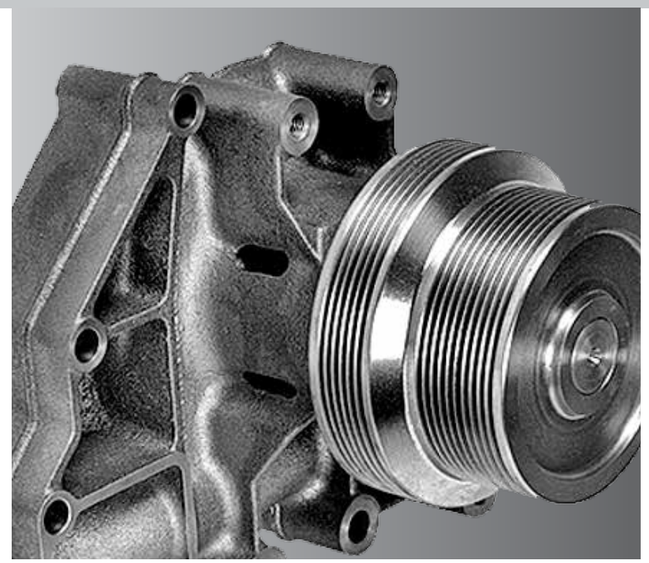
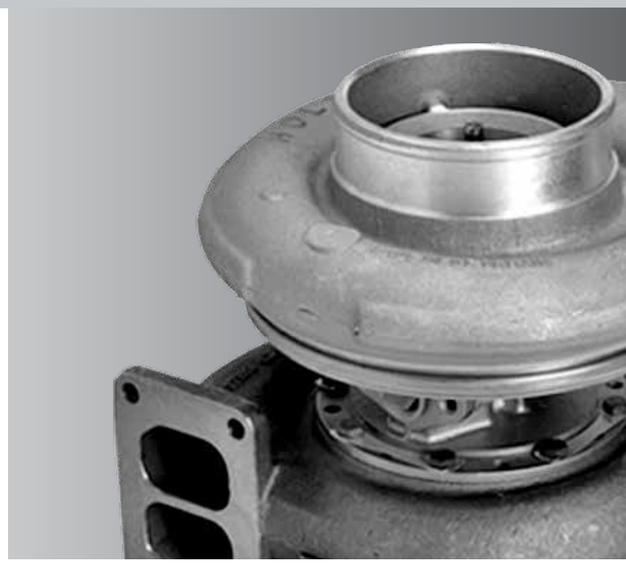




Parts Professional 66

ISX Product Improvements: Connecting Rod and Cylinder Liner

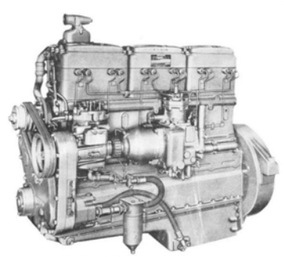
INTRODUCTION

Throughout its history, Cummins has been a leader in the on-highway, heavy-duty trucking industry. As far back as the 1930's, when Cummins introduced its first heavy-duty trucking engine, the company has always strove to lead and innovate in this field. These innovations have paved the way for Cummins to continually improve its industry-leading engine today, the ISX.

A HISTORY OF INNOVATIONS

This brief timeline of the history of Cummins engines and components used in the on-highway, heavy-duty trucking industry shows the tremendous leaps in innovation Cummins has contributed over the years leading up to the ISX.

(Click on each engine or component to learn about its history and innovations)



H Series

1932

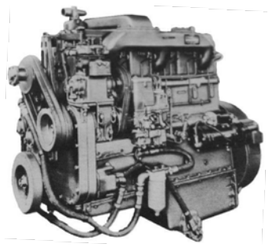
PT Fuel Pump

1945

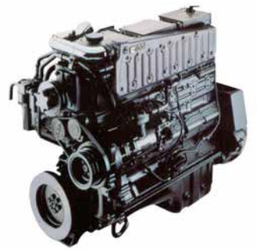
NT 743

1955

NH



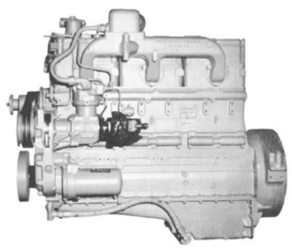
1960



Big Cam

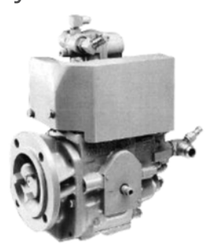
1977-1984

NH/NT 855



1987

Early Electronics



1990

N14

1999

ISX

A HISTORY OF INNOVATIONS

This brief time
on-highway, h
Cummins has

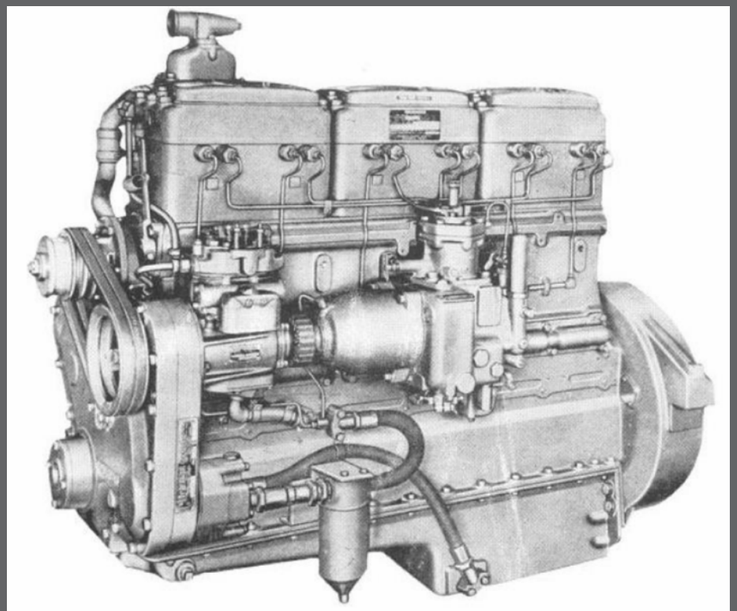
(Click on each en

H Series

1932

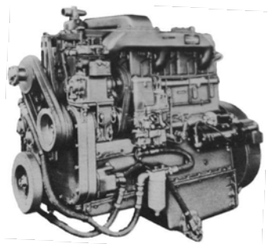
H-Series Engine
(672 cubic inches)

Production of the H-Series engine began in 1932. It was the engine in the first diesel-powered truck sold in North America. The engine was made famous by promotional events, such as running 14,600 miles non-stop on the Indianapolis Motor Speedway and a cross-country New York to Los Angeles trip made in 78 hours. Rated 150 hp at 1800 rpm, a key early innovation was the 1937 addition of supercharging which boosted output to 200 horsepower.



