



**TOKO<sup>®</sup>**

**Tech Manual Nordic 2003/2004**

**Racing-Service**

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## Introduction

Glide waxing at the World Cup level is a very specific and exact science. It is also very secretive. 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 mention one thing though regarding testing at the Olympic Winter Games in Utah. During the year prior to the Games, we (Toko USA) saw around 5 National Team technicians sent over to Heber City, Utah specifically to test waxes and gain experience at the venue for the Olympic Cross Country races. Naturally we had contact with each of these teams. Of these 5 teams, 3 went out of their way to tell us that they were going to wax exclusively with Toko fluorinated glide waxes at the Games as they were consistently the best in each condition tested. These unsolicited remarks came from 2 very strong ski programs that won medals as well as one country that had its best Olympic games in Cross Country skiing ever.

Working in the Toko container at the Games, Toko technicians waxed skis for many competitors including Olympic medalists and World Champions (as well as for many less successful athletes). This is especially significant as usually private or National Team technicians wax racers skis at such important events. After the events, the response from these athletes was enthusiastic every time. Many of these athletes had their best ever performances. Some had less successful races, but were very happy with their skis, which means a lot!

The Games also offered us another opportunity. During the first part, conditions were cold and dry in the morning and warm and dry in the afternoon (with intense sun radiation). The snow was old and mostly transformed. Then it snowed and we were treated to wet new snow, then it dried out and we had dry new snow conditions. Then it warmed up greatly, got very humid, and sometimes snowed, sometimes rained. In short, we experienced almost every snow type possible at the Games. We were well staffed and took the opportunity to test new products. New Fluorocarbons, new Fluorinated waxes, new Klisters, new Grip waxes, and new secret waxes. Some of these new waxes were so successful that they were accepted immediately by National teams and used in the events.

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 finally get the 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, 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 range 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 5-10 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 channels the water off the side of the ski - **Toko Structurite**. Toko was the first company to develop and offer a fluorocarbon in block form (Streamline). This product line is carried on by **JetStream New and Old Snow Bloc**. 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 been scrambling to copy it, but it still sets the standard. The **Toko Groove Pin** is an innovative and successful product designed specifically to aid the waxer in removing wax from the groove and edges of the ski. Again, other companies are attempting to knock it off, but the Toko product is still leading the industry. Toko was the first company to recognize that Fluorinated kick waxes were NOT the way to go. 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 dropped Fluorinated kick waxes. **Toko Dibloc was the first fluorinated glide wax to be used on the World Cup – despite claims from another company, Toko developed Fluorinated glide waxes**. This tradition continues with the Dibloc HF and LF product lines. 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 WaxCat Iron** is 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 for years have been saying that Molybdenum and Graphite are the same, or even that Graphite is better. Now, 5 years after Toko's introduction of Molybdenum glide waxes, our biggest competitors are coming out with some new exciting breakthroughs: Molybdenum glide waxes! **Toko HF Paste** makes 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. HF Paste 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 and are still being used by some 95% of the World Cup and Olympic field. Red Creek uses the best materials and tests thousands of new possible products enthusiastically every season. Red Creek invented Roto Brushes and continues to set the standard. **Toko Tex Wax**, a truly great way of applying iron-on waxes, is also a Toko only product. 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. At the 2002 Olympic Games, many teams had their own bags and many skis were brought to Toko by National Team technicians for Thermo Bag treatment the night before events.

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 6 temperature/snow specific hard waxes and a base klistler 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 two Fluorocarbon products each available in block or powder form (New and Old Snow JetStream). Toko HelX is available in Warm and Cold formulations. 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. 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 the 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 a "cold" grind. Stonegrinders can do amazing things and can get the ski close to this state (while keeping the surface of the base flat) and then a sharp metal scraper should be gently (and at a slight angle like a snow plow) run down the surface. The metal scraper should be kept very sharp and only the **slightest pressure** should be put on the ski base. If the base ends up looking like a Teflon coated flying pan (after close inspection), then it was either burned (too much pressure on the scraper) or torn (dull scraper or dry base during scraping) and will be **slow** especially in non-transformed snow conditions. Ideally 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 temperature 15 degrees F to 29 F untransformed snow), an all around stonegrind will perform well. This is a medium grind that has very 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.

