THE WAX & CARE COMPANY

Tech Manual Nordic 2010/2011

Racing-Service

To learn more, please visit www.TokoUS.com

Introduction
Waxing at the World Cup level is a pretty specific science. National Teams have enjoyed enormous success with Toko, but naturally expect us to be close-lipped about it so as not to lose their advantage. This doesn't just mean regarding what brand is being used, but more importantly, what waxes they are using where and when. For this reason, we don't talk much about who is using what internationally. We can tell you though that virtually every national team uses Toko. Many national teams are involved in the development process of the waxes as they are first introduced on the World Cup level before they hit the retail shelves. If our waxes are popular among National teams and successful like they were during past seasons, we can be very confident in releasing them to the retail market.

This is Toko's last step in evaluating new products. If they are readily accepted by National team technicians and used in big events, then they get the final green light to become mass produced and be sold in the retail stores. **Toko does not have "race stock wax". The products used on the World Cup are identical to those sold in the shops, except for the occasional test product that, if really good, will hit the shops the following year. This has always been Toko's procedure.**

When Jakob Tobler founded Toko in 1916 (first as the Tobler Company which a bit later became Toko), he had no way of imagining what a rapid development lay ahead in ski sport. The tricks and secrets of waxing - together with expert knowledge - over a period of many years of research and development permitted the creation of a wide range of Toko products. For decades, the users of the Toko line could depend on the latest experiences from professional racing continuously being applied in the development of Toko products. What happens in the fringe between snow and ski today is a research subject for entire scientific institutions. The conversion of this knowledge to speed, gliding comfort, and care for ski bases is Toko's very special expertise.

Toko Innovation
Toko has been setting the Ski Wax and Tool world on fire the past 25 years. Toko has quietly pioneered virtually all of the recent wax technology breakthroughs and innovations that have occurred in recent history. Some examples of this include the following: Toko was the first to develop a hand structure tool that allows the waxer to apply an offset structure which makes skis glide faster in moist snow - **Toko Structurite**. Toko was the first company to develop and offer a fluorocarbon in block form (Streamline). This product line is carried on by the **JetStream Bloc** waxes. **Toko developed the first fluorinated glide waxes.** This tradition continues with **the Dibloc HF and LF** product lines. Toko is still the only company to offer a Copper Brush. The **Toko Copper Brush** is far softer than any other metal brush on the market yielding fewer (or no) hairs raised as a result of brushing, but is still aggressive enough to get the job requiring a metal brush done properly. **Toko GelClean** was the first product of its kind. Other companies have since copied, but it still sets the standard. Toko was the first company to recognize that Fluorinated kick waxes were NOT the way to go in general. Five years ago, Toko introduced the **Carbon Grip line** which brought general ridicule from other wax companies representatives. Now, virtually every company has followed Toko's lead and has seen how non-fluorinated kick waxes have wider ranges. Toko was the first company to develop an iron specifically for the purpose of waxing skis. This concept has been greatly built on and the **Toko T14 Digital and T8 Wax Irons** are the newest Toko offering. The **Toko Scraper Sharpener** was the first hand tool developed to sharpen scrapers. It has since then been anatomically shaped and been made more affordable. **Toko HF and LF Molybdenum** is an industry changing product. This product is used as a base layer by the whole elite ski world virtually every time a pair of skis is glide waxed for a race. Toko Molybdenum is simply a great base layer that increases the durability of whatever gets put on top of it. It also improves the properties of the ski base. Our competitors have been saying for years that Molybdenum and Graphite are the same, or even that Graphite is better. Now, 9 years after Toko's introduction of Molybdenum glide waxes, our biggest competitors are coming out with some new exciting breakthroughs: Molybdenum glide waxes**! Other companies have Molybdenum products, but after years of talking Toko and Moly down, they have chosen not to use the name Molybdenum in describing their product. "A top secret new lubricant" sounds much better and does not give us credit for their product**. **Toko Irox and Irox Fluoro** make skiing far more fun for the working (time challenged) skier who likes to ski on fast skis, but doesn't want to take the time to wax them before every ski. Irox Fluoro also is a great product for junior and youth program coaches who wax dozens of skis before a race. It is affordable, easy and quick to put on, and performs extremely well. This is a unique product to the industry that is bound to be copied soon as it is being very well received. **Red Creek Roto Brushes** (distributed under the Toko name) were THE Roto Brush Pioneers. Red Creek uses the best materials and tests many new possible products every season. Red Creek invented Roto Brushes and continues to set the standard. From our experience, **Toko Plexiscrapers** are made from a denser plexiglass than our competitors and hold a sharp edge for a relatively long time. The **Toko Thermo Bag** is a widely used product on the World Cup. Toko was the first company to come out with a finished product of this kind (a portable digitally controlled hot box).

Outside of innovative products, new raw materials, and fast, durable, well performing waxes, Toko has also greatly influenced the industry with its idea of what a wax line should consist of. The Carbon Gripwax line consists of a base wax plus 7 temperature/snow specific hard waxes and a base klister and 4 temperature/snow specific klisters. **This simplicity requires not only less investment on the users end, but also allows the user to become extremely familiar with each wax and its attributes**. The glide wax line has similar strengths: System3 line consists of 3 waxes, LF consists of 4 waxes, and HF consists of 4 waxes (including LF Moly and HF Moly). To be a Toko waxer requires less investment and allows the waxer to be far more familiar with each product. Of course waxes can (and should) be mixed which is easily done. There are three Fluorocarbon products each available in block or powder form (JetStream Yellow, Red, and Blue). Toko HelX is available in Yellow, Red, and Blue formulations as well. Not only does a Toko waxer save money and understand the line better, but he will also be using a product that is certainly the wax of choice on the World Cup and elite North American racing scenes.

The concept of a fast ski
What makes for a fast ski? This is an age old question and there ARE answers to it. Start with the shape of the ski itself (height of the camber, stiffness of the camber in relation to the tips and tail). Ideally, a fast ski would properly share the load of the skier's weight over most of the surface area (especially not forcing the front third of the ski into the snow, but allowing it to run OVER the snow), at the same time, remaining stiff enough not to hyperextend when a skater pushes off (causing drag under foot) or retaining enough camber so when a classic skier glides, the wax pocket is not in contact with the snow. Additionally skis for wet conditions are generally stiffer and have a shorter area of contact with the snow to minimize suction. Secondly a fast ski will have a running surface that is hair free and that has a structure and base material appropriate for the snow conditions. Finally, the base has been prepared with the appropriate wax. So, outside of ski selection, the deciding factors are base material, base structure, and wax.

