23%

ENERGY EFFICIENCY
MACHINE RELIABILITY
RENEWABLE TECHNOLOGIES

LUBRICATION EXPERT

“23% of the world’s total energy consumption originates from tribological contacts. Of that 20% (103EJ) is used to overcome friction and 3% (16EJ) is used to remanufacture worn parts and spare equipment due to wear and wear-related failures”

- Holmberg, Erdemir (2017) Friction

“23% of the world’s total energy consumption originates from tribological contacts. Of that 20% (103EJ) is used to overcome friction and 3% (16EJ) is used to remanufacture worn parts and spare equipment due to wear and wear-related failures”

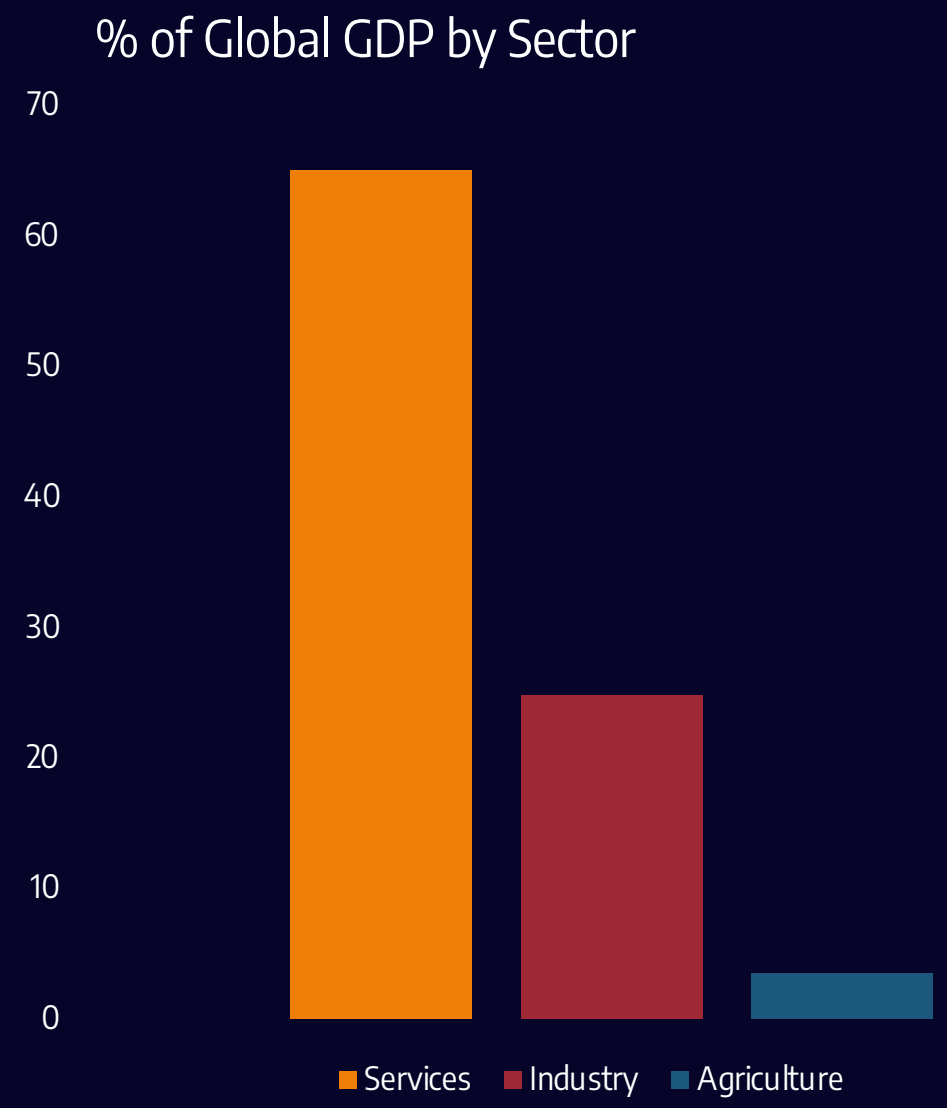
- Holmberg, Erdemir (2017) Friction

“Energy losses due to friction and wear could potentially be reduced by 40% in the long term (15 years) and 18% in the short term (8 years). On a global scale these savings would amount to 1.4% of the GDP annually and 8.7% of the total energy consumption in the long term”

- Holmberg, Erdemir (2017) Friction

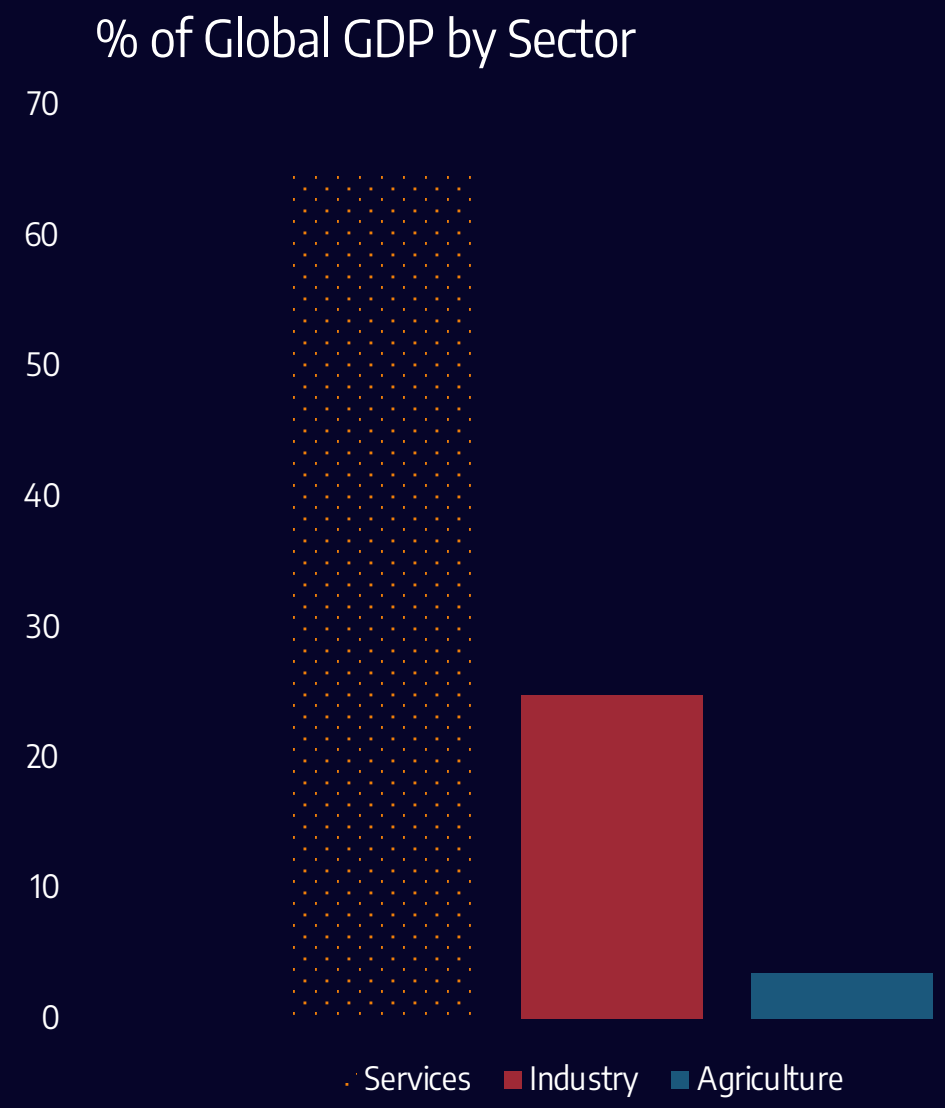
“Energy losses due to friction and wear could potentially be reduced by 40% in the long term (15 years) and 18% in the short term (8 years). On a global scale these savings would amount to 1.4% of the GDP annually and 8.7% of the total energy consumption in the long term”

- Holmberg, Erdemir (2017) Friction



“Energy losses due to friction and wear could potentially be reduced by 40% in the long term (15 years) and 18% in the short term (8 years). On a global scale these savings would amount to 1.4% of the GDP annually and 8.7% of the total energy consumption in the long term”

