INTERNATIONAL WROUGHT COPPER COUNCIL

ANDRITZ Metals USA

Fundamentals for Modern Precision Slitting of Copper

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IWCC Technical Seminar
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ANDRITZ

ENGINEERED SUCCESS

INTERNATIONAL WROUGHT COPPER COUNCIL

ANDRITZ Metals USA

IWCC Legal Disclaimer

The purpose of this presentation is to guide programs benefiting the copper industry and to provide attendees with information to make independent business decisions.

Modern expectations for copper slitting:

- More predictable and repeatable results
- Tighter tolerance mult width
- Reduced quality issues due to equipment and tooling limitations
- Improved reliability & operating life of:
  - Equipment
  - Tooling

The precision limits of a slitting system (Equipment + Tooling) are highlighted by:

- Brand new equipment
- Refurbished equipment
- Tooling, manufactured tolerance
- Tooling condition
- More demanding slitting application

Very Light Gauge Slitting

Common Issues

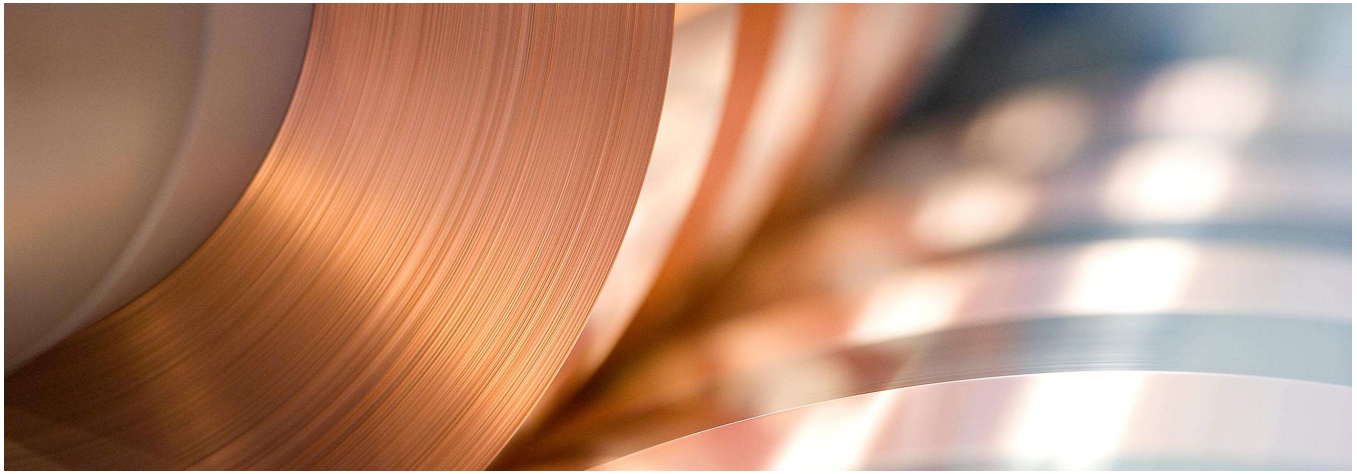
Equipment

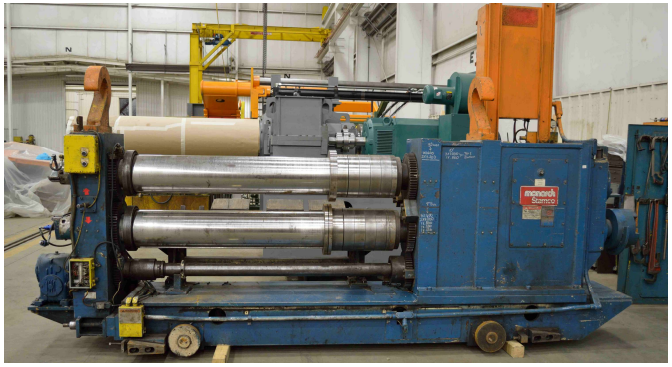
- Not designed for the application
- Worn arbors
- Worn or non-precision bearings
- Misalignment (Equipment or Process)
- Mechanical Damage
- Maintenance related issues
- Wear/Backlash in the knife gap adjustment assembly

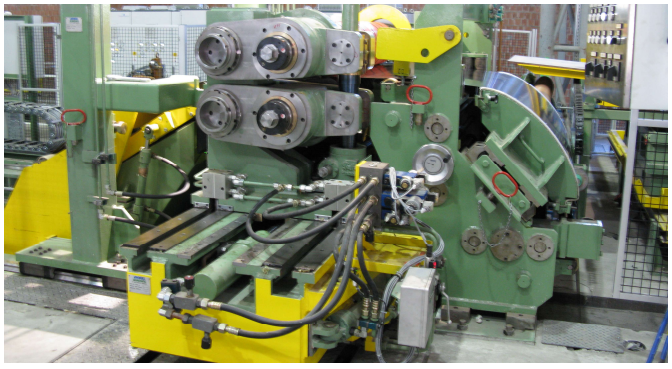
Tooling

- Dirt or build up on tooling
- Nicks, scratches, or chips
- Out of tolerance due to wear
- Dull knives
- Worn stripper rings or bonded spacers