Base Material
This is a subject that is rarely talked about because generally people have very little choice as to what bases they have available to them. Most elite racers today use a graphite base in all conditions. The main advantage of graphite bases over transparent is that they are good electrical conductors which

reduce electrostatic charging caused by friction between the running surface and the snow. This is especially advantageous in dirty snow where dirt absolutely clings to the ski base because of glide-reducing static. One thing that isn't known to many skiers is that transparent bases (on racing skis usually a 6000 transparent base) are superior in at least one snow condition. In very wet new (clean) snow, where the snow is glazed or is saturated with water (making the snow gray or shiny), a transparent base is generally faster than a graphite base. The transparent based skis are usually faster in every way - having a higher terminal velocity as well as having a lower breakaway speed (read about these later). You will find these conditions when it snows and then the sun comes out (or rains afterwards). In virtually all other conditions, a graphite base is at least as fast. (There are many types of graphite bases being used by ski manufacturers involving different densities and containing different ratios of materials, but this isn't something that needs to be discussed).

Base Structure

This is a rapidly developing area of our knowledge of what makes skis fast. The addition of stonegrinding has allowed us to make patterns in our skis that were never possible before. Stonegrinding also allows us to make a more precise finish (and hair free if done correctly) that we can test, duplicate, and improve on leading to even better finishes. If a person takes into account all of the Nordic regions of the world there are virtually 1000 different stonegrind patterns that "work" well, so the discussion will have to stay generalized.

For very cold (snow temp 0 degrees F and colder) and dry snow, a ski should have literally no structure. The base must be completely hair free and should be as glassy smooth as you can make it. Most of the old cadre say skis need to be sanded and then metal scraped and then waxed and scraped and waxed and scraped. Generally, this is worse than an “extreme cold” stonegrind. Stonegrinders can do amazing things and can get the ski close to this state while keeping the surface of the base flat. Then ski on and wax the skis and before too long, they’ll be ideal “cold” skis. A ski racer who lives in a region that can get extremely cold should have a pair of skis **dedicated to extreme cold conditions**.

For "normal" skiing conditions (snow temperatures about 15 degrees F to 29 F untransformed snow), an all around stonegrind will perform well. This is a medium grind that has little depth to it. This is a finish that some Universal or Cold skis come with and can be versatile. A skier with only one or two pair of skis should have a universal structure on their skis.

There are stonegrinds that work very well in wet new snow, wet corn snow, dry corn snow, as well as structures already mentioned for very cold and below freezing. A good strategy is to go with a universal stonegrind and then to add structure as needed with the Toko Structurite. This structure will stay on the ski only temporarily which is a good thing of course. This way it is possible to have excellent skis in varied conditions without having to constantly regrind skis or compromise skis with longer lasting structures.

Humidity and snow crystal shape play as big a role in determining an ideal structure as snow temperature. The more round the crystals and the higher the moisture content of the snow, the more coarse the grind can be. When the snow is still powdery, it is better to be on the fine side. The more the snow has been machined, the more aggressive the structure can be as well. In dirty snow, it is also important to err on the fine side as dirt will accumulate in the structure making the structure less effective (meaning that in wet snow the skis will be slow due to suction) in addition to slowing the skis from the friction caused between the dirt and the snow. Extremely wet new snow is the condition where massive structure is most necessary. In these conditions, there are no commonly used stonegrinds that are very effective. The best solution is a 1-2 mm rill generally with something finer and broken on top of it.

Wax

Waxing isn't so difficult if the basic concepts are understood. When it comes to kick and glide waxing, there are two things that have to be considered: the snow characteristics (and forecast) as well as the characteristics of the waxes that are available. A person has to simply match them up.

Glide Waxes

The different racing glide wax categories include paraffins, synthetic waxes/hardeners, molybdenum (black) waxes, fluorinated waxes, and fluorocarbons. Each has its special properties which offer advantages in certain conditions and disadvantages in other conditions.

Paraffins (System3 Waxes) are the waxes of the good old days which resembled candle wax, except in the Blue range where they are hard and brittle. Paraffins generally are utility waxes by themselves and are good for base cleaning, saturating bases with wax, storage and travel waxing, and preserving the ski bases during training. Pure paraffins are generally slower than the other waxes in their respective category strengths.

X-Cold is a synthetic wax or hardener and is useful in two ways. X-Cold can harden the ski base making it fast in extreme cold snow and can be mixed with other waxes to make them faster in colder snow or more durable. Synthetic waxes are also useful in preventing the ski base from becoming abraded, which happens especially fast when conditions are cold and abrasive. **X-Cold is also very effective when mixed with the Dibloc waxes as it makes them more durable and makes the skis “break away” easier in dry powder snow (Rockies)** - this is a very common combination.

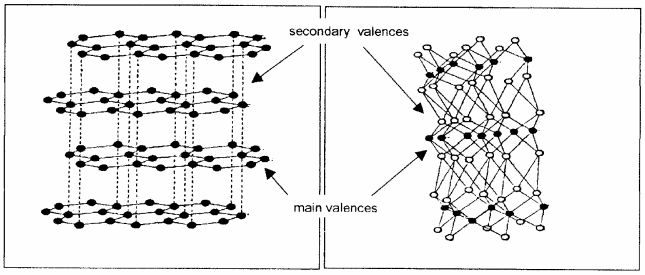
Dibloc LF Blue is a very hard wax. It is an **excellent base wax for X-Cold as well as an excellent final layer in very cold snow.**

Dibloc LF Molybdenum is an excellent base wax that can enhance the properties of a graphite base. It is good at repelling dirt and preventing static build up. Molybdenum is a sort of new generation Graphite that has similar characteristics, but is even more advantageous as it is structurally stronger due to its flexibility - this means whatever you put on top of it will be more durable. **Dibloc LF Molybdenum should be used as a base layer wax in all conditions below freezing**. Above freezing, Dibloc HF Molybdenum is an excellent base wax.

- **Graphite/Molybdenum disulfide**

Graphite and molybdenum disulfide are solid lubricants with a layered structure. These crystalline structures are singled out as strong bonding forces, which are formed into two dimensions (so called „main valence"). These „main valences" are responsible for the formation of layers. The „secondary valences" which are active in-between the layers are very weak and this leads to an easy displacement of the layers (see figure 1).

figure 1



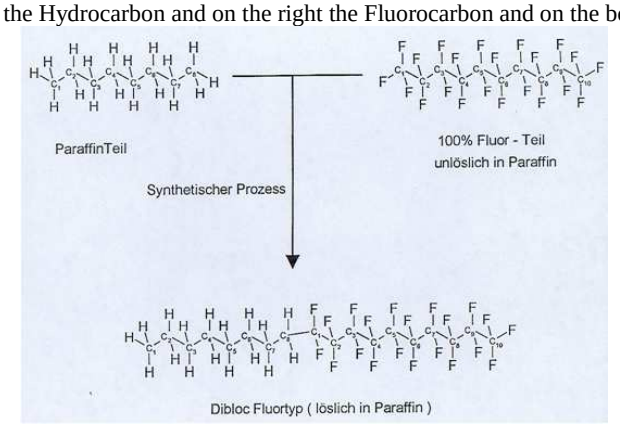
crystal structure of graphite

crystal structure of molybdenum disulfide
(● Mo-Atom, o S-Atom)

