

## CHAPTER 9

### SAFETY CONTROL

This chapter describes the range safety control procedure and the criteria to minimize the life and property lose in case of a flight anomaly following lift-off in JSLC.

#### 9.1 Safety Responsibility and Requirements

The Launch Center designates a range safety commander, whose responsibilities are:

- To work out “Launch Vehicle Safety Control Criteria” along with the LV designer according to the concept of the safety system;
- To know the distribution of population and major infrastructures in the down range area;
- To guarantee that the measuring equipment provide sufficient flight information for safety control, i.e. clearly show the flight anomaly or flying inside predetermined safe range; and
- To terminate the flight according to the “Launch Vehicle Safety Control Criteria” if the launch vehicle behaves so unrecoverably abnormal that the launch mission can never completed and a ground damage is possible.

#### 9.2 Safety Control Plan and Procedure

##### 9.2.1 Safety Control Plan

CALT should provide the detailed safety flight scenario to the safety commander for approval. The following contents related to the flight safety should be included in the flight scenario.

- (1) The difference with the previous flight scenario.
- (2) The characteristics of the launch vehicle.
- (3) The flight trajectory.
- (4) The launch vehicle maximum ability to change flight direction.
- (5) The launch vehicle transient drop-down area along with the launch trajectory.
- (6) The allowed maximum variation limits for LV flight direction.
- (7) The impact area and damage for the boosters and stages.
- (8) The primary failure modes and their effects of the launch vehicle.

### 9.2.2 Safety Control Procedure

Even though a flight anomaly occurs, the launch vehicle will not be destroyed by the ground command during the first 20 seconds following lift-off. The launch vehicle will go 400 meters from the launch pad during the 20 seconds to protect the launch facilities.

The destruction to the launch vehicle can be conducted from 20 seconds of flight to the second stage shut-down and performed by the Command Destruction System (CDS) and Automatic Destruction System (ADS) together.

#### (1) Command Destruction System (CDS)

The ground tracking and telemetry system will acquire the flight information independently. If the flight anomaly meets the destruction criteria, the safety commander will select the impact area and send the destruction command. Otherwise the ground control computer will automatically send the command and remotely destroy the launch vehicle.

#### (2) Automatic Destruction System (ADS)

The launch vehicle system makes the decision according to flight attitude. If the attitude angle of Launch Vehicle exceeds safety limits for about 2 seconds, the control system will send a destruction signal to on-board explosive devices. After a delay of 15 sec., the Launch Vehicle will be exploded. The range safety commander can use the delayed 15 seconds to select the impact location and send the destruction command. If the range safety commander could not find a suitable area within 15 seconds, the launch vehicle will be exploded by ADS.

The objective of choosing impact location is to make the launch vehicle debris drops to the area of less population and without important infrastructures.

The flowchart of the control system is shown in **Figure 9-1**.

