



***Laser
Processing
Technologies***

Laser Hardening

***Direct Laser
Deposition***

**Pump Supplier
To The World**

Flowserve is the driving force in the global industrial pump marketplace. No other pump company in the world has the depth or breadth of expertise in the successful application of pre-engineered, engineered and special purpose pumps and systems.

Pumping Solutions

Flowserve is providing pumping solutions which permit customers to continuously improve productivity, profitability and pumping system reliability.

**Market Focused
Customer Support**

Product and industry specialists develop effective proposals and solutions directed toward market and customer preferences. They offer technical advice and assistance throughout each stage of the product life cycle, beginning with the inquiry.



Dynamic Technologies

Flowserve is without peer in the development and application of pump technology, including:

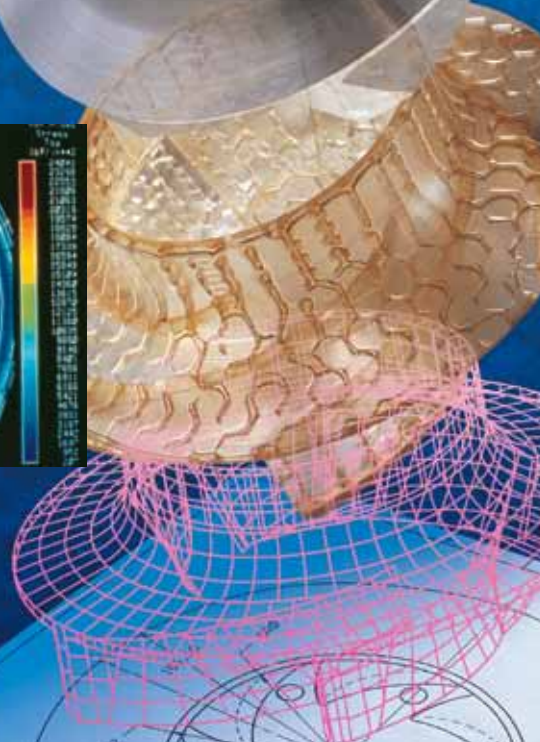
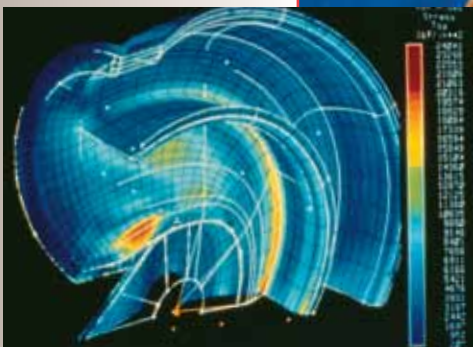
- Hydraulic engineering
- Mechanical design
- Materials science
- Intelligent pumping
- Manufacturing technology

Broad Product Lines

Flowserve offers a wide range of complementary pump types, from pre-engineered process pumps, to highly engineered and special purpose pumps and systems. Pumps are built to recognized global standards and customer specifications.

Pump designs include:

- Single stage process
- Between bearing single stage
- Between bearing multistage
- Vertical
- Submersible motor
- Rotary
- Reciprocating
- Nuclear
- Specialty



Laser Processing Technologies

Laser Hardening

Direct Laser Deposition

Technology Development

Flowserve's on-going commitment to providing extra value to customers is exemplified by its investment in laser technology. This technology is applied through two different processes:

- *Laser Hardening*
 - *Direct Laser Deposition*
- These processes have the ability to create superior surface properties on critical clearance parts, thereby improving pump reliability and durability.



Direct Laser Deposition

Application Experience

Flowserve has placed thousands of *Laser Hardened* and *Direct Laser Deposition* parts in new and old machines. These wear rings, sleeves, bushings and other critical close-clearance running parts continue to benefit the pump user by improving pump life, operability and performance.

