

## **Project description**

### **2.1.a. Where would you locate your shelter on the Moon's surface?**

Other

#### **2.1.b. Explain your choice from question 2.1.**

We would like to locate our moon camp above the equator and below the North Pole. This has been chosen due to the existence of underground caves in the form of tubes, called Lunar lava tubes in which we would build our camp in a cylindrical shape. These tubes can be found in Mare the Serenitatis and the Mare Tranquillitatis. The surface of the moon will hardly be affected by the settlement as we have designed the camp (by using information from the satellites and other resources) prior to the expedition to be able to adapt to the measurements to the cave. These tubes could offer many options for further expansion of the moon camp in future expeditions. In addition to this, since it isn't located far from the equator, sunlight will be more concentrated and with luck, since temperatures aren't as elevated and are more stable inside these caves, there may be iced water (references say temperatures are round about -22°C), however the resources are unknown therefore it could be limited.

### **2.2.a. Where would you build the shelter: on the surface or underground?**

Underground

#### **2.2.b. Explain your choice to question 2.2.**

Around 80% of our camp will be set underground and covered by a layer of soil, this soil is held by a net previously placed above the crater. This will be explained furthermore in section three, question six (3.6). The bottom floor of the main cylindrical building will have attached a depressurization chamber in order to make possible expeditions along the Lunar Lava tube. The other 20% of the camp will be located on the surface of the moon. Two main things are located here, one is the solar panels, these will be placed in a circular shape around the circumference of the crater. In total, we will see 31 solar panels. In addition to this, an emergency escape vehicle will be placed as a safety precaution. Another depressurization chamber will be found outside of the main building in order to allow expeditions along the lunar surface. Finally, a communications tower will also be applied outside of the main building. In the design a terrain model has been provided to show our ideas. Also, we have tried to simulate a lunar lava tube with it.

### **3.1. What will be the size of your Moon Camp?**

The camp is quite big as we have different elements conforming the settlement. There is a main cylindrical building located inside the Lunar Lava tube. This building consists of three floors. The bottom one (first floor) is used as a storage area. The middle one (second floor) is the working area and the top floor (third floor) is the living area. The diameter of the cylindrical structure is 10 metres and the height is three metres per floor. Lastly outside we can find solar panels that are placed concentrically around the centre of the crater organised in two rows. Note: the design has been done in a lot of detail, please have a deeper look in things such as the rover (for example, the wheels...), solar panels, airlocks, doors, communications antenna, and many more!

### **3.2.a. How many people will your Moon Camp accommodate?**

3 – 4 astronauts

#### **3.2.b. Explain your choice to question 3.2.**

Three to four astronauts have been chosen due to the broad area available for the base. Too many astronauts would result in too many resources and much more space needed whilst the camp proposed is too big for just two astronauts. Evacuations would be done in a more

efficient way and I+D+i projects and certain missions would be done in a streamlined and practical way.

### **3.3.a Which local Moon resources would you use?**

Water ice

Regolith (Lunar soil)

Sunlight

### **3.3.b. Explain your choice to question 3.3.**

The water ice will be extracted from the regolith and ice caps (if found), pressurized and finally filtered for it to be used by the astronauts. Also, all the water will be reused in a similar way done in the international space station. Regolith will be accumulated and processed to make bricks to build the base. A manufacturing process involving products and substances developed on Earth will cause a chemical reaction on the regolith soil to make it hard (in a similar way we make concrete here on earth but using regolith instead of sand...). It will also be compressed to secure the piece. Finally, sunlight will be our only source of energy, the use of solar panels will allow all our electronics to work. Nevertheless, in the camp, energy consumption will be optimized to preserve and accumulate electrical energy in a series of battery storage devices on the first (bottom) floor.

### **3.4. Explain how you plan to build your project on the Moon. You should include information about the materials and building techniques you are planning to use. Highlight the unique features of your design.**

In the same way, we build on earth using small bricks, our idea is to expand this concept and use resources on the moon to make these bricks and place them one after the other like a lego. To reduce equipment needed to be transported out of earth we would only produce one type and form of brick: an arc-length of a circumference. Note in the design how these pieces interlock with each other. A series of robots will collect the regolith and process it in moulds and compression units to make the bricks. These will be placed by robots similar to the CANADARM2 aboard the international space station. Once the level is constructed, some light metal beams from earth will be installed to separate floors and a light-weight sheet of material will be stuck on the roof and floor. A circular space will be left on the roof as some equipment needs to be installed inside. Like a big parachute is compressed into a bag sized part, a thick wrapped bag of plastic will be inflated inside this floor using pumps and pipelines coming from the lander. As this bag inflates, it is being pressurized and filled with gases essential to life. It will also cover the shape of the structure. Once this is completed an airlock will be placed. Then furniture and more equipment will be placed. Rolled like a carpet, a thin sticky net will be unrolled on the walls of the structure. This net contains microbes that breath in CO<sub>2</sub> and breath out O<sub>2</sub> to reduce equipment needed for this chemical change. As more demand is needed, more floors will be installed, although ideally, 3 floors are the best configuration. Floors will be separated by a ladder and storage components needed to be transported between floors will be done with a series of rails. Outside the main structure, on the surface of the moon, solar panels will be placed concentrically around the crater in a similar way to which concentrated solar plants are organised. The crater will be covered by a layer of soil supported by some nets previously installed for gamma protection and there will be a mast communication antenna that will be placed in the middle. The surface airlock will be installed and then covered in soil to avoid meteorite collisions. The rovers and the escape capsule will be next to the camp.

