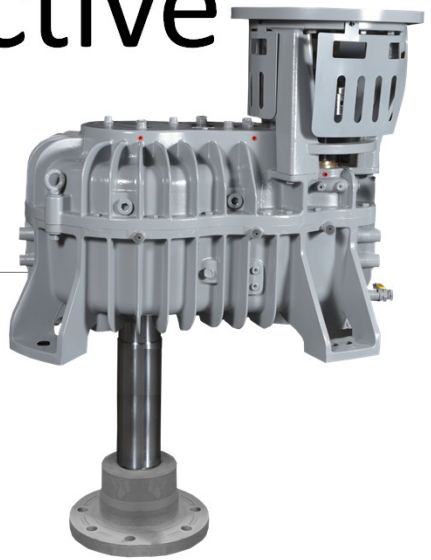
Reliability in an ACC Gear Box: From a Designers Perspective



ACC USER GROUP CONFERENCE 2017, LAS VEGAS, NEVADA

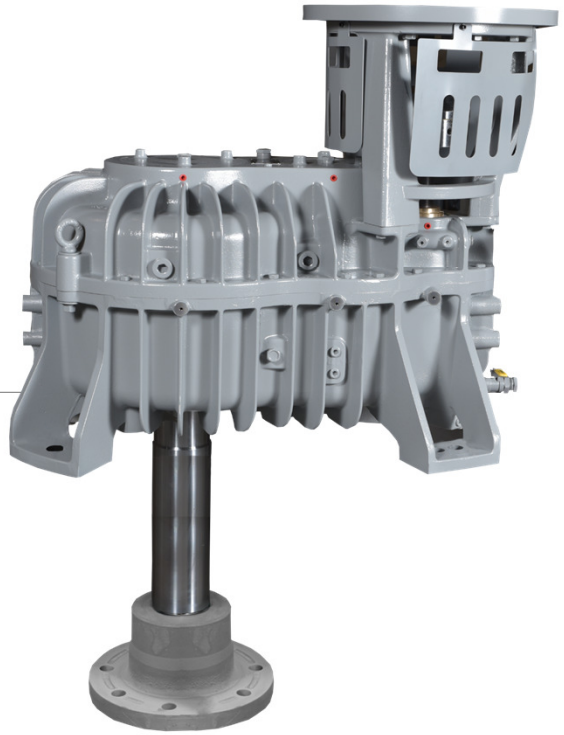
PRESENTED BY: CHAD BROWN, ENGINEERING MANAGER

AMARILLO GEAR COMPANY, LLC

Agenda


3 -Serviceability
2 - Application Considerations
1 – Standards

Standards



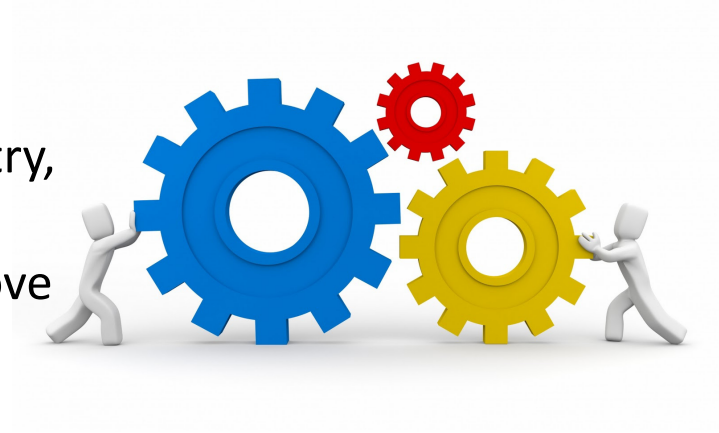
Standard - Defined

A standard is a document that specifies requirements for products, services and/or processes, laying down their required characteristics.

Standards are developed in a consensus-based process organized by a recognized standards body.

Why a standard is important

- sets a baseline and recommends “best practices”
- promotes efficiency and quality assurance in industry, technology, science and the public sector
- serves to safeguard people and goods and to improve quality in all areas of life.



Available Standard Sources – General

AGMA - American Gear Manufactures Association

- Est. 1916
- AGMA is the global network for technical standards, education, and business information for manufacturers, suppliers, and users of mechanical power transmission components.

