INSTALLATION PROCEDURES

ALL HONDA 4 CYLINDERS

1. All machine work may be accomplished on a CNC vertical mill capable of 3-4 axis interpolation with sufficient height to accommodate block height. The bore center distances must be maintained within ±.0005 for sleeve installation to seal properly. (see block specification sheets for dimensions)(See #12 for bore center specs.)

2. All machining must produce a good surface finish and the tolerances must be maintained to assure a quality fit and sleeve seal.

3. Block must be square and perpendicular to machine head. Fixturing should be on main journals provided they are not cracked or distorted. Out of Line 1 and 5, main journals will require main line boring prior to block/sleeve machine work.

4. Final sleeve installation should be accomplished with a brass or aluminum mandrel in cylinders 1 through 4, in that order.

5. After sleeve installation, install a deck plate or head, torque and leave till block is cool.

6. Pressure checking of sleeve seal should be accomplished with a top deck plate and water pump plug as shown in photos. The main cap bolts can be used to torque down the top deck plate which should be gasketed with thin rubber sheeting.

7. Finish boring and honing should only be accomplished with a deck plate installed.

8. Field service and singular sleeve replacement is possible and practical by using a slide hammer sleeve puller with the drive mandrel "Flatted" and oriented to provide main web clearance. Sleeves can then be ordered from Darton, by cylinder number.

9. If needed for oversized bores, machine sleeve I.D. out to allow .004-.008 from finished size for cylinder honing.

10. Prior to boring for sleeve installation, bore the existing sleeve to .010 over to finish bore dimension stopping at the main bearing web.

11. Seal wire grooves in the top of the sleeves can only be machined after decking.

12. B-16 / B-18—3.543 [90mm]  
    F22 & H22/23 & K20—3.701 [94 mm]

NOTES/CAUTIONS

1. Caution: measure each sleeve prior to boring diameter “C” located on the block prints. After measuring each sleeve, machine block to have a .000 to .002 clearance.

2. Take precaution on final washout of block in order not to damage flange sealant or o-rings.

OSHA

Always use approved protective equipment for sight, hearing, breathing, and hands while machining or using chemicals. MSDS sheets are available on chemicals supplied as part of this kit, upon request.
INSTALLATION PROCEDURES

ALL HONDA 4 CYLINDERS

Clean and strip block of all excess bolts, brackets, etc.

Fixture block on machine surface and square, level and secure.

OSHA

Always use approved protective equipment for sight, hearing, breathing, and hands while machining or using chemicals. MSDS sheets are available on chemicals supplied as part of this kit, upon request.
OSHA
Always use approved protective equipment for sight, hearing, breathing, and hands while machining or using chemicals. MSDS sheets are available on chemicals supplied as part of this kit, upon request.
INSTALLATION PROCEDURES

ALL HONDA 4 CYLINDERS

Sequentially bore using bore spacing specifications shown on prints.

OSHA
Always use approved protective equipment for sight, hearing, breathing, and hands while machining or using chemicals. MSDS sheets are available on chemicals supplied as part of this kit, upon request.
INSTALLATION PROCEDURES

ALL HONDA 4 CYLINDERS

Continue boring operation to completely remove parent bore material to crankcase.

OSHA

Always use approved protective equipment for sight, hearing, breathing, and hands while machining or using chemicals. MSDS sheets are available on chemicals supplied as part of this kit, upon request.
INSTALLATION PROCEDURES

ALL HONDA 4 CYLINDERS

1. All machine work may be accomplished on a CNC vertical mill capable of 3-4 axis interpolation with sufficient height to accommodate block height. The bore center distances must be maintained within ±.0005 for sleeve installation to seal properly. (see block specification sheets for dimensions)

2. Remaining inner bore material must be removed to solid area as described in blueprint for cylinder 1. Use a mill and interpolate height, diameter and depth to clean residual parent bore.

Interpolate a mill cutter and bore upper register according to print.

machining must produce a good surface finish and the tolerances must be maintained to assure a quality fit and sleeve seal.

3. Block must be square and perpendicular to machine head.

Fixturing should be on

NOTE: It is essential that all parent bore material be removed down to crankcase surface. No gap can remain. if any gap exists, it must be ground out by hand and filed/deburred (see prints).

OSHA

Always use approved protective equipment for sight, hearing, breathing, and hands while machining or using chemicals. MSDS sheets are available on chemicals supplied as part of this kit, upon request.
INSTALLATION PROCEDURES

ALL HONDA 4 CYLINDERS

Finished block, top view

Finished block, side view

OSHA

Always use approved protective equipment for sight, hearing, breathing, and hands while machining or using chemicals. MSDS sheets are available on chemicals supplied as part of this kit, upon request.
INSTALLATION PROCEDURES

ALL HONDA 4 CYLINDERS

Clean sleeves totally, coat o’ring grooves with supplied lubricant and install o’rings using standard o’ring practice. **Caution, do not over stretch or nick o’rings, water leaks will result.**

Arrange all sleeves prior to install according to bore number.

OSHA

Always use approved protective equipment for sight, hearing, breathing, and hands while machining or using chemicals. MSDS sheets are available on chemicals supplied as part of this kit, upon request.
INSTALLATION PROCEDURES

ALL HONDA 4 CYLINDERS

Pre-heat block, cool sleeves and install in bore sequence. Be sure to square/align flats 90° to assure fit.

Finished block. use an appropriate solid deck plate to seal off deck and test installation to 30-40 psi to assure no water leaks.

OSHA

Always use approved protective equipment for sight, hearing, breathing, and hands while machining or using chemicals. MSDS sheets are available on chemicals supplied as part of this kit, upon request.
INSTALLATION PROCEDURES

ALL HONDA 4 CYLINDERS

* CAUTION *

On some Honda blocks when machining the lower register of the number one cylinder you may reveal casting imperfections, which open to the front cover area. The hole that appears is from one of the bolt seats that hold on the timing cover. (noted by the red pencil) To seal this, apply some silicone to the end of the bolt when replacing the timing cover. Take caution and check for this and other holes because it does not occur on all blocks after machining is completed. Also prior to installation apply flange sealent to highlighted area.(see highlight)

OSHA

Always use approved protective equipment for sight, hearing, breathing, and hands while machining or using chemicals. MSDS sheets are available on chemicals supplied as part of this kit, upon request.
INSTALLATION PROCEDURES

ALL HONDA 4 CYLINDERS

**OSHA**

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This view shows the free standing wall that is remaining after machining to “B” depth.

*note—free standing wall in sand cast water jacket area will vary in size.

This view shows the finished machine block.

1. Casting ridge begins at a $30^\circ$ cut to eliminate remaining free standing wall down to surface “BB”.
2. Refer to example picture of cut in cylinder #1.

*note—cylinder #1 shown and is typical for cylinder#4.
FOR BEST RESULTS:
Darton recommends the use of a Cometic MLS head gasket (non HP) when running any of our MID kits.

NOTES/CAUTIONS:
1. Make sure that block and head surfaces are machined within proper RMS specification.

2. Depending on the type of head bolts used, re-torque head bolts to proper specifications may be required.

OSHA
Always use approved protective equipment for sight, hearing, breathing, and hands while machining or using chemicals. MSDS sheets are available on chemicals supplied as part of this kit, upon request.
Darton recommends the use of Evans coolant with all MID kits!

**MPG+** for all street applications.
**MPGR** for full race applications.

OSHA

Always use approved protective equipment for sight, hearing, breathing, and hands while machining or using chemicals. MSDS sheets are available on chemicals supplied as part of this kit, upon request.
INSTALLATION PROCEDURES

All Honda Engines with Darton MID Sleeves
ADDITIONAL INSTRUCTIONS

Break-in, tuning
Fill the engine with a good grade of mineral oil (not synthetic) with viscosity for your bearing clearance and intended use. Prime the oil system before engine start with ignition off using the engine or dyno starter. We require break-in and tuning using an engine dyno or chassis dyno as follows:

- After initial start up, warm up engine at 2000-2500. Precaution should be exercised to prevent excessively rich or lean conditions, which will gall the cylinders. Monitor oil pressure and temperatures.
- After initial run, adjust valves if using adjustable valve train and retorque heads. Check for leaks.
- Street engines will require multiple run ins with increasing rpm and load up to maximum output.

