

Dramatically Increasing Tension Leveler Capacity on an Existing Push Pull Pickle Line Without Increasing Line Length

Ian Bowman & Dan Cullen

Chief Mechanical Engineer & Manager of Sales and Service Growth

SES

Pete Tortorici & Byron McNair

Finishing Mill Operations Supervisor & Finish Mill Mechanical Supervisor

SDI



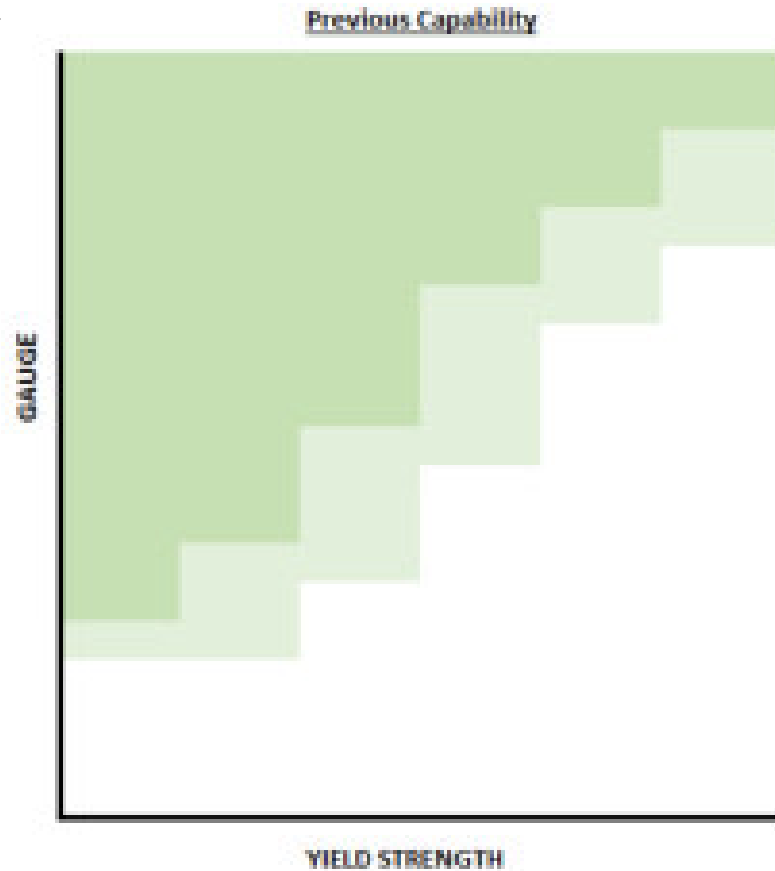
Core Project Goals – Wish List

- ◆ Upgrade began January 2018
- ◆ Goal: Increase Tension Leveling capability on a push pull pickle line without increasing line length or moving existing entry and pickling equipment
- ◆ Goal: Increase Tension Leveling capability on current product mix and future higher strength steel
- ◆ Goal: Product P&O product that can be laser blanked.
- ◆ Goal: Increase yield by decreasing unlevelled footage.
- ◆ Goal: Reduce thread time
- ◆ Goal: Reduce downtime. Existing Tension Leveler was consistently the #1 delay area annually on the PPPL
- ◆ Goal: Have Equipment designed, built and installed within 12 months.
- ◆ Upgrade Details:
 - ◆ Replaced existing 10 roll entry & exit plunging bridles
 - ◆ Replaced existing tension leveler
 - ◆ Installed new BTU bridles for entry and exit tension devices
 - ◆ Installed new 140 Ton Tension Capacity Leveler
 - ◆ Maintain current 500 FPM line speed

Core Project Goals – Reality

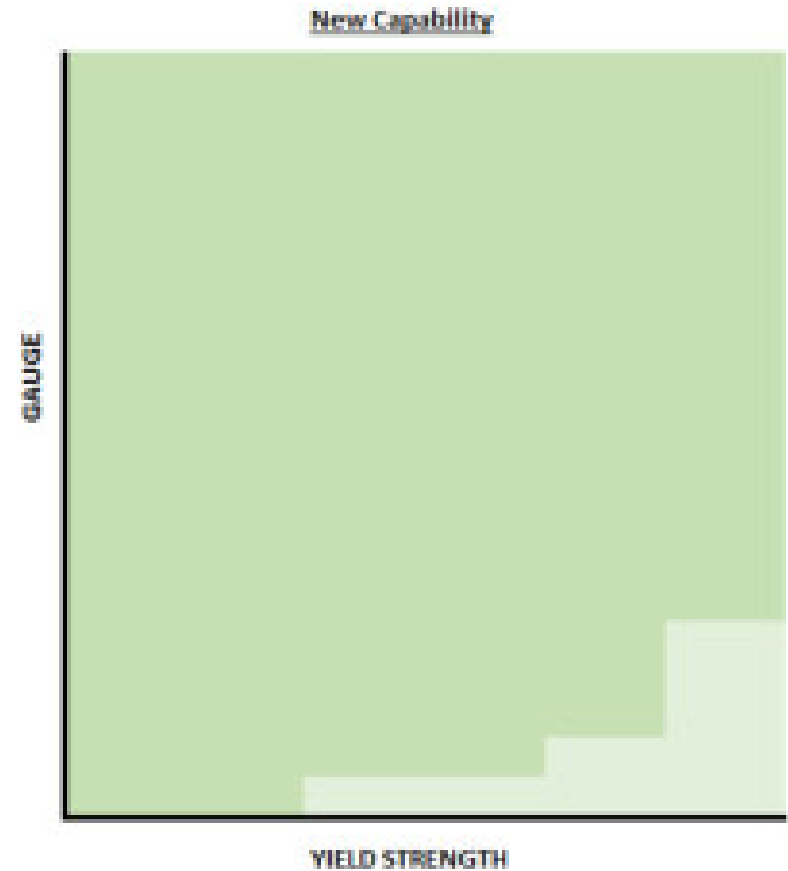
- ◆ Project began January 2018
- ◆ Upgrade Details:
 - ◆ Replaced existing 10 roll Entry & Exit Plunging Bridles
 - ◆ Replaced existing Tension Leveler
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 - ◆ Installed new 140 Ton Tension Capacity Leveler
 - ◆ 3 times more tension than previous leveler
 - ◆ Equipment Installed in January 2019

