lesson plan

Flying the Radioactive Skies

Is radiation a health issue for long-distance fliers?

overview

LESSON CONTEXT

Regular long-distance flight fliers (i.e. flight crews and frequent travellers) are exposed to three to four times the Canadian national average annual background radiation dose. This ionizing radiation, in particular from cosmic rays, can theoretically lead to both somatic and genetic injuries (no health effects of human radiation exposure at hundreds of times these levels have ever been observed). There are currently no mandatory regulations in Canada limiting exposure to cosmic radiation in flight.

LEARNING GOALS

- Calculate exposure to ionizing radiation (in mSv) of long-distance fliers.
- Analyze and understand the impact of ionizing radiation on long-distance fliers.
- Propose a course of action to minimize the health risks due to ionizing radiation to long-distance fliers.

LEARNING ACTIVITIES

In this lesson, students will research the issue of limiting exposure to cosmic radiation in flight from the perspective of an identified interest group, then participate in a town hall discussion of the issue.

BIG IDEAS

Long-distance flight fliers theoretically have greater chances of health risks due to the effects of ionizing radiation from cosmic rays. For the health of this group of people, it is important that safeguards be put in place to minimize their exposure.

time
75-90
MINUTES PLUS TIME OUTSIDE OF CLASS

subjects
SCIENCE
BIOLOGY
PHYSICS

skills
CRITICAL THINKING
COLLABORATION
COMMUNICATION

assessment & evaluation

PRIOR KNOWLEDGE AND SKILLS

- Basic understanding of ionizing radiation
- Experience working in cooperative small groups
- Experience participating in a large group issues-based discussion
- Experience locating legitimate information using internet sources

SUCCESS CRITERIA

- Students participate in meaningful discussion during town hall
- Student research demonstrates understanding of the science and issues involved in long-distance flight

ASSESSMENT STRATEGIES

- Collection of student research notes
- Observation (and recording) of town hall discussion

resources & materials required

- DOC PDF **BLM – Interest Group Perspective: Airlines** – one per student in this group
- DOC PDF **BLM – Interest Group Perspective: Business Travelers** – one per student in this group
- DOC PDF **BLM – Interest Group Perspective: Canadian Border Services Agency** – one per student in this group
- DOC PDF **BLM – Interest Group Perspective: Flight Crews** – one per student in this group
- DOC PDF **BLM – Interest Group Perspective: Medical Professionals** – one per student in this group
- PDF Curriculum alignment
- Electronic device with internet access

minds-on

20 MINUTES

- Begin the discussion by reviewing what radiation means. Ideally, students will be familiar with various types and sources of both ionizing and non-ionizing radiation. If not, students could participate in the **Attack of the 50 Foot Mutant: Radiation in Popular Culture** lesson or the **From the Outside In: Biological Effects of Radiation** lesson.
- Ask whether any students have gone on a long-distance (over 1,000 km) flight, either recently or ever in their lives.
- Choose one flight (preferably the longest-distance one) and calculate the exposure to ionizing radiation from cosmic sources (hereafter known as cosmic radiation) which that student received on that flight, assuming that each person receives 0.01 mSv (milliSieverts) exposure per 1,000 km flown (be sure to calculate round-trip exposure) (see **Did You Know?** at the right).
- Compare that figure to the average Canadian's annual dose of ionizing radiation from all sources of approximately 2.7 mSv (17% of which is from cosmic radiation, the rest being radon gas [50%], radiation from minerals in the soil [20%] and radiation from food and water [13%]). Calculate the percentage of a person's recommended annual dosage that could be accumulated on a typical 10,000 km round trip flight.
- Discuss with the students the implications of this information.
  - » *Is exposure to ionizing radiation from flight a significant source of radiation for the average person?*
  - » *Are there any groups of people who might risk greater than usual exposure from cosmic radiation in flight?*
- Explain to students that studies by Transport Canada showed that flight crew personnel might be exposed to between 1 and 6 mSv annually from cosmic radiation and considers exposure to cosmic radiation of more than 1 mSv annually to be occupational exposure (similar to workers in the nuclear industry). Transport Canada has recommended that flight crews should never exceed 20 mSv annual exposure to cosmic radiation and that an employer should intervene to limit a person's exposure once that person reaches 6 mSv exposure to cosmic radiation in a year. However, this is a recommendation only, with no legislative power.
- The students will discuss the question: Should the federal government legislate limits on exposure to cosmic radiation on long-distance flights?

IMPLEMENTATION OPTION

- Have students read one of the Background Information articles about radiation and air travel before or after the initial class discussion.

DID YOU KNOW?

