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Some time ago ----

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FABRIS
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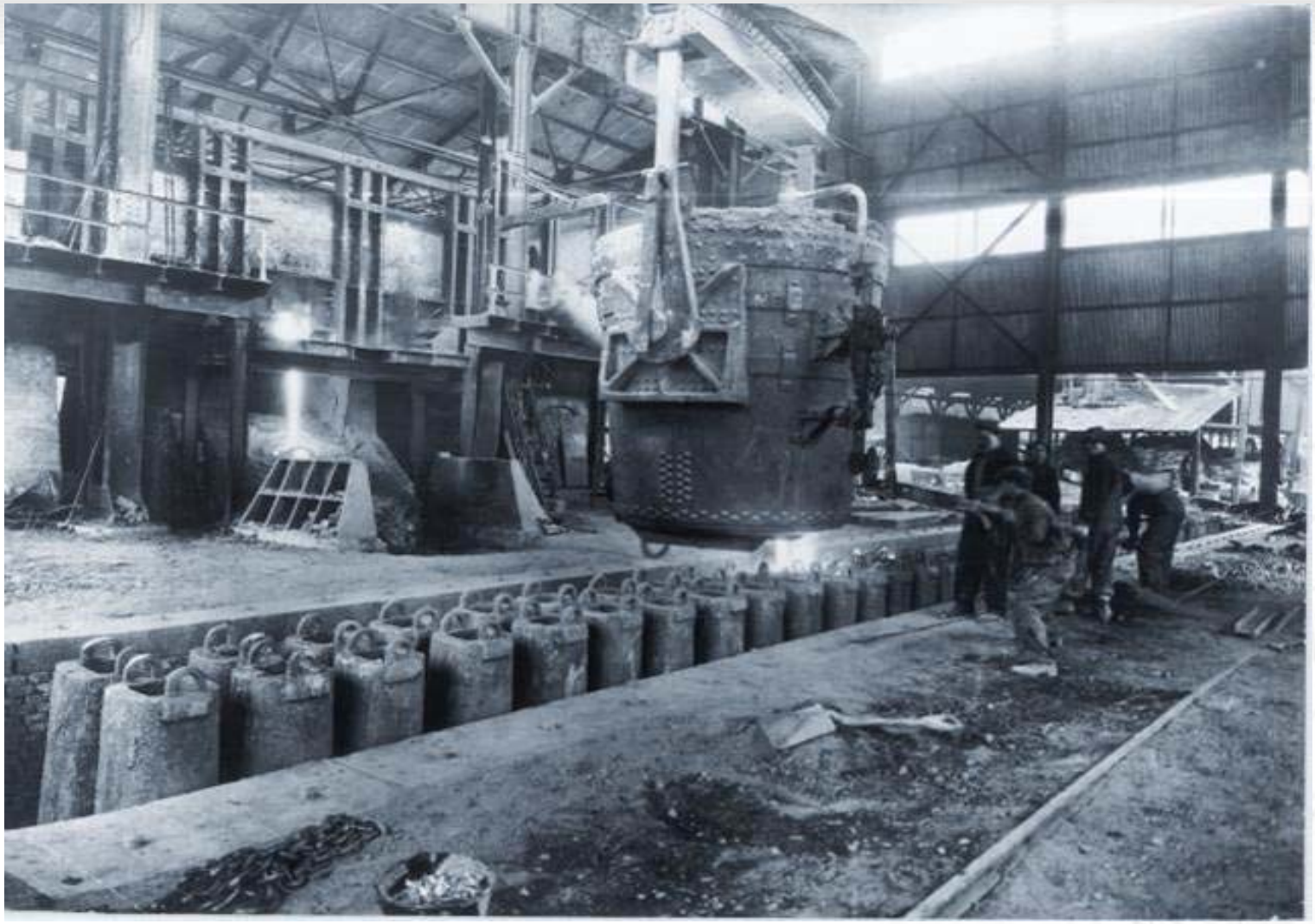
--- Still some time ago ---



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A considerable number of years later ---

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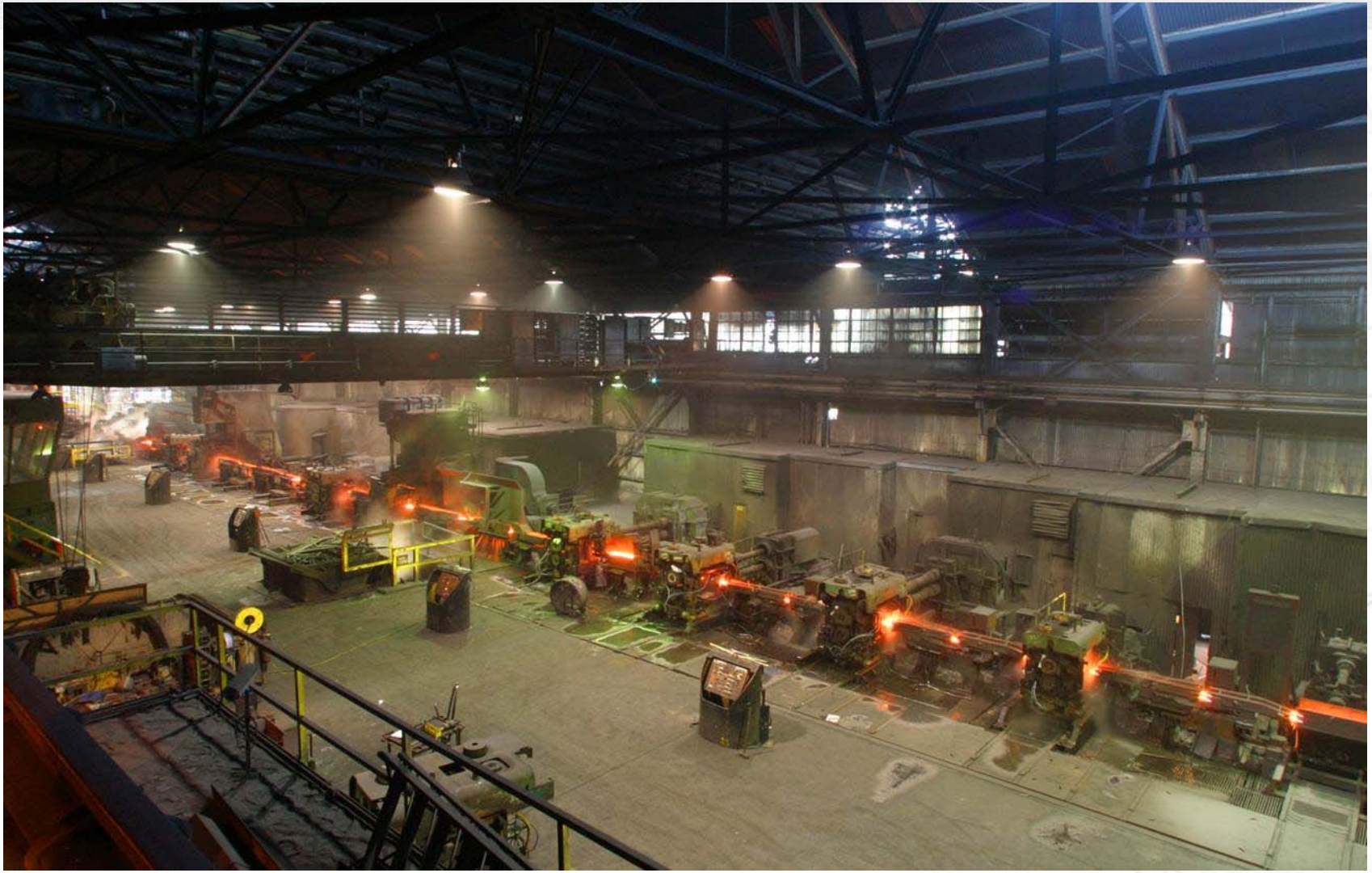
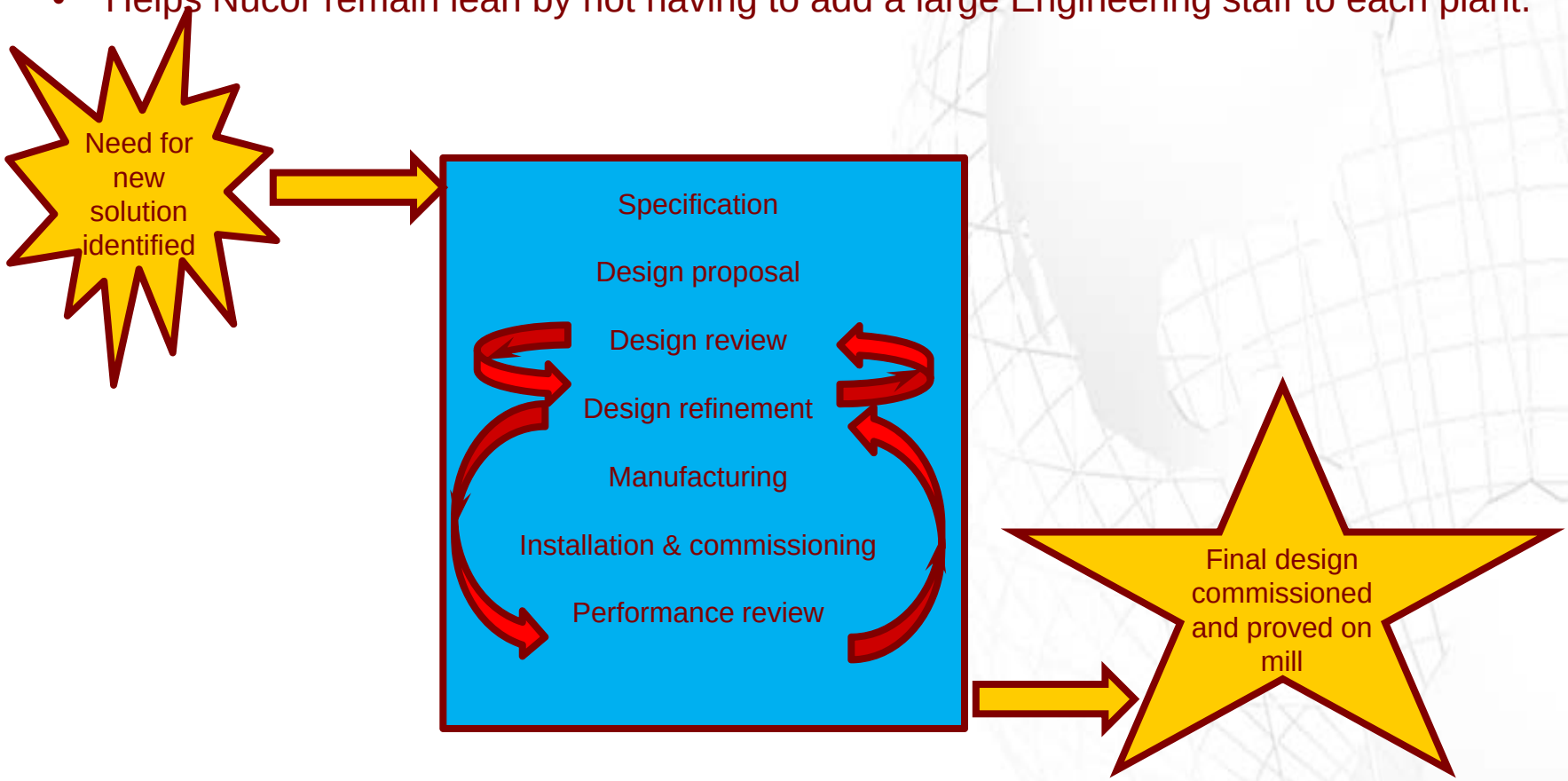
--- Nucor Seattle Today



Success Through Partnership

- Partnering with vendors allows for shared cost when doing R and D.
- Helps Nucor remain lean by not having to add a large Engineering staff to each plant.



