

CHAPTER 9 RANGE SAFETY CONTROL

This Chapter provides an overview of the range safety controls. The safety management for personnel and facilities during launch site operations, including operations associated with the hazardous materials are detailed in the *XSLC User's Manual (Issue 2009)*.

9.1 Responsibility and Requirements of Range Safety

XSLC designates a range safety officer, whose responsibilities are:

- a) To prepare *Launch Vehicle Flight Safety Control Plan* in conjunction with the LV designer in accordance with the safety system concepts previously developed. This includes the safety boundary line derived from the flight trajectory of the LV.
- b) To know the distribution of population and major infrastructures in the down range.
- c) To guarantee that the measuring equipment provides sufficient flight information for safety control, i.e. a clear display of any flight anomaly or assurance of the normal flight status inside the predetermined safe range parameters.
- d) To terminate the flight according to the *Launch Vehicle Flight Safety Control Plan* in cases where the launch vehicle has demonstrated an uncorrectable anomaly such that the flight mission needs to be terminated due to the risk of a ground impact outside the designated safe areas.

9.2 Range Safety Issues for a LV Anomaly

9.2.1 Safety Control Strategy

From the 17th second (for LM-3A/3BE/3C) or 15th second (for LM-3B) following the LV lift off (T_0) to the moment of reaching the theoretical impact area on the open ocean, the launch vehicle must be under the control of the range safety officer so a destruct command can be sent if a flight anomaly occurs. This period of time is called Safety Control Range.

In the period between T_0 and T_0+15 sec (for LM-3B), or T_0 and T_0+17 sec (for LM-3A/3BE/3C), the LV will not be destroyed by ground command even though an anomaly occurs, unless LV explodes itself. This is to ensure that the launch vehicle flies over 400 m (range protection radius) away from the launch pad for the protection of the launch facilities.

Safety Control Ranges of LM-3A Series launch vehicles are defined as follows:

- a) Safety Control Range of LM-3A: The period from T_0+17 sec to $T_{2/3}$ (the time of second/third stage separation);
- b) Safety Control Range of LM-3B: The period from T_0+15 sec to $T_{2/3}$ (the time of second/third stage separation);
- c) Safety Control Range of LM-3BE: The period from T_0+17 sec to $T_{2/3}$ (the time of second/third stage separation);
- d) Safety Control Range of LM-3C: The period from T_0+17 sec to $T_{2/3}$ (the time of second/third stage separation);

9.2.2 Safety Control Procedure

The destruction of the launch vehicle will be implemented by a combination of the Command Destruction System (CDS) and Autonomous Destruction System (ADS).

Command Destruction System

The ground tracking and telemetry system will acquire and interpret the flight information independently. If a flight anomaly reaches the destruction criteria limits, the range safety officer will select the impact area and send the destruction command. The ground control computer can also automatically send a command to the on-board remote control system to destroy the launch vehicle.

Autonomous Destruction System

The on-board ADS is able to make the decision to self destruct based on the deviations of flight attitude and range safety criteria. If the launch vehicle attitude exceeds the safety limits, the ADS will send a destruction signal to the on-board explosive devices. After a delay of 15 seconds, the launch vehicle will self destruct. The range safety officer can use the 15 seconds delay to select an acceptable impact location and send the destruction command, which overrides the automated system. If the range safety officer could not find a suitable area within 15 seconds, the ADS will automatically destroy the LV.

The objective of choosing an impact location is to ensure that launch vehicle debris does little or no damage when it reaches the ground.

The flowchart of range safety control is shown in Figure 9-1.