Calculating exposure to ionizing radiation from flight is not simple, since a number of variables come into play, including the altitude being flown at (higher-altitude flight results in greater exposure, since less of the Earth's atmosphere is available to absorb cosmic rays), the latitude of the flights (flights at higher latitudes, particularly circumpolar flights, result in much greater exposure than flights closer to the Equator) and whether the Sun is in an active period (more solar flares). The rate of 0.01 mSv per 1,000 km flown is an approximate value, averaging the effects of all of the variables.

action

15 MINUTES PLUS RESEARCH TIME OUTSIDE CLASS

- Organize the students into five groups. Each will represent one interest group related to the question of exposure to cosmic radiation on long-distance flight (flight crews, business travelers, airlines, medical professionals and the Canadian Border Services Agency). Students will represent their interest group's perspective at a town hall meeting to be held in class.
- Provide each group with the relevant **Interest Group Perspective BLM** and have each student read over the questions for their perspective that will help guide their research. Each group will research the topic of exposure to cosmic radiation on long-distance flights and provide reasons why, from their interest group's perspective, limitations on annual exposure should or should not be placed by the government. The questions on their **Interest Group Perspective BLM** will provide potential sources and aspects to consider in preparation for the town hall.

consolidation

40–50 MINUTES

- The students will sit in their interest groups to participate in the town hall meeting. The teacher will act as the moderator. The moderator will outline the topic of the town hall meeting ("Should the federal government regulate exposure to cosmic radiation in flight?") and then invite a representative from each interest group to make an opening statement outlining their group's position on the question of regulations to limit exposure to ionizing radiation on long-distance flights and the reasons for that position. Questions that the moderator should ask as prompts during the discussion include:
  - » *Do you believe that regulations limiting exposure to cosmic radiation in flight are required? Why or why not?*
  - » *If regulations to limit exposure to cosmic radiation in flight were adopted, who should the regulations apply to?*
  - » *What are the potential health implications of a decision to restrict annual flight hours for flight crews or frequent fliers?*
  - » *What would the potential financial implications of a decision to restrict annual flight hours for flight crews or frequent fliers be?*
  - » *What infrastructure would be needed to enforce regulations limiting exposure to cosmic radiation for flight crews or frequent fliers?*
  - » *Do the benefits of protecting flight crews and frequent fliers from the effect of cosmic radiation outweigh the costs of implementing such a program?*
- Students should, where relevant, represent their interest group's position on these questions, but should feel free to comment on all of the questions according to their personal opinions. Encourage the students to ask each other follow-up questions and make comments based on each other's answers.
- Once the town hall discussion is complete, poll the students on the initial question. How many students believe that regulations should be put in place to limit long-distance flying? If so, what sorts of limits should be placed?

IMPLEMENTATION OPTION

- Groups could prepare briefing sheets based on their interest group's perspective to be shared amongst students in the class. Each student could then read the briefing sheets and write an op-ed article advocating whether the federal government should legislate mandatory limits to exposure for flight crews and/or frequent flyers on long-distance flights.

DID YOU KNOW?

The Concorde supersonic airliner was the only commercial aircraft to be fitted with a radiation dosimeter, because of the high altitudes at which it regularly flew. A number of air forces monitor aircrew exposure to cosmic radiation, and many military aircraft have radiation protection systems either incorporated into the airframe or as part of the aircrew's flight suits.

extensions

- Have students investigate other potential solutions to the issue of ionizing radiation exposure on long-distance flights. Solutions could include:
  - » issuing protective clothing to flight crews;
  - » flying at lower altitudes;
  - » avoiding polar flight routes; and
  - » building radiation shielding into aircraft structures.
- What would be the implications of these solutions? Students could debate the various solutions, conduct a cost-benefit analysis or create consequence maps.

additional resources

CANADIAN NUCLEAR ASSOCIATION WEB PAGES

- **What is radiation?**
- **Quantifying radiation**
- **Effects on the body**

RELATED TEACHNUCLEAR LESSON PLANS

- **Attack of the 50 Foot Mutant: Radiation in Popular Culture**
- **From the Outside In: Biological Effects of Radiation**
- **Radioactive Half-Life: The Whole Story**

background information

(Retrieved August 2019)

- **Exposure of cosmic radiation of British Airways flying crew on ultralonghaul routes – Occupational and Environmental Medicine, U.S. National Library of Medicine**
  Information on cosmic radiation exposure during long-distance flights, along with ways to monitor exposure.
- **Galactic radiation exposure during commercial flights: Is there a risk? – Canadian Medical Association Journal, U.S. National Library of Medicine**
  Examining the different types of galactic radiation and the risks of exposure during commercial flights.
- **Cosmic Radiation Exposure and Air Travel – Health Canada, Government of Canada**
  A look at what cosmic radiation is, effects of exposure, and potential health implications.
- **What Aircrews Should Know About Their Occupational Exposure to Ionizing Radiation – Civil Aerospace Medical Institute, Federal Aviation Administration**
  A joint report between the U.S. Department of Transportation and the Federal Aviation Administration looks at factors when assessing the effects of radiation on aircrews.
- **Radiation: Quantities and Units of Ionizing Radiation – Canadian Centre for Occupational Health and Safety**
  Information on the measurement of and effects of exposure to ionizing radiation.
- **Measures for Managing Exposure to Cosmic Radiation of Employees Working on Board Aircraft – Transport Canada, Government of Canada**
  This Commercial and Business Aviation Advisory Circular (CBAAC) recommends that air operators develop a program for managing the cosmic radiation exposure of their employees who work on board aircraft.