. . . . the meaning of "debunk"? The American Heritage Dictionary has one definition of "bunk" as "empty talk, nonsense". Further, "debunk" means "to expose or ridicule the falseness, sham or exaggerated claims of (bunk)". It seems that your correspondent has committed a large amount of time recently to debunking sales claims by competing engine manufacturers. The latest involves Caterpillar and their claims of superiority of the 3126B over the Internationalâ DT466E. You can see that this is a very large document with many pages of detailed discussion. As you read through it, you will find that it reveals a number of discrepancies in the Caterpillar literature:

- Argument that the 3126B block is structurally stronger than the DT466E. An examination of the internal structure of both blocks indicates the opposite.
- Allegation that rebuild of a sleeved engine requires special skill levels for the technician, when the operations unique to the sleeve installation are less complex and skill dependent than the basic functions of assembling any engine.
- Claims of functional superiority, such as fuel economy, that are vague and not supported with data.
- Innuendo implying that the International engine suffers design deficiencies that, if they exist, are actually those of other engines from other manufacturers.
- Tabulations that claim the 3126B costs less to operate and rebuild. But, their data tables are filled with errors, incorrect assumptions and cost inconsistencies between the two tables. When corrected, the tables show the costs to be less for the DT466E.
- Comparisons of electronic features that give incorrect and incomplete descriptions of International features and allege that we don't have features that, in fact, we do.

The reason this rebuttal is so lengthy is that simple declarations of "I've got more (or bigger)" can be stated in a few words, and a rational explanation of the pertinent facts and why the claim isn't true often requires a long explanation. This discussion will refer frequently to the accompanying documents that Caterpillar representatives have used in sales presentations to bus customers. They have been marked with "Attachment" identification and guide numbers to help you find the statements that are discussed as we progress through this letter.

Engine Structural and Functional Arguments.

Attachment A appears to be a "homemade" document typed up by an engineer or marketing person (signed DGV) on a personal computer. It is rather old and we could just skip on to the new brochure, but this type of material tends to have a long useful life with salespeople and could surface at any time, so we'll cover it anyway. It refers to the Caterpillar 3116 engine, but the design factors discussed still apply to the current 3126B. The discussion concerns engine power cylinder design and the relative merits of parent bore vs. wet sleeve engines. Of course, since the Cat 3126B is a parent bore engine they are attempting to convince the customer that theirs is better.

A-1. ***Cylinder bore wear.*** DGV's statement about how they've sold only enough salvage sleeves to re-sleeve 1% of the 3116s in service is just the first example of the Caterpillar numbers games you will find throughout this discussion. There are six holes in each engine. Is his quantity one percent of 100,000 (engines sold) or 1000 pieces, or six times that (6000 pieces)? We would agree that most requirements for reboring and installing the sleeve are for caused damage; a foreign object going through the engine or ring/piston breaking, etc. and usually only involving one cylinder. If his quantity is 6000 pieces, that could mean 5 to 6% of the engines could require this operation. That estimate is supported somewhat by the following statement that 10% of the 3208s required sleeves at first overhaul. Whatever the numbers, and 10% of your fleet would be significant to you, installing the salvage sleeve means removal of the engine from the chassis, reboring the block oversize, installing the salvage sleeve and honing it; all in a machine shop. If this is necessary for all six cylinders the cost gets very large. And, when you're done, the cylinder wall wear surface is not at all equivalent to the original manufacture.

Contrast this to the wet sleeve engine where a damaged bore can be replaced quickly in the chassis and the new bore surface is identical to the original manufacture.

A-2. ***"When it comes to 3116 or 3126 durability there is no significant difference in cylinder wall wear for a parent block versus the liner designs . . ."*** We ask: "Where is your data to support this?" We have no direct comparisons to argue for or against this either. We only offer the logic that the hardened and uniformly cooled bore of the sleeved engine will wear longer than the soft and irregularly cooled parent bore.

A-3. ***"Our cylinder bores usually require only the restoration of the cross-hatch pattern or honing at overhaul . . ."*** Usually doesn't mean always, a percentage of the engines opened up will need additional (expensive) work. And field honing cannot approach the original quality of production honing equipment. If the engine owner is comfortable with simply "cleaning up" or honing a cast-in cylinder bore, that procedure is just as valid with a used sleeve. In fact, the heat treated bore of the sleeve is more likely to be in good condition than the soft surface of the cast-in bore. Replacement of the sleeves at overhaul is not mandatory and only needs to be done if there is caused damage or the operator wants to go that extra step to restore the engine to "new" specifications, a step that can only be accomplished with the wet sleeve engine.

A-4. ***Caterpillar has designed the piston rings to be "softer" to reduce wear of the cylinder wall.*** Think about it. They've made the rings softer and compromised the ring life to preserve the more expensive cylinder wall. The DT466 wet sleeve is hardened (heat treated) material, that provides good wear life even with a harder, more aggressive, longer wearing piston ring. The DT466E top ring is plasma coated, which is the state-of - the-art treatment for longest wear life. So, with the wet sleeve you get the best of both - long ring life and long bore life, no compromises.

Their Three Key Factors that influence ring wear:

A-5. ***Ring Temperature.*** Claim: the parent bore design provides flow of coolant higher in the cylinder bore for better cooling of the top piston ring. Caterpillar says the coolant passage in their engine is within .50 inch of the top. International engine engineers addressed this issue years ago and modified the sleeve top land to provide coolant flow to within .56 inch of the top of the bore which is effectively as high as in the parent bore design. This was accomplished with no compromise in the durability of the sleeve. It has been in production in DT466 engines since 1988. The projected B10 life of the engine has steadily increased in the years since and ring/bore wear is not an engine service life limiting issue. And, as for their .50 inch claim, wait till you get to item 12 below.

A-6. ***Piston speed***. Their discussion of piston speed focuses on improvements in their products from the 3208 through the 3116 to the 3126. They're playing another numbers game here. The claimed reduction from the 3116 to the 3126 is solely a result of the rotating speeds used in the comparison because both engines have the same stroke length. * They show the piston speed for the 3126 at 2200 RPM, the rated power speed, and it gives a good low number (1833 FPM). They compare that to the 3116 at its governed speed of 2600 RPM. These are two different operating conditions. Engines operating in actual vehicles spend a considerable share of operating time at governed speed. The 3126 has a governed speed of 2500 RPM. So, the more realistic comparison would be the 3116 with 2167 Feet Per Minute at 2600 RPM to the 3126B with 2083 FPM at 2500 RPM. Yes, it's still a slight reduction in piston speed, but much less than the claim that they made. Incidentally, the DT466E built after August, 1999 will have a piston speed of 2028 FPM at 2600 RPM governed speed, slightly less than the 3126B.

* Piston speed is a result of two factors: length of the stroke and the rotating speed of the engine - RPM.

A-7. ***Cylinder bore surface.*** Yes, plateau honing is the best process for providing a bore surface that gives good oil control, long ring and bore wear life and no "break-in" requirement. Both engines have it; the DT466E sleeve and the 3126B block. The difference comes at time of rebuild. True plateau honing requires processes available only from sophisticated factory production equipment. That process quality is not available in field machining equipment. The DT466E replacement sleeve is made on the original production equipment and has the original surface quality. A 3126B renewed bore surface is not the same as the original.

A-8 and 11. Here we're going to change the sequence of DGV's presentation to join together two related discussions for better clarity.

Cylinder iron mass and ***"The counter bored block of the DT466 and 530 can develop cracks around the counter bore area."*** Both are a "more is better" argument centered on the claim that they have a stronger block/cylinder structure because the cylinder bores and the surrounding "top deck" of the block are solidly joined together. They claim that the sleeved block is deficient and has less strength because block material is machined away to make a place for the sleeve installation.

First a review of the two designs. The top view of the 3126B block is shown in photo 1. If you look carefully at that image you will see that the perimeter of the bore is bordered by eight short segments of iron and eight openings provided for the flow of coolant between the block and the head.

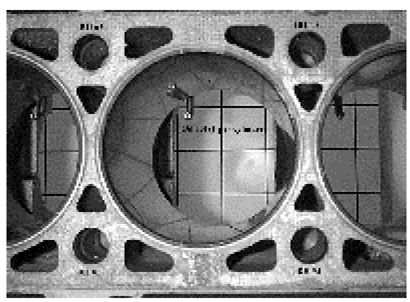


Photo 1. Top Deck of 3126B Block

If you were to cut away the top deck (as we did – photo 2), so that you could see what's inside, you would find that the segments of iron joining the cylinder tops to each other and the walls of the block are about one half inch deep. The bore is a thin cast cylinder anchored at the bottom around the entire diameter to the wall that separates the water jacket from the crankcase. The top is supported by the eight segments as we described. There is no wall located between the cylinders joining the two sides of the block. The only material joining the outer walls of the block between the cylinders is the short segment of material at the top deck. The head bolts are threaded into bosses that project from the outer walls of the block. They are joined to the cylinder walls only by the short segments at the top deck.