Wide Application Possibilities

- Stationary wear rings
- Rotating wear rings
- Close-clearance bushings
- Shaft sleeves
- Balancing drums and sleeves and other critical components



Pump Benefits

- Improved reliability and durability
- Increased mean time between repairs (MTBR) and pump life
- Maintained performance and efficiency

Meeting Special Needs for Pumps in Critical Services in All Industries

- Power generation
- Refining
- Pipeline
- Water injection
- Mining
- Steel
- Waste water



Laser Hardening



Laser Hardening Process

A Natural Upgrade for Close-Clearance Stainless Steel Parts

The Hardening Tradeoff: Ductility vs. Hardness

To achieve greater galling resistance, martensitic stainless steel parts (400 series) are often heat treated for greater hardness. This is commonly referred to as “through-hardening”.

However, this amount of hardening must be limited to prevent brittle, crack-sensitive parts. For this reason, the hardness of rotating, close-clearance parts, such as impeller wear rings, is often held to a level less than the maximum which can be obtained from the material to ensure part reliability.

Eliminating the Hardness Tradeoff

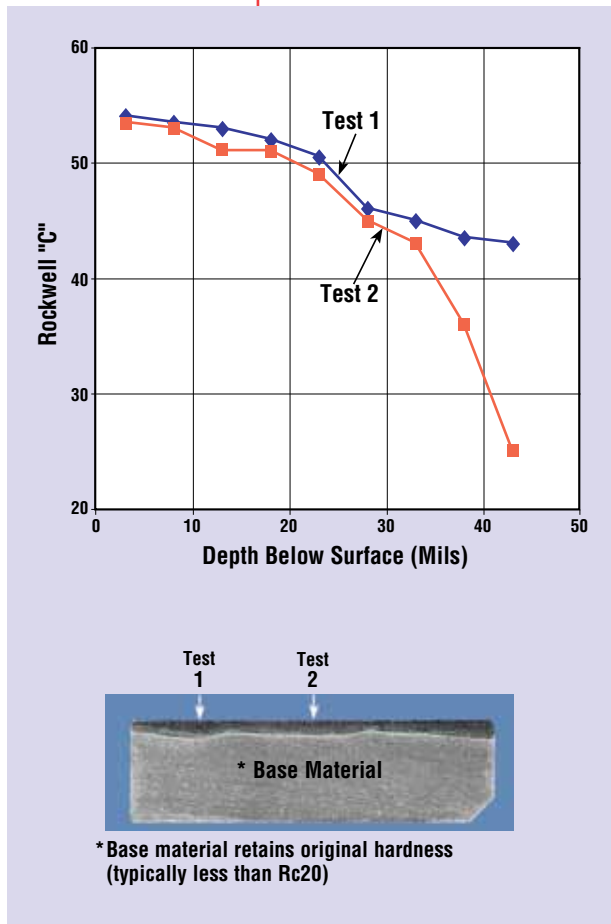
The *Laser Hardening* process eliminates the Hardness Tradeoff in close-clearance rotating wear parts. Since the laser heat treatment only hardens the outer surface of the part, the base material remains unchanged. The result is a reliable, ductile part, with maximized surface hardness – the ideal blend of part characteristics.

The following table outlines the application and superior results of this process:

