CRUX

Aresam- All Hallows' School Brisbane Australia

Space Settlement Proposal

17th Annual International Space Settlement Design Competition

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1.0 Executive Summary

It has been observed by the Foundations Society that the opportunities presented by a new space settlement do not become fully apparent until the location is enabled with people who are living, working and thinking upon that settlement. Therefore, the Foundation Society has proposed to contractors the design, development, construction, and operations of the first large space settlement community in Mars' orbit. "Aresam" will serve as a 'gateway to Mars' providing the link between Mars' surface operations and the rest of humanity.

Surveys show that Mars has a diversity of minerals resources that almost exceed Earth's own ores. The exceptional environment on Mars caused development of formerly unidentified compounds, with properties that are still being examined and the opportunity of new materials potentials might be revealed. Crux anticipates that there will be opportunities for innovative products that can generate markets on Earth's.

Aresam will be the provided for all of Mars' settlements vehicles, food, tools, and other supplies. This includes the development of infrastructure and also the studying of Mars' surface by scientist who will be based on Aresam.

In addition to the exploration of Mars' minerals, Crux believes we have developed the epitomic living design for extraterrestrial habitation. Above all, it involves a safe, comfortable and pleasant living and working environment for residents, additional transient population, business and official visitors, guests of residents and vacationers.

Furthermore, our design does not merely simulate the natural feel of home produced for residents to only superficially enjoy; but rather truly exhibits this sensation through the community and individual activities Aresam and the Foundation Society offer as a means to secure the quality of space life. Hence, we have included attributes that citizens will enjoy and more importantly, respond positively to; plus we have accommodated for easy access of incoming and outgoing space vehicles and personals at resident leisure.

What's more, Aresam will be the most ambitious project ever undertaken by the Foundation Society, a pioneer in development of large space projects. No doubt, Aresam is anticipated to be equally significant in expanding commercial opportunities for space boundaries.

2.0
Structural Design

2.0 STRUCTURAL DESIGN

Named in honour of Ares, the Greek counterpart of the Roman God Mars, *Aresam* is unquestionably the most ambitious settlement project ever undertaken by the Foundation Society. Both the pioneer in the development of future projects on Mars and the vital link necessary to establish operations on the surface, *Aresam* will be a vibrant tourist destination and a bustling port facility. *Aresam* is set to be the fourth of Crux's innovative space developments and will be the first of the Foundation Society's settlements in orbit around Mars. Home to 22 000 full time residents in addition to a transient population of 500 people at full operating capacity, Crux also aims to provide a comfortable and modern living environment for tourists and permanent settlers. To facilitate exploration of the surface of Mars, *Aresam* will also provide a kit to establish a temporary base on the surface for scientific and geological research.

2.1 EXTERNAL CONFIGURATION

2.1.1 SPACE SETTLEMENT DESIGN

The sixth in a long line of the Foundation Society's endeavours, *Aresam* will aim to serve as an interplanetary transfer station in addition to being a future outpost for the exploration of Mars. In accordance with this, Crux proposes that *Aresam* be comprised of two adjacent beaded tori on two levels, radiating from the central port column and linked by ten radial arms on each level in order to maximise ease of operations while allowing minimum energy use during years before population growth. On each level, the outer torus will be made up of thirty individual self-sufficient modules used to fulfil the settlement's residential, recreational, and commercial sectors, while the inner torus will comprise of five modules on each level for agriculture and food processing. The eight smaller modules in the central column will house the settlement's heavy cargo, processing and storage facilities. See Figure 2.1.1.1 for a scale model of the proposed settlement. All modules, in addition to the radial arms, will be pressurised for the comfort and safety of residents.

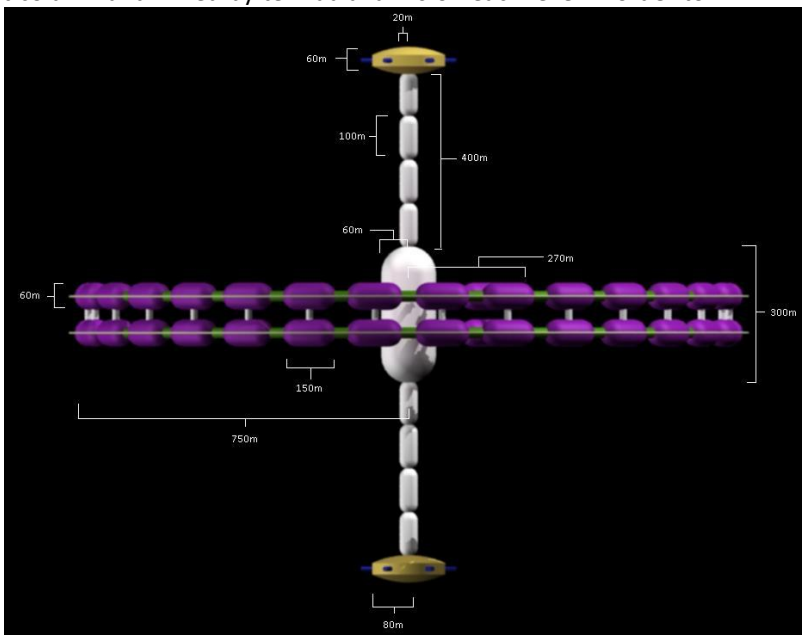


Figure 2.1.1.1: Dimensioned diagram of proposed settlement.

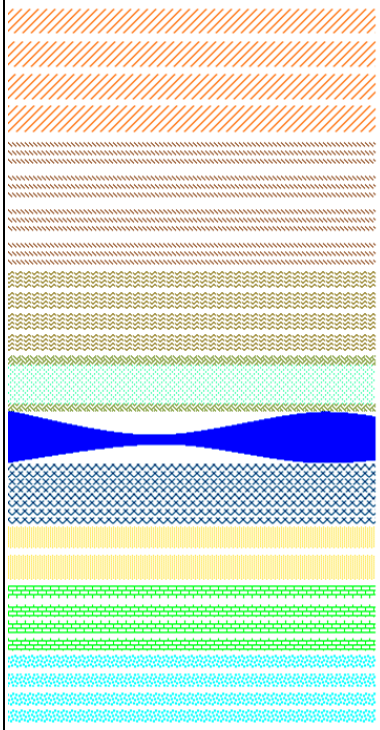
In case of emergency, any of the seventy modules can be shut down and separated from the rest of the settlement in order to contain the situation and guarantee the safety of all persons. As each module is designed with ease of construction in mind, it may be possible to simply remove the inflatable cover and dismantle the inner frame in the unlikely situation that a module was to be rendered completely uninhabitable. Each module will be separated into 14 floors, with a certain number of levels dedicated to commercial, residential, transport, recreational and utilities (Figure 2.2.1) to ensure that each module is independent. At full operating capacity, the 60 residential modules will have the ability to support the expanded *Aresam* population and up to 500 tourists. Located 270m from the central column are the inner tori which will house *Aresam*'s agricultural and scientific departments.

Located at the heart of the settlement will be the central port column with a small enough radius to maintain a gravitational force of ~0g and allows for the safe transportation, processing and storage of

heavy materials. These non-gravitational docking facilities will allow interplanetary ship operations to be achieved with maximum efficiency and safety.

2.1.2 CONSTRUCTION MATERIALS

Crux's proposes to utilise inflatable modules made of a one metre thick 35-layer hull to maximise ease of deployment and streamline the construction process. The materials chosen for the walls of the pressurised modules provide minimal air leakage, high structural integrity, and superior long-lasting protection from debris. The arrangement of layers is described below.

Layer Diagram	Material and Application	N°. of Layers
 ***Figure 2.1.2.1: Diagram showing layering of hull materials.***	[1] Woven silica fibres (Beta cloth) coated with polytetrafluoroethylene (Teflon) for extreme (650°C) heat protection.	4
	[2] Biaxially-oriented polyethylene terephthalate (boPET) polyester film (Mylar).	4
	[3] Polyimide film (Kapton) to restrain the previous layers.	4
	[4] Electro-conductive gel sealed between two polyethylene layers designed to act as a seal in case of any damage. This will be contained between a pair of conductive grid layers which will serve as an electronic sensor system to report any hull damage.	1
	[5] Two partly bonded layers to produce a network of veins for coolant to circulate.	2
	[6] Woven ceramic threads with strong para-aramid synthetic fibre (Kevlar) (Nextel). This will provide much of the structural integrity between layers of the module.	8
	[7] Silicone to provide protection from cosmic radiation.	2
	[8] Strong-para-aramid synthetic fibre (Kevlar).	4
	[9] Aromatic nylon, the Meta variant of the para-aramid Kevlar interleaved with the layer 8 so that no scuffing or damage occurs.	4
The inflated modules will be fitted with an internal aluminium skeleton which will provide the foundation to build decks and other interior structures. The modules are designed to be detachable and self sustaining in an emergency situation and in the event or irreparable damage, an entire module could be removed and replaced.		

2.1.3 ARTIFICIAL GRAVITY

The simulation of the pull of gravity aboard a space station has long since been one of the greatest challenges hindering the colonisation of space. This is due to the adverse effects that high and low gravity have on the human body. In order to prevent the detrimental physiological and psychological impacts of micro gravity, *Crux* proposes to create artificial gravity on *Aresam* in order to enable residents to live in an environment as Earth like as possible. This artificial gravity will be provided through the rotation of the torus structure, which will be initiated by auxiliary solid rocket boosters which can attach to the settlement via the external service rail. Rocket boosters will also be utilised when adjustments are needed to maintain the rotation of the settlement over the predicted 30 years of operation.

When maintained at a constant angular velocity of ~1.07rpm anticlockwise, the rotation of the station will create a centrifugal force of 0.9g-1g in the residential modules of the outer torus. The rationale for selecting the gravitational force of 9.81ms^{-2} for residential and commercial zones is a result of the numerous detrimental effects that both low and high gravity have on the human body.

The settlement's agricultural modules will be maintained at a gravity of between 0.3-0.4g. This lower gravity environment will not affect the crops or poultry as the majority of the colony's food supply will come from aeroponics, aquaponics and in-vitro meat. The sparse amount of crops and live animals

kept on board the colony will not be affected due to the ability of plants to survive in low gravity and the eventual short life-span of animals bred for food. Housed in the central column, the industrial, research and manufacturing modules will have a gravitational force of ~0g. This environment will allow for materials and cargo to be transported easily creating a safer environment for workers as well as low-g experiments to be conducted. The docking and port facilities of *Aresam* have small enough radii to create a virtually zero-g environment to enable ease of use of heavy machinery and are designed to facilitate the docking process.

Passengers who wish to transfer between standard gravity and low gravity areas of the settlement will be able to use a modified PRT (See 3.) traversing inside the radial arms of the settlement. Each trip should take approximately 10 minutes, with a 30 second embarking/disembarking period on each end, with PRT pods travelling at a velocity of 60km/h. This will allow for regular, safe and convenient transition between the two tori. In order to sustain the gravitational forces required for a space station with a diameter of 1.5km, at a constant level, *Aresam* must have a rotational rate around its axis of ~1.07rpm. This will create comfortable centripetal velocity and should provide the near-elimination of the Coriolis Effect for residents aboard *Aresam*.

2.1.4 RADIATION AND DEBRIS PROTECTION

The use of an innovative flexible yet strong outer shell will provide *Aresam*'s residents with superior protection against debris and dangerous cosmic radiation. The 35-layer composite hull described in Section 2.1.2 implements the leading technology in debris and projectile protection, and the electronic missile identification system will ensure any hull breaches can be attended to with utmost speed. *Crux* proposes that Aresam's primary protection against radiation should be a dual layer silicone-based polymer so to make use of local materials extracted from the Martian moons Phobos and Deimos in order to minimise transportation costs. Silicone is favoured as it provides superior, lightweight protection from cosmic radiation in the form of gamma and beta rays.

2.2 INTERNAL ARRANGEMENT

In order to aid in the efficient running of the settlement, *Crux* proposes that *Aresam* be divided into specific zones in order to effectively utilise interior space and allow for ease of transportation within sectors. The standard allocation of levels in residential modules is detailed in Figure 2.2.1.

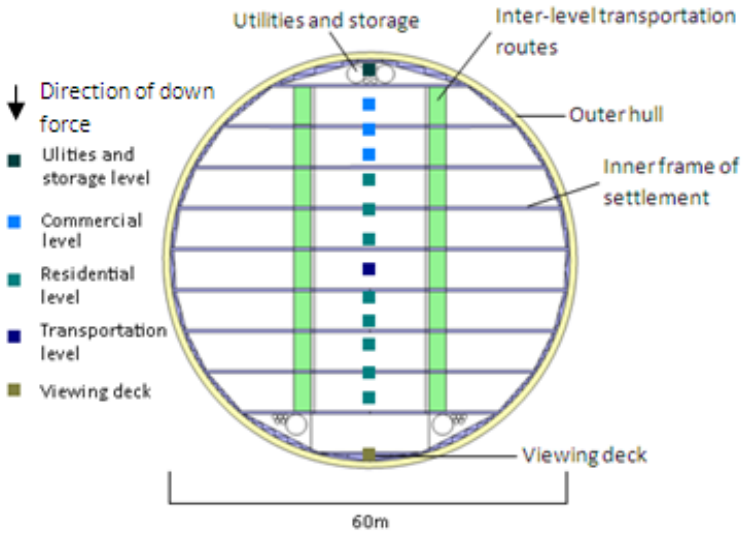
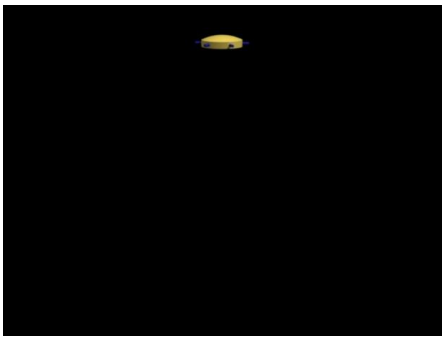
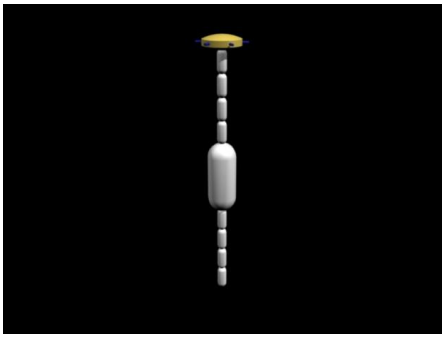
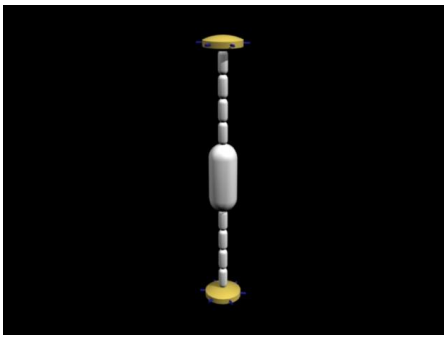
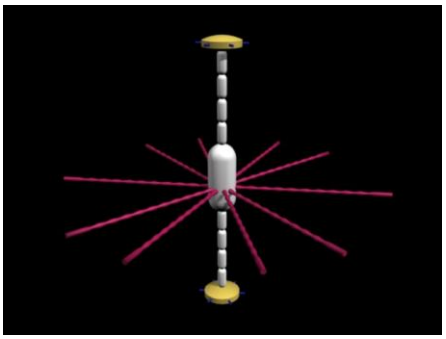
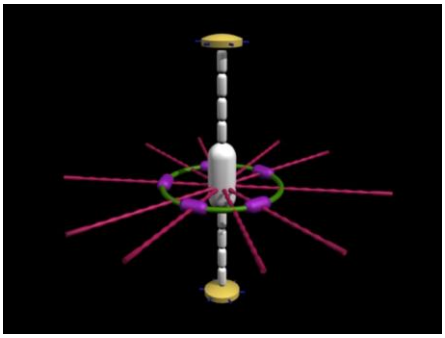
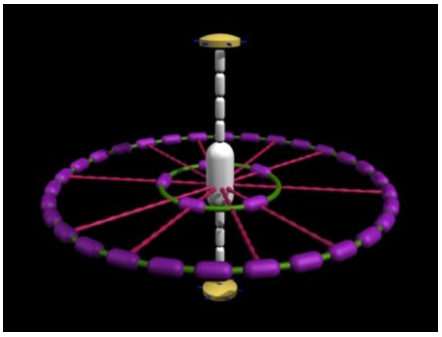
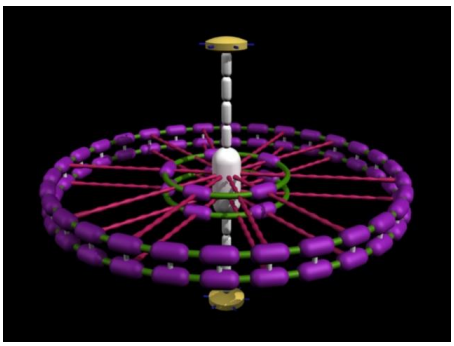
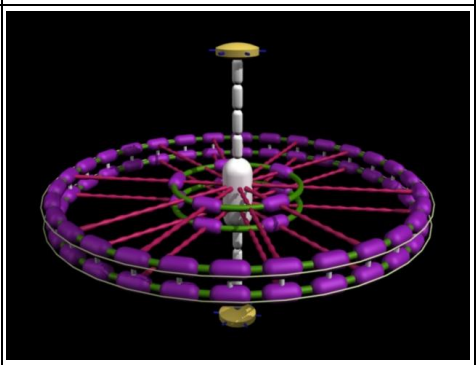


Figure 2.2.1: Allocation of levels for residential modules.

