The Nuclear Age 1945-2011

by Ken Webb

Here it is: the factual detail, the historiography, revision exercises and advice on how to write responses on The Nuclear Age 1945-2011

eBook

"Everything you wanted to know about The Nuclear Age 1945-2011, but were afraid to ask."

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by Ken Webb M.A. (Oxon), C.Ed

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About the author

Ken Webb was educated in the United Kingdom and graduated from the University of Oxford. He taught in several state schools before moving to Pymble Ladies' College where he taught Modern, Ancient and Extension History. He later moved to Ravenswood School for Girls where he also taught the International Baccalaureate course in History. He is a member of the Independent Schools Examination Committee for Modern History. He frequently lectures and runs workshops for Year 12 and teacher groups in Sydney and Regional NSW. In addition to his own work, Ken Webb has contributed to colleagues' work and to newspapers and periodicals. He has also been a consultant on various history video documentaries. Ken Webb is a past NSW winner of the "National Excellence in Teaching" award.

Over the years, Ken Webb has written a wide range of study guides and textbooks for NSW, Victoria and Australia wide, including *"Power and Authority in the Modern World"* (Nelson Cengage Learning), *"Discovering Australian History"* (CUP), *"The Augustan Age 44 BC – AD 14"* (Get Smart Education), *"World War 1: From Sarajevo to Versailles"* (Nelson Cengage Learning), *"Extension History: The Historians"* (HTA of NSW), *"Russia and the Soviet Union 1917-1941"* (Nelson Cengage Learning), *"Spartan Society to the Battle of Leuctra 371 BC"* (Get Smart Education)

"The Nuclear Age 1945-2011" is one of twenty-two titles available in the "Everything you wanted to know about… but were afraid to ask" series written specifically for the NSW Modern and Ancient History syllabuses. Other titles in this series include:

- *Power and Authority in the Modern World 1919-1946*
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Author's note

The purpose of this book – as with all titles in the *"Everything you wanted to know about… but were afraid to ask"* series – is to make life easy for students and teachers working their way through the 'Change in the Modern World Topic' topic: *The Nuclear Age 1945-2011.* It is not intended to be the final word on The Nuclear Age 1945-2011; nothing beats wide-reading and going back to the primary sources!

However, neither teachers nor students always have the time for such luxuries. Teachers have several other classes to worry about, not to mention a growing multitude of administrative and bureaucratic tasks to fulfill! Students have other subjects to study, and may also be burdened with a series of major works. Thus, *"Everything you want to know…"* steps in to make life easy.

The principal aims of this book are to:

- provide the essential factual detail needed to understand the topic;
- provide references to written and visual sources;
- provide an introduction to the essence of historiographical debate;
- provide ideas for approaching the types of questions that might appear when examined on The Nuclear Age 1945-2011.

Rationale for the structure of this book

"The Nuclear Age 1945-2011" is one of six topics in the 'Change in the Modern World' section of the Modern History syllabus.

The syllabus divides the topic as follows:

- Survey: The birth of the Nuclear Age
- Focus of study:
  - The first use of atomic weapons and nuclear deterrence
  - The nuclear threat and weapons testing
  - Towards nuclear disarmament
  - The benefits and risks of the Nuclear Age

These broad headings have been used to structure the book and have been broken down into chapters based on the layout of the syllabus to make the topic more accessible to students. Additional sections have been included on approaching the types of questions that could be set on this topic in the HSC examination.

Think as historians

Key problems historians have in studying *The Nuclear Age 1945-2011* – or indeed any major historical issue – are that we know what happened. Hindsight allows us to look back and isolate those developments which we can now see, from our current perspective, as the key issues. We can isolate the mistakes, criticise the leaders of the time and ask in incredulous tones:

- Would US and Soviet leaders have really followed through with the MAD doctrine?
- How could the British and the French justify their actions during nuclear testing?

This topic also allows us to look forward and consider future issues regarding the Nuclear Age.

Chapter One
Truman, Stalin and the Potsdam Conference

Potsdam

Potsdam sits along the River Havel, about 25 kms south west of the centre of Berlin. It has a history stretching back a thousand years and is rich in architectural and cultural treasures. It was the home of the Prussian kings; Kaiser Wilhelm II's court was based in Potsdam up until early 1918. During the Nazi period, it was the site of the Day of Potsdam, 21 March 1933.[1] After 1945, following the division of Germany, Potsdam found itself situated in communist East Germany, the German Democratic Republic (DDR).[2] This was to be Potsdam's fate until the reunification of West and East Germany in October 1990.

The context of the Potsdam Conference

1939 – 1 September: Germany invades Poland

– 3 September: Britain and France declare war on Germany

– October: Poland is defeated and divided up between Germany and Russia

1940 – June: France surrenders to Germany – Britain fights on alone

1941 – June: Germany invades Russia in Operation Barbarossa

– Britain offers aid to Russia

– December: Japan attacks Pearl Harbour – US declares war on Japan

– Germany declares war on the USA

1942 – US *Lend-Lease Aid* begins to flow into Russia

1943 – German forces are defeated at the Battle of Stalingrad

– The Battle of Stalingrad marks the key turning point in the war

1944 – June: Allied troops invade France on D-Day

1945 – Allied troops move into Germany from the west

– Russian troops move in from the east

1 Here Hitler was seen to bow respectfully to President Hindenburg with the army in the background. It marked a key moment in the Nazi consolidation of power.

2 The Glienicke Bridge which separated Potsdam from West Berlin, was to become the site of several 'spy exchanges' between the Communist East and the non-Communist West during the Cold War.

Background to the Potsdam Conference, 1945

Figure 1.1: Schloss Cecilienhof, Potsdam

The Second World War in Europe came to a formal end on 8 May 1945, following Germany's unconditional surrender. Hitler had committed suicide on 30 April. The leading allied nations had met at Yalta in January/ February 1945. By that time, the war against Nazi Germany had turned strongly in the allies' favour and relations between the three key allied leaders – US President Roosevelt, Soviet leader Stalin and British Prime Minister Churchill – were cordial. The next meeting took place in Potsdam between 17 July and 2 August. The proceedings of the Potsdam Conference took place in the Schloss Cecilienhof.

By the time of the Potsdam meeting, the situation had changed significantly:

- US President Franklin Roosevelt had died on 12 April. Roosevelt had been willing to work with the Soviet Union's leader, Stalin, and believed that he had established a good working relationship with him. The new president, **Harry Truman**, had a different attitude:
  - he did not trust Stalin and was quoted at the time as saying *'I'm tired of babying the Soviets';*
  - Truman ended US Lend-Lease aid to the Soviet Union and made it clear he was going to take a tough line against Soviet demands;
  - Truman had little foreign policy experience and had been very much 'kept in the dark' about America's development of an atomic bomb;
  - he approached the Conference with a need to prove that he could not be pushed around by the more experienced Stalin;
  - during the next few years, Truman would develop the United States' hard-line stance against perceived Soviet expansionism.

In March 1947, he introduced *The Truman Doctrine* which would become the basis of US foreign policy for the next four decades. The United States announced that it would resist communist aggression across the world. He stated at the time:

"I believe it must be the policy of the United States to support free peoples who are resisting attempted subjugation by armed minorities or by outside pressures."

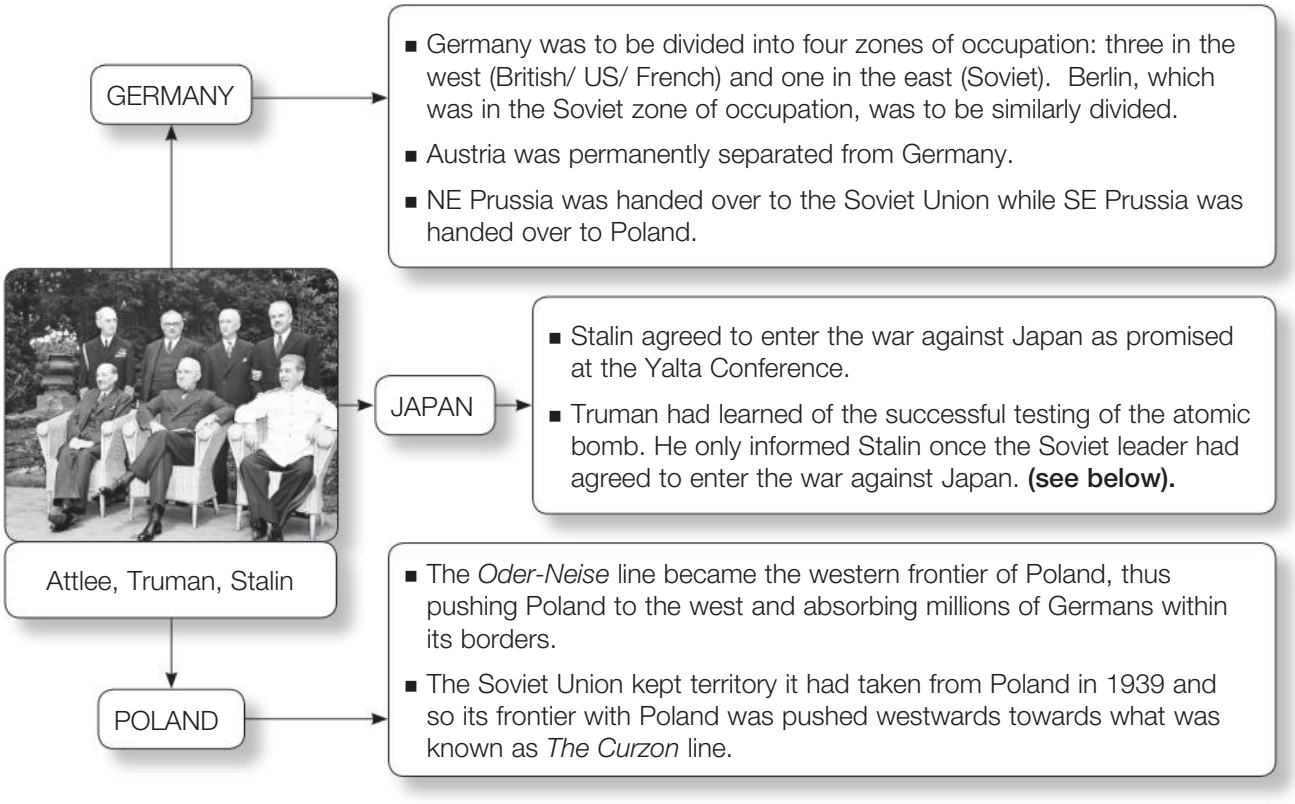
- Winston Churchill represented Britain at the start of the conference:
  - though victorious, Britain had been greatly weakened by the war and was clearly the minor player at Potsdam;
  - Britain held a general election in late July and Churchill's Conservative Party was heavily defeated by the Labour Party;
  - Clement Attlee replaced Churchill at Potsdam;
  - Attlee had been Deputy Prime Minister during the war but had focussed on domestic issues and lacked Churchill's prestige.

- Though the Soviet Union had emerged triumphant by the middle of 1945, Soviet leader, **Stalin**, was fully aware of the enormous death and destruction his country had suffered at the hands of Nazi Germany:
  - Stalin's goals were future security, and reparations from Germany for the damage that it had inflicted on his country since 1941;
  - Stalin had signed off on the idealistic and democratic declarations of earlier allied meetings but he had no intention of accepting anything that might threaten the Soviet Union's dominance in Eastern Europe;
  - rather, he had every intention of securing Soviet control of Eastern Europe behind what Churchill would later call the *iron curtain*;
  - towards this goal, Stalin set about establishing pro-Soviet regimes in the countries that became the Soviet *sphere of influence*;
  - during the later stages of the war, Stalin ensured that his Red Army troops would be present in these countries once hostilities were over.

Several key issues dominated the Potsdam Conference. Above all was what to do with defeated Germany. Its deNazification and demilitarisation were taken for granted but agreement between the leaders went no further than this. The future of Poland was also a major preoccupation. And the war with Japan was continuing. President Roosevelt had earlier sought the Soviet Union's help against Japan. At the time of the Potsdam Conference, there was an expectation in the Truman administration that the war against Japan could continue for many months with the loss of hundreds of thousands of American lives.

Figure 1.2 summarises the key decisions of the Potsdam Conference.

Figure 1.2 The key decisions made at the Potsdam Conference



Exercise 1.1 Answer the following questions in the spaces provided.

1	Where is Potsdam?	
2	When was the Potsdam Conference held?	
3	Who were the key figures at the Potsdam Conference?	
4	How did President Roosevelt's death affect the proceedings of the Potsdam Conference?	
5	What were the main objectives of Stalin at the conference?	
6	Why did Churchill leave the conference early?	
7	What was decided about Germany's immediate future at the conference?	
8	What decision was taken regarding Berlin?	
9	What happened to Poland's frontiers?	
10	How did the issue of Japan affect proceedings at the conference?	

Truman, Stalin, Potsdam and the atomic bomb

The United States conducted its first successful testing of the atomic bomb on 16 July 1945 near Alamogordo in New Mexico. [3] Truman learned of this the following day, 17 July, at Potsdam. The president informed Churchill of the successful test but the two of them agreed not to tell Stalin until later. They wanted to first get Stalin's agreement to enter the war against Japan.

On 24 July, the three leaders had spent time discussing possible peace treaties with the nations of Eastern Europe such as Romania and Bulgaria.

- The discussion went around in circles, and only reached an agreement when Churchill suggested they agree to prepare treaties "for" those countries, rather than "with" them:

3 See Chapter 2.

- the governments of the East European countries had not yet been "recognised".

- It was late in the day, following this arcane discussion, that Truman had a brief, casual, yet momentous private word with Stalin.

Truman stood up and strolled over to Stalin, as if he had nothing of any great importance to say. Truman later explained in his memoirs:

"I casually mentioned to Stalin that we had a new weapon of unusual destructive force. The Russian Premier showed no special interest. All he said was that he was glad to hear it and hoped we would make 'good use of it against the Japanese.'" [4]

Churchill later said:

- he believed Stalin had *no idea of the significance of what he was being told;*
- that Stalin's face remained gay and genial;
- and that he had later asked Truman *'How did it go?'* To which Truman replied *'He never asked a question'*.

Historians have debated whether Stalin really understood what Truman had said.

- Soviet General Shtemenko stated that the Russian General Staff received no special instructions from Stalin after his 'chat' with Truman;
  - this would suggest that Stalin did not understand the import of what Truman had said until after Hiroshima.
- The Soviet Union's World War II hero, Marshal Zhukov had a different recollection:
  - Zhukov says that Stalin told Molotov (Soviet Foreign Minister) that he would need to talk to Kurchatov *and get him to speed things up*;
  - Zhukov said he realised that they were talking about research on the atomic bomb. [5]

Exercise 1.2 Indicate whether the following statements are facts or opinion.

1	Truman had knowledge of the successful testing of the atomic bomb about a week before telling Stalin about it.	FACT/ OPINION
2	Truman's chat with Stalin on 24 July proves that he was not seeking to be deceitful about atomic developments.	FACT/ OPINION
3	Truman believed that Stalin had shown no great interest in what he had to say at the end of proceedings on 24 July.	FACT/ OPINION
4	Stalin understood what Truman had to say on 24 July but was merely trying to give the impression of remaining cool.	FACT/ OPINION
5	Churchill's view at the time was that Stalin did not realise the massive importance of what he was being told.	FACT/ OPINION
6	Historians cannot be certain whether or not Stalin understood the significance of what Truman had told him.	FACT/ OPINION

4 Truman, H S, Memoirs, Volume II: Year of Decisions, Doubleday, Garden City, 1955, p 416

5 Zhukov was referring to Igor Kurchatov who was a leading Soviet nuclear physicist and was believed to be the director of the Soviet Union's atom bomb research program.

What do the historians have to say about "Truman, Stalin and the Potsdam Conference"?

1. Anthony Eden

Foreign Secretary Eden was with Churchill at the Potsdam Conference. In his memoirs he refers to the discussion of whether or not to tell Stalin about "the bomb". It was agreed he had to be told. Eden concurs with other observers that Stalin seemed not to realise the significance of what Truman told him on 24 July:

"…Mr Churchill and I, who were covertly watching, had some doubts whether Stalin had taken it in. His response was a nod of the head and a brief 'thank you'. No comment…" [6]

2. Charles L Mee, Jr

Mee makes an interesting comment regarding the moment Truman informed Stalin about the atomic bomb. He suggests that great turning points in history, such as the fall of the Roman Empire, or the start of the Renaissance, cannot be pinpointed. Such moments become murky as preconditions are outlined and different points of view examined. However, of Truman's 24 July 1945 chat with Stalin, he suggests it is possible to be exact. Mee argues that whether Stalin knew exactly what Truman was talking about or only realised it later:

"…here is one turning point in history that can be dated with extraordinary precision: the twentieth century's nuclear arms race began at the Cecilienhof Palace at 7.30 pm, on July 24, 1945…" [7]

3. Ian Buruma

Buruma describes the approach of the victorious allies towards Germany and Japan at the Potsdam Conference. Allied views on how to treat those defeated in the war took place beyond any consideration of what was happening in the New Mexico desert. It was accepted that both Germany and Japan had to be demilitarised and democratised, though Soviet and western thinking of the term 'democratised' would very soon be seen to diverge. It was agreed that *"all members of the Nazi party who had been more than nominal participants in its activities… shall be removed from public and semipublic office."* Buruma shows how the wording regarding Japan was different. *"There must be eliminated from all time the authority and influence of those who have deceived and misled the people of Japan…"* The powers at Potsdam called for a *"new order of peace, security and justice"* that would drive *"irresponsible militarism"* from the world. Buruma comments on how imprecise such high-sounding words were:

*"…This, too, was a bit vague and indeed misleading. Is there such a thing as "*responsible *militarism"? And who exactly had misled whom?..."* [8]

6 Eden, A, The Reckoning: The Memoirs of Anthony Eden, Earl of Avon, Houghton Mifflin, Boston, 1965, p 635
7 Mee Jr, C L, Meeting at Potsdam, Dell Publishing, New York, 1975, p 192
8 Buruma, I, Year Zero: A History of 1945, Atlantic Books, London, 2013, p 174

Chapter Two
The Manhattan Project and Trinity Test

Introduction

The Manhattan Project was the Anglo-American wartime effort to develop an atomic bomb. The Manhattan Project was formally created on 13 August 1942 and was headed by General Leslie R Groves. Its first offices were at 270 Broadway in Manhattan, New York. It was the custom at the time to call Corps of Engineer districts after the city where they were located. As a result, the atomic bomb project became known as the Manhattan Engineer District, or Manhattan Project. President Roosevelt ordered an allocation of $500 million to the project in December 1942. Its headquarters were moved to Washington. Across the country, various project sites were also set up.

There was a twofold stimulus for the Manhattan Project: firstly, scientific advances being made during the 1930s, and secondly the developing international situation. World War II began with Nazi Germany's invasion of Poland in September 1939. [1]

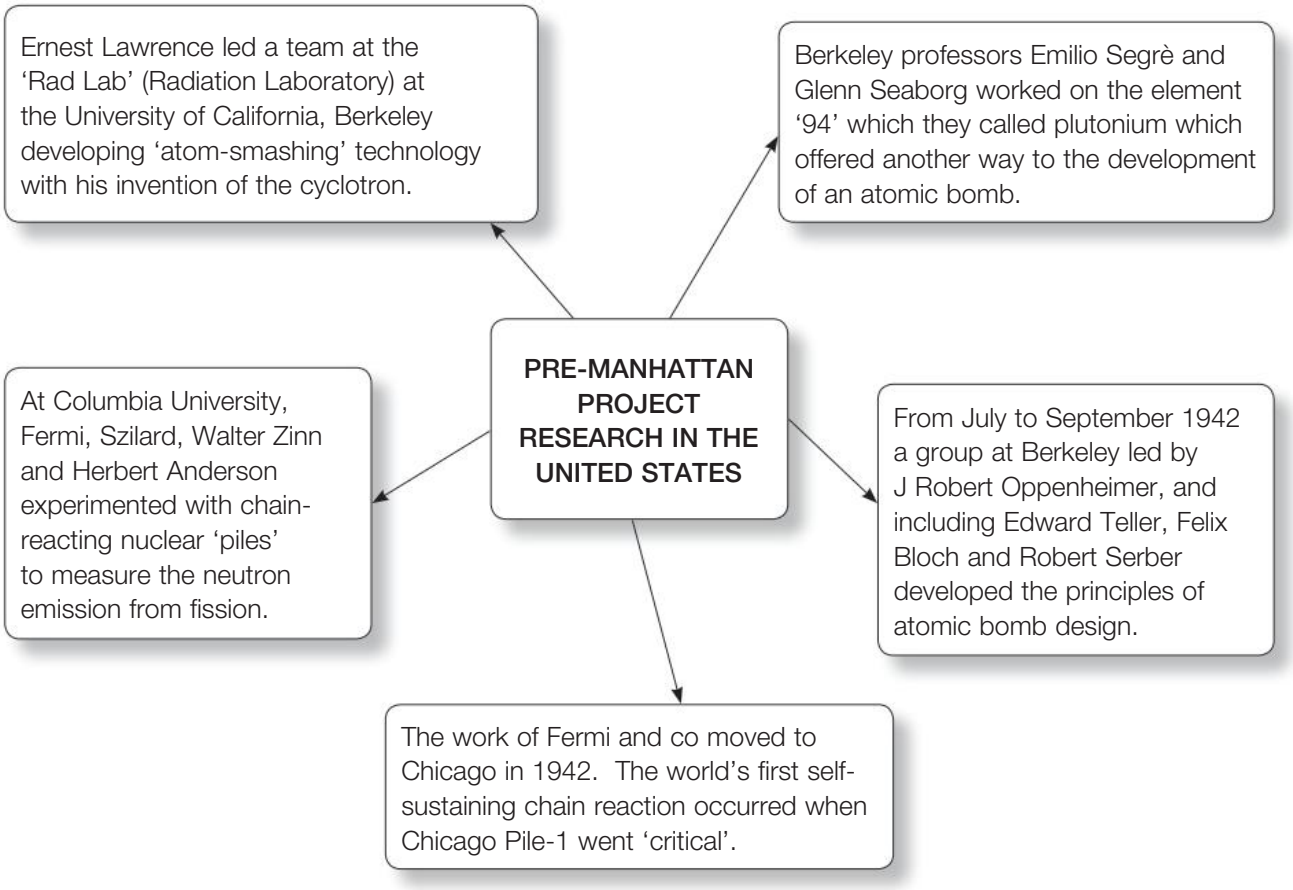
- The German scientists, Otto Hahn and Fritz Strassmann 'inadvertently' discovered nuclear fission. In subsequent years, Germany would pursue its own research into developing an atomic bomb.
- In August 1939 President Roosevelt received a letter from renowned scientist Albert Einstein and Leo Szilard [2] telling him of the possibility of an atomic bomb and that Germany might try to build one. [3]
- Following Einstein's letter, Roosevelt set up the Uranium Committee containing military and scientific experts to investigate the possibility of a nuclear chain reaction.
- In 1941, the British MAUD Committee reported that an atomic bomb was possible and recommended Anglo-American cooperation.
- In response the US government placed its atomic research under the S-1 Committee, part of the Office of Scientific Research and Development, headed by Vannevar Bush.

Research into issues surrounding the atom had been progressing throughout the 1930s. In 1932, the British physicist James Chadwick discovered the neutron. The following year Leo Szilard came up with his idea of using a chain reaction of neutron collisions with atomic nuclei to release energy. In 1934 Italian scientist Enrico Fermi was experimenting with attempts to split uranium atoms. Danish scientist, Niels Bohr, was investigating the fission properties of uranium-235 and uranium-238.

In the years before the establishment of the Manhattan Project, work in nuclear research was occurring in various universities and laboratories throughout the United States. Figure 2.1 outlines some of these.

1 The science leading to the Manhattan Project is unsurprisingly 'mindbogglingly complex'. Scientific explanations in this chapter will be kept to a minimum and simplified as much as is possible. (Perhaps it's a case as Elton John says in his song 'Rocket Man', 'All this science I don't understand'.)
2 Leo Szilard had patented the idea of a nuclear fission reactor in 1934.
3 See Historian 1.

Figure 2.1 United States research pre-Manhattan Project



The Manhattan Project

The bulk of the research and construction of the atomic bomb during the Manhattan Project would take place at *Los Alamos* in New Mexico. For obvious reasons, Los Alamos was surrounded in secrecy. All work to supply, support and guard the top-secret work was carried out by the army.

In charge of the Los Alamos laboratory was J Robert Oppenheimer.

- At its height, there were thousands of project workers living at Los Alamos.
- The skills of physicists, chemists, metallurgists, explosives technicians and a host of other experts were required, along with military personnel.
- Soon after the Project began, Fermi and Szilard successfully produced a chain reaction – a cascade of splitting atoms that were able to release enough energy to trigger an explosion.
- At Los Alamos, scientists were investigating very practical issues:
  - how can an atomic bomb be designed, constructed?
  - how would it be put together?
  - how and where could it be tested?

Los Alamos was not the only location involved in the Manhattan Project. The scientists needed large quantities of unstable, radioactive uranium or plutonium. Uranium was fairly easy to obtain

but it was believed that plutonium might offer a more rapid path to developing the bomb. As a result, both uranium and plutonium were explored.

- A key site involved in the Project was at Oak Ridge in eastern Tennessee:
  - Oak Ridge was the site of a major uranium reactor;
  - the uranium enrichment plants K-25, Y-12 and S-50 were located at Oak Ridge;
  - it also housed a pilot plutonium production reactor, the X-10 Graphite Reactor.
- Another key site was Hanford in Washington:
  - Hanford housed a full-scale plutonium plant;
  - the 'B Reactor' was built here and eventually linked to other reactors.

Additional research on the Manhattan Project took place in other locations:

- these included Harvard and the Massachusetts Institute of Technology;
- the Monsanto Chemical Company in Dayton, Ohio worked on separating and purifying polonium (Po-210) which was used as the initiator for the bombs;
- work was also carried out in Canada at the Montreal Laboratory and the Chalk River nuclear laboratory in Ontario;
- the 509th Composite Group of the Army Air Force, which would be dropping the bomb once the decision was taken to use it, trained in Utah and over Cuba.

By early 1945, the scientists' work was coming together. Oak Ridge and Hanford had produced enough enriched uranium and plutonium for at least one bomb each. Design work was being finalised at Los Alamos. It would soon be time to carry out a test.

Exercise 2.1 Match the description on the left with the person on the right.

1	I was appointed to head the work at the Los Alamos site.		EDWARD TELLER
2	I wrote to President Roosevelt to warn him about German research.		ALBERT EINSTEIN
3	I was the overall head of the Manhattan Project.		LEO SZILARD
4	I was responsible for creating the atom-smashing cyclotron.		ERNEST LAWRENCE
5	I worked with Oppenheimer, Bloch and Serber on early bomb design.		J ROBERT OPPENHEIMER
6	My field of study in my Danish lab was uranium fission properties.		LESLIE R GROVES

7	I headed the S-1 Committee responsible for atomic research.		ENRICO FERMI
8	I worked on nuclear fission research with my German colleague, Otto Hahn.		NIELS BOHR
9	I researched the idea of using a chain reaction of neutron collisions to release energy.		VANNEVAR BUSH
10	I was an Italian scientist who experimented with splitting uranium atoms.		FRITZ STRASSMANN

The Trinity Test

Despite all the work done on the Manhattan Project, there were still some Los Alamos scientists who had doubts about how effective an atomic bomb could be. Estimates on how much energy could be released varied greatly. There was enough weapons-grade uranium for one bomb. Confidence in this bomb, and its 'gun-type design' was such that on 14 July 1945, parts of this bomb, known as 'Little Boy', began its trip to the western Pacific even though it had never been fully tested; it would soon be used against the Japanese city of Hiroshima.

Scientists at Los Alamos believed that a test of the plutonium bomb was crucial in order to determine if it could actually work and to gather data on nuclear explosions. There were several plutonium bombs in production, and it was believed there would be several available by the end of 1945. As a result, the team at Los Alamos decided to test one. Oppenheimer decided to call the test "Trinity". [4]

- The site chosen was known as Jornada del Muerto or 'Journey of Death':
  - it was just over 340 kms from Los Alamos in a remote corner of the Alamagordo Bombing Range;
  - observation bunkers about 10 000 metres from the site centre were set up in different directions.
- Scientists were keen to measure how much energy would be released, the extent of damage, the impact of the expected 'fireball';
  - of most concern to the scientists was the unknown amount of radioactivity that would be released and the army was on standby to evacuate local people;
  - the towns of Albuquerque and Santa Fe were only 320 kms away and a small settlement of about fifty people was only 50 kms away.

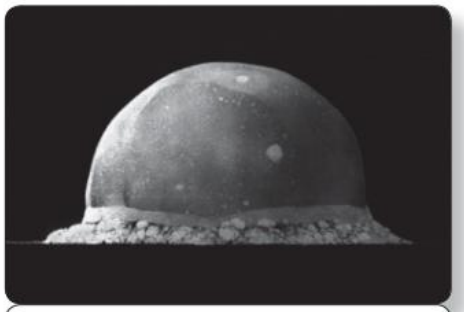
12 July – the plutonium core arrived at the test area

13 July – the non-nuclear components were taken to the test site
"the gadget" (as the scientists called the bomb) was finally put together

4 The origin of the name is unknown but it was believed that Oppenheimer had been inspired by the poetry of John Donne to choose the name Trinity.

15 July – the 'device' was placed at the top of a 35-metre tower

16 July – due to very heavy rain, the planned 4.00 am test time was pushed back to 5.30 am



0.025 seconds into the Trinity Blast

It can be said that the nuclear age began at 5.30 am on 16 July 1945. Seconds after the device exploded there was a huge blast wave and incredible heat was pushed across the desert. An orange and yellow fireball stretched up to the sky and spread, while a second column rose and flattened into a mushroom shape. [5] It was estimated that the detonation force released by the test was equal to 20 000 tons of TNT, about four times what had been expected.

Several of the Manhattan Project scientists were to be haunted for the rest of their lives by the incredible destructive power they had created. In the short term, it was clear that the bombs were now ready for use against Japan.

Exercise 2.2 Complete the following passage using the terms given below.

The first test of an atomic bomb took place in the _____ bombing range, about 340 kms from _____. Scientists had been working on two types of bombs. Confidence in a _____ bomb was high, and so the single one they had, known as _____, was shipped out to the western _____. The _____ Test involved a _____ bomb. This test bomb referred to as _____, was in place by 15 July. _____ delayed the 16 July test but the test proved successful. The term _____ became the popular term to describe the appearance of an _____ explosion.

TRINITY – HEAVY RAIN – LOS ALAMOS – LITTLE BOY – PLUTONIUM - ALAMAGORDO – MUSHROOM CLOUD – URANIUM – PACIFIC – ATOMIC - THE GADGET

5 See Historian 2.

What do the "historians" have to say about "The Manhattan Project and Trinity Test"?

1. Albert Einstein

Albert Einstein's letter to President Roosevelt in August 1939 provided a serious warning about the dangers and opportunities of atomic research at the time. The letter had been written by Leo Szilard following consultation with the physicists Edward Teller and Eugene Wigner. Europe was on the brink of war. Thus, a Nazi Germany in possession of an atomic bomb was a frightening prospect. Einstein said that Roosevelt needed to know that following work by scientists such as Joliot in France, and Fermi and Szilard in the US:

"…it may be possible to set up a nuclear chain reaction in a large mass of uranium, by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future…"

Einstein went on to explain that this could lead to the construction of extremely powerful bombs. The US had only poor uranium ores in limited quantities. The best ores were in Czechoslovakia (now under Nazi rule) and the Belgian Congo. In an ominous tone, Einstein stated:

"…Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Weizsacker, is attached to the Kaiser-Wilhelm Institute in Berlin, where some of the American work on uranium is now being repeated…"

2. Comments made by observers and others involved in the Trinity Test

Nobody in history had ever seen an atomic explosion before. In a real sense, there were no words to describe what had happened and what could be seen. Comments made at the time were to provide the popular terminology to describe the explosion. Charles Thomas, the vice-president of Monsanto (one of the contractors of the Manhattan Project) later wrote:

"…It looked like a giant mushroom; the stalk was the thousands of tons of sand being sucked up by the explosion; the top of the mushroom was a flowering ball of fire…"

The physicist, Luis Alvarez had viewed the test from the air, said that the cloud had the appearance of:

"…a parachute which was being blown up by a large electric fan…(and) had very much the appearance of a large mushroom…"

One of the most renowned responses to the Trinity Test came from J Robert Oppenheimer. He said some time later that the Trinity explosion reminded him of a line from the Hindu holy text, the *Bhagavad-Gita*:

"…Now I am become Death…"

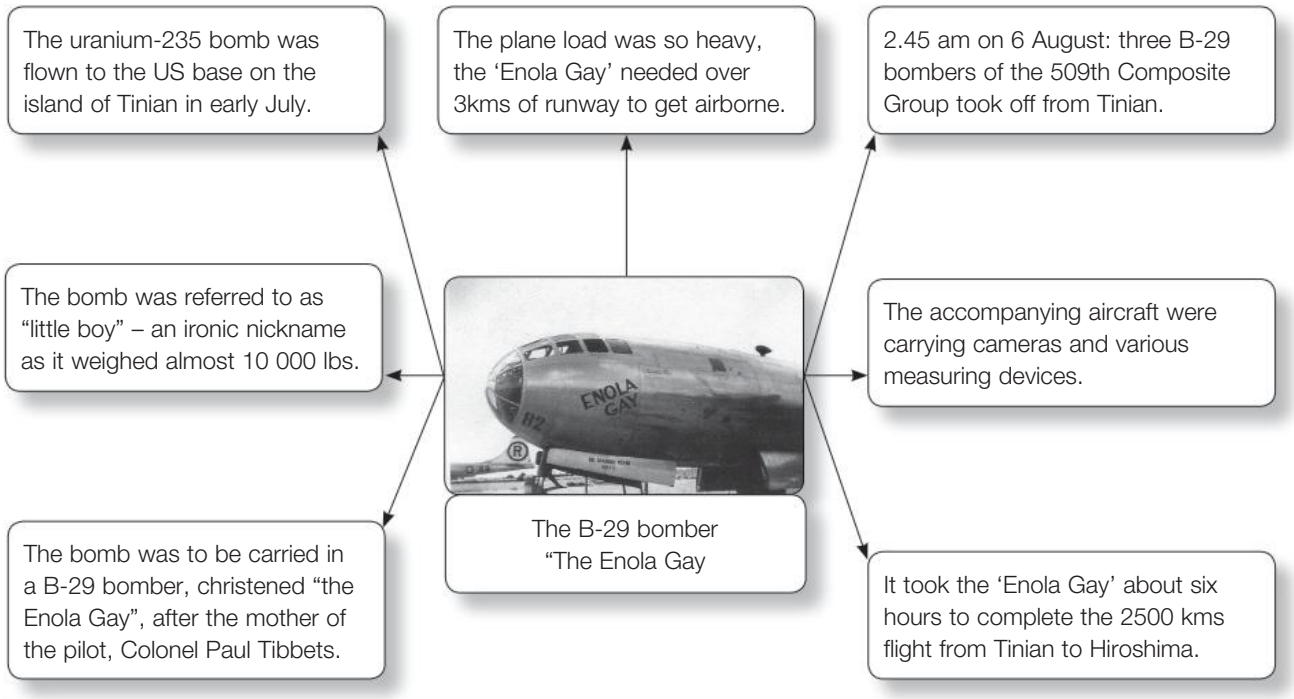
Chapter Three
The dropping of the bombs on Hiroshima and Nagasaki, their impact and legacy

The research of the Manhattan Project came to fruition on 16 July 1945 with the successful Trinity Test. [1] President Truman was informed of the result of Trinity on 17 July. A week later, as explained in Chapter 1, Truman 'casually' mentioned to Stalin that the US now had a weapon of extraordinary power. Truman and his advisors considered what action to take next. [2] However, there was little doubt that the bomb would be used against Japan very soon. The Japanese were warned that they faced *"prompt and utter destruction"* if they did not surrender unconditionally. No reply was given by the Japanese government to the warning and so Truman authorised the use of the bomb in Japan.

Hiroshima: 6 August 1945

Hiroshima was a city of almost 500 000 inhabitants about 800 kms west of Tokyo. It stands on the estuary of the Ota River, towards the southern end of Honshu Island. The city had not been attacked in the same manner that other Japanese cities such as Tokyo had. As is explained in Chapter 4, one reason for choosing Hiroshima as a target was this very fact. It meant that the impact of a single atomic bomb could more easily be assessed. The city contained various war industries and was also the headquarters of the Japanese army that defended the island of Kyushu.