ISO - International Organization for Standardization

- Est. 1943
- Through its members, it brings together experts to share knowledge and develop voluntary, consensus-based, market relevant International Standards that support innovation and provide solutions to global challenges.

DIN - German Institute for Standardization

- Est. 1924
- "Standardization in Germany helps business and society to strengthen, develop and open up regional and global markets."

*There are others

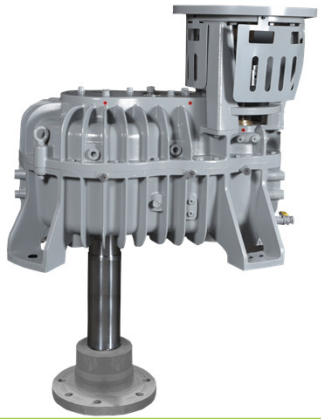
A Comparative Overview

Standards are not necessarily equal or provide the exact same results in analysis

Imperative a designer/purchaser understands this concept

Results from different organizations on the same subject matter will be different

- Mission of the organization
- Originating region of the organization
- General approach



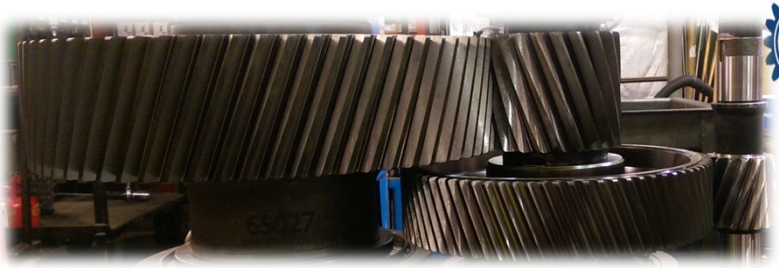
AGMA VS ISO – An Example to consider

INTERNATIONAL STANDARD **ISO 6336-5**

Second edition
2003-07-01

Calculation of load capacity of spur and helical gears —

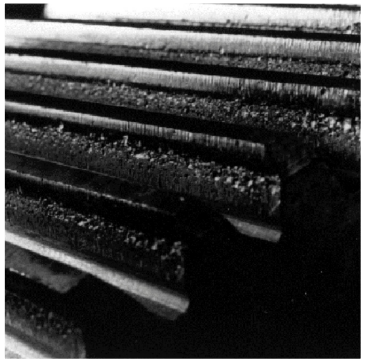
Part 5:
Strength and quality of materials



American Gear Manufacturers Association

Technical Resources

ANSI/AGMA 2001-D04
Revision of ANSI/AGMA 2001-C95
Reaffirmed January 2010



American National Standard

Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth

AGMA VS ISO – An Example to consider

Overview

AGMA	ISO
Began and developed by industry	Based on modeling
Evolved from prior AGMA standards	Derived from DIN gear standard 3990
Proven internationally through manufacture and use	Widely adopted by Europeans, Eastern Bloc and Japan
Empirical standard based on experience	Theoretical standard based on academia
One calculation method ◦ ~60 input variables ◦ Consistent results	5 calculation methods ◦ ~80 input variables ◦ Variable results

