Worker safety and modernization in the industry.

In 1995 the S/A Pernambuco Powder Factory suffered a catastrophic series of fires and explosions. The plant was shut down for 6 months while repairs were being made. This rebuilding program included the incorporation of safety measures unmatched in any other black powder production facility.

Figure 90. A 5.5-ton wheel mill.

The photo shows one of the wheel mill buildings at the S/A Pernambuco Powder Factory.

When in operation there is water on the cement floor around the mill.

In the lower right hand corner of the photograph is a square pool of water. The mill worker wears rubber boots that go about 2/3 of the way up to his knees. When servicing the wheel mill he would first step into the square pool with both feet. Then into the pool that surrounds the wheel mill.

When the wheel mill is in operation no one is permitted to enter the building or even get closer to it than a certain distance. This use of pools of water, with rubber boots, insures that if the operator's foot wear should pick up any bits of gravel they will not cause a fire or explosion with dust around the mill. The pool of water around the mill eliminates the dust problem. It insures that electrostatic discharges could not occur.

In 19th century German powder plants they would usually place sheep skins on the floor of a wheel mill building. Fleece side up. The fleece would trap any powder dust and prevent any inadvertent fire or explosion. At the end of a working shift the sheep skins would be removed for washing and clean ones laid on the floor. The method seen in the photo above is simply another way of dealing with the wheel mill safety in a country where water would not freeze on the floor.

With the 1995 rebuilding of the S/A Pernambuco Powder Factory the owner spent the equivalent of 1 million U.S. dollars on a computer control system in the plant.

This photo shows the control room installed with the 1995 plant rebuilding. Every section of the powder making process could be watched and controlled from the control room.

The workers would perform a required task at a specific machine. The worker would then move away from the building and call the control room. The operator in the control room would then start that piece of machinery in operation. There were emergency shut off switches a safe distance from the machinery but the machines could only be started from the control room.

No other black powder plant in the world has taken this approach to plant safety. It is unknown if this system was set up at the new powder plant built around the machinery salvaged from the S/A Pernambuco Powder Factory when it ceased operations in 2001.

One other powder manufacturer tried to claim that their plant was state of the art safety a few years later but this claim was a sick joke at best.

Within a few years after this system was installed their was an incident where a worker was badly burned while cleaning a wheel mill. This operator had been previously been spoken to about the safe way to clean out a mill pan in a safe manner. One day he ignored the rules and the powder dust in the mill pan caught fire. It is simply not possible to engineer one of these plants to totally eliminate all risks when a worker fails to follow safety rules. This problem has been an issue with other powder plants in the world.

There have been any number of attempts in the past 100 years to replace the traditional machinery used in the manufacture of black powder.

In Dan Pawlak's "Background Of The Invention" in patent 4,128,443 (Pyrodex) he relates: "Yet another disadvantage of black powder resides in the extremely heavy and expensive equipment required in its manufacture. Thus, the composition is commonly mixed, milled under massive stone wheels, pressed in a hydraulic press at about 1200 p.s.i., granulated by crushing the presscake, and then polished and graded. The multi-step operation requires not only considerable expense in investment for equipment, but also it is time-consuming and extremely dangerous in its operation. Thus, the art is in need of a simpler, less expensive, and safer method to produce deflagrating compositions of the lower-pressure, or "black powder" type."

Engineers with Du Pont had tried to produce black powder by replacing the wheel mill with something described as looking like a log in a round bottom trough. A primitive form of an extruder. They were able to produce a blasting powder burn rate product with this but nothing that would be acceptable as a small-arms propellant powder.

We still see the traditional wheel mill in use today simply because it is the most efficient and cost effective way to produce black powder in commercial quantities.

In the early 1980's the U.S. military set up a black powder manufacturing operation at the Indiana Army Ammunition Plant (IAAP) in Charlestown, IN. ICI Americas, Inc. was the prime contractor and the plant was set up around what is known as the Jet-Mill process.

This Jet-Mill process had been patented in 1972 by Kjell Lovold in Norway. The patent being assigned to Norsk Spraengstofindustri A/S.

A jet-mill is a fairly simple machine. Consisting of an annual ring with grooves cut across the face of the inside of the ring. A pipe carry air enters the ring at an angle. A nozzle accelerates the air to a very high velocity as it enters the inside of the ring. Giving what might best be described as a tornado effect. The air swirls around over the face of the grooved ring. Material to be "ground" is introduced into the stream of air being blown into the ring at high velocity. Particle size reduction is brought about when the particles impact on the edges/corners of the grooves cut across the face of the ring. Particle size reduction also occurs as a result of collisions between particles at high velocities.

