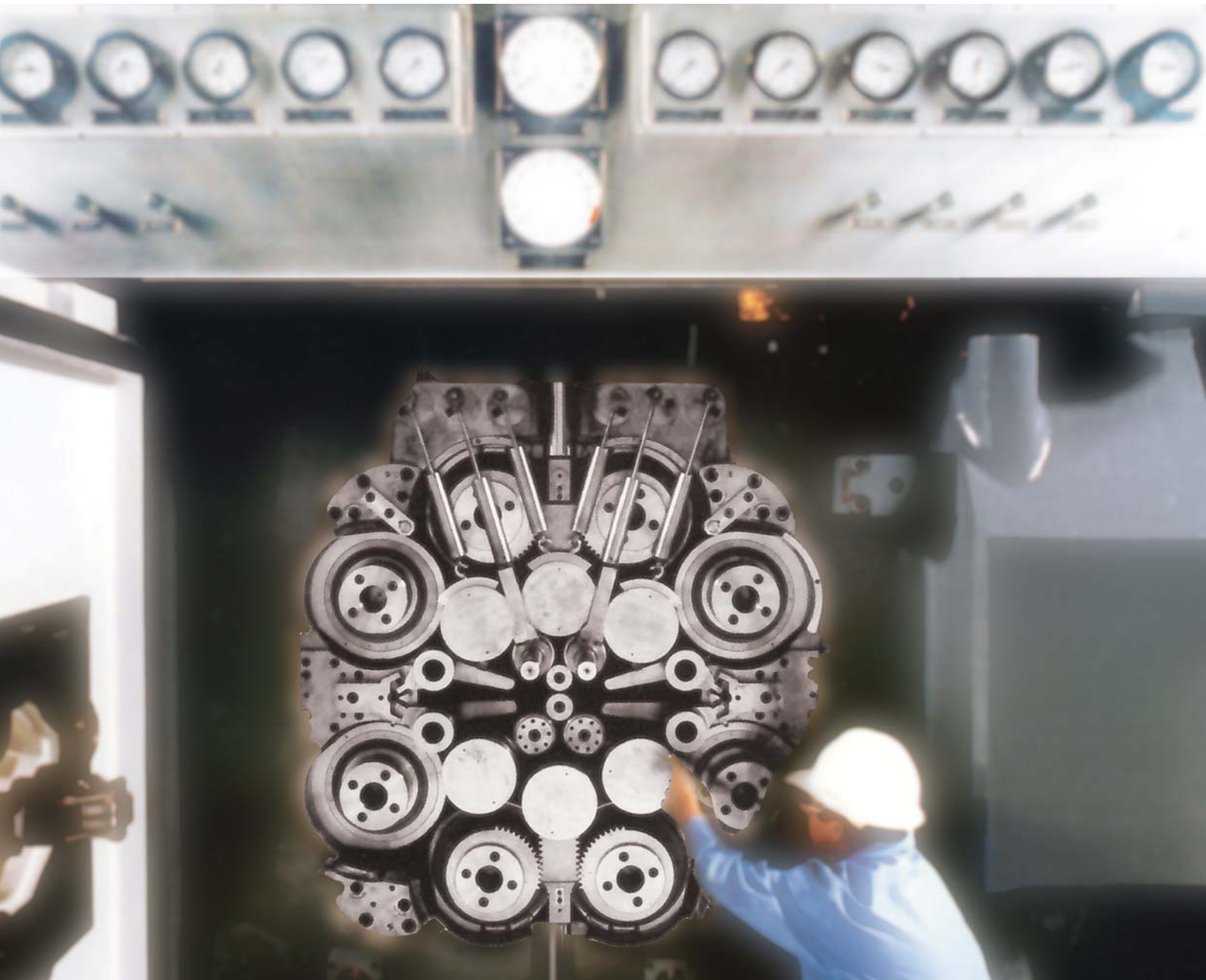
WATERBURY FARREL™

a division of

Magnum Integrated Technologies Inc.