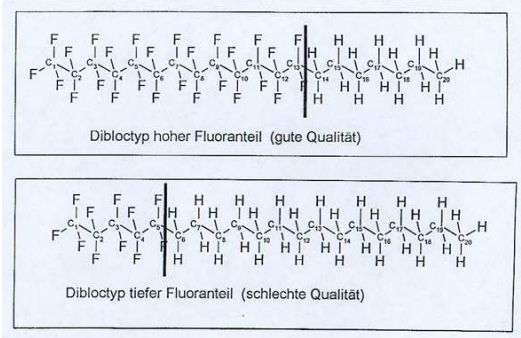
Because the bonding forces between layers (secondary valences) in the case of graphite, are moderate, the shifting of layers among one another, occurs easily (lubricating effect). In the case of molybdenum disulphide there is a very strong bonding between the molybdenum-sulphur atoms which leads to a very high solidity of layers. At the same time there is a weak bonding between each sulphur layer which still enables easy shifting of the layers, even more so than in the case of graphite. In comparison, the molybdenum disulphide has better lubricating characteristics

The Dibloc HF waxes are optimally fluorinated for each temperature range. These are also your most commonly used racing waxes. These are paraffin based waxes with fluorine added to them (and some syntheric as well) which makes them both water and dirt repellent and an excellent base for JetStream. **It is important to note that the fluorinated wax with the most fluorine in it is NOT necessarily the fastest. The optimal amount of fluorine needed varies according to snow crystal shape and the water content of the snow**. Generally, as it gets warmer, more fluorine is needed, which is why Dibloc HF Yellow has more fluorine in it than Dibloc HF Red and HF Blue.

A Fluorinated wax (sometimes incorrectly referred to as a Fluoro) is actually a Hydrocarbon with Fluorine in it. It is a hybrid between a Fluorocarbon and a Hydrocarbon. On the left you can see the Hydrocarbon and on the right the Fluorocarbon and on the bottom is the Fluorinated wax.



There is some confusion regarding Fluorinated waxes. Some companies use "bad quality" fluorinated waxes (defined by their make-up) and then tout their waxes as having "more fluorine than Toko or others". This is simply unfair representation of wax technology and is designed to trick skiers into buying an inferior product. Below you can see the make-ups of "good" and "bad" fluorinated wax molecules. Toko uses fluorinated hydrocarbon molecules that contain a high amount of Fluorine (shown on top) which are far more potent than the molecule shown here with less Fluorine (shown on bottom). When people talk about "percent Fluoro" in their waxes, they are most certainly "selling" their wax rather than letting performance talk for itself. They are likely peddling the bottom type of low-Fluorine containing fluorinated hydrocarbon molecule.



JetStream and HelX
JetStream and HelX both come in blue, red, and yellow formulations. A good general rule in using these waxes is to use the blue JetStream or HelX when waxing with a blue glide wax. Use red with red and yellow with yellow. The waxes can also be mixed very effectively for in between conditions.

In past years, JetStream and HelX were completely different waxes using unique technologies. Now HelX is basically JetStream in liquid form. The waxes test very similarly in any condition. The basic difference is ease and speed of application and durability (see two paragraphs below).

JetStream comes in Block or Powder form. HelX is a liquid. The application method generally reflects which form of the wax that will be used. If rubbing and corking or rubbing and rotocorking, the best form to use is JetStream bloc. If ironing, it is easiest to use JetStream Powder. The quickest and easiest is to use the HelX and spray the wax on, let it dry completely (ideally in a warm room), and polish.

In terms of durability, ironing is the most durable, rotocorking the second most, spraying and polishing the third most, and rubbing and polishing/corking the least. Durability depends greatly on the conditions – how abrasive and dirty the snow is.

First the basics on Fluorocarbons: they are very hydrophobic and dirt resistant. Basically the more water and/or dirt in the snow, the better they will perform in general. Many people think that all Fluorocarbons are the same as they are pure 100% Fluorocarbon. This is not at all true. There are different size molecules which alter the waxes properties as well as different raw materials manufacturers which has an effect on the end product. They can be tailored to perform better in different conditions as well (more moisture, cold, dirt, etc). In short, Fluorocarbons are much like regular wax in that some perform better than others and in different conditions. The blue, red, and yellow JetStream products use different raw materials. They actually have different molecular weights. The containers that the three JetStreams come in (the powders only) are the same size, but there are different amounts of wax in them. JetStream comes by weight, not volume as the molecular weights are different (think a box of Grapenuts versus a box of Raisin Bran).

There are different recommended **methods for applying** JetStream: ironing and "cold" application. For ironing, apply the JetStream to the ski. Iron once very slowly (about 20 seconds tip to tail) without going back at all with the iron on at around 300F or 150C (depends on the wax). Put enough JetStream on the ski to protect the base from the bare iron. Wait some 20 minutes for the wax to completely cool and brush out with a nylon or nylon polishing brush (fluorocarbon brush only). Then polish. Then **lightly** rub on some more JetStream and polish. This makes for a faster finish.

Cold application is as follows: rub the JetStream on and cork it aggressively into the base with a Plasto Kork (synthetic). Take a dedicated horsehair or nylon polishing fluorocarbon brush and work the JetStream into the base (don't brush it OFF the ski, but into the ski base). After this is completed, polish the base. Then **lightly** rub on more JetStream and just polish it well. **One very important point about applying JetStream is that before JetStream is applied, the wax that is under it needs to be brushed out very well.** This is even more important when rubbing it on, brushing it in, and polishing it because the Horsehair or Polishing brush that is used to brush the JetStream into the base will bring up paraffin and mix it with the JetStream if the ski is not completely brushed out. This will make the JetStream less effective and will also gum up the Thermo Pad when polishing. This works very well for short races such as sprints.

The best overall application method for applying JetStream is to rotocork it. Rub a thick layer of JetStream on the ski. Orient the rotocork such that it wants to run backwards (towards you) or another way to look at it is so that it pushes the wax down the ski towards the tail. Then give it some gas, push down pretty hard, and move the rotocork such that takes about 12 seconds to travel from tip to tail. The amount of "gas" to give depends on the drill. Less powerful drills (less torque) seem to do a great job as the friction can be easily controlled by manipulating the pressure and speed at which the rotocork is moved. **The combination of the speed and the pressure (both down and forward) should have an effect of leaving an iridescent or oily-looking film on the base**. This is a sign that the job was done properly. Then brush the wax out with a polishing brush and polish with a pad.

