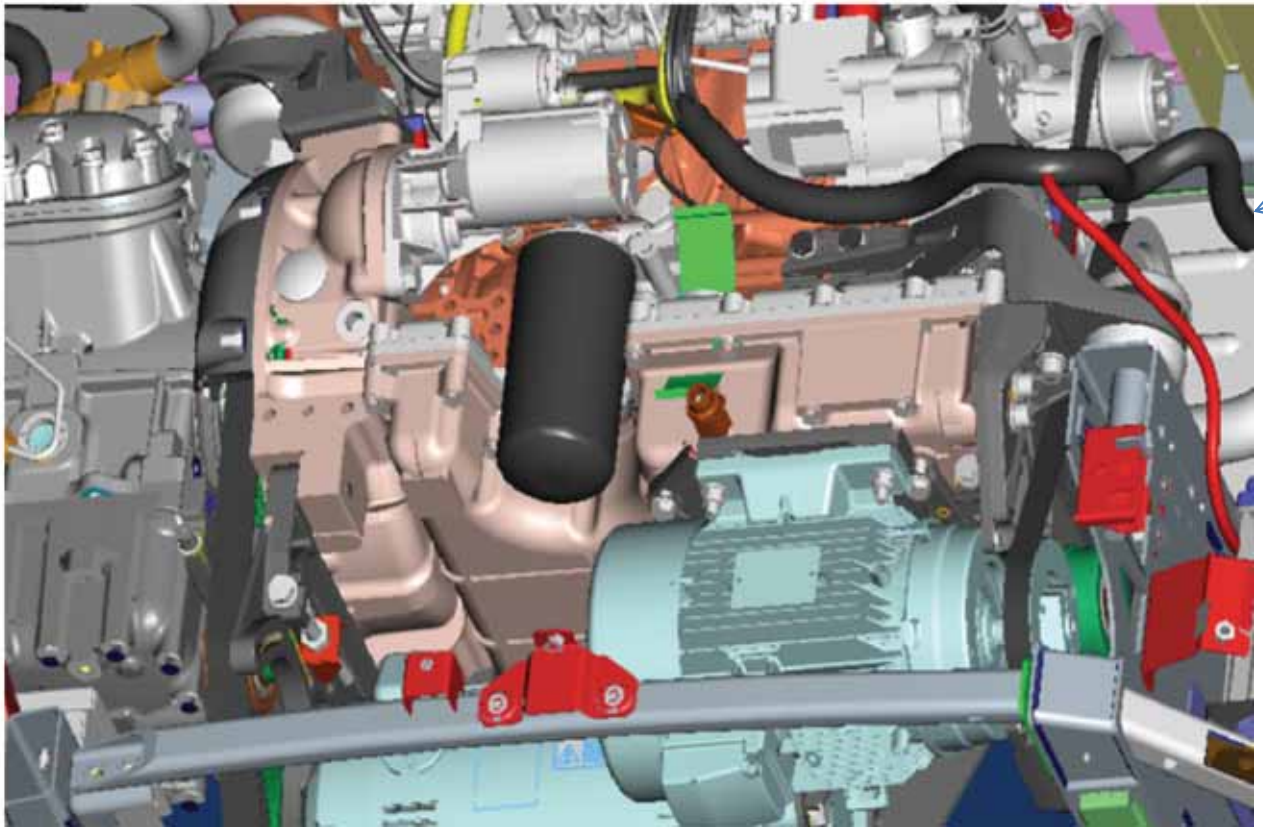
Precedent Refrigeration Module

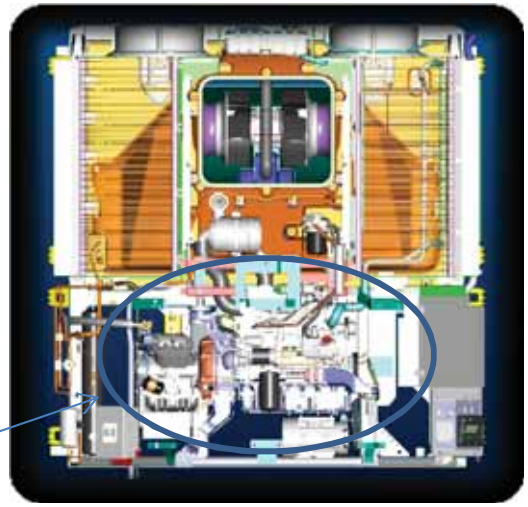
- All key refrigeration components located in one location
- Easily accessible for service and maintenance
- Piping runs minimized





Precedent Extended Component Life

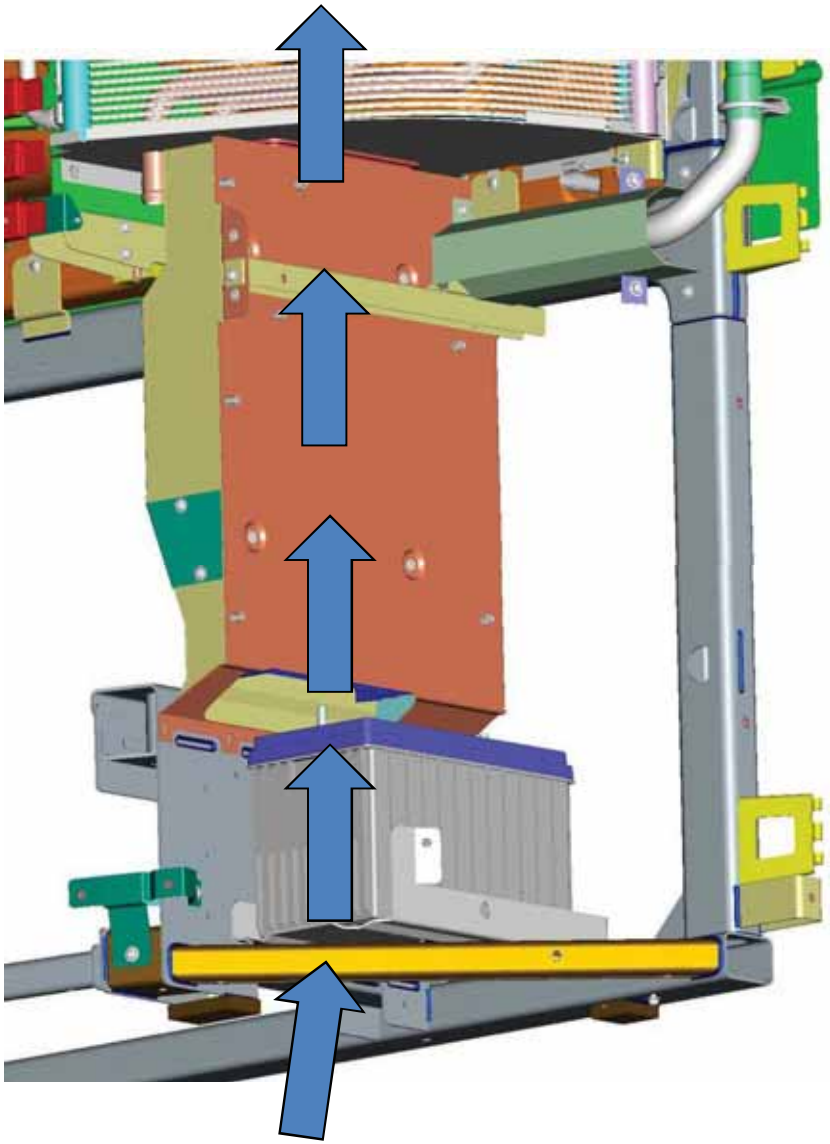




- All belts designed for 12K hour life
- Belts and SmartPower™ items covered under major component warranty

Precedent Cooling Channel

- Vented bottom panel
- Draws air in past battery
- Cooling channel for
  - ECU
  - Battery Charger
  - Battery
- Improved reliability & longevity



