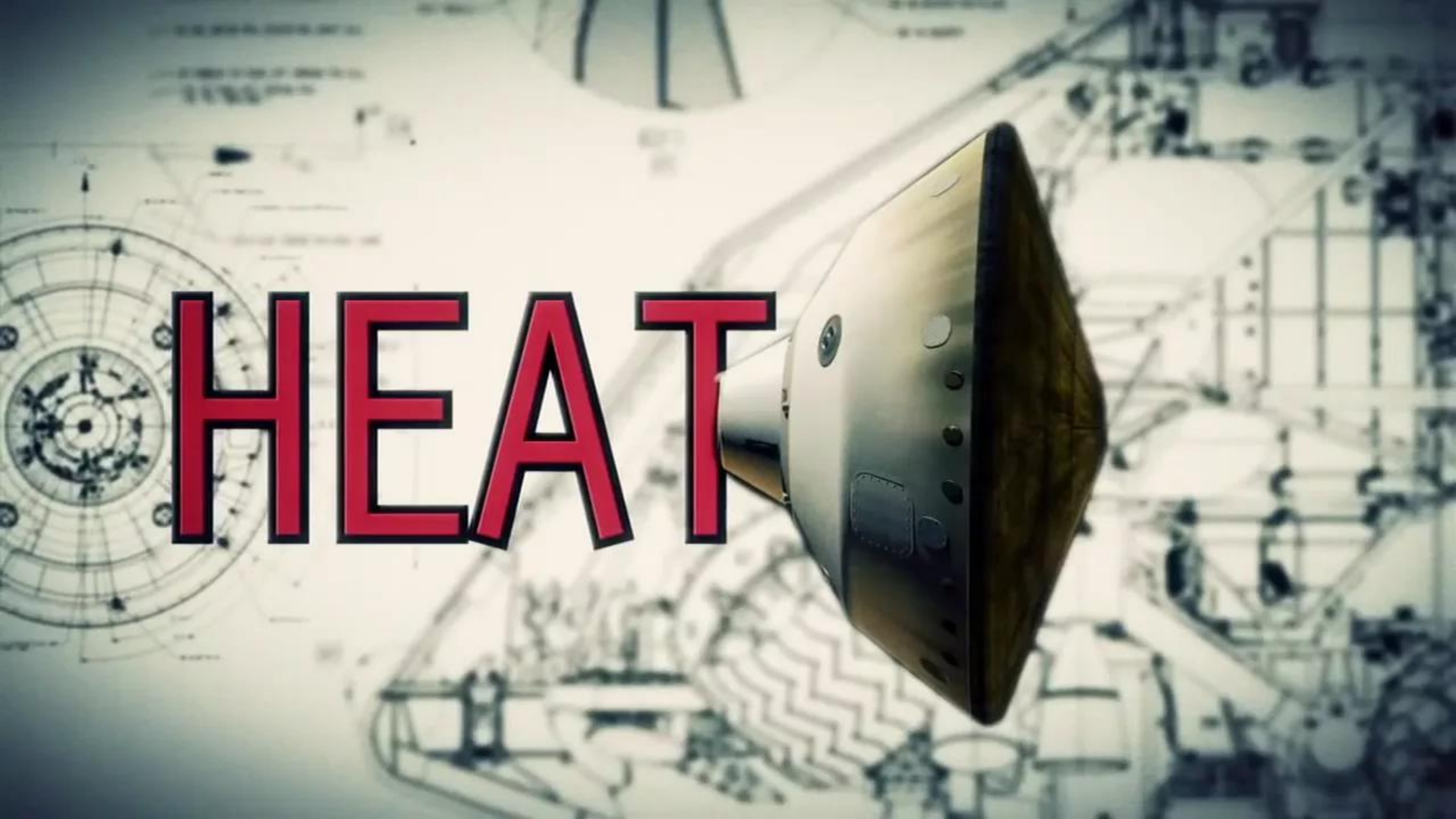
HEAT

1
00:00:00,000 --> 00:00:05,000
(music-dark/mysterious/percussive)

2
00:00:05,000 --> 00:00:13,000
Adam Steltzner 'When people look at it... uhhh, it looks crazy. That's a very natural thing.'

