ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 10

EO C340.08 – DESCRIBE ASPECTS OF THE INTERNATIONAL SPACE STATION (ISS)

Total Time: 30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create a slide of Annex AC.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to orient the cadets to aspects of the ISS, to generate interest, and emphasize the teaching points.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have described aspects of the ISS.

IMPORTANCE

It is important for cadets to describe aspects of the ISS in order to understand the scope of international cooperation involved, the size of the project and the mission capability of the ISS.

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Teaching point 1 **Describe the Major Components of the ISS**

Time: 15 min Method: Interactive Lecture

MAJOR COMPONENTS OF THE ISS

The ISS is a large-scale project which requires international cooperation. Major contributors include the United States through National Aeronautics and Space Administration (NASA); Canada through the Canadian Space Agency (CSA); Britain, France, Germany, and Spain through the European Space Agency (ESA); Italy through the Italian Space Agency; Japan through Tsukuba Space Centre; and Russia through Roscosmos.

Each of these contributors has been responsible for the funding and construction of the major components of the ISS.

Construction of the ISS was started in 1998 and is scheduled to be completed by 2010.



Images of the ISS and its individual modules can be viewed at the NASA website. Each of the modules described here are cylindrical in shape and are connected either to each other or to one of the nodes.

Show slide of Annex AC. If a model is available, it should be used as well.



National Aeronautical and Space Administration, STS-118 Build the Station, Build the Future, NASA (p. 54)

Figure 1 Space Shuttle *Endeavour* (STS-118) After Undocking From the ISS

Zarya

Zarya (sunrise) was the first module of the ISS to be launched. It was also the first Russian contribution. The module is used primarily for storage, though its original purpose was to provide power, communications and orientation control while waiting for the Zvezda module.

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Unity

The Unity Node is a connecting passageway to living and work areas of the ISS. This was the second ISS module and the first US contribution.

Zvezda

The Zvezda Service Module serves as the cornerstone for the first habitable sections of the ISS. The module provided the early living quarters, life support, electrical power distribution, data processing, flight control system and propulsion system. Launched in July 2000, this module has already undergone updates to both hardware and software. This was the second Russian contribution to the ISS.

Harmony

The Harmony Node increases the living and workspace of the ISS by 500 cubic metres. It is a passageway between the three station science facilities (Destiny, Kibo and Columbus), and provides a platform for the Multi-Purpose Logistics Modules, the transfer vehicle, the mating adaptor for the shuttle, and the Canadarm2. This was a US contribution.

Destiny

Destiny is the US laboratory attached to the ISS. Destiny's interior is modular in design so that as mission requirements change, modules can be added or removed. At maximum capacity, Destiny is expected to hold 13 experiments focusing on human life sciences, materials research, Terran observations and commercial applications.

One feature of Destiny which has affected life on earth already is its window. From here, high quality photos and videos of earth can be taken, such as those used for BBC's documentary productions *Blue Planet* and *Planet Earth*.

Multi-Purpose Logistics Modules (MPLMs)

Three MPLMs were constructed by the Italian Space Agency to assist in the transportation of materiel to and from the ISS. The modules are pressurized and are designed to be carried inside the shuttle bay during launch and recovery. Once in space, the shuttle will dock with the ISS and use its Canadarm to transfer the MPLM to a docking port on the ISS. Crew from the ISS will transfer goods to and from the MPLM. Once the transfer is complete the MPLM will return to earth onboard the shuttle.

The three MPLMs are named after famous Italians:

- MPLM Leonardo, named after Leonardo da Vinci;
- MPLM Donato, named after Donato di Niccolo Di Betto Bardi (aka Donatello);
- MPLM Rafaello, named after Rafaello Sanzio (aka Raphael).

Kibo

A Japanese contribution, Kibo (hope) is a scientific research facility. It includes two laboratory facilities, two logistics modules, a Remote Manipulator System, and an Inter-Orbit Communication System. Experiments in Kibo focus on space medicine, biology, Terran observations, material production, biotechnology and communications research.

Columbus

Built in Germany, Columbus is the ESA's largest contribution to the ISS. Columbus is a research laboratory which will expand the research facilities of the ISS. It is attached to the Harmony Node, as well as the Destiny and Kibo research labs. Experiments focus on life sciences, materials sciences, fluid physics, and other research in a weightless environment which cannot be conducted on earth.

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Two unique aspects of Columbus include:

- remote access to experiments, allowing researchers on earth to coordinate with the station crew to conduct experiments; and
- the ability to conduct experiments in the vacuum of space at any of the four exterior mounting platforms.

Automated Transfer Vehicles (ATVs)

In 2008, the ESA started construction on the first of at least seven ATVs. The ATV is designed to be an unpiloted cargo carrier, which will supply the ISS with liquid and dry cargo as well as gases. It has a substantially greater cargo capacity than the Russian *Progress* cargo carrier, which currently delivers cargo to the ISS. Its secondary duty is as a garbage scow, collecting garbage from the ISS.