Figure 3.1 Preparing for the bombing of Hiroshima



1 See Chapter 2.
2 See Chapter 4.

The Enola Gay was over Hiroshima soon after 8.00 am, local time. Thomas Ferebee, the plane's bombardier, used the Aioi Bridge as his aiming point. He was able to see it easily through the plane's bombsight as on the morning of 6 August 1945 in Hiroshima there was clear weather.

- 'Little Boy' was released from the 'Enola Gay' at 8.15 am:
  - the plane apparently 'jumped' upwards at the sudden loss of weight.
- Tibbets immediately did a 155 degree turn to get away from the city:
  - he had been warned he had about 45 seconds to escape the impact from the exploding 'Little Boy'
  - some scientists believed the plane might not escape the blast.
- The bomb descended by parachute:
  - it fell over 9 kms in about 45 seconds before detonating;
  - detonation occurred at about 2000 feet above the city.
- The blast from the explosion was estimated to equal about 12 000 to 15 000 tons of TNT:
- the city experienced a blinding flash of heat and light;
- in an instant the ground level temperature had reached about 7000 degrees Fahrenheit (about 3800 degrees Celsius).

Tibbets said that when the crew looked back, they could see *"a giant purple mushroom".* Fires were springing up everywhere and there was a mass of swirling smoke that reminded him of bubbling hot tar.

"…The city we had seen so clearly in the sunlight a few minutes before was now an ugly smudge. It had completely disappeared under this awful blanket of smoke and fire…"

Nagasaki: 9 August 1945

The Soviet Union had promised to enter the war against Japan three months after the defeat of Nazi Germany which had occurred on 8 May. On 8 August the Soviet Union declared war on Japan and its troops entered Manchuria.

- Truman did not want Soviet involvement in the post-war arrangements for Japan as was to be the case with Germany.
- Hiroshima had not brought about an immediate Japanese surrender.

The Soviet and Japanese actions led to the dropping of a second bomb: Nagasaki.

Nagasaki is located on the western side of the southern Japanese island of Kyushu. It is about 155 kms from Hiroshima. It was an important shipbuilding centre. Nagasaki was not intended to be the site of the second atomic bomb. The original target was Kokura in the north of Kyushu.

- Kokura was circled three times before it was decided to abort the bombing of that city due to poor visibility.
- It was important that pictures could be taken of the impact of the bombing.
- Conditions were more favourable over the second-choice target, Nagasaki.

And so, Nagasaki joined Hiroshima as one of the only two cities in history to be the victim of an atomic bomb.

Figure 3.2 The bombing of Nagasaki

On 9 August Major Charles Sweeney flew a B-29 bomber, called Bockscar, from the island of Tinian to the Japanese mainland.

The bomb was dropped just after 11.00 am local time. It had a force of 22 000 tons of TNT.

The bomb dropped on Nagasaki was called 'Fat Man'. It was a plutonium bomb, slightly larger than the bomb used at Hiroshima.

The physical destruction wrought by the bomb was limited due to the topography of Nagasaki; the hills around the city reduced the effect.

The bomb created ground temperatures of about 7200 degrees Fahrenheit (4000 degrees Celsius).

Exercise 3.1 Match the term on the right with the description on the left.

1	The Pilot in charge of the Nagasaki attack.		PLUTONIUM
2	The name of the plane involved in the Hiroshima attack.		SWEENEY
3	The type of bomb used in the attack on Nagasaki.		KOKURA
4	The model of aircraft used in both atomic bombings.		ENOLA GAY
5	The pilot in charge of the Hiroshima attack.		FAT MAN
6	The nickname of the bomb used against Nagasaki.		B-29
7	The city originally intended as the second atomic target.		TIBBETS
8	The type of bomb used in the attack on Hiroshima.		BOCKSCAR
9	The name of the plane involved in the Nagasaki attack.		URANIUM-235
10	The first city to be targeted by an atomic bomb.		LITTLE BOY
11	The second city to be victim of an atomic bomb.		NAGASAKI
12	The nickname of the bomb used against Hiroshima.		HIROSHIMA

The impact and legacy of the atomic bombs

Overview

Occasionally, there are moments in history when it can be truly said that 'the world changed'. The dropping of the atomic bombs on Hiroshima and Nagasaki was such a moment. The world could never return to what it had been before. The impact and the legacy of the atomic bomb attacks live with the world into the 21st century.

The immediate impact of the bomb comprised the physical destruction of the two cities and the loss of life. The death toll from the bomb did not end on the days of the attacks. For decades to come, victims of the attacks would continue to suffer and die from what had happened (see below).

In the longer term, the legacy of the atomic bomb was mixed.

Hiroshima and Nagasaki finally brought **an end to the Pacific War**: [3]

9 August — Emperor Hirohito accepted a proposal of his Prime Minister, Suzuki, to accept the Potsdam Declaration. This meant unconditional surrender.

14 August — Hirohito ordered his government to prepare a declaration accepting Japan's surrender.

15 August — Extremists in the Japanese armed forces were totally opposed to surrender and attempted a coup. The coup attempt failed. Emperor Hirohito asserted his authority and he addressed his people on national radio for the first time.

We have resolved to pave the way for a grand peace for all generations to come by enduring the unendurable and suffering what is insufferable.

The US accepted the surrender.

2 September — The formal surrender document was signed on the USS Missouri.

For many there were feelings of **guilt and shame** over what had happened to Hiroshima and Nagasaki, and a feeling of **'never again'**:

- movements across the world appeared – and are still present to day – that sought to ban the development and use of nuclear weapons;
- these movements and attempts to limit nuclear armaments will be more fully dealt with in Chapter 10.

However, the **Cold War between the US and the Soviet Union** gained in intensity after 1945:

- the Soviet Union exploded its first atomic bomb in 1949;
- there followed a deadly nuclear arms race between the two superpowers (see Chapter 5);
- technological developments would soon make possible nuclear weapons that dwarfed those used on Japan in 1945;
- for decades to come nuclear testing was carried out by nuclear-armed powers (see Chapters 7, 8 and 9).

3 See Historian 2 for a complete refutation of the view that the atomic bomb brought an end to the war.

An equally frightening future development would be **the issue of nuclear proliferation** as more countries developed the capacity to produce nuclear weapons:

- in 2021, it is believed nine powers now have nuclear weapons and *"scholars believe seventeen have actively explored building the bomb"* since 1945 and *"a number of new potential nuclear powers have appeared on the horizon";* [4]
- in 1945, atomic weapons were capable of destroying cities; in the 21st century, nuclear weapons could destroy the planet;
- nuclear proliferation is the subject of Chapter 12.

The immediate impact

The **physical destruction** experienced by Hiroshima and Nagasaki differed due to each city's different topography. Hiroshima was situated on low flat ground, roughly circular in shape. Nagasaki had no regular shape as it was cut up by hills and mountain spurs. As a result, the impact on Hiroshima was greater.

In Hiroshima, practically everything one mile from the centre of the blast was destroyed, apart from a few reinforced buildings which had been specially built to withstand earthquakes. The insides of these buildings were totally gutted:

- 1200 metres from the centre roof tiles melted;
- 1300 metres away steel frame buildings were destroyed;
- 1350 metres from the centre multi-story brick buildings were totally destroyed;
- 2000 metres from the centre all homes were seriously damaged;
- 2400 metres from the centre most homes were damaged
- 67% of the city's structures were destroyed or severely damaged.

In Nagasaki, almost everything within half a mile of the blast centre was destroyed, including the heaviest structures:

- 450 metres from the centre buildings suffered mass distortion and panels and roofs were blown in;
- 600 metres away concrete buildings with10 inch walls collapsed;
- 1500 metres from the centre steel frame buildings were destroyed;
- 1500 metres from the centre brick walls were severely cracked;
- 2000 metres from the centre roof tiles melted;
- 2400 metres from the centre all homes were destroyed or seriously damaged

It is impossible to precisely calculate the **loss of life** following the atomic bomb as within half a mile of the blast centre, human bodies were vaporised. The destruction and death caused by the atomic bomb had several causes. It is estimated that 50% of loss of life was due to the

4 Sagan, S D, and Waltz, K N, The Spread of Nuclear Weapons: An Enduring Debate, W W Norton and Co, New York, 2013, p ix

blast, 35% due to the heat ray, 5% from the initial radiation and 10% from residual radiation. A joint US-Japan group, the *Radiation Effects Research Foundation* estimated that:

- in Hiroshima between 90 000 and 166 000 people died;
- in Nagasaki, 60 000 to 80 000 died;

these deaths include those killed immediately by the force of the blast and the unbelievable heat, plus those who died from acute radiation exposure.

People exposed to radiation can be affected immediately as cells are killed. However, radiation can also have longer-term effects, causing mutations in the DNA of living cells. Cancers can result. Some of the research into the links between the radiation effects of the atomic bomb and cancer are outlined in Figure 3.3.

Figure 3.3: Links between radiation and cancers

Hiroshima Peace Memorial Park

The deadliest of the long-term effects for survivors of the atomic bomb was leukemia (cancer of the blood cells). Researchers found that rates of leukemia increased about two years after the attacks and peaked about four to six years later. Children were the most severely affected.

The *Radiation Effects Research Foundation* estimated that the attributable risk of leukemia for victims of the bombs compared to non-victims was about 46%.

The increase in the incidence of other cancers tended not to appear until about ten years after the bomb. Studies into the occurrence of these 'solid' cancers (ie excluding leukemia), estimated the rate of attributable risk for bomb victims to be about 11%.

Other studies have focussed on the impact of the bomb on **children**:

- those children who were exposed to radiation before birth (ie *in utero*) were born with a smaller head size and experienced mental disability;
- physical growth was impaired;
- however, cancer rates for children exposed *in utero* were lower than for those who were children at the time of the attacks;
- the children of survivors conceived after the bomb attacks do not seem to have experienced any increase in radiation-related diseases:
  - in November 1946, US President Truman set up the *Atomic Bomb Casualty Commission;*
  - it later reported that of 60 000 pregnancies of local couples between 1948 and 1952, little correlation was found between the parents' exposure to radiation and the frequency of stillbirths or malformations;
  - however, researchers suggest that more time is required to be certain that this is the case.

Though the evidence suggested that radiation had no impact on future children, not everyone in Japan was convinced. Survivors of the atomic bomb – referred to in Japanese as ***hibakusha*** – suffered discrimination and prejudice for decades to come. Many Japanese had fears that survivors might have physical or psychological impairments, and that they might pass on genetic defects to their children.

- this stigma tended to affect women more than men;
- employers were reluctant to take on *hibakusha*;
- *hibakusha* often found it hard to find a willing marriage partner.

After the attacks on Hiroshima and Nagasaki, there were fears that the cities would **continue to be radioactive**. This has proved not to be the case. After a nuclear explosion, there are two types of "residual radioactivity":

- One type comes from the fallout of the nuclear material:
  - most of this was dispersed in the atmosphere or blown away;
  - some fell as "black rain", exposing survivors to radiation;
  - however, radioactivity levels today are so low they cannot be distinguished from the trace amounts around the world that came from the atmospheric testing in the 1950s and 1960s.
- The second type is neutron activity:
  - neutrons can lead non-radioactive materials to become radioactive if they are 'caught' by atomic nuclei;
  - there was very little of this type of contamination because the bombs were exploded so far above the ground.

Today Hiroshima and Nagasaki are thriving, lively cities. The immediate impact of the atomic attacks was horrendous. The term nightmarish is appropriate. However, the cities did not become the nuclear wasteland that was feared at the time. As early as the spring of 1946, the land in and around Hiroshima was becoming dotted with the blooming red petals of the oleander flower, kyochikuto in Japanese. The oleander is now the official flower of the city of Hiroshima.

Figure 3.4: Hiroshima – 1945 and the 21st century

Exercise 3.2 Answer the following questions in the spaces provided.

1	What impact did the atomic bomb have on the course of the war in the Pacific?	
2	What role did Japanese Emperor Hirohito play in bringing about the end of the Pacific war?	
3	Outline the long-term psychological impact across the world of what happened at Hiroshima and Nagasaki?	
4	How was the Cold War affected by the dropping of the atomic bomb?	
5	What is meant by the term nuclear proliferation?	
6	Which city suffered the greater physical damage as a result of the atomic bomb? Why?	
7	What are the estimates of the loss of life at Hiroshima and Nagasaki?	
8	Which type of cancer became more prevalent amongst the children of Hiroshima and Nagasaki?	
9	What were some of the effects on children who were exposed to radiation before birth?	
10	Who were the hibakusha?	
11	How did life become difficult for the hibakusha?	
12	What was the long-term effect of radioactivity on Hiroshima?	

What do the historians have to say about "The dropping of the bombs on Hiroshima and Nagasaki, their impact and legacy"?

1. Wilfred Burchett

Wilfred Burchett was an Australian journalist who was the first person to report directly from Hiroshima for a western newspaper. His story appeared in the London Daily Express on 5 September 1945 under the heading: *I write this as a warning to the world.*

- Burchett's reputation was sullied over the years as he was accused of being a communist stooge, having reported the conflicts in Korea and Vietnam from the communist side.
- The Australian government did its best for many years to deny him permission to enter Australia. Burchett died in 1983 but rumours remain that he had been recruited by the Soviet KGB during the Cold War.
- Regardless of the veracity of those claims, his account of what he saw in Hiroshima very soon after the bomb was dropped remains a valuable eye-witness account. Here are some extracts from that September 1945 newspaper article:

Burchett described seeing people thirty days after the explosion who were:

"…still dying, mysteriously and horribly – people who were uninjured by the cataclysm – from an unknown something which I can only describe as atomic plague…"

He tried to convey that the destruction wrought by the atomic bomb was quite different to the conventional bombing experienced during the war:

"…Hiroshima does not look like a bombed city. It looks as if a monster steamroller had passed over it and squashed it out of existence…"

There were people, said Burchett, who seemed to have suffered no physical injuries but who were dying from strange after-effects:

"…For no apparent reason their health began to fail. They lost appetite. Their hair fell out. Bluish spots appeared on their bodies. And the bleeding began from the ears, nose and mouth…"

Burchett described the sight of bodies so badly burned by the heat of the bomb that it was impossible to establish if the dead were male, female, old or young.

"… Of thousands of others, nearer the centre of the explosion, there was no trace. They vanished. The theory in Hiroshima is that the atomic heat was so great that they burned instantly to ashes – except that there were no ashes…" [5]

5 Burchett, W, London Daily Express, 5 September 1945

2. Edwin P Hoyt

Hoyt argues strongly that the it is a myth that the dropping of atomic bombs on Hiroshima and Nagasaki forced the surrender of Japan. He suggests that to the Japanese militarists, the bomb was merely 'another weapon'. The atomic bomb certainly caused far less physical damage and loss of life than had the B-29 firebombing campaign of Japanese cities earlier in the year. Hoyt shows that the firebombing had:

- destroyed 3.1 million homes;
- had left 15 million people homeless;
- had killed over one million people.

Hirohito realised that if Japan did not surrender unconditionally, the allies would completely destroy Japan, killing millions. Hoyt concludes it was that which:

"…persuaded him to the decision to end the war. The atomic bomb is indeed a fearsome weapon, but it was not the cause of Japan's surrender, even though the myth persists to this day…" [6]

6 oyt, E P, Japan's War: The Great Pacific Conflict, Guild Publishing, London, 1986, p 420

Chapter Four
Truman and the debate on the use of the bomb

Introduction

President Franklin Roosevelt died on 12 April 1945. Harry Truman took the oath of office that day and became the thirty third US President. It fell to Truman to make the decision of whether or not to use the atomic bomb against Japan. Germany had surrendered on 8 May but the war in the Pacific was still raging. Ultimate allied victory over Japan was never in doubt and Japanese cities were defenceless against relentless conventional US bombing. However, questions were being asked.

- How long would it take to force a Japanese surrender?
- How many American lives would be lost in bringing about that surrender?
- What strategy should be pursued by the United States to force the surrender?

In his memoirs, and in countless later interviews, Truman always accepted total, personal responsibility for the decision to use the atomic bomb. He never apologised for making that decision. During the Korean War (1950-53), he overruled the commander of UN troops, General Douglas Macarthur, who had wanted to use atomic weapons against the Chinese. However, he always said that if he ever faced the same circumstances and choices that he faced in mid-1945 over Japan, he would make the same decision he did at that time.

The debate over the use of the bomb will be examined in two ways:

1. A consideration of the military options facing Truman in July/ August 1945.
2. A consideration of the developing international tension and rivalry with the Soviet Union.

Truman's military options in mid-1945

Figure 4.1 outlines the four military options that confronted Truman at the time.

Figure 4.1: Truman's military options

Option 1: Continuation of massive conventional bombing

The first US air raid on mainland Japan came on18 April 1942, "the Doolittle Raid". The raid had no military value and had been carried out partly to raise US morale after Pearl Harbour, and partly to show the Japanese how vulnerable they were. By mid-1944 the situation was quite different. US bombing of Japanese cities had become relentless.

- By 1945, Japanese air defences were practically non-existent and US bombers could attack at will:
  - civilian casualties were in the hundreds of thousands.
  - one firebombing attack on Tokyo in March 1945, killed over 80 000 people.
- Japanese loss of life from the US air force's firebombing of Japanese cities far exceeded the loss of life experienced at Hiroshima and Nagasaki.

However, it was clear that conventional bombing alone would not bring the war to a quick end. Japanese cities might be aflame and turning into piles of rubble, but there was no indication that this strategy was likely to bring on a quick surrender.

Option 2: A full-scale invasion of the Japanese mainland islands

For the Japanese soldier, surrender was dishonourable. No matter what the odds, no matter how inevitable was defeat, fighting on to the death was nearly always chosen over surrender. On many occasions during the Pacific conflict, Japanese forces were willing to suffer massive losses rather than 'sensibly' surrender:

- in 1942, at the Battle of Guadalcanal, the Japanese lost 30 000 men compared to US losses of 1600;
- in mid-1944, at the Battle of Taipan, 5000 Japanese troops committed ritual suicide rather than surrender;
- as US forces moved closer to Japan, American losses mounted as Japanese forces fought to the last man: 6200 lost on Iwo Jima, 13 000 lost on Okinawa.

Truman and his military advisors were well aware that any attempt to take the Japanese mainland would be met with fanatical resistance, not only from the military but civilians as well. Truman commented that an invasion would look like *'Okinawa from one end of Japan to the other'*.

- A land invasion could take anything up to twelve months:
  - military sources estimated US losses could be anywhere between five hundred thousand and one million.
- Extremists inside Japan would almost certainly not allow an unconditional surrender, especially one that might mean the end of the emperor:
  - they were willing to accept any losses – would the American people accept this or would Truman be forced to bring an end to the war?
- Though destined to lose the war, the Japanese were still capable of inflicting great damage on the US and its allies:

- Japanese forces were still present in Indochina, Malaya, the East Indies, various islands and China;
- they still had kamikaze pilots and submarines;
- there were still thousands of allied prisoners in Japanese POW camps.

It was apparent that for all the reasons explained above, few in the Truman administration or the US military relished the prospect of a full-scale invasion of Japan's islands.

Option 3: A demonstration of the atomic bomb in an underpopulated area

It was suggested at the time that the Americans select an uninhabited island and show to the Japanese the impact of an atomic explosion. The logic of this action was that the Japanese would be frightened into surrendering. However, there were several arguments against this strategy:

- if the test explosion failed, it would be humiliating for the Americans and would almost certainly embolden the Japanese to continue fighting;
  - the bomb involved new technology; could a successful explosion be guaranteed?
- the US did not have many bombs ready at the time;
  - was it a good idea to 'waste' one on a demonstration?
- even if the demonstration worked, who would then convince the Japanese authorities to surrender?
  - a lone scientist? a committee of politicians?

As a result of this thinking, the idea of a demonstration explosion was rejected.

Option 4: Use of the atomic bomb on a populated area without warning

It was finally agreed that only bombing a city without any warning would have a dramatic enough impact on the Japanese authorities to force a surrender. Truman set certain conditions for this strategy:

- no warning could be given to the city chosen for the attack as the Japanese might try to attack the incoming aircraft;
- it had to be a city that had not suffered much from conventional bombing so that the impact of a single atomic bomb could not be underplayed;
- it had to be a city with significant industrial facilities;
- Truman did not want to destroy a place of cultural importance such as Kyoto.

For these reasons, Hiroshima was chosen as the target for the atomic bomb.

The Cold War angle regarding the decision to use the atomic bomb

As was explained in Chapter 1, Truman informed Soviet leader Stalin of the success of the Trinity Test in New Mexico on 24 July 1945 at the Potsdam Conference. He had delayed telling

Stalin so as to ensure the Soviet Union's intervention in the war against Japan. Not informing Stalin would have been seen as bad faith towards a wartime 'ally'. At the time Stalin displayed little reaction. However, the Soviets were fully involved in their own atomic bomb research. [1]

Though the US and the Soviet Union had been allies fighting Nazi Germany, by mid-1945 tensions between the two powers were growing, and would soon develop into what would become *The Cold War*. This is not the place to become bogged down into a detailed discussion of the origins of the Cold War. However, some of the factors that led to this development included:

- long-term ideological differences: US belief in capitalism and democracy as opposed to the Soviet belief in state control and a one-party state;
  - each believed the other wished to impose its beliefs on the world.
- the US accused the Soviets of bad faith in post-war arrangements for Poland;
- the US was becoming concerned at the Soviet domination of East Europe by occupying Red Army troops;
- the Soviet Union feared US military and economic strength and its influence in western Europe.

The Soviet Union clearly intended imposing its will on Eastern Europe. Some historians have thus argued that this was a major factor in Truman's willingness to use the atomic bomb, when he did. He was putting on show to Stalin the power of the United States. It was almost a case of "be warned, behave in the future, or else." (Later in this chapter, historians 1 and 2 present this line of argument).

Exercise 4.1 Indicate whether each of these statements is true or false.

1	The decision to use the atomic bomb had already been made before Truman became president in April 1945 following Roosevelt's death.	TRUE/ FALSE
2	Long after his time as president, Truman agonised over the decision to use the atomic and showed great remorse.	TRUE/ FALSE
3	During the Korean War, Truman had strongly opposed using the atomic bomb and was willing to dismiss his military commander who sought such an action.	TRUE/ FALSE
4	By the middle of 1945, Japan was virtually defenceless against the US bombing of its cities.	TRUE/ FALSE
5	By the time of the Potsdam Conference, Truman had accepted that US conventional bombing alone would not force the Japanese to surrender.	TRUE/ FALSE
6	Truman had expressed enthusiasm for a full-scale land invasion of the Japanese home islands, believing this would quickly end the war.	TRUE/ FALSE

1 As will be explained in Chapter 5, Soviet research benefited greatly from top secret information passed on to the Soviet Union by spies.

7	There was every likelihood that both Japan's military forces and its civilian population would bitterly resist any invasion of the Japanese homeland.	TRUE/ FALSE
8	Though Japan had been gravely weakened by mid-1945, it was still in a position to inflict significant damage on US and allied forces.	TRUE/ FALSE
9	Scientists and US military leaders were extremely keen on staging a demonstration use of an atomic bomb as a means of frightening the Japanese into surrender.	TRUE/ FALSE
10	Once the decision had been made to use the atomic bomb against Japan, Truman was unconcerned about the target, just wanting the attack to quickly take place.	TRUE/ FALSE
11	At the time, the Soviet Union had not been interested in developing its own atomic bomb and was happy for the US to continue its research.	TRUE/ FALSE
12	The joint efforts and sacrifices of the US and the Soviet Union against Nazi Germany ensured that good relations would continue long into the future.	TRUE/ FALSE
13	The US was becoming concerned at what was looking like the future domination of Eastern Europe by the Soviet Union.	TRUE/ FALSE
14	After 1945, even though it had won the war against Nazi Germany, the Soviet Union was now fearful of American economic and military strength.	TRUE/ FALSE
15	Historians have universally dismissed the idea that the use of the atomic bomb against Japan had anything to do with the developing Cold War.	TRUE/ FALSE

What do the historians have to say about "Truman and the debate on the use of the bomb"?

1. Charles L Mee Jr

Mee argues that by late June, Truman had been told by many of his key military people that the 'bomb-as-weapon', was unnecessary.

- These included General Eisenhower, Admiral Leahy and air force General Le May.
- General Macarthur who was Supreme Commander in the Pacific said after the war that the bomb had been of little military use.
- Churchill later wrote that Japan's defeat was certain before the first bomb even fell.
- The United States Strategic Bombing Survey stated after the war that Japan would have surrendered even without the atomic bomb.

However, Mee argues that if the bomb had not been used on Hiroshima and Nagasaki, US possession of the atomic bomb would have had no psychological effect on Russia. Referring to the bomb as a 'doomsday machine', Mee concludes that by using the bomb, the psychological effect on Soviet leader Stalin was twofold:

"…the Americans had not only used the doomsday machine; they had used it when, as Stalin knew, it was not militarily necessary. It was this last chilling fact that doubtless made the greatest impression on the Russians…" [2]

2. John Lewis Gaddis

Gaddis argues a quite different line to Mee.

- He quotes Truman as saying: *"Let there be no mistake about it. I regarded the bomb as a military weapon and never had any doubt that it should be used."*
- Gaddis says that the bomb had been used to quite simply achieve victory against Japan as decisively and as economically as possible.
- He says that if it had been ready for use against Germany, a German city not a Japanese city would have been the first target of an atomic bomb.
- Both the British and the Americans had had no qualms about flattening German and Japanese cities with conventional weapons.

Gaddis says that it would have been surprising if the thought of intimidating the Russians with the bomb had not crossed the minds of Truman and his team. However, he argues firmly:

"…Hiroshima and Nagasaki were destroyed, the latter probably unnecessarily, to shock the Japanese into surrendering and thereby to avoid the casualties – on both sides and whatever their extent – that might occur in forcing Japan's defeat by more orthodox means…" [3]

2 Mee Jr, C L, Meeting at Potsdam, Dell Publishing, New York, 1975, p 204
3 Gaddis, J L, We Now Know: Rethinking Cold War History, OUP, Oxford, 1997, p 87

Chapter Five
US and Russian nuclear capacity 1945-2011 and the doctrine of Mutually Assured Destruction (MAD)

Introduction

The most significant legacy of the dropping of the atomic bomb on Hiroshima and Nagasaki in August 1945 was the nuclear arms race that it engendered. Technology does not stand still. Scientists are constantly experimenting, testing and formulating news ways of doing things. This was no more evident than in the development of nuclear weapons. Both the US and the Soviet Union sought to increase its nuclear capability. The atomic bomb was superceded by the hydrogen bomb. Weapons became ever more powerful, delivery systems ever more sophisticated.

Nuclear capability was not merely a matter of more and bigger bombs. These bombs had to reach their targets.

- In the 1940s, an atomic bomb could only be delivered by an aircraft:
  - by the late 1960s, they could be delivered not only by ever bigger and more powerful aircraft, but also by missiles from land-based locations and submarines.
- The development of missile technology continued apace:
  - by the late 1950s, missiles carrying nuclear warheads could reach targets thousands of miles away;
  - at first, it was the case that a missile could carry one nuclear warhead;
  - by the 1970s both the US and the Soviet Union had developed missiles that could carry multiple warheads.

By the early 1970s, both the US and the Soviet Union had developed a degree of ABM (anti-ballistic missile) technology. The aim of an ABM was to destroy a missile before it could reach its target. ABM technology had the means of ending the doctrine of Mutually Destroyed Destruction (MAD) which had held sway in the world of nuclear weapons for many years.

The launching of Sputnik in 1957 by the Soviet Union, took the rivalry between the US and the Soviet Union into space.

- The space race would become a matter of a competition of national prestige.
- However, for some time there were fears that outer space could become a location of nuclear weapons.
- In the 1980s, US President Reagan had a vision of a Strategic Defence Initiative – known as Star Wars – which would have established weaponry in outer space:
  - it did not eventuate but it did force the Soviet Union to waste scarce resources researching the idea.

The end of the Cold War and the collapse of the Soviet Union brought about a great lessening of tension between east and west. Reductions in nuclear weaponry did occur. However, in the two decades that followed the end of the Cold War, nuclear capability only became more sophisticated as new technologies were developed.

The fear that 'the other side' was developing superior nuclear capability has been a feature of the nuclear age. Not surprisingly espionage has played a significant role in the development of nuclear capability as each side sought to 'steal the other's secrets'. Espionage was certainly a major factor in the ability of the Soviet Union to develop the atomic bomb as quickly as it did.

The development of nuclear capability

(1) From the atomic bomb to the hydrogen bomb

From August 1945 to August 1949, the US had a 'nuclear monopoly'. By 1948, the US had about 100 atomic bombs which were all stored inside the United States. At this stage, the only means the US had to 'deliver' an atomic bomb was the B-29 bomber.

The US monopoly ended on 29 August 1949 when the Soviet Union exploded its first atomic bomb at Semipalatinsk in Kazakhstan:

- while the Americans had J Robert Oppenheimer and Edward Teller, the Russians had Igor Kurchatov and Andrei Sakharov;
- the Russians codenamed their bomb *First Lightning*; the Americans referred to it as *Joe 1* (after Stalin).

The Soviet success in producing an atomic bomb with such speed shocked the Americans. The US knew that Stalin was developing atomic weapons but assumed it would take the Soviet Union years to achieve its goal. It was soon learned that Soviet spies had infiltrated top secret American institutions, including Los Alamos.

- US intelligence agents had gained access to WWII era cables – an archive known as *Venona* – that the Soviet consulate in New York had been sending to Moscow:
  - they discovered that Soviet spies had been sending atomic secrets to Moscow.


Klaus Fuchs

- In September 1949, the Americans found out that a member of the British mission, who had been part of the US and Canadian atomic programs, was a Soviet spy. This was *Klaus Fuchs*:
  - Fuchs had left Los Alamos in June 1946 and was now working on the British atomic program at Harwell, south of Oxford;
  - Fuchs was arrested in January 1950, tried and imprisoned; [1] Fuchs' admitted to spying and his testimony led to the arrest of other spies such as Harry Gold, David Greenglass, and Julius and Ethel Rosenberg. [2]

1 Fuchs was sentenced to 14 years in prison. He was released in 1959 and went to East Germany where he lived until his death in 1988.
2 The Rosenbergs were executed in 1953. For decades there were campaigns to clear their names. Declassified Soviet documents available after the Cold War proved they were working for the Russians, though their value to the Russians was far less than their death sentences suggested.

In 1948, the FBI and MI5 learned that a senior figure in the British Embassy in Washington had been providing the KGB with top level atomic secrets.

- *"That someone was Donald Maclean, who turned out to be a key to the most humiliating espionage betrayal in British history."* [3]
- Maclean proved to be part of a highly successful Soviet spy ring known as the *Cambridge Five*, that also included Guy Burgess, Kim Philby, Anthony Blunt and John Cairncross. [4]

Following the Soviet development of its own bomb, US President Truman ordered the development of a 'thermonuclear weapon', or **'H-bomb'**. News of Truman's decision forced the Soviet Union to immediately accelerate their research and development of their own thermonuclear device:

- the US tested its first hydrogen bomb in 1952;
- the decision to develop the H-bomb changed the whole nature of 'nuclear capability';
  - a hydrogen bomb could yield an explosion of ten megatons - or ten million tons of TNT;
  - the bomb that destroyed Hiroshima had a yield of about 12 500 tons of TNT;
- the Soviet Union had its H-bomb in 1953;
- other nations now pursued the same technology;
  - Britain had the H-bomb by 1957. [5]

(2) Delivery systems: from the late 1940s to the 1970s

As well as developing more powerful weapons, much effort was being put into more effective means of **delivering those weapons**.

- The United States at first used the B-29 bomber as its means of carrying atomic weapons.
- The earliest Soviet bomber used for this purpose was the Tupolev 95.
- Over the years, both the US and the Soviet Union have developed more powerful and more sophisticated variants of their original bombers.

Though never giving up bombers as a means of delivering a nuclear weapon, both sides pursued missile technology and more to increase their nuclear capability.

Figure 5.1 outlines some of the key delivery system developments from the late 1940s to the 1970s.

3 Nelson, C, The Age of Radiance: The Epic Rise and Dramatic Fall of the Atomic Era, Scribner, New York, 2014, p 238
4 Maclean and Burgess defected to the Soviet Union in 1951; Philby in 1963. Blunt and Cairncross stayed in Britain, their treachery revealed in 1979 and 1990, respectively.
5 France tested its first nuclear device in 1960; China in 1964.

Figure 5.1 Delivery system developments from the late 1940s to the 1970s

The B-29 bomber was later replaced by the '**Convair B-36 Peacemaker**'. The B-36 was a strategic bomber It had a range of up to 10 000 miles and so could handle intercontinental distances without having to refuel. Its wingspan (230 feet) was the longest of any aircraft ever built. The B-36 was in service from 1949 to 1959, and during that time was the main nuclear weapons delivery vehicle for the US Air Force.

In the mid-1950s, development began on the **B-52 stratofortress strategic bomber**. There have been various models of the B-52; the 'H Model' is still used by the US air force. The B-52 had a speed of 650 mph and a range of 8800 miles. It remained the US air force's main strategic nuclear bomber for decades.

Under President Eisenhower (1953-1961), the US **increased its production of nuclear warheads and long-range bombers**. Many of these aircraft were positioned in allied countries close to the Soviet Union, such as Turkey.

From the 1950s to the 1970s, the US and Russia developed increasingly sophisticated missiles. In January 1954 the US launched its first **nuclear-powered submarine, the *Nautilus*.**

Both sides began developing **ICBMs** ***– inter-continental ballistic missiles***. These missiles were armed with a nuclear warhead that could reach targets on the other side of the world. The US long-range Atlas and Titan models had a range of up to 8000 kms.

The US also developed ***intermediate range ballistic missiles***. These included the Thor and Jupiter models. These had a range of about 2400 kms and were based in Italy and Turkey.

By the late 1950s, the US had developed the ***minuteman missile***. The minuteman stored fuel in its own engines and could be activated in a minute (whereas an Atlas took an hour). They were small and so could be stored underground which protected them from an enemy attack.

In July 1960, the US test fired its first ***Polaris missile*** from a nuclear submarine. Missiles launched in this way were called ***SLBMs – submarine launched ballistic missiles***. Polaris submarines could get very close to the Soviet Union, even moving under the Arctic ice sheet. As they could get so close, the range and accuracy of these missiles were greatly increased. By 1968, Russia had its own SLBMs. By the early 1960s, the US had what became known as a nuclear triad system which comprised long-range bombers, ICBMs and SLBMs.

In 1966, the US introduced the ***MRV – multiple re-entry vehicle***. A MRV was a ballistic missile which could carry multiple warheads. Multiple warheads could be deployed in a pattern against a single target. This meant that the damage inflicted by a missile could be much greater. MRVs were also more difficult to attack by an anti-ballistic missile (ABM – see below). Russia had developed its own MRV by 1967.

By 1970, the US had developed the MRV into the ***MIRV – multiple independently targeted re-entry vehicle***. The principle of the MIRV was similar to that of the MRV. However, the MIRV had the advantage that the different warheads could be fired at separate targets. By 1975 Russia had its own MIRVs.

In 1967, the US started development on an ***ABM – anti-ballistic missile system***. Soon both the US and Russia had the means to make an ABM. A treaty was signed to stop this as such a system might tempt a power into initiating a first-strike, in the belief its enemy's missiles could be prevented from reaching them. (see Chapter 10)

Exercise 5.1 Place the events on the right in the correct chronological order.

1st event		LAUNCH OF THE NAUTILUS
2nd event		ARREST OF KLAUS FUCHS
3rd event		DEVELOPMENT OF MRVs
4th event		FIRST LIGHTNING
5th event		RUSSIA HAS MIRVs
6th event		US TESTS THE H-BOMB
7th event		DEVELOPMENT OF MINUTEMAN MISSLE
8th event		US HAS MIRVs
9th event		US ATOMIC MONOPOLY
10th event		DEVELOPMENT OF SLBMs
11th event		EARLY DEVELOPMENT OF ICBMs
12th event		RUSSIA TESTS THE H-BOMB

(3) Delivery systems: from the late 1970s

The fundamentals of nuclear weapons and delivery systems changed little from the 1970s. However, nuclear weapons increased in power and each side continued to stockpile enough weapons to destroy the earth several times over. Bombers, intermediate and long-range missiles, and submarines continued to be the methods of delivery. Computer technology would

add many degrees of sophistication over the following decades. Bombers became capable of avoiding radar detection.

