

# REGULATION

## on hazard zoning due to snow- and landslides, classification and utilisation of hazard zones, and preparation of provisional hazard zoning

### CHAPTER I

#### Scope and definitions

##### Article 1

###### *Scope*

This Regulation shall apply to the preparation and use of hazard zoning due to snow- and landslides and the utilisation of hazard zones, as well as to the preparation of provisional hazard zoning.

##### Article 2

###### *Definitions*

For the purpose of this Act, the following words and expressions shall have the meanings ascribed to them below:

*action plan:* a community's plan for actions to ensure human safety in buildings located in hazard zones;

*snow catchment area:* the area from which snow can drift into the starting zones of avalanches;

*risk:* a measure of the probability of an event occurring and of the scope and severity of its consequences.

Risk = function (probability, consequences);

*impact pressure:* pressure due to an avalanche or a landslide on a surface which is perpendicular to the direction of flow of the slide;

*acceptable risk:* limits set for acceptable annual local risk taking into account the effect of exposure, set as  $0.3 \times 10^{-4}$  (0.3 deaths per 10,000);

*return period:* the mean time which elapses between comparable events;

*hazard:* a conceivable event leading to personal injury or property damage;

*hazard line:* a line connecting locations where annual local risk is acceptable;

*isorisk line:* a line connecting locations where annual local risk is equal;

*snow- or landslide:* a snow avalanche, landslide or rockfall;

*accidental load:* a load which only results from accidents or other unforeseeable conditions, cf. Icelandic standard ÍST DS 409:1982.

*non-reinforced building:* a building which has not been especially reinforced against load from a possible snow- or landslide;

*local risk:* annual probability of death as a result of snow- or landslides for an individual dwelling continuously in a non-reinforced single family building;

*permanent protective structures:* catching and deflecting dams, supporting structures in avalanche starting zones;

*protective measures:* construction of permanent protective structures, purchasing of residential buildings in hazard zones, reinforcement of buildings, monitoring and evacuation;

*Exposure:* the probability of an individual being in a hazard zone when a snow- or landslide falls, without regard to actions to increase security, e.g. monitoring and evacuation;

*densely populated area:* a collection of buildings where at least 50 people reside, with the distance between buildings generally not exceeding 200 metres;

## CHAPTER II

### **Hazard Zoning Committee, presentation and attestation of hazard zoning**

#### Article 3

##### *Hazard Zoning Committee*

In communities where snow- or landslides have fallen on or near settled areas, or where there is considered to be a danger of such, the local authorities shall have

the risk of slides assessed. A request by a local authority that hazard zoning be carried out shall be sent to the Minister for the Environment, who shall appoint a four-person committee on hazard zoning, the Hazard Zoning Committee.

The Hazard Zoning Committee shall direct the preparation of hazard zoning in the community in question and conclude a contract with the Icelandic Meteorological Office (IMO) on preparation of hazard zoning which must, for instance, provide for the cost and time period of the project. The Hazard Zoning Committee shall decide, in consultation with the local authority, what areas the hazard zoning shall cover. Such Committees shall receive and assess comments from parties concerned and present proposals for hazard zoning upon receiving them from the IMO. A Hazard Zoning Committee is to prepare a hazard zoning proposal for attestation by the Minister for the Environment.

#### Article 4

##### *Appointment of Hazard Zoning Committees*

The Minister shall appoint four members to a Hazard Zoning Committee at the request of the local authority in question. Two of them shall be nominated by the local authority concerned in each instance, with the Minister appointing two members of the Committee without nomination. One of these latter two shall serve as Chairman and cast the deciding vote while the other shall be a specialist with expert knowledge of snow- and landslide danger. Activities of the Hazard Zoning Committee shall conclude once the hazard zoning has been attested by the Minister.

#### Article 5

##### *Presentation and attestation of hazard zoning*

The local authority in question shall be responsible for and arrange presentation of hazard zoning in consultation with the Hazard Zoning Committee.

The hazard zoning shall be advertised and presented at an open meeting in the community. Once the presentation has taken place, the hazard zoning shall be made available at the office of the local authority for inspection for four weeks. The hazard zoning shall be attested by the Minister for the Environment and shall enter into force upon publication in the Official Journal of Iceland (*Stjórnartíðindi*).

#### Article 6

##### *The Icelandic Meteorological Office (IMO)*

The Icelandic Meteorological Office (IMO) shall prepare hazard zoning at the request of a Hazard Zoning Committee, as provided for in an implementation plan drawn up in consultation with local authorities and the Snow- and Landslide Committee.