The Mobile Servicing System (MSS)

The MSS is a robotic system that plays a key role in the assembly and maintenance of the ISS. It moves equipment and supplies around the exterior of the station, supports astronauts during extravehicular activity (EVA), and services instruments and modules attached to the ISS.

The MSS is composed of three parts, all contributed by Canada. They are:

- **Canadarm 2.** The next generation of the Canadarm located in the space shuttle, Canadarm 2 has improved agility, increased size and capabilities, and is not fixed to one position.
- **Mobile Base System.** The mobile base system is a work platform, which moves along rails attached to the outside of the ISS. This provides the Canadarm 2 with lateral mobility along the main trusses of the ISS.
- **Special Purpose Dexterous Manipulator (Dextre).** Dextre is a two armed robot, which may be attached to the Canadarm 2. Its purpose is to handle delicate assembly tasks currently conducted by astronauts.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Which was the first ISS module to be launched?

Q2. Which three modules are research facilities on the ISS?

Q3. What is Canada’s contribution to the construction of the ISS?

ANTICIPATED ANSWERS

A1. Zarya.

A2. Destiny, Kibo and Columbus.

A3. The MSS.

Teaching point 2 **Discuss ISS Missions**

Time: 10 min Method: Interactive Lecture

ISS MISSIONS

The main role of the ISS is to be a research facility. Once construction of the ISS is complete, scientists from the various contributing space agencies will be able to conduct hundreds of experiments from many fields of study.

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Materials International Space Station Experiment (MISSE)

The MISSE will test the durability of hundreds of samples ranging from lubricants to solar cell technologies. The samples are better engineered to withstand the Sun, extreme temperatures and other elements. They will be attached to the exterior of the ISS, taking them outside of the protection of the Earth's atmosphere. By examining how the materials fare in space, researchers will be able to develop new materials for use in spacecraft as well as make materials that can last longer on Earth.

One example of where this research will be used on Earth is in exterior paint. Materials in space are subjected to more ultra-violet radiation (responsible for paint degradation) than materials on Earth. By applying the knowledge gained in these experiments, paint producers can create paint, which will last longer.

Minus Eighty Degrees Celsius Laboratory Freezer for ISS (MELFI)

MELFI is a large freezer onboard the ISS. It uses nitrogen gas (N_2) as the freezing agent. The purpose of MELFI is to store biological and life sciences samples at controlled temperatures. These temperatures range from 10 degrees Celsius to 99 degrees below 0 Celsius. Samples may include blood, urine, or plants.

Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES)

SPHERES are spherical satellites the size of a bowling ball. They will be used inside the ISS to test a set of instructions which will be used by spacecraft performing autonomous rendezvous and docking manoeuvers. Three free-flying SPHERES will perform formation flying inside the cabin of the ISS. Each of these satellites is self-contained with power, propulsion, computers and navigation equipment. The results of this study will be used for satellite servicing, vehicle assembly and determining formations for spacecraft to fly.

Online Viewing of ISS Missions on NASA TV

It is possible to view the ISS missions through online streaming video at the NASA website. Most of the video is archived footage, however live footage is aired during scheduled broadcasts. NASA TV is accessible on the NASA website at http://www.nasa.gov.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What will researchers be able to do with the data gained from MISSE?

Q2. What will the results of SPHERES be used for?

Q3. Where can one go to view NASA TV?

ANTICIPATED ANSWERS

A1. Researchers will be able to develop new materials for use in spacecraft as well as make materials that can last longer on earth.

A2. The results of this study will be used for satellite servicing, vehicle assembly and determining formations for spacecraft to fly.

A3. NASA TV is accessible on the NASA website at http://www.nasa.gov.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What are the two Russian contributions to the ISS?

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Q2. Which Italian contribution will be used to assist the space shuttle in delivering cargo to the ISS?

Q3. Which two vehicles, other than the space shuttle, are used for transporting goods to and from the ISS?

ANTICIPATED ANSWERS

A1. Zarya and Zvezda modules.

A2. The MPLMs (Leonardo, Donato, and Raffaello).

A3. The Russian *Progress* and the ATVs.

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

The ISS is a major step forward for humanity. Not only does it allow for scientific research of space, but it represents collaboration between the different nations of man. Resources that may otherwise be used in conflict are being used to further humanity's knowledge and abilities.

INSTRUCTOR NOTES/REMARKS

A model of the ISS would make an ideal visual aid for this lesson. Scale models may be purchased through online sources or ordered at the local hobby store.

In lieu of a model, a large poster would make a great visual aid. Images and multimedia are available through online sources, including NASA.

REFERENCES

C3-245 NASA. (2008). *International Space Station*. Retrieved February 10, 2008, from http://www.nasa.gov/mission_pages/station/main/index.html.

C3-246 NASA. (2008). *NASA TV*. Retrieved February 12, 2008, from http://www.nasa.gov/multimedia/nasatv/index.html.

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