Mike Wiegele
Helicopter Skiing

Adventure Tourism Hospitality, Recreation and Sports

Responsibility and Legal Liability

"The Missing Link"

TOPIC:

Avalanche

Danger, Safety, Prevention

Avalanche Forecasting for Large Mountain Areas
– A Protocol for Snow Stability Assessment –

December 4, 2010

The Practitioner

CSGA – ISGA

The Practitioner

By: Mike Wiegele

Avalanche Forecasting for Large Mountain Areas

Minimizing Subjectivity for a more Scientific Approach

Introduction

The Practitioner: Goal and Purpose

The operators and ski guides are practitioners in the field and they need to provide a safe and enjoyable experience to their clients and employees. As such, we as practitioners are faced with responsibilities to adhere to in order to achieve our goal as outlined in the following points. Outlined is an effective avalanche forecasting system for safe travel in the backcountry for avalanche avoidance.

1. The Organization:

The organization and the management team must consist of well structured formally trained, experienced, certified personnel with a safe track record.

2. The Law & Legal Liability

Defining responsibility and duty of care

As a practitioner, you must understand how **The Canadian Court of Law** perceives responsibility and legal liability. The**y** state any person, individual, organization, community or government who promotes and carries out a high risk activity where a person can get either injured or killed, which is **foreseeable or preventable** has a duty of care and is responsible to provide the current highest standard of safety (Cloutier, M., 2000, pg 13). You must adhere to the law. Failure of this is subject to legal scrutiny and potentially prosecution in the event of an accident or loss.

3. Risk Management Plan for Loss Prevention

Safe Travel within Avalanche Terrain

Within the mechanized ski industry, an effective **risk management loss prevention plan** including a rescue plan needs to ensure safe travel within avalanche terrain.

5 Step Checklist

MWHS employs a proven **5 step checklist** system for snow stability rating and avalanche danger forecasting system. This helps in better decision making for safe terrain selection and guiding procedures on a particular slope.

Warnings - Early detection - Prevention

The ability to travel safely in avalanche terrain relies on **early detection** and forewarning of avalanche danger prior to heading into the mountains.

4. Big picture thinking promotes teamwork

If you participate in any kind of team activity, then you know how important it is that the team members see the whole picture, not just their own part. Anytime a person doesn't know how his work fits with that of his teammates, then the whole team is in trouble. The better the grasp team members have of the big picture, the greater their potential to work together as a team (Maxwell, J. C., 2009, pg 7). Essentially, the teammates rely on the team members and their ability to pay attention to detail in regards to the system. Anytime the big picture is misinterpreted and the snowpack is miscalculated, safety can be jeopardized.

5. Human aspects

In your everyday moods, your best can change from one moment to another. A person's thinking and actions are often affected by various types of information that are received, factual or fictitious. When someone is not prepared for the task, their interpretations become based on subjective interpretations or understandings, hence the reason for the 5 step checklist. The human mind can be affected due to: poor sleep or lack of sleep, drug or alcohol consumption, arguments, depression, sickness, fatigue or poor attitude, including one's ego.

6. Decision making Conclusions – The big picture

When forecasting you must look at the big picture and visualize snowpack structure. Engage in focused thinking. Think about and look at each detail. Give full considerations for the application of best practices for a reasonable duty of care within the law.

PLANNING YOUR DAY USING THE '*5 STEP*' CHECKLIST

TEAM WORK

A snow stability and weather forecasting assessment team works very closely together and follows the details from the '**5 Step'** Stability Assessment List as well as from the observations made by the ski guiding group during the day in the field. From this exchange of information, the team is able to learn from each other and answer all questions.

Each person should become familiar with the **'5 Step'** Forecasting System in detail, using the same check list to keep on track in an organized thought process of interpretation in a systematic fashion.

The check list should be followed systematically with focus and consideration being given to each item. Measure what contributing impact and effect to the interactions and relations each item may have on the complex behaviour and stability of the snow pack - either strengthening, deteriorating or keeping its present stage for a prolonged period of time and what changes may occur overnight or in the weeks to come as new gliding layers are developed.

THE FORECASTER SERVES THE TEAM

After completing the assessment you may, with the team, brainstorm the various details that may have an impact to the snow pack layers and conclude on an agreed stability rating, terrain selection and guiding procedure.

The forecaster (a senior lead guide) is someone who is well organized and willing to lead the thought process as well as act/liaise between team members.

The two most important functions and jobs for the forecaster are:

1. To compile information
2. To keep communication flowing of new information fund

The four most important tools are:

1. The planner (forecaster)
2. The 5 Step Checklist
3. The collection of information – communicate to other Lead Guides
4. To fill in the information

If the team doesn't have all the answers – ask who can find the answers. Each person on the team completes his/her task, using the check list and fills out the report form at the end of the day.

The first thing you want to do is go over the check list. If anything has not been reviewed or completed, this is your last chance. If there is a problem, this is the time to fix it.

The check list gives you the basic information as to what you may see/find in the field.

By keeping good records and using the check list, you will always know what you have and have not done, and what you may expect to find in the field.

The check list is an indispensable tool in preparation for the detailed forecaster. Every member of the team will do well to monitor the progress and play of the contributory functions to the snow pack profile. This will ensure your success or failure!

Many of us think we can rely on our memories, but nature works in a very secretive, complex, peculiar and phenomenal way that can be overwhelming in size, volume, speed, direction, and time and requires the attention to many details to arrive at an accurate stability assessment rating. No matter what our knowledge, **nature can change its' rules** mid-stream in seconds, minutes or days, leaving us at her mercy and often one step behind.

Note: Nature is a moving target at best. The 5 Step Checklist came about in our continuous search to be one or two steps closer dealing with such an unpredictable force.

"Every little detail is important"

PLANNER – USING THE *'5 STEP'* CHECKLIST

It is like baking a cake – or any important project – the first thing you do? You plan of course.

Baking a cake requires a plan. Every recipe comes with a detailed, descriptive plan. You are given a list of ingredients and exact quantities and you will need an oven that gives you precise temperatures and time. If you toss aside the recipe, use random amounts of ingredients and bake your cake at whatever temperature you feel like using, you will not win any golden awards.

Nature works in chaos and imperfection – 24 hours a day/7 days a week and longer.

Without a plan you are putting yourself and other at risk and likely end up in an avalanche with potentially fatal consequences.

Using the planner check list from the start of each day is the ground work that prepares you for each step to come in the field.

"The beginning of the day is the most important part of your work"

Today is the beginning from what you learned yesterday and the days before. Open your mind to what you can learn today for tomorrow.

A ski guide is a detective/an investigator.

Keep up the good work and luck will be with you.

Your success comes from preparation **NOT** from half measures and good luck. As the old saying goes, ***"The harder I work the more luck I seem to have".***

Mike Wiegele

Mike Wiegele
Helicopter Skiing

THE 5 STEP CHECKLIST

For Snow Stability Evaluation Ratings and Weather Forecasting Systems
– A Protocol for Snow Stability Assessment –

The 5 Step Checklist approach is a joint venture between ski guides and research professor Bruce Jamieson. The checklist has been an ongoing system formulated and molded by a professional team of MWHS, CSGA, University of Calgary and industry experts, especially designed by Mike Wiegele. The purpose of the checklist is to provide a systematic approach for safe travel in the backcountry of large alpine glaciated mountain areas. We are grateful for all those who have supported this endeavor.

Follow the 5 Step in an organized thought process. Focus on each detail and the effect the main contributory factors may have on the snow pack and mountain range.

