



International Operations & Maintenance
Conference in the Arab Countries

Under the theme of
The Integration of Maintenance and Asset Management

 15-16 December 2020

ORGANIZER



ORGANIZING PARTNER



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**Developing an ISO for
Gearbox Vibration
Monitoring**

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Introduction

- An existing ISO standard on vibration monitoring of gear units was withdrawn in 2016
- A new standard has been developed for the measurement and evaluation of the vibration of gear units
 - to replace the withdrawn standard and add further guidance
- This paper presents the background and overview of the development of this new standard

Background

- Noise and vibration standards for Gear Units were covered in:
 - ISO 8579-1:2002, *Acceptance code for gear units – Part 1: Test code for airborne sound*
 - ISO 8579-2:1993, *Acceptance code for gears – Part 2: Determination of mechanical vibrations of gear units during acceptance testing*

ISO 8579-2 Withdrawn

- ISO 8579-2:1993 was withdrawn following a systematic review in 2016
 - It had been developed as a joint working group between two ISO technical committees
 - ISO/TC 60 – Gears, and
 - ISO/TC 108 – Mechanical vibration, shock and condition monitoring
 - ISO only involved ISO/TC 60 in the systematic review
 - ISO 8579-2:1993 failed to receive support from ISO/TC 60

Re-instatement

- ISO/TC 108 raised a formal objection to the withdrawal of ISO 8579-2 in 2016
 - ISO 8579-2 was referenced in TC 108's vibration training standard
- ISO Technical Management Board (TMB) stated that the withdrawal could not be reversed
 - The solution was for a new work item to be raised
- ISO/TC 108 decided to try to reinstate ISO 8579-2
 - or create an equivalent Vibration standard for Gear Units

Options

- The options were:
 - Issue the contents of ISO 8579-2 as a new standard
 - A new standard would also need to match ISO's latest rules
 - ISO 8579-2 did not match the format of ISO/TC 108 latest standards
 - Develop a new part of the ISO 20816 series
 - A project has been underway to combine ISO 10816 (casing vibration) and ISO 7919 (Shaft vibration)
 - These are in latest ISO format, and several have recently been issued

Options

- The decision was made to develop a new part of ISO 20816
 - ISO 20816-9, Mechanical vibration – Measurement and evaluation of machine vibration – Part 9: Gear units
 - This was initiated in 2017
 - Under ISO/TC 108/SC 2, Vibration of Machines
 - With Simon Mills as the project leader

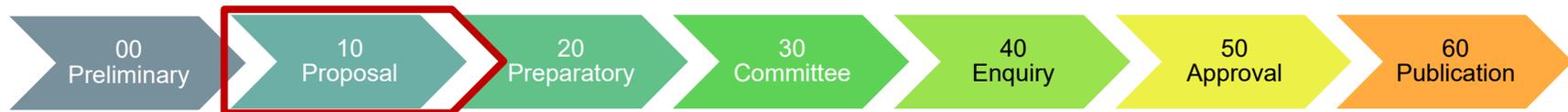
ISO Development Process Stages

- Staged Process
- 7 Steps
- <https://www.iso.org/deliverables-all.html>



ISO Development Process Stages

- A new work item was proposed to create ISO 20816-9
 - Under ISO/TC 108/SC 2 – *Vibration of Machines*
- Initiated in 2017 with Simon Mills as Project Leader
 - (ISO Development Stage 10)



First Working Draft and CD

- A first working draft (WD) was issued in Nov 2017
 - This basically contained the original ISO 8579-2
 - The development project was approved in early 2018



- A committee draft (CD) was issued in April 2018
 - This received more feedback and a second CD issued
 - The second CD was discussed in Berlin March 2019



Second CD and DIS

- A second CD tabulated the vibration limits similar to other parts of ISO 20816
 - It was discussed at ISO/TC 108/SC 2/WG 1 (Working Group 1) in Berlin in March 2019
 - (ISO Development Stage 40).

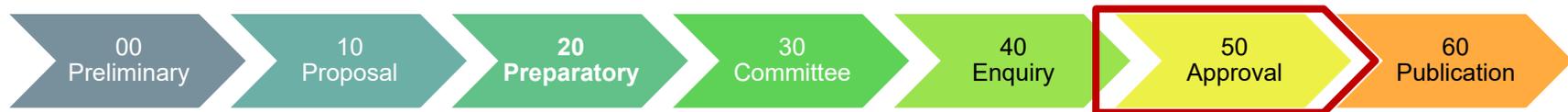


- With some modifications it was approved to be circulated for vote as a Draft International Standard (DIS)
 - (ISO Development Stage 40).



FDIS and Issue as ISO

- A Final Draft International Standard (FDIS) was circulated in March 2020
 - (ISO Development Stage 50)



- ISO 20816-9 was formally issued by ISO in June 2020.
 - (ISO Development Stage 60).



