DEPARTMENT OF AEROSPACE ENGINEERING

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UNIT II - ADVANCED PROPULSION TECHNIQUES

Post-Accident Procedures

In the testing of any rocket propulsion system there will invariably be failures, particularly when some of the operating parameters are close to their limit. With each failure comes an opportunity to learn more about the design, the materials, the propulsion performance, the fabrication methods, or the test procedures. A careful and thorough investigation of each failure is needed to learn the likely causes and identify the remedies or fixes to prevent a similar failure in the future. The lessons to be learned from these failures are perhaps the most important benefits of testing. A formalized post-accident approach is often used, particularly if the failure had a major impact, such as high cost, major damage, or personnel injury. A major failure (e.g., the loss of a space launch vehicle or severe damage to a test facility) often causes the program to be stopped and further testing or flights put on hold until the cause of the failure is determined and remedial action has been taken to prevent a recurrence.

Of utmost concern immediately after a major failure are the steps that need to be taken to respond to the emergency. This includes giving first aid to injured personnel, bringing the propulsion system and/or the test facilities to a safe, stable condition, limiting further damage from chemical hazards to the facility or the environment, working with local fire departments, medical or emergency maintenance staff or ambulance personnel, and debris clearing crews, and quickly providing factual statements to the management, the employees ,

the news media, and the public. It also includes controlling access to the facility where the failure has occurred and preserving evidence for the subsequent investigation. All test personnel, particularly the supervisory people, need to be trained not only in preventing accidents and minimizing the impact of a potential failure, but also how to best respond to the emergency.

Description of a Typical Space Launch Vehicle Launch Procedure

Satellites stay in space for most of their life time. We know that the environment of weightlessness is present in the space. That's why satellites don't require additional strong frames in space. But, those are required during launching process. Because in that process satellite shakes violently, till the satellite has been placed in a proper orbit. The design of satellites should be compatible with one or more launch vehicles in order to place the satellite in an orbit. We know that the period of revolution will be more for higher apogee altitude according to Kepler's second law. The period of geostationary transfer orbit is nearly equal to 16 hours. If perigee is increased to GEO altitude (around 36,000 km), then the period of revolution will increase to 24 hours.

Satellite Launch Procedure:

The four orbit stages involved in the satellite launch procedure are as follows:

- Circular low earth orbit
- Hohmann elliptical transfer orbit
- Intermediate drift orbit
- Circular Geostationary orbit

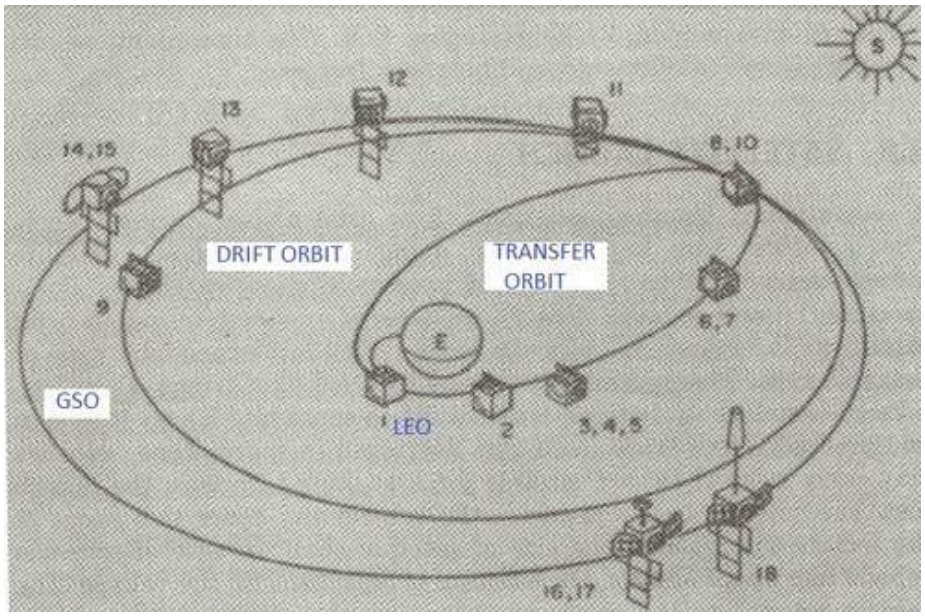

Figure depicts typical satellite launch procedure followed by space companies such as ISRO. Following are the major steps involved in the launch process.

➥Step-1: The launch vehicle takes the satellite into low earth orbit. The satellite is injected into desired 3-axes stabilized mode to achieve gyro condition using commands issued by launch vehicle to carry pyro firing.

➥Step-2: After satellite reaches apogee AKM is fired for long duration to take satellite to intermediate orbit. This intermediate orbit is referred as transfer orbit. AKM is the short form of Apogee Kick Motor which contains liquid fuel.

➥Step-3: The second apogee motor firing is carried out so that satellite attains needed angular velocity and acceleration for Geo-synchronization. This helps satellite to be in LOS from central earth stations. If required it is tracked through other countries earth stations.

➥Step-4: Further stabilization and attitude control is achieved using control of momentum/reaction wheels. Antennas and transponders are turned on which brings satellite into stabilized geostationary orbit. Examples of geostationary satellites are INTELSAT, COMSAT, INSAT etc.

➥Once the satellite is placed in the parking space (i.e. designated orbit), following activities need to be performed as part of maintenance.

➥Orbit maintenance• Attitude maintenance• Thermal management• Power management• battery maintenance• Payload operations• Software requirement.

Satellite Launch Vehicles:

Satellite launch vehicles launch the satellites into a particular orbit based on the requirement. Satellite launch vehicles are nothing but multi stage rockets. Following are the two types of satellite launch vehicles.

- Expendable Launch Vehicles (ELV): Expendable launch vehicles (ELV) get destroyed after leaving the satellites in space.
- Reusable launch vehicles (RLV): this can be used multiple times for launching satellites. Generally, this type of launch vehicles will return back to earth after leaving the satellite in space.

Criteria for Selection of Materials for Rockets and Missiles

The selection criteria for materials for rockets are:

- High strength at elevated temperature
- Ease of fabrication
- High thermal conductivity
- Resistance to chemical action to vapours
- High specific heat
- Resistance to corrosion
- Resistance to mechanical and thermal shock
- High melting point
- Low thermal expansion
- Good vibration resistance.

Selection criteria for materials for space craft structures:

- Extreme working temperature
- High value of strength to weight ratio
- Strength should not deteriorate at extreme temperature to lower acceptable limit
- The material can able to withstand,
- Shock or pressure load
- Thermal load
- Impact loads
- Material should not lose its properties when exposed to cyclic loads.