Scottish CND's educational resource Nuclear Weapons: Yes or No is aimed at late primary to secondary school pupils. It has 4 units: The Nuclear Weapons Debate, Nuclear Explosions, Trident and Pressure Groups.

The resource is as objective and balanced as possible; with opportunities for pupils to develop their thinking skills and with the underlying principle that young people should be encouraged to have knowledgeable debates and opinions about nuclear weapons.

Nuclear Explosions

Suggested Curriculum Links

Scotland - Curriculum for Excellence:

People, past events and societies (History): SOC 3-05a, SOC 3-06a, SOC 3-06b, SOC 4-01a, SOC 4-06a, SOC 4-06b
People in society, economy and business (Modern Studies): SOC 3-15a, SOC 4-15a, SOC 3-18a
Physical wellbeing (Health and wellbeing): HWB 4-16a, HWB 4-17a,
Vibrations and waves (Science): SCN 4-11b
Topical Science (Science): SCN 3-20b, SCN 4-20b

England - Key Stages:

KS3 Physics, KS3 Citizenship - Dealing with conflict, KS3 English - Speaking & Listening, KS3 History - World War Two & Aftermath, KS4 Citizenship - Environmental change & sustainability, KS4 English - Speaking & Listening, KS4 History - The Cold War, KS4 Other subjects - Land and environment, KS4 Physics - Radioactivity

Teacher's notes: Nuclear Explosions

This unit aims to increase pupils' knowledge of why nuclear weapons are weapons of mass destruction.

Video *(available on DVD or via http://www.vimeo.com/scottishcnd)*

- A video that shows the effects of a nuclear explosion and what makes a nuclear weapon different from conventional bombs.

Booklet

- The nuclear explosions booklet compares the destructive power of nuclear weapons with conventional explosives. It includes some information on radiation however there are references below for more detailed resources on these areas.

Challenges

- **Are nuclear weapons worth the risk?**

- Worksheets exploring probability and linking to real nuclear weapons incidents.

- **Effects of a nuclear weapon explosion**

- Tables and illustrations to complete.

- **The effect of high levels of radiation**

- Factsheet with questions.

Further challenges

- **Role Playing**

- In response to the International Red Cross statement. The class are divided into groups of people with different roles dealing with a sudden and unexpected nuclear attack.

- **Nuclear accidents and incidents**

- A timeline to complete showing some civil and military events.

- **How are disasters measured?**

– Four real life events from the civil and military nuclear industries. Pupils are asked to reflect on them and give them gradings of severity *Answers (based on IAEA data): Chernobyl 7, Fukushima provisionally 7, Windscale and Three Mile Island 5.*

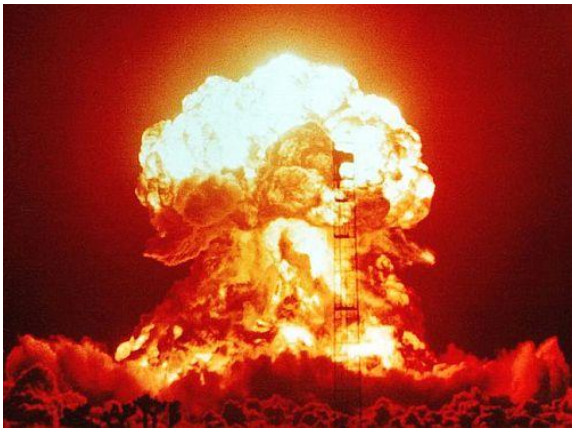
Other recommended resources

- International Campaign to Abolish Nuclear Weapons (ICAN) icanw.org
  A great range of materials for students of all ages (click on Resources / Schools). For example an interactive map lets you put in your address, choose a bomb size and then see what would be destroyed.
  Two other useful nuclear blast radius calculators are Nuke Map: http://nuclearsecrecy.com/nukemap/ and Nuclear Firestorm Simulator: http://www.nucleardarkness.org/nuclear/nuclearexplosionsimulator/

- WMD Awareness Programme wmdawareness.org.uk
  Set up by two Nobel Peace Laureates to 'ensure that reliable information on WMDs is available to all'. See 'Talking Peace' in the Resources section.