Use of a dyno allows one to apply a pre-set load to allow the piston rings, and other components to seat properly. It is also much easier to monitor temperatures and pressures than while driving. Most dynos are equipped with O² and EGT probes to aid in tuning. The timing and fuel curve needs to be tailored to your particular engine to ensure the engine stays out of detonation, which will lead to engine failure. A racing engine is generally built with sufficient clearance to require no further break-in after dyno tuning and power runs. However, we recommend head bolt torques be re-checked cold after dyno testing as the head gaskets will take a set. Remember to replace oil and filter after the dyno session as bearing coatings and metal particles will be trapped in the oil filter. Inspect the oil for foreign material and excessive bearing flakes.

A street engine should be driven moderately for the first thousand miles, as follows:

- full throttle high torque power usage should be limited and never be used until the engine has been running for at least 15 minutes.
- from 0-500 miles, do not exceed 4000 rpm.
- from 500-1000, do not exceed 6000 rpm.
- over 1000 miles, no restrictions.

Also, do not run at the same speed for extended periods during break-in. Make certain the engine is operating at proper coolant temperature and oil pressure. Do not allow the engine to overheat. Make necessary changes if required (radiator, fan, tuning) to get the engine to run in the proper temperature range. We also recommend you do not run synthetic oil until at least 5000 miles. Synthetics work so well that the engine will never break in properly if it is used too soon.

OSHA
Always use approved protective equipment for sight, hearing, breathing, and hands while machining or using chemicals. MSDS sheets are available on chemicals supplied as part of this kit, upon request.
# Sunnen CV-616 Setup

The cost-effective Sunnen CV-616 Automatic Cylinder Hone is one of the most versatile machines you can have in your shop. You can count on consistent results as the CV-616 produces the most precise cylinder bores possible, cylinder after cylinder, block after block.

## Results with Sunnen Honing Stones on Darton Cylinder Sleeve Material

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<tr>
<th></th>
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<th>EHU 518</th>
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<td>C30 PHT 731 - 30 Seconds</td>
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### JHU 623

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<td>MR2</td>
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### JHU 623

**C30 PHT 731 - 15 Seconds**

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<td>MR2</td>
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Results obtained with Sunnen MAN 845 honing oils. Results may vary with other oils.
Honda M.I.D. D16-S1
Cylinder #1

NOTE:
1. BORE THRU TO MAIN WEB AT FINISH
   BORE DIA +.010
2. ON #1 CYL ONLY REMOVE REMAINING 320° ALUM WALL
   DOWN TO .445 BY MILLING OR HAND GRINDING.
   THIS WILL ELIMINATE ALL ALUM WALL THAT WOULD
   FORM A GAP BETWEEN SLEEVE AND WATER JACKET.
   REFER TO PHOTO P6162 IN INSTALLATION MANUAL.
Honda M.I.D. D16-S3
Cylinder #2-3-4

NOTE:
1. BORE THRU TO MAIN WEB AT FINISH
BORE DIA +0.010

SEE NOTE #1
Honda M.I.D. D16-S4
Cylinder #2-3-4

- INTERIOR WATER JACKET WALL -

B
Ø3.750±.005
[995.250mm±.127mm] REF

C
Ø3.246±.001
[822.398mm±.004mm] REF

D
FINISH BORE +.010
BORE THRU TO MAIN WEBS REF

DETAIL A
NO SCALE
Honda M.I.D. B16-S1
Cylinder #1

NOTE:
1. BORE THRU TO MAIN WEB AT FINISH
   BORE DIA +0.10
2. ON #1 CYL ONLY REMOVE REMAINING 320° ALUM WALL
   DOWN TO 4.246 BY MILLING OR HAND GRINDING.
   THIS WILL ELIMINATE ALL ALUM. WALL THAT WOULD
   FORM A GAP BETWEEN SLEEVE AND WATER JACKET.
   REFER TO PHOTO #8182 IN INSTALLATION MANUAL.

REV

REV

NOTE

1

REV

NOTE

1
NOTE:
1. BORE THRU TO MAN WEB AT FINISH
   BORE 0.040" +0.010
Honda M.I.D. B16-S4
Cylinder #2–3

INTERIOR WATER JACKET WALL

\[ \text{FINISH BORE } +0.010 \]
\[ \text{BORE THRU TO MAIN WEBS} \]

\[ \text{DETAIL A} \]

NO SCALE

© [Company Name]
Honda M.I.D. B16-S5
Cylinder #4

NOTE:
1. BORE THRU TO MAN WEB AT FINISH
   BORE DIA +.010
2. ON #4 CYL. ONLY REMOVE REMAINING 250° ALUM WALL
   DOWN TO 4.246 BY MILLING OR HAND GRINDING.
   THIS WILL ELIMINATE ALL ALUM WALL THAT WOULD
   FORM A GAP BETWEEN SLEEVE AND WATER JACKET.
   REFER TO PHOTO #8182 IN INSTALLATION MANUAL.

REV

DESCRIPTION

DATE

APPROVAL

---

NOTE 

SEE NOTE #1

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© HONDA M.I.D. 1995

FOR NA. M.I.D. ENG. HONDA B16-S5-HONDA M.I.D. B16-95
Honda M.I.D. B16-S6
Cylinder #4

DETAIL A
NO SCALE

BLOCK SPECIFICATION - CYL #4
HONDA M.I.D. B16 ENGINE

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Honda M.I.D. B18-S1
Cylinder #1

NOTE:
1. BORE THRU TO MAIN WEB AT FINISH
   BORE DIA +.010
2. ON #1 CYL ONLY REMOVE REMAINING 300° ALUM WALL
   DOWN TO 4.495 BY MILLING OR HAND GRINDING.
   THIS WILL ELIMINATE ALL ALUM WALL THAT WOULD
   FORM A GAP BETWEEN SLEEVE AND WATER JACKET.
   REFER TO PHOTO #8142 IN INSTALLATION MANUAL.

REV

DESCRIPTION

A
B

C

BB


4.626±.001
[117.475mm±.025mm]

3.500±.005
[88.900mm±.020mm]

3.750±.000

3.500±.005

5.520±.008
[140.088mm±.038mm]

0.170mm±.003mm

1.270mm


3.580±.000

0.255mm

0.025mm

4.485±.001
[114.173mm±.025mm]

SEE NOTE #1

NOTE:

The information presented in this document is intended for use in conjunction with the original manual and should not be used for modifications or repairs. The use of this information without proper supervision or qualifications is not recommended.

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Information in this document is subject to change without notice.

For additional information, contact Honda Engine Manufacturing, Inc.

1-1 Honda International, Inc.

800-109-6627

Block Specification - Cyl #1

Honda M.I.D. B18 Engine

HONDA M.I.D. B18-ENGINE
Honda M.I.D. B18-S2
Cylinder #1
Honda M.I.D. B18-S3
Cylinder #2–3

NOTE:
1. BORE THRU TO MAIN WEB AT FINISH
   BORE: OKA -0.010

A
0.20±.002
[13.208±0.051mm]

A
Ø4.025±.001
[117.475±0.025mm]

B
Ø3.004±.005
[99.060±0.127mm]

C
Ø3.004±.005
[99.060±.025mm]

C
Ø88.800±.000

C
0.025±.005 x 60°
CHAM

D
SEE NOTE #1

REV
DESCRIPTION
DATE
APPROVAL
NOTE:
1. BORE THRU TO MAIN WEB AT FINISH
   BORE DIA. +.010
2. ON #4 CYL ONLY REMOVE REMAINING 28G ALUM WALL
   DOWN TO 4.495 BY MILLING OR HAND GRINDING.
   THIS WILL ELIMINATE ALL ALUM WALL THAT WOULD
   FORM A GAP BETWEEN SLEEVE AND WATER JACKET.
   REFER TO PHOTO #8182 IN INSTALLATION MANUAL.