Increase elongation and scale breaking capability



Permanent Elongation

Scale Breaking Only

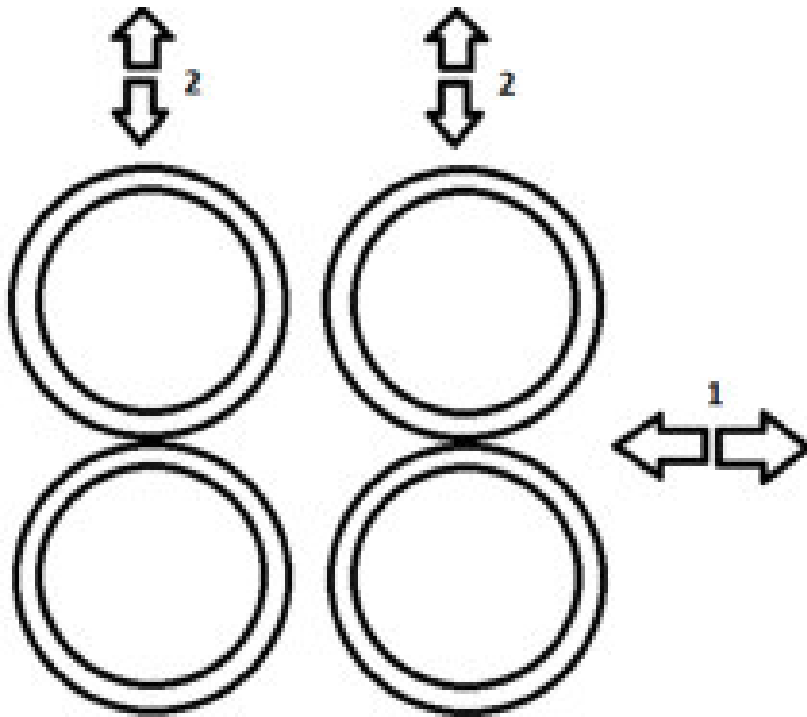


First lets break down the equipment:

First question: What method can be used to dramatically increase tension?

Traditional Methods to Create Tension on a PPPL

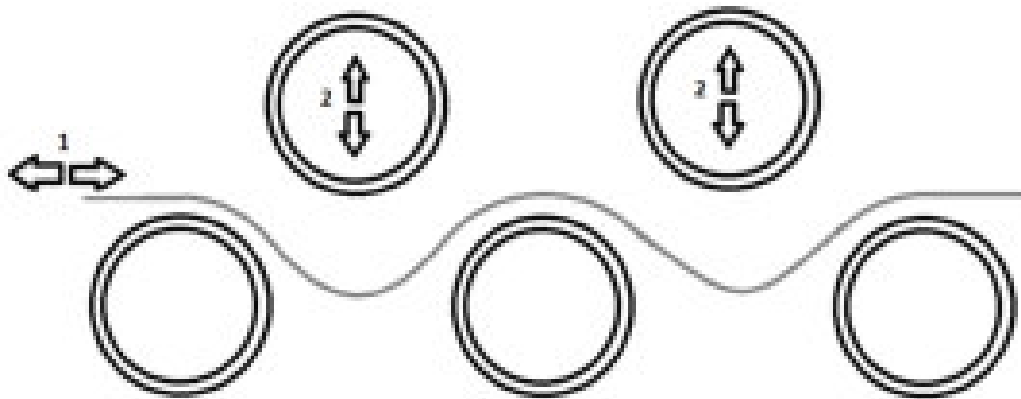
Pinch Roll Tension Device



- Pro: Easy to Thread
- Con: Small contact area (pinch point)
- Con: Material slips through pinch point. Trying to increase pinch pressure significantly decrease life of urethane roll covering
- Con: Limited ability to transfer power via pinch point