Precedent Electronics & Controls

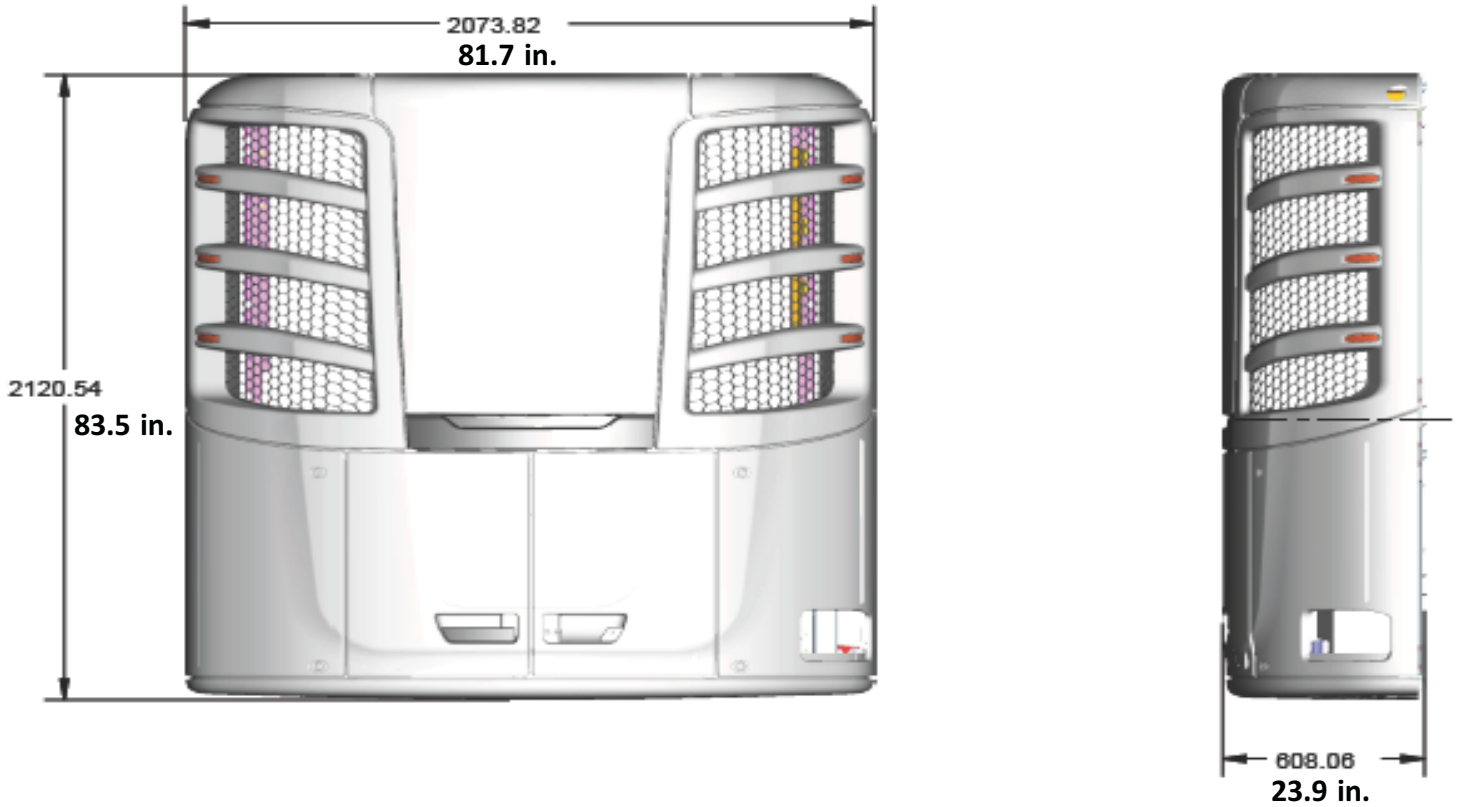
Modular Control System

1. SR-4 controller
2. Fan Contactors
3. Smart Power

All new SR4 Controller

Enhanced User Interface

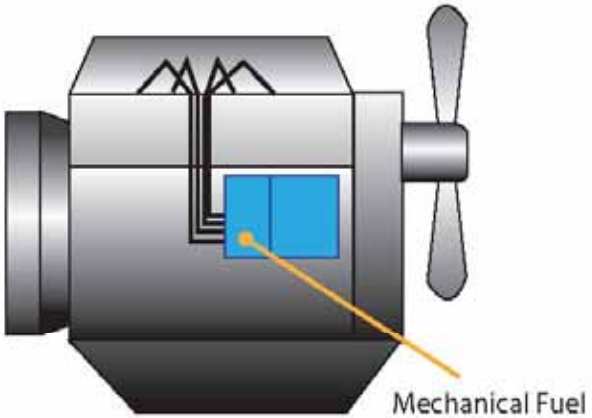
Dimensional Differences



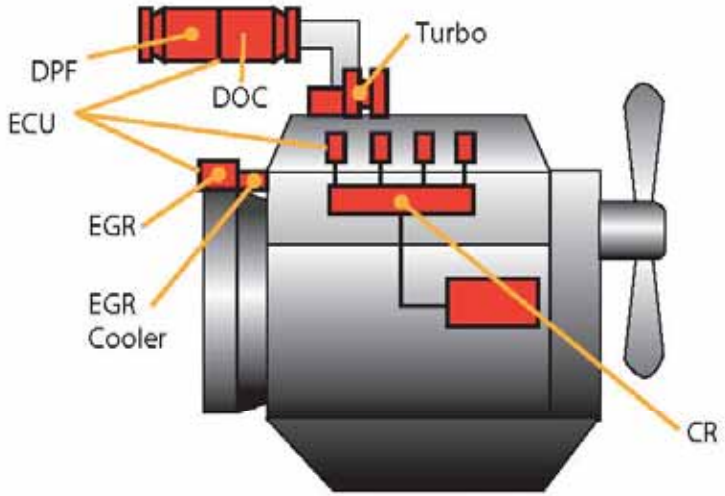
	Height	Width	Depth
Precedent	83.5”	81.7”	23.9”
SB	83.5”	76.1”	23.3”

The Engine Choices

Current vs TIER IV Final Engine Designs > 25hp



Current



Compliance Technology Options*

Terms and Abbreviations

CR - Common Rail fuel injection
PM - Particulate Matter (90% less diesel soot)
DOC - Diesel Oxidation Catalyst (catalytic converter)
EGR - Exhaust Gas Recirculation (cooled)

Turbo - Turbocharger
DPF - Diesel Particulate Filter (with active soot regen)
ECU - Engine Control Unit

*May include some or all of these technologies for compliance

Precedent Engines (Tier 4 Final)

S-600/S-700 (>25 hp)

C-600 (<25 hp)

2013 Single-Temp Models

Precedent

C-600

(<25Hp)

Precedent

S-600

(>25Hp)

SB

SB-230

(>25Hp)

EPA Compliant	EPA Compliant	EPA Compliant
CARB 7-Year Life to 2021	CARB Evergreen	CARB 7-Year Life to 2020

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Precedent

C-600

(<25Hp)

- Full EPA Compliance
- 7 year life in CA to 2021
  - Technologies available to extend life
- Precedent diesel direct electric (DDE) architecture w/ 430 recip
- Smart Power Available
- Smart Power Prep Available
- Reduced maintenance costs
- Increase residual value vs. SB

Precedent

S-600

(>25Hp)

- Full EPA Compliance
- Evergreen in CA
- Industries most environmentally friendly solution
- Precedent diesel direct electric (DDE) architecture
- Smart Power Available
- Smart Power Prep Available
- Trade cycle flexibility
  - Extended trade cycle
- Increase residual value vs. SB and C-600