- Holmberg, Erdemir (2017) Friction

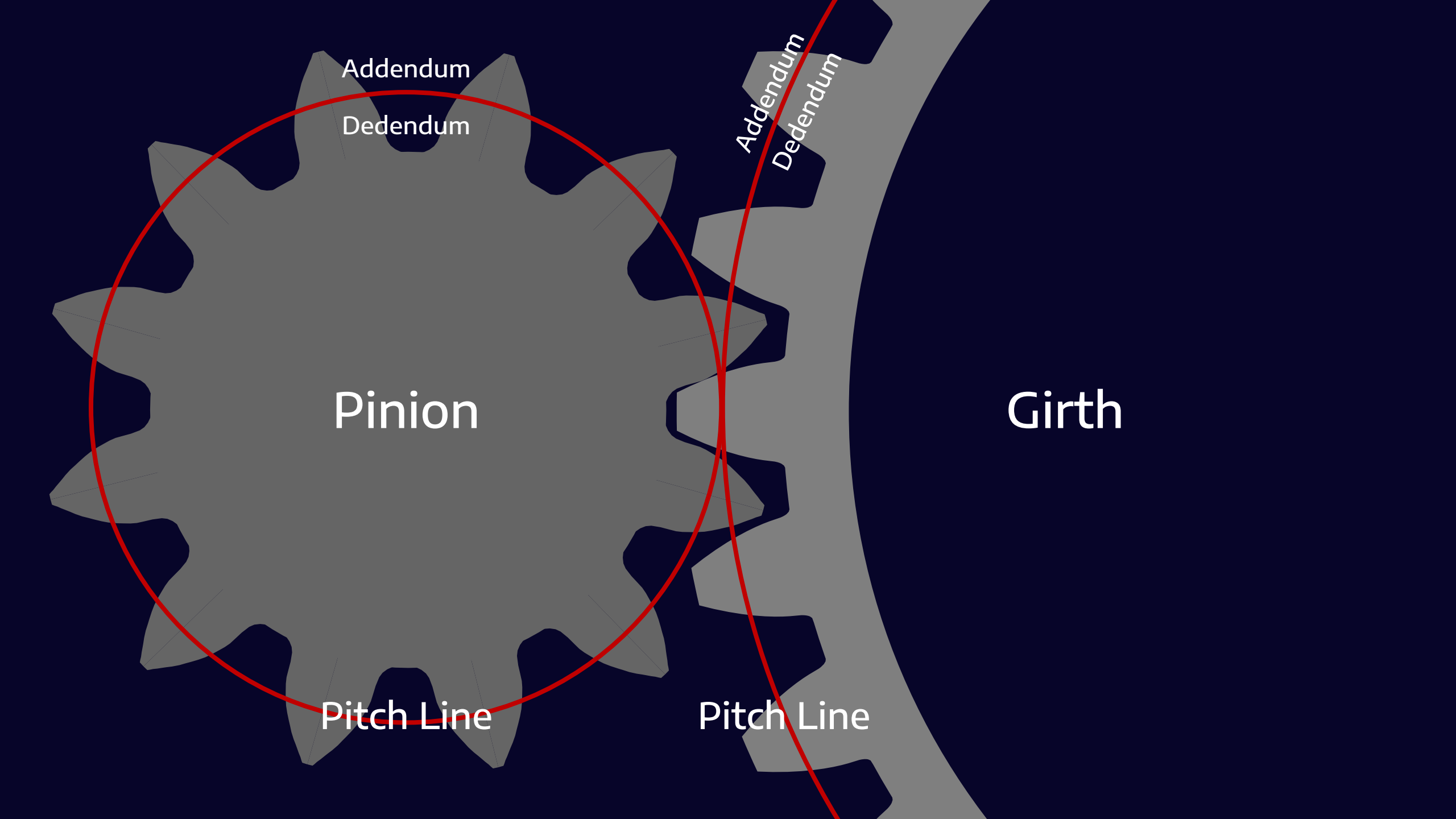


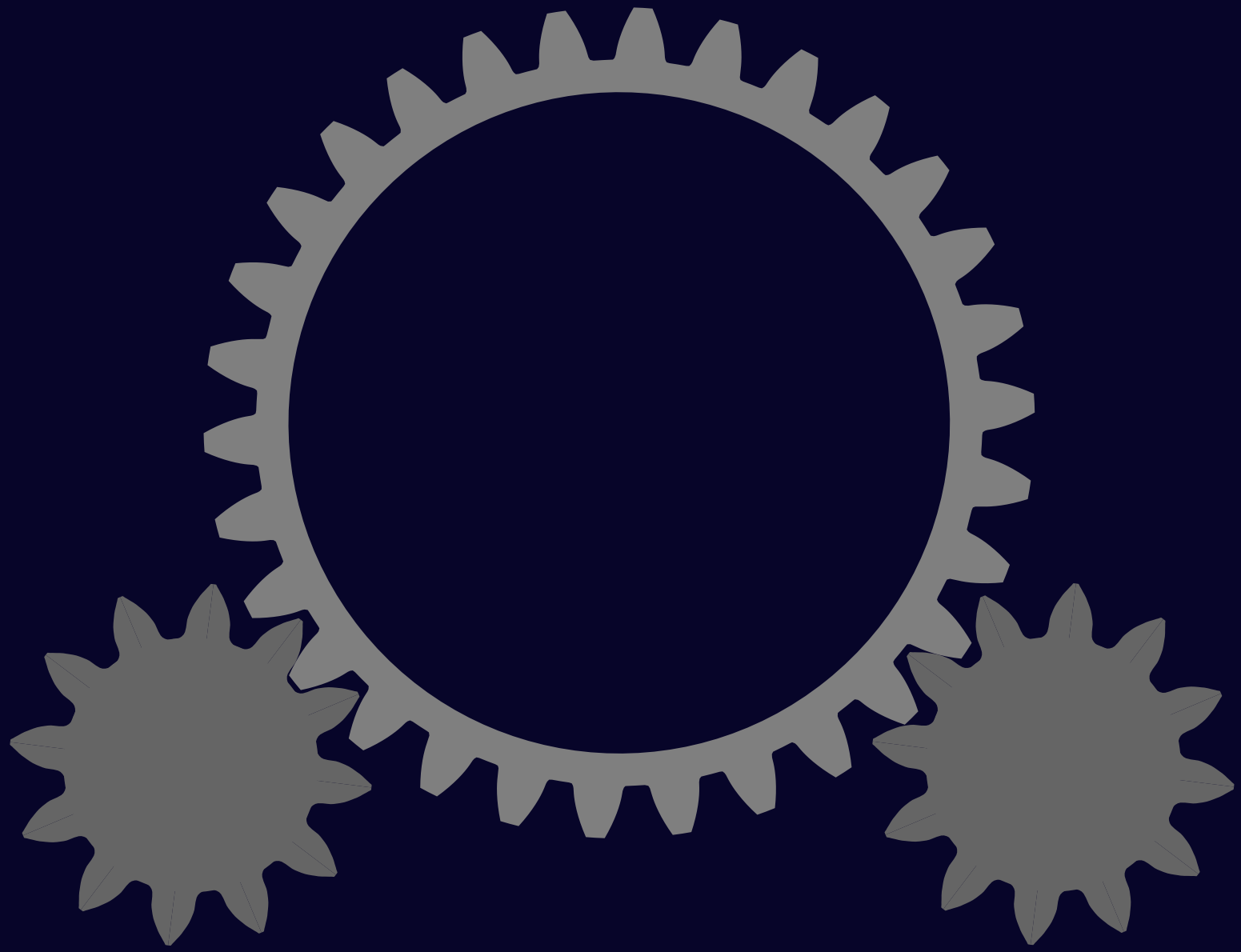
5%

ENERGY

ENERGY EFFICIENT

ENERGY EFFICIENT LUBRICANTS


Addendum
Dedendum
Addendum
Dedendum
Pinion
Girth
Pitch Line
Pitch Line



Seal Drag

Churn

Windage

Circulation

Gear Mesh

Bearings

Seal Drag

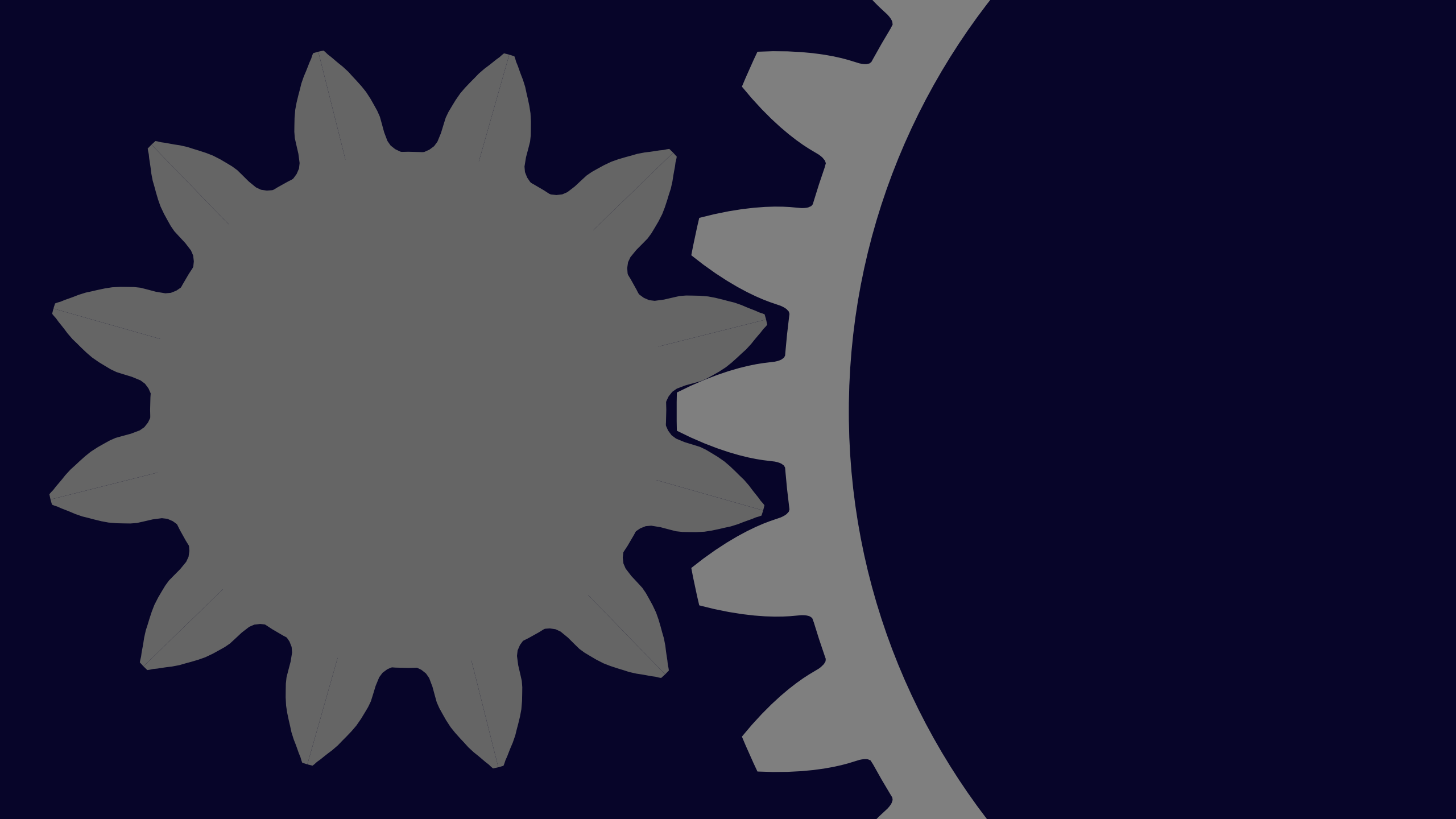
Churn

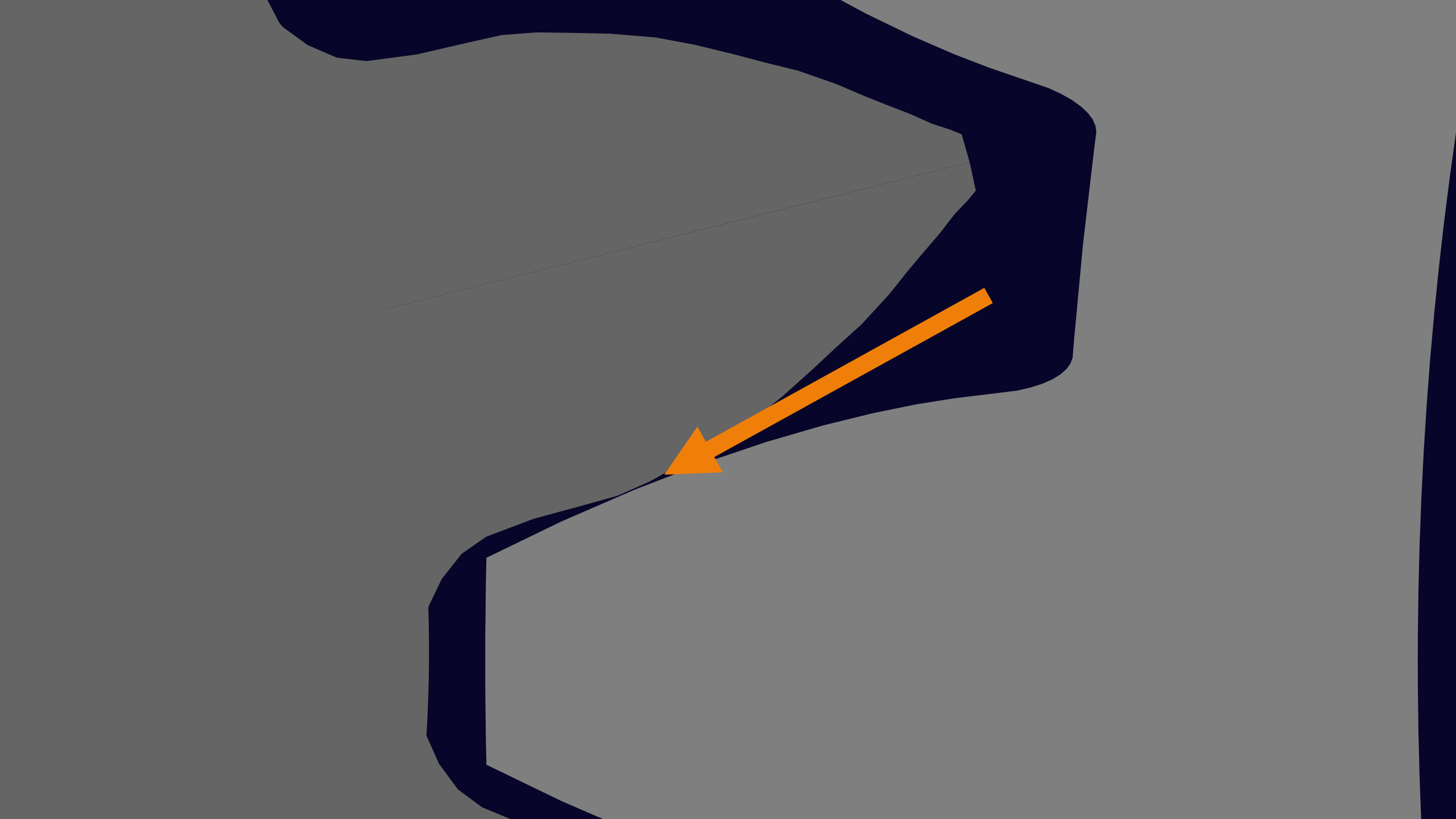
Windage

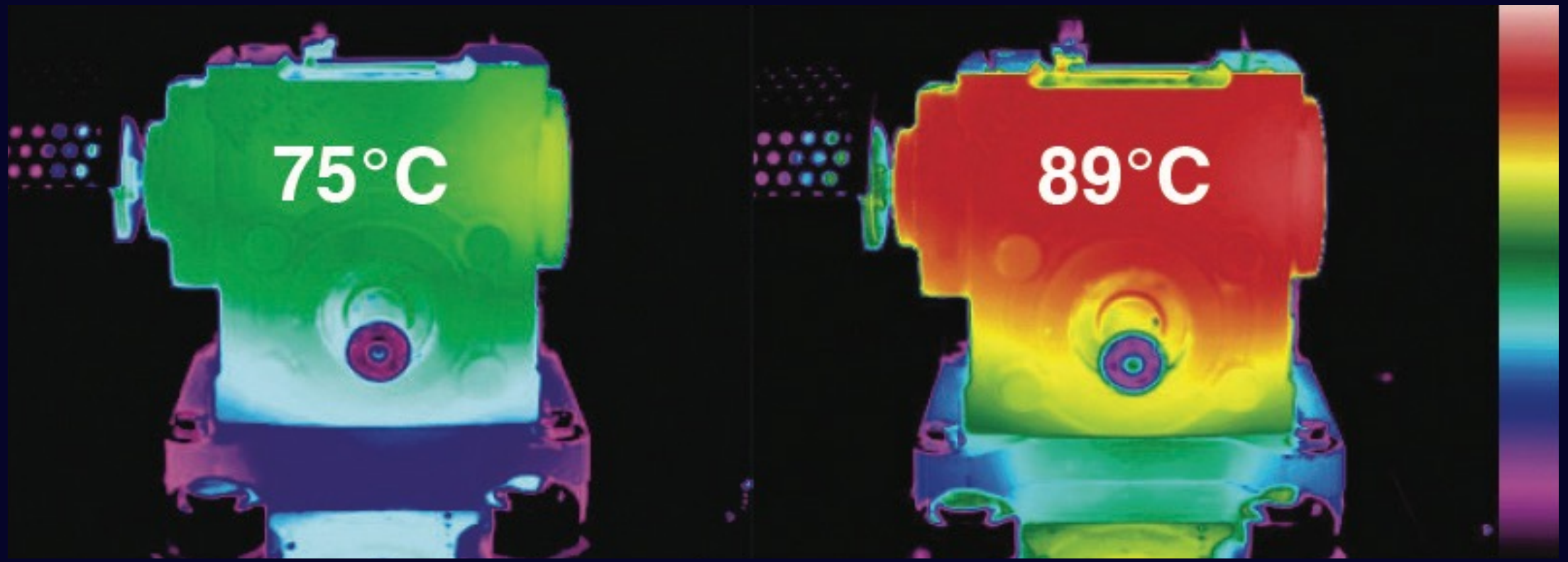
Circulation

Gear Mesh

Bearings







Source: Mobil

Table 3. Case Study #3 - Ammonia Refrigeration Compressors

No.	Company/Location	Comp. Type	HP	Prev. Oil	Elec. Cost kwhr ($)	1000 hr Oper. Cost ($)	Savings Percent	Savings / 1000 hrs. ($)
1	Cold Storage Plant/Ga.	screw	75	mineral	0.0500	3,108.38	9.20	285.97
2	Food Plant/Ark.	screw	300	synthetic	0.0400	9,946.80	7.90	785.80
3	Food Plant/Ark.	screw	300	synthetic	0.0400	9,946.80	9.19	914.11
4	Food Plant/Iowa	screw	400	mineral	0.0550	18,235.80	11.48	2,093.47
5	Food Plant/Kan.	recip.*	200	mineral	0.0500	8,289.00	11.53	955.72
6	Food Plant/Kan.	screw	450	mineral	0.0410	15,293.21	6.37	974.18
7	Food Plant/Kan.	recip.	200	mineral	0.0500	8,289.00	8.37	693.79
8	Food Plant/Kan.	screw	700	mineral	0.0560	32,492.88	7.46	2,423.97
9	Food Plant/Okla.	screw	350	mineral	0.0370	10,734.26	8.48	910.26
10	Food Plant/Texas	screw	100	mineral	0.0680	5,636.52	37.30	2,102.42
11	Food Plant/Texas	screw	150	mineral	0.0680	8,454.78	5.70	481.92
12	Frozen Food Plant/Ga.	screw	200	mineral	0.0700	11,604.60	9.30	1,079.23
13	Frozen Food Plant/Okla.	screw	150	mineral	0.0650	8,081.76	9.00	727.36
14	Frozen Food Plant/Texas	screw	450	synthetic	0.0350	13,055.18	8.10	1,057.47
15	Frozen Food Plant/Iowa	recip.	75	synthetic	0.0550	3,419.21	4.65	158.99
16	Meat Plant/Neb.	screw	75	mineral	0.0700	4,351.73	7.80	339.43
17	Meat Plant/Kan.	screw**	200	mineral	0.0415	6,879.87	11.14	766.42
18	Meat Plant/Kan.	screw	500	mineral	0.0415	17,199.68	10.32	1,775.01
19	Meat Plant/Kan.	screw	500	mineral	0.0415	17,199.68	11.11	1,910.88
20	Meat Plant/Kan.	screw	250	mineral	0.0500	10,361.25	16.97	1,758.30
21	Meat Plant/Kan.	screw	400	synthetic	0.0415	13,759.74	6.99	961.81
22	Meat Plant/Neb.	screw	500	mineral	0.0200	8,289.00	8.21	680.53
23	Meat Plant/Ill.	screw	400	mineral	0.0400	13,262.40	4.36	578.24
24	Poultry Plant/Ala.	screw	250	mineral	0.0500	10,361.25	11.27	1,167.71
25	Poultry Plant/Ark.	screw	400	mineral	0.0450	14,920.20	9.42	1,405.48
26	Poultry Plant/Ga.	screw**	125	mineral	0.0600	6,216.75	8.48	527.18
27	Poultry Plant/Mo.	screw	500	mineral	0.0570	23,623.65	4.12	973.29
28	Poultry Plant/Mo.	screw	450	mineral	0.0570	21,261.29	22.77	4,841.19
29	Poultry Plant/Mo.	screw	500	mineral	0.0300	12,433.50	4.20	522.21
30	Poultry Plant/Okla.	recip.**	175	mineral	0.0600	8,703.45	10.80	939.97
31	Poultry Plant/Okla.	screw	500	mineral	0.0450	18,650.25	13.80	2,573.73
32	Poultry Plant/Texas	recip.	75	synthetic	0.0670	4,165.22	12.74	530.65
33	Poultry Plant/Texas	screw	450	mineral	0.0400	14,920.20	9.00	1,342.82
34	Poultry Plant/Texas	screw	450	mineral	0.0400	14,920.20	6.19	923.56

* 502 Freon Gas
** Compressors in booster service 1 year = 8,760 hours

Note: Royal Purple's proprietary Synerlec® additive technology enabled Uni-Temp™ to produce energy savings even when replacing other premium synthetic oils.