Traditional Methods to Create Tension on a PPPL

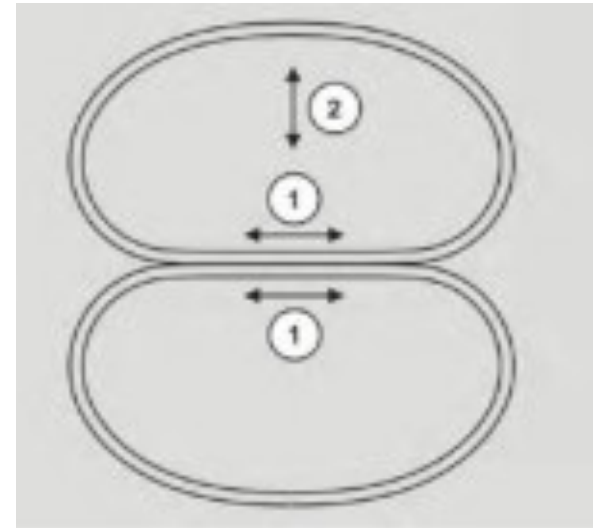
Plunging Bridle System



- Pro: High Tensions of up to 50 Ton possible by achieving wrap around the bridles.
- Con: Thick or very strong products will not allow deep plunging, rendering this bridle ineffective when needed most
- Con: Always have to account for slippage around the rolls.
- Con: Drive side of line very congested with restricted access for the operators.
- Con: Requires significant space

Modern Bridle

BTU Umlauf Bridle



Modern Bridle Description of Operation

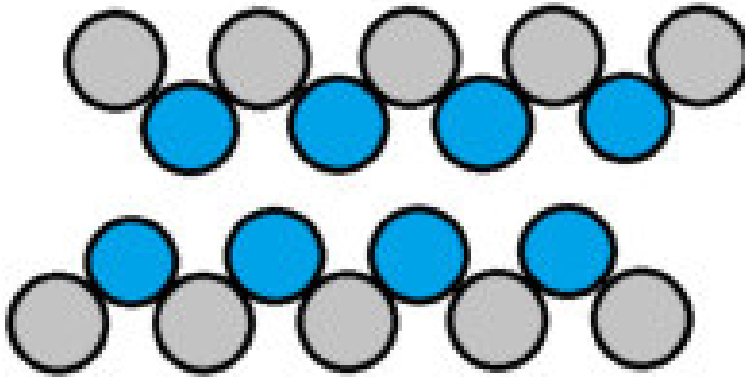
- ✦ The best description of operation is two large “caterpillar” tracks grabbing the strip. There is a top and bottom car that are identical and run around the track path
 - ✦ **Car System:** The contact pressure of the two caterpillar tracks is achieved by hydraulic cylinders, which can be controlled according to the required Strip Tension. The bridle is driven by AC motors with gearboxes and universal joint shafts.
 - ✦ **Car Segments:** Each of the car segments is a carriage design, mounted on support rollers. The elastic coating is vulcanized on steel plates.

Modern Bridle Advantages

- ✦ Tension forces are applied to the strip without any relative motion between the strip and the contact surface of the elastic coated chain segments
- ✦ Ability to apply a high tensile force to the strip, uniformly distributed over the entire strip width. Tensions of up to 140 Ton.
- ✦ Compact design able to fit in tight spaces
- ✦ Easy to thread with tapered wide opening and ability to thread without stopping
- ✦ Built for ease of maintenance

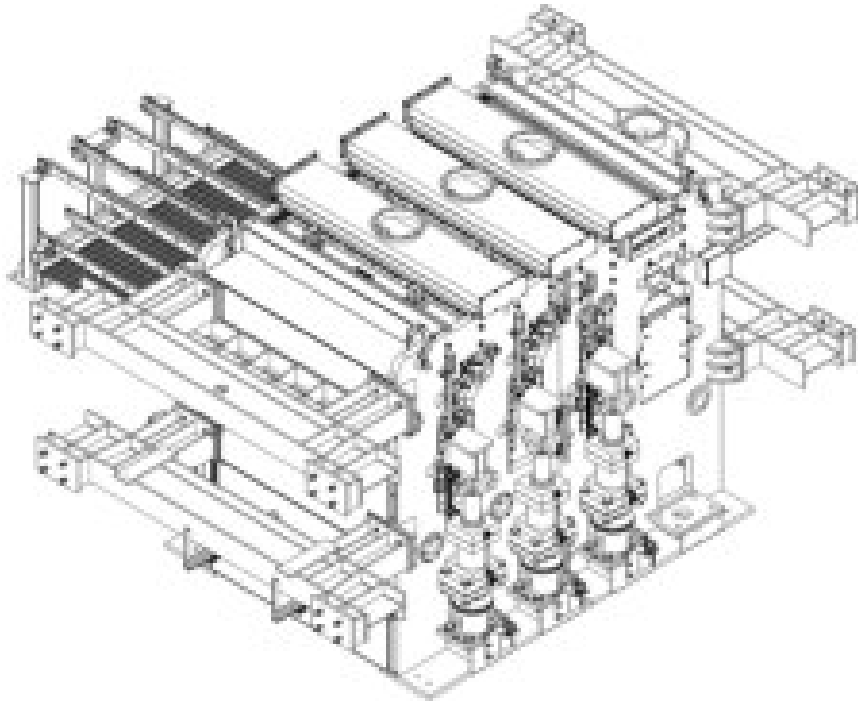
Second question: What machine to put
between the Bridles?