The 5 Steps of Information Collection

1. **Daily Weather Data**
2. **Graphs**
3. **Snow Pack Profiles**
4. **Field Observations**
5. **Ski Test/Stability Rating**

Team Work

Act like a detective looking for a criminal. Remember nature works in an overwhelming power in very secretive ways. Investigate and monitor snowpack stability with continuous shear tests and field observations for clues in critical gliding layers – loads – avalanche cycles. Investigate and monitor the snowpack with continuous shear tests – ski tests – precision guiding and field observations – search for clues.

Communicate findings with other guides.

PREVENTION

5 Steps Information Collection

1. **Daily Weather Data**
2. **Graphs**
3. **Snow Pack Profiles**
4. **Field Observations**
5. **Ski Test/Stability Rating**

STEP 1 **DAILY WEATHER DATA COLLECTION (refer to list)** ❒

- ❒ Freezing Level
- ❒ Temperature
- ❒ Humidity
- ❒ Precipitation
- ❒ Cycle Moderate / High
- ❒ In Snow Temperatures
- ❒ Wind Run 24 hr
- ❒ Load Calculation
- ❒ Maximum Wind Gusts
- ❒ Settlement
- ❒ Wind Direction
- ❒ Synopsis

Please see next page for MWHS's Daily Weather Data Sheet

5 STEP

DAILY WEATHER DATA

CARIBOOS NORTH COLUMBIA
(MONASHEES)

		2,000m
		3,000m

Date : _____ Time : _____ Wx Name : _____
Freezing Level: _____ DPS : _____ Sky : ◯
Ceiling : _____ Visibility : _____ Bar P : _____

	Blue River	St. Anne	Roch Peak	Upper Level 9000'		
				PG	Kelowna	Annette
Temperature						
Temp Range max/min						
Humidity						
Hum Range Low/High						
Dew Point						
Precip (HN)				HNW		
H20mm (HNW)				Ann Wrun/30		
Density kg/m³				Equals Load		
HT. Snow (HS)				Anne max Gust		
Settlement				Roch max Gust		
Wind in Knots						
Wind Speed						
Wind Direction						
Wind Run						
Last Lift		Cycle Time	Mod		High	

Forecast Notes: _____

In Snow Temp – down cm

	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360
Date																			

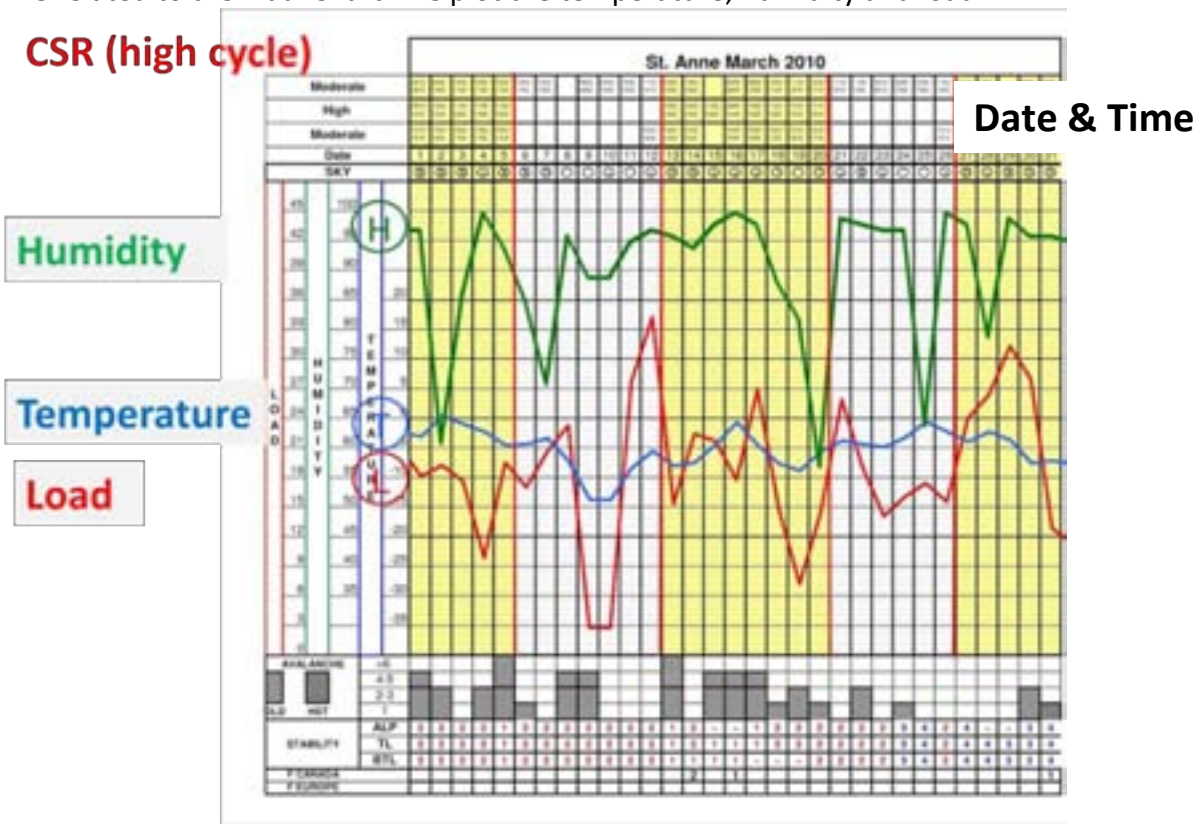
To calculate Load:

24 hour wind run divided by 30. This is added to the precipitation amount (mm measured from the precipitation gauge).

Wind run is the average wind for the hour, added up for 24 hours.

STEP 2 GRAPHS WITH TIDAL TIMES ❒

The maximum inflow of cosmic and solar radiation occurs in the high cycle dated by date and time related to the Tidal Chart. We plot the temperature, humidity and load.



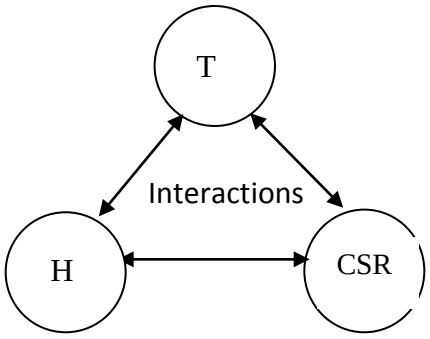
Note: The graph also represents the historical background of the winter season, starting with the first snowfall. It should be noted and kept in mind that storm activities in high alpine terrain including heavy wind and turbulence builds and shapes the snowpack of various depths.

❒ Small
❒ Large
} Trends

❒ Moderate Cycle
❒ High Cycle

Contributing Factors Triangle

Temperature



Humidity

Cosmic Solar Radiation
"Cycle"

Cosmic radiation is made up from charged particles such as protons and Helium that originate from the sun and the wider universe.

Entering the Earth's atmosphere close to the speed of light, these high-energy protons crash and interact with atoms and molecules from gases in the atmosphere. This invisible yet powerful collision can happen many times. In a thousandth of a second, there might be thousands or millions of "secondary" cosmic rays. This is called an "air shower" of cosmic rays.

