INTERNATIONAL STANDARD

ISO 15743

First edition
2008-07-01

Ergonomics of the thermal environment — Cold workplaces — Risk assessment and management

Ergonomie des ambiances thermiques — Lieux de travail dans le froid — Évaluation et management des risques

Reference number
ISO 15743:2008(E)

© ISO 2008

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS

Not for Resale

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

COPYRIGHT PROTECTED DOCUMENT

© ISO 2008

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS

© ISO 2008 – All rights reserved

Not for Resale

Contents

Page

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 15743 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 5, *Ergonomics of the physical environment*.

© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

Introduction

This International Standard is one of a series of thermal standards (see Clause 2 and the Bibliography) intended to be used in the assessment and management of work in the cold, i.e. in conditions that cause uncomfortable sensations of cool or cold. In light physical work, these conditions can occur at 10 °C or below.

A number of industries, types of commerce and occupations involve substantial cold exposure, outdoors or indoors, where individual workers can also be exposed to windy and/or wet conditions. Working in cold environments can involve several adverse effects on human performance and health: thermal discomfort, increased strain, decreased performance and cold-related diseases and injuries. Cold can also interfere with several other factors in the workplace, modifying or aggravating the risk of common hazards and increasing the risk of cold-associated injuries.

Due to the negative impact of cold on human health and performance, as well as on work productivity, quality and safety, a comprehensive strategy of risk assessment and management practices and methods is needed for work in cold environments.

Even though some of the standards referred to above describe specific methods (instruments and indices) to be used to assess the required insulation of clothing for different cold exposures (see ISO 11079), or physiological and psychological consequences related to different thermal exposures, an instruction of practical application for cold working environments is lacking.

This International Standard was created to specify methods and practices for assessing and managing occupational health and performance risks in cold work. The choice of when these are to be used is at the discretion of those responsible for occupational health and/or safety.

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

Ergonomics of the thermal environment — Cold workplaces — Risk assessment and management

1 Scope

This International Standard presents a strategy and practical tools for assessing and managing cold risk in the workplace, and includes

— models and methods for cold risk assessment and management,

— a checklist for identifying cold-related problems at work,

— a model, method and questionnaire intended for use by occupational health care professionals in identifying those individuals with symptoms that increase their cold sensitivity and, with the aid of such identification, offering optimal guidance and instructions for individual cold protection,

— guidelines on how to apply thermal standards and other validated scientific methods when assessing cold-related risks, and

— a practical example from cold work.

This International Standard supports good occupational health and safety (OHS). It is applicable to both indoor and outdoor work situations — indoor work includes work done inside vehicles, outdoor work both inland and offshore work — but is not applicable to diving situations or other types of work performed underwater.

2 Normative references

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

ISO 9886:2004, *Ergonomics — Evaluation of thermal strain by physiological measurements*

ISO 12894, *Ergonomics of the thermal environment — Medical supervision of individuals exposed to extreme hot or cold environments*

ISO 13731, *Ergonomics of the thermal environment — Vocabulary and symbols*

ISO/TS 14415, *Ergonomics of the thermal environment — Application of International Standards to people with special requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13731 apply.

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

4 Strategy for assessment and management

4.1 Cold risk assessment

Cold risk assessment in the workplace follows the principles of risk assessment presented in ISO 15265 and generally accepted principles of risk assessment presented in, for example, BS 8800. It consists of three stages.

a) In stage 1 (observation) possible cold-related hazards at work are identified. This includes collecting qualitative information by an observation method (see 5.2 and Annex A). Based on the observed problems, management methods should be implemented in order to eliminate or reduce the source of harm. A further analysis should be conducted if the problem at work is not easily reduced or eliminated, or whenever it is uncertain whether the preventive actions have been sufficient to guarantee worker health and safety.

b) Stage 2 (analysis) aims at quantifying, analysing and estimating the cold-related effects observed in stage 1 and considered problems (see 5.3 and Annex B). The need for a further analysis in the workplace can also originate from the needs and definitions of occupational healthcare professionals, in assessing specific health-related problems in working situations. It is recommended that occupational health care or safety professionals conduct this analysis. To be able to perform the assessment, these persons should be provided with basic training related to cold, e.g. how to use the methods and estimate the risks. Based on the estimated cold risk, appropriate cold risk management methods should be applied. If it is still uncertain as to whether the management methods are adequate to ensure the worker's health and safety, a further analysis should be conducted (stage 3).

c) Stage 3 (expertise) aims at quantifying, analysing and estimating cold risks. It will deal with highly complex thermal working circumstances and require sophisticated or special measurements. This level should be conducted by the same persons as those involved in stage 2, with the additional assistance of highly specialized experts. The duration of an individual assessment is one day, or more, if necessary. The assessment is aimed at solving any specific cold-related problem found during stages 1 and/or 2. See 5.2.3.

See Figure 1.

© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

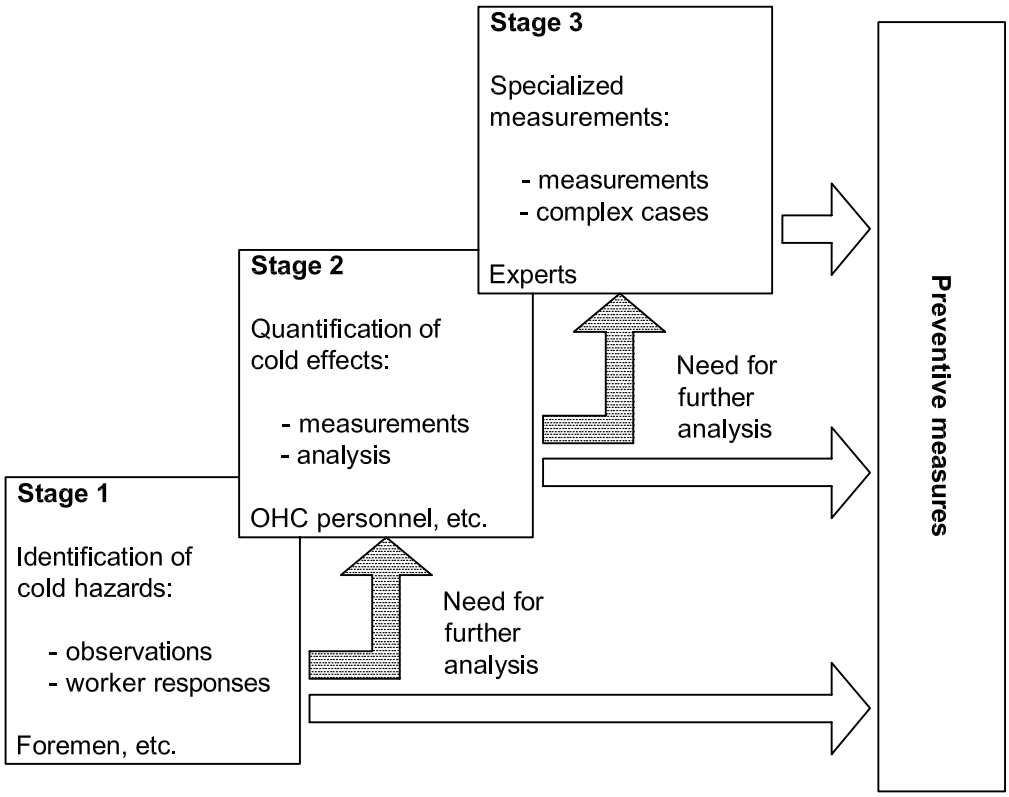


Figure 1 — Model for cold risk assessment in the workplace

4.2 Health assessment

Human responses to cold include complaints, decrease in performance, symptoms, attacks of diseases and cold injuries. The responses show a great individual variation and their presence is difficult to predict from the level of duration and intensity of cold exposure. The only way to identify these responses is to collect information from the individuals.