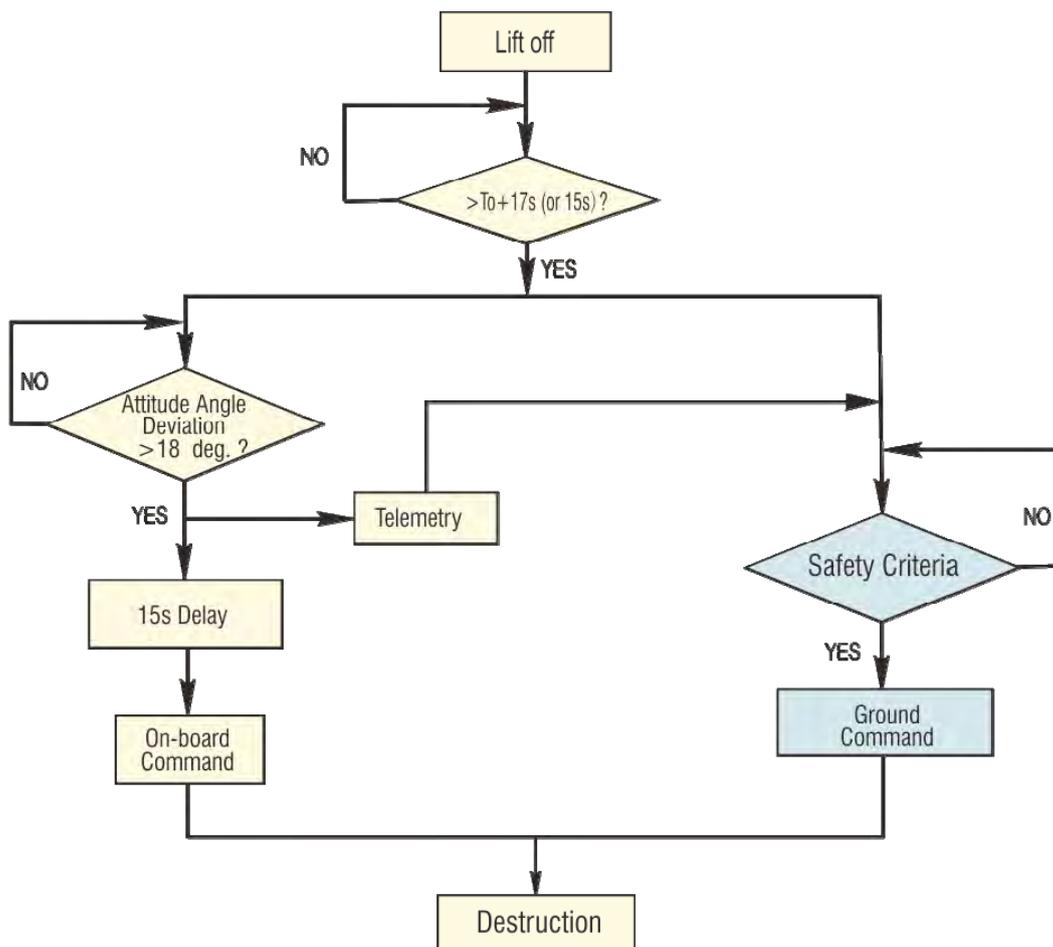


Figure 9-1 Flowchart of Range Safety Control System

9.3 Composition of the Range Safety Control System

The range safety control system includes an on-board segment and a ground segment. The on-board safety segment functions with the onboard tracking system, and jointly is called the Tracking and Safety System. The on-board safety control system consists of the ADS, CDS, explosive devices, tracking system and telemetry system. The ground safety control system consists of the ground remote control station, tracking station, telemetry station and communication system. See Figure 9-2.

The flight data that the safety control system requires includes the flight velocity, flight coordinates, working status of LV subsystems, and the safety command receiving status. The working status of the onboard safety control system is provided by the Telemetry and Tracking system. The safety command to destroy the LV is provided by the ground remote control station (CDS) or the onboard safety control system (ADS).

