LIFE IN INTERNATIONAL SPACE STATION HARMFUL EFFECTS OF MICROGRAVITY CONDITION AND ITS POSSIBLE SOLUTIONS

[1]SHINY PRAVEEN THOTE, [2]MOHIT VISHAL

[1,2]UG Student, Dept. of Aerospace Engineering, SRM University,
Main Campus, Kattankulathur, Chennai-603203
E-mail; [1]shineesania@gmail.com, [2]mohitvishal.2012@gmail.com

Abstract - The main purpose of ISS is to provide habitable environment to the crew members to perform different experiments under the effect of microgravity. It also helps in monitoring earth, moon, stars, planets and space under zero gravity conditions. But living and working in microgravity conditions is not that simple. Microgravity presents a challenging environment to the crew Members. Whether you are sleeping or eating or doing any work, everything in ISS floats around you unless it is secured in place. Moreover bones and muscles weaken, and other changes also takes place within the body. Studying the prolonged effect of microgravity in the human body is another major project going on in ISS. Apart from microgravity there are many other problems faced by crew members. The amount of radiation in the ISS is much more as compared to the Earth because of very thin atmosphere, unable to filter the radiation from sun. There are many harmful effects of exposure to such amount of radiation to the body of crew members. In this paper our team will present the harmful effects of living and working in ISS and their possible solutions to minimize those harmful effects.

I. INTRODUCTION

International Space Station (ISS) is a modular space station made up of more than 100 different components, orbiting around the earth with a speed of 27,600km/h at an orbit height of 330 km.

The ISS consists of pressurised modules, external trusses, solar arrays and other components. The first component of the ISS was placed successfully in the year 1998. After that many different components were launched and attached to the ISS by American Space Shuttles as well as Russian Proton and Soyuz Rockets.

- Facts about ISS:
- Total length - 354 feet
- Total width - 240 feet
- Total mass - 759,222 pounds
- Altitude - 220 miles above mean sea level
- Average speed - 17,239 miles/hour
- Time to orbit earth - 91 minute

II.WORKING OF SPACE STATION

- Atmosphere control, supply and recycling
- Temperature control
- Food supply & Waste to sustain a permanent environment in outer space where people can live and work, the Space Station must be able to provide the following things:
- Life support removal
- Fire protection
- Propulsion
- Communications, Tracking and Navigation
- Generation of Electrical power
- Computers

III.GENERAL PROBLEMS IN OPERATION

A. Atmosphere similar to Earth's

Our atmosphere is a mixture of gases -- 78 percent nitrogen, 21 percent oxygen, 1 percent other gases --at a pressure of 14 lbs./in2 (1 atm). The Space Station astronauts will need a similar atmosphere. To achieve this, oxygen and nitrogen will have to be supplied. The Russian Electron generator will make oxygen by splitting water into hydrogen and oxygen (electrolysis). Solid fuel oxygen generators or oxygen candles will be burned to make additional oxygen, if required. The space shuttle or Progress supply ships will bring nitrogen from Earth, and store it in external tanks on the station. In later phases of construction, external tanks will supply oxygen; these tanks can be refilled by the space shuttle. In the final stage, an additional electrolysis oxygen generator will be added to the station. The pressure control Assembly (a system of pumps and valves) will mix the nitrogen and oxygen in the right percentages, monitor the atmospheric pressure, and de-pressurize the station when necessary to prevent overpressure or to extinguish a fire during an emergency.

B. Carbon dioxide that they exhale removed along with contaminating or trace gases removed.

A carbon dioxide removal assembly (a series of beds of special material) will absorb carbon dioxide and release it into outer space. In addition, back-up chemical carbon dioxide canisters can remove carbon dioxide by reacting it with lithium hydroxide. The trace contaminant control system will filter cabin air to remove trace odors and volatile chemicals from leaks, spills and outgassing. As a back-up, the harmful impurities filter will also be used.

C. Normal humid environment

The major constituent analyzer will constantly monitor

the amount and type of gases in the cabin air, and control the atmosphere supply and recycling systems.