2.3 CONSTRUCTION SEQUENCE

In order to make the construction of *Aresam* as streamlined as possible, Crux proposes that the settlement be built in stages to maximise efficiency and reduce the cost associated with a lengthy construction time. Some materials used for the construction of *Aresam* can be mined from the Martian moons and Earth's own moon to minimise transportation costs, though the significant amount of processing required to produce certain substances means materials can be more effectively sourced from Earth. Robots will be employed in throughout the construction of the settlement (See 5.1). Crux proposes that *Aresam* be built from the outside in, primarily of prefabricated sections, in order to meet the Foundation Society's deadline of 12 years from the commencement of construction.

Stage	Description	Diagram	Timeline
1	All materials for major structural components are mined from *Alaskol* and assembly process begins.	N/A	June 2055
2	All major structural components are transported to settlement location.	N/A	June 2056
3	The cargo docking facility will be the first structure of *Aresam* to be completed. This non-rotating, non gravitational port facility will contain a pressurised cabin to house any personnel needed to oversee the construction of the settlement, and can later provide storage for construction materials delivered ahead of schedule.		Sept. 2057
4	The central column modules will be fitted to the cargo docking facility. These interior of these modules will be equipped with a pressurised lift to allow transit between the docking facilities and the rest of the settlement.		May 2058
5	The human and light cargo docking facility will be attached to the central column. Before *Aresam* residents arrive, this docking facility can be used to supplement the main cargo dock and improve the efficiency of construction.		May 2059
6	Pressurised lift between two docking facilities will become operational.	N/A	Jan. 2060
7	The radial arms of the lower torus will be constructed. These will not be pressurised until necessary.		Jan. 2060

7	*Aresam*'s inner torus will be constructed and low-g modules destined to house *Aresam*'s agricultural sector will be fitted to the frame of the settlement. The framework for the transportation route around the inner torus will be attached to the inner frame of the inflatable modules.		Jul. 2060
8	The 30 residential modules of the lower outer torus will be fitted to the settlement in the same way inner torus modules were fitted in Step 7. The ten lower radial arms can now be pressurised.		Jul. 2061
9	Top layer is added to settlement (see Steps 7-8 above) and adjacent residential modules can begin to be connected for structural integrity. These connections will later allow convenient transportation between the levels of *Aresam*.		Dec. 2062
10	Aresam's exterior service rail will be fitted to the outer torus of the settlement, and auxiliary solid rocket boosters attached to service rail will initiate the rotation of the settlement to produce artificial gravity.		May 2063
11	The completion of interior finishing, transportation routes and infrastructure allows first permanent residents to settle on *Aresam*. At this time, the lower docking facility of the central column will be converted for primarily human use.	N/A	Sept. 2063

2.4 ABILITY TO ADAPT TO EXPANSION

The construction of *Aresam* marks the commencement of the Foundation Society's most adventurous endeavour yet to begin the colonisation of an environment once considered too hostile for human habitation. One of the primary purposes of this new settlement will be to provide a gateway to facilitate the future colonisation of Mars, and due to the rapid development of new technology and the unknown geological and scientific worth hidden under the surface of Mars, *Aresam* must be expected be able to adapt to the changing needs of its population and the Foundation Society. The beaded tori structure proposed by *Crux* will allow minimum energy use in the initial years of construction, as the independent modules can be shut down completely (with the exception of transportation routes) when not in use.

2.4.1 EXPANSION OF DOCKING FACILITIES

Aresam's ports can be expected to become the hub of business activity conducted within the settlement. Aresam's cargo docking station will be large enough to accommodate eight unloading/loading ships at any given time. The docking station will utilise universally standard docking systems to accommodate all ships seamlessly, and regardless of future developments in ship design, Aresam's ports will be able to provide the highest level of service for cargo transportation. These services, in addition to those provided by the human port facility, are outlined in Figure 2.4.1.1.

Type of Vehicle	Services offered
Industrial /cargo ships (Upper Cargo Dock)	▪ Rapid loading/unloading of cargo thanks to Aresam's central hub transport system and additional radial arm transportation ▪ Ship refuelling ▪ Routine maintenance ▪ Minor and major repair ▪ Restocking of supplies ▪ Supplemental security personnel for large business transactions
Commercial travel/ tourist ships (Lower Human Dock)	▪ Easy access for tourists and settlers, efficient processing of luggage ▪ Ship refuelling ▪ Routine Maintenance ▪ Minor and major repair ▪ Restocking of supplies ▪ Staff available to assist tourists

Figure 2.4.1.1: Table showing Aresam's port facility services as envisioned by Crux

2.5 DEPLOYABLE MARS SURFACE BASE

As per the Foundation Society's request, Aresam will be able to supply a deployable base structure for use on the Martian surface when settlers conduct research projects. The structure *Crux* proposes to use will not only fit in a standard cargo container, but as the materials are flexible, will allow extra room for supplies required during the month long stay and reduces the amount of transportation of consumables later needed to supply for the four temporary inhabitant. *Crux* has designed an inflatable, reusable base large enough to provide comfortable living conditions for four occupants over the course of their research project. The materials for this base will be mined from Phobos and Deimos (Figure 2.5.2), which will allow for *Aresam* to quickly meet the needs of scientists and geologists studying the surface of Mars. This temporary base will take the form of a dome, with the silicone walls supported by the air pressure inside the structure.

Depending on the radius of the crater in which the base is situated, the dome will be constructed from approximately 8-12 custom sized silicone panels. For an optimal radius of 6 metres, the interior of the base will provide approximately 113m^2 of interior floor space and a vertical clearance of 3.5 metres. Due to the large amount of food required by four humans in a month, the base will also include a hydroponic garden (supported by a central column and a glass plate in the upper level of the base) which will be exposed to natural sunlight let in by a titanium-reinforced glass top. In order to prevent the detrimental effects that feeling 'closed in' can have on the human brain, the natural light will also be allowed to continue to the main living area. The use of natural light also provides the added benefit of a reduction in overall power consumption. Figure 2.5.1 shows the construction sequence for the deployable surface base.

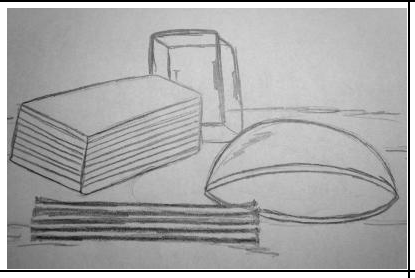
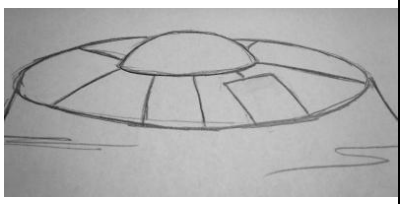
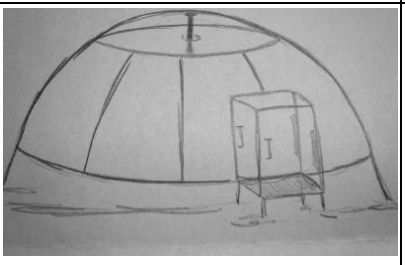
Step	Description and Visual	Time taken
1	Materials necessary to construct dome are unpacked from cargo container by two spacesuited people assisted by robots (See 5.5). 	1 hour
2	Silicon-based polymer panels are laid over crater and attached using titanium rings. The panels are then brought to the centre, sealed to the glass dome and sealed to the adjacent panel to ensure structure is airtight. A removable panel will later be replaced by the airlock when structure is stable. 	4 hours
3	Structure is inflated and airlock is installed. The monitoring of air pressure will be fully automated. 	3 hours

Figure 2.5.1: Construction sequence of Mars surface base.

Materials Used	Source of Materials
Titanium rods; silicone-based polymer; titanium reinforced glass top (prefabricated); airlock.	Titanium: extracted from regolith on Deimos; Silicon: Phobos and Deimos (extracted from minerals e.g. serpentine); Airlock: prefabricated airlock provided.

Figure 2.5.2: Table showing sourcing of materials from Phobos and Deimos for main structural component.

against radiation. A layer of single-walled carbon Nanotubes is 100 times the strength of steel at one-sixth the weight and is known as 'the ultimate bulletproof vest'. Silicon will also used as it is light, durable, does not shrink or expand, can withstand heat and seals out water and other liquids.

INTERNAL ARRAIGNMENT

In order to aid in the efficient running of the settlement, Crux proposes that *Aresam* be divided into specific zones in order to effectively utilise interior space and allow for ease of transportation within sectors. The outer torus *Hera* will house the residential, agricultural and commercial sectors of the colony and will be separated into two main levels. The agricultural and harvesting will be conducted above each residential level reducing the time and cost of transporting goods around the station. The residential, commercial and recreational sectors will be integrated to form one floor of the outer torus *Hera* for the convenience of all residents aboard *Aresam.*

CONSTRUCTION SEQUENCE

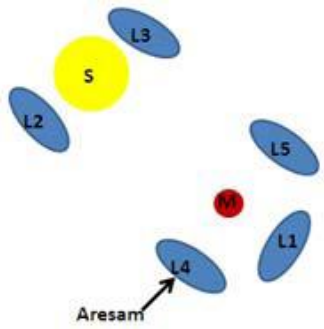
In order to make the construction of *Aresam* as streamlined as possible, Crux proposes that the settlement be built in different stages in order to utilize environments and local resources efficiently for each stage. Materials used for the construction of *Aresam* will be mined from the Marian moons of Phobos and Deimos and robots will be employed in the initial stages of construction to reduce the cost of housing workers. The settlement will be built from the inside out and will become fully operational in approximately 12 years from the beginning of construction.

3.0 Operations and Infrastructure

3.1 CONSTRUCTION MATERIALS SOURCES

3.1.1 Orbital location

Figure 3.1.1.1



Aresam will be stationary within Mars' orbit as it will be placed within one of Mars' libration points. This is possible due to the combined masses of two larger objects (the sun and Mars) providing the centripetal force needed for Aresam to remain in a fixed position in space; rotating with Mars. If Aresam was to be placed in points L1, L2 or L3, a significant amount of 'station keeping' would be required to keep it in a stable position. Therefore, Aresam will be constructed at point L4, a relatively stable point. A number of Martian Trojan asteroids have been discovered in L4 and consequently, the settlement's outer torus will be constructed of impenetrable materials.

3.1.2 Construction Material Sources

The materials used in the construction of Aresam have been chosen for the availability and ease of transport. The table below lists major materials, their source and approximate transport time from order to arrival.

Table 3.1.2.1

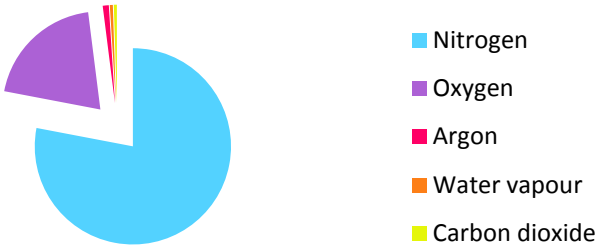
Materials	Elements	Source	Transportation
Beta cloth	Silicon	Lunar crust/ S Type asteroids	< 3 months
Polytetrafluoroethylene (Teflon)	Carbon, Fluorine	C - Type Asteroid/ M-Type Asteroid/ Mars/ Phobos / Deimos	< 3 weeks
Biaxially-oriented polyethylene terephthalate (Mylar)	Carbon, Hydrogen, Oxygen	M-Type Asteroids/ Mars	< 3 weeks
Polyimide film (Kapton)	Carbon, Oxygen	M-Type Asteroids/ Mars	< 4 weeks
Ceramic Fibres (Nextel cloth)	Ceramic		
Para-aramid synthetic fibre (Kevlar, and Kevlar threads in Nextel)	Nitrogen, Oxygen, Hydrogen	Aresam, C-Type Asteroids / Lunar Surface/ Phobos/ Deimos	< 2 weeks
Polyurethane (open cell foam)	Carbon, Nitrogen, Oxygen, Hydrogen	C-Type Asteroids/ Mars/ Phobos/ Deimos	< 3 weeks
Meta form of Kevlar (Kevlar with aromatic Nylon)	Carbon, Nitrogen, Oxygen, Hydrogen	C-Type Asteroids / S-Type Asteroids/ Mars/ Phobos/ Deimos	< 4 weeks
Water	Hydrogen, Oxygen	D-Type Asteroids / Lunar Ice / C-Type Asteroid / Mars	< 2 weeks
Aluminium	Aluminium	The Moon / S-Type Asteroids / 3 recently identified un-known meteorites/ Mars/ Phobos/ Deimos	< 3 weeks
Titanium	Titanium	Lunar crust	< 3 months
Carbon Fibre Reinforced Plastic	Carbon, Polyester	C-Type Asteroids/ Mars/ Phobos/ Deimos	< 4 weeks

3.2 COMMUNITY INFRASTRUCTURE

3.2.1 Atmosphere Control

Aresam's air composition would be approximately the same composition as Earth's. Therefore, it would compose of approximately:

78% Nitrogen
20% Oxygen
1% Argon
0.5% Water vapour
0.5% carbon dioxide

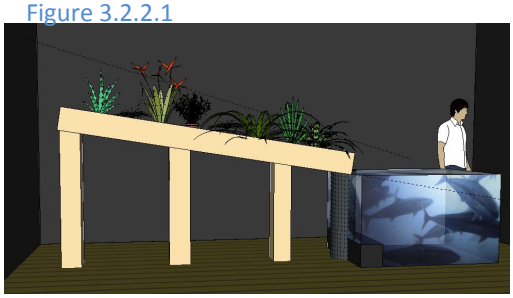


The climate would be controlled by the projection of hot and cold air through industrial air conditioners. Temperatures would be determined by the seasons of the hemisphere with the largest amount of landmass, the northern hemisphere. Aresam's mean temperature would follow that of the global mean, and the temperatures would average ten degrees Celsius above and below the average on summer and winter. For comfort, spring and autumn climates would ease into winter and summer. The average temperature for these seasons would follow the global mean. After a year of the Aresam's recommended climate, residents would be surveyed to determine if the climates are comfortable. Aresam's functions would be set so the entire colony follows the same patterns, as the colony is only the size of a small city. The air pressure would be the average of the air pressure at sea level, 101.325 kPa, but would vary from season to season, due to the expansion and humidity of air.