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State of the Art Machine Shop with full Engineering Design Capability

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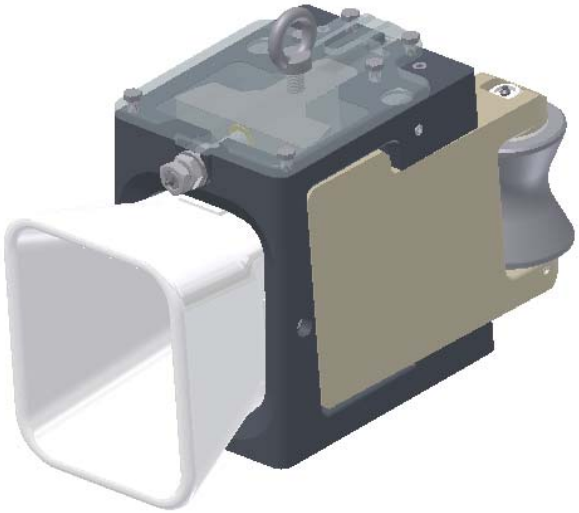
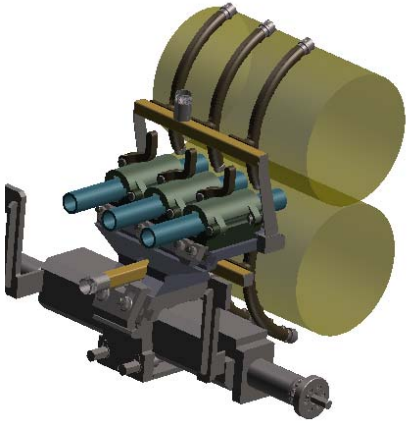
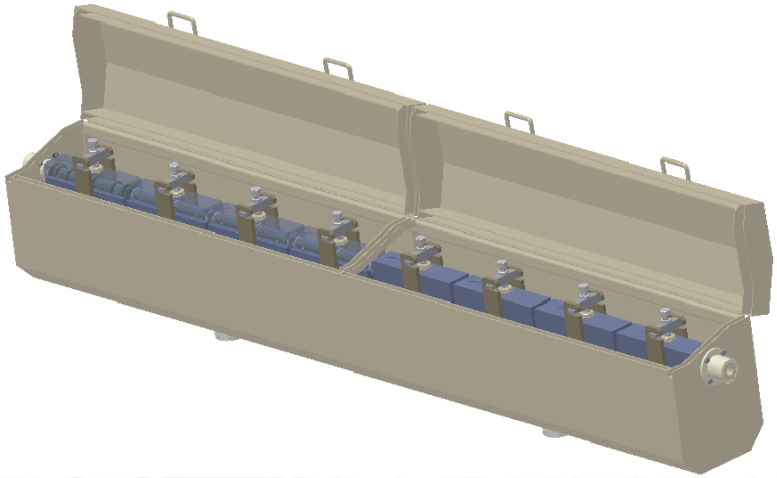
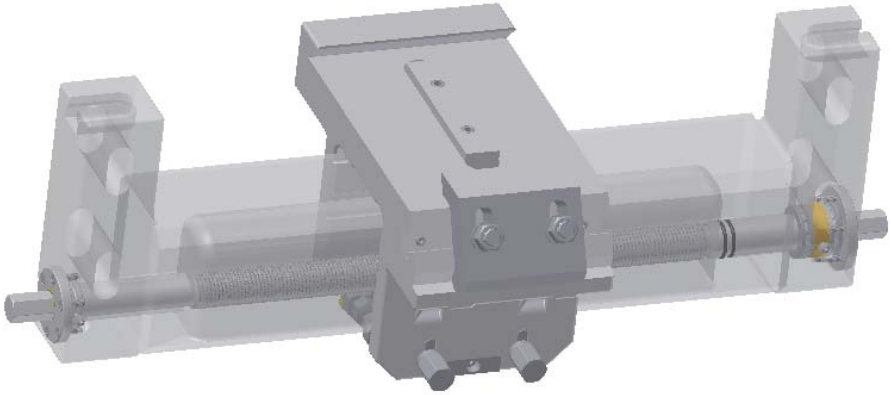
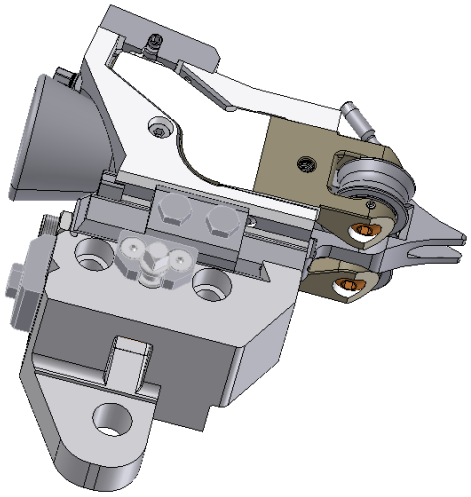
Specialized in the Design and Manufacture of Products for Rolling Mills











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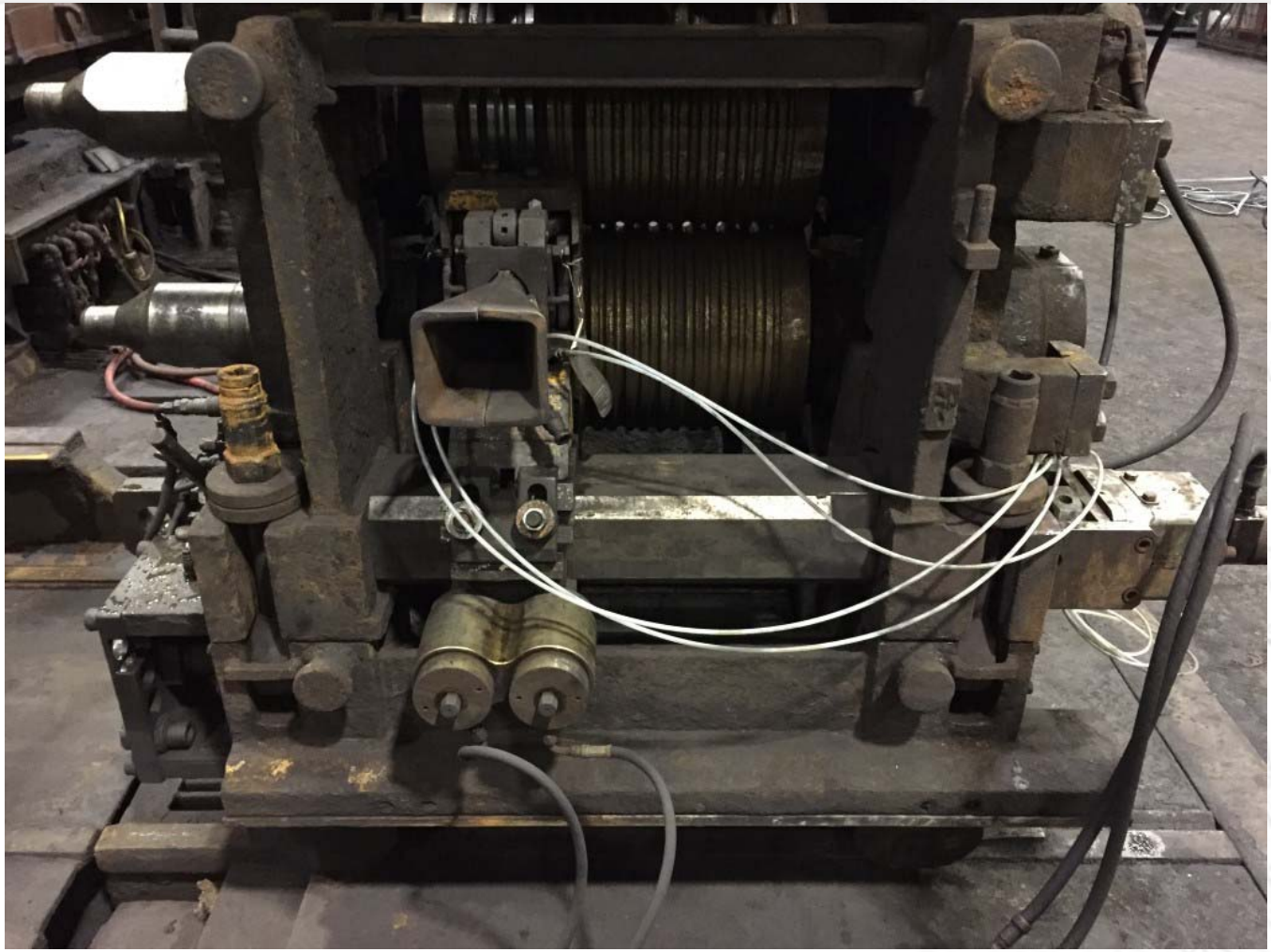
Hydraulic Rest Bars



Nucor Key Requirements

- ***REMOVING TEAM MEMBERS FROM LINE OF FIRE HAZARDS.***
- *SYSTEM REALIABILTY IN A STEEL MILL ENVIROMENT*
- *BE ABLE TO INSTALL ON EXISTING MILL STANDS WITH MINIMUM ALTERATIONS TO EQUIPMENT.*
- *SYSTEM IS DESIGNED TO WORK ON EXISTING MILL HYDRAULIC FUID AND PRESSURES.*

FABRIS a solutions provider.

Traversing Rest Bars for Any Mill Stand

Fabris Part ID: 25796A
Location: SDI, IN

Fabris Part ID: 16647
Location: Republic Lorain, OH

Fabris Part ID: 26399
Location: MacSteel Monroe, MI

Fabris Part ID: 17614
Location: Lucchini Piombino, IT

Fabris Part ID: 18983
Location: Gerdau Ameristeel, OK

Fabris Part ID: 05E045200
Location: Nucor, UT

Fabris Part ID: 23386
Location: Camsa, MX

Fabris Part ID: 27623
Location: Feralpi, Italy

Fabris Part ID: 18385
Location: Nucor, TX

Fabris Part ID: 20258
Location: Gerdau Ameristeel, OK

Fabris Part ID: 17724
Location: Gerdau Ameristeel, OK

Fabris Part ID: 18051
Location: Lucchini Piombino, IT

Fabris Part ID: R994754
Location: Gerdau Ameristeel, NC

Fabris Part ID: 11411
Location: Nucor, WA

Fabris Part ID: 11759
Location: Acciaierie Venete , IT

Fabris Part ID: 27987
Location: AM-Hamburg Germany

Fabris Part ID: 12483
Location: Gerdau Ameristeel, NC

Fabris Part ID: 14143
Location: Siderugica Guadalajara, MX

Fabris Part ID: 14937
Location: AM Indiana Harbor, IN

Fabris Part ID: 18161
Location: Nucor, TX

Fabris Part ID: 23331
Location: Elbe Stahlewerke, DE

Fabris Part ID: 12764
Location: Nucor, MS

Fabris Part ID: 14411
Location: Sicartsa, MX

Fabris Part ID: 28135
Location: Gerdau Corsa

Fabris Part ID: 20327
Location: Nucor, TX

Fabris Part ID: 21015
Location: Siderurgica Diaco Boyaca, Columbia

Fabris Part ID: 11592
Location: AM Indiana Harbor, IN

Fabris Part ID: 23332
Location: - ESF, DE
- Al Ezz, Egypt

Fabris Part ID: 18804
Location: Nucor, IL

Fabris Part ID: 21155
Location: Halyvourgiki, Greece

Fabris Part ID: 23407
Location: Camsa, MX

Fabris Part ID: 28569
Location: Acerbrag, Argentina

Fabris Part ID: 23478
Location: AM Sonasid, Morocco

Fabris Part ID: 18747
Location: Deacero Celaya, MX

Fabris Part ID: 27074
Location: ESF, Germany

Fabris Part ID: 30153
Location: SDI-Bar, IN

Fabris Part ID: 30265
Location: Gerdau, Whitby

Fabris Part ID: 28460
Location: Cogne Acciai, Italy

Fabris Part ID: 27606
Location: Gerdau Monroe, MI

Fabris Part ID: 29032
Location: AM-Hamburg Germany

FABRIS a solutions provider.

RESTBARS

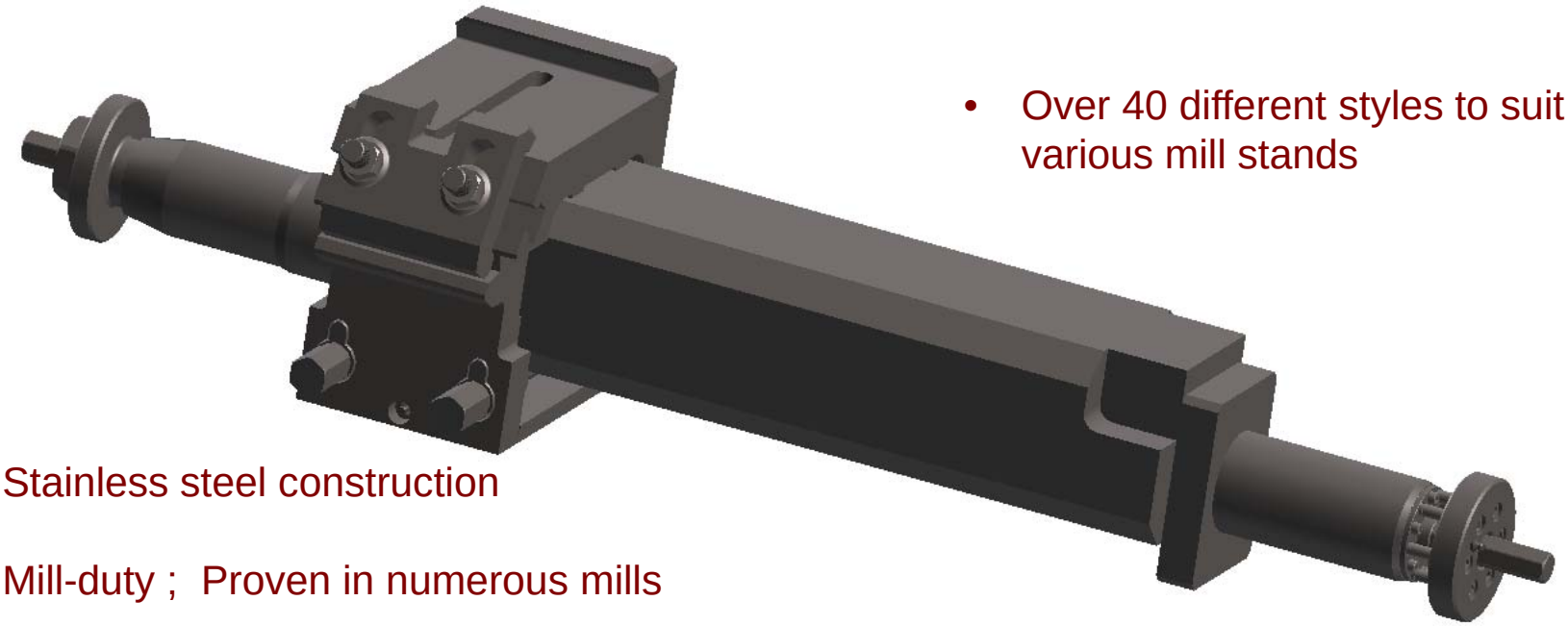
Scale: ■ = 4"