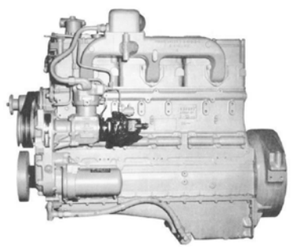
1945

NH



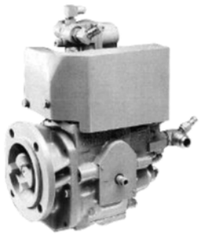
1960

NH/NT 855



1987

Early Electronics



1999

ISX

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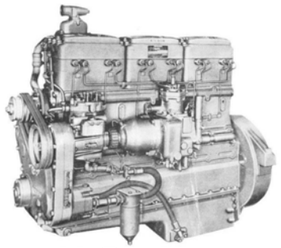
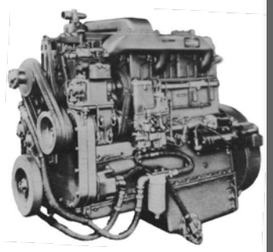


H Series

PT Fuel Pump

1932 — 1 — 1945

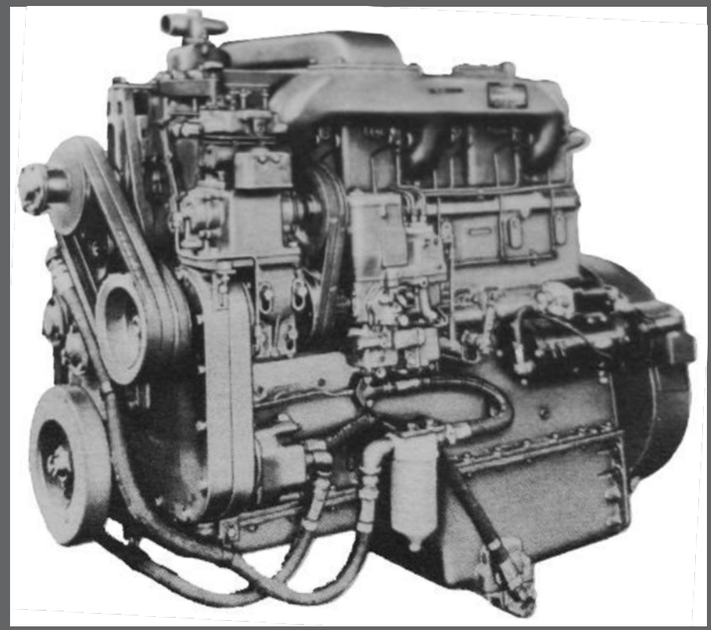
NH



NH Engine
(743 cubic inches)

Production of the NH began in 1945. Its innovations included an increase in bore as well as a four-valve head which improved air handling. Capable of running at higher speeds, it was rated 200 hp at 2100 rpm. The supercharged variant delivered 275 hp; with the 1949 introduction of the double-disc distributor fuel pump, power was up to 300 hp.

X



Engine pictured is the 300 hp NHRBS-600

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(Click on each engine or comp

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1932

1945

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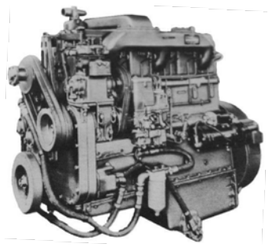
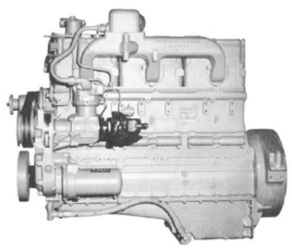


1960

NH/NT 855



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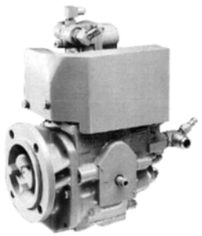

1999

ISX

Pressure-Time (PT) Fuel System

The landmark PT Fuel System was introduced in 1954. The versatile PT pump was far smaller, 80% lighter, and vastly less complex than the single-disc distributor pumps. It would serve on nearly every Cummins engine for over 50 years to come.

X

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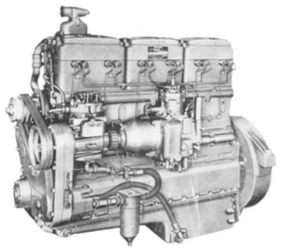

H Series

1932

1945

PT Fuel Pump

1955

NT 743

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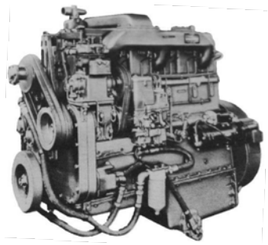
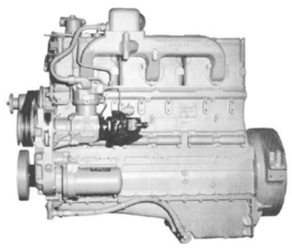


1977-1984

NH/NT 855



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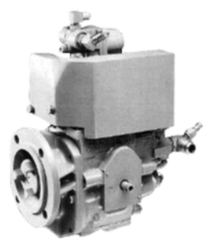
Early Electronics



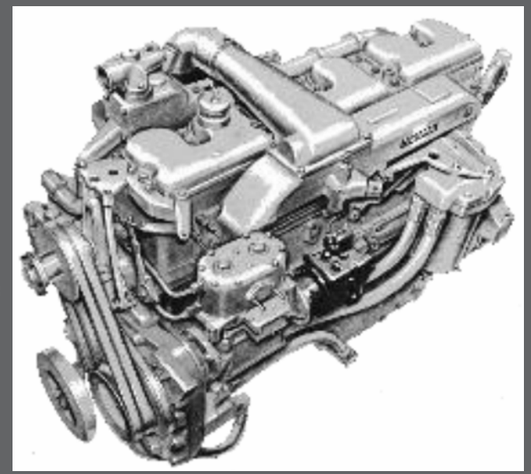
1990

1999

ISX

NT Engine
(743 cubic inches)

Production of the NT engine began in 1955. It's introduction of turbocharging helped yield power ratings as high as 335 hp at 2100 rpm.