NOTE #1

SEE NOTE #1
Honda M.I.D. H22-S2
Cylinder #1 & 4

INTERIOR WATER JACKET WALL

SEE NOTE 2 PAGE 1

DETAIL A
NO SCALE
Honda M.I.D. H22-S3
Cylinder #2–3

NOTE:

1. BORE THRU TO MAN WEB AT FINISH
BORE 0.040 ± 0.010

A
[13.208 mm ± 0.051 mm]

A
[91.223 ± 0.025 mm]

A
[107.855 ± 0.127 mm]

A
[115.443 ± 0.025 mm]

A
[147.855 ± 0.254 mm]

SEE NOTE #1
NOTE:
1. DECK BLOCK SURFACE AFTER SLEEVE INSTALLATION.
Honda M.I.D. K20-S2
Cylinder #1-4
Honda M.I.D. K-24
Cylinder #S1

NOTE:
1. DECK BLOCK SURFACE AFTER SLEEVE INSTALLATION.
NOTE:
ON #1 CYL. REMOVE REMAINING 0.007 ALUM
WALL DOWN TO 0.005 BY MILLING OR HAND GRINDING.
THIS WILL ELIMINATE ALL ALUM WALL THAT WOULD
FORM A GAP BETWEEN SLEEVE AND WATER JACKET.
REFER TO PHOTO PAGE ** IN INSTALLATION MANUAL.
Ford 4.6 Installation Manual
Thank you for purchasing the Darton state of the art new MID Sleeve Kit, US Patent No. 6,799,541. The kit makes possible maximum bore sizes, increased cylinder strength and superior wear resistance.

Darton wants to provide you with the best technical information we have available to ensure that your sleeved engine will perform to your expectations. Because the MID ductile iron sleeve kit “reinvents” the block structure with substantially increased bore wall thickness, certain operational characteristics become more like diesel engine technology than gasoline engine. Therefore, we have formulated a program of required procedures and components, which we believe will ensure operating success of your sleeved engine in whatever application it will see service in.

**Note:** The Ford™ 4.6L M.I.D. Kit requires the use of Ford’s™ Cobra jet 4 valve cylinder heads and gaskets. The use of other heads may require modification of the head at the oil pressure transfer passage. See Darton for details.
INSTALLATION PROCEDURES

Revised: 03.28.2005

Ford 4.6 liter MID Sleeve Kits

Read and make sure you understand these instructions before proceeding with block machining. If you have questions concerning machining, assembly, proper tooling, machines, etc.

PREPARATION, FIXTURING:

1. The block needs to be fully stripped, cleaned and inspected before machining. Main web cracks, or structural damage may prevent satisfactory sleeve installation. Blocks with cracked factory liners are good candidates for sleeving as long as the crack doesn’t extend to the bottom most 1.5" of cylinder wall.

SETUP AND BLOCK MACHINING:

1. With your block mounting fixture securely bolted to the CNC machine table, indicate the centerline of your block mounting bar in the “Y” axis direction. That will be your “Y” fixture or part offset depending on terminology used with your machine. You will only have to do this one time since this position will remain the same. The object is to correct for factory machining errors, block warpage. You want the MID sleeves installed directly over the crankshaft axis and not offset as would probably happen if you merely went off the existing cylinder centerline.

Now set the block up on the CNC machine. The preferred method is with precision made mounting rings located in the front and rear main bearing bores and with the bell housing face securely bolted to a fixture plate. Rotate your fixture so the left (driver’s side bank) is facing up. Indicate the rear deck surface of the block - photo 1. Rotate the block around the crank axis until you get close to zero run out across the deck from side to side. Lock your fixture when you are satisfied the block is true. Zero the degree wheel if so equipped. Note that most blocks will be warped front to back. I recommend dialing in the deck surface at the rear of the block. Note the photo shows indicating the front of the block. Now indicate the “X” centerline of cylinder number five, (left bank first cylinder) - photo 2. The centerline position is your “X” fixture offset position. Enter the “X” and “Y” offsets in your machine’s fixture or part offset table.
2. Clean the rust preventative from the sleeves using laquer thinner. Measure the bottom diameter, the upper flange diameter, and the seating depth of each sleeve. Generally the diameters will be very close - within .001" in any one set. Measure the diameters at 90 degrees and average the result. The average diameter at the lower seal surface of the new MID sleeves is 3.877". This will vary about a thousandth plus or minus. If the largest sleeve averages out at 3.877" and the smallest at 3.876" use 3.8765" as your boring size for that part of the installation. The sleeves should be installed plus or minus .0003" of the measured size. Do not attempt to install MID sleeves if you cannot hold this tolerance. Note that the seating depth of the sleeves may vary a bit. This is not critical since the block will be decked after the sleeves are installed. Average sleeve seating height is right around 4.250". We machine the block shy of this figure so the sleeves protrude a bit after installation.

3. Touch off your tools on the deck surface at the front of the left bank either before you begin machining or as you are about to use them, whichever you prefer. Set your tool length offsets into your machine’s tool table. Machining depths are from the deck surface down.

4. Note that the bore center to center is 3.9382". You need to keep this centerline dimension to +/- .0005". Note that in order to maintain the required tolerances it is mandatory to use a machine with flood coolant. It will be impossible to hold tolerance otherwise and a poor job will be the result.

5. First operation is to bore the four cylinders on the left bank to your finished bore size + .010" diameter to the main bearing webs - photo 3. Depth of cut is 5.960" from the deck surface to the main webs.

6. Next you will machine to the o’ring diameter to a depth of 5.350" and to a nominal diameter of 3.8765". This diameter is your average measured diameter of the sleeve o’ring area. A net fit is preferred and no more than .0005" press fit should be used.

7. Next operation removes the remaining cylinder walls to a diameter of 4.350" and to a depth of 4.220". Photos 5 and 6.

If the block you are machining is a used block, go on to instruction (8). Else follow the instructions below if the block is a brand new never run casting.

If this is a brand new block you are working on it MUST be stress relieved after the roughing operations. It will warp in service distorting the sleeves if this is not done. Rotate the block 90 degrees to get the right bank vertical. Perform the above steps (5 thru 7) on the right bank. You must change the “X” axis fixture or part offset (depending on your machine) for the right bank. The offset is -.9435". In other words the bore centerline of cylinder 1 is .9435" offset towards the
front of the block from cylinder five. Do not alter the “Y” offset position. This will always stay the same unless you remove the fixture from the machine.

Remove the block from the machine, clean and have the block vibratory stress relieved.

After stress relief, remount the block on the machine with the left bank facing up. Indicate the left bank as in instruction (1) above. Indicate the “X” axis centerline of cylinder five. Enter that position in your machine’s fixture or part offset table as you did in instruction one. Continue on to step (8).

8. Next, machine the upper flange diameter to your measured diameter in step (2) +.001". The nominal diameter on the sleeve flange is 4.701". Your flange bore should be 4.702" machined to a depth of .550". You can bore or use circular interpolation for this cut dependent on your tooling and expertise. If you use circular interpolation with a carbide end mill, use two passes leaving ~ .010" for the finish pass - photo 7. This will ensure a better surface finish and rounder hole.