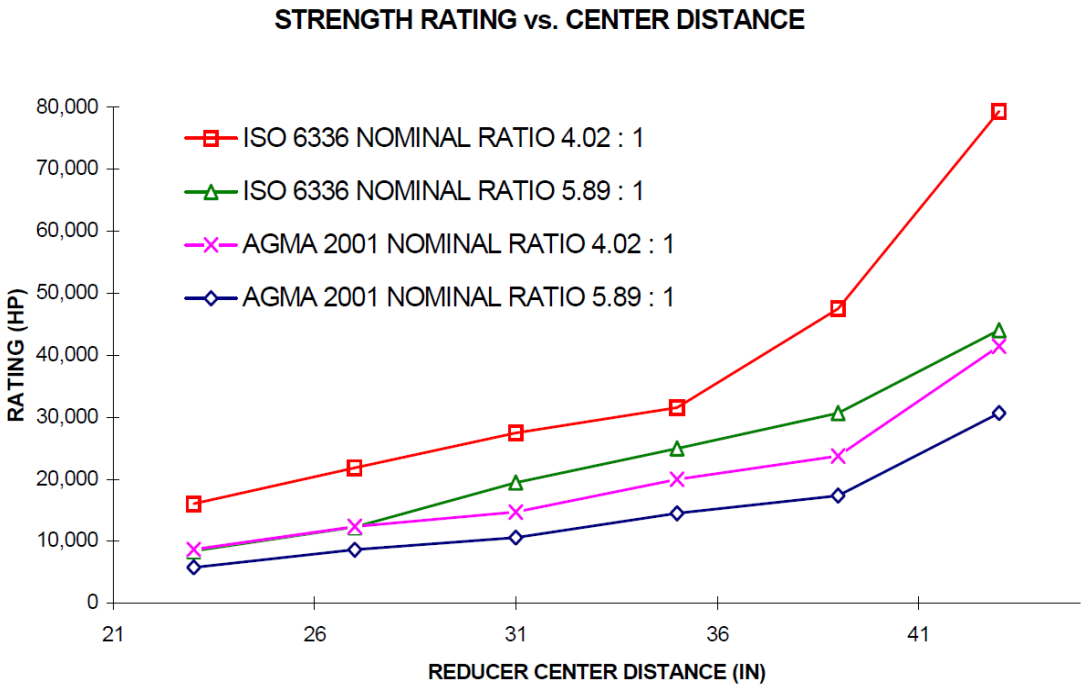
AGMA VS ISO – An Example to consider

Case Study Results

ISO 6336 VS AGMA 2001 GEAR RATING COMPARISON for INDUSTRIAL GEAR APPLICATIONS

Glen Cahala
Rexnord Industries, LLC
Milwaukee, Wisconsin

- Assumptions
  - Single reduction parallel shaft gearbox
  - 2 ratios
  - Input speed of 990 RPM
  - Consistent inputs for both evaluations
- Results
  - AGMA consistently provides higher service factor
  - ISO rating will reduce the temporary overload capacity potentially resulting in permanent plastic deformation



AGMA VS ISO – An Example to consider

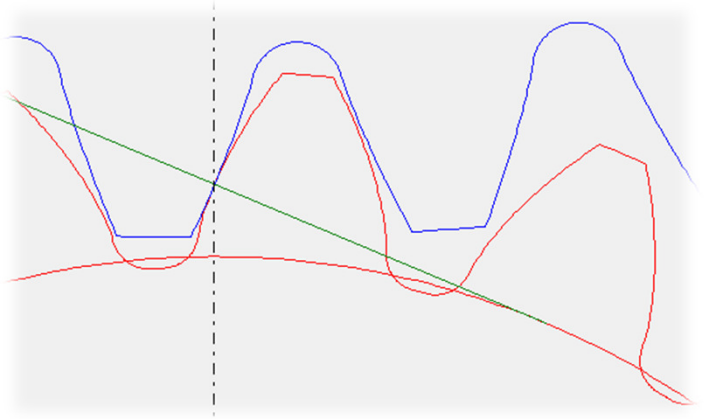
Case Study Key Points

Varying standards on the same subject can yield widely variant results

Gear rating and Reliability can be greatly affected by the standard used

Designer and purchaser must have an awareness of rating standards when comparing gear box selections

