INTERNATIONAL STANDARD

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Condition monitoring and diagnostics of machines — Requirements for qualification and assessment of personnel —

Part 7: Thermography

Surveillance et diagnostic d'état des machines — Exigences relatives à la qualification et à l'évaluation du personnel —

Partie 7: Thermographie

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 5, *Condition monitoring and diagnostics of machine systems*.

This second edition cancels and replaces the first. edition (ISO 18436-7:2008), of which it constitutes a minor revision.

ISO 18436 consists of the following parts, under the general title *Condition monitoring and diagnostics of machines — Requirements for qualification and assessment of personnel —*:

— *Part 1: Requirements for assessment bodies and the assessment process*

— *Part 2: Vibration condition monitoring*

— *Part 3: Requirements for training bodies and the training process*

— *Part 4: Field lubricant analysis*

— *Part 5: Lubricant laboratory technician/analyst*

— *Part 6: Acoustic emission*

— *Part 7: Thermography*

— *Part 8: Ultrasound*

The following part is planned:

— *Part 9: Condition monitoring specialists*

Introduction

Using thermography to monitor condition and diagnose faults in machinery is a key activity in predictive maintenance programmes for most industries. Other non-intrusive technologies including vibration analysis, acoustic emission, lubricant analysis, and motor current analysis are used as complementary condition analysis tools. Those in the manufacturing industry who have diligently and consistently applied these techniques have experienced a return on investment far exceeding their expectations. However, the effectiveness of these programmes depends on the capabilities of individuals who perform the measurements and analyse the data.

A programme, administered by an assessment body, has been developed to train and assess the competence of personnel whose duties require the appropriate theoretical and practical knowledge of machinery monitoring and diagnostics.

This part of ISO 18436 defines the requirements against which personnel in the non-intrusive machinery condition monitoring and diagnostics technologies associated with infrared thermography for machinery condition monitoring are to be qualified and the methods of assessing such personnel.

Condition monitoring and diagnostics of machines — Requirements for qualification and assessment of personnel —

Part 7: Thermography

1 Scope

This part of ISO 18436 specifies the requirements for qualification and assessment of personnel who perform machinery condition monitoring and diagnostics using infrared thermography.

A certificate or declaration of conformity to this part of ISO 18436 will provide recognition of the qualifications and competence of individuals to perform thermal measurements and analysis for machinery condition monitoring using portable thermal imaging equipment. This procedure might not apply to specialized equipment or other specific situations.

This part of ISO 18436 specifies a three-category classification programme that is based on the technical areas delineated herein.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 13372, *Condition monitoring and diagnostics of machines — Vocabulary*

ISO 13374 (all parts), *Condition monitoring and diagnostics of machines — Data processing, communication and presentation*

ISO 13379-1, *Condition monitoring and diagnostics of machines — Data interpretation and diagnostics techniques — Part 1: General guidelines*

ISO 13381-1, *Condition monitoring and diagnostics of machines — Prognostics — Part 1: General guidelines*

ISO 17359, *Condition monitoring and diagnostics of machines — General guidelines*

ISO 18434-1, *Condition monitoring and diagnostics of machines — Thermography — Part 1: General procedures*

ISO 18436-1:2012, *Condition monitoring and diagnostics of machines — Requirements for qualification and assessment of personnel — Part 1: Requirements for assessment bodies and the assessment process*

ISO 18436-3, *Condition monitoring and diagnostics of machines — Requirements for qualification and assessment of personnel — Part 3: Requirements for training bodies and the training process*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13372 apply.

4 Classification of personnel (thermography)

4.1 General

Individuals assessed as conforming to the requirements of this part of ISO 18436 shall be classified in one of three categories depending upon their qualifications. They shall have demonstrated the necessary skills in thermal condition monitoring for their category as indicated in Annex A.

Personnel classified as Category II need to have all the knowledge and skills expected of personnel classified as Category I, while personnel classified as Category III need to have all the knowledge and skills expected of personnel classified as Category II.