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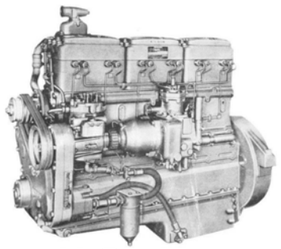

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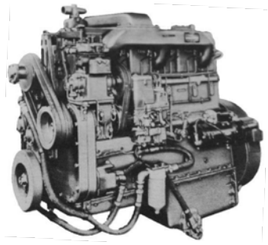
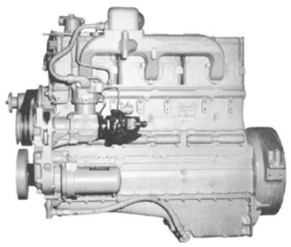


NH

1960



NH/NT 855

NH/NT 855

Production of the NH/NT 855 engine began in 1960. Featuring a further increase in bore, it was introduced at 250 hp naturally aspirated. Various higher turbocharged ratings were released throughout the ‘60s, culminating in 1970 with the NTA-370 (Cummins first aftercooled on-highway product). The NTA-400 followed the next year.

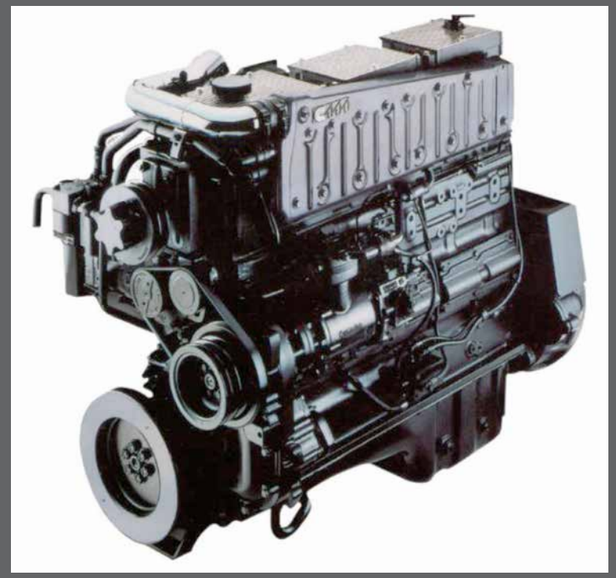
ISX Product Improvements:
Connecting Rod and Cylinder Liner

A History of Innovations

Big Cam

The Big Cam series embodied a host of fuel system and air handling improvements as well as reductions in parasitic losses. These changes allowed the engine to use less power to operate internal components, leading to significant improvements in fuel economy. These enhancements took place in a sequence of continuous improvements.

Big Cam I (1977), Big Cam II (1979), Big Cam III (1982), Big Cam IV (1984)



Engine pictured is a Big Cam IV

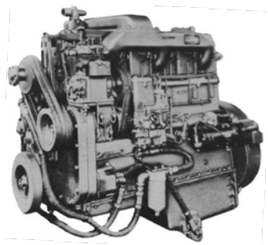
ines and components used in the
the tremendous leaps in innovation
up to the ISX.

and innovations)

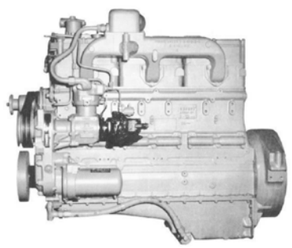
Big Cam

N14

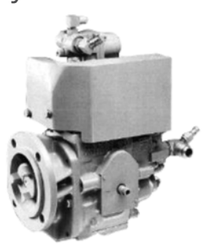
1945 — **NH**



1960 — **NH/NT 855**



1984 — 1987 — Early Electronics



1990 — 1999 — **ISX**

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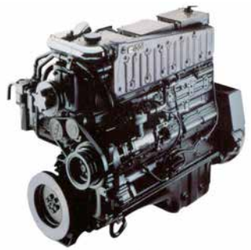

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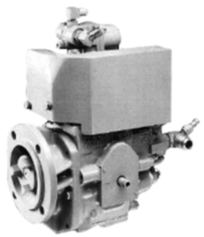
N14

1990

1987

1999

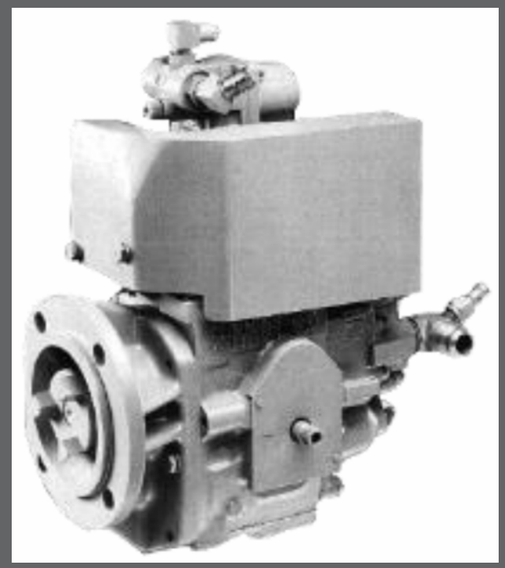
Early Electronics



ISX

Early Electronics

PACE (1987) and PT PACER (1989) were the earliest electronic controls for Cummins engines in the on-highway market. They were added to the Big Cam IV and offered cruise control and road speed governor features.