9. Next, install a long insert style end mill that has .030" radius inserts. You will use interpolation milling for the sleeve seating surfaces. Use circular interpolation to cut a 4.300" diameter to a depth of 4.245". This depth will leave the sleeves protruding .005" after installation. Again, use plenty of coolant to prevent buildup on the tool - photo 8.

10. Finish the left bank by cutting a chamfer at each seating surface ID to facilitate the o’ring passing during installation. I prefer a 45 degree chamfer cut to a depth of .025". If you use a tool like that shown in the photo adjust the spindle speed to ~ 60 rpm to prevent chatter. Photo 9.

11. Repeat operations (8 through 10) on the opposite bank after indexing the block 90 degrees. Note again that the offset for cylinder one (front cylinder on the right bank) is .9435" towards the front of the block from cylinder five on the left bank. Make certain to adjust your part offset position in the machine fixture or part offset table else you will ruin your block.

12. Remove the block from the machine, clean it, deburr it, lightly sand the chamfer you cut for the o’rings. Make certain the head threads are clean. A thread forming tool should be run through the head bolt holes on used blocks. The surface finish should be as shown in photo 10.
SLEEVE INSTALLATION:

1. It is not necessary or recommended to heat the block for sleeve installation. Leaving the block sit in the sun for a few minutes is sufficient. If the machining was done properly the sleeves will easily install with a shot filled plastic mallet and drive home with an aluminum plate and hammer.

2. Install the rubber o’rings into the lower sleeve grooves using minimal stretch. Do not roll the o’rings into the grooves. Lubricate the o’rings and lower area of the sleeves with the supplied lubricant - photo 11.

3. Apply a small amount of supplied Loctite flange sealant on perimeter of each sleeve upper flange as well as the siamesed flat. Only the top .500” of the flat area needs sealant.

4. Start cylinder number one sleeve using a plastic mallet. Drive it in just far enough to engage the upper flange. Start the adjacent sleeve and drive that in to the same depth as the first sleeve. Note that the side of the sleeve with the most holes in the flange goes towards the outside (exhaust side) of the block. Check to make sure the alignment half holes along the flats line up to form round holes. Adjust the clocking as necessary using a pointed tool carefully hammered in the alignment holes. Install the remaining two sleeves to the same depth again checking the clocking. Now drive them in the rest of the way using an aluminum plate and hammer. Lightly tap the pointed alignment tool in all the alignment holes to ensure the holes are round. The sleeves should protrude slightly from the deck surface. Install the sleeves on the opposite bank using the same procedure. Photo 12.

5. Clean off excess sealant from sleeve flange area. Install a pair of torque plates with head gaskets. Torque to 50ft./lbs. using ARP head bolts. This step ensures the sleeves are fully seated. Let stand at least two hours, preferably over night. Remove plates, and deck block head surfaces flat and as smooth as possible. Do not deck any more than is required or you will have problems with the pistons protruding too far out of the block. The only recommended head gasket is the MID specific Cometic gasket. Photos 13, 14, and 15 and 16.

Main cap studs and align honing are highly recommended.
NOTES:

1. PRIOR TO BORING FOR SLEEVE INSTALLATION, BORE EXISTING SLEEVE TO FINISH BORE DIMENSION ±0.010 STOPPING AT MAIN BEARING WEB, Ø 5.950±0.010 FOR HONING CLEARANCE.
2. USE ONLY WITH COBRA ENGINES WITH HEAD GASKETS FOR M.I.D. KIT
3. BORE CENTER 5.9382
4. OPT. MACHING, REMOVE CYLINDER WALL TO DEPTH OF 4.220 THEN CIRCULAR INTERPOLATE Ø #4.300 TO DEPTH OF 4.245.
POST MACHINING
INSTRUCTIONS
Revised: 03.28.2005

Ford™ 4.6L Engines with
Darton MID Sleeves

PREPARATION PROCEDURES
1. Sleeves are delivered with a generous chamfer on the lower edge to help
prevent piston damage. If sleeves are over bored and honed, it is manda-
tory that the bottom edge of the sleeve be chamfered or radiused (30 – 45
deg., Chamfer min. .050") and completely deburred. Failure to do this will
result in severe piston skirt damage and engine failure.
2. We recommend piston skirts be coated with a polymer coating, and
piston tops with ceramic. Due to the acute rod angles at the bottom
of the stroke with stroker cranks, pistons’ wall thrust is increased sub-
stantially, which requires generous chamfers at bore bottom and piston
skirt coating to assure no scuffing and galling. Both coatings may allow
the pistons to be fitted with less piston to wall clearance, which is
desirable in terms of noise reduction and oil consumption on street
 driven vehicles. “Polydyne” and “Swain” are two well-known firms
who can apply these coatings reliably.

ASSEMBLY
1. The block should have the cam and main journals checked and honed
true if necessary.
2. The short block should be trial assembled without rings to inspect
crankshaft, connecting rod, and connecting rod bolt clearance (.080”
min.). Re-chamfer the sleeve bottom wherever it is ground for clear-
ance. (Absolutely no burrs or sharp edges can remain on the bottom
of the bore.) Minimum recommended ring gaps using ductile iron top
and cast iron second rings are as follows: (more gap may be used and
is beneficial)
   • Street performance use – top ring end gap min. .004” x bore diameter
     normally aspirated, second ring .005” x bore diameter.
   • Racing use – .0045” x bore diameter top, .0055” x bore diameter second
     normally aspirated.
• Street with nitrous oxide – .005” x bore diameter top, .006” x bore diameter second.
• Drag racing with nitrous oxide – .007” x bore diameter top and second.
• Supercharged or turbocharged – .006” x bore diameter top and second.

3. We highly recommend the use of 4032 alloy pistons for normally aspirated street use and 2618 alloy for racing, boosted or nitrous street use. 4032 is a low expansion alloy best suited for street use where one would want minimum piston to wall clearance to minimize piston rock, noise and oil consumption. 2618 alloy has superior strength and is the preferred alloy for racing use or street use with nitrous. But this alloy requires significant increases in piston/wall clearance.

4. Both cylinder and align honing must have deck plates installed with the same type gaskets, fasteners as will be used in operation. Honing finish should be done according to the ring face material. For moly rings, generally no finer than 400 grit else the rings may not seat properly for street use; 280 grit for chrome faced rings. A plateau hone should be stroked through the cylinders as a finishing operation. It is of utmost importance that the cylinder walls be thoroughly cleaned after honing to remove abrasives and metal particles. Spray washing, or hot tanking is insufficient. Use paper towels coated with ATF or WD40 to wipe down cylinder walls after the wash operation. Continue wiping with towels and ATF until the towels show no more signs of dirt pick up.

Note: Honing head must be modified to accommodate stones and allow for over-stroke of .200. Piston to wall clearance must be reduced beyond piston manufacture recommendations.

5. Tip: When installing pistons into cylinders, coat pistons and rings with ATF instead of motor oil for faster and more reliable ring seating.

COOLING
The Darton ductile iron MID sleeves were designed specifically for racing and high performance street use. The sleeves are heavy wall construction, designed to remain round for effective ring sealing under conditions of high power output and stress. More power means more heat. This heat must be effectively transferred to the cooling system to prevent damage to the piston and sleeve. Roughly one third of the heat energy of the fuel is lost to the cooling system. The stock Ford cooling system was designed for
400 horsepower and a stock cylinder block with cast-in dry liners. The **Darton** kit effectively converts the block to a wet sleeve configuration as used on diesel engines. One cannot expect the original cooling system to effectively cool and engine producing two or more times the power of the original engine, along with a modified cylinder arrangement. We recommend “Evans NPG+™” coolant be used as well as Evans LS–1 reworked water pump utilizing a relocated thermostat. High output applications may also require a larger radiator and coolant fan. Evans coolant is recommended because of the potential for hot spots and cavitation around wet style sleeves. We realize that most engines built will produce well in access of the stock rated horsepower making cooling system enhancements a must. However, we have customers reporting success with large bores, stock cooling systems, therefore your cooling system requirements/modifications should be dictated by individual usages.

