Efficiency Gains In Flour Milling

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Timken Attendees

- **Wally Sarnowski – SE Regional Director**
- **Tyler Julian – Sales Engineer (S Indiana/ N Kentucky)**
- **Brian Wade – Belt/Chain Specialist (Indiana/Kentucky)**

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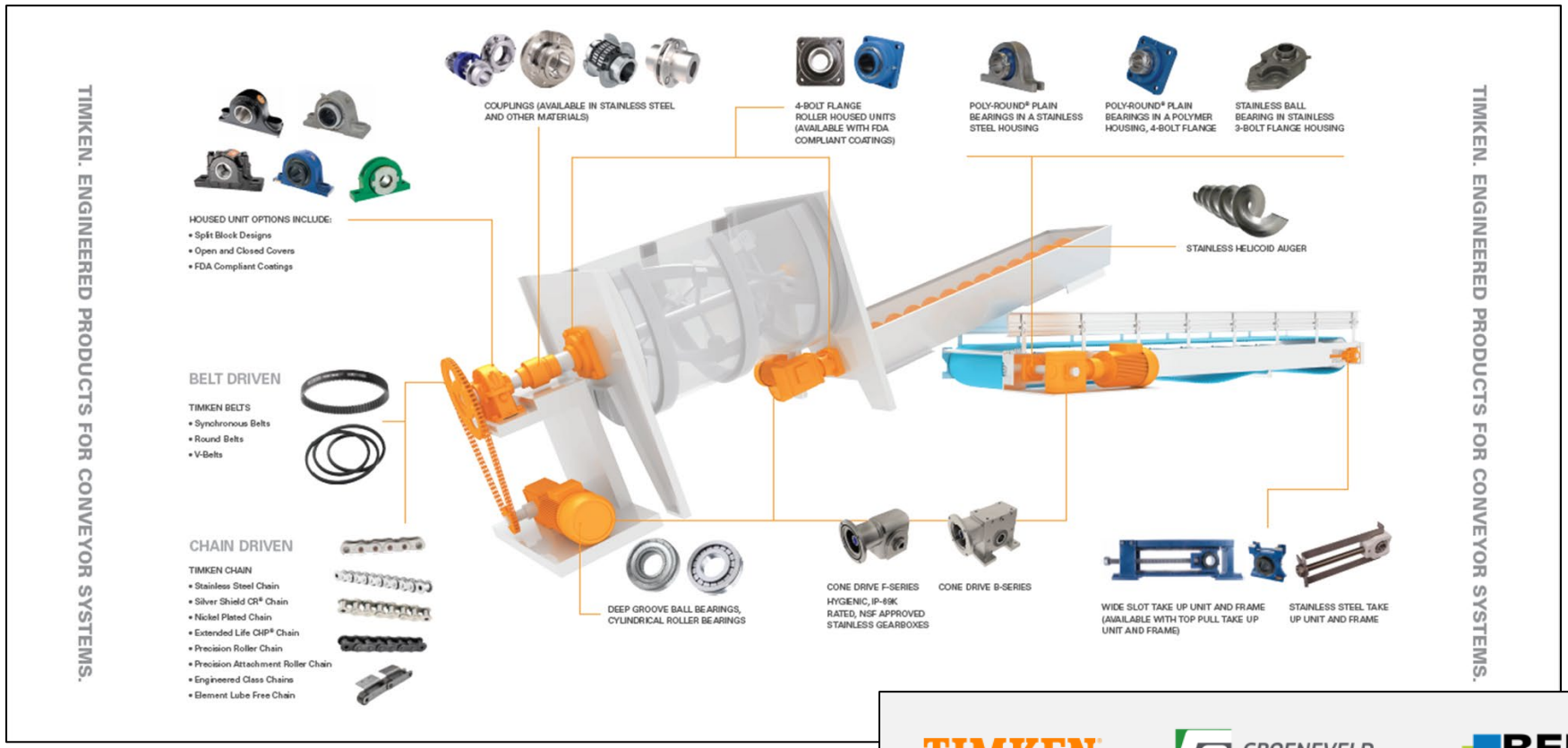
A Broad and Market-Leading Product Portfolio

TIMKEN ROLLON PHILADELPHIA GEAR DIAMOND Cone Drive DRIVES GROENEVELD Lovejoy BEKA PT TECH SPINEA GGB NADELLA DES-CASE iMECH LAGERSMIT

Our Brand Portfolio



TIMKEN · GROENEVELD LUBRICATION SYSTEMS · BEKA LUBRICATION SYSTEMS · Cone Drive · CARLISLE

SPINEA · PHILADELPHIA GEAR · GGB · ROLLON · DIAMOND

NADELLA · DES-CASE · DRIVES · Lovejoy · PTTECH · TORSION CONTROL PRODUCTS · LAGERSMIT

Bearing Definitions:

A **bearing** is a machine element that **constrains relative motion** between moving parts to only the desired motion and **reduces friction** between them.

Bearings create a smooth interface between moving parts, **minimizing the resistance to motion (friction)** that would otherwise **cause wear, heat, and inefficiency.**

Energy Consumption In Flour Milling

Single Roll Stand (35HP)

Recap of Inputs

- **Motor Size:** 35 HP
- **Conversion:** 1 HP = 0.746 kW → 35 HP = **26.11 kW**
- **Efficiency:** 90% → Input power = 26.11 ÷ 0.90 = **29.01 kW**
- **Hours per Year:** 8,760
- **Electricity Rate:** $0.16/kWh

New Cost Calculation

$$\text{Annual Energy Use} = 29.01\,\text{kW} \times 8,760\,\text{hrs} = 254,228\,\text{kWh}$$

$$\text{Annual Cost} = 254,228\,\text{kWh} \times \$0.16 = \boxed{\$40,676.48}$$

Final Answer:

> **At $0.16 per kWh**, a 35 HP motor running continuously for a year would cost approximately **$40,676.48** in electricity.

Entire Mill (30,000 cwts)

Question

> *What is the annual electricity cost for one of the largest U.S. flour mills with a daily capacity of 30,000 cwt, at varying electricity rates of $0.14, $0.16, and $0.18 per kWh?*

Key Assumptions

Assumption	Value
Daily flour production	30,000 cwt/day (equivalent to 1,500 tons/day)
Operating days per year	350 days/year
Annual flour output	30,000 × 350 = **10.5 million cwt/year**
Energy usage per cwt	**3.0 kWh/cwt** (industry benchmark)
Total annual energy usage	10.5 million cwt × 3.0 = **31.5 million kWh**
Electricity rates to evaluate	$0.14, $0.16, $0.18 per kWh

Conclusion

A large U.S. flour mill producing **30,000 cwt of flour per day** and consuming **3.0 kWh per cwt** will spend approximately:

- **$4.41M/year at $0.14/kWh**
- **$5.04M/year at $0.16/kWh**
- **$5.67M/year at $0.18/kWh**

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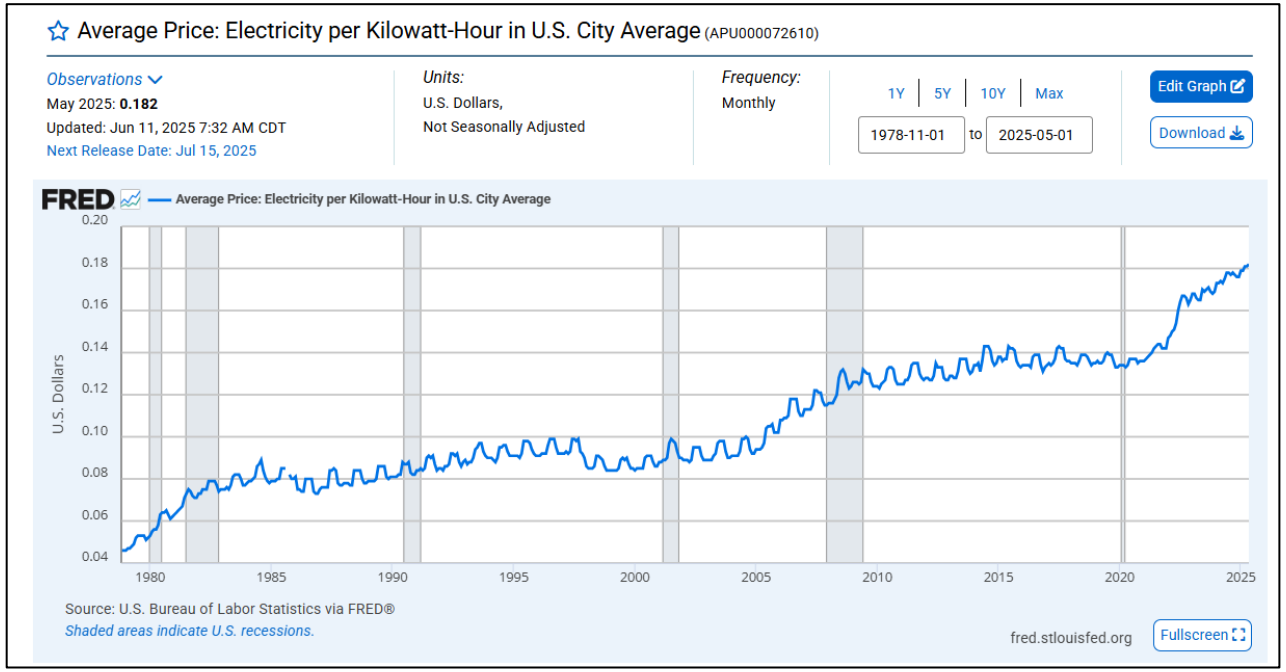
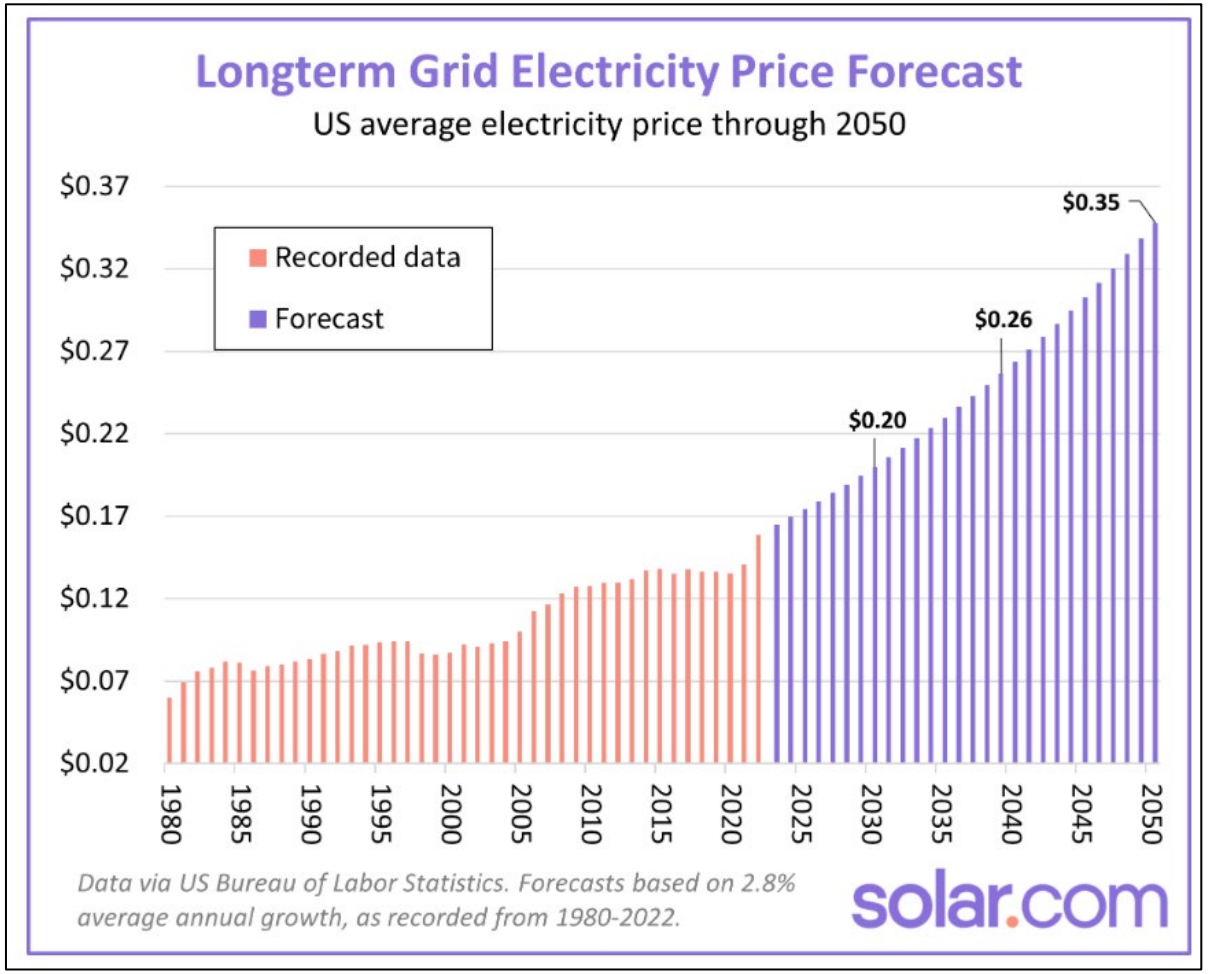
Source: OpenAI. (2025). ChatGPT (GPT-4) [Large language model]. Retrieved July 21, 2025.