Some of the later developments in nuclear capability included the following.

- In the late 1970s, MX ICBMs were developed:
  - these were missiles that could be moved around on mobile launchers;
  - this made them less easy to locate during any attack.
- In 1981, US President Reagan gave the go-ahead for the development of the neutron bomb:
  - in essence the neutron bomb or 'enhanced radiation artillery shell' killed people rather than destroyed land;
  - it was believed it would be more effective against Soviet tanks.
- During the first Reagan administration (1981-85):
  - the US pursued the development of the MX missile and the B-1 bomber;
  - medium-range Pershing II and Cruise missiles were being stationed in western Europe in the 1980s.
- The Soviet Union had been placing its own medium-range missiles in Eastern Europe:
  - these included the SS20, SS4 and SS5 missiles:
  - Reagan tried to bargain away the Soviet missiles by offering not to put the new Pershing and Cruise missiles in Western Europe.
- President Reagan's 'pet project' was the Strategic Defence Initiative which became popularly known as 'Star Wars':
  - the principle behind 'Star Wars' was to place an ABM system in outer space which could shoot down incoming Soviet missiles;
  - it would use laser and particle-beam technology;
  - the scheme was ridiculed by many, would have breached the 1972 ABM Treaty and had it ever come to anything, might have tempted the Soviet Union into launching a first strike.

The end of the Cold War and the collapse of communism in the Soviet Union by 1991, immediately lowered superpower tensions. For some time, it was almost possible to put the fear of a nuclear exchange out of mind: [6]

- between 1990 and 2011, the number of nuclear weapons that the US had fell from 10 904 to approximately 7300;
- in the same period, Russia's nuclear arsenal fell from 37 000 to 17 000;
- the last Soviet/ Russian nuclear test took place on 24 October 1990;
- the last US nuclear test took place on 23 September 1992.

However, is the world truly safe from nuclear weapons in the 21st century? Nine countries (in 2021) have nuclear weapons - that we know of! Victor Gilinsky, writing in the *Bulletin of Atomic Scientists,* 10 December 2020, leaves us with this sobering thought:

"…the nuclear weapons aren't asleep. They are ready to go…"

6 What follows relates only to the US and Russia. The impact of nuclear proliferation will be considered in Chapter 12.

Mutually Assured Destruction (MAD)

The acronym MAD stands for *"Mutually Assured Destruction"*. It is a term which came into common use from the early 1960s. The essence of "Mutually Assured Destruction" is the idea that nobody can win a nuclear war.

- If one side was to launch a nuclear attack on the other, it would be met with immediate and massive nuclear retaliation.
- The US and the Soviet Union had so many powerful nuclear weapons, they would destroy each other, even if one side had more weapons than its enemy.
- The belief in the concept of MAD, it was hoped, would therefore make the chance of a nuclear war almost impossible:
  - this was *nuclear deterrence*;
  - possession of nuclear weapons was seen as the *ultimate deterrent*;
  - the possession of nuclear weapons by one side would always deter the other side from using its weapons.

The danger of course has always been, what if a mistake was made on either side? The world came very close to a superpower nuclear exchange on several occasions during the Cold War, most notably during the Cuban Missile Crisis of October 1962.

From 1947, the United States had followed the policy of 'containment'. Containment involved efforts by the United States to prevent the spread of communism anywhere across the world. It did not involve attempting to destroy communist governments where they already existed.

During the 1950s, the US Secretary of State, John Foster Dulles, took containment further when he promoted the policy of 'brinkmanship'. Brinkmanship involved the US threat of massive retaliation against the Soviet Union in any test of wills. Crises would be 'pushed to the brink', with the US threatening to use nuclear weapons. Dulles' logic was that as the US was so vastly superior to the Soviet Union in nuclear weaponry, the Soviets would think twice about 'misbehaving'. However, Dulles' idea suffered from two fundamental flaws:

- it gave the US only two options in any crisis: a full-scale nuclear response to any Soviet threat or a total backdown;
- it could also result in the US having to use nuclear weapons over issues in which the US had only an indirect interest.

For some years, the US had a major superiority in nuclear weaponry compared to the Soviet Union, despite its fears that this was not so. [7] However, in the 1960s, the Soviet Union pursued nuclear parity:

- parity did not mean that the Soviet Union had an equal number of weapons as the US.
- it meant that it had enough weapons to cause so much destruction on the US, the Americans would be deterred from launching a first strike against it.

Thus, parity meant that Mutually Assured Destruction would be guaranteed.

7 See Historian 1.

The issue of "Space"

In the early 21st century, we have become used to US-Russian cooperation in space. US and Russian astronauts (and other nationalities) work together on the International Space Station. In 2010, the United States' National Aeronautics and Space Administration – NASA – announced that for the foreseeable future, US astronauts would be taken to the International Space Station in Russian spacecraft.

However, for many years, the US and Russia were bitter rivals in space, and the "Space Race" became a feature of the Cold War.

- The United States was thrown into a state of panic and self-questioning when in 1957, the Soviet Union launched the world's first artificial satellite:
  - it was called Sputnik 1 and was about the size of a football;
  - US leaders demanded to know how could a technologically inferior Russia beat the US into space.
- Russian success in space added to US fears about the mythical "missile gap" (see Historian 1).

For some years, both the US and Russia feared that the nuclear capacity of its rival could extend into space. This was not to be the case. "The Space Race" would turn into an east-west propaganda contest about 'who could get the first man in space' or 'who could land a man on the moon first'. It was not until President Reagan's idea of the 'Strategic Defence Initiative' in the 1980s that space entered into the calculations of either side's nuclear capacity (see above).

Exercise 5.2 Define the following terms and acronyms

1	MX ICBM	
2	neutron bomb	
3	Pershing II	
4	SS20	
5	nuclear deterrence	
6	containment	

7	brinkmanship	
8	nuclear parity	
9	MAD	
10	NASA	
11	Sputnik 1	
12	"Star Wars"	

What do the historians have to say about "US and Russian nuclear capacity 1945-2011 and the doctrine of Mutually Assured Destruction (MAD)"?

1. Craig Nelson

During the late 1950s, US politicians became obsessed with what became known as "the missile gap". This was the belief that the Soviet Union heavily outnumbered the United States in the number of missiles it had. Soviet leader, Nikita Khrushchev, added to this fear by frequently boasting about Soviet missile strength.

- President Eisenhower refused to rise to the criticisms aimed at him for doing nothing about Soviet nuclear capability:
  - Eisenhower knew there was no missile gap and that in fact the US was far superior.
  - this was because U2 spy planes were regularly flying over the Soviet Union and could assess the true situation.
- Nelson quotes Khrushchev's scientist son who later said: *We threatened with missiles we didn't have.*

"…By the end of 1959, the Soviets had a total of six long-range missile sites, and each missile needed twenty hours to prepare for launch, meaning that the total number of Soviet missiles available to attack the United States before retaliation was… six." [8]

8 Nelson, C, The Age of Radiance: The Epic Rise and Dramatic Fall of the Atomic Era, Scribner, New York, 2014, p 256

2. Ben Macintyre

In his book 'Agent Sonya', Ben Macintyre tells the fascinating story of Ursula Kuczynski. Kuczynski took on various aliases during her career, including that of a Mrs Beurton, 'elegant' housewife from a typical English village.

- She was in fact one of the Soviet Union's most successful secret agents and during her clandestine career was active not only in England but across Europe and Asia.
- Through her, Klaus Fuchs was to pass on to 'Moscow Centre' an invaluable array of atomic secrets which it described as *Important. Very valuable.*
- Kuczynski would later refer to Klaus Fuchs as her best spy.

Fuchs passed on 570 pages of reports, calculations, drawings, designs for uranium enrichment and a *step-by-step guide to the fast-moving development of the atomic weapon.* Macintyre comments on Fuchs and his work with Ursula Kuczynski:

"…Fuchs' transfer of scientific secrets to the Soviet Union between 1941 and 1943 was one of the most concentrated spy hauls in history… Fuchs was privy to the innermost workings of the atomic project and he held nothing back…" [9]

3. Kenneth N Waltz

Waltz presents an argument that the possibility of 'mutually assured destruction' is what has kept the world at peace in the nuclear age. Conflicts have raged across the world since 1945, but these conflicts have been limited geographically and militarily. The likelihood of MAD, is the ultimate deterrent. The presence of nuclear weapons causes states to be extremely cautious. As Waltz puts it: *Why fight if you can't win much and might lose everything?* He points to the behaviour of President Kennedy and Soviet leader Khrushchev during the Cuban missile crisis as evidence of this type of thinking. This leads Waltz to comment:

"…Deterrence is achieved not through the ability to defend but through the ability to punish… In a nuclear world, one is uncertain about surviving or being annihilated… Nuclear weapons make military miscalculation difficult and politically pertinent prediction easy…" [10]

9 Macintyre, B, Agent Sonya: Lover, Mother, Soldier, Spy, Viking, London, 2020, p 230
10 Waltz, K N, More may be better, in The Spread of Nuclear Weapons: An Enduring Debate, edited by Scott D Sagan and Kenneth N Waltz, W W Norton and Co, New York, 2013, pp 5, 9

Chapter Six

Civilian fears and state programs in the USA to survive the bomb and fallout

In 1999, a Hollywood romantic comedy was released called "Blast from the Past", starring Brendan Fraser, Alicia Silverstone and Christopher Walken. The film told the story of an eccentric scientist, Dr Calvin Webber, who was convinced that nuclear war with the Soviet Union was coming. He builds a fallout shelter in his backyard. As the Cuban Missile Crisis unfolds, Webber goes into the shelter with his pregnant wife, Helen. A passing F-86 fighter aircraft loses control and crashes into the Webber home. Webber, believes the war has come and activates the shelter's time lock for 35 years. Helen gives birth to a son, Adam. For 35 years, the three of them live in a time-warp, immersed in US culture and mores, pre-1962. The shelter unlocks in 1997, and Adam, aged 35, ventures into the world of the late 1990s…

The relevance of this gentle comedy to this chapter is the paranoia felt by the likes of Dr Webber. Americans in the 1950s and 1960s were genuinely fearful of a nuclear attack. The notion of a backyard fallout shelter is not a film director's fantasy; there were thousands of them across the United States, as fearful Americans sought ways to survive the bomb and the fallout from a nuclear attack.

Civilian fears

In his book, *The Rise of Nuclear Fear*, Stephen R Weart describes how humanity's 'emotional' relationship with atomic power and nuclear radiation generally has developed over time. [1] Weart explains how our attitude towards 'things nuclear' changed from *"Gee Whiz"* to *"Oh No"*.

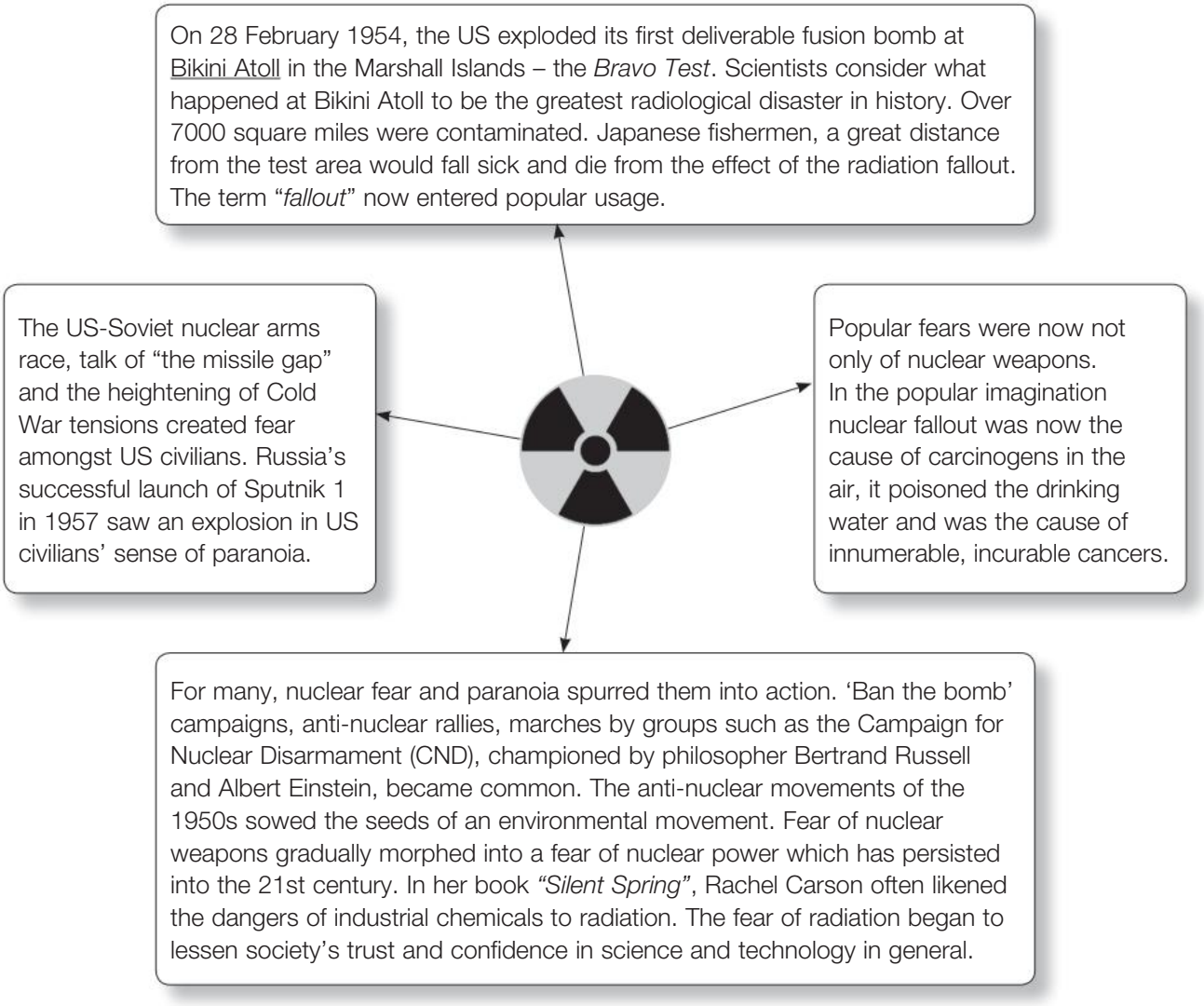
For many years, there was little fear of things atomic. Between 1900 and 1940, 75% of newspaper headlines about radiation were either positive or neutral (Weart). People ordered 'atomic cocktails', children's sports teams would take on names such 'the atoms' or 'the atomics'. For a time, radiation was seen as a kind of *Philosopher's Stone* which would transform the world for the better:

- stories were written about how a small amount of uranium could drive a steamship across the Atlantic Ocean;
- it could light up an entire city;
- the entire British navy could be lifted a few thousand feet into the air with just a small bottle of radium;
- radium-painted watch dials became very popular as they were able to glow in the dark;
- people happily bought radioactive mouthwash, toothpaste and skin creams.

1 Weart, S R, The Rise of Nuclear Fear, Harvard University Press, 2012

However, Hiroshima and Nagasaki changed perceptions and people across the world developed a great fear of 'things nuclear'. From the 1940s onwards, newspapers now contained stories about "cosmic hell fire", or "the prospect of Doomsday". Reports of the suffering of Japanese atomic survivors led to stories about 'atomic bomb disease' or 'atomic plague'. In the mid-1950s, the Bulletin of the Atomic Sciences created the 'Doomsday Clock' to bring home how close humanity was to total planetary destruction – *five minutes to midnight*. Extreme religious groups had long talked about the coming "apocalypse"; now such fears and beliefs were becoming part of mainstream thinking. By the late 1950s and early 1960s, civilian fears of nuclear power had grown enormously. Figure 6.1 outlines the development of some of these fears.

Figure 6.1 Growing civilian fears of the nuclear age.



Popular cinema in the 1950s and 1960s helped both to create civilian fears about nuclear weapons and to confirm those fears.

- Even before WWII, films explored popular concerns about radiation:
  - in the 1936 film, *The Invisible Ray*, Boris Karloff gained the power to kill anyone he touched following his use of a radium ray;
  - the cartoon hero, *Flash Gordon*, was sabotaging 'atom furnaces' in 1936;
  - the 1940 film, *Murder in the Air*, told the story of a US agent guarding a secret atomic ray canon that was able to shoot enemy planes out of the sky;
    - the agent was played by Ronald Reagan, who as President in the early 1980s toyed with his 'Strategic Defence Initiative'. [2]
- In the 1950s more films around the nuclear fear idea appeared:
  - the 1954 Japanese film, *Godzilla*, is considered by some as an analogy to the atomic weapons dropped on Japan;
  - the 1954 film, *Them*, saw giant mutated ants terrorising Los Angeles;
  - the 1959 film, *On the Beach,* depicts the aftermath of a nuclear war. [3]
- Arguably the classic paranoid nuclear era movie is Stanley Kubrick's *Dr Strangelove, or how I learned to stop worrying and love the bomb:*
  - this brilliant film encapsulated the many fears that civilians had about the possibility of nuclear warfare;
  - it had a President unable to control the situation and a mentally-ill general ordering a first strike;
  - it also had pilots who believe they are being tricked by the Soviets not to drop their atomic payload.

The manner in which cinema was able to promote popular fears about nuclear weapons and nuclear power did not end in the 1960s:

- The 1979 film, *The China Syndrome*, tells the story of a potential nuclear meltdown at a nuclear power plant:
  - the film was prescient as thirteen days after the film's release, there was a partial meltdown of reactor number two at the nuclear power plant at Three Mile Island, near Harrisburg, Pennsylvania;
  - the disasters at Chernobyl (1986) and Fukushima (2011) have kept the fears of radiation alive. [4]
- Cold War tensions between the US and the Soviet Union escalated during the first Reagan administration (1981-85). This development saw another acceleration in civilian fears of nuclear war increased and was again reflected in cinema, as seen in:
  - The Day After in 1983;
  - Threads in 1984.

2 See Chapter 5.
3 "On the Beach" was based on the 1957 book by Australian novelist Neville Shute. The film's star, Ava Gardner, was alleged to have commented that: Melbourne is the perfect place to make a film about the end of the world.
4 See Chapter 15.

Exercise 6.1 Indicate whether each of the following statements is true or false.

1	People have never had any positive feelings about the development of radiation and the advent of nuclear power.	TRUE/ FALSE
2	Popular feelings about radiation and nuclear issues changed dramatically following the attacks on Hiroshima and Nagasaki.	TRUE/ FALSE
3	The creation of the *Doomsday Clock* in the 1950s was an attempt by scientists to bring home to ordinary people the dangers from nuclear weapons and power.	TRUE/ FALSE
4	The nuclear test at Bikini Atoll in February 1954 was well received by the civilian population as a great scientific achievement.	TRUE/ FALSE
5	After the Bikini Atoll test in February 1954, the term *fallout* entered the popular lexicon in discussions about nuclear issues.	TRUE/ FALSE
6	The launch of the Russian satellite, *Sputnik 1,* in 1957, had little impact on the attitudes of American civilians regarding their national safety.	TRUE/ FALSE
7	The fears and concerns that ordinary people had about the dangers of nuclear weapons spurred on the development of anti-nuclear movements in the 1950s.	TRUE/ FALSE
8	The long-term effects of anti-nuclear movements included the growth of environmentalism and increasing popular suspicion of science and technology.	TRUE/ FALSE
9	Popular cinema in the 1950s seemed to have ignored the fears that civilians harboured about nuclear weapons and nuclear power in general.	TRUE/ FALSE
10	Stanley Kubrick's film, *Dr Strangelove,* succeeded in convincing people who saw it that there was little danger of a nuclear war occurring due to human error.	TRUE/ FALSE
11	The film, *The China Syndrome,* increased civilian fears about the possibility of a nuclear plant experiencing a meltdown of its reactors.	TRUE/ FALSE
12	By the 1980s, it was clear that civilian concerns about the possibility of nuclear war and nuclear accidents had become things of the past.	TRUE/ FALSE

State programs in the USA to survive the bomb and fallout

A home for your family! This is a property you do not want to miss out on. Fair Haven Village, Ranch-style home, Richmond Ave. Four bedrooms, hardwood floors, full basement with fallout shelter, two-car detached garage and large corner lot. Asking price $22 000. Wallace Wilkinson Real Estate. [5]

5 Adapted from The Palladium Times, Oswego, New York State, 1969.

Such real estate advertisements in the 1950s and 1960s were not uncommon in the United States. Thousands of properties across the United States were built with "a nuclear fallout shelter"; thousands of other properties had such additions built. In the event of a nuclear attack from the Soviet Union, families could seek safety in their 'fallout shelter' until the worst was over (see below). The family of President Kennedy (1961-63) had a fallout shelter on Nantucket Island, Massachusetts, near the family compound at Hyannis Port. The Kennedys also had one on Peanut Island, Florida, near their winter home.

It became US government policy to prepare the civilian population for the possibility of nuclear war, and more, to prepare the civilian population on how to survive a nuclear war and the resultant fallout. President Eisenhower had commissioned the *Gaither Report* in 1957 to advise him on nuclear issues. The detailed report reached many conclusions including:

- the Soviet Union would soon surpass the US in nuclear power;
- the Soviet Union was preparing its population for nuclear war;
- the US must spend $25 billion on fallout shelters;
- the government must launch a campaign advising civilians what they must do in the event of a nuclear war.

A series of civilian defence programs were introduced by the government from the beginning of the 1950s. An *Office of Civil Defence (OCD)* was established, which for two decades promoted the fantasy that people could survive a nuclear war.

- The people of Fair Haven were organised to take part in 'plane spotting' from a building on Victory Street:
  - they were trained to look for enemy planes which matched posters they had been shown.
- The government produced a documentary called *You can beat the A-Bomb*:
  - families were advised to close windows;
  - they should hide under furniture;
  - cover windows with cardboard.
- Cities such as New York, Seattle and Philadelphia introduced the idea of providing dog tags or bracelets for children who might be lost or killed during an attack:
  - ideas were put forward for giving children a tattoo in case their parents died or the children were displaced;
  - this idea was not taken up as it was assumed that during a nuclear attack the skin would most probably be burned off.

School children of the time were taught to "duck and cover" under their school desks, in order to survive a nuclear attack. A cartoon hero was created to spread the message. His name was *Bert the Turtle:*

- when Bert was attacked by flying monkeys wielding sticks of TNT, Bert knew what to do: duck and cover;
- Bert had sound advice for the children. 'During a nuclear explosion, all the windows will probably be smashed, so you know what to do, don't you? Duck and cover under the furniture.

Bert the Turtle

Duck and cover

The most common defence precaution was the construction of a "fallout shelter". This is considered in more detail in Figure 6.2.

Figure 6.2 The "fallout shelter"

People were encouraged to build a fallout shelter in their backyard or in the basement. However, fallout shelters only provided protection from fallout not the blast.

Instructions were given to build shelters with concrete block walls several inches thick, or bricks and earth. Lead would provide protection from gamma rays.

Advice was given on how to install a hand-cranked blower to ensure ventilation. Without this, a crowded shelter could result in exhaustion or suffocation.

Families feared neighbours might invade their well-stocked shelter instead of building their own. Some people built shelters in secret or did so only at night.

GOVERNMENT ADVICE ON FALLOUT SHELTERS

Once in a fallout, people were told to stay put for two weeks and then start going outside for gradually increasing amounts of time.

Business was quick to enter the fallout shelter market. A foxhole type shelter could be built for less than $20. A deluxe shelter would cost a 'survivor' up to $5000.

The government provided booklets on building plans, and advising what type of supplies to stock up with, eg dry package foods, first aid kits, flashlights.

From 'The Family Fallout Shelter', the Department of Defence put out special curricula for Home economics classes on how to furnish one's fallout shelter.

An "Alert America' campaign travelled the country offering advice on how some simple procedures could provide protection. There were travelling exhibits and film shows. Wall Street investors set up fallout shelter businesses. The OCD tended to offer its advice only to 'suburbanites', not 'urbanites'. It was assumed that the centres of cities would be destroyed and their inhabitants would be annihilated. Those people in the suburbs had a chance of surviving. One aspect of life that was not often discussed was the issue of toilet waste. It was assumed that human waste would be placed in a garbage bin that had been lined with plastic. Presumably, once it was full, someone would be given the job of 'popping outside really quickly and dumping it'.

Exercise 6.2 Use the terms below to complete the following passage.

The US government spread the idea that civilians could _____ a nuclear war. An Office of _____ continued to hand out survival advice for up to two _____. Children were trained to _____ and _____ in the event of an attack. They received advice from Bert _____. In some cities, children were given _____ in case they were displaced. The idea of _____ children was quickly abandoned. Early advice given to civilians included hiding under _____ and covering windows with _____. From the 1950s, _____ of fallout _____ were built in people's _____ or in their _____. Government information _____ offered advice on how to _____ a shelter, how to _____ one and what types of _____ to include. _____ soon entered the fallout shelter marketing realising that there were profits to be made from people's _____. One issue which was often omitted from discussions was the issue of _____ waste.

SHELTERS – TOILET – DECADES – BASEMENTS – CIVIL DEFENCE – FURNISH – TATTOOING – THE TURTLE – SUPPLIES – DUCK – FEARS – COVER – BUSINESSES – BUILD – DOG TAGS – SURVIVE – FURNITURE – CARDBOARD – THOUSANDS – BACKYARDS – CAMPAIGNS

What do the historians have to say about "Civilian fears and state programs in the USA to survive the bomb and fallout"?

1. Craig Nelson

Nelson describes the advice that the Office of Civil Defence offered to suburbanites when it came to constructing their fallout shelters. Fallout shelters needed concrete walls which were at least a foot thick, and needed to be shielded by five hundred cubic feet of air and several inches of packed dirt, along with a half inch of lead. A popular snack food in the US since the 1930s was a product called *Twinkies*. [6] It became an element in Civil Defence planning:

"…Twinkies were a staple of shelter pantries since they were supposed to 'stay fresh forever…" [7]

2. President Dwight D Eisenhower

In December 1953, President Eisenhower addressed the General Assembly of the United Nations on the subject of the use and misuse of atomic power. The purpose of his speech was to propose that the major scientific nations of the world contribute to a pool of atomic power resources. His vision was that these resources could be directed towards socially desirable purposes. In the second half of his speech, Eisenhower outlined the positive possibilities of atomic power. However, he was well aware of the dangers of the nuclear age. Earlier sections of his speech could only but add to the fears of American civilians of the time.

"…But let no one think that the expenditure of vast sums for weapons and systems of defence can guarantee absolute safety for the cities and citizens of any nation. The awful arithmetic of the atomic bomb does not permit of any such easy solution. Even against the most powerful defence, an aggressor in possession of the effective minimum number of atomic bombs for a surprise attack could probably place a sufficient number of his bombs on the chosen targets to cause hideous damage…" [8]

Popular fears about a nuclear war have made their presence felt in popular music from the 1950s to the 1980s. Many songs of the time can be found on YouTube, both copies of lyrics and recordings. They range from the satirical to the amusing to the more series. Three examples worth examining are:

- *Talkin' World War III* Blues by Bob Dylan (1963)
- *Fallout Shelter* by Scott Peters (1961)
- *Russians* by Sting (1985)

6 Twinkies became such an accepted American icon, US President Clinton even had one put into a time capsule.
7 Nelson, C, The Age of Radiance: The Epic Rise and Dramatic Fall of the Atomic Era, Scribner, New York, 2014, p 286
8 President Eisenhower at the United Nations General Assembly, 8 December 1953.

Chapter Seven
The nature and impact of nuclear tests in the US and Soviet Union

(1) Nuclear tests in the United States

Most people know that the atomic bomb was only ever used twice 'in anger', against Japan in August 1945, the targets being Hiroshima and Nagasaki. However, it may surprise most people to realise that it is the United States that has been hit by more nuclear weapons than any other country in history. If only atmospheric tests are taken into account, the US has endured more nuclear force and has been covered with more radiation than Hiroshima would have experienced if it had been bombed an additional 29 000 times. As a result of US nuclear testing, 2.4 million of its own citizens have died of nuclear testing-induced cancers.

Between 1945 and 1992, the United States carried out 1054 nuclear tests. Testing occurred at the Nevada Test Site, in Colorado, New Mexico, Mississippi, Amchitka Island (Alaska) and in the Marshall Islands in the western Pacific. The Nevada Test Site was situated about 100 kms north west of Las Vegas:

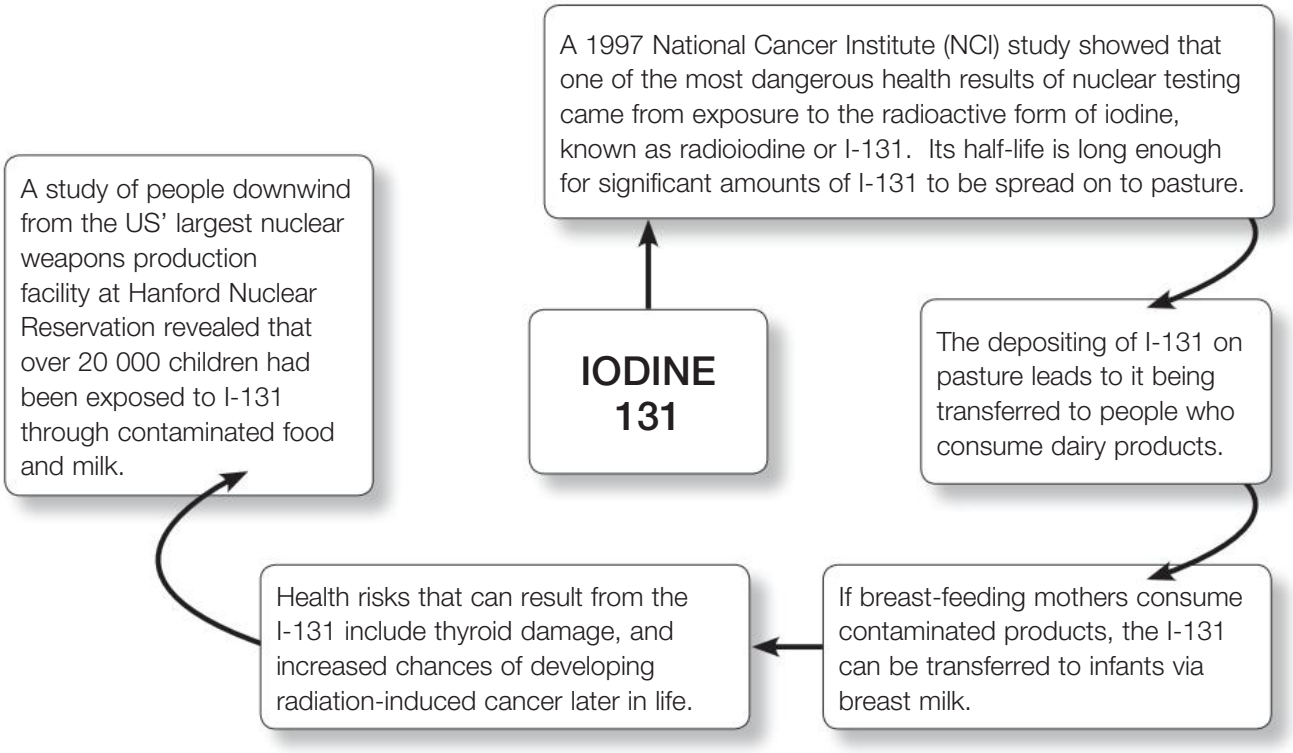
- the test site area covered over 3500 square miles;
- the average yield was 8.6 kilotons;
- between 1951 and 1958, there were 100 atmospheric tests;
- underground testing started in September 1957, and from 1962, all testing was carried out underground;
- high level winds spread radioactive fallout for thousands of miles;
  - people who experienced radioactive fallout from the effect of the winds were referred to "downwinders".
  - 91 of the 220 cast and crew of the 1956 movie *The Conqueror*, being filmed in Utah, downwind of the Nevada Test Site, were diagnosed with cancer – 46 died of cancer by 1980, included the stars of the film, John Wayne and Susan Hayward.

The Sedan nuclear test crater

Each test was given a specific name. In 1951, 'Operation Buster' produced a yield of 21 kilotons. The 'Storax Sedan' Test in July 1962, part of 'Operation Ploughshare', resulted in the creation of the largest man-made crater ever, displacing 12 million tons of earth. The crater created by the blast was 320 feet deep and 1280 feet in diameter. It brought about the radioactive contamination of more Americans than any other test in US history.

The Storax Sedan test released 880 000 curies of iodine 131 into the atmosphere whose effects were experienced as far afield as Iowa and South Dakota. A 'curie' (Ci) is a measure of radioactivity. The potential impact of iodine 131 is outlined in Figure 7.1.

Figure 7.1 The potential impact of iodine 131



US nuclear testing in the Marshall Islands

The Marshall Islands are situated about halfway between northern Australia and Hawaii. Before World War I, the islands were German colonies. Following Germany's defeat, Japan took control of the islands. After World War II, they were administered by the United States. The US recognised the islands' constitution and the Republic of the Marshall Islands in 1979. The Marshall Islands and the United States have maintained a close association ever since.

Between 1946 and 1958, the US carried out 67 nuclear tests at two of the Islands' atolls: Bikini and Enewetak.

- In 1952, 'Operation Ivy' saw the detonation of a thermonuclear device which was codenamed 'Mike':
  - it was more than 400 times bigger than the Hiroshima bomb;
  - the island of Elugelab was vaporised;
  - a massive crater was left and was blanketed in radiation.
- A much bigger test codenamed 'Castle Bravo' was carried out at Bikini Atoll on 1 March 1954:
  - the detonation strength was 15 megatons;
  - the fallout affected an area of more than 11 000 square kms, stretching as far as India, northern Australia, Japan and the US;

- winds carried radioactive materials, showering thousands of people.

- Rongelap Atoll, which was 170 kms from the blast site, was showered with fallout materials including coral rock and soil:
  - many of the people living on Rongelap suffered elements of radiation sickness, ranging from vomiting, hair loss and skin damage.
- A Japanese fishing boat, inappropriately named Lucky Dragon No 5, was 145 kms downwind from the Bikini atoll site:
  - many of the *Lucky Dragon* crew became very ill; one of the fishermen, Aikichi Kuboyama, died.

The **environmental effects** of nuclear testing can be predictably devastating. After the 'Bravo' test on Bikini Atoll, several radioactive isotopes, such as caesium, cobalt and plutonium, were found in the area's soils and waters.

- The radioactivity in the lagoon and the sea gradually disappeared, steadily diluted by the ocean.
- However, it remained on the island for many years:
  - in 1972, about 100 people were allowed back to Bikini after US authorities declared the area "radiologically safe";
  - in 1978, tests showed that these people had taken in very high levels of caesium-137 and strontium-90, and so they had to be evacuated again;
  - coconuts on Bikini remain radioactive because the coconut trees continue to absorb the soil's radioactive elements.

As well as the testing of nuclear devices, the United States also carried out a series of over **4000 radiation** tests between 1950 and 1990. The tests were carried out by various organisations, including the CIA, the Department of Defence and Centres for Disease Control.

These tests were carried out on 'human subjects' in hospitals or sometimes prisons. The aim was to collect data for the military of the impact of radiation on people.

Most of the human subjects who were tested were not informed about the radiation tests. Included in these tests were:

- 800 pregnant women were given radioactive iron, and afterwards they and their foetuses were closely monitored;
- Over 100 Native Americans were injected with radioactive iodine;
- 73 mentally disabled children in Massachusetts were fed radioactive cereal by Quaker Oats and the Atomic Energy Commission;
- The University of Washington irradiated the testicles of 232 prison inmates. The prisoners were paid $100, and were sterilised afterwards for fears that they might become the fathers of radiation-induced mutants!

Various pieces of legislation have been passed by the US Congress to compensate those people who have suffered from exposure to the fallout. These have included:

- 1990: The Radiation Exposure Compensation Act (the Downwinders Act);
  - by 2010, over $1.5 billion had been paid out to over 22 000 victims and their families;
- 1986: a $150 million Nuclear Claims Trust Fund was set up to compensate victims of the Marshall Islands tests;
  - many islanders died before they could receive any compensation;
  - the Marshall Islands government continued to demand 'fairer' compensation from the US;
  - in 2001, the US Nuclear Claims Tribunal awarded an additional $563 million to the islanders for the loss of their land and the hardships the people had suffered.

In April 2010, the US Supreme Court refused to consider any new cases regarding compensation for the impact of earlier nuclear testing.

Exercise 7.1 Answer the following questions in the spaces provided.

