



INTERNATIONAL OPERATIONS & MAINTENANCE CONFERENCE
IN THE ARAB COUNTRIES

UNDER THE THEME

"MANAGING MAINTENANCE WITHIN INDUSTRY 4.0"
COINCIDE WITH THE 16TH ARAB MAINTENANCE EXHIBITION

Latest Developments in Condition Monitoring Standards

Presented by: Simon Mills

Chair of BSI GME21/7 – Condition monitoring of machines

Past Chair ISO TC108/SC5 – Condition monitoring of machine systems

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Member of BINDT VA Working Group

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A large, stylized graphic of the number "4.0" in white, set against a dark blue background. The "4" and "0" are solid, while the "." is a small white dot.



Introduction



- This paper presents a further update of the progress in International Standards in the field of Condition Monitoring (CM) and Vibration Monitoring (VM)

Some History of Standardisation



- British Standards Institute (BSI) is the longest established National Standards Body in the world
- BSI grew from committee of 6 people established by the UK Institute of Civil Engineers in 1901
 - Chaired by Sir John Wolfe-Barry
 - The designer of London's Tower Bridge
- The first British Standard was produced in 1903
 - covering iron & steel sections



First British Standard (from 1903)



No. 1.

BRITISH STANDARD SECTIONS

ISSUED BY
The Engineering Standards Committee.

SUPPORTED BY
THE INSTITUTION OF CIVIL ENGINEERS.
THE INSTITUTION OF MECHANICAL ENGINEERS.
THE INSTITUTION OF NAVAL ARCHITECTS.
THE IRON AND STEEL INSTITUTE.
THE INSTITUTION OF ELECTRICAL ENGINEERS.

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Secretary.

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List 1.

BRITISH STANDARD SECTIONS

ISSUED BY
The Engineering Standards Committee.

EQUAL ANGLES.

Size. A x B	Thickness at Correct Standard Profile.			Mini- mum thickness rolled.	Maxi- mum thickness rolled.	Radii.		Remarks.
	Mini- mum. t	Mean. t	Maxi- mum. t			Root. r ₁	Toe. r ₂	
Inches.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	<p>The dimensions, thickness, and profile of Standard Angles shall be in accordance with the accompanying list and sketch. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is between, above, or below the standards, the flanges will be proportionately longer or shorter than the standards. The profile at the back of the toe will be slightly rounded when above the standards, instead of square; but the radii at the root and toe will remain unchanged. In Equal Sided Angles the thickness of the flanges will be the same. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both. The Committee suggests that all Angles be ordered by size of flanges and weight per foot.</p> <p>A Table giving the Areas of sections in square inches, Weights per footrun, Moments of Inertia, etc., will be issued at a later date.</p>
1 x 1	·125	—	·250	·125	·300	·175	·125	
1½ x 1½	·125	—	·250	·125	·300	·200	·150	
1½ x 1½	·125	—	·250	·125	·350	·200	·150	
1¾ x 1¾	·175	—	·300	·175	·375	·225	·150	
2 x 2	·175	—	·300	·175	·400	·250	·175	
2½ x 2½	·175	—	·300	·175	·450	·250	·175	
2½ x 2½	·250	·375	·500	·200	·500	·275	·200	
2¾ x 2¾	·250	·375	·500	·225	·525	·275	·200	
3 x 3	·250	·375	·500	·250	·525	·300	·200	
3½ x 3½	·300	·425	·500	·275	·575	·325	·225	
4 x 4	·300	·425	·500	·300	·625	·350	·250	
4½ x 4½	·375	—	·500	·325	·650	·400	·275	
5 x 5	·375	—	·500	·350	·700	·425	·300	
6 x 6	·450	—	·625	·425	·775	·475	·325	
7 x 7	·500	—	·675	·475	·850	·550	·375	
8 x 8	·550	—	·750	·550	·950	·600	·425	

The Creation of ISO

- BSI organised the meeting establishing the International Organization for Standards (ISO)
 - It was held in 1946 in London after the end of the Second World War, and attended by delegates from 25 countries.