Typical Roller Leveler



- Reverse bending helps break scale
- Does not completely yield the entire cross section of the material
- Flatness correction of around 10 times I-Units (ie. from 300 I-Units to 30 I-Units).
- Internal scale accumulation can be a challenge on pickle lines
- Many drives shafts can sometimes lead to maintenance challenges

SES 140 Ton Tension Leveler



- Elongation of full cross section
- Relieves internal stresses
- Significant elongation up to 1.5% to break scale
- Flatness correction from incoming 300 I-Units to outgoing 10 I-Units
- Open design with small number of moving parts for easy maintenance and scale removal
- Two elongation sections and One anti-curvature section
- One elongation section is in operation while the other is offline available for maintenance and cleaning
- Room left in frame for 2nd anti-curvature if desired for future material

Tension Leveler 140 Ton



Now walk through recent upgrade example
at SDI Columbus, MS



Outage Timeline Highlights

- ◆ 17 day Outage
- ◆ New equipment: Three Bridles (two at Leveler and one at Recoiler), One Tension Leveler, One Exit Coil Car {with anti-clocking hold-down arm}, and one Outboard Bearing support
- ◆ SDI responsible for demo and installation
- ◆ Outage began January 25, 2019
 - ◆ Removed existing equipment
 - ◆ Demo concrete
 - ◆ Pour new concrete
 - ◆ Install/align new equipment
 - ◆ Pipe & wire new equipment
- ◆ Cold Commission Feb 9th
- ◆ Hot Commission began Feb 10th