1	How many nuclear tests did the US carry out between 1945 and 1992? Where did the testing occur?	
2	What use was made of the Nevada Test Site by those testing nuclear devices in the 1950s and 1960s?	
3	Who were the 'downwinders'?	
4	What was the significance of the 'Storax Sedan Test' in 1962?	
5	What are some of the effects of exposure to iodine-131?	
6	What was the impact of the "Castle Bravo" test?	
7	What happened to the Japanese fishermen on the Lucky Dragon No 5 in March 1954?	

8	What radioactive isotopes were found to be present at Bikini Atoll following the US nuclear tests?	
9	What seemed to have been the long-term impact of nuclear testing on the waters around Bikini Atoll in the Marshall Islands?	
10	How many radiation tests were carried out on human subjects by US authorities between 1950 and 1990?	
11	Why did US authorities carry out radiation tests on human subjects between 1950 and 1990?	
12	What decision did the US Supreme Court made regarding future nuclear testing compensation claims?	

Nuclear tests in the Soviet Union

Between August 1949 and October 1992, the Soviet Union [1] carried out 715 atomic/thermonuclear tests, resulting in 969 detonations. The testing areas used by the Soviet Union were the Semipalatinsk Test Site (STS) in north east Kazakhstan (also known as the Polygon), Novaya Zemlya in the Arctic, and in the Urals mountains.

Between 1949 and 1989, 456 tests took place at Semipalatinsk:

- over 300 underground tests were carried out here after 1961;
- the last test took place at the STS in February 1989;
- the STS was officially closed on 29 August 1991;
- following the test of a 140 kiloton underground nuclear explosion on 15 January 1965, a crater was formed measuring 400 metres wide and 100 metres deep – this became Lake Chagan.

There were 130 nuclear tests carried out in the Novaya Zemlya archipelago in the Arctic region of the Soviet Union between 1954 and 1990:

- this region was chosen as Semipalatinsk was considered to be too close to human settlements for the larger tests;
- the region was previously inhabited by a few hundred nomadic people and their reindeer; these people and their animals were forcibly evacuated;
- tests conducted at Novaya Zemlya account for only 25% of all Soviet testing but the explosive yield of those tests account for 94% of the total yield that resulted from all Soviet testing.

1 The Soviet Union was dissolved in December 1991. The final tests were carried out by 'Russia'.

Figure 7.2 The impact that resulted from the 43 years of Soviet nuclear testing

Little care was taken about the welfare of people living in test site areas. Only a few workers in Kurchatov were said to be living near the Semipalatinsk Test Site (STS). Local officials claimed later hundreds of thousands of people were living within 80 kms of the STS.

People in the STS region were to suffer from a wide range of illnesses and genetic defects. These conditions ranged from cancers to birth defects, impotency and various deformities. Babies were born without limbs or with nerve deformations. Leukemia became widespread.

Specialists have estimated that the cancer rate in the STS is double the worldwide rate. Some doctors have suggested that due to the nature of the testing in the Soviet era, third generation Kazakhs could suffer greater *chromosomal abnormalities* than those living during the tests.

A 1997 joint UN/ Kazakh government study sought to discover the economic, social and psychological impact of testing at the STS. It found the people felt they had been lied to and forgotten. Their condition was worsened by the ongoing economic impact of testing at the STS

The overall health of people living in the Russian Arctic regions has steadily decreased in the decades following nuclear testing. Mortality rates have risen due to increasing incidences of various cancers. In the 1990s, there was evidence of thousands of seals dying due to their habitat's radioactive contamination.

In the post-Soviet era (after 1991), the local economy has suffered because of the stigma attached to the region due to past nuclear testing. Domestic and international investors are loath to sink their funds into the area. Agricultural land in particular still suffers from contamination.

Soviet authorities used the Barents and Kara Seas in the Arctic as a massive "dumping ground" for unwanted radioactive materials. These include weapons, reactors and submarines. As these items corrode, there is a high chance that the radioactive materials contained within them could start to escape. This would lead to the contamination of local marine life and its feeding areas.

Testing in the Novaya Zemlya region led to massive radioactive fallout in the Arctic. This affected not only Soviet Arctic areas but also those of Norway, Alaska and northern Canada. Due to the fallout of nuclear testing in the Arctic, the waters in the Arctic region contain plutonium isotopes.

The geography of the STS region has suffered long-term effects from the nuclear testing. Vast craters have been created, eg Lake Chagan. The impact of underground testing on underground water has accelerated the desertification of the region around the STS.

The Tsar Bomba – The Tsar's Bomb

On 30 October 1961, a Soviet Tu-95 took off from Olenya airfield in the Kola Peninsula in Russia's far north. It was carrying a single bomb, so big it could not fit inside the aircraft and had to be fitted to the underside of the plane. It was 8m long, had a diameter of 2.6m and weighed more than 27 tonnes. The plane's pilot, Major Andrei Durnovtsev, brought his aircraft to Mityushikha Bay. At a height of 34 000 feet, the giant bomb – Tsar Bomba - was deployed by a giant parachute, which itself weighed a ton. At 13 000 feet, the bomb detonated. In a flash, the bomb created an 8km wide fireball. The flash could be seen from 1000 kms away. It is believed the Tsar Bomba unleashed energy of the order of between 50 and 57 megatons – 1500 times the Hiroshima and Nagasaki bombs combined. However, the bomb was too big for effective use. It was too heavy for a missile and no aircraft would be capable of carrying it to a distant (US) target and hope to return. Future weapons would be smaller but constructed for missile use. The fear of fallout from such a bomb spurred on the end of atmospheric testing.

Exercise 7.2 Rearrange the following passage so it reads in a logical flow.

The impact from tests in all three regions has been catastrophic for the people, the environment and the economy of the various testing site regions. The Soviet Union carried out its first atomic test in August 1949. Due to the stigma associated with the test site regions, investors are discouraged from investing. People have suffered in a variety of shocking ways, ranging from high incidences of different forms of cancer and birth deformities. From then until October 1992, it conducted 715 tests. As well as Semipalatinsk, the Soviet Union also conducted tests in Novaya Zemlya and the Ural Mountains. Radioactive fallout is having long-term effects on the environment, particularly in the Arctic. These tests were carried in several regions of the Soviet Union including Semipalatinsk which is in modern-day Kazakhstan.

What do the historians have to say about "The nature and impact of nuclear tests in the US and Soviet Union"?

1. Craig Nelson

In his account of the 'Castle Bravo' test, Nelson relates the terrible immediate effects of the test on the local people, and the surprising longer-term results. Victims too close to the test had inhaled hot ash. Radioactive particles whitened their hair and people suffered radiation burns. Several Marshall Island children died after they had been playing "in the radioactive snow" of the fallout debris. However, half a century later, biologists returned to Bikini to study the impact of long-term radiation. Their surprise discovery was that even after twenty-three detonations:

"…The lagoon waters were completely free of taint, with dosimeters not registering a blip above normal… The area's marine life was extravagantly abundant …" [2]

2. Stephanie Cooke

Stephanie Cooke describes how Soviet leader, Nikita Khrushchev, accelerated Soviet nuclear testing in 1961. Relations between the superpowers had been steadily deteriorating. [3] On 30 August Khrushchev announced that Soviet testing would recommence on 1 September 1961. Four tests were carried out at Semipalatinsk and Sary Shagan in Kazakhstan but the real action soon moved to Novaya Zemlya.

"…In a convulsion of noise and light, a bomb went off every other day, including a Super on October 30. It yielded 50 megatons, the biggest ever exploded anywhere and more than three times more powerful than the American Supers in the Pacific." [4]

2 Nelson, C, The Age of Radiance: The Epic Rise and Dramatic Fall of the Atomic Era, Scribner, New York, 2014, pp 273, 274
3 This worsening of relations involved incidents such as the US U2 spy plane being shot down over the Soviet Union, the construction of the Berlin Wall and the failed CIA invasion of communist Cuba.
4 Cooke, S, In Mortal Hands: A Cautionary History of the Nuclear Age, Bloomsbury, New York, 2009, p 175

Chapter Eight
Maralinga, British nuclear tests, and their impact

Background

Several factors were behind the decision to allow the British testing of nuclear weapons in the outback of Australia. These factors included: naïve hopes of the atomic age, close ties to Britain and Cold War fears.

- Deakin University's David Lowe, comments that at the time of nuclear testing on Australian soil, there was a degree of *"atomic utopian thinking"* – the idea that nuclear power could do anything:
  - Australia was discovering significant amounts of uranium and there was a hope that this might "unleash a vast new capacity for development through the power of the atom". [1]
  - See Historian 1.
- An important factor that made possible British nuclear testing on Australian soil was the very strong pro-British sentiments of Robert Menzies, (Prime Minister 1949-1966): [2]
  - Menzies is reputed to have said that he considered himself *"British to the bootstraps"*;
  - when Queen Elizabeth II visited Parliament House in Canberra in 1963, Menzies quoted the Elizabethan poet, Thomas Ford saying: *"I did but see her passing by, and yet I love her till I die."*
  - in 1950, Britain's Prime Minister, Clement Attlee, sought the agreement of Menzies to test nuclear weapons in Australia;
  - Menzies wanted to maintain close links to Britain and so was happy to agree to the request;
  - Menzies made his decision without even taking the proposal to cabinet first. [3]

Menzies' Minister of Supply, Howard Beale, said on 4 May 1955:

"The whole project is a striking example of inter-Commonwealth co-operation on the grand scale. England has the bomb and the knowhow; we have the open spaces, much technical skill and great willingness to help the Motherland."

- The 1950s was a period of serious Cold War tensions. War was raging in Korea; China had gone communist in 1949 and there were fears of communist influence inside Australia.
  - David Lowe, suggests that Australia at this time had hopes of becoming a nuclear power itself by sharing British technology;
  - Lowe says Australia was willing to station British nuclear weapons in Australia;
  - in the 1950s, Western leaders seriously believed that a Third World War was possible, and that such a war would be nuclear.

1 ABC's The History Lesson, March 2020.
2 Menzies had also been Prime Minister from 1939-1941.
3 Britain had approached both the US and Canada for test sites but was rejected by each nation.

Maralinga and British nuclear tests

Britain tested its nuclear weapons at three locations on Australian territory: the Montebello Islands off the coast of Western Australia, and Emu Field and Maralinga in South Australia. Maralinga is 800 kms north west of Adelaide; it is 55 kms north-west of Ooldea, in South Australia's Great Victoria Desert. These locations are shown in Figure 8.1.

Figure 8.1 Locations of British nuclear test sites in Australia

Britain's testing took place between 1952 and 1963:

- the first nuclear weapon trial took place on 3 October 1952 on the Montebello Islands;
- the tests were then moved to Emu Field in South Australia:
  - two tests took place at Emu Field in October 1953.
- Britain later asked to use a different site at Maralinga, also in South Australia:
  - this site was more convenient as it was closer to the Trans-Australian railway;
  - the first test at Maralinga took place on 27 September 1956;
    - by 1963 seven tests had been carried out at Maralinga;
  - one of the detonations at Maralinga was twice the size of the one that was dropped on Hiroshima;

The tests at Maralinga comprised two separate series:

- the first series of four tests was called “Operation Buffalo”:
  - two explosions took place from towers, one at ground level and another was dropped from an aircraft at 35 000 feet;
- the second series of three tests was called “Operation Antler”:
  - two explosions took place from towers, and one bomb was suspended from balloons.

As well as the major tests, Britain carried out about 200 ‘minor trials’ which were given codes names such as “kittens”, “rats” and “tims”:

- these ‘minor trials’ were carried out to investigate the effectiveness of weapons components and issues of safety;
- sometimes plutonium was set alight or blown up with TNT;
- the plutonium contamination that affected Maralinga was the result of these minor trials.

In 1963, the US, the Soviet Union and Britain signed the Partial Test Ban Treaty. This ended atmospheric nuclear tests. As Maralinga had no facilities for underground testing, this spelt the end of Maralinga’s usefulness for the British. Britain’s connection with Maralinga came to an effective end in 1967.

Exercise 8.1 Indicate whether each of the following statements is true or false.

1	There existed in some circles in Australia during the 1950s a genuine idealistic belief that atomic power would make possible a whole range of future developments.	TRUE/ FALSE
2	Prime Minister Robert Menzies was reluctant to allow British nuclear tests on Australian soil and had to be persuaded to allow it by his cabinet colleagues.	TRUE/ FALSE
3	Australia was not Britain’s first choice for nuclear testing sites as it had earlier unsuccessfully approached the United States and Canada for testing sites.	TRUE/ FALSE
4	A key factor in Australia’s willingness to allow nuclear testing in Australia was brought about because of Cold War tensions and fears of a possible Third World War.	TRUE/ FALSE
5	The Menzies government allowed British nuclear tests to be carried out in all Australian states apart from Tasmania and Victoria.	TRUE/ FALSE
6	The majority of British nuclear tests were carried out in the area close to Western Australia’s Montebello Islands.	TRUE/ FALSE
7	There were over twenty nuclear tests carried out at Emu Field, Maralinga and the Montebello Islands between 1953 and 1963.	TRUE/ FALSE

8	As well as testing major nuclear devices, minor tests were carried out such as setting plutonium on fire.	TRUE/ FALSE
9	All of the tests in both Operation Buffalo and Operation Antler were carried out at ground level.	TRUE/ FALSE
10	The signing of the 1963 Partial Test Ban Treaty between the US, Russia and Britain, brought about an effective end to Maralinga's usefulness.	TRUE/ FALSE

The impact of British nuclear tests

Compared to the level of testing that was carried out by the United States and the Soviet Union, British testing in Australia was on a small scale. However, the impact of that testing was significant both for the people involved, either voluntarily or involuntarily, and on the environment. The impact of the testing will be considered from three perspectives: the impact on service personnel, the environmental impact and the impact on Indigenous people.

(1) The impact on service personnel

British and Australian service personnel who were involved in the British nuclear testing were poorly looked after. Partly through ignorance, and perhaps partly as a result of indifference, protective measures for service personnel were limited.

It remains a matter of conjecture whether people were "deliberately" exposed to radiation. Presumably, this would have been done in the "interests of research", to assess the impact of radioactive materials on the body. [4]

- Following an explosion, RAAF planes were sometimes flown through the mushroom cloud:
  - the purpose of such flights was to collect samples;
  - the air crews lacked radiation measuring instruments;
  - on occasions they did not wear protective clothing;
  - service personnel who had the job of decontaminating planes and other equipment were also exposed to radiation.
- As was the case with service personnel in the US and the Soviet Union, veterans of Maralinga suffered higher rates of cancer mortality than the general population:
  - over thirty per cent of the British and Australian service personnel who had been exposed to the test blasts died of cancer;
  - however, the McClelland Royal Commission of 1984 was unable to conclude that each cancer case had been the result of being at Maralinga. [5]

4 Access to some of the documents relating to the nuclear testing at Maralinga remains restricted.

5 A Royal Commission into British Nuclear Tests in Australia was established in 1984 under Justice James McClelland. It was highly critical of Britain's treatment of Australia and of the Australian government's willingness to accede to the wishes of the British authorities.

- The McClelland Royal Commission also criticised the British for their relaxed attitude towards 'weather conditions':
  - the fallout distance that had been agreed to was 160 kms;
  - in fact fallout on occasions had reached as far as Townsville, Brisbane, Sydney and Adelaide.
- In 1997, an inquiry was carried out into the health of servicemen who had been at Maralinga, by the British Nuclear Test Veterans' Association:
  - the results of the inquiry appeared in the Roff Report;
  - the report concluded that servicemen who had been exposed to the blasts were up to ten times more likely to suffer from cancers that the average person.

(2) The environmental impact

Following the closure of the Maralinga test site in 1967, British authorities organised a "clean-up" of the site. Debris was collected and buried in deep trenches which were then covered in concrete.

However, plutonium-contaminated soil was often just ploughed back into the ground. In 1968, the Australian government accepted a British report indicating that the clean-up was completed.

- In 1984, preparations were being made to return the area of Maralinga to its traditional owners, the Tjarutja:
  - however, when Australian scientists carried out surveys at Maralinga, it was discovered that widespread plutonium contamination was still present.
  - the McClelland Royal Commission stated that unrestricted access to the region could not be allowed until it had been 'properly' cleaned up.
- The Royal Commission stated that Britain should bear the cost of cleaning Maralinga:
  - in 1993, the British government agreed to pay £20 million towards the cost of the clean up of Maralinga (out of an estimated cost of over $100 million)
- By 2000, all but about 120 square kilometres had been remediated to a standard that could allow people to freely enter the region:
  - radiation levels are now estimated to be no more than three times normal, which is what a person experiences following a flight in a plane;
  - the Tjarutja traditional owners finally took possession of Maralinga in November 2009;
  - even so, some locations such as one known as 'Kuli', remain off-limits because they cannot be cleaned up.

(3) The impact on Indigenous people

Little consideration was given to the possible impact of the British nuclear tests on the local Indigenous population. Few resources were directed to seeking out and warning Indigenous families living on country. Consequently, there were many incidents of local people experiencing radiation exposure:

- local Indigenous people experienced the effects of fallout – which they called 'Black Mist' – following the 'Operation Totem' test at Emu Field in 1953;
- in 1957, the *Milpuddle Family* was discovered camping next to a crater formed following a test; Edie Milpuddle was pregnant at the time and later gave birth to a stillborn child; she lost her next child to a brain tumor.
- the higher than usual rates of cancer deaths experienced by service personnel have also been experienced by local Indigenous people.

In the South Australian desert at Woomera, the British tested the missiles which were to carry nuclear warheads. The British *'Blue Streak'* rocket was developed and test-fired from Woomera. Its 'line of fire' was from Woomera to the Indian Ocean, near Broome. On occasions, test rockets did not make it and crashed into the West Australian desert.

At Maralinga, the Tjarutja people were pushed off their traditional lands. The same thing happened south of Broome, where the Yulparitja people were also moved off their lands.

There was an almost total lack of concern from both the British and Australian authorities at the time for the welfare of Indigenous people. This can be discerned in a letter sent by a Mr Alan Butement, who was the Chief Scientist of the Commonwealth Department of Supply, to the manager of a Mr Walter Macdougall. Macdougall had been given the job of warning Indigenous people about the tests. In 1956, Butement wrote to Macdougall's manager and said:

"Your memorandum discloses a lamentable lack of balance in Mr Macdougall's outlook, in that he is apparently placing the affairs of a handful of natives above those of the British Commonwealth of Nations."

Exercise 8.2 Match the description on the left with the correct term on the right.

1	Australia's Prime Minister who was keen to allow British nuclear testing in Australia.		McCLELLAND
2	The islands off the coast of Western Australia which were an early site of nuclear testing.		ANTLER
3	The first South Australia location that was a site for British nuclear testing.		EMU FIELD

4	The minor tests carried out at Maralinga relating to issues such as weapon effectiveness.		BLUE STREAK
5	The second series of nuclear tests carried out at Maralinga.		MENZIES
6	The principal nuclear testing site located in South Australia's Great Victoria desert.		TJANRUTJA
7	The Royal Commission established to examine the impact of British nuclear testing.		KITTENS AND RATS
8	The traditional owners of the Maralinga area.		WOOMERA
9	The rocket testing range in South Australia.		MONTEBELLO
10	The name of the British rocket developed in South Australia.		MARALINGA

What do the historians have to say about "Maralinga, British nuclear tests, and their impact"?

1. Alison Bashford and Peter Hobbins

Bashford and Hobbins make the point that the hopes harboured within Australia for a nuclear future were long-lived. The dreams which were held ranged from nuclear power providing civilian energy needs and grandiose schemes that went beyond the country's possible defence needs. There was even a proposal for using atomic weapons to blast an artificial harbour in Western Australia. An atomic physics unit was set up by the CSIRO. This confirmed personnel and research links with British facilities and led to the creation of the Australian Atomic Energy Commission at Lucas Heights in Sydney, in 1955. Such ideas provided a link to Maralinga. Bashford and Hobbins comment:

"…This research trajectory – and funding – legitimated local acquiescence to British nuclear weapons testing and subsequent recycling of remote sites for Commonwealth and international rocketry experiments…(The) legacies (of British nuclear tests) persisted long after domestic nuclear plans were abandoned in the early 1970s…" [6]

6 Bashford, A, and Hobbins, P, Science and Medicine, in The Cambridge History of Australia Volume 2, CUP, Melbourne 2013, pp 268-9

2. Midnight Oil and Paul Kelly

Some of Australia's foremost writers/ performers have been moved to use their talents to inform audiences about Maralinga. It is sad, but true, that probably the majority of the population of Australia have little or no awareness of what happened to Maralinga and its Indigenous population in the 1950s and early 1960s. What follows are two brief extracts from two songs written about Maralinga. The complete lyrics of each song can be easily located with a Google search. And a simple search on YouTube will bring video performances of each song.

"…In the wind, the ashes fly
The poison crown, the charcoal ground…

…All around, an eerie sound
Their dreams a cloud, their world in shrouds
In the wind, the ashes fly
Not much time, but time to try…" [7]

……

"…First we heard two big bangs
We thought it was the great snake digging holes
Then we saw the big cloud
Then the big black mist began to roll
This is a rainy land…" [8]

3. John Keane

Professor John Keane (University of Westminster, London), wrote a detailed article about the effects of British nuclear testing on servicemen and Indigenous people, for The Age newspaper in 2003. Keane says anecdotal evidence highlights servicemen suffering from:

"…Hip and spine deformities. Teeth that are falling out. Poor eyesight. Bleeding bowels. Post-traumatic anxiety and depression… And perhaps a quarter of them … have disabled offspring…"

Of Indigenous people who were present in the radiated areas, Keane says:

"…women suffered miscarriages. They were herded in trucks or pushed onto trains, expelled from a sacred site at Ooldea, a day's walk from Maralinga airport…" [9]

7 Maralinga, written by Martin Rotsey and James Moginie, performed by Midnight Oil.
8 Maralinga (Rainy Land), written and performed by Paul Kelly
9 Keane, J, Maralinga's Afterlife, The Age, 11 May 2003

Chapter Nine
French nuclear tests in the Pacific and the international response

Background

The reasons for France's development of its nuclear program were similar to those of other nations in the 1950s: the harnessing of nuclear power for domestic purposes and fears of future conflict as the Cold War intensified. However, in France, a key motivating factor was a strong sense of French nationalism and a desire for nuclear independence.

- Some in France had hopes about the peaceful use of nuclear power and its domestic economic applications:
  - by early 2020, France had 56 nuclear power reactors;
  - old units were being closed such as the two at Fessenheim, while new ones were being built such as the one at Flamanville;
  - in 2019, nuclear power accounted for about 70% of total French electricity generation.
- Western nations were concerned at the threat of communism spreading in Europe after World War II:
  - in 1947 Britain and France signed the defensive pact, The Treaty of Dunkirk, and in 1948 the Treaty of Brussels brought in Belgium, Luxembourg and the Netherlands;
  - in 1949, France became a member of NATO – the North Atlantic Treaty Organisation;
  - as the Soviet Union developed its nuclear arsenal, so too did NATO (ie the US and Britain).
- The decision of France to develop nuclear weapons had a strong nationalist element:
  - under the leadership of President de Gaulle (1958-69), France began to resent what it saw as the domination of NATO by the United States, and the "special relationship" between Washington and London:
  - though France never formally left NATO, by 1967, de Gaulle had taken the French fleet away from NATO command and removed French troops from NATO's integrated control;
  - de Gaulle had ordered all non-French NATO troops out of the country by 1967;
  - de Gaulle's nationalist streak led him to pursue an independent French nuclear deterrent; [1]
  - France's triad of air/ sea/ land-based nuclear weapons became the *force de frappe,* or *force de dissuasion* after 1961. [2]

1 It had been French Prime Minister Pierre Mendes-France who made the initial decision to develop a French atomic bomb in 1954.
2 Dissuasion is the French term for deterrence.

French nuclear testing

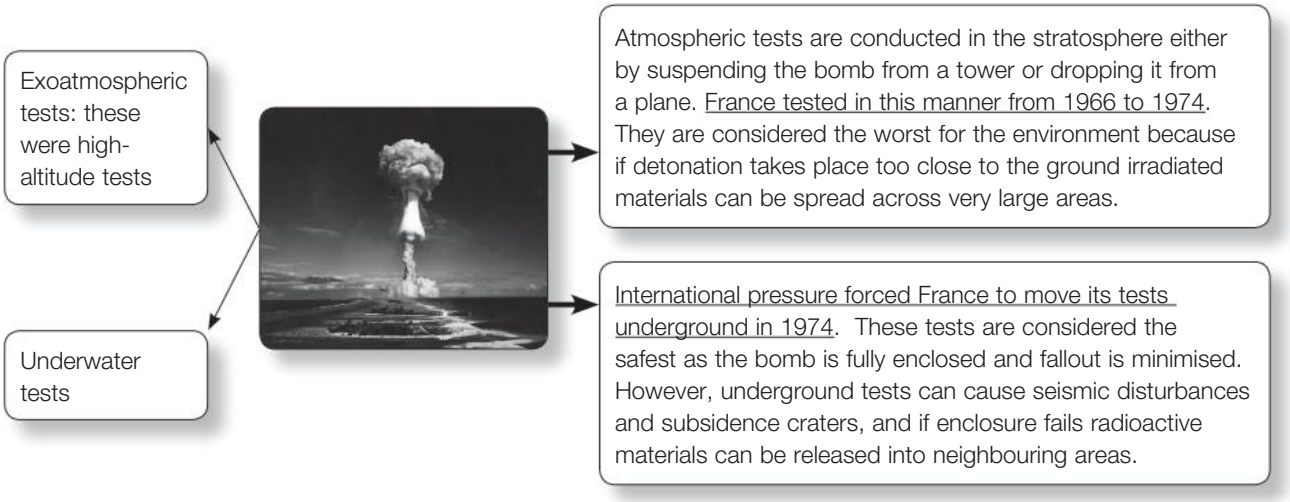
Early French nuclear testing took place in the Sahara in Algeria. On 13 February 1960, a 60 kiloton test was carried out near Reggane in south central Algeria. It was three times as powerful as the United States' first test at Alamogordo in 1945. Following a bloody war of independence, Algeria had gained its independence by 1962, and so a new location was needed.

Following the US example of Pacific testing, France decided on French Polynesia in the South Pacific. Mururoa[3] Atoll and Fangataufa Atoll in the south eastern corner of the Tuamotu archipelago were chosen as the testing sites:

- these atolls were seen as 'being geologically viable';
- they were uninhabited;
- they were distant from other inhabited islands;
- they were downwind from Tahiti which would prevent radioactive fallout reaching the capital, Pape'ete;
- other sites such as Ua Uka in the Marquesas islands and on Rangiroa were dismissed as there was not enough space for an airport.

Tahiti had been a French colony since 1842. It was reclassified after WWII as a *French overseas territory* and became known as French Polynesia. An indigenous nationalist movement appeared in the 1950s led by Pouvana'a a Oopa. In 1957, Pouvana'a became vice-president of French Polynesia. He began campaigning for more indigenous rights and independence under the slogan *'Polynesia for the Polynesian'*. French President, Charles de Gaulle, had Pouvana'a arrested. He was tried and sentenced to eight years, followed by exile from French Polynesia. The President of the Polynesian General Assembly, Jacques-Denis Drollet agreed to the French testing. By the mid-1960s, there were thousands of French troops, including *foreign legionnaires*, engineers and construction workers putting together the infrastructure needed for the French nuclear testing program.

Figure 9.1 Types of nuclear weapons tests



3 Mururoa means 'big secret' in Tahitian.

In 1963, the US, the Soviet Union and Britain signed a Partial Test Ban Treaty ending atmospheric testing. President de Gaulle refused to be part of the treaty.

Nuclear testing in French Polynesia took place from 1966 to 1996, using the atolls at Mururoa and Fangataufa. The first test was at Mururoa. Between 1966 and 1996, France performed 193 nuclear tests in French Polynesia, of which over 40 were conducted in the atmosphere: [4]

- the first test of a plutonium fission device took place on 2 July 1966;
  - 4 July: an atmospheric test with a device dropped from a plane;
  - September 1966: a test specially laid on for President de Gaulle to witness;
- in 1974, President Valery Giscard d'Estaing ordered that all tests should be carried out underground;
- between 1992 and 1995, there was an informal non-testing period when France ceased testing;
- in 1995, President Jacques Chirac announced that France would be conducting eight tests in 1995 though only six were carried out;
- French nuclear testing in French Polynesia finally ended in 1996.

Exercise 9.1 Complete the following passage using the terms below.

France has become a major user of nuclear _____ and in 2020 it had ____ nuclear _____, providing ____% of its power. Perhaps the main reason for France's enthusiasm for nuclear testing was the strong _____ of President _____. French nuclear testing began in _____. Early testing took place in _____ where ___ tests were carried out. In 1966, testing was moved to French _____, where _____ Atoll and _____ Atoll were the chosen sites. _____ tests were carried out in this region. France continued with _____ testing even after the signing of the _____ Treaty in 1963. President _____ ordered tests to be carried out _____ in 1974. As late as 1995, President _____ ordered a series of ___ additional tests though only ___ were carried out. Testing finally came to an end in _____.

POLYNESIA – NATIONALISM – POWER – CHIRAC – ALGERIA – MURUROA – DE GAULLE – CHIRAC – D'ESTAING – REACTORS – FANGATAUFA – PARTIAL TEST BAN – 1960 – 1996 – 70 – 56 – 17 – 193 – 8 – 6 – 193 – UNDERGROUND

4 France had earlier carried out 17 tests in Algeria, for a combined total of 210.

Figure 9.2 The findings of *The Mururoa Files*, released in March 2021

Almost the entire Polynesian population of 110 000 people had been infected with high levels of radiation following the tests between 1966 and 1996. 41 tests were carried out above ground.

Members of the Polynesian population living in the *Gambier Archipelago* at the time of the tests have been shown to have a great occurrence of breast cancer and thyroid cancer.

A French Polynesian Health Ministry report (February 2020) on the evidence of cancer among Polynesians and French service personnel, recognised *"the role of ionising radiation"* in causing excess cancer cases.

One of the conclusions presented by Disclose was that *"French authorities have concealed the true impact of nuclear testing on the health of Polynesians for more than 50 years."*

A French Defence Ministry estimate in February 2017 suggested about 2000 staff members who had been at Mururoa and Fangataufa between 1966 and 1974 had contracted *"radio-induced cancer"*.

A French government commission was set up in 2010 to deal with compensation claims. As of 2021, only 63 Polynesian civilians (excluding soldiers and contractors) have received any compensation from the French government. More than 80% of claims have been rejected.

The French government routinely failed to warn the local Polynesians of the radiation risks connected with the testing. With the *Centaure* test in 1974, authorities could have given warnings two days in advance. Other countries were monitoring the tests remotely. *"Everybody knew what was going on except the Polynesians."*

The Disclose investigation showed that in 2006, the French Atomic Energy Commission (CEA) had underestimated the dose of radioactivity received by the local inhabitants by between two and ten times.

The impact of French nuclear tests

In March 2021, *The Mururoa Files* were released. This was the result of a collaboration between investigative journalists from the media platform Disclose, and spatial designers working at NGO *Interpt* and researchers from *Princeton University's* Science and Global Security program.

The work carried out by these groups was the culmination of a two-year-long investigation of declassified French Defence Ministry documents and health surveys. The original documents were declassified in 2013.

- The investigation shows that French authorities knew about the dangers and the effects of radioactive contamination when carrying out the nuclear testing program in French Polynesia.
- They also show that these dangers were deliberately kept hidden from the people of French Polynesia.
- The French military failed to take preventative measures by evacuating the island inhabitants

Evidence contained in *The Mururoa Files* describes in detail the impact of the testing on the people of Polynesia (and French servicemen). It is a similar story to what happened in South Australia between 1956 and 1963, only on a much bigger scale. France's 193 nuclear tests in French Polynesia dwarfs the number of tests carried out by the British in Australia.

A summary of the findings of the investigation are presented in Figure 9.2.

The International response

Protests against French nuclear testing in the Pacific were widespread in Tahiti, the South Pacific region and across the world. These included:

- the Nuclear Free and Independent Pacific movement;
- the Pacific Conference of Churches (PCC):
  - the PCC famously said of the testing: *"If it's safe, test it in Paris."*

France stopped atmospheric testing in 1974 but continued with underground testing in 1975. This generated an even stronger international response:

- in Europe, Australia, New Zealand and other Pacific nations, there were protests and demonstrations against the French actions;
- trade unions-imposed bans against French companies and shipping;
- there were campaigns to boycott French goods and French airlines;

In 1980, Vanuatu gained its independence and its first Prime Minister was Father Walter Hadye Lini (1980-91). Lini was a strong advocate of setting up socialist governments in the various Pacific territories from East Timor to New Caledonia and across the South Pacific. Lini expelled the French ambassador on three occasions (1981, 1984, 1987) and maintained strong opposition to French nuclear testing.

Organisatons such as *Greenpeace* sent protest boats into the waters throughout French Polynesia to disrupt the testing:

- French intelligence agents were sent to the South Pacific to prevent such protests;
- the most well-known case of such action concerned the Greenpeace boat *"The Rainbow Warrior"*;
- On 10 July 1985, two French agents blew up the *Rainbow Warrior* in Auckland Harbour in New Zealand;
  - the operation was codenamed *Opération Satanique*;
  - the action was carried out by the Direction Générale de la Sécurité Extérieure (DGSE)
  - a Greenpeace photographer, Fernando Pereira, was killed in the action;

The two agents were captured by New Zealand police. At their trial, they pleaded guilty to manslaughter and were sentenced to ten years in prison. They ended up being restricted to the French island of Hao. The French government freed them after two years. New Zealand Prime Minister, David Lange, referred to the incident as an act of terrorism. Others have used the phrase "state-sponsored terrorism".

In August 1985, Pacific leaders set up the *South Pacific Nuclear Free Zone Treaty*. International pressure on France continued until the French finally announced a testing moratorium in 1991. However, when President Chirac recommenced testing in 1995, there was an angry international outburst against the French action. French nuclear testing in French Polynesia finally came to an end in 1996.

Exercise 9.2 Place the event on the left in the correct chronological order.

1st event		END OF FRENCH ATMOSPHERIC TESTING
2nd event		CHIRAC RESUMES TESTING
3rd event		PARTIAL TEST BAN TREATY
4th event		FRENCH MORATORIUM ON TESTING

5th event		FRENCH TEST AT REGGANE IN ALGERIA
6th event		SINKING OF THE RAINBOW WARRIOR
7th event		START OF FRENCH TESTING AT MURUROA
8th event		RELEASE OF THE DISCLOSE REPORT
9th event		SOUTH PACIFIC NUCLEAR FREE ZONE TREATY
10th event		END OF FRENCH TESTING

What do the historians have to say about "French nuclear tests in the Pacific and the international response"?

1. Stephanie Cooke

Cooke relates how US officials became distrustful of British and French physicists who were working in Canada during the war. In January 1943, the US government decided to limit information about the Manhattan Project being passed on to the British and French. Cooperation was partially resumed in August, but French scientists realised that the Americans had plans to monopolise the atomic weapon in the post-war world. Cooke suggests that this, plus French resentment at being treated as 'potential traitors' and the fact that they had contributed much to the research, spurred them to violate their secrecy oaths. Jules Guéron and Bertrand Goldschmidt met secretly with General de Gaulle in Ottawa in July 1944. De Gaulle was at this time the leader of the 'Free French' fighting the Nazis. De Gaulle was informed of the *"weapon of extraordinary power based on uranium"*. Cooke comments:

"…it was this hothouse atmosphere of mutual collaboration and mutual distrust that… the French bomb project effectively began… (Guéron told de Gaulle) It was absolutely necessary to resume atomic research in France as rapidly as possible… (after the meeting, de Gaulle told them) I thank you. I understand you very well…" [5]

5 Cooke, Stephanie, In Mortal Hands: A Cautionary History of the Nuclear Age, Bloomsbury, New York, 2009, pp 58, 59

2. President de Gaulle

Charles de Gaulle was an unapologetic French nationalist. He took control of his country in 1958 when it was faced with a major national crisis in its political and military affairs. During his eleven years as French President, he never wavered from pressing the case for French national interest. This often led to difficulties with France's NATO allies, particularly the United States and Britain.