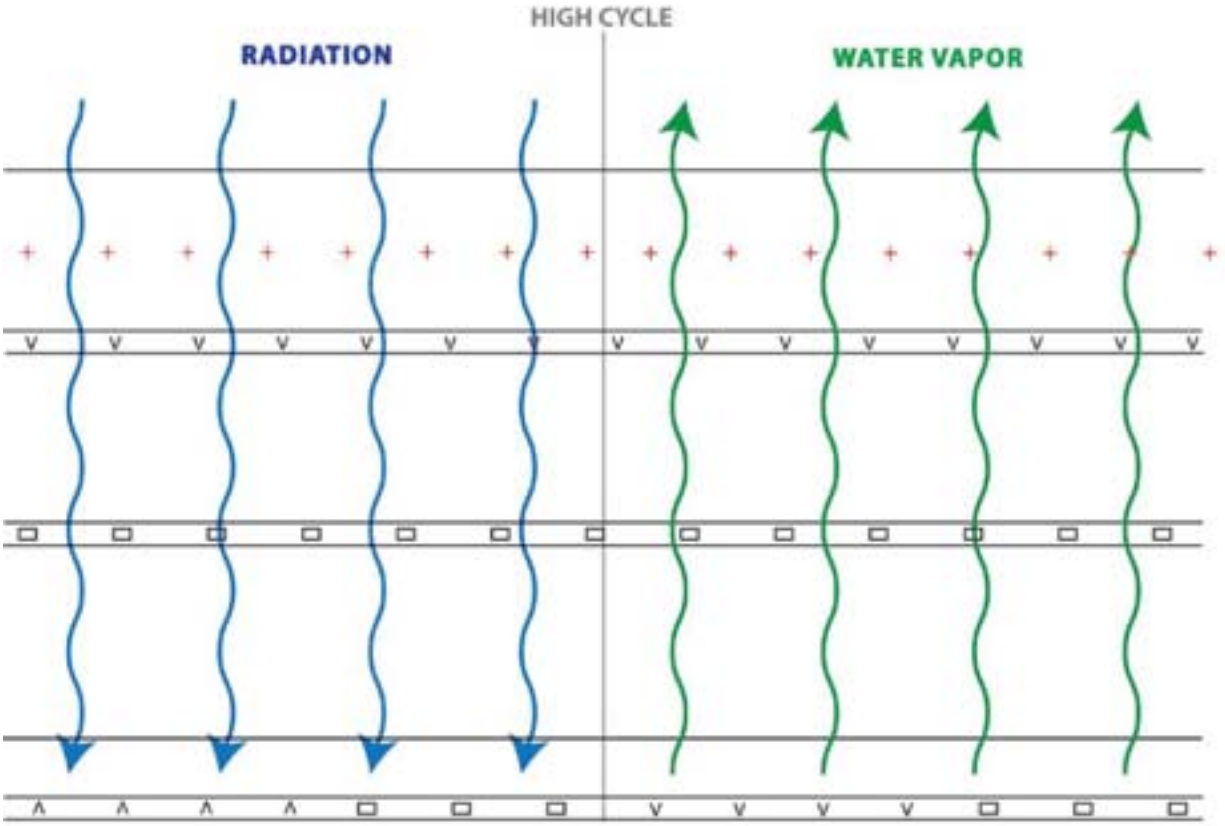
The "air shower" of cosmic rays penetrates deep into the earth's surface, embedding itself into snow, ice and rock.

It is through the process of penetration that the radiation weakens the snowpack. As observed, a snowpack may lift during the atmospheric pressure in high cycle. Essentially radiation enters the snowpack, melting tiny particles of snow and emitting water vapor in the process. The water vapor then seeps back up to the snowpack surface, further deteriorating the strength and stability of the snowpack, thus increasing the probability of snowpack failure and for natural or skier triggered avalanches.

On their own each of the main contributory factors affect snowpack stability and deterioration. However, when all three factors are present, the risk of snowpack failure is at its highest, and the probability of large scale avalanches increases.

Note: We have observed worldwide that most large scale avalanches that run the width and length and those that create new paths in mature forests as well as ice falls and fatalities occur during high cycle. Not giving full consideration to the high cycle may be the missing link in many snow stability assessments.

COSMIC SOLAR RADIATION



A snow layer may lift during atmospheric pressure during high cycle. Snowpack is now saturated with water vapor causing downward tension.

The water vapor then returns to the surface, deteriorating the strength of the snow layers and ice, causing tension and creeping of snowpack - more so in high cycles - increasing the probability of snow pack failure and for natural of skier interference avalanches

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Snowpack profile – shear tests – "if you don't dig you don't know"

It is essential to conduct a thorough snowpack profile, "the pit", by digging a hole from the surface of the snowpack to the ground. Investigate and look for any potential gliding layers existing in the snowpack. Perform a careful assessment and snowpack stability rating, "the shovel shear test" from 1 to 7 with 3 to 5 tests on each gliding layer if in question. This practice is to be carried out on all elevations and exposures. The major, most dangerous gliding layers are depth hoar, surface hoar, hard surfaces, ice, suncrust, wind pressed, rain, melt freeze and upside down powder. Dig to the lowest gliding layer in the snowpack and monitor the stability rating of the known gliding layer existing throughout the winter. Examine snow profile slab hardness by sliding the layer in your **bare hands (gloves off)** and look for space between layers.

SHOVEL SHEAR TEST - *The Avalanche Handbook.*p.133-134. David McClung & Peter Schaerer

The principle objective of the shovel shear test is to locate weak layers and interfaces. Ther shovel shear test is prepared by cutting a vertical column of snow to a depth below suspected weak layers. The shear force is applied by inserting the shovel blade behind the column and pulling in a downslope direction until a failure occurs.

A snow shovel with a blade at least 250 mm wide (not curved) is the principle tool. A saw with a blade length of at least 300 mm is a useful addition, but may be substituted for by the tail of a ski, a section of a collapsible probe, or a string. The test procedure includes:

1. *Cutting the column*: A fresh vertical wall is exposed in a snow profile observation pit and soft snow at the surface is removed. The cross section of the column – 0.3 to 0.4 m in the downslope direction and about 0.25 m across the slope – is marked on the new surface. The cross section is slightly trapezoidal, with the front wider than the back. A trench, wide enough to allow the insertion of the saw for cutting the back side, is dug at the side of the column. A narrow cut (usually conveniently triangular in shape) is made at the other side of the column. The backside of the column is cut vertically and the cutting tool (saw) left at the bottom for depth identification. The backcut should not be deeper than about 0.7 m and it should end in medium hard or hard snow if possible. (*Note*: A longer column could fail in bending at its base, causing weak layers near the surface to be over-looked.)

2. *Application of force*: The shovel is inserted into the backcut. A pull force is applied in the downslope direction by holding the shovel handle with both hands.

3. *Locating a weak layer*: The column shears in a smooth plane when a weakness exists. When no weak layers are present, the column usually breaks obliquely at the lower

end of the backcut. The observer marks the location of the weak layer at the rear wall, then measures the distance from the snow surface or the ground. After the test, the type and size of snow grains in the shear plane can be determined. Because grains responsible for weaknesses (for example, surface hoar) often stick to the underside of the sheared-off column, it is advantageous to turn the column upside down to inspect the grains.

4. *Repetition*: A second, lower column is tested by repeating steps 1 to 3 when weak layers are suspected below the first column.

5. *Recording shear strength*: The magnitude of the force required to cause a failure is estimated and recorded…The strength may be estimated when the column is tested for the presence of weak layers. However, a separate test on a previously identified weak layer (the column should not be longer than the shovel blade) is more reliable.