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ISO Technical Committees



- The first ISO Technical Committee (ISO/TC 1) was established in 1947
- By 1949, 70 technical committees had been established, for example:
 - ISO/TC 1 – Screw threads
 - ISO/TC 4 – Rolling bearings
 - ISO/TC 70 – Internal combustion engines



Where Standards come from



- Member countries, through their National Standards organisations provide:
 - technical expertise
 - committee membership
 - propose new standards
 - produce new standards
 - review existing standards
 - <https://www.iso.org/members.html>

Examples of ISO Full Members



• Australia	SA	• Korea, Rep. of	KATS
• Austria	ASI	• Netherlands	NEN
• Canada	SCC	• Norway	SN
• China	SAC	• Pakistan	PSQCA
• Czech Republic	UNMZ	• Poland	PKN
• Denmark	DS	• Russian Fed.	GOST R
• Egypt	EOS	• Saudi Arabia	SASI
• Finland	SFS	• Spain	AENOR
• France	AFNOR	• Sweden	SIS
• Germany	DIN	• Switzerland	SNV
• India	BIS	• UAE	ESMA
• Iran, Islamic Rep.	ISIRI	• UK	BSI
• Japan	JISC	• USA	ANSI

ISO today



- ISO has published over **22,347** International Standards (at September 2018)
- ISO Standards on Vibration, Shock and Condition Monitoring are managed by:
 - ISO Technical Committee 108 – Mechanical vibration and shock and condition monitoring (ISO/TC 108)
 - ISO/TC 108 has a current portfolio of over **183** documents

Extract from ISO/TC 108's Business Plan



- Mechanical vibration, shock and condition monitoring affects virtually every aspect of human endeavour
- This includes human health and safety, machines, vehicles (air, sea, and land) and stationary structures
 - Extract from ISO Business Plan
 - Re-affirmed: 24 February 2015

