Chemical accidents have been caused by a number of reasons, including human error, design flaws, lack of process and engineering knowledge, equipment failure, and natural disasters. The danger posed to the employees of a chemical plant as well as the public is illustrated by the accidents that have occurred in onshore as well as offshore chemical process industries. Figure 1 provides accident statistics for 1989 from the Accidental Release Information Program (ARIP) of the U.S. Environmental Protection Agency [I]. ARIP statistics cover catastrophic and unplanned releases of chemicals into the atmosphere. However, these statistics underline the fact that a large number of accidents and catastrophic releases occur because of design flaws, wrong equipment specifications, and lack of or disregard of operating and maintenance procedures. The boardroom perspective on the cause of these accidents and what to do about them varies. The total number of process plant accidents cannot be estimated accurately because of underreporting. However, it is clear that the number of accidents is large and many people, both workers and the public, are affected adversely by these accidents. For example, in 1991, the National Response Center received over 16,300 calls reporting the release or potential release of hazardous chemicals [3]. Another study [4] analyzed the EPA’s Emergency Response Notification System database of chemical accident notifications. The study found that from 1988 through 1992, an average of 19 accidents occurred each day (i.e., more than 34,500 accidents involving toxic chemicals occurred over the 5-year period). The promulgation of the Toxic Release Inventory Reporting requirements [51 as part of the Clean Air Act Amendments of 1990 led to the submittal of toxic release information which clearly delineated the number and extent of toxic chemical releases and their potential impact on the public and the environment. In addition to the industry and government agencies, the university has a critical role in changing this situation.

In addition to statistics and the sheer number of facilities involved, a number of highly publicized chemical plant incidents in the 1970s and 1980s focused attention on management systems and technologies. For example, the 1974 Flixborough accident occurred because a temporary pipe was used to replace a reactor which had been removed for repair [61. The temporary piping was not properly designed and supported merely on scaffolding. A management of change system could very well have prevented the incident. The causes behind the 1984 Bhopal accident, which involved the release of methyl isocyanate and caused thousands of fatalities, have been investigated quite extensively with varying conclusions. However, the need for inherently safer design considerations is quite unanimous. Bhopal and many other process plant incidents including the 1984 Mexico City disaster [7] also emphasize the need for application of structured management systems for hazard recognition and identification. According to the official report [81 following the 1988 Piper Alpha disaster in a North Sea offshore rig, a pump relief valve was removed for overhaul and the open end blanked. Another shift not knowing the relief valve was missing, started up the pump. However, this primary reason does not obviate the fact that a number of other factors contributed to the extensive damage. Among other things, the Phillips 1989 explosion 191 in
the high-density polyethylene plant demonstrates the need to adhere to operating procedures and implementing appropriate management systems for contract workers. Many process plant accidents in the 1970s and 1980s also exposed the need for management systems to ensure process and equipment integrity.

Change in population demographics, increasing awareness of process plant hazards, and, above all, the continuing threat of a chemical catastrophe continue to provide the impetus for governments to develop legislation for eliminating or minimizing the potential of such accidents. International efforts include the Seveso Directive covering members of the European Community. Many other nations also have similar laws, such as the Sedesol guidelines in Mexico for performing process risk audits and the post-Bhopal accident prevention law in India. The World Bank has developed guidelines for identifying and controlling hazards, and the International Labor Organization has developed a code of practice for preventing major accidents. In 1990, the U.S. Congress enacted the Clean Air Act Amendments (CAAA) into law. The CAAA directed the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA) to develop regulations to reduce the frequency and severity of chemical plant accidents. In keeping with the congressional mandate given in Section 304 of the CAAA, OSHA promulgated the Process Safety Management (PSM) regulation on February 24, 1992. The PSM regulation is intended to protect workplace employees. Similarly, as mandated by Section 301(r) of the CAAA, EPA promulgated its risk management program regulation in 1996, to protect the public and the environment. In the United States, federal agencies are not the only government regulators active in the chemical accident prevention arena. Several states have empowered their health, safety, and environmental agencies to create regulations requiring companies to establish and practice specific programs to improve safety.