In new fallen snow (or falling snow) around freezing, a new snow grind is effective. Generally this grind looks like the all around finish, but slightly deeper and with narrower angles in the grind.

In most types of corn snow or machined man-made snow, a linear pattern works very well. This is a rarely found grind that resembles a medium rill, but unlike a rill, which is pressed in, this structure is cut in, which provides a cleaner, longer lasting, and more precise finish. This finish also works well (along with the new fallen snow grind) in wet new snow (untransformed as in transparent base conditions).

In very wet transformed snow, an effective type of grind is offset such that there is a substructure of lines every half inch or so angling diagonally off the ski. This is an effective way of channeling water off the ski so it doesn't have to run the distance of the ski reducing suction. This stonegrind works best in transformed snow. A serious racer should have a pair of skis dedicated to these conditions with this finish. This is what is commonly referred to as a "wet grind". This is the grind that Wet snow skis come from the factory with. A "cross hatch" grind that looks like an aggressive Universal grind is also generally an excellent all around wet snow grind.

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 2+ mm rill.

Stonegrinding is only as effective as you let it be. There are racers out there who have 8 pair of skis with the same structure on them. We see them waxing and testing their skis like crazy before events (presumably with the appropriate structure for the conditions). What happens at the next event where the conditions are very different, requiring a different base structure? Usually these racers try to scrape or rill their skis in an effort to minimize their compromise. What they are actually doing is ruining their skis (their bases are generally hairy and wavy) and making them slow in most conditions. The real answer is specialization. A serious racer should have skis with a cold grind, a wet grind, a linear grind, and two with an all around grind. These don't have to be all new skis; if good skis aren't used when the conditions are marginal, they will hold up for years. Specializing skis simplifies things as testing so many pair of skis before each race won't be necessary. This means a pair of skis with an optimal structure for the day's conditions will always

be available. **This method also makes it far easier for people who travel to events as each ski should be waxed with a wax that matches its grind. This way all conditions are covered no matter what the weather does.** (If the conditions are "normal", the cold skis and the wet corn snow skis stay in the bag - they shouldn't even be tested as they won't be good). If a person can specialize like this, metal scrapers and rillers don't need to be used.

Stonegrinding is a superior alternative to rilling. When skis are rilled, the structure is pressed into the base as compared to stonegrinding where the structure is cut cleanly into the base. If a structure is pressed into the base, the base surface will naturally return to its original form before too long. With stonegrinding, the structure lasts far longer as the structure is the base's natural form. Rilling also makes for uneven wavy bases over time and eventually leads to slow skis. In comparison to rilling, the Toko Structurite Tool is far gentler on the bases than a rill and will not damage the base over time.

## 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 (or graphite) 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. They are usually soft and are also inexpensive. 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 offer no performance edge over the other waxes in their respective category strengths, except for sometimes in extreme cold conditions.

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 oxidizing, 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.

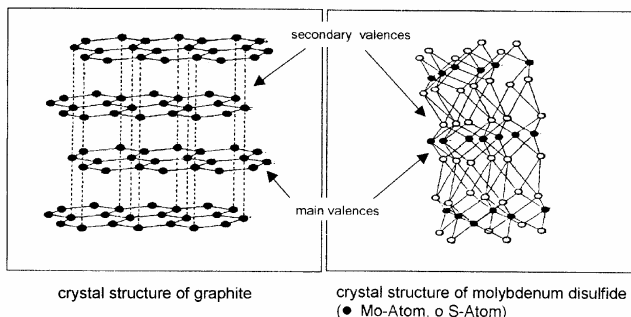
Dibloc LF Blue is a very hard wax containing some fluorine. It is an **excellent base wax for X-Cold as well as an excellent final layer in very cold snow.**

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's 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).

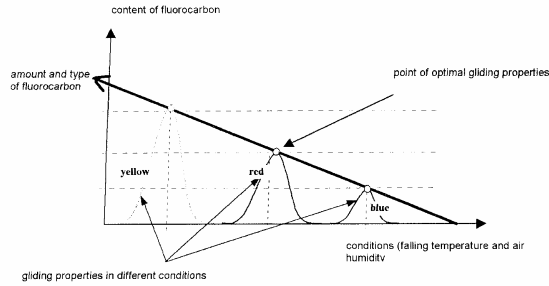
figure 1



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 disulfide 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 disulfide 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 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.