Furthermore, the IMO shall prepare a provisional hazard zoning, cf. Chapter VII, and assessment of avalanche risk in skiing areas, cf. Article 14.

#### Article 7

##### *Cost of preparing a hazard zoning*

The cost of preparing hazard zoning, including the cost of Hazard Zoning Committees, shall be paid from the Snow- and Landslide Fund.

### CHAPTER III

#### **Preparation and use of hazard zoning**

#### Article 8

##### *Preparation and structure of hazard zoning*

In communities where snow- or landslides have fallen on or near settled areas, or where there is considered to be a danger of such, the local authorities shall have the danger of slides assessed.

Such hazard zoning shall cover principally densely populated areas and areas where urban settlement is planned. Furthermore, assessment of avalanche risk should be carried out in organised skiing areas. Hazard zoning for sparsely populated areas, such as individual farms, shall be carried out provided there are valid reasons for so doing in the estimation of the Snow- and Landslide Committee, e.g. when slides have fallen on or come to a stop in the vicinity of residential dwellings.

The results of hazard zoning must involve evaluation of the danger to human life posed by snow- or landslides, i.e. assessment of risk, and such evaluation should take into consideration any protective structures that have been erected.

Hazard zoning shall be presented on a map of the scale 1:5000, showing the delineated hazard zones, and in a report accompanying the hazard map, as provided for in detail in this Regulation.

## Article 9

### *Data collection*

Hazard zoning must be based at least on the following:

1. Base map: The maps must cover areas specified in Article 8, showing the landscape including the highest peaks of the mountains and extending over adjacent snow catchment areas. Information presented on the maps shall be in suitable detail for presentation on a map on a scale of 1:5000 and they must fulfil IMO requirements e.g. as to accuracy and presentation. New maps must be digital.

2. Documentation on snow- and landslides in the area concerned and its vicinity must be gathered by examining written sources, advertising for information and suggestions and conducting interviews with individuals having local knowledge of avalanches, debris flows and snow accumulation. Information shall be collected on the weather conditions associated with snow- and landslide

events, starting zones of slides, snow depth in starting zones and runout zones, avalanche tracks, types of slides, runout distances, the shape of avalanche tongues and other items of significance. If no map exists showing the outlines of known slides, this shall be prepared in digital form, cf. Point 1.

3. Investigation of weather conditions. Information must be collected on weather at nearby weather stations and an overview of climatological conditions prepared. A special investigation shall be made using statistical methods of the relative frequency of avalanche wind directions, extreme precipitation and extreme snow depth.

4. Examination of local settlement history. An overview shall be prepared of the age of buildings in the area, especially those which are or have been located closest to the mountains and/or below possible avalanche paths.

5. On-site inspection. A detailed inspection shall be made of the on-site conditions, starting zones, snow accumulation possibilities and avalanche paths, examining geological and vegetation evidence as to the runout and frequency of slides. An assessment shall be made as to where conditions could lead to floods and slush flows. The size of possible debris flows shall be assessed by quantifying earth material which can break loose and its distribution. An assessment shall be made of the age of slide deposits, traces of which can still be seen. If natural defence dams or man-made dams exist, their efficacy shall be assessed.

## Article 10

### *Risk assessment*

In risk assessment, the risk of snow- or landslides shall be calculated, based in part on documentation which has been gathered as provided for in Article 9. Risk calculations shall take into consideration the recorded frequency of slides from the slope or slopes in question, the local settlement history in the area, the runout

distance distribution of recorded avalanches in the country and possibly in other countries when transposed to the slope or slopes in question, and the expected probability of death for people caught by avalanches. It shall also take into consideration the weather conditions and topography, e.g. wind directions, snow depth, size and location of snow catchment areas and slope aspect and shape of starting zones. The efficacy of protective structures built in order to reduce this risk shall also be assessed and/or calculated. This applies in particular to catching and deflecting dams in avalanche runout areas and to supporting structures in starting zones.

Actions which are aimed at altering snow accumulation, e.g. snow fences or other comparable equipment in the vicinity of avalanche starting zones or in snow catchment areas shall, as a rule, not affect hazard zoning.

If calculations of risk cannot be made due to insufficient information, a hazard map shall nonetheless be drawn up, cf. Article 12, and in its preparation an attempt shall be made to assess risk.

