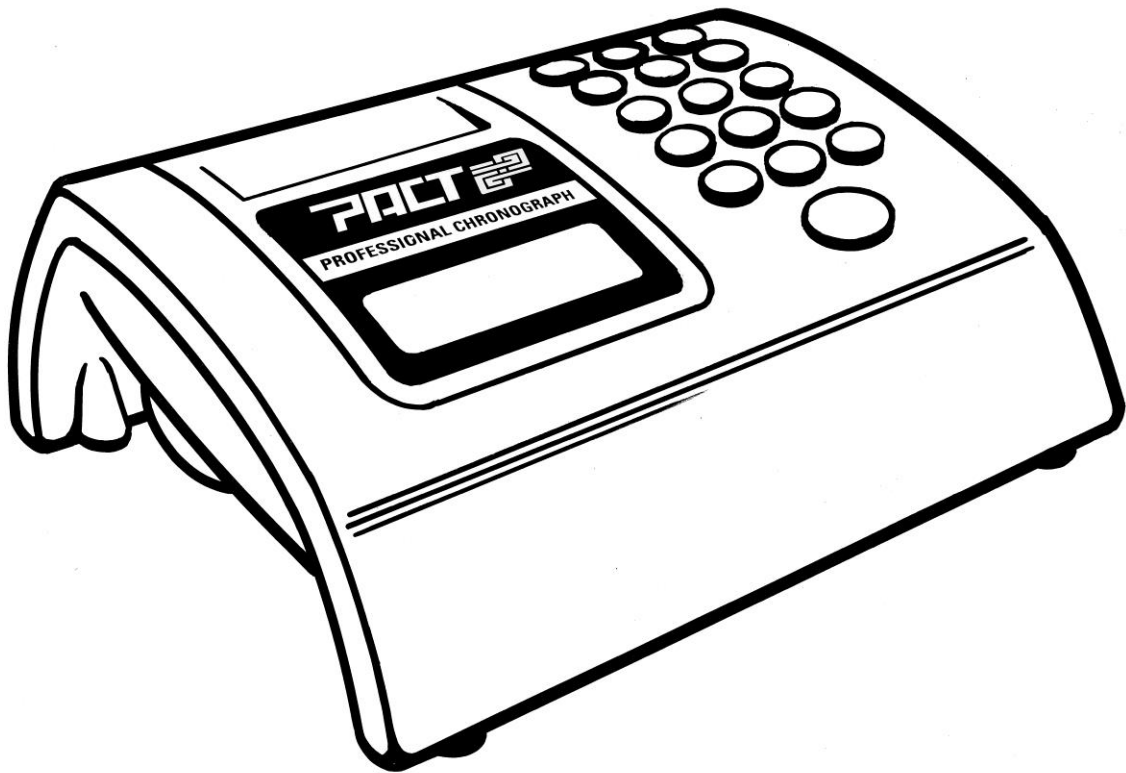# PACT Professional Chronograph XP

Users Manual

May, 2006

PACT Chronograph History

We've been building chronographs in various forms since 1983. Our first was an add-on module to our Shooting Timer we called the "Chrono-Mod." The small success of that product led us to design our first stand alone chronograph in 1985, the *PACT Precision Chronograph*. This proved to be a pretty popular product, as it was the first to offer a modern display, shot review and complete statistical analysis. In 1988 we added the capability to work with an inexpensive battery powered printer.

As happens in a free market, our competition responded with a new unit with a built in printer. So we started asking ourselves, what could we do with a chronograph to really help make it a useful tool for handloaders and folks shooting factory ammo? Our answer was to build a full function ballistic chronograph into the chronograph, so the shooter could actually use his velocity information obtained at the range, to adjust his sights for the correct zero at the range. This was our original PACT Professional Chronograph.

We added a few other features over the years, a Ballistic Coefficient Library, various calculations such as recoil and power that customers requested and other refinements. Then we got very focused in on making scales and powder dispensers.

In 2003 we decided to completely revamp the original PACT Professional Chronograph. All of the electronic hardware in your *PACT Professional Chronograph XP* is new and state of the art, which will allow us to use this "platform" for future refinements for years to come. The bullet detection circuitry is greatly refined. If you have upgraded from the original model, you will find the XP has much better sensitivity in low light, and does a better job in filtering out false readings.