The following table shows that it is not the maximum proportion of fluorocarbon that is critical for optimised gliding characteristics, but rather **which** type of Dibloc is used **where** and in **what amounts**.



### Important facts about Toko waxes

Why is there a difference between Alpine and Nordic glide waxes? – The physical requirements for a waxing system in the case of Alpine are quite different compared to that of Nordic:

- Alpine: balanced wax mixtures, which guarantee best gliding properties at high speeds.
- Nordic: best wax combination, which gives good acceleration at lower speed.

### Dibloc Glide Wax – The new generation

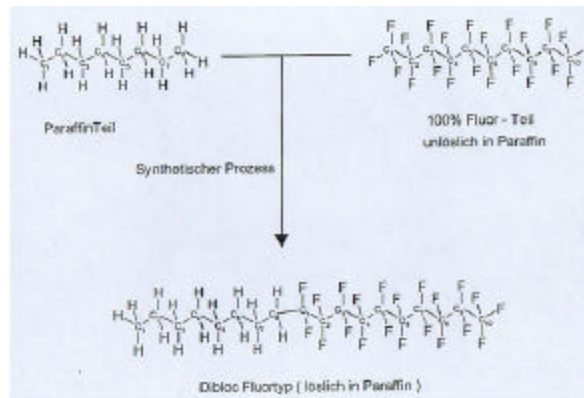
This new Dibloc generation achieves the following objectives:

- maximum speed and acceleration
- best handling and coating effects

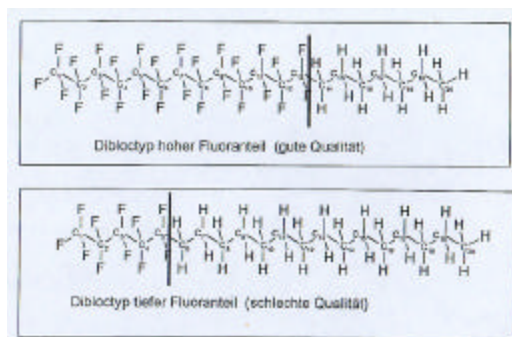
Through the use of new paraffin and additives, a decisive improvement in wax adhesion and processability has been achieved. Low viscosity gives the wax exceptionally good flow properties that favour penetration into the base. Together with the new adhesion additives, this results in improved anchoring to the base.

The new Dibloc waxes are even more water- and dirt-repellent. By varying the fluoro compounds this achieves optimised gliding characteristics for the given temperature ranges.

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 snow is not transformed and humidity is below 40%, X-Cold should be added to the Dibloc HF waxes at a ratio of about 1 X-Cold to 3 Dibloc HF.** This will make the wax more durable and increases the wax's effective range - it also makes the skis "break away" at a lower speed.

JetStream is a fluorocarbon wax (also known as Perfluorocarbon). It is very hydrophobic (repels water which breaks suction) and dirt resistant. JetStream is most effective when the moisture content in the snow is relatively high and/or the snow is dirty. JetStream is also very durable in the appropriate snow conditions. It can be either ironed in (like all of the previous waxes) or corked and polished in. **Some form of JetStream (new or old snow, powder or block) should be used on most race days as a final layer.** JetStream can be used in cold temperatures (snow temp 7 F) when the snow crystals are transformed and humidity is high especially if there is any dirt or in all warmer temperatures (snow temp 25 F) regardless of snow crystal type (use the appropriate form) and humidity. For the range in-between, the dirtier the snow, the higher the water content and humidity, and the more transformed the snow, the more likely you should use JetStream. JetStream should be corked in when the conditions are not so abrasive (or when the race distance is not so long) especially in new snow and ironed in when the snow is abrasive, transformed, and dirty, especially when the distance is longer. **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 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.

The recommended method specifically for applying JetStream New or Old Snow is as follows. 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. 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 brush (fluorocarbon brush only). Then polish. Then **lightly** rub on some more JetStream and polish. This makes for a faster finish. For rubbing and corking (without ironing), rub the JetStream on and cork it aggressively into the base with a Plasto Kork (synthetic). Take a dedicated horsehair 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.