Restbars honour existing mill attachment points and guide base. No machining on your stands, just bolt on and roll

All units are made specifically for your mill, ensuring perfect fit and operation

Saddle is easily traversed without the need to remove guiding equipment

Fabris Traversing Rest Bars

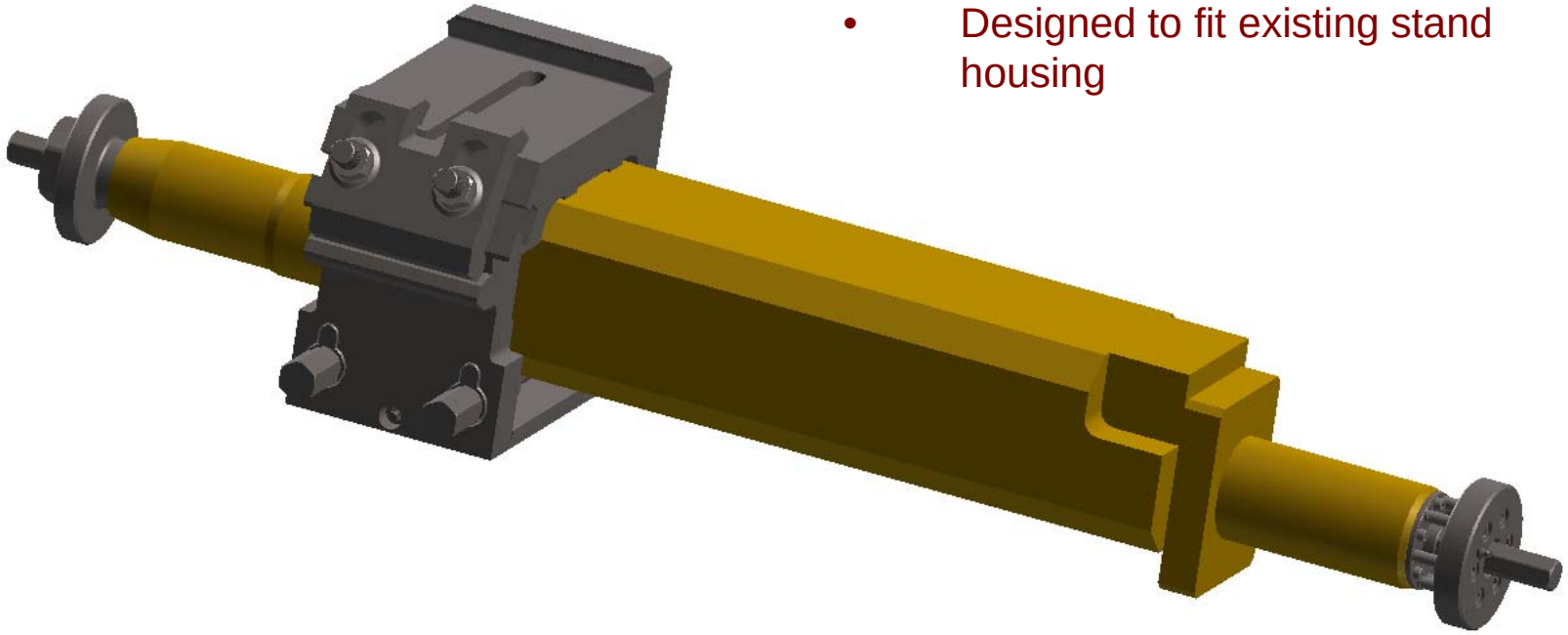


- Over 40 different styles to suit various mill stands

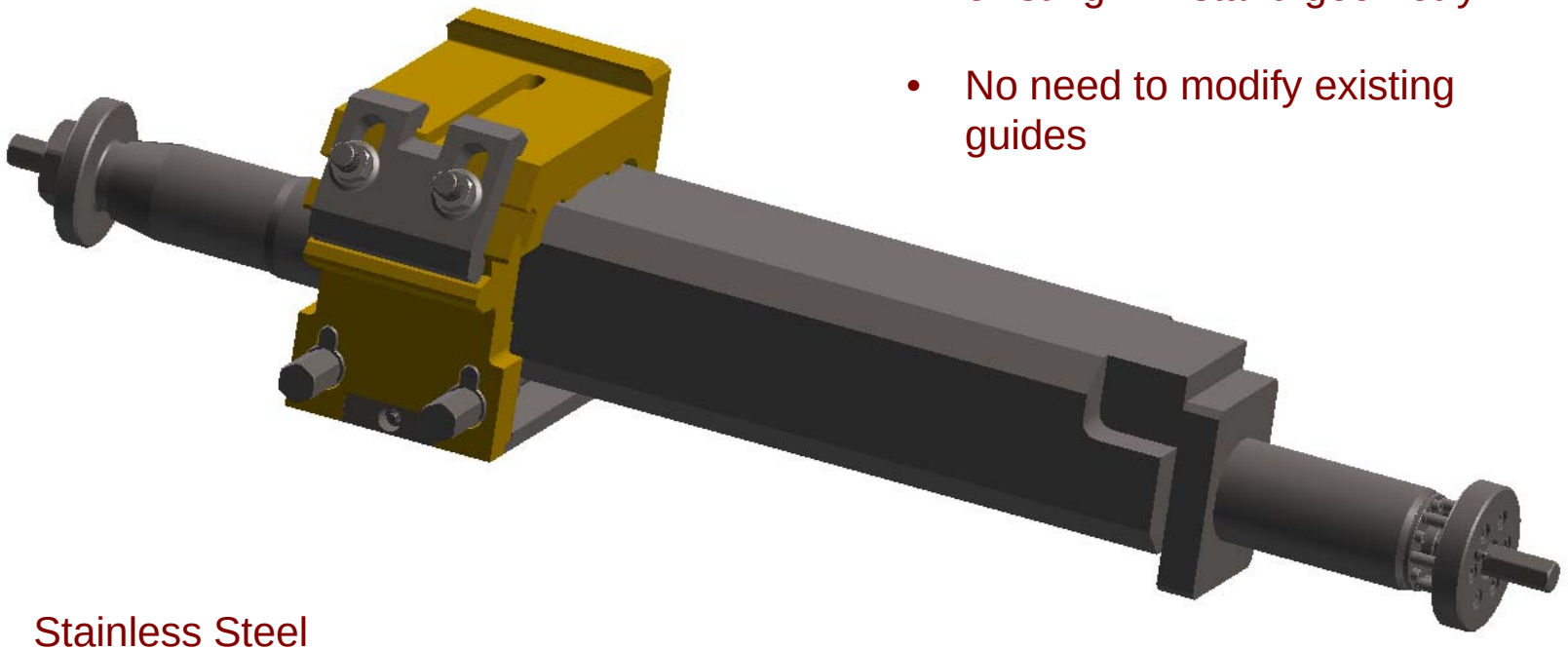
- Stainless steel construction
- Mill-duty ; Proven in numerous mills
- Fast pass changes
- Accurate guide alignment
- Secure guide location

Fabris Traversing Rest Bars - Body

- Cast Stainless Steel body
- Designed to fit existing stand housing



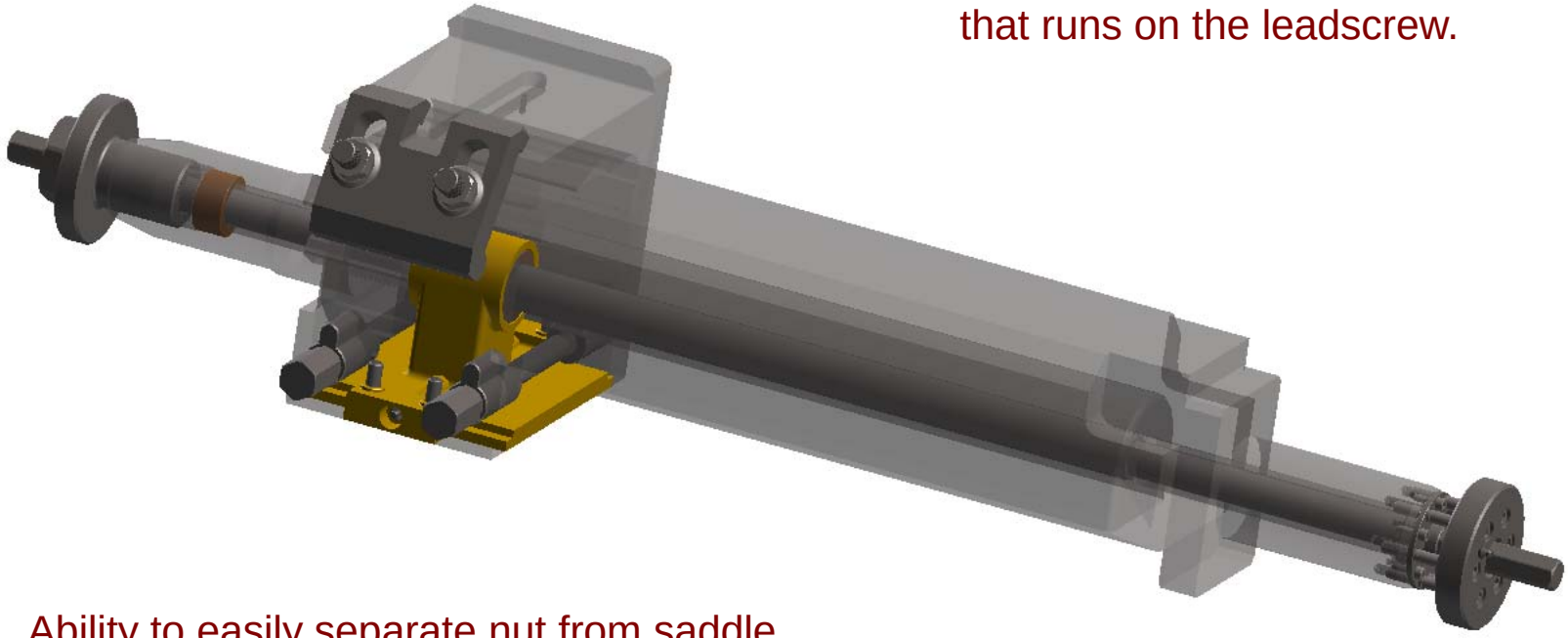
Fabris Traversing Rest Bars - Saddle



- Designed to meet with existing mill stand geometry.
- No need to modify existing guides

- Stainless Steel
- Key helps to ensure secure guide mounting

Fabris Traversing Rest Bars - Nut



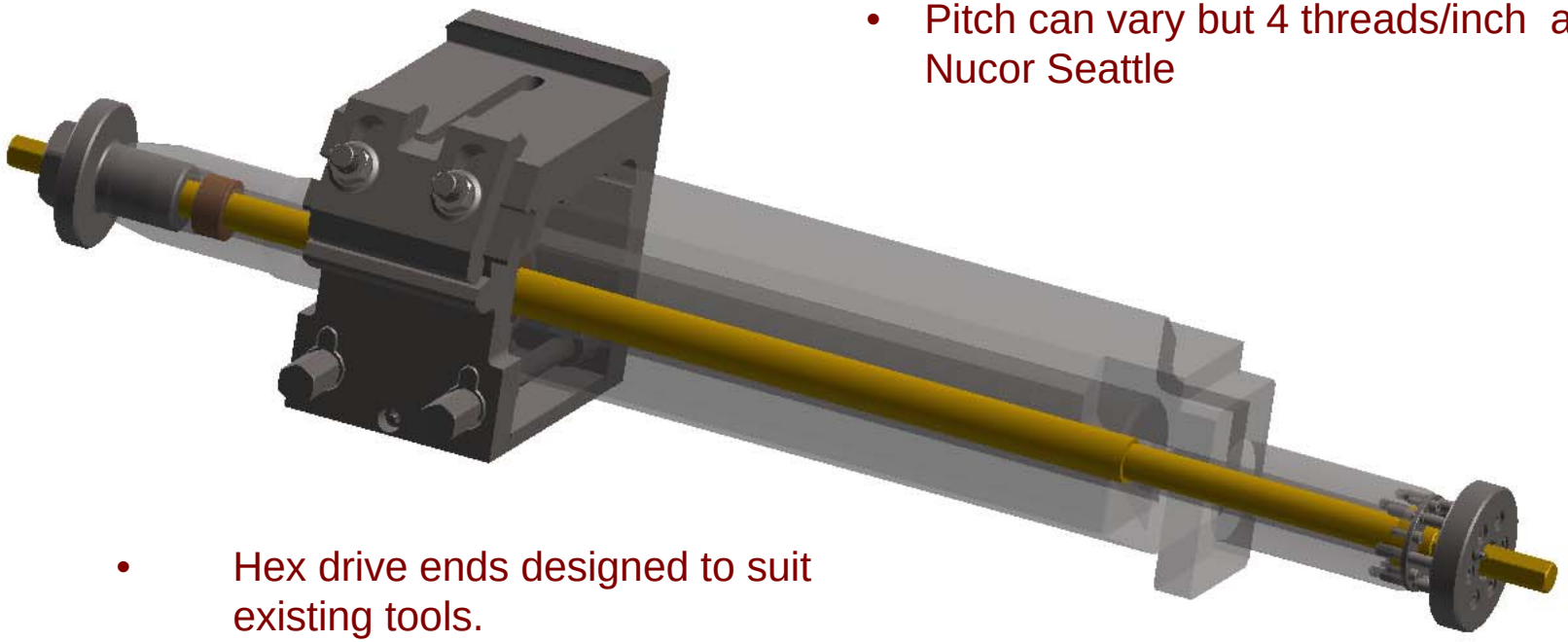
- Incorporates threaded bush that runs on the leadscrew.