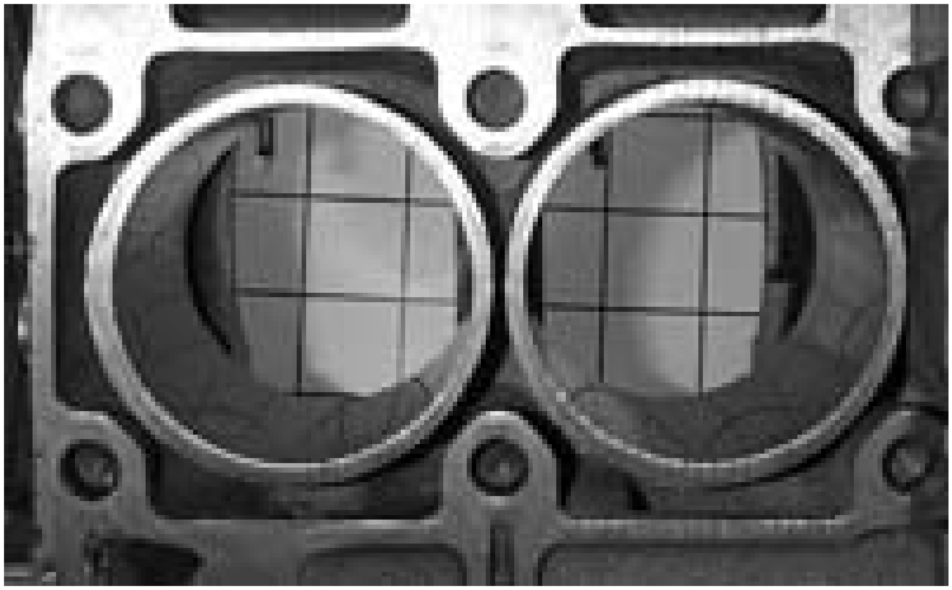


Photo 2. Interior View of 3126B Block

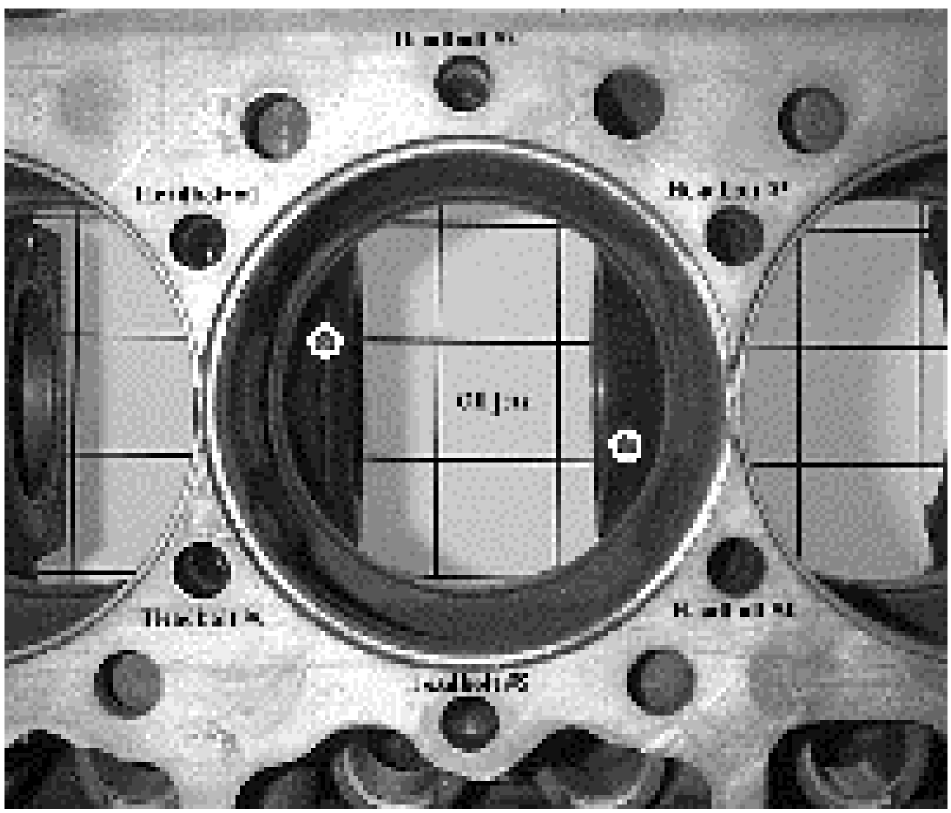


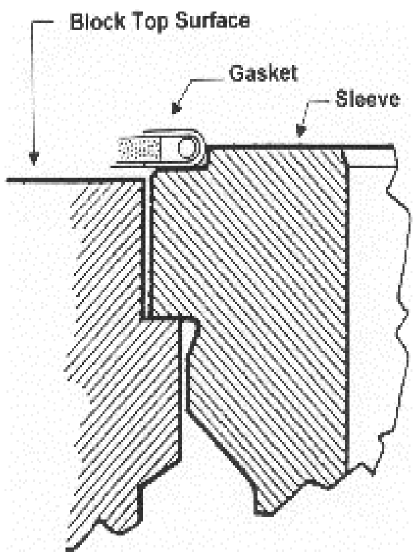
Photo 3. Top View of DT466E Block

The block for the DT466E sleeved design (Photo 3) has a cavity to enclose the cylinder sleeve. This cavity has machined surfaces at the bottom to accept the sleeve seal rings and a pilot recess at the top to locate the top flange of the sleeve. There is a cast-in wall joining the two sides of the block between each sleeve cavity. The cylinder head bolts are threaded to bosses located on the block outer walls and to the walls between the cylinder cavities.

DGV's discussion leads you to believe that the top of the 3126B cylinder bore (casting) is anchored to the top deck of the block with a solid circle of iron, and that includes a bridge between the cylinders. Yes, there is an iron bridge between the cylinders, but it is only the short segment described above (Photo 1.), and it does not extend down into the crankcase, it is only about one half inch deep. As far as strengthening the block is concerned, the DT466E design has an iron bridge joining the outer walls of the block, the full height of the cylinder, between each cylinder (Photo 3.). The 3126B has only those short half inch deep segments between the cylinders. What they portray as an advantage is actually a deficiency; they have less support between the cylinders than we do.

In Photo 2, you can see that the parent bore cylinder is of uneven thickness around the perimeter and along the length because it is machined only on the inside diameter. This uneven thickness results in uneven heat flow from the combustion chamber to the coolant. The wet sleeve is machined on both sides and is of constant thickness to achieve even heat flow around the circumference.

Since they brought up the subject of head bolts, it's proper to point out that they have fewer of them. To clamp the head to the block and compress the gasket, the 3126B head has four bolts per cylinder (Photo 1) while the DT466E has six (Photo 3). Any machine designer will tell you that in the design of a gasket joint, the more bolts, the more closely spaced, the better. The DT466E has more, and more closely spaced, head bolts.



In A-11 DGV alleges that the DT466E block will crack between the cylinders at the counter bore. This is in reference to a very thin area at the top deck of the block formed by the near joining of the two sleeve counterbores. In fact, we did experience some cracking in this thin web in a small percentage of engines of the earlier version of the DT466. In most cases, of this infrequent occurrence, the crack was confined to a non-structural, non-load bearing area. This cracking caused no operating problems and was not apparent until the cylinder head was removed for some other reason. The crack would be removed by a simple grinding operation. In 1994 this area of the block was redesigned and the potential for this cracking was eliminated. Current engines will not experience this.

A-9. ***In-Frame Overhaul.*** This paragraph simply says that their new engine goes further before rebuild is required than their old engine did. Okay.

A-10. ***"Recommendations for in-frame overhauls on . . . the DT466 and 530 are essentially the same as our parent bore engines."*** Sorry, but we disagree. But, read the discussion (far) below in the analysis of their new brochure for comparison of the latest information.

"What's the big advantage of a liner if you replace them at overhaul?" I believe this qualifies as a nonsense question. One of the big advantages is that you <u>can</u>, easily, replace them. As stated above, hardened sleeves provide a longer-wearing surface so that they do not need renewal as soon and, if they do need replacing, it is easily done; in-chassis.

"A linered engine requires a higher skill level for mechanics, because they are dealing with more parts and more points to seal on the engine versus the parent bore block." Let's walk through the process of replacing a sleeve or installing new seal rings on an old sleeve.