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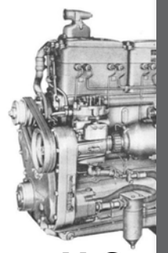


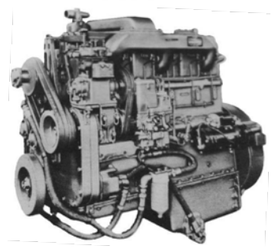
H Ser

N14

1932 990

1945

NH



1960

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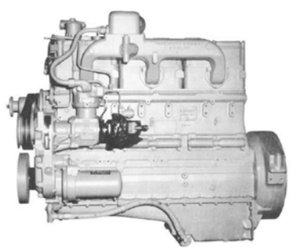

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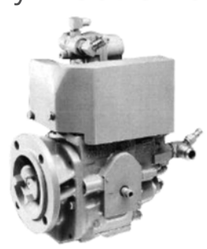

1999

ISX

N14

The N14 was introduced in 1990. It included full authority electronic controls and marked Cummins first use of air-to-air aftercooling. It has the highest on-highway power ratings ever in this family of engines. The power ratings were 460-525 horsepower.

X

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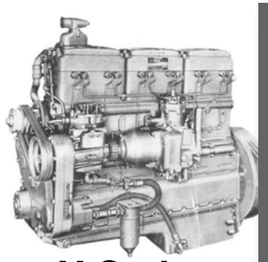

H Series

1932

194

ISX

Introduced in 1999, the ISX made significant improvements on emissions controls for on-highway engines. It eventually introduced the variable geometry turbocharger as well as the XPI fuel system. It is the industry-leading engine for on-highway trucking today.

1999

ISX

THE ISX EVOLUTION

As the requirements of the heavy-duty trucking industry have changed and emissions standards have continued to tighten, the technology of the ISX has evolved. End users require an engine that provides optimum power that can also meet emissions standards. As a result of this need, the technology of the components to support the engine has continued to evolve. Take a look at the chart below to see the critical components in the ISX engine and how they have evolved since the engine was released.

ISX Product Timeline for North America

Years	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Emissions	EPA 1998				EPA 2002					EPA 2007			EPA 2010			EPA 2013		
ECM	CM570				CM870					CM871			CM2250			CM2350		
Block	Standard																	
Head	Dual Cam												Single Cam					
Fuel System	HPI												XPI					
Turbo	Wastegate				Variable - Pneumatic					Variable - Electronic								
EGR	N/A				Yes													
DPF	N/A									Yes								
SCR&DOC	N/A												Yes					
Liners	150mm												150/152mm		150mm			
Con Rod	Saw Cut														Saw Cut / Fracture Split	Fracture Split		

Now let's learn about the improvements highlighted in this training.

66

PARTS PROFESSIONAL

ISX Product Improvements:
Connecting Rod and Cylinder Liner

Connecting Rod

CONNECTING ROD: FRACTURE SPLIT VS. SAW CUT

The connecting rod is subjected to a great amount of stress during engine operation due to the alternating load associated with the up and down movement of the piston in the cylinder. We will learn about what Cummins is using to improve the strength of the connecting rod, but first lets test your knowledge of the connecting rod.

Connecting Rod

(Guess each part of the connecting rod before clicking on the name at left to find out part type)

Connecting Rod Cap

Crankshaft Journal

Piston Pin Journal

Rod bolts

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Connecting Rod
(the entire assembly)

(Guess each part of the connecting rod before clicking on the name at left to find out part type)

Connecting Rod Cap

Crankshaft Journal

Piston Pin Journal

Rod bolts

Back

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Connecting Rod

(Guess each part of the connecting rod before clicking on the name at left to find out part type)

Connecting Rod Cap

Crankshaft Journal

Piston Pin Journal

Rod bolts

Back

Connecting Rod

CONNECTING ROD: FRACTURE SPLIT VS. SAW CUT

Advancements in manufacturing technology have allowed Cummins to utilize the fracture split manufacturing method in the ISX12 and ISX15 engine's connecting rods. The saw cut manufacturing method for the connecting rods is also still utilized in Cummins engines. See below the differences in each and what benefits the fracture split method adds.

(Click on red boxes below to see definitions)

Benefits of Fracture Split Rods

(Click on each benefit to learn more)

CONNECTING ROD: FRACTURE SPLIT VS. SAW CUT

Advancements in manufacturing technology have allowed Cummins to utilize the fracture split manufacturing method in the ISX12 and ISX15 engine's connecting rods. The saw cut manufacturing method for the connecting rods is also still utilized in Cummins engines. See below the differences in each and what benefits the fracture split method adds.

(Click on red boxes below to see definitions)

Saw Cut X

The manufacturing method that directly saws the rod to create a smooth, machined finish on the face of the connecting rod and connecting rod cap mating surfaces.

