

## Section 1 – Your Moon Camp

### 1.1 Write a short summary of the project.(Max 200 words).

- The moon, the final frontier, humankind has been aspiring to a civilization that can survive on the moon since the first landing in 1969. It is the first step to becoming an interplanetary species, the next phase for humanity.
- There will be a lot of challenges due to the hostile environment but with the advances of the last half-century and the ingenuity of the engineers and scientists that are currently working on this project, day by day a moon base grows closer to reality.
- We have found some ideas to combat many of these challenges, among others a centrifuge that can simulate gravity thus reducing muscle atrophy, tubular systems that facilitate communication and transport between units of the base, and tools for using resources that are already on the moon.
- The cost and the risk of settling down on the moon have made humanity lose hope of leaving the planet we have called home for close to 300 000 years, but the possibilities our permanent presence on the moon brings are infinite and could serve as a boost in society, be a safe space in case of disasters and is a treasure trove of resources and information.

### 1.2 Why do you want to build a Moon Camp.Explain why.(Max 150 words).

- Space port that is used for interplanetary travel in our solar system.The moon gravity is 0.166 gs which makes the moon a perfect place for a space port. The excess hydrogen and oxygen from water electrolysis can help fuel the rockets that arrive on the moon from earth that have in plan to travel to Mars and beyond to moons like Europa.
- The mining of helium-3 that can be sent back to earth to be used in nuclear fusion reactors and create clean energy for the people on earth is another important purpose.
- The life of the astronauts can be shared with people, so everybody understands what the base does and how it works. The whole world will also understand that a moon base is feasible and has a lot of uses if a part of what is being done there is documented and released to the public.

## Section 2 – Building your Moon Camp

## **2.1 Where do you want to build your Moon Camp?(Max 150 words).**

- The place we chose for our base is the rim of the Shackleton impact crater close to Malapert Mountain that lies at the lunar south pole.
- We chose this place for it's 80%-90% exposure to the sun which, using photovoltaic cells, will be the main source of electricity for the base.
- The temperature at this site is also more favorable than at more equatorial latitudes as it does not experience the daily temperature extremes of 100 °C when the Sun is overhead, to as low as -150 °C during the lunar night.
- Permanently Shadowed Regions are easier to find in the region. The shadowed polar regions are believed to contain frozen water which our astronauts will use.
- The lunar regolith of the crater also contains a high amount of oxygen, titanium, helium-3 and an abundance of minerals that help with building, sustaining the base and making it a profitable asset.

## **2.2 How do you plan to build your Moon Camp? Describe Techniques, materials and design choices.(Max 250 words).**

The moon camp will be built by moving the lunar soil using a rover and then smelting the regolith with a fresnel lens that focuses the sunlight in one spot which heats up the soil and makes a material similar to cement.

The first step towards building the base will be to dig out a hole big enough to fit the underground part of it. In that hole a rover will place and then melt lunar dust in the shape of the base layer by layer until the hole is full. This process is similar to metal powder 3D printing because the base will be built with layers on the vertical axis by melting lunar dust. After the skeleton is done and the hole is full, the loose lunar soil that is in the base will be dug out. The mechanical parts will be made out of titanium alloy in a furnace that will be brought from earth. The above ground part of the base will be built in a similar fashion to the underground part. After that, a 5 cm layer of titanium alloy and

a 100 cm layer of moon regolith will be placed on the base to ensure protection against radiation.

The gym has artificial gravity that is created with a centrifuge. The floor has a 9 degree angle and with the help of the centrifuge and moon's gravity will simulate earth's gravity. Titanium alloy is light, durable and has been used in aerospace engineering.

## **2.3 How does your Moon Camp protect and provide shelter to your astronauts against the Moon's harsh environment?(Max 300 words).**

The 100 cm layer of resistant material made out of lunar regolith and the 5 cm of titanium alloy will ensure that our astronauts are protected from micrometeorites, galactic cosmic rays and solar particle events. A large part of the base is also underground which means more protection for the crew.

When it comes to bigger meteorites, devices on earth can spot and predict the meteorite's trajectory. If a medium meteorite is going to hit the base, the astronauts will be informed and will have plenty of time to evacuate the part of the base that is going to be damaged and prepare to repair it after the impact. If the meteorite is big, the crew can leave the base, take off and return to earth.

The lack of atmosphere on the moon is a second major problem. The base is divided in many compartments that are separated using airlocks. This way, if a compartment malfunctions or has a problem, the safety of our astronauts is not compromised.

Our base also has a life support system that pressurizes the atmosphere in our base and makes sure it has the right gas ratio. When it comes to thermal insulation, the only insulator that works with the moon's harsh temperatures is aerogel. A small layer is all that we need. This can also be made from the silicon and oxygen that can be found on the moon.(SiO<sub>2</sub> is 40-50% the composition of lunar regolith).

## **Section 3 – Living on the Moon**

### **3.1 Water,Food,Air,Power (Max 300 words).**

#### **WATER**

Ice will be mined and transferred to a melter. After it becomes water, a part of it goes to the life support system and the rest goes to the electrolysis tank. All the excess water like urine and shower water is purified, then released back into the system.

## **FOOD**

At first, astronauts will eat food from earth, until the planting area is complete. Computer models show that certain plants can grow even in lunar soil, like tomatoes and wheat. We can grow the rest of the plants in water rather than soil, with LED lights providing artificial sunlight. This way we cultivate more types of plants which help us cover the astronaut's needs for survival. We will plant tomatoes, beans, wheat, sweet potatoes and algae. These will contain the necessary minerals, proteins, vitamins, fats and carbohydrates.

