

Preliminary Design Review

MARS-OZ PIGLET

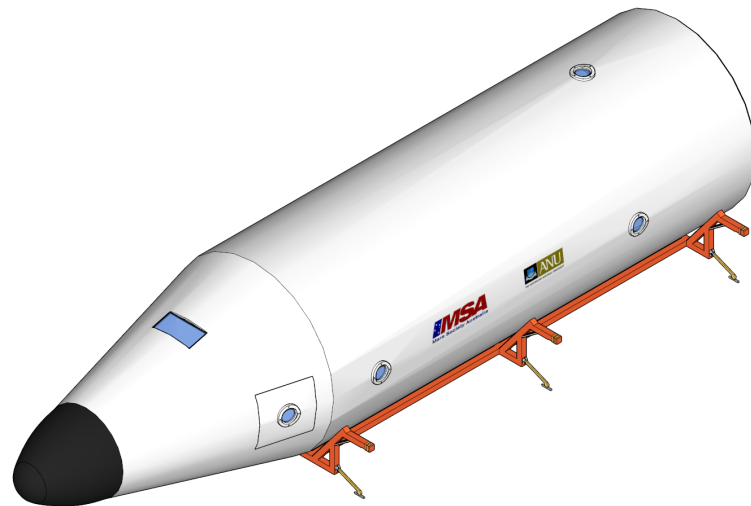


2015



EXECUTIVE SUMMARY

The MarsOz Piglet is an analogue research station to be located in Arkaroola, South Australia for Mars Society Australia. The Piglet is intended to operate as a research centre simulating a Mars-like environment, enabling researchers to investigate human factors, engineering, astrobiology, and geology under Mars-like conditions.



The Marsystems team is tasked with the design of the MarsOz Piglet, which is intended to capture the geometry, dimensions, and aesthetics of potential future Mars Habitats. The Piglet is required to be a self-contained, self-sustaining research station housing a crew of four for periods of two weeks at a time. Consisting of personal living areas and laboratory spaces, the Piglet is to be solar-powered, with energy stored inside an identically structured support station. The Piglet is intended to provide all of the necessary equipment, space and functionality to support Mars-analogue research activities.

Marsystem is responsible for the design of every aspect of the Piglet and its support structure, operating through three central design teams. The structural team is tasked with the design of the external structure, transportation method, and interior layout of the two structures. Ventilation, waste management, and water systems are directly linked to the internal environment of Piglet and are designed by the water team. Finally the power team is responsible for providing power to the structure in accordance with Australian standards, meeting the power requirements of the Piglet's components with an added factor of safety.



1. STRUCTURAL SUBSYSTEM

The main structures of the Piglet and support module have been designed to consist primarily of marine plywood. For ease of design, the external shell of the Piglet is duplicated for the support Piglet, reducing cost and technicality. The MarsOz Piglet has one emergency exit with an easy to open catch mechanism, as well as six windows for adequate vision outside the structure. Inside the structure beyond the airlock comprises four of main areas; including the lab at the rear, meeting area within the cockpit, kitchen, bedroom/storage, and bathroom facilities.

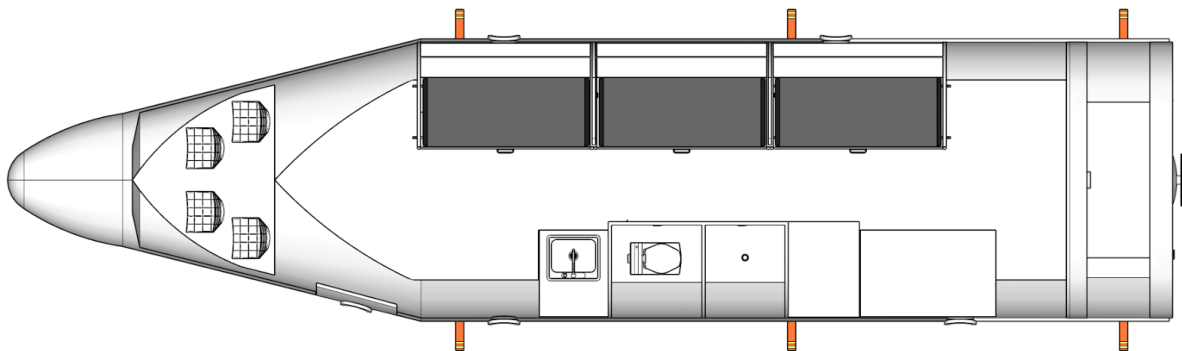


Figure 1.1: Piglet Internal Birdseye View

The support piglet is utilised primarily as a storage area for the major components of the various design subsystems, for example the power storage system and the water storage and recycling tanks. Both structures are 14 metres in length, and 3.4 metres in diameter. To prevent instability and movement they are fixed to a supporting frame made of welded RHS structural steel. This increases the maximum width to 4m, allowing the piglet to be lifted using six hydraulic jacks on each of the flanges. A standard semi-trailer is able to then be reversed under the structure, which may then be lowered for transportation. The weight of the empty Piglet is 4.6 tonnes.