- His steadfastness in pushing French interests and independent action, is illustrated in his attitude to the development of an independent French nuclear arsenal.
- He was challenged once at a press conference in July 1964 that France could never match the nuclear power of the US or the Soviet Union, so was there any point to France's nuclear program.
- He replied that of course, France could never match the great powers.
- However, he argued that once a country had reached a certain nuclear capacity, the size of one's nuclear arsenal becomes immaterial. He concluded:

"…For since a man and a country can only die once, deterrence exists once one has the means to inflict mortal damage on a possible aggressor, the determination to use them and the confidence in one's ultimate decision…" [6]

6 President Charles de Gaulle, 10th Press Conference, Elysée Palace, 23 July 1964

Chapter Ten

Anti-nuclear movements and the role of the UN: test ban treaties, arms limitations, non-proliferation

Overview

The strength of anti-nuclear movements has ebbed and flowed across the world throughout the nuclear age.

- There was a moral revulsion amongst many when the reality of what had happened to Hiroshima and Nagasaki became known:
  - even the father of the atomic bomb, J Robert Oppenheimer, became an ardent campaigner against nuclear weapons and nuclear power.
- Once the Soviet Union detonated its bomb in 1949 which sparked the Cold War arms race, fear became the key motivating factor.
- Throughout the 1950s and the early 1960s, anti-nuclear activism increased:
  - in the 1960s, anti-nuclear feeling was concerned not only with nuclear weapons but increasingly also nuclear power;
  - however, the energy of the anti-nuclear movement was lessened as much protest fervour was directed against the Vietnam War.
- In the 1970s, support for nuclear power increased due to:
  - the oil crisis of 1973; [1]
  - and growing concerns about the environmental effects of fossil fuels.
- From the late 1970s into the 1980s, anti-nuclear sentiment increased across the world due to several factors:
  - the US was placing intermediate nuclear missiles – Cruise and Pershing – across Western Europe;
  - the Soviet Union was placing SS20s in Eastern Europe;
  - the rhetoric of US President Reagan and British Prime Minister, Margaret Thatcher, led many people to fear that the chance of a nuclear exchange between east and west had become more likely.
- Fears about the dangers of nuclear power grew:
  - in 1979 the release of the film, *The China Syndrome*, brought home to people the potential dangers of nuclear power;
  - the release of the film coincided with the major nuclear accident at the *Three Mile Island* nuclear plant in Pennsylvania;

1 Arab states dramatically increased the price of oil in protest against western support for Israel in the 1973 Yom Kippur War between Israel and the Arab states..

- the disaster of the Chernobyl Nuclear Plant in the Ukraine in 1986 greatly added to concerns about nuclear power and so stimulated the anti-nuclear movement;
- Chernobyl and the protests that followed virtually halted the development of nuclear power around the world. [2]

- The strength of the anti-nuclear feeling lessened with the end of the Cold War as the threat of nuclear war between the superpowers receded. However, the anti-nuclear movement still has major concerns:
  - the problem of nuclear waste (see Chapter 14);
  - the fear that terrorists might acquire a nuclear weapon;
  - the spread of nuclear weapons to states such as North Korea. [3]

What is the anti-nuclear movement?

Fears about the possibility of a nuclear war and concerns over the dangers of nuclear power since 1945 have brought millions of people into the anti-nuclear movement. There are many anti-nuclear organisations. They include:

- environmental groups such as:
  - Greenpeace
  - Friends of the Earth.
- professional groups such as:
  - International Physicians for the Prevention of Nuclear War;
  - the Nuclear Information and Resource Service.
- political organisations such as:
  - "Green" parties in many countries;
  - most "left-leaning" parties oppose nuclear power;
  - in the 1980s, the future Labor Minister (and Midnight Oil lead singer), Peter Garrett, stood for the Australian parliament, representing the *Nuclear Disarmament Party*;
  - the *Campaign for Nuclear Disarmament* (CND) – see below;
  - the *Greenham Common Women* – see below.

Many high-profile figures have been part of the anti-nuclear movement. Such figures have come from diverse backgrounds, including the world of medicine (Helen Caldicott), the world of entertainment (U2 front man, Bono) and the world of philosophy (Bertrand Russell).

Since 1945, there have been many dramatic protests against nuclear weapons and the use of nuclear power. There have been calls for nuclear disarmament – *even unilateral nuclear disarmament* – one nation destroying its weapons even when other nations keep theirs. Some of the principal anti-nuclear protests are outlined in Figure 10.1.

2 Events at Chernobyl (and Fukushima in 2011) are examined in Chapter 15.
3 The issue of nuclear proliferation is examined in Chapter 12.

Figure 10.1 Anti-nuclear protests since 1945

The Campaign for Nuclear Disarmament (CND) was launched at a massive public meeting in London, in February 1958. CND attracted a wide range of people, including scientists, clergy, students, Labour Party members, trade unionists, journalists, entertainment figures and academics. For many years, the CND Easter Aldermaston March, from the Atomic Weapons Research Establishment to London - over 80 kms – would attract thousands of marchers. By the late 1960s, it had become less important. The Vietnam War became a focus of protest for most people and the Labour Party pursued a nuclear policy. Divisions appeared within CND between those who were willing to 'break the law' with 'non-violent direct action' (NVDA) and those who argued that breaking the law weakened the movement.

Large protests occurred at Wyhl in West Germany in the early 1970s against a proposed nuclear plant. The plan was dropped in 1975.

In the early 1960s, the 'Committee of 100', led by Bertrand Russell, staged mass civil disobedience protests in London. Hundreds were arrested, including after a protest at Holy Loch in Scotland where US Polaris nuclear missiles were based.

Symbol of CND

The 1980s saw major protests against nuclear power across the world. These included a 200 000 people protest in Bilbao, Spain in July 1977; a 200 000 protest in New York following the Three Mile Island nuclear accident; a 100 000 people protest in Hamburg in 1981; a one million protest in New York in June 1982; a 200 000 people protest in Rome following the Chernobyl disaster.

Cruise Missiles were placed on road vehicles and moved round on regular exercises. Cruise Watch was a network of protesters across Europe who tracked and harassed the movement of the Cruise Missile convoys

Anti-nuclear rallies became regular occurrences in Australia in the 1980s. The Palm Sunday rallies of 1982, brought out 100 000 people. By 1985, the figure had risen to 350 000. Australian protests were aimed at not only nuclear power in general but more specifically uranium mining in Australia and against French nuclear testing in the South Pacific.

In September 1981, a mainly women's march took place from Cardiff to the US Air Force base at Greenham Common where cruise missiles were placed. The temporary camp set up by the women became permanent and 'women-only'. Despite suffering physical abuse from police and frequent violent evictions, the Greenham Common women persisted in their protest for many years.

The role of the United Nations

The United Nations has been concerned with the issues of nuclear weapons and nuclear power from the time of its creation. Even in the 21st century, the UN continues to focus on the issue. [4]

- One of the earliest resolutions passed by the UN General Assembly in 1946 was for the creation of a commission to deal with atomic energy.
- The US Baruch Plan was presented to the UN in June 1946:
  - it was the work of the American businessman Bernard Baruch;
  - at its heart was a plan to place atomic weapons under international control;
  - international suspicions at the time ensured the plan's failure;
  - the US then rejected a Soviet proposal to ban all nuclear weapons.

4 In July 2017, 122 UN states voted in favour of a treaty banning nuclear weapons. It entered into force in January 2021. Member states are allowed to join the treaty in the future. The major nuclear states did not sign the treaty. Australia did not sign the treaty.

The UN has worked hard on the issue of non-proliferation (see below). Its success in the area of non-proliferation has been mixed (see Chapter 12). Concerns about nuclear weapons remain a key focus of the UN. UN Secretary-General Ban Ki-moon stated in February 2012:

"Nuclear disarmament and non-proliferation are not utopian ideals. They are critical to global peace and security. We have a legal and moral obligation to rid our world of nuclear tests and nuclear weapons… A world free of nuclear weapons will be safer and more prosperous."

Exercise 10.1 Answer the following questions in the space provided.

1	What has been the twin focus of anti-nuclear movements across the world since 1945?	
2	Why did the strength of the anti-nuclear movement lessen during the 1960s?	
3	Why did the fears of nuclear weapons increase so dramatically during the early 1980s?	
4	How did cinema and real life combine in 1979 to increase fears regarding nuclear power?	
5	What kinds of groups have been prominent in the anti-nuclear movement since the 1950s?	
6	What is meant by the term 'unilateral nuclear disarmament'?	
7	What was CND? In which country did CND originate?	
8	What role did Aldermaston in the UK play in the anti-nuclear movement?	
9	What was the role of the Greenham Common women in the anti-nuclear movement?	
10	What happened to the proposed nuclear plant at Wyhl in West Germany in the early 1970s?	

11	What was the strength of anti-nuclear protests in Australia throughout the 1980s?	
12	Why were early UN actions to limit nuclear weapons unsuccessful?	

Test-ban treaties

Public and scientific concern about atmospheric testing of nuclear weapons rose steadily throughout the 1950s. From the mid-1950s, the nuclear powers began having low-level talks to tackle the issue. There were two fundamental stumbling blocks:

- verification: how could each side trust the other during a time when Cold War tensions were so great?
- the Soviet Union's refusal to allow on-site inspections.

Agreement on a Test Ban Treaty was close in 1960 but collapsed due to the U2 Incident. An American U2 spy plane was shot down over the Soviet Union and its pilot, Gary Powers, was captured. US President Eisenhower refused to apologise. Soviet leader, Khrushchev, railed against the US, and a planned summit meeting in Paris in 1960 collapsed.

In 1962, the world came very close to a nuclear war during the Cuban Missile Crisis of October that year. The Soviet Union had been placing nuclear missiles in Cuba, ninety miles from Florida. President Kennedy demanded that they be removed and ordered Soviet ships heading to Cuba to turn around. The crisis passed when Khrushchev agreed to remove the missiles. The world survived.

The Cuban Missile Crisis seemed to bring the powers to their senses. A 'hot-line' was established between Washington and Moscow to facilitate communications between the leaders in case of another crisis. The other major outcome of the crisis, was agreement on a Test Ban Treaty.

The Limited Test Ban Treaty: 1963

In June 1963, negotiations for a test ban treaty resumed, with a willingness to compromise evident from all sides. On 5 August 1963, the Limited Nuclear Test Ban Treaty was signed in Moscow.

- Three powers signed the Treaty: The United States, the Soviet Union and Great Britain:
  - Secretary of State Dean Rusk signed for the US, Foreign Minister Gromyko for the Soviet Union and Alec Douglas-Home for Britain.
- France and China were invited to sign the agreement but they refused.

- President Kennedy had to convince his public – and the US Senate – of the worth of the treaty:
  - the Senate finally approved the treaty on 23 September 1963 with an 80-19 margin;
  - Kennedy signed the ratified treaty on 7 October 1963. [5]

The key terms of the treaty are outlined in Figure 10.2.

Figure 10.2 The Limited Nuclear Test Ban Treaty: 1963

Dean Rusk, Andrei Gromyko and Alec Douglas-Home signing the Limited Nuclear Test Ban Treaty.

Underground nuclear testing was allowed provided no radioactive debris fell outside the boundaries of the nation carrying out the test.

Each of the three signatories promised to work towards eventual total nuclear disarmament, an end of the arms race and ending the radioactive contamination of the environment.

The treaty prohibited the powers from testing nuclear weapons in the atmosphere, under water or in outer space.

Though in subsequent years there would be attempts by the powers to limit armaments and prevent nuclear proliferation (see below), there was no major effort at another nuclear test ban treaty until 1996.

The Comprehensive Nuclear Test Ban Treaty (CTBT) 1996

In 1996, the United Nations General Assembly passed the Comprehensive Nuclear Test Ban Treaty. On paper, this was a dramatic and optimistic moment in history. The treaty banned *"any nuclear weapon test explosion or any other nuclear explosion."* The treaty established a global network of facilities that could monitor its provisions and on-site inspections could be demanded if there were any 'suspicious events'.

5 In the American system, an American president (or the President's representative) can sign a treaty. However, it does not become effective until the Senate has 'ratified' it.

US President Bill Clinton was the first leader to sign the treaty. By 2020, the treaty had been signed by 185 nations and ratified by 170. However, there have been problems:

- the treaty cannot come into force unless 44 specific nations ratify it;
- eight of those countries have failed to ratify the treaty: China, India, Pakistan, North Korea, Israel, Iran, Egypt and the United States;
- though President Clinton signed the treaty in 1996, the US Senate rejected it by 51 votes to 48;
- President Obama announced in 2009 that he would try and get the Senate to look at the treaty again but he let the idea drop. [6]

Arms limitations (1) 1960s to 1980s

Nuclear weapons had made the world a very dangerous place. Cuba had shown how close the world could come to annihilation, and that crisis did not slow down the arms race between the United States and the Soviet Union. Neither did it discourage other nations seeking to develop and test nuclear weapons.

However, there were positive signs as well. From the late 1960s, there were efforts to limit the number and type of nuclear armaments. In 1967, the *Outer Space Treaty* banned nuclear weapons being placed in orbit around the earth or in outer space.

At their Moscow summit in May 1972, US President Nixon and Soviet leader Brezhnev signed **The SALT 1 Treaty:**

- 'Strategic Arms Limitation Talks' (SALT) had begun in 1969 and culminated in the SALT 1 Treaty in 1972;
  - the development of new systems of offensive weapons was placed on hold until 1977;
  - limits were set for how many offensive weapons each power could have;
  - each power was allowed only two ABM (anti-ballistic missile) systems:
    - this was important for it was feared that if a power had an effective ABM set up, it might give them the confidence to launch a 'first-strike';
- the 'hot line' was upgraded;
- nuclear weapons were banned from the ocean floor.

Nixon and Brezhnev managed to bring on other agreements:

- the 1972 '*Basic Principles of Relations between the USSR and the USA*':
  - this established the need for good bilateral relations;
- in June 1973, the two leaders signed an "*Agreement on the Prevention of Nuclear War*":
  - this pledged each side to enter immediate negotiations if there was any possibility of a nuclear conflict developing between the two nations

6 In 2018, the Trump Administration announced: "The United States will not resume nuclear explosive testing unless necessary to ensure the safety and effectiveness of the US nuclear arsenal, and calls on all states possessing nuclear weapons to declare or maintain a moratorium on nuclear testing."

From 1974, talks took place between the US and the Soviet Union for a **SALT 2** agreement. It was signed in Vienna in June 1979 by US President Carter and President Brezhnev. SALT 2 planned to:

- limit each side's delivery systems to 2400;
- place limits on missile size;
- limit the number of warheads per missile;
- place limits on the development of new missile systems.

SALT 2 was never ratified by the US as a protest against the Soviet Union's invasion of Afghanistan in December 1979. However, both sides stuck to the treaty's main terms throughout the 1980s.

Arms limitations (2) 1985 to 1991

Between 1985 and 1991, there were significant steps in the direction of arms limitation. During the first administration of President Reagan (1981-85), US-Soviet relations were tense, with each side involved in an arms build-up. However, during Reagan's second term (1985-89), the Soviet Union had a new leader: Mikhail Gorbachev. Gorbachev was keen to limit the arms race and lower Cold War tensions. The efforts of both sides brought about significant results.

- Gorbachev took immediate steps on arms reduction as soon as he came to power in 1985:
  - he froze the deployment of SS-20 missiles in Europe;
  - he declared a unilateral moratorium on Soviet nuclear testing;
  - he suggested the US and the Soviet Union reduce their nuclear arsenals by 50%.
- Throughout 1986, Gorbachev made further suggestions for reducing the number of nuclear arms in Europe:
  - at the Reykjavik summit in October 1986, Reagan and Gorbachev had serious discussions about eliminating all nuclear missiles in a decade.
- At the Washington Summit between Presidents Reagan and Gorbachev in December 1987, **The INF Treaty** was signed: [7]
  - all ground-launched missiles with a range of 500-5500 kms were to be verifiably destroyed;
  - in the next three years 1846 Soviet and 846 US missiles were destroyed;
  - each side made concessions that allowed for inspections.

7 INF: Intermediate-Range Nuclear Forces.

In January 1989, the US had a new president, George H W Bush (1989-93). Presidents Bush and Gorbachev continued the progress that had been made in arms limitations since 1985.

- November 1990: *The Conventional Forces in Europe (CFE) Treaty* was signed:
  - this agreement was concerned with limiting each side's military hardware and resulted in an agreement to limit the number of tanks of each side's alliance (NATO and the Warsaw Pact) to 20 000.
- In July 1991 the two sides signed the START Treaty: [8]
  - neither side was allowed more than 6000 nuclear warheads;
  - neither side was allowed more than 1600 ICBMs/ SLBMs and bombers;
  - this involved agreement was not finally implemented until 2001 by which time the Cold War had been over for a decade.

(At the end of 1991, the Soviet Union disintegrated. This complicated agreement that had been made towards the end of the Cold War. These issues, and nuclear disarmament since the end of the Cold War, will be covered in Chapter 11.)

Non-proliferation

The term "non-proliferation" refers to attempts to prevent countries developing their own nuclear weapons. By the mid-1960s, there were five nuclear powers: the US, the Soviet Union, Britain, France and China. Realistically, there was no chance of "disarming" these nations. However, real efforts were made to prevent new nations obtaining nuclear weapons.

The 1968 **Treaty on the Non-Proliferation of Nuclear Weapons (NPT)** had several goals:

- to prevent the spread and creation of nuclear weapons and associated technology;
- to promote the peaceful use of nuclear energy;
- to implement a safeguards system under the responsibility of the International Atomic Energy Agency (IAEA) to ensure compliance with the treaty and to undertake inspections;
- the aim of the inspections is to make it difficult for nations to divert fissile material for weapons use;
- to ideally ultimately achieve general and complete nuclear disarmament.

The NPT entered into force in 1970 and in May 1995, it was extended indefinitely. Over 190 nations have joined the NPT.

An important part of nuclear non-proliferation is the creation of *"Nuclear-Weapon-Free Zones (NWFZ)"*. These are distinct zones or areas around the world which states have agreed should have a *"total absence of nuclear weapons"*. The UN Disarmament Commission has established a set of guidelines for the creation of NWFZ.

8 START: Strategic Arms Reduction Treaty. The treaty was renamed START 1 when talks began on a new START treaty.

Unfortunately, despite the best efforts of the UN and signatories to the NPT, this has not prevented nuclear proliferation (see Chapter 12).

Exercise 10.2 Match the description on the left with the term on the right.

1	The event which caused the collapse of the 1960 Paris Summit and delayed the Test Ban Treaty.		SALT 1
2	The event in 1962 which brought the world very close to the brink of nuclear war.		THE HOT LINE
3	Direct communication set up between the US and Soviet leaders in a time of crisis.		THE START TREATY
4	Agreement between the Soviet Union, the US and Britain to ban atmospheric testing in 1963.		THE U2 INCIDENT
5	Idealistic UN treaty to end all nuclear explosions throughout the world in 1996.		SALT 2
6	Major arms limitation agreement signed by the US and the Soviet Union in 1972.		THE CTBT
7	Major arms limitation agreement signed by the US and the Soviet Union in 1979.		THE INF TREATY
8	The 1987 agreement to greatly reduce US/ Soviet Intermediate Nuclear Forces.		THE CUBAN MISSILE CRISIS
9	Agreement of 1991 to limit Soviet and US nuclear arsenals, finally implemented in 2001.		THE LIMITED TEST BAN TREATY
10	The 1968 treaty which attempted to prevent the spread of nuclear weapons to other nations.		THE NPT

What do the historians have to say about "Anti-nuclear movements and the role of the UN: test ban treaties, arms limitations, non-proliferation"?

1. Odd Arne Westad

Odd Arne Westad makes the point that the Cold War affected everybody as nobody could escape the consequences of a nuclear war. The world survived the Cold War but Westad emphasises that the nuclear arms race was 'profoundly dangerous'. There were many reasons why people joined anti-nuclear movements. The chance of a cataclysm was highest amongst them. As Westad says, the world came closer to nuclear war than most people realised. However, anti-nuclear campaigners knew only too well that nuclear war could have come about due to accident or due to intelligence failures. And the consequences would have been all too predictable. Westad quotes the organisation, The International Physicians for the Prevention of Nuclear War, when it was awarded the Nobel Peace Prize in 1985. They explained what the consequences of a nuclear war would be:

"…A horror-stricken and dust-covered Earth, burned bodies of the dead and wounded, and people slowly dying of radiation disease…" [9]

2. Bret Baier

Baier describes the optimism which accompanied the signing of the INF Treaty in December 1987 at the Washington summit between US President Reagan and Soviet leader Gorbachev. The INF was significant in that it actually reduced the number of nuclear weapons; other agreements had only reduced the rate of increase. Baier quotes both leaders' optimistic feelings about the INF Treaty but also Reagan's caution. Reagan said of the treaty:

"…We can only hope that this history-making agreement will not be an end in itself, but the beginning of a working relationship that will enable us to tackle the other issues…"

Gorbachev's replied, saying that he hoped 8 December 1987 would be a date:

"…that will mark the watershed separating the era of a mounting risk of nuclear war from the era of a demilitarisation of human life…"

Reagan then offered his familiar warning to Gorbachev which the Soviet leader received with a laugh:

"…Doveryai no proveryai – trust but verify…" [10]

9 Westad, O A, The Cold War: A World History, Penguin Books, 2018, p 628
10 Baier, B, Three Days in Moscow: Ronald Reagan and the Fall of the Soviet Empire, William Morrow, new York, 2018, pp 214, 215

Notes

Chapter Eleven
Nuclear disarmament after the Cold War

Context

The most dangerous aspect of the Cold War had been the nuclear arms race. Both sides accepted the wisdom of achieving arms limitation agreements. This was partly due to their desire to lessen the chance of an 'accidental' nuclear war, and partly due to a desire to minimise the horrendous cost of the arms race.

However, due to the tensions of the Cold War, arms agreements made only limited progress. The 1987 INF Treaty (see Chapter 10) paved the way for future agreements. However, it was the collapse of communism, and the end of the Cold War which made possible real strides in nuclear disarmament.

The rapid and generally peaceful collapse of communism at the end of the 1980s took the world by surprise.

- Throughout 1989, the Soviet-dominated countries of Eastern Europe were freed of their communist regimes:
  - in some countries it was achieved peacefully, eg Hungary;
  - in some countries violently, eg Romania.
- In November 1989, the Berlin Wall came down:
  - the Wall had long been *'the'* symbol of the Cold War;
  - by October 1990, East and West Germany were reunited.
- The communist regime inside the Soviet Union itself collapsed in 1991:
  - Mikhail Gorbachev brought the Soviet Union to an end on 25 December 1991 when he resigned as President of the Soviet Union;
  - Boris Yeltsin became President of the new Russian state;
  - The Soviet Union was replaced with the loose Commonwealth of Independent States (CIS).

The Cold War which had dominated international relations since the end of the Second World War was over.

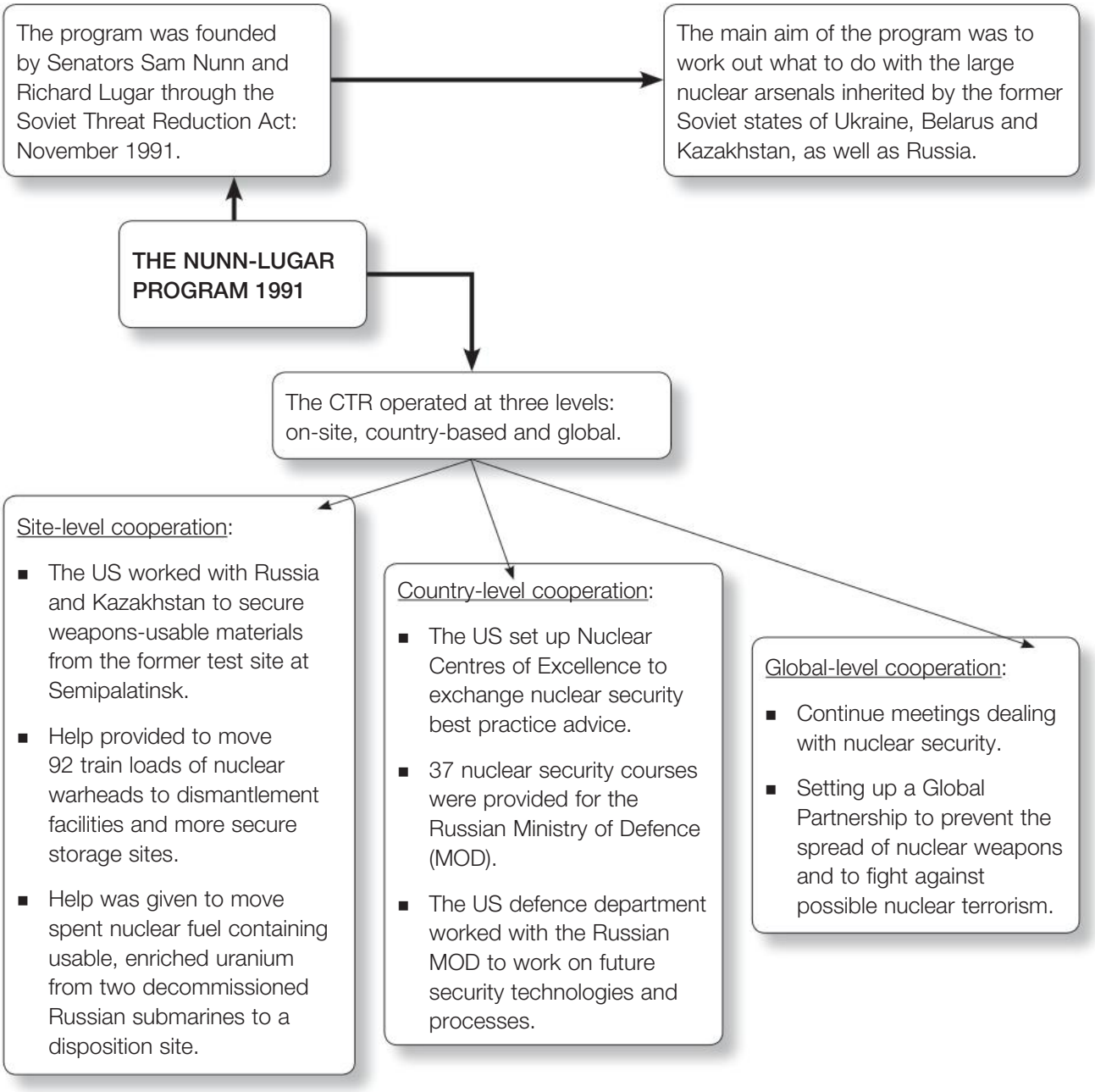
The Nunn-Lugar Program

Boris Yeltsin visited Washington in 1992; he and President Bush discussed political and economic reform. However, of prime importance for the US was its concern over what might happen to the former Soviet Union's vast nuclear arsenal:

- was the new, weakened Russian state capable of maintaining the safety standards of its nuclear weapons?
- could Yeltsin prevent warheads falling into the wrong hands?
- what should happen to those weapons now in the hands of newly independent states such as Kazakhstan?

US Secretary of State, James Baker, assured the new Russian government that the US was willing to fund its efforts to secure its nuclear, chemical and biological weapons. In November 1991, the US Congress passed the *Nunn-Lugar Act* which put in place the *Department of Defence Cooperative Threat Reduction (CTR) Program* or the *Nunn-Lugar Program*. Its key provisions are outlined in Figure 11.1.

Figure 11.1 Outline of the Nunn-Lugar Program



Continuing steps in nuclear disarmament

(The comments that follow relate to the twenty years after the Cold War (the scope of this syllabus topic). However, at the time of writing (2021), US-Russian relations have become far more strained due to various events since 2011, eg Russia's annexation of Crimea in 2014 and alleged Russian interference in US elections. Russia's involvement in the Syrian Civil War and its growing closeness to China have also cooled US-Russia relations.)

It would be fair to say that the world is a safer place in the early 21st century than it was at certain tense moments during the Cold War. However, the story of nuclear disarmament since the demise of the Soviet Union and communism has been mixed.

The end of the Cold War paved the way for a series of treaties for reductions in conventional (non-nuclear) and nuclear armaments.

- Steps in this direction had begun with the INF Treaty (1987), START1 (1991), START 2 (1993, ratified by Russia in 2000).
- They continued with the Strategic Offensive Reductions Treaty, or SORT (2002) and the New START (2010).
- In 1986, the US and the Soviet Union had about 86 000 strategic nuclear warheads; by the second decade of the 21st century that figure had fallen to about 8300.
- Detailed verification mechanisms were put in place so that each side would know what the other side had – perhaps Reagan's "trust but verify" notion was becoming a reality…..
- START 1 and New START brought about a major reduction in the number of deployed strategic warheads. However, tactical nuclear weapons did not become a key part of existing arms control treaties.

However, during the administrations of President George W Bush (2001-2009), efforts at maintaining the nuclear disarmament momentum slowed.

- In December 2001, Bush announced the termination of the 1972 Anti-Ballistic Missile (ABM) Treaty (effective May 2002):
  - Bush argued that it needed an ABM system to combat possible long-range missile attacks by "rogue" states, such as North Korea or Iran;
  - Russia did not object at the time as such a system would not be enough to eliminate its own nuclear deterrent;
  - however, when in 2007 the US announced plans to place 'interceptors' in Poland and the Czech Republic – to counter a possible Iranian attack – Russia raised strong objections.
- Also in 2002, Russia, now led by President Vladimir Putin, withdrew from the START 2 agreement.
- The SORT agreement (2002) limited the number of weapons each side could use. However, there were also less positive elements to the agreement:
  - it had become vague on definitions and methods of counting;
  - it also lacked 'comprehensive verification obligations';
  - no limits were put on 'delivery systems and nondeployed warheads'.
- In 2007, Russia suspended the Conventional Armed Forces in Europe (CFE) Treaty.
- Also in 2007, Russian Defence Minister, Sergey Ivanov, was raising doubts about the efficacy of the 1987 INF Treaty:
  - these doubts were echoed by President Putin at the Munich Security Conference of that year;

- President Putin's argument was that Russia (and the US) was restricted in its INF deployments but states such as Iran, Pakistan and North Korea were not. [1]

By 2009, the US had a new president, Barack Obama, and Russia a new president, Dmitry Medvedev. [2] There were some hopeful signs for nuclear disarmament during the first Obama administration (2009-13):

- Obama's Prague April 2009 speech sought the 'best of both worlds':
  - he outlined a vision of a 'nuclear weapon-free world';
  - but qualified that by saying that 'the United States will maintain a safe, secure and effective arsenal to deter any adversary.'
- In April 2010, the US and Russia signed the New START agreement which came into force in February 2011. The agreement:
  - contained agreed verification measures;
  - limited the number of deployed strategic nuclear warheads each side could have to1550;
  - limited the number of launchers (bombers/ long-distance missiles) to 800;
  - it had a ten-year term. [3]

Unfortunately, the hoped-for continuation in nuclear disarmament and strong US-Russian relations faded when Putin returned as president in 2012. Instead of seeking treaty-based arms agreements with the Obama administration, Putin preferred to focus on the modernisation of Russia's military. Russia did not take part in the fourth of the nuclear security summits (2016) that had been initiated by the Obama administration to deal with the threat of nuclear terrorism. [4]

Conclusion

The end of the Cold War may have rendered the world safer but it did not mean the end of the Nuclear Age:

- the US and Russia kept their nuclear weapons at the margins of international affairs but those weapons were always capable of playing a major role 'if circumstances warranted such a decision';
- in the 21st century concerns remained about the nuclear capabilities of smaller powers and the ever-present fear of terrorists gaining access to weapons.

1 In February 2019, the Trump administration (2017-21) suspended the INF Treaty. On 2 August 2019, the administration formally stated that it had withdrawn from the treaty. Secretary of State Mike Pompeo (2018-21) stated at the time: "Russia is solely responsible for the treaty's demise."

2 Dmitry Medvedev was president 2008-2012. His prime minister was Vladimir Putin, who still held the 'real' power in Russia. Putin returned to the presidency in 2012 and is still president at the time of writing (2021).

3 On 26 January 2021, President Biden and Vladimir Putin spoke on the phone about extending the treaty. This was agreed to, and on 3 February, US Secretary of State, Antony Blinken, announced that the US had formally agreed to extend the treaty until 2026.

4 However, Russia did play a key role in the 2015 Iran nuclear deal and has kept to the New Start commitments.

Exercise 11.1 Place the following events in the correct chronological order.

1st event		RUSSIA RATIFIES START 2
2nd event		SORT SIGNED
3rd event		SOVIET THREAT REDUCTION ACT
4th event		US TERMINATES THE INF TREATY
5th event		START 2 SIGNED
6th event		OBAMA'S PRAGUE SPEECH
7th event		US EXTENDS NEW START TILL 2026
8th event		BUSH TERMINATES THE ABM TREATY
9th event		NEW START SIGNED
10th event		RUSSIA SUSPENDS THE CFE TREATY

Exercise 11.2 Match the person on the right with the job description

1	President of Russia from 2000-2008, and from 2012.		VLADIMIR PUTIN
2	President of the United States from 2009-2017.		GEORGE W BUSH
3	President of Russia immediately after the end of the Cold War.		JOE BIDEN
4	US Secretary of State from January 2021.		MIKHAIL GORBACHEV
5	The last leader of the Soviet Union.		ANTONY BLINKEN
6	President of the United States from 2017-2021.		BARACK OBAMA
7	US Secretary of State from 2018-2021.		DMITRY MEDVEDEV

8	President of Russia from 2008-2012.		MIKE POMPEO
9	President of the United States from January 2021.		DONALD TRUMP
10	President of the United States from 2001-2009.		BORIS YELTSIN

What do the historians have to say about "Nuclear disarmament after the Cold War"?

1. Kenneth N Waltz

Waltz presents an argument to suggest that any ABM system will always be ineffective and thus a waste of money. His ideas clearly punch holes in the Bush administration's decision to abandon the AMB Treaty in 2002. [5] If a would-be attacker doubts that its missiles would get through, they would simply fire many more. No ABM system will stop them all. An attacker could place decoys on missiles to confuse the ABM system. Cruise missiles are quite small; a Chinese *Silkworm* can fit into a shipping container and could be fired at any port in the world. This all leads Waltz to conclude:

"…Missile defences would be the most complicated systems ever deployed, and they would have to work with near perfection in meeting their first realistic test – the test of enemy fire. No president will rely on such systems but will instead avoid actions that might provoke an attack…" [6]

2. Stephanie Cooke

Cooke discusses the changing ideas on nuclear tactics which developed under President George W Bush and the dangers this involved. She shows that even in the 21st century, planners still incorporate nuclear weapons into their defence strategies. Under Bush, the emphasis was on a 'range of scenarios'. Defence strategy was now not just on explosive power but on an ability to adapt nuclear technology to *shifts in the nature of military conflicts* and to consider strikes on countries such as Iran and North Korea. When Bush placed interceptors in Poland, Cooke argues he threatened to rekindle the cold war. Cooke comments:

"…Putin warned he would aim some of his country's nuclear missiles at any country that agreed to accept the American interceptors. He also began what could become strategic nuclear partnerships in Latin America…" [7]

5 It also provides a strong argument against Reagan's 'Star Wars' ideas in the 1980s.
6 Waltz, K N, Waltz Responds to Sagan, in The Spread of Nuclear Weapons: An Enduring Debate, edited by Scott D Sagan and Kenneth N Waltz, W W Norton and Co, New York, 2013, p 103
7 Cooke, Stephanie, In Mortal Hands: A Cautionary History of the Nuclear Age, Bloomsbury, New York, 2009, p 403

Chapter Twelve
Issues of proliferation: Israel, India, Pakistan, Iran, North Korea

Background

In his book, co-written with Scott D Sagan,[1] Kenneth Waltz suggests the use of the word "spread" rather than "proliferation" when discussing the growing number of nations since 1945 who have developed nuclear weapons:

- his argument is that nuclear weapons have really only proliferated "vertically", ie existing nuclear powers have added to their arsenals;
- "horizontally", they have spread across the world to other countries slowly.

The United States was the first nation to have atomic/ nuclear weapons in 1945. It was joined by the Soviet Union (Russia) in 1949. Britain joined the 'nuclear club' in 1952, France in 1960 and China in 1964.

On 1 July 1968, the *Treaty on the Non-Proliferation of Nuclear Weapons (NPT)* was signed. In came into force on 5 March 1970. The treaty had three main purposes:

- to stop the spread of nuclear weapons and weapons technology;
- to promote cooperation in the peaceful use of nuclear energy;
- to assist in the achievement of nuclear disarmament.

In May 1995, the treaty was extended indefinitely and now 191 nations have ratified the NPT.

It is assumed that there are now nine nations that have nuclear weapons. The original five powers (US, Russia, Britain, France and China), India, Pakistan and North Korea. It is assumed Israel also has nuclear weapons, though that country's official line is to neither confirm nor deny its ownership of nuclear weapons.