Some people use a lot of speed and very little pressure with success. I have had success with very low speed and higher pressure. I find that I have better control and the end result is clean, fast, and durable.

Another very good method for applying JetStream is to do a "quick iron" – 300F and taking about 6 seconds tip to tail – followed by rotocorking.

Mixing the JetStreams is very effective when conditions are changing or in between.

As mentioned before, the current HelX is different from the old HelX Warm and Cold. The new HelX is not nearly as durable and thus is generally used for short races (and Alpine). There are two main methods of **applying HelX**. The first is to prepare the base by cleaning it with the yellow side of the Dual Pad, and then to spray HelX on so the **entire base is wet**. Then let dry for around 30 minutes (or overnight). This works best inside in a warm place. Then polish the base well with the white side of the Dual Pad. If dried properly, this application is as fast and as durable as any other.

The second method is quicker and **can also be done last-minute outside**. Spray the HelX so the entire base is wet. Rotocork the base until the base is shiny and polished looking (don't worry about the groove). Then brush out with a Nylon Polishing Brush, and then polish with Thermo Pad or Dual Pad. This method tests identically to the above method in speed and durability, but takes less time. Rotocorking in this method should be done with very little pressure.

Before applying HelX, make sure that the underlying layers of wax (HF, Moly, etc) have been scraped and brushed out properly.

After waxing with HelX, the ski should be treated just like after waxing with JetStream (brush out well with Copper Brush, then wax with System3, scrape and brush out well with Copper Brush, then LF Moly, then HF of the day, then HelX again.). We have done a tremendous amount of testing here and this is adequate post-HelX treatment.

Snow conditions
Extreme cold new snow (snow temp at less than 7 F) is usually very dry and abrasive. The crystals are extremely sharp. To skis, these are the most "extreme" conditions. Skiing on cold new snow could be likened to skiing on broken glass. **The only real factor slowing the skis down is the dragging of the sharp pointy crystals on the ski base. The solution is to make the base as hard as possible**. (About the only thing that slides on broken glass is glass as it is so hard the broken glass doesn't stick into it). This is where X-Cold is so valuable. Another thing to consider when waxing

for a race in extreme cold new snow is what the skis were waxed with the last few times. If a warmer wax was used, then this needs to be taken into consideration as the base will be softer than if a colder wax was used. The longer the race is, the more layers of cold wax need to be applied as each layer makes the base harder and more durable. If the base didn't get enough layers then it will become abraded and break down during the race and become slow. Dibloc LF Blue followed by Dibloc LF Molybdenum followed by Dibloc LF Blue, followed by X-Cold is an optimal combination. After waxing, the skis should be scraped well with a sharp scraper and brushed out well first with a copper brush and then with a horsehair brush to get every bit of wax off of the surface of the base as it would only drag on the sharp snow and slow the skis down. Another very good combination is the same first two layers followed by a mixture of Dibloc LF and HF Blue or Dibloc HF Blue mixed with XCold Powder 1:1. If conditions are fast, JetStream Blue will be very good even in the extreme cold.

When examining cold new snow conditions, an important element to consider is at what temperature the snow fell and what the moisture content of the new falling snow was. The warmer and wetter the snow fell, the more aggressive, sharper, and abrasive the snow will be. If the snow fell in below 0 F temperatures, it will be extremely dry and not sharp. **XCold Powder is really good as a final layer in this type of snow which is traditionally very slow.**

Cold old snow is different to cold new snow conditions. The crystals aren't as sharp and the moisture content is higher. A racer could probably use **Dibloc HF Blue** depending on humidity and snow temperature. The warmer and more moist it is, the more fluorine can be used. As a final layer**, JetStream Blue** is generally **faster than straight HF Blue** in these conditions.

The most common conditions seem to be either new or old untransformed snow with snow temperatures between 20 and 30 degrees F. The main consideration in these conditions as to what wax to use is how slippery the wax is on the snow. This is a strange concept, but is the main factor in these types of conditions. JetStream is excellent in this situation as are the HF Dibloc waxes which makes selection simple. The **Dibloc HF wax should be selected according to snow temperature and JetStream should be applied afterwards. Dibloc LF Molybdenum** is an excellent underlying base wax for the Dibloc HF waxes and is generally what we use under the Dibloc wax of the day.

When the snow is somewhat cold to very cold and fast, waxing is pretty straight forward. You'll want to use **JetStream** over **the Dibloc HF** wax of the day. If the snow is slow and somewhat cold to very cold, you will need to add in **XCold** Powder. This is a special wax that does not just harden the base. It is most useful in increasing breakaway speed. The skis slide better at slower speeds with **XCold**. It can be used by itself as a top layer when it is very cold and slow, but normally it is mixed with the wax of the day- usually **HF Blue**. Drip the HF wax on the skis and then sprinkle the **XCold** on top of it. Then heat them in **together**, let cool, scrape, and brush. If the HF wax is heated in before dripping the XCold on top, the XCold doesn't seem to go into the base as well.

In new fallen wet snow to new saturated snow the big challenge is repelling water so suction doesn't slow the skis down. **Dibloc HF Yellow is the optimal wax followed by JetStream.**

In dirty snow, the primary concern is keeping the skis clean. Once skis become dirty, they will be slow in any condition, especially wet snow. In these conditions, the recommendation is to wax with LF Molybdenum (wet dirty snow) or LF Blue (cold dirty snow) followed by HF Molybdenum (wet dirty snow) or HF Blue (cold dirty snow) followed by the appropriate JetStream ironed in, brushed out, and polished. If a structure change is necessary (rilling or Structurite), it should be applied directly before the JetStream is put on so it stays sharp and clean.

Kick Waxes

Toko was the first company to abandon Fluorinated kick wax, 3 years before the other companies (there aren't that many fluorinated kick waxes being offered or used out there now. Fluorinated kick waxes glide pretty well, but don't work as well as non-fluorinated waxes in as broad a spectrum of conditions. Their range is far narrower – they ice up easier. **Carbon offers advantages over fluorine in that the framework of the molecular structure is far tighter and doesn't allow any room for snow crystals to get inside causing icing of the wax. This allows Carbon waxes to be used in a wider variety of snow conditions which is very important for days with changing conditions or when there are different conditions in different areas of a race course.** Carbon waxes are easy to work and offer very good kicking and gliding relationships as well. The Carbon waxes are available as both hard wax and klister.

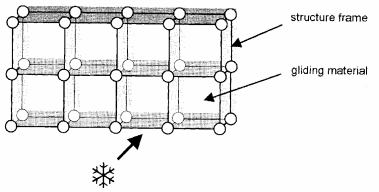
Carbon Grip Wax - Generation

General characteristics:
- very easy handling
- smooth polishing of layers
- very good grip and glide
- no icing!