Cold-related health assessment is a three-stage medical screening conducted by occupational health professionals. Each stage involves identification of cold-related health risks both in the workplace as well as assessing the health of individuals.

a) Stage 1 consists of a health check (see Annex D). The method used is a medically-based questionnaire whose purpose is to identify potential individuals having cold-related diseases or cold-related personal working limitations. The factors to be identified are, for example, cold sensitivity, cold urticaria, respiratory symptoms, cardiovascular symptoms, peripheral circulatory disturbances, symptoms related to white fingers, musculoskeletal symptoms, the effect of cold on performance and the occurrence of local cold injuries. As a result of stage 1 of the assessment, those individuals with no personal need for any further analysis with regards to cold are identified.

b) Stage 2 is largely taken up by an interview and a clinical investigation of persons suspected of having a cold-related individual health problem. The content of the interview and clinical investigation is dependent on the results of the preliminary questionnaire and is symptom- or disease-specific. If cold-related diseases or working limitation are recognized, an additional risk evaluation (Annex B) in the workplace might be needed.

c) Stage 3: if there are still some open questions on the individual's health status or other cold consequences, a more detailed analysis in a hospital expert unit or units or a provocation laboratory might be needed. When evaluating health aspects, it is important also to utilize the information obtained from the workplace risk assessment, e.g. the risk check at stage 1 and possibly more quantitative information from stages 2 and 3.

See Figure 2.

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

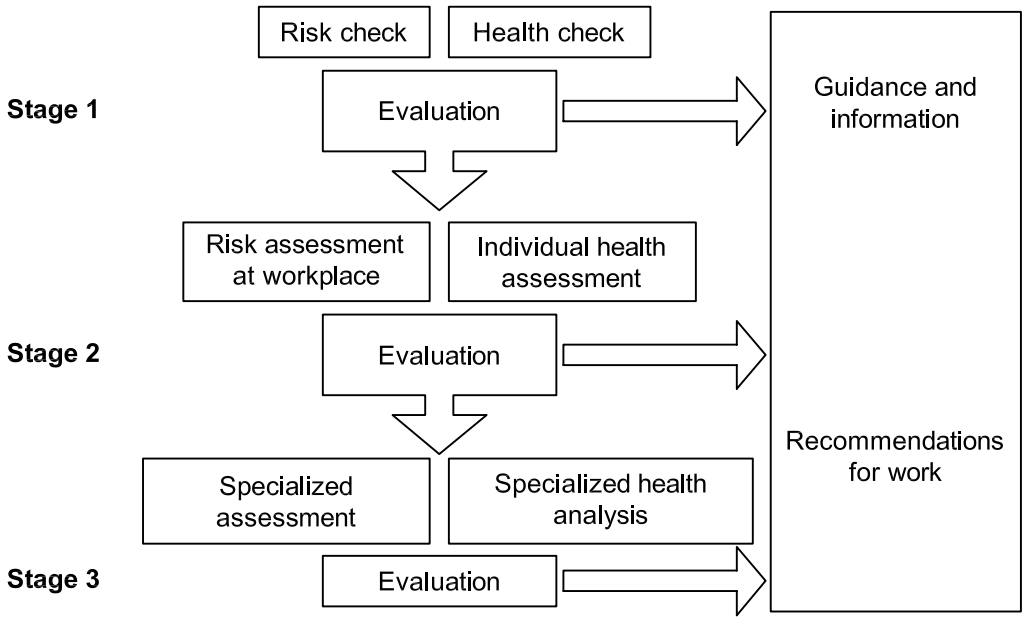


Figure 2 — Relationship between cold risk assessment and health assessment

The health assessment made by the occupational health professionals helps people to conduct their working activities in cold environments. Usually, as a result of the screening, only very few persons have severe limitations for working in a cold environment. However, it is very common that individuals have minor limitations or complaints. As a result of the selection, the occupational health professionals accept or reject employees for work in a cold environment. Those accepted need particular advice, training and information in order to ensure their optimal health and performance in cold work. The content of the information is dependent on the conditions in the workplace, and on an individual's cold-related diseases or limitations.

ISO 12894 provides guidance for the medical supervision of individuals exposed to extreme hot or cold environments and ISO/TS 14415 for the application of International (thermal) Standards for people with special requirements. Use them, as appropriate, when acting on the results of the health assessment. They advise health professionals on how to manage those individuals having an identified disease or limitation but not the majority of subjects having cold-related complaints, symptoms or working limitations without recognized disease.

During stage 3 of the risk assessment (see 4.1), and possibly already at stage 2, follow the guidelines given in ISO 9886 for the evaluation of thermal strain by physiological measurements.

4.3 Cold risk management

The cold risk management model (see Figure 3) and practices presented in 5.3 and Annex C should be fully integrated into the OHS management system and practices of the company/organization carrying out the assessments, in order to ensure the implementation and continuance of the activities. This kind of system may be established according to, for example, OHSAS 18001, which is compatible with the ISO 9001 quality management and ISO 14001 environmental management systems.

The workers, foremen and safety delegates, as well as the occupational health care professionals involved, should be trained to identify, assess and manage the cold-related risks at work.

--`,,```,,,,````-`-`,,`,,`,`,,`---

© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

5 Practices for cold risk assessment and management

5.1 Responsibilities

The employer is primarily responsible for the assessment and management of potential cold-related risks to health and safety in the workplace. A responsible person should be nominated to conduct these activities in the department or section of the company. This person should be provided with adequate training. Collaboration and consultation with occupational health professionals is useful.

5.2 Cold risk assessment

5.2.1 Stage 1: Observation

For the assessment of cold-related hazards, an observation method should be used (see Annex A). The method does not require comprehensive training. Furthermore, for a person at the workplace who is familiar with the contents of the work, conducting the observation does not take long. Therefore, it is recommended that, for example, foremen, work safety delegates or workers conduct the observation.

The checklist given in Annex A contains checkpoints related to the type of cold exposure, use of cold protective clothing, use of personal protective equipments (PPE), as well as environmental factors. Each factor is categorized into three different classes according to its seriousness: “no problem”, “slight problem” and “serious problem”. No immediate preventive measures are needed for the first two classes (scoring 0 and 1). However, a slight cold-related problem (scoring 1) indicates that improvements to reduce or eliminate the source of harm could be made in the long run to improve workers' occupational health and safety.

When conducting the observation at the workplace it is important first to identify the major tasks being carried out there. The purpose of this planning is to group the tasks or the workers exposed to cold in a similar way. Each of these groups should be then observed separately. It is important to include all the different problems that can exist due to cold. The planning may be conducted in a team at the workplace by a manager and/or foremen, workers and safety experts.

When conducting the actual observation, it is important to remember to observe the “average work situation”. This means that the observer should consider whether, for example, contact with cold materials is usually a problem in the work that is observed and not just during a specific observation. Environmental conditions should be looked at in a similar manner. If some parts of the check remain unresolved or observation is difficult, it is recommended that the opinion of the worker be sought, for example, in respect of use of protective clothing.

In outdoor work the observation should be conducted whenever the ambient conditions, work tasks or work environment markedly change. In cold indoor work it is not necessary to perform the observation so frequently because the climatic conditions and work tasks are often relatively constant.

5.2.2 Stage 2: Analysis

The main actions at this stage are

— follow-up on the stage 1 checklist,

— focus on identified problems,

— find direct cost-effective solutions, and

— allow decision about possible need for specialist assessment (stage 3).

It is important to note that this level of cold risk assessment ought not to require specific instrumentation or too complex analysis. The assessments include simple measurements and the use of tables and criteria values (see Annex B).

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

5.2.3 Stage 3: Expertise

Stage 3 aims at quantifying, analysing and estimating cold risks. The assessments should be performed by, for example, occupational healthcare professionals, occupational hygienists or other expert institutes with adequate competence. The duration of an individual assessment is one day or more and includes more complex analysis involving special instrumentation. The assessment is aimed at solving a specific cold-related problem based on the needs of the lower levels of cold risk assessment.

5.3 Cold risk management

Whenever any of the checkpoints show a serious problem, this should be taken into consideration at the workplace. For a specific problem there are usually several possible solutions. Each workplace should choose the preventive measures that are best suited for its own situation. After choosing a preventive action, it is important to select a person who will be responsible for applying the solution. After a corrective action has been taken, a re-check should be conducted to evaluate its sufficiency to reduce or eliminate the source of harm.