SB

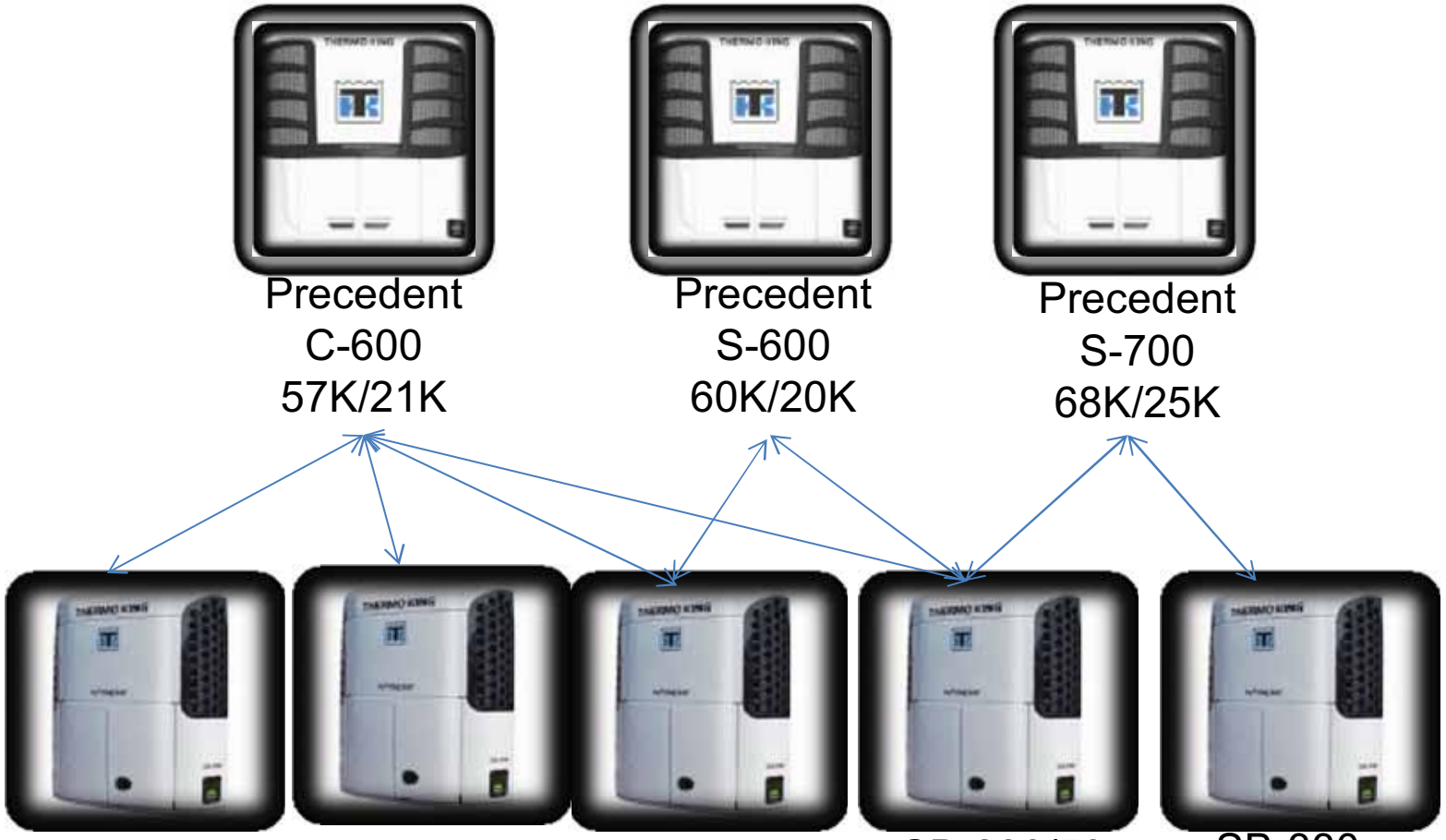
SB-230

(>25Hp)