Once the head and the piston/rod assembly are removed, the top of the sleeve is exposed. In most cases the mechanic can simply reach down through the bore of the sleeve, grasp it at the bottom and pull it out of the block. If it is too tight for that, a simple screw thread puller will do the job. The new (or old) sleeve is then fitted with new elastomer sealing rings on the outside of the lower end. These are installed by simply rolling them in place in grooves in the sleeve outer diameter. A lubricant is applied with the fingers and the assembly is ready for installation in the block. To install, the sleeve is inserted in the bore of the block and pushed down into place with simple hand pressure. And it's done. Does that sound to you like a high skill level procedure? If you could not depend upon a mechanic to do that operation reliably, could you trust him/her to properly torque the cylinder head bolts or install the main and rod bearings?

A-12. In seguing to the next topic, DGV jumps around and has some disjointed construction in the text of item 12. I'll condense the statement to: ***"The 3126 has the coolant jacket covering the bore to within .50 inch of the top."*** It then moves on to explain (in their terms) how International revised the sleeve design to raise the level of the coolant jacket around the sleeve. They claim that in doing so we "sacrificed" the integrity of the liner pilot and increased the bending forces on the sleeve and shortened ring life and caused the liner seals to leak. Sounds just terrible, doesn't it? Well . . . here's what really happened.

They are partially correct; getting the coolant flow around the upper part of the bore is a good thing. It improves the cooling of the top piston ring to reduce "sticking" and increase ring life. In 1988 International recognized that a product improvement could be realized by raising the coolant jacket penetration on the sleeve. The sleeve was modified to raise the level of the coolant to .56 inch from the top of the bore. As for the dire consequences DGV predicts, they just didn't happen. The piston ring life was improved, which is what we set out to do, and the liner life was also improved because of the better cooling. In regard to reducing the depth of the pilot, the pilot does locate the sleeve position, but it does not carry the "bending and twisting forces of the engine". The sleeve is retained in place and the applied loads are controlled by the clamping force of the cylinder head against the sleeve upper flange, not by the pilot diameter. As for the sealing rings, the double ring design is more reliable today than in 1987, due to improvements in the ring material and design.

Let's go back to the Caterpillar design. Remember that the top of the cylinder is surrounded by eight segments of cast iron and eight ports to allow coolant flow. The eight segments are about one half inch deep, and this is what they're referring to as cooling to within that distance of the top. But, wait, the open ports allow coolant to flow all the way to the top, past the cylinder and into the head. So, around the top of the bore there is heat flow to the coolant through alternate areas of thin wall and the iron segments. This causes uneven disbursement of the heat from the chamber to the coolant. With the wet sleeve design the heat flow path is even all around the bore. Their heat flow pattern is poorer than ours, rather than better.

And, related to the subject of cooling, Photo 1 shows that the 3126B has one oil spray piston cooling jet per cylinder. Photo 3 shows that the DT466E has two per cylinder for more evenly distributed cooling of the piston.

Recently, Caterpillar has published a glossy brochure with corporate identification that is specifically aimed at the bus customer and is a direct competitive comparison with the International DT466E. It contains many of the elements of Attachment A along with some new items. It is presented as attachment B.

B-1. This is a discussion of their long experience in making diesel engines. Their background is good, but it is not unique, or even as good as International's. We have built over a million units each of the DT466 and the T444E. Their 800,000 quantity includes a number of different engine models built over a span of many years. We assume their number includes the 3208 dating back 25 years. The 3126B, on the other hand, is a relatively new engine, having been in production since late 1997. It is significantly different from the 3116 that it replaces with a new cylinder head, new valve system, new crankcase structure, etc.

B-2. The heart of this argument is that today's parent bore design engines have adequate service life to satisfy the needs of many school bus owners and will run the useful life of the bus without need for rebuild. We agree. That's why we have a very good parent bore engine of our own, the T444E and why it represents the majority of our school bus engine sales. Rebuttal of their statements on maintenance costs and fuel economy will be developed farther on in this document.

B-3. ***More Strength and Rigidity.*** This argument was covered in items A8 and A11 above. The allegation that "most" wet sleeve engines require liner replacement at rebuild is incorrect. Maybe Caterpillar's heavy duty engine rebuild requirements include that provision, but ours for the DT 466E do not. Any bore condition that's acceptable for re-use in a parent bore engine is acceptable in a wet sleeve.

B-4. ***Better piston design.*** They say the two piece steel crowned piston is capable of enduring higher firing pressures. Yes, it is. And we use this type design in the high power versions of the International 530. But that's the only real reason for employing this design. Our school bus ratings of the DT466E have firing pressure control that makes this high cost piston unnecessary. Maybe the CAT engine has design and operating elements that make this extra measure necessary to get adequate resistance to cracking. But, there's more. The top ring is the highest loaded ring on the piston. The aluminum piston in the DT466E is fitted with an extra hard NI-Resist insert at the top ring position that has longer wear life than either aluminum or steel. The service life of our piston design is more than adequate; the piston is not the life-to-overhaul determinator. We could take this argument back to their criticism of wet sleeve design – why spend the extra cost if you don't need it? Remember this discussion when you get to the rebuild cost discussion below.

They claim that the steel top piston allows a higher top ring position for better fuel economy than aluminum pistons. They are partially correct. A higher top ring position does help fuel economy. But you don't have to have a steel piston to get there; our top ring location is essentially the same as theirs. The top ring location below the top of the piston is 9.5mm for the 3126B and 10.0mm for the DT466E. Now picture in your mind one half millimeter.

B-5. ***More efficient cooling.*** They say that the parent bore design allows coolant passages higher up on the bore. (See discussion A5 above). Here they resort to innuendo. The statement is "some wet sleeved mid range engines" have the coolant passage top at 20.3 mm from the top of the bore. They don't say which. Since the DT466E is the only competitive engine directly discussed in this brochure the structure of the discussion would lead you to believe/accept that this dimension applies to the International engine. Not so. The DT466E coolant passage reaches up to 14.22 mm from the top of the sleeve, not effectively different from the 12.7 mm of the 3126B.

"Lack of thorough cooling"? We've already described to you how cooling around a wet sleeve is more even and efficient (items A8, 11 and 12). As for the cooling causing block cracking, go back to Item A11.

B-6. ***Weighs less than a sleeved engine.*** This is a curious turn in their discussion. Earlier they claimed the 3126B crankcase is stronger because it has more iron in it. If the parent bore design results in a lighter engine than one with sleeves, then the weight difference should be represented by the relative weights of the block assembly. We weighed the 3126B block alone and the DT466E block with sleeves. The Cat block was 404 lb. and the International block with sleeves was 410 lb. A difference of six pounds. Is that significant? The DT466E has 10% more displacement and weighs less than 2% more. Sounds like a more efficient design, doesn't it?

B-7. ***Better fuel economy.*** More innuendo. The statement is that the 3126B is six percent better on fuel economy than competitive engines. Doesn't say all competitors, or which, yet the DT446E is the only engine named in the document. Doesn't say by what measure, but other passages in the brochure indicate this is by dynamometer measurement. Because the usual engine fuel consumption curve developed on a dynamometer represents the engine at full load in a steady state condition it doesn't always relate to the vehicle operation, which is largely part load and transient (varying load and speed) in nature. They also don't say if this measurement applies to their engine before or after Caterpillar's compliance with the Environmental Protection Agency's consent decree, which will result in significant changes to their engine control system. International's part of the consent decree did not cause any changes in the DT466E emissions certification, fuel system calibration or operating strategy.

B-8. ***Low Maintenance Costs.*** Here they clearly state the DT466E as the competitor and the claim is 10.2% lower cost. Better take a closer look. The chart is reproduced below with a column added to illustrate the changes we think necessary to make the comparison valid. Notice that the analysis is for a cycle of 300,000 miles, yet they stated at the opening of the document that most buses run only 150,000 in their lifetime-so why use 300,000 for this analysis? You'll see why as we go on.

