1
00:00:33,170 --> 00:00:30,290
we were going to start out with a series

2
00:00:35,630 --> 00:00:33,180
of slides and follow that with a video

3
00:00:37,130 --> 00:00:35,640
of course the slides and also the video

4
00:00:39,680 --> 00:00:37,140
we're silent we will provide the

5
00:00:42,140 --> 00:00:39,690
narration and we hope that what we can

6
00:00:44,570 --> 00:00:42,150
do although it's not totally adequate

7
00:00:47,000 --> 00:00:44,580
but what we hope to do is show you a

8
00:00:50,180 --> 00:00:47,010
slice of what it's like to be on orbit

9
00:00:52,790 --> 00:00:50,190
and to conduct a mission a fantastic

10
00:00:57,130 --> 00:00:52,800
missions such as sts-80 so if we could

11
00:01:00,860 --> 00:00:59,390
well the one thing we know is that you

12
00:01:03,799 --> 00:01:00,870
can't have a mission until you have a

13
00:01:05,690 --> 00:01:03,809

patch and I was assigned as patched

14
00:01:07,700 --> 00:01:05,700
chairman on this flight so low-key about

15
00:01:08,779 --> 00:01:07,710
my goal was to come up with the patch it

16
00:01:10,820 --> 00:01:08,789
told a little bit of story about the

17
00:01:12,800 --> 00:01:10,830
mission before I get started I can't

18
00:01:15,469 --> 00:01:12,810
necessarily take credit for this design

19
00:01:17,060 --> 00:01:15,479
though real Mike sandy who was a an

20
00:01:18,680 --> 00:01:17,070
artist for Lockheed Martin was moved

21
00:01:22,010 --> 00:01:18,690
back east now came up with this design

22
00:01:24,560 --> 00:01:22,020
but what did I tell you and the center

23
00:01:28,580 --> 00:01:24,570
top portion of the patch is obvious Paz

24
00:01:31,330 --> 00:01:28,590
satellite the spectrograph astronomy

25
00:01:33,589 --> 00:01:31,340
satellite that we deployed on day one

26
00:01:35,660 --> 00:01:33,599
connected it at the bottom of the three

27
00:01:37,309 --> 00:01:35,670
red lines which are a portion of the

28
00:01:38,800 --> 00:01:37,319
astronauts symbol and those are there to

29
00:01:41,210 --> 00:01:38,810
represent in fact the astronaut office

30
00:01:42,740 --> 00:01:41,220
involvement with these satellites the

31
00:01:44,990 --> 00:01:42,750
two satellites we took up with both free

32
00:01:46,910 --> 00:01:45,000
fliers and for a large portion did a lot

33
00:01:49,249 --> 00:01:46,920
of science on their own but we would

34
00:01:50,870 --> 00:01:49,259
like to emphasize our portion in getting

35
00:01:52,669 --> 00:01:50,880
in there and help conducting the science

36
00:01:55,190 --> 00:01:52,679
at the bottom portion that is the wake

37
00:01:57,139 --> 00:01:55,200
shield satellite that the story was and

38
00:01:59,779 --> 00:01:57,149

was deeply involved with the entire time

39
00:02:01,279 --> 00:01:59,789
it was deployed you'll notice in the

40
00:02:03,260 --> 00:02:01,289
dark blue background they're stars

41
00:02:06,139 --> 00:02:03,270
they're 16 white stars represent a day

42
00:02:08,779 --> 00:02:06,149
for each one star for each day of the

43
00:02:11,510 --> 00:02:08,789
flight there's also two larger blue

44
00:02:13,640 --> 00:02:11,520
stars which were to represent the eve

45
00:02:15,650 --> 00:02:13,650
EAS and you've got to tell you now and I

46
00:02:17,600 --> 00:02:15,660
put those on I was also hopeful that we

47
00:02:19,729 --> 00:02:17,610
would wind up with the record duration

48
00:02:21,170 --> 00:02:19,739
mission so if you count those two that's

49
00:02:23,230 --> 00:02:21,180
18 days and in fact that's what I

50
00:02:26,230 --> 00:02:23,240
mission turned out to be

51
00:02:27,780 --> 00:02:26,240
pretty clever I did that on my last

52
00:02:31,000 --> 00:02:27,790
flight and we didn't get that actually

53
00:02:33,580 --> 00:02:31,010
yeah and then lastly around the

54
00:02:35,530 --> 00:02:33,590
perimeter the gray area where the names

55
00:02:36,790 --> 00:02:35,540
are encompassed if you look at that and

56
00:02:40,480 --> 00:02:36,800
kind of remove the shuttle you'll see a

57
00:02:43,510 --> 00:02:40,490
sea and it's kind of appropriate that

58
00:02:48,410 --> 00:02:43,520
that C stands for Columbia other

59
00:02:51,110 --> 00:02:48,420
commander cockle also enjoyed that seat

60
00:02:52,520 --> 00:02:51,120
but the and then obviously the center of

61
00:02:54,440 --> 00:02:52,530
the patch to what we really want to tell

62
00:02:55,910 --> 00:02:54,450
