

# *NivoTest* : a personal assistant for avalanche risk assessment

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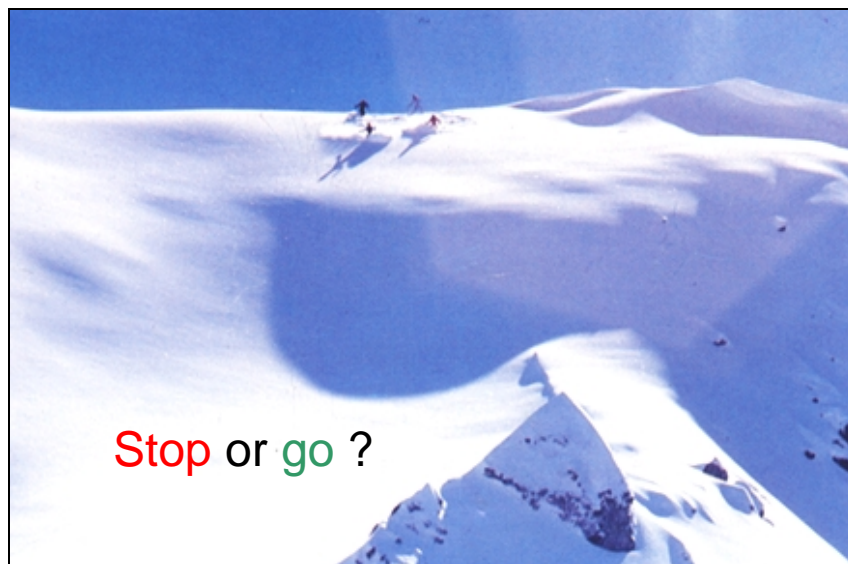
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## Introduction

### **About avalanche risk...**

Every mountaineer knows that avalanche hazard varies notably according to local conditions : at the same time, in the same region, one mountain route may be dangerous while another one may be safe. The hazard also depends on the vulnerability of the skiers which differs a lot according to their education, equipment and training. That means that knowing snow conditions is not enough to reliably estimate avalanche risk : diagnosis (and decisions) should be based on many criteria including local weather- and snow conditions as well as local topography and vulnerability of the skiers.

***NivoTest* was designed to help back-country skiers and free-riders to care about all these kinds of criteria when evaluating avalanche risk.**



**Fig. 1.** *Is avalanche risk low or high (here and now) ? NivoTest helps to answer...*

# 1. Description


*NivoTest* is a small card (85 x 150 mm) with a revolving graduated disk. It is a pocket tool to be used on the terrain.



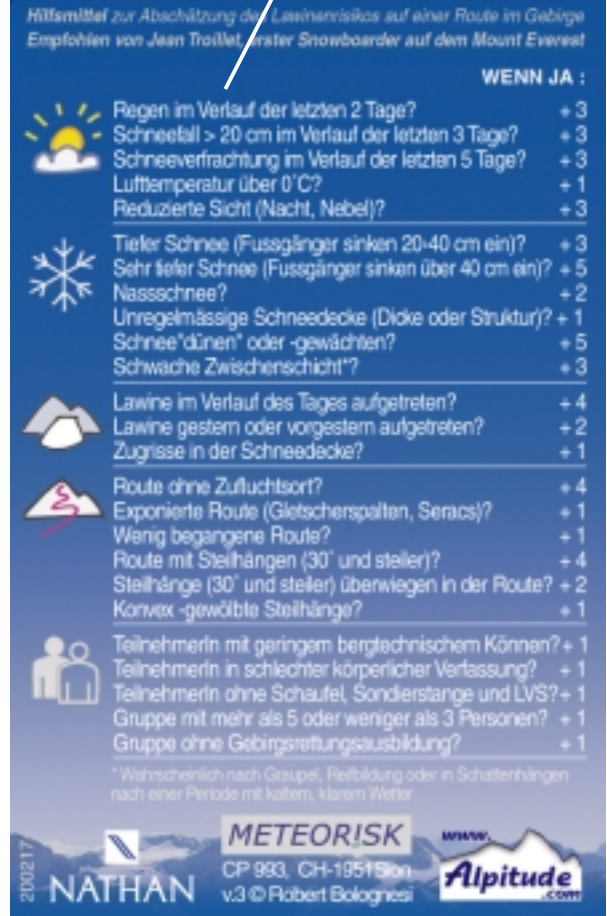
On the face of *NivoTest*, one can read 25 questions about weather, snow pack, past avalanches, topography and group ability (fig. 2).