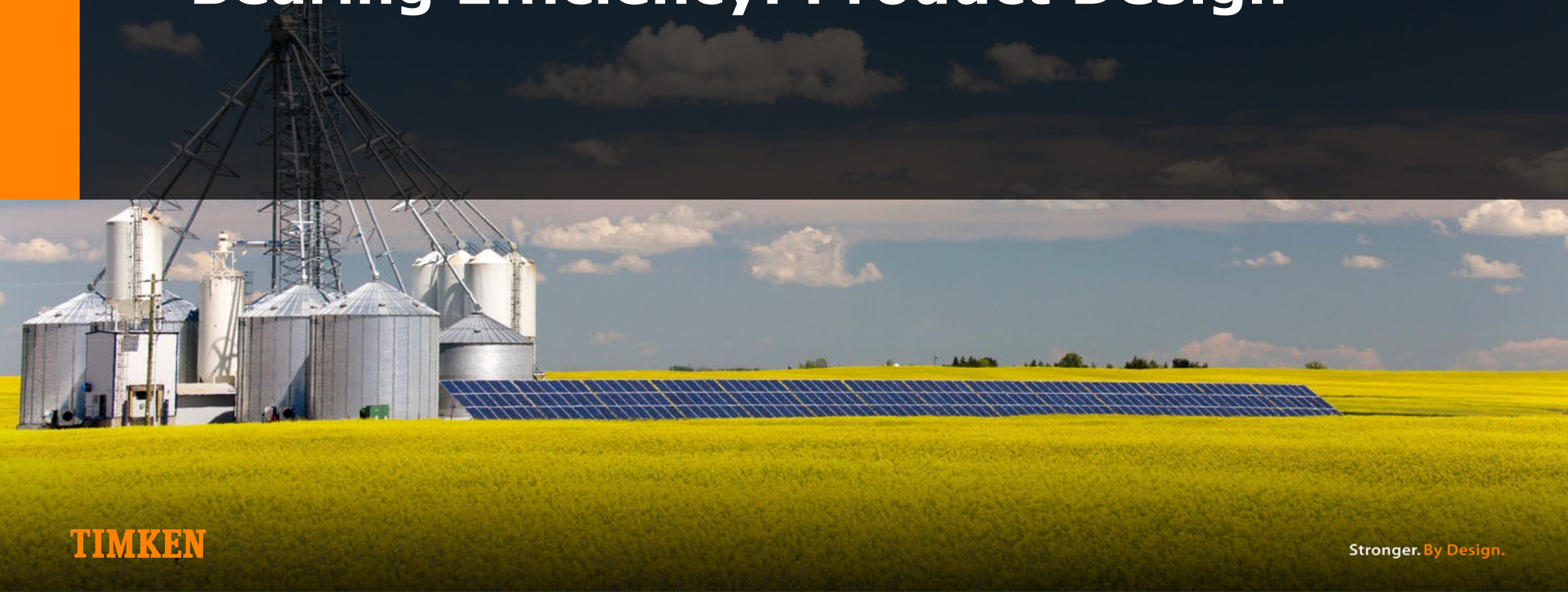
Average Electric Costs in US / Long Term Forecast

- Electricity is a major input cost for flour production
- Average electric costs climbed 27% in the last 10 years
- Electricity costs are projected to continue climbing
- Some sources predict an additional 25% increase by 2030 due to growing data center investment, EV adoption, etc.





Bearing Efficiency: Product Design



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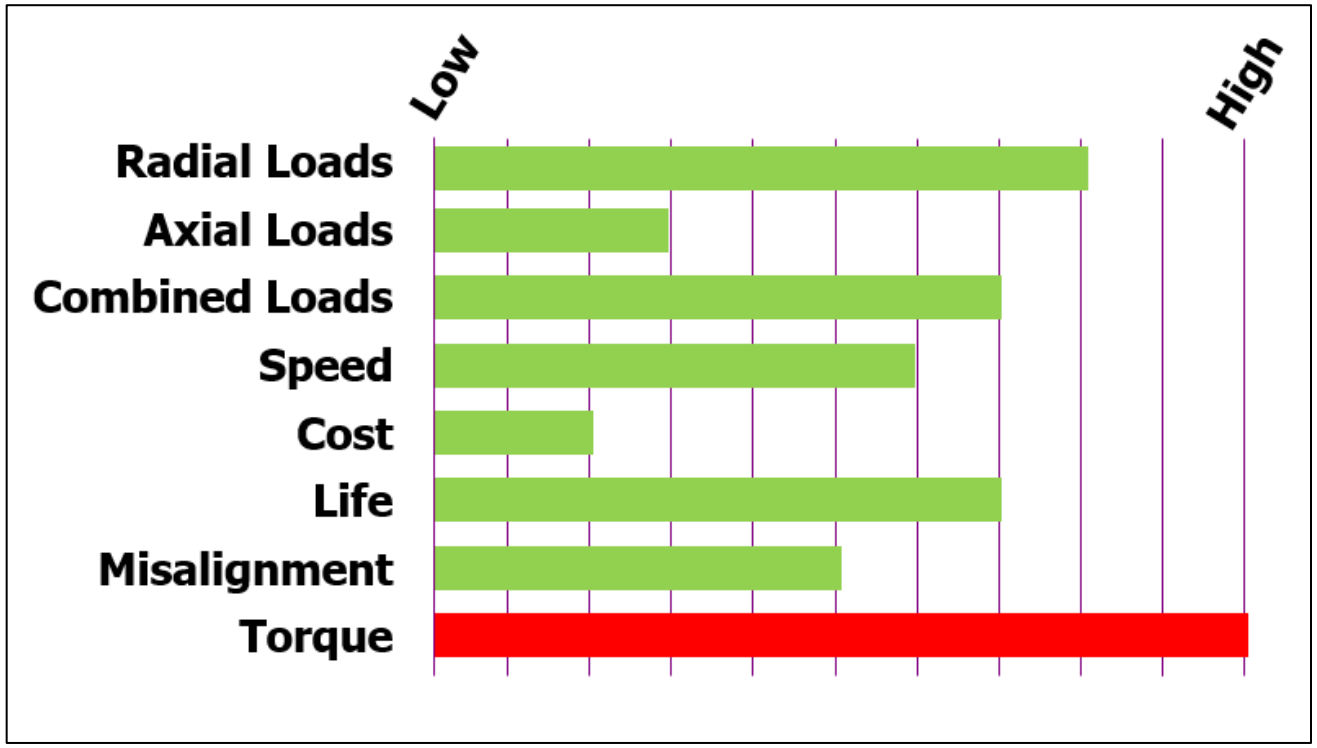
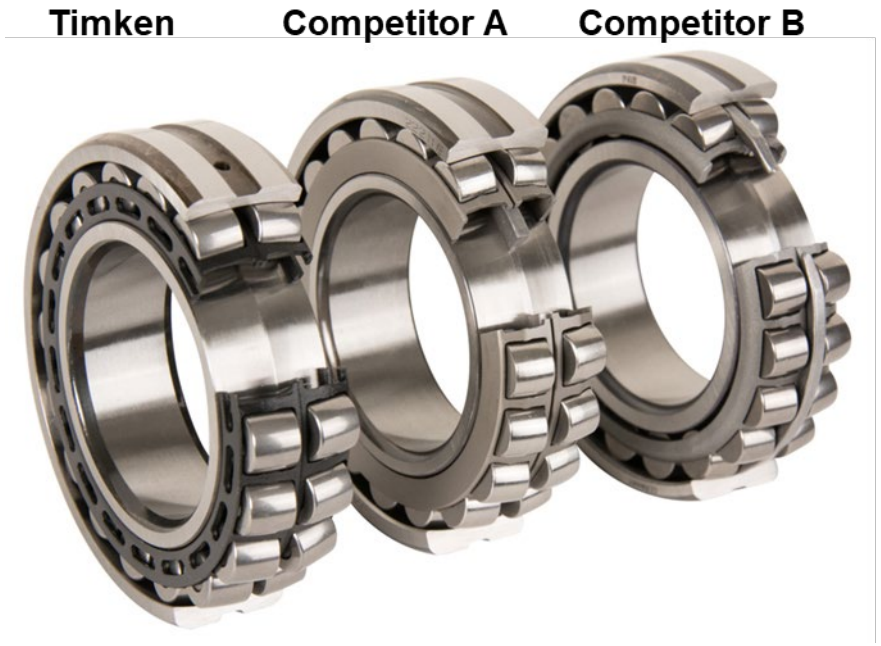
Spherical Roller Bearings