Depending on the type of the industry and company/organization, various preventive measures against cold hazards can be implemented. Annex C provides lists of different possible measures. The occupational safety delegates, supervisors and workers should carry these out at the workplace. The worker's participation is strongly recommended. All participants need to be informed about the actions to be made. The company/organization is advised to name the responsible persons in each of the following sections. ISO 12894, ISO/TS 14415 and ISO 9886 may be used, as applicable. The questions at the end of each section can be useful in planning. The selected activities should be indicated in the cold risk management plan. An example for a form for making such a plan is given in Annex C. The purpose of planning is to systematically take into account different aspects related to cold, as well as guarantee successful timing for implementing different management activities.

--`,,```,,,,````-`-`,,`,,`,`,,`---

© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

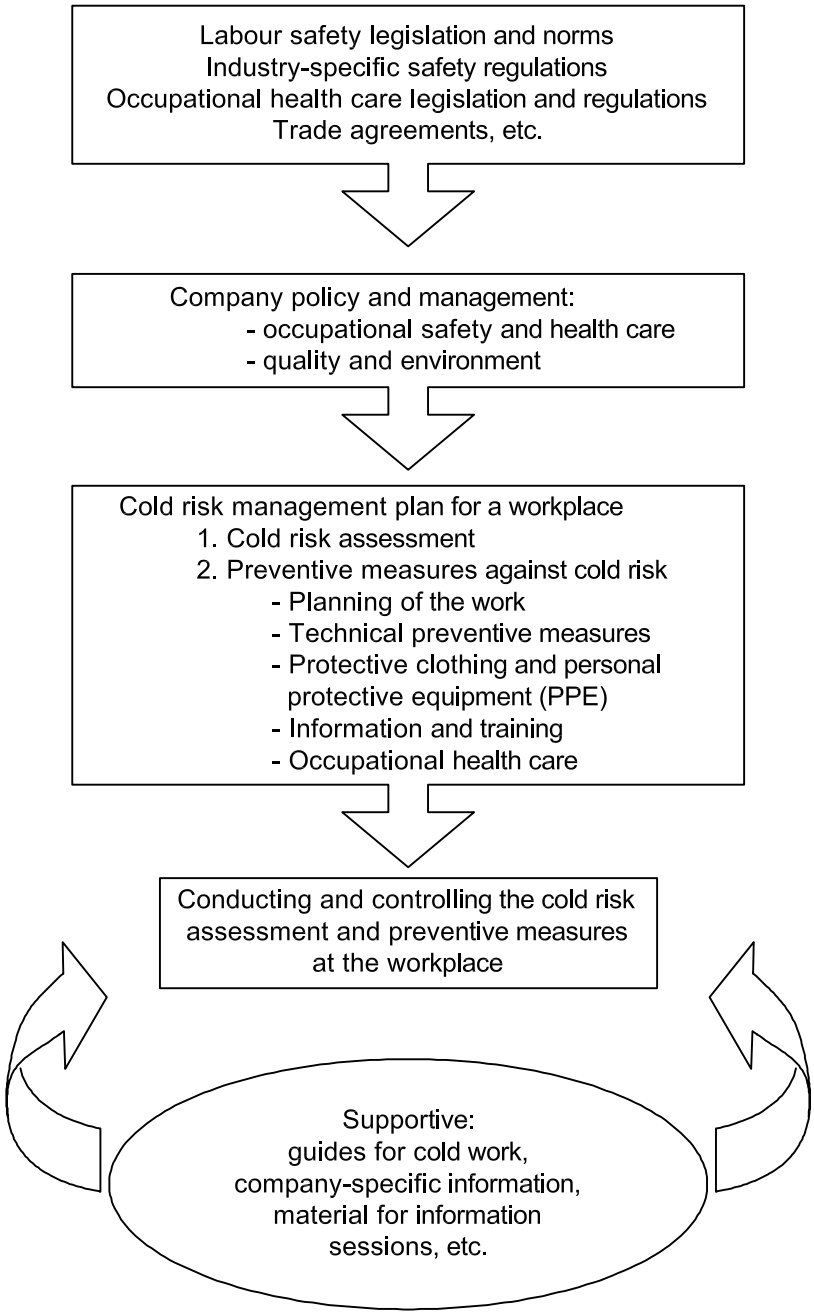


Figure 3 — Cold risk management model

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

Annex A
(informative)

Checklist for identifying cold-related problems at work

A.1 How to use the checklist

A.1.1 Consider the work environment comprehensively. Before using the checklist, screen the different work activities to be observed. Categorize the prevailing working situation to include all circumstances during the day and for a foreseeable time period. Use the observation checklist separately for each working activity. If it is not possible to observe all the tasks in work, conduct the check at a later date. If several employees are engaged in the same tasks, conduct the observation according to the individual having *in your opinion* the most problems in the cold.

A.1.2 Check through each condition/category separately and mark the proposed score that best corresponds to the situation. The score "0" indicates that no preventive actions are needed, "1" that certain problems related to cold exist and should be dealt with in the long run, while "2" indicates problems related to cold that can involve a risk of impaired health and performance. A score of "2" means that corrective action to reduce or eliminate the problem must be implemented immediately.

A.1.3 Provide remarks or indications of particular observations related to each condition.

EXAMPLE "Worker is poorly protected against wind", "gloves not used at all".

Such remarks will enhance the interpretation of the results.

A.1.4 The checklist should be used

— a few times during winter (once a month and/or when environmental conditions have changed),

— when work activity changes considerably, and

— when working environment changes considerably.

It should be repeated to check the adequacy of conducted preventive measures.

© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

A.2 Checklist for identification of cold-related problems

Name of company: ……..…….…….. Date: ……..…….

Observed task: ……..……..…. Temperature: …….. °C

…….... Wind speed: …….. m/s

Scoring:

0	No need for preventive actions	1	Corrective actions are recommended in the long run	2	Immediate need for corrective actions

1. Cold air

0	Air temperature does not cause any problem
1	Air temperature causes some problems
2	Air temperature clearly causes problems

Remarks:……
……

2. Wind/air movements

0	No air movements
1	Light cold air movements (e.g. sensation of draught, light wind)
2	Strong cold air movements (e.g. strong wind blowing occasionally or repeatedly)

Remarks:……
……

3. Contact with cold surfaces while handling tools/materials or when sitting, kneeling or lying on cold surfaces

0	Not at all
1	Working for short periods with thin gloves, sitting, kneeling or lying on cold surfaces
2	Working with bare or insufficiently protected hands or for longer periods sitting, kneeling, standing or lying on cold surfaces

Remarks:……
……

4. Exposure to water/liquids/wetness

0	No exposure
1	Short periods of exposure (e.g. when handling cold materials, raining, snowfall)
2	Long periods of exposure (e.g. continuously handling cold fluids or wet materials)

Remarks:……
……

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

5. Cold protective clothing (excluding hands, feet and head)

0	Adequate
1	Partly inadequate (e.g. only some winter garments in use)
2	Inadequate (e.g. cold protective clothing is not used although needed, or too warm clothing/garments have to be used)

Remarks (please specify whether the problem is excessive cooling or heating/continuous or occasional): ……..
.....

6. Protection against cold: hands, feet, head (estimated based on prevailing conditions, examples in parenthesis represent mainly protections against very cold weather)

0	Sufficient (e.g. undergloves and mittens, winter boots with thick soles and loose insoles, windproof winter headwear covering the ears)
1	Adequate (e.g. gloves with lining, winter shoes with thick soles, safety helmet with undercap or a non-windproof headwear)
2	Insufficient (e.g. gloves without lining, no gloves, shoes with a thin sole, safety helmet without a cap or bareheaded)

Remarks: ……
……..

7. Use of personal protective equipment (helmet, hearing protection, etc.)

0	No interference
1	Interferes to some extent (e.g. clumsiness, restricted movements, impaired protection against cold)
2	Considerable interference (e.g. considerable difficulties in combining cold protective clothing and use of PPE or cold protective clothing/PPE are not used at all)

Remarks:……
…….....