First of all the disk must be revolve to start position. Then one must answer each of the questions by "yes" or "no" according to local conditions. Most of the questions can be answered by observing the environment. Other questions require to look at the map or to remember the past weather conditions. If the answer is "yes" then the disk must be rotated (1 to 5 graduations depending on the question). For instance : if it has been raining in the course of the last two days then the disk has to be turned three graduations onward.

Revolving disk



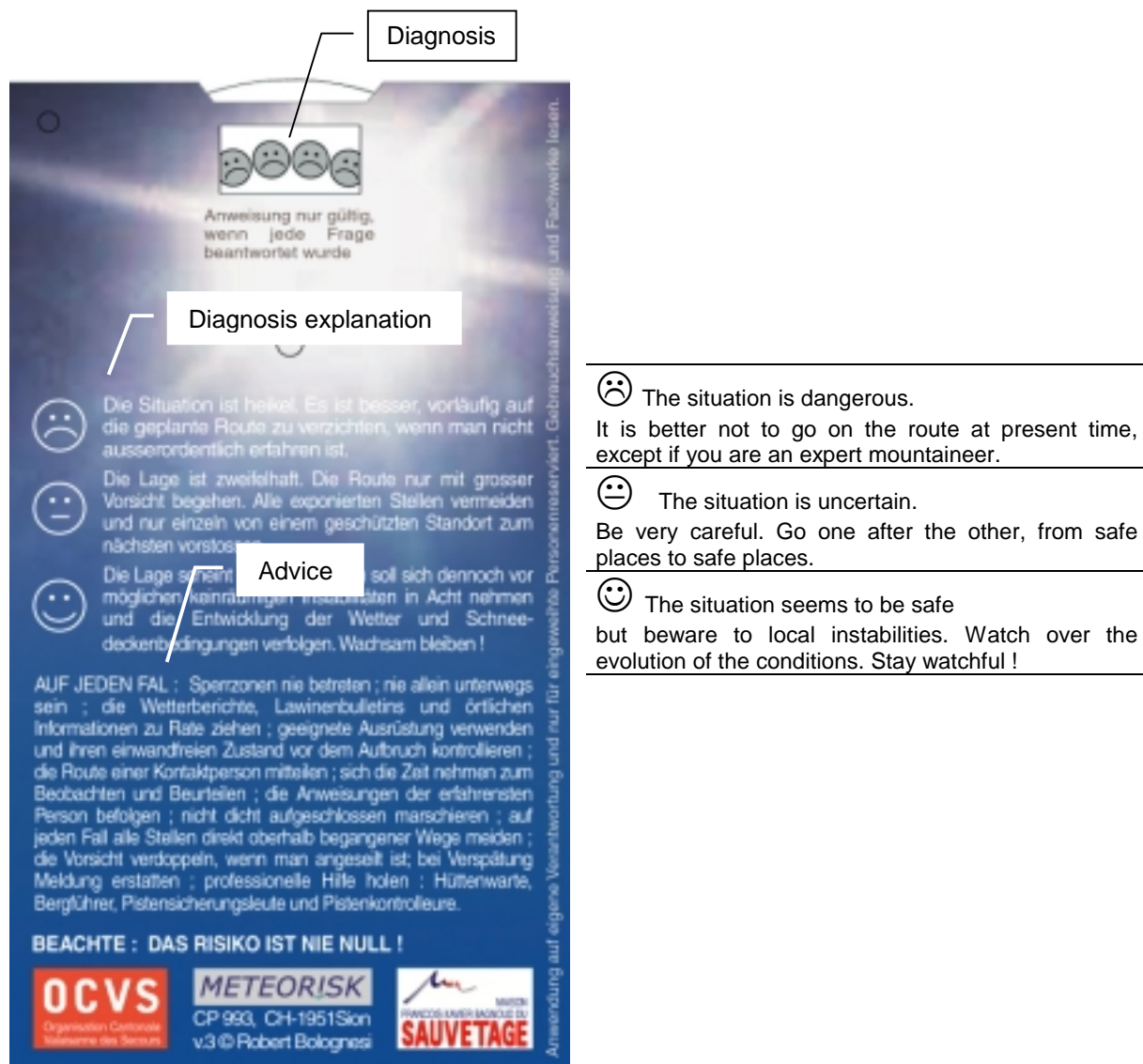
Questions



Question	Points
Rain during last 2 days ?	+ 3
Snowfall > 20 cm during last 3 days ?	+ 3
Snow drifting during last 5 days ?	+ 3
Air temperature > 0°C ?	+ 1
Low visibility (night, fog) ?	+ 3
Deep snow (pedestrian sinking 20 to 40 cm) ?	+ 3
Very deep snow (pedestrian sinking : 40 cm or more)?	+ 5
Wet snow ?	+ 2
Irregular snow pack (thickness or structure) ?	+ 1
Snow accumulations or cornices ?	+ 5
Intern week layer ?	+ 3
Avalanche happening today ?	+ 4
Avalanche happening yesterday or day before ?	+ 2
Snow pack with cracks ?	+ 1
Route without any protected area ?	+ 4
Dangerous route (cliff, crevasse, seracs) ?	+ 1
Unattended route ?	+ 1