- Full EPA Compliance
- Evergreen in CA to 2020
- Traditional all-mechanical

SB vs. Precedent Model Line Up

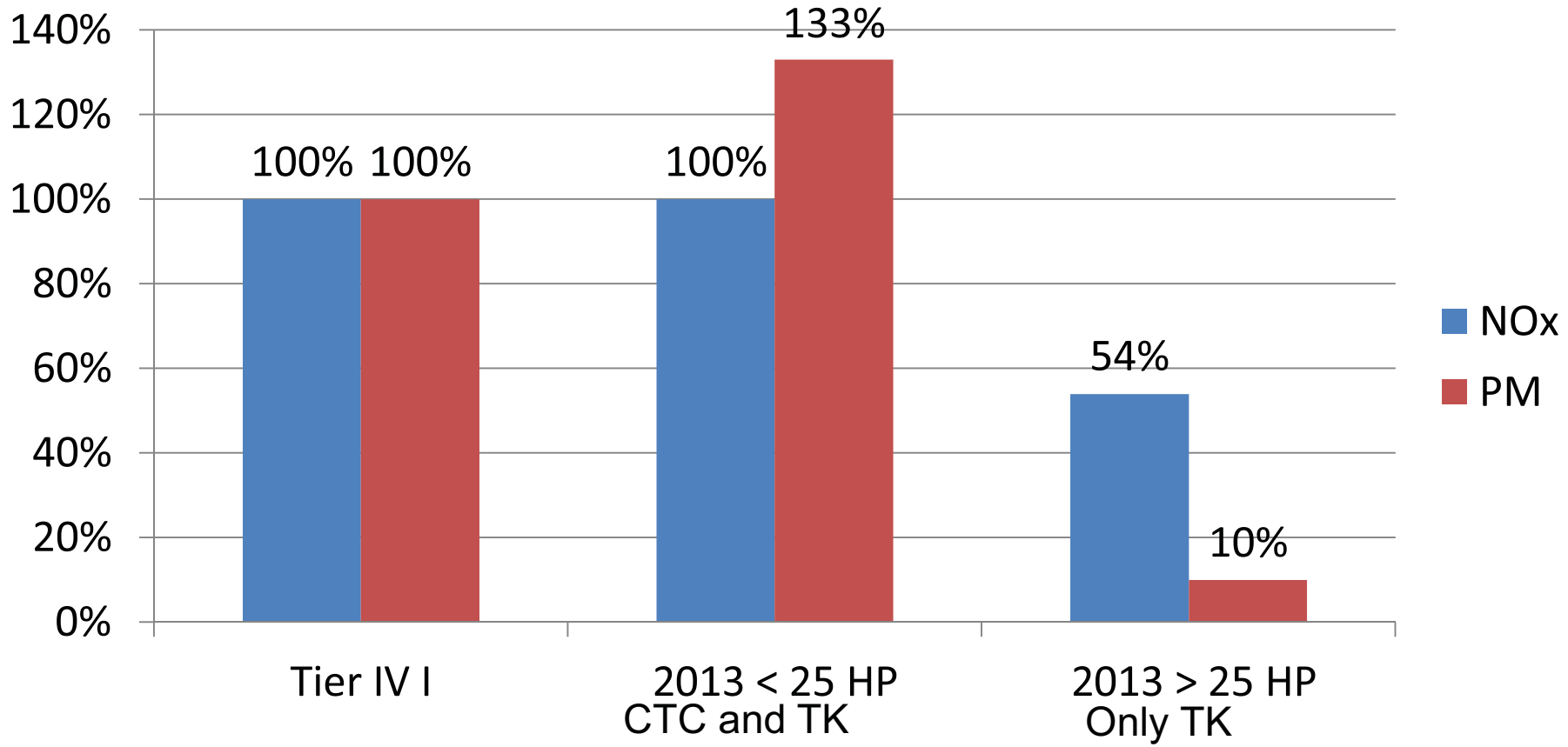
(Capacity at 35/100 & -20/100*)



