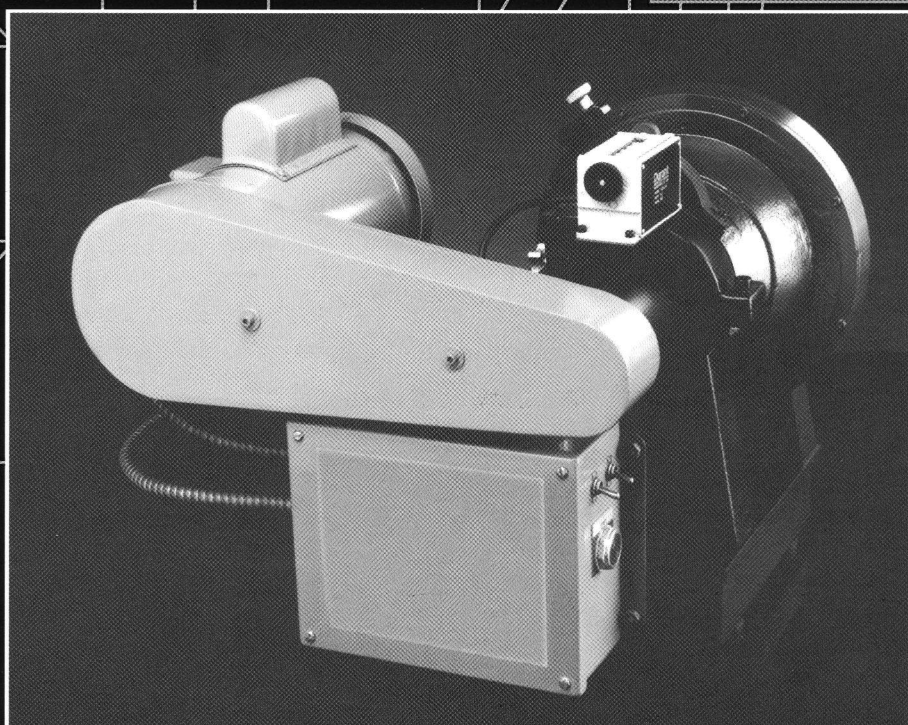
THE ERVIN TEST MACHINE



ERVIN

The Ervin Test Machine was engineered and developed to provide a method to evaluate the quality of metal abrasives. This information can assist the abrasive user in making the best abrasive selection to insure efficiency and the lowest possible cost in production use.

The Ervin Test Machine will measure both the Durability (life) and Transmitted Energy (impact energy) of the abrasive, which are the two key measures of the value and quality of a metal abrasive.

The Ervin Test Machine is portable and easy to use.

The Ervin Test Machine has become the standard measuring tool in the industry. It is used by most of the abrasive manufacturers in the world to assess the quality and consistency of the abrasive manufacturing processes. Also, many large, metallic abrasive users have purchased Ervin Test Machines for their quality assurance laboratories to insure that the quality of the abrasive is consistent and as specified when purchased.

Over 200 Ervin Test Machines have been sold and are in use all over the world. Widespread acceptance of the Ervin Test Machine centers around the fact that it gives consistent and reliable results in a relatively short time.

Ervin has a number of these machines available as loaners to be utilized by companies who may wish to evaluate the abrasive choices available to them and to evaluate the possible purchase of an Ervin Test Machine.

TESTING SHOT AND GRIT

The Ervin Test Machine for abrasives was designed to simulate the action of a production blast cleaning and/or shot peening machine, and provide a laboratory tool to quickly test the performance of metal abrasives.

During testing, the abrasive is propelled by a centrifugal wheel or beater head rotating at approximately 7,000 RPM which accelerates the abrasive to a velocity of approximately 200 feet per second, comparable to the velocity of a production blast cleaning or shot peening machine. The abrasive is thrown against an anvil surface. After impact, the abrasive falls to the bottom of the rotating anvil recycling assembly which picks up the abrasive and returns it to the wheel where it is thrown against the anvil surface again. The anvil recycling assembly rotates at 25 RPM which means that the abrasive is recycled through the wheel 25 times per minute. The Durability Test described below establishes the conditions for measuring the durability or fatigue life of the abrasive.

During Durability testing, the peening attachment is replaced by a plug that continues the curved surface of the anvil. For testing of Transmitted Energy, the plug is replaced with the peening attachment which holds an Almen Strip in the path of the abrasive being tested.