The NPT has been ratified by more countries than any other arms limitation or disarmament agreement in history. However, Israel, India and Pakistan have refused to sign up to the treaty. [2]

Four nations that once had nuclear weapons no longer have them. When the Soviet Union dissolved in 1991 (see Chapter 10), the newly independent states of Kazakhstan, Belarus and Ukraine found themselves with nuclear weapons on their soil (formerly part of the Soviet Union's nuclear arsenal). These states liquidated their weapons in the 1990s. [3] South Africa decided in 1989 to dismantle its nuclear weapons program. By this time, it had produced six bombs and had one under construction. South Africa joined the NPT in 1991.

1 Waltz, K N, and Sagan, S D, The Spread of Nuclear Weapons: An Enduring Debate, W W Norton and Co, New York, 2013
2 South Sudan (founded in 2011) has not yet signed up to the treaty.
3 Had Ukraine and Kazakhstan kept their nuclear weapons, they would have become the world's 3rd and 4th largest nuclear powers respectively.

Issues of proliferation: (1) Israel

Israel's official line regarding its nuclear weapons capability is to maintain a policy of *"nuclear ambiguity"* or *"nuclear opacity"*. The Israeli government never admits to having weapons. [4] Israel also tries to ensure that its Arab neighbours (enemies) do not develop any nuclear capacity. In June 1981, Israel attacked the Iraqi Osiraq reactor. The policy of preventing proliferation in the Arab world became known as the Begin Doctrine. [5] The Begin Doctrine continued long after Begin's time in office. In 2007, Israel attacked a suspected Syrian reactor at Al-Kibar.

- In the mid-1950s, Israeli Prime Minister David Ben-Gurion, decided that Israel needed a nuclear weapons program. The two key figures in this development were Ernst Bergmann, Ben-Gurion's chief scientific advisor, and Shimon Peres, director-general of the Ministry of Defence in the 1950s.
  - Shimon Peres later said: *Ben-Gurion believed that science could compensate us for what Nature has denied us.*
  - It was Peres who developed the 'special relations' with France, key to Israel's early nuclear program.
- In October 1957, Israel obtained a reactor and an underground reprocessing plant from France:
  - the facility was built in the Negev Desert near the town of Dimona;
  - France was keen to maintain secrecy about its deep involvement in the Israeli nuclear program;
  - President De Gaulle later decided to end French government assistance but French companies were allowed to continue working for the Israelis for an Israeli acknowledgement of its *peaceful purpose*.
- In 1960, Israel also received help from Norway which provided it with heavy water for the Dimona reactor:
  - the heavy water was needed for plutonium production;
  - by 1965, Israel was producing its first plutonium;
  - it is believed that by mid-1967, Israel had two or three nuclear devices.
- US Presidents Kennedy and Johnson had not been enthusiastic about Israel's nuclear ambitions. However, in 1969, President Nixon and Israeli Prime Minister, Golda Meir, reached an "understanding", known as the Nixon-Meir deal. The essence of this 'deal' was:
  - Israel promised not to declare or test its nuclear capacity;
  - the US would not pressure Israel to sign the NPT and would cease inspections of Israeli facilities;
  - by 1973, Israel had deployed its first nuclear-capable ballistic missile.
- In the 1970s, Israel and South Africa grew closer with South Africa supplying Israel with uranium and Israel supplying South Africa with tritium.
- In 1979, US intelligence sources believed that a low-yield nuclear explosion had taken place off the eastern coast of South Africa. US officials admitted that they believed it was an Israeli device.

4 Knowledge of Israel's secret nuclear program was revealed to the British press in 1986 by the nuclear technician, Mordechai Vanunu (see below).
5 Menachem Begin was Israeli Prime Minister, 1977-83.

- At the time of the Gulf War in 1991, [6] Israeli Prime Minister, Yitzhak Shamir warned Iraq that if threatened by Iraqi chemical weapons, Israel would strike back hard. He added: *Israel has a very strong deterrent capability.*
- Israel had failed to detect Iraq's renewed nuclear research of the late 1980s and was becoming concerned at Iran's intentions. This spurred the Israeli government to develop a sea-based second-strike-capability:
  - Israel had German-built Dolphin-class submarines and are assumed to be able to deploy nuclear-tipped cruise missiles;
  - by the second decade of the 21st century, Germany had supplied Israel with half a dozen vessels.
- The US Defence Intelligence Agency estimated that Israel had between 60 and 80 nuclear weapons by the early 21st century.

By 2011, Israel's major nuclear concern in the region was the potential of Iran to develop nuclear weapons. Prime Minister Netanyahu has made it clear that Israel would not "tolerate" Iran having a nuclear capability. If this meant that Israel would have to strike at Iranian nuclear facilities to prevent that country developing the bomb, then that is something Israel would have to do. Attacking Iran would not be as straight forward as earlier attacks on Iraq and Syria, and the consequences for the Middle East could be catastrophic.

Mordechai Vanunu *is a former Israeli nuclear technician. His opposition to the development of 'weapons of mass destruction' led him to reveal to the British press in 1986 details of Israel's nuclear weapons program. He was later lured to Italy by an agent of Israeli's secret service, Mossad. He was drugged, kidnapped and taken back to Israel. After a secret trial, he was sentenced to eighteen years in prison, eleven of which he spent in solitary confinement. He was released in 2004 but was immediately subject to various restrictions on his freedom of speech and movement. Since 2004, he has been arrested and imprisoned several times for giving interviews and trying to leave Israel. To some, Vanunu is a heroic whistle-blower. As far as the Israeli authorities are concerned, he is traitor. In June 2020, official restrictions on his freedoms were renewed for another twelve months.*

Issues of proliferation: (2) India

There were several factors that led to the Indian decision to pursue the path of nuclear weapons. India's first Prime Minister, Nehru, sought national prestige and energy self-reliance. Key figures in the Indian security establishment argued that India needed a nuclear deterrent, pointing to the rise of China. India's nuclear weapons development is outlined in Figure 12.1.

6 Iraq invaded Kuwait in 1990. In what became the First Gulf War, US-led forces drove Iraq out of Kuwait in early 1991 in "Operation Desert Storm".

Figure 12.1 India's nuclear weapons path

The brains behind India's early nuclear program was Homi Bhabha. He was able to persuade Indian leaders like first PM, Jawaharlal Nehru (1947-64), to follow an ambitious nuclear program. At first, Nehru's main concern was energy.

By the 1960s, India was in a position to pursue the idea of nuclear weapons. In November 1964, PM Shastri (1964-66) gave the go-ahead for theoretical work on the *Subterranean Nuclear Explosion for Peaceful Purposes (SNEPP) project.*

Indian scientists made progress on developing the capacity for an explosion. A political decision was needed. PM Indira Gandhi (1966-77) ordered the testing of a fission device – a peaceful nuclear explosion.

India's first nuclear test came on 18 May 1974. India was roundly condemned for the explosion by countries that had supplied it with nuclear technology and materials for peaceful use only.

India did not weaponise its nuclear capacity until the late 1980s. PM Rajiv Gandhi (1984-89) was concerned at oblique nuclear threats that had come from Pakistan. At the same time, he spoke for nuclear disarmament at the UN.

PM Vajpayee authorised two tests for 11 and 13 May 1998. India formally announced it was a nuclear-weapon state. In 1999, India declared a "no-first use", defensive policy with its *"credible minimum nuclear deterrence."*

In January 2003, India said it reserved the right to use its weapons to retaliate against a biological or chemical attack or to protect Indian troops operating in Pakistan. Indian nuclear forces are controlled by a civilian Nuclear Command Authority.

Since 2000, India and the US have signed various nuclear cooperation agreements. In 2009 India and the international Atomic Energy Agency (IAEA) concluded a safeguards agreement. As of 2019, India had 26 reactors under IAEA safeguards. It has nuclear cooperation agreements with several countries and participates in the international nuclear trade, importing uranium from countries such as Australia.

It is estimated that as of 2019, India has a nuclear arsenal of about 130-140 warheads.

Exercise 12.1 Indicate whether each of the following statements is true or false.

1	It is assumed that in the early 21st century, there are only nine states which have nuclear weapons.	TRUE/ FALSE
2	When the Soviet Union was dissolved in 1991, the newly independent republics of Belarus, Kazakhstan and Ukraine were determined to keep their nuclear weapons.	TRUE/ FALSE
3	The 1968 Treaty on the Non-Proliferation of Nuclear Weapons (NPT) gained popular support from only a small number of nations.	TRUE/ FALSE
4	Israel has always refused to be open and above aboard about its nuclear program and whether or not it has a stockpile of nuclear weapons.	TRUE/ FALSE
5	The 'Begin Doctrine' was a policy of the Israel government in the early 1980s to discourage Arab states from developing nuclear weapons through negotiation.	TRUE/ FALSE
6	France gave important early assistance to the Israeli nuclear program and continued even after President De Gaulle's decision to reduce government involvement.	TRUE/ FALSE
7	US President Nixon's attitude to Israel's nuclear plans were encouraging compared to the attitude of former Presidents Kennedy and Johnson.	TRUE/ FALSE
8	Israeli authorities have always viewed Mordechai Vanunu as an idealistic and honourable man who placed his conscience above anything else.	TRUE/ FALSE
9	India's main interest in a nuclear program when Prime Minister Nehru was in power concerned the production of energy.	TRUE/ FALSE
10	When PM Indira Gandhi's government authorised a nuclear test in 1974, governments around the world were full of praise and admiration for India's achievement.	TRUE/ FALSE
11	Since the 1980s, the desire of the Indian government to develop nuclear weapons was due in large part to its fear of a possible military threat from Pakistan.	TRUE/ FALSE
12	Due to its policy of developing nuclear weapons, states like the US and Australia have refused to engage in any agreements that might assist India's nuclear program.	TRUE/ FALSE

Issues of proliferation: (3) Pakistan

Britain gave up his control of the Indian subcontinent in 1947. Following the departure of the imperial power, the world witnessed the bloody birth of new nations: Pakistan and India. [7] Ever since the 'partition of British India', relations between Pakistan and India have been tense, sometimes resulting in military conflict, often over each state's rival claims for the provinces

7 Pakistan comprised a western and an eastern region. East Pakistan became Bangladesh in 1971.

of Jammu and Kashmir. Pakistan claimed it needed to pursue a nuclear weapons program because of its adversarial relationship with India. [8]

Pakistan commenced its nuclear program in the 1950s with the establishment of the Pakistan Atomic Energy Commission (PAEC) in 1956. A key figure in promoting the future Pakistani nuclear program was Zulfikar Ali Bhutto. [9]

- Foreign Minister Bhutto stated as early as 1965: *If India builds the bomb, we will eat grass or leaves, even go hungry, but we will get one of our own.*
- Following Pakistan's defeat by India in December 1971, Bhutto told his nuclear officials that he wanted a Pakistan bomb within three years:
  - India's first nuclear test in May 1974 energised Pakistani authorities to develop nuclear weapons.

The head of the PAEC was Munir Ahmad Khan; he led the Commission along the plutonium path to nuclear weapons. However, Pakistan faced obstacles in developing its program due to international export controls which were tightened following India's 1974 test:

- to overcome this, Cooke says that one of the program's leading figures, A Q Khan, [10] *"completely circumvented the international nuclear safeguards regime to deliver his country the technology and the material for nuclear weapons";*
- this proved a successful way of avoiding export controls. Khan claimed that Pakistan was able to produce a nuclear device as early as 1984.

A key element in the international assistance Pakistan received in developing its program was China. From the late 1970s, China provided:

- assistance on nuclear and missile-related matters, and warhead designs;
- centrifuge equipment and other aspects of the paraphernalia necessary for developing nuclear weapons;

The turning point in Pakistan's nuclear development came in 1998. In May of that year, India conducted tests on 11 and 13 May; five explosions in all. Pakistani Prime Minister, Nawaz Sharif ordered that Pakistan should respond in the same manner:

- on 28 May 1998, Pakistan detonated five explosions;
- on 30 May there was a sixth explosion;
- the government announced the commissioning of a plutonium production reactor at Khushab.

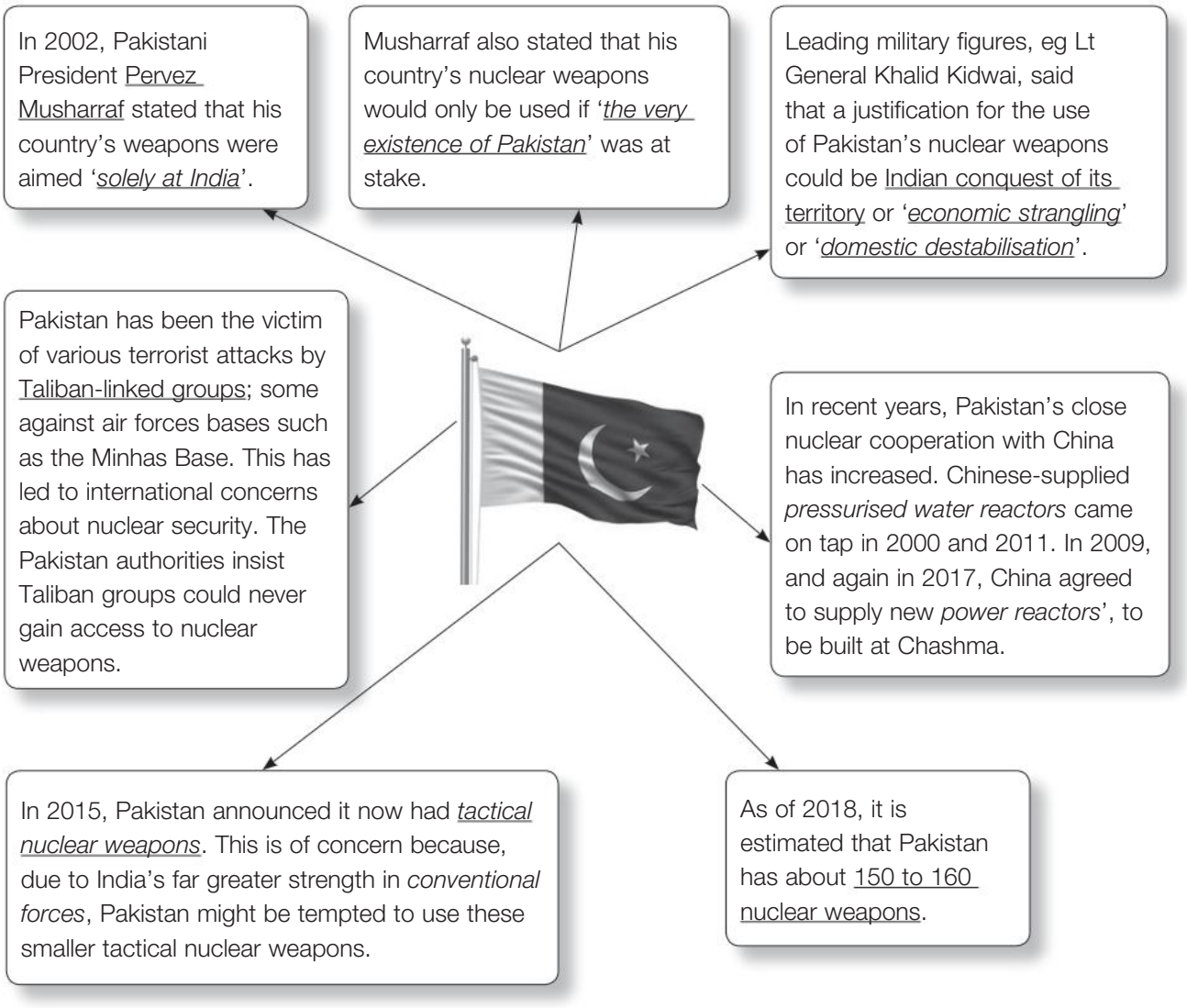
The nuclear ambiguity which Pakistan had earlier adhered to was dropped and the government stated it would maintain a *credible minimum deterrent against India.*

8 India and Pakistan went to war over Kashmir in 1947 and 1965, and fought a limited war in 1999. Their contested border is known as the 'Line of Control'. Minor exchanges of fire are regular occurrences. In 1971 they fought briefly when civil war broke out in Pakistan, that resulted in East Pakistan becoming Bangladesh.

9 Bhutto was President of Pakistan from December 1971 to August 1973. A new constitution gave greater power to the post of Prime Minister, a position Bhutto held from 1973-77. He was overthrown in a coup in 1977. Bhutto was executed in 1979.

10 Abdul Qadeer Khan - See Historian 1.

Figure 12.2 Aspects of and concerns about Pakistan's nuclear stance.



Issues of proliferation: (4) Iran

The issue of Iran and nuclear proliferation exists against a background of the poisonous state of US-Iran relations. The 1979 Islamic Revolution in Iran brought the downfall of a staunch US ally in the Shah of Iran. In 1979, Iranian students took over the US embassy in Tehran and held 52 people hostage for over a year. The US was humiliated by this episode, and a later failed attempt at rescue. The US regularly accuses Iran of backing terrorists. To the Iranians, the US is *"the Great Satan"*; to the Americans, Iran is part of President G W Bush's *"axis of evil".*

It has been a fundamental element of US (and Israeli) foreign/ defence policy since the Iranian Revolution to prevent Iran from gaining nuclear weapons.

However, Iran's interest in developing a nuclear program goes back to the 1950s, many years before the 1979 Islamic Revolution. [11]

11 The Shah of Iran, a close ally of the US, came to the throne in 1941. He was overthrown in 1979 during the Islamic Revolution which brought Ayatollah Khomeini to power and which turned Iran into an Islamic state.

1950s	■ The US provided technical help to Iran under its Atoms for Peace program, introduced by President Eisenhower. ■ Iran's nuclear program made little progress.
1967	■ The US provided Iran a 5 MWt research reactor that was fueled by highly enriched uranium.
1974	■ The Atomic Energy Organisation of Iran was set up. ■ The Shah announced plans to construct 23 nuclear plants within twenty years
1974-78	■ During this period Iran signed agreements with various countries to obtain uranium yellowcake, train its technicians overseas and gain a financial stake in a uranium enrichment plants in Europe.
In 1979, the Shah's regime was overthrown in the Islamic Revolution which brought to power Ayatollah Khomeini.	
Early 1980s	■ Iran's nuclear program almost disintegrated as skilled technicians fled overseas. ■ Ayatollah Khomeini was opposed to nuclear technology and Iran had become bogged down in the war with Iraq.
1987	■ Iran signed a nuclear cooperation agreement with Pakistan.
1990	■ Iran signed an agreement with China.
1990s	■ Russia offered to assist Iran's nuclear program by completing the construction of the Bushehr Nuclear Power Plant. ■ The US believed that Iran was using its nuclear program as a cover for nuclear weapons development. ■ It pressured various nations to back off agreements it had made with Iran.
1996	■ The US 'Iran Sanctions Act' was introduced to penalise US and foreign firms which invested too heavily in Iran's energy programs.
2002	■ Iran announced that it had built nuclear facilities near Natanz and Arak.
2003-2005	■ Iran was involved in discussions with the IAEA about suspending some of its nuclear program activities such as attempts at enrichment. ■ Faced with threats of more sanctions, Iran agreed to the November 2004 Paris agreement with the EU-3 (France, Germany, UK) to again limit its enrichment and conversion activities.

2000s	■ There is a constant 'toing and froing' between Iran, the IAEA, the EU-3, the US and the UN Security Council about Iran's possible nuclear activities. ■ The US government imposed additional sanctions, eg the June 2005 Executive Order penalising entities and individuals who help support *Weapons of Mass Destruction* proliferation. ■ The Security Council issued Resolution 1696 calling on Iran to suspend its enrichment activities along with a host of other measures aimed at stifling Iranian nuclear development. ■ UN Resolution 1803 of March 2008 widened sanctions against Iran.
2000s	■ Iran does not seem to have been intimidated by international sanctions action against it. ■ In April 2006, Iran announced that it had enriched uranium for the first time at its Natanz Plant. ■ In February 2009, Iran announced its first successful satellite launch. ■ In September 2009, Iran informed the IAEA that it had built a second uranium enrichment plant at Fordow. ■ In May 2011, the Bushehr nuclear power plant successfully achieved a *'chain reaction'.* ■ In 2009, President Ahmadinejad announced that Iran was planning to build ten additional uranium enrichment facilities.

Western countries, led by the US, are convinced that Iran's nuclear program is directed to the creation of nuclear weapons. This is why economic sanctions have been placed on Iran.

- However, in 2015, the preliminary "Iran nuclear deal framework" was worked out between the "P5+1" (the permanent members of the UN Security Council plus Germany), and the European Union:
  - in essence Iran was to have a nuclear program which would not lead to the production of nuclear weapons.
- In 2018, President Trump pulled the US out of the Iran nuclear deal, arguing the deal would not have prevented the Iranians developing nuclear weapons:
  - the US re-imposed sanctions on Iran.
- In early 2021, newly elected President Joe Biden indicated that he was willing to try and restore the 2015 deal.

Issues of proliferation: (5) North Korea

Context

In his 'State of the Union' address on 29 January, 2002, President George W Bush referred to 'an axis evil'. He was referring to three states whom he accused of supporting terrorism and of seeking 'weapons of mass destruction'. One was Iran (see above); the second was Iraq which the United States invaded in 2003. The third of those states was North Korea.

Between 1910 and 1945, Korea was occupied by Imperial Japan. Following Japan's defeat in 1945, Korea was divided into north and south at the 38th parallel.

- Within a short time, North Korea had become the Democratic People's Republic of Korea, a communist state under the leadership of Kim Il-Sung.
- South Korea became the non-communist Republic of Korea under Syngman Rhee. In 1950, North Korea invaded South Korea.
- The Korean War (1950-53) which followed ended in a stalemate and the Korean peninsula remained divided at the 38th parallel – as it still is today.

Kim Il-Sung died in 1994. He was followed as North Korea's leader by his son Kim Jong-Il. The son died in 2011. The 'Kim dynasty' continued when Kim Jong-un took power. [12]

North Korea's nuclear progress

North Korea began a 'ballistic missile program' in the 1970s when it gained Soviet Scud-type missiles from Egypt. In the 1990s, working with Iran, it began producing its Nodong medium-range ballistic missiles. North Korea has also successfully tested an SLBM, the Pukguksong-1.

In the early 1990s, it came to the notice of the IAEA that North Korea's progress in its nuclear program was far more extensive than that country had declared:

- North Korea withdrew from the IAEA in 1994;
- the US hoped to prevent North Korea leaving the NPT and so negotiated an Agreed Framework Agreement:
  - North Korea would freeze its nuclear program;
  - it would allow IAEA inspectors back into the country;
  - the US would provide a light water reactor and some energy assistance.
- the Agreed Framework Agreement broke down and in January 2003, North Korea withdrew from the NPT;

There followed 'Six Party Talks' – China, Japan, Russia, South Korea, the US and North Korea. The aim was to find a diplomatic solution to North Korea's nuclear program. In 2009 these talks fell apart.

For several years, North Korea has gone its own, unpredictable way:

- in July 2017, it carried out a successful test of its first ICBMs;

12 At the time of writing (2021), Kim Jong-un is still North Korea's leader.

- these were the Hwasong-14 and Hwasong-15 models;
- Kim Jong-un has made boasts that he has missiles that can reach the west coast of the USA and the northern coast of Australia.

- in September 2017, North Korea claimed it had tested a thermonuclear weapon;
- at the same time Kim Jong-un has been willing to talk (sincerely or not):
  - he met South Korea's leader, President Moon Jae-in, in 2018 after announcing a halt to all nuclear and ISBM tests;
  - in 2018 and 2019, Kim met US President Trump on three occasions though nothing substantive emerged from the talks and hopes of achieving a 'nuclear-free' Korean peninsula remain elusive.

Exercise 12.2 Who am I?

1	In 1986, I exposed Israel's secret nuclear program to the world.		ERNST BERGMANN
2	I ordered the first testing of a nuclear device by India in May 1974.		DONALD TRUMP
3	In 1998, I ordered the testing of six nuclear devices by Pakistan.		NAWAZ SHARIF
4	I continued the work of my father in the development of ballistic missiles and testing.		AYATOLLAH KHOMEINI
5	I became the leader of Iran after the 1979 Islamic Revolution.		SHIMON PERES
6	I was the chief scientific advisor to the Israeli Prime Minister in the 1950s.		KIM JONG-UN
7	I met Kim Jong-un three times but we did not reach any nuclear agreements.		MORDECHAI VANUNU
8	I announced in 1998 that India was now a nuclear-weapon state.		ATALI BIHARI VAJPAYEE
9	I was a key figure in Pakistan's nuclear program in the 1970s and 1980s.		INDIRA GANDHI
10	I was the director-general of the Israeli Ministry of Defence in the 1950s.		A Q KHAN

What do the historians have to say about "Issues of proliferation: Israel, India, Pakistan, Iran, North Korea"?

1. Stephanie Cooke

Cooke comments on the role played by A Q Khan in the development of the Pakistan nuclear program. Khan gained almost mythical status in Pakistan.

- In 1981, President Zia renamed the Kahuta plant the *Khan Research Laboratories*.
- Cooke suggests that Khan was a superb self-promoter, and tried to take much of the credit for Pakistan's bomb, though the work had been done by the PAEC (Pakistan Atomic Energy Commission).

Though his role in actually designing and assembling the bomb was minimal, Cooke comments:

"…Khan's main contribution to the effort was building a successful enrichment enterprise; without a reprocessing facility, the Pakistanis were totally dependent on him to produce their bomb material, highly-enriched uranium…" [13]

2. Craig Nelson

Nelson comments on the extent to which the Israelis "allegedly" went to prevent non-friendly states developing a nuclear program. Any state which veered from the Non-Proliferation Treaty could face investigation by the IAEA, international boycotts and censure. However, some states have resorted to assassinations and cyberattacks to prevent proliferation.

- In November 2011, Iran's Atomic Energy Organisation director, Fereydoon Abbasi escaped an assassination attempt.
- However, an Iranian particle physicist was killed in a similar attack in January 2010, as was an electronics specialist in July 2011.
- In November 2020, Iran's chief nuclear scientist, Mohsen Fakhrizadeh, was assassinated.
- The Iranian government blamed Israel for the killings.

They also blamed Israel for cyberattacks. Two malware viruses, Flame and Stuxnet, were discovered infecting Iranian computers in the spring of 2012. Nelson says the impact of the malware was significant:

"…Flame is lithe spyware that turns on computer microphones and Skypes the recorded conversations; scans the neighbourhood's Bluetooth gadgets… Stuxnet infected Iran's uranium-enriching centrifuges and sped them up until they committed suicide…" [14]

13 Cooke, Stephanie, In Mortal Hands: A Cautionary History of the Nuclear Age, Bloomsbury, New York, 2009, p 273
14 Nelson, C, The Age of Radiance: The Epic Rise and Dramatic Fall of the Atomic Era, Scribner, New York, 2014, p 338

Chapter Thirteen
The contributions of nuclear medicine and energy

It is very easy to argue that the Nuclear Age has had only a negative impact on the world. The destruction and dangers of the Nuclear Age can be summed up with a list of names and events: Hiroshima, Nagasaki, Semipalatinsk, Bikini Atoll, Castle Bravo, Novaya Zemlya, the Tsar Bomba. Maralinga, Mururoa Atoll, Three Mile Island, Chernobyl, Fukushima, nuclear proliferation – The Cuban Missile Crisis.

However, it can equally be argued that the Nuclear Age has also brought benefits to humanity. Two such areas of benefit are "medicine" and "nuclear energy".

The contribution of nuclear medicine

"Nuclear medicine is the use of radioactive materials in diagnostic or therapeutic procedures, most notably treatments for various forms of cancer."
(The US Nuclear Regulatory Commission).

Nuclear medicine has grown over many decades with scientists from many fields contributing to its development. These fields have included chemistry, physics, medicine, engineering. It is so widely used in the 21st century, it is worth remembering how it has transformed the diagnostic and therapeutic work of those working in medicine.

In essence, nuclear medicine works by giving a patient a radioactive compound or radiopharmaceutical. This can be inhaled, swallowed or injected. The type of compound used, and the amount that a patient is given, varies depending on which part of the body is being studied and the condition of the patient:

- the compound travels through the body and gives off gamma rays (invisible radiation);
- the gamma rays indicate where the compound is in the body.
- special equipment can detect the gamma rays and records them as flashes of light which can then produce pictures of the body part being studied;
- doctors then interpret what has been identified, usually with the assistance of appropriate computer technology, to check if body organs are working properly and to diagnose diseases.

The radioactive materials that are ingested leave the body in a few hours, or can remain for as long as a few months. Doctors have to be careful not to expose patients to too much radiation as that can damage organs or tissues, possibly even cause cancer.

Figure 13.1 Nuclear Medicine in practice

DIAGNOSTIC PROCEDURES IN NUCLEAR MEDICINE

- Nuclear medicine can diagnose heart problems with a stress test using *Sestamibi*. This contains *technetium-99m*.
- Heart disease can also be diagnosed with the use of a PET scan.
- Thyroid disease can be diagnosed by using a radioactive iodine thyroid scan. This uses sodium iodine which contains iodine-131.
- Brain scans are used to check for poor blood circulation, brain infection, strokes or tumours.
- Lung scans are used to detect blood clots by injecting a radioactive compound that is carried by the blood to the lungs.
- Liver and gallbladder imaging is carried out to diagnose liver disorders such as cirrhosis or tumours, and to check for gallbladder disease.
- Bone scans are carried out to look for fractures, tumours, bone infections.

Positron emission tomography (known as a PET scan) is a nuclear medicine examination. It creates a three-dimensional image of functional processes in the body. A PET scan uses a small amount of a radioactive drug to highlight differences between healthy and diseased tissue.

A PET scan is used by doctors to find information about how body organs are functioning. PET scans give a clear view of how organs are working at a cellular level and if they have been damaged. They help doctors decide on treatment options. They are often used to diagnose heart problems, determine appropriate cancer treatment and help in the diagnosis of Alzheimer's disease.

THERAPEUTIC PROCEDURES IN NUCLEAR MEDICINE

- *Radioimmunotherapy* is a therapeutic procedure in nuclear medicine in which a radioactive element (eg iodine-133 90) is tagged to an antibody that then targets a specific cancerous cell.
- *Brachytherapy* uses a radioactive source like iridium-192. This is inserted inside or close to a tumour in order to kill cancer cells while not harming neighbouring cells.
- *Thyroid Ablation* is carried out to decrease the function of some or all of the thyroid gland. It uses sodium iodine which contains iodine-131.

Some procedures may use radiation or perform functions similar to radioisotopes. However, these are not part of nuclear medicine. Nuclear medicine can detect radiation coming from inside a patient's body. Other procedures expose the body to radiation from the outside. Such procedures include x-rays, CT scans, ultrasound and MRIs.

The contribution of nuclear energy

Nuclear energy is derived from the splitting of uranium or plutonium atoms through a chain reaction in a reactor. This process is known as nuclear fission. The energy that is released from the splitting of the atoms is used to heat water into steam. The steam that is created then turns a turbine and this creates electricity.

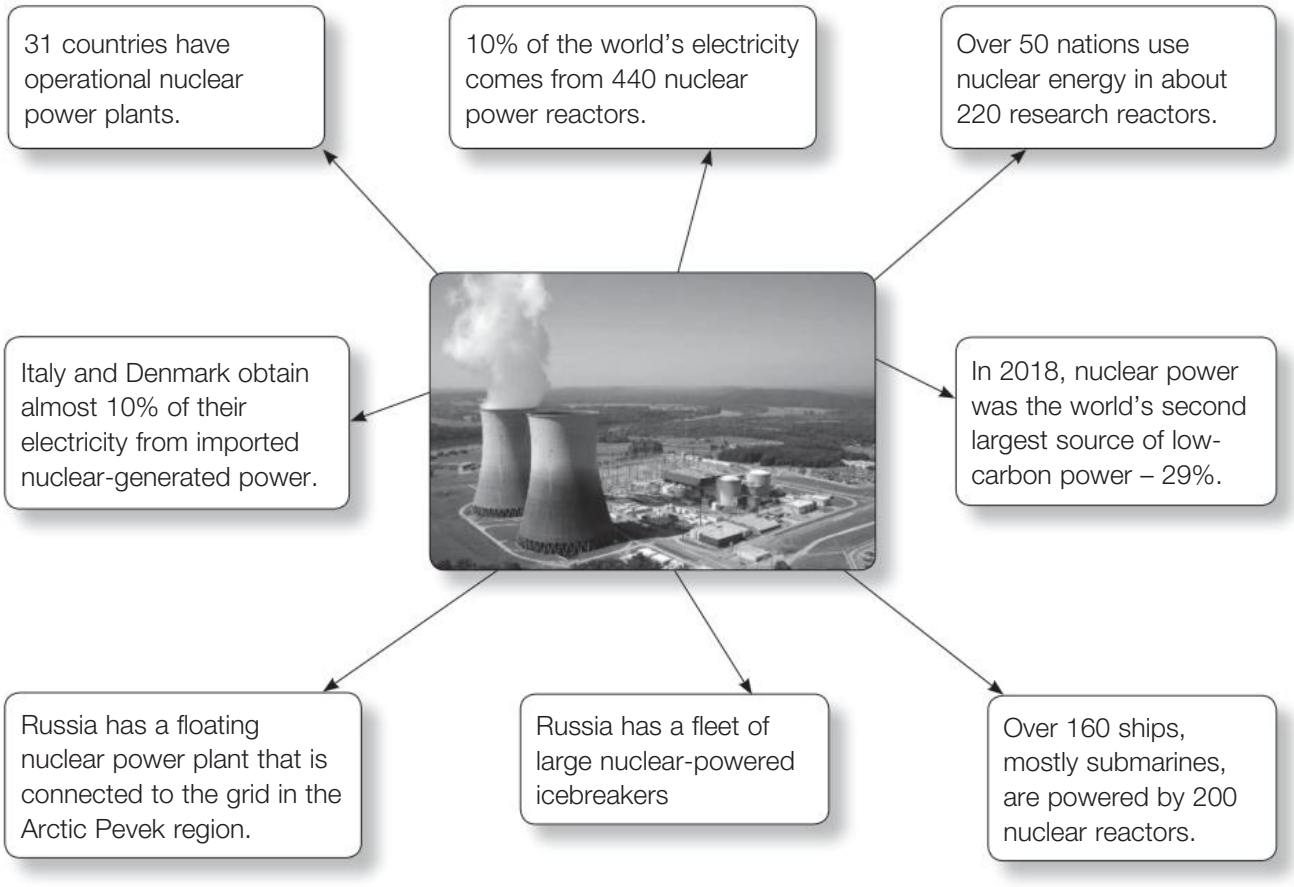
The nuclear technology associated with this process was developed in the 1940s; its purpose at that time was to produce an atomic bomb. However, in the years after World War II, many scientists directed their efforts towards the peaceful use of the nuclear process in order to generate power.

There are many issues surrounding the use of nuclear energy:

- these include matters concerning waste and storage, safety and security (see Chapter 14);
- accidents, past and possibly future (see Chapter 15);
- the arguments for and against the use of nuclear energy, and the expansion or winding back of nuclear energy (see Chapter 16).

The first commercial nuclear power stations began operating in the 1950s. The expansion of nuclear energy has not occurred at the high rate which its backers predicted in the early years of the Nuclear Age. However, nuclear energy has grown to play a significant part in world energy output. This is outlined in Figure 13.2.

Figure 13.2 The use of nuclear energy as of early 21st century



Exercise 13.1 Complete the following passage using the terms given below.

The Nuclear Age has made the world a more _____ place. However, it cannot be denied that the pursuit of nuclear programs has also brought _____. Nuclear medicine has allowed medical specialists to more accurately _____ medical problems. _____ disease can be diagnosed using an iodine thyroid scan. Lung scans can detect _____. Liver _____ can detect the presence of _____. A PET scan can be used to detect _____ and help diagnose _____'s disease. Nuclear medicine is also used to kill _____ cells. Research into nuclear _____ in the 1940s was primarily aimed at producing an _____ bomb. From the 1950s, _____ use of nuclear energy was also pursued. Over ___ countries have nuclear power plants. ____ reactors cross the world produced 10% of the world's electricity. Countries like _____ and Denmark import almost ___% of their electricity from nuclear-generated power. Several navies have _____ powered by nuclear _____. Russia has a fleet of nuclear-powered _____.