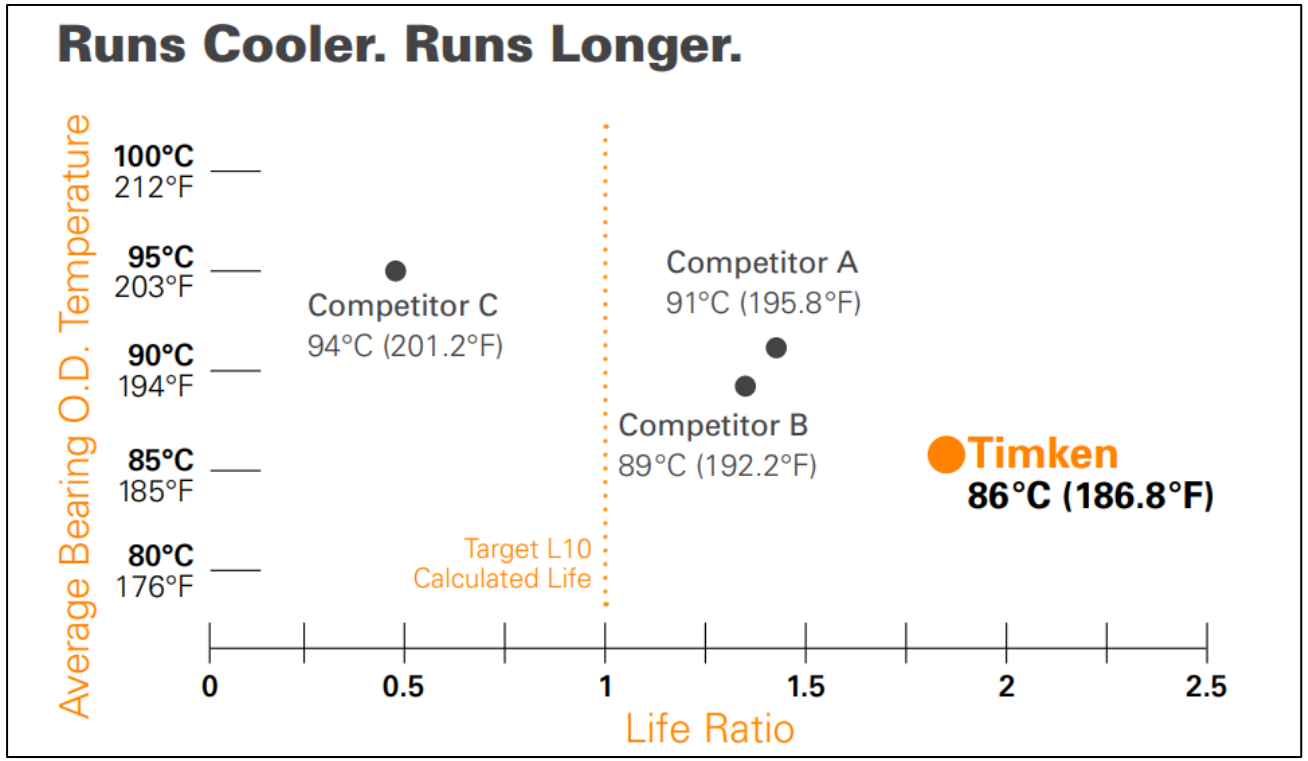


- Most flour mills are designed utilizing spherical roller bearings for roll stands
- Spherical roller bearings are a cost-effective design with combined (radial/axial) load carrying capabilities and exceptional misalignment tolerance.
- However, spherical roller bearings are a high torque / high drag bearing design.
- Spherical roller bearings generally operate ~98% efficiency (load/speed/setting dependent)

Spherical Roller Bearing Design



- **Optimized efficiency.** Eliminating the center guide ring reduces running torque up to 4%, creating less friction.
- **Lower operating temperatures*.** In head-to-head testing, our spherical roller bearings required 4% to 10% less running torque and ran 5˚ C cooler than the competition.



Heat = Torque = Powerloss

4% C1 loading. Assumed 4% increase in efficiency at optimal mounted RIC. 120 Mill Stands.

Calculation Template	Value	Units
Timken Bearing P/N:	22315K	-
Timken Torque:	1.154	NM
Competitor Torque:	1.202	NM
# of Bearings per mill stand:	4	-
# of mill stands:	120	-
Operating RPM:	600	RPM
Operational Lifetime of Consideration:	5	Years
Cost of Electricity:	0.17	$/kWh
CO2 Emissions per kWh	0.8523	lbs CO2/kWh
Total Torque Savings with Timken =	0.048	NM
Timken Efficiency Improvement:	4.0	%
Total number of bearings in mill:	480	-
Energy Consumption Per Competitor Bearing:	75.726	Watts
Energy Consumption Per Timken Bearing:	72.702	Watts
Total Energy Consumption Competitor:	36348.48	Watts
Total Energy Consumption Timken:	34896.96	Watts
Lifetime Energy Consumption Competitor Bearing:	1592063424	Watts
Lifetime Energy Consumption Timken Bearing:	1528486848	Watts
Savings Calculations	**Watt-Hours**	**$**
Per Bearing Lifetime:	*132451*	*$22.52*
Per Mill Stand Lifetime:	*529805*	*$90.07*
Entire Mill (5 Years):	***63576576***	***$10,808.02***

Bearing Efficiency: Maintenance Best Practices

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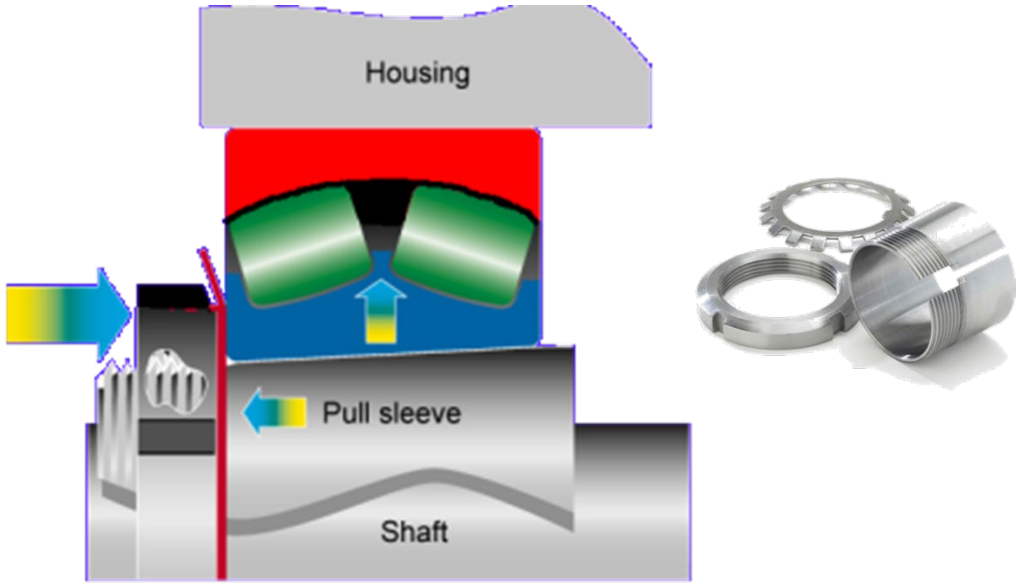
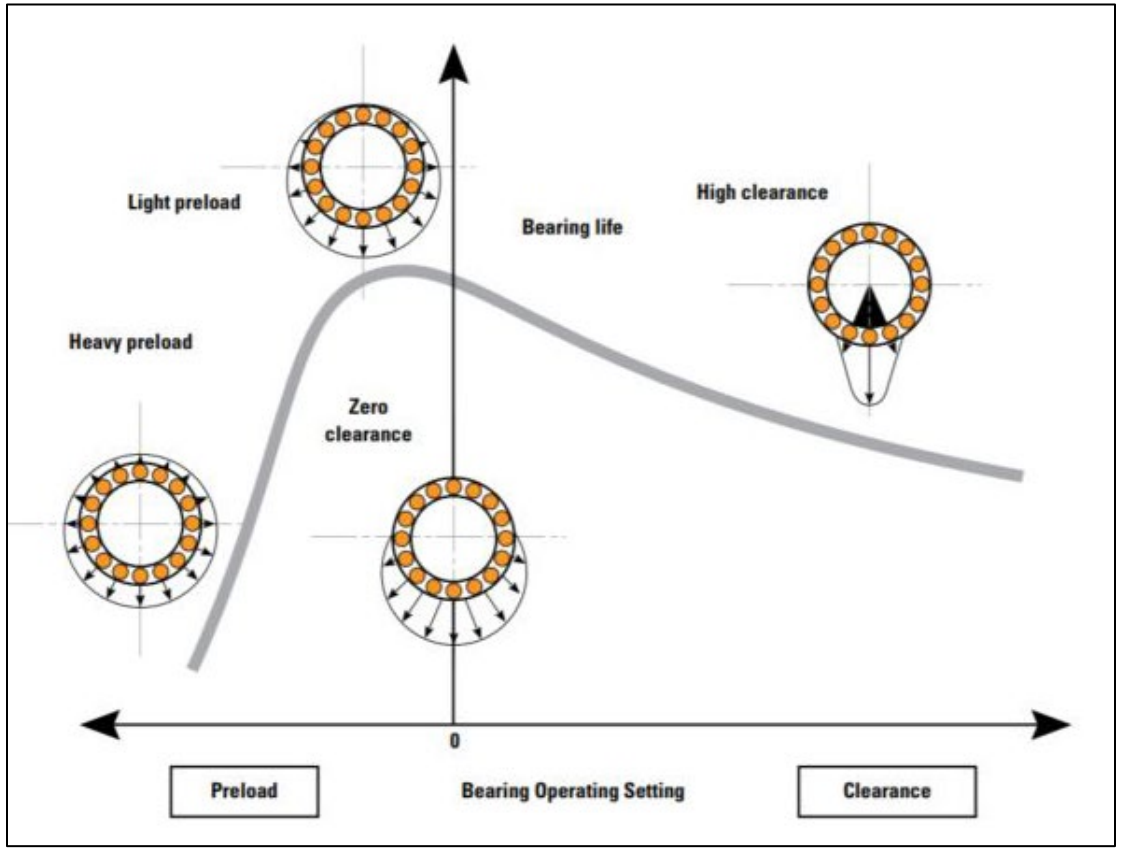
Tapered Bore SRB Installation