Finally, while we could have put this in a square box and had it work just fine – we do know that looks count. It's more fun to play show and tell with your buddies if you have a really cool looking gizmo. So we spared no expense on the industrial design and tooling side to build you a chronograph that looks as good as it works. We hope you will enjoy our effort.

How Do I Work This Thing?

OK, with all appreciation and respect to our lady customers - odds are you are a *he* and have no intention whatsoever of reading this manual. This is too bad because some of the more interesting and arcane features of your PACT XP are kept out of the way, and you will need this manual to find them. Also, really having an understanding of how a chronograph works will not only help you when odd light conditions cause this thing to behave strangely – but will also arm you with all sorts of shooting trivia with which you can dazzle the unwashed.

Still not going to read past this page? OK, here is the quick and dirty:

1. Put the skyscreens on the mounting bracket – you'll figure it out.

2. Put the battery in the XP – **DON'T PUT IT IN BACKWARDS!!!** SEE THE LITTLE "+" SIGN and DO THAT! The screen should come on. If it does not, the battery is in backwards.

3. The first sensor the bullet gets to must be plugged into "Start.

4. The second sensor the bullet gets to must be plugged into "Stop."

5. If you get that backwards it won't work.

6. The display should read "FIRE WHEN READY." If it doesn't push GO.

7. Stop

8. If you hit (shoot) any part of this system bits and pieces of stuff will fly in all directions BLINDING, MAIMING and KILLING you and those around you.

9. So as we have been saying for twenty years:

10. **Wear Eye Protection!**

11. You chrono is ready for you to fire a round. It should display the velocity of each round fired on the top line on the display, and whatever statistic you want on the bottom line.

12. You can play around with the buttons and figure most of the rest out.

14. Or, you can read on.

HOW CHRONOGRAPHS WORK

A chronograph is a very high-speed stopwatch. It times the bullet over a known distance and converts that time to a velocity. The trick is in figuring out just when to start and stop the watch. Most folks look at a chronograph and get the idea that we "trigger" the timer on seeing the "shadow" of the bullet. This is not quite right. What we do is look at the average light level over recent history (actually a fraction of a second) and treat that as the currant ambient light level. Thet we electronically cock our selves – not unlike a set trigger. What touches your PACT Chrono off (starts and stops the clock) is a VERY rapid *change* or perturbation in the light level.

Interestingly, sometimes the change is up – it gets brighter when the bullet flies over the sensor. This happens if the ground (which is reflected by the bullet) is brighter then the "sky." Usually, it gets a bit darker when the bullet crosses over the sensor, but we can detect a change in either direction.

So we set our trigger, the bullet (or something else) pulls the trigger, and we start counting: one Mississippi, two Mississippi, etc. Of course we are doing that counting faster then our Masters In Washington can spend our money, around 11,000,000 counts per second. So now the bullet is flying over our known distance drag strip,18 inches in our case. We start the count when the tip of the bullet crosses the Start sensor and we stop when it crosses the Stop sensor. A bit of calculating and we know the velocity.

Once we have the velocity for that shot we store it and the shot number in memory, and calculate whatever statistic you have selected for the bottom line of the display. We default to the Average Velocity, but you can select what ever you are after – and we calculate everything when you Review your shots.

In the background we store every shot in memory by String Number, Shot Number and Velocity. You can review any string in memory and make print outs if you like.