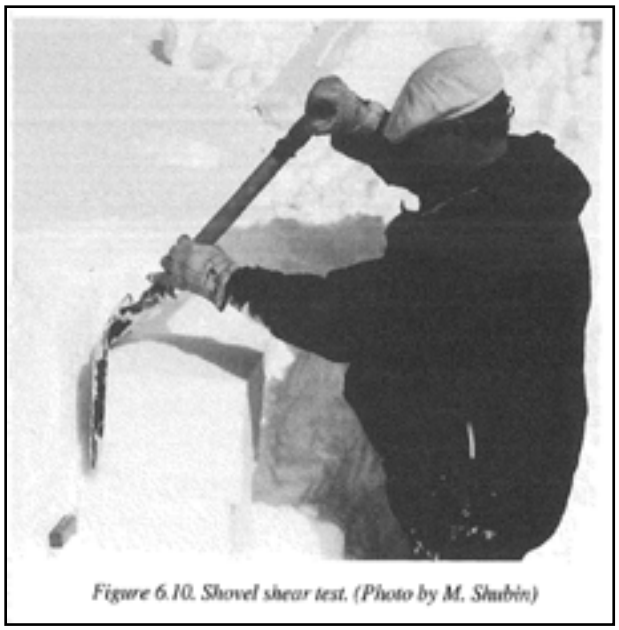


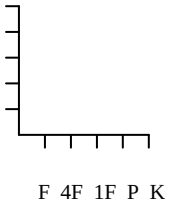
Figure 6.10. Shovel shear test. (Photo by M. Shubin)

Detective – Investigate

QUESTION: How much snow on a gliding layer? Load (weight)

3.1. Alpine

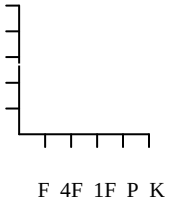
❑ ALP



❑ New Precipitation _____
❑ Storm Snow _____
❑ Elevations _____ ❑ Exposure_____
❑ Description of Gliding Layer _____
❑ Depth of Gliding Layer _____
❑ Critical Load on Gliding Layer _____
❑ Shears _____

3.2. Tree Line

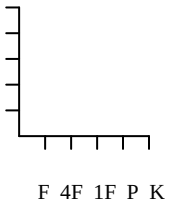
❑ TL



❑ New Precipitation _____
❑ Storm Snow_____
❑ Elevations _____ ❑ Exposure_____
❑ Description of Gliding Layer _____
❑ Depth of Gliding Layer _____
❑ Critical Load on Gliding Layer _____
❑ Shears _____

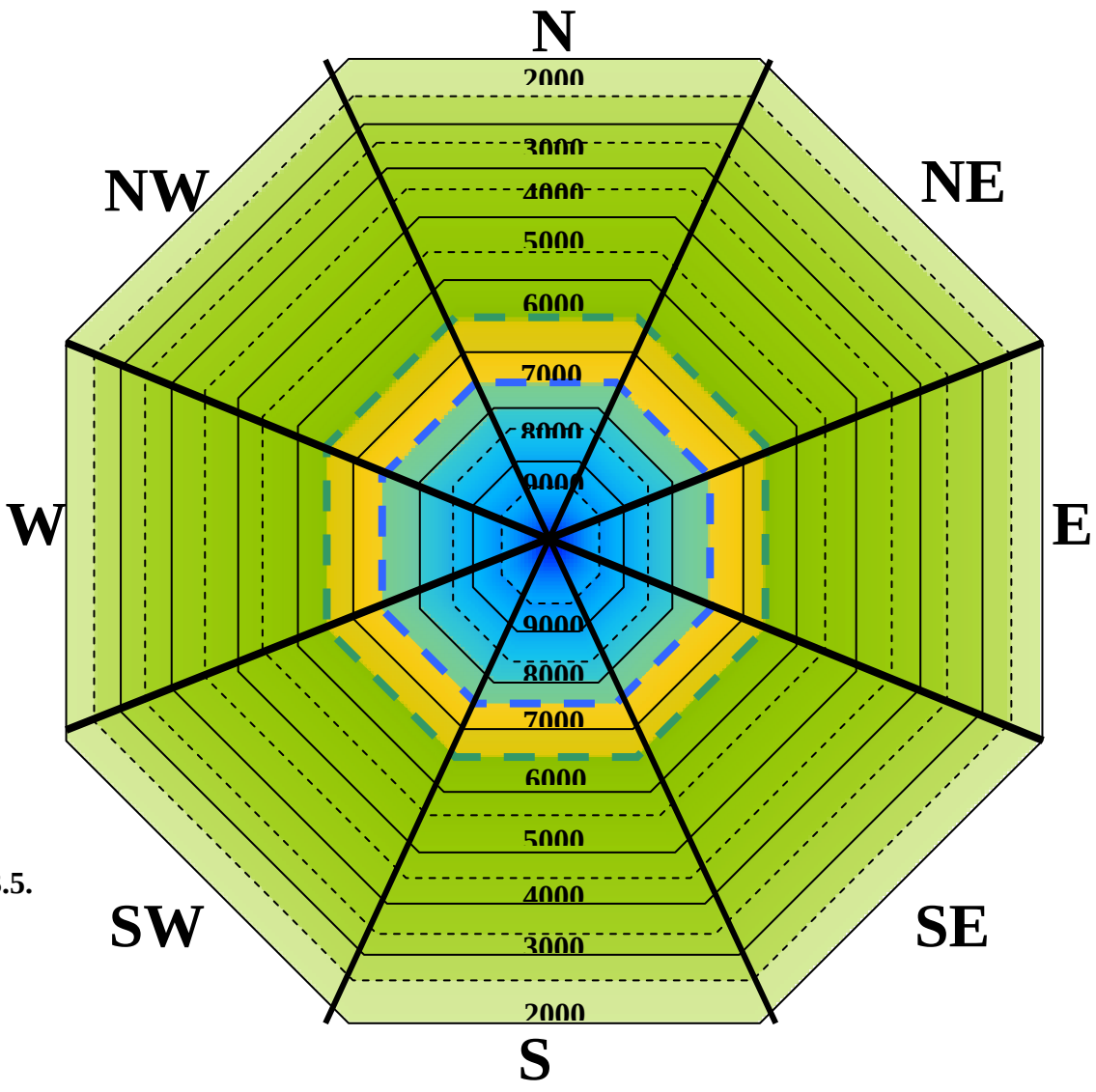
3.2. Below Tree Line

❑ TL



❑ New Precipitation _____
❑ Storm Snow_____
❑ Elevations _____ ❑ Exposure_____
❑ Description of Gliding Layer _____
❑ Depth of Gliding Layer _____
❑ Critical Load on Gliding Layer _____
❑ Shears _____

3.4. Snowpack Profile in Elevation, Exposure – Zones, Ranges



3.5.

- ❒ New Precipitation
- ❒ Storm/Snow
- ❒ Snow Transport by Wind
- ❒ Sun Effect
- ❒ SHEARS

Note: Avalanche failure in elevations

Wind Direction and Speed

Light ❒	Moderate ❒	Strong ❒	Gust ❒
< 20 km	20 – 40 km	40 km >	

STEP 4 FIELD OBSERVATIONS ❒

Field Observations – A thorough field observation notes any natural avalanche activities and how they have been triggered by noting: exposures – elevation – depth of crown fracture – distance of travel – and size of avalanches. This alerts the practitioner of early warnings of danger of any other potential avalanche failure that may occur on similar slopes.

4.1 Natural Trigger

- ❒ Natural Avalanches 24 hrs, 48 hrs or longer - estimate
- ❒ Ice Fall
- ❒ Cornice Fall
- ❒ Rock Fall
- ❒ Tree Fall
- ❒ Mushrooms

Observations

- ❒ Elevation – exposure
- ❒ Foot Penetration
- ❒ Ski Penetration
- ❒ Snow Surface
  Wind Effected
  Snow Drifts – Pockets
  Slab Forming - Alpine

STEP 5 SHEAR TEST AND OBSERVATIONS ❒

Ski Tests and Slope Stability Rating. Ski tests on slopes are to verify the snow stability forecast rating – to be carried out during the day. Tests are to be done on safe steep slopes that can produce an avalanche no larger than class 1-1.5 in size while avoiding terrain traps.