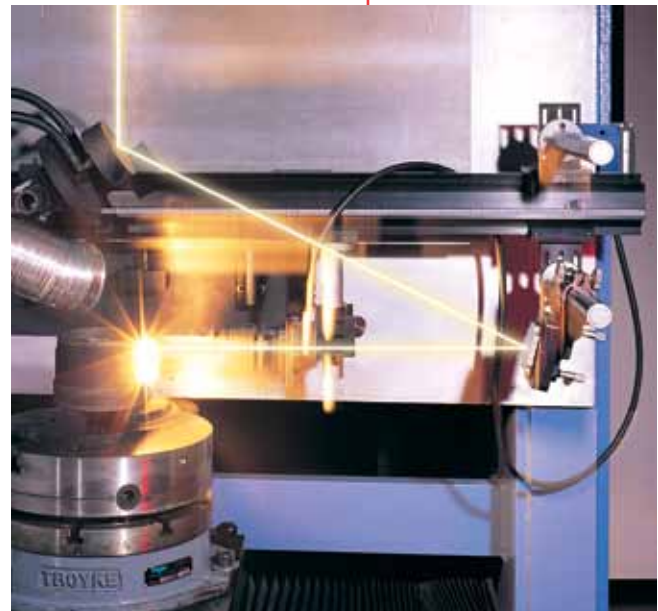
Pump Benefits

- Extends wear part life
- Helps preserve “as design” wear ring clearances, which benefits pump performance, efficiency and vibration
- Reduces sensitivity to galling, corrosion and erosion
- Eliminates possibility of cracking associated with brittle parts

Hardness Survey
Laser Impeller Ring



Laser Hardening	
Application	Results
<ul style="list-style-type: none"> • A martensitic stainless steel with specially controlled chemistry is used to provide uniform and repeatable hardness. • The laser heats the material's surface to the austenitizing temperature. • The part is allowed to cool via a self-quenching action. 	<ul style="list-style-type: none"> • Part surface becomes Rc50 to 55. • Typical hardened depth is 0.75 mm (0.030 in). <i>Note: This hardened depth is greater than expected running clearance wear.</i> • Part base material remains ductile (Rc20 max.) • Consistent ring hardness is achieved through: <ul style="list-style-type: none"> - Controlled chemical composition - Precise laser application - Repeatable manufacturing procedures



**Direct Laser
Deposition
Welding Process**

**Superior Surface
Characteristics**

**Achieve Superior Surface
Characteristics**

The *Direct Laser Deposition (DLD)* welding process metallurgically bonds a metal powder to the base material. Due to a controlled and localized heat input, this process can be applied to various base metals without distortion or the need for post weld heat treatment.



Application of 420 Stainless Steel Powder on CA-15 Impeller Hub

Choice of Metal Powders

- Chemistry similar to or different from base material
- Application specific characteristics
 - Level of hardness
 - Corrosion resistance
- Brands
 - Ultimet®
 - Stellite®
 - Flowserve proprietary blends

Pump Benefits

- Improves pump reliability
 - Reduces chance of galling
 - Reduces chance for cracking
- Increases mean time between repairs
 - Improves life of wear parts
 - Maintains performance and efficiency
- Restores worn pump components
 - Repairs to “as design” geometry
 - Upgrading to superior surface characteristics
 - Salvages used parts that would otherwise be scrapped



Restored and Upgraded Boiler Feed Impellers

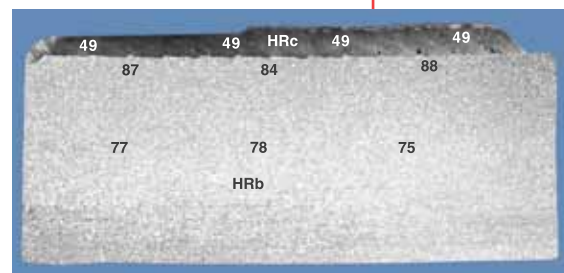
Typical Applications

Liquid	Base Material	Base Material Hardness (Rc)	DLD Hardness (Rc)	Pump Applications
Water/ Hydrocarbons	Martensitic Stainless Steels (400 Series)	22	52	Boiler Feed Circulating Water Service Water Hydrocracker Charge
Seawater/ Corrosive Liquid	Austenitic Stainless Steels (300 Series)	15	42-58	Tower Bottoms Circulating Water Service Water Cooling Water Ash Sluice