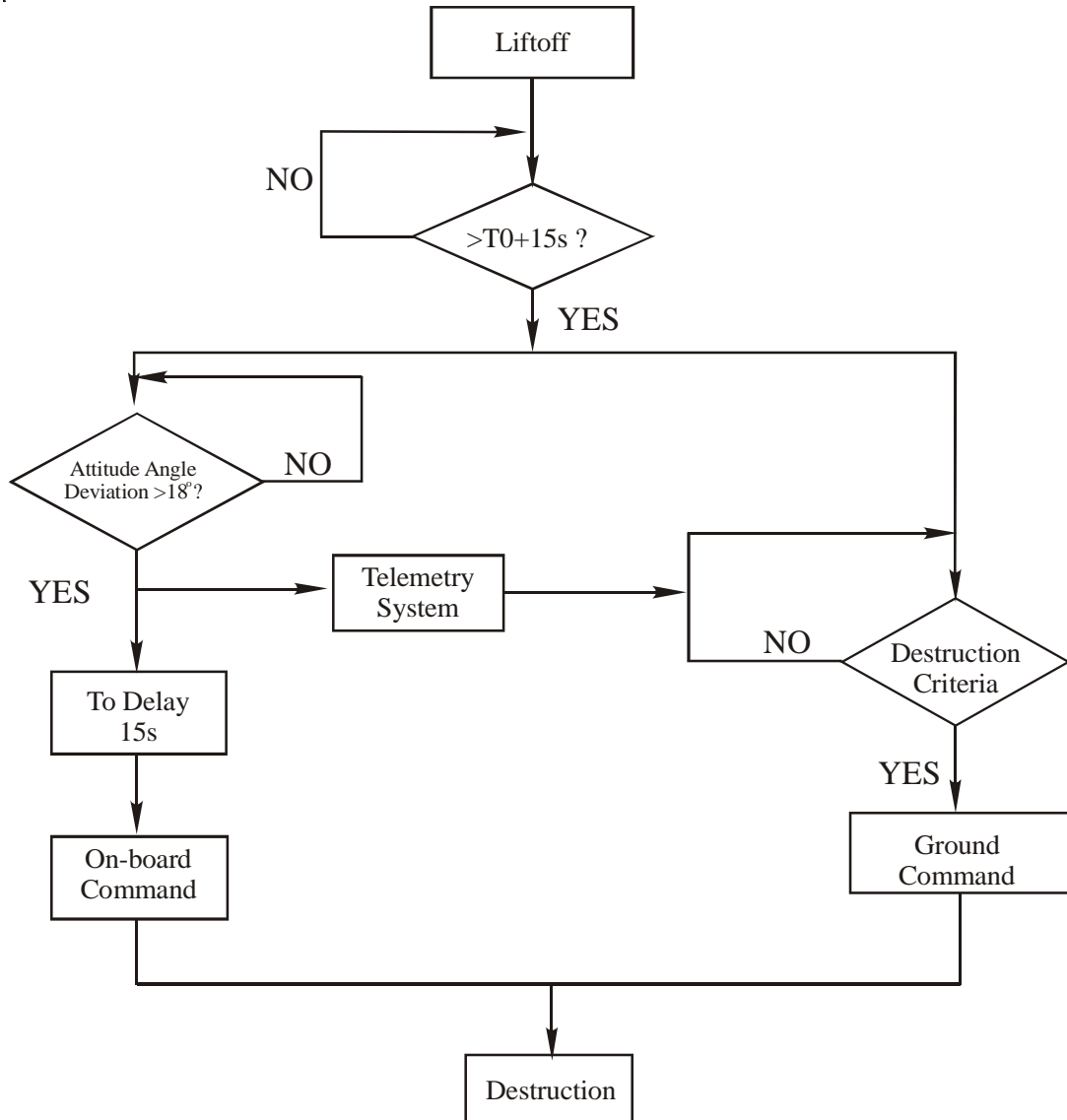


Figure 9-1 Flowchart of Control System

### 9.3 Composition of Safety Control System

The range safety control system includes on-board segment and ground segment. The on-board safety segment works along with the onboard tracking system, i.e. Tracking and Safety System. The on-board safety control system consists of ADS, CDS, explosion system, tracking system and telemetry system. The ground safety control system consists of ground remote control station, tracking station, telemetry station and communication system.

The flight data that the safety control system needs include: flight velocity, coordinates, working status of LV subsystems, safety command receiving status, working status of onboard safety control system, as well as safety command to destroy the LV from ground.

### 9.4 Safety Criteria

The range safety criteria are the regulation used to destroy the launch vehicle. It is determined according to the launch trajectory, protected region, tracking equipment, objective of flight, etc. See **Figure 9-2** for range safety in launch site.

#### 9.4.1 Approval Procedure of Range Safety Criteria

The range safety criteria vary with different launches, so the criteria should be modified before each launch. Normally the criteria is drafted by JSLC, reviewed by CALT and CLTC and approved by the safety commander.

#### 9.4.2 Common Criteria

- If the launch vehicle flies toward the reverse direction, the safety commander will select a suitable time to destroy the launch vehicle considering the impact area.
- If the launch vehicle flies vertically to the sky other than pitches over to the predetermined trajectory, it will be destroyed at a suitable altitude.
- If the launch vehicle shows obvious abnormal, such as roll over, fire on some parts, it will be destroyed at a suitable time.
- If the engines of launch vehicle suddenly shut down, the launch vehicle will be destroyed immediately

- If the launch vehicle exceeds the predefined destruction limits (including attitude being unstable seriously), it will be destroyed at a suitable altitude considering the impact area.

### 9.4.3 Special Criteria

- If the launch vehicle is closer than 400m away from the launch pad, the launch vehicle will not be destroyed to protect the launch site.
- If the launch vehicle leaves the normal trajectory and flies to the North Technical Center during 20~30 seconds, i.e.  $Z \geq 400\text{m}$  or  $X \leq -400\text{m}$ , the launch vehicle will be destroyed immediately to protect the North Technical Center. (Where  $Z$  is the distance between launch vehicle and the normal launch plane,  $X$  is the horizontal distance between the launch vehicle and the launch pad.)