5.1 Primary test for consideration

- ❒ 1. Natural occurrence – field observations from point 4, check for natural activities
- ❒ 2. Ski Cuts Test - fracturing/slide cracks on test slopes; each turn is a test
- ❒ 3. Shovel Shear Tests by Practitioner
- ❒ 4. Sympathetic trigger by – helicopter – skiers descent
- ❒ 5. Whumphs – slope settlement by skiers weight – sudden collapse
- ❒ 6. Hand Shear Test – Results – Densities – Mushroom Tests – Examine gliding layer
- ❒ 7. Slab density and hardness test with fist and finger (gloves off)

5.2 Secondary Test

- ❒ 1. Rutschblock (R.B.)
- ❒ 2. Compression
- ❒ 3. Explosives

} Can be unreliable and inconsistent in certain situations. The use of shovel sheer tests are recommended.

Note: Quality of Shear Test - Sudden Plainar (SP/RP)

- ❒ Clean Shear – Fast?
- ❒ Uneven Break
- ❒ No Shear

5.3 Classification Shear Test Rating from 1 – 7 (using shovel sheer test)

	Very Easy	Easy	Easy Moderate	Moderate	Moderate Hard	Hard	Very Hard
Symbol	**VE**	**E**	**EM**	**M**	**MH**	**H**	**VH**
	(1)	2	3	(4)	5	6	(7)

NOTE: When making a shear test & rating:
To rate a shear test as **"very hard"** you have to use strong resistance and pull very hard. If you are not pulling hard then it is **"moderate".** When cutting the back off the block and it pops out with little effort it is **"very easy".** Look at the sheared surface and check to see if quality of shears is clean, uneven, or hard. Examine gliding layer. Shovel shear tests is most reliable in comparison to other tests. Shovel shear on regular route class 1 avalanche potential only or prior to entering class 2, 3, 4 & 5. Make 3 to 5 tests if not sure of type of shear especially when stability rated from 4 down and risk is higher. On test 4 and 5, apply uninterrupted focus on final rating decision. **Recent natural avalanches overrule all other tests.**

Field Observations that Override Stability Rating :

1. Avalanche activity take precedence over results of stab
2. Snow Pack Characteristics with unfavourable structure.
3. Whumpfs indicate a space in the snowpack that is settling. Thus causing an avalanche given the right terrain. Resulting in decreased stability
4. Isolated natural avalanches may occur even when stability for the area is good. (For regional and larger forecast areas)

Shovel Test Considerations:

1. Quality of Shear : Clean Shear or Uneven Surface / Break
2. Gliding Layer Types : Persistent week layers
3. Layer Hardness / Density
4. Location
5. Aspect
6. Elevation

Definitions:

1. **Increased Shovel Shear Resistance:** use for qualifying the stability rating from 1 - 7. (If you are not pulling hard, it is not a hard shear)
2. **Natural avalanches:** Avalanches triggered by weather events such as snowfall, rain, wind, temperature changes etc.
3. **Heavy Load:** A cornice fall, a compact group of people, a snowmobile or explosives.
4. **Light Load:** A single person or a small cornice fall.
5. **Isolated terrain features:** Extreme terrain; steep convex rolls; localized dispersed areas (pockets) without readily specifiable characteristics.
6. **Specific terrain features:** Lee slopes, sun exposed aspects.
7. **Certain snow pack characteristics:** Shallow snow pack with facetted grains, surface hoar, crust, persistent weaknesses & Identified weaknesses

FAILURE DESCRIPTION FOR SHOVEL SHEAR TEST

		Field Observations		
Stability Rating	**Comment on Snow Stability**	**Natural Avalanches :** (Excluding avalanches triggered by icefall, cornice, rock fall, ect.)	**Triggered Avalanches** (Including avalanches triggered by icefall, cornice, rock fall, ect.)	**Shovel Test**
① Very Poor	Snow pack is unstable	Widespread Natural & Sympathetic avalanches	Widespread triggering of avalanches by light loads	**Very** Easy Shears
② Poor	Snow pack is unstable	Natural Avalanches ; in areas with specific terrain features or certain snowpack characteristics	Avalanches maybe triggered by light loads in MANY areas with sufficiently steep slopes	**Easy** Shears
③ Poor-Fair	Snowpack is variable (natural activity has slowed)	Areas with specific terrain features (Steep bowl, lee load aspects + convex roles) and with specific snowpack characteristics can produce Natural avalanches	Skier Triggering possible with light loads	**Easy** Moderate Shears
④ Fair	Snowpack varies considerably with terrain often resulting in local unstable areas	Very isolated natural activity in specific terrain features such as steep and unsupported slopes	Skier Triggering remains possible	**Moderate** Shears
⑤ Fair-Good	Snowpack is mostly stable	Natural avalanches possible only from large loads i.e. ice falls and large cornices	Skier triggering unlikely but possible in isolated areas with specific terrain features or with heavy loads	**Moderate** / Hard Shears
⑥ Good	Snowpack is stable	Natural Activity Unlikely	Avalanches may be triggered by heavy loads in isolated terrain features	**Hard** Shears (Must Pull Hard)
⑦ Very Good	Very Stable Snowpack	No Natural Avalanches Expected	No Results from heavy loads such as large cornice falls or heavy loads in isolated terrain features	**Very Hard** Shears (Or No Results)

NOTE: Increased Shovel Shear Resistance

Shovel Shear Test	VE	E	EM	M	MH	H	VH
	1	**2**	**3**	4	**5**	**6**	7
Stability Rating	VP	P	P-F	F	F-G	G	V-G

5.4. Lead Guides Summary - PM Daily Report List from Date: ❒

- ❒ Area Runs Skied
- ❒ Observation
- ❒ Stability Status
- ❒ Snow Pack Profile
- ❒ Concerns

ALP 1 – 3 – 4 – 6 – 7

TL 1 – 3 – 4 – 6 – 7

BTL 1 – 3 – 4 – 6 – 7

- ❒ Elevations
- ❒ Exposure
- ❒ Locations
- ❒ Other

5.5. Lead Guide AM Discussions – Comments on Safety

- ❒ Stability Analysis – Information Exchange_____
- ❒ Avalanche Research _____
- ❒ C.A.A.Exchange_____
- ❒ Useful information (List) of Field Observations _____
- ❒ Others _____
- ❒ Concerns _____

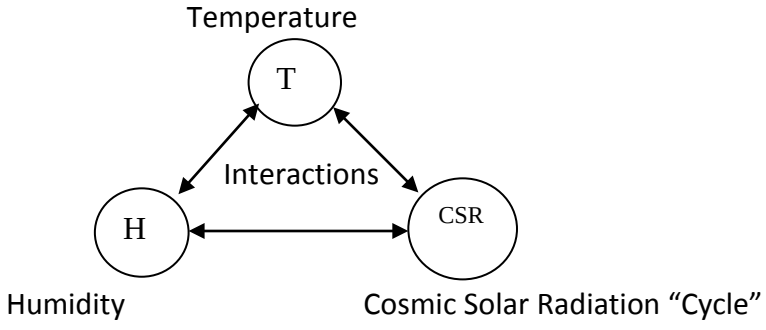
5.6. Stability Rating for Avalanche Forecast

Is based on the following:

5.7. Daily weather data. Details - Rapid Change. **"Step 1"**

5.8. Contributory factors **"Step 2"**

Graph Cycle - **Sudden Changes** (refer to graph on p.9)



5.9. Snowpack profile Shear Tests. Quality? Results? "Step 3"
Date of Last Profile _____ Location _____

- Search for gliding layers present.