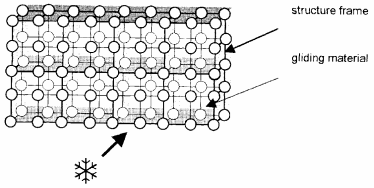
Why *carbon* ?

Our goal was to achieve a very strong structure in the grip material, but nevertheless with very good gliding properties.
In using new synthetic hydro*carbon* compounds (waxes, resins etc.) we obtained a dense structure with the above mentioned characteristics. Especially the property of no icing of the carbon grip layers can be explained with the following model conception:

Dibloc Grip Wax :



Carbon Grip Wax :



Looking at the model of Carbon Grip Wax, you can clearly see, that a snow crystal has a much harder time to penetrate into the structure, as the structure frame of the material itself is much more condensed, than in the case of the Dibloc Grip wax model. Because snow crystals will penetrate only slightly into the layer of wax of Carbon Grip Waxes, there will be no icing of the layers.

The concept of waxing for classic skiing is such that ideally when the skier is in the glide phase, the kick wax is barely off the snow. During the kick phase, the wax pocket should be fully depressed so snow crystals embed themselves in the kick wax allowing for kick. Accomplishing this scenario is dependent on the skis having the proper relationship in camber to the skier's weight and fitness. The skier also needs to have the necessary fitness and technique to work the camber properly.

The hard waxes and klisters can be applied according to the Toko snow temperature/type chart (use a snow thermometer). This is straightforward business. Kick wax should be applied in layers. This makes the wax more durable as well as allowing the waxer to keep the finish smooth. In abrasive conditions, a base wax should be corked or ironed in. Generally the first layers should cover the entire kick zone. The last few layers should be concentrated more in the middle (shorter).

A special wax is the Carbon Silver as it is unique among kick waxes. Toko Carbon Silver can be an effective wax in difficult ski waxing conditions. It works in conditions where soft wet corn snow is covered by new fallen wet snow. Cover the klister of the day (determined by the corn snow) with a thin layer of Carbon Silver. Carbon Gripwax Silver should be experimented with a great deal as it is so versatile. **Carbon Gripwax Silver should be applied much like klister in that it should not be rubbed on, but rather dabbed on and then smoothed out.** When applied thinly, the Silver is very resistant to icing.

One other Silver Hardwax/Klister combination that we have had success with is to cover our warmer klisters (Multiviola or Orange) with Silver Hardwax. This is not an easy application. The klister needs to be cooled, and the silver gets dripped onto the klister such that it stays on the surface which speeds up the klister and keeps it from icing. This combination is especially great in wet corn snow that has been covered by fresh snow.

Carbon Silver GripWax can also be mixed with klister to keep it from icing.

In "haries" conditions (32F and snowing where nothing kicks or something kicks then ices up), there is one wax combination that can sometimes work well. Apply Silver Klister to the ski. Let it cool. Then rub Carbon Gripwax Yellow over it and cork aggressively. Apply the Yellow again and again cork aggressively. What is on the skis should look like a mess. It should also seem kind of aerated sort of like if the Silver Klister and Yellow Gripwax were reacting to one another. Try it out; it can be pretty good with a wide range especially around 32F and snowing. Straight Silver Klister also can work well in these conditions if it is snowing but very wet. Hairies usually work better, but it is nice to know that there are waxes that can work OK in these conditions too.

Some techniques specific to kick waxing include layering, ironing, covering klister with hard wax, and mixing waxes. Layering a colder wax over softer wax is effective in loose snow to allow for better kick because it allows the snow crystals to penetrate the kick wax easier (for better grip) at the same time the softer kick wax isn't going to drag as the conditions are not abrasive and the softer wax is covered with a colder wax.

Sometimes the snow shears underfoot. This is when the snow breaks. The kick wax sticks to the snow, but the snow that the kick wax is sticking to breaks from the snow underneath it creating a slip. In this case, it is good to extend the length of the kick zone to minimize the chance of the snow shearing. Outside of this scenario, it is best not to lengthen the kick zone as it causes drag.

In long classic races where the temperatures are going to warm up in later parts of the race, a warmer softer wax (that ought to work late in the race) ought to be covered by a harder wax (that ought to work in the beginning of the race). During the race, the softer wax will become exposed. In such scenarios, it is important to ski carefully on the downhills so the soft wax isn't exposed to early or rubbed off completely as it will not be as durable as the hard waxes in the early colder conditions.

Generally speaking, when a skier wants good kick and fast skis throughout a whole ski session, the wax pocket should be sanded (150 grit in klister conditions and 180 grit in hard wax conditions). Then either Carbon Basewax Green or Green Klister should be ironed in and corked such that a thin smooth layer remains. After this layer cools, the appropriate wax can be added. If the waxes are added outside on-site, and it is cold out, it is important to warm the green (especially in klister conditions) enough to make it slightly tacky. This will enable the new wax to adhere to the green. Otherwise the final layer will wear off quickly and the Base Green Klister will be left by itself.

In cold conditions when using klister (Green Klister covered by Viola Klister for example), sometimes it is cold enough that the klister freezes. At this point, the wax is there, but it loses its properties – frozen klister is not at all sticky – and does not kick at all. Warm the klister up and cover it with a layer of kick wax such as Carbon White or Blue. This will help prevent the klister from freezing.

Klister can also be covered by hard wax effectively in conditions where there is ice covered by a little powder. Before applying the hard wax, the klister must be allowed to cool. When corking the hard wax, the cork should be kept moving in a light fashion and the klister should not be "corked". The corking should be superficial. The most common scenario in covering klister is Viola covered by a blue or red. The klister has to completely cool first before applying the hard wax. Mixing waxes is generally a technique used with klisters. Silver klister is also often times mixed with universal (Multiviola) or Orange. When mixing klisters, the easiest way is to make stripes of klister covering the distance from the groove in the middle of the ski to the edges on each side. Mixing can be accomplished by alternating the klisters used in the stripes. The wax should then be heated by a torch and smoothened out.

Regarding the klisters, a waxer should pretty much go off the wax chart when selecting Viola, Multiviola, and Orange. Then Silver Klister can be added, especially to the Multiviola and Orange klisters depending on need. A little Silver goes a long way and should be used sparingly. Silver generally does not glide as well as Orange, but kicks far better. In really super wet slushy snow, especially more fine grained, straight Silver Klister can be very good.

One very common scenario that confuses people is when the snow is around 26 F and corned up which would lead to a simple choice of Base Green Klister followed by Multiviola Klister. Then as the tracks get skied in and perhaps it gets a bit warmer, the Multiviola starts to slip a bit. A distinction needs to be made between slipping because the tracks became wetter or because they got "slipperier, due to being skied in". In the wetter scenario, adding or changing to Orange Klister would be sensible. In the second scenario, adding Silver Klister to the Multiviola would be the recommended adjustment. Sometimes conditions are such that 1/3 Multi, 1/3 Orange, and 1/3 Silver is an excellent combination (over Base Green Klister).