Source: Royal Purple

Table 3. Case Study #3 - Ammonia Refrigeration Compressors

No.	Company/Location	Comp. Type	HP	Prev. Oil	Elec. Cost kwhr ($)	1000 hr Oper. Cost ($)	Savings Percent	Savings / 1000 hrs. ($)
1	Cold Storage Plant/Ga.	screw	75	mineral	0.0500	3,108.38	9.20	285.97
2	Food Plant/Ark.	screw	300	synthetic	0.0400	9,946.80	7.90	785.80
3	Food Plant/Ark.	screw	300	synthetic	0.0400	9,946.80	9.19	914.11
4	Food Plant/Iowa	screw	400	mineral	0.0550	18,235.80	11.48	2,093.47
5	Food Plant/Kan.	recip.*	200	mineral	0.0500	8,289.00	11.53	955.72
6	Food Plant/Kan.	screw	450	mineral	0.0410	15,293.21	6.37	974.18
7	Food Plant/Kan.	recip.	200	mineral	0.0500	8,289.00	8.37	693.79
8	Food Plant/Kan.	screw	700	mineral	0.0560	32,492.88	7.46	2,423.97
9	Food Plant/Okla.	screw	350	mineral	0.0370	10,734.26	8.48	910.26
10	Food Plant/Texas	screw	100	mineral	0.0680	5,636.52	37.30	2,102.42
11	Food Plant/Texas	screw	150	mineral	0.0680	8,454.78	5.70	481.92
12	Frozen Food Plant/Ga.	screw	200	mineral	0.0700	11,604.60	9.30	1,079.23
13	Frozen Food Plant/Okla.	screw	150	mineral	0.0650	8,081.76	9.00	727.36
14	n Food Plant/Texas	screw		synt	50	13,05	8.10	1,057.47
15	zen Food Plant/Iowa	recip.	75	nt/Ok	50	3, 1	4.6	158.99
16	eat Plant/Neb.	screw	75	ineral	700	4, 73	7.4	339.43
17	Me nt/Kan.	screw**		mineral	0415	6, 7	7	6.42
18	Me nt/Kan.	scr w		ineral	0415	17,1		01
1	Kan.	scr w	500	neral	0.0415	17,199.68	11	88
20	Me nt/Kan.	screw	250	nera	0.0500	10,361.25	6.97	30
21	Me nt/Kan.	screw		synth	0.0415	13,759.74	6.99	81
22	Meat Plant/Neb.	screw	500	mineral	0.0200	8,289.00	8.21	680.53
23	Meat Plant/Ill.	screw	400	mineral	0.0400	13,262.40	4.36	578.24
24	Poultry Plant/Ala.	screw	250	mineral	0.0500	10,361.25	11.27	1,167.71
25	Poultry Plant/Ark.	screw	400	mineral	0.0450	14,920.20	9.42	1,405.48
26	Poultry Plant/Ga.	screw**	125	mineral	0.0600	6,216.75	8.48	527.18
27	Poultry Plant/Mo.	screw	500	mineral	0.0570	23,623.65	4.12	973.29
28	Poultry Plant/Mo.	screw	450	mineral	0.0570	21,261.29	22.77	4,841.19
29	Poultry Plant/Mo.	screw	500	mineral	0.0300	12,433.50	4.20	522.21
30	Poultry Plant/Okla.	recip.**	175	mineral	0.0600	8,703.45	10.80	939.97
31	Poultry Plant/Okla.	screw	500	mineral	0.0450	18,650.25	13.80	2,573.73
32	Poultry Plant/Texas	recip.	75	synthetic	0.0670	4,165.22	12.74	530.65
33	Poultry Plant/Texas	screw	450	mineral	0.0400	14,920.20	9.00	1,342.82
34	Poultry Plant/Texas	screw	450	mineral	0.0400	14,920.20	6.19	923.56

* 502 Freon Gas
** Compressors in booster service 1 year = 8,760 hours

Note: Royal Purple's proprietary Synerlec® additive technology enabled Uni-Temp™ to produce energy savings even when replacing other premium synthetic oils.

4–37%

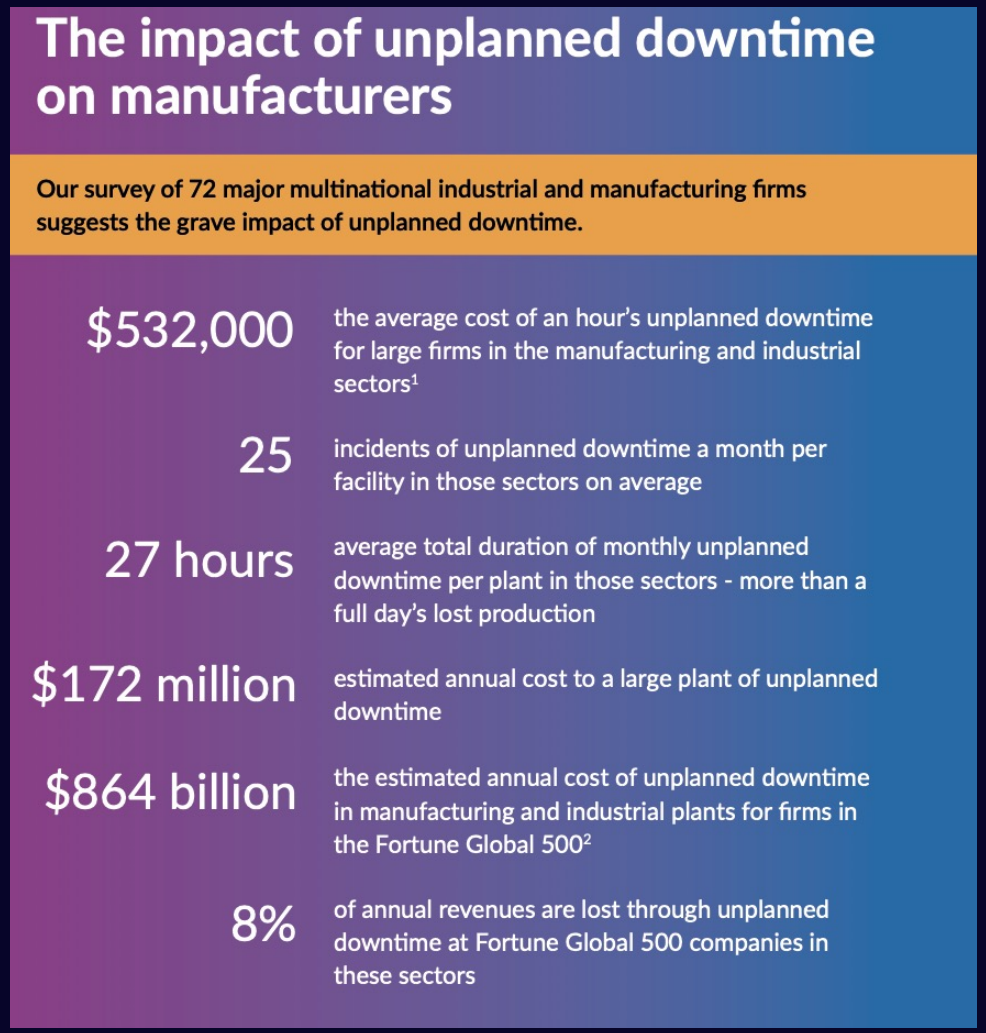
Source: Royal Purple

MACHINE

MACHINE FAILURE

MACHINE FAILURE AVOIDANCE

Annually, machine failures cost ~$1 Trillion



Senseye Industry Insights

International Society of Automation estimates that downtime costs the manufacturing industry nearly $650 billion every year.

"Six to seven percent (over $1 Trillion) of the Gross National Product is required just to repair the damage caused by mechanical wear."