The idea being that this method would both grind the ingredients and mix them together.

A jet-mill is less costly compared to a wheel mill. The jet mill is very simple and requires almost no maintenance. It was thought to be a good deal safer in operation when compared to a wheel mill.

Prior to ICI Americas using the jet-mill at the IAAP there was one in operation in Norway at the Norsk Spraengstofindustri A/S facility.

It had been in operation for only a short period of time before an explosion ended limited production. The operation was not rebuilt.

The proposed jet-mill process call for a jet-mill to replace the wheel mill in the powder-making process. Another jet-mill would be used to polish the powder, replacing the traditional polishing barrel.

The idea being that with two jet-mills in this process what had traditionally been a totally batch type production could be converted to something more akin to a continuous process. Such an operation would be cheaper to build and cheaper to run when compared to a traditional plant.

The IAAP produced small test batches of black powder using oak wood charcoal. This alone is a drastic deviation from tradition. Nobody ever made a useable black powder using oak as a source of charcoal. The selection of oak charcoal makes no sense. It is extremely difficult to reduce oak wood charcoal to a particle size suitable for use in any but the slowest burning type of black powder, i.e., blasting type powder. There is simply no historical backing for the selection of oak.

The US Army Ballistic Reasearch Laboratory at Aberdeen Proving Ground published data on the IAAP Jet-Mill Process product in a report titled, "Evaluation Of Black Powder Produced By Indiana Army Ammunition Plant". Technical Report BRL-TR-2596. Published in October 1984.

This report had been preceded in 1981 by a report titled, "The Influence Of Physical Properties On Black Powder Combustion". Technical Report ARBRL-TR-02308.

In the 1981 report the investigators looked at ingredient particle size produced by the jet mill process at IAAP. They reported that the ingredient particle sizes produced by the jet mill process were smaller than that produced by the more traditional method. To determine this they examined the ground ingredients using a scanning electron microscope and using a test based on sedimentation rates.

Before going any deeper in this. The author has had years of experience in laboratory work. Specifically particle size determination by a number of methods. Materials subjected to a variety of methods of particle size reduction including some work with a jet mill.

A scanning electron microscope may be used to view and measure individual particles as would be seen in black powder. But it will not give what is termed a particle size distribution range.

The idea of measuring particle size by sedimentation rate is a valid concept up to a point. The particles being tested must be of a uniform density and a uniform shape. Preferably spherical. In the case of the charcoal in black powder it is in odd shaped pieces looking as if it had been shredded. Then there is the point of sulfur particles being in with the charcoal. Different densities and different particle shapes. The test method simply cannot deal with all of the variables in this. They calculate particle size based on sedimentation rate

At the time they could have easily run the powder samples through a Coulter Counter normally used to count and size red and white blood cells. Sample particle density is not a factor in this test method. To look at charcoal particle size you simply break the sample down in water, filter it and then dry the mixture of charcoal and sulfur. Then subject that to a heated vacuum oven to volatilize and draw off the sulfur. Then run that through the Coulter Counter and you get a weight distribution size weight percent curve for the sample. Quick, neat and accurate.

It is important to note that after the jet-mill facility blew up in Norway it was not rebuilt. After a few test batches at IAAP that unit was mothballed. The IAAP was then closed. The military did not pursue the concept.

It appears that as long as there is still a supply of traditional black powder manufacturing machinery available it will still be made using the traditional machinery. But how long into the future is in question. No one continues to build the traditional wheel mill. The last company producing wheel mills as a stock item was Krupp in Germany. In 1985 the S/A Pernambuco Powder Factory purchased 9 wheel mills produced by Krupp in Germany. Krupp had announced that they would no longer produce wheel mills except on special order at a much higher price.

When GOEX moved their operation to the then new plant near Minden, LA they abandoned the old 10-ton Du Pont designed wheel mills at the Moosic, PA plant. The new plant at Minden was set up around 3 wheel mills that had been salvaged out of a closed plant in South Africa. When the salvaged machinery was shipped to the U.S. the container on board the ship carrying the spare parts went overboard in a storm. So replacement parts for their 3 5.5-ton wheel mills must be custom made. It is nearly impossible to destroy the large heavy wheels in a wheel mill but most use cast steel bed pans which are expensive to replace by fabrication and replacement drive gears are expensive to custom make.