Universal Klister (from the Sportline) is one of Toko's best klisters. In mixed conditions or any general warm condition, it should be tested.

At the 2002 Olympic Games, we found something remarkable. Carbon Basewax Green, when applied EXTREMELY thick, is incredibly versatile. (Rub on very thick, iron in, smooth and let cool, then rub on thick and cork, then rub on thick and cork. Use Klister zone for hard track skis and go short with powder skis.) We found it tremendous in abrasive manmade snow or semi-transformed snow where we weren't sure whether to use kick wax or klister. The range was tremendous (it even worked with snow temperatures of -1F), the kick was "rollerski" and the glide was "skating ski". Since then, we have tested this extensively. We have found that in order for the Carbon Basewax Green to work very well (kick) it needs to be applied very thick. This will compromise glide, especially if not kept off the snow. **For this reason, this special wax and application is recommended for difficult waxing conditions with multiple conditions around the course. It is highly resistant to icing and kicks on almost all types of snow. Since 2002, we have used this solution to win National Championships a couple times. It can be superb.**

When selecting kick waxes, the two big determining factors are how much "kick" the wax gives as well as how "fast" the wax is. Most people forget about the glide part and focus on the kick part. This is a bad practice especially as sometimes a softer wax will be just as fast but offer better kick. On the other hand, sometimes a harder wax will be far faster and kick just as well. Of course the conditions need to be considered, especially in classic skiing as the tracks can change so fast and generally do during an event. Events with multiple loops change especially fast (usually glazing as the course gets more and more skied in which requires a softer wax than otherwise) where it usually will become more difficult to get "kick" on the later laps.

A very common mistake when kick waxing is to be "too conservative" and wax way too warm. This is not conservative really as a wax that is softer than necessary for the conditions will be scraped off the skis very quickly resulting in no "kick" at all. If <u>really</u> worried about kick, go with a **thick** layer of Base Green (as suggested above) and go for it. It will be slow, but provide superb kick.

One big challenge in kick waxing is identifying the ski's wax pocket when at an on-snow demo where resources are limited. Of course the first option is to wax according to where the skier says it is. Another option is to squeeze the skis together in both hands and look how the camber breaks - usually a wax pocket is fairly well defined and designed to fit a particular weight skier. This is a very rough way of finding a wax pocket. The problem that this can cause though is that the wax pocket may not fit the skier which means if the skis are waxed according to how they were designed; the waxed area might be too short or long. For this reason, the recommended method for identifying a wax pocket during on snow demos should be to ask the skier, eyeball the camber and make a small adjustment if things don't seem to add up. Kick wax should also be applied heavier with less skilled skiers as their climbing technique generally wouldn't be as good and they would be more likely to slip.

On the elite level, just as important as which wax to use, is ski selection. An elite skier ought to have klister flex skis, hard track skis, and soft track skis. The more concerned the skier is about losing wax and the better the classic skier is, the higher the probability that the skier ought to use stiffer skis. When a skiers skis drag on the kick wax or klister, this not only slows the skis down, but is also a sign that kick wax is being lost.

When kick waxing skis for another, it is important to keep in mind first and foremost, that the skis need to work for the other person. To test the skis and to find that the skis are good, shows only that the skis are good for you. The final tester ultimately needs to be the owner of the skis. They need to be waxed according to his abilities. Needless to say, the better the classic skier is, the easier the task becomes.

Tools and Brushes

Tools, brushes, and Thermo Pads are a vital part of ski waxing. Tools such as plastic scrapers, groove scrapers, metal scrapers, and structurites must be kept clean and sharp. Scraping with a dull scraper is not only less effective but leads to a poor base finish. A sharp scraper doesn't need as much pressure put on it and will also continue to remove unwanted base hairs. Brushes remove wax from the base structure. If they are dirty the skis will pick up this dirt. Brushes also need to be designated for specific wax groups as the wax is retained by the bristles and then returned to the ski in later uses. **A serious racer should have a horsehair brush for extreme cold, two Nylon Polishing brushes (one for finishing the Red and Yellow waxes and another dedicated to finishing JetStream), a copper brush (the most commonly used brush).** If this is not done, when a waxer brushes out JetStream with a brush that had earlier been used to brush out a System 3 Yellow, the paraffin would be smeared over the JetStream making it less effective. This holds true for Roto Brushes as well. Brushes should be marked clearly for their purpose so no compromise is made. **Thermo Pads are used to polish JetStream (or HelX).** It is important to point out that a Horsehair brush is especially good for cold temperatures not because of the issue of static build up, but because the bristles are so fine. The Horsehair bristles are something like 1/4 as wide as a regular Nylon brush bristle, such that they go deeper into the ski. The Nylon Polishing brush also has bristles that are very fine, but are not as stiff as the horsehair brush. This makes it perfect for finishing all waxes especially JetStream. In cold temperatures, it is especially important to remove all of the wax from the surface of the ski. Because of this, it is recommended to do most of the brushing with a Copper brush followed by Horsehair. It is a good tactic to bring the Horsehair to the start and brush the skis out again as the bases will be cold and more wax will be pushed out onto the surface of the skis. You want that wax removed so it does not drag on the cold sharp snow. In wet dirty snow, it is very important that the Dibloc wax be removed completely from the surface of the ski before the JetStream is applied. This will make the JetStream more effective and keep the skis more hydrophobic and dirt resistant. The copper brush should also be used after skiing and before waxing to remove dirt and to "open" the ski base. It is true that in past years, we have done just fine without a polishing brush. However, the polishing brush is outstanding when finishing fluorinated waxes (HF/LF) and is highly recommended for finishing fluorocarbons such as JetStream.

A review of brushes:

Copper – use always before waxing to clean base and prepare it for wax. Also use Copper as the first brush used after scraping. Brush just in tip-to-tail direction. Basically, the copper brush can be used all the time after skiing and before waxing as well as the first brush that you use after scraping. Follow this with a more appropriate brush depending on the wax that is being brushed out.

Nylon – an "all purpose" Nylon brush is OK but doesn't do anything really well. If a person had just one brush, it would be OK. If a person were to have three brushes though, Copper, Horsehair, and Nylon Polishing would be the three recommended brushes. The Nylon brush can be used in both directions and also "scrubbed" with.

Combi – for people who don't want to buy a Nylon and a Copper. This brush is purely a question of economics.

Horsehair – recommended for blue waxes in cold conditions. Bristles are very fine and pretty stiff.