Scheduled Maintenance – Mid-range Truck Engines		**Cat 3126B**	**International DT-466E**	**DT-466E Corrected**
Based on published maintenance guidelines and 300,000 miles of	Oil Change Interval (miles)	10,000	12,000	12,000
	Sump Capacity (quarts)	30	28	28
	Frequency	30	25	25
	Oil Cost	$1,125.00	$875.00	$875.00

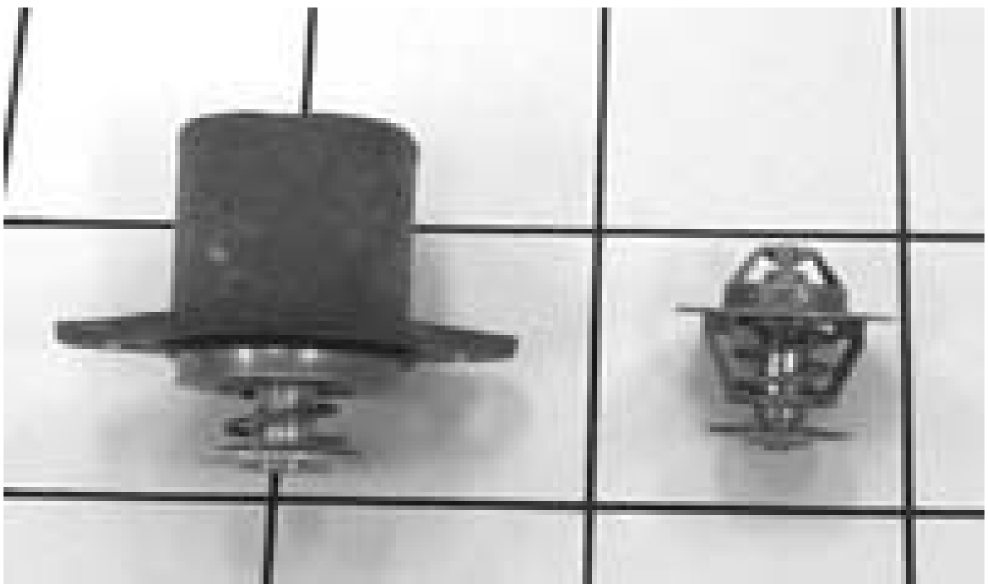
Rate @ $50.00/hour *Parts Pricing 1/98.* *Antifreeze costs for 3126B based on use of Extended Life Coolant. At time of publication, some mid-range engine competitors have not approved the use of ELC in their engines*	Oil Labor Cost	750.00	750.00	625.00
	Oil Filter Cost	242.40	482.00	482.00
	Fuel Filter Cost	273.90	148.92	148.92
	Fuel Filter Labor Cost	150.00	80.00	80.00
	Antifreeze Cost	0.00	150.00	49.00
	Antifreeze Labor Cost	0.00	217.50	25.00
	Coolant Extender	8.47	0.00	8.47
	Thermostat Cost	22.59	65.85	65.85
	Thermostat Labor Cost	165.00	165.00	50.00
	Valve Adjustment Labor	217.50	150.00	150.00
	Coolant Filter	0.00	164.00	43.09
	Coolant Filter Extended Labor	5.00	50.00	5.00
	TOTAL	$2,959.86	$3,298.27	$2577.33

Beginning with the oil change interval, the 10,000 mile interval for the 3126B is not the standard offering. The standard is 6,000 miles. To get 10,000 miles a larger oil pan and sump capacity is offered, at additional cost, and that cost is not presented as part of this picture. It should be. The customer must pay this cost up front to get the benefit of longer change intervals. Of course, this argument has little relationship to the usual bus operator's oil change practices. School bus oil change should not be based on miles, but better on hours of engine operation. Many operators change oil by the calendar. Each operator who is interested in this type of cost analysis should insert the numbers that fit their particular operation and practices. But we'll go on with this discussion using Caterpillar's logic.

For oil labor cost, the same amount is shown for both engines, but the International engine doesn't require as many changes. The frequency line above shows only 25 changes for the 466 vs. 30 changes for the 3126B. We used their cost per change and used a ratio of 25/30 to show the International corrected number.

Antifreeze and antifreeze labor costs. They based this comparison on using Extended Life Coolant (ELC) in the 3126B and standard coolant in the DT466E. Here, is some more innuendo. The fine print at the side of the chart says "some mid-range engine competitors have not approved the use of ELC in their engines". That does not apply to the DT466E, we have announced acceptability of ELC in this International engine. So the extra cost of changing antifreeze can be deleted. We must clarify, though, that the ELC is not yet available as a factory installed option with the DT466E. Therefore, we have included a cost for changing a new vehicle from standard coolant to ELC and added the cost for the coolant extender. That is why the International cost is reduced, but does not go to zero. Incidentally, this factor is probably the reason that Caterpillar chose to use the 300,000 mile cycle for this comparison, they needed their perceived antifreeze cost advantage to make their total number come out smaller.

Thermostat and thermostat labor cost. For some unstated reason they decided that the coolant thermostat would require replacement twice in the 300,000 miles of service. Perhaps that is necessary with their automobile gasoline engine type of thermostat. The DT466E employs a design derived from those used in heavy duty diesel engines so we don't forecast that it would require two replacements, but left that factor in place to avoid the argument. The photo below illustrates the difference in construction between the two thermostats.



DT 466E 3126B

Photo 2. Thermostat Design

We do contest the cost attributed to labor for replacing the 'stat. They assigned 1.6 hours for that operation. We'll accept their assessment for their own engine if they think that much time is required, but the actual time for ours, including coolant drain down and refill, is .5 hour which reduces the DT466E cost to the amount shown in the corrected column.

Coolant filter and labor. We reduced that to only what is required to remove the DCA precharged filter and install a plate to cover the opening. A filter is not required with the ELC.

With these corrections you can see that the scheduled maintenance cost for the DT466 is significantly less than the 3126B.

B-9. ***Reliability.*** This factor is stated in a slightly different manner than International uses; yet it can be translated to a common measure. They state the number of 1.5 repairs per 150,000 miles. Since that is their standard warranty period it means 1.5 repairs per unit during the warranty. We measure number of repairs per 100 units (R/100) during the warranty period. Their measure would then be expressed as 150 R/100. We consider this type of warranty data to be competitive proprietary information so I can't give you our exact number. But, I can tell you that the R/100 figure for the DT466E is far below the 150 level that they have expressed. You'll have to trust me on this one.

B-10. ***Long life to overhaul.*** Here they claim a B_{10} life of 300,000 miles, equal to the DT466E. This is the first time we've seen Caterpillar publish a B_{10} figure for this engine. It's a little hard to accept for a parent bore engine with soft cylinder walls. B_x-life was once a good benchmark by which customers could judge the relative life of various engines, but it has degenerated into a confusing numbers game. It's easy to make claims about long life and to play a one-upsmanship game. Competitors cannot check on or challenge the validity because the B_x analysis (if correctly done) is based on proprietary statistical information from laboratory and customer experience. There is no quick, concise test to determine these values. Your belief in the numbers is a matter of credibility. (For a complete discussion on Bx life, see Did You Know letter DUK#231)

B-11. ***In frame overhaul, parts cost.*** We find it interesting that early in the document they make the statement that "most mid-range wet-sleeved engines require replacement of the sleeves at overhaul" yet they do not include that cost in this analysis. That's good, because we agree with the latter, it's not necessary to replace the sleeves.

In-Frame Overhaul Cost Comparison-Parts Only

	Cat 3126B	**DT-466E**	**Works Kit**
Pistons	$747.06	$247.80	--
Piston Pins	130.80	51.42	--
Piston Rings	260.28	239.46	--
Piston Retainers	8.28	2.40	--
Cylinder Head	878.45	1,133.33	1,133.33
Connecting Rod	351.78	770.28	684.00
Connecting Rod Brg.	53.46	68.10	--
Main Brg.	113.40	99.90	--
Oil Pain Gasket	22.37	22.44	--
Cyl. Head Gasket	37.76	50.49	--
Gasket Seals	285.00	285.00	--

Thermostat	10.97	24.58	--
Oil Filter	8.11	21.47	--
Fuel Filter	9.37	15.15	--
Works Kit			1,068.97
TOTAL	$2,917.09	$3,031.82	$2886.30

Note that the Caterpillar pistons cost three times as much, or $500 more to replace than the International. That's due to the high cost of the two piece piston they feel is necessary in their engine.

If you look closely, you'll find that the prices they show for expendable items like filters and thermostats are not the same in the two charts for maintenance and rebuild. It's almost like two separate people made the charts and they didn't compare their results.

Also note that they have an entry for "gasket seals". That seems like an oxymoron because gaskets usually don't have seals and seals usually don't have gaskets and certainly not $285 worth in one engine. And why would the cost be identical for two distinctly different engines? We just don't understand what this item means. We accepted their number for their engine and eliminated this confusion when we reverted to the strategy described in the next paragraph.

Instead of buying all these individual parts we recommend using the "Works Kit". The added column at the right side deletes the costs of all the individual parts that are included in the International Works Kit rebuild package and adds a line amount for the kit. Moreover, the Kit includes a number of other gaskets and minor parts that are needed for a complete overhaul plus a new set of cylinder sleeves. The total amount they ascribe to the individual parts is greater than the cost of the Works Kit that includes the bonus of the new sleeves. Although we don't insist on replacement of the sleeves at rebuild, the cost of the overhaul kit makes that an attractive option.