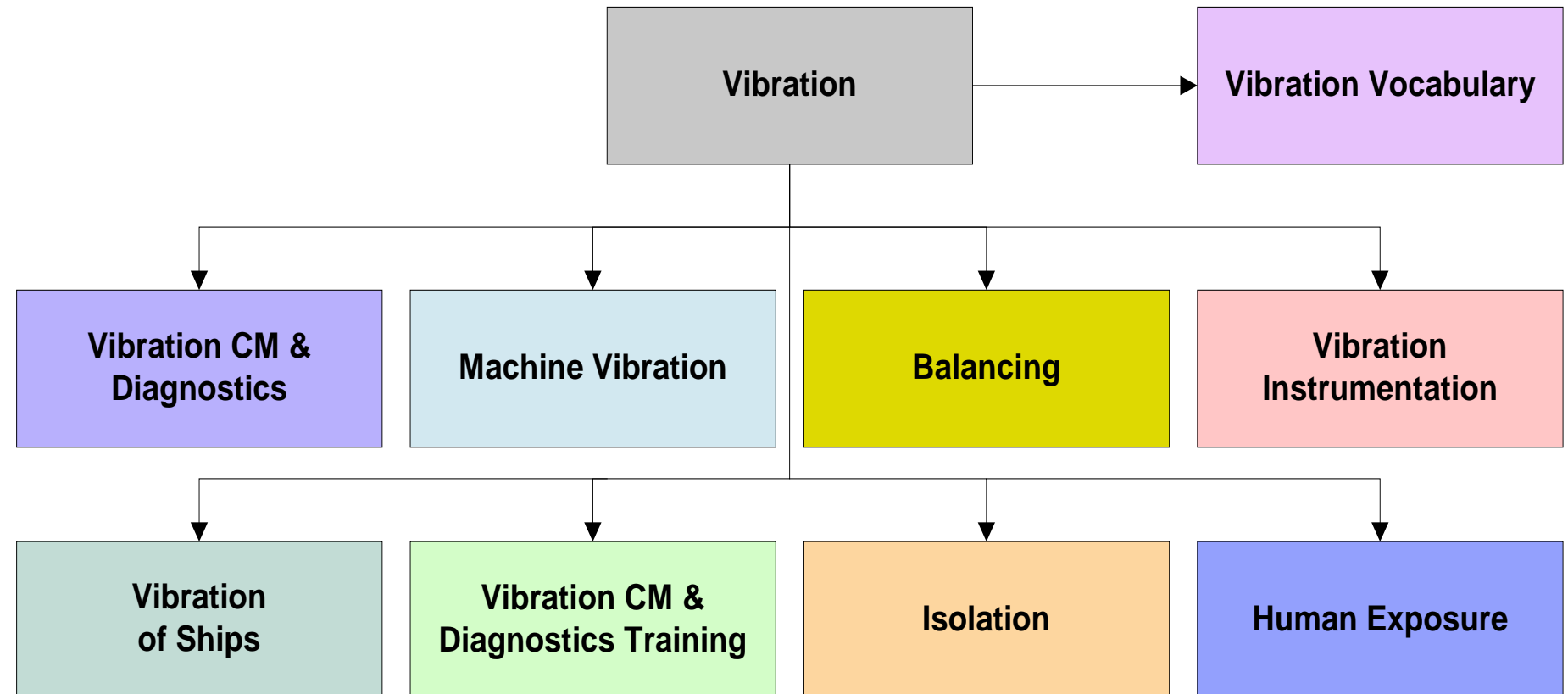
ISO Vibration Standards



- ISO Vibration Standards are managed either directly at Committee Level by ISO/TC 108 (e.g. WG31 – Balancing) or by ISO/TC 108 sub-committees
- ISO/TC 108/SC 2 has issued **54** International Standards relating to Machine Vibration and Shock since 2000
- Currently **6** are in development or review

Overview of relevant Vibration Standards

- The subject areas of Vibration International Standards useful to Vibration Analysts are shown below.
 - Also see the ISO On-line Browsing Platform:
<https://www.iso.org/obp>



Recently Updated Vibration Standards



- ISO 10816 and ISO 7919 Standards are in the process of being combined into parts of a new ISO 20816 series
 - ISO 10816-8 was first published in 2014 & superseded in 2018 by ISO 20816-8
 - ISO 10816-21 was published in 2015
 - ISO 20816-1 was published in 2016
 - ISO 20816-2 was published in 2017
 - ISO 20816-4 and 5 were published this year
- The Balancing Standards are all becoming parts of the ISO 21940 series
 - ISO 21940-11 & ISO 21940-12 were published in 2016
 - ISO 21940-2 was published in 2017