* Preliminary data

2013 Emissions Reduction

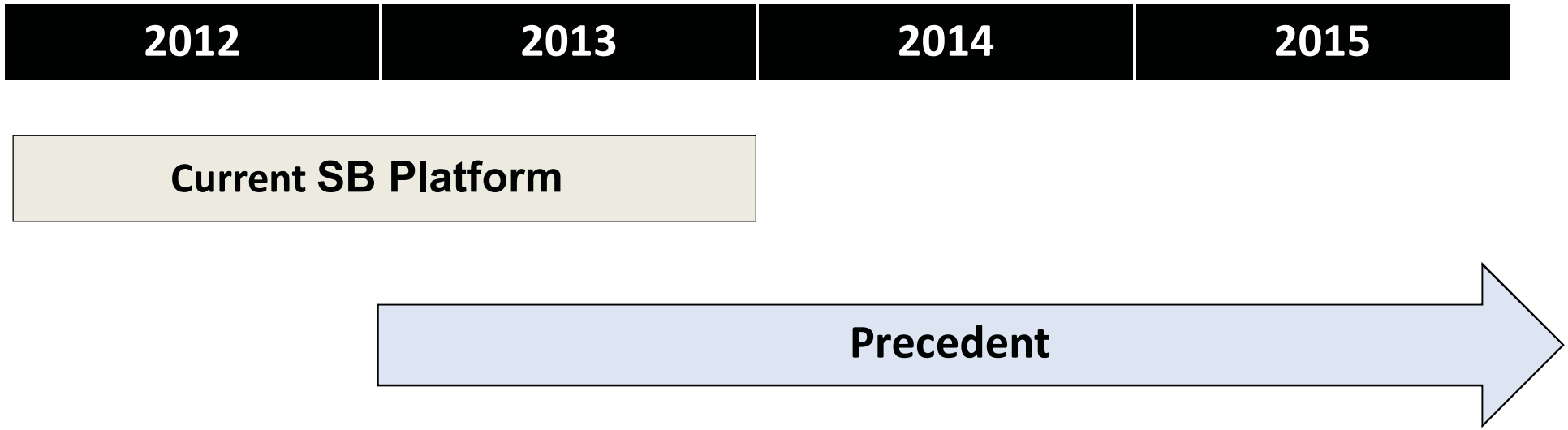
(Regulatory Levels)



Precedent offer choice of engine options to allow you to select an emissions output that complies to different engine standards.

Precedent Unit Configuration

Thermo King elected to phase out the SB platform to allow you the opportunity to phase the Precedent platform into your operations.