4.2 Category I

Individuals classified as Category I are qualified to perform infrared thermography according to established and recognized procedures. Personnel classified as Category I shall be able to:

a) apply a specified thermographic measurement technique;

b) set up and operate the thermal imaging equipment for safe thermographic data collection;

c) identify, prevent, minimize and control poor data acquisition and error sources;

d) perform basic fault detection, severity assessment and diagnosis in accordance with established instructions;

e) perform basic image post-processing (measurement tools, emissivity adjustments, span and scale adjustments, etc.);

f) maintain a database of results and trends;

g) verify the calibration of thermographic measurement systems;

h) evaluate and report test results and highlight areas of concern.

4.3 Category II

Individuals classified as Category II are qualified to perform infrared thermography according to established and recognized procedures. Personnel classified as Category II shall be able to:

a) select the appropriate infrared thermography technique and understand its limitations;

b) apply thermography theory and techniques, including measurement and interpretation of survey results;

c) specify the appropriate hardware and software;

d) perform advanced fault diagnoses;

e) recommend appropriate field corrective actions;

f) perform advanced image post-processing (image, trending, montage, subtraction, superimposition, statistical analysis, etc.);

g) use generally recognized advanced techniques for infrared thermography and fault diagnosis in accordance with established procedures;

h) prepare reports on equipment condition, fault diagnoses, corrective actions and the effectiveness of repairs;

i) be aware of the use of alternative or supplementary condition monitoring technologies; and

j) provide guidance to and supervise Category I personnel.

4.4 Category III

Individuals classified as Category III are qualified to perform infrared thermography according to established and recognized procedures. Personnel classified as Category III shall be able to:

a) develop and establish thermographic programmes, write working procedures and instructions including determination of machines for periodic/continuous monitoring, frequency of testing, the use of advanced techniques;

b) determine severity assessment, acceptance criteria and testing procedures for new, in-service and faulty equipment;

c) interpret and evaluate codes, standards, specifications and procedures;

d) designate the particular test methods, procedures and instructions to be used;

e) perform prognostics for fault conditions;

f) recommend appropriate types of thermodynamic (radiation-, convection-, conduction-based) corrective actions;

g) recommend appropriate types of machinery engineering corrective actions;

h) provide guidance to and supervise Category I and II personnel;

i) recommend the use of alternative or supplementary condition monitoring technologies, and

j) be able to manage condition monitoring programmes.

NOTE It is the employer's responsibility to ensure that Category III personnel have the necessary competency in the required management skills, for example creating budgets preparing cost justifications and managing personnel development.

5 Eligibility

5.1 General

Candidates should have a combination of education, training and experience to ensure that they understand the principles and procedures applicable to thermographic measurement and analysis.

It is advised that all candidates have their colour perception assessed by the Ishihara 24 plate test. A record of test results should be retained and presented to the assessment body upon request. In the event that a colour perception deficiency, indicated by misreading four or more of the 24 plates, is detected during the Ishihara test, a further "task specific" test is to be carried out by the employer to ascertain whether the detected colour perception deficiency affects the individual's ability to satisfactorily perform analysis of thermographic data using colour palettes. Failure to pass this test may require the candidate to use a monochrome palette. This "task specific" test, and any requirement to use a monochrome palette, is to be documented and a record of the test made available to the assessment body upon request.

5.2 Education

Candidates seeking classification do not need to provide evidence of formal education to establish eligibility. However, it is recommended that candidates for Category I and Category II have at least a secondary school graduate qualification or its equivalent. Category II and III candidates shall be able to manipulate simple algebraic equations, use a basic scientific calculator, and be familiar with the operation of personal computers. Successful completion of two or more years of mechanical technology

or mechanical engineering at an accredited college, university, or technical school is highly recommended for candidates seeking classification to Category III.

5.3 Training

5.3.1 Introduction

To be eligible to apply for assessment based on this part of ISO 18436, the candidates shall provide evidence of successful completion of training based on the requirements of Annex A. The documents in the Bibliography should be used as the domain of knowledge for the training syllabus. Such training shall be compliant with the requirements of ISO 18436-3. The minimum duration of training is shown in Table 1. Training should be in the form of lectures, demonstrations, practical exercises or formal training courses.

Qualification requirements shall be in accordance with this part of ISO 18436. Training time devoted to each subject shall be in accordance with Annex A and Table 1. See Annex B for a non-exhaustive list of the topics and sub-topics to be covered.

