

1
00:00:25,019 --> 00:00:28,179
As the Sun rises over the Guiana Space Center

2
00:00:28,179 --> 00:00:30,660
the team conducts final checks on the health and status

3
00:00:30,660 --> 00:00:35,899
of the Ariane 5 rocket and its payload ...

4
00:00:35,899 --> 00:00:38,699
— the James Webb Space Telescope —

5
00:00:38,700 --> 00:00:47,480
... NASA's number one science priority.

6
00:00:56,420 --> 00:00:59,039
The Webb telescope is designed to look back to a time

7
00:00:59,039 --> 00:01:01,859
when stars and galaxies were first forming,

8
00:01:01,859 --> 00:01:05,239
over 13.5 billion years ago.

9
00:01:05,239 --> 00:01:08,459
With its revolutionary design and capabilities

10
00:01:08,459 --> 00:01:10,959
the Webb telescope is about to unleash a new

11
00:01:10,959 --> 00:01:19,059
dawn of discovery.

12
00:01:25,260 --> 00:01:27,840
Seconds before liftoff the Ariane 5's

13
00:01:27,840 --> 00:01:31,520
liquid-fueled engine comes to full power ...

14
00:01:31,519 --> 00:01:35,259
... followed by the ignition of the two solid rockets.

15
00:01:35,260 --> 00:01:40,540
We have liftoff!

16
00:01:48,680 --> 00:01:51,560
The Webb telescope is finally on its way –

17
00:01:51,560 --> 00:01:54,060
the result of years of study and development

18
00:01:54,060 --> 00:01:55,320
by thousands of team members

19
00:01:55,319 --> 00:02:00,039
in the United States, Canada, and Europe.

20
00:02:00,040 --> 00:02:02,340
Webb space craft descends nearly vertically

21
00:02:02,340 --> 00:02:06,159
through the heavy lower atmosphere of Earth.

22
00:02:09,180 --> 00:02:12,159
As the rocket reaches maximum acceleration

23
00:02:12,159 --> 00:02:14,939
the spent solid rocket motors are jettisoned safely

24
00:02:14,939 --> 00:02:16,979
into the Atlantic Ocean.

25
00:02:16,979 --> 00:02:18,259
Reaching the upper atmosphere,

26
00:02:18,259 --> 00:02:20,829
where protection is no longer needed,

27
00:02:20,830 --> 00:02:28,120
the payload fairing is jettisoned and falls away.

28
00:02:28,120 --> 00:02:30,879
Accelerating through the atmosphere the Ariane 5

29

00:02:30,879 --> 00:02:37,199
rocket's first stage expends its fuel and shuts down.

30
00:02:37,199 --> 00:02:39,319
The empty first stage then separates

31
00:02:39,319 --> 00:02:43,400
from the upper stage.

32
00:02:43,400 --> 00:02:45,260
After first-stage separation,

33
00:02:45,259 --> 00:02:47,459
and before second stage ignition,

34
00:02:47,460 --> 00:02:50,599
the Webb telescope has a slightly downward trajectory

35
00:02:50,599 --> 00:02:53,699
as its speeds over the Atlantic Ocean.

36
00:02:53,699 --> 00:02:55,560
The upper-stage motor ignites

37
00:02:55,560 --> 00:02:57,420
and the ascent to L2 resumes –

38
00:02:57,419 --> 00:03:03,239
never again to be interrupted.

39
00:03:03,240 --> 00:03:05,879
The exposed telescope is delicate

40
00:03:05,879 --> 00:03:08,960
and must be protected from the sun's fierce heat.

41
00:03:08,960 --> 00:03:11,560
To avoid overheating and damage,

42
00:03:11,560 --> 00:03:14,460
a carefully designed series of oscillations are performed

43
00:03:14,460 --> 00:03:18,540

that provide the necessary protection.

44
00:03:18,539 --> 00:03:21,439
Near the end of powered flight the roll program stops

45
00:03:21,439 --> 00:03:23,659
and the launcher then assumes the proper attitude

46
00:03:23,659 --> 00:03:28,639
for separation.

47
00:03:32,819 --> 00:03:35,639
After separation from the Ariane upper-stage,

48
00:03:35,639 --> 00:03:37,458
the Webb telescope continues its

49
00:03:37,460 --> 00:03:40,020
journey to L2 under its own power

50
00:03:40,020 --> 00:03:42,200
taking the next step to its final orbital station

51
00:03:42,199 --> 00:03:46,399
1 million miles from Earth.

52
00:03:51,039 --> 00:03:53,019
The Webb telescope is about to unleash

53
00:03:53,020 --> 00:03:57,680
a new dawn of discovery.

54
00:04:13,639 --> 00:04:15,819
The Webb telescope separates from the launcher's

55
00:04:15,819 --> 00:04:17,259
second stage.

56
00:04:17,259 --> 00:04:19,019
The white ring close to the Earth

57
00:04:19,019 --> 00:04:21,939
represents the Hubble Space Telescope's orbit.