also was the space shuttle mission and

63
00:02:57,589 --> 00:02:55,920

there's the on-orbit configuration of

64
00:03:02,720 --> 00:02:57,599
the space shuttle while we conducted the

65
00:03:04,460 --> 00:03:02,730
science we go on to the next line we

66
00:03:07,190 --> 00:03:04,470
took off on a beautiful day in the

67
00:03:08,630 --> 00:03:07,200
afternoon in Florida and this is

68
00:03:09,979 --> 00:03:08,640
probably about three seconds into the

69
00:03:12,650 --> 00:03:09,989
flight by the time we get to the top of

70
00:03:14,870 --> 00:03:12,660
the tower we're going to 120 miles per

71
00:03:16,759 --> 00:03:14,880
hour but the real excitement for the

72
00:03:19,540 --> 00:03:16,769
crew is during those last three or four

73
00:03:22,280 --> 00:03:19,550
seconds prior to the Boosters lighten I

74
00:03:25,040 --> 00:03:22,290
think NASA does a countdown so that it

75
00:03:27,229 --> 00:03:25,050
can make the crew more scared when it

76
00:03:29,030 --> 00:03:27,239
when it comes time for the Boosters to

77
00:03:34,220 --> 00:03:29,040
light but we were we were in the hoopin

78
00:03:35,900 --> 00:03:34,230
and Hollerin mode at this point well one

79
00:03:37,490 --> 00:03:35,910
of the first activities during the

80
00:03:40,460 --> 00:03:37,500
mission was the deployment of the

81
00:03:42,199 --> 00:03:40,470
Orpheus Paz spacecraft we grappled the

82
00:03:43,820 --> 00:03:42,209
spa's about three and a half hours into

83
00:03:45,740 --> 00:03:43,830
the flight and we were set up for a

84
00:03:47,690 --> 00:03:45,750
seven-hour deploy we ended up deploying

85
00:03:49,840 --> 00:03:47,700
about eight and a half hours to to get

86
00:03:51,770 --> 00:03:49,850
some of the ground configuration

87
00:03:55,220 --> 00:03:51,780
corrected before we did the actual

88
00:03:56,750 --> 00:03:55,230

deploy but Orpheus Paz is a spacecraft

89
00:03:59,240 --> 00:03:56,760
that was born out of a joint agreement

90
00:04:01,789 --> 00:03:59,250
between NASA and the German Space Agency

91
00:04:04,280 --> 00:04:01,799
and it consists of the spa's carrier and

92
00:04:06,080 --> 00:04:04,290
the Orpheus suite of telescopes and

93
00:04:08,090 --> 00:04:06,090
instruments built by put in the United

94
00:04:11,210 --> 00:04:08,100
States and in Germany and they take

95
00:04:13,099 --> 00:04:11,220
ultraviolet spectrum or look at light of

96
00:04:15,800 --> 00:04:13,109
higher energy than optical light of

97
00:04:18,590 --> 00:04:15,810
things like stars in our own galaxy

98
00:04:20,360 --> 00:04:18,600
other galaxies and also look at the

99
00:04:21,740 --> 00:04:20,370
material between the stars to get a

100
00:04:26,600 --> 00:04:21,750
better understanding of the star

101
00:04:29,120 --> 00:04:26,610
formation process well along with the

102
00:04:31,010 --> 00:04:29,130
deploy came a fairly large photo TV

103
00:04:33,920 --> 00:04:31,020
requirement overhead and that helped to

104
00:04:36,110 --> 00:04:33,930
make our day one not only busy but very

105
00:04:38,330 --> 00:04:36,120
busy and this is a photo of Tom in the

106
00:04:39,740 --> 00:04:38,340
middle of the that nest and as a matter

107
00:04:42,080 --> 00:04:39,750
of fact along with that what a five

108
00:04:43,880 --> 00:04:42,090
recorder set up he's a he's holding a

109
00:04:46,190 --> 00:04:43,890
checklist and I'd like to mention Martha

110
00:04:47,719 --> 00:04:46,200
may and the photo TV she designed this

111
00:04:52,170 --> 00:04:47,729
checklist and without her help would

112
00:04:58,210 --> 00:04:54,370
we'll skip ahead a bit here to flight

113
00:04:59,980 --> 00:04:58,220

day 4 and we were busy here deploying

114
00:05:01,990 --> 00:04:59,990
the wake shield facility our other prime

115
00:05:05,050 --> 00:05:02,000
payload on them on the flight and I'm

116
00:05:06,790 --> 00:05:05,060
operating the RMS controls at the aft

117
00:05:09,760 --> 00:05:06,800
flight deck looking back into the

118
00:05:12,970 --> 00:05:09,770
payload Bay and we deployed the wake

119
00:05:14,710 --> 00:05:12,980
shield after a long period of orbiter

120
00:05:17,050 --> 00:05:14,720
free drift where we didn't fire the

121
00:05:18,850 --> 00:05:17,060
orbiters thrusters to keep contamination

122
00:05:21,000 --> 00:05:18,860
of the wake shields experimental side to

123
00:05:23,620 --> 00:05:21,010