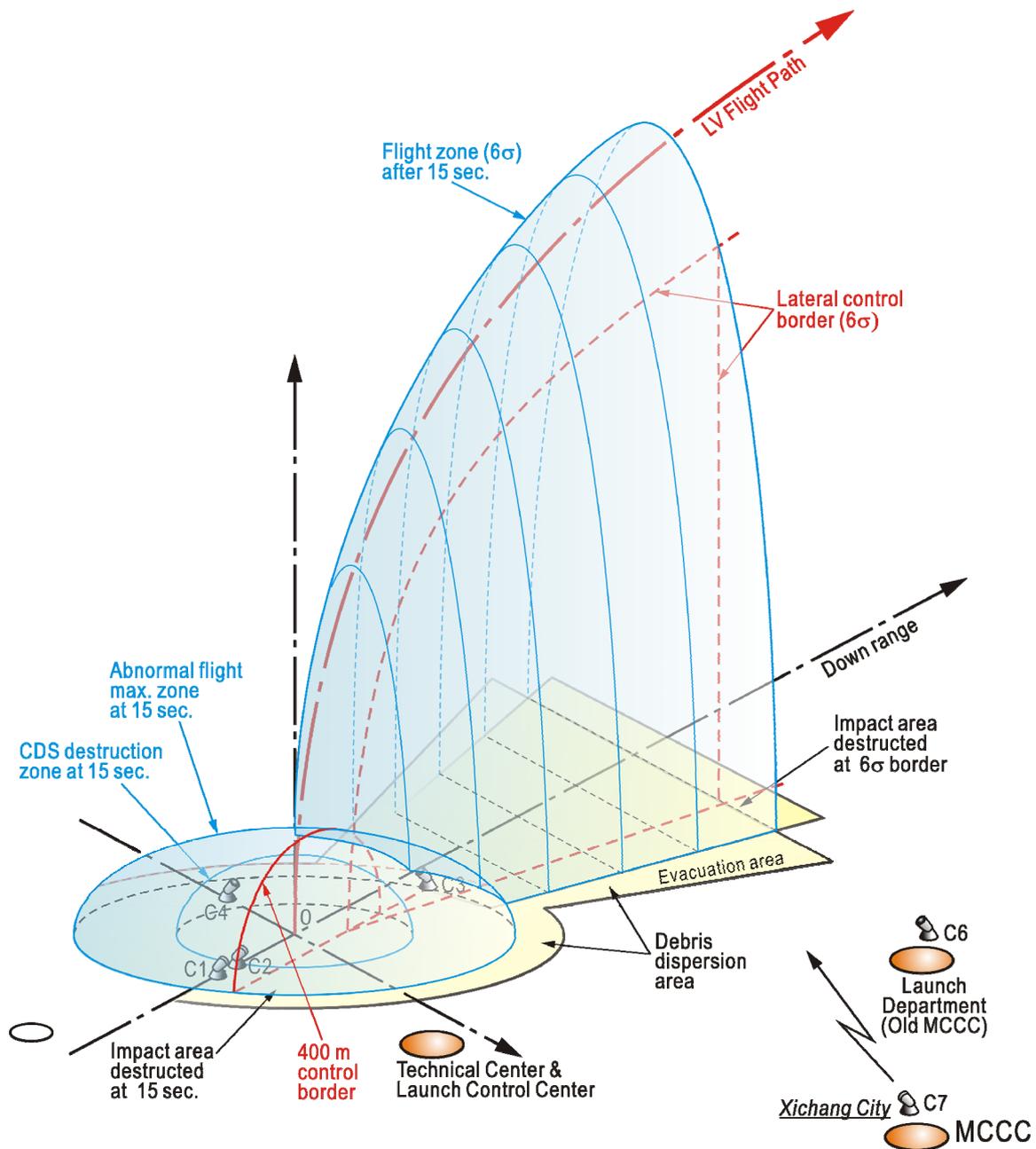


Figure 9-2 Range Safety Control System at XSLC

9.4 Safety Criteria

The range safety criteria are regulations that have been developed to allow the range safety officer to make an informed decision regarding a launch vehicle if the designated flight trajectory deviates from the designed flight path. This may result in the destruction of the launch vehicle when the designated flight zone is exceeded. The criteria are developed based on an overall consideration of the combination of the launch trajectory, regions to be avoided as an impact zone, tracking equipment, mission objectives, etc.

9.4.1 Approval Procedure of Range Safety Criteria

The range safety criteria vary with each launch mission, and are updated before each launch. The criteria are drafted by XSLC, reviewed by CALT and CLTC and then implemented by the range safety officer at each launch.

9.4.2 Common Criteria of Range Safety Control

- a) If the launch vehicle flies in the reverse direction, the safety officer will select a suitable time to destroy the launch vehicle considering the impact area.
- b) If the launch vehicle flies vertically to the sky rather than pitching over to the predetermined trajectory, it will be destroyed at a certain altitude.
- c) If the launch vehicle has demonstrated specific anomalies, e.g. rolling over, fire on the vehicle, it will be destroyed at a certain time.
- d) If the launch vehicle flies beyond the predefined destruction limits (including the attitude limits beyond which the launch vehicle becomes seriously unstable), it will be destroyed at a certain altitude considering the impact area.

9.4.3 Special Criteria

- a) If the distance between the abnormal launch vehicle and launch pad is less than 400 m, the launch vehicle will not be destroyed in order to protect the launch site.
- b) If the launch vehicle leaves the normal trajectory and flies towards the Technical Center during the initial 17 to 30 seconds (LM-3A, LM-3BE, LM-3C) or 15-30 seconds (LM-3B) and $Z \geq 400$ m (in the launch coordinate system), the launch vehicle will be destroyed immediately to protect the Technical Zone. In this case Z is the distance between the abnormal launch vehicle trajectory and the normal trajectory plane.
- c) If launch vehicle is flying beyond the predefined safety limit towards the old MCCC during the period of 30-60 seconds, it will be destroyed immediately to protect the old MCCC.

9.5 Emergency Measures

Before the launch takes place, specific facilities and areas within the launch complex will be evacuated of all non-essential personnel in accordance with the predetermined evacuation plan.

XSLC has the following capabilities for implementing emergency procedures:

- a) A designated emergency commander
- b) First aid team
- c) Firemen and ambulances
- d) Standby motor vehicles
- e) Helicopters

Rescue equipment and food, water, oxygen for one-day usage are available in the Launch Center and the Technical Center.

The customer can check all the emergency equipment and verify the safety measures implemented for range safety before the launch. Any comments or suggestions regarding the range safety can be discussed during the launch campaign and launch site review.