Sendzimir® Mills

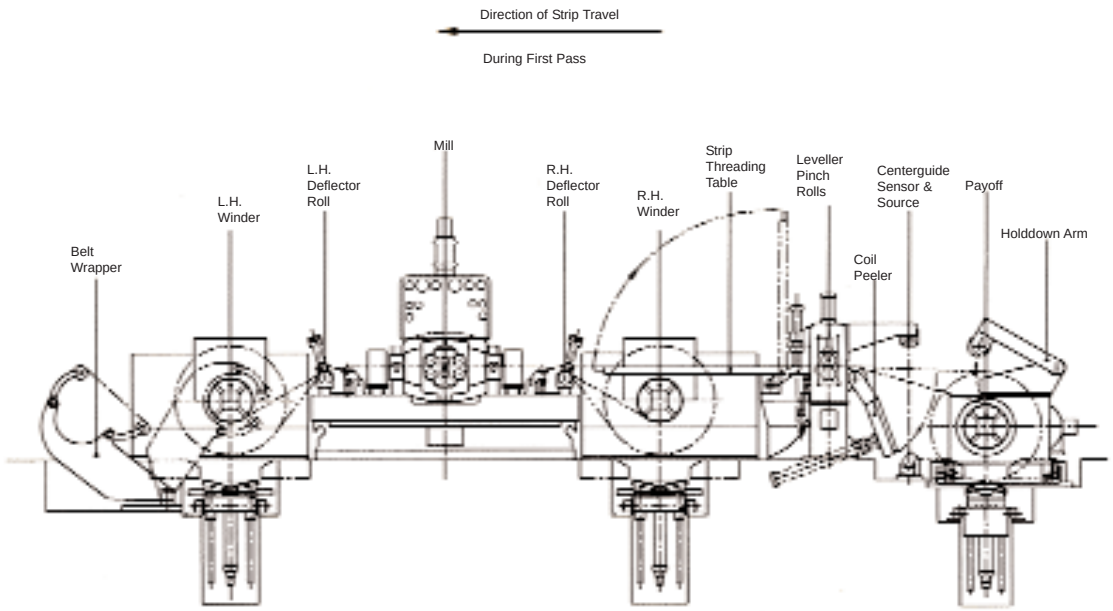


Design Quality

This cluster-type mill is the most flexible and powerful of its kind. It is used to roll both ferrous and non-ferrous metals and is designed to make heavy reductions at high speeds. the roll cluster contains 12 rolls and 8 backing bearing assemblies. Four of the rolls are driven by intermediate rolls.

