April 9, 2013

**An Open Letter to Jimmy Carter, Former President of the United States of America**

# A Positive Lesson from the Accident at Three Mile Island

To Dr. Pluviose: This is interesting and valuable. I hope you will share it with technicians who are still active. Jimmy Carter

Mr. President,

A recent string of incidents at some power plants suggests that the failures of Three Mile Island (TMI) still haunt us. The report, which was submitted to you in October 1979, blamed mainly the maintenance of the equipment and the defective training of the operators.

An apparently overlooked but crucial fact is that nine times before the TMI accident, the pilot-operated relief valve (PORV) had become stuck in the open position. However, according to international standards, a relief valve must open when the conditions require it, and must close when the pressure in the tank has returned to its normal value. The PORV at TMI thus did not comply with the standards. Consequently, it did not function correctly. The cause of these failures is to be sought in an unexplored part of physics where energy must be massively and quickly degraded.

Because at the time of the accident, the physics of chaos was still in its infancy, it was not possible to determine the initial cause of the TMI disaster, namely the functioning of the PORV in the chaotic domain. As I have been personally involved for a long time in the operation of valves, I would like to highlight the role played by this safety valve in the TMI disaster, and to suggest a beneficial solution.

The only reason for recalling this tragic accident at this time is because what I have to say applies to all valves, and especially to those that currently vibrate all over the world.

Control and relief valves are quite often involved when incidents occur in power plants. Scientists have been trying for centuries to understand their operation.

Consider for a moment the phenomena occurring in an ordinary faucet. When the faucet is opened, the speed of the fluid increases and therefore the fluid has a kinetic energy that degrades downstream. The motive power contained in this jet is dissipated in the atmosphere where it is definitively lost. The fluctuations observed when the laminar flow transforms into a turbulent flow follow the laws of chance and lead us to consider a turbulent flow as a manifestation of chaos. From these two easily observable phenomena, it can be concluded that dissipation of energy and instabilities accompany all types of flows.

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In most installations, the fluid is confined downstream in a pipe, where it becomes even more difficult to describe the underlying physical nature of the processes since other chaotic phenomena appear.

The significant differences in pressure existing between the tanks upstream and downstream at the time of the opening of a safety valve abruptly set the fluid in motion. The fluid has a considerable kinetic energy and hence a kinetic power which can reach tens of megawatts. The flows go through very dangerous chaotic zones and then more or less stable supersonic structures are formed. The fluid, by whatever means it likes, degrades its kinetic energy into heat, but also into other harmful forms, such as vibration, noise, etc. which can severely damage the installation.

Supersonic structures formed by billions of billions of self-organized molecules are called dissipative structures, to convey the joint ideas of order and disorder. These structures exchange energy and matter with their surroundings, and therefore persist for a certain time before disappearing. In valves, these dissipative structures are unwelcome; we must absolutely prevent them from occurring.

At the TMI facility, the disturbances caused by the fluid ridding itself of its kinetic power must have had such an impact on the valve rod during its opening that it became mechanically impossible for it to close. In other incidents, even when the valve does close, it is no longer leak-proof.

Inadvertently, we have allowed chaos to enter safety devices whose purpose is to guarantee the safety of people and facilities. The dangerousness of uncontrolled flows in valves remains a cause for serious concern. For example, as recently as December 2012, the AFP press agency reported the random functioning of a steam valve in a nuclear power plant in France.

A proactive solution, which uses what I have called the principle of worst action, consists in deliberately destroying the structure of the supersonic flows, as soon as they appear, so that the molecules cannot aggregate in dissipative structures. By thus creating intense disorder in the microscopic world, chaos can be avoided in our macroscopic world. The principle of worst action is applicable when the kinetic powers to be degraded are huge. The device used to achieve this is the Kinetic Energy Degrader or more briefly a Vistemboir.

Physics was cruel towards mankind at Three Mile Island. It tried to warn us but we did not listen. Today, this lesson was heard.

Sincerely,

Dr. Michel Pluviose
Honorary professor
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