a minimum and it was a very nice ballet

124
00:05:26,500 --> 00:05:23,630
designed by our friends and Mission

125
00:05:28,330 --> 00:05:26,510
Control to put together this same ballet

126
00:05:30,640 --> 00:05:28,340
and choreograph the release of the wig

127
00:05:32,650 --> 00:05:30,650
shield while we maneuvered the satellite

128
00:05:34,720 --> 00:05:32,660
to the various positions on the arm

129
00:05:39,790 --> 00:05:34,730
required to get it in deployed

130
00:05:41,800 --> 00:05:39,800
configuration here you can see the wake

131
00:05:44,230 --> 00:05:41,810
shield being unbirth from the payload

132
00:05:45,880 --> 00:05:44,240
bay and we removed it from the

133
00:05:49,120 --> 00:05:45,890
protective cone in the back of the

134
00:05:51,220 --> 00:05:49,130
payload bay that kept the experimental

135
00:05:53,470 --> 00:05:51,230
surface the growth services free from

136
00:05:54,940 --> 00:05:53,480
contamination during the launch pad stay

137
00:05:56,950 --> 00:05:54,950
the ascent in the early part of orbit

138
00:05:59,230 --> 00:05:56,960

and as we lift it up here we go into a

139
00:06:01,360 --> 00:05:59,240
complicated sequence of maneuvers to

140
00:06:02,980 --> 00:06:01,370
clean off the experimental bottom of the

141
00:06:04,840 --> 00:06:02,990
wake shield or the wake side of the

142
00:06:09,130 --> 00:06:04,850
satellite and story I'll tell us a bit

143
00:06:11,080 --> 00:06:09,140
more about that science here's the

144
00:06:14,320 --> 00:06:11,090
weight shield after a time is released

145
00:06:16,390 --> 00:06:14,330
it management awake shield program and

146
00:06:18,700 --> 00:06:16,400
the science is conducted on it is out of

147
00:06:20,530 --> 00:06:18,710
the University of Houston it's

148
00:06:22,750 --> 00:06:20,540
manufactured right across the water

149
00:06:25,300 --> 00:06:22,760
there in South Shore harbor by space

150
00:06:29,080 --> 00:06:25,310
craft industries wake shield is a

151
00:06:31,300 --> 00:06:29,090
satellite to study the manufacture of

152
00:06:34,570 --> 00:06:31,310
semiconductor materials out there and a

153
00:06:36,969 --> 00:06:34,580
perfect vacuum 10 to the minus 14 it's a

154
00:06:39,550 --> 00:06:36,979
battery-operated has thermal passive

155
00:06:41,409 --> 00:06:39,560
system it has its own attitude a

156
00:06:44,020 --> 00:06:41,419
termination system that looks at earth

157
00:06:46,240 --> 00:06:44,030
horizon and it controls its attitude

158
00:06:49,000 --> 00:06:46,250
with torque errs the orange structures

159
00:06:51,820 --> 00:06:49,010
that you can see magnetic torque and a

160
00:06:59,140 --> 00:06:51,830
reaction control feel it performed

161
00:07:06,020 --> 00:07:02,480
operating wake shield we do that using

162
00:07:08,510 --> 00:07:06,030
portable computers I used a pilot seat

163
00:07:11,540 --> 00:07:08,520

here and I strapped to personal

164
00:07:13,220 --> 00:07:11,550
computers to the pilot seat and it looks

165
00:07:15,860 --> 00:07:13,230
something like a pipe organ where you

166
00:07:17,570 --> 00:07:15,870
had different kinds of keyboards one of

167
00:07:19,700 --> 00:07:17,580
those computers was used for monitoring

168
00:07:26,630 --> 00:07:19,710
the system and the other was for sending

169
00:07:27,920 --> 00:07:26,640
commands to it of the scientists and

170
00:07:29,420 --> 00:07:27,930
mission specialists on the mission we're

171
00:07:31,760 --> 00:07:29,430
real excited about the science on

172
00:07:33,230 --> 00:07:31,770
glenwood shield but the pilots we're

173
00:07:35,420 --> 00:07:33,240
pretty excited about the fact we get a

174
00:07:37,970 --> 00:07:35,430
rendezvous with it to pick it back up so

175
00:07:40,730 --> 00:07:37,980
here's taco the app station on Rhonda we

176
00:07:42,050 --> 00:07:40,740
did our fight day 7 the wake shield had

177
00:07:44,060 --> 00:07:42,060
accomplished all the science it

178
00:07:47,390 --> 00:07:44,070
attempted during this mission which was

179
00:07:48,860 --> 00:07:47,400
a pretty aggressive schedule and tacos

180
00:07:54,290 --> 00:07:48,870
at the app station flying that

181
00:07:55,880 --> 00:07:54,300
rendezvous in flight day 7 it's not a

182
00:07:58,490 --> 00:07:55,890
one-person show getting right a good

183
00:08:00,860 --> 00:07:58,500
with a with an orbiting satellite of

184
00:08:04,160 --> 00:08:00,870