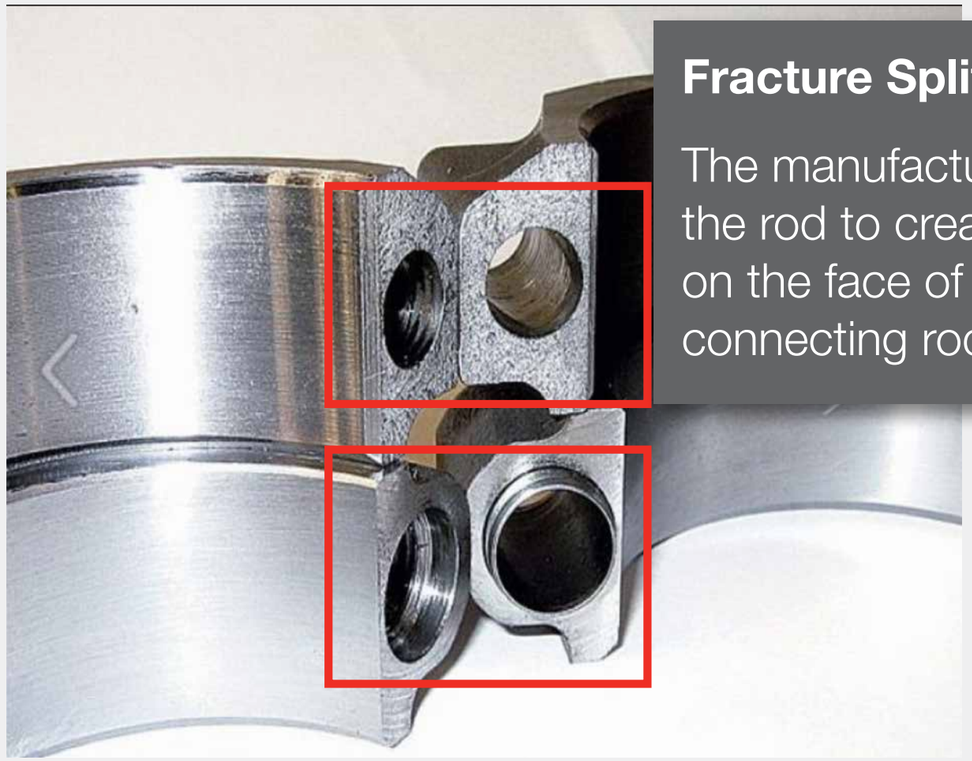
Benefits of Fracture Split Rods

(Click on each benefit to learn more)

CONNECTING ROD: FRACTURE SPLIT VS. SAW CUT

Advancements in manufacturing technology have allowed Cummins to utilize the fracture split manufacturing method in the ISX12 and ISX15 engine's connecting rods. The saw cut manufacturing method for the connecting rods is also still utilized in Cummins engines. See below the differences in each and what benefits the fracture split method adds.

(Click on red boxes below to see definitions)



Fracture Split

X

The manufacturing method that fractures the rod to create a rough, uneven finish on the face of the connecting rod and connecting rod cap mating surfaces.

t Rods

arn more)

CONNECTING ROD: FRACTURE SPLIT VS. SAW CUT

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(Click on red boxes below to see definitions)

Provides more contact area X

The fracture of the connecting rod creates a unique, uneven mating surface between the connecting rod and the connecting rod cap, which results in more contact area between mating components.

Connecting Rod

CONNECTING ROD: FRACTURE SPLIT VS. SAW CUT

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(Click on red boxes below to see definitions)

Decreases joint movement and fretting

The uneven mating surface creates more points of contact between mating components, resulting in decreased joint movement and fretting.

X

Connecting Rod

CONNECTING ROD: FRACTURE SPLIT VS. SAW CUT

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Durability X

This durability comes from the fracture split joint providing a high shear strength (resistance to slip in the plane of the joint) due to interlocking of the uneven mating surfaces.

CONNECTING ROD: FRACTURE SPLIT VS. SAW CUT

Although the methods of manufacturing are different for fracture split connecting rods and saw cut connecting rods, they can still be utilized in the same engine. When this occurs, there a few critical things to remember about how to identify and handle the different rods.

Fracture Split

Saw Cut

Fracture split connecting rods and saw cut connecting rods require different bearings. The oil drilling for each type of bearing is different; they are not interchangeable.

(Note the difference in the pictures above)

For more information please refer to: TSB120067 (QuickServe login required)

CONNECTING ROD: FRACTURE SPLIT VS. SAW CUT

Now that you know how to identify each type of rod, it is important to learn how to handle and assemble the parts appropriately. The following should be kept in mind:

1. Each fracture split connecting rod must be matched with its corresponding rod cap as the surfaces are unique and must be matched the same way each time they are assembled. Both the rod cap and the connecting rod are serialized on one face to make sure of proper orientation.

CONNECTING ROD: FRACTURE SPLIT VS. SAW CUT

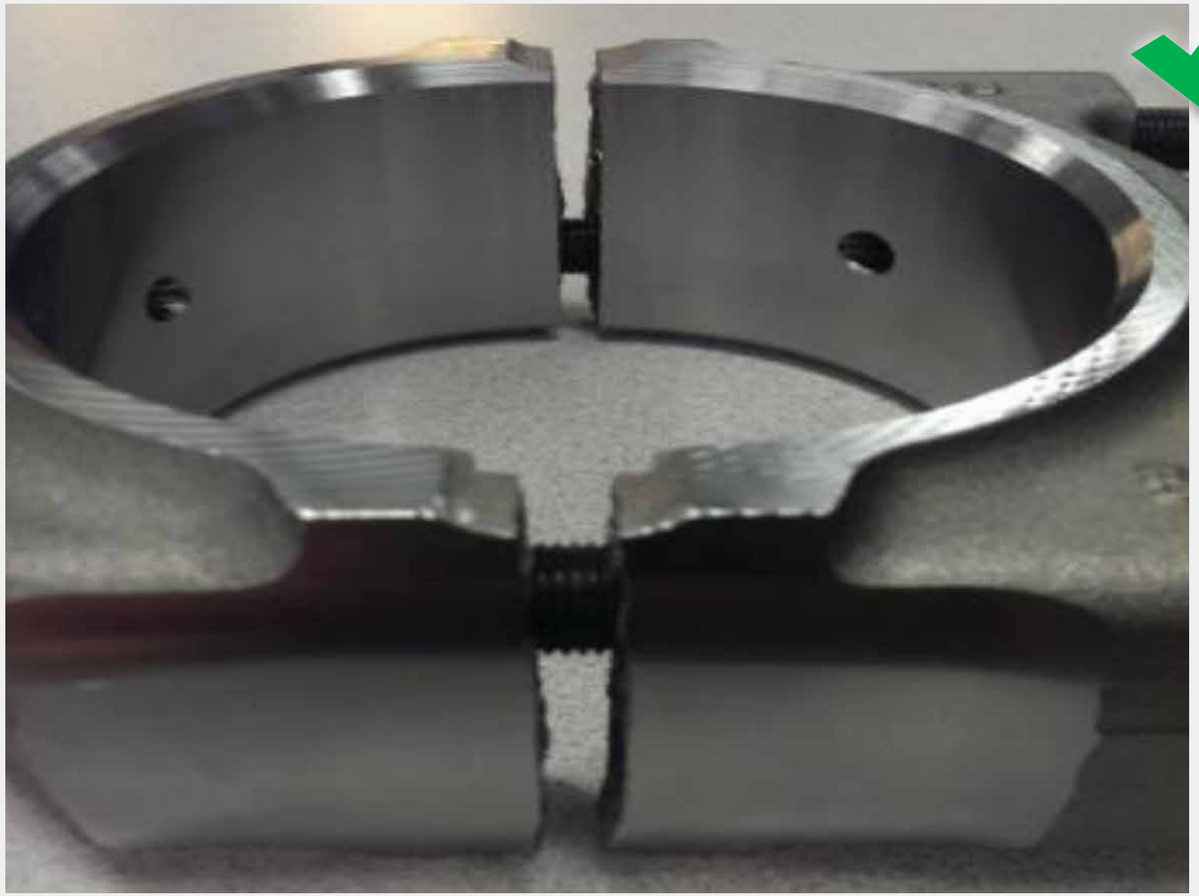
2 These fracture split connecting rods are not being properly handled.