Prof. Ernest Rabinowicz

“Proper selection and placement of contamination control devices in a system to attain the targeted cleanliness eliminates (the root cause of) up to 80% of hydraulic system failures”

- *Systematic Approach to Contamination Control*, Vickers Inc

PARETO

“Proper selection and placement of contamination control devices as a system to attain the targeted cleanliness eliminates the root cause of) up to 80% hydraulic system failure”

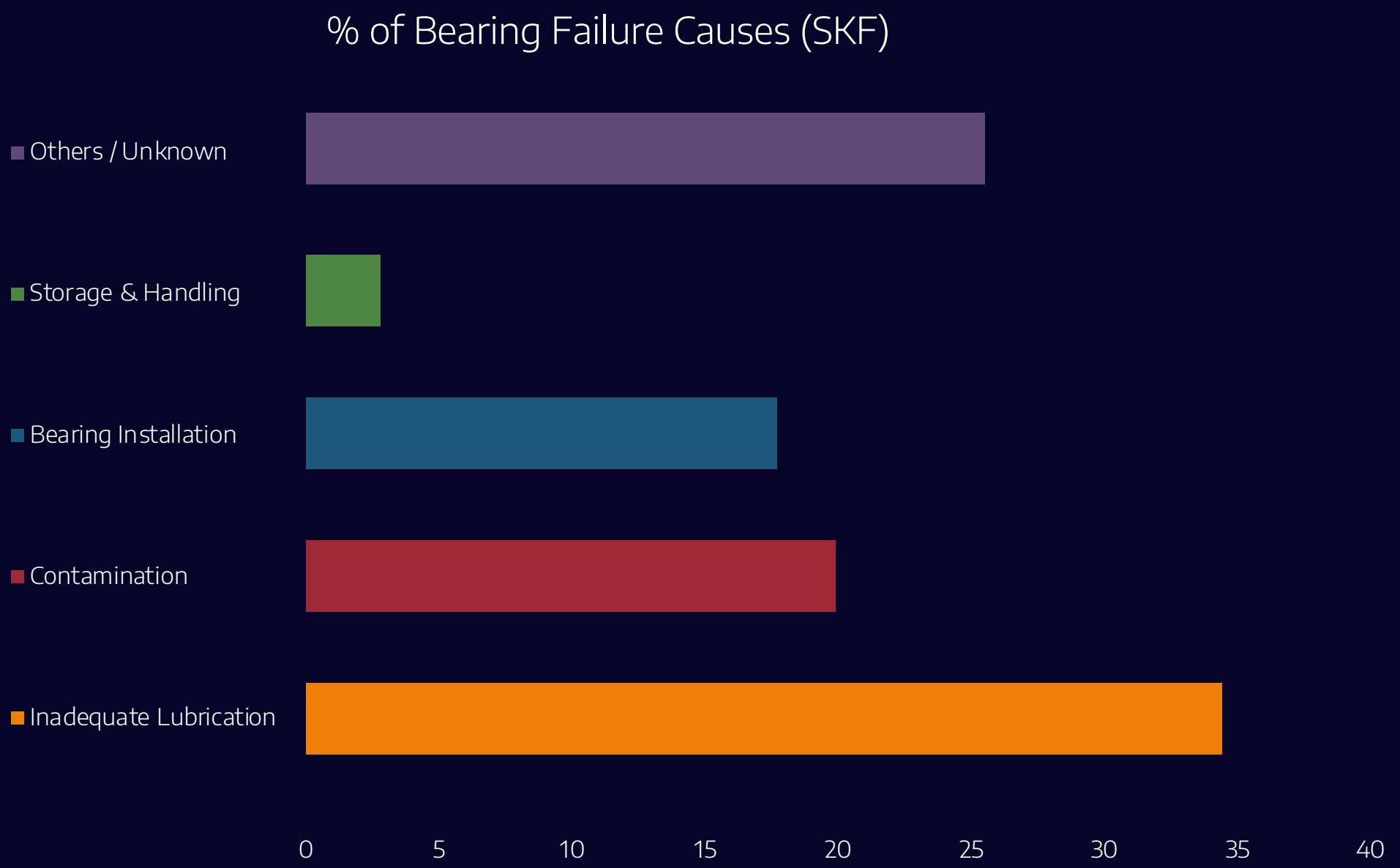
- *Systematic Approach to Contamination Control*, Vickers Inc

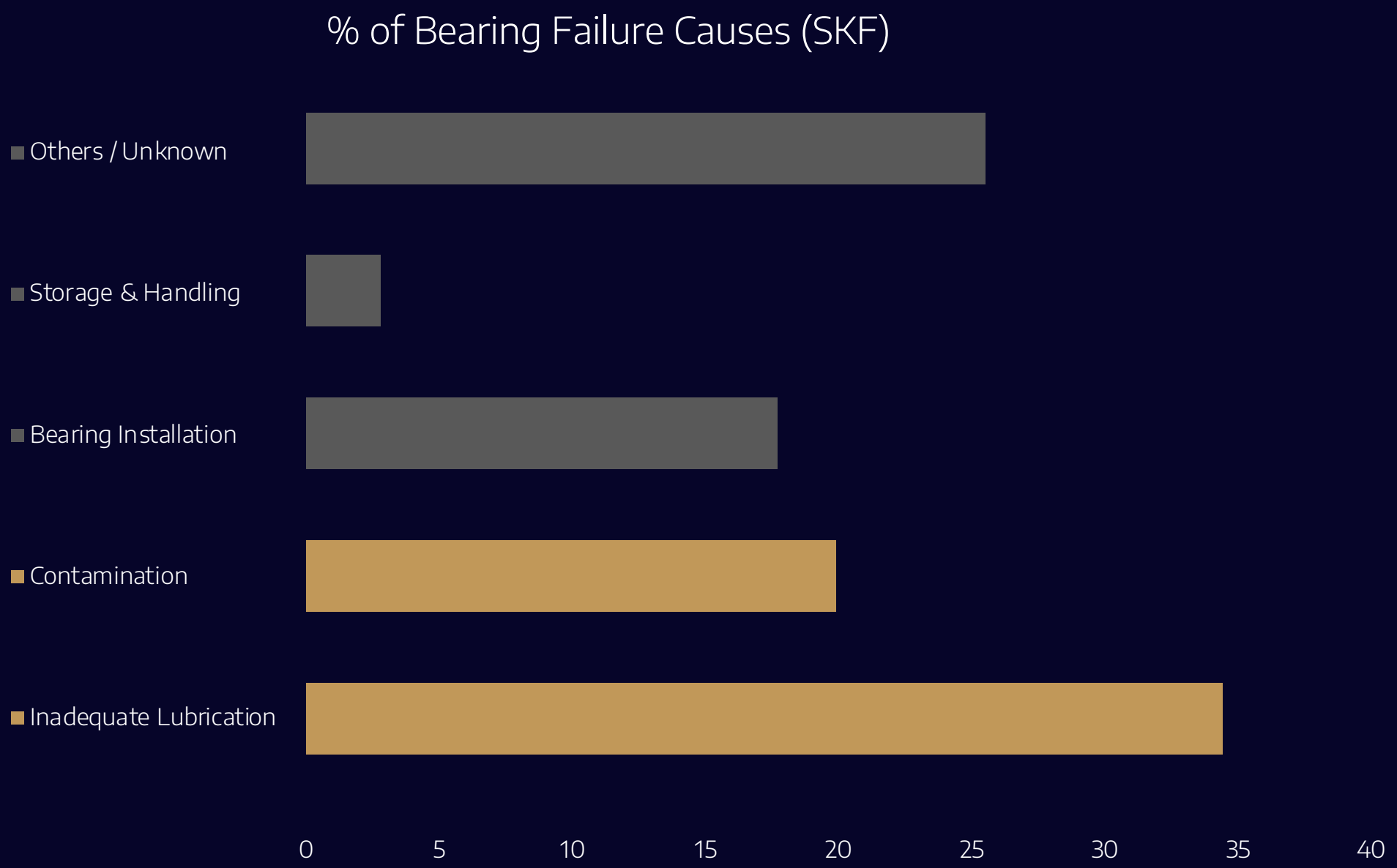
“... bearings can attain a much longer life than predicted by normal life calculation methods. These special conditions are when the rolling surfaces are effectively separated by a lubricant film and when the surface damage caused by contaminants is limited. In fact, under ideal conditions, it is possible to speak of infinite life”

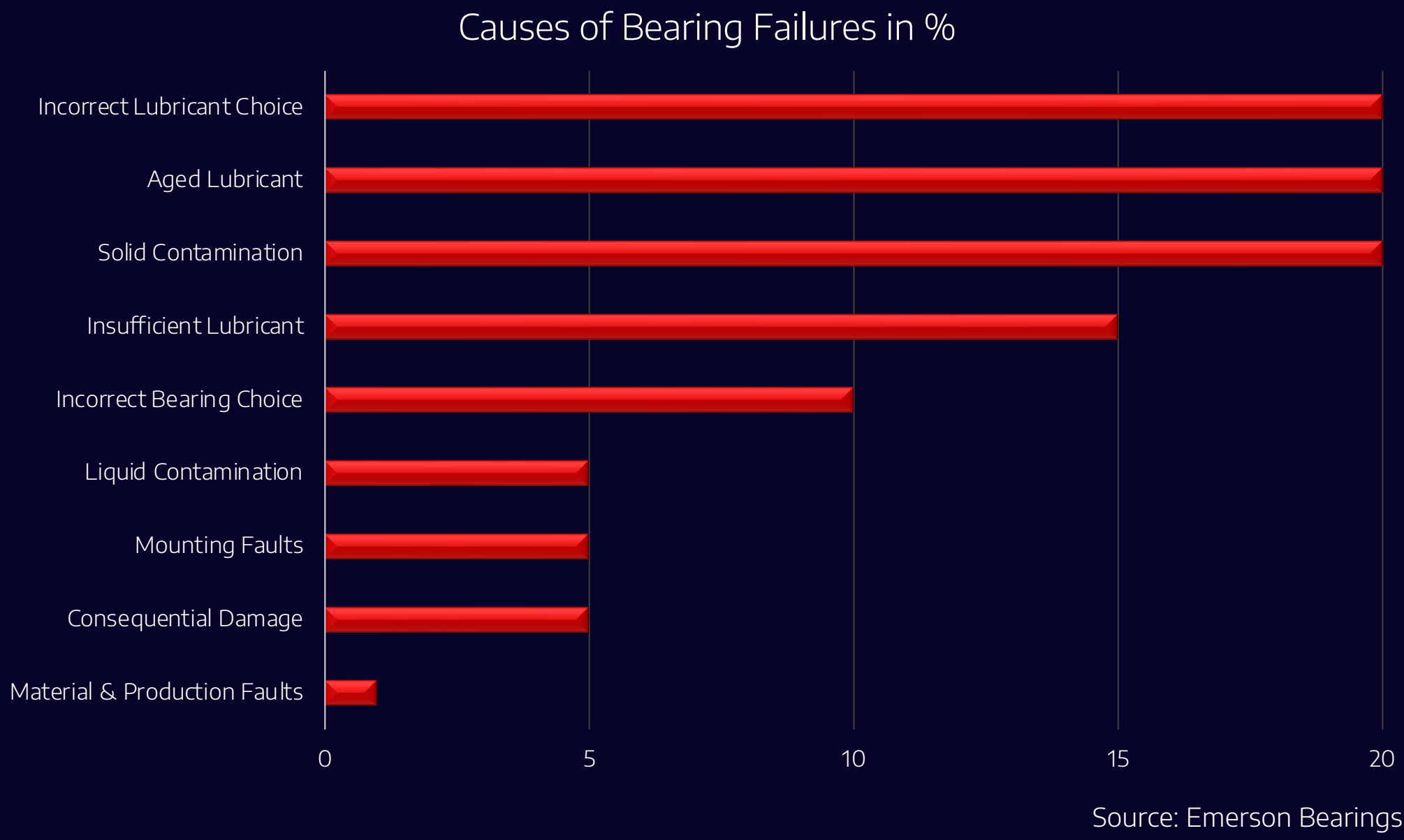
- *Bearing Maintenance Handbook*, SKF

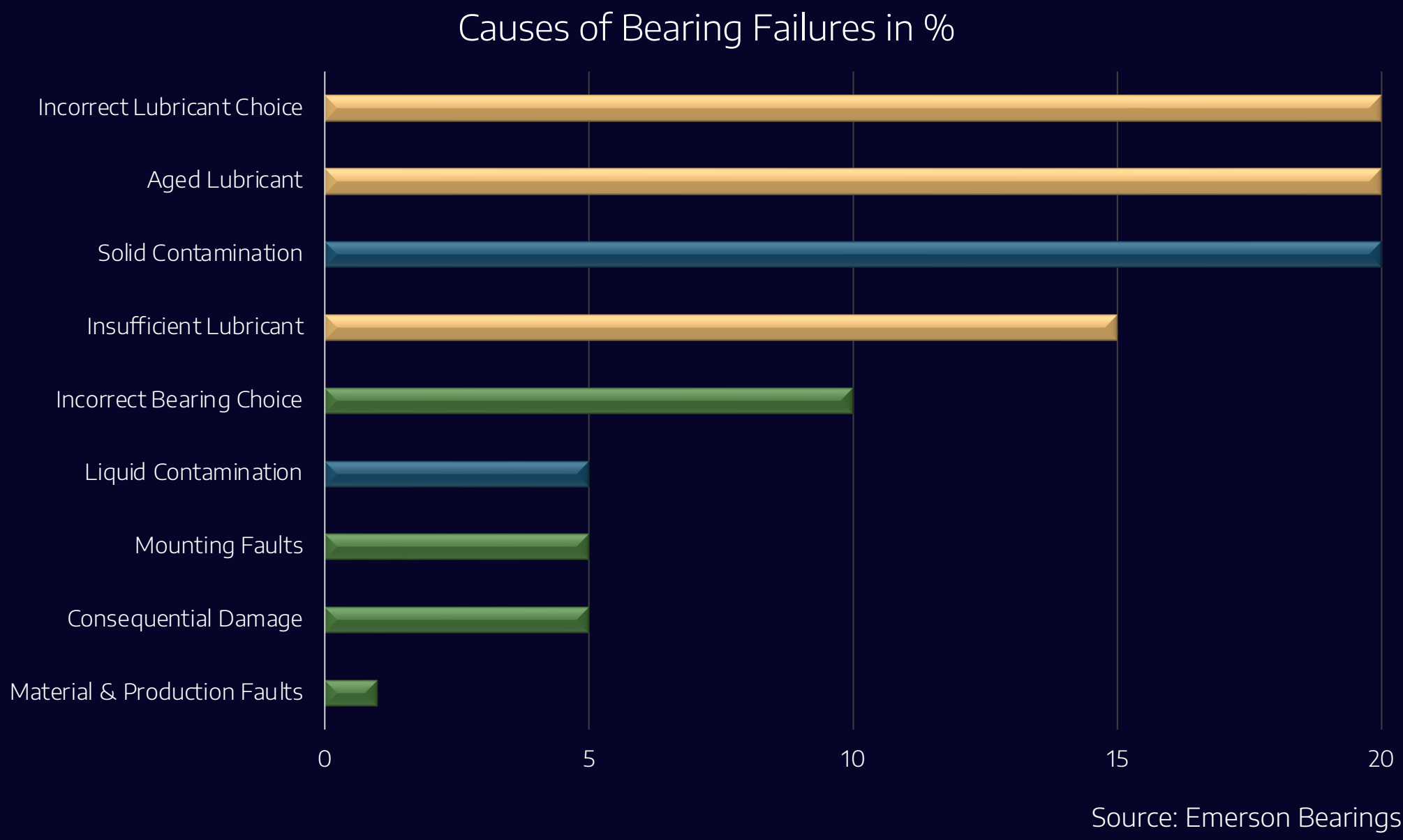
"... bearings can attain a much longer life than predicted by normal life calculation methods. These special conditions are when the rolling surfaces are effectively separated by a lubricant film and when the surface damage caused by contaminants is limited. In fact, under ideal conditions, it is possible to speak of infinite life"

