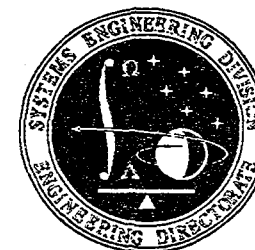




COMMON LUNAR LANDER TRAJECTORY ANALYSIS



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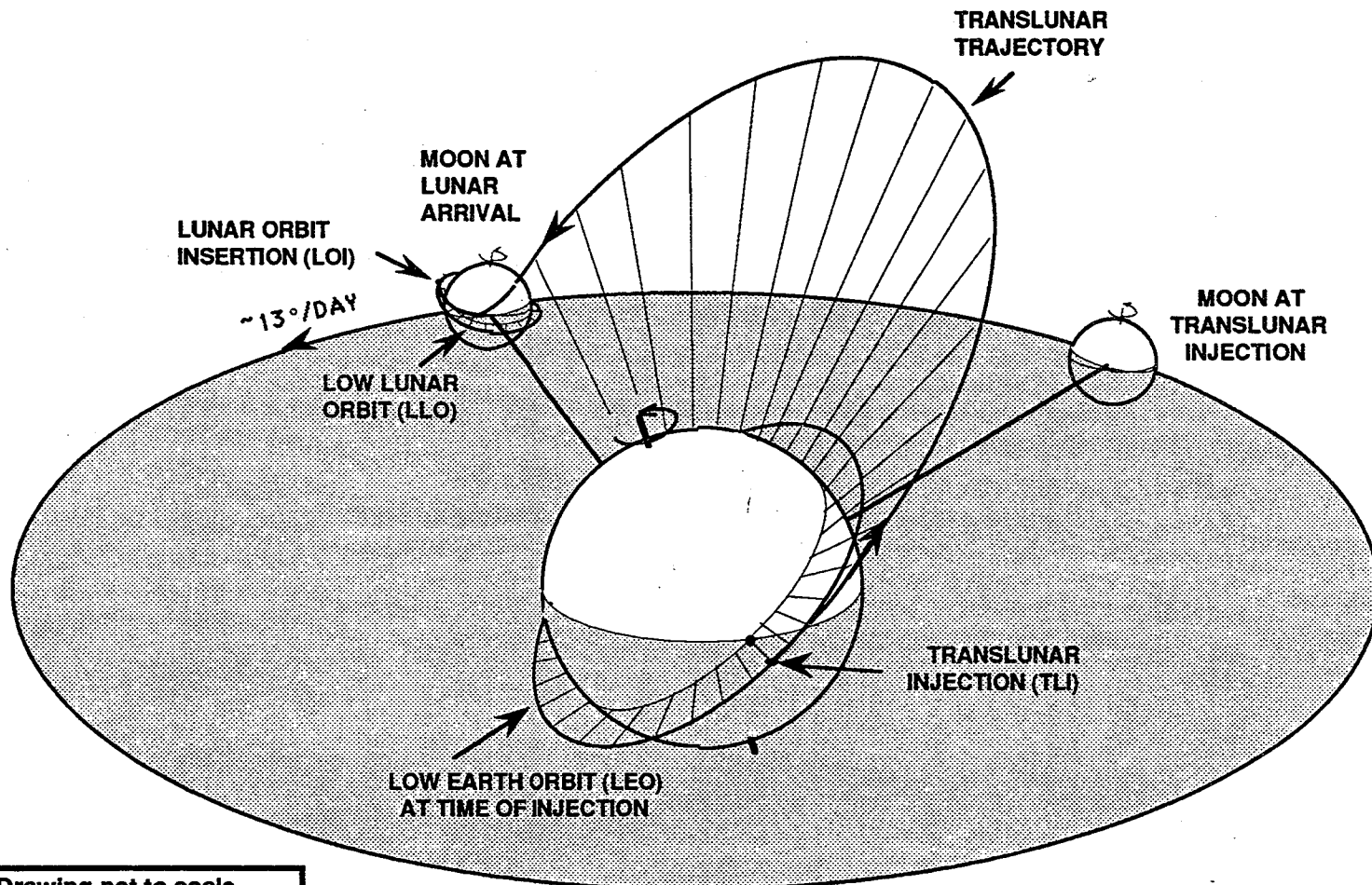
COMMON LUNAR LANDER TRAJECTORY REQUIREMENTS

- **Earth launch flexibility**
 - **14-day launch window to be achieved by variable loiter time in lunar parking orbit**
- **Land at any specified lunar latitude and longitude**
- **Land at any specified time in the lunar day/night cycle**
- **Program will operate during the entire 18.6 year lunar cycle**