Not connected to corresponding end. Serialized end is matched with non-serialized end.

Stood up on the fractured surface ends. This can cause damage.

CONNECTING ROD: FRACTURE SPLIT VS. SAW CUT

3 The two pieces of the connecting rod cannot be rubbed together when being disassembled.



ISX Product Improvements:
Connecting Rod and Cylinder Liner

Cylinder Liner

CYLINDER LINER: APR

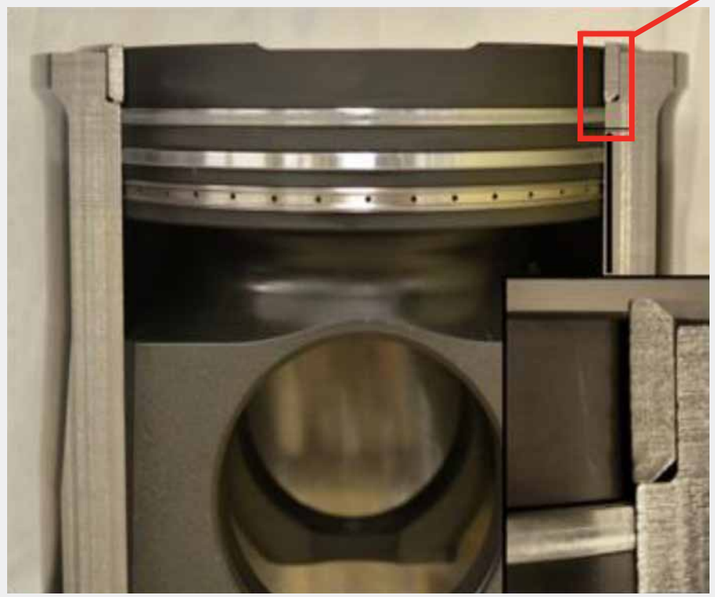
Carbon build-up can be found in all combustion engines as it is a by-product of the combustion event. It can lead to carbon packing, which is a more severe build-up of the carbon on the piston, and can cause excessive oil consumption. To prevent this, Cummins has began placing the APR (Anti-Polishing Ring) on ISX15 cylinder liners (Not utilized in ISX12 as there is no current need).

Let's see how the APR cylinder liner works to prevent carbon build-up.

CYLINDER LINER: APR

(Click on the terms in red to learn more)

The APR protects the surface finish of the cylinder liner by preventing carbon packing from polishing the liner walls. By scraping the **outside diameter (OD) top land** of the piston, it keeps carbon build-up at a minimum. This prevents oil consumption by maintaining the integrity of the **crosshatch** in the liner wall.



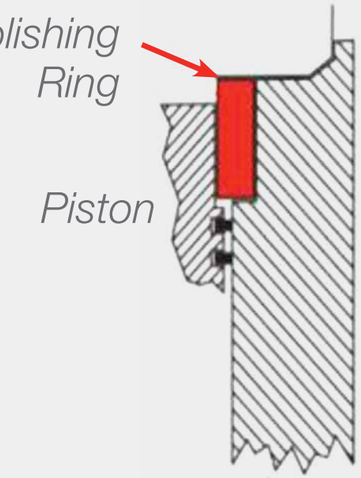
APR Part Profile

What is it? ... A removable **carbon** scraper ring

Where is it? ... At the top of the cylinder liner overhanging the **liner bore**

What does it do? ... Scrapes the carbon deposits off of the top land of the piston

Why does it do this? ... To prevent carbon thickness from building up to a level that will contact the cylinder liner and accelerate **bore polish**



Close-up illustration of APR scraping carbon on top land of piston

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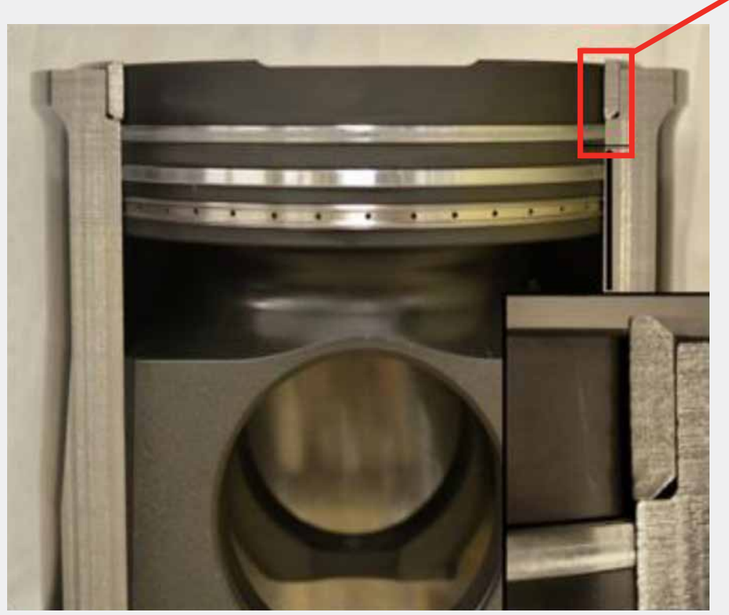

APR

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What does it do? ... Scrapes the carbon deposits off of the top land of the piston

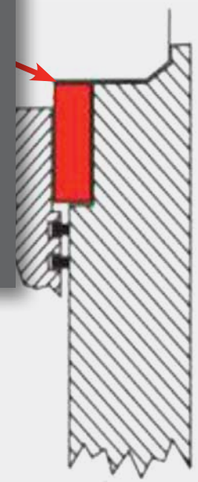
Why does it do this? ... To prevent carbon thickness from building up to a level that will contact the cylinder liner and accelerate **bore polish**

Outside Diameter (OD) Top Land

X

Very top of the piston where carbon can potentially build-up

…ylinder Head



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Crosshatch X

Area on the cylinder wall that allows oil to reside.