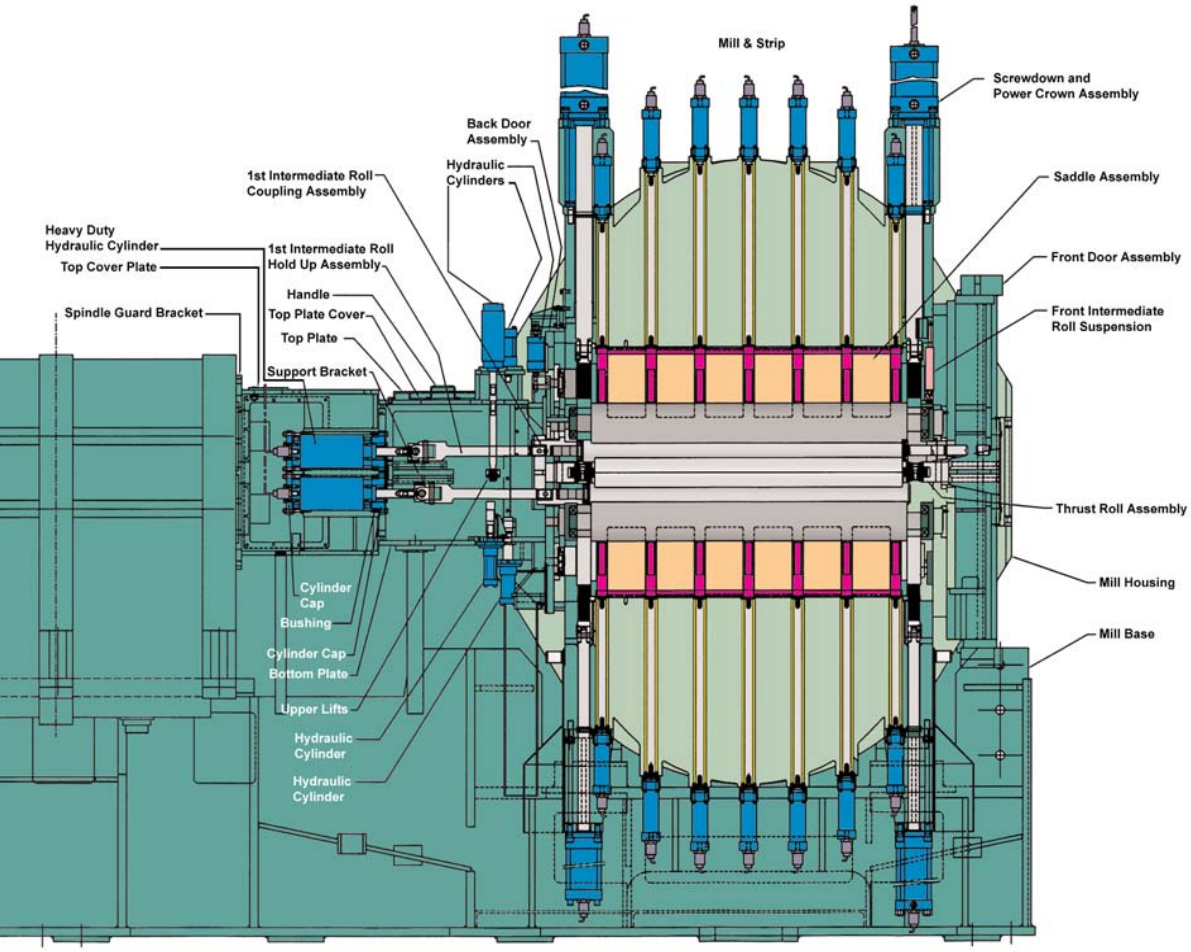
Rigid, compact mill housing eliminates deflection of work rolls and produces a uniformly close gauge tolerance strip. We supply 20-High Mills in either reversing or one-way operations.

All of these cluster mills use hydraulic servo-controlled screwdowns. A standard feature of most of these mills is a mechanically operated crown adjustment (a patent feature of Waterbury Farrel). Some of the larger mills of this type may be equipped with "AS-U-ROLL"™ power crown adjustments.



Due to the demands set forth by the stainless steel industry for better quality strip, Waterbury Farrel® made another revolutionary change in the traditional monoblock Z-Mill® Rolling Mill by including bottom power crown control and by substantially increasing the mass of the housing to achieve higher mill rigidity. The mill (colored graphic) can roll stainless strip of 0.1mm thick and 1300mm wide at very high speeds while maintaining close tolerances. Advantages of this design include:

* Very low mill stretch
* Superior flatness control
* Elimination of crown on rolls
* Accurate passline adjustment
* Larger housing cavity for wider application range of rolls and better coolant control