ISO/TC 108/SC 5

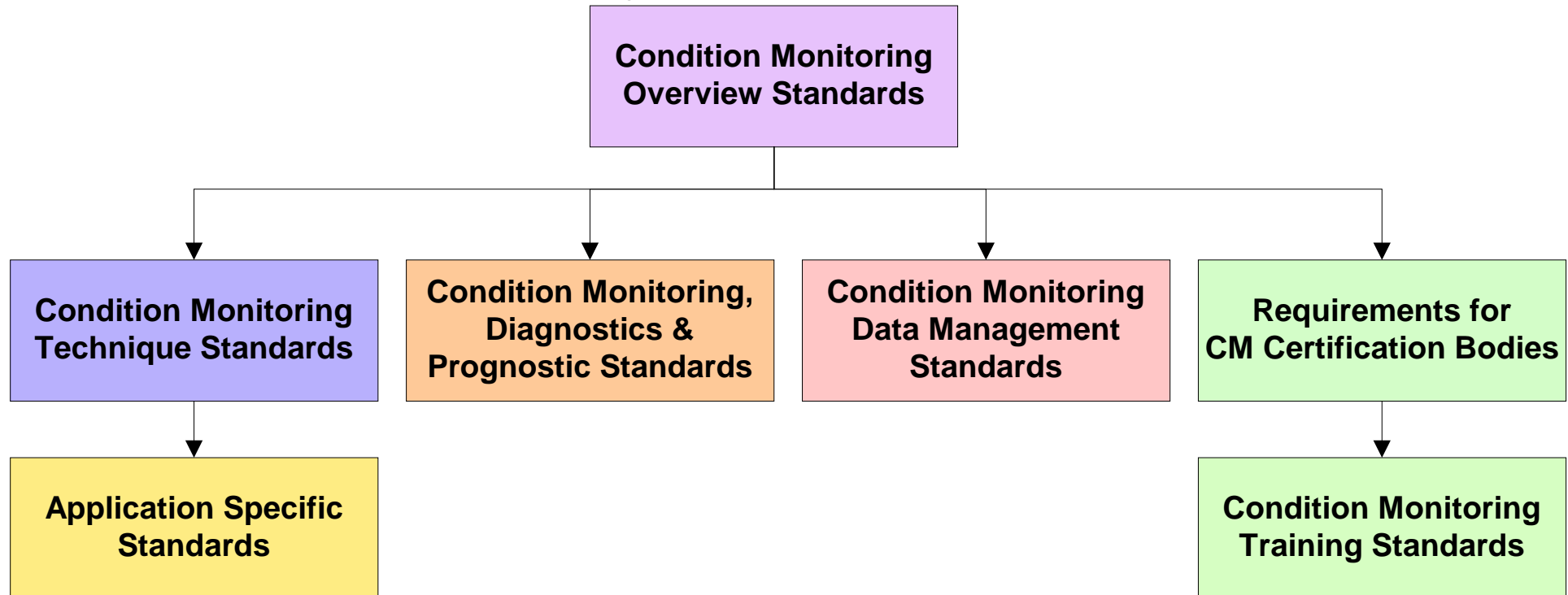


- Development of technology of vibration CM, & other techniques such as thermal imaging & tribology led to the establishment of a new sub-committee under TC108 in the 1990's
- ISO/TC 108/SC 5 – Condition monitoring & diagnostics of machines



ISO Condition Monitoring Standards

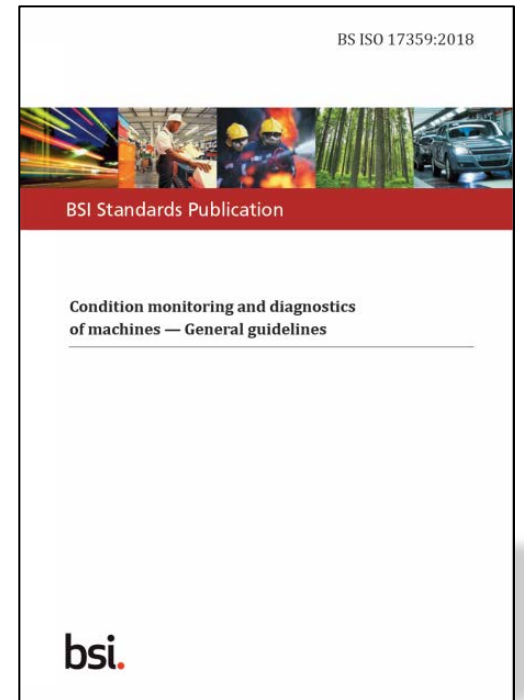
- ISO/TC 108/SC 5 has issued **24** International Standards relating to Condition Monitoring and Diagnostics since 2000. Currently **5** are in development or review
 - ISO CM standards subject areas include:



ISO 17359:2018



- ISO 17359:2018, Condition monitoring and diagnostics of machines – General guidelines
 - The umbrella document to ISO Standards covering Condition Monitoring (CM)
 - Originally issued in 2003
 - Second edition issued in 2011
 - Incorporated & superseded ISO 13380
 - Third edition published in 2018
 - Updates portfolio of CM Standards
 - Adds power transformer symptom table
 - Links from ISO 55000 Series



ISO CM Technique Standards



- CM Technique Standards include:
 - Vibration
 - Thermography
 - Acoustic Emission
 - Ultrasound
 - Lubricant Sampling, Analysis & Tribology



ISO CM Application Standards

- CM Applications Standards include:
 - Induction Motors
 - Gas Turbines
 - Structures
 - Power Transformers
 - Wind Turbines



ISO CM Training Standards



- Training Standards have also been developed in the ISO 18436 Series:
 - Vibration condition monitoring and diagnostics
 - Thermography
 - Field lubricant analysis
 - Lubricant laboratory technician/analyst
 - Acoustic emission
 - Ultrasound



Recently Issued CM Standards



- Recently published or revised CM Standards include:
 - ISO 13379-1 (CM Prognostics) was re-issued in 2015
 - ISO 18129 (CM of Electric Motors) was published in 2015
 - ISO 17359 (CM Guidelines) 3rd edition came out in 2018
 - ISO 18095 (CM of Power Transformers) was published in 2018

BINDT CM Certification Scheme



- In the UK, BINDT has a well-established ***third-party*** certification scheme and runs examinations for the various categories of CM practitioners
- BINDT manages certification in compliance with appropriate parts of ISO 18436 for CM personnel in the following areas:
 - Vibration Analysis
 - Infrared Thermography
 - Wear and Debris Analysis
 - Acoustic Emission