Route with steep slope (30° or more) ?	+ 4
Steep slope above the route ?	+ 2
Convex steep slope ?	+ 1
Member of the group with low technical level ?	+ 1
Member of the group with bad physical training ?	+ 1
Member without any transceiver and shovel ?	+ 1
Group > 5 members or < 3 members ?	+ 1
Group without rescue ability ?	+ 1

**Fig.2** : *NivoTest* : face (questions)

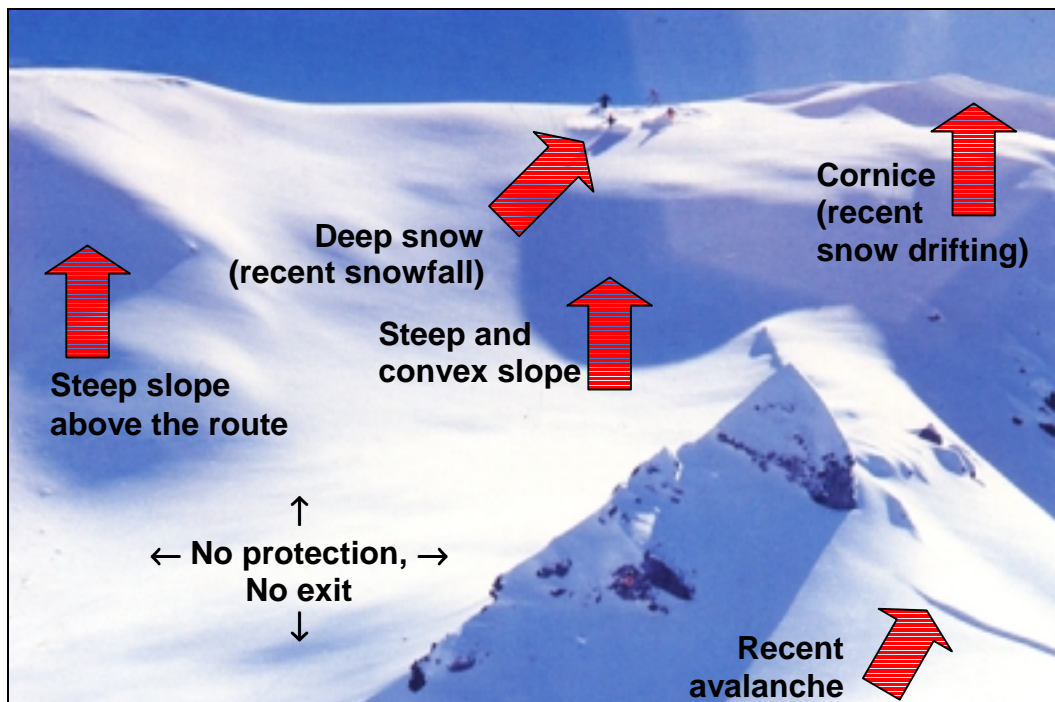
When all the questions are answered, one simply flips the *NivoTest* over (without changing the disk position) and read the diagnosis with corresponding advice (fig. 3). The diagnosis is put into friendly pictograms which shortly indicate the situation.



**Fig. 3.** *NivoTest* : back (diagnosis and advices)

The *NivoTest* reminds some usual advices to be kept in mind when mountaineering during winter. It also includes a user guide which quickly teach how to use it, 2 rulers to estimate a threshold slope angle (30°) from maps and a table to write emergency and information phone numbers.

## The *NivoTest*, in practice...



**Fig.4.** *The NivoTest in practice.*

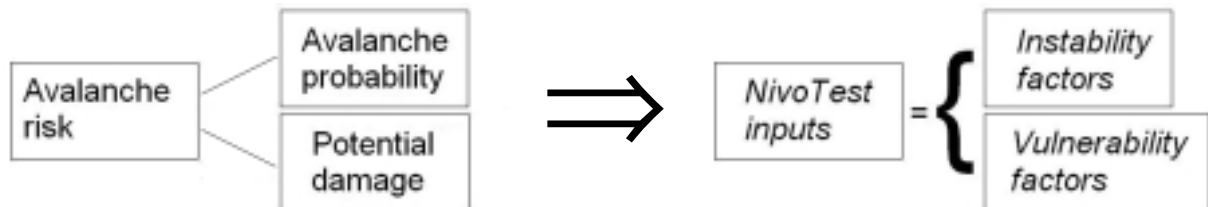
In that case the *NivoTest* diagnosis is "⊗", meaning that the situation may be dangerous. The skiers should stop and choose another route.