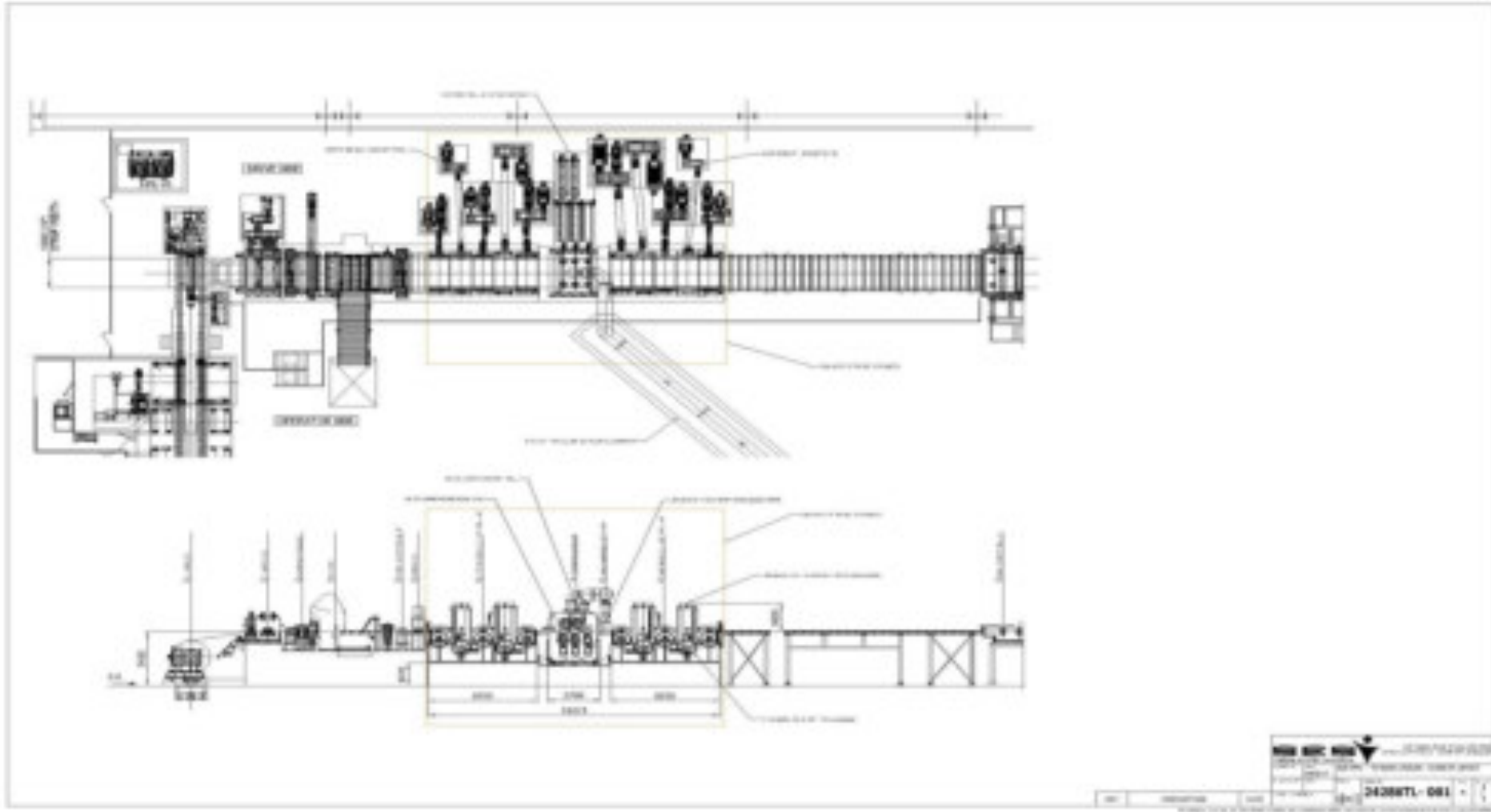
Line Parameters – New 140 Ton Leveler

Technical Data

- ✦ Material: Hot Rolled P&O, Mild Steel, High Carbon, HSLA and AHSS
- ✦ Yield Strength: 25,000 to 110,000 PSI
- ✦ Thickness:
 - ✦ Max 0.500"
 - ✦ min 0.060"
- ✦ Width:
 - ✦ max 74"
 - ✦ min 36"

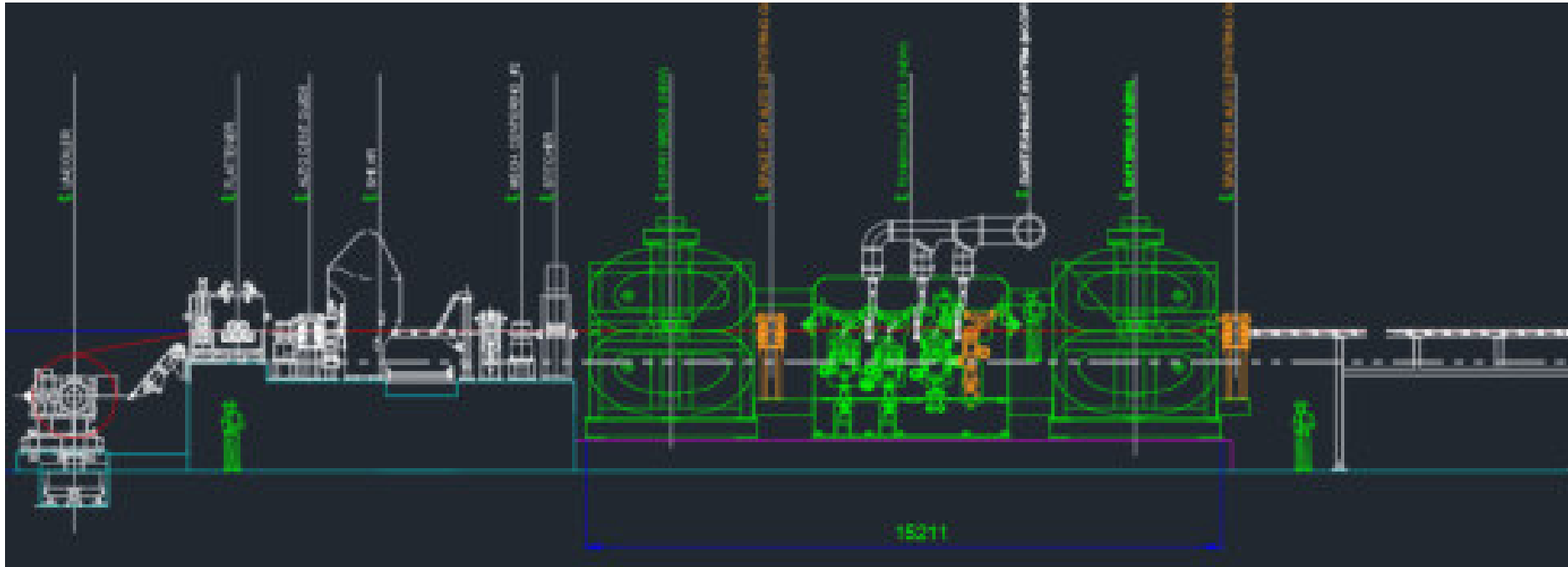
- Line Parameters
 - Process Speed 50 to 500 FPM
 - Thread Speed 150 FPM
 - Acceleration / Deceleration Rate 60 FPM/SEC
- New Line Tension – With Umlauf Tension Unit
 - Tension Limit 280,000 pounds
 - Motor Power Needed 8000 HP Total
 - (qty. 8) 1000 HP AC

Existing PPPL Leveler Arrangement



Total Leveler Length = 15221 mm (49.94 ft)