- *Bearing Maintenance Handbook*, SKF

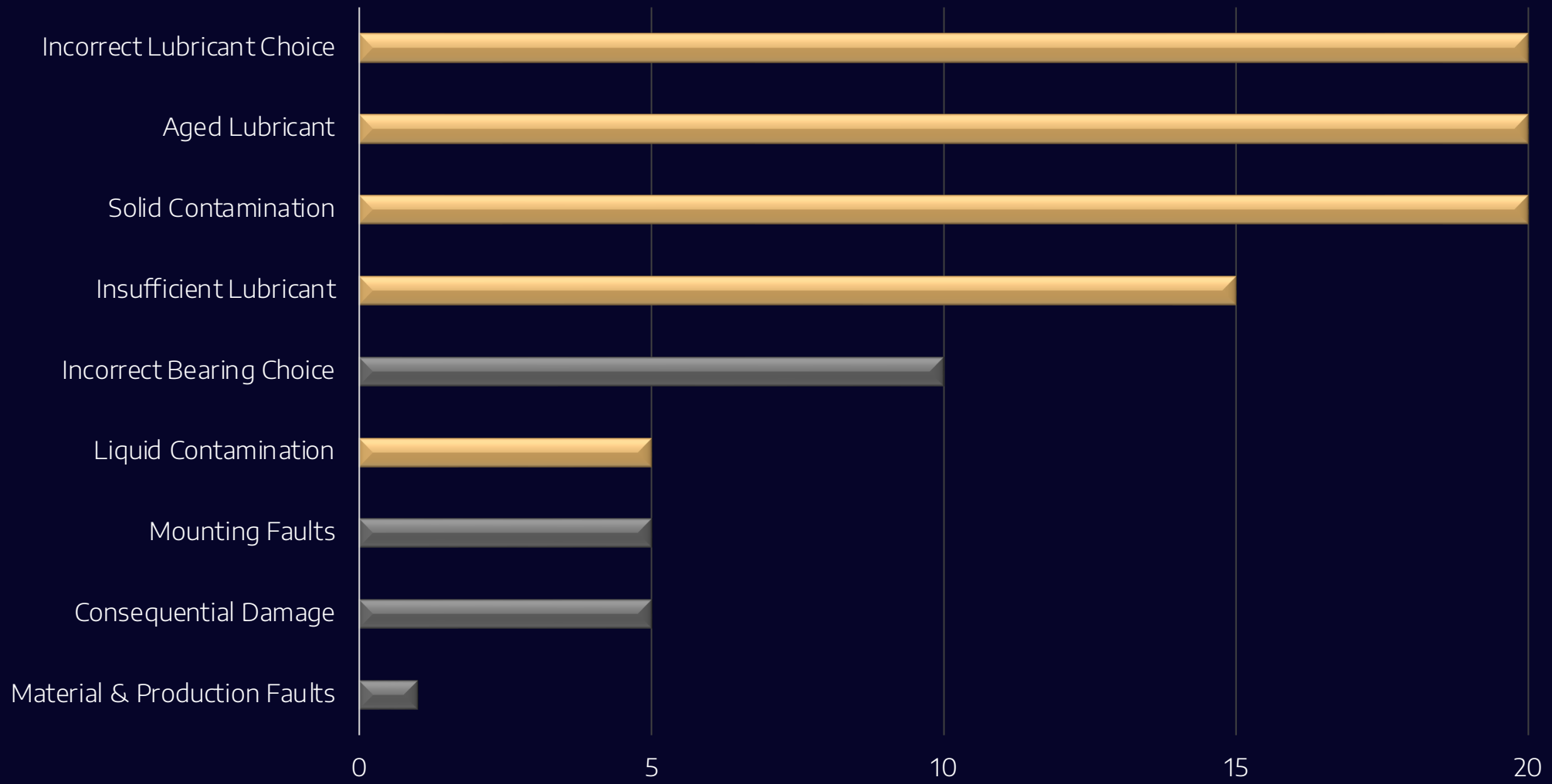

% of Bearing Failure Causes (SKF)
Others / Unknown
Storage & Handling
Bearing Installation
Contamination
Inadequate Lubrication
0
5
10
15
20
25
30
35
40


% of Bearing Failure Causes (SKF)
Others / Unknown
Storage & Handling
Bearing Installation
Contamination
Inadequate Lubrication
0
5
10
15
20
25
30
35
40


Causes of Bearing Failures in %
Incorrect Lubricant Choice
Aged Lubricant
Solid Contamination
Insufficient Lubricant
Incorrect Bearing Choice
Liquid Contamination
Mounting Faults
Consequential Damage
Material & Production Faults
0
5
10
15
20
Source: Emerson Bearings

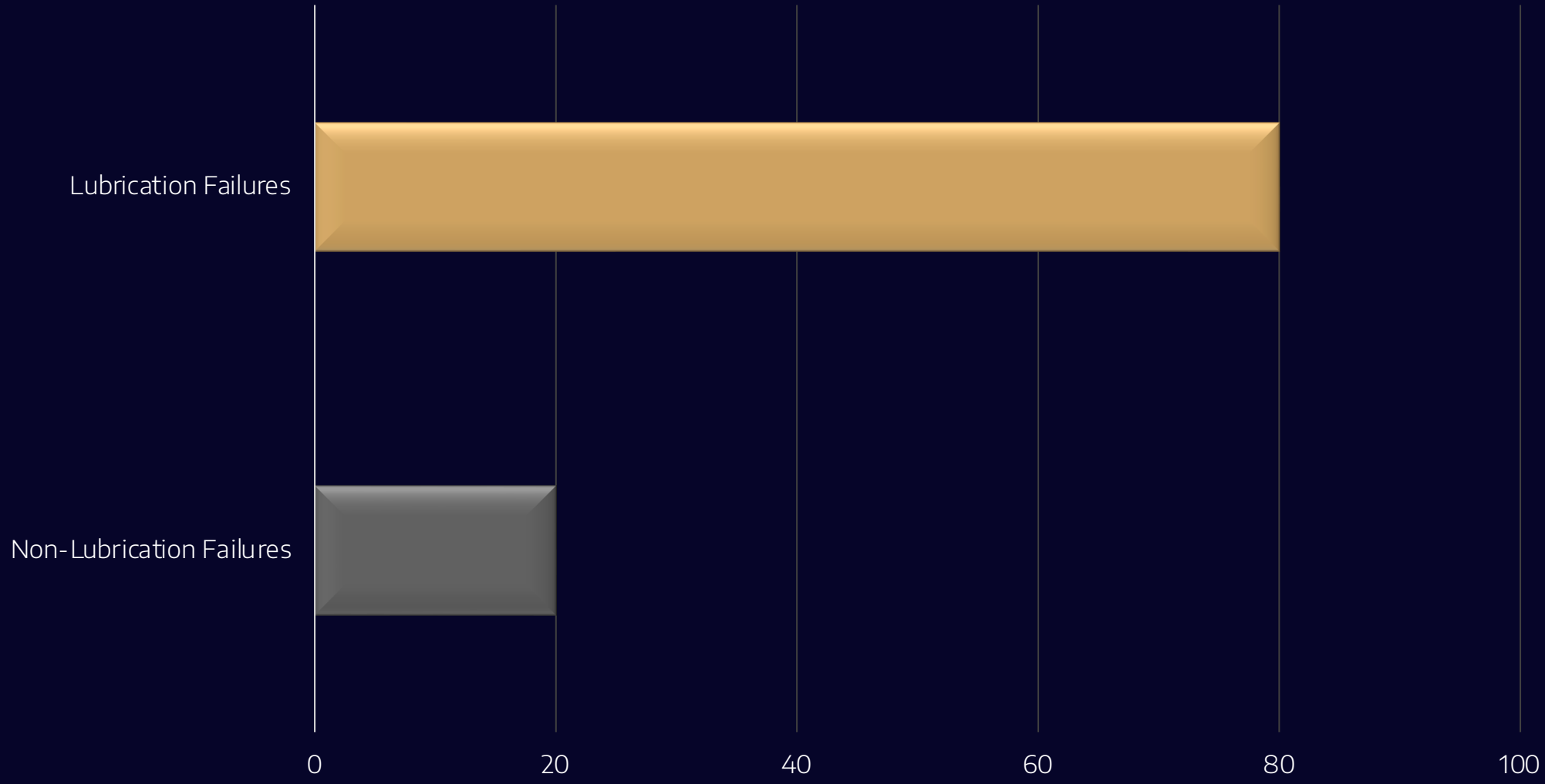

Causes of Bearing Failures in %
Incorrect Lubricant Choice
Aged Lubricant
Solid Contamination
Insufficient Lubricant
Incorrect Bearing Choice
Liquid Contamination
Mounting Faults
Consequential Damage
Material & Production Faults
0
5
10
15
20
Source: Emerson Bearings