- Greenpeace.org's online games such as 'Nuke Sweeper' allow young learners to develop their knowledge of these serious issues while having some fun. It may look like a game, but the weapons systems locations are real -- do you know where the weapons of mass destruction are? Another educational online game, Peace Doves, is available from nobelprize.org

Nuclear Explosions



Name _____ Class _____

What do I know about nuclear explosions before I start this booklet?

My knowledge of nuclear explosions is:

Weak OK Strong

1 2 3 4 5 6 7 8 9 10

What do I know about nuclear explosions after I finished this booklet?

My knowledge of nuclear explosions is now:

Weak OK Strong

1 2 3 4 5 6 7 8 9 10

Nuclear Explosions

How powerful is a nuclear weapon?

Bombs are usually made using high explosive. Nuclear weapons are much more powerful so they are Weapons of Mass Destruction (WMD). Nuclear weapons contain a metal called plutonium. A small amount of plutonium can produce a very large amount of energy.

A Trident nuclear weapon is a similar size and shape to a large traffic cone. It weighs 200 kilograms (about the weight of three adults). It has the same power as 100,000,000 kilograms of high explosive.

Trident nuclear weapon

200 kg 

100,000,000 kg 

So, nuclear weapons can destroy things on a massive scale...

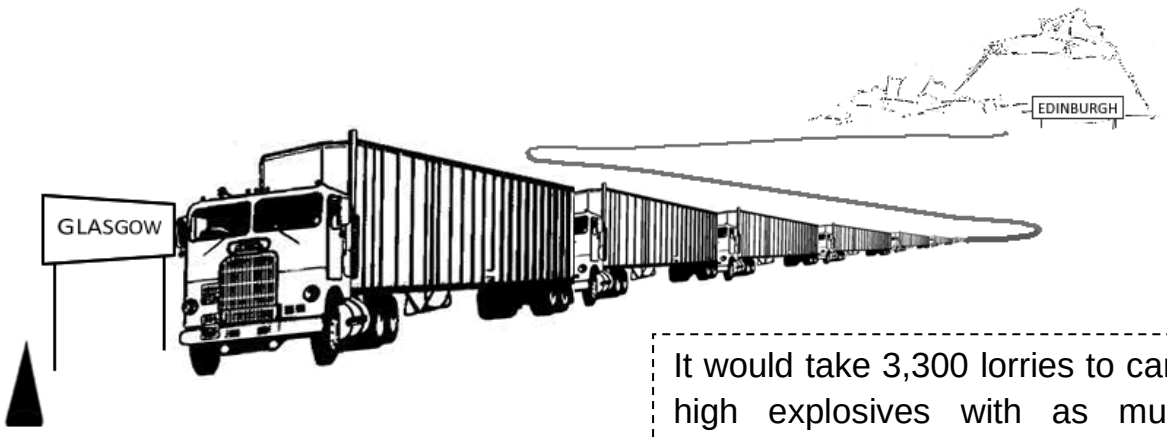
200 kilograms of nuclear weapon has the same power as 100,000,000 kilograms of high explosive.

200:100,000,000 = **1:500,000**

1 kilogram of nuclear weapon has the same power as ..... kilograms of high explosive.

Nuclear Explosions

How powerful is a nuclear weapon? (contd.)



A nuclear weapon is the size of a large traffic cone

It would take 3,300 lorries to carry high explosives with as much destructive power as one nuclear warhead.

If a cup full of high explosive blew up in your class it would destroy the room and kill or injure everyone in it. Now imagine what would happen if a large lorry, packed full of high explosive blew up. It would kill or injure everyone in the street and many people who were further away.

The destructive power in one nuclear weapon is the same as in 3,300 lorries full of high explosive. 3,300 lorries, bumper to bumper, would stretch for 53 kilometres. This is the distance from the outskirts of Edinburgh to the outskirts of Glasgow.

Nuclear Explosions

Casualties and Radiation

A nuclear weapon would kill everyone within a radius of 1.6 kilometres when it exploded, and many others who were further away.

Think of three places that you would reach if you travelled at walking speed for 20 minutes from your home. Write down these three places –

1.

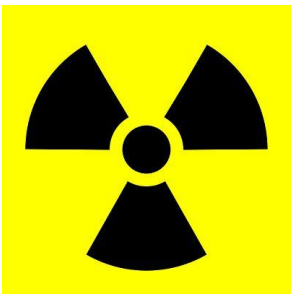
2.

3.

If a nuclear weapon exploded at your house these places would all be destroyed.