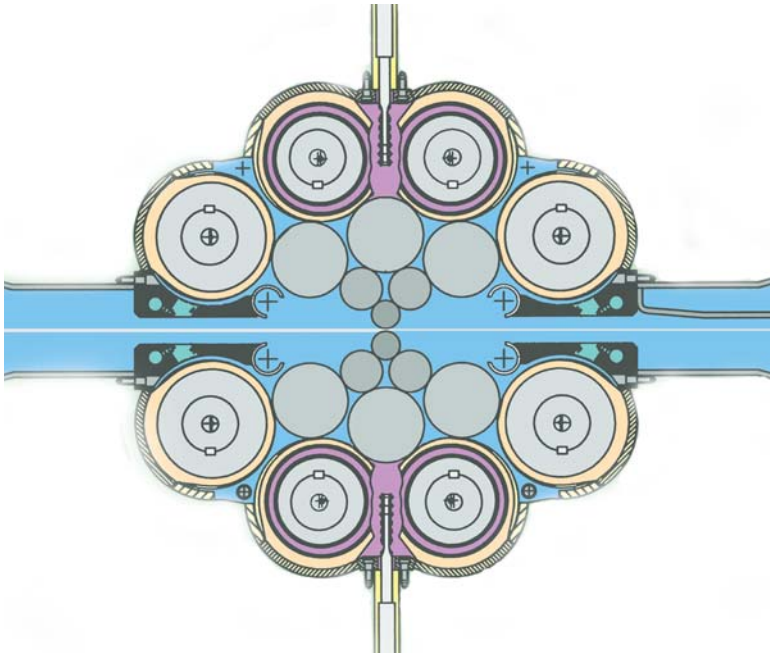


Strengths of Sendzimir® design

- Unlike a mono block housing that is machined permanently, due to which it never loses its alignment and never needs any maintenance, a mill with split housing sees considerable drift over time.
  Low rigidity.
- Gage thickness accuracy better than ? 3 ?m at the roll bite cannot be achieved in split housing mills whereas Sendzimir mills can achieve better than?0.1 ?m using backing assemblies
- Mills of split housing type have more components, which mean more wear and more maintenance (and less production).
  The skill level required of the operators and maintenance personnel for mills with split housing design is very high.
- Most split housing designs require that the extremely high roll separating forces be directly transmitted through hydraulics, performance of which is unstable, difficult to accurately predict and compensate for. In a mono block housing, a large linear displacement of the screw down rod indirectly effects a fractional linear displacement of the rolls by accurate mechanical displacement through the eccentrics.
  The mono block mill housing has the shortest stress path which represents a high mill modulus whereas the split mill housing design has more interfaces in the stress path which reduces its mill modulus.
  Each of the interfaces has a friction that increases the hysteresis and this is very bad for roll gap accuracy in split housing.
  Mills with split housing design need to be accurately calibrated and this issue does not exist with the mono block design.
  Due to the large quantity of small size components, the natural frequency of the split housing mill will be lower because of which there is a higher possibility of mill vibration causing strip defects.

The exclusive design features of Waterbury Farel® Z-Mills offer significant advantages over 4-high and other types of cluster mills. Major advantages of Z-Mills are:

Extreme accuracy of gauge
Highest standard of surface finish
Shape instantly adjustable
No limitation of width of strip
Minimum number of passes
Reduction (or elimination) of intermediate anneals
Quick & easy roll changes
Small work rolls make tungsten carbide rolls economical to use
Freedom from camber and edge cracking
Compact design
Low foundation costs
Smaller roll grinder