### 9.5 Emergency Measures

Before the launch takes place, people will be evacuated from some related facilities and area according to the predetermined plan.

JSLC has the following emergency measures:

- ◇ Emergency commander
- ◇ First aid team
- ◇ Fire fight team
- ◇ Ambulance
- ◇ Backup vehicles
- ◇ Helicopter

Rescue equipment and food, water, oxygen for one-day use are available in the North Technical Center and LCC.

All the safety equipment can be checked by the User before using. Any comments or suggestions can be discussed in the launch mission or launch site review.

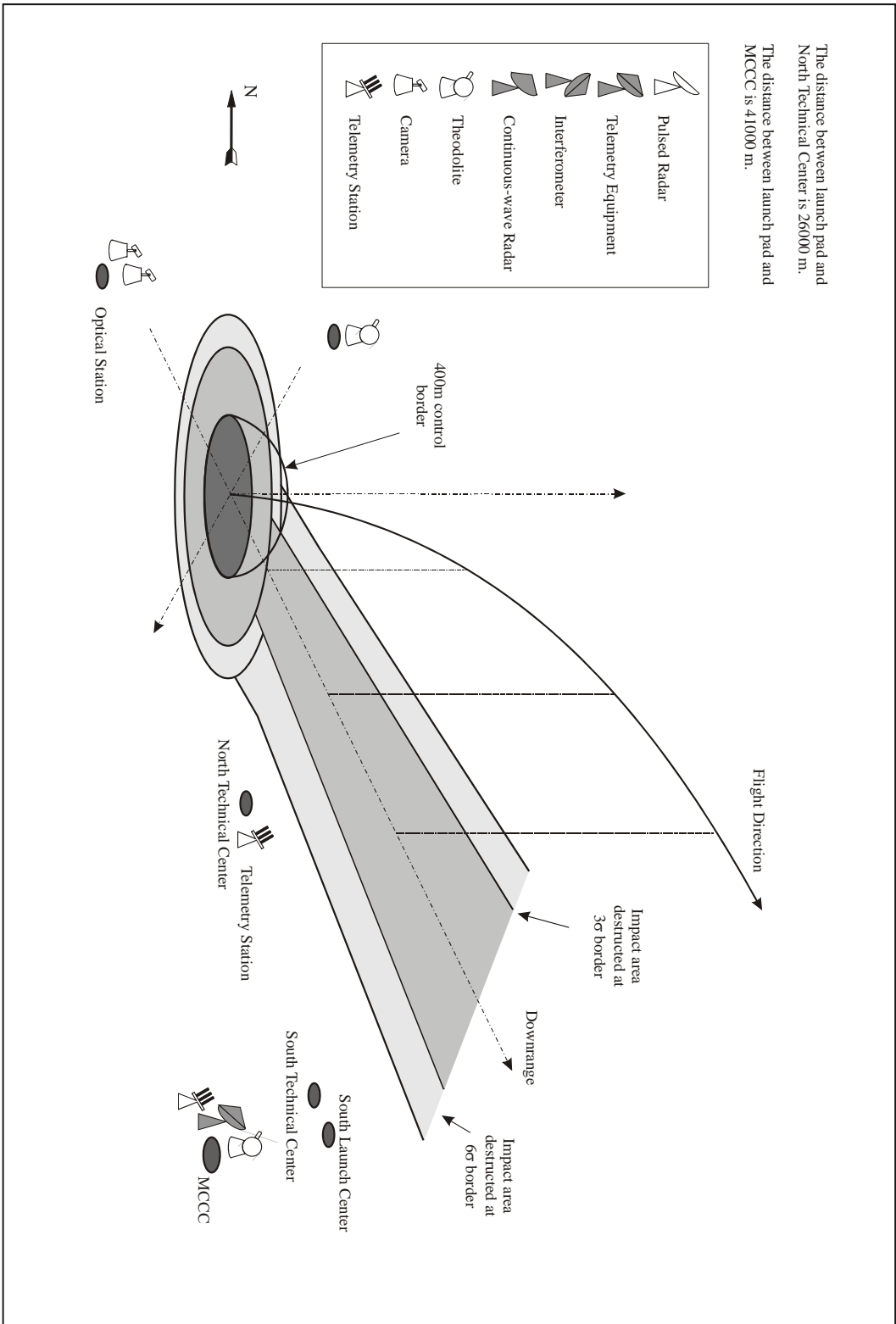


Figure 9-2 Ground Safety Control System in North Launch Center of JSLC