We don't understand why they would believe that replacement of the connecting rods is necessary in an ordinary overhaul. Unless it's another case where they needed the indicated cost imbalance to make their bottom line come out smaller (to offset the high cost of their pistons). Rather than to debate this point, we simply inserted the correct price (new with exchange) for DT466E rods and went on.

You can see that, once again, when the correct analysis is applied, the cost for the International engine is lower, not higher.

Instead of all the discussion and argument above, the relative merits of sleeved and parent bore engines can be summarized in a simple way. Caterpillar builds several engine families of the wet sleeve design. These include the C10, C12 and 3406 models. They are used in the heavy duty over-the-road type trucks where long life and rebuildability are mandatory. If you were to take the Caterpillar arguments discussed above at face value and believe that they are truly concerned about the viability of the sleeved design, you would expect that they would be soon converting the heavy duty sleeved models to parent bore design. Don't bet on it.

On the other hand, we're not saying the parent bore engine is a deficient design. We make a very good one ourselves - the T444E. It's just that a parent bore design is not more durable or more easily rebuilt than a sleeved engine, and anyone who tries to tell you that it is trying to sell what they have available.

Electronic Control Systems and Parameters.

Caterpillar is also distributing material that claims their electronic system is more complete and sophisticated than International's. Two presentations are discussed here. One is in the form of presentation slides and the other a three fold brochure. The slides are attachment C. Two slides were reduced in size and combined into one page to improve the clarity for this discussion. These slides are also old, but, like DGV's document, they tend to continue to appear.

C-1. ***The 3126 has a single unit Electronic Control Module and the International engines have three.*** This is simply obsolete information. The International engines have been equipped with a single unit control system since November 1997.

C-2. ***The 3126 has more programmable electronics than International.*** Another numbers game. We'll agree that in a sheer numbers count they have more programmable items. The real question here is how many are important to you? It's a little like a shoe company offering purple shoes. It may be something their competitors don't have, but if you don't want purple shoes, does it matter? Detail discussion of this claim is presented in the analysis of the three fold brochure in the next section.

C-3. ***International's "Third Party" electronics do not offer these "Standard" 3126 Features.*** The third party phrase refers to the fact that Caterpillar manufactures their own electronic controllers and International purchases the controller from an outside supplier. That is meant to imply that our equipment is inferior because we don't make it ourselves. Not necessarily so. We chose the supplier carefully, and the equipment is designed and produced to International's specifications, is exclusive to our engines and not used by anyone else. In other words, it is not a "shelf item" with design and manufacturing compromises.

The second slide at the bottom of attachment C is designed to imply that the entire list of operating parameters is not available with International engines. Not so. Rather than to discuss this list in detail, we'll move on to the brochure that includes these items plus more.

Attachment D reproduces a table from the brochure that compares available electronic parameters from Caterpillar, Cummins and International. We modified the chart, adding a column to the left, which assigns a number to each item to ease reference in the discussion. Their assessment of what features are available in International engines contains errors, so we added a column to the right labeled <u>International Corrected</u> with the correct listing of our features. Also, many of the parameters touted in their list do not apply to buses (they're purple shoes), so we identified the <u>Bus Specific</u> items in the right side column. Items that require some definition and explanation, especially where we disagree with them about International availability, are presented below and are identified by the line numbers added to the table. There is no discussion/argument about items that obviously don't pertain to buses, such as Power Take Off (PTO) functions.

D-2. **Vehicle Speed Limit.** We describe this as Road Speed Limiting. An electronic control to limit, or govern, the chassis road speed to a programmable set speed.

D-3. **VSL protection.** VSL protection refers to designing the system to defeat attempts to circumvent the vehicle speed limiting. The most common method of doing this would be to disconnect the vehicle speed sensor (speedometer signal) at the transmission. In both the Caterpillar and International systems, if the speed signal is lost (disconnected) the engine control reverts to a reduced engine speed limit so that the driver is faced with a reduced vehicle speed.

D-4. **Soft Vehicle Speed Limit.** Item 8. **Soft Cruise Control.**

It's easiest to discuss these items together. If the Cruise Control system is designed to maintain the vehicle speed very close to the selected/desired speed, the control and the engine will vary the fuel rate (throttle) setting frequently to try to hold the set speed. This can be a problem on rolling or uneven pavement. The engine will be "busy" adjusting the power setting up and down. This is distracting and uncomfortable for the driver and can waste fuel. Apparently, Caterpillar experienced problems with an aggressive cruise control on their heavy duty engines in over-the-road trucks and changed the operation to allow the vehicle speed to vary on either side of the set point to reduce the engine power setting corrections. They describe "Soft Cruise" as allowing the vehicle speed to vary 2.5 mph to either side of the set point. When the engineers at International were developing the cruise control system they recognized the need for this variation and designed the system to do that in the original release. So, we had "soft cruise" in our system from the beginning - we just didn't give it a catchy name.

Extending this logic to the Vehicle Speed Limiting, if the cutoff of fuel when the road speed set point is reached is too abrupt the driver experiences discomfort, etc. Soft VSL simply tapers the speed off gradually. The International system was designed this way from the beginning, just as with the cruise control.

D-9 **Idle Vehicle Speed Limit.** If the chassis is stationary and the engine idle speed is increased with the electronic hand throttle (controlled by the same switches as the cruise control), this function returns the engine speed to the normal low idle setting when the system senses vehicle speed of 1 mph or more. If anything causes the bus to move, the engine returns to low idle. The Caterpillar system has the ability to change the speed setting that triggers the change to levels higher than 1 mph. This adjustment capability is usable in some unique truck applications using power take off drives, but is certainly not desirable for a bus.

D-10. **Idle RPM Limit.** This programmable feature can be used to set an upper limit on how fast the engine can be operated with the hand throttle (chassis stationary). It is valuable in a bus because it can be used to limit the speed at which the driver can operate the engine in the morning warm-up time, for instance. Caterpillar's document is in error; International engines have this feature available.

D-12 & 13. **Fast idle engine RPM 1 & 2.** With this feature the cruise control/hand throttle switches can be programmed such that a momentary push of the switch can direct the engine to a preselected set fast idle speed. For instance, Speed 1 could be set to a desired speed for morning warm-up and Speed 2 could be set to another speed that improves the alternator charge rate to support operation of a chair lift. The Caterpillar chart is incorrect; the International system has two preselected speeds available.

D-22, 23 & 24. **Engine speed limits related to gear selection.** These features are directed to a concept called progressive shifting that is used in heavy duty highway tractors. They are not applicable to automatic transmissions.

D-25. **Top Engine Limiting.** Another heavy duty engine feature. It is equal to the governed engine speed, unless it is programmable and the control is set to a speed lower than the governed speed. It has no value in a bus.

D-26. **Low idle engine RPM.** This feature allows the operator to adjust the low idle setting of the 3126B in a range from 700 to 800 RPM. Their major stated advantage is to set it as low as possible for best fuel economy. Their low setting is 700 RPM, same as ours. The other claimed advantage is to set the idle speed away from a point that produces vibration in mirrors or other body items. We avoided that situation with smart engine mount isolation design. International chose to not make this adjustment available. Setting the speed too low can lead to engine functional and durability problems and setting it too high can lead to excessive "creep" and shift shock with automatic transmissions.

D-31. **Maintenance Indicator Mode.** We call it the Change Oil Lamp. It’s an automatic system to remind the operator to change the oil when a programmed level of miles, engine hours or fuel consumed is reached. Both the International engines and the 3126B have this feature available. With the Caterpillar system a special added readout unit may be required. In International products, the indicator is included as part of the instrument panel gauge cluster.

D-32. **Theft deterrent.** Requires a driver to enter a password to start the engine. Also requires a special Caterpillar-supplied driver information display option on the vehicle to function.

D-33. **Engine Power Uprateability.** Changing the power rating of International engines can be done on a selective basis if the engine mechanical equipment, the cooling system and the driveline components are appropriate to the change.

D-41. **Cold Ambient Protection.** . CAP automatically advances the engine speed when it has been idling for a set period of time. This is done to maintain the engine temperature in cold weather. Both the 3126B and the International engines have it.

See Did You Know letter DUK#168 for a complete explanation of this important feature.

Their discussion of electronic feature advantages can be characterized as a lot of hype and little substance. Also, it appears that it was originally constructed for truck customers and later picked up for use with bus customers because it was available and would be an impressive looking list.

The Origin of the HEUI fuel system.

We have not seen a Caterpillar corporate publication, but have heard of verbal discussions and have seen Caterpillar engine distributor correspondence that alleges that International simply "bought" the HEUI fuel system from Caterpillar as a turnkey completed product. Not so.

