I. INTRODUCTION

The purpose of introducing the SECURE reactor concepts is, simply stated, to surmount the present impediments to the rational use of nuclear energy in many countries.

Although these difficulties are well-known to everyone concerned, a short summary of the present situation is useful as a background to the design philosophy underlying the SECURE concepts.

During operation a large power reactor contains gigacuries of radioactivity in the fuel, the dispersal of which in the environment would constitute a major disaster. And the after-heat does indeed constitute a mechanism for self-dispersal of much of this radioactivity.

Were it not for the necessity of preventing this dispersal, nuclear power technology would be simple and cheap. By now it has become highly complex (as exemplified by the use of about ten times more valves than in a fossil plant of similar capacity) and consequently economic only in very large units. These characteristics alone limit its use to large integrated power grids.

Nuclear power, that should be the great equalizer in energy costs employing as it does a cheap fuel with negligible transport cost, now tends to become yet another privilege of the rich industrial nations. Even in the industrialized countries, where very large units can be accommodated, much
of the economic advantage that nuclear power should enjoy has been lost because of the trend toward design complexity.

How did this unfortunate development come about?

The root cause is a basic incompatibility of the reactor design principles employed with light water reactors (LWRs) since the 1950s with the public's ever increasing demand for guarantees against radioactivity dispersal in the environment.

To prevent break-downs and malfunctions in an operating reactor developing into accidents involving radioactivity dispersal, recourse is taken to the so-called defence in depth strategy. This implies reliance on active protection measures involving actuation of pumps, valves, electric power sources etc. and, to a varying extent, operator intervention.

But these components and systems may fail and the operators may err - the public and the regulators it puts in place can never be made to believe anything else. The industry response to this has been more of the same - more safety systems, more equipment, better equipment, better operator training, etc. Redundancy, diversity, spatial separation of systems, quality assurance and increased requirements for operator knowledge and skill have been the catchwords.

The end result is the present complexity which in itself may represent a safety problem because of the increased burden on operators and the potential for unforeseen interaction between seemingly unrelated safety systems. In some recent assessments of technological risks, evidently being taken seriously (1), this complexity is considered the prime argument for non-acceptance of nuclear power.

And public confidence evidently continues to elude nuclear power. The proliferation of safety systems only seems to act as a confirmation of the suspicion that the technology is basically hazardous. The TMI incident served as a confirmation for the critics and as a source of nagging doubt for those who remained open-minded.