Radiation

Nuclear weapons are not only very powerful. They also spread radiation. When a nuclear weapon explodes it gives out deadly radiation and it turns buildings into radioactive dust. This dust is then blown far away by the wind. When this dust lands near someone they are exposed to radiation. This radiation can make people ill. Some people will die quickly. Many others will get cancer years after the nuclear explosion.



Think!

Why is radioactive dust so dangerous?

In Scotland today there are 120 nuclear weapons which are ready to be used.

If one nuclear weapon killed 100,000 people, how many people would be killed by 120 nuclear weapons?

How does this number compare with the population of Scotland, which is around 5 million?

Nuclear Explosions

Discuss:

a) Imagine you are a soldier fighting in a war. Do you think that it would be right to kill:

   1. An enemy soldier who was shooting at you?
   2. A civilian who was walking along the street?
   3. A young child in his or her home?

b) If a nuclear weapon explodes do you think that civilians and children are likely to be killed?

c) Imagine a nuclear weapon has exploded in your town or city. It has destroyed or damaged all the hospitals, fire stations and police stations. Who will be able to help the thousands of people who are injured? What will happen to these people who are injured if they can't get any help?

d) Do you think it would ever be right to explode a nuclear weapon?

Nuclear Explosions

Challenge - Are nuclear weapons worth the risk?

Consider the probability of each of the following incidents happening and tick the box you think is right.

1. Nuclear weapons used in war

never	unlikely	50/50	likely	certain

2. Nuclear weapons launched in error

never	unlikely	50/50	likely	certain

3. Two nuclear armed submarines collide in the Atlantic Ocean

never	unlikely	50/50	likely	certain

4. An accident with a nuclear weapon

never	unlikely	50/50	likely	certain

Nuclear Explosions

Challenge - Are nuclear weapons worth the risk? (contd.)

1. Nuclear weapons used in war

Near the end of World War 2 a nuclear bomb was dropped on Hiroshima on 6 August 1945. A second one was dropped on Nagasaki on 9 August 1945. The cities were destroyed and tens of thousands of people were killed.

2. Nuclear weapons almost launched in error

On 25 January 1995 a weather rocket was launched from Norway. Russia thought this was a nuclear attack and started to prepare to launch their missiles in response. Then they realised it was a false alarm.

Incident	Where	When	Worth the risk?
1. Nuclear weapons used in war			
2. Nuclear weapons almost launched in error			
3. Two nuclear armed submarines collide			
4. Nuclear weapon accident			

3. Two nuclear-armed submarines collide

HMS Vanguard (British) and Le Triomphant (French) collided in the Atlantic on 3rd February 2009. Both were underwater and on patrol.

4. Nuclear weapon accident

On 17 January 1966 an American nuclear-armed bomber collided with another aircraft over Palomares in Spain. Three nuclear bombs crashed down to earth. The high explosive in the bombs went off, but luckily there wasn't a nuclear explosion. Plutonium was scattered over a wide area.

Nuclear Explosions

Challenge - Effects of a nuclear weapon explosion

When a nuclear weapon explodes, it has several effects:

- **Blast**: There is a blast wave which destroys buildings.
- **Heat**: There is intense heat which causes fires over a wide area.
- **Immediate radiation**
  At the moment of the explosion, deadly radiation affects those in the vicinity.
- **Radioactive fallout**
  Radioactive dust is blown for a long distance downwind of the explosion.

These are the horrific consequences of a nuclear weapon exploding. Your challenge is to make a dramatic, eye-catching illustration of this.

The following tables show the effects of the detonation of a 100 kiloton Trident warhead.

Nuclear Explosions

Challenge - Effects of a nuclear weapon explosion (contd.)

Add illustrations in each box to show the effects of a nuclear explosion.

	0 - 1.6 km	1.6 - 2 km	2 - 4 km	4 - 7 km
Blast	Fatal	most buildings destroyed	Extensive damage to buildings	casualties from blast damage
Heat	Engulfed by fire	Fatal for all those in the open; extensive fires.	Fatal for those directly exposed to the explosion	Severe burns to those directly exposed; Some fires
Immediate Radiation	Fatal			

Nuclear Explosions

Challenge - Effects of a nuclear weapon explosion (contd.)

The additional effect of fallout on those downwind of the explosion.

Add illustrations in each box to show the effects of a nuclear explosion.