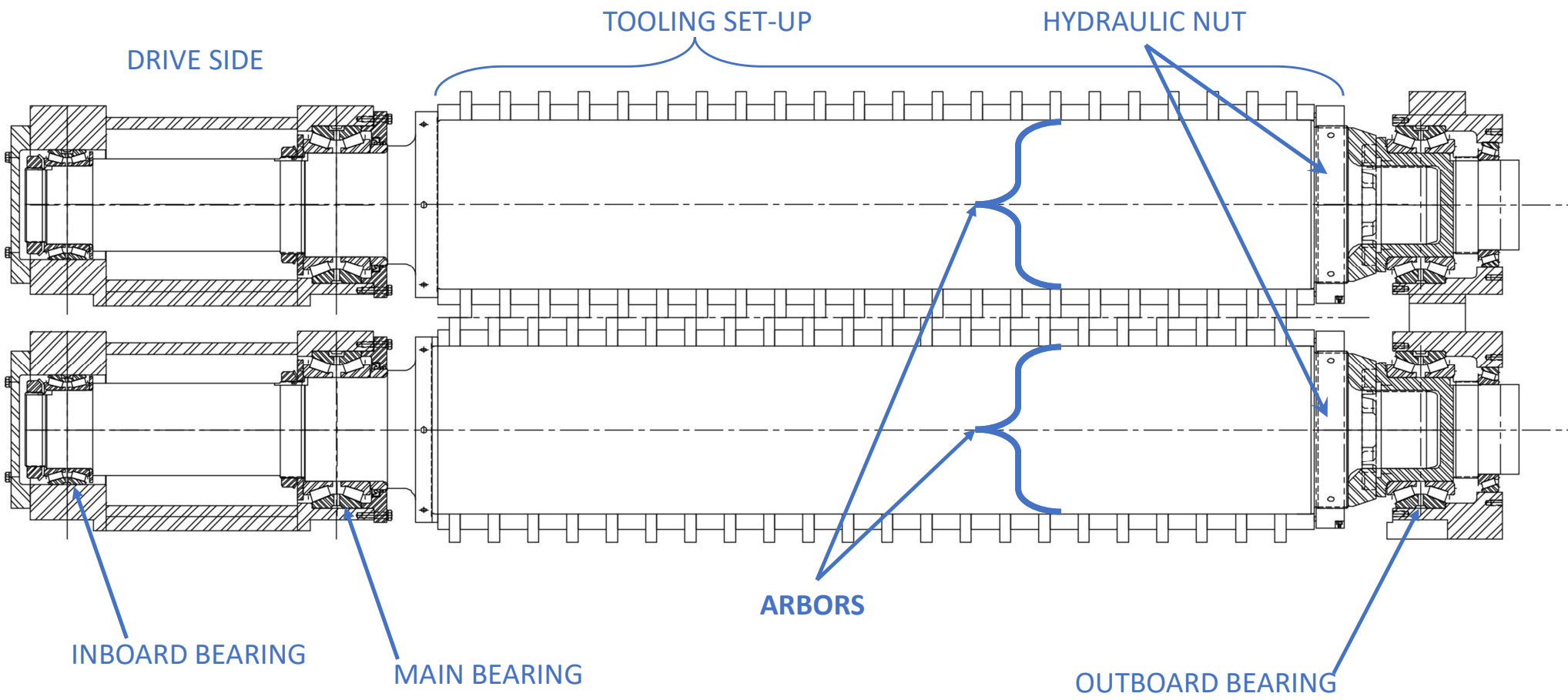
EQUIPMENT







SLITTER DESIGN



SLITTER DESIGN

CUSTOMER APPLICATION PARAMETERS

MATERIALS	GAUGES	STRENGTHS
WIDTHS	LINE SPEED/ PRODUCTION	NUMBER OF CUTS

SLITTER DESIGN

OEM DESIGN

CUSTOM ENGINEERED PARAMETERS + **PURCHASED COMPONENT PARAMETERS**

SLITTER DESIGN

OEM DESIGN
CUSTOM ENGINEERED PARAMETERS

DRIVETRAIN	ARBOR DESIGN	TOOLING
Single Input – Internal Gearing	Deflection	Surface Finish
Dual Input – External Gear Reducer	Bearing Loads	Tooling Tolerance
	Bending Stress	Locking Mechanism

SLITTER DESIGN

OEM DESIGN
PURCHASED COMPONENT CONSIDERATIONS

DRIVETRAIN	BEARINGS	Locking Mechanism
Single Input – Internal Gearing	CLASS 0 - PRECISION	AUTOMATED HYDRAULICS
Dual Input – External Gear Reducer	CLASS 2 - STANDARD	HIGH PRESSURE NUTS
	OTHER	STANDARD PRESSURE NUTS

TAPERED ROLLER BEARING – PRECISION CLASS IN RELATION TO VERTICAL KNIFE GAP

INCH	METRIC	RADIAL RUN-OUT
4	K	.002" (0.051mm)
2	N	.0015" (0.038mm)
3	C	.0003" (0.0076mm)
0	B	.00015" (0.00381mm)
00	A	.000075" (0.001905mm)
000	AA	.000040" (0.001016mm)

0.010" Thick Material = 9-11% Vertical Gap

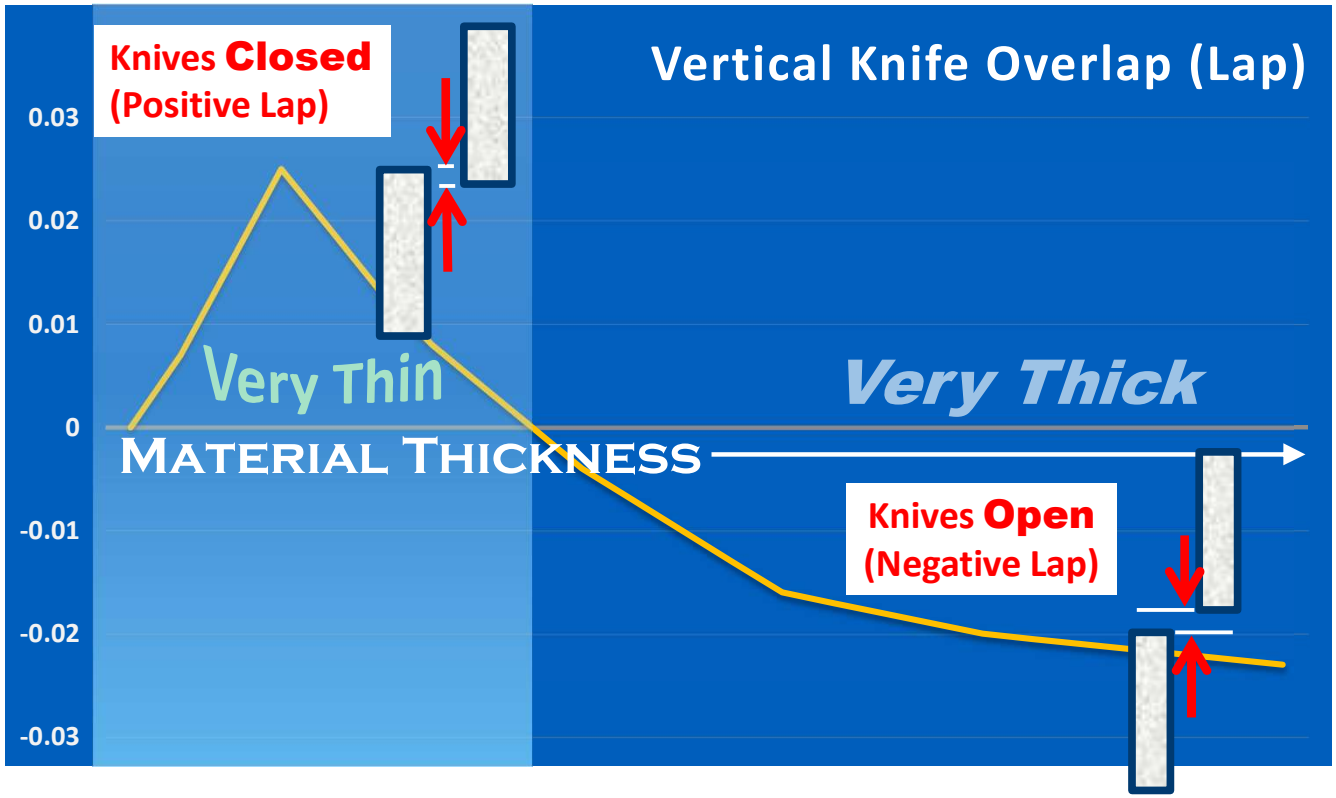
.0009"-.0011" = .**000**2" Difference (**Class 0 Precision**)