Ervin Test Machine Calibration

The Ervin Test Machine is offered in either 110 volt 60 Hertz, 220 volt 60 Hertz, 100 volt 50 Hertz or 200 volt 50 Hertz, depending on the customer's requirements. All Ervin Test machines are calibrated at the factory using 110 volt AC 60 Hertz and converted to the power requirements of the customer. The Ervin Test Machine should be recalibrated after every 20 durability tests or after any mechanical changes (such as new V-belts) to maintain reliable test results.

An S-550 calibration shot, developed in the Ervin laboratory, is supplied with the machine. Additional supplies are available from Ervin as needed.

Calibration Procedure

1. Check for worn or slipping drive belts. Replace if necessary.

2. Make sure the set screws in the adjustable sheaves are tight.

3. Check the condition of the screen using a flashlight. Replace the screen if it has any holes worn through.

NOTE: Keep a dust bag tied over the tubular opening of the Anvil recycling assembly to capture any dust created when running the test.

4. Start the Ervin Test Machine and check the rotation speed of the anvil/recycling device by timing 10 revolutions with a stop watch and calculate the RPM. The rotation speed of the anvil recycling device must be 25 RPM ± 0.5 RPM.

5. Adjust the speed of the anvil/recycling device by changing the setting of the adjustable sheave on the low speed drive motor and retest speed.

6. Repeat steps 4 and 5 until the speed is correct.

7. Check the RPM of the High Speed Beater Shaft with a tachometer.

NOTE: Each Ervin Test Machine is an individual and may have different requirements for the beater shaft speed. The proper speed is determined using the S-550 Calibration Shot.

8. Place the 100 grams ± 0.1 grams of S-550 Calibration Shot into the anvil/recycling device through the charge/discharge opening and seal the opening with the rubber stopper provided.

9. Set the counter for 500 cycles.

10. Turn the machine on. The counter will stop the machine after 500 cycles.

11. Empty the Calibration Shot into the tray provided, making sure that all is removed by removing the rubber stopper and rotating the anvil/recirculating device several times while rapping it with the plastic faced hammer provided with the machine.

12. Place the sample on an 8 inch diameter, 40 mesh, 0.0165 inch opening test sieve, and screen the sample until all the fines are removed, about 3 minutes.

13. Weigh the amount of sample remaining on the test sieve and record as % Retained.

14. Calculate the Loss, 100% - weight from #13 and record.

15. Record as Accumulative % Loss. Replace lost material with new standard until you have 100 ± 0.1 grams.

16. Repeat steps 10-15, adding the % Loss from each 500 pass test run to the Accumulative % Loss from the preceding step and recording as Accumulative Loss until the Accumulative % Loss exceeds 100%.

17. Determine the durability, or number of cycles or passes to cause exactly 100% replacement, by interpolation, using the following formula:

$$\text{Durability} = \text{Total Passes} - \overset{a}{\left(\frac{\text{passes per test run}}{\text{\% last lost}}\right)}\overset{b}{\left(\text{accumulative \% loss} - 100\right)}$$

   a. Divide 500 by the % loss from last test run to give the number of cycles required to give 1% loss.

   b. Subtract the 100 from the last accumulative % loss.

   c. Multiply a by b.

   d. Subtract c from the total number of cycles to arrive at the final durability in cycles or passes.

18. The Durability of the S-550 Calibration Standard should be 2,900 ± 50 passes.

19. If the Durability is less than 2,850 passes, decrease the speed of the high speed beater by opening the adjustable sheave on the high speed beater motor.

20. If the Durability is greater than 2,950 passes, increase the speed of the high speed beater by closing the adjustable sheave on the high speed motor.

21. Repeat steps 1-20 until the Durability of the S-550 Calibration Standard meets the standard of 2,850 - 2,950 passes.

Durability Test

The Durability Test is run exactly like the Ervin Test Machine Calibration Procedure above, using any shot or grit sample in place of the S-550 Calibration Standard.