BINDT
THE BRITISH INSTITUTE OF
NON-DESTRUCTIVE TESTING



Vibration Analyst CM Syllabus

Ref	Subject	Cat 1	Cat 2	Cat 3	Cat 4
1	Principles of vibration	6	3	1	4
2	Data acquisition	6	4	2	2
3	Signal processing	2	4	4	8
4	Condition monitoring	2	4	3	1
5	Fault analysis	4	5	6	6
6	Corrective action	2	4	6	16
7	Equipment knowledge	6	4	4	-
8	Acceptance testing	2	2	2	-
9	Equipment testing and diagnostics	-	2	4	4
10	Reference standards	-	2	2	2
11	Reporting and documentation	-	2	2	4
12	Fault severity determination	-	2	2	3
13	Rotor and bearing dynamics	-	-	-	14
	Total hours for each category	30	38	38	64

Thermography CM Syllabus

Ref	Subject	Cat 1	Cat 2	Cat 3
1	Introduction	0.5	-	-
2	Principles of infrared thermography (IRT)	6	7	6
3	Equipment and data acquisition	5	3	1
4	Image processing	6	2	1
5	General applications	4.5	-	-
6	Diagnostics & prognostics	1	2	2
7	Condition monitoring applications	4	10.5	7
8	Corrective actions	-	3	6
9	Reporting and documentation (ISO Standards)	1	0.5	0.5
10	Condition monitoring program design	0.5	0.5	3.5
11	Condition monitoring program implementation	1	1	1
12	Condition monitoring program management	0.5	0.5	2
13	Training examination	2.0	2.0	2.0
	Total hours for each category	32	32	32

Supporting Handbooks

- BINDT is publishing a series of CM Handbooks, with 3 already available:

- A VM Handbook

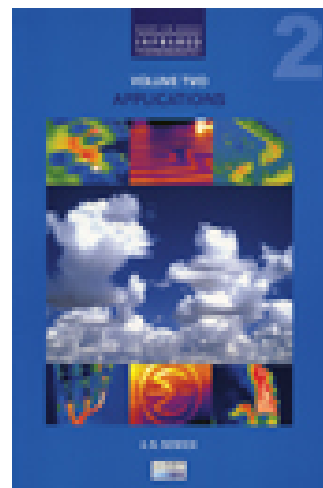
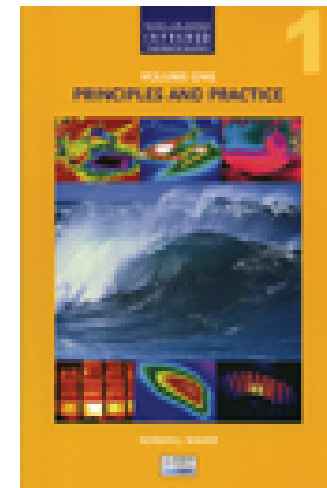
- To support ISO 18436-2
- Available from BINDT:
 - Price £90

- Two Thermography Handbooks

- To support ISO 18436-7
- Available from BINDT:
 - Price £65 each

- An Introduction to CM Handbook is in preparation

- Will be available from BINDT in 2019



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Conclusions



- The portfolio of International Standards covering condition monitoring is still growing
- Qualification and assessment in the field of Condition Monitoring (CM) is progressing well, and has gained international credibility
 - Third-party certification schemes such as BINDT's PCN schemes ensure that certified CM practitioners utilise standard references, techniques and procedures
 - These qualification and certification initiatives have an international market, and are contributing to standardising condition monitoring and diagnostics training, processes and procedures
 - They are having a positive impact throughout the asset management life cycle

Questions



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

References



- BSI: THE FIRST HUNDRED YEARS 1901 – 2001, Robert C McWilliam, The Institution of Civil Engineers, ISBN 0 7277 3020 7
- International Organization for Standardization (ISO) – www.iso.org
- British Institute of Non-destructive Testing (BINDT) – www.bindt.org
- British Standards Institute – www.bsigroup.com
- ISO 17359:2018, Condition monitoring and diagnostics of machines – General guidelines
- ISO 18436-2:2014, Condition monitoring and diagnostics of machines – Requirements for qualification and assessment of personnel – Part 2: Vibration condition monitoring
- BINDT INST338, Infrared Thermography Handbook – Volume 1. Principles and Practice – N Walker – BINDT, ISBN 0 903 132 338
- BINDT INST32X, Infrared Thermography Handbook – Volume 2. Applications – A N Nowicki – BINDT, ISBN 0 903 132 32X
- BINDT INST397, Vibration Monitoring & Analysis Handbook – S R W Mills – BINDT, ISBN 978 0 903132 39 7