Table 1 — Minimum duration of cumulative training (hours)

Category I	Category II	Category III
32	64	96

Training may be modularized into two or more subject areas covering general scientific principles and application-specific knowledge in order to allow for mutual recognition between non-destructive testing and condition monitoring assessment bodies.

5.3.2 Training for supplementary classification

A modular training course designed to cover those topics specific to thermography-based condition monitoring may be undertaken.

Such supplementary training courses shall cover the topics outlined in Annex A for subjects five (5) to eleven (11) inclusive. The duration of such training shall comply with the durations stated in Annex A for the relevant subject areas.

5.3.3 Additional training on machine knowledge

In addition to the training hours shown in Table 1, candidates should attend machinery and component training, or equivalent on-the-job training, of at least a similar duration to that specified in Table 1.

Such training shall be in addition to any formal education compliant with 5.2, inclusive of any college or university education. If undertaken, the additional training shall cover the design, manufacturing, installation, operation and maintenance principles of machines and components, the failure modes and mechanisms associated with each principle, and the typical thermodynamic behaviours associated with each mechanism. Such training shall be validated by verifiable records.

5.4 Experience

5.4.1 To be eligible to apply for assessment based on this part of ISO 18436, the candidate shall provide evidence to the assessment body of experience in the field of thermography-based machinery condition monitoring in accordance with Table 2. Classification to Category II and Category III requires previous classification at the lower category.

Table 2 — Minimum cumulative practical, interpretation and programme management experience requirements (months)

Category I	Category II	Category III
12 months	24 months	48 months
NOTE The experience hours are based on 16 hours minimum per month of thermography-based machinery condition monitoring experience in accordance with Clauses 4 and 5.		

5.4.2 The minimum total experience durations specified (in months) are required to enable the acquisition of experience in all category criteria in accordance with ISO 18436-1 and 5.4.5.

5.4.3 Candidates shall keep verifiable documentary evidence of hours and nature of work for their thermography-based machinery condition monitoring experience in accordance with ISO 18436-1. Candidates for Categories I and II shall have this evidence validated by a Category II or III person or, in the absence of such a person, by the candidate's technical supervisor.

5.4.4 Candidates for Category III shall have this evidence validated by a Category III person or, in the absence of such a person, by the candidate's technical supervisor.

5.4.5 The validation process for all categories requires the signature of the validating person on the documentary evidence. The validating person should augment this validation process via oral assessment, accompanied task performance, report submission and review, procedure submission and review, or a combination thereof, in order to increase the confidence in the validation.

6 Examinations

6.1 Examination content

6.1.1 For each category, candidates shall be required to answer a fixed minimum number of multiple choice questions in a specified time duration as indicated by Table 3.

6.1.2 Questions shall be of a practical nature, yet test the candidate on concepts and principles required to conduct infrared thermography for condition monitoring of machines.

6.1.3 The examination papers for Category I shall consist of a Part A – General Thermography (comprising a number of multiple choice questions) and a Part B – Practical Application. The Part B examination shall cover quality data acquisition, the recognition, prevention and control of error sources, and basic fault diagnosis. This examination may include both physical data acquisition tasks in addition to image interpretation.

6.1.4 The examination papers for Category II shall consist of a Part A – General Thermography (30 questions) and a Part B – Practical Application. The Part B examination shall cover diagnostics and image interpretation for condition monitoring of machines. This examination may include both physical data acquisition tasks in addition to image interpretation.

6.1.5 The examination papers for Category III shall consist of a Part A – General Thermography (30 questions) and a Part B – Practical Application. The Part B examination shall cover diagnostics and image interpretation, solution design, and solution verification. This examination may include both physical data acquisition tasks in addition to image interpretation. The image interpretation questions should be based on case histories requiring fault identification, solution recommendation, and a solution verification process. Part B may also include narrative and short answer questions. Some questions shall involve the interpretation of thermal images. Simple mathematical calculations using a basic scientific calculator may be required. A summary of common formulae may be provided along with the examination questions.

6.1.6 Examination content shall be proportionate with the training syllabus contained in Annex A.

6.1.7 Assessment bodies may, at their discretion, make accommodations for candidates with conditions that may require some form of compensation.