Caterpillar and International have different business approaches to procurement of fuel systems for their diesel engines. Caterpillar long ago made a business decision to develop and manufacture their own fuel systems. This gives them complete control over design and manufacture and a degree of exclusivity of product. Caterpillar’s engine division has a separately identified fuel system operation that makes fine quality products. International made a business decision to purchase fuel systems from suppliers who specialize in this type of product. Doing so takes advantage of economies of scale where the shared volumes of multiple engine manufacturers results in high volume of production of the fuel system components. The advantages of this approach are reduced product cost, shared development expertise and improved product quality from high volume production equipment. There are arguments pro and con for both approaches, neither is "correct" or "best", it is simply a business decision.

In the mid-1980s, with the drastically more stringent exhaust emissions requirements of the 1990s on the horizon, the engineers at International recognized that significant changes in diesel fuel systems would be required. Many people in the industry were predicting that qualifying to the forthcoming particulate matter standards would require the use of alcohol fuels. International disagreed, believing that the new standards could be met while continuing to use diesel fuel, but this would require improvement in the fuel quality (reduced sulfur content) and innovative new fuel injection systems with electronic controls and significantly higher injection pressures. The mechanical fuel system just could not be improved to the extent needed to meet the new performance levels. International engineers began to search the world, literally, to find a fuel system with the necessary performance capabilities. This quest included talks with Caterpillar's fuel division during which the concept of a hydraulically actuated, electronically controlled, unit injector (HEUI) was discussed as a potentially suitable fuel system. No operating prototype existed at the time of these discussions.

International decided to team with Caterpillar to develop the HEUI and the joint program began in 1987. In the development process Caterpillar provided the injector hardware and manufacturing factors, while International engineers developed the engine components, designed and programmed the computerized control system and refined the on-engine operation and performance characteristics. This was a substantial program, which eventually took seven years to complete. Included in the development process was the need to determine the optimum operating pressure fluid, which resulted in a change from fuel, at the beginning, to lubricating oil. It was, in the truest sense, a cooperative development program. Neither party did it all. Each made substantial engineering contributions to the program and both companies hold patents on the HEUI product. This program culminated in the production start of the first engine application of HEUI, the International T444E, in February 1994. It was more than a year later that the first Caterpillar engine application, the 3116E, began production. It is safe to say that without the expertise and effort of the International engineers there would be no HEUI fuel system in production today.

Consistent with International's economies-of-scale focus, one of the agreements in the program was that, once the HEUI system was developed, Caterpillar would be free to sell it to other engine manufacturers, and they are now doing that.

Rather than to focus on who did what and who is the creator of the HEUI system we should emphasize that the real winner in this story is the customer. For, the customer, who buys either the Caterpillar or the International engine, enjoys the benefits of the finest diesel fuel injection system on the planet.

Congratulations. You made it all the way through this lengthy discussion. What you found in this review of the Caterpillar documents is a collection of errors, misleading statements and innuendo – all of which add up to bunk. The mid-range engine business is very competitive and some find it necessary to resort to extreme measures to attract the customer. We try to stick with the facts. Check us out.

Oh, yes. One more thing. What are the advantages of the DT466E over the 3126B? Well, the list starts with the item that has been the central focus of this entire discussion; wet replaceable cylinder sleeves. In a diesel engine they provide longer life-to-overhaul and faster, easier rebuilding to original equipment standards – if you need to. Others:

- Larger displacement, 7.6 liters vs. 7.2.
- Valve rotators.
- Two piston cooling jets per cylinder vs. one.
- Six Head bolts per cylinder vs. four.
- Integrated chassis. We make the engine and we make the chassis for a coordinated design. Each segment is designed to work with the other.
- Over a million DT466 engines built. Twenty five years of development and constant improvement of the same basic configuration behind today's product.
- Common product responsibility. When a problem occurs, there is no question about who is responsible. In other bus chassis an outside manufacturer provides the engine. There are different systems and policies between the manufacturers to work with when a

warranty or out-of-warranty problem occurs. With an International chassis it's one dealer and one manufacturer to work with.

- Higher resale value when it comes time to replace your bus. International chassis products with the DT466 consistently command higher prices in the used market than our competition. A major reason for this is the security to the new owner of easy rebuildability provided by the wet sleeve design.

Dan Herman

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Fax 312 836 3038

e-mail dan.herman@navistar.com

Attachment A

ATTACHMENT A

PARENT BORE *VERSUS* LINERED ENGINE

OUR EXPERIENCE WITH PARENT BORE BLOCK ENGINES GOES BACK MORE THAN 25 YEARS. WE'VE SOLD OVER 700,000 3208's...THE MAJORITY OF THESE WERE SOLD BY FORD DEALERS......AND OVER 100,000 3116's & 3126's.

(1) CYLINDER BORE WEAR: OUR EXPERIENCE TODATE ON THE 3116's SHOWS THAT WE HAVE SOLD ONLY ENOUGH DRY SLEEVE'S TO SLEEVE LESS THAN 1% OF THE 3116 ENGINES IN USE. AND OUR EXPERIENCE ON THE 3208 OVER IT'S LIFE-SPAN WAS THAT LESS THAN 10 % REQUIRED SLEEVE'S AT THE FIRST OVERHAUL.

(2) WHEN IT COMES TO 3116 OR 3126 DURABILITY THERE IS NO SIGNIFICANT DIFFERENCE IN CYLINDER WALL WEAR FOR A PARENT BORE BLOCK VERSUS THE LINER DESIGNS OF BOTH THE CUMMINS C-SERIES OR THE NAVISTAR DT 466 OR 530 ENGINES.

(3) UNLESS THERE IS UNUSUAL DAMAGE FROM ANOTHER SOURCE, SUCH AS DIRT ENTRY...OUR CYLINDER BORES USUALLY REQUIRE ONLY THE RESTORATION OF THE CROSS-HATCH PATTERN OR HONING AT OVERHAUL...AND THIS CAN USUALLY BE DONE IN CHASSIS.

IF THE BORE IS DAMAGED, IT CAN BE RE-BORED UP TO 0.040" (40 THOUSANDTHS) AND DRY SLEEVES ARE AVAILABLE.

(4) CYLINDER BORE DURABILITY: WHEN LOOKING AT THE DURABILITY OF THE CYLINDER BORE OUR MAIN DESIGN OBJECTIVE IS ....THE "SOFT LANDING THEORY"... WHICH IS TO DESIGN THE PISTON RINGS SO THAT THEY WILL WEAR OUT FIRST BEFORE THERE IS BORE WEAR. TO FURTHER TIP THE BALANCE IN FAVOR OF DURABILITY, WE ALSO ADD A PISTON COATING THAT IS LESS ABRASIVE ...TO INSURE LONGER CYLINDER BORE DURABILITY.

THERE ARE *THREE KEY FACTORS* THAT INFLUENCE PISTON RING WEAR...WHICH IN TURN DETERMINES *NORMAL* CYLINDER BORE WEAR:

(5) 1. RING TEMPERATURE....THE PARENT BORE DESIGN ALLOWS THE CYLINDER BORE TO BE COOLED TO WITHIN ONE-HALF INCH (0.5") OF THE TOP OF THE CYLINDER. THIS LESSENS THE CHANCE FOR PISTON CARBON PACKING OR RING STICKING...AND POSSIBLE FAILURE.

(6) 2. PISTON SPEED.... WHILE THE 3116 HAS A CONSERVATIVE PISTON SPEED OF 2,167 FT. PER MINUTE, THE 2200 RPM, 3126 RATINGS, ARE EVEN LOWER AT.... 1,833 FT. PER MINUTE. BOTH HAVE A LOWER PISTON SPEED THAN THE OLD 3208.

(7) 3. CYLINDER BORE SURFACE... THE BORE SURFACE IS PLATEAU HONE FOR SMOOTHNESS. PLATEAU HONING IS A PROCESS THAT IMPARTS A BORE FINISH...THAT DOES NOT REQUIRE ENGINE BREAK-IN.

(8) CYLINDER IRON MASS: ANOTHER FEATURE OF THE PARENT BORE IS THE ADDITIONAL IRON MASS AROUND THE PISTON BORE WHICH ADDS MORE RIGIDITY AND STRENGTH TO THE BLOCK VERSUS A LINERED ENGINE. AND THIS ADDED IRON MASS ALLOWS US TO USE EVENLY SPACED, EXTRA LARGE HEAD BOLTS WHICH TRANSFER THE FIRING LOADS FROM THE HEAD...DIRECTLY TO THE HEAVIEST PORTION OF THE BLOCK.

SINCE THE 3116 & 3126 CYLINDER BORE IS CAST-IN, EXTRA MATERIAL IS LEFT IN THE BLOCK CASTING THAT WOULD HAVE BEEN REMOVED IN A LINERED ENGINE.