**BREAK–IN, TURNING**

Fill the engine with a good grade of mineral oil (not synthetic) with viscosity for your bearing clearance and intended use. **Prime the oil system** before engine start with ignition off using the engine or dyno starter. We require break–in and tuning using an engine dyno or chassis dyno as follows:

- After initial start up, warm up engine at 2000–2500, at no more than 100–150 ft. pounds of torque for 15–30 minutes. Precaution should be exercised to prevent excessively rich or lean conditions, which will gall the cylinders. Monitor oil pressure and temperatures.
- After initial run, adjust valves if using adjustable valve train and re-torque heads. Check for leaks.
- Street engines will require multiple run–ins with increasing rpm and load up to maximum output.

Use of a dyno allows one to apply a pre-set load to allow the piston rings, and other components to seat properly. It is also much easier to monitor temperatures and pressures than while driving. Most dynos are equipped with O_ and EGT probes to aid in tuning. The timing and fuel curve needs to be tailored to your particular engine to ensure the engine stays out of detonation, which will lead to engine failure. A racing engine is generally built with sufficient clearance to require no further break–in after dyno tuning and power runs. **However, we recommend head bolt torques be re–checked cold and retorqued if necessary after dyno testing to guarantee gasket seal.** Remember to replace oil and filter after the dyno session as bearing coatings and metal particles will be trapped in the oil filter.
Inspect the oil for foreign material and excessive bearing flakes.

A street engine should be driven moderately for the first thousand miles, as follows:

- full throttle high torque power usage should be limited and never be used until the engine has been running for at least 15 minutes.
- from 0–500 miles, do not exceed 4000 rpm.
- from 500–1000, do not exceed 6000 rpm.
- over 1000 miles, no restrictions.

Also, do not run at the same speed for extended periods during break-in. Make certain the engine is operating at proper coolant temperature and oil pressure. Do not allow the engine to overheat. Make necessary changes if required (radiator, fan, turning) to get the engine to run in the proper temperature range. We also recommend you do not run synthetic oil until at least 5000 miles. Synthetics work so well that the engine will never break in properly if it is used too soon.

**NOTES / CAUTIONS / WARNINGS**

1. Proper eyewear protection should be worn at all times during block machining.
2. Use of appropriate breathing filtration is highly recommended.
3. Observe all cautions and warnings on manufacturers MSDS’s.
4. Failure to follow installation instructions will result in unsatisfactory performance and may involve sleeve distortion, water leaks, oil leaks, compression leaks or combinations thereof.
5. All sleeves are warranted against manufacturing defects for 1 year from date of sale. Damage as the result of engine failure is not covered, nor is any consequence of such damage weather or not caused by sleeves.
6. Caution must be exercised as old sleeves are bored out to prevent tearing of aluminum in block and possible tool breakage; original sleeves are ribbed and cast in place.
7. All machining must produce a good surface finish and the tolerances must be maintained to assure a quality fit and sleeve seal.
8. Field service and singular sleeve replacement is possible and practical using a slide hammer sleeve puller with the drive mandrel “Flatted” and oriented to provide main web clearance. Sleeves can then be ordered from Darton, by cylinder number.
Darton recommends the use of Evans coolant with all MID kits!

MPG+ for all street applications.
MPGR for full race applications.
FOR BEST RESULTS:
Darton recommends the use of a Cometic M.I.D. MLS head gasket. These head gaskets are specifically made for use with our M.I.D. kits.

NOTES/CAUTIONS:
1. Make sure that block and head surfaces are machined within proper RMS specification.

2. Depending on the type of head bolts used, a retorque of head bolts to proper specifications may be required.
The cost-effective Sunnen CV-616 Automatic Cylinder Hone is one of the most versatile machines you can have in your shop. You can count on consistent results as the CV-616 produces the most precise cylinder bores possible, cylinder after cylinder, block after block.

**Job: Ford 4.6L block with Darton sleeves**

<table>
<thead>
<tr>
<th>Semi Finish</th>
<th>Plateau Finish</th>
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<tbody>
<tr>
<td><strong>Cylinder Part #:</strong></td>
<td><strong>600-120 (4.125&quot;)/600/120</strong></td>
</tr>
<tr>
<td><strong>Stone Part #:</strong></td>
<td><strong>EHU 412</strong></td>
</tr>
<tr>
<td><strong>Stroke Length:</strong></td>
<td><strong>6&quot;</strong></td>
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<tr>
<td><strong>Feed Rate:</strong></td>
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<td><strong>Top Over Stroke:</strong></td>
<td><strong>5/8&quot;</strong></td>
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<td><strong>Bottom Over Stroke:</strong></td>
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<tr>
<td><strong>Spindle Speed:</strong></td>
<td><strong>170 rpm</strong></td>
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<tr>
<td><strong>Stroke Speed:</strong></td>
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<tr>
<td><strong>Honing Oil:</strong></td>
<td><strong>MAN 845</strong></td>
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<tr>
<td><strong>Stroke Scale:</strong></td>
<td><strong>2 3/4&quot; PNP 1275</strong></td>
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<tr>
<td><strong>Guide Shoes:</strong></td>
<td><strong>CK-3070</strong></td>
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<tr>
<td><strong>Cross Hatch Angle:</strong></td>
<td><strong>25-30</strong></td>
</tr>
<tr>
<td><strong>Material:</strong></td>
<td><strong>Ductile</strong></td>
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<td><strong>Cylinder Length:</strong></td>
<td><strong>5 5/8&quot;</strong></td>
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<td><strong>Load Meter:</strong></td>
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<td><strong>Time Cycle:</strong></td>
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<tr>
<td></td>
<td><strong>45 seconds</strong></td>
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Sunnen CV-616 Setup

The cost-effective Sunnen CV-616 Automatic Cylinder Hone is one of the most versatile machines you can have in your shop. You can count on consistent results as the CV-616 produces the most precise cylinder bores possible, cylinder after cylinder, block after block.

**Results with Sunnen Honing Stones on Darton Cylinder Sleeve Material**

<table>
<thead>
<tr>
<th>Sunnen CV-616</th>
<th>EHU-412</th>
<th>C30 PHT 731 - 45 Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>EHU 412</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RA</td>
<td>23.14 a&quot;</td>
<td>RA</td>
</tr>
<tr>
<td>RY</td>
<td>231.14 a&quot;</td>
<td>15.4 a&quot;</td>
</tr>
<tr>
<td>RZ</td>
<td>184.4 a&quot;</td>
<td>RY</td>
</tr>
<tr>
<td>RPK</td>
<td>26.34 a&quot;</td>
<td>RZ</td>
</tr>
<tr>
<td>RVK</td>
<td>68.14 a&quot;</td>
<td>RPK</td>
</tr>
<tr>
<td>RK</td>
<td>80.14 a&quot;</td>
<td>RVK</td>
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<tr>
<td>MR1</td>
<td>7%</td>
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</tr>
<tr>
<td>MR2</td>
<td>86%</td>
<td>MR2</td>
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<table>
<thead>
<tr>
<th>Sunnen CV-616</th>
<th>EHU 518</th>
<th>C30 PHT 731 - 30 Seconds</th>
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<tr>
<td>EHU 518</td>
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<td></td>
</tr>
<tr>
<td>RA</td>
<td>25.1 a&quot;</td>
<td>RA</td>
</tr>
<tr>
<td>RY</td>
<td>266.2 a&quot;</td>
<td>RY</td>
</tr>
<tr>
<td>RZ</td>
<td>198.3 a&quot;</td>
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</tr>
<tr>
<td>RPK</td>
<td>29.9 a&quot;</td>
<td>RPK</td>
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<tr>
<td>RVK</td>
<td>44.5 a&quot;</td>
<td>RVK</td>
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<tr>
<td>RK</td>
<td>89.7 a&quot;</td>
<td>RK</td>
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<tr>
<td>MR1</td>
<td>6%</td>
<td>MR1</td>
</tr>
<tr>
<td>MR2</td>
<td>88%</td>
<td>MR2</td>
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### Sunnen CV-616 Set-up