course it's a team of scores of people

185
00:08:06,200 --> 00:08:04,170
on the ground and in flight and each

186
00:08:08,570 --> 00:08:06,210
crew members got a job to do and in the

187
00:08:09,920 --> 00:08:08,580
case of this flight we wanted to take

188
00:08:11,750 --> 00:08:09,930

some independent measures of the

189
00:08:13,730 --> 00:08:11,760
distance of the satellite and the rate

190
00:08:17,900 --> 00:08:13,740
that it was closing on us and we use a

191
00:08:20,120 --> 00:08:17,910
police laser speed gun to do then that's

192
00:08:22,679 --> 00:08:20,130
exactly what that is it's something you

193
00:08:26,100 --> 00:08:22,689
may have seen face-to-face sit in

194
00:08:28,229 --> 00:08:26,110
and your everyday walk of life and it's

195
00:08:30,269 --> 00:08:28,239
a very accurate machine and we had Tammy

196
00:08:32,519 --> 00:08:30,279
stretched out across the carpet looking

197
00:08:34,350 --> 00:08:32,529
up at the two satellites on each of the

198
00:08:38,219 --> 00:08:34,360
rendezvous measuring their speed in the

199
00:08:40,379 --> 00:08:38,229
distance from us meanwhile somebody has

200
00:08:43,439 --> 00:08:40,389
to run the show well I'm back having fun

201
00:08:45,889 --> 00:08:43,449
doing the flying and up until the time

202
00:08:48,210 --> 00:08:45,899
that we take over the manual flying

203
00:08:50,610 --> 00:08:48,220
Rommel here in the in the commander's

204
00:08:52,590 --> 00:08:50,620
seat did the or the trajectory

205
00:08:53,910 --> 00:08:52,600
adjustment burns that are used to get us

206
00:08:56,730 --> 00:08:53,920
right on track to be ready to rendezvous

207
00:08:58,980 --> 00:08:56,740
with the whichever satellite we're going

208
00:09:01,559 --> 00:08:58,990
after and he also monitors all the

209
00:09:02,879 --> 00:09:01,569
systems on board Columbia which I might

210
00:09:09,030 --> 00:09:02,889
point out we're working perfectly and

211
00:09:11,150 --> 00:09:09,040
and gave us no trouble at home here's a

212
00:09:13,559 --> 00:09:11,160
shot of the wake shielded just after a

213
00:09:15,749 --> 00:09:13,569

grapple and we're swinging it from the

214
00:09:18,269 --> 00:09:15,759
raffle position into the payload Bay

215
00:09:19,679 --> 00:09:18,279
again to be berth on flight day 7 in the

216
00:09:21,660 --> 00:09:19,689
background there it's very pretty view

217
00:09:23,879 --> 00:09:21,670
of the Pacific Ocean the Gulf of

218
00:09:25,920 --> 00:09:23,889
California on the right and the island

219
00:09:28,889 --> 00:09:25,930
off the coast of the Baja Peninsula is

220
00:09:31,470 --> 00:09:28,899
the island of the guardian angels in

221
00:09:35,160 --> 00:09:31,480
Mexico and we had a spectacular view of

222
00:09:36,840 --> 00:09:35,170
the the wake shield orbiter and the

223
00:09:39,389 --> 00:09:36,850
earth below throughout all of these

224
00:09:40,650 --> 00:09:39,399
phases of the flight and it just takes

225
00:09:42,540 --> 00:09:40,660
your breath away when you're trying to

226
00:09:44,069 --> 00:09:42,550
work in the payload Bay and something of

227
00:09:48,449 --> 00:09:44,079
skimming buying in the background the

228
00:09:51,329 --> 00:09:48,459
spectacular is this here we have our

229
00:09:53,910 --> 00:09:51,339
wake shield RMS operator Tom did all of

230
00:09:55,980 --> 00:09:53,920
the RMS operations on the wake shield

231
00:09:57,990 --> 00:09:55,990
and here he's performing some attached

232
00:10:00,059 --> 00:09:58,000
ops meaning the arms attached to wake

233
00:10:02,759 --> 00:10:00,069
shield the day after we did the

234
00:10:05,220 --> 00:10:02,769
retrieval and you can see the wake

235
00:10:07,290 --> 00:10:05,230
shield through the aft window and the

236
00:10:10,319 --> 00:10:07,300
tail and of course all of this is done

237
00:10:15,689 --> 00:10:10,329
against the backdrop of the earth as we

238
00:10:17,490 --> 00:10:15,699

orbit around it this slides in here to

239
00:10:18,749 --> 00:10:17,500
represent some of the mid-deck science

240
00:10:21,119 --> 00:10:18,759
experiments we had on board and

241
00:10:24,360 --> 00:10:21,129
especially mid-flight about how seven

242
00:10:26,249 --> 00:10:24,370
eight nine or so the we had a pretty

243
00:10:28,379 --> 00:10:26,259
large host of mid dec experiments the

244
00:10:30,900 --> 00:10:28,389
one that tan is working here is called

245