Designer should utilize application standards when available

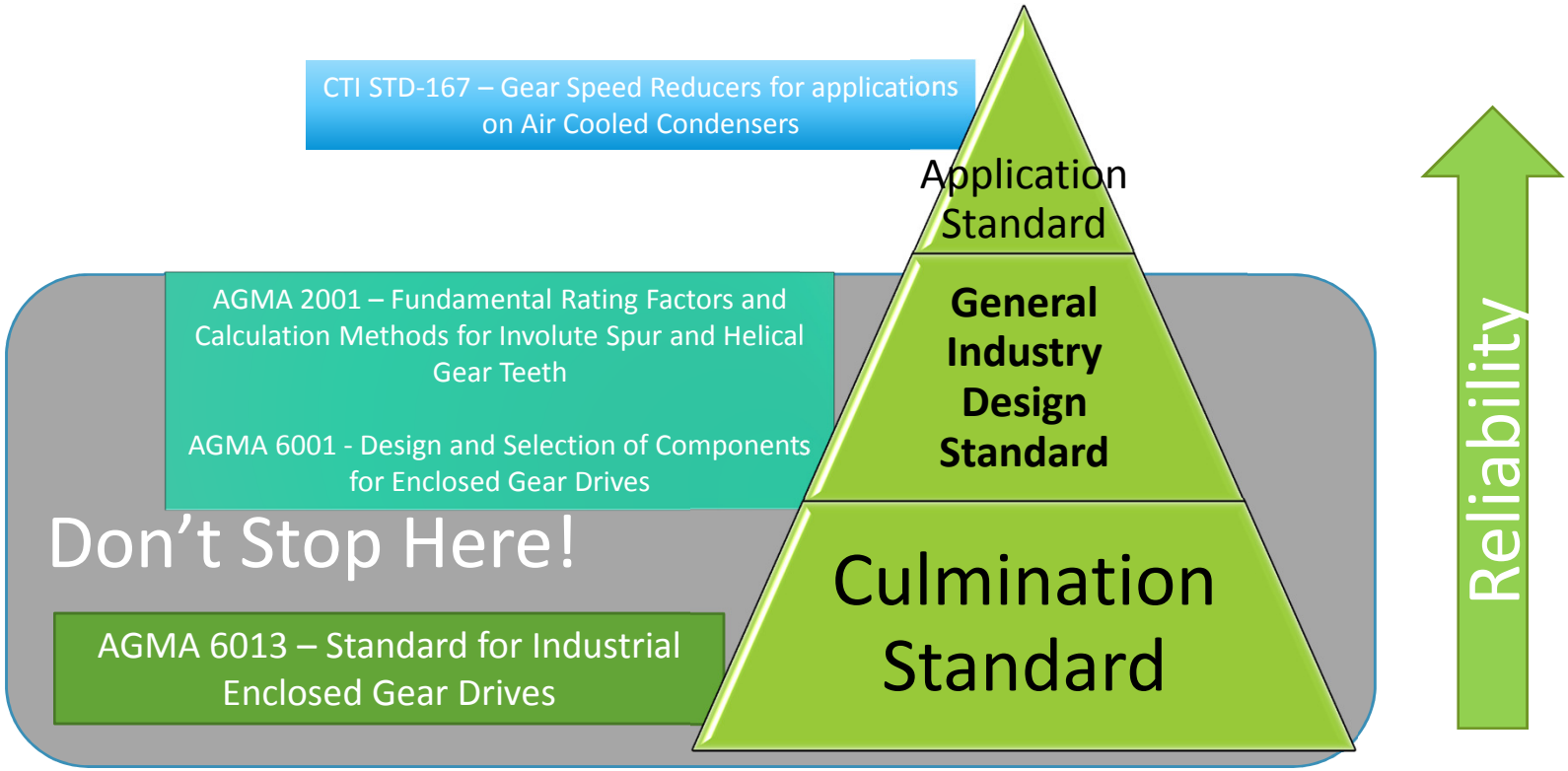


Available Standard Sources - Application

CTI – Cooling Technology Institute

- Est. 1950
- As a broad based industry association, our mission is to advocate and promote, for the benefit of the public, the use of all environmentally responsible, cooling technologies, such as wet cooling towers, air-cooled condensers, dry coolers, indirect cooling, and hybrid systems