- Ability to easily separate nut from saddle assists with maintenance of rest bar

- Includes grease points to ensure smooth operation

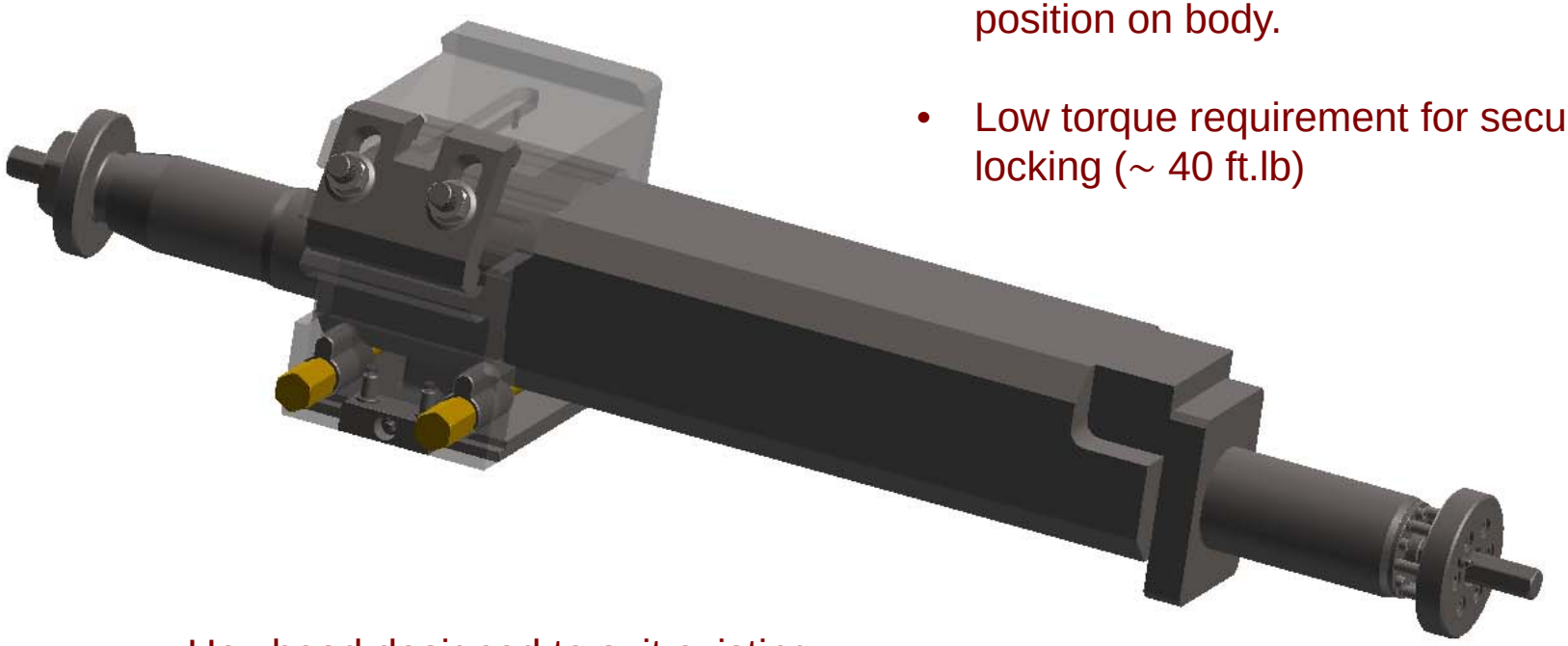
Fabris Traversing Rest Bars – Lead Screw

- ACME thread lead screw
- Pitch can vary but 4 threads/inch at Nucor Seattle



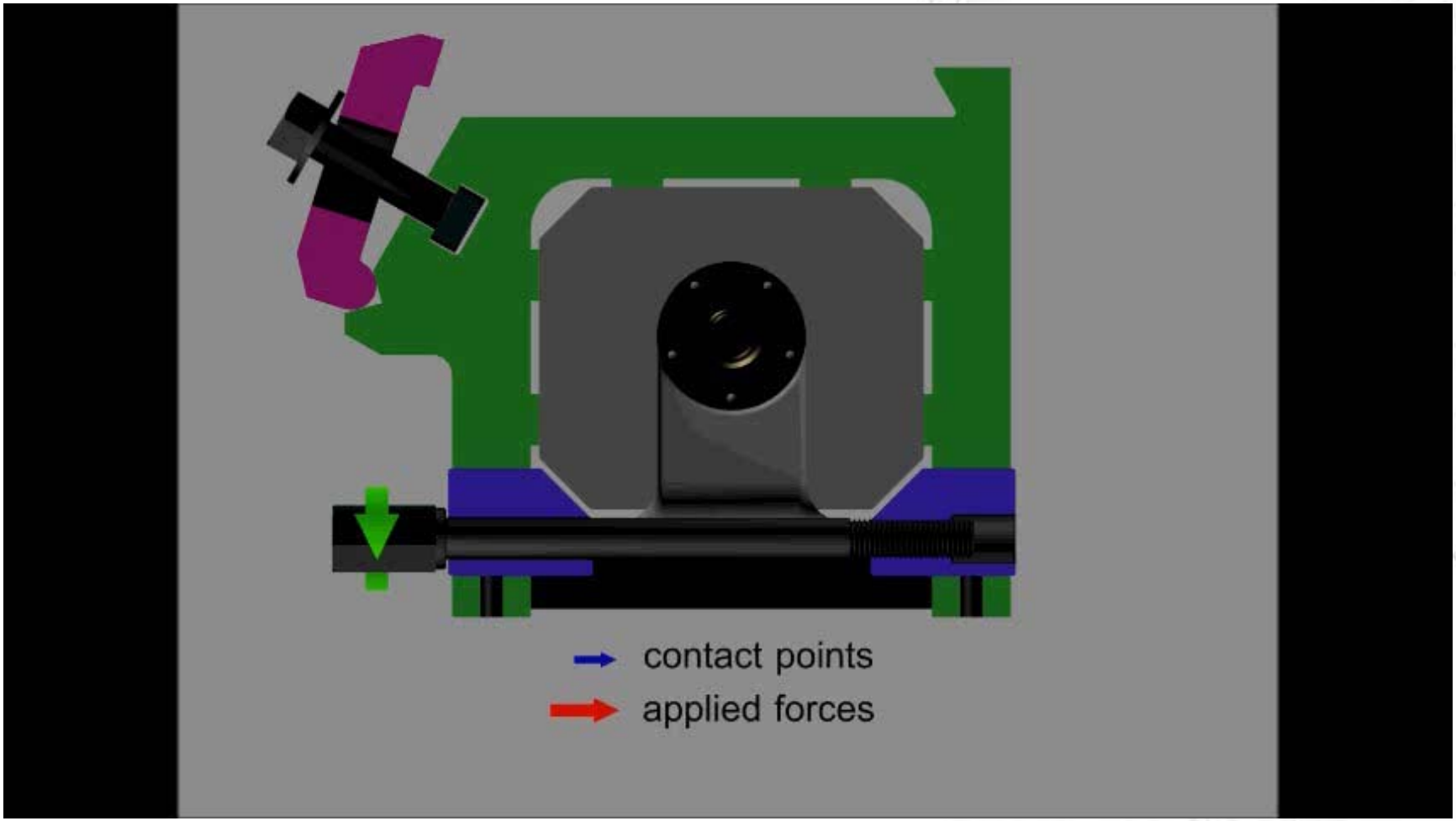
- Hex drive ends designed to suit existing tools.

Fabris Traversing Rest Bars – Clamping Screws



- Clamping screws secure saddle in position on body.
- Low torque requirement for secure locking (~ 40 ft.lb)
- Hex head designed to suit existing tools where possible

Fabris Traversing Rest Bars – Clamping Animation

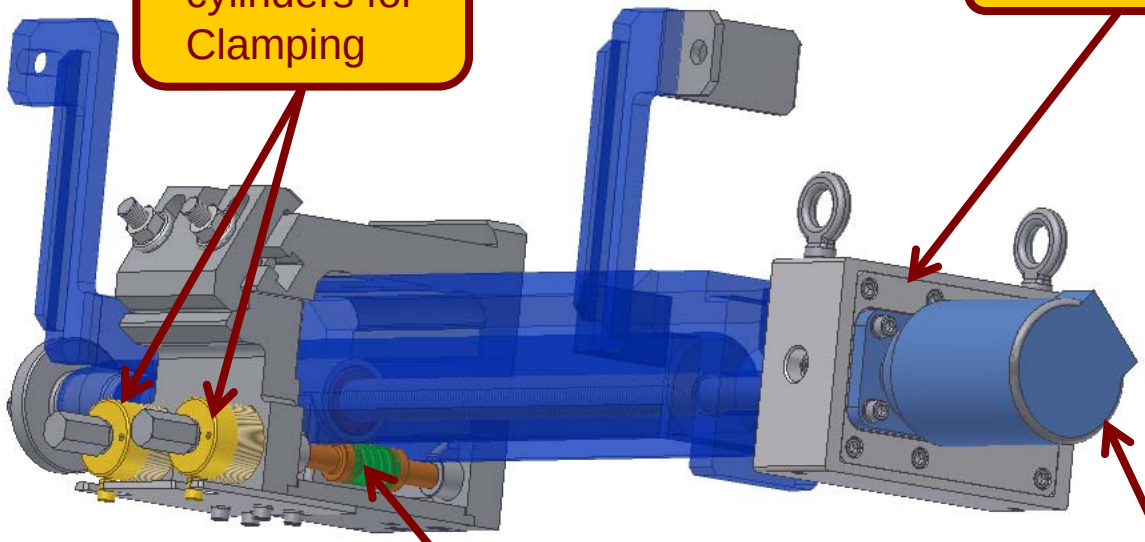


Hydraulic Rest Bar , Design Requirements

- One touch* remote operation for Up/Down or Left/Right
- Proven rest bar design features to be retained
- Must fit to existing rest bars
- Clamping to be reliable and repeatable
- Traverse speed to be suitable for fine-tuning guide position whilst still rapid enough for pass changing
- Must work off existing mill hydraulic supply

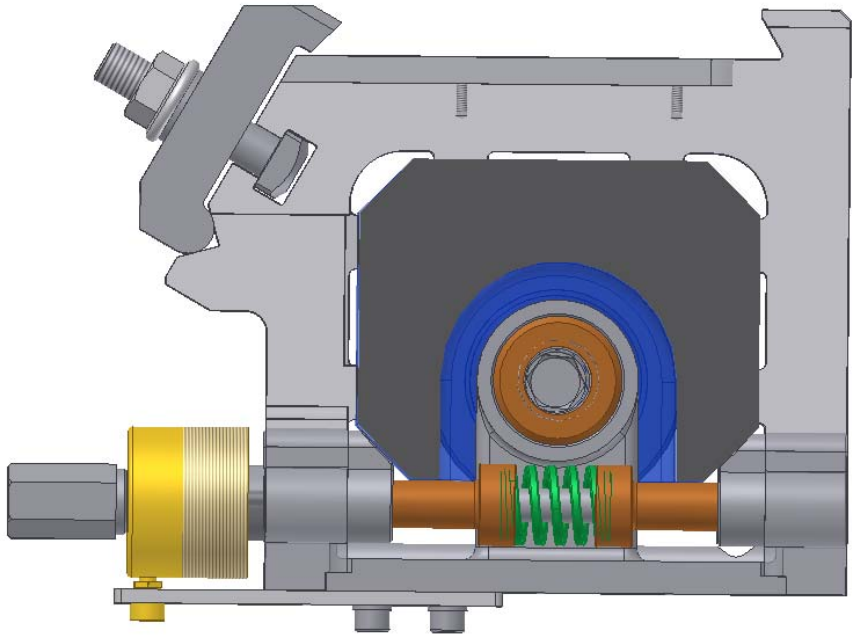
(* Changed during product evaluation)

Trial phase 1 - Hydraulic Clamping



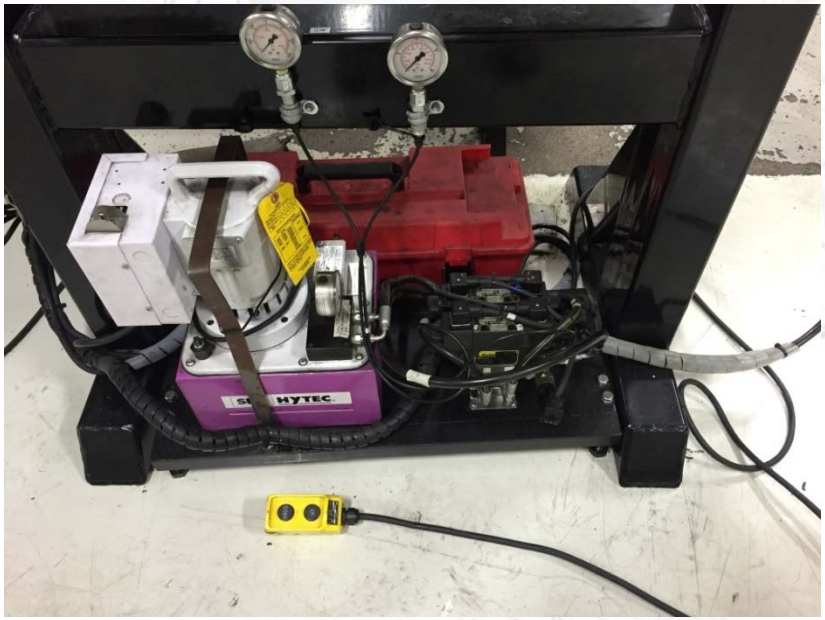
Trial phase 1 - Hydraulic Clamping

- Clamping screws adjusted with unpressurized cylinders
- Set for smooth, sliding contact.
- Pressurization of cylinders provides the saddle clamping force
- Requires check valves on hydraulic lines to ensure clamping is maintained.