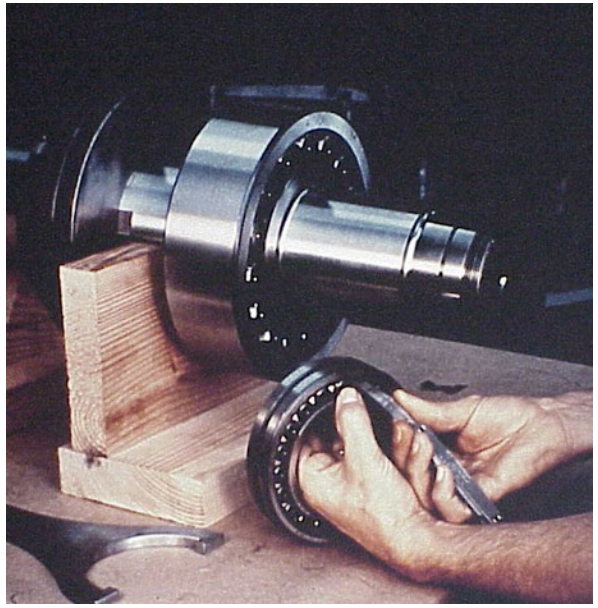


- Most flour mills use tapered bore spherical roller bearings on a tapered shaft. Some use adaptors. Same logic.
- A locknut drives the tapered bearing bore up the tapered seat creating an interference fit.
- This process also causes deflection of the bearing inner race and removes preset clearance from the bearing cavity



- Bearing installation correlates to "load zones", heat generation, and operating torque
- Overtightening – "thermal runaway" → bearing failure
- Under-tightening – inadequate holding power on shaft

22315K Recommended Mounted Clearances



Confirm factory clearance

TABLE 5. RADIAL INTERNAL CLEARANCE LIMITS – SPHERICAL ROLLER BEARINGS – TAPERED BORE

Bore (Nominal)		Radial Internal Clearance Prior To Mounting						Suggested Reduction of RIC Due to Installation		Axial Displacement of Inner Ring for RIC Reduction – Tapered Shaft[1][2]				Minimum Permissible RIC After Installation[1]		
		Normal C0		C4						1:12 Taper		1:30 Taper				
		C2		C3		C5										
Over	Incl.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	C0	C3	C4
mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.
20 0.9449	30 1.1811	0.020 0.0008	0.030 0.0012	0.040 0.0016	0.055 0.0022	0.075 0.0030	0.095 0.0037	0.015 0.0006	0.020 0.0008	0.230 0.0091	0.300 0.0118	– –	– –	0.015 0.0006	0.025 0.0010	0.040 0.0016
30 1.1811	40 1.5748	0.025 0.0010	0.035 0.0014	0.050 0.0020	0.065 0.0026	0.085 0.0033	0.105 0.0041	0.020 0.0008	0.025 0.0010	0.300 0.0118	0.380 0.0150	– –	– –	0.015 0.0006	0.025 0.0010	0.040 0.0016
40 1.5748	50 1.9685	0.030 0.0012	0.045 0.0018	0.060 0.0024	0.080 0.0031	0.100 0.0039	0.130 0.0051	0.025 0.0010	0.030 0.0012	0.380 0.0150	0.460 0.0181	– –	– –	0.02 0.0008	0.030 0.0012	0.050 0.0020
50 1.9685	65 2.5591	0.040 0.0016	0.055 0.0022	0.075 0.0030	0.095 0.0037	0.120 0.0047	0.160 0.0063	0.030 0.0012	0.038 0.0015	0.460 0.0181	0.560 0.0220	– –	– –	0.025 0.0010	0.040 0.0015	0.060 0.0025
65 2.5591	80 3.1496	0.050 0.0020	0.070 0.0028	0.0950 0.0037	0.120 0.0047	0.150 0.0059	0.200 0.0079	0.038 0.0015	0.051 0.0020	0.560 0.0220	0.760 0.0299	– –	– –	0.025 0.0010	0.045 0.0017	0.075 0.0030
80 3.1496	100 3.9370	0.055 0.0022	0.080 0.0030	0.110 0.0043	0.140 0.0055	0.180 0.0071	0.230 0.0091	0.046 0.0018	0.064 0.0025	0.680 0.0268	0.970 0.0382	– –	– –	0.036 0.0014	0.050 0.0020	0.075 0.0030

Use manufacturer guidelines to determine reduction in clearance

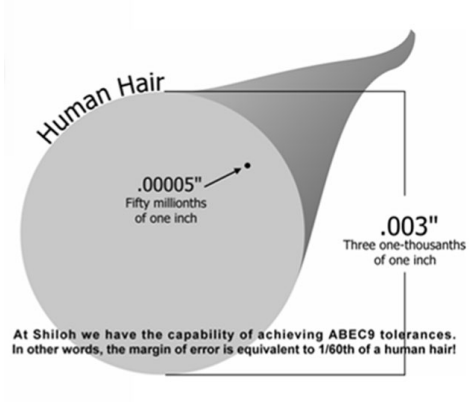
Install per recommended reduction

C0: Recommended Mounted Clearance Range = 0.0010” to 0.0022”

- Min. Recommended Mounted Clearance = **0.0010”**
- Max. Recommended Mounted Clearance = 0.0037”-0.0015” = **0.0022”**

C3: Recommended Mounted Clearance Range = 0.0017” to 0.0032”

- Min Recommended Mounted Clearance = **0.0017”**
- Max Recommended Mounted Clearance = .0047” -0.0015’ = **0.0032”**

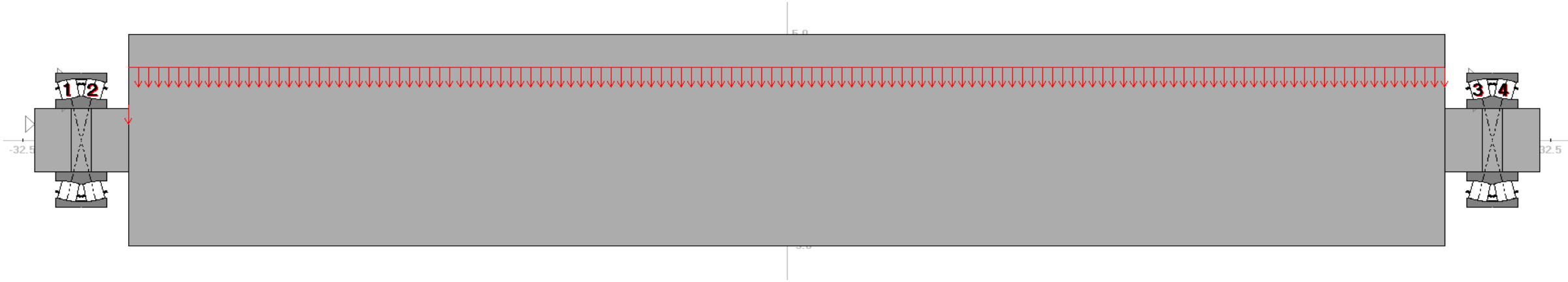


Radial Internal Bearing Clearance vs. Power

Syber® Modeling

- **Bearing:** Left 22315K fixed, right 22315K float
- **Shaft temp**. = 130°F, Housing temp. = 120°F
- **RPM** = 550
- **Lubricant** = ISOVG220 Grease @130°F
- **Distributed loads** (arrows in model): 8080lbs (4% of C1 rating) / 2 bearings
- **Mounted clearances evaluated:**
  - -0.001” (too tight)
  - 0.000” (tight)
  - **0.001” (lower spec)**
  - **0.002” (upper spec)**
  - 0.003” (loose)

Bearing	LZ (deg)	LZ (deg) AVG	Mounted Clearance (in)	Mounted Clearance (in) AVG	Operating Clearance (in)	Total Torque (in.lbf)	Total Power (Btu/m) per brg row	Total Power (Btu/m) per Bearing
1 (22315KEJW33 **)	360	360	-0.0010	-0.0010	-0.0012	31.627	11.70	23.4000
2 (22315KEJW33 **)	360		-0.0010		-0.0012	31.605	11.70	
3 (22315KEJW33 **)	360	360	-0.0010	-0.0010	-0.0012	31.566	11.68	23.3700
4 (22315KEJW33 **)	360		-0.0010		-0.0012	31.590	11.69	
1 (22315KEJW33 **)	212	211	0.0000	0.0000	-0.0003	14.508	5.37	10.7200
2 (22315KEJW33 **)	209		0.0000		-0.0003	14.445	5.35	
3 (22315KEJW33 **)	209	211	0.0000	0.0000	-0.0003	14.442	5.34	10.7100
4 (22315KEJW33 **)	212		0.0000		-0.0003	14.505	5.37	
1 (22315KEJW33 **)	146	146	0.0010	0.0010	0.0007	11.768	4.36	8.7100
2 (22315KEJW33 **)	146		0.0010		0.0007	11.761	4.35	
3 (22315KEJW33 **)	146	146	0.0010	0.0010	0.0007	11.760	4.35	8.7000
4 (22315KEJW33 **)	146		0.0010		0.0007	11.767	4.35	
1 (22315KEJW33 **)	123	123	0.0020	0.0020	0.0017	10.244	3.79	7.5600
2 (22315KEJW33 **)	122		0.0020		0.0017	10.175	3.77	
3 (22315KEJW33 **)	122	123	0.0020	0.0020	0.0017	10.172	3.76	7.5500
4 (22315KEJW33 **)	123		0.0020		0.0017	10.237	3.79	
1 (22315KEJW33 **)	109	109	0.0030	0.0030	0.0027	9.637	3.57	7.1400
2 (22315KEJW33 **)	109		0.0030		0.0027	9.641	3.57	
3 (22315KEJW33 **)	109	109	0.0030	0.0030	0.0027	9.641	3.57	7.1400
4 (22315KEJW33 **)	109		0.0030		0.0027	9.637	3.57	

