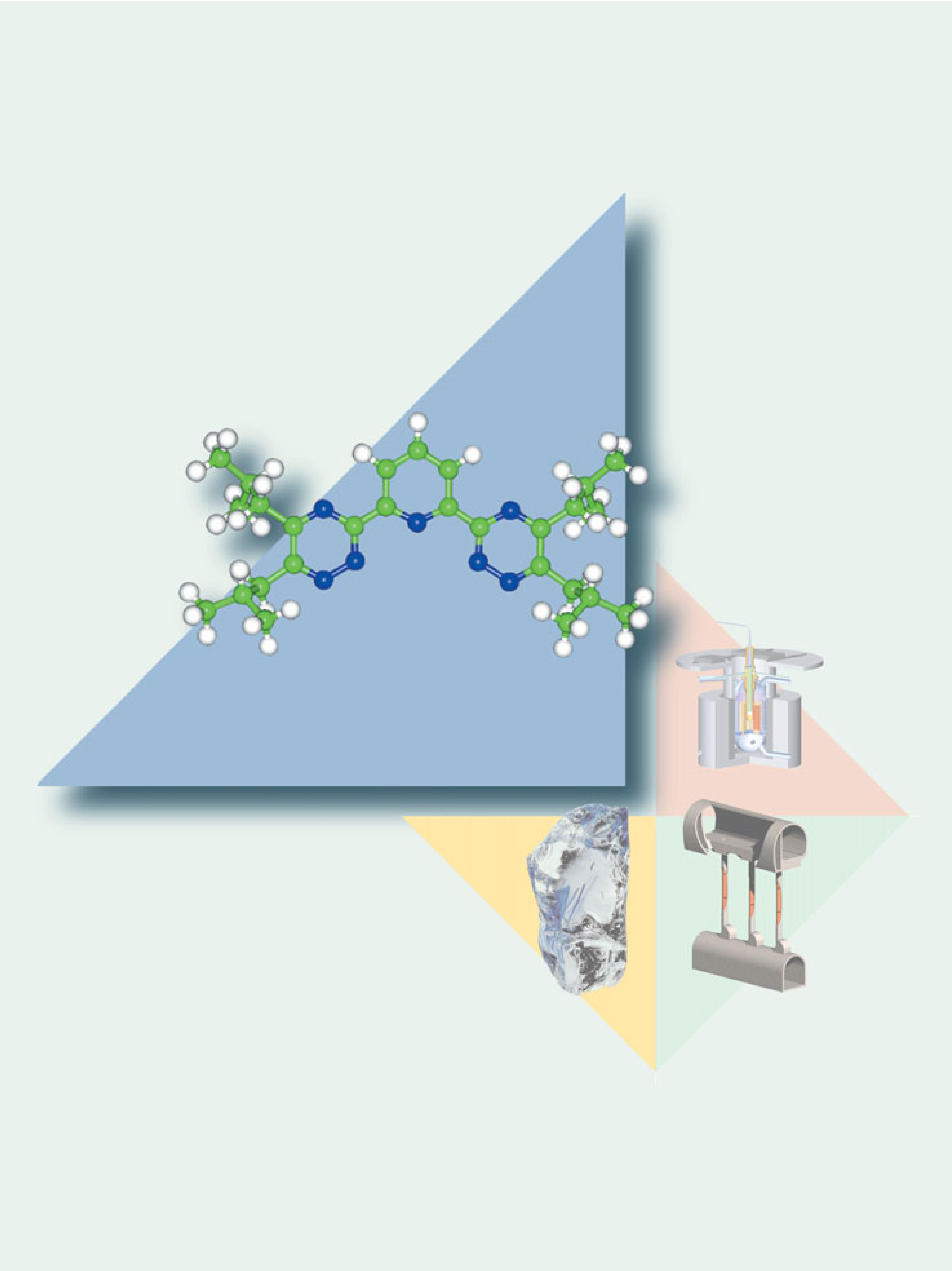

I. SORTING

The purpose of spent-fuel reprocessing, as performed in France today, is to extract uranium and plutonium and condition the remaining high-level radioactive waste in a glass matrix. This selective partitioning, carried out using the Purex process, significantly reduces the volume and toxicity of final waste compared with the fuel prior to reprocessing. The concept of separation can be extended to other highly radiotoxic, long-lived radioelements found in waste, such as certain minor actinides and fission products. Once rid of these, the remaining waste would lose its radiotoxicity much more quickly. The separated products would then need to go through another process, such as transmutation or, in some cases, specific conditioning.

The minor actinides concerned by this "advanced separation" process are neptunium, americium, and curium. After plutonium, they represent the highest radiotoxic inventory in spent fuel. At a later stage, attempts could be made to extract other, relatively abundant, long-lived fission products (iodine-129, technetium-99, and cesium-135) which, owing to their chemical properties, are potentially mobile in the very long term in disposal sites.

The research program strategy for separating these long-lived radionuclides consists in adding extra processes to existing industrial spent-fuel reprocessing methods, and exploiting the full potential of the Purex process. CEA research teams, in cooperation with French and foreign laboratories, have defined the framework of an advanced separation process based on new chemical processes using highly selective molecules.

Studies have shown that neptunium can be separated out, just like iodine and technetium, by adjusting the Purex process. In 1994, it was demonstrated that combined extraction of actinides and lanthanides was scientifically feasible using the Diamex process. Demonstration of technical feasibility is expected by 2005. Separating lanthanides, which are extremely abundant in the solution obtained (ten times as many lanthanides as actinides), then calls for the development of particularly selective molecules. The main reference molecules have been synthesized, and their performance verified under experimental conditions on small quantities of real radioactive solutions. This is known as the Sanex process. Lastly, the Sesame process is aimed at separating americium from curium. Sanex and Sesame have passed scientific feasibility tests. For cesium, specific molecules – calixarene-crown compounds – have been developed. These are highly selective, extremely resistant, and have proved to be most effective cesium traps. Technical feasibility demonstrations are expected by 2003 for the neptunium separation process, and by 2005 for the Sanex, Sesame, and cesium separation processes.