Over the years there has been an almost continuous series of accidents involving people using energetic materials, too many of which involve fireworks, their manufacture or their preparation for use. There are important lessons that can be learned from these accidents; unfortunately most of these come too late for the people suffering those accidents. Even more unfortunately, many of the same factors have combined to produce similar accidents again and again.

The “rule” was developed as part of the safety training of personnel of a major (non-fireworks) pyrotechnic manufacturing company.\[^{[1]}\] Before discussing the rule, perhaps it is appropriate to review a few points from hazard management in general.\[^{[2]}\] Hazard management is generally thought to consist of three activities: Recognition, Evaluation, and Control. In simplest terms, recognition is just making a list of hazards; those things that could go wrong that have some potential for injury or financial loss. In evaluating the list of hazards, they are ranked (prioritized) according to the magnitude of the risk associated with each hazard. In doing this, there are two central considerations: what is the likelihood (probability) of having an accident, and what are the consequences (severity) in the event of an accident. Control consists of those actions taken to mitigate the hazards on the prioritized list, generally starting with those representing the greatest risk. Risk is reduced whenever actions are taken to reduce the probability of having an accident, or when actions are taken to reduce the severity of the consequences. Certainly the greatest reduction of risk occurs when both the probability and consequences of an accident are minimized. In considering those actions that might be used to reduce (control) risk, it is often useful to have a somewhat formalized process to help guide ones thinking. This process is often referred to as following or applying a risk control hierarchy. The remainder of this article is a discussion of one possible risk control hierarchy for working with energetic materials.

The rule is simple, each time before using energetic materials, especially if there is any change in the conditions of use, ask yourself the set of questions given below and act accordingly. These questions sound simple, perhaps almost to the point of seeming so trivially simple as to be ridiculous. However, before you dismiss them out of hand, please spend a moment considering them more fully. The questions are:

1) *Do you really need to use it?*

2) *How little of it can you use?*

3) *Can it be somewhere else?*

4) *Do you really have to do what you are doing to it?*

5) *Can you use “personal protection equipment”?*

In considering these questions, do not automatically dismiss any of them with “that’s how it has always been done” attitude. It is true that one may conclude that the way it has always been done is the best. However, in the authors’ experience, very often there are safer ways to operate that involve no more work or expense. Further, it is surprising how many times it will be discovered that there are safer ways to operate that are actually easier or involve less expense. The key part of the exercise is to spend some time honestly considering alternatives and to keep an open mind while doing so. Although one might argue a little about the order of the questions, generally start at the top and work down. In the remainder of this article, each of the questions will be discussed briefly.

1) *Do you really need to use it?* This is really asking, are there safer alternatives you should be considering? In some cases this may even include the use of non-explosive materials or methods. However, generally it is intended to assess the possibility of using less sensitive materials. Most typically, the greatest hazards associated with working with energetic materials are associated with their
accidental ignition (or initiation). Obviously the likelihood of accidental ignition is reduced when less sensitive materials are used. Among approximately equally sensitive materials, consideration should also include considering alternatives that have fewer undesirable health or environmental effects in either their unreacted or reacted form. Also the consequences of an accident are reduced when less violent or less energetic materials can be substituted. Further, one should consider other hazardous features of a process, such as the use of flammable versus non-flammable solvents or adhesives.

2) How little of it can you use? In a sense this is really at least two questions. This is asking you to consider whether you can use less of the energetic material in manufacturing a specific device. However, it is also asking you to consider things such as, do you really need to have as much raw material and/or completed items in the immediate work area. Obviously both are important because the consequences (severity) of an accident upon the accidental ignition of energetic materials is reduced when the total amount of those materials involved is reduced.

3) Can it be somewhere else? For the most part, this is suggesting consideration be given to conducting the most hazardous operations remotely. However, this also includes less expensive things such as keeping raw materials covered and/or stored at a safer distance, not allowing finished items to accumulate in the work area, and keeping the area free of spilled composition and dusts. As in question 2, these are actions that will reduce the consequences of an accidental ignition.

4) Do you really have to do what you are doing to it? For the most part, this is another step in reducing the probability of an accident, this time by considering alternate processing methods. For example, this might include the alternative of pressing a composition as opposed to ramming it using mallet blows, considering the use of a phlegmatizer (adding a small amount of lubricant) to reduce sensitiveness to friction when compacting a composition, and using electrostatically conductive containers and grounded equipment during processing. As another example, one should consider using less hazardous mixing techniques, such as adding the chlorate oxidizer to a smoke composition in increments so as not to temporarily produce an especially hazardous mixture.

5) Can you use “personal protection equipment”? This is really ones last line of defense, and while the use of personal protection is certainly appropriate, it should not be seen as a substitute for other methods of reducing the severity of an accident. Personal protection equipment includes items such as small fire and explosion shields, face shields, safety glasses, leather aprons and gloves, hearing protectors, and breathing masks.

Hazard management is little more than the application of common sense and finding safer alternatives that are no more difficult or expensive often requires only a little thought. It is amazing how infrequently this is done, especially when one considers the high personal and business expense of accidents, and the consistency with which accidents seem to occur. Please take a little time to consider how your operations involving energetic materials might be performed more safely.

References