**JHU 623**

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<tr>
<th>RA</th>
<th>10 μ&quot;</th>
<th>RY</th>
<th>99.6 μ&quot;</th>
<th>RZ</th>
<th>85.5 μ&quot;</th>
<th>RPK</th>
<th>17.8 μ&quot;</th>
<th>RVK</th>
<th>18.8 μ&quot;</th>
<th>RK</th>
<th>34.7 μ&quot;</th>
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</thead>
<tbody>
<tr>
<td>MR1</td>
<td>10%</td>
<td>MR2</td>
<td>89%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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**C30 PHT 731 - 15 Seconds**

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<tr>
<th>RA</th>
<th>6.4 μ&quot;</th>
<th>RY</th>
<th>79.7 μ&quot;</th>
<th>RZ</th>
<th>62.3 μ&quot;</th>
<th>RPK</th>
<th>4.8 μ&quot;</th>
<th>RVK</th>
<th>13.3 μ&quot;</th>
<th>RK</th>
<th>20.9 μ&quot;</th>
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</thead>
<tbody>
<tr>
<td>MR1</td>
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<td>89%</td>
<td></td>
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<td></td>
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Results obtained with Sunnen MAN 845 honing oils. Results may vary with other oils.
LS-1™
Installation Manual
Thank you for purchasing the Darton state of the art new MID Sleeve Kit, US Patent No. 6,799,541. The kit makes possible maximum bore sizes, increased cylinder strength and superior wear resistance.

Darton wants to provide you with the best technical information we have available to ensure that your sleeved engine will perform to your expectations. Because the MID ductile iron sleeve kit “reinvents” the block structure with substantially increased bore wall thickness, certain operational characteristics become more like diesel engine technology than gasoline engine. Therefore, we have formulated a program of required procedures and components, which we believe will ensure operating success of your sleeved engine in whatever application it will see service in.

Note: Certain LS–1 head castings (‘97 – mid ‘99 with a factory casting cut out on face near cylinder 3 or 6) need to be modified/welded to be suitable for use with the DARTON MID kit. Most late model heads work as is.
INSTALLATION PROCEDURES

NOTES: ____________________________

Revised: 11/01/04

LS1 - LS6 Sleeve Kits

Read and make sure you understand these instructions before proceeding with block machining. If you have questions concerning machining, assembly, proper tooling, machines, etc.

PREPARATION, FIXTURING

1. The block needs to be fully stripped, cleaned and inspected before machining. Main web cracks, or structural damage may prevent satisfactory sleeve installation. Blocks with cracked factory liners are good candidates for sleeving as long as the crack doesn’t extend to the bottom most 1.5” of cylinder wall.

SETUP AND BLOCK MACHINING

Note: Prior to beginning machine work, review block machine prints to familiarize yourself with all critical dimensions, which must be adhered to.

1. With your block mounting fixture securely bolted to the CNC machine table, indicate the centerline of your block-mounting bar in the “Y” axis direction. That will be your “Y” fixture or part offset depending on terminology used with your machine. You will only have to do this one time since this position will remain the same. The object is to correct for factory machining errors, block warpage. You want the MID sleeves installed directly over the crankshaft axis and not offset as would probably happen if you merely went off the existing cylinder centerline. Bores must be 90° perpendicular and on crank cylinder centerline.

Now set the block up on the mounting fixture. The preferred method is with precision made mounting rings located in the front and rear main bearing bores and with the bell housing face securely bolted to a fixture plate. Rotate your fixture so the left (driver’s side bank) is facing up. Indicate the rear deck surface of the block (by the bell housing) - photos 1 and 2. Rotate the block around the crank axis until you get close to zero run out across the deck from side to side. Lock your fixture when you are satisfied the block is true. Zero the degree wheel if so equipped. Note that most blocks will be warped front to back. This is why we recommend dialing in the deck surface at the rear of the block. Now indicate the “X” centerline of cylinder number one, (left
bank first cylinder) - photos 3 and 4. The centerline position is your “X” fixture offset position. Enter the “X” and “Y” offsets in your machine’s fixture or part offset table.

2. Clean the rust preventative from the MID sleeves using lacquer thinner. Measure the bottom diameter, the upper flange diameter, and the seating depth of each sleeve. Generally, the diameters will be very close - within .001” in any one set. Measure the diameters at 90 degrees and average the result - photos 5, 6 and 7. The average diameter at the lower seal surface of the new MID sleeves is 4.284”. This will vary about a thousandth plus or minus. If the largest sleeve averages out at 4.285” and the smallest at 4.284” use 4.2845” as your boring size for that part of the installation. The sleeves should be installed plus or minus .0003” of the measured size. Do not attempt to install MID sleeves if you cannot hold this tolerance. Note that the seating depth of the sleeves may vary a bit. This is not critical since the block will be decked after the sleeves are installed. Average sleeve seating height is right around 4.334” - photo 8. We machine the block shy of this figure so the sleeves protrude .005 to .008 after installation.

3. Touch off your tools on the deck surface at the front of the left bank either before you begin machining or as you are about to use them, whichever you prefer - photos 9 and 10. Set your tool length offsets into your machine’s tool table. Machining depths are from the deck surface down.

4. Note that the bore center to center is 4.400”, same as a small block Chevy. You need to keep this centerline dimension to +/- .0005”. Note that in order to maintain the required tolerances it is highly advisable you use a machine with flood coolant. It will be impossible to hold tolerance otherwise and a poor job will be the result due to the heating of the block causing distortion.

5. First operation is to bore the four cylinders on the left bank to 4.170” diameter to the main bearing webs. Use a double cutter boring head with .030” radius inserts for this operation, which will allow sizing in one pass - photos 11 and 12. Depth of cut is 6.250” from the deck surface.

6. Next operation removes the remaining cylinder walls to a diameter of 4.830” and to a depth of 3.125” on cylinder number one and 4.315” on cylinders two, three, and four. Again, a double cutter head should be used for this operation along with plenty of coolant. CAUTION: When you machine the right bank, all cylinders are machined to the 4.315” depth, except the number one cylinder which will break through into
the timing chain area if you go down the full depth. You will later machine number one cylinder with a flat to prevent this break through from occurring – photos 13 and 14.

If the block you are machining is a used block, go on to instruction (7). Otherwise follow the instructions below if the block is a brand new, never run casting.

If this is a brand new block you are working on it MUST be stress relieved after the roughing operations. It will warp in service distorting the sleeves if this is not done. Rotate the block 90° to get the right bank vertical. Perform the above steps (5 and 6) on the right bank. Remember that the cylinder walls of all cylinders on the right bank are removed to a depth of 4.315”. You must change the “X” axis fixture or part offset (depending on your machine) for the right bank. The offset is +.950”. In other words the bore centerline of cylinder 2 is +.950” offset towards the rear of the block from cylinder one. Do not alter the “Y” offset position. This will always stay the same unless you remove the fixture from the machine.

Remove the block from the machine, clean and have the block vibratory stress relieved - photo 15.

After stress relief, remount the block on the machine with the left bank facing up. Indicate the left bank as in instruction (1) above - photo 16. Indicate the “X” axis centerline of cylinder one - photo 17. Enter that position in your machine’s fixture or part offset table as you did in instruction one. Continue on to step (7).

7. Next, install your precision boring head - photo 18. Machine the lower bore area of each cylinder on the left bank to a depth of 5.710” in several steps to the sleeve lower diameter dimension you previously measured and averaged in step (2) above - photo 19. Always double check your work so the finished bore is within plus or minus .0003” of your target diameter. The finish needs to be RA 32 or better (bottom o’ring and press area).