8. Other problems related to cold

0	1	2	
			Long term cold exposure/working in the cold (e.g. continuously > 2 h)
			Light work (e.g. measuring, monitoring)
			Highly varying workload (light/heavy)
			Varying thermal environments (e.g. frequent moving between in and outdoors)
			Slipperiness
			Insufficient lighting
			Other factors (specify):
			…….
			…….....
			……

© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

A.3 Evaluation of results and selection of corrective actions

A.3.1 Mark the score (0, 1 or 2) for each condition of the check to Table A.1 in the “Score” column.

A.3.2 In the “Other problems” row, enter the highest observed score. If several of the checkpoints indicate the highest score, use only one score.

NOTE 1 Each of these checkpoints can be separately evaluated when evaluating the results and choosing the preventive measures.

NOTE 2 A score of “1” indicates that no preventive measures are needed just now but that improvements in the company's OHS system can be conducted to improve worker's health and safety with regards to cold.

NOTE 3 A score of “2” indicates that preventive measures to reduce or eliminate adverse effects related to cold are required immediately. Examples of different methods are indicated in Annex C.

A.3.3 Propose a suitable “Preventive measure” in that column. If the problem can not be solved by simple management methods, mark a cross in “Need for further analysis”.

NOTE During evaluation of the results and choosing of preventive measures, there is interaction between certain factors. For example, cold air interacts with wind/air movements, cold protective clothing and with the protection of the extremities. Furthermore, water/liquids/wetness interacts with touching of cold materials and cold protective clothing, etc. These interactions can aggravate the cold risk.

A.3.4 Discuss with the management of the company/organization as to which of the management methods are to be implemented (“Implementation”).

A.3.5 Set a “Date of recheck” for estimating the adequacy of the applied preventive measures.

Table A.1 — Summary of results and selected preventive measures

Problem	Score 0,1 or 2	Preventive measure	Implementation		Need for further analysis	Date of recheck
			No	Yes		
1. Cold air						
2. Wind/air movement						
3. Touching cold surfaces						
4. Water/liquids/moisture						
5. Cold protective clothing						
6. Protection against cold: hands, head, feet						
7. Use of PPE						
8. Other problems						
Responsible person: …….. Date: ……. Approval: ……						

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

Annex B
(informative)

Analysis of cold-related problems

B.1 General

Stage 2 (analysis) of the cold risk assessment (see 4.1) is intended to be used by persons with knowledge of the subject and who are familiar with the relevant standards (e.g. safety engineers, industrial hygienists).

The aims of assessment at this stage are to

— follow-up the stage 1 checklist (Annex A),

— focus on identified problems,

— perform a simple workplace evaluation by professionals in co-operation with company staff,

— carry out a limited number of measurements,

— find direct cost-effective solutions, and

— allow decisions to be made on the possible need for further specialist assessment (stage 3).

For preventive measures and problem solutions, see Annex C. Relevant information for this level can also be found in Reference [30].

B.2 Cold air

Evaluate cold stress using IREQ (required insulation and clothing effects — see ISO 11079):

a) measure or estimate air temperature (see ISO 7726);

b) measure or estimate air velocity (see ISO 7726);

c) determine exposure times;

d) estimate activity level for the calculation of metabolic heat production (see ISO 8996);

e) estimate thermal insulation of clothing (see ISO 9920);

f) calculate $IREQ_{neutral}$ and $IREQ_{min}$ using

   — a computer program (see ISO 11079:2007, Annex F), or

   — graphs (see Figure B.1);

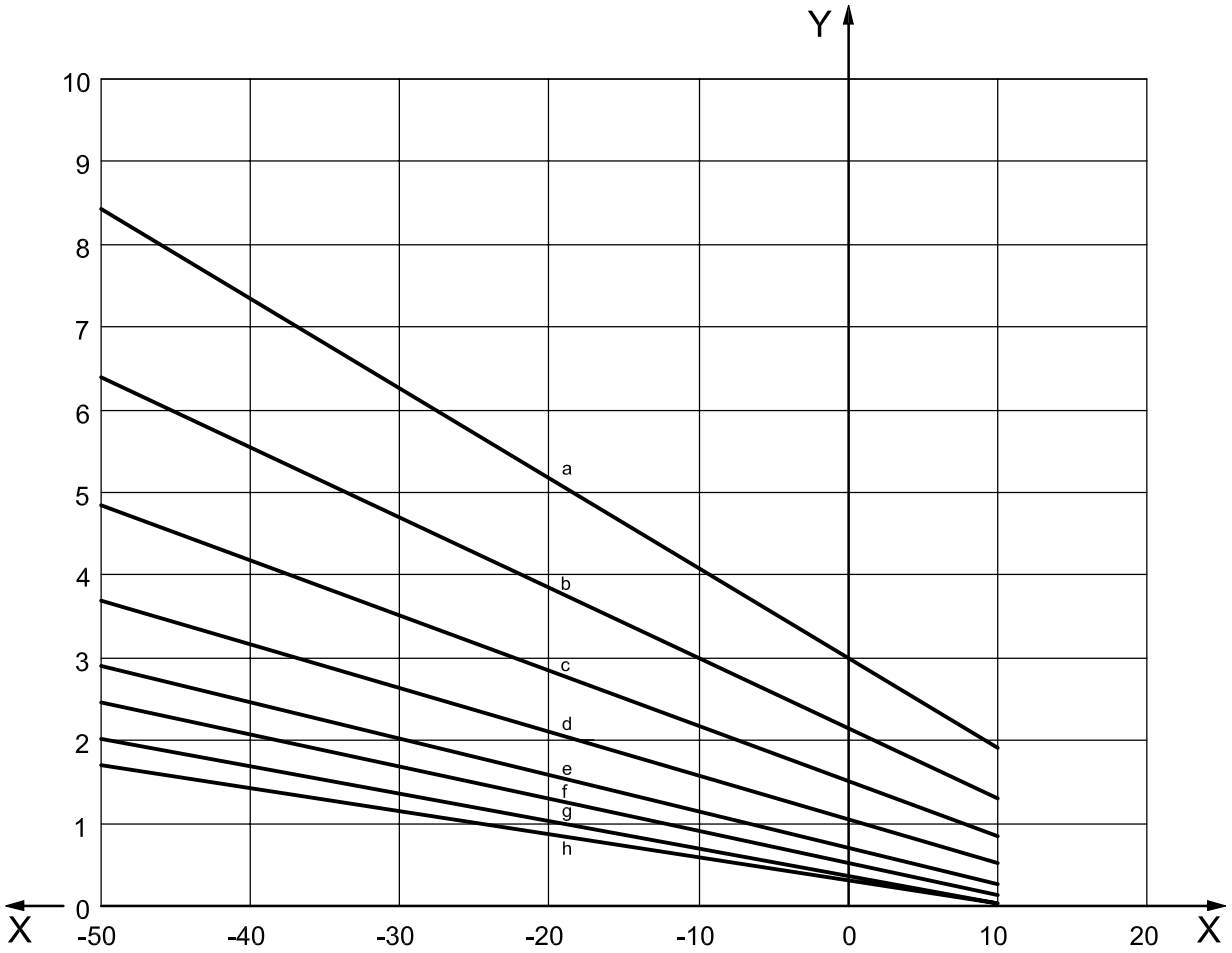
g) compare IREQ with the actual clothing insulation;

h) if clothing insulation is lower than $IREQ_{min}$, calculate the DLE (duration limited exposure) time.

NOTE 1 This first evaluation is for calm wind conditions only (e.g. indoor environments).

--`,,```,,,,````-`-`,,`,,`,`,,`---
© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

NOTE 2 ISO 11079 contains graphs illustrating IREQ as a function of different climatic and activity values, of which Figure B.1 is an example. $IREQ_{min}$ (minimal requirements of insulation) are presented as a function of ambient operative temperature at eight levels of metabolic heat production. The operative temperature is the integrated value of the air temperature and mean radiant temperature weighted according to values of the convective and radiation heat transfer coefficients, respectively.