0.100" Thick Material = 9-11% Vertical Gap

.009"-.011" = .**00**2" Difference (**Class 2 Standard**)

VERTICAL KNIFE CLEARANCE

Only sink the knives enough to make the cut



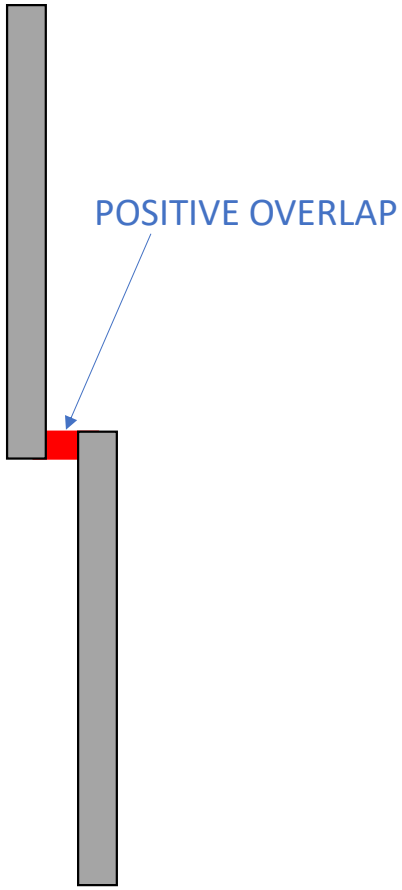
ARBOR DEFLECTION
IMPACT ON VERTICAL KNIFE CLEARENCE

Main Contributing factors to Deflection:

- Gauge (Thickness^2)
- Arbor Diameter
- Bearing Span

0.010" Thick Material = +0.005" Overlap
Deflection limited to ~10% Material Thickness = 0.001"
14 Cuts - 6.00" Arbors
36 Cuts - 8.00" Arbors

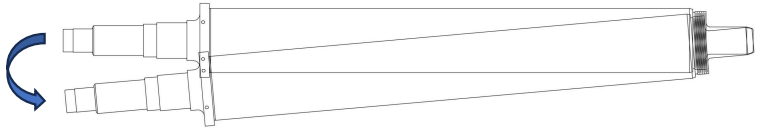
0.100" Thick Material = +0.011" Overlap
Deflection limited to ~10% Material Thickness = 0.010"
4 Cuts - 6.00" Arbors (3.5X Less)
8 Cuts - 8.00" Arbors (4.5X Less)



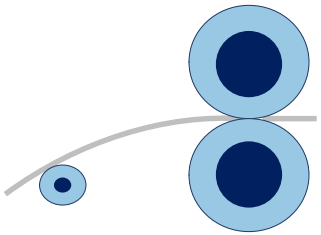
ARBOR DEFLECTION & MAINTENANCE
IMPACT ON HORIZONTAL KNIFE CLEARENCE

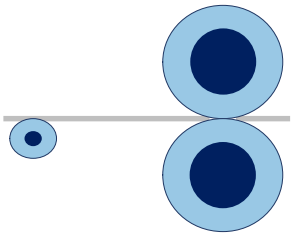
- Arbor End Play

- Arbor parallelism



- Other issues: Pass line/idler roll set up



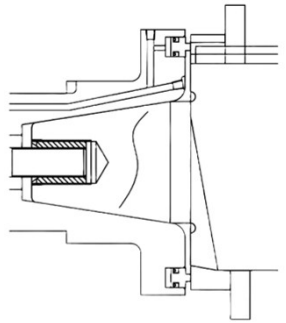


SLITTER TOOLING

Knives

Spacers + Rubber Stripper Rings
OR
Bonded Spacers

Hydraulic Lock Nuts
OR
Automated Hydraulic Lock System



Slitter Knife Considerations

- Key Dimensions
  - Outer Diameter
  - Inner Diameter
  - Keyway (if any)

- Knife Thickness vs. Material Thickness
  - 3:1 ratio for non-ferrous material & medium carbon steels

    Example:
    - *Maximum slit material thickness of 0.125”*
    - *Minimum knife thickness should be 0.375”*

- Knife Material
- Surface Finishes
- Manufacturing Tolerances

Slitter Knife Considerations

Knife Material (tool steel)

Performance characteristics:

- Wear resistance

vs.

- Toughness (not needed for copper)

Copper: Favor wear resistance

High chrome tool steel.