3
00:00:13,000 --> 00:00:18,000
'Sometimes when we look at it, it looks crazy.'

4
00:00:18,000 --> 00:00:25,000
'It is the result of reasoned, engineering thought.'

5
00:00:25,000 --> 00:00:28,000
'But it still looks crazy.'

6
00:00:28,000 --> 00:00:32,000
'From the top of the atmosphere, down to the surface-'

7
00:00:32,000 --> 00:00:34,000
'It takes us seven minutes.'

8
00:00:34,000 --> 00:00:42,000
'It takes 14 minutes or so for the signal from the spacecraft to make it to Earth-'

9
00:00:42,000 --> 00:00:46,000
' that's how far Mars is away from us.'

10
00:00:46,000 --> 00:00:53,000
'So, when we first get word that we've touched the top of the atmosphere,'

11
00:00:53,000 --> 00:00:55,000
'the vehicle has been alive...'
(music intensifies- heavier percussion)

12
00:00:55,000 --> 00:01:07,000
'or dead, on the surface, for at least seven minutes.'
(music crescendos- dark pounding drums)

13
00:01:07,000 --> 00:01:12,000
Tom Rivellini: 'Entry, descent and landing, also known as EDL, is referred to as the '7 minutes of terror'.'

14
00:01:12,000 --> 00:01:21,000
'Because we've got literally seven minutes to get from the top of the atmosphere to the surface of Mars-'

15
00:01:21,000 --> 00:01:26,000
'going from 13,000 miles an hour to zero, in perfect sequence, perfect choreography, perfect timing...'

16
00:01:26,000 --> 00:01:31,000
'and the computer has to do it all by itself, with no help from the ground.'

17
00:01:31,000 --> 00:01:35,000
'If any one thing doesn't work just right, it's game over.'

18
00:01:35,000 --> 00:01:37,000
(whoosh)
(music -tension/drums steadily building)

19
00:01:37,000 --> 00:01:41,000
Adam Steltzner: 'We slam into the atmosphere and develop so much aerodynamic drag,'

20
00:01:41,000 --> 00:01:45,000
'our heat shield, it heats up and it glows like the surface of the sun.'

21
00:01:45,000 --> 00:01:49,000
'1600 degrees!'

22
00:01:49,000 --> 00:01:54,000
Miguel San Martin: 'During entry, the vehicle is not only slowing down- violently, though the atmosphere,'

23
00:01:54,000 --> 00:02:02,000
'but also we are guiding it, like an airplane! to be able to land in a very narrow, constrained space.'

24
00:02:02,000 --> 00:02:07,999
'This is one of the biggest challenges that we are facing, and one that we have never attempted at Mars.'

25

00:02:08,000 --> 00:02:08,999
'it'll only slow us down to about 200 miles an hour.'

26
00:02:09,000 --> 00:02:12,000
Tom Rivellini: 'Mars- it's actually really hard to slow down,'

27
00:02:12,000 --> 00:02:15,000
'because it has just enough atmosphere, that you have to deal with it-'

28
00:02:15,000 --> 00:02:17,000
'otherwise, it will destroy your spacecraft.'

29
00:02:17,000 --> 00:02:23,000
'On the other hand, it doesnt have enough atmosphere to finish the job.'

30
00:02:23,000 --> 00:02:25,000
'We're still going about 1000 miles an hour.'

31
00:02:25,000 --> 00:02:28,000
'So at that point we use a parachute.'

32
00:02:28,000 --> 00:02:32,000
Anita Sengupta: 'The parachute is the largest and strongest super-sonic parachute-'

33
00:02:32,000 --> 00:02:33,000
'that we've ever built to date.'

34
00:02:33,000 --> 00:02:40,000
'It has to withstand 65,000 pounds of force! even though the parachute itself only weighs about 100 pounds.'