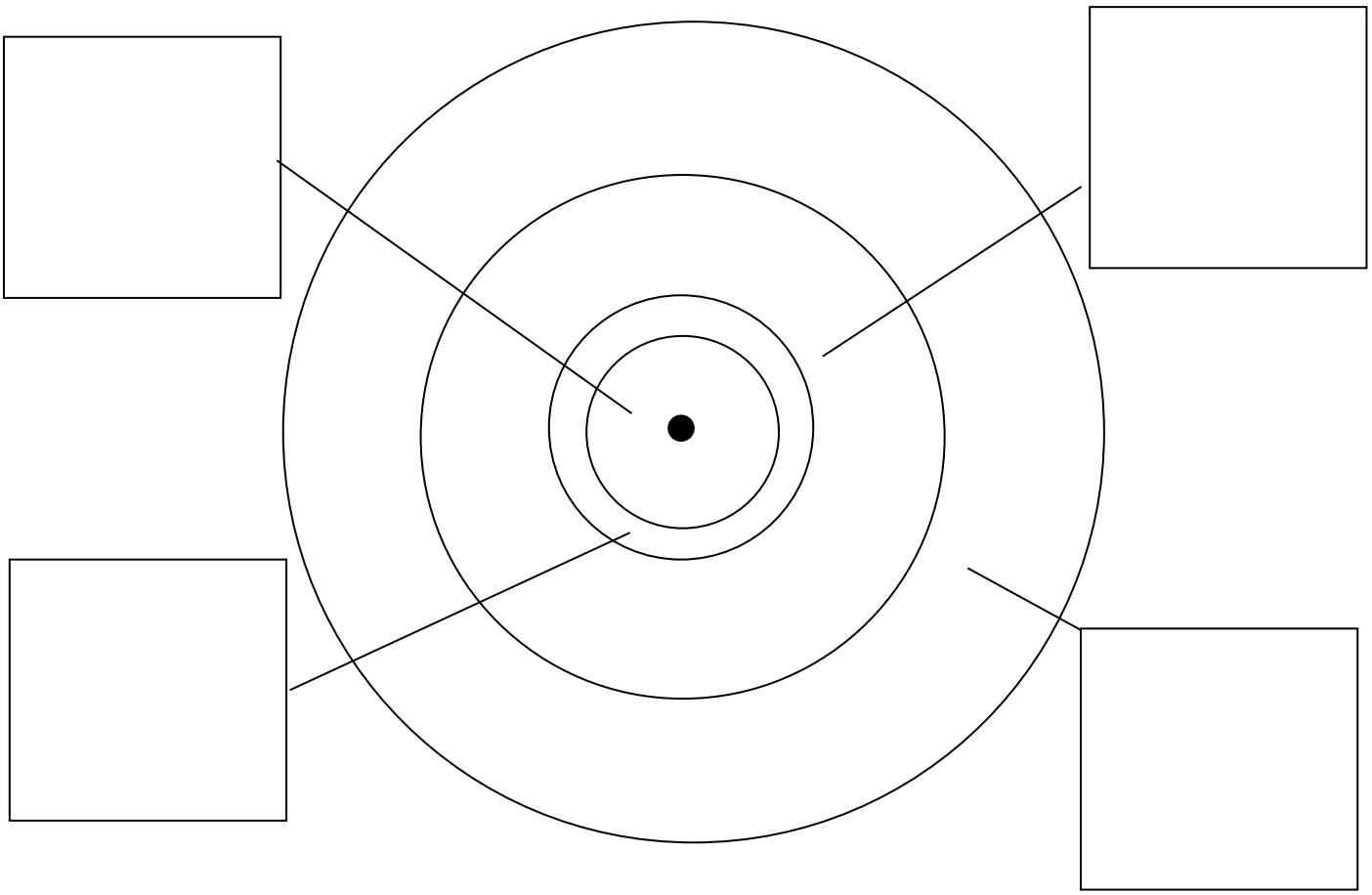
Distance	5 km downwind	11 km downwind	83 km downwind
Effect of fallout	Fatal for half the population who are indoors.	Fatal for ¼ of the healthy population who are indoors.	Fatal for ¼ of those in the open.

Nuclear Explosions

Challenge - Effects of a nuclear weapon explosion (contd.)