58
00:04:21,939 --> 00:04:24,339
And the larger orbit is the geosynchronous orbit

59
00:04:24,339 --> 00:04:27,099
where most telecommunications satellites are located.

60
00:04:27,100 --> 00:04:30,160
The solar array is Webb's first deployment.

61
00:04:30,160 --> 00:04:32,680
When completed all the Webb's electrical power needs

62
00:04:32,680 --> 00:04:34,459
are satisfied by the solar array for

63
00:04:34,459 --> 00:04:36,699
the remainder of the mission.

64
00:04:36,699 --> 00:04:38,199
The on-board control system

65
00:04:38,199 --> 00:04:39,819
continually monitors and updates the

66
00:04:39,819 --> 00:04:43,899
attitude to ensure power generation and thermal safety.

67
00:04:43,899 --> 00:04:46,599
To preserve the cleanliness of the mirrors

68
00:04:46,600 --> 00:04:50,700
thrusters are located only on the sunlit side of
the observatory

69
00:04:50,699 --> 00:04:54,240
The trajectory is designed without employing a retrofire

70
00:04:54,240 --> 00:04:56,019
which necessitates pointing the delicate

71
00:04:56,019 --> 00:04:59,659
telescope at the Sun.

72
00:04:59,660 --> 00:05:02,820
If course corrections are needed these velocity

73
00:05:02,829 --> 00:05:04,478
additions must be done early in the

74
00:05:04,478 --> 00:05:06,519
flight to most efficiently use the

75
00:05:06,519 --> 00:05:10,240
mission's limited, precious fuel.

76
00:05:13,300 --> 00:05:15,720
After completing mid-course corrections

77
00:05:15,720 --> 00:05:21,380
the Webb telescope passes the orbit of the moon.

78
00:05:35,300 --> 00:05:37,520
Webb's initial transformation

79
00:05:37,519 --> 00:05:43,539
is the deployment of the sunshield pallets.

80
00:06:04,180 --> 00:06:06,189
The tower separating the telescope and

81
00:06:06,189 --> 00:06:11,519
instruments from the spacecraft and sunshield is next.

82
00:06:15,339 --> 00:06:18,539
Next, the aft flap deploys.

83
00:06:18,540 --> 00:06:20,640
This is key to managing momentum buildup

84
00:06:20,639 --> 00:06:22,579
and fuel consumption.

85
00:06:22,579 --> 00:06:25,039
This structure helps to balance the pressure

86
00:06:25,040 --> 00:06:27,400
from the sun's light on the Webb telescope around its

87
00:06:27,420 --> 00:06:31,300
center of mass.

88
00:06:31,300 --> 00:06:33,139
After the sunshield pallets reach their

89
00:06:33,139 --> 00:06:35,300
final positions, the membrane launch

90
00:06:35,300 --> 00:06:37,139
restraints are released.

91
00:06:37,139 --> 00:06:39,060
These have kept the sunshield membrane

92
00:06:39,060 --> 00:06:40,399
safely in place

93
00:06:40,399 --> 00:06:42,560
from final stowage at the Northrop Grumman

94
00:06:42,560 --> 00:06:47,040
facility in California through shipment and launch.

95
00:06:49,639 --> 00:06:52,300
The sunshield protective covers roll back,

96
00:06:52,300 --> 00:07:02,199
permitting membrane deployment.

97
00:07:02,199 --> 00:07:09,479
The covers over the core region released next.

98
00:07:09,480 --> 00:07:12,040
Then the mid booms extend and the sunshield

99
00:07:12,040 --> 00:07:17,520
assumes its hexagonal tennis-court-size shape.

100

00:07:37,800 --> 00:07:41,280
It is now time to tension the sunshield membranes –

101
00:07:41,279 --> 00:07:43,819
each thinner than a human hair –

102
00:07:43,819 --> 00:07:45,810
pulling each of the uniquely sized and

103
00:07:45,810 --> 00:07:48,759
shaped layers to their optimal position.

104
00:07:48,759 --> 00:07:51,319
When deployed, the sun shield allows the

105
00:07:51,319 --> 00:07:55,699
telescope to cool the 385° fahrenheit below zero;

106
00:07:55,699 --> 00:07:58,180
cold enough to liquify air.

107
00:07:58,180 --> 00:07:59,720
While the layer closest to the Sun

108
00:07:59,720 --> 00:08:02,860
is almost 190° fahrenheit above zero

109
00:08:02,860 --> 00:08:05,000
— nearly the boiling point of water.

110
00:08:05,000 --> 00:08:08,600
That's almost 600°

111
00:08:08,600 --> 00:08:11,330
— true fire and ice.

112
00:08:11,720 --> 00:08:14,280
Once in the shadow of the deployed Sunshield,

113
00:08:14,279 --> 00:08:16,219
the telescope and instruments continue

114
00:08:16,220 --> 00:08:18,120

cooling down to their final operational

115

00:08:18,120 --> 00:08:21,040
cryogenic temperatures.