Note: Above values are typical and may vary by application



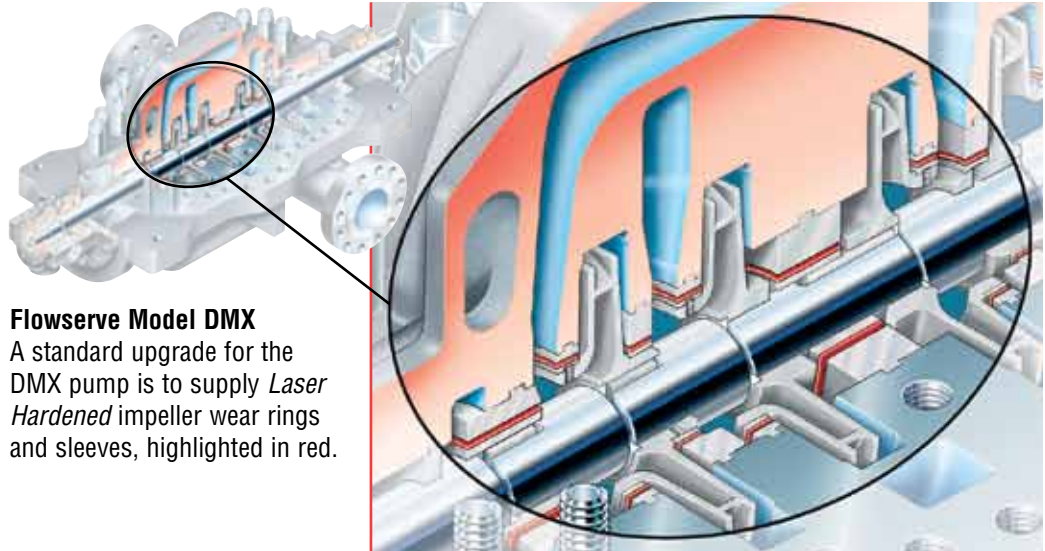
Proof-testing of Ultimet Powder on 316 SS



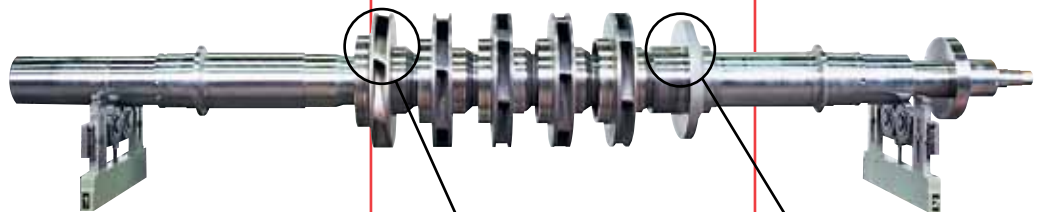
Micrograph Showing DLD Cross Section

© Ultimet is a registered trademark of the Haynes International, Inc.
© Stellite is a registered trademark of the Deloro Stellite Company, Inc.

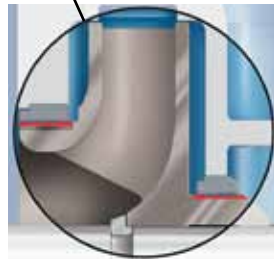
**Laser Hardening
and Direct Laser
Deposition
Applications**



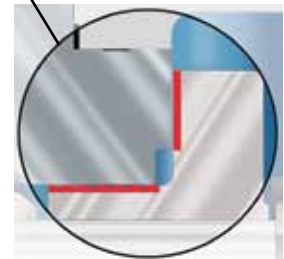
Flowserve Model DMX
A standard upgrade for the DMX pump is to supply *Laser Hardened* impeller wear rings and sleeves, highlighted in red.