- Observe the strength, deterioration or dormant condition of the snowpack by continuous monitoring and testing. Be aware of prolonged and delayed action.

5.1.1. Critical load of precipitation – wind calculations

- On top of gliding layer (slab) 30-50 cm up – from low density to slab forming to pencil hardness.

5.1.2. Field observations "Step 4"

- observe for wind transported snow of uneven deposits from 50 cm to 2 m.
- of recent natural avalanche activities occurring – in **elevations, exposure,** location and steepness in ALP – TL - BTL. Running path – deposits
- wide spread avalanche activities.
- isolated activity: search for isolated, potential avalanche areas – type of slope more likely to fail. Investigate why isolated activity failure occurred.
- Be aware that for the majority of the winter season, the alpine terrain is not visible and inaccessible due to poor weather.

5.1.3. Ski test results "Step 5"

On small steep roles 28º up mushrooms. Test space in class 1 potential only (on regular routes). Not on larger avalanche potential slopes.

5.1.4. Ski guide daily field observation report

Stability Rating

Shovel Shear Test	VE	E	EM	M	MH	H	VH
	(1)	**2**	**3**	(4)	**5**	**6**	(7)
Stability Rating	VP	P	P-F	F	F-G	G	V-G

PUTTING KNOWLEDGE INTO PRACTICE

Stability Rating – Concluding all possible findings of information that is to assist the practitioner in decision making for safe travel in avalanche terrain.

Summary – decision making

Analyze all pertinent information of the 5 step avalanche danger forecasting system – stability rating all avalanche potential slopes elevations – exposures - locations. Analysis and decision making is to be completed in an organized, systematic approach of thought process and applied to terrain selection and guiding procedures.

1. Terrain Selection: Stability Rating – Elevations – Exposures – Locations

Question: What is the stability? Conclusion? Decision?

ALP (7,500 – 11,600 ft)				
N	S	E	W	
				Storm
				Old
				Deep

TL (6,500 – 7,500 ft)				
N	S	E	W	
				Storm
				Old
				Deep

BTL (2,230 – 6,500 ft)				
N	S	E	W	
				Storm
				Old
				Deep

1.1 Terrain Selection

❒ ***Regular Route in very easy (VE) and easy (E) shear test with critical load***

Questions to be asked:

1. Where Are the Weaknesses?
2. What is a Critical Load? 30cm Up plus Overload? Wind transported snow? Variable depths? Wind activity 12 hrs – 24 hrs
3. What impact or effect are the Contributory Players having on snowpack deterioration, strengthening or prolonged present stage?
4. What is the potential outcome?
5. Slab formation from storm snow or deep slab effect?
6. What type of Terrain – Elevations, Exposures, Shape, and Steepness?
7. Is there a large snow cornice above – potential for avalanche slopes or mushroom rocks

1.2 "Common Terrain Traps"

1. Cliffs – rock or ice
2. Trees
3. Gullies
4. Unsupported Slopes – type of slopes more likely to fail
5. Exposure to Higher Opposing Mountains
6. Avalanches Crossing Skiable Terrain from alpine in or through forest

1.3 Guiding Procedures and Considerations

7. What are the Guiding Procedures – Practices
8. Safe favorable routes?

9. Are there any terrain traps – cliffs, trees, gullies – near skiing route?
10. Be aware of skiers skiing beyond safe boundaries given, unaware or ignorant of back country mountain hazards and dangers.
11. Be aware of individual skiers purposely skiing beyond given boundaries – influencing other skiers in the group and skiing out of boundaries is a constant threat.
12. Terrain selection is based on stability ratings of potential avalanches and consequent dangers.
13. Practice precise guiding procedures when a gliding layer is present in snow pack with critical load on steep terrain. Be sure to position yourself in a safe location.

2. Field Decision Making

Review all "5 Steps" from the Beginning to assure considerations are given to each point!!!

- ❒ Zone
- ❒ Mountain
- ❒ Skiing Descent Route
- ❒ Type of Skiing Route
- ❒ Reconfirm Stability in Field in Elevations – exposures, area
- ❒ Communicate with Other Lead Guides
- ❒ Report All Field Activity & Observations

Communication

2.1. Communication is a **mandatory** responsibility of all Lead Guides – after storms, after first and second runs – VP to P stability. Must reconfirm stability.

2.2. The exchange of new findings and observations is a critical component of safe guiding.

2.3. It is essential that any results of ski cuts, slope tests, profile observations, weather anomalies (changes) and observed activity be shared with all Guides immediately when it occurs.

2.4. Discuss confidence or suspicion of snow stability in unfavorable slopes or with major gliding layers especially when avalanche potential exceeds class 2 in size.

Always call on fly by with other Guides

Substantiate your good or bad feelings with information and facts
Substantiate your confidence with factual measured information, not perception

Do not venture out into avalanche terrain unless the slope is assessed using 5 steps system

Accreditation:

Thank you to all those people worldwide who have dedicated their entire life to promote and teach mountain safety as well as those who have lost their lives while doing it. All those people left a lasting impression that inspired me for continuous development as well as fine tune the "5 step" avalanche forecasting system. Our mission, purpose and goal continue to be to save lives.

Special Mention to the following:
Peter Shearer, Melchior Schild, Binx Sandhal, Peter Lev, Monti Atwater, Willi Pfisterer, Ron Perla, Dave McClung, Dave Hamre, Ono Wieringer, Liam Fitzgerald, Raymond Maier, Bill Harrison, Juri Chrisjanson, Bruce Jamison, Chris Stetham, Claire Isrealson, Don Vockeroth, Hans Jorg Schweitzer, Hans Jorg Etterer, Colin Johnston, Bob Sayer, Our entire ski guiding staff, Walter Strolz, Norbert Wiegele, Martin Heuberger, Manfred Augerer.
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Legal Council: Gordon Dixon, Robert Kennedy, Jim Miles
Expert Consultants: Brent Harley, as well as many other professionals including authors of literature on the topic of Safe Mountain travel.

Books Referenced:
Cloutier, R. (2000). *Legal Liability and Risk Management in Adventure Tourism*. BC. Bhudak Consultants Ltd.
Herman, R. & Goldberg, R. (1979). *Sun, Weather and Climate*. MI. Grand River Books.
Maxwell, J.C. (2009). *How Successful People Think: Change your thinking, change your life*. NY. Center Street Hachette Book Company.
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Disclaimer:
This paper is for experts only.

Presentation to Accompany:

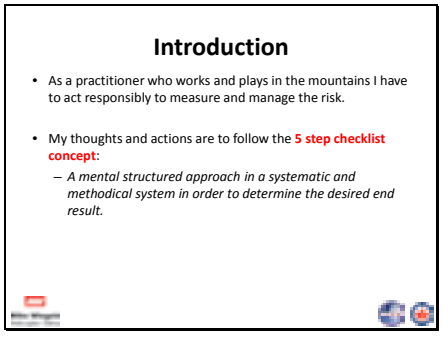
Adventure Tourism Hospitality, Recreation and Sports

Avalanche Forecasting for Large Mountain Areas

Presented by: Mike Wiegele
Assisted by: Bill Mark

Slide 1

Slide 2



—I am an adventure practitioner who works and plays in the mountains among the ice and snow.

—As such, I have to act responsibly to measure and manage the risk and dangers to a person.