116

00:08:21,040 --> 00:08:23,760
At the completion of membrane tensioning,

117

00:08:23,759 --> 00:08:25,819
the secondary mirror deploys in

118

00:08:25,819 --> 00:08:30,319
position as latched rigidly in place.

119

00:08:30,319 --> 00:08:32,718
The aft deployable radiator releases and

120

00:08:32,719 --> 00:08:35,000
springs into position, allowing the

121

00:08:35,000 --> 00:08:36,828
instruments to radiate their waste heat

122

00:08:36,828 --> 00:08:40,000
directly into space and away from the telescope.

123

00:08:40,000 --> 00:08:41,620
Disposing of excess heat is

124

00:08:41,629 --> 00:08:43,639
crucial to the mission so that it does

125

00:08:43,639 --> 00:08:46,159
not overwhelm the faint infrared signals

126

00:08:46,159 --> 00:08:49,500
to be collected from the cosmos.

127

00:08:49,500 --> 00:08:52,940
The cord fold wings deploying and latching place;

128

00:08:52,940 --> 00:08:54,920
completing the major deployments of the

129

00:08:54,919 --> 00:08:58,199

largest telescope in space.

130

00:09:07,340 --> 00:09:09,480

As the Webb telescope continues out to

131

00:09:09,480 --> 00:09:11,370

its operational orbit around the sun-Earth L2,

132

00:09:11,370 --> 00:09:14,159

the observatory continues to

133

00:09:14,159 --> 00:09:20,659

cool down to its final cryogenic temperature state.

134

00:09:20,659 --> 00:09:24,740

A trajectory correction applied 29 days after launch

135

00:09:24,740 --> 00:09:27,899

puts the Webb telescope into its halo orbit;

136

00:09:27,899 --> 00:09:31,220

a key part of the mission design.

137

00:09:31,220 --> 00:09:33,899

The sun-Earth L2 point is where Webb's

138

00:09:33,899 --> 00:09:37,360

orbit around the Sun is synchronized with Earth's.

139

00:09:37,360 --> 00:09:40,940

At this point, 1 million miles from Earth

140

00:09:40,940 --> 00:09:43,380

Webb is free from the thermal influences of the

141

00:09:43,379 --> 00:09:45,740

Earth and all eclipses.

142

00:09:45,740 --> 00:09:48,899

Additionally, the sun, Earth, and moon,

143

00:09:48,919 --> 00:09:50,539

the brightest objects in the sky

144

00:09:50,539 --> 00:09:53,179

are hidden by the deployed sunshield

145

00:09:53,179 --> 00:09:56,000

giving Webb a dark, cold, and stable

146

00:09:56,000 --> 00:10:01,740

environment to carry out its mission of discovery.

147

00:10:01,740 --> 00:10:03,799

Once the mirrors and detectors are

148

00:10:03,799 --> 00:10:06,799

sufficiently cold, the wavefront sensing

149

00:10:06,799 --> 00:10:09,559

and control operations can begin.

150

00:10:09,559 --> 00:10:12,138

This sophisticated multi-step operation's

151

00:10:12,139 --> 00:10:14,990

ultimate goal is to position each of the

152

00:10:14,990 --> 00:10:17,120

Webb telescope's movable mirrors into

153

00:10:17,120 --> 00:10:21,759

their correct final positions and orientations

154

00:10:21,759 --> 00:10:25,059

Once the mirrors are aligned, the mission team will continue

155

00:10:25,068 --> 00:10:26,808

checking out the science instruments;

156

00:10:26,808 --> 00:10:29,819

preparing them for operations.

157

00:10:29,820 --> 00:10:31,420
Commissioning is completed about

158
00:10:31,429 --> 00:10:34,219
160 days after launch.

159
00:10:34,220 --> 00:10:38,120
And the science mission is ready to begin.

160
00:10:38,120 --> 00:10:40,279
This brings to fruition the work of the

161
00:10:40,279 --> 00:10:42,860
thousands of members of the Webb team

162
00:10:42,860 --> 00:10:45,200
from the United States of America,

163
00:10:45,200 --> 00:10:47,840
Canada, and Europe.

164
00:10:47,840 --> 00:10:52,560
Astronomers from all over the world can now use this facility

165
00:10:52,559 --> 00:10:57,359
to study the universe.

166
00:10:57,360 --> 00:11:00,300
NASA's James Webb Space Telescope

167
00:11:00,299 --> 00:11:02,240
is a game-changer.

168
00:11:02,240 --> 00:11:04,120
Discoveries made by this observatory

169
00:11:04,120 --> 00:11:05,980
will rewrite textbooks;

170
00:11:05,980 --> 00:11:07,800
inspiring the next generation of

171
00:11:07,799 --> 00:11:12,959

future engineers and scientists.

172

00:11:12,960 --> 00:11:15,560

This revolutionary tool will provide an

173

00:11:15,559 --> 00:11:18,139

unprecedented view into the birth of the

174

00:11:18,139 --> 00:11:20,519

first stars and galaxies

175

00:11:20,519 --> 00:11:24,519

unleashing a new dawn of discovery.