	0 - 1.6 km	1.6 - 2 km	2 -4 km	4 -7 km
% killed	100	55	8	1
% injured		40	45	25

These circles show the distances from the explosion. Transfer the information into the boxes.



Nuclear Explosions

Challenge - The effect of high levels of radiation

When an unstable atom decays (breaks down) it gives out ionizing radiation. This can be very dangerous if the levels are high enough. Ionizing radiation can kill humans. The Gray is a unit used to measure the amount of radiation received.

When a nuclear bomb explodes people are exposed to radiation.

Low levels of radiation cause cancer.

Very high levels of radiation exposure have the following effects:

Level of radiation	**Effect**	**Proportion of deaths**
0.5 – 1 Gray	Decrease in blood cell count	
1 - 2 Gray	Signs of bone marrow damage	Up to 10 % would die
2 - 4 Gray	Vomiting. Severe bone marrow damage	Between 10 % and 50 % of would die
4 – 6 Gray	Sore head and fever	50 % would die within 6 weeks
6 – 8 Gray	Bad headache and high fever	Between 50 % and 100 % would die within 3 weeks
More than 8 Gray	Unconscious	Death certain within 12 days.

Source: "High Dose Radiation Effects and Tissue Injury" Health Protection Agency, March 2009.
http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1237362785677

Nuclear Explosions

Challenge - The effect of high levels of radiation (contd.)

1. If you were 1.2 kms from a Trident warhead when it exploded and received 20 Gray what might happen to you?
2. If you were 1.7 kms from a Trident warhead when it exploded and received 5 Gray what might happen to you?
3. If you were 2 kms from a Trident warhead when it exploded and received 0.9 Gray what might happen to you?

These figures only indicate the amount of direct radiation from the explosion. There would also be fallout over a wide area which would expose people further away to radiation.

Radiation can be useful. Radiation is used in hospitals. You might want to research useful uses of radiation.

Nuclear Explosions

Further Challenge - Role playing

Setting the Scene

Nuclear bombs have exploded in Scotland. It is an unexpected attack and it is not known if more will be dropped.

In November 2011 the International Federation of Red Cross Societies said that the Red Cross would not be able to respond adequately to the “incalculable suffering” that would result from the use of nuclear weapons.

Your class will respond to this in different ways:

- A group who are the Government
- A group who work for the BBC
- A group who work for the emergency services
- A group who are ‘the public’

How will each group respond to the emergency?

1. Using the group role sheet discuss what you will do. Remember, the radiation levels are rising and therefore there is only 5 - 10 minutes to decide. Make a 5 point list of what is most important to do.

2. Use the list to create 4 dramatic scenes or write individual essays or report to class.

Nuclear Explosions

Further Challenge - Role playing (contd.)

Group role sheet

Government group	Emergency Services group
Your area has survived. Problems: A large area of Scotland has been destroyed with lots of casualties and radiation spreading. Some communication links don't work. What do you do? Think about: Evacuation and first aid Informing and advising the public	In your group you have: fire fighters, health service workers (doctor, ambulance driver etc) and police. Decide who you are. What do you do? Think about: How do you help? Where do you get information? Personal safety
BBC group	**Public group**
Your broadcasting centre has not been damaged however radiation levels are rising. What do you do? Think about: Duty to the public Working with the Government Personal safety	Your area has survived however some buildings have been destroyed and most people who were outside have serious injuries. There is very little information about what has happened. What should you do? Think about: Are you injured? Radiation levels are rising, should you help others?

Nuclear Explosions

Further Challenge - Nuclear Accidents and Incidents

Read the list of nuclear accidents and incidents; these are only some of the incidents which have actually happened! Decide which were to do with nuclear power (electricity made in a nuclear power station) and which ones were to do with nuclear weapons.

*Mark **W** for weapons and **P** for power.*

Write each of the accidents and incidents on the timeline.

☐ **1945** Hiroshima and Nagasaki. Both cities destroyed by nuclear bombs

☐ **1956** A flight of swans nearly led to an attack by USA on Russia

☐ **1957** Windscale in England which was a factory for producing nuclear material for weapons. A fire caused radioactive contamination of the surrounding land.

