knowledge of system behaviour in the event of a major pipe rupture. The basic tools are test rigs which simulate the systems of interest, and powerful analytical programs based on correlations of the experimental data.

Materials and systems. Design and development of nuclear systems taxes many disciplines in the fields of chemistry and materials. Zirconium is the basic constituent of structural alloys in the reactor because of its neutron transparency. Behaviour of the alloys when subjected to stress, temperature and neutron irradiation is studied at both the research and engineering levels. Strength, ductility and particularly creep properties are important. The corrosion behaviour of zirconium alloys and of the less exotic materials external to the reactor is extremely important because of their influence on system integrity, fouling of heat transfer surfaces and — perhaps most significant — deposition of radioactive corrosion products which impair maintenance access.

System design and assessment. The final design of a power reactor is the result of compromise. Cost and performance of a large number of reactors, each representing a different combination of design parameters, are computed in order to find the optimal design. The process is carried out by computer programs which contain sub-routines drawing on the expertise of many areas, to perform the design and cost calculations. Core design is the most complex segment because of the elaborate computations required to describe the properties of a reactor core and because the composition and behaviour of the core change as fissile material is burnt, fission products accumulate, and old fuel is replaced by new. The reactor physics programs are based on basic research data such as nuclear cross-sections and fission yields, and on experimental measurements of lattice assemblies in zero-energy research reactors like ZED-2.

Equipment, components and reliability. Reliability is one of the most important attributes of a nuclear generating station because of its influence on cost. The R&D contribution is two-fold: the development of reliability analysis techniques for use by designers, and R&D work to improve the reliability of equipment. Analytical methods have been developed and adapted from other industries and are now being routinely used in design; R&D retains a consulting role. Some areas of technology involved are wear and friction, materials, corrosion, vibration, fluid mechanics and mechanics of materials. Combined analytical and experimental effort has been applied to pumps, shaft seals, valves, heat exchangers and mechanical joints. Another aspect is development and application of non-destructive methods of quality control and in-service inspection appropriate to the nuclear plant environment. This frequently requires greater than normal sensitivity of measurement together with remote operation to avoid radiation.

Liaison and technology transfer. The work described above has a single objective: to improve the cost/effectiveness of CANDU systems. The improvement does not occur in the laboratory; it occurs in reactors operated by a utility. Virtually every R&D group communicates with industry or utilities through symposia, meetings, consultations, technical assistance, problem solving work in the field, and industrial development contracts. The laboratories are active participants in the power program.

Systems analysis. All future options are more complex than the once-through natural uranium CANDU cycle. The options involve fissile enrichment in the form of U^{235} or plutonium, added to uranium or thorium, in various types of reactor. They involve uranium enrichment facilities, fuel reprocessing plants, processes for remote fabrication, and waste management facilities. Development planning must be based on the answers to such questions as: which reactor–fuel cycle combination is most likely to optimize the consumption of capital and uranium in the Canada of 2010? The question is strategic; its answer, fundamental to R&D planning, requires comprehensive analysis of options and probable future conditions.

Advanced nuclear systems. The laboratories are also concerned with nuclear systems other than fission reactors. Current areas of interest are fusion power, electrical breeding of fissile material by fusion or spallation processes and uranium enrichment. World progress in fusion power development is closely monitored through normal scientific channels by research personnel who are competent to assess, interpret and contribute.