Mill Type	Work Roll Diameter (Nom.)		Backing Bearing Diameter		Strip Width, Max.				Typical Product	Minimum Gauge	
					Narrowest Mill		Widest Mill				
	Inch	mm	Inch	mm	Inch	mm	Inch	mm		Inch	mm
ZR-32	0.250	6.35	1.875	47.63	4.25	105	7.25	180	Ultra-thin foil nonferrous, high carbon, stainless steel	0.0001	0.003
ZR-34	0.400	10.16	3.000	76.20	7.5	190	15	380	Electrical alloys, stainless, tantalum zirconium, super alloys & bimet-	0.0004	0.01
ZR24	0.844	21.44	4.724	119.99	8.5	215	19.5	495	Low carbon, high carbon, stainless steels, copper, brass, phosphorous, bronze, aluminum alloys.	0.0008	0.02
ZR-33	1.125	28.58	6.299	160.00	8.625	220	26	660		0.001	0.03
ZR-33SC	1.260	32.00	6.299	160.00	8.625	220	26	660			
ZR-33WF	1.378	35.00	6.299	160.00	8.625	220	26	660			
ZR-23	1.578	40.08	8.858	225.00	19	480	50	1270		0.002	0.05
ZR-23SC	2.000	50.80	8.858	225.00	19	480	50	1270			
ZR-23M	2.420	61.47	8.858	225.00	19	480	50	1270			
ZR-23WF	2.450	62.23	8.858	225.00	19	480	50	1270			
ZR-22	2.125	53.98	11.811	300.00	26	660	52	1320	Low carbon, high carbon and stainless steels	0.003 to 0.004	0.07 to 0.1
ZR-22B	2.500	63.50	11.811	300.00	26	660	52	1320			
ZR-22BB	3.000	76.20	11.811	300.00	26	660	52	1320			
ZR-22S	2.687	68.25	11.811	300.00	26	660	52	1320			
ZR-22WF	2.598	65.99	11.811	300.00	26	660	52	1320			
ZR-21	3.500	88.90	16.000	406.40	33	840	66	1675		0.006	0.15
ZR-21WF	3.622	92.00	16.000	406.40	33	840	66	1675			

Old Mill Housing vs New Mill Housing

Larger housing cavity needed for better coolant handling and cobble disposal

Zero deflection in the rolling direction permissible since there are no restraining devices

Zero radial deflection permissible since there are no restraining devices

Minimum vertical deflection permissible since screwdown control becomes non linear at large values

Ensures even crown on both sides of the strip

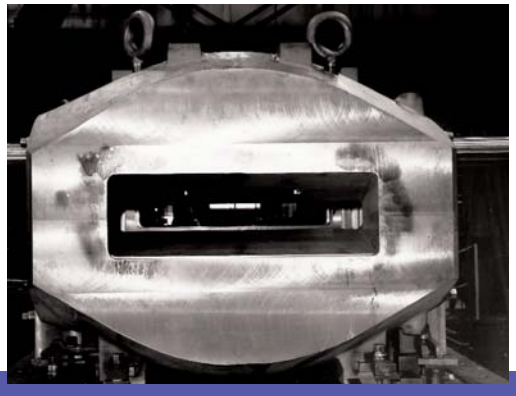
Provides double the I/Os for flatness control

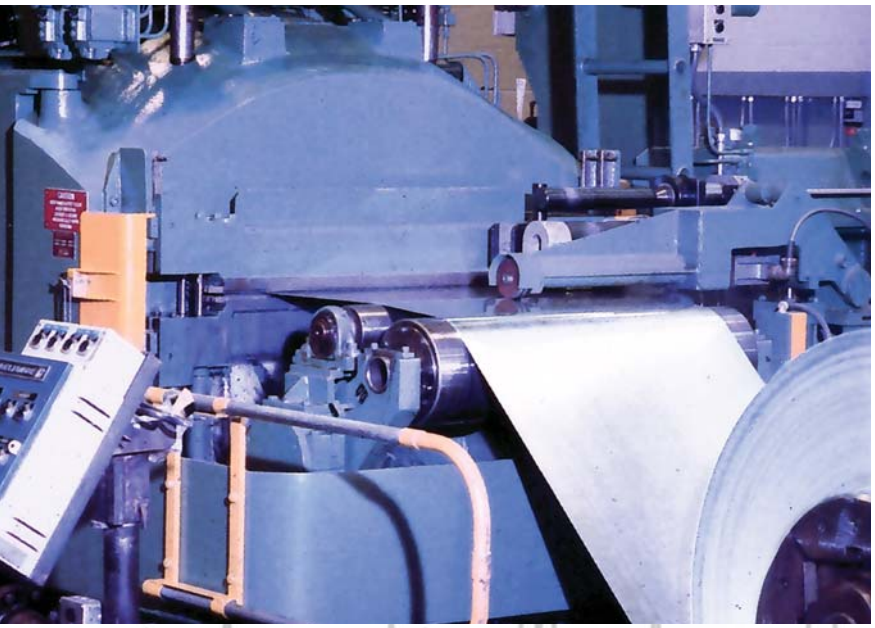
Combined with longer stroke 1st intermediate rolls, this eliminates the need for crowned rolls