Bearing Failures are 80% Lubrication-Related

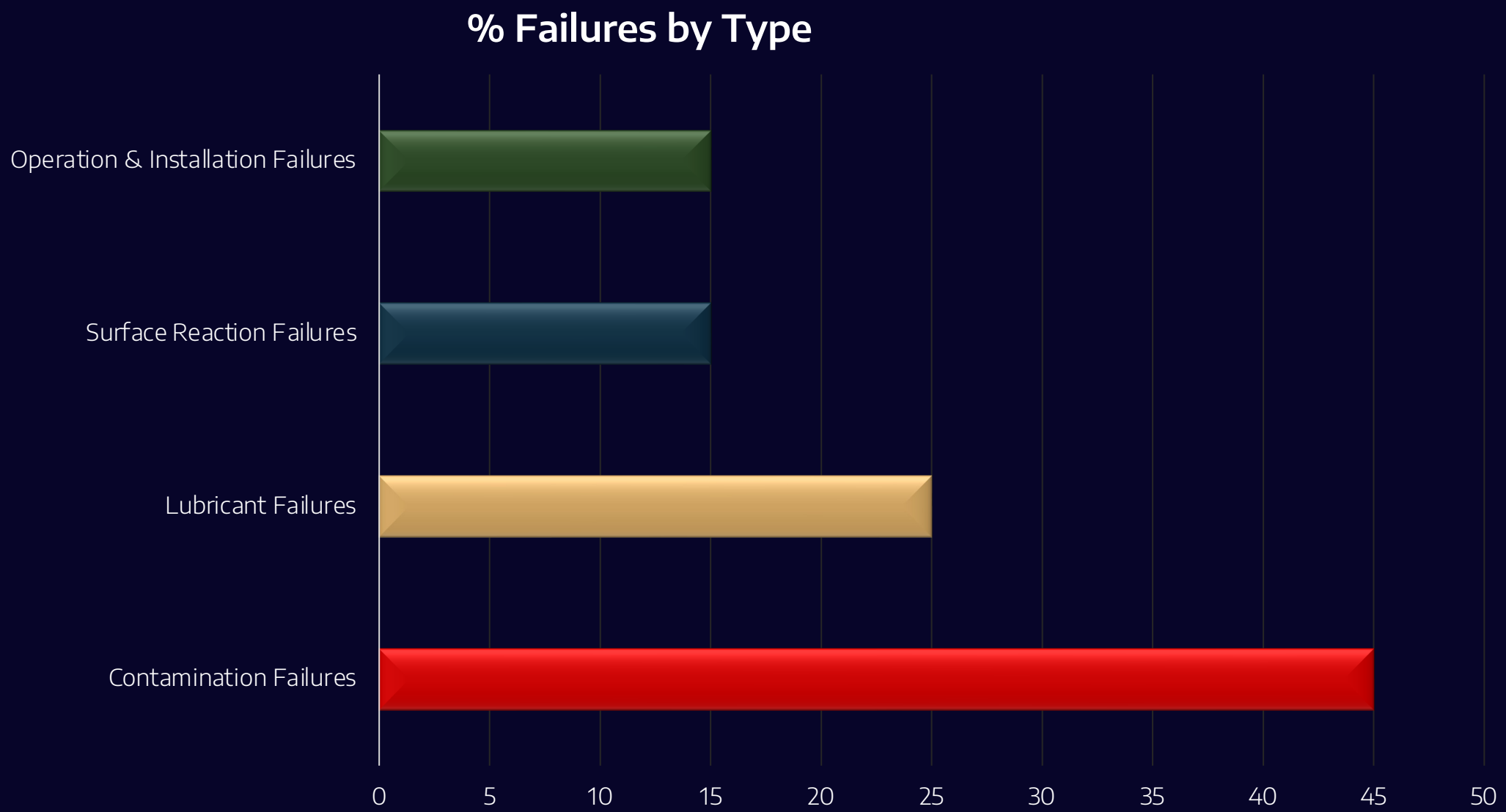


Source: Emerson Bearings

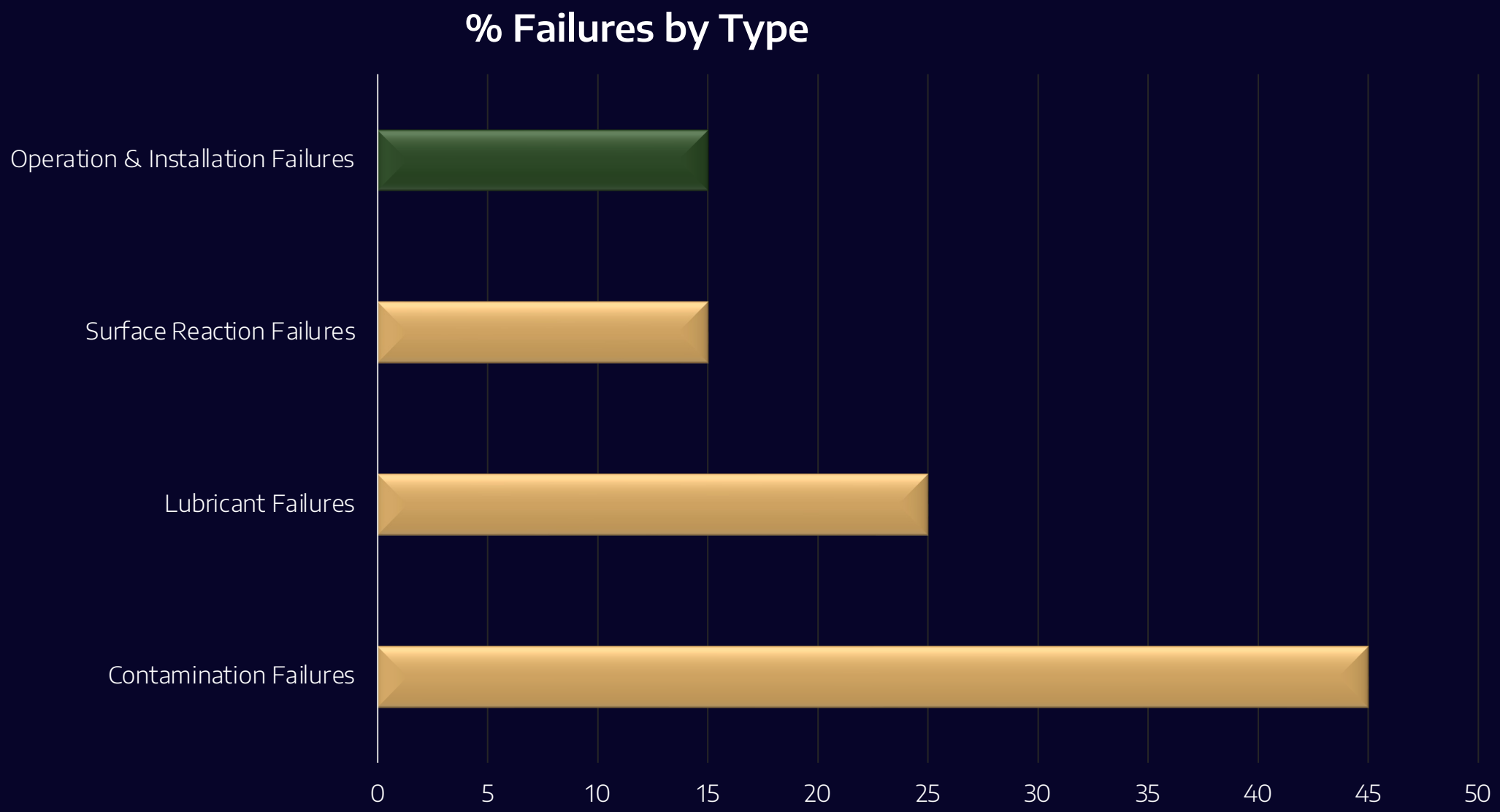
Bearing Failures are 80% Lubrication-Related



Source: Emerson Bearings



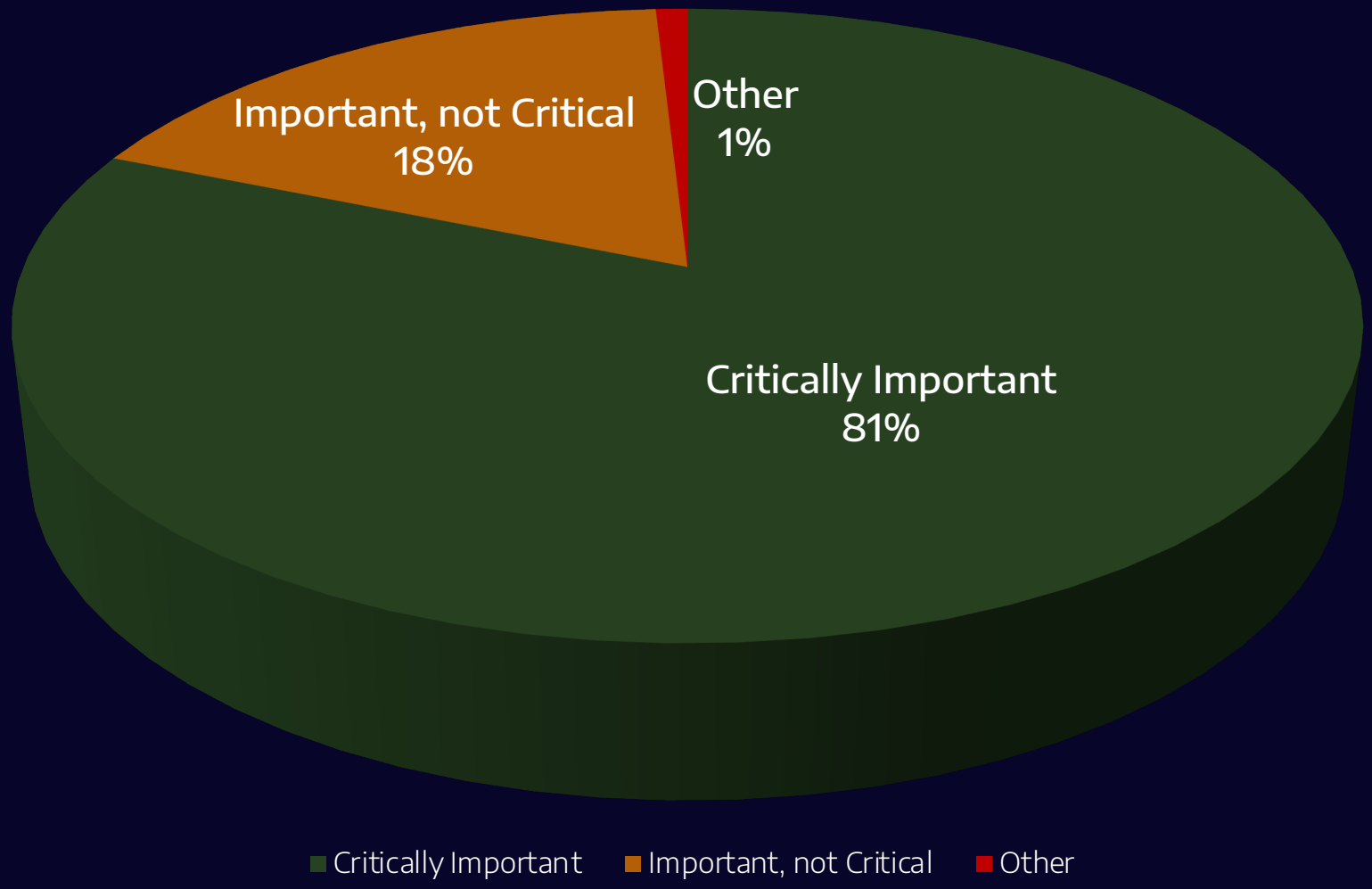
Source: Cummins



Source: Cummins

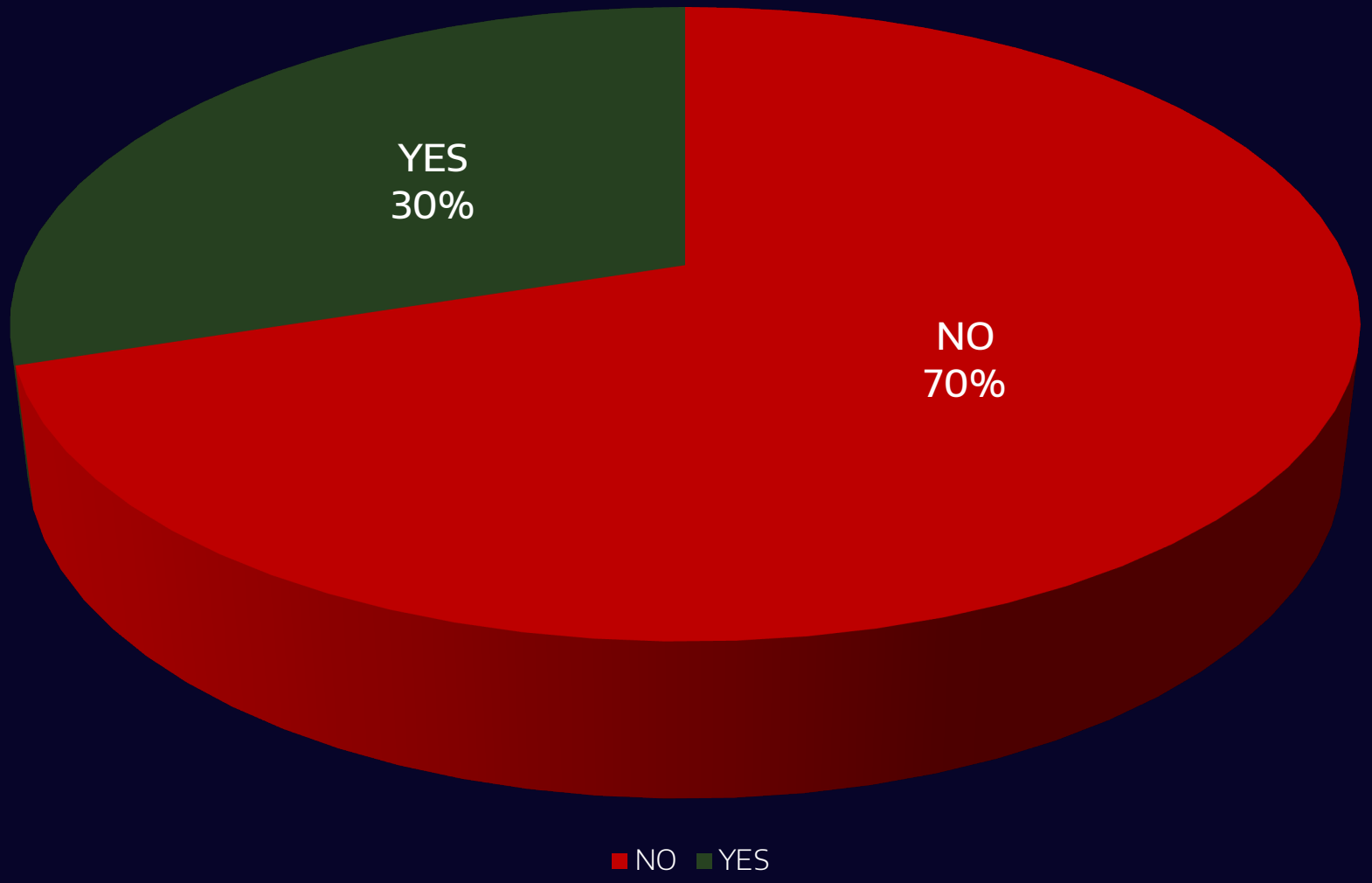
70%

How Would You Describe the Importance of Precision Lubrication?