CHRONOGRAPH OPERATION

First of all you will need to get your sky screens mounted to the bracket as shown in the illustration. Make sure the sensor's "click" into position.
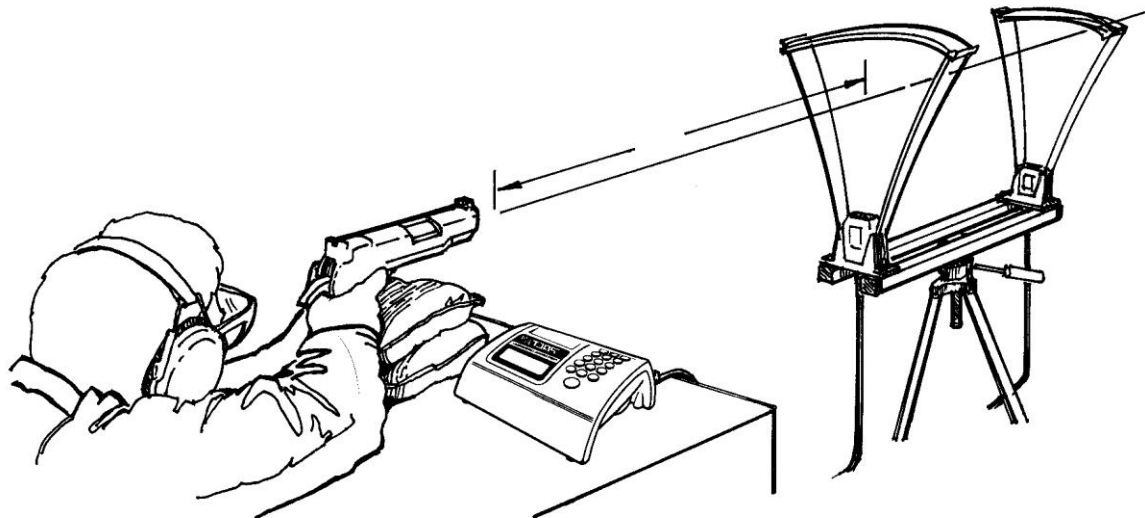
This will insure that the screens are precisely 18" apart.

Fit the black side pieces into the white cross piece and then slide the whole thing into the sensor. The first skyscreen the bullet will pass over gets plugged into START, the second into STOP.

Turn the unit on. The screen will display some messages then "**FIRE WHEN READY**." If it says something else press **GO** so that it says **FIRE WHEN READY** – it has to say that for you to begin a new string of fire.

MAKE SURE YOU HAVE YOUR SHOOTING GLASSES ON – IF YOU HIT A SKYSCREEN OR THE DEVICE HOLDNG IT, BITS OF PLASTIC, METAL AND BULLET WILL FLY IN ALL DIRECTIONS AND **RIP YOUR EYES OUT**.

DON'T PUT A METAL PLATE IN FRONT OF YOUR SKYSCREENS

When you fire you should aim in such a way that the bullet passes over the **center** of both screens 5 to 8 inches above the sensor at the bottom of the "V." Under most light conditions you can actually shoot higher and still get a reading, but the lens is focused at that distance – 5 to 8 inches.

Go ahead and fire a round. The XP should say something like:

#01   2450.3 FPS
Avg. Vel. 2450.3 FPS

This says that you have fired one shot, which was 2450.3 FPS and your current average velocity is 2450.3 FPS.

If nothing happened, you probably had the screens plugged in backwards (it's easy to do). Check that and give it another go.

Note that you must wait about one second between shots. This gets all the data stored and allows a moment for the smoke to clear. If you fire faster then that you may get an error reading or skip a shot.

Fire a few more shots. Your screen will display something like:

#05   2465.2 FPS
Avg. Vel. 2458.5 FPS

Your XP actually calculates all of the statistics for your current string after each shot, any one of which can be displayed on the bottom line of the display. Take a look at your keypad. You'll see that keys 1 through 5 are devoted to these functions. Go ahead and press each one and watch what happens to the bottom line of the display.

AVG is the current average velocity of the string.

HIGH/LOW   is the highest and lowest velocity of the string.

EXTRM SPRD is the difference between the highest and lowest velocities.

MAD stands for Mean Absolute Deviation and is the average amount that the shots deviated from the average velocity. This is what most folks think Standard Deviation is. MAD is, in our view, the best indicator of the consistency of your loads.

The second number is the MAD expressed as a percent of your average velocity – the *Coefficient of Variation*. This lets you make a meaningful comparison of the average variations of two loads with substantially different velocities. In other words you can say that this load of xxx with a 150Gr spitzer has a average deviation of 1.3%. My next load of yyy with a 168Gr BT had an average variation of .9%.

$$MAD = \frac{1}{n} \sum_{i=1}^{n} \left| x_i - \bar{x} \right|$$

STD DEV stand for Standard Deviation. As with MAD, we also express this as a percent of your average velocity. Note that there is a problem using SD with the small sample sizes we typically work with in shooting – the act of adding more samples will, in and of itself, lower the SD a bit.

$$s_x = \sqrt{V(x)} = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} \left(x_i - \bar{x} \right)^2}$$

See that "n – 1" thing? That is the problem. The sample size minus one. So if you fire five shots, then fire the exact same five shots again making a total of ten – the SD drops a bit.