### **3.5. Describe and explain the design of the entrance to your Moon Camp.**

As you slowly land on the lunar surface you will see a soil-covered airlock surrounded by tens of solar panels placed around a covered crater. In the middle, there is a large mast of a communication antenna pointing to our home planet. As you approximate the airlock you

devise two taps, one leads to the oxygen storage system whilst the other to the fuel storage system. As you manually open the door some lights go on and when the door closes and you press a button in a touchscreen you hear the sound of powerful gases being ejected around you as the airlock pressurizes. Now it is safe to take your spacesuit off. You now have to descend a ladder to go to the main building after opening a second door.

### **3.6. Explain how the Moon Camp provides protection for the astronauts.**

Our moon camp has been designed to protect our astronauts: the killer gamma rays will be diminished and stopped because we have covered the camp with a layer of soil on top of the crater using nets (In the design it is shown as a layer of soil with a 70% opacity). Inside these lava tubes, the temperature becomes much more stable and easier to control. Since we are protected from the sun equipment regarding the settlement (apart from the solar panels) is also protected. Meteorite showers are terminated thanks to the protection offered by the layer of soil previously mentioned. On top of the communication antenna, a radar kit will be used to try to detect these meteorites and warn the astronauts if there is a potential danger. The escape capsule (this isn't included in the design presented) will be located as close to the camp as possible so in case there is an emergency, astronauts can quickly flee outside. This capsule will be placed in a safe location from meteor strikes, maybe inside a crater (if it is available).

### **3.7. Describe the location and arrangements of the sleeping and working areas.**

From the three floors already mentioned, the upper floor will be the sleeping and living area. This is because it is the area closest to the airlock in case an evacuation procedure is executed. Here astronauts will be provided with a bed and a toilette. Also, in the centre of the floor, there will be a table to talk about missions. Equipment regarding communications to earth will be placed so astronauts can talk with their families and with operation directors here on earth. A mini-gym will also be located here, on the upper floor. The working area will be set on the middle floor. A large lab will be placed inside here where investigations and experiments will be carried out. Samples will be tested and processed for the travel to earth. Finally, other I+D+i projects will be also done. We believe these two areas have to be separated as studies have shown how mixing these two areas creates worse results when it comes to sleeping quality and completed task quality.

### **4.1. Describe what will be the power source for the shelter.**

The power source would be supplied by the solar panels. This renewable energy will be used in the best efficient way and batteries will store this energy in case of power shortages or system failures and for night consumption. Many of these (30-40) will be installed around the camp on the surface to maximize light absorption.

### **4.2. Describe where the water will come from.**

Water will be mainly extracted from the soil, this will be done by increasing the pressure and temperature to the block of regolith so that ice will melt to water and it will be collected and stored. Also, in a similar way to the international space station, most of the water will be recycled from urine, water vapour and other sources to minimize expeditions required to the extraction of regolith for water. Maybe more water will be supplied from earth, but not much as it isn't profitable.

### **4.3. Describe what will be the food source.**

The main food source would come from plants and insects that will be grown in an artificial environment. The plants would be grown using hydroponic gardening (plants will be provided with the minerals and water supply they need so that there isn't the need for soil) in the bottom floor. The optimum light source with a specific wavelength and CO<sub>2</sub> concentration will be provided to decrease the limiting factors affecting photosynthesis. A

variety of crops will be grown in this way. Previously, the seeds from these plants would be genetically modified to increase crop yield and diminish the chances of getting a disease. Proteins will come from insects grown in this artificial environment. Insects offer lots of proteins and they grow in much less time and they produce lots of offspring. Apart from this, some food packets similar to the ones in the international space station will be used.

### **5.1. What would you like to study on the Moon?**

Once in the moon, we were thinking of doing further expeditions to investigate in other possible locations of water ice and try to find frozen microbial life (although it is very unlikely...). There has been a recent discovery of weak magnetic fields on the surface of the moon that forms “sunburns”. We would like to investigate on these variations in the magnetic field to see what is causing them and how we can reproduce it to improve protection from the sun. This protection would enable larger moon camps to be installed, not necessarily underground, so it is a big issue to investigate. We would also investigate how the human body reacts to a long term stay in an environment outside earth to improve technologies to take humans further from our planet safely. New technologies will be tested as they might have game-changing effects here on earth. We see the moon camp as an opportunity for humans to try things in a really harsh environment. Maybe food technologies can be improved with the help of CRISPR or other genetic changes and tested in this lunar outpost. 3D printing can be improved as well as other manufacturing and construction techniques may be developed. The possibilities are infinite.