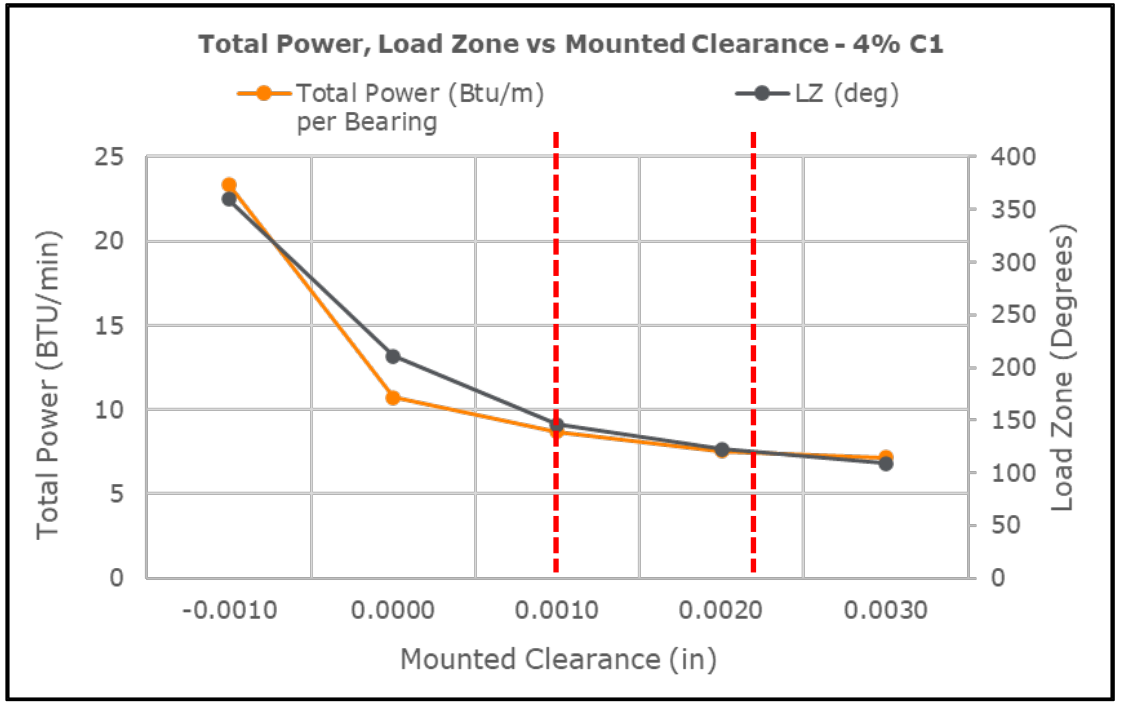


Clearance vs. Power

--- = Recommended mounted clearance range

The analysis shows a decrease in operating torque as mounted clearance increases:

- The proper clearance range per Timken's SRB catalog was identified as **0.0010" to 0.0022".**
- Total power efficiency gains were calculated between **1.3%** and **13.2%** when moving from a **0.001"** to a **0.002" mounted clearance**
  - 1.3% to 13.2% depending on loading condition
  - Results show sensitivity at **lower loading conditions** as mounted clearance has a greater effect on consumed power.
  - **As loads increase**, the consumed power attributed by clearance changes becomes smaller.
  - Calculations can be refined with specific loading conditions provided to Timken (belt tension spec, roll weight)
- Great efficiency gains are realized when moving from a mounted **preload condition to a clearance condition**. Pre-loaded bearings should **never be used** in this application for this reason and the risk of thermal runaway.
- Although greater efficiency gains can be realized at 0.003" mounted clearance, this condition is **not recommended**. Too loose of a clearance can create conditions for roller sliding, inner ring fretting, and other operational issues. **The need to replace a bearing prematurely negates the potential efficiency gained during operation.**



	4% C1 Loading		
	Scenario 1	Scenario 2	Scenario 3
Original Mounted Setting	-0.0010	0.0000	0.0010
Total Power Consumed Per Bearing (BTU/m)	23.4	10.7	8.7
Improved Mounted Setting	**0.0020**	**0.0020**	**0.0020**
Total Power Consumed Per Bearing (BTU/m)	7.6	7.6	7.6
Decrease in Power Consumption	15.83	3.16	1.15
Efficiency Improvement %	**67.7**	**29.5**	**13.2**

Results: 13% calculated efficiency gain between high end (.002") and low end (.001") of target setting range.

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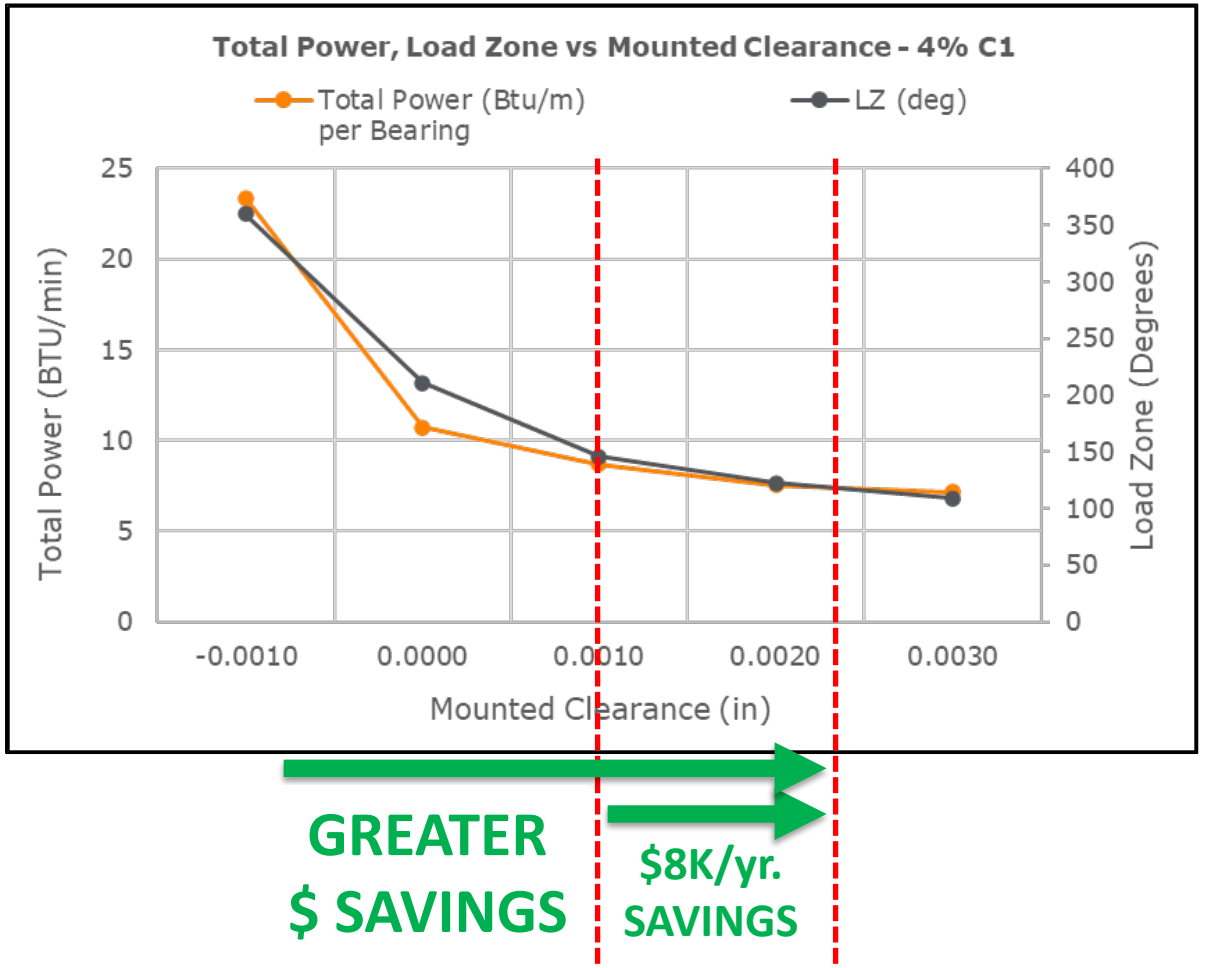
Clearance vs. Torque Savings

4% C1 loading. Moving from 0.001" mounted RIC to 0.002" (Calculated 13.2% efficiency gain). 120 Mill Stands.

Calculation Template	Value	Units
Timken Bearing P/N:	22315K	-
Timken Torque (0.002" Mounted RIC):	1.154	NM
Timken Torque (0.001" Mounted RIC):	1.329	NM
# of Bearings per mill stand:	4	-
# of mill stands:	120	-
Operating RPM:	600	RPM
Operational Lifetime of Consideration:	5	Years
Cost of Electricity:	0.17	$/kWh
CO2 Emissions per kWh	0.8523	lbs CO2/kWh
Total Torque Savings with Timken =	0.175	NM
Timken Efficiency Improvement:	13.2	%
Total number of bearings in mill:	480	-
Energy Consumption Per Competitor Bearing:	83.727	Watts
Energy Consumption Per Timken Bearing:	72.702	Watts
Total Energy Consumption Competitor:	40188.96	Watts
Total Energy Consumption Timken:	34896.96	Watts
Lifetime Energy Consumption Competitor Bearing:	1760276448	Watts
Lifetime Energy Consumption Timken Bearing:	1528486848	Watts
Savings Calculations	**Watt-Hours**	**$**
Per Bearing Lifetime:	*482895*	*$82.09*
Per Mill Stand Lifetime:	*1931580*	*$328.37*
Entire Mill (5 Years):	***231789600***	***$39,404.23***



Belt Efficiency: Product Design

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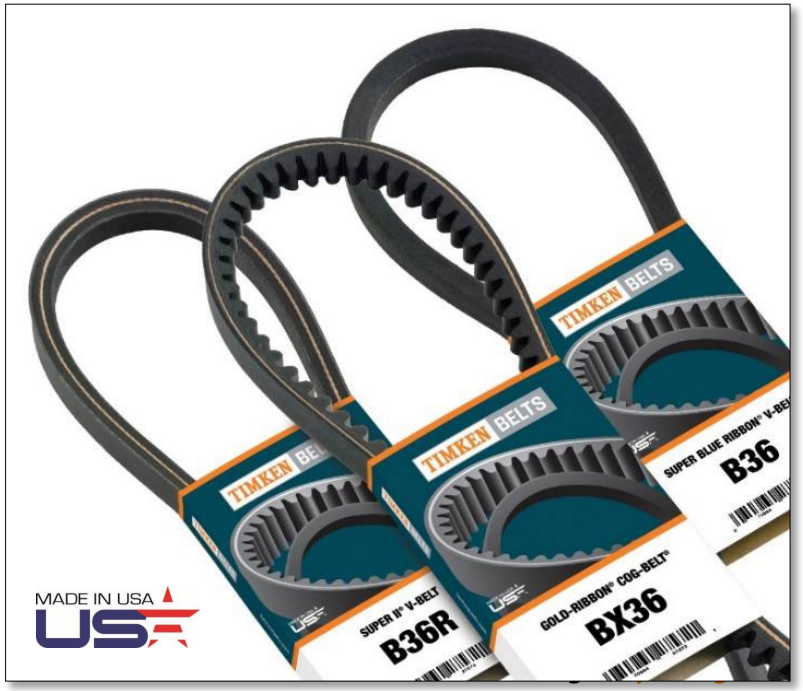
TIMKEN BELTS History

1905 Dayton Rubber Manufacturing Company (DRMC) founded
1921 DRMC invents first raw edge V-belt
1926 DRMC invents cog-type raw edge V-belt
1959 New belt plant opens in Springfield, MO
1960 DRMC becomes Dayco
1969 Technical center established in Springfield, MO
1986 New belt plant opens in Fort Scott, KS
2001 Carlisle Companies acquires the industrial belt division of Dayco
2015 The Timken Company acquires the Carlisle belt business
2015 One billionth belt sold
2015 Introduces Panther XT belts
2017 Launches Drive Engineer app
2021 Formally launch Timken brand belts



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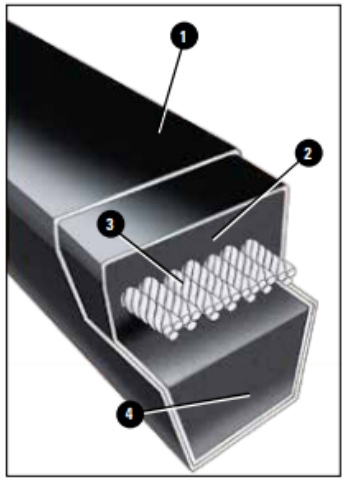
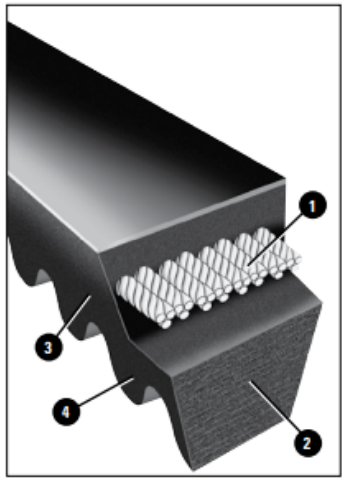
Roll Stand: Input Drive Belt Selection

There are two basic types of v-belt construction. One is wrapped molded which has a fabric cover. The other – usually rated higher in horsepower – is known as raw edge.