Key

X operative temperature, t_o, °C

Y IREQ, clo

Air velocity: 0,4 $m \cdot s^{-1}$

Air permeability of outer layer: 8 $l \cdot m^{-2} \cdot s^{-1}$

a 70 $W \cdot m^{-2}$

b 90 $W \cdot m^{-2}$

c 115 $W \cdot m^{-2}$

d 145 $W \cdot m^{-2}$

e 175 $W \cdot m^{-2}$

f 200 $W \cdot m^{-2}$

g 230 $W \cdot m^{-2}$

h 260 $W \cdot m^{-2}$

Figure B.1 — Example graph — $IREQ_{min}$ as a function of operative temperature at eight levels of metabolic rate

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

B.3 Determination of wind cooling (taken from ISO 11079:2007, Annex D)

The wind causes a cooling effect on the skin. This effect may be expressed as a wind chill temperature. The wind chill temperature (t_{WC}) defines the ambient temperature, which at a wind speed of 4,2 km · h^{-1} produces the same cooling power (sensation) as the actual environmental conditions. The wind chill temperature (in degrees Celsius) is determined by the following formula:

$$t_{WC} = 13{,}12 + 0{,}6215 \cdot t_a - 11{,}37 \cdot v_{10}^{0{,}16} + 0{,}396\,5 \cdot t_a v_{10}^{0{,}16} \quad \text{(B.1)}$$

Wind velocity (v_{10}) is defined as the standard meteorological value measured 10 m above ground level. This value is obtained from weather stations and weather forecasts. If the local wind velocity (v_a) at ground level is measured, it must be multiplied by 1,5 before it is inserted in Equation (B.1).

Calculated values for t_{WC} and criteria associated with the evaluation of the risk of cold injury based on the index are given in Tables B.1 and B.2.

Table B.1 — Cooling power of wind on exposed flesh expressed as a comparative wind chill temperature (t_{WC}) at a defined wind speed of 4,2 km · h^{-1}

v_{10}		t_a °C										
km·h^{-1}	m·s^{-1}	**0**	**–5**	**–10**	**–15**	**–20**	**–25**	**–30**	**–35**	**–40**	**–45**	**–50**
5	**1,4**	–2	–7	–13	–19	–24	–30	–36	–41	–47	–53	–58
10	**2,8**	–3	–9	–15	–21	–27	–33	–39	–45	–51	–57	–63
15	**4,2**	–4	–11	–17	–23	–29	–35	–41	–48	–54	–60	–66
20	**5,6**	–5	–12	–18	–24	–31	–37	–43	–49	–56	–62	–68
25	**6,9**	–6	–12	–19	–25	–32	–38	–45	–51	–57	–64	–70
30	**8,3**	–7	–13	–20	–26	–33	–39	–46	–52	–59	–65	–72
35	**9,7**	–7	–14	–20	–27	–33	–40	–47	–53	–60	–66	–73
40	**11,1**	–7	–14	–21	–27	–34	–41	–48	–54	–61	–68	–74
45	**12,5**	–8	–15	–21	–28	–35	–42	–48	–55	–62	–69	–75
50	**13,9**	–8	–15	–22	–29	–35	–42	–49	–56	–63	–70	–76
55	**15,3**	–9	–15	–22	–29	–36	–43	–50	–57	–63	–70	–77
60	**16,7**	–9	–16	–23	–30	–37	–43	–50	–57	–64	–71	–78
65	**18,1**	–9	–16	–23	–30	–37	–44	–51	–58	–65	–72	–79
70	**19,4**	–9	–16	–23	–30	–37	–44	–51	–59	–66	–73	–80
75	**20,8**	–10	–17	–24	–31	–38	–45	–52	–59	–66	–73	–80
80	**22,2**	–10	–17	–24	–31	–38	–45	–52	–60	–67	–74	–81

The shaded areas refer to the different classes of risk according to Table B.2.

© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

Table B.2 — Wind chill temperature (t_{WC}) and freezing time of exposed skin

Classification of risk	t_{WC} °C	Effect
1	−10 to −24	Uncomfortably cold
2	−25 to −34	Very cold, risk of skin freezing
3	−35 to −59	Bitterly cold, exposed skin may freeze in 10 min
4	−60 and colder	Extremely cold, exposed skin may freeze within 2 min

B.4 Contact with cold surfaces through handling of tools, equipment and machinery, sitting or lying

Evaluate contact cooling (see ISO 13732-3):

a) determine the surface temperature of contacted material;

b) determine the type of contacted material;

c) determine the type of contact (touching or gripping).

Relations between material temperature and contact duration are also given in ISO 13732-3 for different types of materials and different effect criteria — pain, numbness or frostnip (very superficial freezing of small skin area):

d) determine the surface temperature of the material;

e) select the appropriate material and effect criteria;

f) determine the corresponding allowed time for contact.

B.5 Contact with water, liquids or moist materials

Liquids have a cooling power much higher than that of air. Wet skin will cool by evaporation and continuous handling of liquids (e.g. water). Wet and moist conditions at temperatures between 0 °C and 15 °C can cause considerable cooling of hands and fingers.

Special attention needs to be given to liquids with a freezing point below zero (e.g. gasoline, ethanol). These cool, first, by convection due to their low temperature and high cooling power, and, second, by evaporation of the liquid.

Frostbite can develop in a few seconds if gasoline is spilled on the bare hands at −10 °C.

B.6 Protective clothing against cold (not hands, feet and head)

Determine the cooling effect on the body in a cold environment by

— thermal insulation of used cold protective clothing ensemble (clo value), and

— body heat available from muscular and metabolic energy production.

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

Determine the thermal insulation of clothing by estimation from the tables of similar ensembles given in ISO 9920 or by using the measurements given in EN 342.

The insulation value is presented as a clo value or in SI units (1 clo = 0,155 $m^2 \cdot °C \cdot W^{-1}$).

With knowledge about the insulation value for used or available cold protective clothing, the conditions for heat balance during the prevailing climate and activity can be evaluated.

Evaluate the heat balance using IREQ:

a) measure or estimate the air temperature;

b) measure or estimate the air velocity;

c) determine exposure times;

d) estimate the activity level (see ISO 8996);

e) estimate or determine the clo value for selected cold protective clothing;

f) calculate the heat balance using either a computer program or graphs.

B.7 Protection against cold for hands, feet and head

In addition to whole body cold protection, attention needs to be paid to the protection of hands, feet and head. Because hand protection with gloves or mittens interferes with manual function, a compromise must be achieved between requirements for performance and those for cold protection.

Evaluate hand heat balance by making use of knowledge of

— climatic conditions

— body heat production

— thermal insulation of handwear (see EN 511)

Similarly, information about the thermal insulation of footwear [40] can be used for the evaluation of cold protection.

© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

Annex C
(informative)

Guidelines for planning and managing cold work

C.1 General

A company's/organization's occupational health and safety management system should contain its main policies on occupational health and safety issues and should follow the approach of OHSAS 18001 (in turn compatible with ISO 9001 and ISO 14001). Reference [30] provides basics and applications for analysing and managing cold work.

The key elements for continuous improvement in occupational health and management [17], [18] are

— the company's/organization's OHS policy,

— planning,

— implementation and operation,

— checking and corrective actions, and

— management review.

The management of cold risks should be integrated into the company's/organization's occupational health and safety policies.

C.2 Recognition of cold risks at the workplace

The status of the awareness of cold risks within the company/organization should first be identified:

— How are the cold risks taken into consideration in the company's OHS management system?

— What are the measures that should be conducted/documented?

— What information or material is needed?

— Who are the responsible persons?

C.3 Assessment of cold risks at the workplace

The present status in the assessment of cold risks should be recorded:

— How are the cold risks assessed in the workplace?

— What are the measures that should be conducted/documented?

— What information or material is needed?

— Who are the responsible persons?

--`,,```,,,,````-`-`,,`,,`,`,,`---
© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

C.4 Management of cold risks in the workplace

C.4.1 General

Depending of the type of the workplace, various preventive measures against cold risks can be conducted. The following are lists of different measures to be chosen. The preventive measures are usually carried out at the workplace by the occupational safety delegates, supervisors and workers. The workers' participation is strongly recommended. All partners need to be informed about the actions to be performed. The company should appoint the responsible persons for each phase or aspect of a project. The questions posed here can be useful in planning. The activities should be recorded in the conclusion of the cold risk management plan.