Table 3.2.1.1

Season	Mean Temperature
Spring	20 degrees
Summer	25 degrees
Autumn	18 degrees
Winter	15 degrees

Figure 3.2.2.1



3.2.2 Food Production

It is essential to establish a self sustaining food source on Aresam. To do this, all fruits and vegetables will be produced using Aeroponics. Aquaponics is another method which will be utilized to grow plants and it also allows users to produce fish at the same time (see picture …). Red meats, such as lamb and beef, will be produced using in-vitro techniques. This is favorable for some vegetarians, as it does not inflict suffering on animals. There will be chickens, mainly hens, on Aresam to produce poultry and eggs. Milk will be produced using soy beans (from Aeroponic methods) to create nutrient enriched soy milk. Lastly, other foods which are needed onboard Aresam will be imported from Earth. The table ( ) below clearly shows these methods, the foods they produce, how it works and the pros of choosing that method:

Table 3.2.2.2

Methods	Food Produced	How the method works	Pros of using this method
Aeroponics	Fruit, Vegetables, Wheat and Grain	Grown in greenhouses that are temperature-controlled, artificially lit and employ an **aeroponic system**, this uses nutrients and a small amount of water instead of soil. Crops can include soybeans, peanuts, spinach, cabbage, lettuce	- Grows plants with little water and no soil is needed - Tend to produce larger fruit, roots and leaves - Weather does not affect the aeroponic plants - Does not have to be imported from Earth - Faster to grow (due to disease free environment) - If somehow the aeroponic crop fails, hydroponics can be used to save the crop - Aeroponic growing is considered to be **safe and**

		and rice. Wheat berries and soybeans can be grown and processed into pasta or bread. The process of growing plants that have their roots suspended in air and that has a nutrient mist feeding them without the use of soil or an aggregate medium.	**ecologically friendly** for producing natural, healthy plants and crops - The conservation of water and energy. (compared to hydroponics, aeroponics offers lower water and energy inputs per square meter of growing area) - Conducted in air combined with micro-droplets of water, **almost any plant** can be grown - Aeroponics can limit disease transmission since plant-to-plant contact is reduced and each spray pulse (mist) can be sterile - More cost effective than other systems as less water and less nutrients are needed in the system and therefore reduced maintenance and manufacturing costs - Crops can create other foods such as pasta and bread - No need to import large quantities of soil, etc. - Aeroponics system can be automated
Aquaponics	Vegetables and Fish	Cultivation of plants and aquatic animals in a recirculating environment. Effluent (e.g. fish waste) from aquatic animals accumulates in water when they are kept in a closed tank. The water becomes high in plant nutrients, yet this is toxic to the aquatic animal. The plants take up the nutrients, which reduces the water's toxicity. The water is returned to the aquatic environment. This process of recycling the water is cost effective and helps sustain fish and plants (making it efficient).	- Produces both fish and plant - Good source of Omega-3 and Protein for people on the settlement - Conservation of water through recycling - More options
In-vitro	Red Meat – Lamb and Beef	It involves taking muscle cells from various animals and joining each cell with a protein which causes it to grow into large portions of meat.	- Healthier alternative to conventional meat - Costs less to produce - Possible alternative for vegetarians - Uses less space and creates more meat than traditional livestock - Minimizes consumer illness, more clean
Chickens	Poultry and Eggs	Attained through traditional methods	- Meat which people are used to eating - Produces eggs as well
Soy beans (from Aeroponics) to Soy Milk	Nutrient enriched soy Milk	Soy beans (grown from Aeroponics) are used to create nutrient enriched soy milk	- Produces milk - Almost everyone can have it – lactose and gluten free
Imported Other Foods	Sugar, salt	Imported from Earth	- More choice in foods

All foods will be stored on the agricultural level of the inner torus. Meat and crops will be packaged separately and stored in storage rooms of adequate atmosphere and temperature, connected to the corresponding food production areas until they are needed at various areas around the settlement. They would be transported to areas where they would be sold to the public. By using these methods it allows Aresam to eventually have a self sufficient food source, which won't need to rely on imported goods from Earth and therefore be much more cost effective.

Figure 3.2.2.3

3.2.3 Electrical Power Generation

Table 3.2.3.1

Priority	Source	Size	No.	Purpose	Power Generated
Primary	• Solar	5km squared	1	Powers all common electronics, lights, computers and robotics	**1168 mW**
Secondary/Back up	• Hydrogen Batteries	1m squared	1	Used to power the flywheel or perpetual batteries, Powering segways	
	• Solar Power Satellites (automated solar tracking system)(Initial supply)	200m squared	1	Contributes to running the station when solar power in unavailable. Powers the station during construction Used to power the flywheel or perpetual batteries,	
	• Piezoelectricity	87000m squared	6		Experimental stages, power output unknown

Electricity on Aresam will be generated from multiple sources, so if one was to fail, multiple backups would be available. Energy on Aresam will primary be Provided through the inclusion of 5km^2 of solar sails, which will be moved around the central column by sticky bots, subcontracted from Magellan, to angle solar panels to the most direct area of sunlight, increasing the efficiency of harnessing all possible solar energy. By choosing to include Solar Energy as the main form of electricity generation Crux can ensure a reliable and nonstop supply of energy where possible, due to the the solar paneling's ladder formation, if one part of a solar panel was to fail, no other part of the panel would be affected. It would easily be prepared as the materials required to construct the panels, mainly silicon, are of great abundance on the surface of mars. Each solar panel will transfer all received energy to microwave receivers.

By including piezoelectricity, each pod will be able to be self sufficient if an emergency was to occur, as piezoelectricity is continuously harnessed from vibrations excreted by humans, robots and transport systems. Six separate satellites in a solar orbit between earth and mars will be equally spaced, and a minimum of one satellite will be in plain sight of Aresam at all times. Microwaves will be used to transfer electricity between the satellites and to Aresam. Small microwaves receivers will line the hull, to receive energy and to service communications between earth, Aresam and possible mars settlements. The inclusion of the multiple back up sources will be of necessary inclusion, as Aresam circulates around Mars, therefore the sunlight will be blocked by mars at certain times in its revolutions.

The backup sources and stored energies will suffice for the amount of energy lost in solar 'blackouts' from the primary source of solar energy. Crux has chosen renewable sources of energy, as the by-products of other methods could be a possible threat to the safety of Aresam and all current residence, and would add extra unnecessary stress to the running of Aresam in the destruction of energy production by-products. The chosen methods are safe, efficient and have had no proven side effects after extended use.

3.2.4 Water Management

Each resident will be allocated 200L of water each day (the average amount consumed on Earth in developed countries), hence 4400kL will be required each year for human consumption. 1000kL will be allocated for industrial use and other settlement operations. As well as water being produced through Aresam's waste treatment plant, water will be sourced from the extensive permafrost (water

ice mixed into soil and frozen to the hardness of rock due to low temperatures) at Mars' poles. The water from which this ice is composed is incredibly pure; 95% at the northern pole, and yields a significant amount of water due to high hydrogen levels. At the southern pole, thermal imaging indicates extensive permafrost; up to 3.7km below Mars' surface. This reserve alone would yield enough pure water to cover the planet in a layer 11m deep, i.e. 1.6E18kL of pure water.

The ice would be harvested from Mars' poles using large machines with tooth-like gears to bite into, grind up and extract it. The retrieved ice would then be collected by robotic probes and transported to Aresam where it would enter a vacuum chamber. Here, it would be fed into a pressurized vessel and warmed to reach a liquid state. From here it would be filtered and purified to remove contaminants until it was safe for human consumption. This water will be purified through using a method used by NASA's Apollo spacecraft; water is passed through a bed of tiny resin beads containing iodine. Iodine ions into the water supply work in the same way as chlorine. In the event that more water is needed, it could also be sourced from Mars' terrain and atmosphere. A solvent such as CO_2 is easily accessible as it makes up 95% of Mars' atmosphere and can be used to create water when combined with Martian rocks containing hydrogen. CO_2 would become such a solvent after undergoing a process in which it is compressed to a pressure of 73 atm and heated to 31.1°C. As a result, it becomes a supercritical fluid and a great solvent. Rocks containing hydrogen would be submerged in this solution to form water through chemical reaction. Once purified, water would be stored in large reservoirs until it would be needed to be transported throughout the settlement via Archtiles in the walls. All hard water will be recycled at a recycling plant and then purified using this same method. The plant will consist of multiple 30kL tanks, capable of recycling 2kL in one hour. This recycling will prevent too much water being harvested from Mars' surface and atmosphere and will produce little waste as recycling in space is close to 100% efficient.

3.2.5 Household and industrial solid waste management

As manual compaction of waste and subsequent on-board storage will not be a long term option, all household and industrial waste on Aersam will be collected and transported to a major waste treatment area. Wet Carbonization and advanced combustion technologies will be used to convert solid wastes into uniform and clean fuels while recyclable materials such as paper, cardboard, plastic and metals will be recycled. Metabolic wastes and components will be transported through Archtiles in the floors of the settlement and will be transformed, through moderate temperature and pressure carbonization, into uniform and pumpable slurry, which will be combusted in NASA's fluid-bed combustion and gas cleanup system. Through this procedure, combustion of the carbonized slurry produces relatively low CO and NO emissions; within the Spacecraft Maximum Allowable Concentrations (SMAC) and no air pollution. The CO_2 and H_2O generated during conversion of the wastes can be used for human consumption, to support plant growth systems and provide for a closed-loop, regenerative life support system.

3.2.6 Communication Systems

3.2.6.1 Internal communication

To ensure high speed connectivity and communications within Aresam, optical fibers and copper wires system will be in place for high speed internet connectivity. Optical fibers will be incorporated for the majority of communications on Aresam. To minimize data storage, efficient software will be subcontracted. A majority of the internal communications system will be comprised of optic fibers, as it is lighter weight, does not spark, has faster connection rates, does not spark, is not affected by electromagnetic interference, high electrical resistance, electromagnetically radiating and therefore provides more security as it is difficult to tap into and are smaller in cable sizes. Due to the circumstances of Aresam, security and safety of residents and high security internet areas were the main considerations. Due to the composition of the fiber optics and due to the circumstances and limitations of the Space environment, fiber optics was chosen as the most appropriate method of communication. Fiber optics will also be used to distribute natural light from outside of the hull to the

light fixing in each house, where possible, and therefore minimizing electricity consumption due to light production.

3.2.6.2 External communications

The six satellites which were in place in the solar orbit are of multi purpose to Aresam. The satellites not only transfer energy between each satellite, they will also be used to send transmissions between earth, mars and Aresam. Due to the spacing of the satellites, continuous communications will be able to be received, and therefore providing reliable and continuous communication. The reliability of this system was the main consideration, as it is necessary that constant communication between Houston and Aresam exists.

Figure 3.2.6.2.1

3.2.7 Transportation Systems

Aresam's internal transportation system would be a grid of Personal Rapid Transit (PRT) stations running over the surface of the settlement. PRT is a new and innovative mode transport which is cheaper, safer, lighter (weight) and 'greener' to run. PRT consists of a grid of elevated rails with small passenger cars which hold 3-6 passengers and under computer control. PRT stations are off the main line, so there is no line up and travel is non-stop. There is no schedule so passengers arrive to a waiting PRT vehicle. As the vehicles are computer automated, the chance of collision is minimal, as the computer reaction time is much faster than that of a human and the PRT forces a safe distance between each vehicle. On average the vehicles will travel at a speed of 60 km/h. PRT requires ¼ of the energy used by a car. The price of the PRT system would be payed back with the money earned by the system, each passenger paying a set price per km through the use of a specialised credit card. The stations would be no further that 750 m apart so passengers would walk or bike ride to the closest PRT station.

The PRT vehicles would be large enough to carry a bicycle as well as the option of hired bicycle lockers on site. It would be recommended that no cars would be brought up to Aresam, due to the cost to run, the pollution and the resources. Though there would be no roads on Aresam, foot paths would run over the entire settlement for both pedestrians and bicycles to encourage active forms of transit. A maglev will be available to transport people throughout all sections of the settlement. It is quicker, quieter and faster than wheeled transportation and will function using magnetic levitation. There will be 3 Maglevs each of which are made up of 3 carriages which can each hold 50 people. Transport throughout levels of the Torus will be via lifts. There will be three lifts throughout Aresam. The lifts will be circular, will operate on a pulley system and will rotate using magnetics. Each will hold a maximum of 20 people at a time and will travel at 10m/second. The lifts will be pressurised and an oxygen tank will be available in each lift in the case of emergency. Cargo and passenger lifts will have the same weight and will be of the same proportions.

3.2.8 Cycle Provisions

Aresam would follow an 'Aresam Standard Time' which would be synced to the NASA, Houston time slot and date to help communications between NASA and Aresam. The day and night cycle on average would be 12 hours of daylight and 12 hours of night per year. This would follow the climate conditions, as the day hours would get longer in the summer and shorter in the winter. To create the cycle, light equivalent to the strength of the sun would be on during the day, and would gradually dim to darkness with some slightly dimmer street lights, and lights to be turned on in residential buildings when elected. The elected cycle would imitate that of the cycles on earth and therefore create a comfortable and stimulating environment for the residence of the colony.

3.2.9 Storage Facilities

Food will be produced in each module, with extra food gathered to be stored in a large freezer, located in each module. The storage facility will contain up to ten months of the minimum food required to retain human life for up to ten months. The food will be stored between -40°C to -45°C, as this inactivates any microbes and will also allow for safe storage if energy was to be cut off temporarily. Large cubes of ice will also be stored in this freezer, and if required, excess heat produced by robots, machines, etcetera, would heat the water if required.

3.2.9.1

	Amount required Per Capita per day	Amount stored per capita
Water	5kg	1500kg
Wheat	0.345Kg	103.5kg
Rice	0.04 Kg	12kg
Other grain	0.1 Kg	30kg
Herbs & Leaf vegetables	0.085 Kg	25.5kg
Other Vegetables	0.2 Kg	60kg
Fruit	0.214Kg	64.2kg
Total	5.984Kg	1795.2kg

3.3 PRIMARY MACHINES FOR SETTLEMENT CONSTRUCTION

As detailed in 5.1 and 2.3, the most challenging construction phase of *Aresam* will involve the positioning and inflation of the pre-fabricated modules of the settlement. After being pressurised, the interior of these modules can be fitted with an aluminium frame attached to the main transportation lines and radial arms of the settlement. To ensure maximum precision, *Crux* proposes to use FUR-F1M8 (Appendix 4) and SR-F1M8 (Appendix 4) robots, which are able to work effectively in both groups and as individuals (See 5.1). The completion of the tori will allow transportation routes to begin operating, and all interior construction materials and automated robots will be able to be efficiently supplied to the modules to in order to complete the interior design and prepare *Aresam* for its first wave of settlers.

3.4 REFINING AND RESOURCES

Phobos and Deimos both contain C-type ore, therefore the minerals which will be mined are silicates, oxides and sulphides. There will be one station placed on each moon. These two stations must not be permanent as these two moons' orbits are changing every year and there is the chance of them crashing onto mars or exiting their orbit around mars.

Phobos is the smaller and closer moon to mars and therefore can be used as primary station. It is also orbiting mars almost 4 times faster than Deimos and therefore they will line up 4 times 30 hour. Deimos orbits around Mars every 30 hours while Phobos orbits mars every 8 hours. They all lie on almost one plane so the travelling between these will be easier.

A secondary station will be placed on Deimos which controls and manages robots. It sends explorer 2 robots every day to explore the surface and come back with gathered information. After a rich mine is identified 3 mineral robots are sent there which collect to minerals and bring them back to the base. Then these minerals are cleaned and packed and will be sent to the primary station every 10 days (=240 hours) when Deimos and Phobos have the minimum distance and are lined up with mars.

A primary station is built on Phobos which is bigger than Deimos station and does extra tasks as well. It sends 3 explorer robots every day to explore the surface and come back with gathered information. After a rich mine is identified 4 mineral robots are sent there which collect to minerals and bring them back to the station. These minerals plus the ones which have been sent from Deimos are then cleaned and analysed in there and the results of investigations are then sent to Aresam. Useful minerals are then sent to Aresam using space-ships every 30 hours.

There will be a several refining stations on Aresam which refine the selected minerals depending on their type and make them ready to use.