**JetStream New Snow should be used in one general condition: all types of falling new snow where a snowball can be easily made. Any time the snow is glazing up, JetStream New Snow will easily outperform anything else on the market. JetStream Old Snow should be used in two general conditions: either transformed snow with or without dirt, or cold snow (powder or corn) that isn't really sharp and abrasive. JetStream Old Snow is the more universal wax. In cold powder snow, the fastest JetStream Old Snow application is to rub on, not to iron.**

**JetStream New and Old Snow can be mixed. Mixing the two JetStreams is very effective when conditions are mixed new and old snow, or are new snow containing dirt, or in situations when the snow changes drastically during the course of a race. This is a dynamite combination. If you are not sure which JetStream to use, mix them!**

There has been some misunderstanding regarding the make-ups of JetStream New and Old Snow. JetStream Old Snow is not different from JetStream New Snow simply because it has Molybdenum in it. It is also made up of a different "type" of fluorocarbon. (Fluorocarbons from different suppliers can vary as well as Fluorocarbons can be different lengths).

**When testing JetStreams, break away and end speeds need to be considered. JetStream New Snow usually has tremendous high end speed. So when testing it, if it breaks away well, then go with it! JetStream Old Snow breaks away (low end speed feels very fast) very well. So, if the high end speed is good, then it is surely the wax of the day!**

**JetStream New Snow is especially effective in classic races as the tracks glaze up earlier than in skating events. Keep this in mind when considering wax selection as in most non transformed classic ski conditions, JetStream New Snow should be the final layer.**

HelX is Toko's best overall glide wax. It comes in Warm and Cold formulations. When HelX is "going", absolutely nothing compares. It is durable and does no damage to the base (unlike some other liquid products from other brands in the past). 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.

The most important thing to consider when discussing HelX is that it needs to dry completely. Absolute best results will be found if HelX is applied inside and is allowed to dry for 30 minutes plus. After drying, there should be white powder on the base. When applied outside, the powder is not as easy to see and application is not as effective. Complete drying is most critical.

HelX Warm is the best thing out there when the snow is WET. It is especially **effective when there is a glaze or the presence of water in the superficial layer of the snow.** This is most commonly found in wet new snow or very wet corn snow. HelX resistance to dirt is still being evaluated. It is certainly not bad, but in extremely dirty conditions involving longer races, until more is known, one should definitely consider JetStream Old Snow Powder ironed on as the top candidate.

**The name and information on the packaging regarding HelX Cold is misleading. It is for colder conditions (less moisture in the snow) than HelX Warm, true, but not really for Cold conditions. HelX Cold is for conditions that do not have quite enough moisture for HelX Warm to perform in, but still some moisture. One can find these conditions in air temperatures from freezing to about 15 degrees depending on if waxing is being done for skating or classic and also depending on where it is. Anchorage, New England, the Lakes regions of the Midwest, and the extreme Northwest are humid enough that HelX Cold can be used in some relatively cold conditions, but not "cold"! HelX Cold will be more universal than Warm in the typical dry areas of the country (Rockies) except when the snow is truly wet.**

There are some tricks in using HelX, but they are still being tested and developed. Bottom line is if there is moisture in the snow, especially glazing, HelX will be good so long as it dries completely and there is white powder on the base before polishing.

**From wettest and warmest to coldest and most arid, the recommendation is the following: HelX Warm, HelX Cold, JetStream Old/New mix, JetStream Old ironed on (for longer races and abrasive or dirty snow), JetStream Old rubbed on and polished.**

When waxing with HelX, the underlying waxes should be brushed out well. Then the yellow side of the Dual Pad should be used to scrub the ski. This "prepares" the base for HelX. After the HelX is completely dry (white powder on the base), polish the base aggressively with the white side of the Dual Pad.

One unbelievable Toko wax is the HF Paste wax. This stuff really works, although at this point, has still not been used in a World Cup or National Championship caliber race. The HF Paste should be rubbed onto a clean ski and then it should be **quickly wiped off and buffed with base tex** (not a Thermo Pad!) until shiny. The only way to truly appreciate the HF Paste is to try it as it works far better than could be believed in almost any condition. This would be a miracle product for junior and youth coaches, especially at the low price. There is no comparable product on the market at all to Toko HF Paste wax. The **best** condition for HF Paste seems to be **skied-in powder snow that is around 15 F. Do NOT let this product sit and gel, it will only make it slow.**

### 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 oxidize and break down during the race and become slow. WL 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 nylon brush and then with a horsehair brush to get every bit of wax off of the surface of the base as it would only scrape on the sharp snow and slow the skis down. A Copper brush can also be used to remove the first part of the wax out, followed by Nylon, then Horsehair. JetStream should not be used in these conditions. 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.