C.4.2 Organizational preventive measures against cold risks

In the planning phase of projects:

— schedule work for a warmer season (for outdoor work);

— check if work can be done indoors (for outdoor work);

— allow more time per task with cold work and protective clothing;

— provide heated space or heated shelter for recovery;

— provide training of complex work tasks under normal conditions;

— ascertain appropriate knowledge and competence of staff;

— separate goods and work stations and keep different temperature zones;

— provide extra manpower to shorten and/or reduce exposure.

Before every work shift:

— check climatic conditions at onset of work;

— schedule adequate work-rest regimens;

— allow for individual control of work intensity and clothing;

— prepare schedule and control stations (outdoors);

— organize communication system (outdoors).

During the actual work shift:

— provide for break and rest periods in heated shelter;

— provide for frequent breaks for hot drinks and food;

— care for flexibility in terms of intensity and duration of work;

— provide replacement of clothing items (socks, gloves, etc.);

— provide access to extra clothing for warmth;

— monitor subjective reactions (“buddy” system)(outdoors)

— report regularly to foreman or base (outdoors);

— provide for sufficient recovery time after severe exposures (outdoors).

--`,,```,,,,````-`-`,,`,,`,`,,`---
© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

C.4.3 Technical preventive measures against cold risks

C.4.3.1 Tools, equipment, machinery

Select tools manufactured for cold conditions. Conduct repair and maintenance work indoors.

C.4.3.2 Work area

Minimize heat loss caused by contact with cold items, air movements and wet environment.

C.4.3.3 Slippery surfaces

Minimize slippery surfaces by material selection and preventing formation of icy surfaces. Use warning signs where surfaces are slippery.

C.4.3.4 Lighting

Provide sufficient light and avoid shadows, reflections and straight glare.

C.4.3.5 Climbing on stairs and ladders/working at heights

Select stairs and ladders intended and tested for cold conditions. Check for firm contact with the ground.

C.4.4 Protective clothing and personal protective equipment

C.4.4.1 Clothing

Select clothing with which the previous experience is positive. In the case of new clothing, select tested garments. Adjust the insulation level according to climatic factors and activity level (see ISO 11079:2007, Annex B). Use multi-layer clothing for optimal function and adjustability of the clothing. Zippers and other fasteners must also function in snow and windy conditions, and be manipulated by cold, clumsy fingers.

C.4.4.2 Handwear

Mittens provide the best thermal insulation. If necessary, thin inner gloves (“contact gloves”) can be used. Use only dry handwear.

C.4.4.3 Footwear

Select boots with good thermal insulation, especially in soles, with enough space for toes, and with good anti-slip properties. Keep socks dry, replacing them if necessary.

C.4.4.4 Head protection — Use of a safety helmet in the cold

Select adjustable and windproof headwear. Ensure that the helmet and other personal protective equipment fit with headwear.

C.4.4.5 Face and respiratory protection

Face protection is useful in windy conditions, as is respiratory protection with heat and moisture exchangers during heavy physical exertion in very cold conditions.

C.4.4.6 Personal protective equipment used with cold protective clothing

Check the comfort properties and compatibility of the PPE when used together with cold protective clothing.

--`,,```,,,,````-`-`,,`,,`,`,,`---

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

C.4.5 Training and information, learning and guidance material

Provide education and information on the special problems of cold, provide training — especially for complex tasks — and provide information and training in first-aid and treatment of cold injuries.

C.4.6 Occupational health care actions for cold work

How are the cold-related health aspects taken into consideration in occupational health care in the workplace?

What are the measures that should be conducted?

What information or material is needed?

Who are the responsible persons?

© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

C.5 Cold risk management planning form — Example

COLD RISK MANAGEMENT PLAN FOR WORKPLACE					
Workplace:					
Plan prepared by:					
Responsible persons	**Name and initials**				
Workplace foreman					
Occupational safety					
Occupational safety delegate					
Other					
Who controls the activities?					
COLD RISK ASSESSESMENT					
(Procedure used in this workplace)			**Resp. person**	**Date**	**Control**
Cold risk assessment					
Assessment using the checklist					
PREVENTIVE MEASURES AGAINST COLD RISKS					
1	**Organizational preventive measures**	**Measures to be conducted**			
	In the planning phase of project				
	Before every work shift				
	During the actual work shift				
2	**Technical preventive measures**	**Measures to be conducted**			
	Tools, equipment, machinery				
	Work area				
	Slippery surfaces				
	Lighting				
	Climbing on stairs, work at heights				
	Others				
3	**Protective clothing and PPE**	**Measures to be conducted**			
	Clothing				
	Handwear				
	Footwear				
	Head protection				
	Face and respiratory protection				
	PPE/others				
4	**Information and training**	**Measures to be conducted**			
5	**Occupational health care**	**Measures to be conducted**			
	Risk assessment				

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

Annex D
(informative)

Cold work health questionnaire

D.1 Introduction

Cold causes many different health and performance risks in several lines of industries involving work outdoors or in cold indoor conditions (see ISO 12894 and ISO 9886). Cold work is taken here to mean *work in conditions where the ambient temperature is less than 10 °C or that causes a sensation of cold*.

The following questionnaire can be used to form guidelines for further examinations based on a health check. In the questionnaire, the worker is able to describe how he or she considers the effects of cold on his/her own personal health and performance. Based on the responses, the occupational health care unit, in co-operation with the worker him/herself, can then evaluate the possible need for supportive actions. The questionnaire is confidential and answering it is optional.

D.2 Occupational health care guidelines (for further examinations based on a health check)

Key

☐ No need for further investigation

▒ Requires further investigation/specific interview

Cold sensitivity

1. How do you generally feel in the cold?

		Very unpleasant	Unpleasant	Slightly unpleasant	Pleasant
a)	Whole body	1	2	3	4
b)	Fingers	1	2	3	4
c)	Toes	1	2	3	4

▒ Detailed interview of performance **if** the respondent has answered in Question 12 that — considering concentration or motivation — performance is decreased due to cooling.

2. Are you exceptionally sensitive to cold?

a) 1 No

b) 2 Yes

▒ Detailed interview of cold sensitivity.

© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

Cold urticaria

3. Do you experience an intense itching of the skin in the cold or after cold exposure, related to a superficial inflammation (eczema) or like a rash (urticaria)?

a) 1 No
b) 2 Yes

Detailed interview of cold urticaria.

Respiratory symptoms

4. Do you experience…

	In warm	In cold	In cold during exertion	Not at all
a) Shortness of breath?	1	2	3	4
b) Extended coughing or coughing fits?	1	2	3	4
c) Wheezing?	1	2	3	4
d) Increased excretion of mucus from the lungs?	1	2	3	4
e) Very profound rhinitis?	1	2	3	4

Detailed interview of respiratory function.

Cardiovascular symptoms

5. Do you experience…

	In warm	In cold	In cold during exertion	Not at all
a) Chest pain?	1	2	3	4
b) Cardiac arrhythmias?	1	2	3	4
c) High blood pressure?	1	2	3	4

Detailed interview of cardiovascular function.

Symptoms related to peripheral circulatory disturbances

6. Do you experience episodic…

	In warm	In cold	Not at all
a) Circulatory disturbances in hands and/or feet	1	2	3
b) Blurring of vision	1	2	3
c) Headache named migraine	1	2	3

Detailed interview of peripheral circulatory disturbances.

--`,,```,,,,````-`-`,,`,,`,`,,`---
© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

Symptoms related to white fingers

7. Are your fingers exceptionally sensitive to cold?

a) 1 No
b) 2 Yes

Detailed interview of Raynaud phenomenon.

8. Is the colour of your fingers episodically changing to…

		In warm	In cold	Not at all
a)	White	1	2	3
b)	Blue	1	2	3
c)	Red/violet	1	2	3

Detailed interview of Raynaud phenomenon.