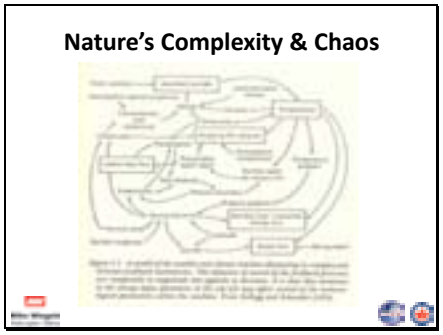
—My thoughts and actions are to follow the 5 step checklist concept.

—A mental structured approach in a systematic and methodical system in order to determine the end result and how this may most efficiently be attained.

Presented to:

IKAR ISSW CAA

Slide 3



MASTERY

The greater man's "MASTERY" of nature,

The more essential is his understanding of causes

In order that mastery be disciplined to obedience.

~Harvey Brooks

"Modern science continues to refine the approach to snow science;

atmospheric regiments by peeling away mysterious natures phenomenon of human understanding of how nature actually works".

Slide 4

- **Our organization:**
  consists of experts in the field that have the highest current international safety standards
- **The Law and legal liability:**

  We must adhere to the Canadian law
  We are responsible for people when we take them on high risk activities
  It is our Duty of Care to provide the highest current safety standard

Slide 5

Our Goal is to provide a safe and enjoyable experience for our guests and employees.

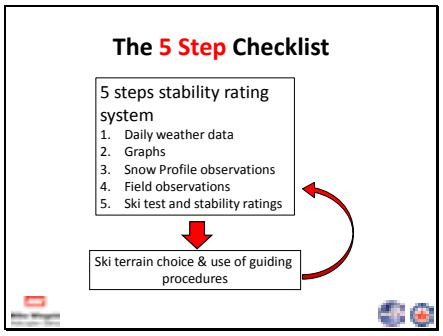
Slide 6

This allows us to choose terrain that is appropriate for the current avalanche conditions, in this slide you can see avalanche terrain and old avalanches around our skiing route down safe terrain.

3 Key Components:

- Forecast Systems
- Early Warnings
- Prevention – selection of mountain route and guiding procedures

Slide 7

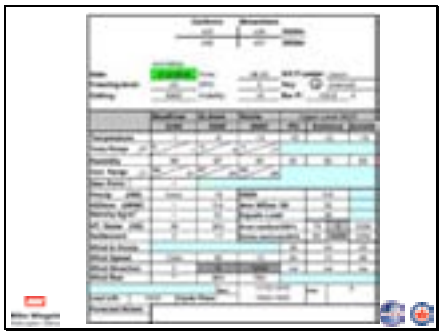


Now I want to talk about the 5 step stability rating process
We use this structured organised 5 step approach to make skiing terrain choices
Safe travel between all mountain hazards

Slide 8

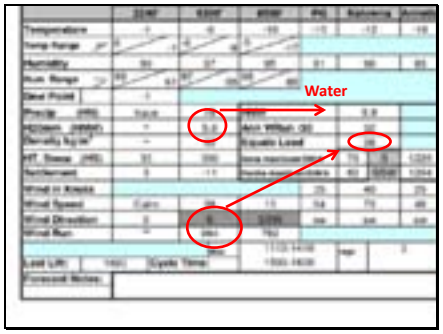
The first of the 5 steps is collecting Daily weather data.

Slide 9



We collect and review this data and analyse every detail

Slide 10

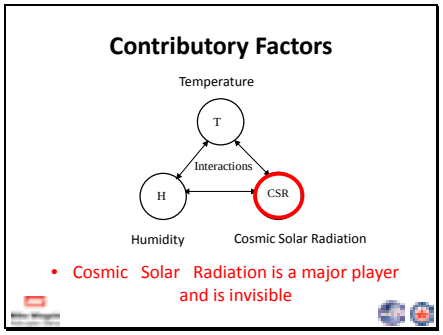


—We look at wind run, which is the average wind for the last 24 hours

—Load is calculated by dividing the wind run by 30 and adding the mm of precipitation

—to come up with a calculation of potential load on the leeward slopes (avalanche slopes)

Slide 11



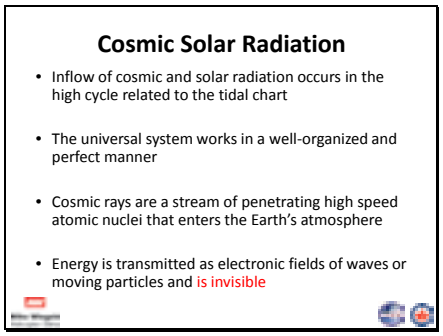
—Stability ratings and forecast are based on these 3 Key contributory factors

—All can work together or act individually.

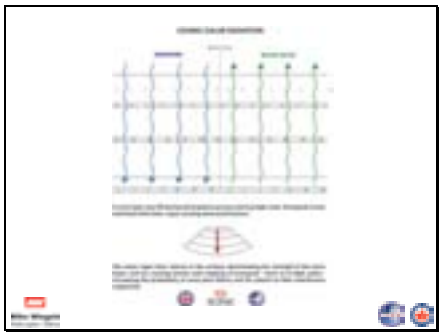
(click) Cosmic Solar Radiation is a major player

—Cosmic Solar Radiation is a major player and is invisible

Slide 12



Slide 13

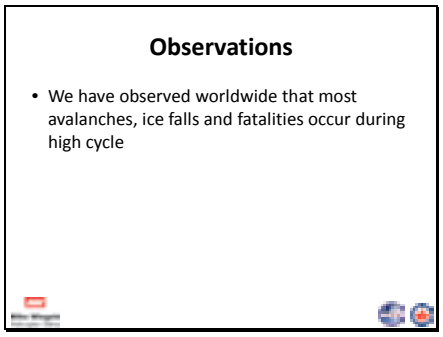


A snow layer may lift during atmospheric pressure during high cycle. Snowpack is now saturated with water vapor causing downward tension.

The water vapor then returns to the surface, deteriorating the strength of the snow layers and ice, causing tension and creeping of snowpack - more so in high cycles
- increasing the probability of snow pack failure and for natural or skier triggered avalanches

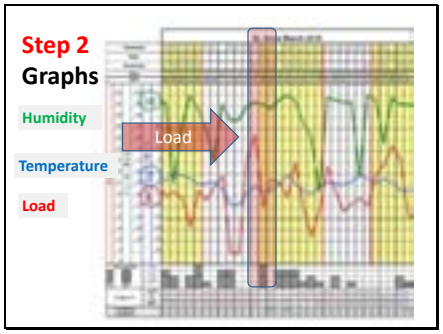
snow crystals turn into water like the run of the river occurring more so in high cycle

Slide 14



We have observed worldwide that most avalanches, ice falls and fatalities occur during high cycle

Slide 15

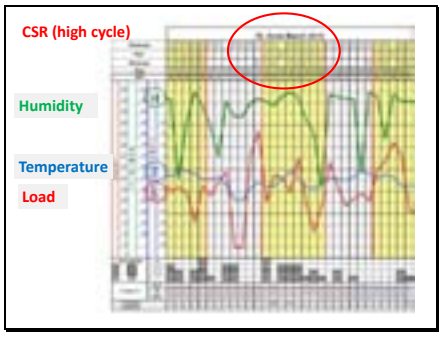


We also plot this on a monthly basis. On this we plot the temperature, humidity and load

If you look at the graph here you can see the load was very high as there was extreme wind that day that cause a spike in the load calculation.