## Article 11

### *Acceptable risk*

Local risk to humans in residential dwellings, schools, day-care centres, hospitals, community centres and similar locations is considered acceptable if it is less than  $0.3 \times 10^{-4}$  annually. For commercial buildings where there is steady activity, the risk is acceptable if local risk is less than  $1 \times 10^{-4}$  annually. For recreational homes, risk is considered acceptable if local risk is less than  $5 \times 10^{-4}$  annually. In determination of these limits an exposure of 75% is assumed for residential dwellings, 40% for commercial buildings and 5% for recreational homes. In addition, it is assumed that children do not generally occupy commercial buildings, with the exception of schools and day-care centres.

Human exposure can be assessed by other means than as provided for in the first paragraph, provided grounds are given for such assessment. Such assessment applies, for example, to commercial buildings where people do not work or stay on a regular basis. There may also be reason to demand greater security than is provided for in the first paragraph, for instance, if extensive human exposure in recreational homes in winter is anticipated, or for large workplaces.

## Article 12

### *Hazard maps and classification of hazard zones*

The hazard zoning shall be delineated on a map on the scale 1:5000 showing hazard zones and their classification and also on the master plan map of the community concerned. The community, the Ministry for the Environment, the IMO, the National Civil Defence of Iceland and the Planning Agency shall each preserve a copy of the attested hazard map together with the accompanying report.

A hazard map must show a hazard line, i.e. a line which distinguishes areas where the local risk is acceptable from areas where the risk is greater than this. Areas upslope from the hazard line shall be marked with the letters A, B or C respectively, in accordance with the increasing risk, cf. Chapter V. The outlines of the area covered by hazard zoning shall be shown on the hazard map.

In areas that are protected by protective structures, both local risk in the absence of such measures and local risk taking the structures into consideration shall be shown. The hazard map shall identify especially structures and landscape features which reduce risk and may not be altered for safety reasons.

## Article 13

### *Explanation accompanying a hazard map*

The report accompanying a hazard map must include:

1. a summary of the investigation carried out as provided for in Article 9, including overview maps of registered avalanches and debris flows;
2. a frequency map showing, for each location in the area covered by the zoning, the calculated or estimated frequency of snow avalanches. The map must at least show lines where avalanches can be expected to fall on average every 100, 300, 1000 and 3000 years. If available data are not sufficient for calculating the frequency of avalanches, this map may be replaced by comments on the recurrence interval of slides;
3. in the report accompanying the hazard zoning, as provided for in Article 10, there shall be an overview of the premises for the zoning and the data upon which it is based. An account must also be given of the calculations which have been carried out and their results. Where it does not prove possible to base the zoning on calculations, an explanation shall be given as to how the result was obtained and the grounds supporting it.

#### Article 14

##### *Skiing areas*

Before work commences on infrastructure in designated skiing areas, the local authority in question must have the avalanche hazard assessed, and this shall be taken into consideration in the planning of the area and arrangement of structures, cf. Chapter VI. Information shall be gathered on known avalanches and possible starting zones, flow directions and runout distances of avalanches appraised, together with other aspects which may be of significance. The conclusions of this investigation shall be presented on a map, together with the report which accounts for the premises used and the information which was collected. If there is considered to be a danger of avalanches, the operator shall prepare a plan for regular monitoring of avalanche hazard. The IMO shall prepare hazard zoning of designated skiing areas at the request of the local authority in question.

## CHAPTER IV

### **Planning of areas**

#### Article 15

##### *Planning of areas*

If an existing detail and/or master plan is not in accordance with the results of hazard zoning, the plan must be revised to bring it into accord with the hazard zoning. Hazard zoning must be submitted as an accompanying document with a proposal for a detail and master plan where appropriate. Zoning plans for sparsely populated areas shall always be approved and/or attested to with a proviso concerning the possible slide hazard which may be brought to light by hazard zoning of individual areas, cf. the first paragraph of Article 8.

Hazard zoning shall be taken into full consideration in all planning. If dispute arises concerning the accordance of hazard zoning and a detail and/or master plan, the Ruling Committee for Planning and Construction shall decide on the question as provided for in the Planning and Building Act, No. 73/1997, as subsequently amended. In reviewing a master plan the local authority shall assess whether there is cause to review hazard zoning.

No residential, recreation or commercial area may be planned for zones previously without buildings unless it has been established that the risk to human life from snow- or landslides will be acceptable, cf. Article 11.

#### Article 16

##### *Zoning plans*

Regional, master and detail plans must identify hazard zones, cf. Articles 8 and 12. An explanation shall be given as to what rules apply to each of them concerning activities and building of structures. Furthermore, an explanation shall be given for any already existing and planned protective structures against snow-

or landslides, and what land use is proposed for hazard zones and nearby areas and how this accords with rules that apply to each individual area.