Note : an avalanche occurred here one minute later...



## 2. Theoretical aspects

The *NivoTest* is based on the classical theory which states that the risk depends on two independent kinds of factors : on the one hand the probability that the event (the avalanche) occurs and on the other hand the damage that could be caused by this possible event (“potential damage” or “vulnerability”). Therefore *NivoTest* inputs consist of snowpack instability factors as well as skiers vulnerability factors (fig.5).



**Fig. 5.** The classical risk theory and its application

- Instability factors comprise past weather conditions (rain, snowfall, snow drifting, high air temperature), snow conditions (deep snow, wet snow, cornices, snow accumulation, irregular snowpack, intern week layer, avalanche occurrences...), and topography (steep slopes, exposed route, convex slopes...).
- Vulnerability factors consist of conditions which could increase the gravity of an hypothetical accident (bad visibility, skiers without self-rescue capability, unattended route...).

Both kinds of factors (instability factors and vulnerability factors) are directly and closely related to :

- weather- and snow conditions (past and present conditions)
- terrain characteristics
- skiers ability and equipment

This is why the questions asked by the *NivoTest* concern these three topics.

The inputs of *NivoTest* gathered 25 of the most relevant factors for avalanche risk assessment. The choice and the weighting of the factors is based on practical knowledge and on the statistical analysis of a great number of cases including unstable situations as well as stable situations.

The *NivoTest* establishes a score by adding the weight of the observed risk factors (when rotating the disk). If the score is greater than a first threshold then the situation is uncertain ; if the score is greater than a second threshold then the situation is considered as dangerous.

This diagnostic method (called scoring) is very simple but nevertheless efficient because :

- it is tolerant : an error on an input has no great influence on the diagnosis
- it is stable : a little variation on inputs cannot generate a big variation on diagnosis
- it is very reliable for comparative diagnosis.

The more the inputs are numerous, independent and equally weighted, the more the method gives good results. The *NivoTest* fulfills this condition.

### 3. Usage

#### 3.1. Who may use the *NivoTest* ?

*NivoTest* is dedicated to mountaineers, snowboarders and skiers who want to assess avalanche risk in order to ride more safely. It is designed to help :

- to learn
- to make decisions
- to teach

Therefore, **everybody may use the *NivoTest*** but the way to use it depends on the experience and knowledge of the user : beginners may use it to learn ; with some experience, one can use it as a decision support tool ; mountain guides or avalanche experts may use it as a friendly teaching support (fig. 6).

		Ways of use		
		Learning	Making decisions	Teaching
Kinds of user	Expert		(X)	<b>X</b>
	Initiate	(X)	<b>X</b>	
	Beginner	<b>X</b>		

**Fig. 6.** Ways of use the *NivoTest* according to the users.

#### ***NivoTest* as a learning support**

With the *NivoTest*, the beginner can learn from actual cases what should be observed to assess local avalanche risk. He can understand very quickly what are the main risk factors and if he does not understand a question then he knows what he should learn...

He can also read on the *NivoTest* a lot of instructions which promote a safety attitude when mountaineering : never ride alone, consult avalanche bulletin, never forget transceivers and check they work before each tour...

#### ***NivoTest* as a decision support**

*NivoTest* gives an avalanche risk assessment, according to local conditions from 25 field observations.

It can be used to :

- assess the risk for a given mountain road and a given group
- compare the risks for different routes
- compare the risk for different groups

So *NivoTest* helps to make rational decisions.

#### ***NivoTest* as a teaching support**

*NivoTest* is well suited for practical courses. Gather two mountaineers and give them a *NivoTest* : they will immediately talk about snow and avalanches ! Give a *NivoTest* to a teenager : he will learn very quickly just because he plays...

### 3.2. How to use the *NivoTest* ?

The *NivoTest* must be considered as **one of the tools** to be used (fig. 7).