Table 3 — Minimum examination content

Categories	Number of questions	Time h	Passing grade %
Category I	50	2,0	75
Category II	60	2,0	75
Category III	60	2,0	75
Supplementary exam	30	1,0	75

6.2 Conduct of examinations

All examinations shall be conducted in accordance with ISO 18436-1:2012, 8.1, except that candidates may also have access to pencils and erasers if computer-based marking is used.

6.3 Supplementary examination

6.3.1 Supplementary modular examinations may be made available to those with an equivalent classification, as determined by the relevant assessment body, covering the topics outlined in A.1, subjects 1 to 4, and compliant with the other requirements of this part of ISO 18436. This examination comprises a separate supplementary module covering condition monitoring of machines.

6.3.2 Supplementary modular examinations will be graded separately.

6.3.3 Supplementary examination candidates shall have satisfactorily completed a course of training covering the syllabus to be examined and shall provide verified documentary evidence of the training.

Annex A
(normative)

Training course requirements and minimum training hours for thermography personnel

A.1 Training syllabus

Subject		Hours of training		
		Category I	Category II	Category III
0.	Introduction	0,5	—	—
1.	Principles of infrared thermography (IRT)	6	7	6
2.	Equipment and data acquisition	5	3	1
3.	Image processing	6	2	1
4.	General applications	4,5	0	0
5.	Diagnostics and prognostics	1	2	2
6.	Condition monitoring applications	4	10,5	7
7.	Corrective actions	—	3	6
8.	Reporting and documentation (ISO International Standards)	1	0,5	0,5
9.	Condition monitoring programme design	0,5	0,5	3,5
10.	Condition monitoring programme implementation	1	1	1
11.	Condition monitoring programme management	0,5	0,5	2
12.	Training examination	2,0	2,0	2,0
Total hours for each category		**32**	**32**	**32**

A.2 Detailed list of topics and hours of instruction

Subject		Topics	Hours of training		
			Category I	Category II	Category III
0.	Introduction	Context of condition monitoring versus NDT, overviews of intent behind topics, and explanation of personnel classification categories	0,5	—	—
1.	Principles of infrared thermography (IRT)		6	7	6
		Heat and heat transfer	*		
		Conduction fundamentals	*		
		Fourier's Law		*	*
		Conductivity/resistance	*		
		Convection fundamentals	*		
		Newton's Law of Cooling		*	*
		Radiation fundamentals	*		
		Electromagnetic spectrum	*		
		Atmospheric transmission	*	*	
		IR wavebands and lens materials	*		
		Radiation reference sources		*	*
		Planck's Law		*	
		Wien's Law		*	
		Stefan-Boltzmann Law	*		
		Emittance, reflectance and transmittance	*		
		Emissivity	*	*	*
		Factors affecting emissivity	*	*	*

Subject		Topics	Hours of training		
			Category I	Category II	Category III
2.	Equipment and data acquisition		5	3	1
		How your infrared camera works	*		
		Infrared camera selection criteria		*	
		Spectral band	*	*	
		Temperature measurement range	*		
		Thermal sensitivity (NETD)		*	
		Lens selection	*	*	
		Optical resolution	*	*	
		Operation of equipment	*	*	
		Accessories	*	*	
		Camera controls	*		
		ISO 18434-1	*	*	
		Safe data acquisition	*	*	
		Getting a good image	*		
		Image composition	*	*	*
		Image clarity (optical focus)	*		
		Thermal tuning (range, level and span)	*		
		Palette selection	*		
		Emissivity determination	*	*	
		Error source recognition, prevention or control	*	*	
		Waveband selection criteria		*	*
		Recognizing and dealing with radiation (reflections, reflected apparent temperature)	*	*	*
		Recognizing and dealing with convection	*	*	*
		Recognizing and dealing with conduction	*	*	*
		Effects of incorrect emissivity	*	*	
		Camera calibration	*	*	
		Environmental and operational conditions	*	*	
		Data and image storage	*		