- ♦ High hardenability
- ♦ High polish-ability

Slitter Knife Considerations

Surface Finishes

Smooth & Highly polished to resist material build up

- Precision Plus
  - 4 Ra & semi-reflective polish

- Precision Plus Plus ← Recommended for copper
  - 2 Ra & Mirror polish

Manufacturing tolerances

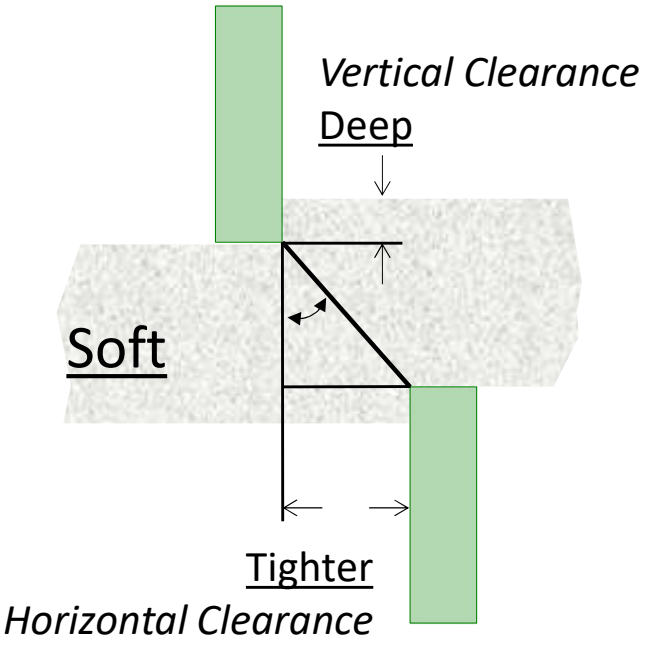
- Precision Plus
  - + / - 0.000040” millionths