Hierarchy of Standards



Application and Serviceability

A BRIEF LOOK INTO CTI STD-167

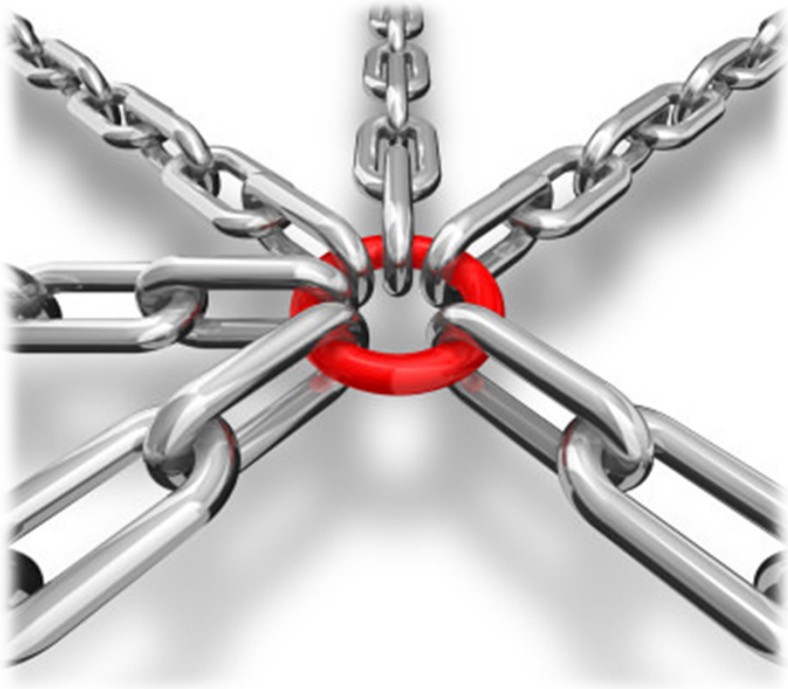
CTI STD-167 Introduction

Purpose of the standard is to establish **design**, installation, and operating practices for ACC gearboxes due to their unique and severe operating conditions

Owner/operators, Gearbox manufacturers, ACC OEMs, and other component suppliers were members of the committee

Contains the best current state of knowledge regarding Gear Speed Reducers for application on ACC's

Aids purchasers and **DESIGNERS** of gearboxes for the ACC user



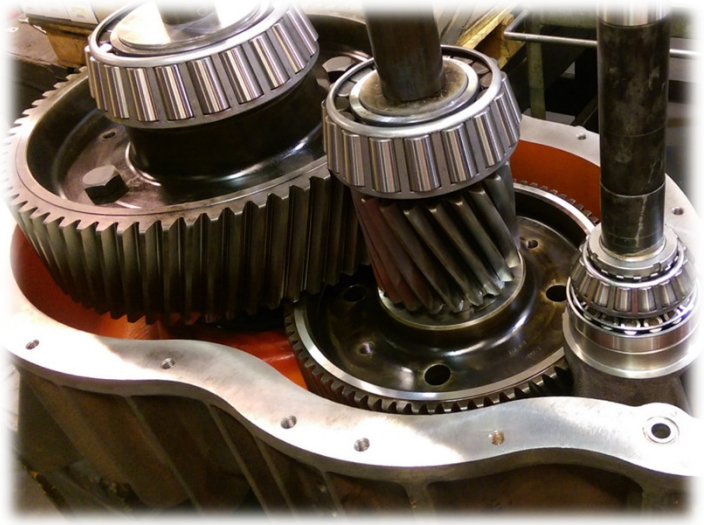
CTI STD-167 Design Highlights

Shafting, Gear and Thermal ratings shall be in accordance with AGMA standards to ensure reliability

- Specific rating guidelines are provided
- Best practice is adequate thermal rating without external cooling

Bearing life (L10a) minimum requirements are:

- 50,000 hours on input and intermediate
- 100,000 hours on the output



CTI STD-167 Service Factor

The service factor has been used in AGMA standards to include the combined effects of:

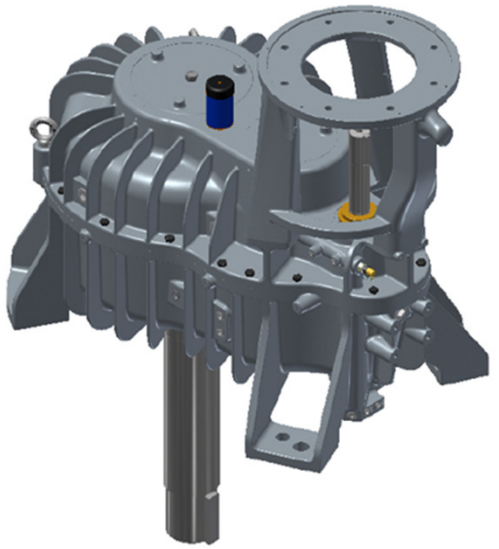
- Overload
- Reliability
- Life
- other application related factors

Shall utilize AGMA 6013 for rating of the overall gearbox

Shall utilize 2.0 AGMA Service Factor on the **motor nameplate power** to assure maximum life and reliability of the gearbox