## CHAPTER V

### **Classification, definition and utilisation of hazard zones**

#### Article 17

##### *Definition of hazard zones*

Hazard zones are delineated by a line, the hazard line, which is drawn on the basis of a decision on acceptable local risk, as provided for in Article 11. On the slope above the hazard line, the hazard zones are divided into three classes reflecting increasing risk. Hazard zone A is delineated by the isorisk lines  $0.3 - 1 \times 10^{-4}$ . Hazard zone B is delineated by the isorisk lines  $1 - 3 \times 10^{-4}$ . Hazard zone C is the area where local risk is over  $3 \times 10^{-4}$ . Below the hazard line the annual local risk is lower than  $0.3 \times 10^{-4}$ .

TABLE I

#### **Definition of hazard zones**

	Local risk – $\times 10^{-4}$ Lower limit	Local risk – $\times 10^{-4}$ Upper limit
Hazard zone A	0.3	1.0
Hazard zone B	1.0	3.0
Hazard zone C	3.0	-

#### Article 18

##### *Action plan*

A local authority shall draw up a plan of action to ensure the safety of people in buildings in hazard zones which shall be available within six months after the attestation of the hazard zoning. The plan shall be based on the implementation

plan of the Snow- and Landslide Fund, which aims at concluding the most urgent protective measures against snow- and landslides for C zones no later than 2010; it shall enter into force upon its attestation by the Snow- and Landslide Committee.

In hazard zone C, security shall be ensured with permanent protective structures or the purchasing of residential housing. For hazard zones A and B, human safety can be ensured through monitoring and evacuation.

## Article 19

### *Utilisation of hazard zones*

New residential and commercial buildings, as well as cottages intended for overnight stays in skiing areas, can be erected in hazard zones A. Schools, day-care centres, hospitals, community centres, multifamily dwellings with more than four apartments and other comparable buildings may be erected provided they are reinforced to withstand impact pressure, cf. Table II.

In hazard zones B new individual and multifamily dwellings with up to four apartments may be built, and additions made to schools, day-care centres, hospitals, community centres, multifamily dwellings with more than four apartments and other comparable buildings, provided the buildings and/or additions are reinforced to withstand impact pressure, cf. Table II. Commercial buildings may be erected, as well as cottages in skiing areas, which are not intended for overnight stays, without reinforcement requirements. No new schools, day-care centres, hospitals, community centres, multifamily units with more than four apartments, or other comparable buildings may be erected.

In hazard zones C only new structures, which people are not expected to occupy on a regular basis as a residence or place of employment, may be built, such as pumping or transmission stations, power lines and other comparable structures, and provided that it will not create increased risk to other settlement if

the structure is subjected to the impact of a snow- or landslide. Residential and commercial buildings may, however, be modified but only in such manner that the total risk in the area concerned does not increase, e.g. due to increase in the number of apartments or number of employees.

TABLE II

**Impact pressure in hazard zones, calculated as accidental load, kN/m<sup>2</sup>**

	<b>Residential dwellings, hospital and community centres, schools day-care centres and comparable buildings</b>	
<b>Area</b>	<b>Lower limit</b>	<b>Upper limit</b>
Hazard zone A	5	20
Hazard zone B	20	90

Impact pressure at a specific location in the area is to be assessed based on location and on-site conditions.

The design of structural elements is to be based on impact pressure from snow- or landslides as provided for in Table II. This pressure is calculated as an accidental load and the structure is to be calculated at the limit state. In general this means that buildings in hazard zones must be of reinforced concrete with a concrete ceiling and that walls facing the slope should as a rule have no openings or windows. Otherwise windows and doors must be able to withstand the impact pressure. Design of structures in hazard zones shall be based on the following papers, Rb(V9).003, Rb(V9).004 and Rb(V9).005, issued by the Building Research Institute of Iceland. Designers must without exception submit their calculations for approval by the building supervisor concerned who will verify the design data.

## Article 20

### *Special utilisation of hazard zones A and B*

In hazard zones A and B structures may be erected without the restrictions provided for in Article 19, provided a decision has been taken by the local authority to protect the area with permanent protective structures within five years' time, in accordance with an attested action plan for the community, cf. Article 18.