Nylon Polishing – can be combined as a daily training brush with the Copper (start with Copper and finish with Nylon Polishing). It is also an excellent finishing or polishing brush for all waxes. Lastly, **it is an excellent brush to finish Fluorocarbons (JetStream and HelX) with as it removes the wax, but doesn't completely take it off the surface of the base as Horsehair can do.**

The Structurite is wide enough to accommodate any racing ski on the market. It comes with a Red bit which is good for most conditions around freezing. The Yellow and Blue bits are available separately. The Blue bit is surprisingly good in colder conditions. Structure can be applied before the HF layer, before the JetStream layer or on top of everything. The earlier that it is applied the less aggressive it will be (and the less that will be left). The later it is applied in the ski preparation process, the more aggressive and stronger it will be.

Roto Brushes are especially advantageous when preparing many pair of skis. There are 4 different brushes to the Red Creek Nordic brush line. They are Grey Nylon 4 mm (universal brush for paraffins or fluorinated waxes), Black Nylon 10 mm (softer brush for polishing and fluorocarbons), Horsehair 6 mm (harder brush for colder waxes), and Copper 11 mm (an ideal brush for cleaning the base and opening pores before waxing). With the first three brushes rotation speed should be about 3000 rpms (high), but with the Copper, rotation speed should be kept below 800 rpms. **When brushing, weight should be kept completely off the brush (don't push down).** The shafts are hexagonal, which ensures that the brushes will never slip.

Rotocorking is a super effective way of applying JetStream. Any serious waxer who uses fluorocarbons should have a rotocork.

General

Now and then ski bases get a little slow from improper usage of fluorocarbons (without using paraffins in between) or because they haven't been waxed consistently and have become abraded or dried out. **A good way of reconditioning them is to hot wax, scrape, and copper brush them multiple times. The hot wax should alternate between a hardened wax (such as LF Blue or System 3 Blue) and a softer wax such as System 3 Yellow or LF Yellow.** This alternating between soft and hard restores the ski base. The application of the softer wax (which goes deeper and easier into the base), allows the harder wax to go deeper and easier into the base than otherwise making for a truly fast and durable wax job. This method is also recommended for new skis after 5 initial coats of soft wax. System 3 Red and LF Red are excellent waxes to cover the bases with if storage is necessary (over the summer for example). LF Molybdenum can be mixed in as well. Base Prep wax is also a good storage wax.

The recommended snow temperature ranges listed on the waxes and on the waxing charts are only guidelines. Experienced waxers will also be able to read between the lines and make adjustments. For example, a common condition in the Rockies is 18% humidity with snow temperatures that are fairly warm (28 to 31 degrees F). A waxer would be tempted to go straight off the snow temperature, but since the humidity is so low, there is surely less moisture in the snow than would be normally found at those snow temperatures. A recommended adjustment would be use a wax colder than what would normally be recommended (HF Red in this case). A similar adjustment would be made for windblown snow, which generally has very little moisture content. Of course a major issue often times overlooked is also how cold the snow became the night before. When it gets very cold the night and morning before an event, the snow will be especially dry until it really warms up and the wax selection should be adjusted accordingly (go with a harder wax) unless very warm snow temperatures are anticipated.

Another mistake that is commonly made is that people scrape their skis without letting the wax cool long enough. The wax must be allowed to cool for at least 20 minutes (at room temperature) and preferably an hour. The reason for this is that it takes time for the wax to slowly cool and stay "in" the base. The most delicate part of this is the absolute surface area of the base. If this wax is still the least bit soft then the wax will not adhere (in reality it will not remain IN the absolute top layer of base) and the base will have a matte finish like it was over scraped (same effect actually). This is especially important in powder snow conditions where all mistakes or inadequacies make a bigger difference.

When waxing with extremely hard waxes (LF Blue, HF Blue, or XCold), the wax needs to be ironed evenly on the base in a consistent tip to tail motion (this is the same with all waxes). The iron also needs to be hot enough to really melt the wax. This way there will be no air between the wax and the ski after the wax cools. Then the scraper should be very sharp. When scraping, little pressure should be applied downwards (as always). The wax should NOT chip, but rather resemble fine sawdust when scraped properly. If the wax is chipping off, most likely there was air between the wax and the base. This is probably because the wax wasn't heated enough.

Many people hot scrape to clean their skis. When hot scraping, most times the scraper picks up a mass of "black stuff". Most of this is actually base material. When a base is hot, it is also soft. A plexiglass scraper is much harder than this soft warm plastic base. The results ("black stuff") are predictable. Be careful when hot scraping not to put much pressure on the scraper. This is the same when scraping in general. Most times people scrape until they have scraped into the base (lines of dry Ptex can be seen behind the scraper). Keep in mind that hot scraping removes structure. Stonegrinds are expensive.

Great attention needs to be paid to forecasts and incoming weather as the real issue is picking the correct wax for the conditions during the event, not before it. **Weather prediction is often the greatest challenge as identifying an appropriate wax in any given condition is usually straight forward.** (At elite competitions, wax is tested the morning of the race (at least top finish) and then all of the skis are waxed quickly at the last moment, but this is not realistic for 99% of the racing that takes place).

Toko is also a different kind of company. Rather than exploiting what is in many cases our customers ignorance, Toko's philosophy is to earn respect for the long haul through service, honesty, and fairness. If a wax isn't performing to our standard, we will not recommend it for a race. One example of this is the Dibloc III Red from the 1999/2000 season. We found it wasn't really good except for in transformed snow conditions. So, rather than recommend Dibloc III Red in powder snow (and keep appearances up), we recommended Yellow/Blue mix or Dibloc III Yellow/XCold Powder mix. The Dibloc HF Red from the 2000/2001 season was tremendous, which is why we recommended it for all conditions in the appropriate temperature range. Also, instead of coloring System3 Yellow a different color, repackaging it, and naming it "New Ski Base Preparation Wax", we recommend System3 Yellow for the penetration phase of new ski preparation and other waxes for later stages of new ski base preparation. Rather than having 8 different varieties of System3, Dibloc LF, and Dibloc HF glide waxes, we have 3 colors. If the temperature falls between colors, we recommend mixing them. This makes the system simple and requires our customer to invest less money to have the Toko program.

Ski maintenance is a simple concept that if not practiced can make a profound difference. **Ski ties (sleeve style are most effective) should always be used**. They don't just help keep skis together, but also protect the bases from rubbing together and scratching. Skis should be waxed before travel to protect the bases from drying out. Skis also should be storage waxed for the summer. A medium type wax such as System 3 or LF Red is effective as it is hard enough to last the summer, but soft enough to really go into the base. When removing dirt or old kick wax from bases, Toko Gel Clean or Toko Wax Remover should be used as these products don't dry the ski base and are easy to work with. The Copper brush is also excellent in cleaning and getting a base ready for waxing after skiing.