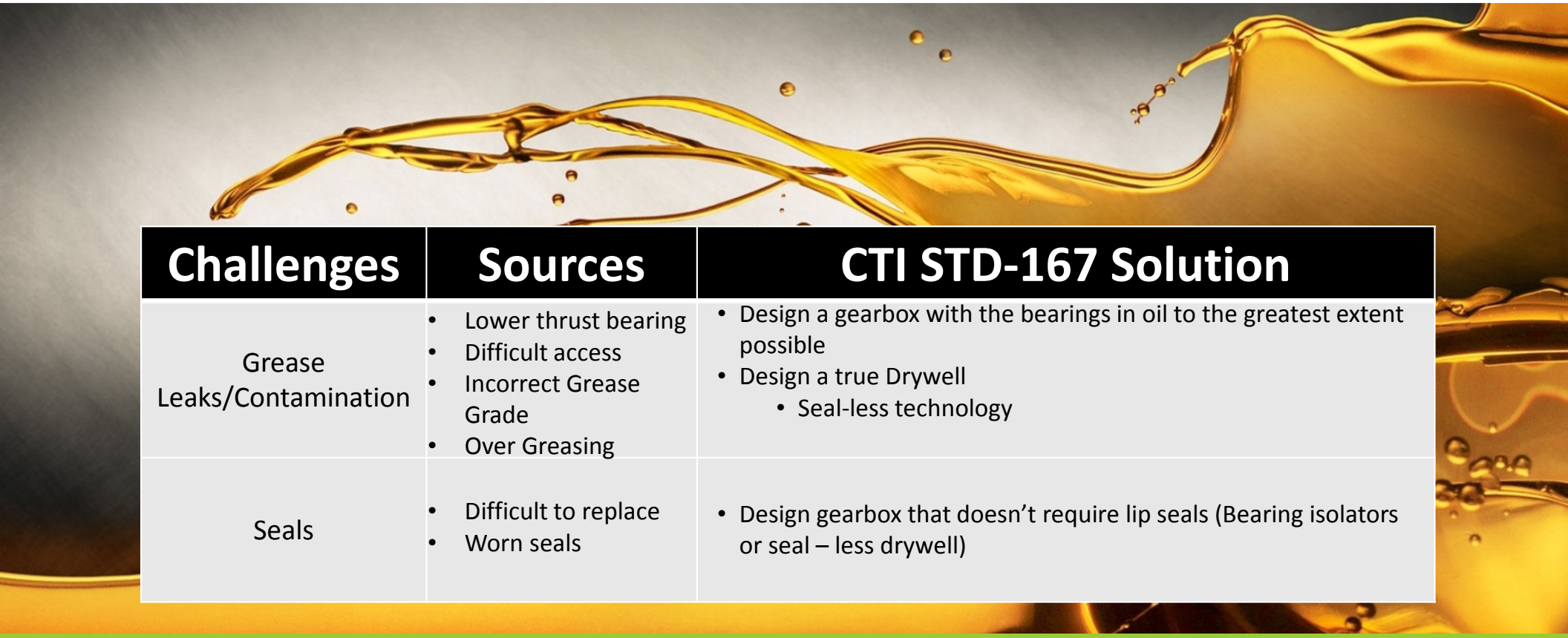
Critical to understand rating system and the rating under evaluation as alternate standards will require a service factor higher than 2.0

$$\frac{Mechanical\ Rating}{Application\ rating} \geq 2.0\ \boldsymbol{per\ AGMA}$$