The test conditions shall be as follows:

A Durability Test on a typical 40-50 Rockwell C, S-460 shot is shown below:

Abrasive Size	Hardness Rockwell C	Passes Per Test Run	Take Out Sieve Opening
SHOT			
S-780 - S-390	Up to 50 Rockwell C	500	0.0165 inches
S-330 - S-170	Up to 50 Rockwell C	500	0.0117 inches
S-780 - S-170	50-60 Rockwell C	250	0.0117 inches
S-780 - S-170	Over 60 Rockwell C	100	0.0117 inches
GRIT			
G-12 - G-18	Up to 50 Rockwell C	500	0.0165 inches
G-25 - G-40	Up to 50 Rockwell C	500	0.0117 inches
G-12 - G-40	50-60 Rockwell C	250	0.0117 inches
G-12 - G-40	Over 60 Rockwell C	100	0.0117 inches

Accumulative Passes	% Loss	Accumulative %Loss
500	7.0	7.0
1,000	16.9	23.9
1,500	21.5	45.4
2,000	21.9	67.3
2,500	19.6	86.9
3,000	17.6	104.5

2,872 Durability = Passes to Replace 100%

Transmitted Energy Test

The purpose of this test is to evaluate the effectiveness of the transmission of the kinetic energy of the moving abrasive particles into useful shot peening or blast cleaning energy at the work surface. An Almen Test Strip is attached to the peening attachment, and the Almen Strip is peened with test abrasive under controlled conditions in the Ervin Test Machine. The curvature of the Almen Strip is developed when it is impacted by the abrasive being tested and is a measure of the energy transmitted to the Almen Strip by the abrasive being tested. The characteristics of the test machine are constant. Therefore, variations in the Almen Arc Height (energy transmission) result from variations in the characteristics of the abrasive being tested.

Procedure

1. Using a sample splitter, carefully split the operating mix of used abrasive shot from the last durability test run (step 18) to obtain a sample of 50.0 ± 0.1 grams.
2. Place the sample from #1 into the test machine.
3. Place an Almen A Strip in the test machine fastened to the peening attachment. The peening attachment is designed to match the peening test strip holder discussed in SAE J-442 with an additional attachment on the back to mount it in the Ervin Test Machine.
4. Set the machine counter and peen the Almen Strip for 40 cycles.
5. Measure the arc height of the strip using an Almen Gage.
6. The resulting number is Transmitted Energy.

Test Machine Maintenance

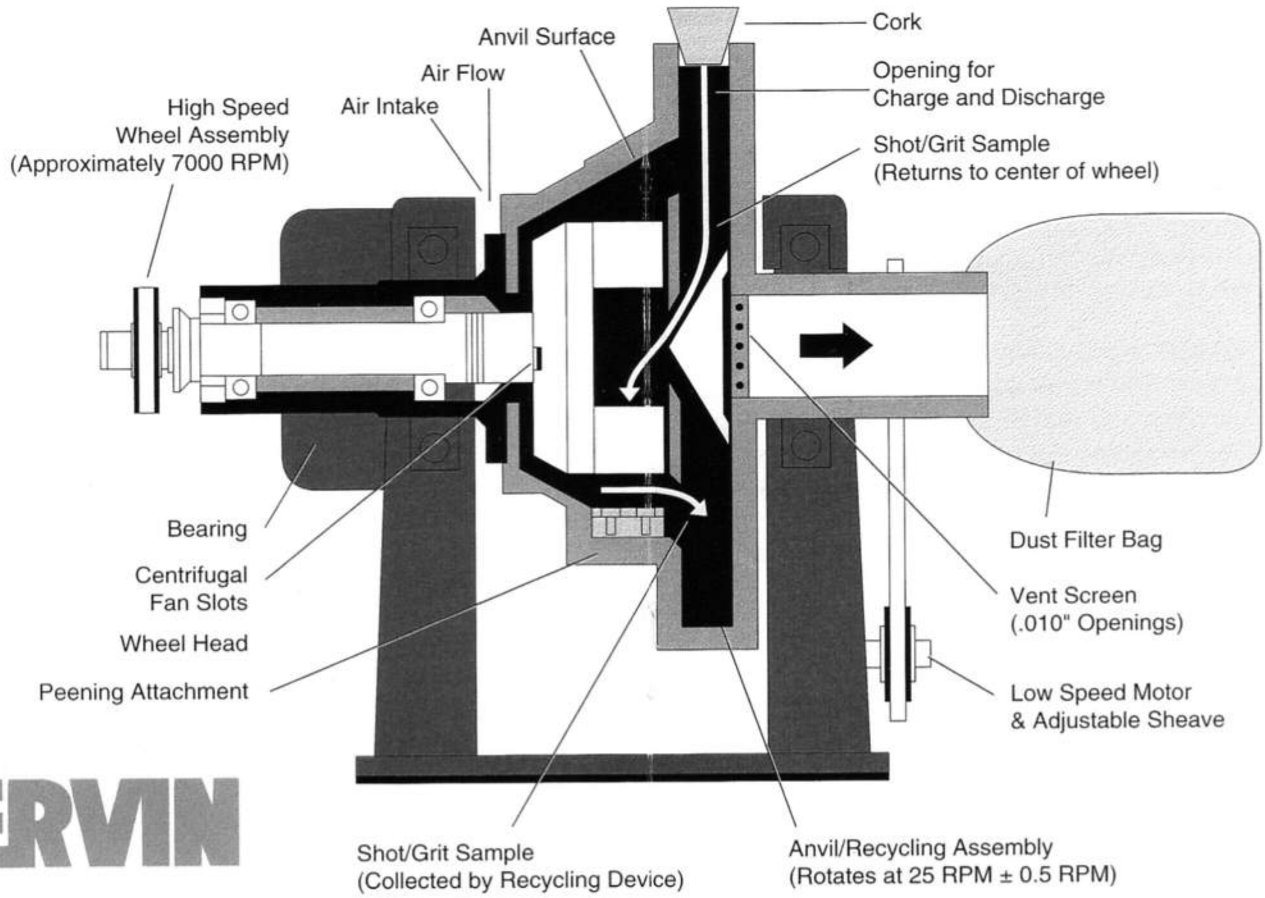
The large bearings in the pedestals and the precision high speed shaft bearings are permanently lubricated at the factory and do not need lubrication.