## **AIR**

When it comes to air, we have a number of ways to sustain the level of oxygen needed for our astronauts while ejecting the excess carbon dioxide into space. We can extract oxygen from moon regolith and then heat it up until it becomes gaseous.(2000 degrees celsius). Another way is water electrolysis, if we have a surplus. After a while, our algae will be enough to sustain our atmosphere. The 78% nitrogen needed in our atmosphere can be found in regolith.(Low quantities).

## **POWER**

Solar cells are going to be the main power source for our base. They will also be able to retract and go underground when an imminent meteorite impact is detected.

RTGs (radioisotope thermoelectric generators) are going to be placed in the crater underground (more efficient in low temperatures). They will act as a backup and will be able to sustain the moon camp when power cells can't.

Batteries will be kept as a backup in case the RTGs fail.

### **3.2 How will your Moon Camp deal with the waste produced by the astronauts on the Moon?(Max 150 words).**

What remains of the purified urine and feces can be used as fertilizer for the hydroponic plants. When it comes to remaining plant products that can't be used as food, we will use an aerobic process that converts organic materials into a nutrient-rich soil amendment natural decomposition. This will then be combined with the lunar soil from the farm, and help the next batch of plants grow.

When it comes to pieces of metal and residue, we have a shredder that can be used to recycle spare materials that otherwise would be unused. Many items will be made out of

metal from the moon instead of regular materials so it is recyclable. For example, the small amount of plastic that we gather will be stored until it can be burned in the earth's atmosphere when a mission from the moon to earth is already planned.

### **3.3 How will your Moon Camp maintain communications with Earth and other Moon bases?( Max 150 words).**

The permanent capability of communication with the earth is an important subject to take into consideration, which is why a radio antenna would not be enough as it has periodic blind spots depending on the earth's and the moon's relative orientations. This is why we would use multiple communication satellites that would be permanently orbiting both astronomical bodies. These satellites would be transmitting information from one to another in a line by finding the shortest path needed for the signal to reach both the earth and the moon, in a similar fashion to how cell phone towers work.

These transmissions would be made all the time and would include research results and an overall report of the day and sometimes in special situations even stating certain requests for the next transport from earth. Another form of communication can be chats between the astronauts and their loved ones.

## **Section 4 – Science and Technology on the Moon**

### **4.1 What scientific topics would be the focus of the research in your Moon Camp.**

**(geology,biology,astronomy,robotics,etc). (Max 300 words).**

The first and most important topic of research that will be done on the moon is physics. The helium-3 present in abundance there could be used for small-scale nuclear fusion experiments that could bring the earth closer to achieving clean energy. Other physics-based experiments could be conducted using the special conditions of the moon's surface like the lack of an atmosphere or the low gravitational pull. One good example would be the development of transportation through vacuum that is currently pursued on earth due to its high efficiency caused by the lack of friction.

Another significant topic is biology which can be further divided by the focus of said research. Firstly, the reactions of the human body to the moon's environment should be closely monitored and periodically reported to a team of specialists on earth, which could help improve future space suits and bases. Secondly, the growth of various

species of plants in domes on the moon must be documented and studied to improve said domes and even choose the plants that adapt the best and give the most nutrients to the astronauts.

The third focus of the research conducted in our moon base is astronomy. The main problem with accurately studying astronomy on earth is the excessive amount of light pollution. Without cities, the moon would be the perfect place for big, advanced telescopes and other observation instruments that cannot be launched directly into space.

Lastly, there is the subject of geology: the lunar soil composition must be studied closely in order to find out what unknown exploitable resources could be mined from there. Another reason to study the geology of the moon is to decide which places are the best for building other future bases.

## **Section 5 – Life as an astronaut**

### **5.1 How will the astronauts train to prepare for the moon mission?(Max 300 words).**

The training required from our astronauts for this moon mission can be divided into two main categories: basic space travel training and moon surface adaptability training.

Firstly, and most importantly, comes the training that any astronaut that will travel outside of the earth's atmosphere must go through. This includes medical tests, physical training, extra-vehicular activity training, and procedure training. The total training time for basic space travel can take up to two years for an astronaut to be ready to leave earth. This can also be divided into three main parts: safety and survival training in case of failure, life-sized model and specific technology training (vacuum chambers, parabolic flights, and neutral buoyancy facilities) and mission-specific training (special simulations of the exact flight).

Secondly, the astronauts will have to train both physically and psychologically for their prolonged stay on the moon, but also for the various duties and experiments they will have to perform there. An especially important factor that must be taken into consideration in order to ensure the mission's success is the astronaut's mental health. A long stay on the moon with just two crew members to socialize with will have a significant impact on them, which is why intensive psychological training is required. When it comes to the physical training, the astronauts should be able to live at least somewhat comfortably in the lower pressure and gravity environment that is waiting for

them on the moon. Lastly, the role specific training will have to be different for each crew member as they will have clear separate duties to fulfill. However, this does not mean the other crew members will not know the basics of the other's roles, as there is always the possibility of accidents and failures that will require swapping jobs.

## **5.2 What space vehicles will your future Moon mission need? Describe the vehicles found in your Moon Camp and consider how you will travel to and from Earth, and explore new destinations on the Moon's surface.(Max 150 words).**

Our first rover, Helios, will be in charge of building our base and can be controlled remotely. Our second rover, named Europa ( after the icy moon), will mainly be used for mining ice and regolith, but also to explore the moon's surface since it has seats for the astronauts.

When it comes to traveling to and from earth our crew will use a reusable rocket designed to carry heavy payloads. It should be able to resist re-entry multiple times and the heat shield should be repairable in case of damage.

We can also use our rocket for moon exploration. Since the moon has no atmosphere and low gravity, exploring the moon using this method is efficient as hydrogen fuel can be made locally.

In the future we could build a frictionless magnetic rail system made from iron extracted from the moon. This system can connect all the bases.