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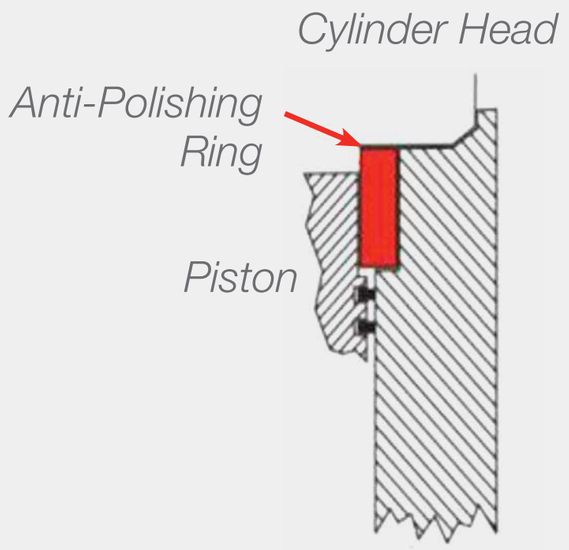

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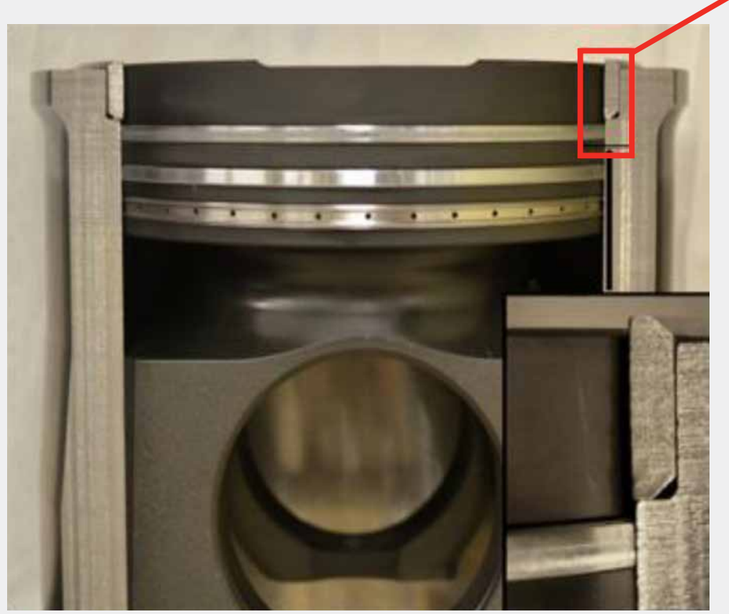

APR Part Profile

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A material that is a by-product of the combustion event.

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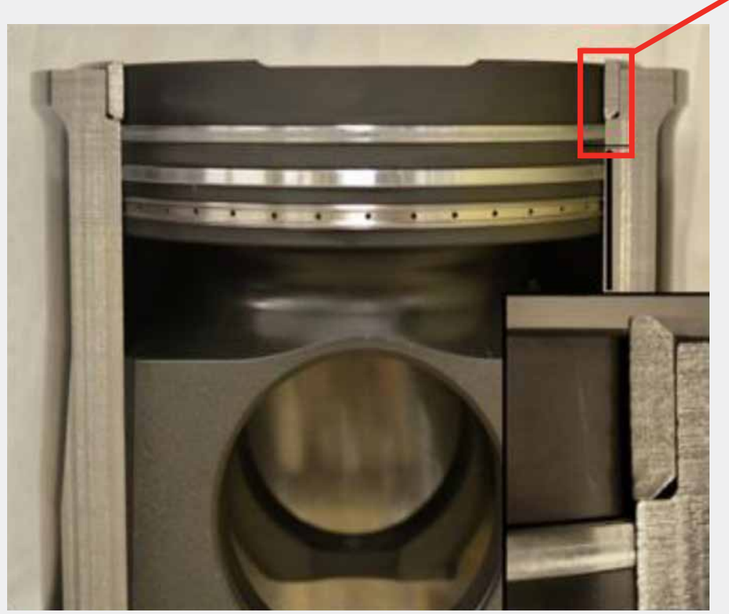

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What does it do? ... Scrapes the carbon deposits off of the top land of the piston

Why does it do this? ... To prevent carbon thickness from building up to a level that will contact the cylinder liner and accelerate **bore polish**

Liner Bore X

The inside area of the cylinder liner where the piston moves up and down.

Cylinder Head

ishing Ring

Piston

Close-up illustration of APR scraping carbon on top land of piston

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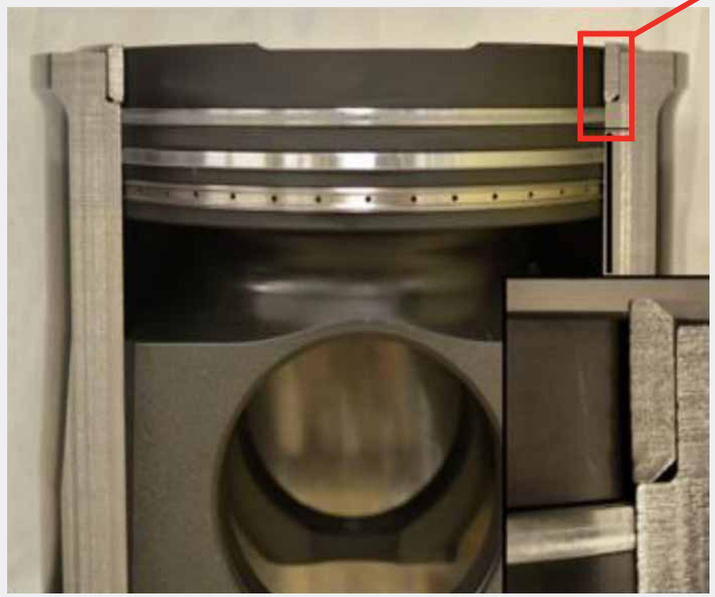