- Precision Plus Plus ← Recommended for copper
  - + / - 0.000020” millionths

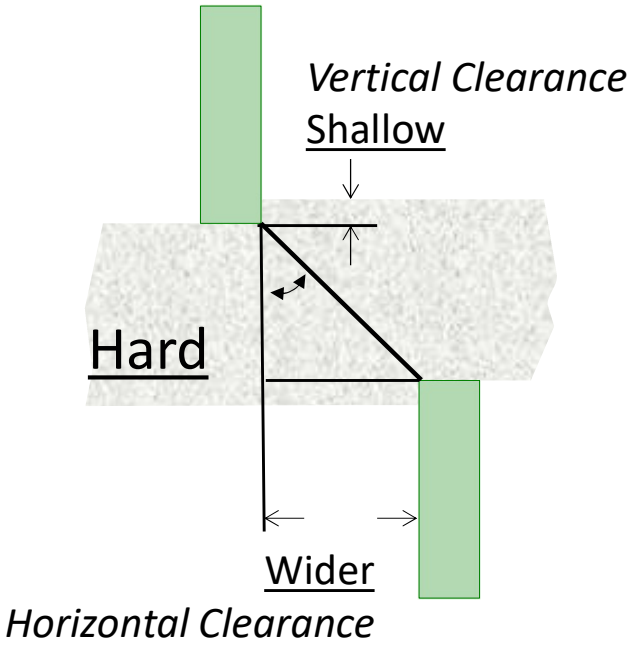
SLITTER TOOLING SET-UP

Material Properties vs. Cut Geometry

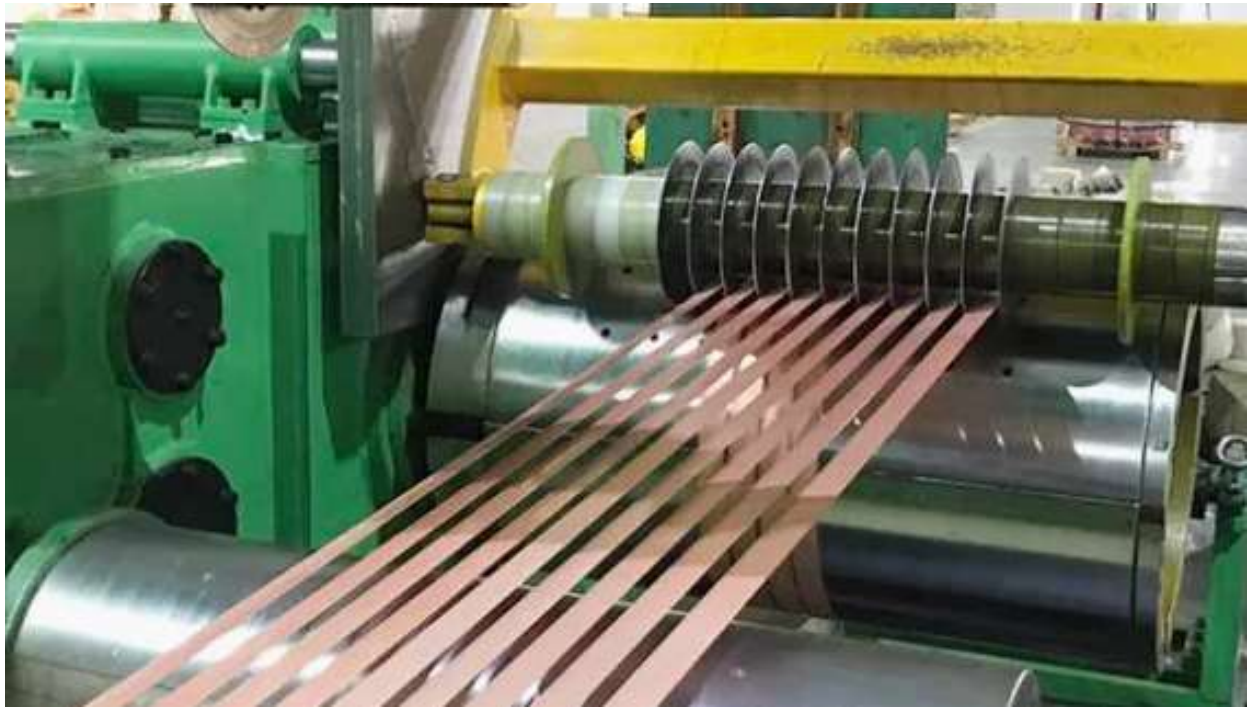
Copper



Steel



SLITTER TOOLING TOLERANCE



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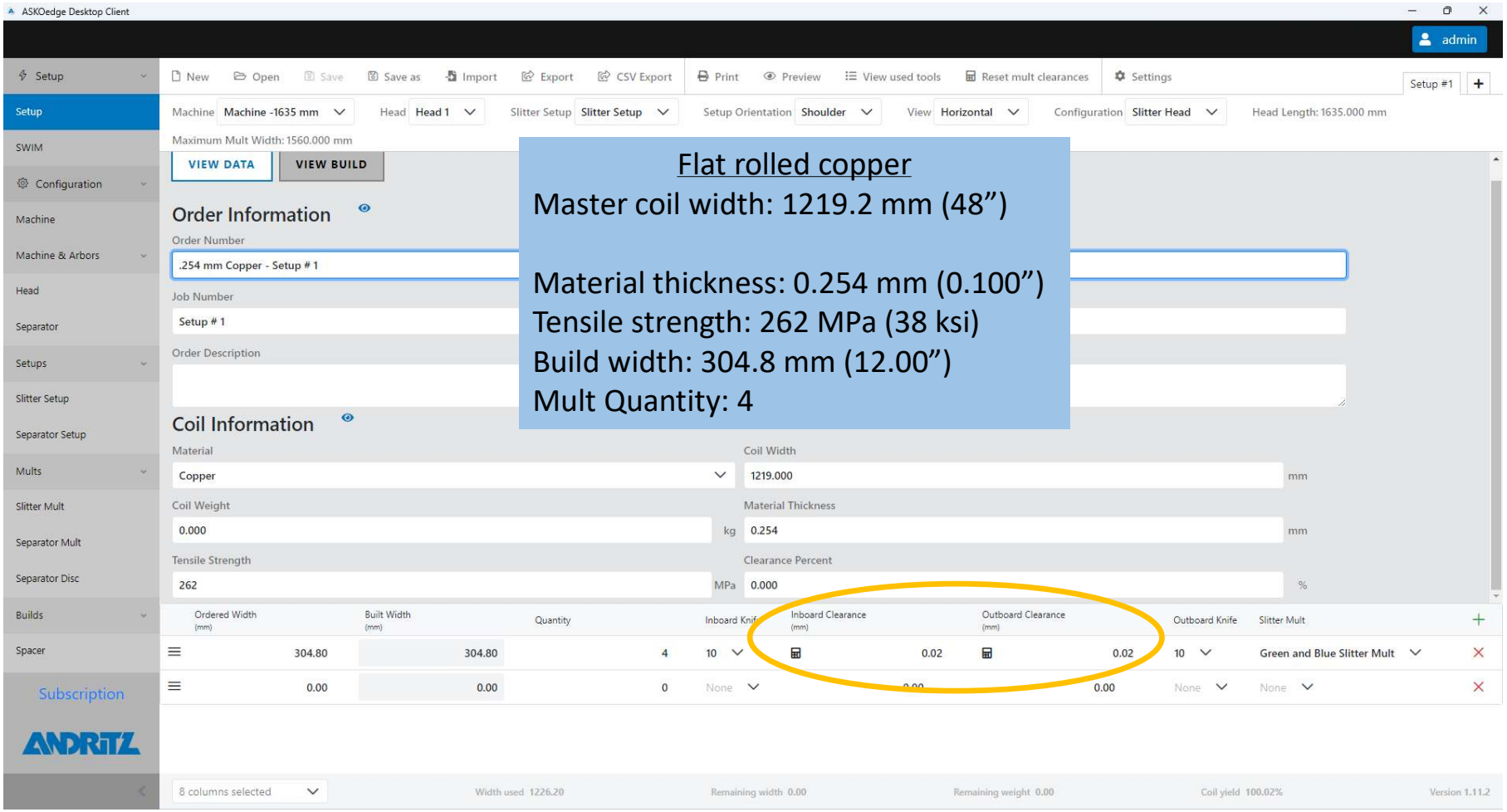
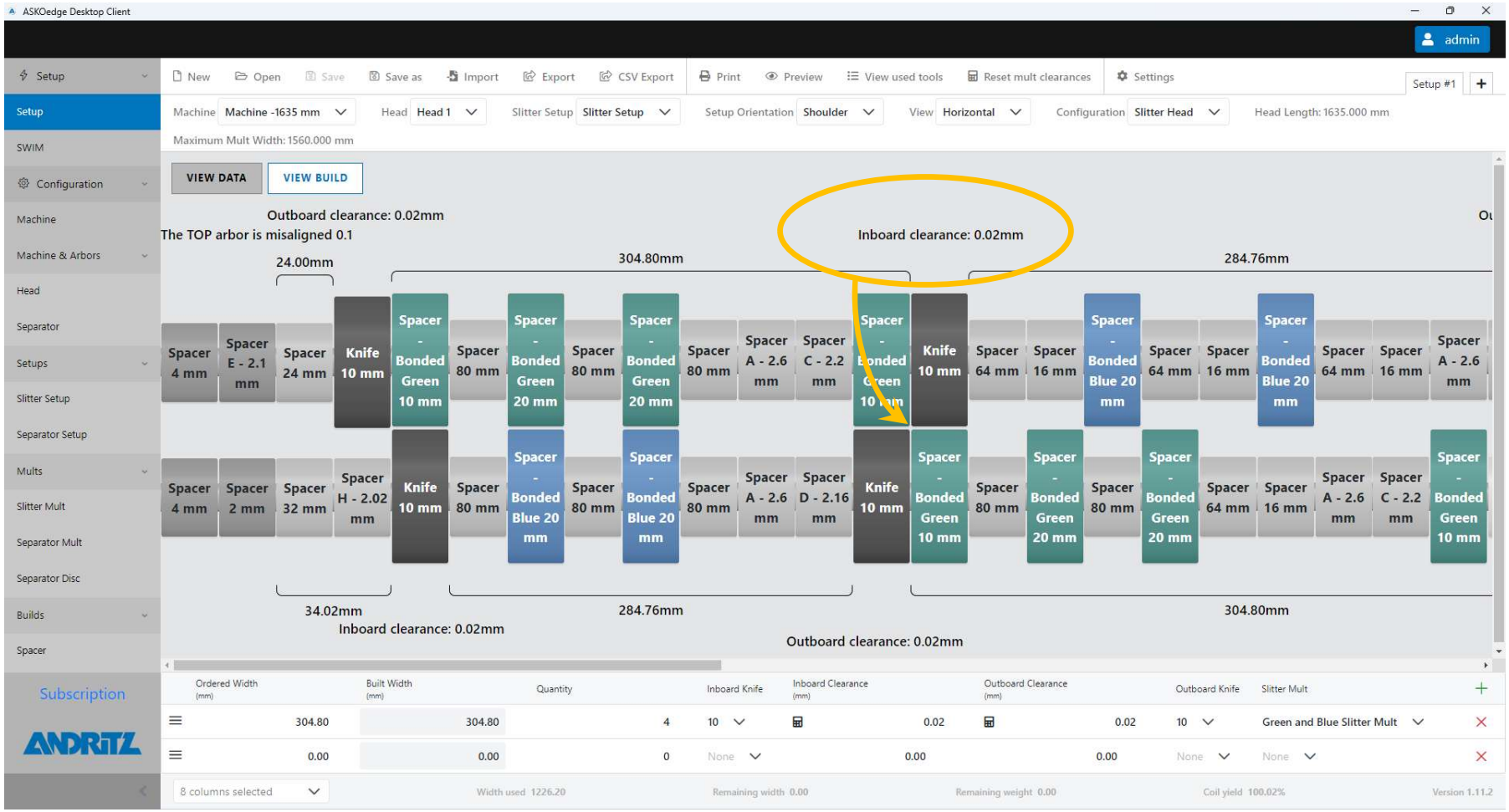