New PPPL Leveler Arrangement

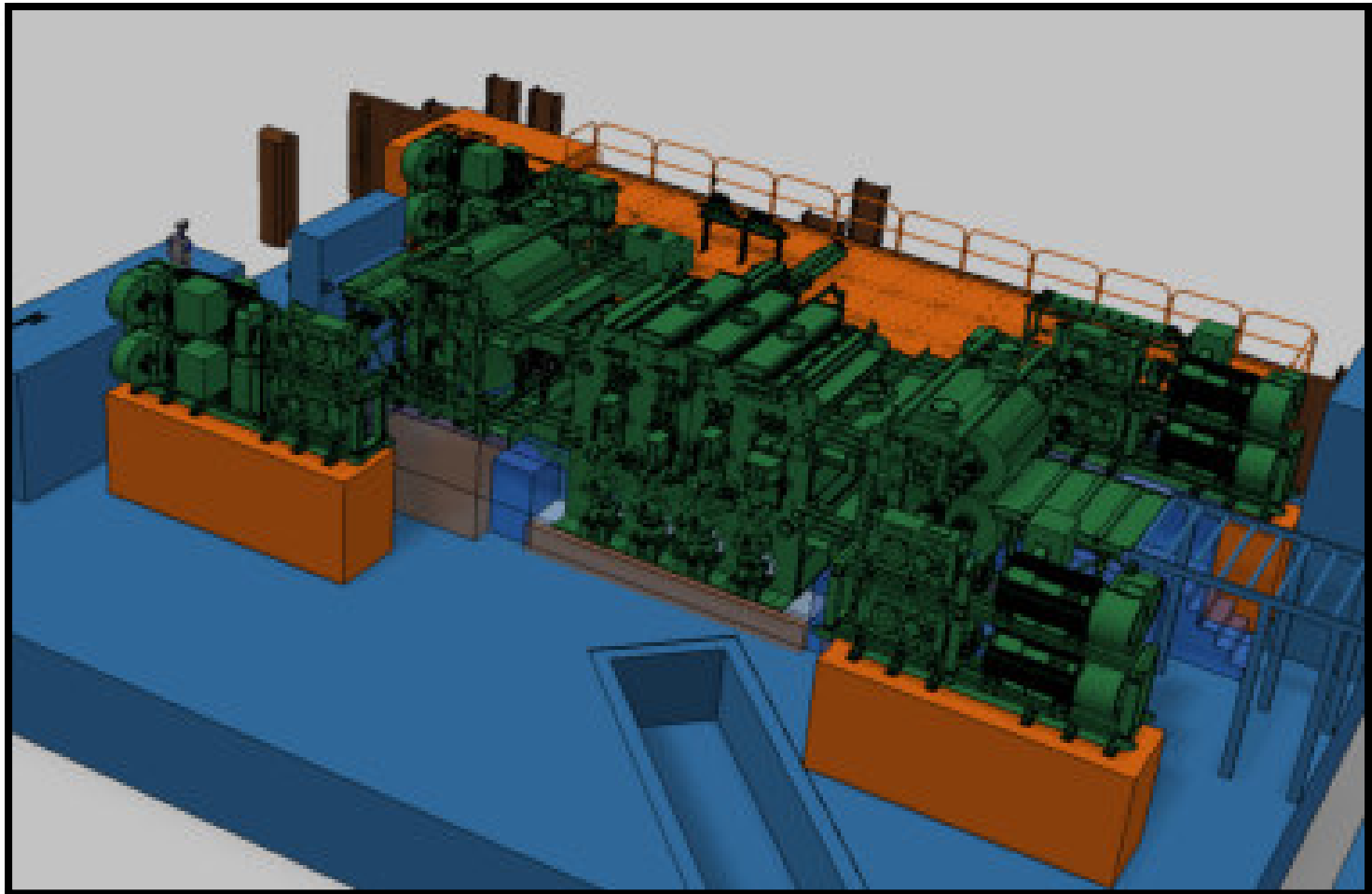


New Total Leveler Length = 15211 mm (49.9 ft)

Operator side before-Plunging bridle system



New PPPL Tension Leveler Arrangement



Drive side before. Plunging bridles cardan shafts. Very congested



New PPPL Tension Leveler Arrangement (Drive Side)