When examining cold new snow conditions, the most 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. **In this unusual condition, JetStream Old Snow over LF/HF Blue mix over LF Molybdenum is the answer.** JetStream Old Snow breaks away very easily and is super versatile.

Cold old snow conditions should be treated similar to cold new snow conditions except that the crystals aren't quite as sharp and the moisture content is probably a little higher. A racer could probably use **Dibloc LF Blue or 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 Old Snow is generally slightly faster than HF Blue in these conditions. If there is any dirt, JetStream Old Snow is surely the wax of the day.

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. HelX Cold or JetStream is excellent in this situation as are the HF Dibloc waxes which makes selection simple. In this temperature range and in humidity under 40%, X-Cold should be sprinkled over the Dibloc HF wax. Then heat them in **together**, brush, and polish. **In more humid conditions, Dibloc HF wax should be selected according to snow temperature and HelX or JetStream should be applied afterwards.** In newer snow JetStream should be rubbed in and polished. Dibloc LF Molybdenum is an excellent underlying base wax for the Dibloc HF waxes as usual.

One effective method in determining if HelX or JetStream should be used (especially when it's in question in conditions such as drier powder) is to wax two pair of race skis. Test both and determine which are going to be the day's race skis. Then apply HelX or cork and polish JetStream on the slower skis and test again. If they sped up significantly, then it should be applied to the race skis. (Of course in conditions that require ironing of JetStream, this is not practical, but in those conditions, it is usually easy to make the decision whether to use JetStream or not).

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 HelX Warm.** It is a very wet day when Dibloc HF Yellow is used alone. More commonly Dibloc HF Red and HF Yellow should be mixed. In very wet new snow that is not glazing, very aggressive structure is needed.

In clean to cleanish **corn** snow from snow temperatures 20 to 32 degrees F, the appropriate **Dibloc HF wax should be chosen followed by JetStream Old Snow ironed and polished in.** HelX may or may not be faster. HelX is generally best when there is a water film most commonly found in newer snow conditions.

**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 when the most dirt is usually found. 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 LF Molybdenum (cold dirty snow) followed by JetStream Old Snow ironed in, brushed out, and polished, followed by JetStream Old Snow lightly rubbed on and polished (all dirty snow conditions). 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. In the case of very cold dirty powder snow, XCold, HF Blue, or LF Blue can be mixed with LF Molybdenum to keep the skis clean and fast.

### Kick Waxes

Some six years ago, fluorinated kick waxes were introduced to the market with great success. Compared to the traditional kick waxes, fluorinated kick waxes glide better with minimal sacrifice in kick. Now Toko has taken kick waxes a step further with Carbon Kick Waxes. **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.

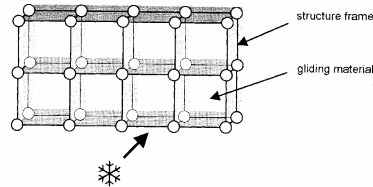
### Carbon Grip Wax - Generation

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

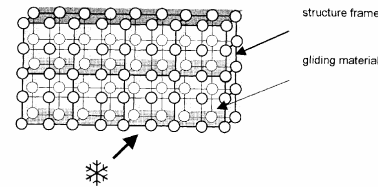
#### Why carbon ?

Our goal was to achieve a very strong structure in the grip material, but nevertheless with very good gliding properties. In using new synthetic hydrocarbon 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 isn't touching the snow (causing the ski to drag). During the kick phase, the wax pocket should be fully depressed so snow crystals embed themselves in the kick wax allowing for kick. These are ideal classic conditions that should be strived for. Accomplishing this scenario is dependent on the skis having the proper relationship in camber to the skier's weight and fitness (and technique).

The hard waxes and klister 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 many layers - up to 4 depending on conditions and the situation. 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.