ATTACHMENT A

PARENT BORE *VERSUS* LINERED ENGINE

8 THE LINERED CUMMINS C-SERIES AND NAVISTAR DT466 AND 530 HAVE A THINNER CENTER WALL IN ORDER TO ACCOMMODATE THE LINERS.

ON THE CUMMINS C-SERIES THERE IS ONLY 2.5 MM (0.1") OF IRON LEFT BETWEEN CYLINDER BORES. THE NAVISTAR DT466 & 530 HAS LESS...1.5 MM (.060") VERUS OUR 3116 THAT HAS 20 MM (.8") OF IRON BETWEEN THE BORES. THAT'S *8 TIMES* MORE THAN THE C-SERIES AND *13 TIMES* MORE THAN NAVISTAR.

9 IN-FRAME OVERHAUL: WITH THE 3126 & 3116 THE IN-FRAME OVERHAUL PROJECTION IS BETWEEN 350,000 AND 400, 000 MILES...OR 30,000 TO 36,000 GALLONS OF FUEL USED. THIS IS LONGER MILES AND BETTER FUEL USAGE GUIDELINES THAN THE OLD 3208 WHICH WAS 300,000 MILES & 30,000 GALLONS OF FUEL.

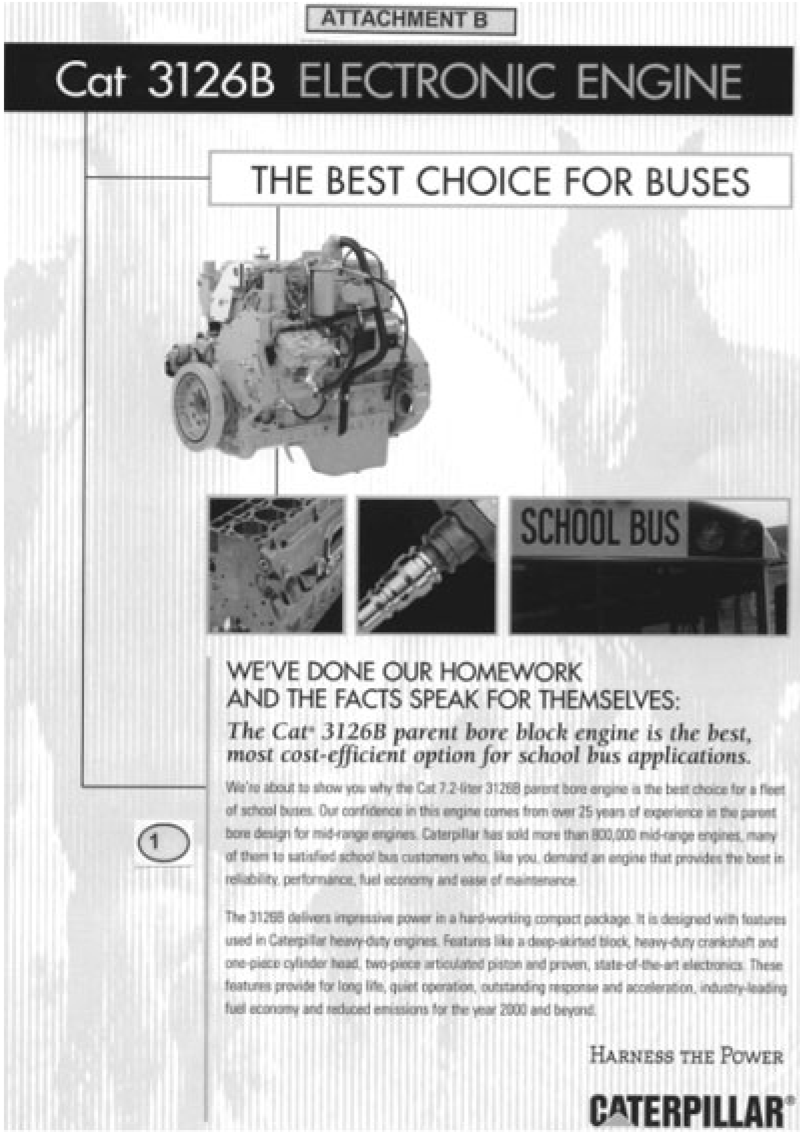
10 RECOMMENDATIONS FOR IN-FRAME OVERHAULS ON BOTH THE CUMMINS C-SERIES AND NAVISTAR DT 466 & 530 ARE ESSENTIALLY THE SAME AS OUR PARENT BORE ENGINES. AND...WHAT'S THE BIG ADVANTAGE OF A LINER...IF YOU REPLACE THEM AT OVERHAUL. BOTH CUMMINS & NAVISTAR HAVE IN-FRAME OVERHAUL KITS THAT INCLUDE LINERS. A LINERED ENGINE ALSO REQUIRES A HIGHER SKILL LEVEL FOR MECHANICS, BECAUSE THEY ARE DEALING WITH MORE PARTS AND MORE POINTS TO SEAL ON THE ENGINE....VERSUS THE PARENT BORE BLOCK

11 COUNTER-BORED BLOCK: THE COUNTER-BORED BLOCK OF THE DT 466 & 530 CAN DEVELOP CRACKS AROUND THE COUNTER BORE AREA. AND THE CUMMINS C-SERIES USES A MID-STOP LINER...THAT RULES OUT GETTING COOLANT TO THE TOP OF THE BORE....IN FACT IT CAN ONLY BE COOLED TO WITHIN 20.3 MM (0.80") OF THE TOP...VERSUS THE 3116 OR 3126 WHICH CAN BE COOLED TO WITHIN 12.7 MM (0.5") OF THE TOP...WITHOUT WEAKENING THE BLOCK.

12 ORIGINALLY DESIGNED TO ONLY BE COOLED TO WITHIN 25.4 MM (1.0 ") OF THE TOP, NAVISTAR HAD TO RESORT TO SACRIFICING THE LINER PILOT TO IMITATE OUR FEATURE. (THE PILOT IS THE PART OF THE LINER JUST BELOW THE FLANGE THAT MAKES THE METAL-TO-METAL CONTACT AND THAT ACTUALLY POSITIONS THE LINER WITHIN THE BORE) AS THE PILOT SHRINKS, SO DOES THE LINER'S ABILITY TO RESIST THE BENDING AND TWISTING FORCE'S OF THE ENGINE...WHICH CAN SHORTEN NOT ONLY RING AND LINER LIFE...BUT CAN CONTRIBUTE TO COOLANT LEAKS AROUND THE LINER SEALS FROM THE EXTRA MOVEMENT OF THE LINER. EVEN AFTER NAVISTAR CUT OUT MOST OF THE LINER PILOT, THE WATER JACKET IS AS THIN AS 0.08"...VERSUS .32" WITH THE 3116 & 3126.

DGV920
9/18/96

Attachment B



ATTACHMENT B

Why choose a parent bore engine?

The parent bore engine has several advantages over a wet-sleeved engine that make it better suited for use in school buses. But essentially, it comes down to this: why spec a more expensive wet-sleeved engine that requires more skill and parts to overhaul when, chances are, you won't need to overhaul the engine?

(2) Consider this: a typical school bus averages 15,000 miles a year, and the bus is usually traded before 10 years. Thus, the engine's life cycle mileage is only 150,000 miles. The 3126B has a life-to-overhaul of 300,000 to 400,000 miles, so you probably won't need to overhaul the engine during the time you own it.

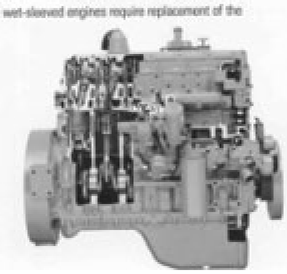
Low life cycle costs make the parent bore engine an attractive option for school districts. Maintenance costs on the 3126B are 10.2 percent less than those for the International DT-466E*. The outstanding fuel economy of the 3126B reduces ownership costs as well. Caterpillar lab tests show that the 3126B is up to 6 percent more fuel-efficient than competitive engines.

*Based on published maintenance intervals. Over 300,000 miles of operation with 10,000 mile oil change intervals.

The mechanics of the issue

Let's look at some design advantages of the Cat 3126B over wet-sleeved engines.

(3) **More strength and rigidity.** In a parent bore engine, additional mass around the piston bores helps stiffen and strengthen the cylinder block. In wet-sleeved engines, spacing between cylinder walls has to be thinner to accommodate the liner. The thinner structure provides less resistance to bending and twisting forces, which leads to shortened ring and liner life. A wet-sleeved engine is more likely to develop coolant leaks around the liner seals because these seals weaken and crack. In fact, most mid-range wet-sleeved engines require replacement of the liners at overhaul, not reuse.