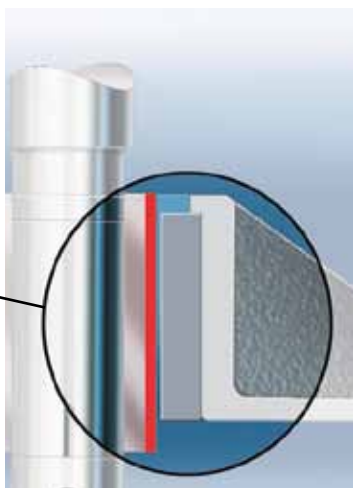
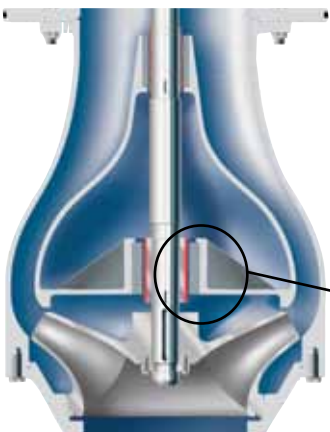
**22 400 kW (30 000 hp),
5500 rpm Boiler Feedwater
Pump Rotor Restoration**
Upgraded to feature *DLD* treated impeller front and back integral wear rings and *Laser Hardened* balancing drum, highlighted in red.



Impeller Hubs



Balancing Drum



Shaft Sleeves



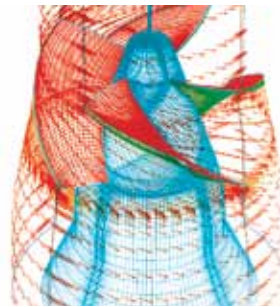
**Circulating Water Pump in
Silty River Water Service**
Retrofitted with DLD upgraded shaft sleeves for abrasion and corrosion resistance, highlighted in red.

Global Service and Technical Support

Advanced Technologies

Few if any pump companies can match Flowserve's capabilities in hydraulic and mechanical design or in materials engineering. These capabilities include:

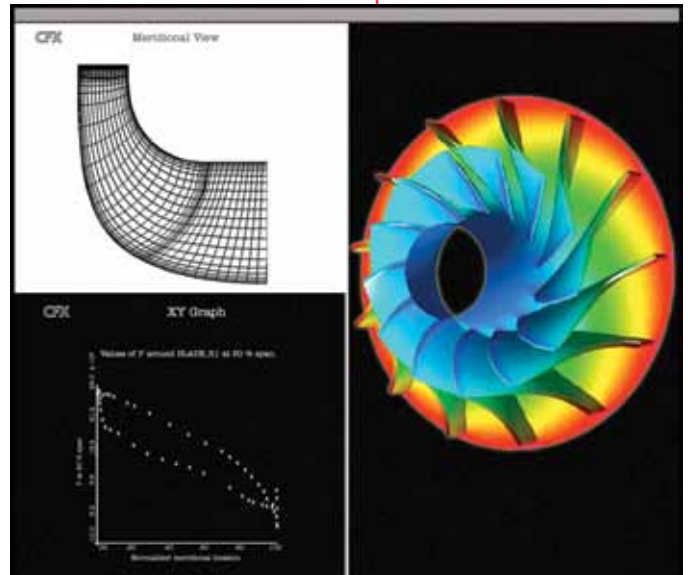
- Computational fluid dynamics
- Flow visualization
- Cavitation studies
- Efficiency optimization
- Finite element analysis
- Rapid prototyping
- Captive high nickel alloy and light reactive alloy foundries
- Non-metallic materials processing and manufacturing



Service and Repair Group

Flowserve's Service and Repair Group is dedicated to maximizing equipment performance and reliability-centered maintenance programs. Pump related services include:

- Startup and commissioning
- Diagnostics and prognostics
- Routine and repair maintenance
- ANSI and ISO power end exchange program
- Re-rates, upgrades and retrofits
- Spare parts inventory and management programs
- Training



Pump Improvement Engineering Services

Flowserve is committed to helping customers obtain the best possible return on their pump equipment investment. Engineering assistance and technological solutions for pumping problems are readily available.

These services include:

- Field performance testing
- Vibration analysis
- Design analysis and root-cause problem solving
- Material improvements
- Pump and system audit
- Advanced technology solutions
- PumpTrac™ remote pump monitoring and diagnostic services
- Instruction manual updates
- Training courses

**Flowserve... Supporting Our Customers
With The World's Leading
Pump Brands**



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