Subject		Topics	Hours of training		
			Category I	Category II	Category III
3.	Image processing		6	2	1
		Temperature measurement	*	*	
		ISO 18434-1	*	*	*
		Non-contact thermometry	*		
		Comparative quantitative thermography	*	*	
		Comparative qualitative thermography	*	*	
		Environmental influences	*	*	
		Camera measurement tools	*	*	
		Measurement tools	*	*	
		Palette selection	*		
		Level and span adjustment	*		
		Distance (atmospheric) correction	*	*	
		Emissivity correction		*	
		Statistical analysis		*	
		Image subtraction		*	*
		Image montage	*	*	*
		Temperature trending	*	*	*
		General image interpretation guidelines	*	*	*
		General guidelines for establishing thermal severity assessment criteria (ISO 18434-1, engineering codes and standards)		*	*
4.	General applications		4,5	0	0
		Discussion on general industrial applications	*		
		Active and passive thermography	*		
5.	Diagnostics and prognostics		1	2	2
		Basic principles of diagnostics (ISO 13379)	*	*	*
		Basic principles of prognostics (ISO 13381-1)		*	*
6.	Condition monitoring applications		4	10,5	7
		Machinery engineering principles (components and construction)	*	*	*
		Typical machinery failure modes and mechanisms and their associated thermal signatures	*	*	*
		Severity assessment and acceptance criteria (engineering codes and standards)	*	*	*
		Safety issues	*	*	*
		ISO 18434-1	*	*	*

Subject		Topics	Hours of training		
			Category I	Category II	Category III
7.	Corrective actions		—	3	6
		Machinery corrective and/or preventive actions		*	*
8.	Reporting and documentation (ISO International Standards)		1	0,5	0,5
		Report writing	*	*	*
		Thermographers' and end-users' responsibilities	*	*	*
9.	Condition monitoring programme design (ISO 17359, ISO 18434-1, ISO 13379, ISO 13381-1)		0,5	0,5	3,5
		General principles	*	*	*
		Technique selection		*	*
		Measurement intervals		*	*
		Reference temperatures	*	*	*
		Baseline temperatures	*	*	*
		Procedure development		*	*
10.	Condition monitoring programme implementation (ISO 17359, ISO 13381-1, ISO 18434-1)		1	1	1
		Overview	*		
		Safe systems of work	*	*	
		Roles and responsibilities		*	*
		Training and assessment		*	*
11.	Condition monitoring programme management		0,5	0,5	2
		Safety management	*	*	*
		Equipment management	*	*	*
		Procedure management		*	*
		Skills and competencies management		*	*
		Database management	*	*	*
		Managing corrective action implementation		*	*
12.	Training examination		2,0	2,0	2,0
Total hours			**32**	**32**	**32**

NOTE 1 Category II includes the knowledge of Category I; Category III includes the knowledge of Category I and Category II.

NOTE 2 At Categories II and III, the times allocated are indicative only, indicating the bias towards application topics, and the actual time spent for each topic is flexible, provided an advised minimum of approximately 24 h is allocated per field of application.

NOTE 3 * Indicates topics to be taught at indicated category.

Annex B
(normative)

Training course sub-topics

This is a guide to the topics that shall be covered. This list is not exhaustive.

Subject		Topics	Sub-topics
1.	Principles of IRT	Heat transfer	
		Electromagnetic spectrum	
		Emittance, reflectance and transmittance	Factors affecting emissivity, reflectance and transmittance
		Atmospheric transmission	
		IR wavebands and lens materials	
		Conduction fundamentals	
		Fourier's Law	Heat flow; conduction; target thickness; general principles
		Conductivity/resistance	
		Convection fundamentals, Newton's Law of Cooling	
		Radiation fundamentals	Reference sources
		Planck's Law	Emissivity; real temperature difference; general principles; blackbodies
		Wien's Law	General principles
		Stefan-Boltzmann Law	
2.	Equipment and data acquisition	How your imager works	
		Selection criteria	Noise Equivalent Temperature Difference (NETD); frame repetition; object size; distances; transmissivity; Instantaneous Field Of View (IFOV); filters; detectors; resolution; palette selection; waveband selection criteria; effects of incorrect emissivity
		Range and level settings	Temperature measurement range; thermal tuning (range, level and span)
		Operation of equipment	Accessories; emissivity determination
		Controls	
		Lenses	Lens material, selection
		Getting a good image	Image composition
		Clarity (focus)	Optical resolution; focus
		Dynamic range	General principles; NETD
		Recognizing and dealing with reflections	Reflections; reflected apparent temperature
		Recognizing and dealing with convection	Roofs; ground; structures; mass transport