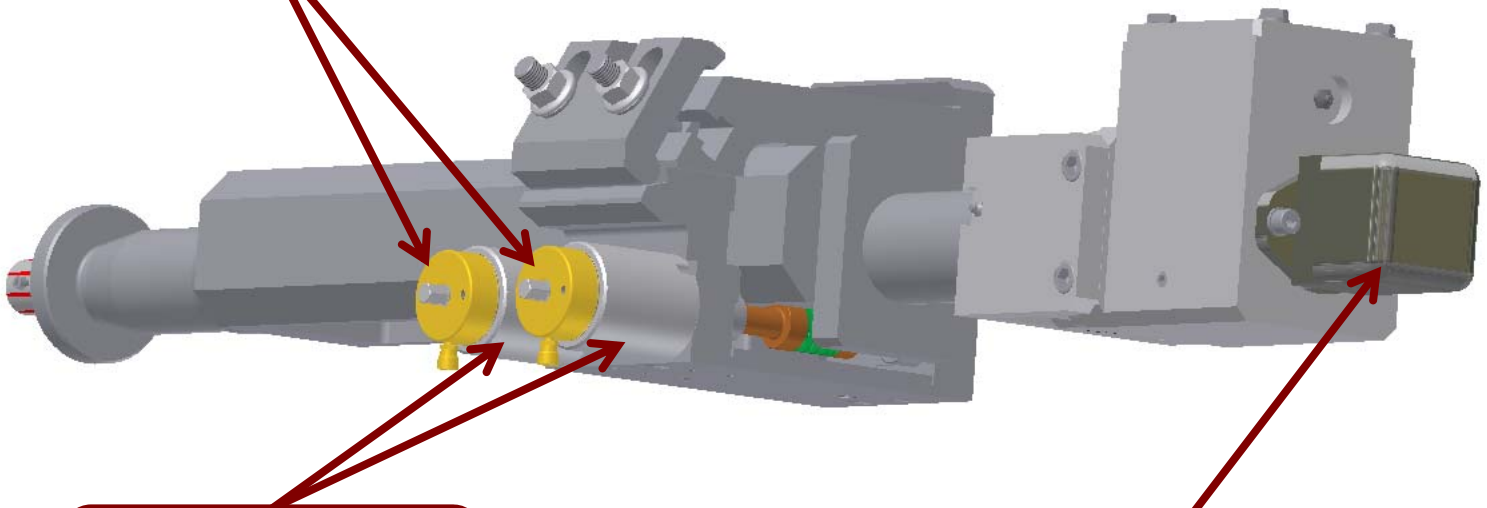
Trial phase 1 - Hydraulic Clamping

- Self-contained hydraulic unit
- Promising results but inconsistent clamping forces



Trial phase 2 - Hydraulic Unclamping

Single acting cylinders – same as previous design

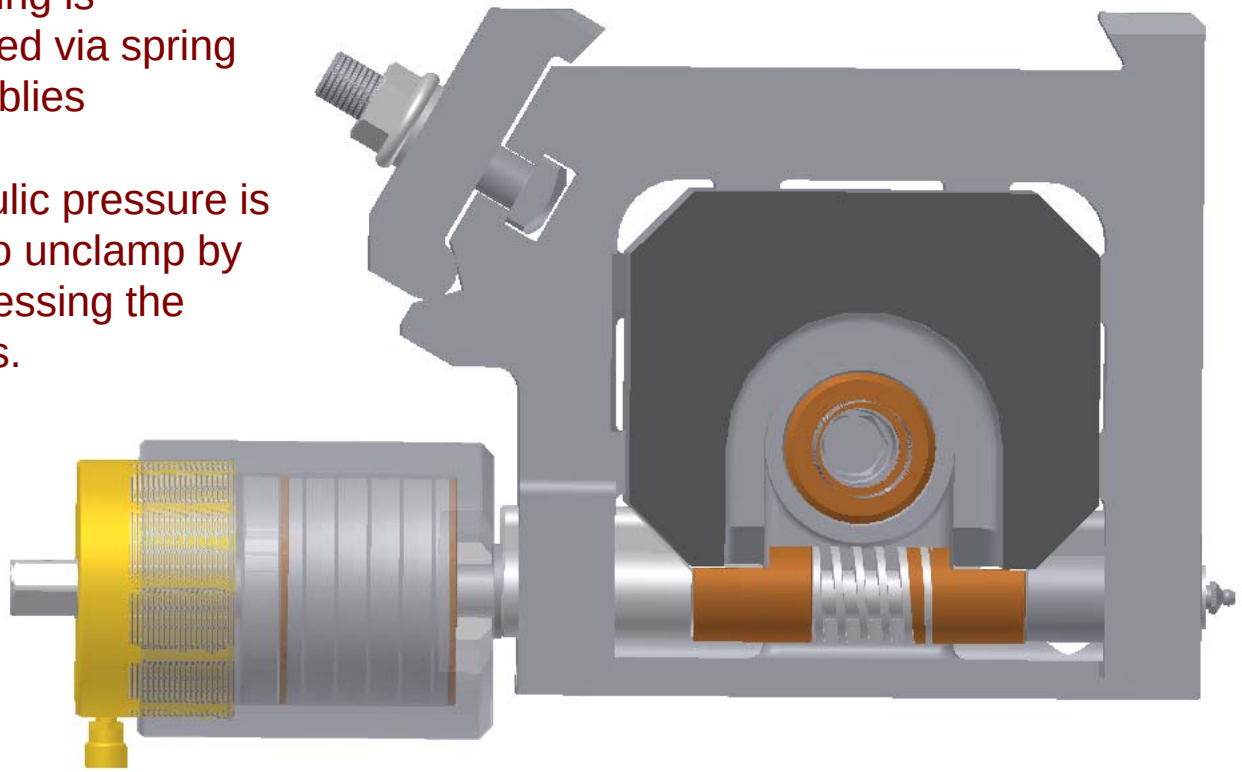


Clamping spring assemblies

Revised motor and gear assembly

Clamping – General

- Clamping is achieved via spring assemblies
- Hydraulic pressure is used to unclamp by compressing the springs.



Trial phase 2 - Hydraulic Unclamping

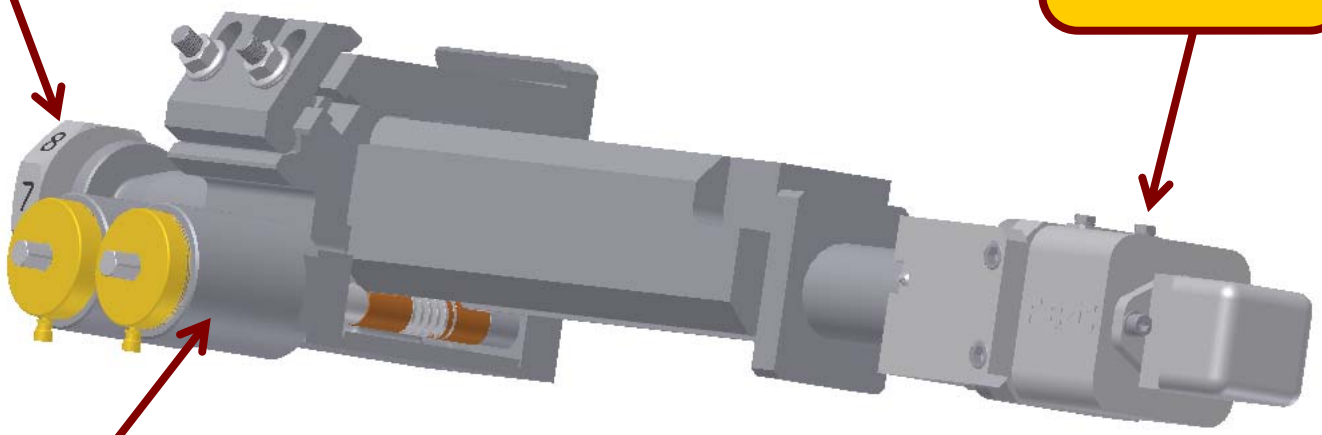
- Single acting cylinders used to unclamp the saddle

- Self-contained hydraulic unit
- High pressure (2900 psi)

Final Design

Indicator wheel (both ends)

Compact housing for gearing

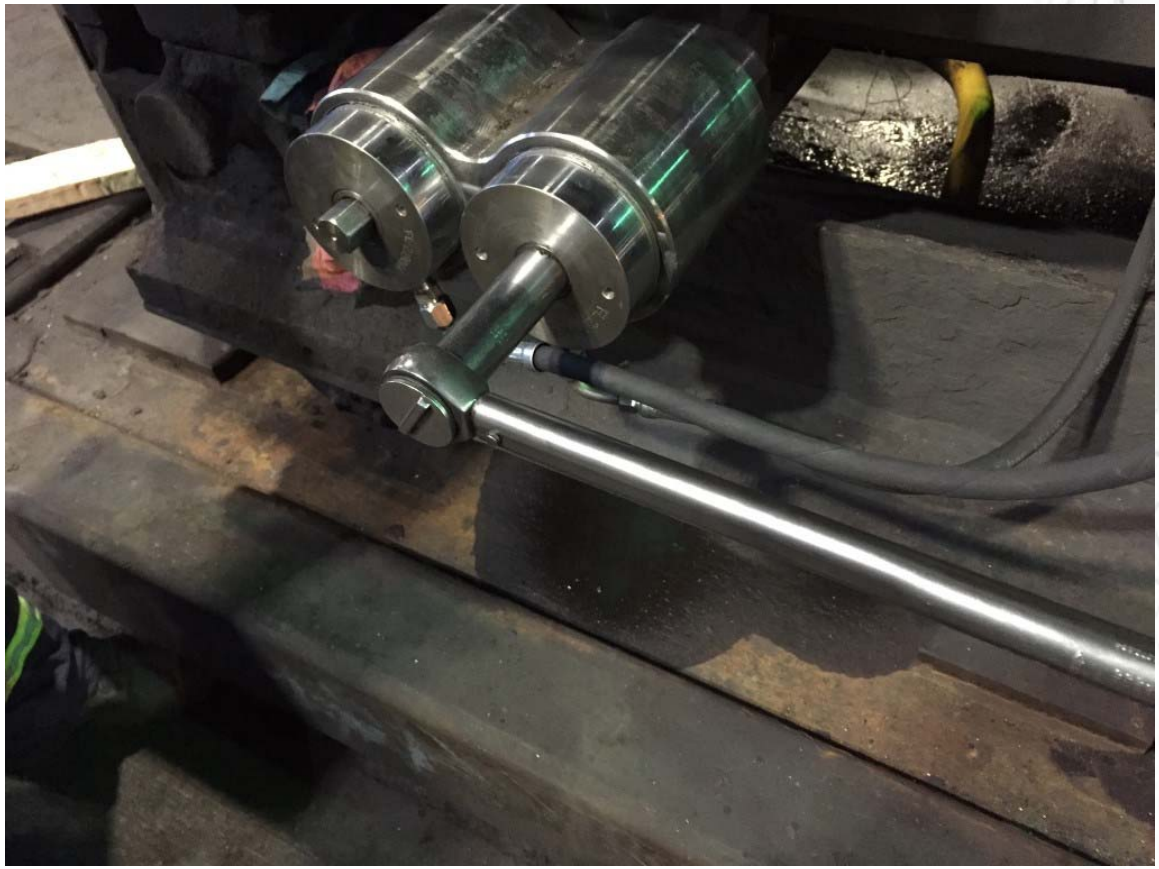


New clamp assembly with custom designed cylinders – will work at lower pressures

Clamping – Cylinder Design

- A custom-designed cylinder was required to fit in the required geometry.
- The cylinder was designed to provide adequate force to overcome the clamping force with a hydraulic supply pressure as low as 1000 psi

Presetting the Clamping Force



- When fitting the rest bar the clamping assembly needs to be preloaded to the appropriate clamping force.
- 40 ft.lb provides adequate clamping and can still be overcome by 1000 psi hydraulics
- Note: In the event of a hydraulic failure the clamping can be manually operated.