00:10:33,540 --> 00:10:30,910
view Cpl that's a capillary pumped loop

246
00:10:35,669 --> 00:10:33,550
which the concept of is to try to prove

247
00:10:36,480 --> 00:10:35,679
out that we can in fact hump a loop to

248
00:10:38,310 --> 00:10:36,490
remove heat from the

249
00:10:40,440 --> 00:10:38,320
struments in space without using a

250
00:10:42,300 --> 00:10:40,450
mechanical pump but rather using the

251
00:10:46,860 --> 00:10:42,310
fluid mechanics properties as well as

252
00:10:49,110 --> 00:10:46,870
heat to drive it hard to doing a

253
00:10:51,360 --> 00:10:49,120
spacewalk we do an extensive check out

254
00:10:54,139 --> 00:10:51,370
of the spacesuits and the life support

255
00:10:57,240 --> 00:10:54,149
systems on the back several days before

256
00:10:59,610 --> 00:10:57,250
going to do the EV a we also configure

257
00:11:01,530 --> 00:10:59,620
an done stole all the tools and arrange

258
00:11:03,180 --> 00:11:01,540
them in the airlock so we've

259
00:11:07,139 --> 00:11:03,190
choreographed that tool flow before

260
00:11:10,620 --> 00:11:07,149
going out the door this is EV a day here

261
00:11:12,900 --> 00:11:10,630
and Tami's getting suited up and you can

262
00:11:14,790 --> 00:11:12,910
see I'll be in the picture to my hand

263
00:11:17,610 --> 00:11:14,800

down there to the left putting on

264
00:11:20,340 --> 00:11:17,620
Tammy's club getting suited up I'm

265
00:11:22,590 --> 00:11:20,350
called the IV person all the suits all

266
00:11:24,840 --> 00:11:22,600
the tools everything we did on board I

267
00:11:29,400 --> 00:11:24,850
performed absolutely flawlessly and they

268
00:11:31,949 --> 00:11:29,410
were ready to support a spacewalk well

269
00:11:33,930 --> 00:11:31,959
as everyone knows a screw and a

270
00:11:36,420 --> 00:11:33,940
mechanism in the hatch precluded us from

271
00:11:38,190 --> 00:11:36,430
performing the epa's and Tom and I had a

272
00:11:42,360 --> 00:11:38,200
lot of creative ideas about how we might

273
00:11:44,220 --> 00:11:42,370
actually get that hatch open and we also

274
00:11:46,769 --> 00:11:44,230
had a number of tools on board not just

275
00:11:48,690 --> 00:11:46,779
the EBA tools but the ifm tools and so

276
00:11:51,090 --> 00:11:48,700
we went looking through the bag of

277
00:11:53,460 --> 00:11:51,100
tricks and and chose a hammer and a

278
00:11:56,639 --> 00:11:53,470
crowbar which also might be used as a

279
00:11:58,949 --> 00:11:56,649
chisel and took this photograph in jest

280
00:12:00,690 --> 00:11:58,959
as if we were going to go and take one

281
00:12:06,850 --> 00:12:00,700
more crack at the hatch before we called

282
00:12:12,370 --> 00:12:10,000
not dividing up the slides to see who

283
00:12:16,030 --> 00:12:12,380
will talk about them it's normally a

284
00:12:18,400 --> 00:12:16,040
democratic process but the vote in this

285
00:12:20,580 --> 00:12:18,410
case was four to one that I would begin

286
00:12:23,050 --> 00:12:20,590
the one ended up talking about this

287
00:12:25,000 --> 00:12:23,060
washing your hair on orbit turns out

288
00:12:27,520 --> 00:12:25,010

there's not much different than than

289
00:12:33,070 --> 00:12:27,530
washing your hair down here especially

290
00:12:34,630 --> 00:12:33,080
for used to me especially for me but you

291
00:12:37,350 --> 00:12:34,640
don't want to put too much stuff on it

292
00:12:41,290 --> 00:12:37,360
cuz you haven't got that much water to

293
00:12:43,000 --> 00:12:41,300
get it off but I'm just like it's

294
00:12:44,560 --> 00:12:43,010
somewhat like you know watching a car

295
00:12:46,240 --> 00:12:44,570
you get too much soap on it down here

296
00:12:53,180 --> 00:12:46,250
but some people wash their cars and

297
00:12:58,830 --> 00:12:56,400
and that Tami took the liberty of

298
00:13:00,840 --> 00:12:58,840
converting some of the orbiter air

299
00:13:05,340 --> 00:13:00,850
conditioner system to her own personal

300
00:13:06,960 --> 00:13:05,350
hair dryer she was hands down the one

301
00:13:12,240 --> 00:13:06,970
that needed a hair dryer the most on

302
00:13:13,380 --> 00:13:12,250
board what we'd like to do now is go

303
00:13:15,950 --> 00:13:13,390
ahead and show you some of the Earth

304
00:13:18,210 --> 00:13:15,960
Observation slides that we've got and

305
00:13:19,590 --> 00:13:18,220
this one just came out beautifully in

306