You will also notice that both the temperature and humidity are on the rise, and it is the day before high CSR cycle

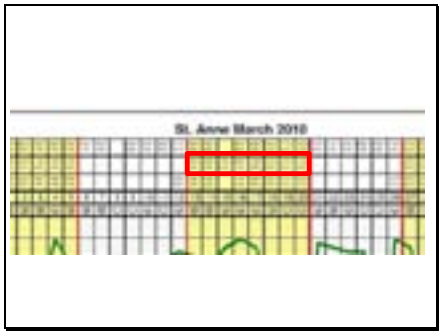
Slide 16



This chart demonstrate the importance of date and time of high cycle on that day

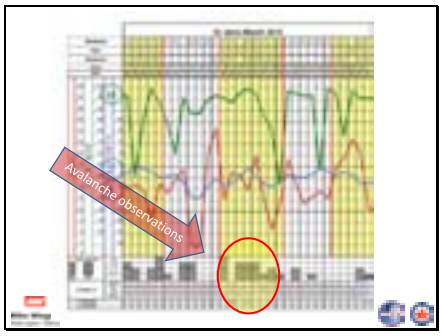
(FLIP TO NEXT SLIDE FOR CLOSE UP)

Slide 17



As you can see better on this close up

Slide 18

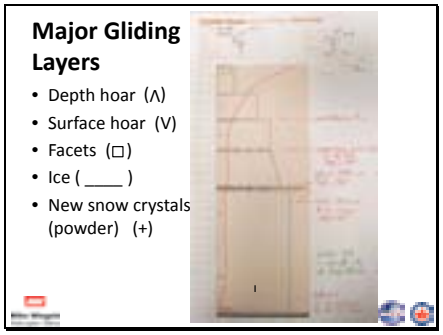


Avalanche occurrences are also plotted on this chart.

Slide 19

Step 3 is Snow pack profiles
I believe that if you don't dig, you don't know.

Slide 20



The major gliding layers you might find in a profile are:
Depth hoar
Surface hoar (V)
Facets ( )
Ice (____)
New snow crystals
(powder) (+)

At this moment I am out in the field, I have to ask myself a question, to make a calculated decision:

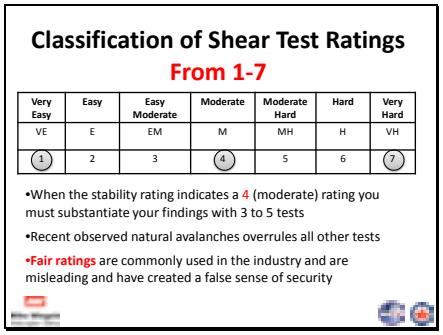
- what are the gliding layers
- What is the Shear factor
- What is the load and
- what are the contributory factors.

Don't go onto the slope by the seat of your pants

Slide 21

I find that the shovel shear test is the best tool to find and rate weak layers and their probability on sliding

Slide 22



Here is the rating for shovel shear test on a 1 to 7 scale.

- When the stability rating indicates a 4 (moderate) rating you must substantiate your findings with 3 to 5 tests
- Recent observed natural avalanches overrules all other tests
- **Fair ratings** are commonly used in the industry and are misleading and have created a false sense of security

Slide 23

The 4th step of the 5 step forecast is field observations
We observe and report any avalanches or other signs of instability, such as whumpfs, cracking etc

Duddly Mountain in high cycle: Natural with 3 to 5 metre crown

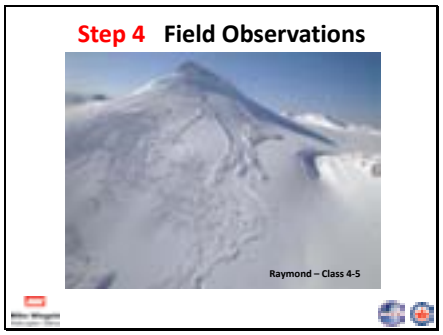
Slide 24

All exposures N-E-W-S natural Tiger Stripes Class 3

Slide 25

Smoke Creek 7600’ 2530 Metre
An Alpine deep scab instability.
High Cycle Class 4-5
3-4m crown, 1km wide

Slide 26



High Cycle Class 4-5
Natural avalanche: 3-5 metre / crown – snow cornice release

Slide 27

The same avalanche, full extent, 3600’ or 1200 m vertical

Our job is to investigate, analyze and rationalize why the avalanche occurred

Slide 28

Finally we rate the stability, and use ski tests to verify this in the field if we chose to go into avalanche terrain.
We use a scale from 1 to 7 for stability.

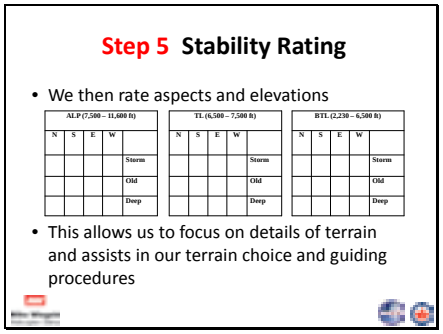
Listen Feel – Look - Analyse – "Think" when you are in the field
(Click)**Every turn is a ski test**

Slide 29

We rate the stability, and use ski tests to verify this in the field if we chose to go into avalanche terrain. We rate this daily on a white board

We review every slope, elevation and exposure in addition to each profile and observation.

Slide 30

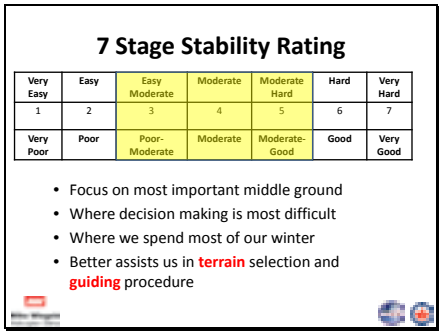


—Focus on all information received

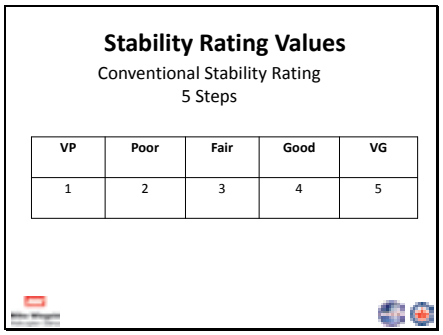
—Start from the beginning and allow time to check'

—Think, verify and substantiate your decisions.

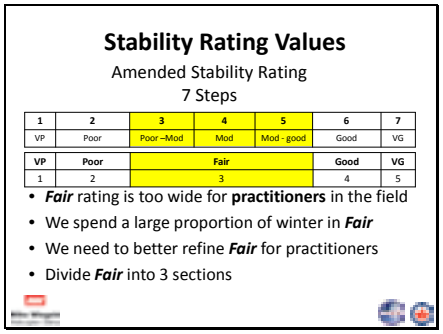
Slide 31



Slide 32



Slide 33



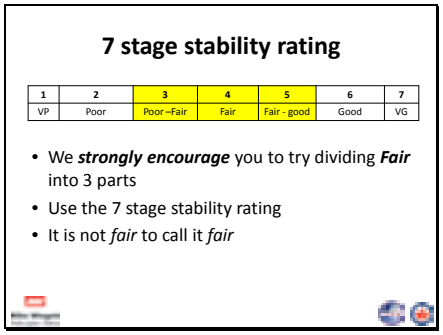
An expert must have the skill to differentiate between 1 and 7 while making a profile assessment

Fair rating is too wide for **practitioners** in the field
Spend a large proportion of winter in ***Fair***

We need to better refine ***Fair*** for practitioners
Divide ***Fair*** into 3 sections

This is an illustration of comparisons

Slide 34



Slide 35

The 5 Step Checklist Method gives us a guideline to assess snow stability and avalanche potential

By using the 5 step system every day, we can maintain consistent and better terrain choices have fun and be safe

Somewhere out there is a perfect slope for you

Be safe and have fun!

Thank you

Slide 36