Clamping Forces and Pressures

Spring deflection (in)	Spring load(lbF)	Screw Torque (ft. Pounds)	Pressure (psi)
0	0	0	0
0.1	1400	13.77952756	214.4403444
0.2	2757	27.13582677	422.2943067
0.3	4080	40.15748031	624.9404322
0.4	5376	52.91338583	823.4509224
0.5	6654	65.49212598	1019.204322

Preload to 40 Ft. Pounds

1000psi will deflect springs from 0.3” to 0.5” – creating 0.1” (2.5mm) clearance under each wedge

Testing at Fabris Inc.

The system was tested in-house before shipping to Nucor

Hydraulic Motor

TB 0045

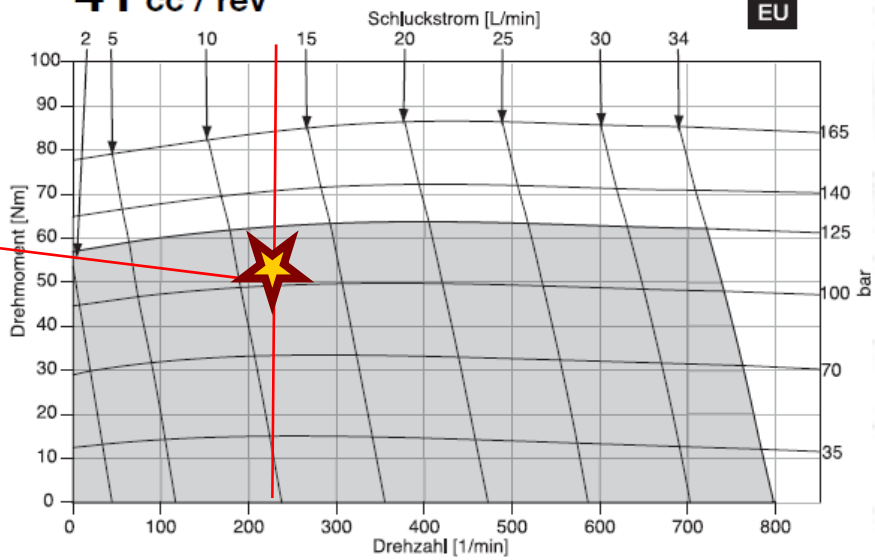
2.5 cu in / rev PRESSURE (PSID)

Flow (GPM)	500	1000	1500	1800	2000	2400
.5	116 **31**	263 **17**				
1	124 **76**	276 **61**	427 **43**	518 **36**	579 **29**	706 **18**
2	134 **167**	294 **149**	453 **131**	547 **121**	609 **113**	723 **97**
3	132 **256**	293 **239**	455 **220**	553 **210**	617 **200**	746 **183**
4	132 **344**	296 **326**	465 **307**	567 **295**	635 **285**	769 **268**
5	128 **433**	294 **414**	465 **393**	569 **380**	639 **370**	779 **352**
7	117 **609**	284 **589**	458 **566**	564 **551**	635 **540**	779 **520**
9	107 **785**	275 **764**	449 **739**	555 **722**	627 **710**	770 **689**

TORQUE (LB IN) 555
SPEED (RPM) 722

220 rpm
3 gal/min (12 L/min)
1500 psi (103 Bar)
37 ft.lb (50Nm)
148 ft.lb on Leadscrew

41 cc / rev

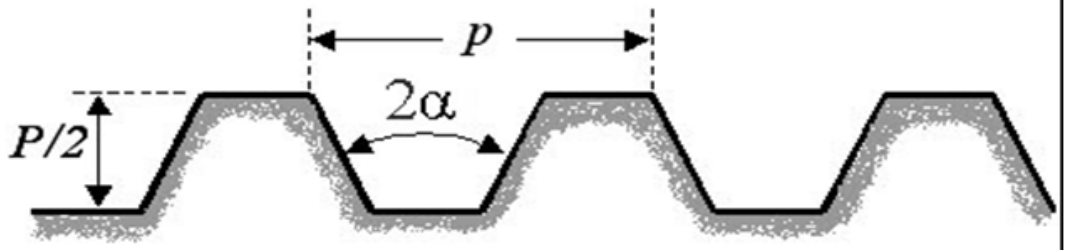


☐ Cont. ☐ Int.

Traversing Loads & Pressures

Acme Lead Screw Calculator (Unified/ANSI) v1.0

ASME/ANSI B1.5-1988 Acme Lead Screw Thread

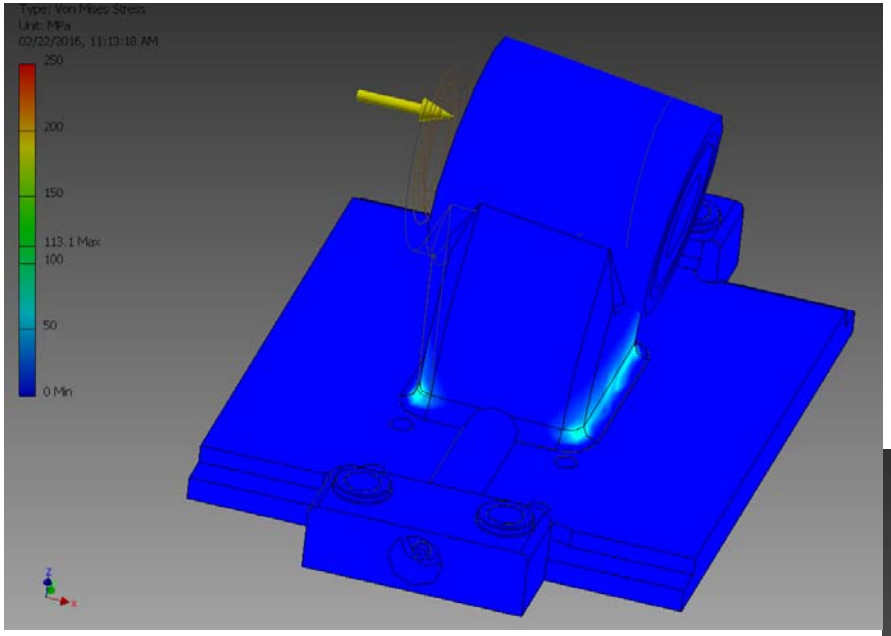


Major Diameter of Lead Screw, dmajor (Inches)	1 1/2
Threads per Inch	4
Load, F (Lb)	15933
Coefficient of Friction, μ	0.1
Thread Angle, 2α	29
Number of Thread Starts	1
Mean Diameter of Lead Screw, dmean	1.375
Lead, l	0.250
Lead angle	3.31
Torque To Raise The Load (Lb-In)	**1776.00**
Torque To Lower The Load (Lb-In)	**494.52**

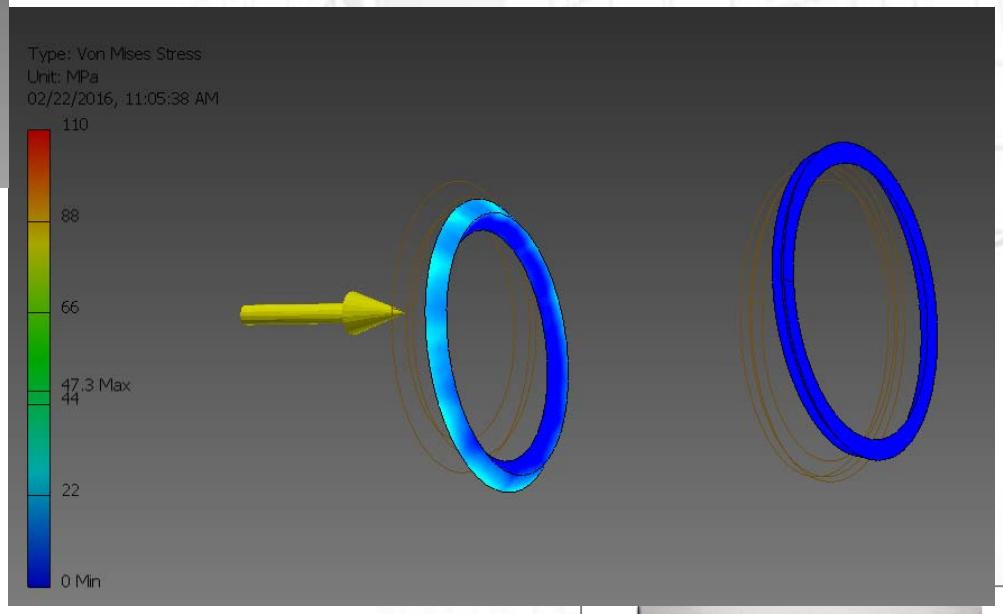
Maximum traversing force at 1500 psi

Torque produced at 1500 psi (148ft.lb)

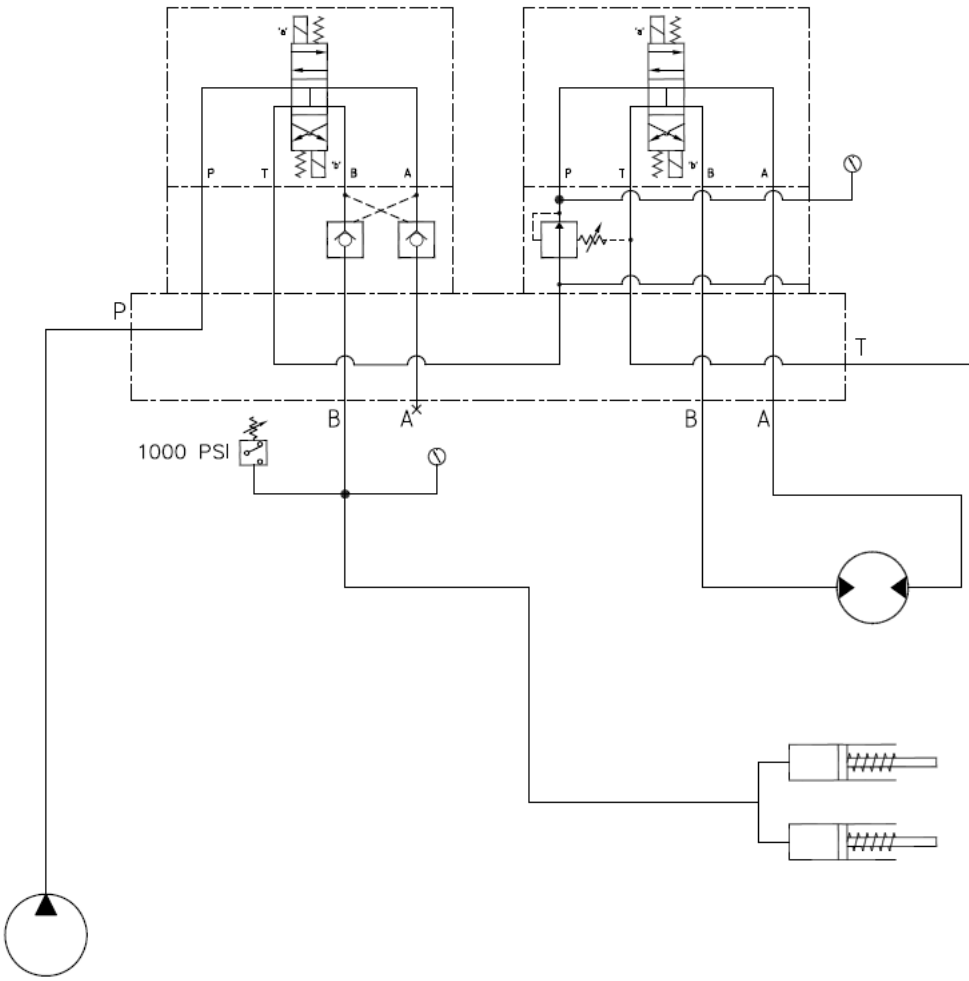
Stresses on Nut @ 1500 psi Hydraulic Pressure