Look, use what you want – we give your both. But we recommend MAD over SD and in either case, the number should be expressed as a % of your average velocity.

Note: You can have up to 20 shots *in a single string*.

REVIEWING YOUR STRING

At any time you can press the REVIEW key to review any string stored in memory. You will be asked what string you want to review. If you want to review the last string just push REVIEW a second time, otherwise enter the number of the string you want to have a look at, then press REVIEW.

Each time you press the REVIEW key the XP will take another step through the review process; stepping through all the statistics of your string and then each shot.

If you spot an erroneous velocity during REVIEW, you can press the DELETE key to clear it from memory. When you REVIEW the string again, that shot(s) will be gone and the statistics recalculated.

During REVIEW, if you want to jump to a specific shot just press the shot number you want to see, then press REVIEW and the XP will jump to that shot.

If you want to add (fire) more shots to the string you are reviewing, press the ADD SHOTS button at anytime during REVIEW.

To start a new string push GO until you see, "FIRE WHEN READY"

PRINTING YOUR STRING

Note: In the interest of saving paper and battery life, we advance the paper just enough so that you can see printing was accomplished, but not enough to run the last line out of the machine. Many shooters will run a long strip. If you want a short print out, just pull the paper to the end of the printing and **tear it off from right to left**.

You can always print the two lines that are on the display by pressing **PRINT**. Outside of the REVIEW function, this will produce a "screen shot."

During REVIEW, if you press the **PRINT** button, you will get a complete print out of the string being reviewed. Again, we don't run the paper all the way out.

LIGHT CONDITIONS, MUZZLE BLAST AND ERRORS

Your XP needs two things to see the bullet: Enough light to make the sensor "turn on," and sufficient contrast between the bullet and the "sky."

In other words it will not work in the dark or very low light conditions.

A clear blue-sky day also poses a problem, even though the ground is bright (because it reflects the sun) the actual sky can be quite dark. Think of those sunny days when you can see the moon.

The white cross piece or Diffuser Screen addresses the problems of shooting on a sunny blue-sky day. When the sun light hits it, the light scatters and we get an artificial overcast. It also keep the sun from getting a straight line-of-sight shot at the sensor eye.

As a rule, use the white diffuser screens at the top of the V. The exception to this would be a dark overcast or foggy day. Under those conditions there is no direct sunlight to diffuse – the water droplets in the clouds or fog already did that for you. The problem under these conditions can be lack of sufficient light to operate. If that occurs and the XP has problems seeing the bullet try leaving the white top piece off, you can still use the side pieces as aiming guides.

Muzzle blast can be a problem. When firing a subsonic round, the blast can and does get to the sensor before the bullet. If it has enough power when it gets there, it may trigger one or both of your sensors; causing a bad reading in either case. In this situation the answer is to back up a bit – so the blast has more

distance over which to diminish. This is a bigger problem with high blast slow speed rounds such as black powder and shotguns, but you may see it now and again with your trusty .45 ACP.

Other problems with muzzle blast include blowing your skyscreens over, more of an issue with very high blast rifles. If that happens just set them out a little farther. Another odd problem can come when the sun is low behind you and you are shooting a high blast gun. We have seen on rare occasion, a situation in which the sensors triggered on the shadow of the muzzle blast crossing the diffuser screens as the actual blast crossing between the sun (which is behind you) and the diffuser screens (which are in front of you).

You would suspect that error if your velocities were impossibly consistent, perhaps varying by only a few feet per second. Again this is not a common problem, but if you suspect it you might try removing the diffuser screens or shooting a low blast gun as a test.

The final problem we see now and again is a powerful side blast hitting the chronograph it self, causing the unit to miss trigger and fail to record your shot. This was more of a problem back when muzzle breaks were popular on center fire rifles. Most shooters who were using those have since had to sell them to fund their new high dollar hearing aids, so it's really not much of a problem any more. If you have one of these monsters, or are shooting some other massive blast gun and your XP is getting hammered, try putting something between the muzzle and the chronograph to shield it.

ODDS & ENDS

How do you know if your chronograph is telling you the truth? If the sensors are the correct distance apart (a problem with all "fold up" chronographs) and the reading is in the range of what you are expecting, you can count on the accuracy being in the .5% range. That is point five percent **not** five percent. In practice you will find the readings are actually much better then that, closer to .3% or better. Overcast days will produce more consistent readings then bright sunny days.

