TEXAS SPACE GRANT CONSORTIUM
DESIGN CHALLENGE

**TOPIC # - TDC - 24 – S22**

# INITIAL MARS BASE

## OBJECTIVE

Develop a basing concept for the initial human habitation of Mars. The Base will provide for the health, safety, and productivity of the initial crews, within a budget of $5 billion (US 2020 dollars) per year for ten years. The Base will house up to 14 people (nominally 7) for up to 26 months (Nominally 18 months). Initial launches will occur no later than seven years from inception.

- Carefully plan the Base
- Identify all functions required, and in what sequence.
- Lay out the sequence of deployment, over several Martian opportunities (26-month intervals).
- Design selected module(s); one or more [e.g. habitat, laboratory, rovers, etc.]
- Design selected utilities and subsystems [e.g., power distribution, water, wastewater, environmental control, recreation, health, safety].
- Develop a program plan, including a detailed budget and schedule.
- Provide a physical model of your village using a CAD system such as Fusion360. Produce the model with an Additive Manufacturing Device (3D printer) if available.
- Utilize a maximum of 10 KW of nuclear power, and maintain two pressurized rovers (provided to your base, not your responsibility)

The task should include a pictorial layout of the entire Mars village which satisfies the above requirements. It will then be left to the team's discretion to select one or more modules for more detailed analysis and design. Study products should include the physical model of the Mars village, as well as the required periodic and final reports on the project.

## BACKGROUND

Long range NASA plans call for the human exploration of the planet Mars. Mars must be made the second safest place in the solar system for humans to live. All facilities for safe, healthy, and productive human habitation must be pre-deployed prior to the commitment of humans to a Mars mission. A mission must be designed which is capable of being deployed with existing US launch systems, specifically the Delta IV Heavy, SLS, Space X Falcon 9 Heavy, and/or BFR vehicles. Your program budget must include these launches.

## SPECIFICATIONS

- Provide for autonomous deployment and self-checkout on Mars, with potential intervention from Earth after time delay of at least 45 minutes.
- All facilities will be provided for safe, healthy, and productive human habitation for up to 26 months (plus deployment time). These include:
    - Food and water [Initially to be carried from Earth, plus possible water in-situ from Mars underground sources]. Water will be 90% recycled and may be used for radiation protection.
    - Power [Two Kilo-power nuclear reactors (one active, one reserve) will be the primary sources. Not your responsibility].
    - Safety from solar events and cosmic radiation.
    - Rovers for EVA exploration [pressurized]. (These will be provided and are not included in your task.)
    - Health maintenance, exercise, and recreation. Competitive games to be considered.
    - Repair and routine servicing of Space Suits and Rovers, with spare parts.
    - Medical and hospital facility; provisions for major surgery.
    - Sleep and privacy: separate crew compartments with personal provisions, including work stations and communications to Earth.
    - Hygiene: toilets [non-polluting], showers, washing facilities.

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UT Center for Space Research / NASA Johnson Space Center

  - Laundry for clothing.
- Any other facilities identified in the course of the study as essential to human survival, health, safety, productivity, and return to Earth.
- A deployment process and sequence will be developed which considers the shelf-lives of all deployed items and provides for robotic joining of all facilities prior to human arrival.
- Mass properties, volumes, power profiles, launch packaging are required.
- Detailed schedules, deployment sequences, and cost estimates (required).
- Deployment of the initial "village" will take place over several Mars "opportunities," spaced 26 months apart.
- Use of derivatives of existing launch vehicles [e.g.: Delta IV Heavy, SLS, Space X Falcon 9 Heavy and BFR] is encouraged.

## DESIGN TEAM PROFILE

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| **NASA MENTOR:** | Hum Mandell |
| **LEVEL:** | Undergrad students of any level [FR, SO, JR, SR]; or mixture of undergrad/graduate students |
| **MAJOR / DISCIPLINES:** | Open to all majors / disciplines. Recommend the inclusion of a team member majoring in aerospace engineering, electrical engineering, software engineering, and/or mechanical engineering/mechanisms. |
| **TEAMS:** | Mentor may accept as many as two teams for this project. |
| **DURATION:** | One or Two-Semester Project |
| **PARTNERS:** | Partnerships with private industry are encouraged [e.g.: for rover or module design]. Visits to elementary and secondary schools are encouraged to promote Mars exploration. |