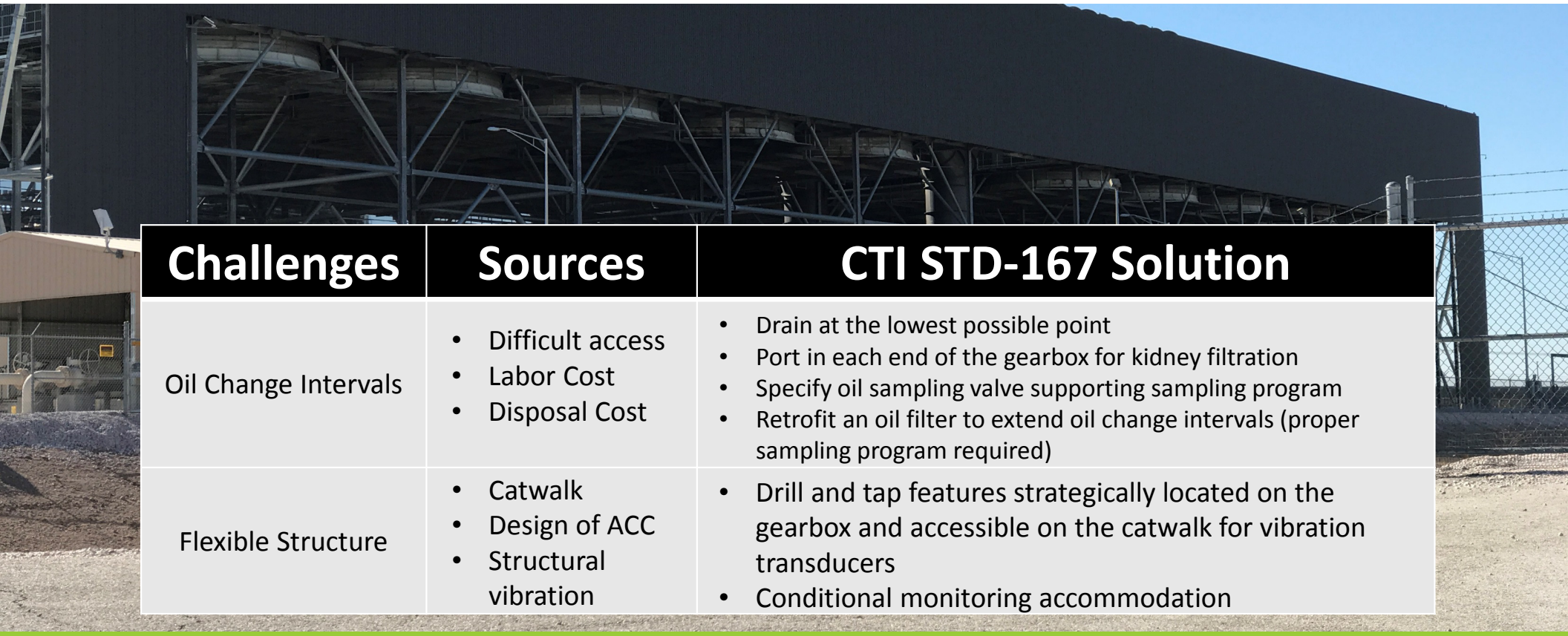
CTI STD-167 Improving Reliability

Challenges	Sources	CTI STD-167 Solution
Dynamic loading	Motor Starting Torque	• Minimize # of starts • Proper service factor • Rating based on motor power
	Unknown and varying wind loads	• Service Factor • 100,000 hours on output shaft bearings • Stabilize output shaft (If length is excessive) • Extended bearing spans
	Fan operating characteristics	



Challenges	Sources	CTI STD-167 Solution
Grease Leaks/Contamination	• Lower thrust bearing • Difficult access • Incorrect Grease Grade • Over Greasing	• Design a gearbox with the bearings in oil to the greatest extent possible • Design a true Drywell • Seal-less technology
Seals	• Difficult to replace • Worn seals	• Design gearbox that doesn't require lip seals (Bearing isolators or seal – less drywell)

CTI STD-167 Improving Reliability



Challenges	Sources	CTI STD-167 Solution
Oil Change Intervals	• Difficult access • Labor Cost • Disposal Cost	• Drain at the lowest possible point • Port in each end of the gearbox for kidney filtration • Specify oil sampling valve supporting sampling program • Retrofit an oil filter to extend oil change intervals (proper sampling program required)
Flexible Structure	• Catwalk • Design of ACC • Structural vibration	• Drill and tap features strategically located on the gearbox and accessible on the catwalk for vibration transducers • Conditional monitoring accommodation

CTI STD-167 Improving Reliability

In Summary

Understand the hierarchy of standards to your advantage when designing and selecting a gearbox for Air Cooled Condenser use

Remember: Different standards yield different results

CTI STD-167 should be used to provide the highest reliability in an ACC application – ***Levels the playing field***

ACC gearboxes face unique challenges that need to be understood and addressed by the owner/operator, EPC, ACC OEM, gearbox manufacturer to ensure maximum ***RELIABILITY***

Amarillo® Gear

1917 - YEARS - 2017

Amarillo® Gear Company LLC

Phone: 806-622-1273

Email: cbrown@amarillogear.com (Engineering)

Email: bneely@amarillogear.com (Sales)

Web: www.amarillogear.com