System will safely stall if saddle is traversed against a dead stop



Final Design – Hydraulic Supply



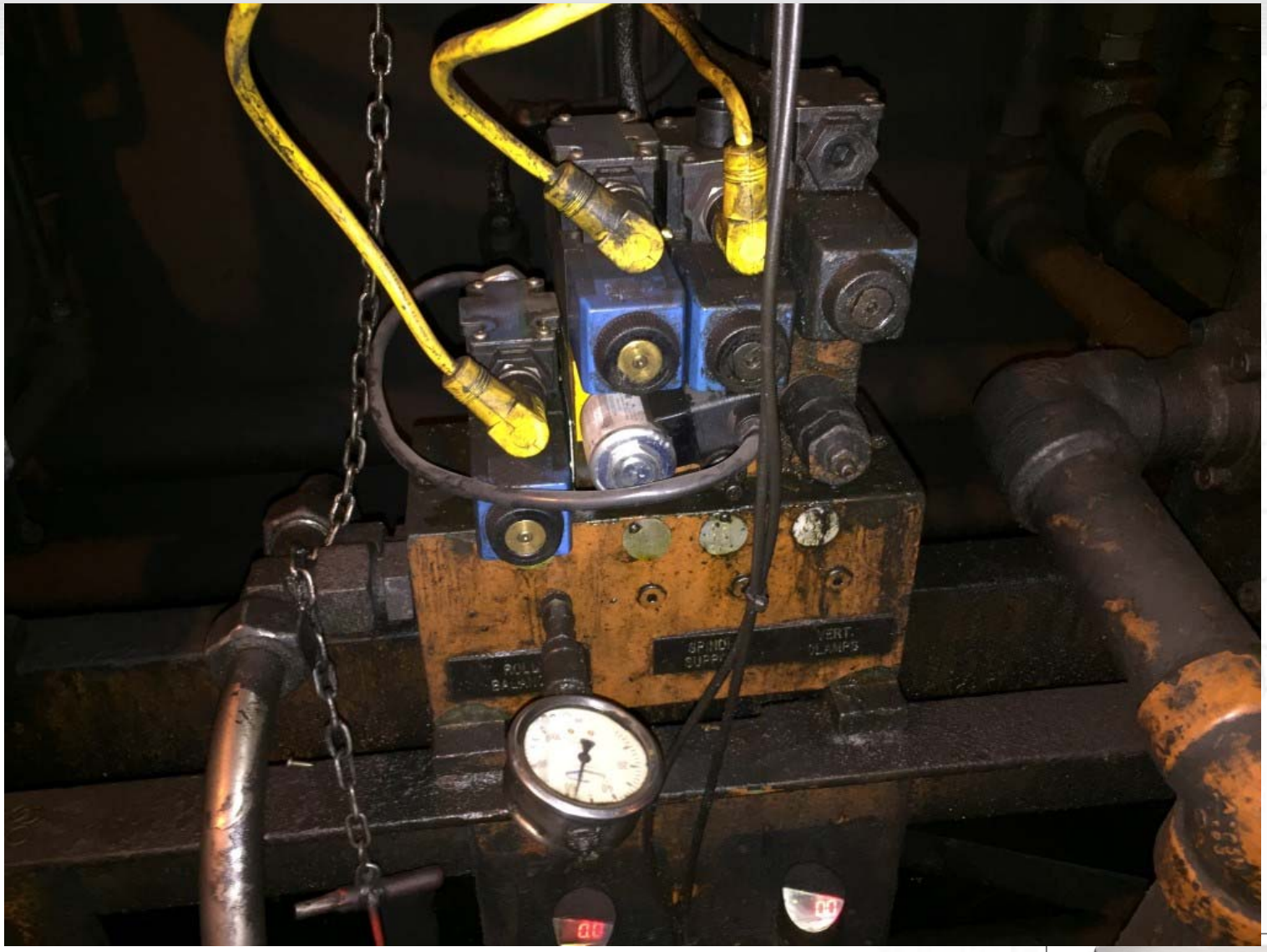
The hydraulic supply, valves and controls were all supplied by Nucor Seattle

The supply pressure is 1500 psi. This is well above the minimum requirement of 1000 psi.

The pressure relief can be set to protect the mechanical components from overload in the event of exceeding travel.

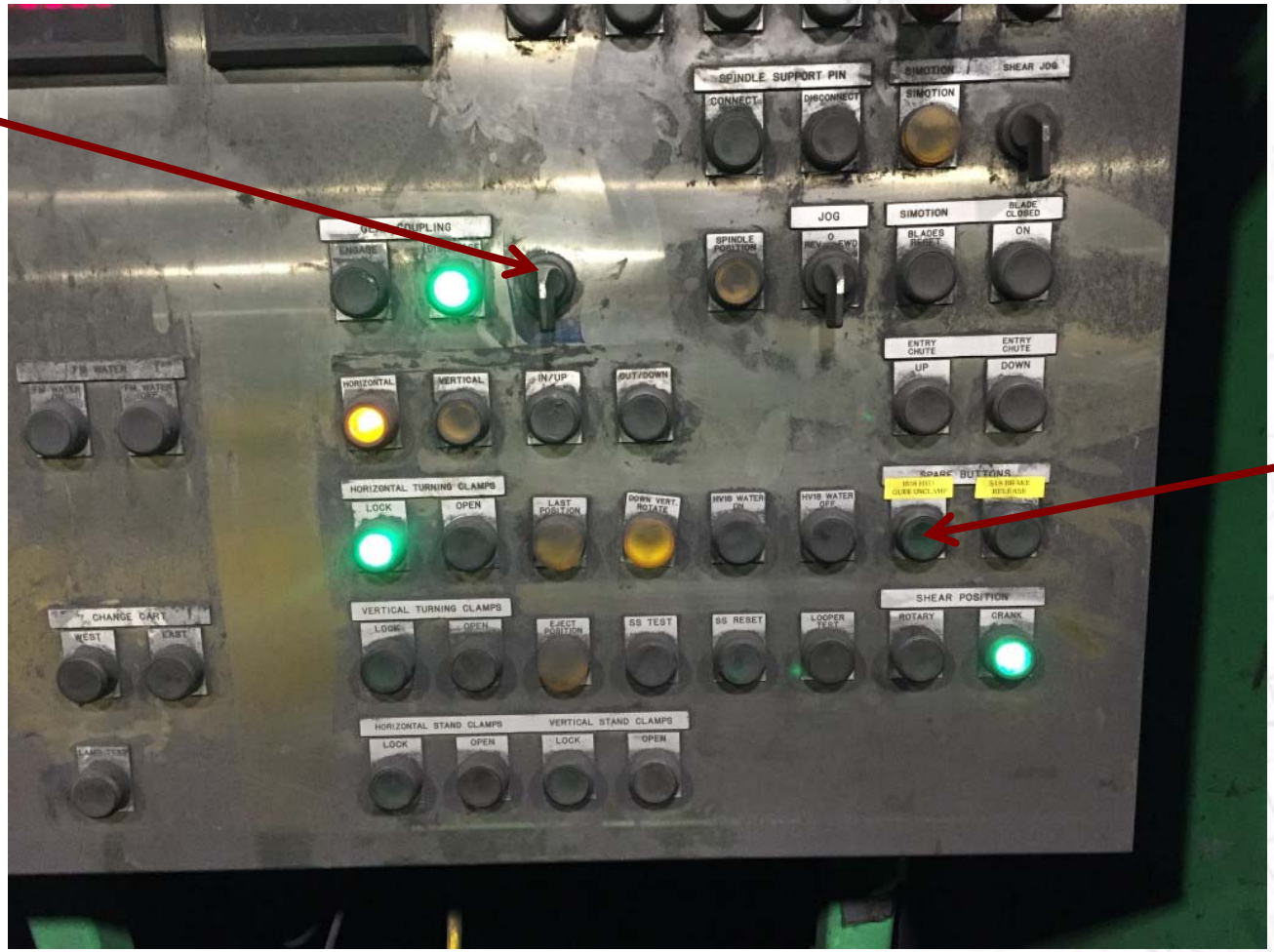
Nucor have added flow controls to fine-tune traverse speed

Final Design - Valves



Final Design – Controls

Traverse up/down



Unclamp

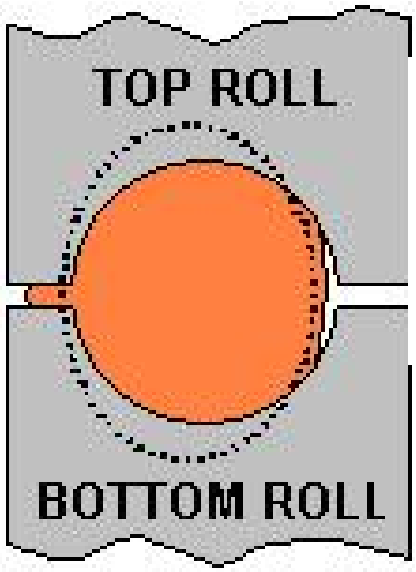
Traverse Speed

- The traverse speed can be adjusted using flow control valves.
- Separate clamping and traverse controls enable jogging
- 240 rpm at the motor equates to 60 rpm on the lead screw (4:1 gearing)
- Linear speed = 15 inches/min
- Fast/Slow circuits can be added to provide pass change/guide adjust option.

Pass Change

Applications: Guide alignment

•Utilize bar gauge output to correct entry guide alignment



Applications: Automatic Pass Changes

- Developing position feedback.
- Saddle will traverse by distance entered into controller or to pass number.
- Potential for time significant time saving during product changes or pass changes for roll wear.
- Guide automatically traversed to position. Fine adjustment can still be performed visually.
- Current status : In house testing

The Road to Success

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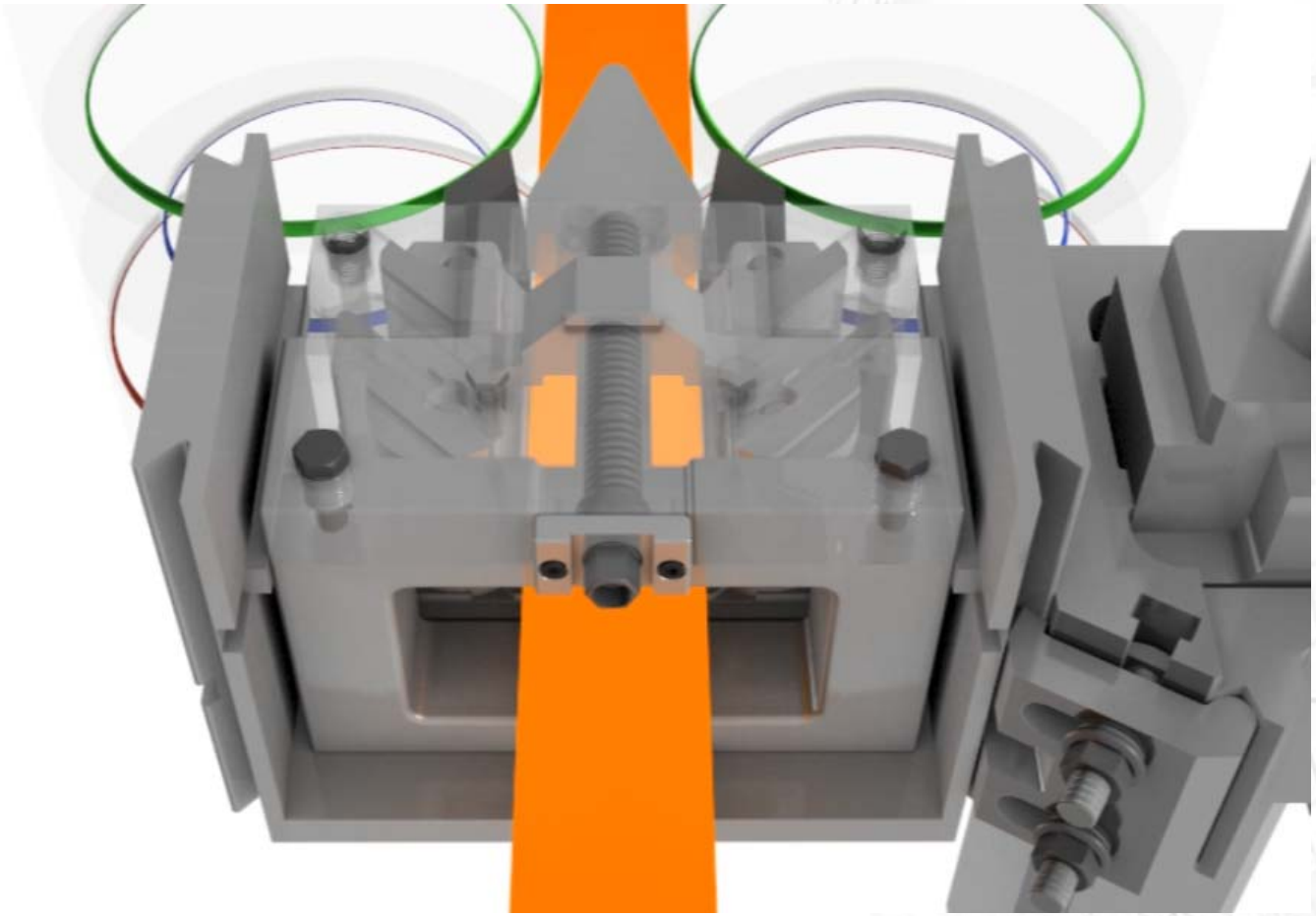
Flat Edger Delivery Guide



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Flat Edger Delivery Guides – Original guides

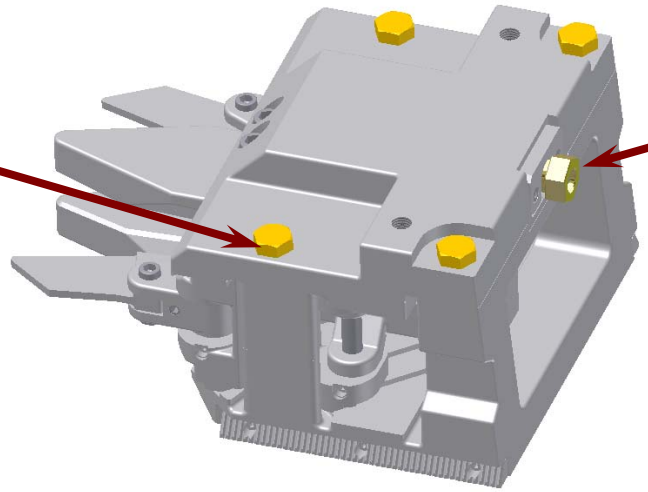
- Flats ranging from 1 ½”- 6” wide and 0.25” – 1.125” thick.
- Static delivery guides on edger passes.
- A lot of rebuilds required for product width changes.
- Nucor Seattle identified the need for a guide that can be adjusted for different widths on the mill stand.