☐ **1962** Cuban Missile Crisis. Russian weapons placed on the island of Cuba increased the risk of nuclear war with USA

☐ **1968** An aircraft carrying nuclear material crashed on Greenland. This could have led to a nuclear explosion which would have looked like an attack by Russia

☐ **1979** Three Mile Island. Nuclear material released into the atmosphere because of an accident at the power station, on the East Coast on USA

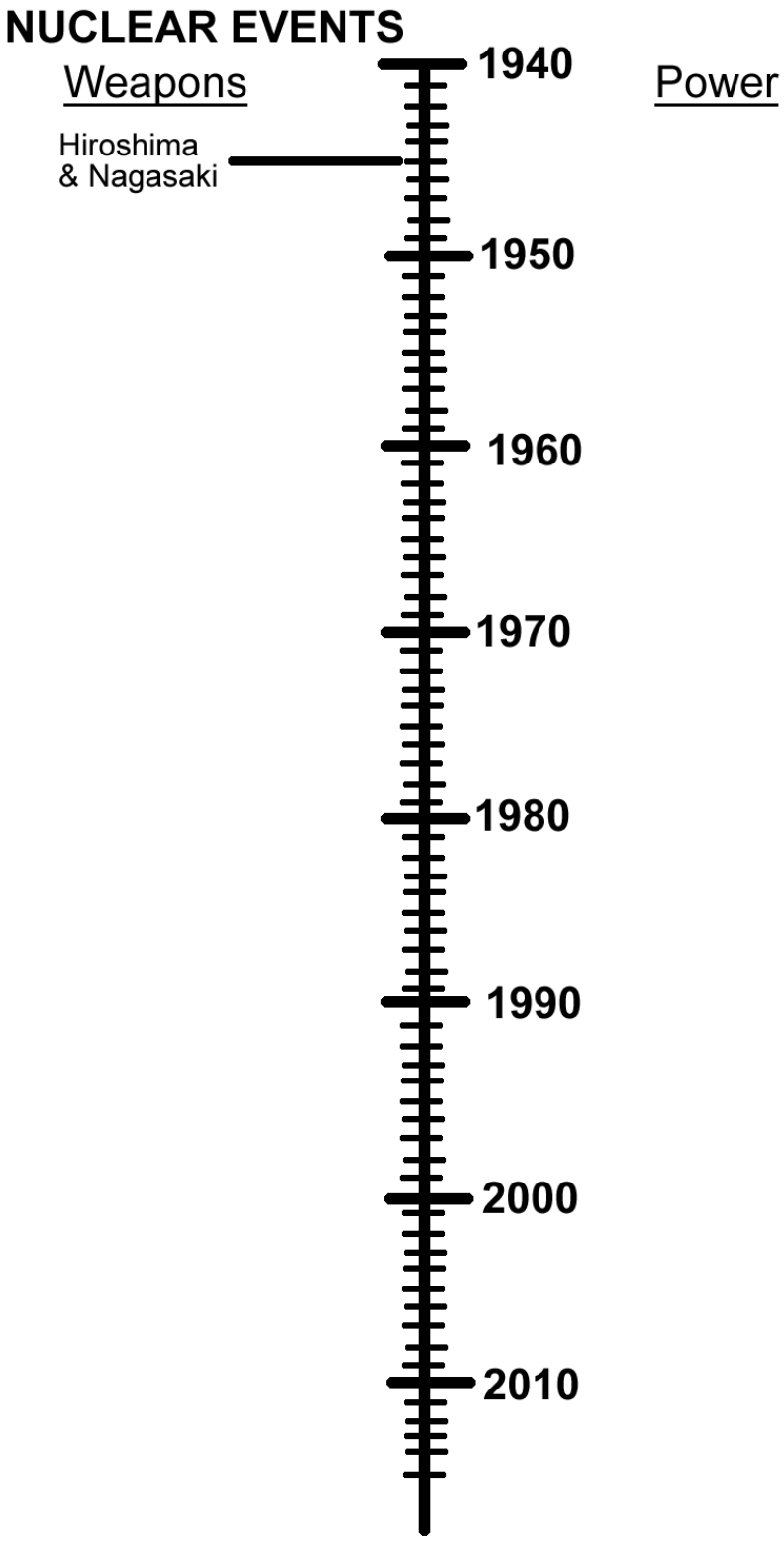
☐ **1986** Chernobyl, Ukraine. Radioactive material released because of an accident at the nuclear power plant.

☐ **1995** Norwegian rocket incident. A Norwegian rocket launched to collect weather information was mistaken as an USA attack by Russia. The mistake was recognised just in time to stop a counter attack.