00:13:22,410 --> 00:13:19,600
all five of us claimed were the ones

307
00:13:24,720 --> 00:13:22,420
that took it but the what this is as a

308
00:13:27,480 --> 00:13:24,730
Sinai Peninsula the Red Sea on the left

309
00:13:29,250 --> 00:13:27,490
side and from the leg of the Sinai from

310
00:13:31,410 --> 00:13:29,260
the Red Sea the Suez Canal is on the

311
00:13:34,050 --> 00:13:31,420
right just above it is the Nile Delta

312
00:13:35,670 --> 00:13:34,060
Cairo is in there there are some

313
00:13:38,520 --> 00:13:35,680

pyramids in there we actually shot the

314
00:13:40,320 --> 00:13:38,530
pyramids from space and fortunately for

315
00:13:41,730 --> 00:13:40,330
me the pyramids are very close to what I

316
00:13:43,440 --> 00:13:41,740
thought where I thought the pyramids

317
00:13:45,930 --> 00:13:43,450
were so they did come out my slides and

318
00:13:48,540 --> 00:13:45,940
then the Nile you can see the Nile above

319
00:13:51,510 --> 00:13:48,550
the Red Sea with with the large band in

320
00:13:53,370 --> 00:13:51,520
it also I just like to point out the

321
00:13:55,470 --> 00:13:53,380
curvature of the earth and something

322
00:13:58,620 --> 00:13:55,480
that's always stuck out to me is how

323
00:14:00,720 --> 00:13:58,630
black space is it is absolutely the

324
00:14:06,450 --> 00:14:00,730
starkest blackest black I've ever seen

325
00:14:09,270 --> 00:14:06,460
expression next to the earth we spend a

326
00:14:12,050 --> 00:14:09,280
lot of our time over water in an

327
00:14:14,880 --> 00:14:12,060
equatorial or 28 degree inclined orbit

328
00:14:16,670 --> 00:14:14,890
and most of the time you just pay

329
00:14:19,860 --> 00:14:16,680
attention to the clouds only in passing

330
00:14:21,360 --> 00:14:19,870
however late in the flight on a couple

331
00:14:22,980 --> 00:14:21,370
of our wave off days that got added to

332
00:14:24,360 --> 00:14:22,990
the end of the flight we glanced down

333
00:14:25,680 --> 00:14:24,370
and the Indian Ocean while we were

334
00:14:27,890 --> 00:14:25,690
strapped into our seats waiting for the

335
00:14:30,510 --> 00:14:27,900
deorbit burn that never came and saw

336
00:14:32,370 --> 00:14:30,520
cyclone Daniella here in the Indian

337
00:14:34,800 --> 00:14:32,380
Ocean off the east coast of Madagascar

338
00:14:36,180 --> 00:14:34,810

and we watched this storm over a couple

339
00:14:38,400 --> 00:14:36,190
of successive days and were able to get

340
00:14:40,830 --> 00:14:38,410
some pictures of this hurricane down in

341
00:14:42,390 --> 00:14:40,840
the southern hemisphere I is very well

342
00:14:44,670 --> 00:14:42,400
defined there and penetrates right down

343
00:14:46,380 --> 00:14:44,680
to the sea surface and the other detail

344
00:14:49,860 --> 00:14:46,390
that you might notice is that the spiral

345
00:14:51,960 --> 00:14:49,870
bands of this storm are in a clockwise

346
00:14:53,790 --> 00:14:51,970
direction and that's just the opposite

347
00:14:55,470 --> 00:14:53,800
of hurricanes up here in the northern

348
00:14:57,420 --> 00:14:55,480
hemisphere so you can really see

349
00:14:59,580 --> 00:14:57,430
Coriolis forces at work in the different

350
00:15:01,410 --> 00:14:59,590
hemispheres and this was the only big

351
00:15:02,940 --> 00:15:01,420
hurricane we saw in 18 days so we

352
00:15:07,100 --> 00:15:02,950
managed to grab it at the end of the

353
00:15:12,990 --> 00:15:10,530
this is a view of one of the islands in

354
00:15:15,660 --> 00:15:13,000
the Bahamas the Great Exuma Island and

355
00:15:17,730 --> 00:15:15,670
to the right on the dark portion you can

356
00:15:20,639 --> 00:15:17,740
see the tongue of the ocean the depth of

357
00:15:22,380 --> 00:15:20,649
that water is about 3,000 feet whereas

358
00:15:24,960 --> 00:15:22,390
the depth close to the island is about

359
00:15:27,420 --> 00:15:24,970
10 feet so there's a tremendous gradient

360
00:15:30,150 --> 00:15:27,430
in depth I'm over a very short distance

361
00:15:32,160 --> 00:15:30,160
I must say that I'm always struck in

362
00:15:34,139 --> 00:15:32,170
particular by the coastlines when I view

363
00:15:37,680 --> 00:15:34,149

the Earth from orbit the blues and

364
00:15:39,449 --> 00:15:37,690
greens around the the chain of islands

365
00:15:42,060 --> 00:15:39,459
in the Bahamas is extraordinarily

366
00:15:48,750 --> 00:15:42,070
