

NUCLEAR SCIENCE ...
today's science fiction,
tomorrow's way of life!



NUCLEAR science

Nuclear science is an exciting and dynamic field of study! In just 50 years, scientists around the world progressed from discovering X-rays and identifying the components of atoms, to testing and producing destructive atomic bombs.

In the next ten years they demonstrated the use of nuclear energy to generate electricity and even to propel a submarine, the USS Nautilus being the first.

With the power of nuclear becoming increasingly apparent, politicians and civilians became involved in the next four years in directing this energy towards peaceful means.

The foundation was laid for the nuclear agreements, regulations, safeguards and treaties which today govern all nuclear-related matters and ensure the safety of citizens throughout the world.

FEAR of the unknown

We are all afraid of things and situations which we do not understand! In fact, everyone is afraid of ionising radiation, except those who understand and work with it. Knowledge is the only thing that frees us from fear, allowing us to know what is safe, what is unsafe, and how to work safely.

IT ALL comes down to atoms

Atoms (composed of protons and neutrons in the nucleus and electrons moving outside the nucleus) are the basic building blocks of everything we know. Both chemistry (the study of the interactions between atoms) and nuclear physics (the study of the interactions of sub-atomic particles) are therefore very important research fields. The application of the knowledge generated by this research flows into many fields of science, technology, engineering and medicine.

NUCLEAR APPLICATIONS in everyday life

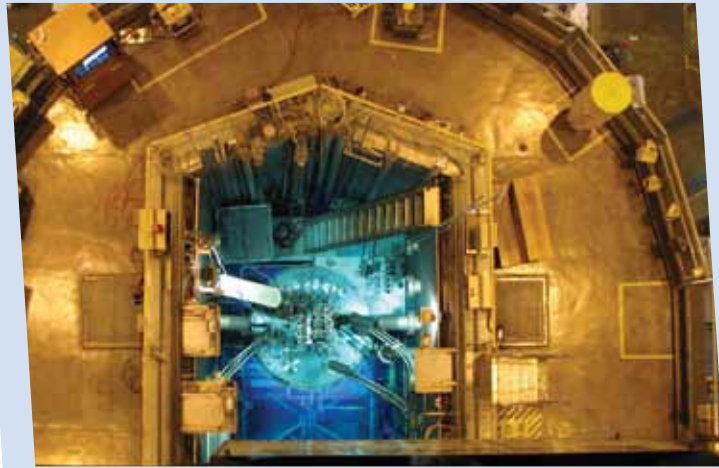
The following are just some of the many applications resulting from nuclear research:

- Nuclear energy – electricity and propulsion
- Nuclear medicine – diagnostics and treatment
- Radiation – sterilisation of medical instruments and supplies
- Insect eradication – the release of insects sterilised by irradiation
- Industrial applications – detection of leaks and defects in closed systems
- Domestic applications – smoke detectors and self-luminous safety signs

BECOMING INVOLVED in the exciting nuclear science world

If you wish to follow a career in nuclear science you need to:

- Study maths and science at school level
- Obtain a science degree at tertiary level, or
- Obtain an engineering degree at tertiary level, or
- Obtain a medical degree at tertiary level, or
- Obtain a technical diploma at an FET college



NUCLEAR MILESTONES at a glance

1895-1899 Ernest Rutherford discovers alpha and beta radiation

1895 Wilhelm Roentgen discovers X-Rays

1905 Albert Einstein relates mass to energy in the famous formula $E=mc^2$

1919 Rutherford discovers that alpha particles ionise hydrogen gas

1930 Sir Arthur Eddington's *The Internal Constitution of the Stars* is published, which systematically addresses the problem of where the energy, radiated from stars, originated, concluding that the only process that explains the high amounts of energy released and the long lives of stars is one in which lighter constituents build up heavier nuclei - fusion

1939 Albert Einstein writes a letter to US President Roosevelt which discusses German nuclear research and the possibility of building an atomic bomb