<p><b>1</b> . First decision : stay at home IF</p>	<p><b>bulletin</b> risk level * <math>\geq 4</math> <b>and</b> inexperienced group  <b>OR</b>  bulletin risk level* = 5  <b>OR</b>  very bad weather conditions  (observed or forecasted conditions)  <b>OR</b>  Member of the group tired, ill or injured  <b>OR</b>  Missing or failing equipment  (for instance : no transceiver...)</p>
<p><b>2</b> . Second decision : change the route IF</p>	<p><b>diagnostic <i>NivoTest</i> = ☹️</b>  <b>OR</b>  prohibited area, local alarm bulletins...  <b>OR</b>  group too late</p>
<p><b>3</b> . Third decision : go round the slope IF</p>	<p>Unfavorable indices  (big snow accumulations, cracks...)  <b>OR</b>  alarm signals  ("Whoum", near avalanche release...)  <b>OR</b>  <b>Alarming test</b></p>

\* risk level (European scale) indicated in the regional avalanche bulletin.

**Fig.7.** How to use the *NivoTest*.

*The decision should be made after 3 steps ; the *NivoTest* should be used only at the second step, when choosing the route*

### 3.3. When to use the *NivoTest* ?

The *NivoTest* can be used at any time for learning or teaching or comparing routes according to assumptions.

It must be used on field, just before choosing the route, to make decision from actual observed conditions.

## 4. FAQ (Frequently Asked Questions)

### **Why doesn't the *NivoTest* take slope orientation into account ?**

North slopes are frequently unstable because of weak layer formation. Therefore it seems more pertinent to take weak layers into account than slope orientation, since south slopes may be quite more dangerous than north slope in some conditions ! Note also that slope orientation has different effects according to latitude...

### **Why does the *NivoTest* consider that 30° is the threshold for dangerous angles ?**

Avalanches are more frequent on slopes which are steeper than 30°. But avalanches are bigger on slopes which are around 30°. Because the size of the avalanche is a risk factor as well as its occurrence probability, it seems reasonable and careful to consider 30° as a threshold for dangerous angles.

### **Why doesn't the *NivoTest* take the regional avalanche bulletin into account ?**

The *NivoTest* is not based on the avalanche bulletin for several reasons :

- the bulletin is not everywhere and every time available.
- *NivoTest* is usable even if the bulletin does not refer to the European scale of avalanche risk
- *NivoTest* would remain valid if the scale of risk to which the bulletin refers changed
- the bulletin informs about the regional risk that may be different of the local risk
- the reliability of the diagnosis is potentially higher if the degree of risk given by the avalanche bulletin is not included in *NivoTest* inputs (fig. 8) : if the bulletin is not perfectly exact owing to the fact that the local conditions differ from the general conditions then the diagnosis of the *NivoTest* is not affected. Reciprocally, if the *NivoTest* is misused because the skier carries out a bad observation of the local conditions, the information given by the bulletin is not corrupted.

### **Can the *NivoTest* replace the avalanche bulletin ?**

The *NivoTest* supplements but does not replace the avalanche bulletin because :

- it only concerns a route while the bulletin concerns a region
- it deals with present situation while the bulletin is a forecast
- it takes into account vulnerability while the bulletin does not

### **Is the *NivoTest* useful for professionals ?**

A lot of professionals like to use the *NivoTest* as a teaching support. But the *NivoTest* has some other advantages for professionals :

- it makes possible a rational comparison between two routes
- it can be customized according to the expert knowledge

# Conclusion

The *NivoTest* is not the "ultimate solution" for avalanche safety but it may help a lot. Like all the tools, it has some advantages and some limits :

## Limits of the *NivoTest*

Some mountain guides may think that the *NivoTest* is too much alarmist. In fact, when the *NivoTest* indicates that the situation is dangerous, an experienced mountain guide can often find a safe route. But one must remember that the *NivoTest* is not dedicated to experienced professionals but to inexperienced people.

## Advantages of the *NivoTest*

The *NivoTest* is :

- Safe (designed to help beginners)
- Simple and funny (OK for teenagers)
- Didactic
- Pertinent (gives an actual risk evaluation)
- Self-sufficient (do not need a bulletin)
- Cheap ( $\pm 1$  US \$)

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## Note

The *NivoTest* is based on a statistical analysis of more than 7000 actual cases. It was tested by several mountain guides (by Jean Troillet himself), ski patrol men and scientists, in France, Italy and Switzerland. It have been approved by the Scientists Board of ANENA (Association Nationale pour l'Etude de la Neige et des Avalanches - France).

## The author

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Has been working 21 year long as snow researcher (CEMAGREF, Swiss Federal Institute for Snow and Avalanche Research, *METEORISK*). Designer of several mathematical models for local avalanche forecasting (AvaLog, NivoLog) ; published many scientific papers (ISSW, IGS..).

At present time, manages *METEORISK*, a private research and engineering company dealing with risks due to meteorological events.