beautiful and I wish that you could all

367
00:15:50,519 --> 00:15:48,760
enjoy such a view this is probably the

368
00:15:53,610 --> 00:15:50,529
winner of the most photographed spot

369
00:15:55,199 --> 00:15:53,620
award on sts-80 it's not Everest the

370
00:15:58,050 --> 00:15:55,209
highest peak on the planet just a bit

371
00:15:59,310 --> 00:15:58,060
over 29,000 feet and it's the large

372
00:16:01,949 --> 00:15:59,320
mountain right at the center of the

373
00:16:04,710 --> 00:16:01,959
picture with a very large shadow going

374
00:16:06,870 --> 00:16:04,720
off to the upper right so the right of

375
00:16:09,389 --> 00:16:06,880
this picture is the high plateau of

376
00:16:12,449 --> 00:16:09,399
Tibet average altitude about three miles

377
00:16:15,090 --> 00:16:12,459
above sea level and stretching towards

378
00:16:17,850 --> 00:16:15,100
Mount Everest is a very deep V shaped

379
00:16:19,860 --> 00:16:17,860
Valley that makes it easy for us as crew

380
00:16:21,420 --> 00:16:19,870
members to identify it from space when

381
00:16:22,829 --> 00:16:21,430
you pick up that Valley can walk right

382
00:16:23,940 --> 00:16:22,839
up it to the left there to Mount Everest

383
00:16:25,590 --> 00:16:23,950
in the center of the picture and

384
00:16:27,870 --> 00:16:25,600
surrounding the mountain or a number of

385
00:16:30,840 --> 00:16:27,880
glaciers coated with boulders that you

386
00:16:32,370 --> 00:16:30,850
can see in the fine detail and some of

387
00:16:34,650 --> 00:16:32,380
our pictures off to the left would be

388
00:16:37,079 --> 00:16:34,660

the Indian side of the subcontinent here

389
00:16:38,880 --> 00:16:37,089
and of course not Everest has shoved up

390
00:16:43,319 --> 00:16:38,890
to the heights it's reached because

391
00:16:44,880 --> 00:16:43,329
India slide cramming into the Asiatic

392
00:16:47,790 --> 00:16:44,890
continent and thrusting news Mountain

393
00:16:49,079 --> 00:16:47,800
skyward one of the prettiest mountain

394
00:16:54,150 --> 00:16:49,089
chains that we saw anywhere on the

395
00:16:56,760 --> 00:16:54,160
planet this is a view of Mount Pinatubo

396
00:16:59,370 --> 00:16:56,770
which is a volcano in the Philippines on

397
00:17:01,530 --> 00:16:59,380
the island of Luzon it erupted several

398
00:17:04,949 --> 00:17:01,540
years ago and we continue to photograph

399
00:17:06,809 --> 00:17:04,959
it and a note in this photograph down in

400
00:17:09,360 --> 00:17:06,819
the lower left corner is clark air base

401
00:17:11,100 --> 00:17:09,370
you can just see the runway running sort

402
00:17:14,730 --> 00:17:11,110
of up to the left and down to the right

403
00:17:16,799 --> 00:17:14,740
and the mud flows that are coming down

404
00:17:18,360 --> 00:17:16,809
from this mountain after after the

405
00:17:20,460 --> 00:17:18,370
eruption a lot of the vegetation

406
00:17:22,590 --> 00:17:20,470
was removed and so the mountain is

407
00:17:24,689 --> 00:17:22,600
eroding at a more rapid pace than would

408
00:17:26,760 --> 00:17:24,699
be normal for a for an older mountain

409
00:17:29,250 --> 00:17:26,770
that has all of its vegetation in place

410
00:17:32,700 --> 00:17:29,260
the Earth Observation scientists here at

411
00:17:35,400 --> 00:17:32,710
JSC track can successive photographs of

412
00:17:39,510 --> 00:17:35,410
places like this and can use that to

413
00:17:41,370 --> 00:17:39,520

determine how ecologically various areas

414
00:17:45,470 --> 00:17:41,380
the world's are being affected by the

415
00:17:49,380 --> 00:17:47,760
sometimes we go after very specific

416
00:17:51,330 --> 00:17:49,390
targets on the earth with our earth

417
00:17:53,630 --> 00:17:51,340
observation photos we have a list that

418
00:17:56,160 --> 00:17:53,640
sent up each day from Mission Control

419
00:17:58,320 --> 00:17:56,170
with our targets for the day that the

420
00:18:00,000 --> 00:17:58,330
best opportunities for looking at change

421
00:18:02,730 --> 00:18:00,010
on the globe for example or weather

422
00:18:04,620 --> 00:18:02,740
phenomenon sometimes we just shoot the

423
00:18:07,200 --> 00:18:04,630
pictures for aesthetics and here we are

424
00:18:08,970 --> 00:18:07,210
way out over the Pacific Ocean well west

425
00:18:11,160 --> 00:18:08,980
of Christmas Island and well southwest

426
00:18:12,930 --> 00:18:11,170