Flat rolled copper

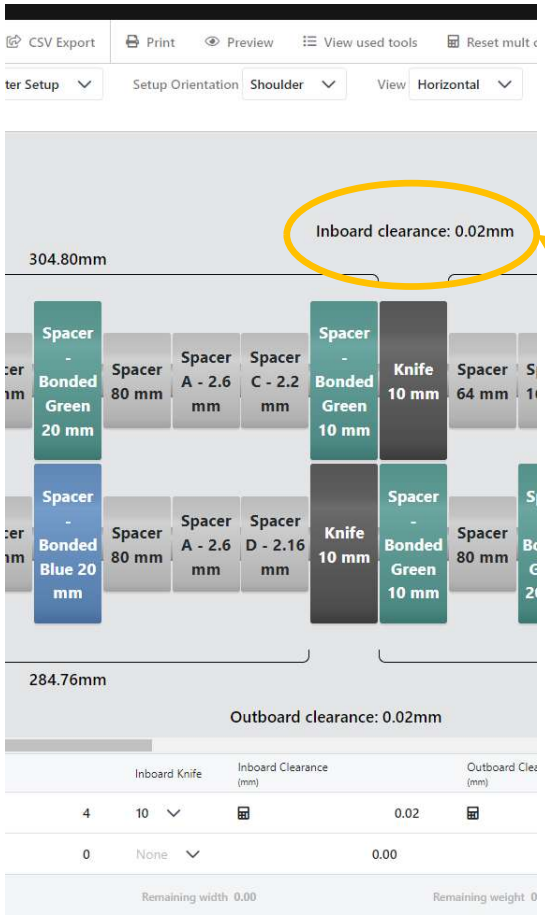
Master coil width: 1219.2 mm (48”)

Material thickness: 0.254 mm (0.100”)
Tensile strength: 262 MPa (38 ksi)
Build width: 304.8 mm (12.00”)
Mult Quantity: 4

SLITTER TOOLING TOLERANCE



SLITTER TOOLING TOLERANCE



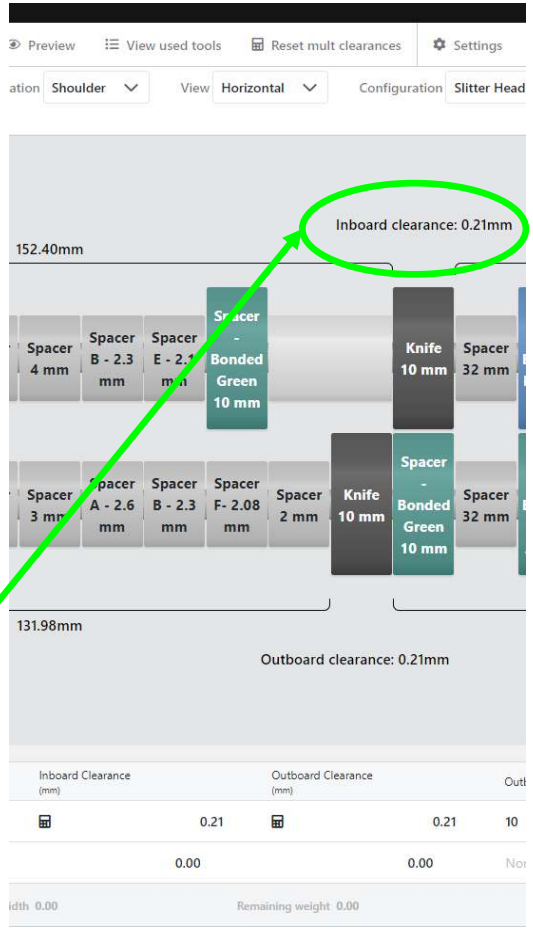
Example 1, **Gauge**

Master coil width: 1219 mm (48”)

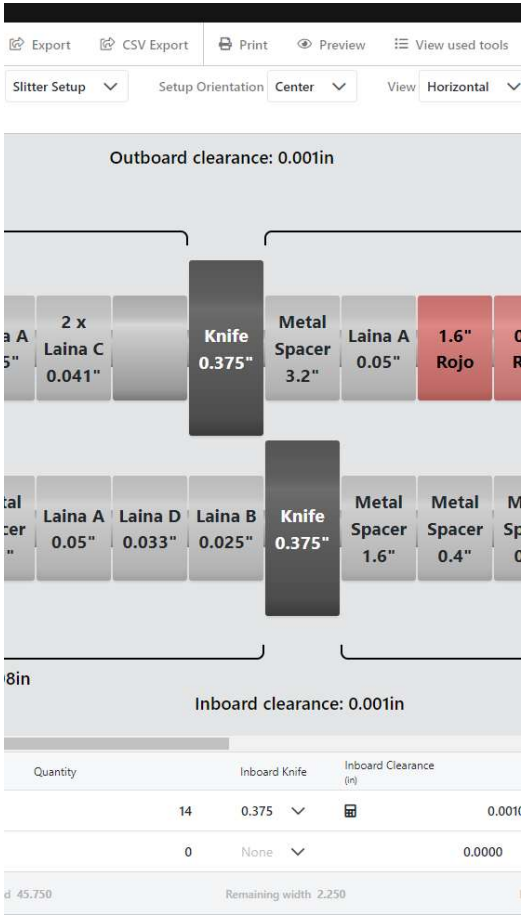
Material thickness: 0.254 mm (0.010”)
Tensile strength: 262 MPa (38 ksi)
Build width: 304.8 mm (12.00”)
Mult Quantity: 4
Horizontal Clearance: 0.02 mm (.0008”)

vs.