The gear box on the low speed motor should be kept full of good quality mineral oil.

Put a drop of light machine oil on the end bearings of the automatic counter shaft once per month.

Follow normal maintenance procedures on the electric motors, V-belts and sheaves.

The machine should be returned to the manufacturer for replacement of high speed bearings, castings or other special parts.



ERVIN

THE BASICS OF ABRASIVE BLAST CLEANING

Blast Cleaning Definition

Blast cleaning has been defined in an 1871 patent on sandblasting as "An impact cleaning operation that is neither cutting, grinding or abrading. It is essentially a pounding, battering or bombarding of the work surface by successive impacts of flying abrasive." The definition has changed only by the fact that recyclable metallic abrasives, shot and grit, are used in place of sand in high production blast cleaning operations.

The flying shot or grit particle gets its energy from the rotating wheel in a centrifugal blast machine or from the compressed air and nozzle in an air blast machine. The kinetic energy of the flying particle can be calculated using the physics formula $E = \frac{1}{2} MV^2$, where E = Kinetic Energy, M = the mass of the particle (related to size) and V = the velocity of the particle imparted by the wheel or compressed air.

This flying, energetic particle impacts and compresses the topmost surface layers of the part being cleaned and also any contamination on the surface. This compressing action flexes the surface of the part being cleaned as well as the contaminants, breaking the bond between the part and contamination, and, as a result, the contamination is removed.

During this impacting process, the abrasive is also subjected to very high flexing stresses which cause the eventual failure, through fracture and fatigue, creating a range of particle sizes (operating mix). The small pieces are removed from the machine, usually by an air or screen separator, because the energy of these small particles is usually too low to be effective for blast cleaning. A certain percentage of small particles is necessary to clean the detailed areas of the part that are inaccessible to larger particles. This particle failure requires replacement with new abrasive to maintain a full supply of abrasive to clean efficiently.

THE BASICS OF SHOT PEENING

The process of shot peening is very similar to the process of blast cleaning. The primary differences are that grit is not used in shot peening, peening process controls are much more precise, and all fine and broken particles are removed by a screen or air wash separator.

In shot peening, kinetic energy is imparted to the flying shot particle by a centrifugal wheel or compressed air nozzle, just as it is in blast cleaning. The kinetic energy of the flying particle again compresses the part surface. This compression of the part surface causes beneficial residual compressive stresses in the topmost surface layer of the part being peened. Since fatigue failures result from surface tensile stresses caused by the application of a cyclic load, the surface layer of residual compressive stresses effectively delays fatigue failure of the peened part. The magnitude of residual compressive stresses produced by shot peening is monitored using Almen Test strips.