A special wax is the Carbon Silver as it is unique among kick waxes. Toko Carbon Silver can be an effective wax in the most difficult ski waxing conditions of all (commonly found at on-snow demos): when it is snowing around 32 degrees F. Most waxes ice up at these temperatures and don't kick or glide, but the Carbon Silver sometimes still performs quite well. It also works in conditions where soft wet corn snow is covered by new fallen wet snow. Carbon Gripwax Silver should be experimented with a great deal as it is so versatile. It can even be mixed with klister (Gripwax Silver mixed with Multivoila Klister was the wax at the '99 World Championships in Ramsau). **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.

In "haries" conditions (32F and snowing where nothing kicks or something kicks then ices up), there is one wax combination that can sometimes work very 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 really excellent with a wide range especially around 32F and snowing.

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.

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 downhill 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.**

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. Sometimes it works well to combine two waxes for "in between temperatures". Silver klister is also often times mixed with universal (Multivoila) or Orange. When applying klister, it is important to cover the whole width of the base (except for the groove of course). 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 smoothed 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. Generally Silver Klister is not used by itself. 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. Generally, the most Silver Klister that would be used would be a 1:1 mix with Orange Klister.

**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 Warm 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 weather to use kick wax or klister. The range was tremendous (it even worked with snow temperatures of -1), the kick wax "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 can compromise glide. 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 all types of snow.

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, especially an event with multiple loops (usually glazing 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 really worried about kick, go with a **thick** layer of Base Green (as suggested above) and go for it.

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 skier's 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, a nylon brush for general paraffin and fluorinated waxes, Horsehair and Nylon for JetStream, a copper brush, and a polishing brush.** If this is not done, when a waxer brushes out JetStream with a brush that had earlier been used to brush out a World Loppet Yellow, the paraffin would be smeared over the JetStream making it less effective. This holds true for Red Creek Roto Brushes as well. Brushes should be marked clearly for their purpose so no compromise is made. The same principle also holds true for the Thermo Pads. **Thermo Pads are used to polish JetStream.** 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 Nylon brush bristle, such that they go deeper into the ski. 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 Nylon brush and then in the appropriate conditions (no need to use Horsehair on HF Yellow, for example), finish with a few passes with the Horsehair. **The Copper brush is also an excellent tool for removing warmer wax that needs to be**

**removed, such as HF Yellow.** In wet dirty snow, it is very important that the Dibloc wax be removed completely from the ski before the JetStream is applied. This will make the JetStream more effective keeping the skis more hydrophobic and dirt resistant. The copper brush should also be used after skiing and before waxing to remove oxidation and 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.

The Dual pad can also be used to polish JetStream or HelX.

Brushing techniques have not been tested extensively (yet) as most other factors in finishing a ski have been. As a general rule, the Nylon brush should be used most often and for finishing (polishing brush is also nylon, but softer). Horsehair is excellent as a finishing brush for extreme cold and for brushing JetStream INTO the ski. Copper is excellent for removing warmer waxes and as a first step in removing the very hard cold waxes as well as for getting a ski “ready” for waxing.

The Structurite is great. Because of the Structurite’s offset structure (which allows the water off the SIDE of the ski), the skis needs less structure than a traditional linear rill. **In wetter corned up conditions, ideally a coarse rill should be applied followed by the Structurite with the coarse offset bit twice. The Structurite will fit all skis on the market including the ‘99-’00 widest Atomic Beta. The Structurite also has linear bits available – coarse (about 1.25mm) and fine (about .75mm). Outside of performance on any particular day, the major selling point of the Structurite is that it will not ruin a base. The structure is pressed into the base rather than cut like a rill. After 2-3 ironings, the structure is no longer apparent as the base will return to its original form (like waves in water).**

Red Creek Roto Brushes are the dominant brush used in the elite ski racing world. Virtually every Snowboard, Alpine, and Nordic national team in the world uses exclusively Red Creek Roto Brushes. Red Creek pioneered Roto Brushes and since then has lead the world in research and development of brushes. Red Creek is a Swedish company. At the Nagano Olympic Games, some 100 Olympic teams finished their skis with Red Creek Roto Brushes.

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, 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. They also come in single or double sizes.