Subject		Topics	Sub-topics
		Recognizing and dealing with conduction	
		Calibration	
		Environmental and operational conditions	Error source recognition, prevention or control
		Data storage	Data and image storage
3	Image processing	Temperature measurement	ISO 18434-1; non-contact thermometry; comparative quantitative and qualitative thermography; temperature trending
		Measurement functions	Camera measurement tools
		Accuracy	
		Emissivity measurements	Emissivity corrections
		Avoiding errors	
		Small spot size	
		Distance	Distance and atmospheric corrections
		Atmospheric attenuation	Environmental influences
		Support data collection and equipment	General principles
		Environmental data	Wind; rain; sun; reflections
		Software	Compatibility; area; statistical analysis; functions; principles
		Image interpretation	Emissivity; detectors; solar reflection; night reflection; qualitative evaluation; radiosity; image subtraction; image montage; general image interpretation guidelines
		Establishing thermal severity criteria (absolute, delta, statistical)	Principles; quantitative evaluation; maximum operating temperature; general guidelines for establishing thermal severity assessment criteria (ISO 18434-1, engineering codes and standards)
4.	General applications	—	Discussion on general industrial applications not covered by the sector topics defined
		Mechanical	Principles; motors; pumps; gearboxes; engines; electric motors, compressors, fans; rotating equipment; reciprocating equipment; active and passive thermography
		Acceptance criteria	Principles; allowed temperatures and temperature drops
		Safety issues	Principles; risk assessment; health, safety and environment; electricity at work regulations; HV current breakers; maximum temperature; inspections; safety protocols
5.	Diagnostics and prognostics	Diagnostics principles and processes	Principles; processes; ISO 13379
		Prognostic principles and processes	Principles; processes; motors; ISO 13381-1

Subject		Topics	Sub-topics
6.	Condition monitoring applications	Mechanical engineering (components and construction)	Principles; mechanisms; bearings; lubrication
		IR theory to mechanical applications and thermal signatures	Applications; signatures; steam traps; friction; lubrication, cooling, typical machinery failure modes and their associated thermal signatures; ISO 18434-1
		Applications	Limitations
		a) Rotating equipment	Drive shafts; bearings; gears, fans, motors, hydraulic drives; pumps; compressors; turbines; belt drives
		b) Fluid flow	Heat exchangers; clean laboratories; steam traps; pumps; boilers; valves; pressure vessels; pipes; condensates
		c) Power transmission	Pumps; valves; motors
		Fault analysis	Principles; pipe cladding; cryogenics; baseline
		Acceptance criteria	Baseline; acceptance principles; severity assessment and acceptance criteria (engineering codes and standards)
7.	Corrective actions	Mechanical	Recommendations for pumps, bearings, motors, compressors, engines; machinery corrective and preventive actions
8.	Reporting and documentation (ISO International Standards)		
9.	Condition monitoring programme design	Overview	ISO 17359, ISO 18434-1, ISO 13379, ISO 13381-1; general principles
		Techniques selection	Thermal imaging; non-contact pyrometers; heat flux indicators; vibration analysis, oil analysis, acoustics, other CM techniques
		Measurement intervals	Principles
		Procedure development	Prioritization; costs; protocols; defect severity analysis
		Reference temperatures	Principles; severity of anomalies
		Baseline temperatures	Principles
10.	Condition monitoring programme implementation	Overview	ISO 17359, ISO 13381-1, ISO 18434-1
		Safe systems of work	Procedures
		Roles and responsibilities	Relevant parts of ISO 18436
		Training and assessment	Relevant parts of ISO 18436
11.	Condition monitoring programme management	Safety management	Protocols; risk assessment
		Equipment management	Principles
		Procedure management	Principles, ISO 17359
		Skills and competencies management	Relevant parts of ISO 18436
		Database management	ISO 13374, ISO 13372, ISO 13379
		Managing corrective action implementation	Principles; protocols; corrosion/temperature

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