(4) **Better piston design.** The 3126B features a tw
piece piston of the same design found on heavy-
Cat engines. This design allows for higher injecti
pressures and higher top ring position for better
fuel economy. Another advantage of the design
is the chrome hard-faced piston rings, which cre
less wear and tear on cylinder walls. Other com
petitive engines use a less durable, single-piece
aluminum piston.

(5) **More efficient cooling.** The parent bore desig
cools within 12.7 mm of the tops of the cylinders
versus only 20.3 mm in some wet-sleeved mid-r
engines. This is an especially important feature
because today's pistons have rings located in hig
positions. The lack of thorough cooling in a wet-
sleeved mid-range engine can cause counter-bor
cracks.

(6) **Better horsepower-to-weight ratio.** The pare
bore engine's compact design gives it a superior
horsepower-to-weight ratio. Even with all its he
duty components, the 3126B weighs in at less th
a sleeved engine. This translates into fuel savin
and lower overall operating costs.

(7) **Performance at the pump.** Fuel economy
is an important consideration when purchasing
engine for an operation funded by tax dollars. A
it's another reason the Cat 3126B is the best en
choice for school buses. The 3126B is 6 percent
more fuel-efficient than competitive engines, th
to ADEM 2000,™ Caterpillar's new generation of
electronics, and HEUI, the Hydraulically-actuate
Electronically-controlled Unit Injector fuel syste

ADEM 2000 provides three times faster proc
ing and eight times more memory for increased
capability over the previous electronics package
Through a combination of engine monitoring an
electronic controls, ADEM 2000 delivers impro
performance and fuel economy and meets the
emissions standards. The HEUI fuel system wo
with the engine's electronic control module (EC
to deliver improved fuel economy and driveabil
by providing precise monitoring and control of
fuel/air system and allowing for quicker respon
to operating conditions.

ATTACHMENT B

Low maintenance costs

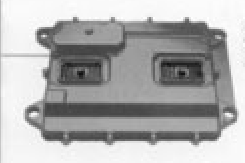
8

When it comes to maintenance costs, the Cat 3126B parent bore engine beats the International DT-466E and other competitors hands down — with 10.2 percent lower annual maintenance costs.

Scheduled Maintenance – Mid-range Truck Engines

	Cat 3126B	International DT-466E
Oil Change Interval (miles)	10,000	12,000
Sump Capacity (quarts)	30	28
Frequency	30	25
Oil Cost	$1,125.00	$875.00
Oil Labor Cost	750.00	750.00
Oil Filter Cost	242.40	482.00
Fuel Filter Cost	273.90	148.92
Fuel Filter Labor Cost	150.00	80.00
Antifreeze Cost	0.00	150.00
Antifreeze Labor Cost	0.00	217.50
Coolant Extender	8.47	0.00
Thermostat Cost	22.59	65.85
Thermostat Labor Cost	165.00	165.00
Valve Adjustment Labor	217.50	150.00
Coolant Filter	0.00	164.00
Coolant Filter Extended Labor	5.00	50.00
TOTAL	$2,959.86	$3,298.27

Based on published maintenance guidelines and 300,000 miles of operation. Labor Rate @ $50.00/hour. Parts Pricing 1/98. Antifreeze costs for 3126B based on use of Extended Life Coolant. At time of publication, some mid-range engine competitors have not approved the use of ELC in their engines.



Reliability is on your side

9

The 3126B was engineered to Cat heavy-duty engine standards, which means it provides exceptional reliability. The 3126B continues to meet Caterpillar's reliability goal of less than 1.5 repairs per 150,000 miles. This includes all types of repairs, from a loose wire to a more complicated repair. Results of a continuous six-month survey of purchasers of the new 3126B engine show that 93 percent would "buy a Cat Truck/Bus Engine again."

Long life to overhaul

10

Here's good news for school districts looking for the most cost-efficient engine for their buses: If you go with the Cat 3126B parent bore engine and follow good preventive maintenance practices, you should never have to overhaul the engine before you trade the bus. That's because the 3126B has a life-to-overhaul of 300,000 to 400,000 miles and a B10 life of 300,000 miles, which means 90 percent of the engines will reach this figure.

If you do keep your buses long enough to require an overhaul, you'll be glad to know that Cat in-frame overhauls cost less — up to 4 percent less than overhaul costs for the DT-466E.

In-Frame Overhaul Cost Comparison Parts Only

11

	Cat 3126B	DT-466E
PISTONS	$747.06	$247.80
PISTON PINS	130.80	51.42
PISTON RINGS	260.28	239.46
PISTON RETAINERS	8.28	2.40
CYLINDER HEAD	878.45	1,133.33
CONNECTING ROD	351.78	770.28
CONNECTING ROD BRG.	53.46	68.10
MAIN BRG.	113.40	99.90
OIL PAN GASKET	22.37	22.44
CYL. HEAD GASKET	37.76	50.49
GASKET SEALS	285.00	285.00
THERMOSTAT	10.97	24.58
OIL FILTER	8.11	21.47
FUEL FILTER	9.37	15.15
TOTAL	$2,917.09	$3,031.82

Based on published overhaul recommendations.
Suggested Consumer Price for Caterpillar and Suggested Fleet Net Prices for Navistar as of 1/98.

Attachment C

ATTACHMENT C

3126 Electronics VS. NAVISTAR

- 3126 USES ONE ECM VS. THREE FOR THE T444E, DT466E, AND 530
- 3126 HAS MORE PROGRAMMABLE ELECTRONICS THAN NAVISTAR
- NAVISTAR'S "THIRD PARTY" ELECTRONICS DO NOT OFFER THESE "STANDARD" 3126 FEATURES:

3126 Parameters vs Navistar

- PTO VSL
- PTO RPM LIMITING
- PTO RAMP RATE
- PTO SET SPEED
- PTO TORQUE LIMIT
- PTO REMOTE CONTROL
- SOFT CRUISE
- SOFT VSL
- VSL TAMPER RESISTANCE
- LOW IDLE RPM
- IDLE SHUTDOWN TIMER
- 3 EXHAUST BRAKE MODES

Attachment D

MIDRANGE ELECTRONIC PARAMETERS COMPARISON						
Item	Features	3126B	ISB/ ISC	T444E/ DT466E/530E	Intl. Corrected	Bus Specific
1	Vehicle ID	x		x	x	
2	Vehicle speed limit	x	x	x	x	x
3	VSL protection	x	x		x	x
4	Soft vehicle speed limit	x	x		x	x
5	Low/high cruise control set speed limit	x	x	x	x	x
6	Engine retarder interface	x	x	x	x	x
7	Customer parameter lockout	x		x	x	x
8	Soft Cruise control	x	x		x	x
9	Idle Vehicle Speed Limit (VSL)	x			x	x
10	Idle rpm limit	x	x		x	x
11	Idle/PT0 rpm ramp and bump rate	x		x	x	
12	Fast idle engine rpm #1	x	x		x	x
13	Fast idle engine rpm #2	x	x	x	x	x
14	PTO configuration - cab & remote	x	x	x	x	
15	PTO Top Engine Limit (TEL)	x	x	x	x	
16	PTO rpm set speed	x	x	x	x	
17	PTO cab throttle rpm limit	x	x	x	x	
18	PTO vehicle speed limit	x		x	x	
19	PTO torque limit	x	x			
20	PTO shutdown timer	x	x			
21	PTO activates cooling fan	x				
22	Lower gears engine rpm limit	x				
23	Intermediate gears engine rpm limit	x	x			
24	Gear down protection rpm limit	x	x			
25	Top engine limiting	x	x			
26	Low idle engine rpm	x	x			
27	Idle shutdown timer/override	x	x	x		
28	A/C pressure switch fan-on time	x	x			
29	Fan w/engine retarder in high mode (10/98 availability)	x				
30	Quick-stop recorder (10/98 Availability)	x				
31	Maintenance indicator mode	x	x	x	x	x
32	Theft deterrent	x				x
33	Engine power uprateability	x	x		x	x
34	Customer password #I & #2	x	x	I only		
35	Powertrain data link J 1939	x	x	x	x	x
36	Dash display interface	x	x			
37	Flash downloading capability	x	x			
38	Engine protection shutdown	x	x	extra cost opt.		
39	Idle time minutes	x	x			

40	Brake PTO disable	x	x			
41	Cold ambient protection	x	opt.	x	x	x
42	Fleet Info. Software (FIS) (10/98 availability)	x	x			
43	Wireless download capabilities (10/98 availability)	x	x			
44	Custom reports, (FIS/dash display)	x	x			
45	Date & time stamping (battery back-up)	x	C-only			
46	ECM records — PTO time/fuel, idle time/fuel, engine load factor	x	x			