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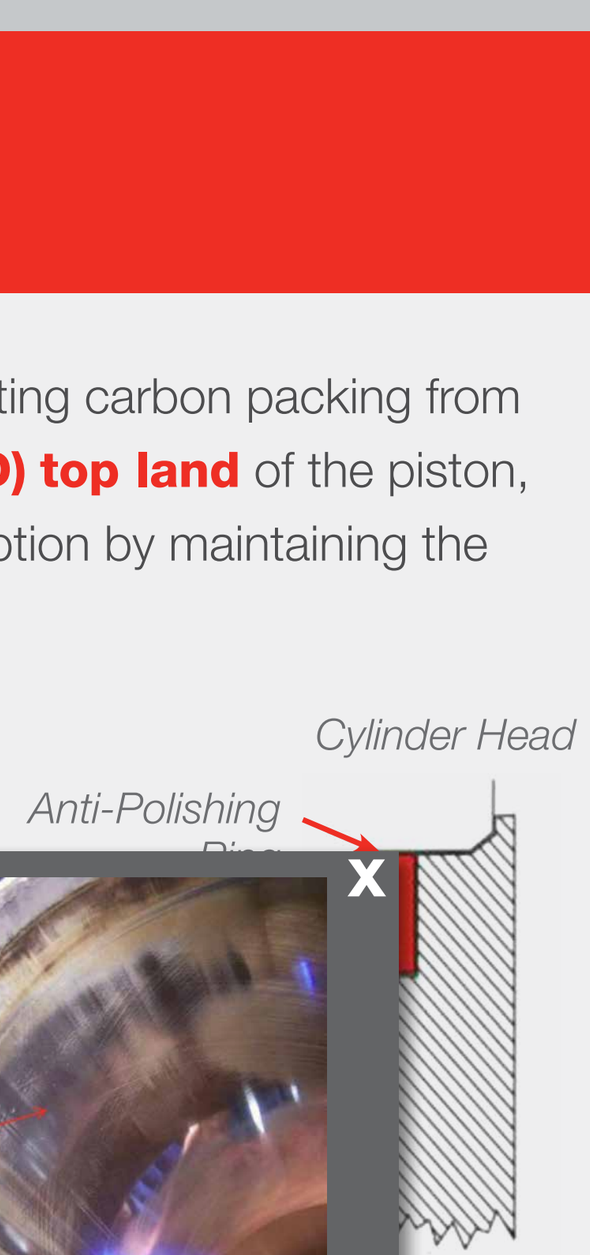

illustration
craping
n top land
of piston

Bore Polish

The effect when excess carbon on the OD top land of the piston rubs against the ID of the liner.

SUMMARY

- The need for a cleaner and more powerful engine has led to great innovations and improvements in Cummins products. Cummins history and success in the on-highway, heavy-duty industry dates back to the 1930's and continues today as the most recent improvements are implemented to meet the needs of customers.

Review of Current Improvements

- The fracture split connecting rod is an innovation that Cummins utilizes to improve the strength of a critical component in its engines.
- The APR cylinder liner keeps the engine clean and cuts down on carbon build-up to prevent oil consumption and preserve the life of the engine.

66

PARTS PROFESSIONAL

ISX Product Improvements:
Connecting Rod and Cylinder Liner

CONGRATULATIONS!

You have completed **Parts Pro 66.**

Now let's test your knowledge with a quiz.

ISX Product Improvements:
Connecting Rod and Cylinder Liner

QUIZ

Stress on the connecting rod during engine operation comes from:

(a) The bearings in the connecting rod

(b) Oil from the engine

(c) The alternating load associated with the up and down movement of the piston

(d) Operating temperature during engine operation

ISX Product Improvements:
Connecting Rod and Cylinder Liner

QUIZ

True or False: Fracture Split connecting rods are the only type of connecting rods used in the ISX engine.

(a) True

(b) False

ISX Product Improvements:
Connecting Rod and Cylinder Liner

QUIZ

The fracture split manufacturing method creates a rough, uneven mating surface on the face of the area between the rod cap and connecting rod in order to:

(a) Provide more planting surface area

(b) Decrease joint movement and fretting

(c) Increase durability

(d) All of the above

66

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ISX Product Improvements:
Connecting Rod and Cylinder Liner

QUIZ

True or False: Fracture split connecting rods require different bearings than saw cut connecting rods.

(a) True

(b) False

66

PARTS PROFESSIONAL

ISX Product Improvements:
Connecting Rod and Cylinder Liner

QUIZ

Carbon Polish causes:

(a) Excessive oil consumption

(b) Fretting

(c) Bore overhang

(d) Emissions compliance

ISX Product Improvements:
Connecting Rod and Cylinder Liner

QUIZ

The APR protects the outside diameter of the top land of the piston by:

(a) Accelerating bore polish

(b) Preventing carbon build-up

(c) Using oil

(d) Polishing the liner walls

QUIZ

Technology has evolved in part because customers need the following:

(a) A more powerful engine

(b) An engine capable of meeting more stringent emissions regulations

(c) Stronger components to support a more powerful engine

(d) All of the above

ISX Product Improvements:
Connecting Rod and Cylinder Liner

QUIZ

The external difference between saw cut connecting rods and fracture split connecting rods is:

(a) The size of the connecting rod

(b) The material of the connecting rod

(c) The oil drilling

(d) The cap screws

ISX Product Improvements:
Connecting Rod and Cylinder Liner

QUIZ

The fracture split connecting rods are available on which of the following engines:

(a) ISX12 only

(b) ISX15 only

(c) Both ISX12 and ISX15

(d) Neither ISX12 or ISX15

ISX Product Improvements:
Connecting Rod and Cylinder Liner

QUIZ

True or False: The APR cylinder liner is now available in the ISX15 but not the ISX12.

(a) True

(b) False

66

PARTS PROFESSIONAL

ISX Product Improvements:
Connecting Rod and Cylinder Liner

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