PEACEFUL – CIRRHOSIS – REACTORS – BLOOD CLOTS – DANGERS – DIAGNOSE – FISSION – SUMARINES – THYROID – BENEFITS – ITALY – ICEBREAKERS – 10 – 30 – 440 – CANCEROUS – IMAGING – BOMB – HEART – ALZHEIMER

Chapter Fourteen
Radioactive waste and issues of storage, safety and security

Overview

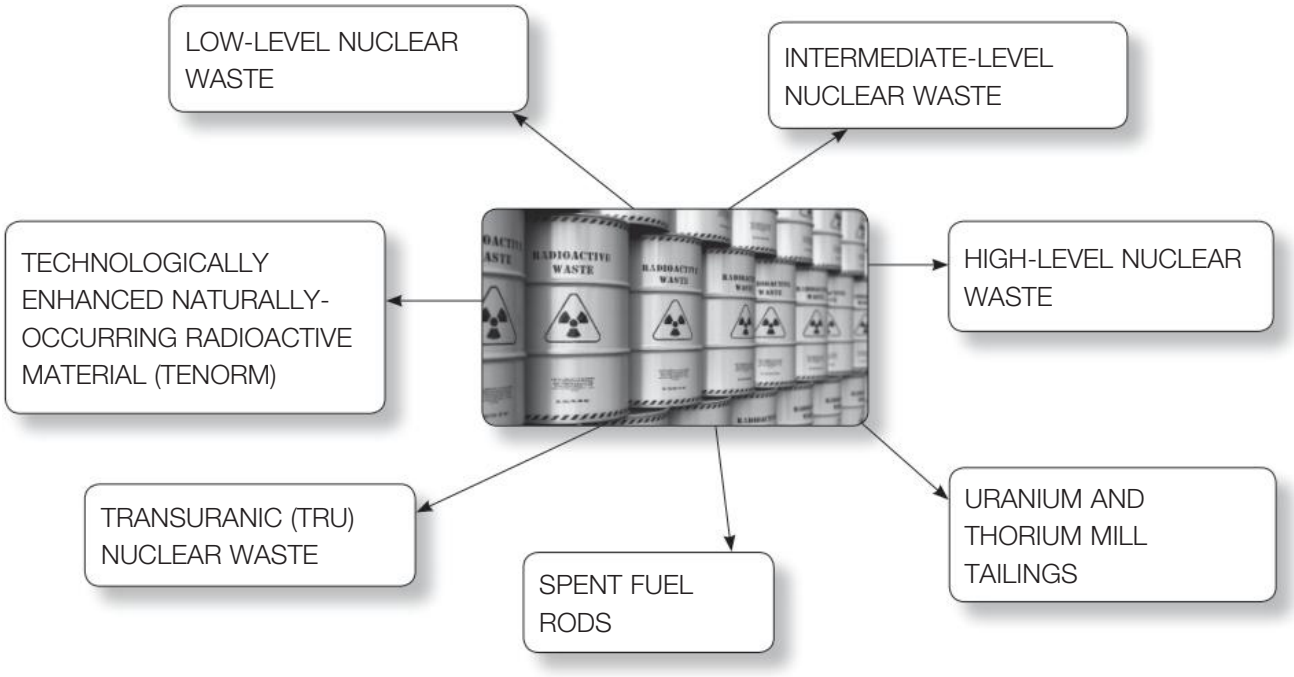
Nuclear energy, whether it is used to generate electricity or to produce weapons, has one fundamental and very serious drawback: **nuclear waste**. If not handled carefully, nuclear waste has the potential to cause major damage to the environment and the surrounding atmosphere. Radioactive isotopes do eventually decay but the time taken can vary. Some decay in hours; Strontium-90 has a half-life of 30 years; [1] Plutonium-239 has a half-life of 24 000 years. Across the world:

- it is estimated that 250 000 metric tons of highly radioactive waste sits in storage close to nuclear power plants or weapons producing facilities;
- there are 90 000 metric tons in the United States alone;
- in Hanford, Washington state, there are 212 million litres of radioactive waste in underground storage tanks.

Much of the waste awaits some form of permanent storage in deep geological repositories. However, for now, most of the waste is stored in solid metal containers. Some of the waste goes back to the 1940s. As time goes on, the containers age and degrade. Some aging containers have already begun to leak the toxic waste contained within.

Not all nuclear waste is the same. Figure 14.2 outlines the different types of waste.

Figure 14.2 The different types of nuclear waste



1 This means that half the radioactivity will decay in 30 years.

Each type of nuclear waste has a different level of danger, and each type's method of storage, security and safety can vary.

(1) Low-level nuclear waste

Low-level nuclear waste is generated from the nuclear fuel cycle, and mainly comprises materials that have been contaminated by radioactive substances.

- Much of this waste has the appearance of common items;
  - they can include such things as paper, rags, plastic bags, packaging material and protective clothing.
- This sort of waste can be generated by any industry or activity that uses radioactive material:
  - this would include medical facilities.
- Low-level waste has disposal facilities specialising in near-surface disposal.

(2) Intermediate-level waste

This kind of waste comprises chemical sludges, nuclear reactor parts and any contaminated materials from reactors that have been decommissioned.

- This kind of waste contains more radioactive materials than low-level waste:
  - disposal may involve it being solidified in concrete.
- Short-lived waste of this kind, that might include non-fuel materials from a reactor is dumped in shallow repositories;
  - for longer-lived waste a geological repository is used.

(3) High-level nuclear waste

High-level waste is primarily used nuclear fuel taken from a reactor and waste generated from the reprocessing of spent nuclear fuel:

- most US liquid high-level waste comes from defence-related activities;
- most spent nuclear fuel comes from commercial power plant reactors;
- high-level waste comprises about 95% of the radioactivity from nuclear reactors.
- Most high-level waste is stored on the site where it was created.

European countries such as Finland and Switzerland are planning deep geological repositories for their waste. For some time, the US had a proposal pending to store the country waste under Mount Yucca, in Nevada:

- the site lies 300 metres below ground level and 300 metres above the water table;
- at the end of this chapter, historian 1 comments on the Mount Yucca idea.

(4) Uranium and Thorium mill tailings

After the mining and milling of uranium and thorium ore has been completed, radioactive wastes in the form of mill tailings are left. These tailings are radioactive sludge that remain after the uranium-bearing substances are taken from the ore.

- Uranium tailings keep a significant level of radioactivity and the waste is considered to be very hazardous:
  - it contains radioactive isotopes that include thorium-230, radium-226 and radon 222;
- Care has to be taken with storage:
  - The wind can carry tailings stored on open ground great distances;
  - they can then enter the food chain.

Mill tailings are stored at the production sites in carefully designed ponds, called 'impoundments'.

(5) Spent fuel rods

The United States Nuclear Regulatory Commission describes a fuel rod as: *"long, slender, zirconium metal tubes containing pellets of fissionable material, which provide fuel for nuclear reactors."*

- The fuel rods are organised into bundles;
  - these are called fuel assemblies which are loaded individually into the core of the reactor.
- Once used, the spent fuel assembly is taken out:
  - the spent fuel rods give off enormous heat and so they need to be stored in water until they can be disposed of safely.

(6) Technologically enhanced naturally-occurring radioactive material (TENORM)

There are some radiological materials that exist 'naturally' in the environment. This *naturally-occurring radiological material* (NORM) can become concentrated as a result of human activity. Such activity can include mining and resource extraction.

- NORM that has been concentrated or relocated is known as Technologically Enhanced NORM (TENORM):
  - there is a variety of industries and processes that can produce TENORM:
  - these include oil and gas drilling, mining, water treatment;
- For TENORM waste to cause health risks, it has to be breathed in or ingested:
  - lung cancer can often be the main result of improper disposal of TENORM;
  - if TENORM waste is disposed of correctly, the risk to public health is all but eliminated.

(7) Transuranic (TRU) nuclear waste

Transuranic nuclear waste TRU is a biproduct that that is generated mainly from nuclear weapons production facilities, but also from nuclear research and power generation plants.

- A key part of TRU waste is plutonium.
- The level of radiation from TRU is not high:
  - however, if particles present in the waste are breathed in it can be dangerous;
  - the radiation emitted by the particles can harm the lungs.
- Since 1999, TRU that is generated from United States defence nuclear activities is permanently disposed at the Waste Isolation Pilot Plant in New Mexico.

Vitrification

One method that scientists have come up with to store liquid nuclear waste is to *vitrify it.* The essence of this process is to turn the hazardous waste to a more easily managed immobile solid-glass. This process has several advantages:

- the glass prevents the toxic waste from leaking into the environment;
- it also offers some shielding against radioactivity leakage;
- it is highly durable.

Vitrification is a common practice. India, France, the UK and other countries have been carrying out the process for many years. The US has been doing it since about 2000. At Hanford (see above), the site is gearing up to vitrify its waste.

- The work is to be done on-site at the *Hanford Tank Waste Treatment and Immobilisation Plant:*
  - it is also known as the *Hanford Vit Plant.*
- Construction began in 2002 and according to the US Department of Energy, it is due to commence operation in 2023.
- Experts are fearful that the steel canisters surrounding the glass might eventually corrode and groundwater could seep in:
  - this water could interact with the glass and degrade it.

No matter how sophisticated the methods of storage, safety and security, the issue of how to deal with nuclear waste remains. [2]

Gerald S Frankel is a materials scientist from Ohio State University. Commenting on the issue of nuclear waste, some of it dating back over seventy years, he says:

"…It's a societal problem that has been handed to us from our parents' generation. And we are – more or less – handing it to our children…"

2 This and other issues will be discussed in Chapter 16.

Exercise 14.1 Answer the following questions in the spaces provided.

1	Why is the nuclear waste produced by weapons facilities and power plants such a problem?	
2	What is meant by the term “half-life”?	
3	What is the half-life of Plutonium-239?	
4	What is the estimated quantity of highly radioactive waste sitting in storage close to nuclear facilities?	
5	Which type of nuclear waste has disposal facilities which near the surface?	
6	What is the estimated percentage of high-level radioactive nuclear waste from nuclear reactors?	
7	Where is most high-level waste stored?	
8	Why does special care need to be taken with uranium tailings waste?	
9	What has to happen to spent fuel rods before they can be safely disposed of, and why?	
10	From how far back in time does some of the nuclear waste present in the US go?	
11	Where is the United States’ transuranic nuclear waste disposed of?	
12	What process for dealing with nuclear waste is planned for the Hanford Vit Plant?	

Exercise 14.2 Indicate whether each of the following statements is fact or opinion.

1	Concerns about dealing with the issue of nuclear waste have been greatly exaggerated.	FACT/ OPINION
2	There are many different types of nuclear waste, depending on what aspect of nuclear power is being carried out.	FACT/ OPINION
3	Several European countries have plans for deep geological repositories for their nuclear waste, as did the US with its Mount Yucca proposal.	FACT/ OPINION
4	Some elements of radioactive waste have a half-life of thousands of years.	FACT/ OPINION
5	Vitrification is a brilliant and final solution for dealing with liquid nuclear waste.	FACT/ OPINION

What do the historians have to say about "Radioactive waste and issues of storage, safety and security"?

1. Craig Nelson

Nelson describes what happened to the proposal for disposing of nuclear waste at Mount Yucca in Nevada. Between 1978 and 2008, the Department of Energy spent $9 billion studying the feasibility of Mount Yucca as a depository for high-level nuclear waste. It was meant to begin operation on 31 January 1998. As a result of delays, the US now has more waste than Yucca Mountain could hold. When the idea was raised for using Mount Yucca in the late 1970s, there was not a single Nevada congressman who opposed the idea. By the second decade of the 21st century, everyone in Nevada opposes the idea. The people of Nevada were well aware that their state had been the main site for atmospheric testing in the United States. The Federal negotiator, Richard Stallings, had to accept that the people were terrified. To the people of Nevada, says Stallings, nuclear waste was *"some kind of green, oozy stuff that's spewing poison, that you get near it and you'll die within minutes or hours."* In 2012, Nevada triumphed and the Yucca proposal was dropped. Nelson quotes Stallings to explain why the Mount Yucca idea was a non-starter.

"…we're talking about a product that's not going to be around for a few hundred years, but thousands of years… You can't find any engineer that's going to sign on to a document that this hole in the ground is going to be safe for ten thousand years or safe for even two hundred years, I mean that's impossible to do…" [3]

3 Nelson, C, The Age of Radiance: The Epic Rise and Dramatic Fall of the Atomic Era, Scribner, New York, 2014, p 374

Chapter Fifteen
Chernobyl, Fukushima and their impact

Background to nuclear accidents

In the history of the Nuclear Age, the words “Chernobyl” and “Fukushima” resonate. Just the words “Chernobyl” or “Fukushima” are enough to bring home the potential for nuclear catastrophe when ‘things go wrong’. However, what the average person may not be aware of is how many serious nuclear accidents there have been since the advent of the Nuclear Age. Before Chernobyl and Fukushima are examined, here is a list of earlier nuclear accidents, and nuclear weapons near misses.

Date	Location	Impact
December 1952	Chalk River, Ontario, Canada	Operator mistakes led to an explosion inside the reactor core, leading to a fuel meltdown. Radioactive water was spread widely.
November 1955	Experimental Breeder Reactor No 1, Idaho, United States	Operator errors caused a partial meltdown. Control rods were not lowered fast enough, temperatures reached 1000 Centigrade, and half the uranium fuel in the core melted.
October 1956	Marcoule, France	A fire occurred in the reactor. There was a widespread leak of radioactive particles into the air but the extent of contamination was never revealed.
September 1957	Kyshtym, Southern Urals, Soviet Union	An explosion at a nuclear plant led to radioactive materials being spread across a wide area. This led to the deaths of hundreds of people in nearby villages.
October 1957	Windscale, Cumbria, United Kingdom	Fire spread through one of the reactors. A radioactive plume was sent into the air, spreading radioactive particles across parts of England and northern Europe.
January 1961	Experimental Reactor, SL-1, Idaho Falls, United States	A ‘control rod’ was pulled out too far and too fast – almost certainly intentionally. [1] All the radiation needles registered extremes. There were fatalities. One man was impaled on a ceiling by part of a fuel rod that had shot upwards.
January 1961	Goldsboro, North Carolina, United States	A B-52 bomber broke up in mid-air and its two nuclear bombs fells to the ground.

1 Investigations into this incident reported rumours that one of the operators was ‘involved’ with the wife of another, and that the accident was a murder suicide.

January 1966	Over the Mediterranean near Palomares, Spain	A B-52G bomber collided with a mid-air fuel tanker. Both planes were destroyed. The B-52G was carrying four thermonuclear bombs which fell to the ground near the village of Palomares.
January 1968	Thule, Greenland	A B-52 bomber caught fire and crashed into the sea eight miles from the Thule air base in Greenland. It was carrying a thermonuclear weapon.
Early 1975	Da Nang, South Vietnam	The US had a research nuclear reactor at Da Nang. With communist North Vietnam soon to overrun the city, the US air force was just able to retrieve the nuclear fuel.
March 1979	Three Mile Island, Harrisburg, Pennsylvania, US	This plant had two separate units. The TMI-2 unit suffered a partial meltdown. No deaths were reported but Three Mile Island remains the most serious accident in US commercial nuclear energy history.

…And this list could go on for several pages…

Chernobyl [2]

Introduction

On 26 April 1986, the Chernobyl Nuclear Power Plant in the Ukraine (then part of the Soviet Union) exploded. Experts in the field consider that Chernobyl is the worst nuclear disaster since the beginning of the Nuclear Age.

The Chernobyl Nuclear Power Plant is situated about 130 kms north of the Ukrainian capital, Kiev and 20 kms south of the border with Belarus.

- It comprised four reactors, designed and constructed in the 1970s and 1980s.
- It had a manmade reservoir covering 22 sq kms which had been built to provide cooling water for the reactor. The reservoir was fed by the Pripyat River.
- The closest settlement to Chernobyl was the newly built city of Pripyat, about 3 kms away. In 1986, its population was close to 50 000.
- An older and smaller town, called Chernobyl, was about 15 kms from the plant. Its population was about 12 000.
- The surrounding region was made up of farmland and forests.

2 Ukrainian is the official language of Ukraine today, and so Ukrainians refer to Chernobyl as Chornobyl.

What happened at Chernobyl?

The causes of the Chernobyl disaster can perhaps be put down to three factors:

- flawed Soviet design technology;
- the mistakes of operators;
- the lack of a safety culture in the old Soviet Union.

Nuclear technology is complex and the specific factors leading to the accident are complicated. However, in essence, this is what happened.

- The explosion took place during a routine maintenance check:
  - operators were intending to test the electrical systems;
  - they turned off vital control systems – which went against safety regulations;
  - this caused the reactor to reach dangerously unstable and low power levels.
- Reactor 4 had been shut down on 25 April – for maintenance checks. Experts remain divided about the precise cause of the explosion:
  - however, it appears that the first explosion was caused by an excess of steam;
  - the second explosion was influenced by hydrogen;
  - the excess steam was the result of the reduction of the cooling water;
  - this caused steam to build up in the cooling pipes (called the positive-void coefficient);
  - this caused an enormous power surge which the operators were unable to shut down.
- The explosions came at 1.23 am on 26 April:
  - they destroyed reactor 4;
  - and started a booming fire;
  - following this, radioactive debris of fuel and reactor parts were spread over the area;
  - fire then spread from the building housing reactor 4 to nearby buildings;
  - the blowing wind then carried toxic fumes and dust.

The first fire was put out by 5.00 am but the resulting graphite-fuelled fire took almost ten days to deal with. Stephanie Cooke suggests that temperatures generated by the graphite fire reached 2500 ˚ Centigrade. Poisonous emissions continued to be pumped into the atmosphere for another ten days.

What were the results of the Chernobyl disaster?

The immediate impact of the disaster was the radioactive fallout: [3]

- most of the released radiation was iodine-131, cesium-134 and cesium-137;
  - iodine-131 has a half-life of about eight days, but it can be easily ingested and tends to localise in the thyroid gland;
  - cesium-137 has a 30-year half-life and so remained a concern for a long time to come.

3 Figures are based on estimates from The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)

- the material released in the explosion fell close by as dust and debris:
  - however, lighter materials were blown across neighbouring regions in Ukraine and Belarus, and within about three days as far afield as Scandinavia.
- evacuations did not commence until 36 hours after the explosion, and people were already showing signs of radiation sickness, such as vomiting and headaches:
  - a 30 km area around the plant was sealed off and by mid-May 116 000 people had been evacuated;
  - in the next few years, over 200 000 more people were moved to less contaminated areas.

Figure 15.1 The health impact of the Chernobyl disaster

Radiation doses on the first day of the disaster led to 28 deaths by the end of July. This included six firefighters. The men who attempted to put out the fires in the early stages showed particular heroism as they would have known they were exposing themselves to lethal doses of radiation.

Power workers, and firefighters who survived, received radiation doses high enough to produce acute radiation syndrome (ARS) which produces nausea, vomiting, fevers. UNSCEAR states that between 1991 and 2015, up to 20 000 cases of thyroid cancer had been found in people who were under 18 at the time of Chernobyl.

However, the overall rates of cancer and other health issues resulting from Chernobyl have proven to be lower than were expected. It also appears that there is little evidence of increases in rates of leukaemia, even among those who have had the job of 'cleaning up'.

Many pregnant women were encouraged to have abortions for fear of having children with birth defects. This was done even though radiation levels were too low for most of them to be in any real danger. Incorrect medical advice led to one million abortions in Russia and Europe.

The IAEA set up the Chernobyl Forum in February 2003, bringing together various UN organisations and relevant groups from Ukraine, Belarus and Russia. The Forum presented its reports in April 2005. Among its findings was the psychological impact of Chernobyl. The report stated that people in the area have suffered a 'paralysing fatalism' caused by myths and preconceptions about radiation. A culture of dependency developed. Mental health, alcohol and smoking abuse have been a much greater problem than radiation.

The environmental impact of the disaster

Trees surrounding Chernobyl were destroyed by high levels of radiation. The local woodland area became known as the 'Red Forest' as the dead trees had taken on a bright ginger colour.

The damaged reactor from the disaster was encased in a 'concrete sarcophagus'. There were concerns about how effective this encasement was so in 2006 a 'New Safe Confinement' structure was started, completed in 2017. It was designed to safely prevent radiation leaks for 100 years.

Despite the scale of the disaster, reactors 1,2 and 3 continued in operation after 1986:

- reactor 2 was shut down in 1991;
- reactor 1 was shut down in 1996;
- reactor 3 was shut down in 2000;
- the complete decommissioning of the Chernobyl site is expected to end by 2028.

There have been some 'interesting' longer-term developments:

- wildlife is now thriving, presumably due to the lack of human interference;
  - significant numbers of wolves, deer, eagles, bears are now present in the surrounding woodlands.
- many people have returned to the region;
- Chernobyl has also become a tourist destination. [4]

All this has happened despite the WHO and IAEA [5] estimates that there will be 4000 excess cancer deaths, ie more than would be expected, because of lingering radiation.

- However, two thirds of Chernobyl's radiation was deposited on populations well beyond its locale, across to Western Europe.
- A report commissioned the by the European Parliament's Green Party has suggested that because of the large population of western Europe, excess cancer deaths could be from seven to fifteen times WHO's estimate:
  - this means that between 30 000 and 60 000 people's lives are potentially at risk.

Exercise 15.1 Indicate whether each of the following statements is true or false.

1	Until Three Mile Island and Chernobyl, there had been hardly a single nuclear accident or near miss.	TRUE/ FALSE
2	The Chernobyl nuclear reactor had been carefully located so that it was nowhere near any population centres.	TRUE/ FALSE
3	Chernobyl comprised four separate nuclear reactors and at the time of the disaster, it was only reactor four which exploded.	TRUE/ FALSE

4 The HBO series "Chernobyl" (2019) may have stimulated this.
5 World Health Organisation and International Atomic Energy Agency

4	No responsibility for the Chernobyl disaster can be fairly laid at the door of Soviet nuclear design or the safety culture of the Soviet Union.	TRUE/ FALSE
5	Radiative debris fell throughout the Chernobyl region, but radioactive fallout spread as far afield as Russia, Belarus and even Scandinavia.	TRUE/ FALSE
6	Cases of thyroid cancer became far more prevalent due to Chernobyl though cases of leukemia did not increase as many experts had feared.	TRUE/ FALSE
7	Fear of possible birth deformities led almost a million women to have abortions following the Chernobyl disaster.	TRUE/ FALSE
8	Though the physical health of people was profoundly affected Chernobyl, there seemed to be no long-term psychological impact.	TRUE/ FALSE
9	Forest areas in the immediate vicinity of Chernobyl were destroyed as a result of radiation fallout.	TRUE/ FALSE
10	As a result of the explosion at Chernobyl, all four reactors in the complex were immediately closed down and never saw service again.	TRUE/ FALSE
11	As human involvement in the Chernobyl region entered a steep decline, the region saw the return of wild life.	TRUE/ FALSE
12	Estimates suggest that despite the radiation fallout from Chernobyl, it seems that there is unlikely to be any great increase in cases of cancer.	TRUE/ FALSE

Fukushima

The <u>earthquake and tsunami</u>

The Fukushima Daiichi Nuclear Power Plant is located in the town of Okuma in the Fukushima Prefecture, on the eastern coast of the island of Honshu. It is about 220 kms north east of the capital, Tokyo.

On 11 March 2011, at 2.46 pm, local time, a giant earthquake occurred off the east coast of Japan. It measured 9.0 on the Richter scale:

- the earthquake was the most powerful ever recorded in Japan;
  - it is known as the *Great East Japan Earthquake* or the *2011 Tohoku Earthquake*.
- the power of the earthquake was so great that it triggered a tsunami which swept across the north-eastern part of Honshu island;
  - over 18 000 people were killed due to the earthquake and tsunami; entire towns were wiped off the map.
- residents in the area had little more than ten minutes warning of the tsunami;
  - in the months to come, nearly half a million people were forced to evacuate as a result of the earthquake, tsunami and nuclear accident.

What happened at Fukushima?

The systems at the Fukushima Nuclear Plant detected that there had been an earthquake and so the reactors were shut down. The cores were still incredibly hot and for this reason the plant's emergency diesel generators were activated in order to keep coolant pumping around the cores.

However, the tsunami was soon to play a critical role in the disaster:

- a 15-metre-high wave hit Fukushima:
  - this wave broke the defensive sea wall, quickly flooding the nuclear plant;
  - the emergency generators were quickly disabled.
- despite workers' best efforts to restore the power, three of the reactors overheated and cores began to melt – a nuclear meltdown;
  - a series of chemical explosions followed;
  - radioactive materials began to leak into the air and the ocean;
  - this necessitated further evacuations and a wider exclusion zone.
- all four reactors were to be written off:
  - after two weeks, three reactors (Units 1-3) had been stabilised and by July were being cooled with recycled water from the new treatment plant;
  - an official *cold shutdown condition* could not be announced until December;
  - Units 2-4 were shut down in 19 April, Unit 1 on 20 April;
  - it was decided in December 2013 that none of the damaged reactors would ever be restarted.

What was the impact of the Fukushima disaster?

Figure 15.2 outlines some of the results of the disaster.

Figure 15.2 The impact of Fukushima

During the immediate disaster, there were no fatalities. Some workers were hurt in the explosions, and many were exposed to radiation. However, the long-term impact of the radiation is uncertain. A 2013 WHO report suggested that there had been no noticeable increases in the rates of cancer in the surrounding region:

- risks of radiation beyond the plant appeared to be fairly low;
- official figures indicate that there were 2313 'disaster-related deaths' among evacuees from the Fukushima prefecture;
- some people who died during the evacuation were hospital patients who were moved due to radiation fears.

Inquiries into who or what was responsible for the disaster followed in subsequent years. In 2012, Prime Minister Yoshihiko Noda declared that the state shared at least some of the blame for what happened, an assessment that a 2017 court ruling agreed with. The court stated that evacuees should be paid compensation. At the time, the plant operator – Tokyo Electric Power (Tepco) – was criticised for failing to meet safety requirements. However, a 2019 Japanese court ruling cleared several Tepco executives of negligence.

The clean-up after the Fukushima disaster is still ongoing. It is estimated that it could take decades to remove the nuclear waste, fuel rods and the more than a million tons of radioactive water still at the site. In April 2021, the Japanese government began allowing the dumping of radioactive water from the plant into the Pacific Ocean. It is said that this process could take thirty years. Environmental groups, such as Greenpeace, have argued that this should not be done due to the radioactive materials contained in the water.

Chernobyl, Fukushima and the impact on the nuclear industry

The impact of Chernobyl and Fukushima – and of Three Mile Island before these two disasters – has been to severely dent government enthusiasm, and popular acceptance for nuclear power. Fears about a nuclear meltdown and concerns about what to do with nuclear waste persist into the 21st century. Such anxiety has been a boon for the environmental movement which has persistently campaigned hard against the building of nuclear reactors.

Nuclear industry spokesmen have done their best to play down the repercussions of these nuclear disasters:

- in the wake of Chernobyl, the British and French governments went to great lengths to reassure their people that they faced no health risks;
  - this was despite the fact that radiation readings were telling them the opposite;
  - a 2005 French investigation proved that the government had announced radiation measurements which were half the level of neighbouring countries;
  - the same investigation showed that the government had known of high radiation levels in Corsica and south eastern France but concealed what it knew.
- western nuclear organisations tried hard to convince the public that their nuclear reactors bore little resemblance to the RBMK reactor at Chernobyl with its lack of safety features.

Ever since Chernobyl, the nuclear programs in Europe and North America have almost ground to a halt.

Exercise 15.2 Place events on the left in the correct chronological order.

1st event		THREE MILE ISLAND
2nd event		MARCOULE ACCIDENT
3rd event		WINDSCALE FIRE
4th event		CHERNOBYL
5th event		KYSHTYN ACCIDENT
6th event		CHALK RIVER ACCIDENT
7th event		FUKUSHIMA
8th event		B-52G ACCIDENT

What do the historians have to say about "Chernobyl, Fukushima and their impact"?

1. Stephanie Cooke

Cooke suggests a variation on the psychological impact of Chernobyl. She refers to those at the centre of the Soviet system, scientific and political. When Chernobyl happened, many Soviet officials and scientists retreated into deep denial. It had been a shock to the values and beliefs that they had lived with.

"…(they) were completely disoriented… Not a few committed suicide, and a number of scholars consider that the accident delivered such a psychic blow it resulted in the break-up of the Soviet Union three years later…" [6]

2. Brett L Walker

Walker's description of the impact of Fukushima suggests that the radiation fallout was more serious than official sources stated. Radioactive material was turning up everywhere, in water supplies, baby formula, beef and green tea. Fukushima radiation *permeated Japan's national food chain*. Officials were detecting radiation in every prefecture, including distant Okinawa. Half the children in Fukushima had internal radiation. Walker comments:

"…Within two years after the triple disaster, physicians had already detected higher than normal rates of thyroid cancer in Fukushima's children, with nearly half of them showing evidence of thyroid cysts (though some of this evidence is disputed)…" [7]

6 Cooke, Stephanie, In Mortal Hands: A Cautionary History of the Nuclear Age, Bloomsbury, New York, 2009, p 318
7 Walker, B L, A Concise History of Japan, CUP, Cambridge, 2015, p 297

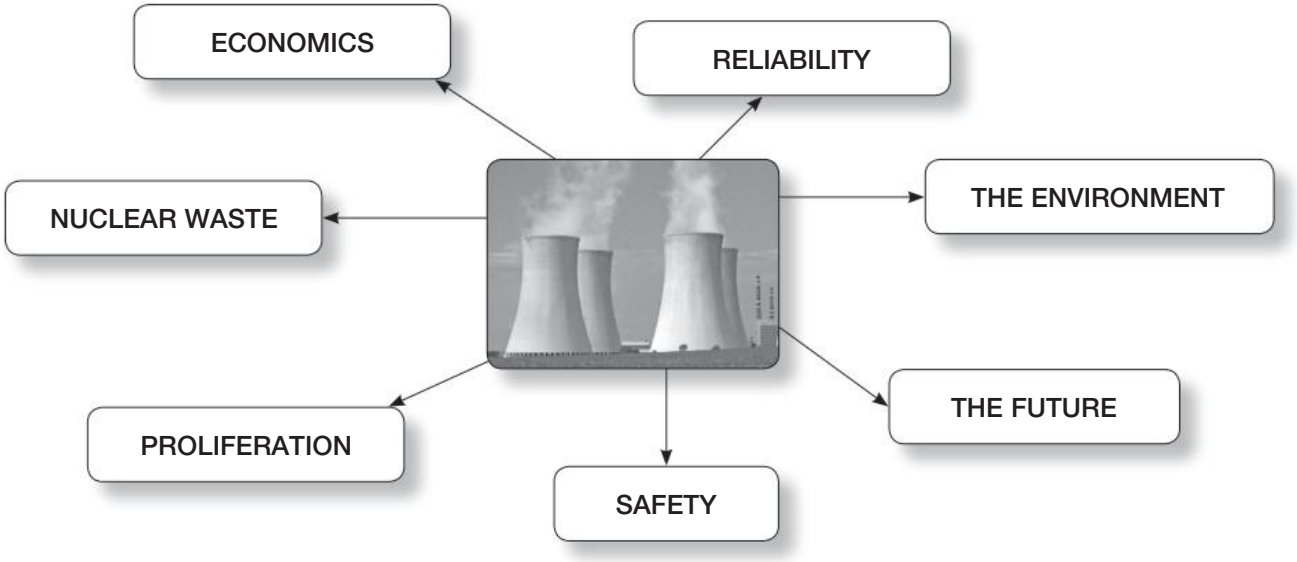
Chapter Sixteen

Ending the nuclear age and the question of expanding or winding back nuclear energy

As we move through the third decade of the 21st century, the debate about the winding back or an expansion of nuclear energy remains active.

The case "for" nuclear energy

Figure 16.1 The areas that supporters of nuclear energy focus on.



1. Economics

Nuclear energy is cost-efficient and makes strong economic sense.

- Though the upfront capital cost of construction of a nuclear reactor/ plant is great, in the long term its operational running costs are low:
  - in the US reactors have been licensed to operate for 80 years.
- Fossil fuel prices can be subject to great price fluctuations; this is not the case with nuclear energy whose price can be predicted well into the future.
- As technology develops, the price of nuclear energy can only fall.
- Some estimates suggest that the energy released from a fission reactor is up to ten million times greater than that given out by the burning of fossil fuels.

2. Reliability

Supporters argue that nuclear power is the most reliable energy available today.

- Unlike solar power and wind power, it does not require the sun or the wind:
  - nuclear energy can be generated at any time throughout the day or night, winter or summer.

- Business can rely on a consistent power supply from a nuclear reactor.

3. The environment

As climate change continues to be a major challenge in the world, there is a need to reduce the use of fossil fuels and gradually eliminate carbon emissions.

- In 2018, 64% of the world's electricity was still being generated by the burning of fossil fuels.
- Nuclear energy does not produce carbon emissions.
- The lifetime carbon dioxide emissions associated with a nuclear plant are among the lowest of any electricity generating source.

4. The future

If scientists can learn how to control atomic fusion – the same reactions as those that fuel the sun – it would become possible for the world to have unlimited energy supplies.

- The nuclear industry is not there yet.
- However, the prospect that innovation might one day overcome the challenges is an exciting one, argue the proponents of nuclear energy.
- Nuclear energy's possible future potential is incalculable.
- In April 2021, Australian Prime Minister, Scott Morrison, announced a $566 million investment in research partnerships with other countries. This included work on new technology relating to small modular nuclear reactors.

5. Safety

Opponents of nuclear energy point to past nuclear accidents (see Chapter 15).

- Supporters of nuclear energy argue that the loss of life in producing nuclear power has been far less than other energy sources.
- As each year passes, and technology improves, safety standards of nuclear reactors increase.
- Nuclear accidents are exceedingly rare.

6. Proliferation

Proponents of nuclear energy argue that the industry does not increase the chances of nuclear weapons proliferation.

- North Korea developed nuclear weapons but it has never produced nuclear electricity.
- The *Megatons to Megawatts Program* that ran from 1999-2013 converted material from US/Russian weapons stockpiles, equivalent to 20 000 bombs, to nuclear fuel which amounted to between 13-19% of global uranium needs.

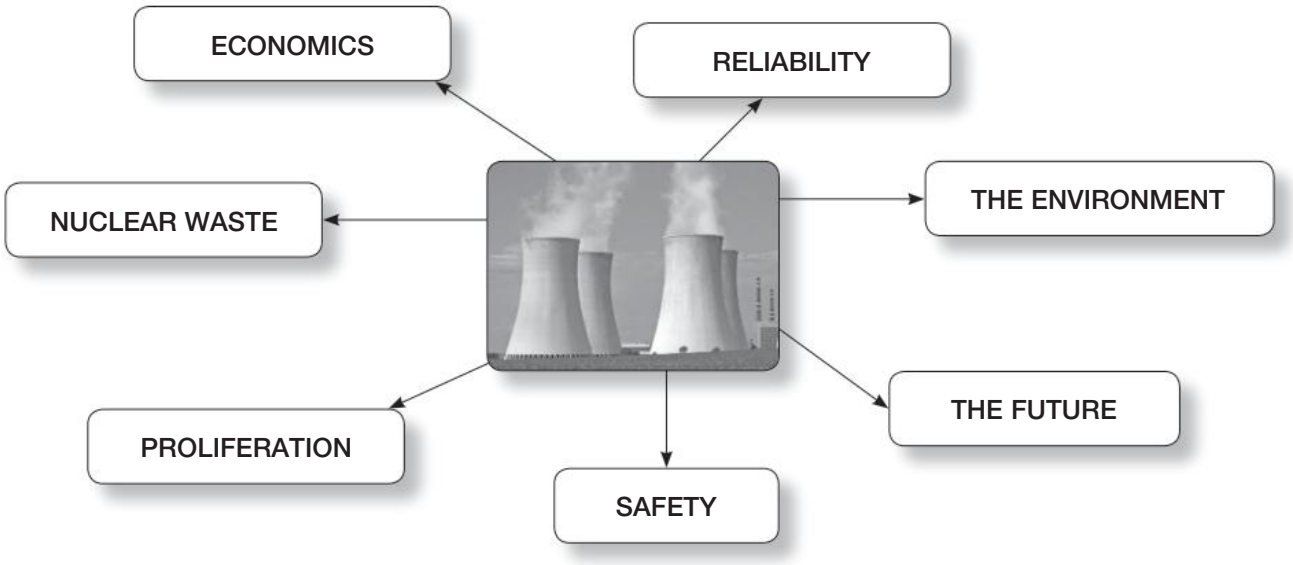
7. Nuclear Waste

Unlike other power sources, nuclear power is the only one that takes on the responsibility for dealing with its waste.