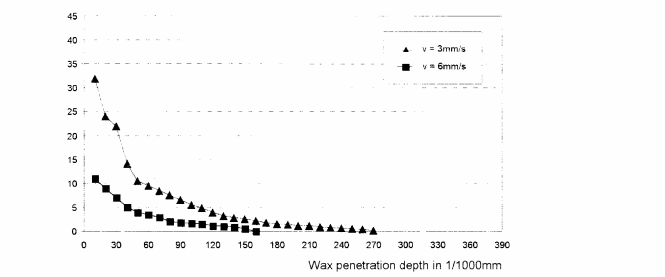
Optimally a **form bench should always be used when working the ski base** (scraping, corking, or brushing). A form bench supports the ski along the whole length such that when the base is worked, the ski is supported, and pressure can be applied evenly and confidently. Without a form bench supporting the ski, the base will have uneven pressure applied to it, mistakes will be made, and the ski base will lose its good characteristics.

Ironing

Ironing is very important as heat is dangerous to ski bases, but it is also how we apply wax. A quality iron is the first step to proper ironing. A quality iron has a thick base which allows the heat to disperse to the whole base before contacting the ski base, accurate temperature settings which allow the operator to see what temperature the iron is set at, and a good thermostat. Irons can be compared to cooking with a frying pan on a stove. If the frying pan is very thin, then the food over the heating element becomes burned while the food on the edges hardly even gets cooked. This is why a thick base is needed. If the iron has a poor thermostat, when it gets too cool, the heat gets turned up until the base gets too hot until the heat gets turned down etc. A quality thermostat is sensitive to small temperature changes and makes the proper adjustments so temperature is kept within an optimal window. A digital thermostat as found on digital irons keeps the temperature very constant. This is especially important when you consider that the iron wants to heat up between waxings when sitting on the table and cool off when it comes in contact with the ski. "Travel irons" and clothes irons are exactly what should not be used as they have all of the properties of a poor iron. Furthermore, the iron should always be kept moving in a deliberate tip to tail motion. Ideally the motion should be fluid with no stops. **A useful test to see how hot the ski base is becoming is to touch the ski base immediately after the iron has passed over it with a clean finger. If the base is too hot to keep the finger on it, then the iron is heating up the base too much.** (Either turn the temperature down or move the iron a little faster).

Diagram 1 shows two bases waxed in different ways. In the case of base 1, the hot wax device was drawn over the base at a speed of 3 mm/s, twice this speed being used for base 2 (6 mm/s). The temperature was 130 °C.

Diagram 1 wax temperature T = 130 °C



This shows clearly that the amount of wax penetrating the base is proportional to the heat treatment time. It also shows that the wax penetrates to a far deeper level.

The temperature that a ski feels is a result of the combination of the temperature that the iron is set at and the amount of time the ski is exposed to the heat. Although heat can lead to base damage, it also leads to the best wax penetration. (See diagram 1). We need to use as much heat as possible,

especially when dealing with hard glide waxes on a cold race day. The more heat used (combination of iron temperature and time) the better the wax penetration. Heat is our friend so long as it doesn't damage our base.

It is also important to note that some skis seem more prone to bubbling from heat than others. This is due to a difference in base materials as well as a difference in ski construction. (Ex. a foam core and a honeycomb core will insulate the base differently). Keep this in mind when ironing and get to know your equipment.

Toko R & D – Testing

Many years, the Toko team tests hundreds of new Toko formulations of glide waxes, grip waxes, and klisters. These formulations get narrowed down to just one which gets introduced to the market when the Toko Race Service and chemists are confident that it is the optimal formulation based on the latest technology and scientific know-how.

Glide Testing Skis

Glide testing is more complicated than people think. Some would have you think that all you need to do is get a speed trap, pick a gradual hill, slide down the hill a few times, and pick the pair of skis with the fastest times. If this is what you do, there is a good chance that you will have blown it.

The slightest amount of wind, even a very light breeze makes such a test worthless. Bad (incorrect) information is worse than nothing. When there is even a slight wind, the results should be thrown out as the difference in the wind between runs makes for a bigger difference than the difference in speed between the skis.

Furthermore, speed trap testing is done in a track. The conditions in the track change rapidly as they get skied in. After a short while, the conditions in the track are different than the conditions out of the track (generally the track is glazed while outside of the track it is not). Such a test will give "results" and "information", but the information is not pertinent to what will run best out of the track. This is a big problem. People want "results" though and look past this obvious problem.

Also, it is rare that the snow conditions are consistent throughout an entire race course. Often times there are sections that have been shoveled or have had snow making. There are sections that are generally shaded and are thus colder with finer snow and other sections that receive more sun and either contain more moisture or are corned up and faster. To test in one section of a course (in the tracks and with a breeze) and to then focus on these results like they are FACT somehow is simply weak-minded and improper. The wax used will consistently be the wrong one, regardless of what the "results" say.

The ski that glides the farthest or the fastest in a test is not necessarily the fastest ski for the race. The important thing to note here is that the test has to fit what we are trying to measure. The two basic components of ski speed measurement (as relates to cross country skiers) are breakaway speed and terminal velocity. Breakaway speed is the speed at which the ski suddenly begins to feel free and accelerates. Most conditions offer a distinctive breakaway speed which is usually somewhere around the pace skiers race at. This makes the breakaway speed especially important as a small discrepancy will make a big difference over a race. **Breakaway speed can be noticed subjectively and will also show up in tests that involve speeds resembling that in a race (from as slow as climbing to as fast as on a flat).** Terminal velocity is the high end speed that the ski can reach. In courses with long fast downhills with runouts this is also worth noting, although most of the time breakaway speed should be the most important consideration. Testing on a steep downhill will give an indication of the skis highest end speed (or terminal velocity). The breakaway speed test should be done on more gradual terrain. The skiers should start from standing and after a few seconds of acceleration time should go through the timing system with the

window about 4 to 5 seconds. **Average speed through the timing system should be similar to that in racing.** During speed tests, the body should always be in the same position (tuck is most consistent because of wind) and the skier should concentrate on starting the same way every time.

The best method of testing remains skiing and "going by feel" as well as timing long (20-30 seconds) sections on gradual rolling downhills out of the tracks. These long sections should include slower speeds that would reflect the speed skiing on a gradual uphill or flat. Most times such downhill sections are not available near a start, so "going by feel" should be the primary testing tool. Despite this, most companies and big teams use speed traps in tracks to test which is simply misleading.

Racers spend hundreds of hours training and thousands of dollars on equipment each year. Making skis perform better is an essential component to winning races and enjoying ski sports. Toko is the world leader in this specialty.

Toko USA
Toko Brand Management Office
752 South 200 West
Heber City, UT 84032
www.TokoUS.com