New Guide : FRE-4F-6

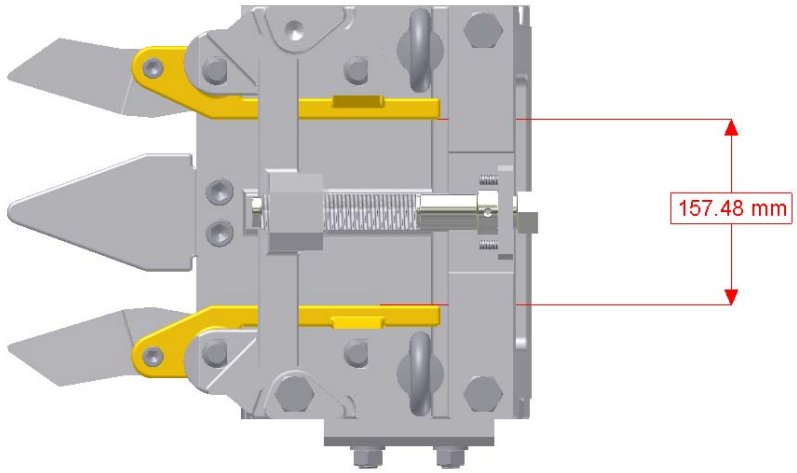
- Single point adjustment
- Mechanism based on established 4 roller entry guide design
- Wear plates control edges of flat
- Scraper blades in spring contact with the bottom of the edger pass – 7mm (0.275”) thick
- Adjustment range : 1.4” – 6.2”
- Gap between upper and lower inserts = 18mm (0.7”) but can be adjusted

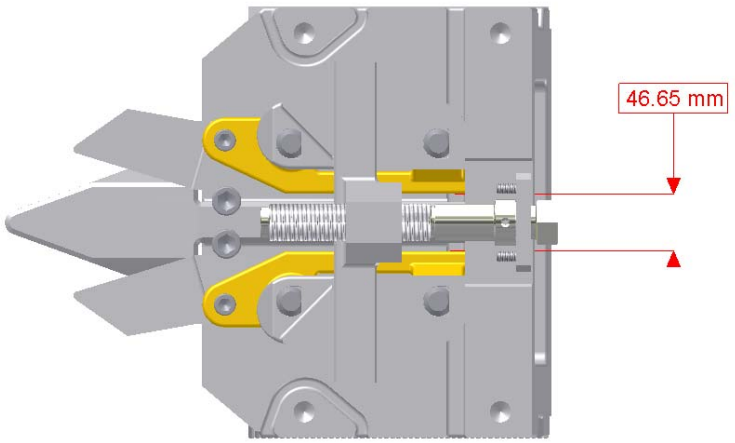
Adjustment

To adjust, the 4 Top housing bolts are loosened



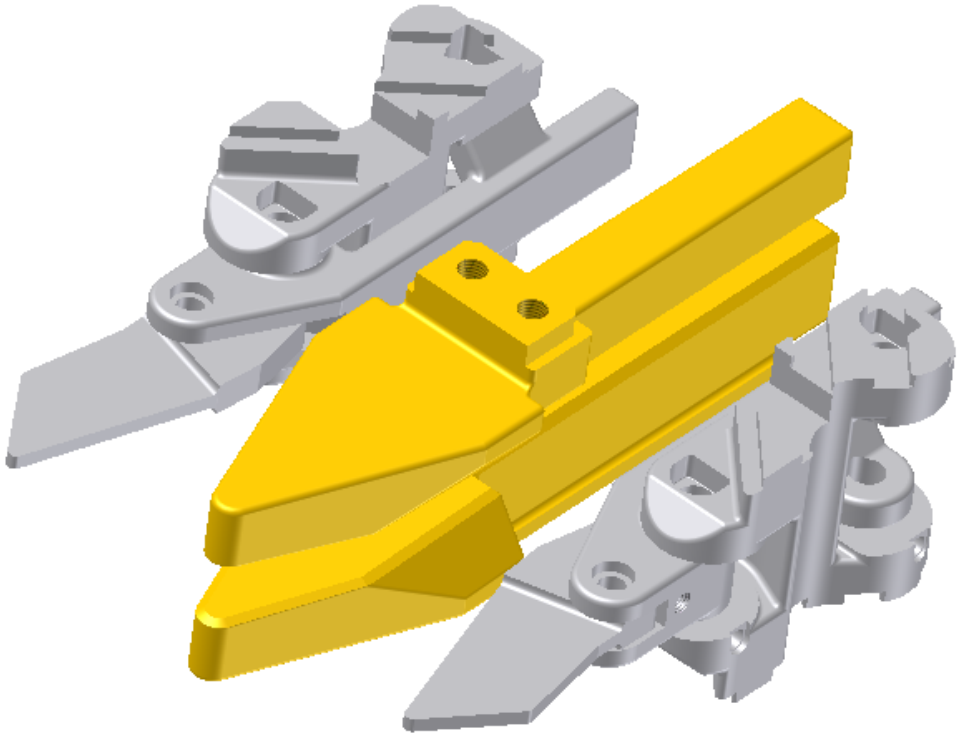
Rear adjuster screw is used to adjust the side guide parting





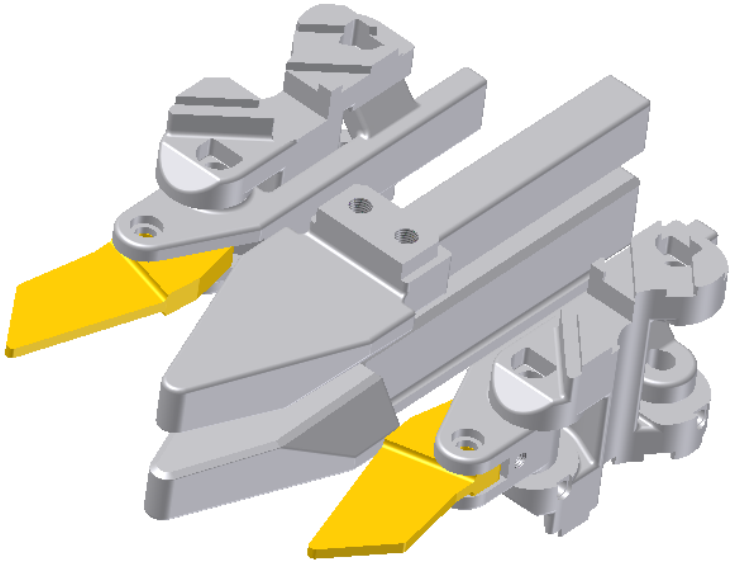
Wear Plates

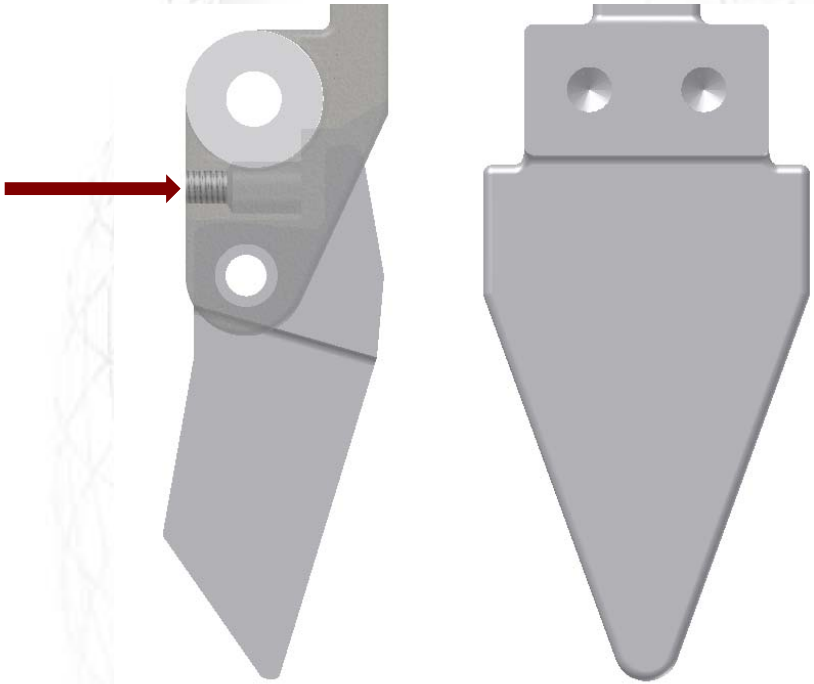
- Upper and lower wear plates of different thicknesses are used for different flat thicknesses
- Wear plates are easily interchangeable



Scraper Blades

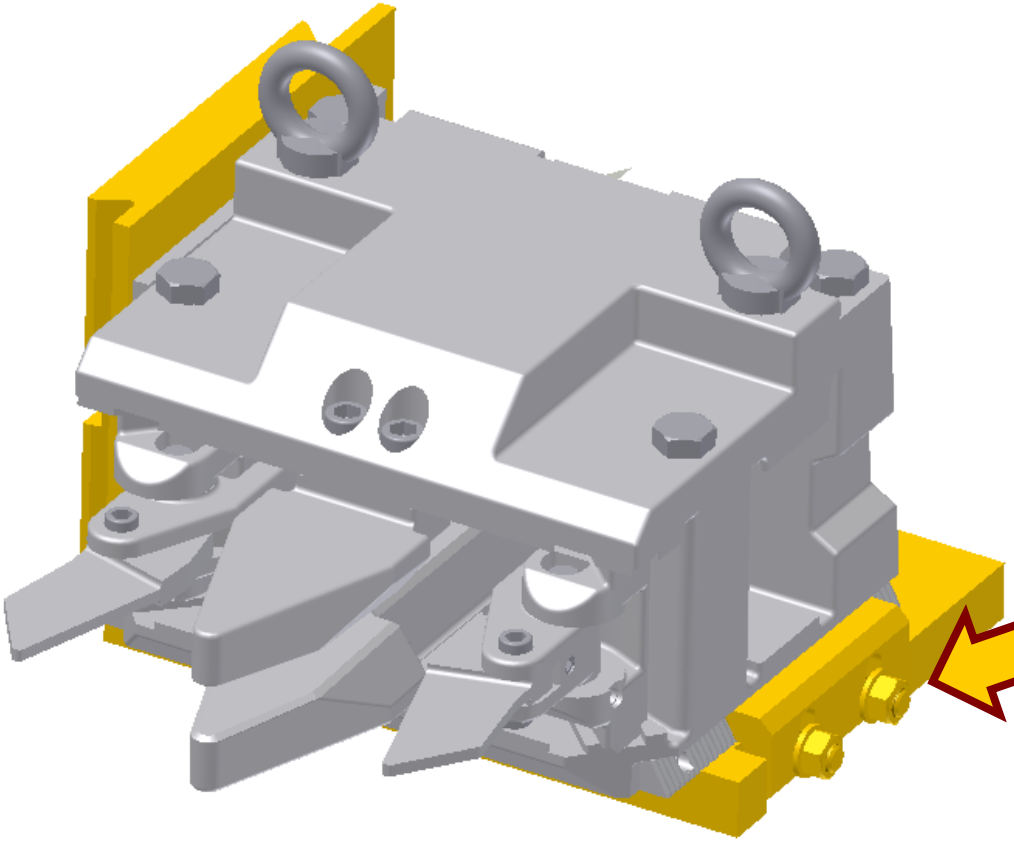
- Investment cast scraper blades engage in the edger pass.
- Scraper thickness selected to fit minimum edger pass width
- Scraper is kept in contact with the mill rolls by spring force

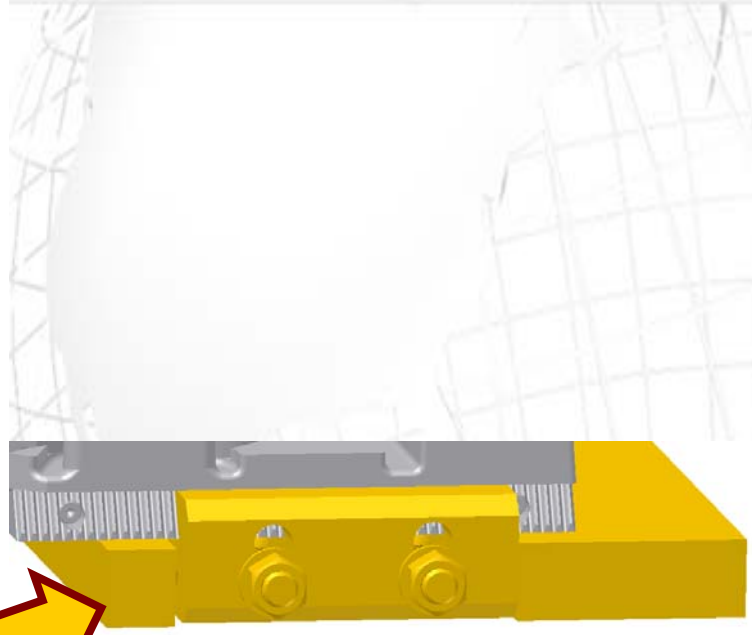




- Set screw can be used to set the spring pre-load

Saddle





- L-Style Saddle allows for easy access to guide adjustment on the vertical stand

- Serrated side dovetail allows the guide position to be adjusted close to the mill rolls

Animation of FSD-4F-6

The Road to Success