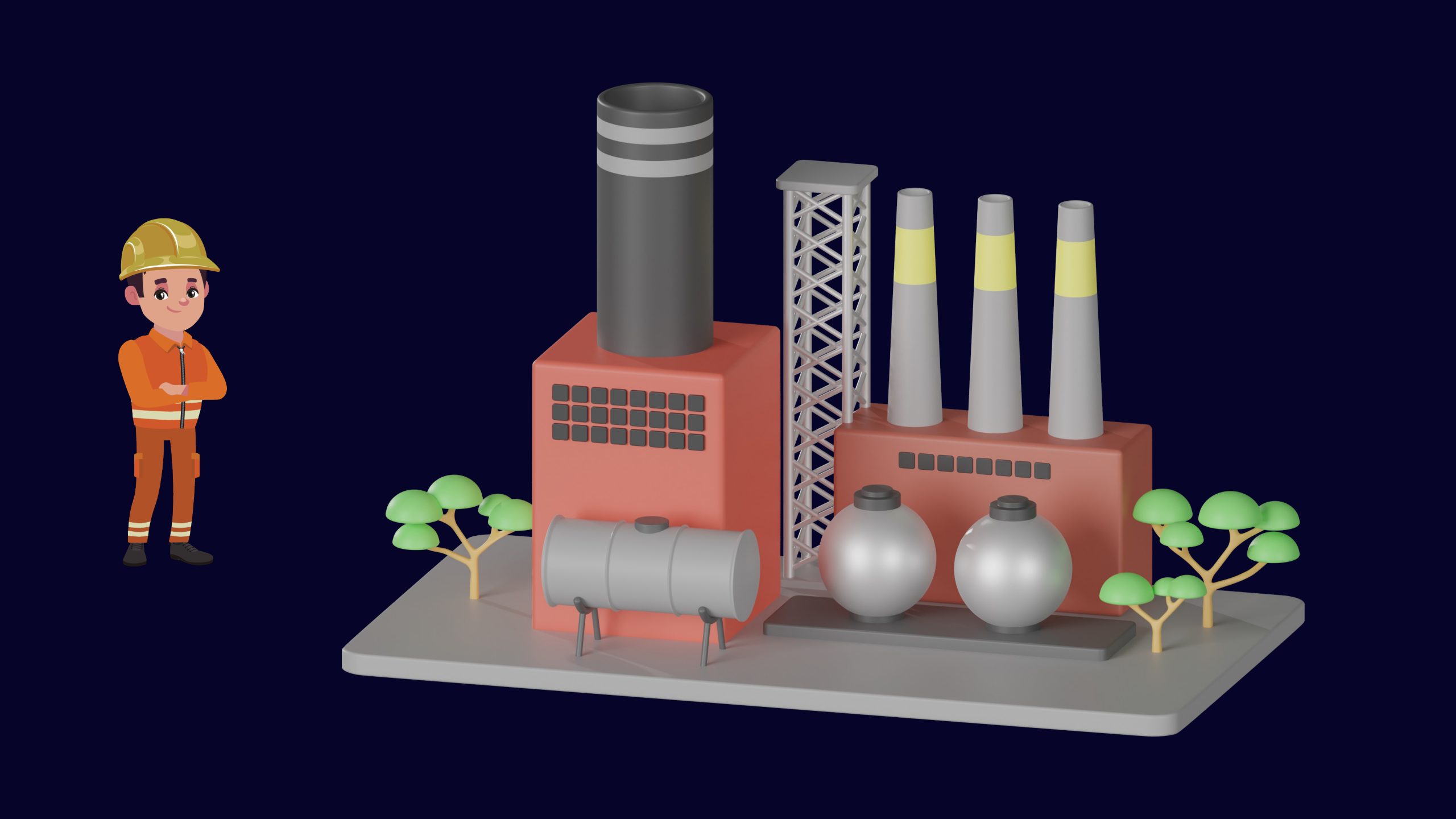


Source: ReliabilityWeb

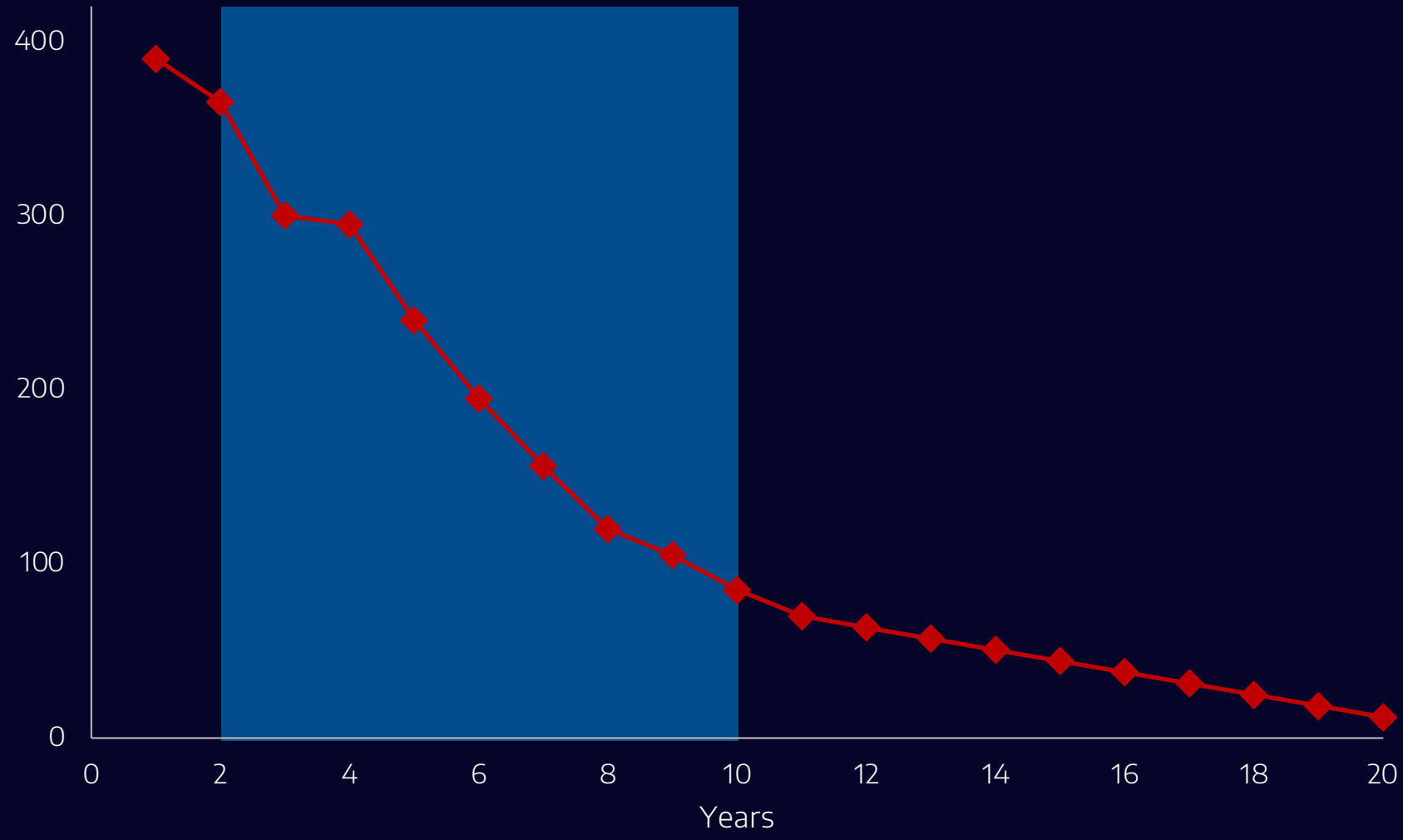
Have you achieved a level of lubrication that you would consider close to best practice?