Table 1-1 Presents the Structural Costs

Component	Total Cost (AUD)
Walls/benches	\$50 322
Floor and Support	\$10 383
Doors	\$10 000
	\$70 705

Table 1-1: Structural System Component Costs



2. WATER SUBSYSTEM

2.1 Water Management

The Mars Oz Piglet must be able to provide water for four people during the span of two weeks. The water storage system must be able to supply water for drinking, laundry, laboratory, showering and kitchen use. In order to reduce space and make the Piglet more sustainable, the Piglet must be able to recycle grey water back to potable standards. Water management components are listed in Table 2-1 below.

Table 2-1: Water System Component Costs

	Model	Quantity	Total Cost (AUD)
Clean Water Tank	TankWorld 600L Tank	1	\$465
Grey Water Tank	TankWorld 600L Tank	1	\$465
Waste Water Tank	TankWorld 330L Tank	1	\$425
Water Filter	Gravity-SiC Ceramic Filter	1	\$1,092
Hot Water Heater	Dux Proflo Electric Hot Water Tank	1	\$340
Water Transfer Pump	Ozito 600W Transfer Water Pump	2	\$238
			\$3,008

2.2 Waste Management

The waste system must be able to cope with the variety of different waste products accumulated over two week durations of the inhabitation of Oz Piglet. The system must be able to manage different types of waste including human, general, glass, metals and chemicals. Refer to Table 2-2 below for component list and cost.

	Model	Quantity	Total Cost (AUD)
General Waste Disposal	SmartAsh Incinerator	1	\$2,600
	Willow Dome Rubbish Bins (60L)	5	\$80
Glass and Metal Disposal	Maxi Bin 240L Wheelie Bin	1	\$99
Human Waste Disposal	Blankenship Incinolet	1	\$2,611
	Bathroom Extraction Fan VentAir Olson 250mm	3	\$225
Chemical Storage	Justrite Acids And Corrosive Storage Cabinet	1	\$1,532
	Schott Duran 1L chemical Storage Bottle	12	\$240
			\$7387

Table 2-2: Waste System Component Costs



2.3 Ventilation and Heating

Indoor ventilation and temperature control of the MarsOZ Piglet is an integral part of the final design. There are two ventilation systems incorporated into the Piglet, one that circulates air throughout the whole unit and the other acting as a contaminant remover purely for the laboratory space. The temperature and humidity of the Piglet can also be manually adjusted. The prices shown below in Table 2-3 are simply the cost of purchasing the items required and do not cover the installation cost. Installation cost is approximated at \$3000 AUD.

	Model	Quantity	Total Cost (AUD)
General Ventilation	Air Winding Machine	1	\$307
	Air Vents, Piping and Vent Covers	TBC	\$400
Air-conditioning Unit	Gree Electric Air-Conditioning Unit	1	\$3,100
Laboratory Ventilation	IQ Air GC Multigas Ventilator	1	\$1,650
			\$6,107

Table 2-3: Ventilation and Heating Component Costs



3. POWER SUBSYSTEM

The design of the Mars-Oz Piglet power system takes the form of an off-grid photovoltaic solar power system. This design is heavily informed by the work of Red Planet Renewables in early 2015 on designing a power system for the larger Mars-Oz habitat. The Piglet power system is comprised of three main subsystems, electricity generation, energy storage and electricity