35
00:02:40,000 --> 00:02:44,000
(blast-whoosh)

36
00:02:44,000 --> 00:02:49,000
Tom Rivellini: 'When it opens up that fast, it's a neck-snapping 9G's!'

37
00:02:49,000 --> 00:02:51,000
Steve Lee: 'At that point we have to get that heat shield off.'

38
00:02:51,000 --> 00:02:55,000
'It's like a big lens cap, blocking our view of the ground to the radar.'

39
00:02:55,000 --> 00:03:00,000
'The radar has to take just the right altitude and velocity measurements at just the right time-'

40
00:03:00,000 --> 00:03:02,000
'or the rest of the landing sequence wont work.'

41
00:03:02,000 --> 00:03:06,000
(heavy wind sound)
(music pulsing/intense)
0:03:06.0,0:02:08.0
Tom Rivellini: 'This big huge parachute that we've got-'

42
00:03:11,000 --> 00:03:14,000
'And that's not slow enough to land.'

43
00:03:14,000 --> 00:03:17,000
'So we have no choice but we've got to cut it off!'

44
00:03:17,000 --> 00:03:18,000
(whoosh)
(music cuts)

45
00:03:18,000 --> 00:03:20,000
'And then come down on rockets.'

46
00:03:20,000 --> 00:03:21,000
(engines blast)

47
00:03:21,000 --> 00:03:22,000
'Once we turn those rocket motors on-'

48
00:03:22,000 --> 00:03:25,000
'if we dont do something, we're just going to smack right back into the parachute!'

49

00:03:25,000 --> 00:03:26,000
(engines blast)
(music- big pounding drums)

50
00:03:26,000 --> 00:03:30,000
'So the first thing we do is make this really radical 'divert maneuver''

51
00:03:30,000 --> 00:03:32,000
'We fly off to the side.'

52
00:03:32,000 --> 00:03:38,000
Adam Steltzner: 'Diverting away from the parachute, killing our horizontal velocity and our vertical velocity'

53
00:03:38,000 --> 00:03:44,000
'getting the rover moving straight up and down, so it can look at the surface with its radar-'

54
00:03:44,000 --> 00:03:45,000
'and see where we're gonna land.'

55
00:03:45,000 --> 00:03:48,000
'And we head straight down'

56
00:03:48,000 --> 00:03:50,000
'to the bottom of a crater'

57
00:03:50,000 --> 00:03:53,000
'right beside a six kilometer-high mountain!'

58
00:03:53,000 --> 00:03:55,000
(music- grand)

59
00:03:55,000 --> 00:03:58,000
Anita Sengupta: 'We can't get those rocket engines too close to the ground.'

60
00:03:58,000 --> 00:04:02,000
'Because if we were to descent propulsively all the way to the ground-

61
00:04:02,000 --> 00:04:06,000

'we would essentially create this massive dust cloud. That dust cloud could then land on the rover-'

62
00:04:06,000 --> 00:04:09,000
'It could damage mechanisms and it could damage instruments.'

63
00:04:09,000 --> 00:04:14,000
'So the way we solve that problem, is by using the skycrane maneuver.'

64
00:04:14,000 --> 00:04:20,000
Adam Steltzner: '20 meters above the surface, we have to lower the rover below us-'

65
00:04:20,000 --> 00:04:23,000
'on a tether that's 21 feet long.'

66
00:04:23,000 --> 00:04:27,000
'And then deposit it, on its wheels, on the surface.'

67
00:04:27,000 --> 00:04:28,000
(music- intense and climactic)

68
00:04:28,000 --> 00:04:31,000
Miguel San Martin: 'As the rover touches down and is now on the ground,'

69
00:04:31,000 --> 00:04:34,000
'the descent stage- it's on a collision course with the rover!'

70
00:04:34,000 --> 00:04:39,000
'We must cut the bridal immediately and fly the descent stage to a safe distance from the rover.'

71
00:04:39,000 --> 00:04:44,000
(music crescendos and ends)
(thunderous rockets echo)