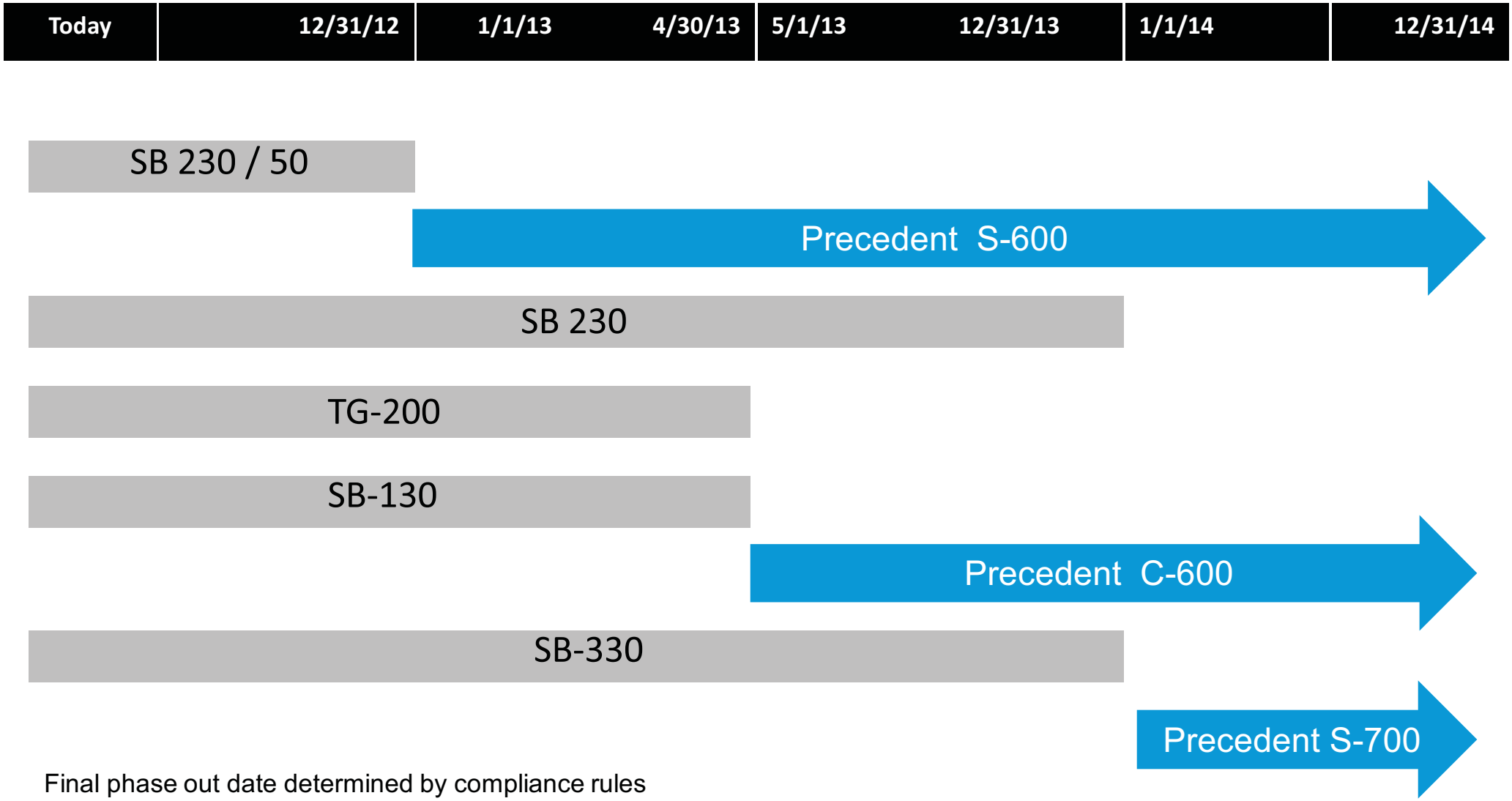
CARB and the EPA (Tier IV I)

Unit Model Year

Calendar Year	2011	2012	2013	2014	2015	2016	2017	2018	2019
2012	X								
2013	X	X							
2014	X	X	X						
2015	X	X	X	X					
2016	X	X	X	X	X				
2017	X	X	X	X	X	X			
2018	X	X	X	X	X	X	X		
2019	X	X	X	X	X	X	X	X	X
2020			X						
	>7	7+	7+	5+	4+	3+	2+	1+	<1

All Engines in 2012 and after will be 2012 Engines (SB Platform)

Precedent Phase in – SB Phase out (ST)



Final phase out date determined by compliance rules

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The Precedent Message

Compliance Choices without Compromising Performance

Providing industry-leading heating and cooling capacity without the uncertainty of future compliance

Choices for Today and Tomorrow

A range of product configurations and options allow you to transition to the new platform, when the time is right, based on the specific needs of your business

Double-Digit Fuel Savings

Diesel Direct Electric (DDE) architecture engineered specifically to deliver double-digit fuel savings in real-world applications

Thermo King Peace of Mind

Industry's largest and most reliable dealer network, combined with lowest lifecycle cost solutions, confirm you have made the smartest long-term decision for your fleet


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