- Civil nuclear waste has never been a problem, unlike industries involved in heavy metals.
- The amount of waste that needs to be disposed of is far less than that produced by other power sources.
- High-level waste can be disposed of in deep geological repositories.
- The radioactivity of nuclear waste lessens over time.

The case "against" nuclear energy

Figure 16.2 The areas that opponents of nuclear energy focus on.



1. Economics

Though in the long-term nuclear energy can be cost-efficient, the start-up costs for most but the richest nations are prohibitive.

- If things go wrong – and accidents do happen – the compensation costs associated with the nuclear industry could be incredibly high.

2. Reliability

Nuclear power may not have the variability of solar and wind.

- However, when an accident occurs, it is unlikely that a nuclear reactor can be restarted:
  - this is the lesson of Chernobyl and Fukushima.
- In such a situation, countries would have to fall back on fossil fuels.

3. The environment

Nuclear energy may release no carbon emissions but it does have a major effect on the environment in terms of mining and water use/ discharge.

- As with all forms of mining, uranium does not leave the land untouched:
  - uranium mining in particular is well known for releasing radon and arsenic.
- Nuclear power plants are usually located near extensive water supplies, lakes or oceans. This is necessary for large quantities of water are needed for cooling purposes.
  - the nuclear power plant takes the ocean/ lake water, known as "cooling water", to condense the steam back into water;
  - this cooling water is released back into the ocean/ lake, often having a temperature of up to 50 degrees centigrade;
  - this can change the chemistry of the ocean/ lake and in turn can make the body of water uninhabitable for some species of aquatic life.
- Nuclear plants use enormous amounts of water:
  - in 2015, the US used 320 billion gallons (1200 billion litres) of water to produce its nuclear power:
  - this could become a major issue if efforts to reduce global warming do not succeed.

4. The future

Nuclear energy is not a renewable energy source. Solar power is; when solar power is turned into electricity, it does not reduce the power of the sun.

- Uranium is a finite resource:
  - once it is mined and used, it is gone; more cannot be produced.
- Experts suggest that the earth has about 200 years' worth of uranium, assuming current rates of use are maintained:
  - however, should there be a significant expansion of nuclear energy, that time frame is reduced.

5. Safety

Safety standards in nuclear plants are strict. However, accidents can happen, and when they do, the impact of a nuclear meltdown can be catastrophic.

- Opponents of nuclear energy merely have to say the words "Chernobyl", "Fukushima" and "Three Mile Island" to make their point.
- Radiation leaks can have terrible consequences, which continue long into the future.

6. Proliferation

It may be the case that North Korea developed nuclear weapons even though it does not have a nuclear power industry. However, the presence of nuclear power plants can clearly facilitate the development of a weapons program.

- Several countries have developed enrichment and reprocessing capacity, key steps to producing weapons:
  - this has been done in Israel, India and Pakistan.
- Iran has attempted to develop enrichment and reprocessing:
  - in April 2021, Iran announced that it started enriching uranium up to 60% purity;
  - in early April 2021, Iran's Natanz uranium enrichment site was hit by a 'planned explosion';
  - Iranian authorities claim this was a sabotage attack carried out by Israel.

7. Nuclear waste

Nuclear power produces hazardous waste which can remain dangerously radioactive for thousands of years.

- High-level waste is often stored onsite:
  - what happens when the plants run out of storage space?
- The consequences of leaks from radioactive waste into surrounding areas can be serious for agricultural land, livestock and of course local populations.

FIND-A-WORD "THE NUCLEAR AGE 1945-2011"

There are twenty terms/ locations/ names relating to "The Nuclear Age 1945-2011" in the "find-a-word" below.

See if you can locate them.

F	U	K	U	S	H	I	M	A	E
R	A	Y	P	T	E	N	A	A	F
A	R	S	W	A	Y	I	N	O	D
N	E	H	A	R	T	K	H	T	I
C	L	T	S	W	I	I	A	B	M
E	L	Y	T	A	N	B	T	C	O
K	E	M	E	R	I	N	T	G	N
A	T	B	M	S	R	R	A	S	A
O	L	Z	N	A	T	A	N	T	R
R	I	C	Y	D	Q	F	O	U	E
U	R	A	N	I	U	M	M	H	A
R	A	M	A	H	N	E	E	R	G
U	N	D	X	Z	A	V	J	B	A
M	A	R	A	L	I	N	G	A	N

TELLER – REAGAN – WASTE – ATOM – ABM – GREENHAM – BIKINI – FUKUSHIMA – FRANCE – KYSHTYM – MANHATTAN – TRINITY – IRAN – NATANZ – DIMONA – MARALINGA – MURUROA – URANIUM – MAD – STAR WARS

Advice on Writing HSC Responses on "Change in the Modern World"

Basic examination information

The examination paper for HSC Modern History comprises four parts:

- Section I: Power and Authority in the Modern World 1919-1946
- Section II: National Studies
- Section III: Peace and Conflict
- Section IV: **Change in the Modern World**

Each section is worth 25 marks. It is important that students allocate their time correctly and allow 45 minutes for each section.

Section IV – Change in the Modern World – comprises six options of which **The Nuclear Age 1945-2011** is one. It will appear as Option E in Section IV.

- There will be one question set on *The Nuclear Age 1945-2011*.
- It will be in the form of a "structured essay question":
  - that is, it will not be a single essay question;
  - it will contain several parts, possibly three parts, possibly four parts;
  - all parts of the question must be answered.
- One part of the question will be worth 10 to 15 marks.
- Questions set on *The Nuclear Age 1945-2011* may come from any part of the syllabus including "Survey", "Focus of Study" or "Key Features".
- The allocation of marks for each part of the question will probably vary over the years. Possible mark distributions might be:

Part (a)	Part (b)	Part (c)	Part (d)
5 marks	8 marks	12 marks	
4 marks	6 marks	15 marks	
3 marks	4 marks	8 marks	10 marks
5 marks	5 marks	15 marks	
3 marks	4 marks	6 marks	12 marks

The most likely combination is: Part (a) -5; Part (b) -8; Part (c) -12.

Time allocation within the question on The Nuclear Age 1945-2011 is of crucial importance.

- Questions that have a low mark value will probably commence as "describe" or "outline" or "how did" or "what is". Such questions are aiming at low level skills. They are essentially narrative or descriptive questions.
  - If a question is worth 3 marks, students should provide three distinct points, in a paragraph and spend no more than five minutes answering it.
  - If a question is worth 4 marks, students should provide four distinct points, in a paragraph and spend no more than seven minutes answering it.
  - A student could write three pages on such a question but will still only receive three (or four) marks.

- Questions that have a mark value of about 6-8 marks, will probably commence as "explain" or "account for" or "what was the most significant factor" or "why". Such questions are aiming at higher level skills. They require some argument in the answer.
  - If a question is worth 8 marks, students spend about 15 minutes answering it.
  - 5 minutes on this type of question would clearly be insufficient; 30 minutes is a misallocation of time.
  - This is a more lengthy response. It needs a brief introduction and to be written with paragraphs.
  - Students could almost treat it as a mini-essay.

- Questions that have a mark value of 10-15 marks, will probably commence as "to what extent" or "discuss the view" or "assess" or "evaluate". Such questions are aiming at much higher-level skills. They seek a judgment, require analysis, and the more sophisticated that analysis can be, the better.
- Time allocation is crucial.
- As a rough guide, a 10 mark question needs about 18 minutes, a 12-mark question about 23 minutes and 15-mark question about 27 minutes.
- These will be lengthy responses.
- These types of questions need to be treated as a mini-essay with all the usual techniques required for an essay: an introduction, paragraphs that are linked, an argument throughout and a conclusion.
- Markers will be looking for an argument in the introduction which will be supported throughout the response with specific evidence.
- Students need to avoid falling into 'a narrative trap' and simply 'telling the story' and 'reeling off a string of facts'.

Responding to HSC questions on "The Nuclear Age 1945-2011"

Five-mark questions might be similar to the following:

- Describe the impact of the bombing of Hiroshima and Nagasaki.
- Outline the impact of British nuclear testing in Australia.
- Describe the main anti-nuclear movements of the 1950s and 1960s.
- Describe the main types of radioactive waste.
- What happened at Chernobyl in April 1986?
- Describe the events leading up to the Trinity Test of July 1945.
- Outline the doctrine of Mutually Assured Destruction (MAD).
- Describe the impact of French nuclear testing in the Pacific.

Describe the impact of French nuclear testing in the Pacific. (5)

Allow about nine minutes, two or three paragraphs, provide clear facts. A response to this question might include:

- testing took place at Mururoa (and Fangataufa) between 1966 and 1996;
- there were 193 nuclear tests, 41 tests above ground; testing went below ground in 1974;
- French authorities routinely failed to warn local people of an impending test;
- French authorities were guilty of providing inadequate evacuation measures;
- almost the entire population of Polynesia suffered exposure to radiation;
- release of the March 2021 Mururoa Files provided evidence of increased rates of thyroid and breast cancer amongst the local population;
- French defence and scientific personnel have also suffered long-term effects from radiation exposure;
- one impact of French nuclear testing in the Pacific was the way that it galvanised international protests;
- protests grew in Europe, Australia, New Zealand and other Pacific nations;
- there were trade bans and boycotts against French commerce;
- Greenpeace carried out protests by sailing into waters near French nuclear sites;
- French agents blew up the Greenpeace vessel *The Rainbow Warrior* in 1985, killing a Greenpeace photographer

Eight-mark questions might be similar to the following:

- Explain the debate around Truman and the use of the bomb in August 1945.
- Explain the long-term legacy of the dropping of the bombs on Hiroshima and Nagasaki in August 1945.
- What was the nature and impact of nuclear tests in the US and the Soviet Union?
- Explain how two of the following have been able to ignore non-proliferation: Israel, India, Pakistan, Iran, North Korea.
- Explain the positive role that nuclear power has played since 1945.
- Explain the arguments for and against the expansion of nuclear energy.
- What has been the role of the United Nations in the pursuit of test bans, arms limitation and non-proliferation?
- Explain the short-term and long-term impact of the nuclear accidents at Chernobyl (and/ or Fukushima).

Explain the debate around Truman and the use of the bomb in August 1945. (8)

Allow about fifteen minutes, treat as a mini-essay, needs a brief introduction, paragraphs. A response to this question might include:

- Truman's decision to use the atomic bomb in August 1945 centred around the desire to bring a rapid end to the war with Japan, and the developing tension with the Soviet Union;
- there was no indication that the strategy of continuing mass conventional bombing of Japan would force the Japanese to surrender;
- a full-scale land invasion of Japan would almost certainly have resulted in hundreds of thousands of US casualties, not to mention possibly millions of Japanese casualties;
- ordinary Japanese would have most likely fought on with 'sticks' rather than surrender, especially if extremists were able to gain control of the Japanese government;
- there was every indication that the Japanese would fight to the last man and woman rather than lose their emperor;
- the idea of a demonstration of the atomic bomb in an uninhabited region was rejected as a successful test could not be guaranteed and failure would have been humiliating for the US, and would have emboldened fanatics within the Japanese military;
- the US did not have that many bombs in August 1945;
- tensions were growing between the US and the Soviet Union, even though they had been allies against Nazi Germany;

- Soviet influence was growing in Eastern Europe and Truman did not want a Soviet occupation presence in Japan;
- use of the bomb could end the war quickly before the Soviet Union could play any meaningful role against Japan;
- it could also serve as a warning to the Soviet Union, 'be warned, behave'.

Higher-mark questions might be similar to the following:

- To what extent did the development of US and Russian nuclear capacity between 1945 and 2011 achieve its goals?
- Evaluate the efforts of American governments to prepare its people for a nuclear war in the 1950s and 1960s.
- Assess the impact of anti-nuclear movements in bringing about nuclear disarmament.
- To what extent has nuclear disarmament been achieved since the Cold War?
- Evaluate the impact of the nuclear accidents at Chernobyl and Fukushima on the ongoing debate about the expansion or winding down of nuclear energy.
- To what extent did Truman's decision to use the atomic bomb in 1945 have more to do with the US' worsening relationship with the Soviet Union rather than ending the war with Japan?
- To what extent were the concerns of local populations taken into account during nuclear weapons testing programs?
- Assess the success of stemming the spread of nuclear weapons since the *1968 Treaty on the Non-Proliferation of Nuclear Weapons*.

Assess the impact of anti-nuclear movements in bringing about nuclear disarmament. (12)

Allow about twenty-three minutes, treat as a mini-essay, needs an introduction, and the response should incorporate the usual essay rules. Ensure that the introduction outlines the argument of the response.

- Provide your introduction with arguments that the response will pursue:
  - a cynical view of the anti-nuclear movements could argue that they have played no role in bringing about nuclear disarmament;
  - governments ignored the protests, no matter how large they were;
  - it was the impact of great power politics that brought about moves towards nuclear disarmament;
  - however, the protests raised public awareness, saw growing Green activism and affected the long-term nuclear energy debate.

- Governments were able to ignore anti-nuclear movements:
  - in the 1950s, such movements tended to be the preserve of the 'left', intellectuals and students, eg CND and the likes of Bertrand Russell;
  - Cold War tensions throughout the 1950s convinced governments that they had to maintain weapons development and expansion;
  - in the US, there was a popular misconception of a 'missile gap' which led to pressure on government to 'keep up with the Russians';
  - anti-nuclear movements in the Eastern Bloc were practically non-existent;
  - when Cold War tensions grew in the early 1980s, leaders like Reagan and Thatcher simply ignored the protests of groups such as the Greenham Common women; the stationing of Pershing and Cruise (and SS20) missiles continued;
  - massive anti-nuclear protests such as those at Wyhl, Bilbao and New York could be ignored.
- When nuclear disarmament did occur, it was the result of great power politics rather than protesters:
  - from 1985, the Soviet Union had a new leader, Mikhail Gorbachev;
  - he pursued policies of openness (glasnost) and restructuring (perestroika) which ultimately led to an easing of tensions with the US;
  - the Reagan administration responded which helped bring about the INF Treaty in 1987;
  - by 1991, communism had collapsed in Eastern Europe and the Soviet Union had disintegrated – the Cold War was over;
  - this made possible negotiations between the US and Russia which resulted in a series of arms limitation agreements;
  - the number of nuclear weapons held by the US and Russia dropped dramatically in the years after the end of the Cold War;
  - anti-nuclear movements had little to do with this.
- However, anti-nuclear protests added to the growth of anti-nuclear sentiment:
  - concerns about waste, storage and accidents grew;
  - Chernobyl and Fukushima added to this.

Anti-nuclear movements were often dramatic and widespread but ultimately governments' actions regarding nuclear disarmament were determined by great power politics and larger political developments.

Timeline

1942 –	August:	Formal start of the Manhattan Project
1945 –	May:	End of World War II in Europe
	July:	The Trinity Test
	July – August:	The Potsdam Conference
	August:	Bombing of Hiroshima and Nagasaki
		Japan's surrender ends World War II in the Pacific
1949 –	August:	Soviet Union's first nuclear test
1952 –		US tests its first hydrogen bomb
	October:	First British test on Montebello Islands
1953 –		Soviet Union tests its first hydrogen bomb
1954 –	March:	Castle Bravo Test at Bikini Atoll
1956 –	September:	First British test at Maralinga
1957 –		Britain has the hydrogen bomb
		Soviet Union launches the first satellite, Sputnik 1
	September:	Nuclear accident at Soviet Kyshtym site
1950s –		Office of Civil Defence set up in the US
		Development of ICBMs and IRBMs
1958 –	February:	Creation of CND
1960 –		US development of SLBMs
	February:	French test at Reggane in Algeria
		U2 Incident -Collapse of the Paris Summit
1960s –		The term MAD gains common usage
1961 –	October:	Soviet Tsar Bomba exploded

1962 – July:	The Storax Sedan Test
October:	The Cuban Missile Crisis
1963 –	Partial Test Ban Treaty
1964 –	Release of Dr Strangelove
1966 –	US develops the MRV
July:	First French test at Mururoa Atoll
1967 –	Soviet Union develops the MRV
	Outer Space Treaty
1968 –	Treaty on the Non-Proliferation of Nuclear Weapons (NPT)
1969 –	The Nixon-Meir Deal
1970 –	US develops the MIRV
1972 – May:	US and Soviet Union sign SALT 1
	Anti-Ballistic Missile Treaty (ABM)
1974 –	French tests at Mururoa go underground
	India's first nuclear test
1975 –	Soviet Union develops the MIRV
1979 –	Release of *The China Syndrome*
	Three Mile Island nuclear accident
	US and Soviet Union sign SALT 2
	Israel tests a nuclear device off the coast of South Africa
1980s –	Pershing and Cruise missiles stationed in Western Europe
	Soviet Union stations SS20,SS4,SS5 missiles in Eastern Europe
	Reagan pursues the 'Star Wars' project
1981 – September:	Start of the Greenham Common protests
1985 – March:	Gorbachev becomes Soviet leader
July:	Sinking of The Rainbow Warrior in Auckland Harbour

1986 – April:	Chernobyl nuclear accident
	Mordechai Vanunu reveals details of Israeli nuclear program
1987 – December:	US and Soviet Union sign the INF Treaty
1989 – November:	Fall of the Berlin Wall; end of communism in Eastern Europe
1991 – July:	US and Soviet Union sign the START Treaty
November:	The Nunn-Lugar Act
December:	Dissolution of the Soviet Union
1995 – May:	NPT extended indefinitely
1990s –	North Korea developing a missile program
1996 –	Final French test at Mururoa
	Comprehensive Nuclear Test Ban Treaty
1998 –	India announces it is a nuclear-weapon state
	Pakistan carries out six test explosions
2001 –	US announces termination of the ABM Treaty
2002 – January:	US President Bush's 'axis of evil' announcement
	SORT Treaty
	Iran announces it has nuclear facilities at Natanz and Arak
2010 –	New START
2011 – March:	Tohoku earthquake/ tsunami/ Fukushima nuclear accident

Glossary

ABM	anti-ballistic missile
axis of evil	President George W Bush's collective term for Iran, Iraq and North Korea
Bikini Atoll	US nuclear test site in the Marshall Islands
Blue Streak	British rocket development
Bockscar	B-29 bomber used against Nagasaki
brinkmanship	US policy of taking crises to the brink of nuclear war
Castle Bravo	massive US nuclear test at Bikini Atoll March 1954
Chernobyl	site of nuclear plant accident, Ukraine/ Soviet Union 1986
CIS	Commonwealth of Independent States
CND	Campaign for Nuclear Disarmament
Cold War	ideological/ power conflict between the Communist east and non-Communist west after 1945
containment	US policy of stopping the spread of communism
Cruise	US intermediate missile
CTBT	Comprehensive Nuclear Test Ban Treaty
Curzon Line	Soviet Union's post-1945 western frontier with Poland
Dimona	site of main Israeli nuclear facility
dissuasion	French term for deterrence
downwinders	people who experienced radioactive fallout from the effect of winds
Emu Field	site of British nuclear testing in South Australia
Enola Gay	B-29 bomber used against Hiroshima
fallout	radioactive impact on the atmosphere following a nuclear test
Fangataufa Atoll	site of French nuclear testing in the South Pacific
Fat Man	name given to the plutonium bomb used against Nagasaki
First Lightning	code name for Russia's first atomic test
force de frappe	French triad of air/ sea/ land-based missiles
Fukushima	Japanese nuclear plant, site of major accident 2011
Great Satan	Iran's description of the US
Greenham Common	site of US cruise missile base in the UK, scene of women's protests 1980s
Greenpeace	enviromental organisation opposed to French nuclear testing in the Pacific
H-bomb	massively powerful thermonuclear weapon
hibakusha	atomic bomb survivors
hot line	direct line of communiation between the US and Soviet leaders after 1963
IAEA	International Atomic Energy Agency
ICBM	intercontinental ballistic missile
INF	Internediate nuclear forces
iodine-131	form of radioactive iodine
iron curtain	Winston Churchill's term used to indicate the border between communist and non-communist Europe
kamikaze	Japanese suicide pilots in WWII
Kyshtym	Soviet nuclear plant, site of major accident 1957
lend-lease	aid provided by the US to its allies during World War II
Little Boy	name given to the uranium bomb used against Hiroshima
Los Alamos	main research facility of the Manhattan Project

MAD	mutually assured destruction
Manhattan Project	Anglo-US scientific research in WWII to produce an atomic bomb
Maralinga	site of British nuclear testing in South Australia
MIRV	multiple independently targeted re-entry vehicle
missile gap	US misplaced belief in Soviet missile superiority in the 1950s
Montebello Islands	site of British nuclear testing off West Australian coast
MRV	multiple re-entry vehicle
Mururoa Atoll	site of French nuclear testing in the South Pacific
MX ICBM	missile on a mobile launcher
NASA	(US) National Aeronautics and Space Administration
Natanz	Iranian nuclear power plant
neutron bomb	enhanced radiation artillery shell
Novaya Zemlya	major Soviet nuclear test site
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
nuclear parity	having enough nuclear weapons to inflict immeasurable destruction on a superior armed enemy
nuclear proliferation	the spread of nuclear weapons
Oder-Neise line	Poland's post 1945 western frontier with Germany
Operation Antler	British nuclear test series at Maralinga
Operation Buffalo	British nuclear test series at Maralinga
Opération Satanique	French operation to blow up the Rainbow Warrior
Pershing	US intermediate missile
PET scan	positron emission tomography, a nuclear medicine diagnostic tool
Polaris	submarine based missile
POW	prisoner-of-war
radiopharmaceutical	radioactive compound used in nuclear medicine
Rainbow Warrior	Greenpeace vessel blown up by French agents in Auckland Harbour, 1985
SALT	Strategic Arms Limitation Talks
Semipalatinsk	major Soviet nuclear test site
SLBM	submarine launched ballistic missile
SORT	Strategic Offensive Reductions Treaty
sphere of influence	an area dominated by a power but not involving that power's direct political control
Sputnik 1	Soviet artificial satellite launched in 1957
SS20 SS24 SS5	Soviet intermediate missiles
Star Wars	popular term for the Strategic Defence Initiative
START	Strategic Arms Reduction Treaty
strategic defence initiative	President Reagan's outer space ABM concept, often referred to Star Wars
Taliban	Islamic anti-western insurgents based in Afghanistan
Three Mile Island	site of nuclear plant accident, Pennsylvania 1979
Trinity	name given to the first testing of an atomic bomb
Tsar Bomba	massive 50 megaton plus nuclear device exploded by the Soviet Union October 1961
U2	US spy plane, shot down over the Soviet Union 1960
Woomera	rocket testing range South Australia

Dramatis Personae

Attlee, Clement	British Prime Minister 1945-51
Ban Ki-Moon	UN Secretary-General 2007-16
Ben-Gurion, David	Israeli Prime Minister 1948-53, 1955-63
Bergmann, Ernst	leading scientific advisor to the Israeli government in the 1950s
Brezhnev, Leonid	Soviet leader 1964-82
Bush, George H W	US President 1989-93
Bush, George W	US President 2001-2009
Carter, Jimmy	US President 1977-81
Chirac, Jacques	French President 1995-2007
Churchill, Winston	British Prime Minister 1940-45, 1951-55
Clinton, Bill	US President 1993-2001
De Gaulle, Charles	French President 1958-69
Dulles, John Foster	US Secretary of State 1953-59
Durnovtsev, Andrei	pilot of Tu-95 that dropped the Tsar Bomba
Ferebee, Thomas	bombadier on the Enola Gay that bombed Hiroshima
Fuchs, Klaus	Soviet spy in the 1940s
Gandhi, Indira	Indian Prime Minister 1966-77, 1980-84
Garrett, Peter	1980s anti-nuclear campaigner
Giscard d'Estaing, Valery	French President 1974-81
Gorbachev, Mikhail	Soviet leader 1985-91
Groves, Leslie R	head of the Manhattan Project
Hirohito	Emperor of Japan during World War II
Hitler, Adolf	German Fuhrer 1933-45
Kennedy, J F	US President 1961-63
Khan, Abdul Qadeer	leading Pakistani nuclear physicist
Khomeini, Ayatollah	leader of the Islamic Republic of Iran 1979-89
Khrushchev, Nikita	Soviet leader 1956-64
Kim, Jong-un	leader of North Korea 2011>
Kurchatov, Igor	Soviet physicist, director of Soviet atom bomb research program
Lange. David	Prime Minister of New Zealand 1984-89
Lini, Walter Hayde	Prime Minister of Vanuatu 1980-1991
Lugar, Richard	co-author of Nunn-Lugar program
Macarthur, Douglas	commander of UN troops in the Korean War 1950-51
McClelland, James	Judge who headed the 1984-85 McClelland Royal Commission into British nuclear testing
Menzies, Robert	Prime Minister of Australia, 1939-41, 1949-66

Nixon, Richard	US President 1969-74
Nunn, Sam	co-author of Nunn-Lugar program
Obama, Barack	US President 2009-2017
Oppenheimer, J R	head of the Los Alamos research facility
Pereira, Fernando	Greenpeace photographer on the Rainbow Warrior killed by French agents
Peres, Shimon	director-general of the Israeli Ministry of Defence in the 1950s
Pouvana'a a Oopa	French Polynesian independence agitator
Putin, Vladimir	President of Russia 2000-08, 2012>
Reagan, Ronald	US President 1981-89
Roosevelt, Franklin	US President 1933-45
Russell, Bertrand	leading figure in the CND
Sakharov, Andrei	Soviet atomic scientist
Sharif, Nawaz	Prime Minister of Pakistan, 1990-93, 1997-99, 2013-17
Stalin, Josef	Soviet leader 1928-53
Sweeney, Major Charles	pilot of Bockscar that bombed Nagasaki
Tibbets, Colonel Paul	pilot of the Enola Gay that bombed Hiroshima
Truman, Harry	US President 1945-53
Trump, Donald	US President 2017-21
Vajpayee, Atal Bihari	Indian Prime Minister 1996, 1998-9, 1999-2004
Vanunu, Mordechai	whistle-blower in 1986 of the Israeli nuclear weapons program
Yeltsin, Boris	President of Russia, 1991-99

Answers to Revision Exercises

Exercise 1.1

1 – next to the Havel River, 25 kms from the centre of Berlin; 2 – 17 July to 2 August 1945; 3 – Truman (US), Stalin (SU), Churchill, then Attlee (Br); 4 – Truman did not trust Stalin, took a harder line against him than Roosvelt would have; 5 – future security and economic compensation; 6 – he had lost the General Election; 7 – it was divided into four zones of occupation: US/ Fr/ Br/ Soviet; 8 – it was divided into four zones of occupation; 9 – western border now the Oder-Neise line, its eastern border now the Curzon line; 10 – Stalin promised to join the allies against Japan.

Exercise 1.2

1 – fact; 2 – opinion; 3 – fact; 4 – opinion; 5 – fact; 6 – fact

Exercise 2.1

1 – J Robert Oppenheimer; 2 – Albert Einstein; 3 – Leslie R Groves; 4 – Ernest Lawrence; 5 – Edward Teller; 6 – Niels Bohr; 7 – Vannevar Bush; 8 – Fritz Strassmann; 9 – Leo Szilard; 10 – Enrico Fermi

Exercise 2.2

Alamagordo – Los Alamos – uranium – Little Boy – Pacific – Trinity – plutonium – the gadget – heavy rain – mushroom cloud – atomic

Exercise 3.1

1 – Sweeney; 2 – Enola Gay; 3 – plutonium; 4 – B-29; 5 – Tibbets; 6 – Fat Man; 7 – Kokura; 8 – uranium-235; 9 – Bockscar; 10 – Hiroshima; 11 – Nagasaki; 12 – Little Boy

Exercise 3.2

1 – the bomb forced Japan to accept defeat; 2 – he used his position to demand his country surrender; 3 – many people felt guilt, anti-nuclear movements appeared; 4 – the atomic bomb attacks spawned a nuclear arms race; 5 – the spread of nuclear weapons among different powers; 6 – Hiroshima, due to its topography; 7 – Hiroshima 90-166 000; Nagasaki 60 000-80 000; 8 – leukemia; 9 – smaller head size, impaired physical growth; 10 – Japanese term for survivors of the atomic bomb; 11 – they suffered prejudice and discrimination; 12 – almost no effect.

Exercise 4.1

1 – false; 2 – false; 3 – true; 4 – true; 5 – true; 6 – false; 7 – true; 8 – true; 9 – false; 10 – false; 11 – false; 12 – false; 13 – true; 14 – true; 15 – false

Exercise 5.1

1st – US atomic monopoly; 2nd – First Lightning; 3rd – arrest of Klaus Fuchs; 4th – US tests the H-bomb; 5th – Russia tests the H-bomb; 6th – launch of the Nautilus; 7th – early development of ICBMs; 8th – development of the Minuteman missile; 9th – development of SLBMs; 10th – development of MRVs; 11th – US has MIRVs; 12th – Russia has MIRVs

Exercise 5.2

1 – missiles that could be moved around on mobile launchers; 2 – a nuclear device that kills people but leaves the land untouched; 3 – US medium-range missile; 4 – Soviet medium-range missile; 5 – use of the possession of nuclear weapons to deter an enemy from attacking; 6 – US policy of preventing the spread of communism; 7 – policy of Secretary of State Dulles pushing crises to the brink of using nuclear weapons; 8 – possession of enough nuclear weapons to deter an enemy from using its nuclear weapons; 9 – mutually assured destruction; 10 – National Aeronautics and Space Administration; 11 – Soviet Union's first satellite; 12 – popular term for President Reagan's Strategic Defence Initiative

Exercise 6.1

1 – false; 2 – true; 3 – true; 4 – false; 5 – true; 6 – false; 7 – true; 8 – true; 9 – false; 10 – false; 11 – true; 12 – false

Exercise 6.2

survive – Civil Defence – decades – duck – cover – the turtle – dog tags – tattooing – furniture – cardboard – thousands – shelters – backyards – basements – campaigns – build – furnish – supplies – businesses – fears – toilet

Exercise 7.1

1 – 1054; Nevada, Colorado, New Mexico, Mississippi, Amchitka Island, Marshall Islands;
2 – from 1951-58 over 100 atmospheric tests; from 1957 start of underground tests;
3 – people who received fallout from an explosion as wind blew debris towards them;
4 – created world's biggest man-made crater; 5 – thyroid damage, cancers; 6 – massive fallout, Rongelap Atoll showered with fallout debris; 7 – they fell ill, one died; 8 – caesium, cobalt, plutonium; 9 – the water recovered, diluted by the ocean; 10 – 4000; 11 – test the impact of radiation on humans; 12 – it would not consider any more compensation claims

Exercise 7.2

The Soviet Union carried out its first atomic test in August 1949. From then until October 1992, it conducted 715 tests. These tests were carried in several regions of the Soviet Union including Semipalatinsk which is in modern-day Kazakhstan. As well as Semipalatinsk, the Soviet Union also conducted tests in Novaya Zemlya and the Ural Mountains. The impact from tests in all three regions has been catastrophic for the people, the environment and the economy of the various testing site regions. People have suffered in a variety of shocking ways, ranging from high incidences of different forms of cancer and birth deformities. Radioactive fallout is having long-term effects on the environment, particularly in the Arctic. Due to the stigma associated with the test site regions, investors are discouraged from investing.

Exercise 8.1

1 – true; 2 – false; 3 – true; 4 – true; 5 – false; 6 – false; 7 – false; 8 – true; 9 – false; 10 – true

Exercise 8.2

1 – Menzies; 2 – Montebello; 3 – Emu Field; 4 – kittens and rats; 5 – Antler; 6 – Maralinga; 7 – McClelland; 8 – Tjanrutja; 9 – Woomera; 10 – Blue Streak

Exercise 9.1

power – 56 – reactors – 70 – nationalism – de Gaulle – 1960 – Algeria – 17 – Polynesia – Mururoa – Fangataufa – 193 – atmospheric – Partial Test Ban – d'Estaing – underground – Chirac – 8 – 6 – 1996

Exercise 9.2

1st – French test at Reggane in Algeria; 2nd – Partial Test Ban Treaty; 3rd – start of French testing at Mururoa; 4th – end of French atmospheric testing; 5th – sinking of the Rainbow Warrior; 6th – South Pacific Nuclear Free Zone Treaty; 7th – French moratorium on testing; 8th – Chirac resumes French testing; 9th – end of French testing; 10th – release of Disclose Report on French testing

Exercise 10.1

1 – nuclear weapons and nuclear power; 2 – the Vietnam War; 3 – the aggressive rhetoric of Reagan/ Thatcher and the arms build-up; 4 – The China Syndrome and the Three Mile Island nuclear accident; 5 – environmental, left-wing, professional groups; 6 – one country disarms even if others do not; 7 – Campaign for Nuclear Disarmament, the UK; 8 – Atomic Weapons Research establishment, site of an annual anti-nuclear march 1950s/ 1960s;
9 – they protested against US cruise missiles in Britain/ set up a permanent protest camp outside the US Greenham Common base; 10 – after massive demonstrations it was cancelled; 11 – large-scale Palm Sunday protests; 12 – rival suspicions, difficulty of verification checks

Exerecise 10.2

1 – the U2 Incident; 2 – the Cuban Missile Crisis; 3 – the hot line; 4 – The Limited Test Ban Treaty; 5 – the CTBT; 6 – SALT 1; 7 – SALT 2; 8 – the INF Treaty; 9 – the START Treaty; 10 – the NPT

Exercise 11.1

1st – Soviet Threat Reduction Act; 2nd – START 2 signed; 3rd – Russia ratifies START 2; 4th – Bush terminates the ABM Treaty; 5th – SORT signed; 6th – Russia suspends the CFE Treaty; 7th – Obama's Prague speech; 8th – New START signed; 9th – US terminates the INF Treaty; 10th – US extends the New START Treaty.

Exercise 11.2

1 – Vladimir Putin; 2 – Barack Obama; 3 – Boris Yeltsin; 4 – Antony Blinken; 5 – Mikhail Gorbachev; 6 – Donald Trump; 7 – Mike Pompeo; 8 – Dmitry Medvedev; 9th – Joe Biden; 10th – George W Bush

Exercise 12.1

1 – true; 2 – false; 3 – false; 4 – true; 5 – false; 6 – true; 7 – true; 8 – false; 9 – true; 10 – false; 11 – true; 12 – false

Exercise 12.2

1 – Mordechai Vanunu; 2 – Indira Gandhi; 3 – Nawaz Sharif; 4 – Kim Jong-un; 5 – Ayatollah Khomeini; 6 – Ernst Bergmann; 7 – Donald Trump; 8 – Atal Bihari Vajpayee; 9 – A Q Khan; 10 – Shimon Peres

Exercise 13.1

dangerous – benefits – diagnose – thyroid – blood clots – imaging – cirrhosis – heart – Alzheimer – cancerous – fission – bomb – peaceful – 30 – 440 – Italy – 10 – submarines – reactors – icebreakers

Exercise 14.1

1 – if not handled properly it can cause major damage to the environment and the surrounding atmosphere; 2 – the period of time it takes for nuclear waste radioactivity to decay; 3 – 24 000 years; 4 – 250 000 metric tons; 5 – low-level nuclear waste; 6 – 95%; 7 – on site where it was created; 8 – the wind can carry them to open ground and they can enter the food chain; 9 – stored in water/ because of the enormous heat they give off; 10 – 1940s; 11- the Waste Isolation Pilot Plant in New Mexico; 12 – vitrification.

Exercise 14.2

1 – opinion; 2 – fact; 3 – fact; 4 – fact; 5 – opinion

Exercise 15.1

1 – false; 2 – false; 3 – true; 4 – false; 5 – true; 6 – true; 7 – true; 8 – false; 9 – true; 10 – false; 11 – true; 12 – false

Exercise 15.2

1st – Chalk River accident; 2nd – Marcoule accident; 3rd – Kyshtyn accident; 4th – Windscale fire; 5th – B-52G accident; 6th – Three Mile Island; 7th – Chernobyl; 8th – Fukushima

FIND-A-WORD

F	U	K	U	S	H	I	M	A	E
R	A	Y	P	T	E	N	A	A	F
A	R	S	W	A	Y	I	N	O	D
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C	L	T	S	W	I	I	A	B	M
E	L	Y	T	A	N	B	T	C	O
K	E	M	E	R	I	N	T	G	N
A	T	B	M	S	R	R	A	S	A
O	L	Z	N	A	T	A	N	T	R
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U	R	A	N	I	U	M	M	H	A
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M	A	R	A	L	I	N	G	A	N

Notes

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