Symptoms related to musculoskeletal system

9. Do you experience…

		In warm	In cold	Not at all
a)	Neck/shoulder or upper extremity pain	1	2	3
b)	Back or hip pain	1	2	3
c)	Pain in lower extremities	1	2	3

Detailed interview of musculoskeletal symptoms.

10. If you have another symptom (e.g. dizziness, exceptional fatigue, dysmenorrhea, transient paralysis of limbs, transient memory loss)**, under what conditions do you experience it?**

		In warm	In cold
a)	What symptom?	1	2
b)	What symptom?	1	2

Detailed interview of cold-related symptoms.

© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

Local cold injuries

11. Have you ever had frostbite of blister grade or more severe?

a) 1 No
b) 2 Once
c) 3 Several times

Detailed interview of frostbite.

Effect of cold on performance

12. How does cold affect the following factors of your performance during work?

		Performance decreased due to symptoms	Performance decreased due to cooling	Improves performance	No effect
a)	Concentration	1	2	3	4
b)	Motivation	1	2	3	4
c)	Hand grip force	1	2	3	4
d)	Musculoskeletal endurance	1	2	3	
e)	Other — which? ……	1	2	3	
f)	Other — which? ……..	1	2	3	

Detailed interview of performance.

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

Annex E
(informative)

Cold work assessment and management in indoor work — Example from the food processing industry

E.1 The workplace

The cold risks were analysed in a food processing company, where the sausage, meat and marinated frozen meat packing departments were investigated.

Air temperature in the departments was 3 °C to 6 °C. Air velocity was usually less than 0,2 m/s, but occasionally higher near openings. Humidity was about 80 %. The temperature of the products and machine surfaces was usually kept between 3 °C and 4 °C, and sometimes −2 °C (marinated meat). The pauses — of about 8 min every hour, with 35 min for lunch — were taken at normal room temperature (about 21 °C). The clothing worn by the workers consisted of long underwear and middle wear and a special one-layer outer garment. Thin cotton gloves covered by thin plastic gloves were used.

The work was usually light, consisting of repetitive movements by both arms. Work was usually done in two shifts, starting at 6:00 or 14:30.

About 70 % of the workers were women and the workers' age range was 19 to 56.

E.2 Stage 1 — Observation (from Annex A)

For the first-stage risk analysis, the checklist according to A.2 for identification of cold-related problems was used. The scoring system was that specified in A.1.2 and used by the checklist presented in A.2.

1. Cold air

Observation: Air temperature causes clear problems (score 2). The problems were especially related to hands, see questions 3, 4 and 6.

2. Wind/air movements

Observation: Light air movements (e.g. sensation of draught, light wind) (score 1).

3. Contact with cold surfaces while handling tools/materials or when sitting, kneeling or lying on cold surfaces

Observation: Working with bare or insufficiently protected hands or for longer periods sitting, kneeling, standing or lying on cold surfaces (score 2). Cooling of hands caused performance decrement, cold pain and occasional numbness.

4. Exposure to water/liquids/wetness

Observation: Long periods of exposure (e.g. continuously handling cold fluids or wet materials) (score 2).

5. Cold protective clothing (excluding hands, feet and head)

Observation: Sufficient (score 0).

--`,,```,,,,````-`-`,,`,,`,`,,`---

© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

6. Protection against cold: hands, feet, head

Observation: Insufficient (score 2). Hand protection insufficient.

7. Use of personal protective equipment (helmet, hearing protection, etc.)

Observation: No interference (score 0).

8. Other problems related to cold

— Long-term cold exposure/working in the cold (e.g. continuously > 2 h): score 2.

— Light work (e.g. measuring, monitoring): score 1.

— Highly varying workload (light/heavy): score 0.

— Varying thermal environments (e.g. frequent moving between in and outdoors): score 1.

— Slipperiness: score 0.

— Vibrating tools: score 0.

— Insufficient lighting: score 0.

Conclusions: Long-term repetitive work in the cold environment with insufficiently protected hands caused cold hazards, especially in hands (1., 3., 4., and 6.). The hazards, very common in this type of industry, show immediate need for corrective action.

E.3 Stage 2 — Analysis (from Annex B)

1. Cold air

Calculation of IREQ shows that the need for insulation is 1,8 clo. The available clothing insulation is 1,6 clo to 2,1 clo. Consequently, there are no marked problems with whole-body thermal insulation.

2. Wind/air movement

Air movements do not produce marked problems.

3. Contact cooling

Contact material is meat or sausages. The product temperature is 4 °C. The type of contact is gripping. The contact is very short but repeated. Contact cooling does not cause any immediate danger from frostbite or numbness but gradually the hands cool below 15 °C, causing performance degradation and cold pain. The problem with hands and fingers is further analysed in the 4. and 6.

4. Contact with moist materials

The contact material surface is usually moist. It facilitates contact cooling but does not moisten the inner gloves due to the protection given by the outer plastic gloves.

5. Protective clothing against cold

Thermal insulation of the cold protective clothing is generally sufficient (see 1.).

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

6. Protection against cold for hands, feet and head

Finger temperatures decreased often below 15 °C, causing cold pain (see ISO 9886 and ISO 10551). This was due to thin gloves, with insufficient thermal insulation, and the accumulation of moisture in the inner gloves due to insensible perspiration. Changing to dry gloves was recommended, as needed. Moreover, use of the correct size of glove was encouraged, in order to maintain optimal hand and finger circulation without impairing manual performance.

7. Possibility of performing the work at a higher room temperature

For hygienic reasons, room temperature could not be increased.

E.4 Stage 3 — Expertise

Because the cold protection of hands appeared to be the most difficult problem, a special development project was carried out. In the project, all available gloves were compared and the optimal glove was chosen. The project also increased workers' awareness about cold problems and available solutions.

© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

Bibliography

[1] ISO 7726:1998, *Ergonomics of the thermal environment — Instruments for measuring physical quantities*

[2] ISO 8996:1990, *Ergonomics — Determination of metabolic heat production*

[3] ISO 9001, *Quality management system — Requirements*

[4] ISO 9920:1995, *Ergonomics of the thermal environment — Estimation of the thermal insulation and evaporative resistance of a clothing ensemble*

[5] ISO 10551:1995, *Ergonomics of the thermal environment — Assessment of the influence of the thermal environment using subjective judgement scales*

[6] ISO 11079:2007, *Ergonomics of the thermal environment — Determination and interpretation of cold stress when using required clothing insulation (IREQ) and local cooling effects*

[7] ISO 11399:1995, *Ergonomics of the thermal environment — Principles and application of relevant International Standards*

[8] ISO 13732-3:2005, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 3: Cold surfaces*

[9] ISO 14001, *Environmental management systems — Requirements with guidance for use*

[10] ISO 14505 (all parts), *Ergonomics of the thermal environment — Evaluation of thermal environments in vehicles*

[11] ISO 15265, *Ergonomics of the thermal environment — Risk assessment strategy for the prevention of stress or discomfort in thermal working conditions*

[12] EN 511:2006, *Protective gloves against cold*

[13] EN 342:2004, *Protective clothing — Ensembles and garments for protection against cold*

[14] EN 343, *Protective clothing — Protection against rain*

[15] BS 8800:1996, *Guide to occupational health and safety management systems*

[16] DIN 33403-5, *Climate at the workplace and its environments — Part 5: Ergonomic design of cold workplaces. (*In German: *Klima am Arbeitsplatz und in der Arbeitsumgebung — Teil 5: Ergonomische Gestaltung von Kältearbeitsplätzen)*

[17] OHSAS 18001:1999, *Occupational health and safety management systems. Specification*[1)]

[18] OHSAS 18002:2000, *Occupational health and safety management systems. Guidelines for the implementation of OHSAS 18001*

[19] ANTTONEN, H. Occupational needs and evaluation methods for cold protective clothing. *Arctic Med. Res.* 1993;52(Suppl. 9):1-76

1) UK occupational health and safety advisory services management system specification.