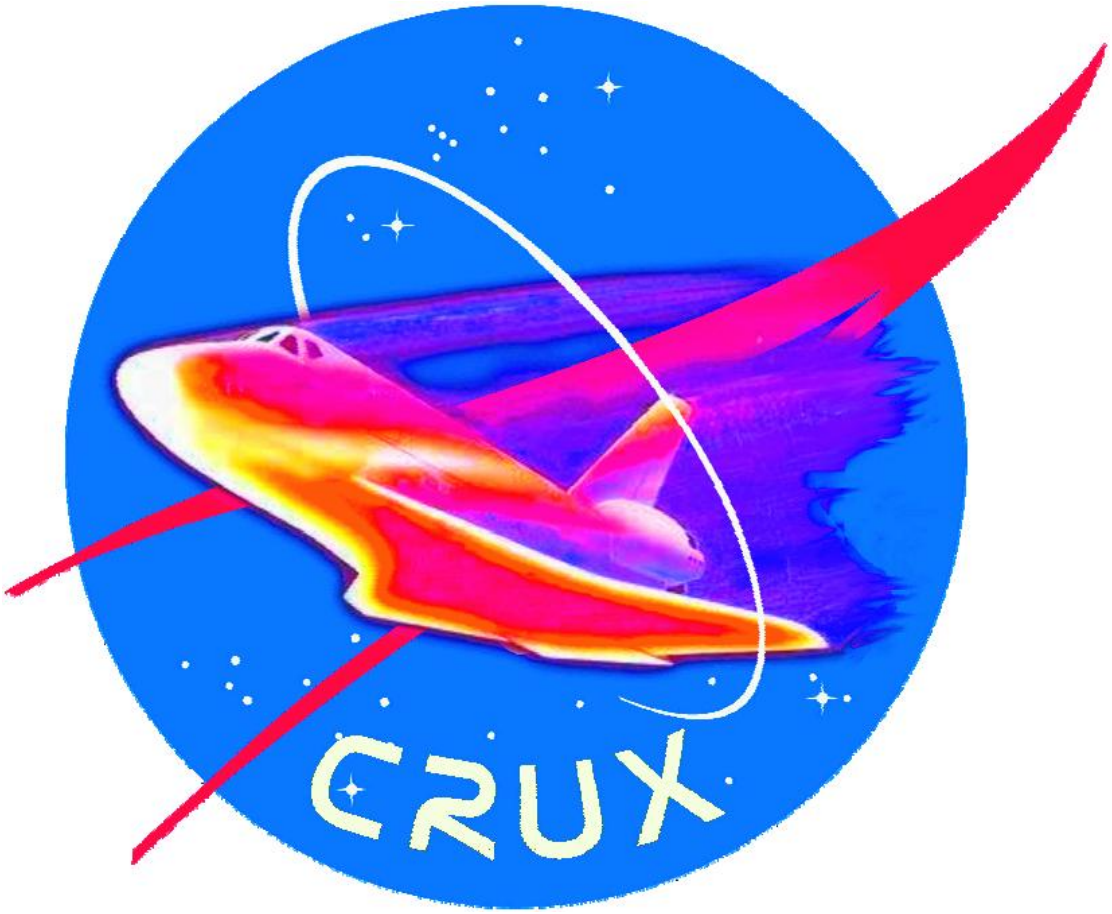
The power for stations on Phobos and Deimos cannot be obtained from the sun solely because the moons do not receive enough energy from the sun. Hence, solar energy will be sent by microwaves from Aresam, when available and extra energy stored in a perpetual battery on each station for when energy is not obtainable.

3.5 MARS SURFACE BASE

Air, food, power, water, and waste systems required for operations of a prefabricated base as described in Structural 2.5. The quantities required for this prefabricated base are:

Table 3.5.1

Requirements for 4 people	Quantities
Air	Capacity for scrubbing, 2000L of CO_2 per day
Food	2666.664 kg/month (for all 4 humans)
Power	5 kW
Water	140L per day per person
Waste Systems	1kg Recycling per day



4.0
Human Factors

Human Factors

4.0 CRUX FACILITIES

Aboard the *Aresam* Space Settlement, the physical and psychological health of all residents, both permanent and transit, is a number one priority. To maintain a healthy working and living standard, *Aresam* has incorporated traditional community structures and luxuries to make all residents physical transition as easily as possible into life on a space settlement. Each sector still maintains ultra-modern luxuries and facilities. *Aresam*'s community public services and facilities will provide state of the art resources and commodities for the residents. Natural sunlight and panoramic views of space and Mars below have been considered in the overall design of *Aresam*, to assist residents in psychologically adapting to life in space.

4.1. Entertainment

The most attractive feature *Aresam* will offer residents is its supernatural views of Mars. Visitors and residents will be encouraged to view the facilities, including industrial operations, of the settlement. Vantage points will be constructed from a safe distance and will be closely monitored to ensure residents safety. A Universal Telescope will be available to all residents of *Aresam*, allowing unparalleled views of the universe and Mars below. The Space Walk and Space Shuttle rides will also give the tourists an outside vantage point of the settlement and give them the chance to explore space first hand. Professional Zero-G ball games are games which are played in microgravity and will add to the entertainment value, as they are expected to appeal to all demographics. They are able to be viewed by both residents and visitors to the settlement and it is an activity which is only undertaken on *Aresam*. Residents and visitors are also able to play Zero-G ball games and participate in competitions.

Visitors will be able to make use of an internet connection to Earth through their resort facilities to communicate with Earth. In addition, FogScreen, a new technology that allows users to project images and video onto a screen of 'dry' fog, will be used to enhance the communication experience. Full body projections of people can be recorded and transmitted onto the screen to create real-life interactivity.

Virtual gaming will also be a significant attraction for tourists and Aresam residents. Haptic technology, a tactile feedback tool, will be used to create a gaming experience in which the player is completely immersed in the gaming environment. A full body Haptics suit will apply small vibrations, forces and pressures upon the user to simulate real life movements and feelings. 3D glasses and headsets can also be applied to recreate extensive visual surroundings.

In addition to space-related entertainment, there will also be a variety of forms of entertainment like those found on Earth. Extensive libraries containing both online and material information, multimedia entertainment and a high-speed internet file sharing system with Earth will be located on each sector. A multi-layered theater and studio venue for dance, drama, music and visual arts is to be constructed in *Atesam*. Audiences will be able to view films, art works, lectures and live performances in the 0000-seat theater and adjoining gallery.

Shopping malls will be constructed in each sector, stocking the latest in fashions and personal technologies. Retail products will vary depending on the theme of the sector. The need for staff will be eliminated with self-checkouts that will charge items to an account with a simple hand scan.

It is hoped that these enhanced media, technology and entertainment experiences will encourage tourism to Aresam to provide valuable economic return and financial growth for the Foundation Society.

4.1.2 Medical

As expected, Medical Precautions and Assistance aboard the *Aresam* space settlement is of the highest priority. Prior to being permitted to commence transportation to *Aresam*, residents are required to undergo rigorous physical and psychological examinations to ensure they are appropriately equipped to deal with life on a space settlement. Members of the Foundation Society chosen to live aboard *Aresam* are selected based upon five selective qualities, namely: knowledge, health, motivation, adaptability and altruism. Each of these qualities acts to ensure that each resident

is psychologically equipped to deal with life aboard the *Aresam* space settlement, and to contribute positively to life within the community. In addition to physical and psychological examinations on every human leaving Earth, there will also be extensive checks on all cargo being transferred to *Aresam*. These examinations, on both human and cargo will be repeated again, just as extensively, upon reaching Hermes, the port facilities on *Aresam*.

Aboard the *Aresam* settlement, there will be compulsory checking and quarantine of all passengers and cargo. This includes mandatory medical checkpoints entering the lifts to leave the any of the capsules. Anything that is potentially found aboard the humans entering these capsules will be transferred directly to medical quarantine or the hospital. Each capsule has a small health clinic with a major hospital in every 3 capsules. Medical checkpoints are also located where human and/or cargo enters or disembarks from the lifts.

Due to the health requirements aboard *Aresam*, it is equipped to deal with even the most serious of medical issues, at least until reinforcements can be sent from Earth. Divided amongst the hospitals are a minimum of 440 beds, ensuring a minimum of 2% of the entire permanent population aboard *Aresam* can be hospitalized at any given time. Included in these hospitals will be several specialists employed by *Aresam*, dealing in infectious disease and equipped with enough vital equipment to deal with a epidemic outbreak, with the equipment being able to sustain a third of the permanent residential sector. In addition to these hospitals, there will be a number of private family GP's available in each of the residential sectors, reducing the strain on hospitals. However, if there was an emergency infectious disease outbreak, the capsule infected would be immediately sealed off from the rest of the settlement, using sealable bulk-heads. Specialists would then be sent into the sector and vaccines would be appropriately distributed. Such an outbreak would also ensure immediate closing of the lifts and PACTS. All passengers and cargo recently deported from that sector would be thoroughly checked. If a capsule is rendered uninhabitable for whatever reason, all residents would be immediately evacuated in less than 30 minutes from the time such a warning was issued.

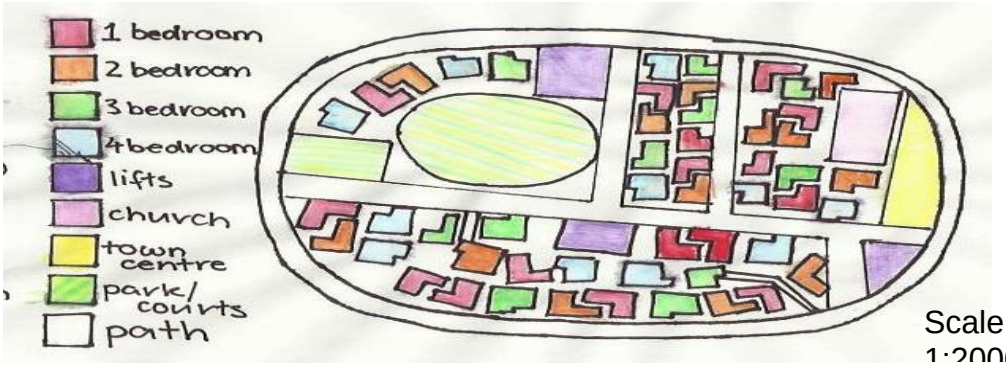
To assist in an infectious disease outbreak, the PACTS will be installed with permanent air ventilation systems, which will constantly asses the quality of the air, and send an alert if there is an issue. However, in such an event that the Maglev is shut down, all passengers aboard will be immediately transferred to the closest medical quarantine. The Maglev system consists of three separate, 3 carriage Maglev's on constant rotation. Each carriage has the capacity to carry 50 people each, and therefore it has been decided that there will be **6** robots per sector on standby to clean the Maglev, taking an approximate 6 minutes in total from the time the robots enter the Maglev, to when it is fully functional and back in rotation.

4.1.3 Parks and Recreation

Aresam aims to provide all levels of sport and recreational activities, including professional and amateur sport. To cater for such a range of sporting pursuits in such a relatively enclosed space, a mass sporting facility will be constructed. This single leveled sporting facility (due to 4m clearance on each level), designed entirely of Architiles, will cater for a diverse range of sporting interest, in addition to a mass gym open for public use. Haptics will be used for virtual exercise that occupants can use in their own home. It allows for exercise that feels completely realistic and residents can therefore take part in virtual sports, such as kayaking, which wouldn't normally be available. The facility will house a football sized oval, each surrounded by grandstands for professional sporting events, or amateur sports as soccer, or football. These fields will have the ability to be changed (due to Architiles construction) of changing to become basketball style courts, for use of such sports as netball and volleyball. There are also gyms which can be easily reached. It is, however, recognized that due to space restrictions and limitations of such a space settlement, certain sports and hobbies such as rowing or horse-racing are unable to be catered for (but will be available using Haptics). In addition to the mass sporting facility, there will be a several parks located in each of the capsules, with ample grass and playgrounds available for families and social gatherings for the *Aresam* residents.

Due to the diverse range of cultures aboard *Aresam*, it can be expected that there will be a diverse range of religious views as well. However, due to the limitations on space, *Aresam* settlement can only accommodate places of worship for the five main religions. In each residential level a multipurpose worship room can cater for those religions. It will have timetabled ceremonies for each religion.

Figure 4.1.3.1 Community Design



Scale (cm): 1:2000

4.1.4 Education

Education and schooling is considered a top priority aboard *Aresam*. However, due to the relatively small number of school aged residents aboard *Aresam,* with approximately 410 of the initial 22'000 residential population being children, divided among the three residential sectors, it has been decided there is a need for Virtual Education Schooling. Virtual Education schooling allows for the diverse range of languages expected aboard the settlement. In addition to this, virtual schooling has the capacity to cater for the transient population and the expected expansion of the population. This virtual schooling system will be implemented into each home who requests Virtual Education via the internet, with classes and lectures being transmitted online and exams being conducted at the Headquarters at set times of the year. Virtual Education Headquarters (VEH) will be installed into *Athena* sector for residents who have issues with the system or queries about the course, and where all course uploading will be handled by the technicians.

As on Earth, there will be compulsory schooling from the age of 6, with *Aresam* residents completing 7 years of primary schooling, and 5 years of high school education. In addition to this, Virtual Universities will also be available, allowing *Aresam* residents to find work in all fields once completing their education. Education aboard *Aresam* will mirror those courses on Earth, so that residents can also find work in their chosen field on Earth, should they choose to move. However, it is recognised that virtual education schooling is psychologically isolating, particularly for young children. Therefore, there will be organised activities and amateur sporting events after school hours where children will learn the social skills ordinarily gained by attending school.

4.1.5 Distribution of Consumables

To sustain *Aresam* residents, it has been decided that there will be a number of fresh produce available to them daily that will be grown in the agricultural capsules. It will then be stored until needed and transported to residential areas for use. Residents can go to the designated shopping levels to easily buy food, clothes, appliances and consumables. They have access to shops via lifts which are all within walking distance. 3% of space is allocated to paths. These levels also have communication devices to stay in touch with loved ones. The amount recommended for residents is shown in the table below (Figure 4.1.4.1).

Figure 4.1.4.1

Consumable	Sourced from	Quantity (per year)
Food and produce	Initially Alaskol then self sufficient	8,000 kg
Clothing	Organic means on settlement	100,000 units
Appliances	Imported from earth and manufactured	200,000 units
Gifts and entertainment for tourism	Earth, Alaskol and settlement	50,000 units

4.2.1 Residential Design

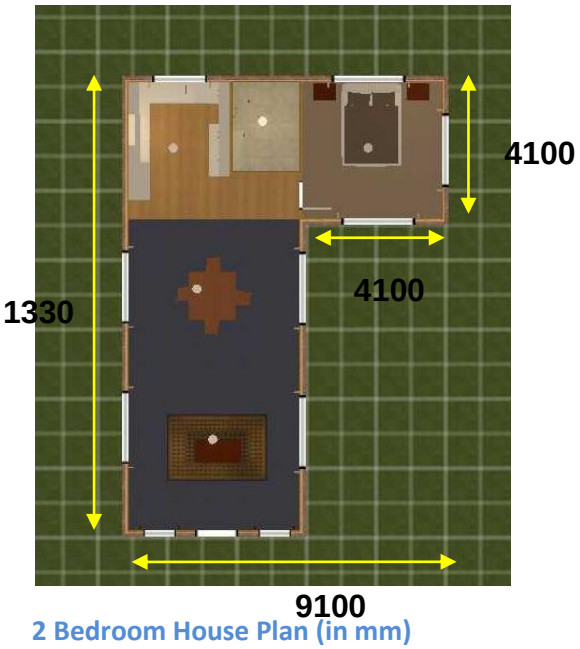
The table below demonstrates the average capacity, quantity and cost of the residential homes located in each capsule. Each capsule will have similar number of houses, but not the exact same layout. **Figure 4.2.1.1**below indicates quantities and prices of each house aboard Aresam. The figures following that are four images of the floor plan and external residency view of each type of house available for residents.

Figure 4.2.1.1

Style of House	Area (sq. ft.)	Price (1250 credits/sq. ft.)	Quantity
1 Bedroom	896.7	1 120 875	17160
2 Bedroom	1 073	1 341250	440
3 Bedroom	1168	1 460 000	220
4 Bedroom	1 385	1 731 2550	147

Figure 4.2.1.2.

1 Bedroom house plan (in mm)



2 Bedroom House Plan (in mm)

Figure 4.2.1.3

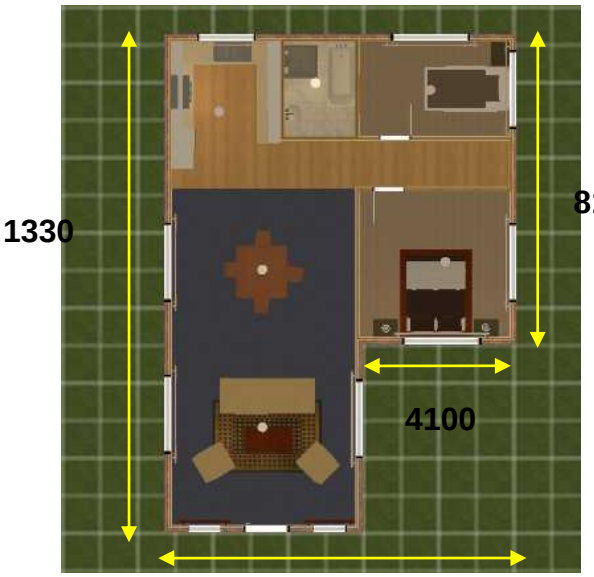


Figure 4.2.1.4.