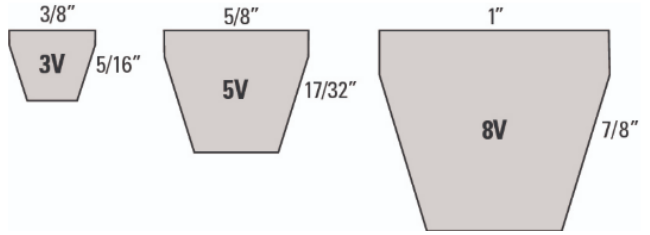
Wrapped Molded V-Belt

1. **Cover**
   Heavy duty fabric impregnated with rubber protects the core.
2. **Tension Section**
   Synthetic rubber specially compounded to stretch as belt bends around sheaves.
3. **Cords**
   High-strength synthetic fiber cords carry the horsepower load.
4. **Compression Section**
   Synthetic rubber compounds developed to support cords evenly and compress while bending around sheaves.

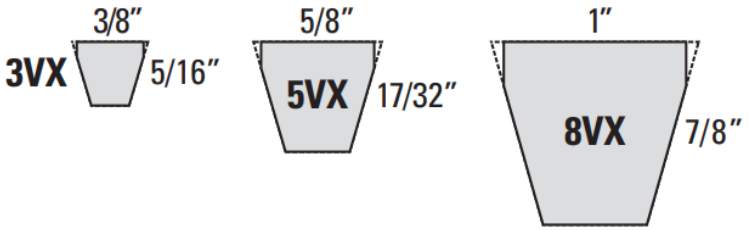


Raw Edge Cog-Belt

1. **Cords**
   High-strength synthetic fiber cords carry the horsepower load.
2. **Compression Section**
   EPDM compound is resistant to heat and cracking, supports the cords evenly and compresses while bending around sheaves.
3. **Raw Edge Sidewalls**
   Grip the sheave to reduce slippage and increase efficiency. Allow more cord width for increased horsepower capacity.
4. **Cogs**
   Some raw edge belts have precision molded cogs to improve belt flexibility and reduce bending stress on small diameter sheaves.



Wrapped Belts (Ex. A, B, C, 3V, 5V)
93% Efficient



Raw Edge Cog-Belt (Ex. AX, BX, CX, 3VX, 5VX)
95% Efficient

Differential Drive Belts

Synchronous/V-Ribbed Belt

- 8M or 14M RPP® synchronous profile with PVK on the back

Designed to improve performance and drive life offering high torque synchronous along with v-ribbed capability. Uniquely engineered with an advanced polymer compound, the belts are resistant to oil, heat, and abrasion.

Dual Sided Synchronous Belt

- Double sided 8M or 14M RPP® synchronous profile

Dual sided synchronous belt delivers 100% load capacity on both sides of the belt. The belt features an advanced polymer construction, strong fiberglass cords, and a wear resistant nylon tooth facing.

Double Sided V-Ribbed Belt

- Dual sided PVL v-ribbed belt

Double sided v-ribbed belts operate efficiently with high load-carrying capacity at high speeds on small diameter pulleys providing smooth, vibration-free performance in a compact drive. The special "truncated" rib design enhances belt flexibility and resists cracking.

SYNCHRONOUS/V-RIBBED ROLLER MILL BELT

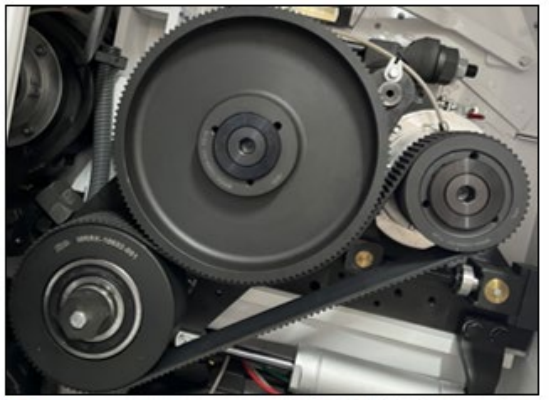
1760	-	8M	-	PK	12	-	3
Pitch length (mm)		Tooth pitch		V-ribbed K profile	Number of Ribs		Number of matched belts

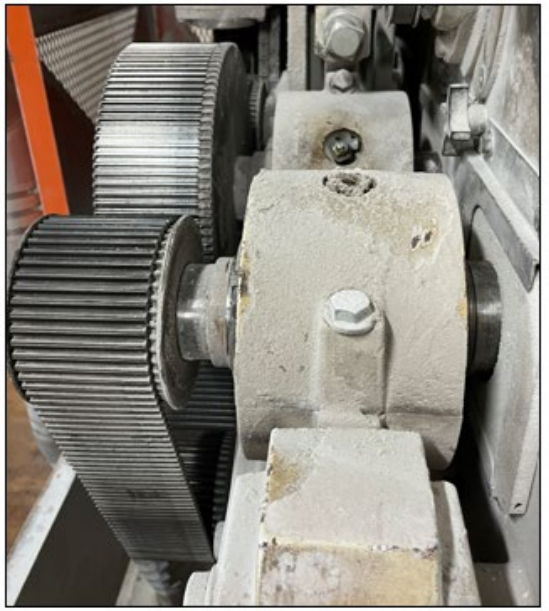
DUAL SIDED SYNCHRONOUS ROLLER MILL BELT

D	1778	-	14M	-	55
Double sided	Pitch length (mm)		Tooth pitch		Width (mm)

DUAL SIDED V-RIBBED ROLLER MILL BELT

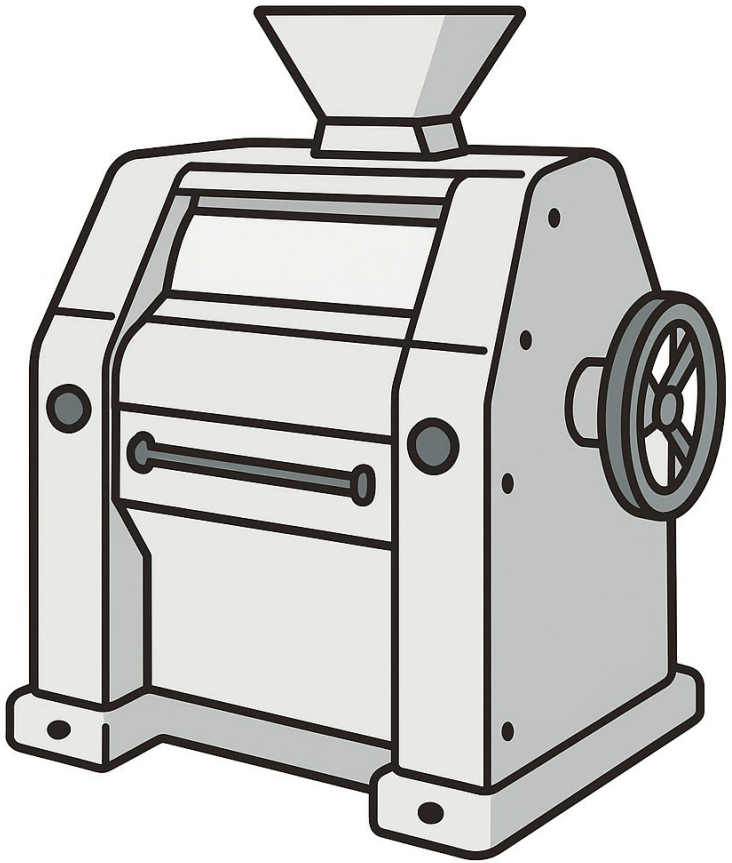
1765	PVL	22	D
Effective length (mm)	V-ribbed L profile	Number of Ribs	Double sided





- Synchronous belts typically achieve an efficiency of around 98%

Roll Stand / Input Drive Efficiency – Single Stand



Hours Used Per Year: 8760 — CALCULATE HOURS

Motor Rating: 35 HP

Motor Efficiency: 90 %

Utility Rate: .1289 KWH

Premium Cost: $

Upgrade From: Super Power-Wedge (3V, 5V, 8V)