ISO 20816 Series

- ISO 20816-1 is the basic part of the ISO 20816 series
 - Gives the general requirements for evaluating the vibration of various machine types
 - When the vibration measurements are made on both (or either) non-rotating parts and rotating shafts

ISO 20816 Series

- ISO 20816 includes:
 - **Part 1:** General guidelines
 - **Part 2:** Land-based gas turbines, steam turbines and generators in excess of 40 MW, with fluid-film bearings and rated speeds of 1 500 r/min, 1 800 r/min, 3 000 r/min and 3 600 r/min
 - **Part 4:** Gas turbines in excess of 3 MW, with fluid-film bearings
 - **Part 5:** Machine sets in hydraulic power generating and pump-storage plants
 - **Part 8:** Reciprocating compressor systems
 - **Part 9:** Gear Units

ISO 10816 Series

- ISO 10816 still includes:
 - **Part 3:** Industrial machines with nominal power above 15 kW and nominal speeds between 120 r/min and 15 000 r/min when measured in situ
 - **Part 6:** Reciprocating machines with power ratings above 100 kW
 - **Part 7:** Rotodynamic pumps for industrial applications, including measurements on rotating shafts
 - **Part 21:** Horizontal axis wind turbines with gearbox

ISO 20816-9 Scope

- ISO 20816-9 provides specific provisions for assessing the vibration of individually housed, enclosed, speed increasing or speed reducing gear units
- It applies to gear units of nominal power rating from 10 kW to 100 MW and
- Rotational speeds between 30 r/min and 12 000 r/min (0,5 Hz to 200 Hz)

ISO 20816-9 Scope

- It can be used for acceptance testing and by agreement between manufacturer and customer or operator for guidelines for routine operational measurements
- Guidelines are provided for assessing the vibration of gear units when operating under steady-state conditions.
 - The criterion considers the magnitude of the observed vibration
 - However, no criteria are provided for transient operating conditions

Changes from ISO 8579-2

- It is now in 20816 series format
- It includes the assessment zones A to D
- It adds acceleration guidelines in addition to displacement and velocity guidelines
- It has an expanded classifications table
- It removes some of ISO 8579-2's non-essential text

Basis for Vibration Guidelines

- ISO 20816-9 includes vibration guideline tables similar to other parts of ISO 20816
- These have the following units vibration:
 - Displacement
 - Velocity
 - Acceleration

Vibration Displacement Rating (DR)

- Values for shaft vibration displacement at zone boundaries are now included in a table:
 - Extract of Table:

DR	Shaft relative vibration peak-to-peak displacement at zone boundaries μm		
	Zone boundary		
	A/B	B/C	C/D
50	31,5	50	80
80	50	80	125
125	80	125	200

Vibration Velocity Rating (VR)

- Values for housing vibration velocity at zone boundaries are now included in a table:
 - Extract of Table:

VR	Housing vibration RMS velocity at zone boundaries mm/s		
	Zone boundary		
	A/B	B/C	C/D
3,15	2,00	3,15	5,0
5	3,15	5,0	8,0
8	5,0	8,0	12,5

Vibration Acceleration Rating (AR)

- A new table with values for vibration acceleration rating has been included:
 - Extract of Table:

AR	Housing vibration true peak acceleration at zone boundaries m/s ²		
	Zone boundary		
	A/B	B/C	C/D
31,5	20,0	31,5	50.0
50,0	31,5	50,0	80.0
80,0	50,0	80,0	125.0

Classification Table

- A new classification table has been included
 - Examples in sub-classes I (a) and II (a) are aligned to API 613 and API 617 respectively
 - An extract of the Table is shown next:

Gear Unit Classifications (Extract of Table)

Class	Sub-class	Examples of Gear Units	Vibration ratings			
			Power	DR	VR	AR
I	(a)	Special-purpose, enclosed, precision single or double helical one or two stage speed increasers and reducers of parallel shaft design.	Any	31,5	3,15	50
	(b)	Marine etc.	Low*	31,5	3,15	**
			High*	50	8	**
II	(a)	General-purpose, enclosed, single or multi-stage gear units incorporating parallel shaft, helical and right angle spiral bevel gears	Any	50	5	80
	(b)	High-speed (over 3 600 r/min)	Low*	50	5	**
			High*	80	8	**

Conclusion

- ISO 20816-9 was published in June 2020
- This has filled a gap in the ISO machine vibration standards portfolio

Questions

- Thank you for your attention
 - You are welcome to contact me if you have questions about BSI or ISO standardisation

References

- ISO 8579-1:2002, Acceptance code for gear units – Part 1: Test code for airborne sound, www.iso.org/obp
- ISO 8579-2:1993, Acceptance code for gears – Part 2: Determination of mechanical vibrations of gear units during acceptance testing (withdrawn), www.iso.org/obp
- Vibration Monitoring of Gear Units – Status of ISO 20816-9 Development, BINDT CM 2019, Glasgow, UK
- ISO Development Process, <https://www.iso.org/deliverables-all.html>
- ISO 20816-9:2020, <https://www.iso.org/obp/ui#iso:std:iso:20816:-9:ed-1:v1:en>
- ISO 20816-1:2016, Mechanical vibration – Measurement and evaluation of machine vibration – Part 1: General guidelines
- API 613, Special Purpose Gear Units for Petroleum, Chemical and Gas Industry Services, www.api.org
- API 677, General-Purpose Gear Units for Petroleum, Chemical and Gas Industry Services, www.api.org