In twenty years of building chronograph's we have yet to have a unit returned for repair because it read too high. However about once a month a member of the Magnum/Weatherly club has us, "check his unit out" because it reads "200 feet low" with his latest warp speed zapper. Most recently we saw some of this during the brief popularity of the 30-378. While we have seen a few bad counter chips out of tens of thousands of chronographs tested, it is damn near impossible for a chrono to read "200 feet low" with one cartridge and correct with another.

If you want to compare two chronographs, you should set them up so that a single shot register on both units. We recommend that you compare average velocities on 10 shot strings. To compare the "Variability" of one chronograph to another, compare the SD's or Med's (if available) recorded on each string on each chronograph. If chronograph "A" has a 10% lower SD or MAD **on the same**

string then chronograph "B" then you can correctly say that chronograph "A" has a slightly lower "total system error." Note that even with two truly independent chronographs set up, you can get **duplicate erroneous readings.** This is caused by the simple fact that en error caused by environmental conditions will likely effect both machines.

To shoot indoors you will need to provide a light source directly above the diffuser screens - you need to fake up an overcast day. Depending on the distance from the screens, as little as a 60 watt incandescent bulb will provide enough light to operate. Note that florescent lights will not work at all!

The XP will turn itself off after about 15 minutes of non-use.

When the XP is off, like most electronic stuff these days, it's not really off but asleep. And it is burning just the smallest bit of power. If you use it once, then put it up for months, we suggest you pull the battery.

TROUBLE SHOOTING

Hopefully you won't have any problems with your PACT Professional Chronograph XP. We have really worked hard to incorporate into it all we have learned about chronographs in order to make it as reliable as possible. Of course every so often a capacitor dies, a resistor breaks or an integrated circuit goes on vacation. These things don't happen very often and we go to great lengths to see to it that we use only the best possible components. If your XP does misbehave, here are some things to check.

Are the screens plugged in correctly?

Is the battery up to speed? As the battery gets low on power, the sensors will become less sensitive.

Water can wreak havoc inside your skyscreens. If you leave them out in the rain they will fill with water and short out. If that happens, it may be necessary to take them apart to dry out. You probably won't leave them out in the rain twice.

If you do have a question or a problem, for goodness sake, **DON'T SUFFER IN SILENCE!** Call us at 800 PACT INC. Our success depends on your satisfaction. We will get you sorted out.

BALISTIC CALCULATION

You XP contains a full function ballistic computer and a very complete library of almost all currently manufactured bullets. This allows you to calculate the bullet flight path for most any set of conditions. Because we have an interest in both field and target shooting, we have include zeroing options to address both disciplines.

The actual formulas used today for trajectory calculation date back to World War 1 and were refined between the wars. We certainly did not invent them and do not hold ourselves out as "ballisticians." We simply use the established methods in ways to give you some useful data that will help you at the range and in the field.

In order to predict or calculate where your bullet will be at a given range relative to your zero – we need to know three things: The height of your sight above the bore, the velocity, and the Ballistic Coefficient (BC) of your bullet – this is the "drag factor". Your PACT XP has a library of around 800+ bullets, provided to us by every major and most minor bullet manufactures. If you are using a bullet we don't have in the library, you can just manually enter the BC.

OK, let's calculate a trajectory.

Press "**CALC TRAJ**" (number 7). You will be asked for a velocity. Type one in, say 3000 and press **SET** .

Next you are asked for the Ballistic Coefficient of your bullet using our "rolling menu." If you press **1** you can manually enter a BC, if you press **2** you can access the bullet library. Press **2.**

Lets tell it .338 for your caliber and press **SET,** then 225 for a weight and press **SET**. Now you will see a rolling menu with every manufacture listed who makes a .338 caliber 225 grain bullet. Press **2** for Hornady in this case. Now you see a rolling menu with the two bullets Hornady makes which meet this criteria. Press **2** again for their SST bullet. We briefly display the BC, .430 in this case, and move on to the next question.