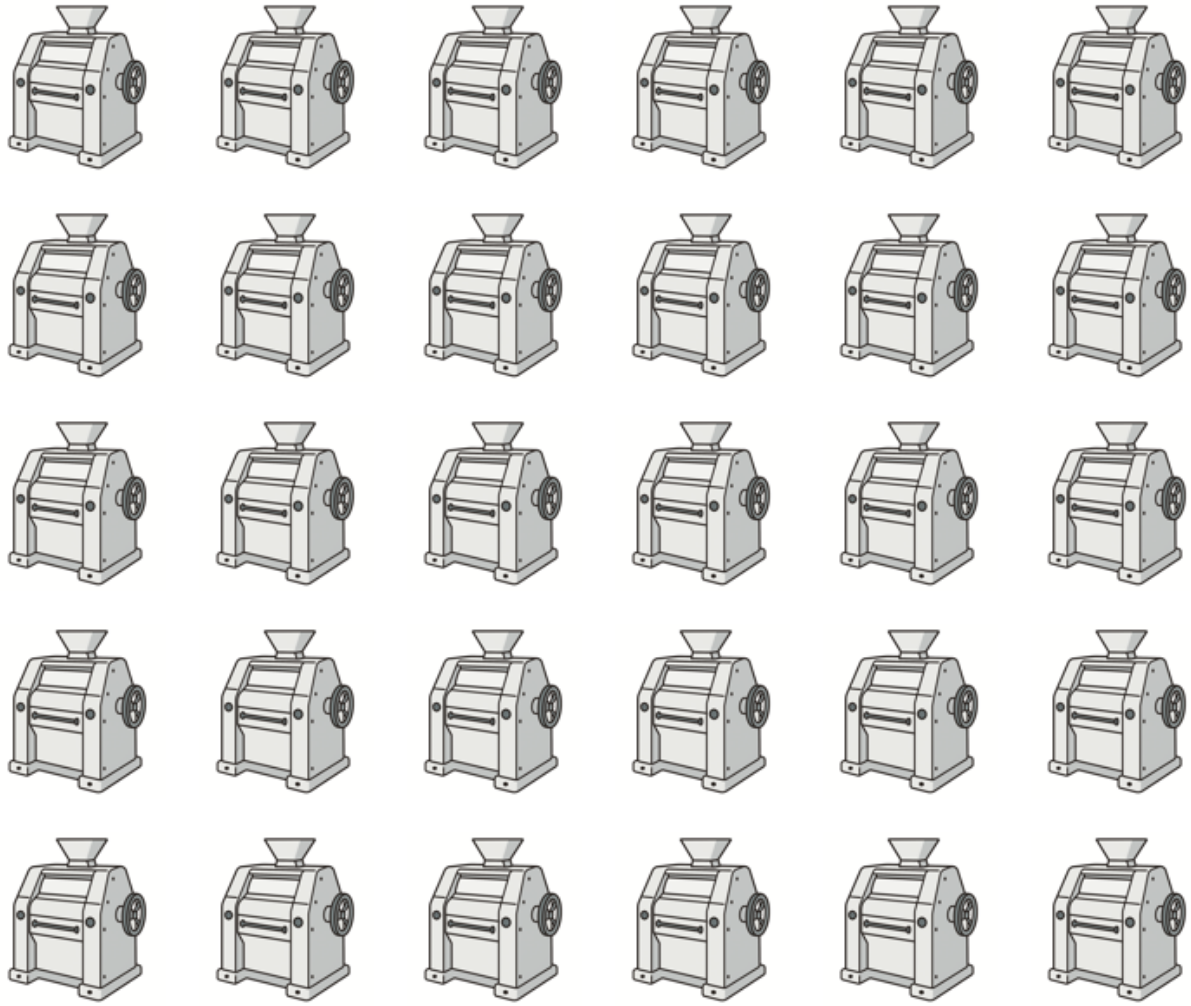
Upgrade To: Power-Wedge Cog-Belt (3VX, 5VX, 8VX)

ENERGY SAVINGS

Annual KWH:	254,137
Annual Energy Cost:	$ 32,758.30
Annual Energy Savings:	$ 655.17
Payback:	0.00 months

2% efficiency gain on a roll stand operating 24/7 would result in $655/yr. savings

Roll Stand / Input Drive Efficiency

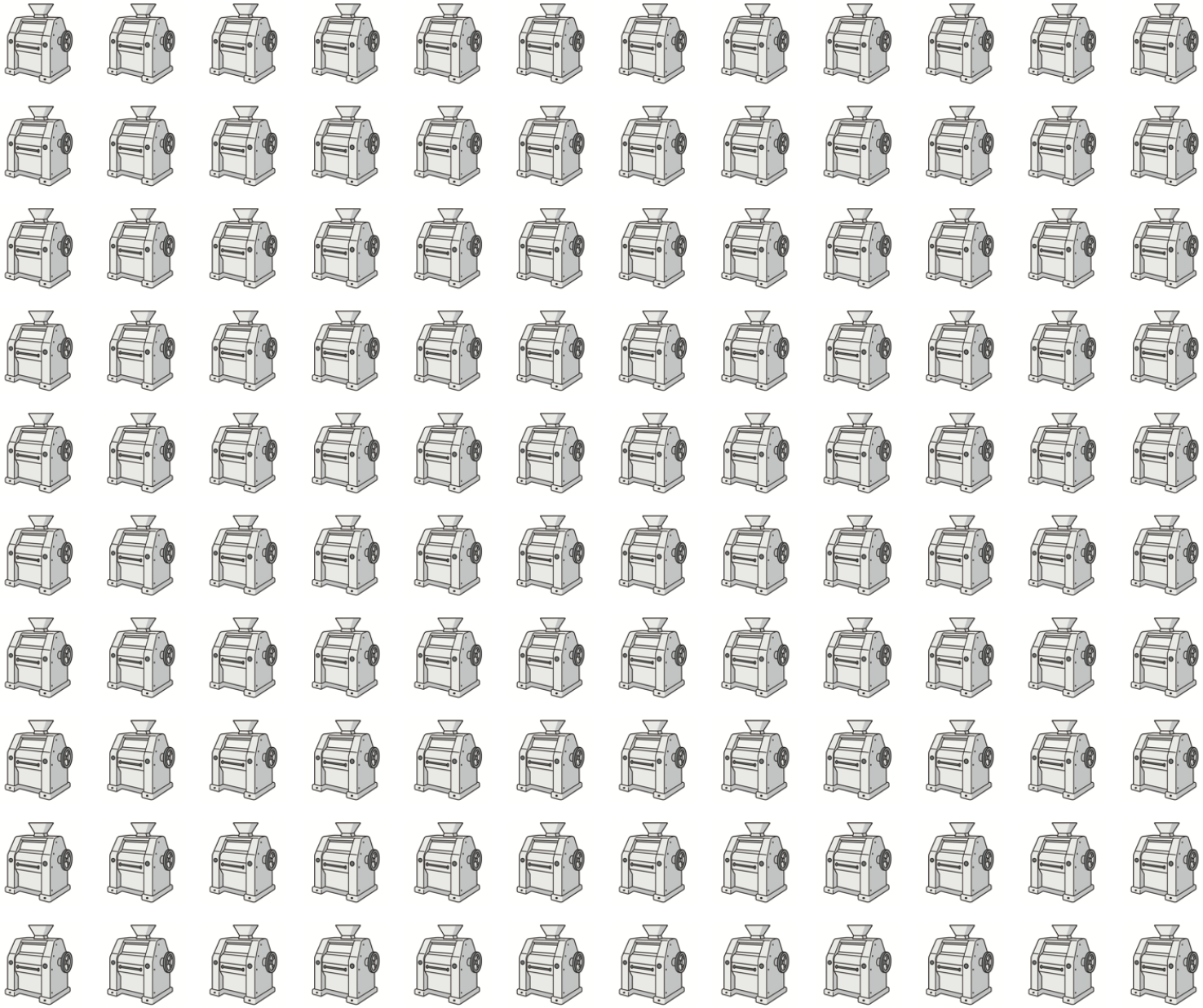


Mill operating 30 single high roll stands.

2% Efficiency Gain X 30 X $655 savings

= $19,650

Roll Stand / Input Drive Efficiency



Large flour mill operating 120 roll stands.

2% Efficiency Gain X 120 X $655 savings

= $78,600

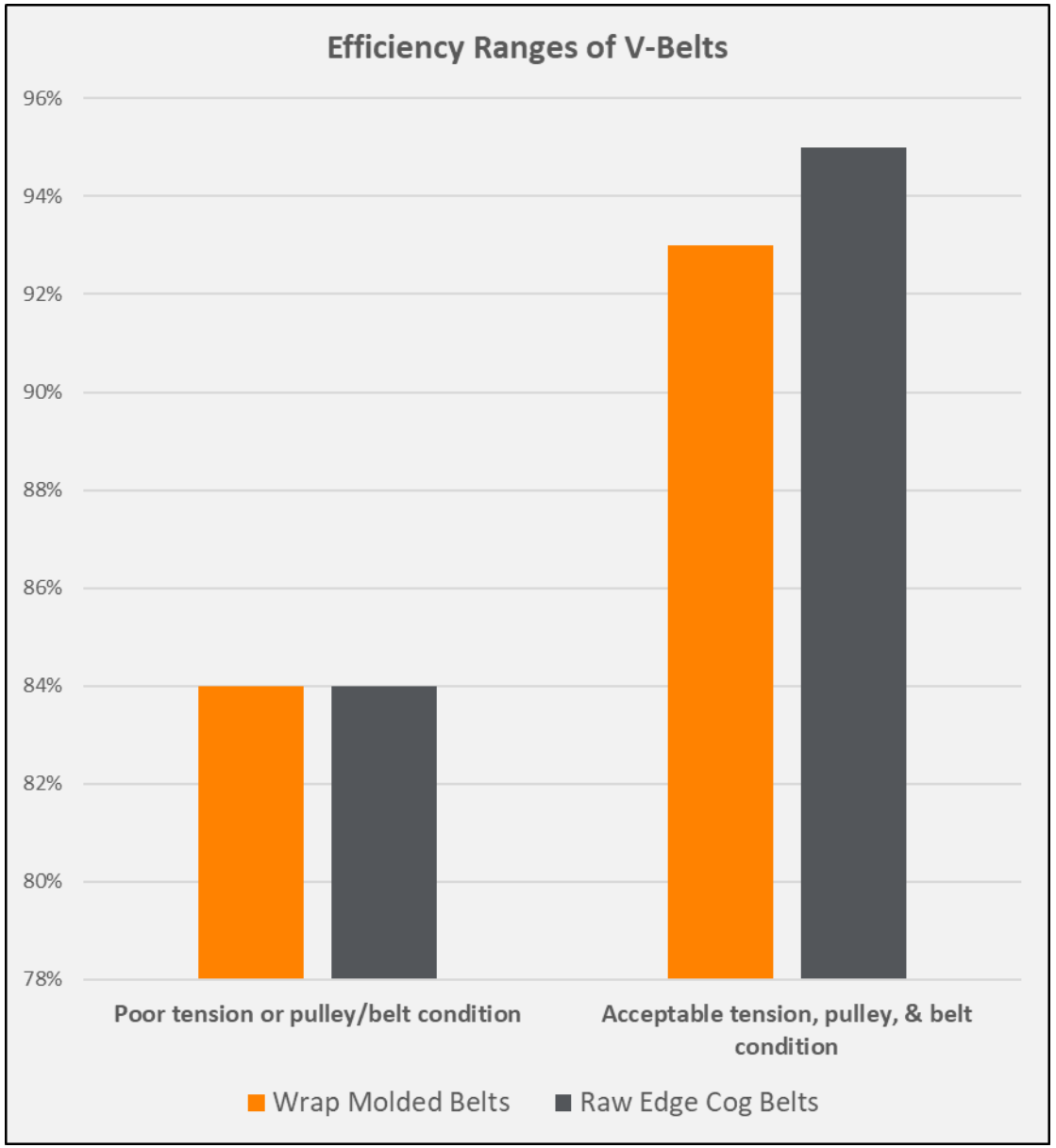
Belt Efficiency: Maintenance Best Practices

TIMKEN

Stronger. By Design.