3 Bedroom House Plan (in mm)

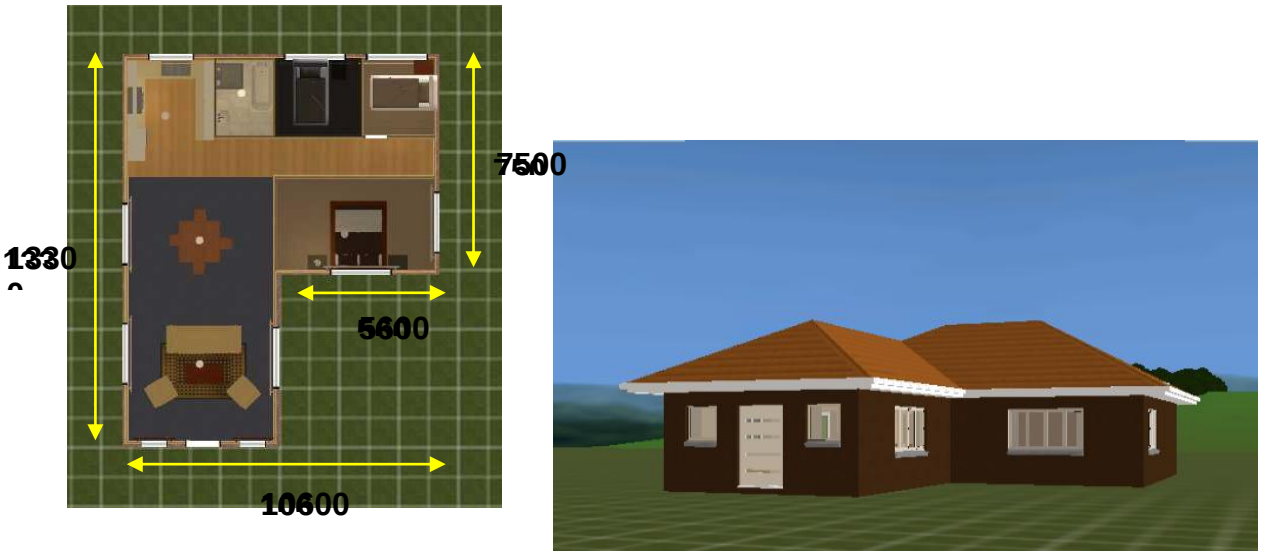
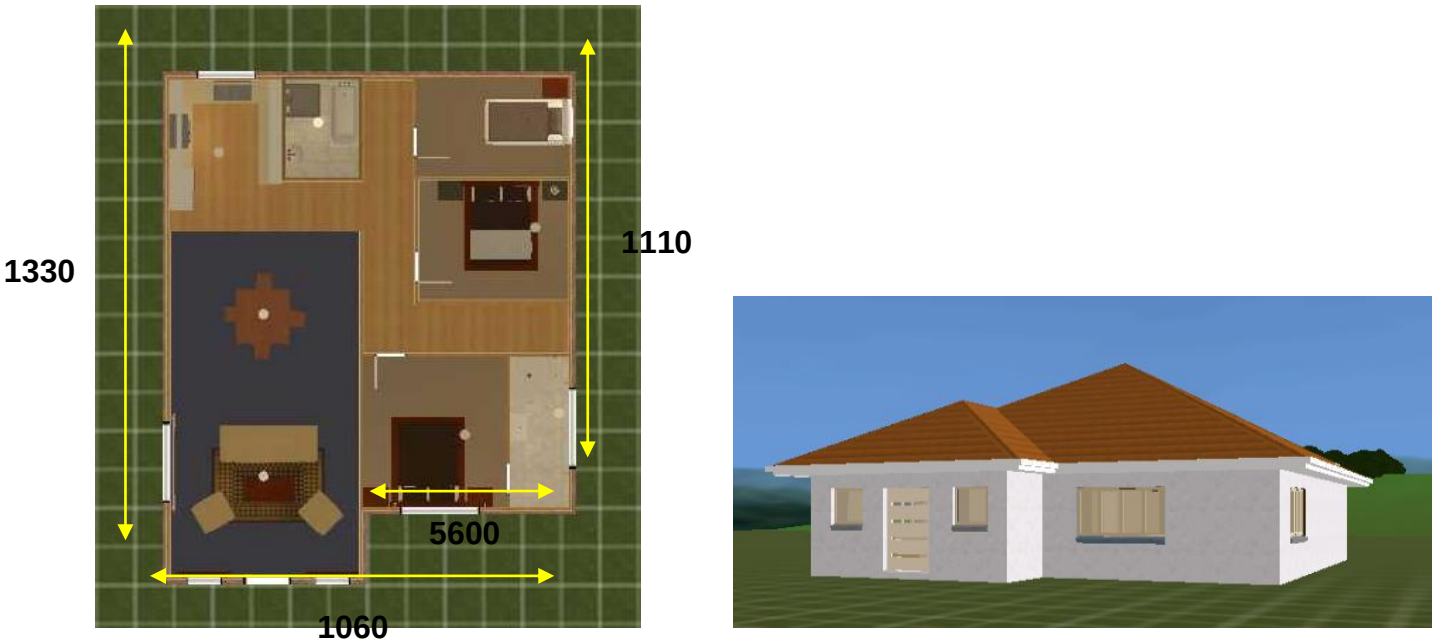


Figure 4.2.1.5 Bedroom House Plan (in mm)

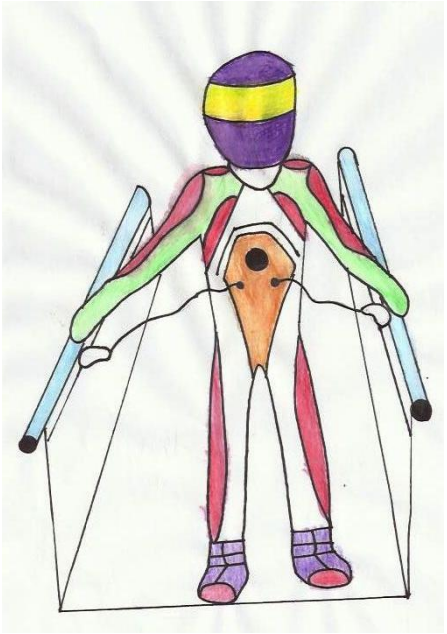


4.3 DEVICES, SYSTEMS and VEHICLES

4.3.1 Safety in low-G areas

Safety is a priority for residents and workers travelling through the many low-G areas. Attached to the spacesuits will be tethers, one on each side, with carabiner clips on each side attached to a rail. Above the carabiner rail, is another moving rail that the person can grasp. They are standing on a travelator that pulls them along at the same rate as the rail. If anything should happen, such as the person's foot getting caught, there is a button on the suit that immediately disconnects the tethers so the person isn't hurt. There are also rails attached to the top of low-G areas just in case a person becomes loose. They will then be able to manipulate themselves back down by using their SAFER.

Figure 4.3.1.1

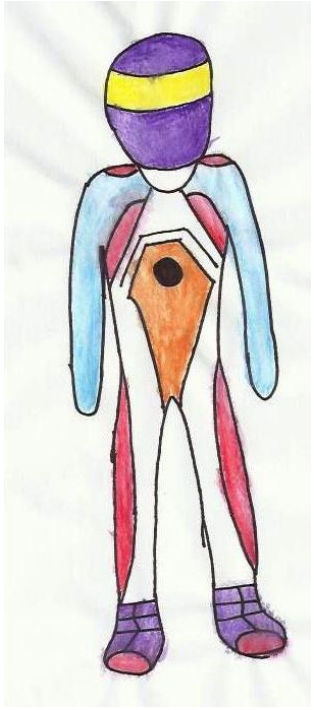


4.3.2 Spacesuit

The spacesuit that will be used by residents in many situations is one that allows for maximum mobility and personalisation. It consists of strong materials such as Kevlar, which is bulletproof, and several layers of insulation as well as spandex with small plastic tubes to transport water over the body for temperature control. The tight layer that creates pressure on the body sis constructed of strong synthetic fibres. There is a backpack that contains all food and oxygen supplies as well as a SAFER (jetpack with joystick for occupants to control). The helmet is made of polycarbonate plastics and uses anti-fog and gold visor technology to ensure safety. It has an earpiece and speaker for easy communication. To don and doff the suit Astronauts must first don the synthetic fibre, elastic and spandex layers. Then insulation and Kevlar (including helmet and boots) layers are attached automatically. Gas then begins to circulate throughout the helmet. To doff the suit the same process is used but reversed. The outer layers are removed automatically and then the inner spandex and synthetic fibres are removed. This all takes place in an airlock on *Aresam. Crux* will subcontract Lossless Airlocks for the construction of *Aresam's*

airlocks. They range their airlocks to fit one person to three people simultaneously in different chambers. Different sized airlocks will be positioned depending on where they are needed and the amount of people estimated to use each one. Lossless airlocks pride themselves on their efficiency when ejecting persons. There is almost no loss of atmosphere for each opening to space. Before the person is ejected the airlock changes the air pressure to match that of the environment being entered into. This can take several hours if the person isn't wearing a spacesuit. Astronauts exiting *Aresam* entirely will be wearing a pressure suit but those simply travelling thorough low-G areas may not. The occupant is enveloped in a coated Kevlar tube that is then forcefully ejected when the outer doors are opened.

Figure 4.3.2.1



4.4 Changing Demographics

Within each capsule residents will be grouped for ease and to have a positive community atmosphere. *Crux* has decided to group residents by basic beliefs (not religion) to avoid conflict and disagreements. When entering the settlement a short quiz is taken to ensure people and families are placed in capsules with similar personality traits. This will ensure guests are happy with the community atmosphere and will easily be able to come across new friends. This won't be upheld religiously as having different personalities in a community can be beneficial and allows residents to meet new and interesting people. When being placed in a capsule racial background will also be taken into account. This will ensure capsules can have similar community events and can communicate with each other well. This will combat isolation within the capsules. It is expected that over time many demographics will change. The system in place used to group residents can accommodate change as the quiz can easily be modified for future society.

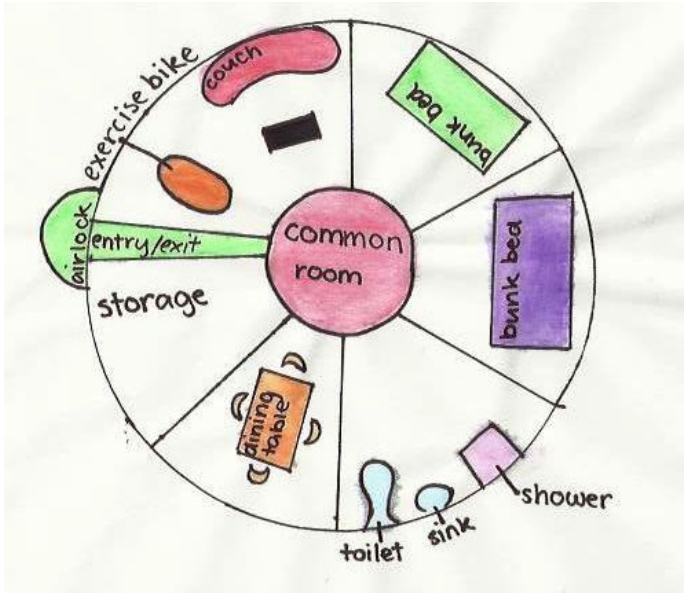
Table 4.4.1

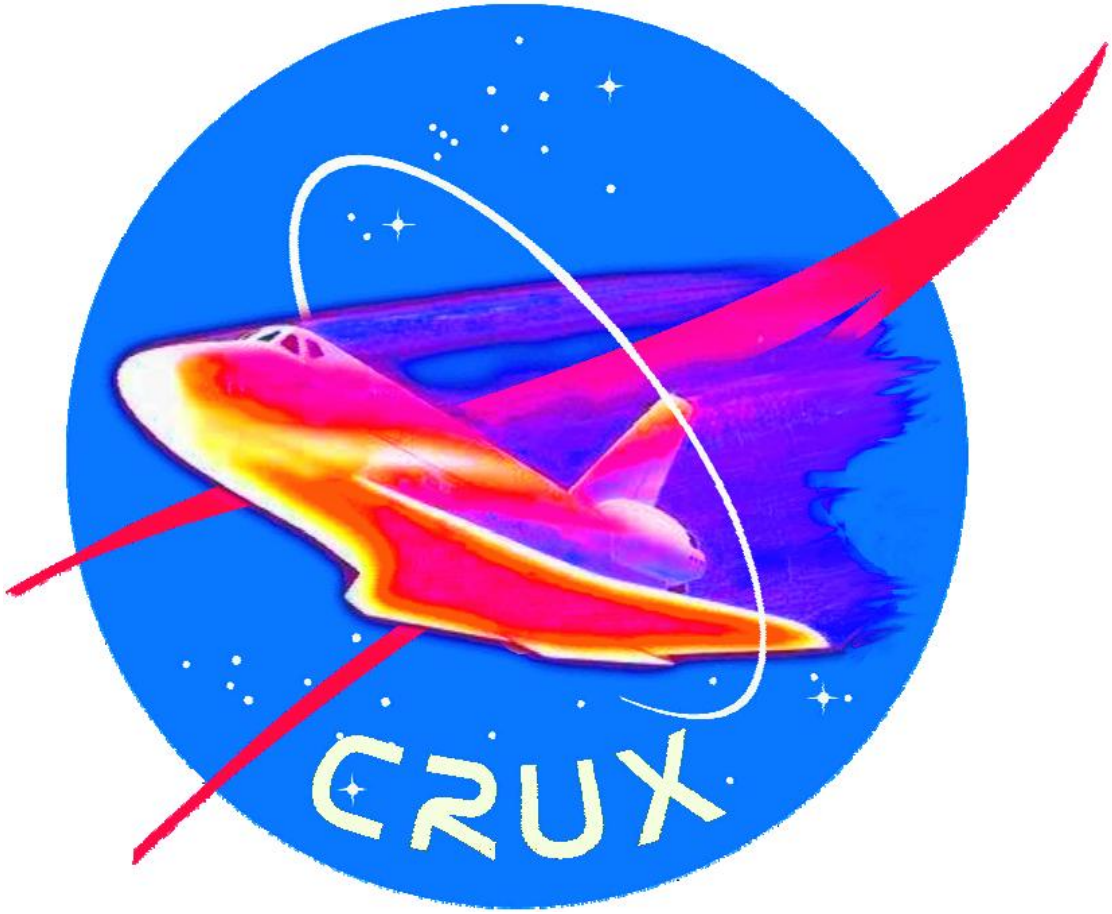
Examples of Racial Background	Examples of Personality traits
European	Openness
Australian/American	Conscientiousness
Russian	Extroversion
Asian	Agreeableness
African	Neuroticism

4.5 Prefabricated Base

The prefabricated base that is to be used on mars surface will only be used by a small group of people for limited time. It is not necessary to have access to every luxury a house has. As it changes size depending where it lands on Mars an approx. size is not applicable. However, there is a minimum requirement for occupants to be able to live comfortably. It will be It is a circular shape with the airlock attached to the outside. It has an entry through to the common room. Off the common room there are two bedrooms with a folding bunk bed in each. Then there is a bathroom with a portable shower, toilet and sink. The dining room is only equipped with a fold out table and chairs because the complex is fully automated. Robots will be preparing food and controlling waste. There will also be limited entertainment and communication. Residents will be able to communicate with Aresam and be able to watch TV. There is also an exercise bike to keep occupants fit and participate in exercise. A section will also be used for storage. It will keep the food, clothes and other essentials stored ready for use.

Figure 4.5.1 Prefabricated Base floor plan





5.0
Automation Design and Services

Automation Design and Services

Crux ensures only the highest caliber of autonomous devices to be utilized in the construction and operation of Aresam. Our company prides itself on automated devices; primarily our adaptable multi-purpose F1M8 robots and our Grumbo space vehicles. As such, all robots or cargo vehicles will be specialized variants of the modular F1M8 robots or Grumbo Jumbo vehicles. Automated devices will be utilized to perform hazardous and monotonous tasks, ensuring the safety of all residents.