COMMON LUNAR LANDER TRAJECTORY CHARACTERISTICS

- **Earth Parking Orbit (185 km circular orbit)**
 - **Due east launch from ETR into a 28.45 deg inclination**
 - **Standard circular orbit for the launch vehicles examined**
- **Minimum Energy Trajectories**
 - **5 day transfer time**
 - **Near Hohmann transfers**
- **Lunar Parking Orbit (122 km circular orbit)**
 - **Minimizes deorbit, descent , and landing delta-V cost**
 - **Inclination and Ascending Node defined for each specific landing site and lunar loiter time**
- **All lunar landing sites are accessible**

COMMON LUNAR LANDER TRAJECTORY



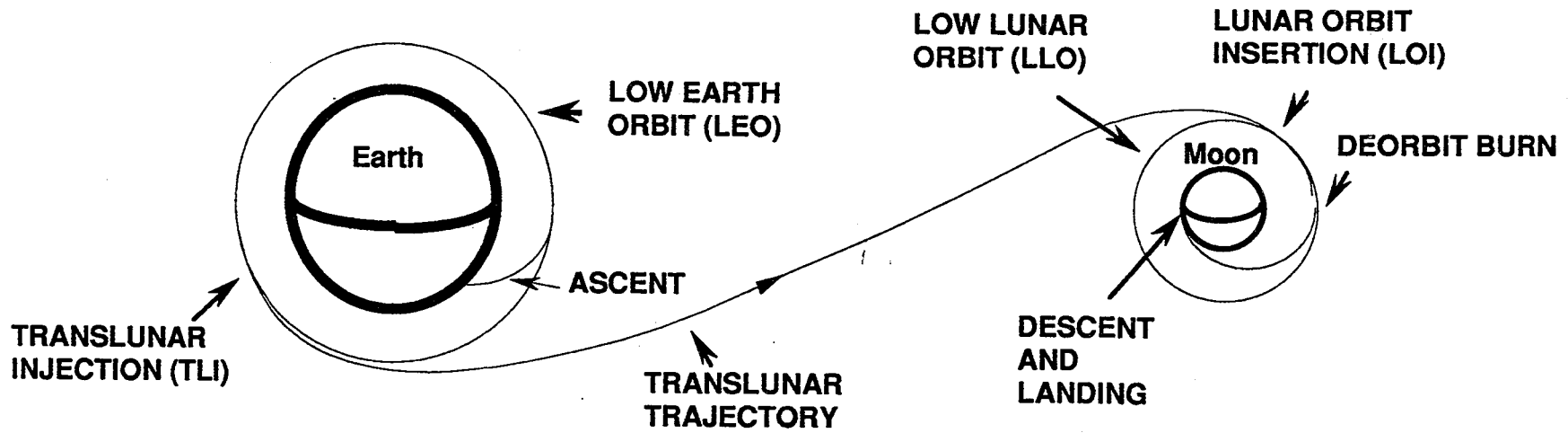
Drawing not to scale

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COMMON LUNAR LANDER TRAJECTORY



Drawing not to scale



COMMON LUNAR LANDER TRAJECTORY TIMELINE

<u>TRAJECTORY EVENT</u>	<u>DURATION</u>	<u>ALLOCATED DELTA-V *</u>	<u>COMMENTS</u>
Launch	20-30 min		
Earth Parking Orbit Coast	0-90 min		185 km Circular Orbit
Translunar Injection		3200 m/s	
Translunar Coast	5 days	30 m/s	Midcourse correction (100% lighting)
Lunar Orbit Insertion		840 m/s	
Lunar Parking Orbit Coast	0-14 days		122 km Circular Orbit (Minimum of 61% lighting)
Deorbit Maneuver		30 m/s	
Deorbit Coast	51 min		122 x 15 km Orbit
Descent and Landing	9 min	1820 m/s	

* Does not include provisions for dispersions and performance reserves

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COMMON LUNAR LANDER ALTERNATE TRAJECTORY

- **SCENARIO**

- 90° Inclination Orbital Plane required
- 122 km. Circular Orbit
- Approximately 90° or - 90° Ascending Node location at LOI

- **ADVANTAGES**

- 100% light during entire lunar orbit
- Minimum batteries needed during lunar orbit coast

- **DISADVANTAGES**

- Solar Panel shadowing may occur during translunar coast and maneuver/IMU realignments
- Launch Windows occur once or twice a month
 - The landing site determines which opportunity is valid based on the maximum lunar orbit loiter time
 - The lighting constraints allowable are sunrise and sunset
- Launch Window duration is estimated at 2-3 days at most

COMMON LUNAR LANDER ALTERNATE TRAJECTORY