8. Next, machine the upper flange diameter to your measured diameter in step (2) +.001”. The nominal diameter on the sleeve flange is 5.140”. Your flange bore should be 5.141” machined to a depth of .500”. You can bore or use circular interpolation for this cut dependent on your tooling and expertise. If you use circular interpolation with a carbide end mill, use two passes leaving ~ .010” for the finish pass - photo 20. This will ensure in a better surface finish and rounder hole.

9. Next, install a long insert style end mill that has .030” max radius inserts. You will use interpolation milling for the sleeve seating surfaces. Number one cylinder has a flat machined at an offset angle to
prevent break through into the timing chain area as stated above. You must have a program to machine this flat and seat to a depth of 4.328” according to the drawings. Machine cylinder one to the 4.328” depth in several passes usually .250” to .300” per pass depending on the rigidity of your set up. All other cylinders use a circular interpolation cut 4.800” diameter to a depth of 4.328”. This depth will ensure the sleeves protrude .005” to .008” after installation. Again, use plenty of coolant to prevent buildup on the tool - photo 21 and block distortion due to machining induced heat.

10. Finish the left bank by cutting a chamfer at each seating surface ID to facilitate the o’ring passing during installation. Adjust the tool so it clears the flat on number one cylinder. We prefer a 45° chamfer cut to a depth of .025”. If you use a tool like that shown in the photo adjust the spindle speed to ~ 60 rpm to prevent chatter – photos 22 and 23.

11. Repeat operations (7 through 10) on the opposite bank after indexing the block 90°. Note again that the offset for cylinder two (front cylinder on the right bank) is +.950” towards the rear of the block from cylinder one on the left bank. Make certain to adjust your part offset position in the machine fixture or part offset table else you will ruin your block.

12. Remove the block from the machine, clean it, deburr it, lightly sand the chamfer you cut for the o’rings. Make certain the head threads are clean. A thread forming tool should be run through the head bolt holes on used blocks. The surface finish should be as shown in photos 24, 25, and 26.

SLEEVE INSTALLATION
1. A maximum temperature differential of 50° f between sleeves and block is recommended. It is not necessary or recommended to heat the block for sleeve installation. Leaving the block sit in the sun for a few minutes is sufficient. If the machining was done properly the sleeves will easily install with a shot filled plastic mallet and drive home with an aluminum plate and hammer.

2. Install the rubber o’rings into the lower sleeve grooves using minimal stretch. Do not roll the o’rings into the grooves. Lubricate the o’rings and lower area of the sleeves with the supplied lubricant – photo 27.

3. Apply a small amount of supplied Loctite flange sealant on perimeter of each sleeve upper flange as well as the siamesed flat. Only the top .500” of the flat area needs sealant – photo 28.

4. Start cylinder number one sleeve using a plastic mallet. Note that because of the flat on this sleeve it should self-orient closely as far as
clocking is concerned. Drive it in just far enough to engage the upper flange. Start the adjacent sleeve and drive that in to the same depth as the first sleeve. Note that the side of the sleeve with the most holes in the flange goes towards the outside (exhaust side) of the block. Check to make sure the alignment half holes along the flats line up to form round holes. Adjust the clocking as necessary using a pointed tool carefully hammered in the alignment holes. Install the remaining two sleeves to the same depth again checking the clocking. Now drive them in the rest of the way using an aluminum plate and hammer. Lightly tap the pointed alignment tool in all the alignment holes to ensure the holes are round. The sleeves should protrude slightly from the deck surface. Install the sleeves on the right bank using the same procedure. This bank is more difficult because there is no flat on the front sleeve to help with alignment. Eye the first sleeves as close as you can then make the necessary adjustments when the adjacent sleeve is installed – photos 28 - 33. Or mark the block and sleeve with permanent marker pens for orientation. Sleeves depicted in photo 30 are not aligned correctly and will cause an installation problem.

5. Clean off excess sealant from sleeve flange area. Install a pair of torque plates with a copper gasket or a Fel Pro 1041 head gasket. Torque to 50 to 60 ft./lbs. using ARP head bolts. This step ensures the sleeves are fully seated. Let stand at least two hours, preferably over night. Remove plates, and deck block head surfaces flat and as smooth as possible. Do not deck any more than is required or you will have problems with the pistons protruding too far out of the block. The only recommended head gasket is the MID specific Cometic gasket. Use the Fel Pro gasket only to seat the sleeves – photos 34, 35, and 36.

Note: Main cap studs and align honing are highly recommended.
1st STEP: ROUGHING OUT CYLINDER #1

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<th>DESCRIPTION</th>
<th>DATE</th>
<th>APPROVAL</th>
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<td>B</td>
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2nd STEP: FINISHING CYLINDER #1

3.125±.005 REF

0.020 x 90° CHAMFER

SEE SHEET 3 SECTIONS G-D & H-H FOR CLARITY

5.141±.001

4.802±.001

4.170±.002 REF

5.710±.010

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**BLOCK SPEC LS-1 CYL #1-S3**

**DETAIL H**

- 2.1995 REF
- .020 x 60' CHAM REF
- 3.125 ± .005
- 1.205 REF
- .000 MAX CUTTING TOOL RADIUS
- Ø4.170 REF
- Ø4.800 REF
- Ø4.800 REF
- 4.328 REF
- 5.710 REF
- Ø4.800 REF

**SECTION H-H**

**SECTION G-G**

- 2.1995 ± .0005
- 20°±1'
- 160°±1'
- 180°
- 0°
- R.375±.001
- 2 PLCS
- 5.710 REF
- 4.328 REF
- 2.1995 REF

**CONSENT OF**

**DARTON INTERNATIONAL, INC.**

**BLOCK SPECIFICATION**

**LS-1 M.I.D. CYL #1**

File No. F:\ACAO\DATA\D\IRTON\LS-1\BLOCK SPEC LS-1 M.I.D. CYL #1 - S3
1st STEP: ROUGHING OUT CYLINDERS 2-8

SEE SHEET 2 FOR REVISIONS

1/21/04
POST MACHINING INSTRUCTIONS

Revised: 11/01/04

LS-1 – LS-6 Engines with Darton MID Sleeves

PREPARATION PROCEDURES

1. Sleeves are delivered with a generous chamfer on the lower edge to help prevent piston damage. If sleeves are over bored and honed, it is mandatory that the bottom edge of the sleeve be chamfered or radiused (30 – 45 deg., Chamfer min. .050”) and completely deburred. Failure to do this will result in severe piston skirt damage and engine failure.

2. We recommend piston skirts be coated with a polymer coating, and piston tops with ceramic. Due to the acute rod angles at the bottom of the stroke with stroker cranks, pistons’ wall thrust is increased substantially, which requires generous chamfers at bore bottom and piston skirt coating to assure no scuffing and galling. Both coatings may allow the pistons to be fitted with less piston to wall clearance, which is desirable in terms of noise reduction and oil consumption on street driven vehicles. “Polydyne” and “Swain” are two well-known firms who can apply these coatings reliably.

ASSEMBLY

1. The block should have the cam and main journals checked and honed true if necessary.

2. The short block should be trial assembled without rings to inspect crankshaft, connecting rod, and connecting rod bolt clearance (.080” min.). Re-chamfer the sleeve bottom wherever it is ground for clearance. (Absolutely no burrs or sharp edges can remain on the bottom of the bore.) Minimum recommended ring gaps using ductile iron top and cast iron second rings are as follows: (more gap may be used and is beneficial)

   • Street performance use – top ring end gap min. .004” x bore diameter normally aspirated, second ring .005” x bore diameter.