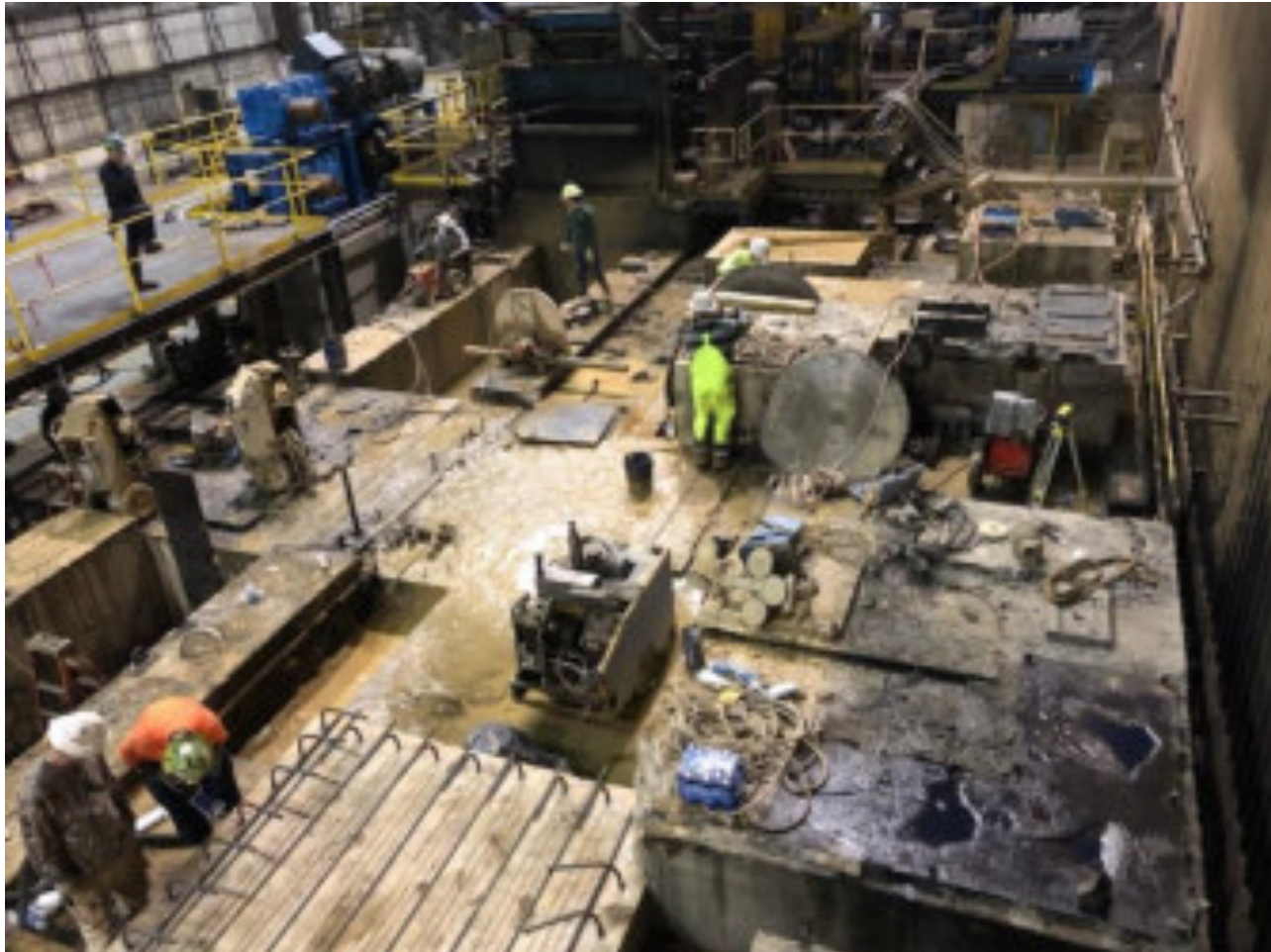


Photo Timeline



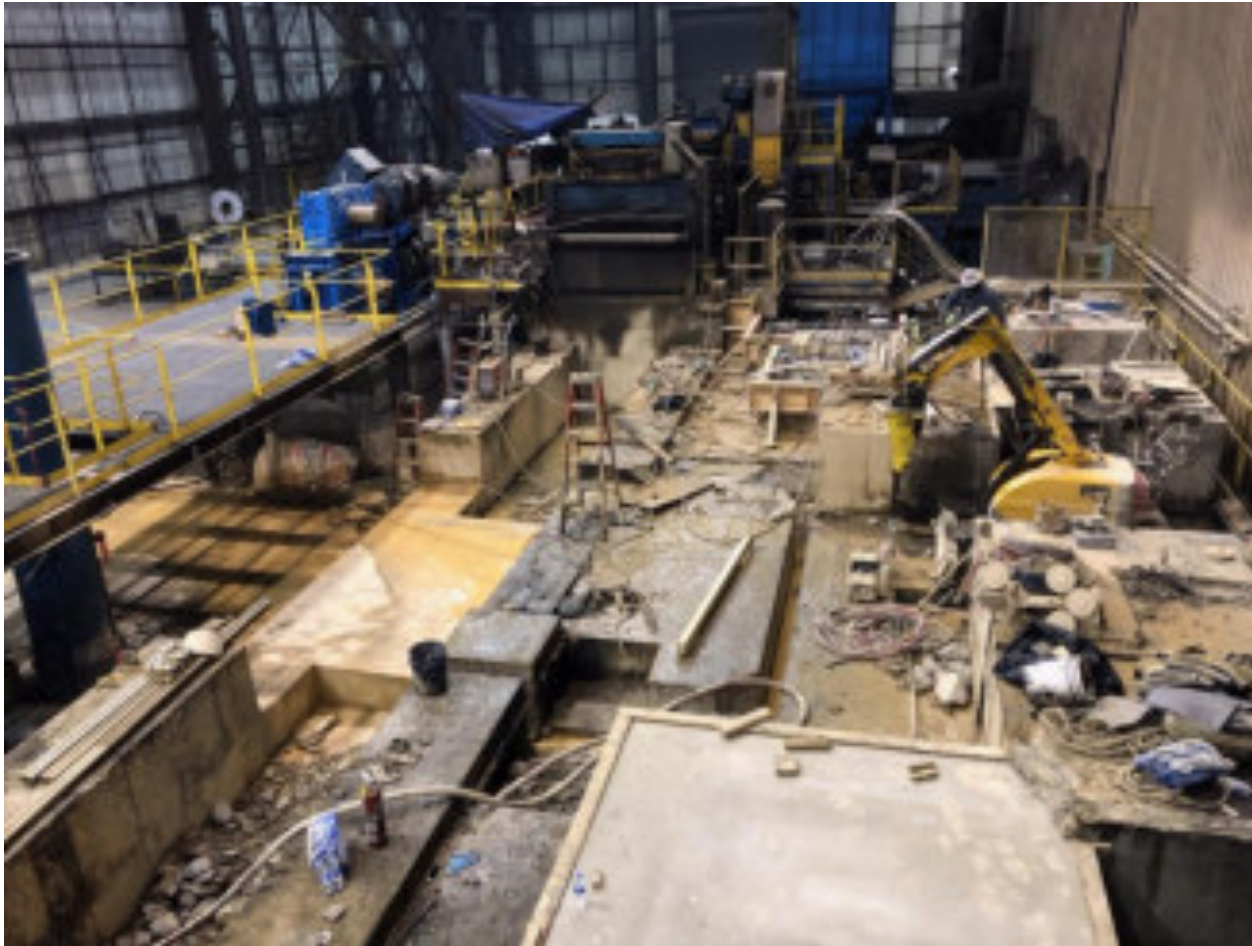
January 25, 2019

Photo Timeline



January 28, 2019

Photo Timeline



January 30, 2019

Photo Timeline



February 2, 2019

Photo Timeline



February 3, 2019

Photo Timeline



February 4, 2019

Photo Timeline



February 5, 2019

Photo Timeline



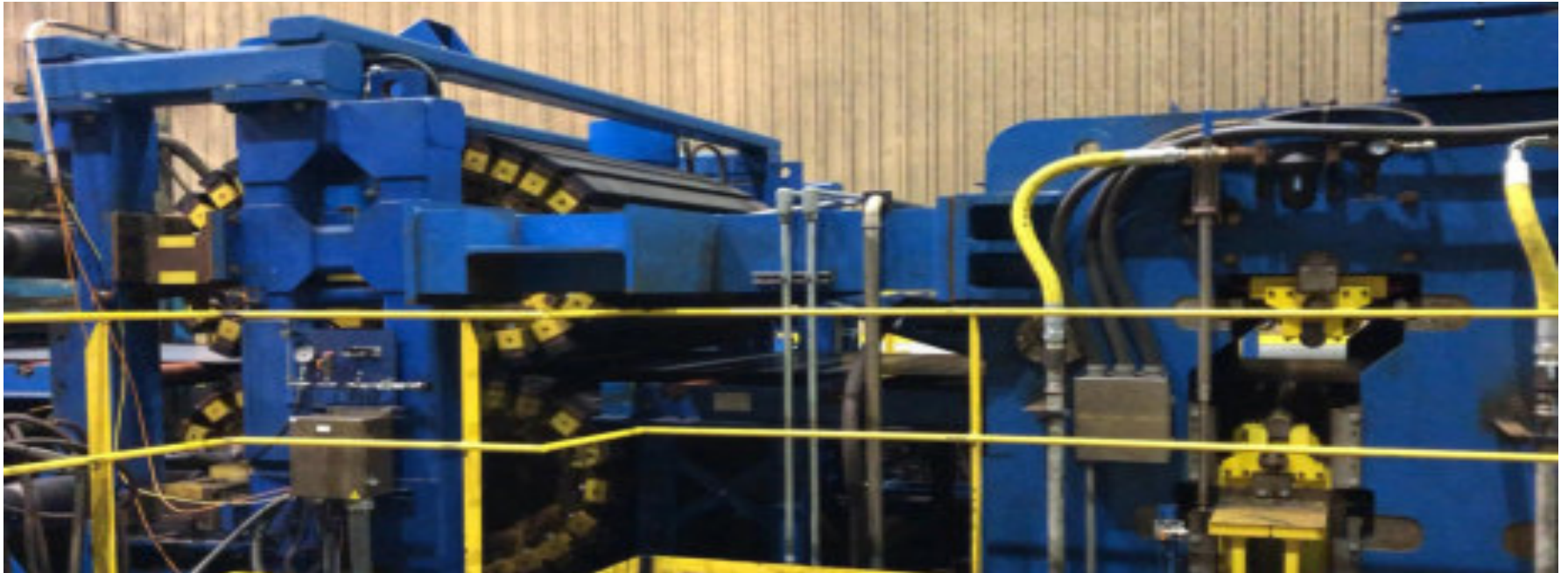
February 8, 2019

Photo Timeline



February 10, 2019

Photo Timeline –Commissioning



February 15, 2019

Photo Timeline - Threading



February 16, 2019

Photo Timeline – Leveler Engaging



February 16, 2019

Summary

- ✦ As AHSS are entering the market, the need for greater tension is needed to process and control the material
- ✦ Upgrading current process line Tension Levelers/Scale Breakers will be needed to handle the AHSS
- ✦ This solution allows for increasing the Tension and Leveler capacity without changing the length of the line
- ✦ The modern bridle provides the ability to apply high tensile force to the strip and uniformly distributed over the entire strip width.
- ✦ The modern bridle is simple to thread with greatly reduced unprocessed strip/yield loss
- ✦ Maintenance costs TBD

Special thank you

- ✦ SDI management for their vision on the future of the industry and courage to pursue a competitive advantage through innovation
- ✦ SDI employees for their infinite collaboration
- ✦ SDI customers for promoting the use of advanced materials and encouraging manufactures to advance their manufacturing capabilities
- ✦ Umlauf and SES management, engineers, and technicians for their commitment to advance the steel industry into new fields



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SES