### 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 oxidized or dried out. **A good way of reconditioning them is to hot wax, scrape, and brush them multiple times. The hot wax should alternate between a hardened wax (such as LF Blue or WL Blue) and a softer wax such as World Loppet Yellow, LF Yellow, or HF Yellow. HF Moly is also excellent for this purpose** (used as the soft wax) and should be alternated with WL Blue or LF Blue. This alternating between soft and hard waxes seals the waxes in and restores the ski base to a healthy saturated sheen. 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. WL Red or 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.

**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 to either mix X-Cold with Dibloc HF Yellow or go with straight HF Red. The LF waxes also perform well in these conditions. A similar adjustment would be made for windblown snow, which generally has very little moisture content and very sharp crystals. Wind generally lowers the moisture content of snow as well (in colder temperatures). Of course a major issue often times overlooked is also how cold the snow became the night before. When it got very cold the night and morning before an event, the crystals become very dry and sharp and the wax selection should be adjusted accordingly (go with a harder wax) unless 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 and has a bigger effect with the non hardened waxes - the Reds and Yellows. This is not so important when using JetStream or in extreme cold (as the extreme cold waxes harden quickly).

When waxing with extremely hard waxes (WL Blue, 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). This way there will be no air between the wax and the ski after the wax cools. Then the scraper must 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 or the scraper was used with uneven pressure resulting in a less than flat ski or a base that was “dug into” a little.

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.** (On the World Cup and at US Nationals, wax is tested the morning of the race 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).

It should be mentioned that there is a difference between the Toko Alpine and Nordic waxes. The Alpine waxes are formulated for terminal velocity (high end speed) and are therefore softer where the Nordic waxes are formulated more for breakaway speed (low end acceleration) and are harder and

more durable. Other companies do not distinguish between the two resulting in easier merchandising and inventory control, but quite a performance compromise.

**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. Toko is the only wax company to have a Race Wax Tip Line or anything similar to this. This service costs Toko a lot of money and time, but, in line with the Toko philosophy, is part of the deal - the relationship with the skier.

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 and oxidizing. Skis also should be waxed for the summer. A medium type wax such as World Loppet 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.

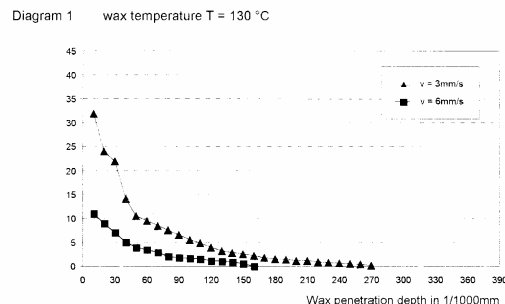
### Ironing

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 thermostat with a window. 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. This is especially important when you consider that the iron heats up between waxings when sitting on the table and cools off when it comes in contact with the ski. **The Toko WaxCat has a thick base, accurate temperature settings, and a sensitive thermostat and should be used.** Another feature of the Toko iron is that on the back of the iron is a chart outlining what temperature setting to use on which waxes. "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. (Ironing also polarizes the wax and in certain conditions it makes a difference that the ions are aligned with one another). **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).

On the elite level, there are two general methods of ironing. The first is to always use high heat and simply move the iron faster when less heat is required (still from tip to tail in a controlled motion). This method creates a lot of smoke, but is quite fast and effective. The second method is to use a temperature setting appropriate to the wax being used (reflected on the back of the iron) and to move the iron slowly all the time. The first method controls the heat that the base feels by the speed of the iron, the second by the temperature of the iron. (If one passes his finger through a flame, the heat felt is determined by the speed with which the finger passes through the flame or see diagram 1). What needs to be taught in all cases during waxing clinics is the second method.

**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.**

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.



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.

# Toko R & D – Testing



This past year, the Toko team tested approximately 300 new Toko formulations of Alpine glide waxes, 200 Nordic glide waxes, 200 grip waxes, and 150 klusters each year. 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.

## Testing Skis

Ski testing is more complicated than people think. **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 downhill 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 magnets about 4 to 5 seconds apart. **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.

Speed traps are completely worthless or misleading often times. For a classic race, glide testing in the tracks is appropriate. For a skating race, generally speaking skiing will be done outside of the tracks. Also during testing in the tracks, the conditions in the tracks change dramatically rapidly reflecting a condition completely different than what will be raced on. The best method of testing remains skiing and “going by feel” as well as timing long (20-30 seconds) sections on gradual rolling downhill 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.

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.



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