Removal size in a shot peening operation is very critical because of the need to control the shot particle energy, and, therefore, shot size within a narrow range.

BASICS OF SHOT AND GRIT

As can be seen from the description of Blast Cleaning and Shot Peening, the quality of the shot and grit used is the key to an efficient operation. Up to the point of impact with the part surface, all types and quality levels of shot and grit of the same size are identical. It is at the instant of impact on the part surface that the quality and performance of the abrasive particle becomes critical. The abrasive particle must efficiently transmit energy into the part surface to remove contamination or produce residual compressive stresses.

How efficiently this energy is used is dependent on the following shot and grit characteristics:

1. Hardness
2. Microstructure
3. Physical Defects (cracks, shrinkage, voids)
4. Chemical Analysis
5. Size
6. Fatigue Life (durability)
7. Transmitted Energy

Hardness

The standard hardness range for cast steel shot and grit is 90% minimum 40-50 Rockwell C (400-540 Knoop). This is designated S hardness for AMASTEEL Shot and Grit. There are several other different hardness ranges of shot and grit specified to accomplish different cleaning and peening requirements. Other custom hardnesses of AMASTEEL Shot and Grit are M, 50-55 Rockwell C; L, 55-60 Rockwell C; and H, 60 minimum Rockwell C.

If the abrasive is too soft, a large portion of the available kinetic energy is absorbed by the abrasive particle as it flattens against the workpiece surface. This kinetic energy is lost and is not available for blast cleaning, resulting in slower cleaning and longer cycle times. The hardness of shot for shot peening should be approximately equal to the hardness of the work being peened. Shot that is too soft will not produce the proper level or depth of residual compressive stresses. The effect of low hardness shot cannot be compensated for by increasing peening cycle times.

Harder abrasive breaks down more rapidly and usage rates increase. Sometimes slow cleaning or low peening results are caused by excessive fines resulting from the rapid breakdown if broken abrasive removal is not watched closely. Harder abrasive creates more extensive wear in the machine, possibly increasing maintenance costs. However, harder abrasives must be used in select circumstances.

Microstructure

The microstructure of the abrasive must resist deformation as it impacts against the surface of the workpiece, minimizing the energy loss and giving maximum fatigue life. Tempered martensite is the most fatigue resistant microstructure available in cast steel abrasives on the market today. In addition, the microstructure must be free of brittle iron carbides which contribute very strongly to premature abrasive fracture and high abrasive usage.

Physical Defects: Cracks, Shrinkage, Voids

The abrasive must be as free as possible of physical defects that may contribute to the fracturing of the shot. All abrasive manufactured today will have a certain number of these defects due to the methods of manufacture used. Application of Statistical Process Control in the manufacturing process will minimize the number of abrasive particles with these objectionable defects.

Chemical Analysis

Chemical analysis is very important in controlling microstructure. In addition, carbon content that is too high contributes to early particle failure due to the formation of weak, brittle, grain boundary carbides. Carbon content that is too low produces an abrasive that will deform and absorb energy as discussed previously. Sulfur and phosphorous content must be kept as low as possible since both contribute to early fatigue failure and is well documented in metallurgical texts.

Size

Abrasive size is very critical. Every blast cleaning or shot peening machine propels a constant number of pounds of abrasive per hour, which is dependent upon the horsepower of the centrifugal wheel or the volume of air used per hour in an air blast machine.

The number of particles in a pound is therefore a function of the particle size.

A pound of S-660 shot contains 14,000 particles. A pound of S-330 (half the diameter of S-660) contains 110,000 particles, 8 times as many as S-660. Therefore, a wheel that throws one pound, would throw 14,000 impacts of S-660 or 110,000 impacts of S-330. Conversely, 1 particle of S-660 would have 8 times the impact energy of 1 particle of S-330 due to the $E = \frac{1}{2} MV^2$ energy formula discussed earlier.

A small abrasive particle may not possess sufficient energy to clean or peen effectively.

It is important to select the smallest size of abrasive that will clean properly because it will cover the surface the fastest. Significant increases in cleaning speeds are possible by using the smallest size of abrasive that produces adequate cleaning or shot peening.