Belt Tensioning & Alignment

- 93-95% belt efficiency assumes acceptable operating parameters
- Proper installation & maintenance of V-belts can achieve up to 97% efficiency
- Studies have shown efficiency losses can exceed 10% due to factors such as belt tension, pulley alignment, belt or sheave wear



Belt Tensioning, Alignment Tools

https://www.driveengineer.com/

Robust Drive Design & Analysis in the Palm of Your Hand!

The powerful Drive Engineer® web app from Timken Belts delivers robust belt drive design and analysis to your desktop or mobile device!

- For v-belt or synchronous drives
- Comprehensive belt, pulley and drive details
- Easily filter results
- Lookup tools and drop-down menus
- Conflict detection and warnings
- Pop-up drive design tips
- Easy to save and share results
- PowerMiser™ energy savings calculator
- Imperial or metric data input
- Belt tensioning training videos
- Literature and other resources

www.driveengineer.com
Desktop: Save to "Favorites"
Mobile Applications: "Add to Home Screen"

Drive Engineer is a free web application and is not available from the App store.

- Leverage Timken belt & specialists to complete maintenance training sessions
- Use driveengineer.com to calculate drive efficiency, installation frequencies, and more
- Easy tool to use to quantify cost savings

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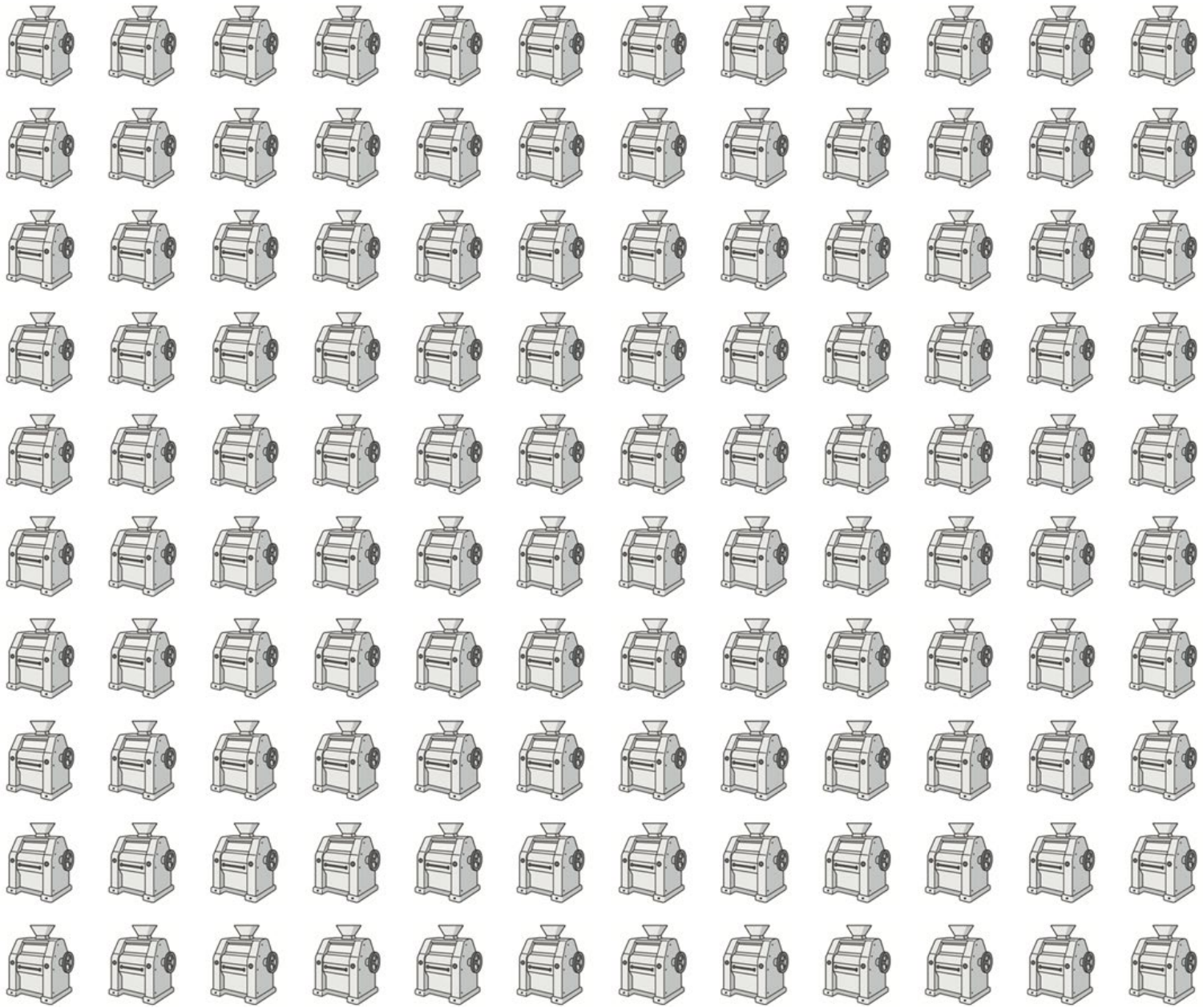
Roll Stand / Input Drive Efficiency – 5% Efficiency Gain



ENERGY SAVINGS

Annual KWH:	254,137	
Annual Energy Cost:	$ 32,758.30	
Annual Energy Savings:	$ 1,637.92	
Payback:	0.00	months

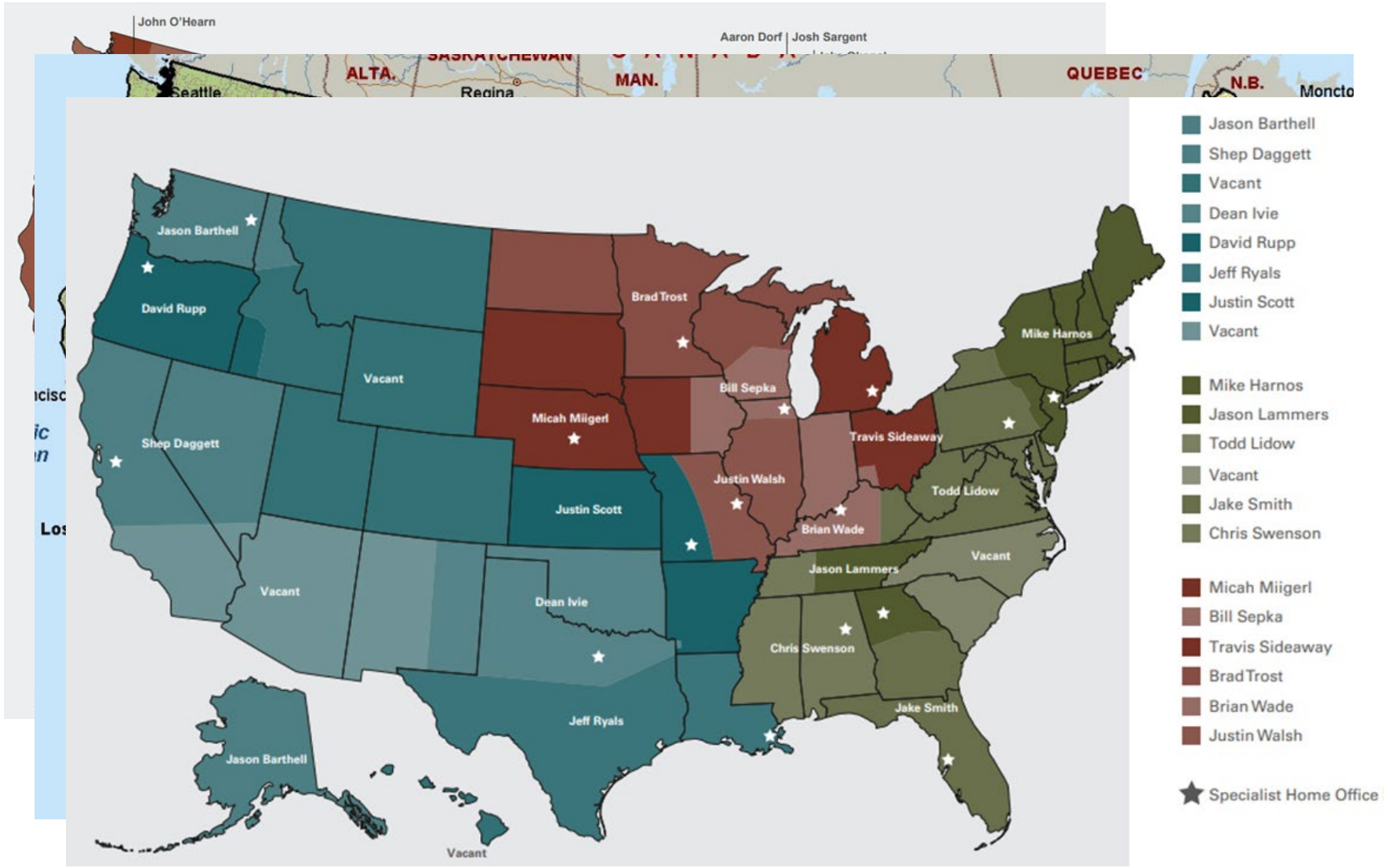
Large flour mill operating 120 roll stands.

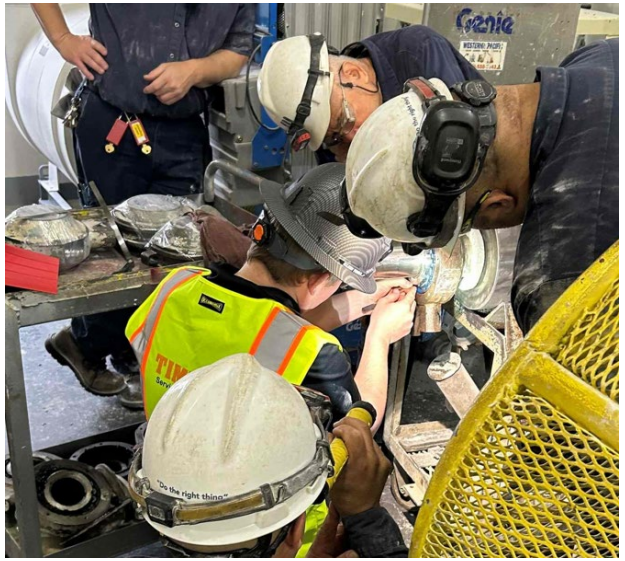
5% Efficiency Gain X 120 X $1,638 savings

= $196,600

What can you do to achieve savings?

- Leverage products and resources (**training = free!**) offered by Timken
- Other considerations: lubrication programs, sealing, damage analysis, etc.





THANK YOU

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- **Wally Sarnowski – SE Regional Director**
- **Nate Wilson – District Manager (Mississippi, Tennessee, Kentucky)**
- **Tyler Julian – Sales Engineer (S Indiana/ N Kentucky)**
- **Brian Wade – Belt/Chain Specialist (Indiana/Kentucky)**