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

[20] BELL, J.L., GARDNER, L.I., LANDSITTEL, D.P. Slip and fall-related injuries in relation to environmental cold and work location in above-ground coal mining operations. *Am. J. Ind. Med*. 2000;38(1):40-8

[21] BLOMKVIST, A.C., GARD, G. Computer usage with cold hands; an experiment with pointing devices. *Int. J. Occup. Saf. Ergon* 2000;6(4):429-50

[22] BROWN, W.D. Heat and cold in farm workers. *Occup. Med*. 1991;6(3):371-89

[23] BUDD, G.M. Ergonomic aspects of cold stress and cold adaptation. *Scand. J. Work Environ. Health* 1989;15(Suppl. 1):15-26

[24] CAMPBELL, D.S. Health hazards in the meatpacking industry. *Occup. Med.* 1999;14(2):351-72

[25] CHEN, F., LI, T., HUANG, H., HOLMÉR, I. A field study of cold effects among cold store workers in China. *Arctic Med. Res*. 1991;50(Suppl. 6):99-103

[26] COCHRANE, J.J., FREEMAN, S.J. Working in arctic and sub-arctic conditions: mental health issues. *Can. J. Psychiatry* 1989;34(9):884-90

[27] CONWAY, G.A., LINCOLN, J.M., JORGENSEN, S.A., KLATT, M.L., MANWARING, J.C. Preventing deaths in Alaska's commercial fishing industry. *Int. J. Circumpolar Health* 1998;57(Suppl. 1):503-9

[28] ENANDER, A.E. Effects of thermal stress on human performance. *Scand. J. Work Environ*. Health 1989;15(Suppl. 1):27-33

[29] GRIEFAHN, B. Limits of and possibilities to improve the IREQ cold stress model (ISO/TR 11079). A validation study in the field. *Appl. Ergon*. 2000;31(4):423-31

[30] HASSI, J., MÄKINEN, T., HOLMÉR, I., PÅSCHE, A., RISIKKO, T., TOIVONEN, L., HURME, M. *Guide book for work in cold*. (In Finnish: Opas kylmätyöhön; also available in Swedish and Norwegian). Finnish Institute of Occupational Health/National Institute for Working Life, Sweden/Thelma As, Norway, 2002. 111 pages

[31] HASSI, J., GARDNER, L., HENDRICKS, S., BELL, J. Occupational injuries in the mining industry and their association with statewide cold ambient temperatures in the USA. *Am. J. Ind. Med*. 2000;38(1):49-58

[32] HOLMÉR, I. Work in the cold. Review of methods for assessment of cold exposure. *Int. J. Occup. Environm. Health*. 1993;65(3):147-155.

[33] HOLMÉR, I. Cold stress. Part I — Guidelines for the practitioner. *Int. J. Ind. Erg*. 1994;14(1):139

[34] HOLMÉR, I. Cold stress. Part II — The scientific basis (knowledge base) for the guide. *Int. J. Ind. Erg*. 1994;14(1):151

[35] HOLMÉR, I. Prediction of responses to cold. *Arctic Med. Res*. 1995;54(Suppl. 2):48-54

[36] ILMARINEN, R., TAMMELA, E., KORHONEN, E. Design of functional work clothing for meat-cutters. *Appl. Ergonomics* 1990;1(21):2-6

[37] KAMON, E. Ergonomics of heat and cold. *Tex. Rep. Biol. Med*. 1975;33(1):145-82

[38] KAPPES, B., MILLS, W., O'MALLEY, J. Psychological and psychophysiological factors in prevention and treatment of cold injuries. *Alaska Med*. 1993;35(1):131-40

[39] KEIM, S.M., GUISTO, J., SULLIVAN, JR. J. Environmental thermal stress. *Ann. Agric. Environ. Med*. 2002;9(1):1-15

[40] KUKLANE, K. Footwear for cold environments. Thermal properties, performance and testing. *Arbete och Hälsa* 1999:23 (PhD thesis)

© ISO 2008 – All rights reserved
Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

[41] LEMEN, R.A., MAZZUCKELLI, L.F., NIEMEIER, R.W., AHLERS, HW. Occupational safety and health standards. *Ann. N.Y. Acad. Sci*. 1989;572:100-6; discussion 107-9.28

[42] MÄKINEN, T.M., HASSI, J. Usability of ISO thermal standards for cold risk assessment in the workplace. *Int. J. Circumpolar Health* 2002;61(2):142-53.

[43] MALCHAIRE, J., GENG, Q., DEN HARTOG, E., HAVENITH, G., HOLMER, I., PIETTE, A., POWELL, S.L., RINTAMÄKI, H., RISSANEN, S. Temperature limit values for gripping cold surfaces. *Ann. Occup. Hyg*. 2002;46(2):157-63

[44] MARTENS, W.J. Climate change, thermal stress and mortality changes. *Soc. Sci. Med*. 1998;46(3):331-44

[45] MERGLER, D., VEZINA, N. Dysmenorrhea and cold exposure. *J. Reprod. Med*.1985;30(2):106-11

[46] MESSING, K., REVERET, J.P. Are women in female jobs for their health? A study of working conditions and health effects in the fish-processing industry in Quebec. *Int. J. Health Serv*. 1983;13(4):635-48

[47] MESSING, K., TISSOT, F., SAUREL-CUBIZOLLES, M.J., KAMINSKI, M., BOURGINE, M. Sex as a variable can be a surrogate for some working conditions: factors associated with sickness absence. *J. Occup. Environ. Med*. 1998;40(3):250-60

[48] NÄYHÄ, S., HASSI, J. Cold and mortality from ischaemic heart disease in northern Finland. *Arctic Med. Res*. 1995;54(Suppl. 2):19-25

[49] NELSON, T.M., MCINTYRE, J.W., LABRIE, I.G., CSIKY, A. Self-perception of the ability to work in the cold. *Behav. Med*. 1991;17(1):15-23

[50] NUNNELEY, S.A. Physiological responses of women to thermal stress: a review. *Med. Sci. Sports* 1978;10(4):250-5

[51] PARSONS, K.C. International standards for the assessment of the risk of thermal strain on clothed workers in hot environments. *Ann. Occup. Hyg*. 1999;43(5):297-308

[52] PARSONS, K.C: *Human thermal environments. The effects of hot, moderate and cold environments on human health, comfort and performance*. Taylor & Francis, London 2003

[53] POPE, D.P., CROFT, P.R., PRITCHARD, C.M., SILMAN, A.J., MACFARLANE, G.J. Occupational factors related to shoulder pain and disability. *Occup. Environ. Med*. 1997;54(5):316-21

[54] TAESLER, R. The bioclimate in temperate and northern cities. *Int. J. Biometeorol*. 1991;35(3):161-8

[55] TOCHIHARA, Y., OHKUBO, C., UCHIYAMA, I, KOMINE, H. Physiological reaction and manual performance during work in cold storages. *Appl. Human Sci*. 1995;14(2):73-7

[56] VÄYRYNEN, S. Ergonomic design of machinery for use in the cold. A review based on the literature and original research. *Arctic Med. Res*. 1992;51(Suppl. 7):87-91

[57] VIROKANNAS, H. Thermal responses to light, moderate and heavy daily outdoor work in cold weather. *Eur J Appl Physiol Occup Physiol* 1996;72(5-6):483-9

[58] VIROKANNAS, H., ANTTONEN, H. Combined effects of cold, vibration and smoking, particularly in snowmobile users. *Arctic Med. Res*. 1994;53(Suppl. 3):29-34

[59] WIESLANDER, G., NORBACK, D., EDLING, C. Local cold exposure of the hands from cryosectioning work in histopathological and toxicological laboratories: signs and symptoms of peripheral neuropathy and Raynaud's phenomenon. *Occup. Environ. Med*. 1996;53(4):276-80

[60] WILLIAMS, N. Working in extreme temperatures — Cold. *Occup. Health* (Lond.) 1993;45(7):233-5

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS
Not for Resale

ICS 13.180

Price based on 31 pages

--`,,```,,,,````-`-`,,`,,`,`,,`---

© ISO 2008 – All rights reserved

Copyright International Organization for Standardization
Provided by IHS under license with ISO
No reproduction or networking permitted without license from IHS

Not for Resale