Fatigue Life: Durability

Fatigue life or durability is the ability of the abrasive to resist failure or breakdown due to the impact of the abrasive on the workpiece. The abrasive with the greatest durability will be the most economical abrasive to use if it has the ability to transmit adequate energy to clean or shot peen.

Transmitted Energy

The ideal abrasive must be able to transform the maximum amount of kinetic energy to the surface of the workpiece to be cleaned or shot peened. Shot that deforms and absorbs energy at impact such as the example of low hardness, will take longer to clean or peen due to the amount of energy lost through deformation. Therefore, the most efficient abrasive for blast cleaning or shot peening will transmit the most kinetic energy to the workpiece surface.

Summary

The abrasive that transmits the greatest amount of energy to the workpiece with the greatest fatigue life will produce the most economical blast cleaning or shot peening operation. Abrasive with proper hardness, microstructure, chemical analysis, size and a minimum of physical defects will contribute to greater transmitted energy and durability.

ERVIN

TECHNICAL DATA

High Speed Drive Motor: Baldor L3509-50

	60 Hertz Option	50 Hertz Option
Horse Power	1	1
Volts	115/230	115/230
Amperes	9.8/4.9	9.2/4.8
R.P.M.	3,450	2,850
Phase	Single	Single

Low Speed Drive Motor and Gear Reducer:

	60 Hertz Option	50 Hertz Option
Horse Power	1/6	1/6
Phase	Single	Single
R.P.M.	1,725	1,425
Gear Ratio	40	40

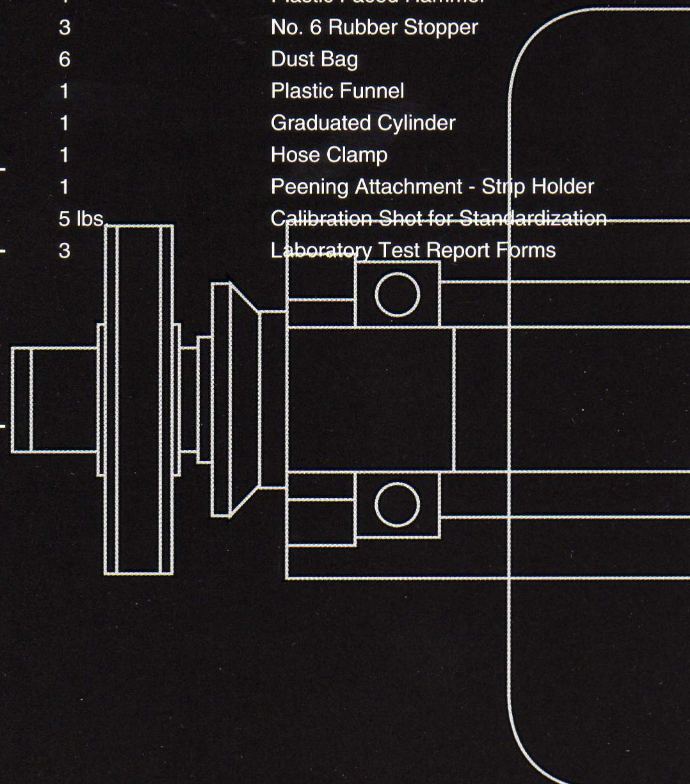
Fixed Sheave: High Speed Shaft

	1AX30 - 60 Hertz	1AX25 - 50 Hertz
	Belt Size 3L or 4L	Belt Size 3L or 4L

Variable Sheave: High Speed Motor
Variable Pitch FPH
Browning
Sheave number 1VP62 x 5/8”
Variable Sheave: Low Speed Drive Motor
1VP25 x 1/2” Browning Variable Pitch Sheave

Accessories List

Quantity	Description
1	5/32” Allen Wrench
1	3/16” Allen Wrench
1	Collection Tray
1	Plastic Faced Hammer
3	No. 6 Rubber Stopper
6	Dust Bag
1	Plastic Funnel
1	Graduated Cylinder
1	Hose Clamp
1	Peening Attachment - Strip Holder
5 lbs	Calibration Shot for Standardization
3	Laboratory Test Report Forms



ERVIN

Ervin Industries, Inc. • P.O. Box 1168 • Ann Arbor, MI 48106
Toll Free: (800) 748-0055 • Telephone: (734) 769-4600 • Fax: (734) 663-0136