☐ **2011** Fukushima, Japan. A civil nuclear power plant damaged by an earthquake and tsunami released radioactive material into the sea and atmosphere.

Nuclear Explosions

Further Challenge - Nuclear Accidents and Incidents (contd.)

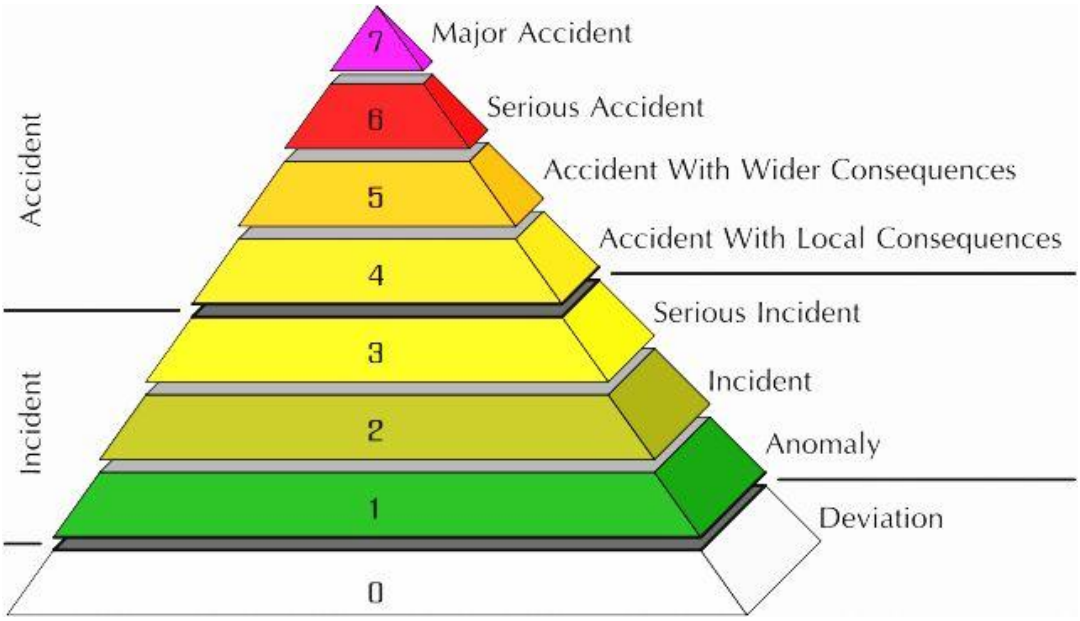


Nuclear Explosions

Further Challenge - How are disasters measured?

The **International Nuclear and Radiological Event Scale** (**INES**) is used to classify nuclear accidents and incidents. Each level is ten times more severe than the level before:

Scale	Event	Relative Magnitude
7	major	10 times scale 6 (1000000)
6	serious	10 times scale 5 (100000)
5	accident with wider consequences	10 times scale 4 (10000)
4	accident with local consequences	10 times scale 3 (1000)
3	serious accident	10 times scale 2 (100)
2	incident	10 times scale 1 (10)
1	anomaly	



Source: "INES - The International Nuclear and Radiological event scale"
http://www.iaea.org/Publications/Factsheets/English/ines.pdf

Nuclear Explosions

Further Challenge - How are disasters measured?

Here are 4 nuclear events from the Nuclear Accidents and Incidents timeline, try to grade them then find out what was the official grade

Chernobyl, Ukraine April 1986

A civil nuclear power plant accident when some core radioactive material was released into the atmosphere. There were 56 deaths within days and direct cancer fatalities are estimated at over 4000. Parts of Chernobyl abandoned. All of Pripyat (population 49,000) abandoned. Countries throughout Europe had to take action because of the radiation.

Scale ____

Fukushima, Japan in 2010

Earthquake followed by a tsunami damaged a civil nuclear power plant. 20 km exclusion zone. Long term effects on humans not known

Scale ____

Windscale UK 1957 (near the Lake District)

Fire at the factory producing nuclear material for weapons when radioactive dust was released into the atmosphere contaminating farm land across the North West of England. After this accident Windscale was renamed Sellafield and began being a civil nuclear power plant too.

Scale ____

Three Mile Island, East coast of USA 1979

Nuclear material was released into the atmosphere because of an accident.

Scale ____