5.1 Automation of Construction Processes

Automated robots and machinery are imperative to the construction of the settlement, as they reduce the amount of manual labor required and make the construction process shorter, more accurate and safer. Humans will be able to supervise and control away from the site using the Video Probe (See Appendix 4).

5.1.1 Transportation of Materials and Equipment

Machinery will be used to both transport and deliver the materials and equipment which are essential for the Aresam settlement. The Grumbo Jumbo MCAR will be the primary form of transportation for both processed construction materials and pre-constructed sections to the construction site. The Grumbo Jumbo RCAR will transport the automated cargo necessary for the construction. Lastly, the Grumbo Jumbo ICAR will transport the cargo which is required to build the interior of the Aresam settlement. The tables below list the automated robots which will be utilized for construction.

Table 5.1.1.2

Name	Description	Purpose	Location	Quantity
Grumbo Jumbo MCAR (50mx40mx60m)	Materials cargo	The MCAR transports refined metals, pre-constructed and materials which are needed for settlement	From Earth to on-site construction	60
Grumbo Jumbo RCAR (45mx15mx10m)	Robot cargo (all automation)	Will transport automated robots for the construction of the settlement.	From Earth to on-site construction	70
Grumbo Jumbo ICAR (55mx10mx10m)	Transports interior cargo	ICAR will transport the required interior materials	From Earth to on-site construction	90

5.1.2 Assembly of Settlement

The primary construction phase will be positioning the pre-fabricated pieces of the settlement and welding them together to create a main frame. This will be done by using FUR-F1M8 (see appendix 4). All shaping of materials will be done with the SR-F1M8 which can work in groups and use its hydraulic 3 axis arm to do this. The basic interior structure is built into the main frame, and all necessary materials will be delivered to corresponding pods just before final seal off. The WAL-F1M8 and UTIL-F1M8 will then complete the interior design.

Table 5.1.2.1

Name	Description	Purpose	Location	Quantity
FR-F1M8 (8mx6mx10m)	Robots which construct the framing of the settlement – welding, and positioning	Assembles the frame of the settlement	On-site	520
SR-F1M8 (6mx4mx6m)	Small robots which attach sheeting of the settlement. They work in groups or individually.	Bends shapes and attaches exterior sheeting of the structural settlement.	On-site	155
IN- F1M8 (1mx1mx10m)	Robots to inject, and pump any liquids into the hull	To apply outer liquid barriers to hull	On-site pumping from MCAR	100
ViP-F1M8 (1mx2mx1m)	Captures a video of the construction in real time	Allows supervision of building sequence	On-site	55

5.1.3 Interior Finishing

The WAL-F1M8, UTIL-F1M8 and FUR-F1M8 assists with the construction of the interior finishing of the settlement. The WAL-F1M8 uses Architiles to create the interior walls for homes. Architiles are made of Nanoplastics and consists of four layers; a surface layer of variable texture, a power plane beneath, a computing and communications layer and a honeycomb section to enable channeling of liquid waste when needed. UTIL-F1M8 installs the utilities for the settlement. Lastly, the FUR-F1M8 (See Appendix 4) is a robot which installs the interior furnishings for the settlement.

Table 5.1.3.1

Name	Description	Purpose	Location	Quantity
WAL-F1M8 (4mx2mx6m)	Installs walls for the interior of the settlement	To create interior walls for homes using Architiles	On-site construction	300
UTIL-F1M8 (10mx5mx8m)	Robot which installs utilities in the interior of the settlement.	Installs utilities for the settlement. Such as lighting, wiring, and plumbing	On-site construction	550
FUR-F1M8 (2mx4mx2m)	Furnishes the interior of the settlement.	Installs the interior furnishings, flooring and painting.	On-site construction	1000

5.2 AUTOMATION OF SAFTEY AND OPPERATIONS

5.2.1 Critical Data Security

Measures will be in place on Aresam to make the access of critical data secure. These measures include the standard hand print security, for accessing lower level clearance information. To access higher security data authorization codes and 2-3 person access -depending on the level of security- will be needed. These measures insure a higher level of security for critical data.

To ensure round the clock safety and efficiency Aresam will have a routine SmartScans. SmartScan will utilize basic sensors such as heat, infrared, pressure and flow, and substance scanning, etc. and use a smart computer that's constantly analyzing this information to spot anomalies. The SmartScan Sever will also be an extra measure for constant data security using the latest virus and computer firewall software.

Table 5.2.2 lists all emergency and contingency plans

Issue	Response
Fire	Alarm, evacuation and appropriate fire extinguishing method applied. Then fire affected area sealed off until damage can be assessed.
Hull damage	Automated projectile detection network that alerts robots to fix the breach if necessary Refer to 2.1
Atmosphere Contamination	Alarm and evacuation. Contaminated area purged of contaminated gases and then replaced.

Data and computer damage	Data redundancy built in. Backup systems and constant information transmission allow for a greater data security.
Solar flare	All structures and external devices are radiation shielded.
Quarantine	Cargo check before and after transportation Medical quarantine: Emergency lockdown procedure- quarantine measures to contain an outbreak
Leaks	With all the storage and piping involving liquid and gas, pressure and flow will be sensored. In the case a leak occurs, the flow of the substance stops, or area sealed off until area can be surveyed for damage.
Power back ups	In the case of a power failure, there are emergency power generators.

Table 5.3.3 shows all automated operations systems

Operation	Requirements	Robots/Automated systems	Computers
Power Generation	Power allocation	Solar Panel Moving, Microwave following receivers.	Moving Solar Panels to where there is sun light. Moving microwave receivers in correspondence to the satellite tracking. Power direction and usage control.
Transport	Safe travel	The PACT – transportation between pods for people and cargo.	Calculate higher efficiency, continuous movement, and on/off programs. Tracking, logs and emergency monitoring.
Cargo and docking	Control cargo processing	Automated transfer, loading and storage	Tracking, logs
Agriculture	Growth and processing	Agriculture packaging, processing machine, water regulation and food transportation	Growth monitoring, Management of processing and food delegation
Communication and safety	Data Security and monitoring of all critical areas	NA	Data Restrictions and network monitoring, records of all data access
Navigation	Aresam orbiting mars	Adjusts movement accordingly	Monitors course and Coordinates movement
Systematic environment and error check	Regulation of environment and detection of any errors	Daily scans	Analysis of data and delegation of response
Water management	Purification, storage and recycling	Automated processes	Monitoring of Purification, recycling, storage and usage
Climate Control	Monitoring Atmosphere	NA	Monitoring of atmosphere, programming to of seasonal changes
Community, repair and general maintenance	Internal, communal and household Upkeep	Working with Grumbo and Their F1M8 repair robots	Scans for damage, programming and monitoring for home and communal upkeep

5.3 Habitability and Community Automation

5.3.1 Automation to enhance livability, productivity and convenience

To enhance the livability of the settlement, each individual aboard Aresam will be issued with a Personal Remote Control and Communication Device (PRCCD) (See Appendix 5). The PRRCD will have the three main functions of communication, information and remote controlling of all personal environmental and entertainment. The PRRCD will also have many optional extra applications for entertainment, security and work. Basic PRRCD is small and light enough to wear on wrist or arm but this is optional. The PRCCD will allow remote controlling, from anywhere within the settlement, of environmental settings in residences relating to climate control and atmospheric conditions, lighting and home entertainment systems. Each PRCCD will be fingerprint activated to allow for complete security in operation.
For greater ease and convenience in household washing and cleaning, each home and workplace will have a cleaning robots, Scrub-F1M8, and FloorScrub-F1M8 assigned for everyday cleaning tasks such as dusting, bed clothe changing, floor cleaning etc.(See Appendix 5). These will work independently after instruction, using Sensors to identify objects obstructing the device, Static dusters attached to flexible extendable arms which collect dust of surfaces static dusters and vacuum collects dust from ground, and ultraviolet and ultrasonic -where appropriate- to sterilize. In addition to this, each residence aboard Aresam will be fitted with washing machines- the HWM's. These new and improved washing machines will be similar to those on earth with added features to maximize convenience and efficiency in the home. It works so that clothing will be placed in a chute, a Sensor then detects when full, Clothing fibres are scanned then clothing is sorted and placed into the machine to be washed, with the appropriate cycle. Additional cycle includes, Anti-crease spin cycle, Items are pressed and folded ready for collection (See Appendix 5). All items from the machine will then be mechanically folded and carried through a mechanical roller portal onto a conveyer belt. The clean and folded items will then be piled up at the end of the conveyer belt, making the washing process easier and more convenient for residents.

5.3.2 Automation to perform maintenance and reduce manual labor

As a means to reduce manual labor, routine, monotonous, or hazardous tasks will be performed by numerous automated systems. General maintenance and repair work to be completed aboard Aresam will be carried out by automated robots for tasks such as internal and external repairs of the settlement and structures within it. In addition to this, their tasks would also include locating any damages or mechanical and structural flaws aboard Aresam requiring restoration or repairs.
The majority of maintenance and repair tasks to be completed aboard Aresam will be performed by variants of Crux's multi-purpose F1M8 robots to reduce manual labor. Once the construction of the settlement is complete, most of the construction robots – the FUR-F1M8, UTIL-F1M8 and SR-F1M8 – will be reassigned to maintenance and repair work, to make cost-effective use of robots already aboard Aresam. Routine checks of all utility and operations systems incorporated with a –smart scan- will allow for efficient and accurate repairs.

5.3.3 Privacy and control of personal data and systems

Privacy and security of personal data is essential to ensuring the safety of individuals aboard Aresam. Many different forms of security measures have been explored, so that the residents of this settlement can be best ensured. For a basic level security clearance, allowing access into the home or workplace and low level security data, an individual's handprint will be swiped at an entry point (see appendix 5). This was chosen as the best security because of its ease and un-obtrusiveness. This allows access to day-to-day actions without needing to carry anything. This also is a completely safe way of both identification and password without the chance of it getting lost. In the same manner, any person can use this for access into their own place of residence and workplace outside of unrestricted community facilities. As such, if a person wanted to visit another resident, they must be

let in by that person. For higher level clearance, authorization codes with the PRCCD, and multiple persons to verify authorization will be needed.

5.3.4 Access to computing and robot resources

All residents aboard Aresam will have access to community computing and robot resources both from individual's homes and workspaces. The PRCCD allows roaming internet access from anywhere within the settlement and connections to the Aresam intranet. All accommodation will also be fitted with a wall mounted computer for easy home internet access. In terms of access to robot resources, robot networks will be available to the general public for various tasks on a time rental scheme – the length of rental depending on the task required for completion.

5.4 Internet Connectivity

5.4.1 Method for exchange of data

Aresam will make use of laser optical transmission systems with a fan-like ray to relay data to Earth, while data reception will be controlled by a network of highly sensitive Single-Photon Detectors (SPDs). However, the fluctuating distance between Mars and Earth caused by variations in orbital times poses a challenge for the exchange of internet data packets between Aresam and Earth-based repositories. The weakness of the proposed method involving the use of laser optics lies in the necessity of a linear link between Earth and Aresam, which is often obstructed by Mars or solar conjunction, potentially causing communication delays of up to two months. Signal repeaters consisting of a transmitter, a storage system and a network of SPDs and will be installed at libration points L3 and L4 as well as on Alaskol to prevent attenuation of the optical signal, provide an alternative route when paths between Aresam and Earth are obstructed and avoid data corruption in the event of a coronal mass ejection.

5.4.2 Data Transfer Process

Exchange of data between Earth and Aresam will rely on the creation of a 'Virtual Net Package' (VNP) consisting of different types of data depending on time of day (Houston Time). This VNP will be streamed to Aresam's server using the laser optical transmission system, where one copy will be kept in case of data corruption, and one copy will be used to update Aresam's Virtual Net. As the Virtual Net updates instantaneously within the Aresam network, users will appear to have instant browsing access and the ability to freely collaborate. Upon the conclusion of the allotted time period, a computer on Aresam's network will: log changes made within Aresam's network; check for and attempt to prevent data corruption; and create a new VNP to be transmitted back to Earth's servers. This process is detailed in Figure 5.3.2.1.

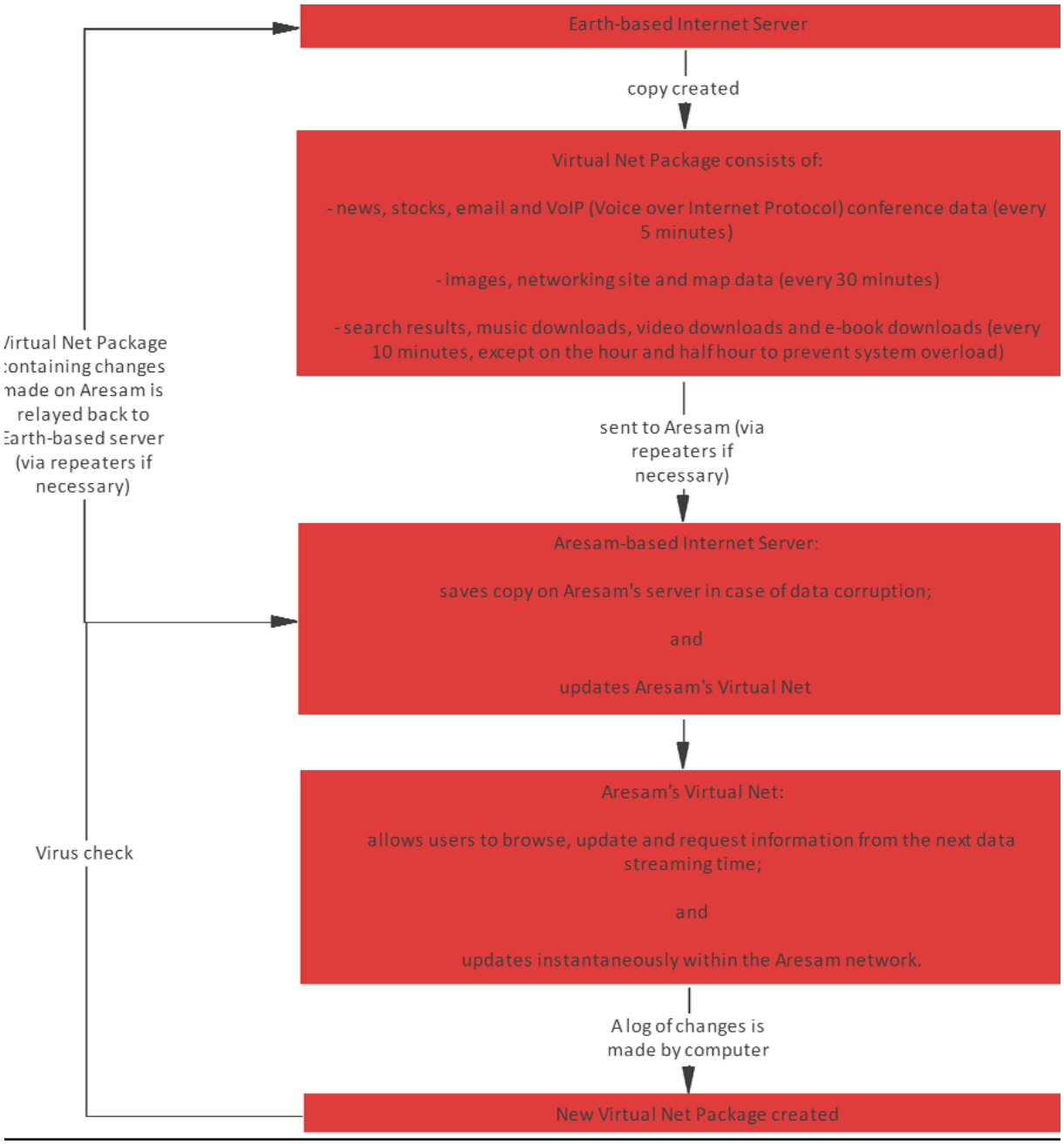
5.4.3 Internet Experience on Aresam

As the Aresam network operates independently to Earth's network, changes made by users on the Aresam network will appear instantly within Aresam's network. In relation to the changes made on Earth's network, users will simply be made aware of the data streaming delay time between Earth and Aresam upon beginning their browsing session. Table 5.3.3.1 details the user experience on Aresam.