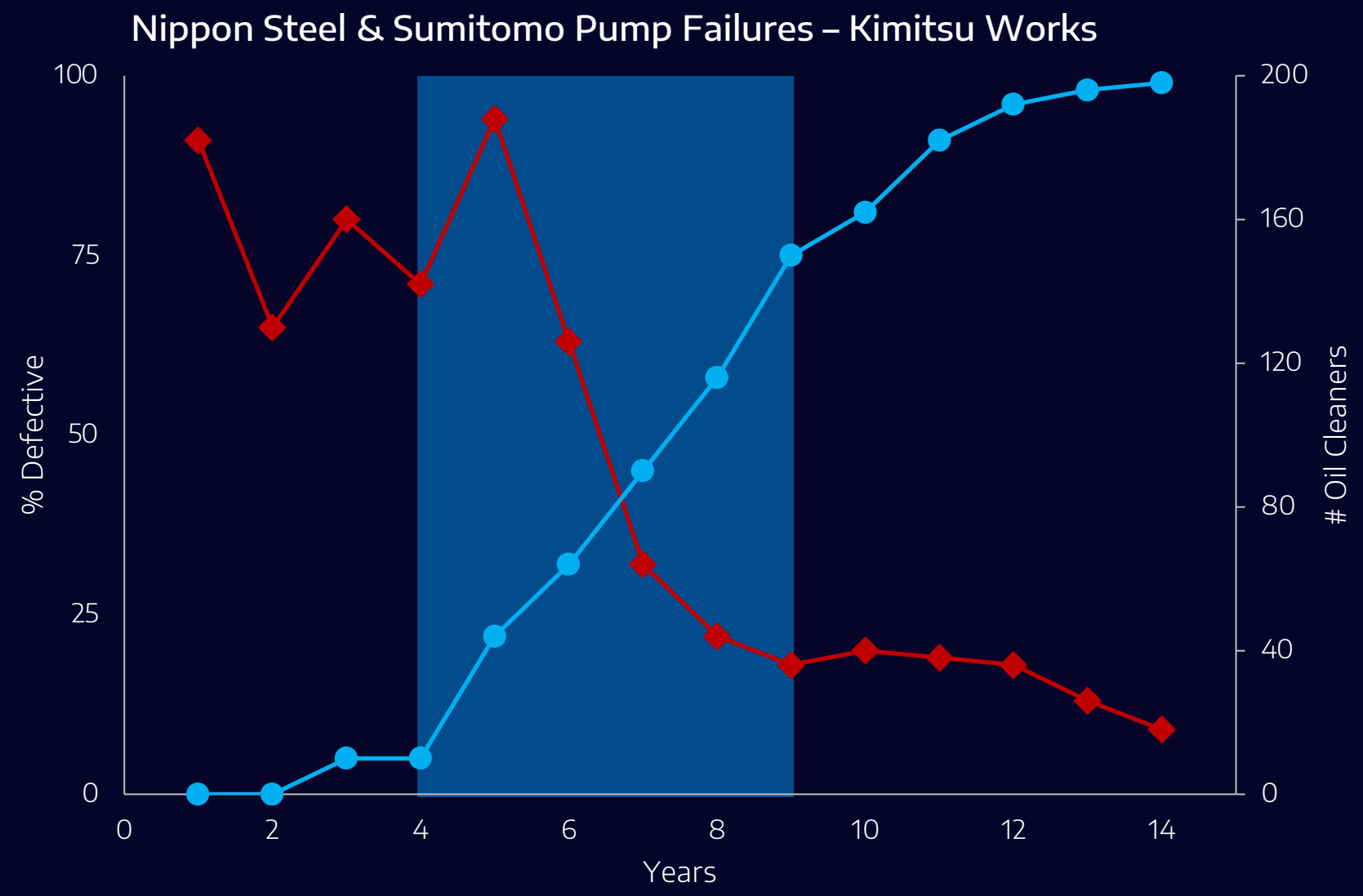


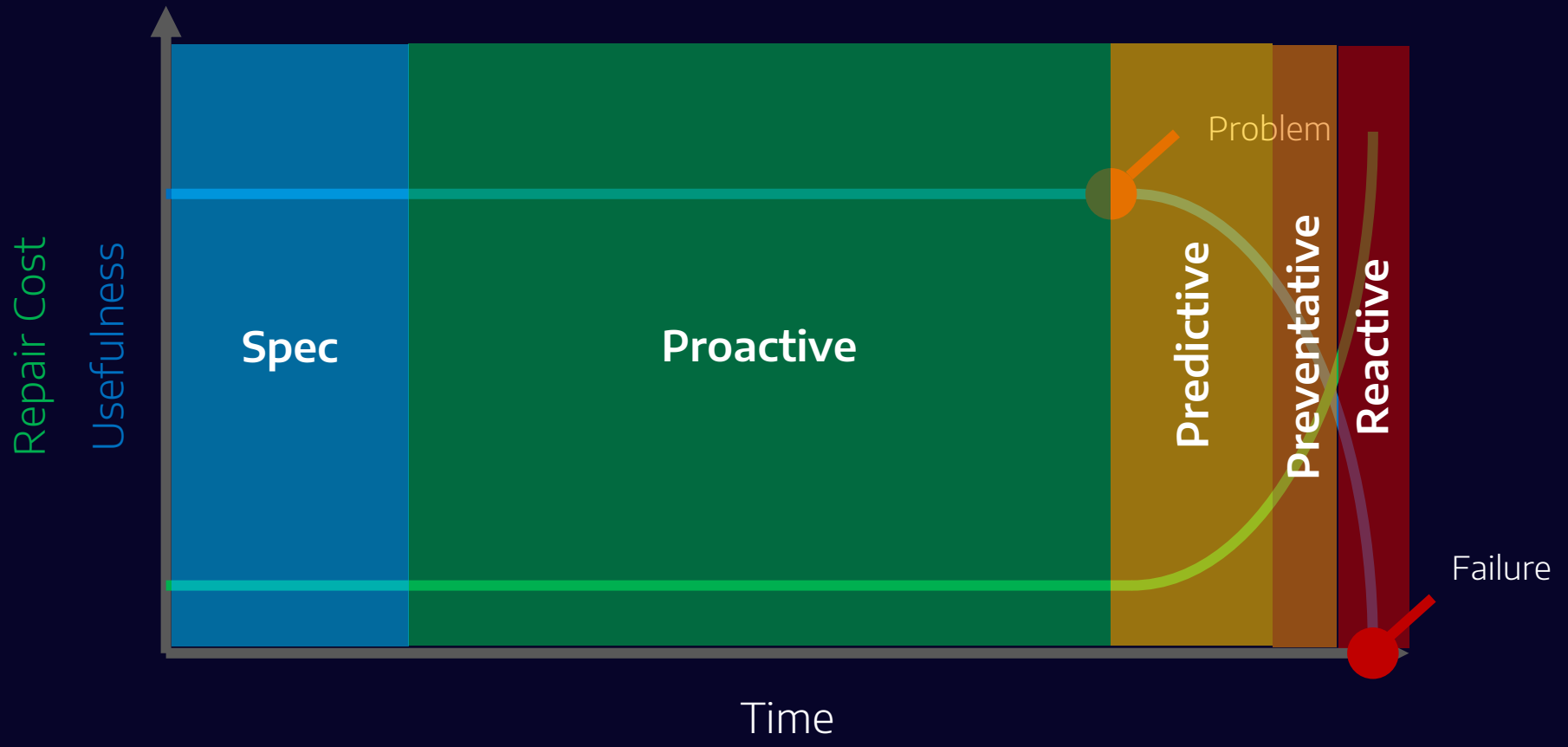
Source: ReliabilityWeb

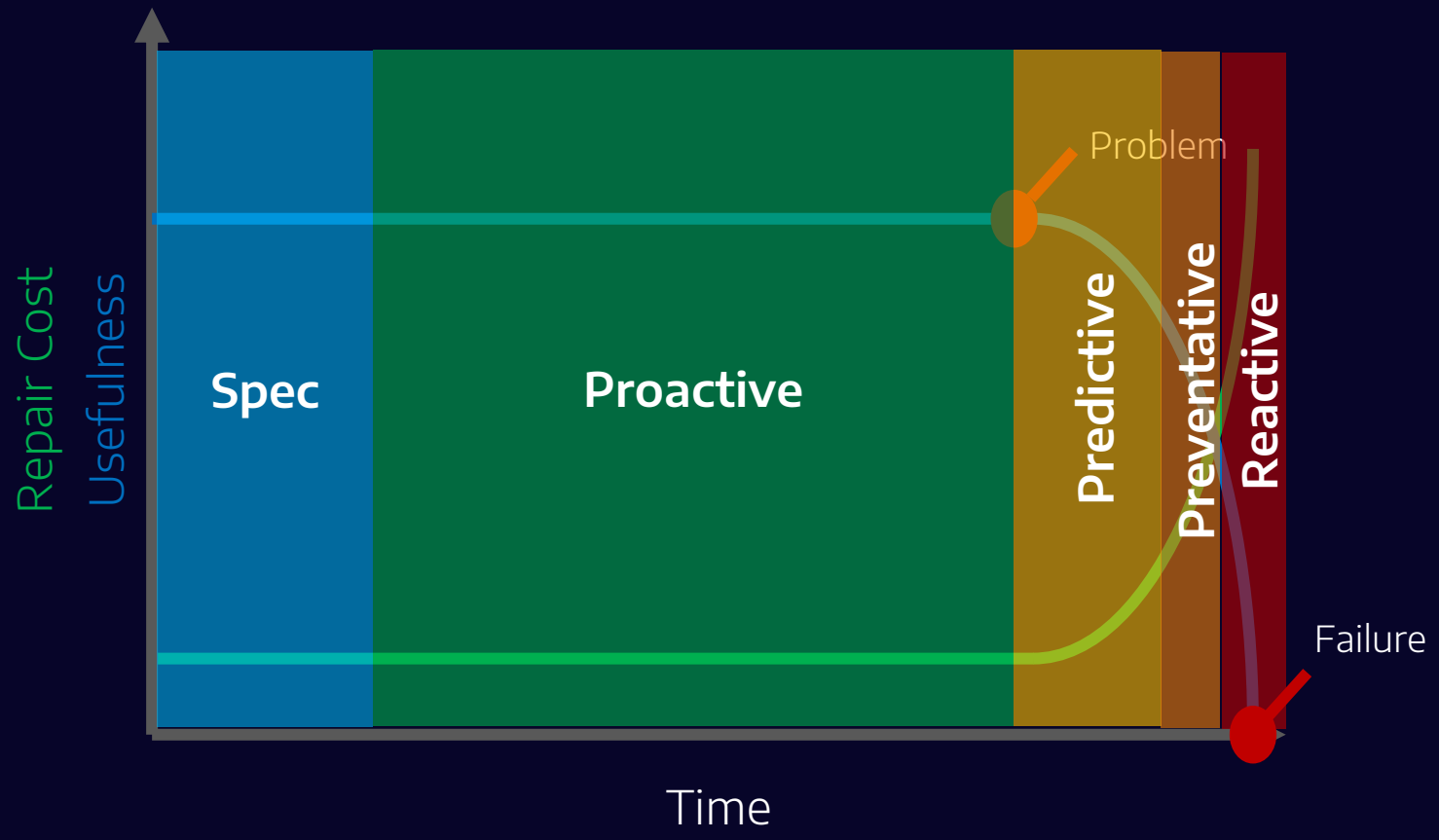


Nippon Steel & Sumitomo Bearing Failures – Kimitsu Works




Nippon Steel & Sumitomo Pump Failures – Kimitsu Works
100
75
50
25
0
% Defective
200
160
120
80
40
0
Oil Cleaners
0
2
4
6
8
10
12
14
Years


Repair Cost
Usefulness
Spec
Proactive
Predictive
Preventative
Reactive
Problem
Failure
Time



Mining

Oil & Gas

Power Generation

Processing

Construction

Transport

Water

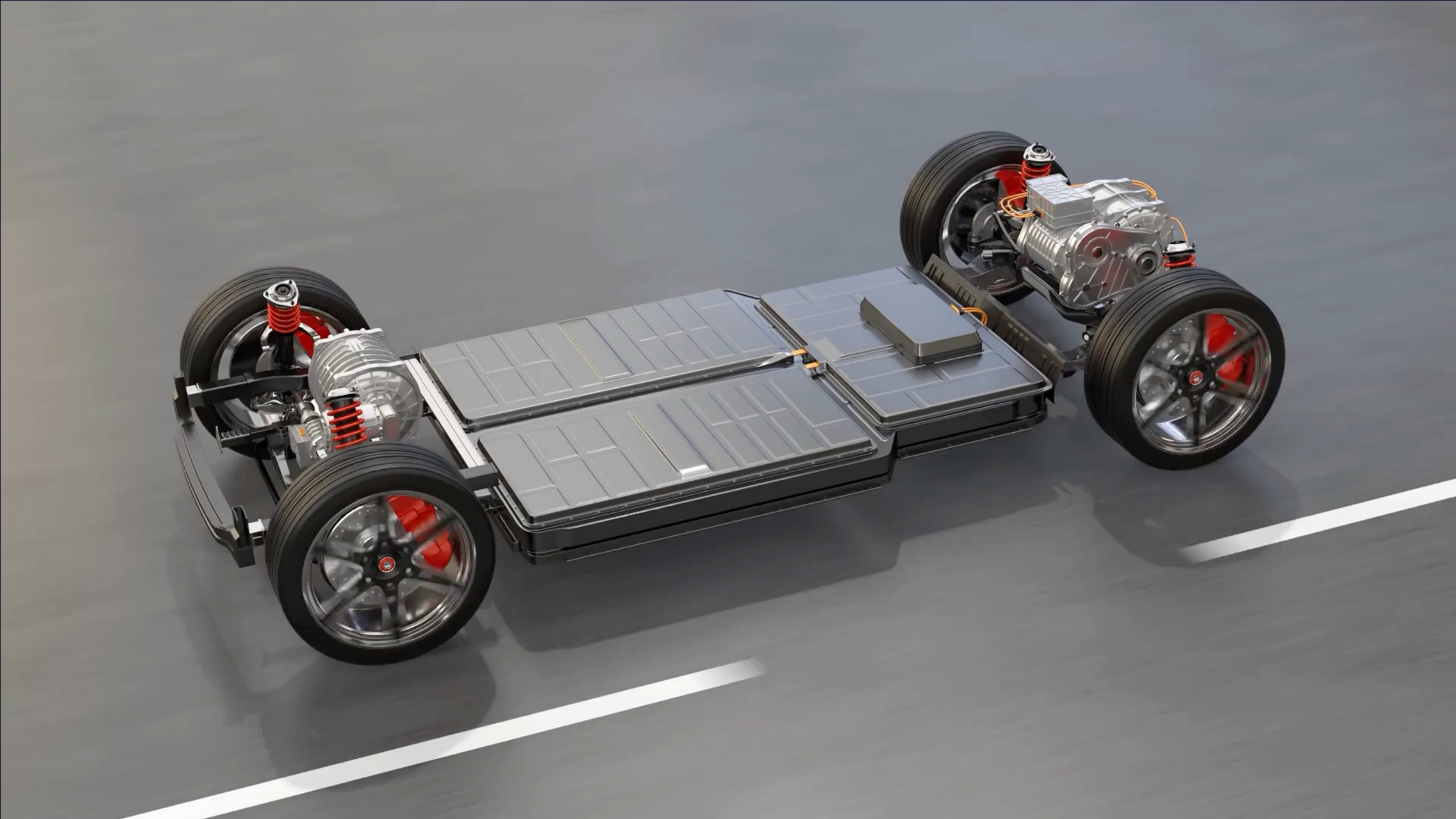
Food

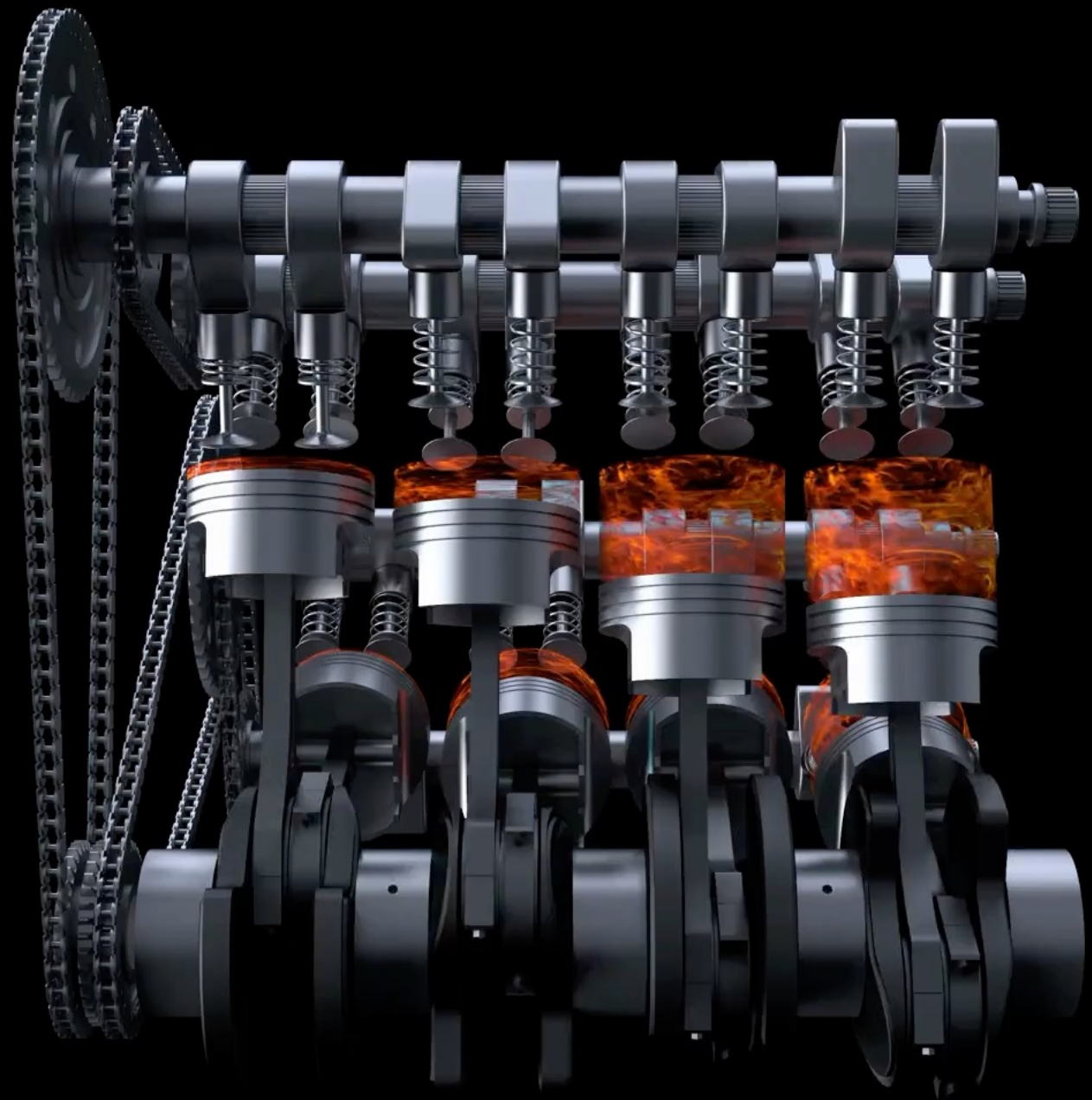
Pulp & Paper

ENABLING

ENABLING RENEWABLE

ENABLING RENEWABLE TECHNOLOGIES





23%

5%

70%

70%

More reliable

More sustainable

More profitable

Learn from a

Listen to a podcast from a

Get help from a

Become a

Find a

Learn from a

Listen to a podcast from a

Get help from a

LUBRICATION EXPERT

youtube.com/lubricationexplained
https://lubrication.expert
rafe@lubrication.expert