Material thickness: 2.540 mm (0.100”)
Tensile strength: 262 MPa (38 ksi)
Build width: 152.4mm (6.00”)
Mult Quantity: 8
Horizontal Clearance: 0.21 mm (0.008”)



SLITTER TOOLING TOLERANCE



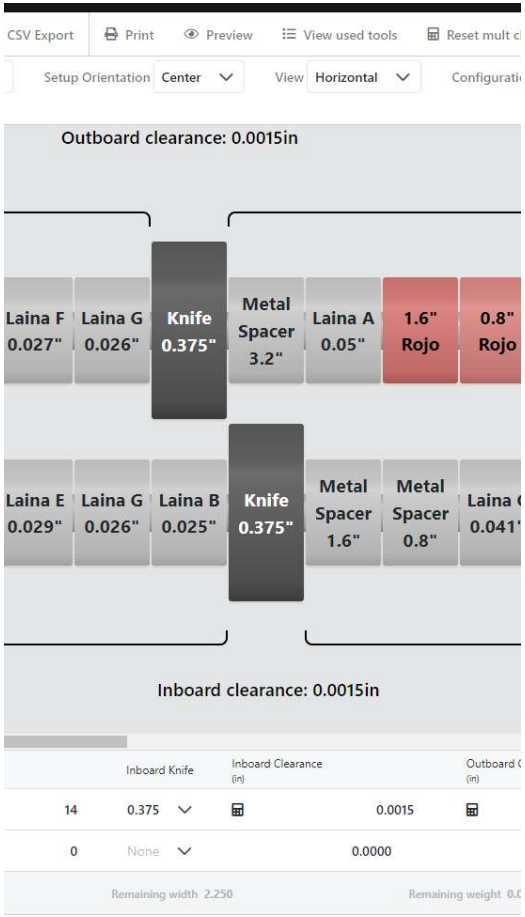
Example 2, **Tensile Strength**

Master coil width: 1219 mm (48”)

Material thickness: 0.254 mm (0.010”)
Tensile strength: 262 MPa (38 ksi)
Build width: 82.55mm (3.250”)
Mult Quantity: 14
Horizontal Clearance: 0.0254 mm (.001”)

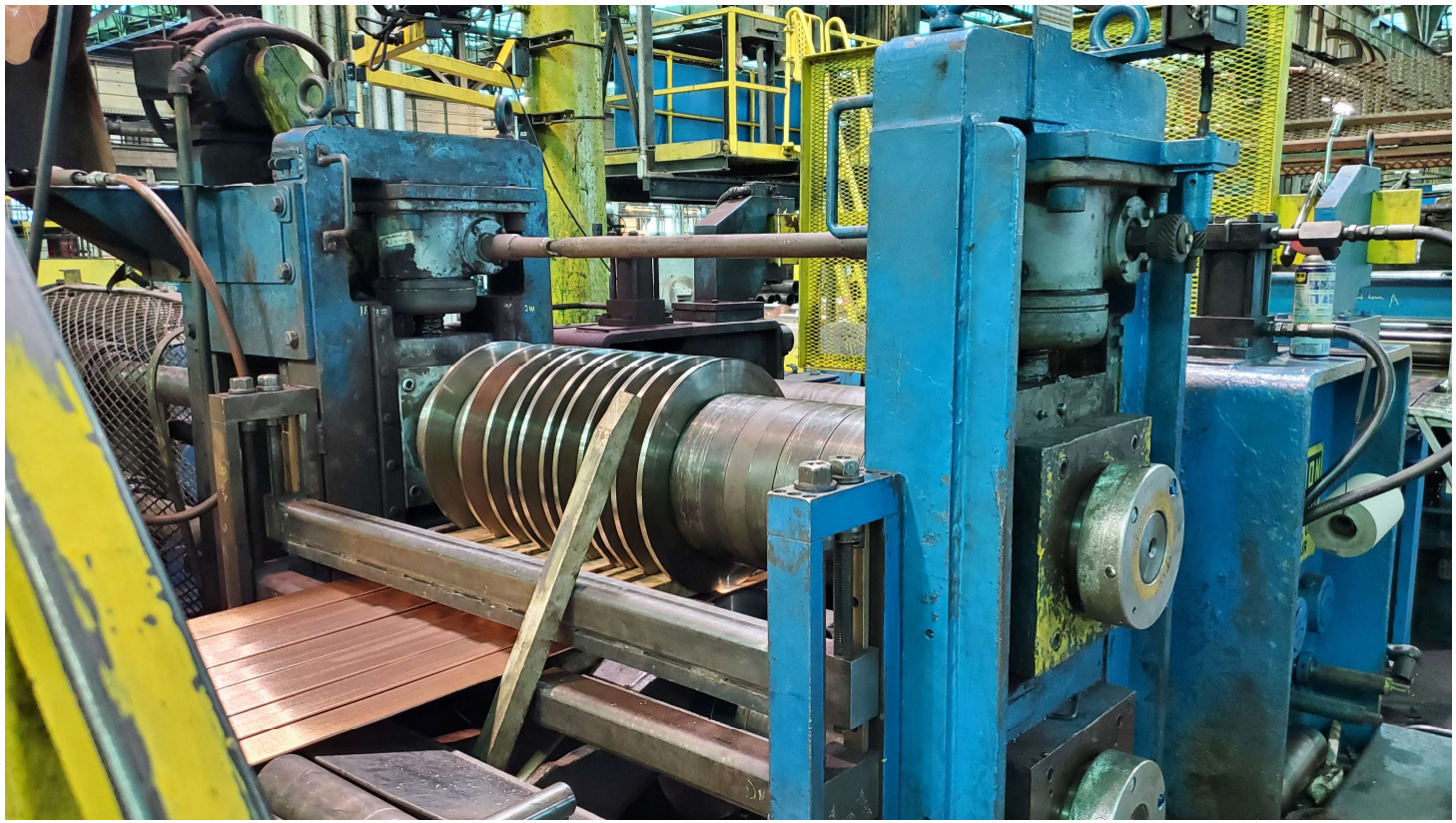
vs.