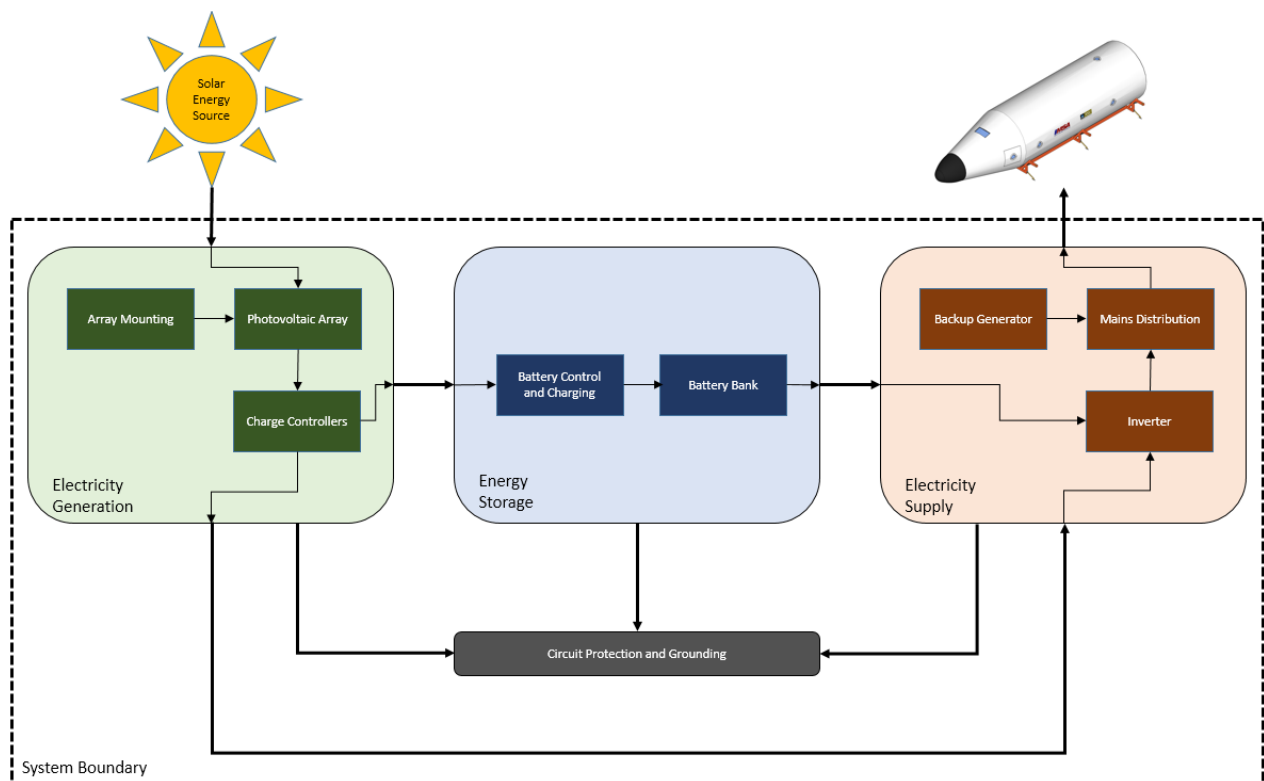


Figure 3-1: Power System Architecture

supply. Figure 3-1 presents the system architecture.

The electrical system requirements and specifications are shown in Table 3-1.

Metric	Value
Piglet daily electricity requirements	40kWh
Peak load (with safety factor)	10kW
Photovoltaic maximum generation capacity	20kW
Electricity storage capacity	89kW

Table 3-1: Power System Requirements and Specifications

The components for the three subsystems are listed below in Table 3-2.



Subsystem	Component	Specifications	Cost (AUD)
Electricity Generation	Solar Panel	250W 24V Mono x 80 units 20kW max. output 20 sets of 4 panels in series Above 90% efficiency for 10 years	\$19,600
	PV Array Mounting	10-45 degrees of tilt 10 year warranty	\$10,000
	Charge Controller	150V max. DC input 12/24V output 20 units required (one for each series set)	\$7,500
Energy Storage	Battery	12V/220Ah AGM Deep Cycle 17 sets of 2 batteries in series. 24V system output	\$24,620
Electricity Supply	DC/AC Inverter	4500W output power 3 units required at peak load	\$10,680
	Backup Generator	15kW max. output	\$12,045

Table 3-2: Power System Major Component Specifications and Costs

4. TOTAL COST SUMMARY

Major Components	Cost (AUD)
Water, Waste, Ventilation	\$17,047
Power, Communications	\$101,400
Structural	\$70,705
Personnel (Wages)	Cost (AUD)
Design (ANU)	\$55,000
Construction	\$30,000
Additional Costs	Cost (AUD)
Additional Furnishings	\$30,000
Transportation	\$5,000
Total	\$309,152

Table 4-1: Combined Cost Summary