Provides superior steering control of strip

Features & Advantages

- Ensures even crown on both sides of the strip
- Provides double the I/Os for flatness control
- Combined with longer stroke 1st intermediate rolls
- Provides superior steering control of strip
- Double “As-U-Roll”™ Crown Control
- Double bottom screw down control
- Easily removable screw down racks
- Bigger housing cavity
- Recessed coolant spray nozzles
- Proportional coolant flow control
- High resolution bottom screw down
- Superior backing assemblies Superior gauge & flatness control and uniform wear of rolls





Select Achievements include:

199 Installations worldwide represent about half the mar ket share

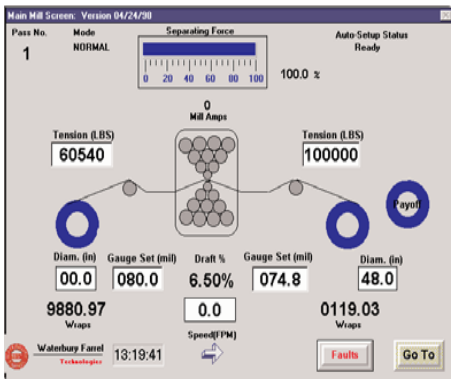
67 Sendzimir Mills Supplied for Rolling Stainless Steel

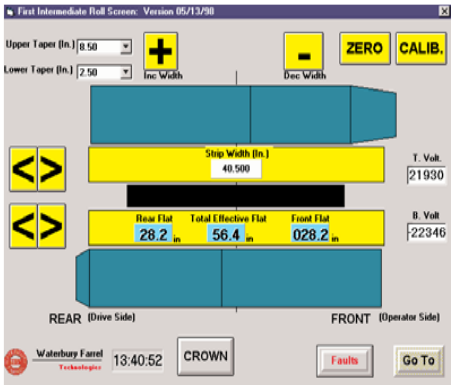
Mill Speeds up to 3500 fpm (1067 m/min) have been achieved

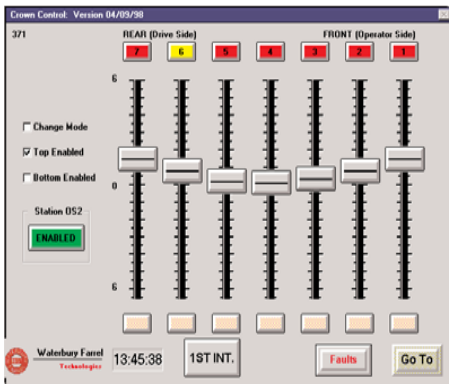
Thinnest Material rolled on a Waterbury Farrel Mill is 0.76µm

These computerized Hydraulic Automatic Gauge Control systems permit the production of close tolerance strip merely by pushing a button. The system automatically and consistently maintains extremely tight tolerance throughout the lenth of every coil, regardless of speed. Basically, the MICRON ® AGC, one of the most sophisticated and successful computerized control systems in the world, patented by WATERBURY FARREL®, monitors the strip gauge and corrects variations within milliseconds. Corrections are transmitted to an accurate, highly-responsive electro-hydraulic servo-screwdown.

Other components of the system include precision high-response gauges, a state-of-the-art industrial computer and appropriate interface and operational software, as well as management printout data and automated rolling schedule.







Left: *Demonstrates ability to use either upper or lower power crowns.*
Shows ability to manipulate crown consols from any one of 3 touch screens two at the mill and one in the pulpit.
Middle: *Sample Screen from the Operator Interface Graphic Software.*
Right: *AccuVision 1'st intermediate control touch screen.*

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