Material thickness: 0.0254 mm (0.010”)
Tensile strength: 483 MPa (70 ksi)
Build width: 82.55mm (3.250”)
Mult Quantity: 14
Horizontal Clearance: 0.0381 mm (0.0015”)



SLITTER TOOLING

Yesterday's Technique



SLITTER TOOLING TOLERANCE

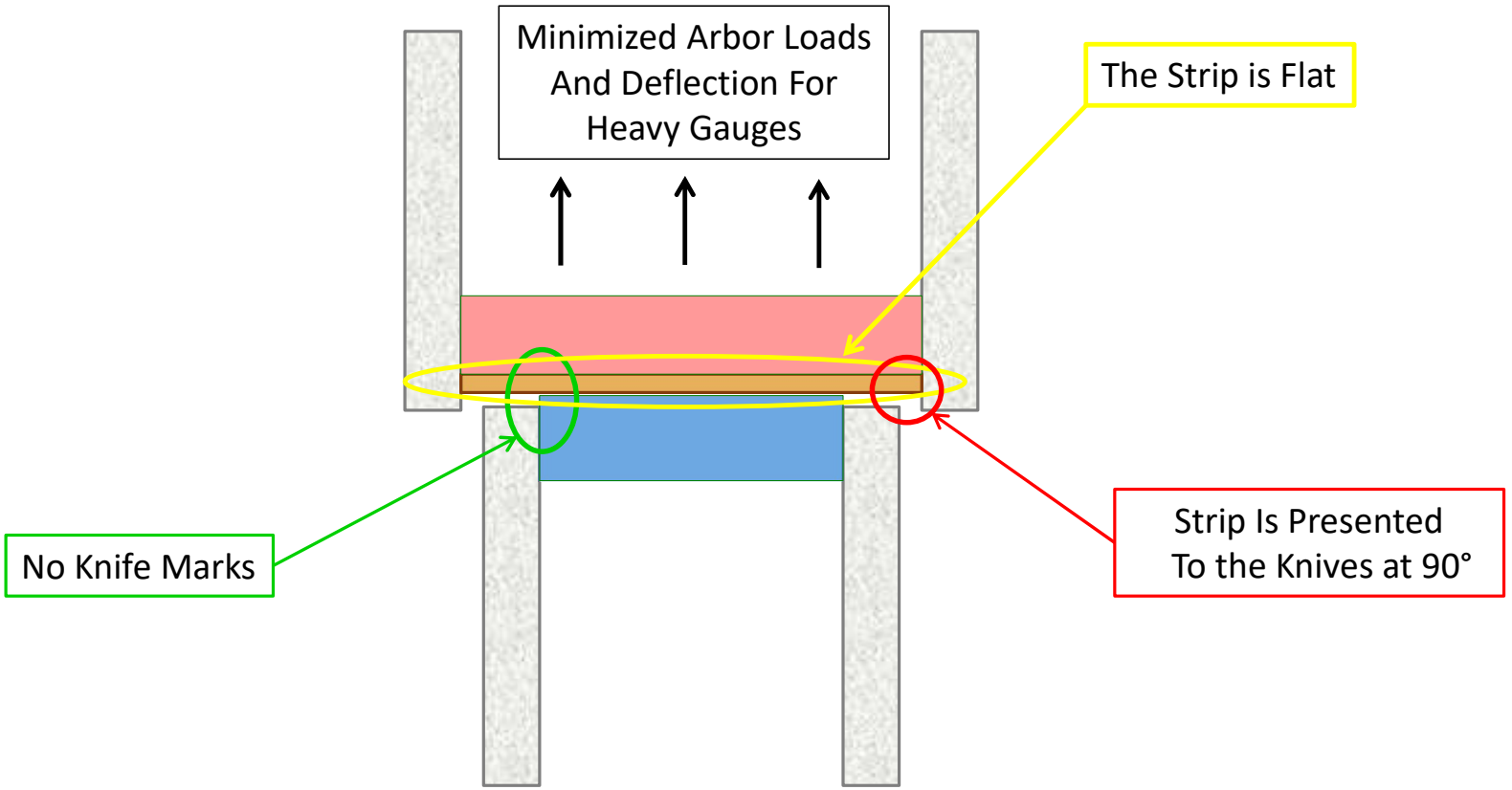
Today's Technique

Spacers + Rubber Stripper Rings

Bonded Spacers

SLITTER TOOLING TOLERANCE

Proper Stripper Ring Practice



Slitter Stripper Ring Considerations

Ferrous material
Stripper ring sizing

Material Thickness	MALE	FEMALE
.020” to .055”	+.020” to +.030”	.000” to -.010” under knife OD
.056” to .090”	+.020” to +.030”	-.055” to -.065” under knife OD
.091” to .125”	+.020” to +.030”	-.090” to -.100” under knife OD
.126” to .180”	+.020” to +.030”	-.125” to -.140” under knife OD
.181” to .250”	+.020” to +.030”	-.180” to -.200” under knife OD

VS.

Copper material
Stripper ring sizing

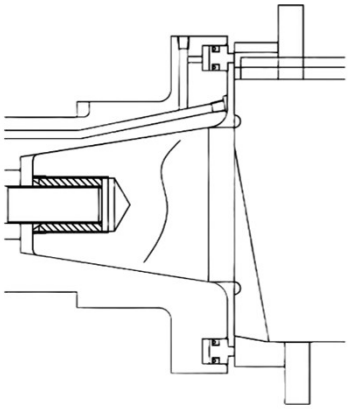
Material Thickness	MALE	FEMALE
.001” to .015”	+.010”	even with knife OD
.016” to .035”	+.010	-.020” under knife OD
.036” to .060”	+.020” to +.030”	-.035” to -.045” under knife OD
.061” to .090”	+.020” to +.030”	-.060” to -.070” under knife OD
.091” to .125”	+.020” to +.030”	-.090” to -.100” under knife OD
.126” to .180”	+.020” to +.030”	-.125” to -.140” under knife OD
.181” to .250”	+.020” to +.030”	-.180” to -.200” under knife OD

Arbor Locking Mechanism

Yesterday's Technique

Mechanical Spanner Nuts

- Squareness problems
- Uneven pressure
- Difficult to mount
- Thread damage
- Hammer damage



Today's Technique

Automated Hydraulics &

High Pressure Hydraulic Nuts

- Uniform loading
- No thread damage
- Easy to tighten

Precision Slitting of copper
is best achieved with a holistic approach that includes:

- Equipment design
- Tooling tolerances
- The processing line's actual capabilities
- Condition of the incoming material

INTERNATIONAL WROUGHT COPPER COUNCIL

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Thank you!

Grazie, धन्यवाद , Danke, ありがとう , Gracias, Merci

What questions do you have?