Table 5.4.3.1

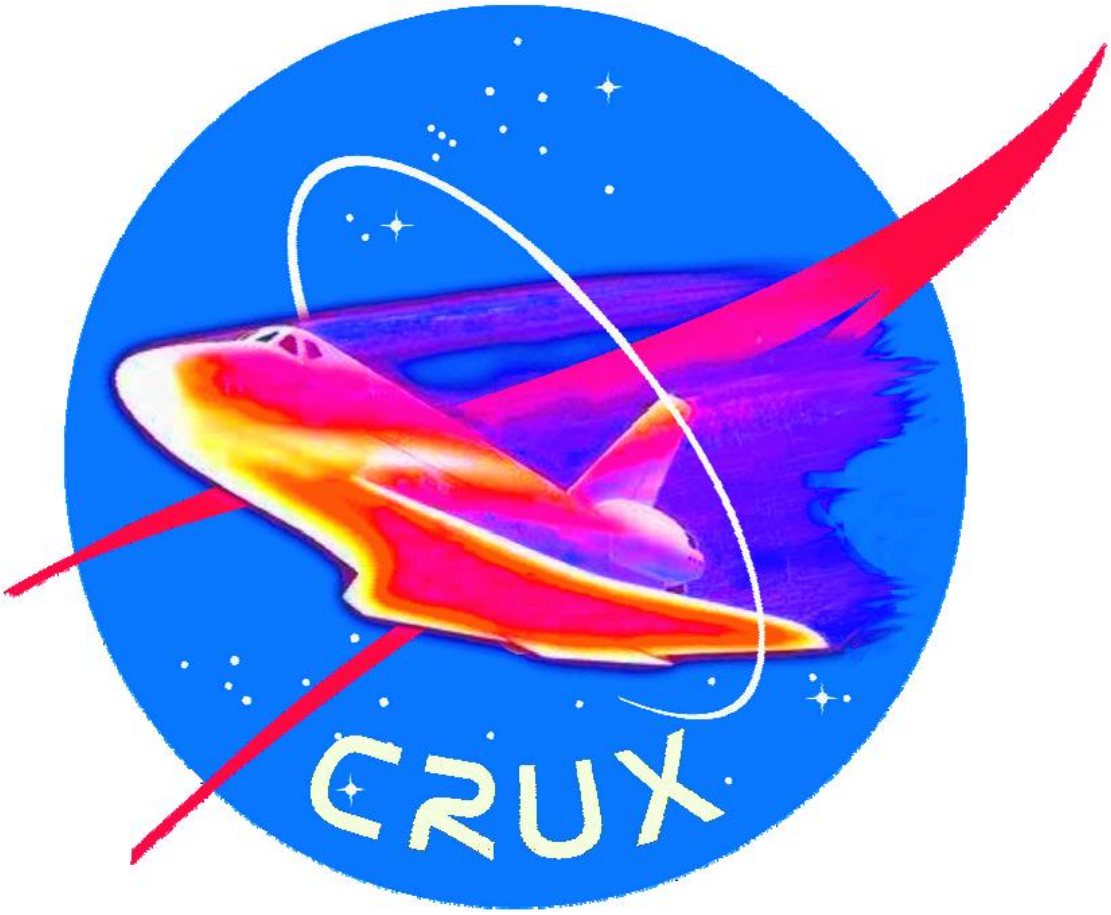
Situation	User Message or Action Taken [follows the form: *User Message*/Experience]	User Options Available [follows the form: *User Options* (Corresponding function)]
A user begins a browsing session.	*Due to delays in data exchange between Earth and Aresam, your browsing session on Aresam will differ slightly to that on Earth. Please note that your changes to Aresam's network will appear on Earth's network (and vice versa):* *- in five (5) minutes for news, stock information, email, VOIP conferences and video conferences* *- in thirty (30) minutes for images, social networking sites and maps* *- upon request for searches, videos, music and books*	*Okay* (Accept notice and continue browsing session).
A user chooses to browse pages containing news, stock information, emails, VOIP conferences or video conferences.	No message appears. The user is provided with the most recent version of the page.	None.
A user chooses to browse images, social networking sites or maps.	No message appears. The user is provided with the most recent version of the page.	None.
A new VNP is available while a user is browsing	*An updated version of your currentpage is available. Do you wish to view the new version?*	*Yes* (View the updated VNP now). *No* (Update when user refreshes).
A user chooses to request music, videos, books or a search.	*Your request will be sent to Earth based repositories in [time until next update in minutes].*	*Okay* (Wait for request).
The most recent VNP has been corrupted or unable to reach its destination.	*A technical error has prevented the server from updating. We apologise for the delay.*	*Okay* (Wait for next VNP to arrive).

Figure 5.4.3.2 Aresam's Virtual Net



5.5

Like the settlement the mars base construction will also be mainly automated. This will insure speed, efficiency, and safety. The automated robots to construct the base will be hybrid space buggy-F1M8's much like the FR-F1M8 and SR-F1M8. Operations on mars, Phobos and Deimos will be automated in the same manner as on settlement operations (see 3.4).



6.0
Schedule and Cost

Schedule and Cost

Task	Cost (000 000' USD)	Start	Finish	Days
Award contract	0	5/07/55	5/07/55	1
Develop final design	295	5/08/55	5/31/55	24
Develop computer programs used for systems on *Aresam*	3430	6/01/55	5/30/56	365
All materials for major structural components to be used in construction are mined at Alaskol.	27250	6/01/56	5/31/57	365
Assembly process begins on Alaskol.	48250	6/01/57	2/25/58	270
Using Grumbo Jumbo MCAR, all construction materials are shipped to settlement location	24500	2/26/58	6/25/58	120
Ship F1M8s from Earth to settlement location to begin construction	25500	6/27/58	12/03/58	160
Construction at *Aresam* settlement site begins with the construction of the cargo port and central column	32000	12/05/58	4/23/59	140
Construction continues according to construction sequence, Table 2.3.	29000	4/25/59	4/08/60	50
Completion of outer structure in accordance with Table 2.3.	45500	8/10/60	8/09/61	365
Port Facilities within Aresam are completed and functional, allowing for the arrival of materials for construction.	15500	8/11/61	8/10/62	365
3 Residential sectors interior design is completed, and thoroughly checked to ensure quality and functionality..	37000	8/12/62	1/01/63	143
Agricultural sector is designed and checked to ensure functionality and the design allows for appropriate produce to sustain *Aresam* residents	27300	1/03/63	9/29/63	270
Industry and manufacturing begins construction, using F1M8's and materials mined from Alaskol.	45000	9/30/63	2/26/64	150
Industry and manufacturing is finalized.	18200	3/28/64	9/13/64	170
Ship initial workers and engineers to Aresam to oversee finished settlement and ensure it is functional and able to sustain members of the Foundation Society.	4500	9/15/64	1/12/65	120
Final check of all security and maintenance.	2700	1/14/65	1/13/66	365
Populate the entire space station and allow tourism industry to begin	20000	1/15/66	5/05/67	476
Handover of settlement to the Foundation Society	0	5/07/67	5/07/67	1
Total	405925			4220

7.0 Business Development

Business Development

Aresam will host a variety of commercial and industrial business ventures, which can adapt over time. This structure and layout of *Aresam* enables. The settlement will employ a new currency of credits, which are exchanged at one credit for every US Dollar.

Transportation Node and Port

In order to transfer freight between spacecraft travelling to and from *Aresam*, docking and cargo handling implements have been situated near terminals. Warehouses will also be situated near arrival and departure terminals for visitors to store their goods between arrival and departure. Terminal facilities such as fast food restaurants, duty-free shopping and membership clubs will also be put into service in order to handle passenger traffic between Earth, Earth orbit destinations, Mars and other locations in the solar system. Ship crews disembarking into *Aresam* will be provided with accommodation and recreational activities to complete whilst staying in the settlement. Accommodation options for the crews will be located within the residential areas of *Aresam* as an alternate environment away from the confinement of their ships. Both ordinary in-transit vacationers to *Aresam* and crew members will be exposed to a wide variety of recreational activities such as restaurants, theatres, and amusement parks whilst on their stay.

In- transit vacationers will also be able to experience great accommodation at reasonable pricing located in the three residential areas near all recreational activities. Medical and quarantine services will also apply in arrival and departure terminals to accommodate to foreign goods being brought into *Aresam* and to account for and sick or injured personnel flying to or from the settlement. Due to the initiation of the Foundation Society's operations of settlements near and on Mars, in-transit visitors to *Aresam* will reach to a population not exceeding 500 therefore, terminal, accommodation and recreational facilities will be equipped to service for a large amount of in-transit visitors.

It has been predicted that tourism on board *Aresam* will be very successful as multitudes have shown interest in holidaying on *Columbiat*. We forecast the settlement as a major success in the tourism industry, and therefore will be providing a resort and activities to attract potential daring customers. Resorts will be located in the residential sections of the settlement and will house public parks, restaurants and other amenities for use by both vacationers and permanent residents. Along with all these activities are the resort services, which will include a connection to Earths internet and pools. In addition to these, Aresam aims to accommodate transient visitors to the settlement with a variety of activities, including;

Activity	Price
Space Walk	300 Credits Per Person
Space Shuttle Rides	400 Credits Per Person
Zero G Ball Games	100 Credits Per Person
Universal Tour of Facility	75 Credits Per Person
Viewing Deck	35 Credits Per Person
New Perspectives Astronomical Experience	65 Credits Per Person
Movies	20 Credits Per Person
Gyms	30 Credits Per Person
Restaurants	N/A
Parks	Free

Space Manufacturing

The biggest commercial venture that will be undertaken by *Aresam* will be the manufacturing of raw space materials into exportable goods for economical gain, making up 73.2 percent of annual income for the settlement. *Aresam* will house industrial facilities used for the refining of raw materials into metals used to manufacture spacecraft and other contrivances. These facilities will allow for

manufacturing and assembly within zero-G so as to provide increased efficiency and cost-effectiveness, maximising dividends. Launch vehicles, lunar landers, inter-planetary craft and service and utility vehicles will be constructed and serviced within the dry-docks of the settlement and will provide expansion capabilities for humankind.

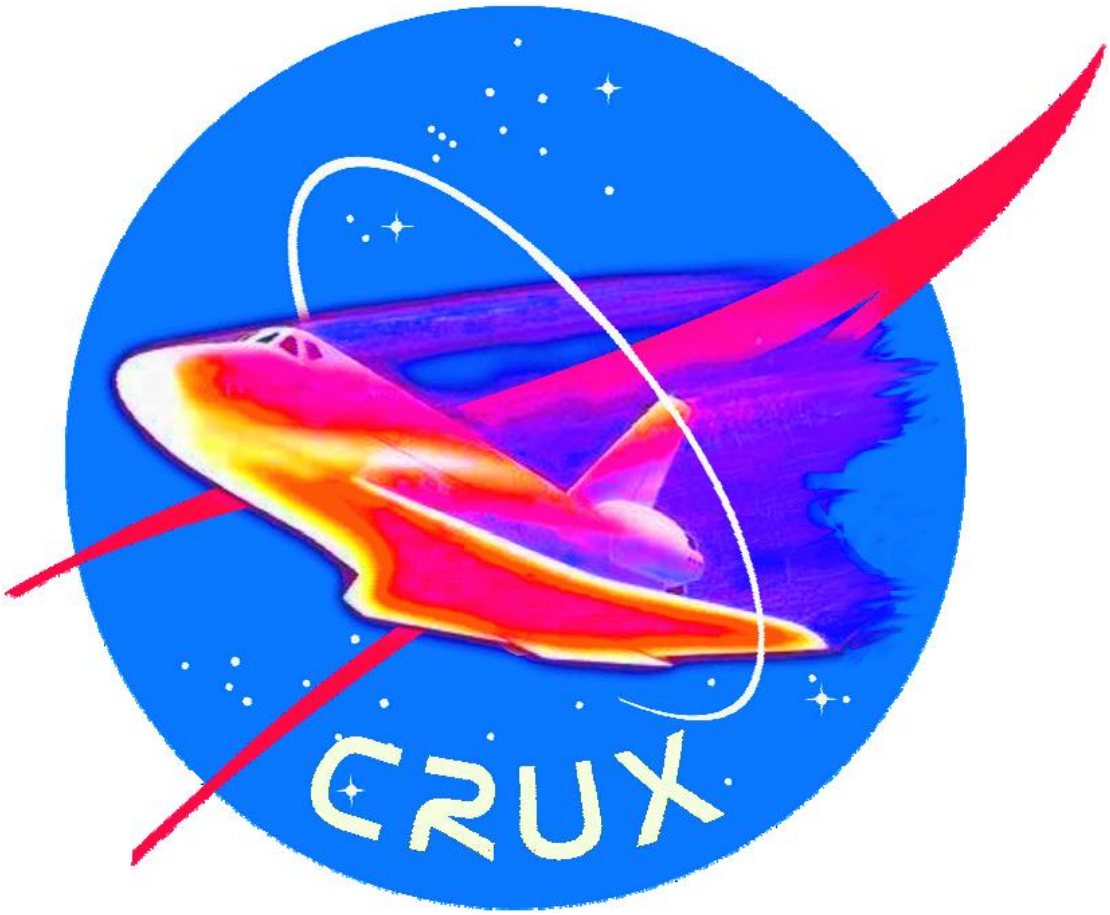
The manufacturing industry of *Aresam* will also provide materials and products that will be utilised for the creation of future settlements throughout the void of space. When necessary, specific sectors will be able to work together so as to produce construction robots and components for these settlements that can then be assembled and positioned. It will provide pre-existing infrastructure that will ease the costs of other large projects.

Vehicles and goods required for other projects will be able to be constructed within the confines of *Aresam*. These will include solar power and communications satellites, as well as vehicles required for use on lunar terrain.

Research Development for commercial products from Mars resources

Within the main structure of the settlement, a research centre will be situated in order to develop commercial products from Mars resources. The main purpose of this research centre is to further examine and experiment on materials in certain laboratories collected from Mars. Some of these materials include iron (III) oxide (rust), basalt and silica. Previously, the Phoenix Lander after collecting a sample of the soil from Mars concluded that it contained essential nutrients such as magnesium, potassium, sodium and chloride all of which are vital for living organisms to grow. These periodic elements could therefore help in the development of the settlement as they can not only be used in experiments but can also be used to create everyday items such as soap, fertilizers and dry and air-free solvents. As many of the materials/ elements extractable from Mars have great commercial potential, small factories located directly beside the Research centre will immediately begin production of the everyday items listed above to contribute to the profit of the overall settlement. As materials brought into the settlement are of an unknown hazard rate, quarantine services will be provided within the laboratories of the Research Centre if a material is proven to be dangerous to human life form.

Quarantine Procedure:
Examine Material → Secure the Laboratory→Call on specialist to examine specimen →Clear material or send it off for further examination



8.0 Appendices

Appendix 1

Figure 3.2.2.1 – Aquaponics Diagram

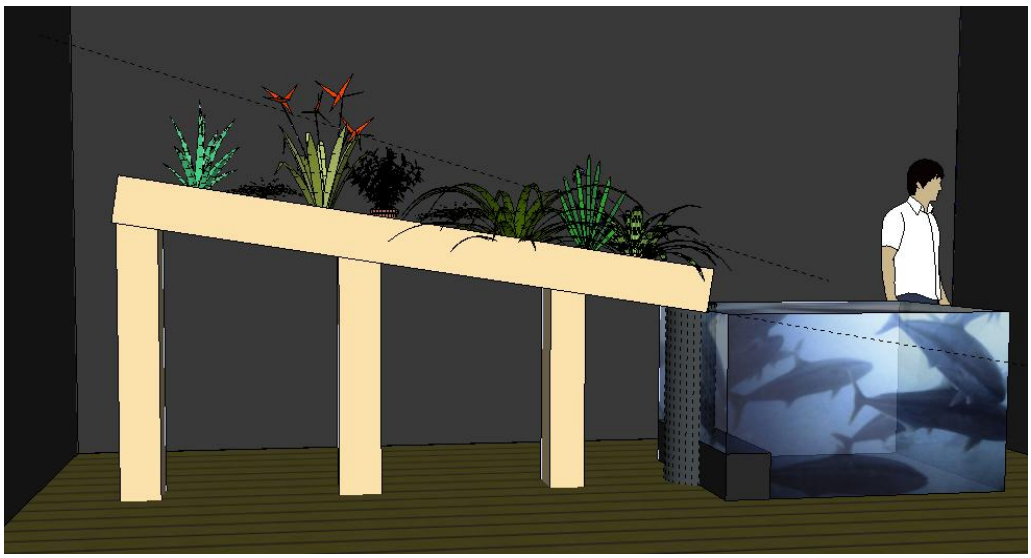


Figure 3.2.6.1 – External Communications

Appendix 2

Figure 4.2.1.2.