D. Water Recycling

Besides air, water is the most important element aboard the Space Station. Initially, the space shuttle and Progress supply vehicles will bring water from Earth. On the Space Station, water will be highly conserved. There will be no long, luxurious showers. In fact, most astronauts get by with sponge baths. The water recovery and management subsystem will collect, recycle and distribute water from various sources including:

- Sink
- Shower
- Urine
- Heating and cooling systems

The water recovery and management subsystem consists of various condensers, filters and water purifiers. The water will be used for drinking and cooling electrical systems. This system is not 100 percent efficient, and water will be lost through the Electron oxygen generator, airlocks and carbon dioxide removal systems. Water will be periodically replenished from Earth. However, this system will greatly reduce the amount of water needed from Earth.

E. Temperature Control

Outer space is an extremely cold environment, and temperatures will vary drastically in different parts of the Space Station. You might think that heating the Space Station would be a problem. However, the electronic equipment generates more than enough heat for the station. The problem is getting rid of the excess heat. So the temperature control system has to carry out two major functions, distributing heat where it is needed on the station and getting rid of the excess. To do this, the Space Station has two methods to handle temperature control:

- Passive methods - generally simple; handle small heat loads and require little maintenance
- Insulating materials, surface coatings, paints - reduce heat loss through the walls of the various modules, just like your home insulation
- Electrical heaters - use electrically heated wires like a toaster to heat various areas
- Heat pipes - use liquid ammonia in a pipe to transfer heat from a warm area to a cold area over short distances. The ammonia evaporates at the warm end of the pipe, travels to the cold end and condenses, giving up heat; then the liquid travels back to the warm end along the walls of the pipe (capillary action).
- Active methods - more complex; use fluid to handle large heat loads; require maintenance
- Cold plates - metal plates that collect heat by direct contact with equipment or conduction
- Heat exchangers - collect heat from equipment using fluid. The equipment radiates heat to a fluid (ammonia), which in turn passes heat on to water. Both fluids are pumped and recirculated to remove heat.
- Pumps, lines, valves - transport the collected heat from one area to another
- Heat rejection units - large, winged structures, similar to solar panels that radiate the collected heat to outer space.

F. Food Supply

The space shuttle and Progress supply ships will bring food to the Space Station. Food comes in several forms The Space Station has a galley (kitchen) equipped with the following:

- Food storage compartments
- Food warmers
- Food preparation area

G. Waste Removal

Like any home, the Space Station must be kept clean. This is especially important in space, where floating dirt and debris could present a hazard. Wastes are made from cleaning, eating, work and personal hygiene. For general housecleaning, astronauts will use various wipes (wet, dry, fabric, detergent, disinfectant), detergents and wet/dry vacuum cleaners to clean surfaces, filters and themselves. Trash will be collected in bags, stowed in a Progress supply ship and returned to Earth for disposal. Solid waste from the toilet is compacted, dried and stored in bags, where it is returned to Earth for disposal (burning). Water reclaimed from solid waste is processed and purified for drinking purposes.

H. Fire Protection

Fire is one of the most dangerous hazards in space. During astronaut Jerry Lininger's stay on Mir, a fire broke out. The Mir crew extinguished the fire, but not before the station was damaged. The Space Station has a fire detection and suppression subsystem that consists of the following:

- Area smoke detectors in each module
- Smoke detectors in each rack of electrical equipment
- Alarms and warning lights in each module
- Nontoxic portable fire extinguishers - foam or liquid extinguishers that are either

I. Navigation

The Space Station must be able to know precisely where it is in space, where other objects are and how to go from one point in space to another, especially during re boosting. To know where it is and how fast it is moving, the Space Station uses both U.S. and Russian global positioning systems (GPS). To know which way it is pointing, its attitude, the Space Station has several gyroscopes. The combination of all this information will help the Space Station move from one point to another in space. In addition, the Russian navigation system uses sighting on the stars, sun and

Earth's horizon for navigation.

J. Escape

If a crew member has a serious injury or illness, he or she will need to get back to Earth as soon as possible. The whole crew of the space station might have to evacuate in the case of a serious fire, or some other life-threatening damage to the station. So there has to be a way to escape the station quickly. A Soyuz capsule will always be docked at the Space Station, capable of carrying two people in a medical emergency, or three people in other emergencies. A crew will take a fresh Soyuz capsule to the station every six months. NASA is designing and building a crew-return vehicle (CRV), called the X-38, for emergency use. The X-38 will be capable of transporting 7 people to the surface. Biological Problems faced by the Human Body Due to Weightless Conditions From bones to balance to tiny cells, scarcely any system in the body remains unaffected by weightlessness. Yet astronauts adjust quickly and come to enjoy the freedom of zero gravity, save for the threat of solar and galactic radiations that can devastate human tissues and genes. When astronauts return to Earth, their space adapted systems must learn to cope again with gravity.