   • Racing use – .0045” x bore diameter top, .0055” x bore diameter second normally aspirated.
• Street with nitrous oxide – .005” x bore diameter top, .006” x bore diameter second.
• Drag racing with nitrous oxide – .007” x bore diameter top and second.
• Supercharged or turbocharged – .006” x bore diameter top and second.

3. We highly recommend the use of 4032 alloy pistons for normally aspirated street use and 2618 alloy for racing, boosted or nitrous street use. 4032 is a low expansion alloy best suited for street use where one would want minimum piston to wall clearance to minimize piston rock, noise and oil consumption. 2618 alloy has superior strength and is the preferred alloy for racing use or street use with nitrous. But this alloy requires significant increases in piston/wall clearance.

4. Both cylinder and align honing must have deck plates installed with the same type gaskets, fasteners as will be used in operation. Honing finish should be done according to the ring face material. For moly rings, generally no finer than 400 grit else the rings may not seat properly for street use; 280 grit for chrome faced rings. A plateau hone should be stroked through the cylinders as a finishing operation. It is of utmost importance that the cylinder walls be thoroughly cleaned after honing to remove abrasives and metal particles. Spray washing, or hot tanking is insufficient. Use paper towels coated with ATF or WD40 to wipe down cylinder walls after the wash operation. Continue wiping with towels and ATF until the towels show no more signs of dirt pick up.

Note: Honing head must be modified to accommodate stones and allow free over-stroke of .200. Piston to wall clearance must be reduced beyond piston manufacture recommendations.

5. Tip: When installing pistons into cylinders, coat pistons and rings with ATF instead of motor oil for faster and more reliable ring seating.

COOLING
The Darton ductile iron MID sleeves were designed specifically for racing and high performance street use. The sleeves are heavy wall construction, designed to remain round for effective ring sealing under conditions of high power output and stress. More power means more heat. This heat must be effectively transferred to the cooling system to prevent damage to the piston and sleeve. Roughly one third of the heat energy of the fuel is lost to the cooling system. The stock Corvette cooling system was designed
for 400 horsepower and a stock cylinder block with cast-in dry liners. The Darton kit effectively converts the block to a wet sleeve configuration as used on diesel engines. One cannot expect the original cooling system to effectively cool and engine producing two or more times the power of the original engine, along with a modified cylinder arrangement. We recommend “Evans NPG+ ” coolant be used as well as Evans LS-1 reworked water pump utilizing a relocated thermostat. High output applications may also require a larger radiator and coolant fan. Evans coolant is recommend- ed because of the potential for hot spots and cavitation around wet style sleeves. We realize that most engines built will produce well in access of the stock rated horsepower making cooling system enhancements a must. However, we have customers reporting success with large bores, stock cooling systems, therefore your cooling system requirements/modifica- tions should be dictated by individual usages.

BREAK–IN, TUNING
Fill the engine with a good grade of mineral oil (not synthetic) with viscosity for your bearing clearance and intended use. Prime the oil system before engine start with ignition off using the engine or dyno starter. We require break–in and tuning using an engine dyno or chassis dyno as follows:

∑ After initial start up, warm up engine at 2000–2500, at no more than 100–150 ft. pounds of torque for 15–30 minutes. Precaution should be exercised to prevent excessively rich or lean conditions, which will gall the cylinders. Monitor oil pressure and temperatures.

∑ After initial run, adjust valves if using adjustable valve train and re–torque heads. Check for leaks.

∑ Street engines will require multiple run–ins with increasing rpm and load up to maximum output.

Use of a dyno allows one to apply a pre–set load to allow the piston rings, and other components to seat properly. It is also much easier to monitor temperatures and pressures than while driving. Most dynos are equipped with O_ and EGT probes to aid in tuning. The timing and fuel curve needs to be tailored to your particular engine to ensure the engine stays out of detonation, which will lead to engine failure. A racing engine is generally built with sufficient clearance to require no further break–in after dyno tun- ing and power runs. However, we recommend head bolt torques be re–checked cold after dyno testing as the head gaskets will take a set. Remember to replace oil and filter after the dyno session as bearing coat- ings and metal particles will be trapped in the oil filter. Inspect the oil for
foreign material and excessive bearing flakes.

A street engine should be driven moderately for the first thousand miles, as follows:

- full throttle high torque power usage should be limited and never be used until the engine has been running for at least 15 minutes.
- from 0–500 miles, do not exceed 4000 rpm.
- from 500–1000, do not exceed 6000 rpm.
- over 1000 miles, no restrictions.

Also, do not run at the same speed for extended periods during break–in. Make certain the engine is operating at proper coolant temperature and oil pressure. Do not allow the engine to overheat. Make necessary changes if required (radiator, fan, turning) to get the engine to run in the proper temperature range. We also recommend you do not run synthetic oil until at least 5000 miles. Synthetics work so well that the engine will never break in properly if it is used too soon.

NOTES / CAUTIONS / WARNINGS

1. Proper eyewear protection should be worn at all times during block machining.
2. Use of appropriate breathing filtration is highly recommended.
3. Observe all cautions and warnings on manufacturers MSDS’s.
4. Failure to follow installation instructions will result in unsatisfactory performance and may involve sleeve distortion, water leaks, oil leaks, compression leaks or combinations thereof.
5. All sleeves are warranted against manufacturing defects for 1 year from date of sale. Damage as the result of engine failure is not covered, nor is any consequence of such damage weather or not caused by sleeves.
6. Caution must be exercised as old sleeves are bored out to prevent tearing of aluminum in block and possible tool breakage; original sleeves are ribbed and cast in place.
7. All machining must produce a good surface finish and the tolerances must be maintained to assure a quality fit and sleeve seal.
8. Field service and singular sleeve replacement is possible and practical using a slide hammer sleeve puller with the drive mandrel “Flatted” and oriented to provide main web clearance. Sleeves can then be ordered from Darton, by cylinder number.
NOTES:

PHOTO 1

PHOTO 2
NOTES:

PHOTO 12

PHOTO 13
PHOTO 18

PHOTO 19
FOR BEST RESULTS:
Darton recommends the use of a Cometic M.I.D. MLS head gasket. These head gaskets are specifically made for use with our M.I.D. kits.

NOTES/CAUTIONS:
1. Make sure that block and head surfaces are machined within proper RMS specification.

2. Depending on the type of head bolts used, a re-torque of head bolts to proper specifications may be required.
Darton recommends the use of Evans coolant with all MID kits!

MPG+ for all street applications.
MPGR for full race applications.
The cost-effective Sunnen CV-616 Automatic Cylinder Hone is one of the most versatile machines you can have in your shop. You can count on consistent results as the CV-616 produces the most precise cylinder bores possible, cylinder after cylinder, block after block.

Job: LS-6 Chevy block with Darton sleeves

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<tr>
<th></th>
<th>Semi Finish</th>
<th>Plateau Finish</th>
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<tr>
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<td>600-120 (4.125&quot;)/600/120</td>
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<td>C30 PHT 731</td>
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<td>Feed Rate:</td>
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<tr>
<td>Time Cycle:</td>
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Sunnen CV-616 Setup

The cost-effective Sunnen CV-616 Automatic Cylinder Hone is one of the most versatile machines you can have in your shop. You can count on consistent results as the CV-616 produces the most precise cylinder bores possible, cylinder after cylinder, block after block.

### Results with Sunnen Honing Stones on Darton Cylinder Sleeve Material

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<thead>
<tr>
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<tr>
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<td>15.4 μ&quot;</td>
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<td>RY</td>
<td>231.14 μ&quot;</td>
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<td>RZ</td>
<td>184.4 μ&quot;</td>
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<td>MR2</td>
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<td>MR1</td>
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<tr>
<td>MR2</td>
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<tr>
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<td>JHU 623</td>
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Results obtained with Sunnen MAN 845 honing oils. Results may vary with other oils.