1 Bedroom house plan (in mm)

Figure 4.2.1.3

2 Bedroom House Plan (in mm)

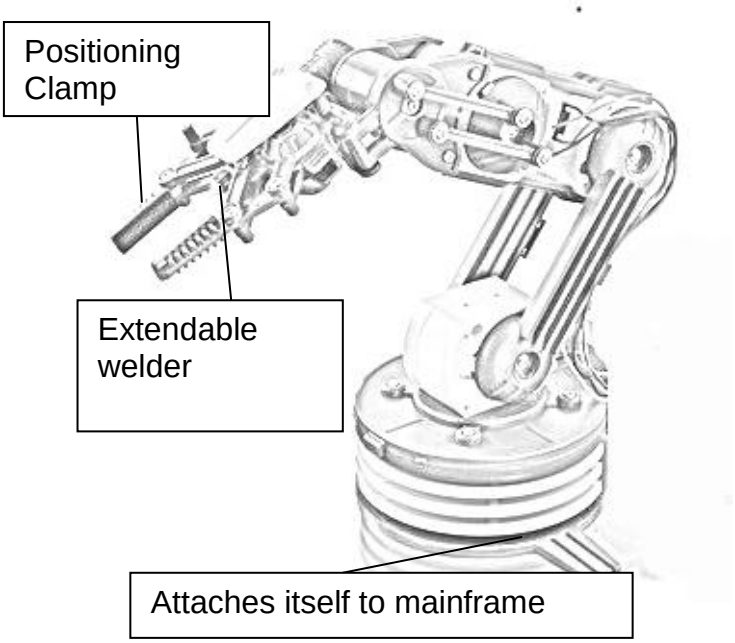
Appendix 3

Figure 4.2.1.4.

3 Bedroom House Plan (in mm)

Figure 4.2.1.5. 4 Bedroom House Plan (in mm)

Appendix 4

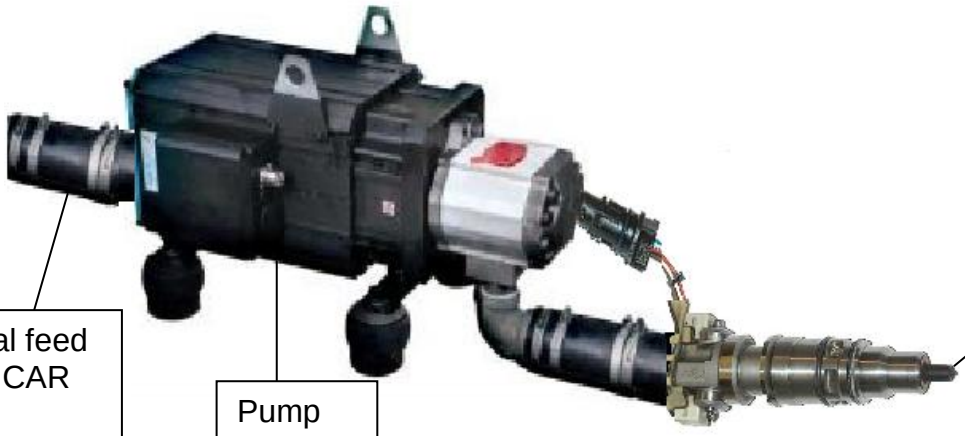


FR-F1M8 (8mx6mx10m)

ViP-F1M8 Video Probe

3 axis hydraulic arm- allows for greater strength and movement in manipulating materials

SR-F1M8



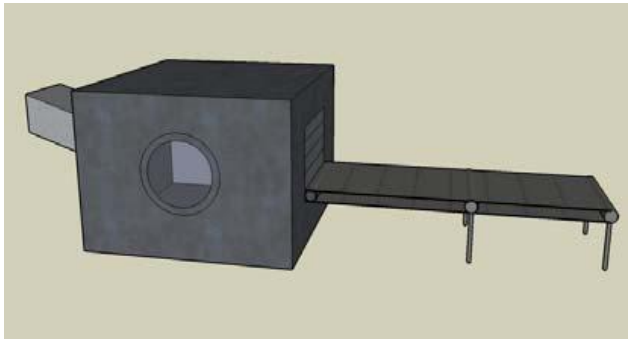
Material feed from MCAR

Pump

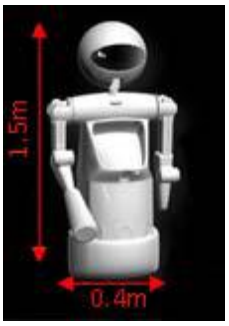
Injecting Nozzle

IN-F1M8

Appendix 5



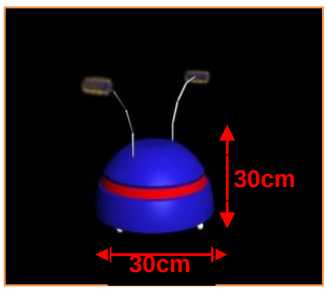
Home Washing Machines (HWM's)



Scrub-F1M8

Wrist /hand band For PRCCD

Personal Remote Controlling and Communications Device (PRCCD)



FloorScrub-F1M8

Hand Scan Security

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Compliance matrix

Section Heading	Requirement	Meeting of Requirement	Page Number
2.0	Room for 20000 full time residents plus an additional 50 transients Initial Operational Capability and increasing by 50 per year for 30 years	"Home to 22 000 full time residents in addition to a transient population of 500 people at full operating capacity, Crux also aims to provide a comfortable and modern living environment for tourists and permanent settlers."	5
2.1	Overall exterior view of settlement with major visible features Show rotating and non rotating sections, pressurized and non pressurized sections	*"...that Aresam be comprised of two adjacent beaded tori on two levels, radiating from the central port column and linked by ten radial arms on each level in order to maximise ease of operations while allowing minimum energy use during years before population growth."* *Figure 2.1.1.1: Dimensioned diagram of proposed settlement*	5
2.2	Overall map or layout of interior lands areas showing usage of those areas	*In order to aid in the efficient running of the settlement, Crux proposes that Aresam be divided into specific zones in order to effectively utilise interior space and allow for ease of transportation within sectors. The standard allocation of levels in residential modules is detailed in Figure 2.2.1.*	6
2.3	Drawings showing at least six intermediate steps of settlement assembly	Crux proposes that *Aresam* be built from the outside in, primarily of prefabricated sections, in order to meet the Foundation Society's deadline of 12 years from the commencement of construction. *Table 2.3.1*	6
	Specify method of initiating rotation for artificial gravity	*Table 2.3.1*	6
2.4	Drawings/maps showing interfacings and or other systems and other systems enabling future expansion	*One of the primary purposes of this new settlement will be to provide a gateway to facilitate the future colonisation of Mars, and due to the rapid development of new technology and the unknown geological and scientific worth hidden under the surface of Mars, Aresam must be expected be able to adapt to the changing needs of its population and the Foundation Society. Figure 2.4.1.1*	

2.5	Drawings of deployed and undeployed prefabricated base configurations plus one interim configuration illustrating deployment process	*The structure Crux proposes to use will not only fit in a standard cargo container, but as the materials are flexible, will allow extra room for supplies required during the month long stay and reduces the amount of transportation of consumables later needed to supply for the four temporary inhabitant. Crux has designed an inflatable, reusable base large enough to provide comfortable living conditions for four occupants over the course of their research project.* *Figure 2.*5.1 and figure 2.5.2	
3.0	Describe Facilities and infrastructure necessary for building and operating the settlement and associated communities	*"Aresam will be stationary within Mars' orbit as it will be placed within one of Mars' libration points. This is possible due to the combined masses of two larger objects (the sun and Mars) providing the centripetal force needed for Aresam to remain in a fixed position in space; rotating with Mars."*	9
3.1	Table identifying types, amounts and sources of construction materials	*"The materials used in the construction of Aresam have been chosen for the availability and ease of transport." Table 3.1.1*	
3.2	Charts or tables specifying quantities required of air, food,	*"…To do this, all fruits and vegetables will be produced using Aeroponics."*	10-14
	power,	*"Energy on Aresam will primary be Provided through the inclusion of 5km^2 of solar sails,"*	
	water,	*"As well as water being produced through Aresam's waste treatment plant, water will be sourced from the extensive permafrost (water ice mixed into soil and frozen to the hardness of rock due to low temperatures) at Mars' poles"*	
	waste handling,	*"All household and industrial waste on Aersam will be collected and transported to a major waste treatment area."*	
	communication devices and	*"optical fibers and copper wires system will be in place for high speed internet connectivity"*	
	internal transport vehicles		

		"Aresam's internal transportation system would be a grid of Personal Rapid Transit (PRT) stations running over the surface of the settlement"	
3.3	Drawings of primary construction machinery, showing how it shapes and manipulates raw materials or structural components into finished form	*"After being pressurised, the interior of these modules can be fitted with an aluminium frame attached to the main transportation lines and radial arms of the settlement."*	15
3.4	Illustration of Phobos and Deimos mining base	*"There will be one station placed on each moon. These two stations must not be permanent as these two moons' orbits are changing every year and there is the chance of them crashing onto mars or exiting their orbit around mars."*	15
3.5	Chart or table listing quantities of air, food, power, water and waste	*Air, food, power, water, and waste systems required for operations of a prefabricated base as described in Para 2.5 (Table 3.5.1)*	16
4.0	Provide natural sunlight and views of space outside and Mars below for residents	*"Natural sunlight and panoramic views of space and Mars below have been considered in the overall design of Aresam, to assist residents in psychologically adapting to life in space."*	18
	Include features in design community facilities and residences enabling motility and access with a practical minimum of motion	*"To maintain a healthy working and living standard, Aresam has incorporated traditional community structures and luxuries to make all residents physical transition as easily as possible into life on a space settlement"*	18
4.1	Map and or illustrations depicting community design and locations of amenties with a distance scale Identify percentage of land allocation to roads and paths	*Figure 4.1.3.1*	20
4.2	External drawing and interior floor plan of at least four home designs, the area for each residence design and number required for each design	*Figure 4.2.1.1 Figure 4.2.1.2 Figure 4.2.1.3 Figure 4.2.1.4 Figure 4.2.1.5*	21-22
4.3	Drawings showing examples of handrails, tethers, cages and other systems enabling safe human access to any location on or in low-g settlement areas	*Safety is a priority for residents and workers travelling through the many low-G areas. Attached to the spacesuits will be tethers, one on each side, with carabiner clips on each*	23

		side attached to a rail. Figure 4.3.1.1	
4.4	Chart or table showing anticipated demographic trends for Aresam	*"When entering the settlement a short quiz is taken to ensure people and families are placed in capsules with similar personality traits." Table 4.4.1*	24-25
4.5	Drawings of base structure interior floor plan and amenities	*Figure 4.5.1*	25
5.0			
5.1	Drawings showing automated construction and assembly devices-both for exterior and interior applications and illustrating how they operate	*"The Grumbo Jumbo MCAR will be the primary form of transportation for both processed construction materials and pre-constructed sections to the construction site." Table 5.1.1.1*	27
5.2	Chart or table listing anticipated automation requirements for operation of settlement identifying particular systems and amd robots to meet automation needs	*"…standard hand print security, for accessing lower level clearance information. To access higher security data authorization codes and 2-3 person access -depending on the level of security- will be needed." Table 5.2.1, Table 5.2.2*	28
5.3	Drawings of robots and computing systems that people will enoucter and diagrams of network and bandwith requirements	*"To enhance the livability of the settlement, each individual aboard Aresam will be issued with a Personal Remote Control and Communication Device (PRCCD)"* *"General maintenance and repair work to be completed aboard Aresam will be carried out by automated robots"*	30
5.4	Tables describing or images showing internet user experiences on aresam including user messages to identify delays and methods to create appearance of instant access	*"Aresam will make use of laser optical transmission systems with a fan-like ray to relay data to Earth, while data reception will be controlled by a network of highly sensitive Single-Photon Detectors (SPDs)." Table 5.4.3.1*	31
5.5	Robotic base deployment assistants and Phobos/Deimos operations	Like the settlement the mars base construction will also be mainly automated. This will insure speed, efficiency, and safety. The automated robots to construct the base will be hybrid space buggy-F1M8's much like the FR-F1M8 and SR-F1M8. Operations on mars, Phobos and Deimos will be automated in the same manner as on settlement operations (see 3.4).	
6.1	Durations and completion dates	*Figure 6.1.1*	36

	of major design, construction and occupation tasks		
6.2	Charts or tables listing separate costs associated with different phases of construction and clearly showing billing costs that will be billed to foundation society	*Figure 6.1.1*	36
7.1	Docking, warehousing, and cargo-handling capability to transfer freight between spacecraft, including cargo associated with large-scale Mars surface development and industrial enterprises planned for Mars and the asteroids - Terminal facilities to handle passenger traffic in transit to and from the Mars surface	*"…docking and cargo handling implements have been situated near terminals. Warehouses will also be situated near arrival and departure terminals for visitors to store their goods between arrival and departure."*	38
	Base and repair depot for afleet of Mars surface landing / launch vehicles	*"…a base and repair depot will be situated near the storage warehouses to accommodate for all ship replenishing and repair needs."*	38
	Vehicles spending time on the surface will accumulate dust on exterior and interior surfaces; show method(s) for preventing dust from entering enclosed areas in Aresam	*"…vehicles spending time on its surface will accumulate dust on both interior and exterior surfaces. Methods for ensuring the purity of atmosphere inside Aresam must therefore be provided."*	
	Medical and quarantine services assure treatment and isolation of serious illnesses	*"Medical and quarantine services will also apply in arrival and departure terminals to accommodate to foreign goods being brought into Aresam and to account for and sick or injured personnel flying to or from the settlement."*	38
7.2	Describe manufacturing processes to be conducted in pressurized, non-pressurized, rotating, and non-rotating volumes of Aresam	*"…manufacturing and assembly within zero-G so as to provide increased efficiency and cost-effectiveness, maximising dividends. Launch vehicles, lunar Landers, inter-planetary craft and service and utility vehicles will be constructed and serviced within the dry-docks of the settlement and will provide expansion capabilities for humankind."*	38
	Illustrate a representative scene from a production line.	*"…Essentially, the production line on Aresam will consist of a set of sequential operations established in a factory located directly beside the Aresam Research Centre*	39

		whereby materials are put through a refining process to produce an end-product that is suitable for onward consumption. The refining processes to be conducted for the marketable products manufactured on Aresam are initially the same as the quarantine procedure (See 7.3). This refining process will ensure the purity of materials collected on Mars before they are then made into marketable products."	
	Show how vehicles intended for surface operations will be transported	*"…Vehicles and goods required for other projects will be able to be constructed within the confines of Aresam. These will include solar power and communications satellites, as well as vehicles required for use on lunar terrain. The vehicles will be transported via space shuttles departing the Port facility at regular intervals. The vehicles may also be transported via the Maglev facility."*	39
7.3	Provide laboratory(ies) for assay of and experiments with materials collected on Mars	*"…a research centre will be situated in order to develop commercial products from Mars resources. The main purpose of this research centre is to further examine and experiment on materials in certain laboratories collected from Mars."*	39
	Provide capability to quickly begin production for product(s) identified as having commercial potential	*"…As many of the materials/ elements extractable from Mars have great commercial potential, small factories located directly beside the Research centre will immediately begin production of the everyday items listed above to contribute to the profit of the overall settlement."*	39
	Although surveys have not found life on Mars, more ambitious exploration of the planet may find life; labs must be configured to enable quarantine if materials hazardous to humans are identified.	*"…As materials brought into the settlement are of an unknown hazard rate, quarantine services will be provided within the laboratories of the Research Centre if a material is proven to be dangerous to human life form.*	39

	Quarantine Procedure: *Examine Material Secure the Laboratory Call on specialist to examine specimen Clear material or send it off for further examination."*