## Article 21

### *Utilisation of areas below protective structures*

In areas where human security with respect to slides has been increased by means of protective structures, as reflected in a revised hazard zoning, the density of the settlement may be increased and structures renewed, cf. Article 19. In spite of the fact that protective structures are designed and built with the aim of making the safety of people below them acceptable, a local authority should take into consideration the danger of snow- or landslides in planning and development of communities.

## CHAPTER VI

### **Protective structures**

## Article 22

### *Protective structures*

Defences against slides shall only be built to increase the safety of people in areas already populated. If the requirements pursuant to Article 11 are not fulfilled without special protective structures against slides, no new, previously unpopulated areas may be planned for residential settlement, recreational dwellings or commercial activities.

In designing protective structures against slides, the aim shall be to increase security so that following their building the local risk to people below them will be as near as possible to acceptable local risk as provided for in Article 11 and never more than  $1.0 \times 10^{-4}$ .

In a preliminary investigation of protection measures, consultants shall appraise local risk with and without permanent protective structures. Special maps, accompanying their proposals for defences, shall show the isorisk lines as provided for in Article 17, indicating clearly what areas are protected by protective structures and what the local risk is with and without consideration for protective structures.

Monitoring of the danger of snow- and landslides and evacuation plans shall not affect the location of isorisk lines nor hazard maps. Maps and evacuation plans must be reviewed if permanent protective structures against slides are built.

Zoning plans must give an account of protective structures which have been build or are planned, together with special conditions on the reinforcement or elaboration of structures.

## Article 23

### *The local authority*

A local authority shall make a proposal to the Snow- and Landslide Committee for protective structures for hazard zones in areas already populated.

The local authority shall carry out construction of protective structures in accordance with a decision by the Snow- and Landslide Committee.

Local authorities shall be responsible for the maintenance of protective structures.

## CHAPTER VII

### **Provisional hazard zoning**

#### Article 24

##### *Scope*

The provisions of Chapter VII of this Regulation shall apply to the handling of zoning proposals, granting of construction permits and preparation of provisional hazard zoning in areas where slides have fallen or where there is considered to be a danger of such and for which no attested hazard zoning is available.

#### Article 25

##### *Zoning proposals and construction permits*

Before a local authority may modify a detail plan or master plan, approve a new plan or grant a construction permit in accordance with a current detail plan in a potential snow- or landslide area, where no attested hazard zoning is available, it shall seek the opinion of the Planning Agency concerning handling of the issue. The Planning Agency shall assess whether it requests a provisional hazard zoning from the IMO. Such assessment shall be subject to the nature of the situation, for instance, whether any previous appraisal of hazard has been made in one form or another. If the Planning Agency deems that provisional hazard zoning is necessary, it shall send the IMO a request to this effect.

#### Article 26

##### *Provisional hazard zoning*

Upon receiving a request for provisional hazard zoning due to a planning proposal or permit application, the IMO shall estimate the scope of such zoning. If this is very extensive, the IMO shall request that the local authority in question deal with the hazard zoning as provided for in Chapter II of this Regulation.

Otherwise the IMO shall prepare a provisional hazard zoning for the area and delineate hazard zones in accordance with Chapter V. The IMO shall, as a rule, reach a decision on an inquiry within six weeks of its receipt. Should it be impossible to deal with the inquiry within this time limit, the party concerned shall be informed of such in writing and the planned procedure explained.

#### Article 27

##### *Opinion of the Planning Agency*

The Planning Agency must respond to an inquiry from a local authority, as referred to in Article 25, and notify the authority of its opinion as promptly as possible. The Planning Agency's opinion must indicate whether construction, as provided for in the planning proposal or permit application, is authorised. The Planning Agency defines, in consultation with the IMO the requirements which new construction must fulfil and sets other relevant conditions for approval of a planning proposal or individual permit application.

A provisional hazard zoning due to a construction permit must at least specify the structural requirements for buildings to be erected there.

#### Article 28

##### *Entry into force*

This Regulation is issued in accordance with the fourth paragraph of Article 4 of Act No. 49/1997, as subsequently amended, and shall enter into force immediately.

##### *Temporary provisions*

###### I.

Hazard Zoning Committees must have concluded hazard zoning, cf. Article 3, for the following centres of population no later than the end of 2001: Bildudalur,

Bolungarvík, Eskifjörður, Hnífsdalur, Ísafjörður, Neskaupstaður, Ólafsvík,  
Patreksfjörður, Seyðisfjörður and Siglufjörður.

*Ministry for the Environment, 6 July 2000*

**Siv Friðleifsdóttir.**

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*Smári Þorvaldsson*