1942 The US Manhattan Project begins

1945 Los Alamos becomes the site for an atomic laboratory

1945 The first atomic bomb is tested by the US at Alamogordo, New Mexico

1945 An atomic bomb, *Fat Man*, is dropped on Nagasaki, Japan (9 August). The 10,000 pound plutonium bomb, dropped on the site of a Mitsubishi torpedo manufacturing plant, kills 40,000 people and injures 60,000. Japan surrenders on 14 August

1946 The US tests an atomic bomb underwater at Bikini Atoll

1946 The US Oak Ridge facility ships the first nuclear reactor-produced radioisotopes for civilian use to the Barnard Cancer Hospital in St. Louis

1949 The Soviet Union detonates its first atomic device

1951 First usable electricity from nuclear fission is produced at US Experimental Breeder Reactor 1 (EBR-I)

1952 US explodes first fusion device at Eniwetok

1954 USS Nautilus, the first nuclear submarine, is launched

1954 The US Atomic Energy Act of 1954 is passed to promote the peaceful use of nuclear energy through private enterprise and to implement President Eisenhower's 'Atoms for Peace' Programme

1957 An electron-beam is used for fabrication of safer nuclear fuel rods

1961 US, UK, and USSR observe an informal suspension on nuclear tests

1963 Limited Test Ban Treaty signed by US and Soviet Union, prohibiting underwater, atmospheric, and outer space nuclear tests (More than 100 countries, including South Africa, have subsequently ratified this treaty)

1897 Becquerel and Marie Curie discover radioactivity

1898 Marie and Pierre Curie isolate the two new chemical elements polonium and radium

1908 Rutherford discovers that alpha particles are helium nuclei and beta particles are electrons

1929 Nuclear fusion is first investigated in a theoretical paper by Atkinson & Houtermans

1932 James Chadwick discovers the neutron as a product when beryllium is bombarded by alpha particles

1934 Fermi bombards heavier elements with neutrons in order to produce trans-uranium elements

1938 Otto Hahn and Fritz Strassman, two German scientists, and Lise Meitner, demonstrate nuclear fission. Meitner's name is not mentioned on their seminal paper, since she was a woman and a Jew fleeing Nazi persecution

1944 The first reactor begins operation in Richland, Washington, US

1945 Fermi demonstrates nuclear chain reaction at the University of Chicago; soon many top-secret nuclear research/production facilities are built for the Manhattan Project

1945 An atomic bomb, *Little Boy*, is dropped on Hiroshima, Japan, by the US B-29 bomber, Enola Gay. The 9,700 pound uranium bomb destroys everything within five square miles, kills 70,000 people and wounds another 70,000

1946 The Atomic Energy Act establishes the Atomic Energy Commission in the US, placing further development of nuclear technology under civilian control

1948 The US does atomic tests at Eniwetok Atoll

1948 South Africa establishes the Atomic Energy Board

1952 First British atomic detonation at Monte Bello Islands, Australia

1953 Eisenhower proposes "Atoms for Peace" programme to UN General Assembly, to develop peaceful applications for nuclear energy through international collaboration

1954 The first hydrogen bomb (H-bomb), *Castle Bravo*, is tested

1955 Arco, Idaho becomes first US town to use electricity from a nuclear reactor

1957 The International Atomic Energy Agency (IAEA) is formed to promote the peaceful use of nuclear energy and provide international safeguards and an inspection system to ensure nuclear materials are not diverted for military purposes

1960 France conducts first nuclear test in the Sahara desert

1962 First surface ship sails on nuclear energy

1964 China (PRC) tests first nuclear bomb

1965 South Africa commissions its research reactor, SAFARI-1



NEED TO KNOW MORE?

The South Africa Nuclear Energy Corporation (Necsa) develops and utilises nuclear technology as part of the National System of Innovation. Necsa also aims to raise awareness of nuclear science and its applications among the South African public, learners and students. If you would like to visit Necsa or would like a Necsa representative to visit your school, contact Necsa at:

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