IV. DIFFERENT PROBLEMS ENCOUNTERED

A. Disorientation

Spacefarers usually become disoriented. Without gravity there is no 'up' or 'downs'. The inner ear sends confusing data to the brain, while eyes play tricks with visual illusions. For many astronauts the sensory mix-up brings temporary nausea. Deprived of gravity information, a confused brain engenders visual illusions. Body fluids surge to the chest and head. Neck veins bulge. The head enlarges a bit, as do other organs. Sensing too much fluid the body begins to excrete it, including calcium, electrolytes and blood plasma .The production of red blood cells decreases, rendering the astronauts slightly anemic. With the loss of fluids legs shrink. Spinal discs expand and so do the astronaut.

B. Cardiovascular Problems

Cardiovascular adaptation to space flight investigations have documented an initial increase in astronaut cardiac function followed by a progressive reduction in both left ventricular volume index and stroke volume index with a compensatory increase in heart rate to maintain cardiac output. The reduced cardiac size and stroke volume have been presumed to result from a reduction in circulating fluid volume within a few days after orbital insertion, but no specific mechanism for the reduced stroke volume has been identified. Factors which influence the filling of the heart during diastole include: (1) the atrial pressure, (2) the inertia of the blood as it enters the ventricle, (3) the transmural pressure difference, (4) the myocardial compliance including myofibril passive, elastic recoil, and (5) the gravitational acceleration dependent hydrostatic pressure that exists in the ventricle due to its size and anatomic orientation.

C. Bone Loss

Healthy astronauts have strong bones until they go into space, where weightlessness triggers bone loss. Density in weight- bearing bones declines at the rate of 1 to 2 % a month. During stay in a Space Station a astronaut could reach the weakened state of severe osteoporosis.

D. Radiation Damage

Radiation exposure for Space Station astronauts is far greater than on Earth's surface or in orbit because a Space Station will no longer be shielded from Earth's magnetic field and atmosphere. This could translate to a cancer risk. Supernova forge heavy ions – atoms heavier than Helium and shorn of electrons – that bombard cells in a branching pattern, causing breaks in the DNA sequence

E. Developments of Infections

In a Space Station even development of minor infections can snowball into large crisis situations. Even cases of poisoning may take place due to the varied diet patterns.

V.TREATMENTS AND RESEARCH DEVELOPMENTS

- To face the challenges of disorientation due to weightlessness, virtual rooms can be used, i.e. a room which mimics weightless conditions where a few symbols would be placed to serve as orienting clues as the person moves. Researchers hope to adapt this technique to help astronauts maneuver in large space crafts.
- Underwater Labs and low pressure chambers can also serve as preparatory areas.
- Radiation damage leading to cancer can be detected and removed by the use of an optical imaging system wherein an astronaut not necessary a doctor will use optical imaging to locate the cancer or clot and destroy it with a laser beam.
- Development of body parts in-vitro artificially can help to a large extent e.g. to deal with the ear, an astronaut may consult a three dimensioned computer model of the injured person's body. The computer then teaches him how to build a polymer model of the ear and then grow new cartilage using the injured astronaut's DNA .Then the computer would guide him in seating the new ear part and a ultrasound pulse would heat and seal the wound. This same technique can be used to treat a ruptured artery.
- Even now the most effective method to treat bone loss is an advice to the astronauts to do regular

excise in the Space Station. Quoting illness a Kozlovska a physiologist working with cosmonauts, "A regular detailed exercise can help in reducing bone loss." She highlights the example of astronaut Station Lucid who being 53 still remained in good shape due to regular exercise in Space.

- To cope with infections scientists envisage the need of new drugs, miniature optical and ultrasound devices that will pinpoint the exact location of concern. Also a complete record of each astronaut's
- DNA sequence needs to be kept for development of artificial body parts.

REFERENCES

[1] www.nasa.gov/audience/foreducators/stem-on-station/dayinthelife

[2] http://www.engadget.com/2014/11/04/international-space-station-explainer

[3] https://www.esa.int/esaKIDSen/SEMQ1JWJD1E_LifeinSpace_0.html

[4] http://www.theguardian.com/science/2010/oct/24/international-space-station-nasa-astronauts

[5] Space Station Educator's Guide.

★★★