Standard Atmosphere? If you are going to me shooting at higher altitudes this makes a difference as the air is thinner which has the effect of raising the effective BC of the bullet. For this example, press **NO.** Enter an altitude of **8000** feet and press **SET,** and a temperature of **72** and press **SET.**

The sight height really does matter if you want the drop table to be accurate. We default to 1.5" but if you are really setting a gun up for the field it is well worth the hassle to measure. It in the difference from the center of your bore to the center of your scope. We'll use 1.5 for this, so just push **SET**.

Now we ask you to tell us if you want us to calculate your maximum point blank range, or zero to a specific distance. Most field shooters (hunters and warriors) use a Max Point Blank Range zero. Target shooters, because they will know the distance to the target, will zero to that range. Since we are shooting the .338 today, let's pick **1 (press it),** The Max Point Blank Range.

Pick the vital zone size. This is will let us come up with the maximum distance that you can fire this bullet at this velocity and never have the bullet climb above or fall below this circle. After a good bit of consultation with knowledgeable folks, we set the default to 6". Press **SET** to accept that.

Now you are asked the starting range you'd like, just press **SET,** to accept the default range of 50 Yards, **SET** again for the ending range of 500, and **SET** once more for the range increment of 50 yards. You could have changed any of those by entering a different number before pressing **SET.** Let's leave the cross wind alone in this case by pressing **SET** again. Finally, let's go ahead and make a printout by selecting **2** from our rolling menu.

One very cool thing you can do with this if you have a gun which is already zeroed, is print a drop table with a off set at 100 yards. You'd go through the same procedure, but tell the XP to set the zero to a specific range, then tell it how high at that range. So if you already had your trusty M70 set 2" high at 100, with the same bullet and velocity.

Note that in either case, we always tell you where to zero at 100 yards.

OPTIONS

The **OPTN** button gives you a rolling menu with eight options, most of these you will probably never mess with, but some are fun.

1 BC Library – Lets you look up the BC of any bullet in the library, about 800 currently with more to come.

2 Third Column – Lets you select the data to appear in the third column of your ballistic print out.

3 Metric Mode – Changes velocity to MPS. Trajectory still in yards.

4 Full BC Report – This gives all the data for each reporting distance.

5 Free Recoil – This is fun. Calculates free recoil based on gun, charge weight, bullet weight, and velocity. Then we compare it to a standard 30-06 round and give you a PACT Recoil Index. In our example 338 we've been using, that works out to about 30.9 ft/pounds of recoil, which is 159 on our recoil index – a 30-06 being equal to 100.

6 **Compute BC** – Let's you compute the actual BC of a bullet from two chronograph readings. Not considered sporting by the marketing departments of certain bullet manufactures. (Actually, now days they are pretty close).

7 Print Contrast – When it is real cold, the print wont be as dark. Also we have found that the paper can sometimes vary roll to roll. After chasing this for a few years we wised up and gave you the control. The default is **5**.

8 Print Test – We use this to test your printer

MENU

Here we put features we think you will use more often.

1 Separation - The distance in inches between the centers on the screens. Needs to be 24 if you are using our red bracket.

2 Print Mode – Normally we only print when you tell us to, this saves batteries and the rain forest (aka jungle). But if you select **2 When Fired,** we will print the velocity when you fire the round. Note that we will not kick out enough paper for you to see the bottom of the printing.

3 Clear Memory – Gives you the option of wiping the shots in memory and restoring the system defaults.

4 PC Connect – This tells the XP to look for your computer. Pushing **GO** gets you back out of this.

POWER CALCULATION

The **CALC PWR** button gives you another rolling menu with four choices:

1 IPSC Power – used for calculating the "Power Factor" for various types of action shooting competition.

2 Kinetic Energy – the preferred calculation of power by those who shoot light bullets going fast.

3 Taylor "Knock Out" takes into account weight, velocity and caliber. If you have your "480 Rugar" in hand, this will make you look the best.

4 Momentum this in one of those real world calculations that is only popular among shooters actually trying to knock something over – metal silhouettes.

SERVICE

Your XP is backed by our limited lifetime warranty. We don't care where you bought it or if you have your receipt. If it breaks we'll fix it for free, if you break it (drive off with it on the hood of your car) we fix it for cost. But should you have a problem, we do ask that you *please* call us at 800-722-8462 before you send it in. Very often we can figure out the problem over the phone and come up with a way to get you rolling again.

ALWAYS WEAR YOUR EYE PROTECTION