of Hawaii over nowhere in particular but

427
00:18:15,600 --> 00:18:12,940
the Sun was going down to the west and

428
00:18:17,820 --> 00:18:15,610
we caught the cloud layers and the Sun

429
00:18:18,990 --> 00:18:17,830
glint in a nice golden glow there and

430
00:18:20,640 --> 00:18:19,000
it's just one of the prettiest sights

431
00:18:23,490 --> 00:18:20,650
the clouds here almost three-dimensional

432
00:18:25,320 --> 00:18:23,500
as they float above the surface of the

433
00:18:27,480 --> 00:18:25,330
pacific here and we all had a keen eye

434
00:18:29,460 --> 00:18:27,490
for these shots thanks to story I think

435
00:18:31,410 --> 00:18:29,470
he was more aesthetically inclined than

436
00:18:32,780 --> 00:18:31,420
the rest of us in his views out the

437
00:18:38,160 --> 00:18:32,790
window and he always called attention to

438
00:18:39,690 --> 00:18:38,170

spectacular sights like these this is

439
00:18:43,020 --> 00:18:39,700
the island of the wahoo one of the

440
00:18:47,880 --> 00:18:43,030
islands in the Hawaiian chain that is a

441
00:18:50,700 --> 00:18:47,890
well eroded extinct volcano we passed

442
00:18:52,560 --> 00:18:50,710
over the Hawaiian chain every day we got

443
00:18:54,600 --> 00:18:52,570
a lot of good photos of it because a lot

444
00:18:57,060 --> 00:18:54,610
of times it was clear and also we passed

445
00:18:59,520 --> 00:18:57,070
over the islands during a cruel wake

446
00:19:01,620 --> 00:18:59,530
period and when the earth was lit at

447
00:19:03,960 --> 00:19:01,630
this point at the very bottom of the

448
00:19:06,150 --> 00:19:03,970
slide there you can see a straight

449
00:19:08,150 --> 00:19:06,160
structure on the bottom shoreline that

450
00:19:10,890 --> 00:19:08,160
is a Honolulu International Airport

451
00:19:13,140 --> 00:19:10,900
Hickam Air Force Base you can see the

452
00:19:16,950 --> 00:19:13,150
body of water on the bottom that is

453
00:19:19,230 --> 00:19:16,960
Pearl Harbor to the very right lower is

454
00:19:22,230 --> 00:19:19,240
a diamond head in the beach above from

455
00:19:24,510 --> 00:19:22,240
that is Waikiki Beach the very top of

456
00:19:25,590 --> 00:19:24,520
the slide is why I may obey the North

457
00:19:29,370 --> 00:19:25,600
Shore where they have

458
00:19:31,260 --> 00:19:29,380
very large surf some personal thoughts

459
00:19:32,520 --> 00:19:31,270
on that slide is I do have a boy that

460
00:19:35,010 --> 00:19:32,530
lives down there in the bottom in

461
00:19:36,150 --> 00:19:35,020
Honolulu off to the right I can do ebay

462
00:19:39,270 --> 00:19:36,160
i was stationed in the Marine Corps

463
00:19:41,520 --> 00:19:39,280

there 40 years ago now we did waive off

464
00:19:47,430 --> 00:19:41,530
two extra days and that brought us to a

465
00:19:51,539 --> 00:19:47,440
landing on a pro Harbor Day well here we

466
00:19:55,080 --> 00:19:51,549
are on flight day 15 having rendezvous

467
00:19:56,850 --> 00:19:55,090
with the orpheus spas and preparing to

468
00:19:59,399 --> 00:19:56,860
retrieve it one thing you might notice

469
00:20:01,110 --> 00:19:59,409
about this space quot spacecraft is that

470
00:20:03,690 --> 00:20:01,120
its equipment equipped with some black

471
00:20:06,029 --> 00:20:03,700
and white dots and those dots were used

472
00:20:09,240 --> 00:20:06,039
as part of the space vision system

473
00:20:12,060 --> 00:20:09,250
experiment which is basically a camera

474
00:20:13,890 --> 00:20:12,070
and some computer smarts that looks at

475
00:20:16,200 --> 00:20:13,900
the position of these dots on an object

476
00:20:18,000 --> 00:20:16,210
like a spacecraft can determines things

477
00:20:20,220 --> 00:20:18,010
like position and attitude very very

478
00:20:22,409 --> 00:20:20,230
accurately and we're hoping to use the

479
00:20:24,930 --> 00:20:22,419
space station the space vision system

480
00:20:26,520 --> 00:20:24,940
when we construct the space station and

481
00:20:28,919 --> 00:20:26,530
so we wanted to perform some tests on

482
00:20:30,750 --> 00:20:28,929
that system and the orpheus spas folks

483
00:20:33,419 --> 00:20:30,760
were kind enough to let us use their

484
00:20:35,549 --> 00:20:33,429
spacecraft as a testbed but on flight

485
00:20:38,220 --> 00:20:35,559
day 15 we did rendezvous with Orpheus

486
00:20:40,470 --> 00:20:38,230
and retrieved it after 14 successful

487
00:20:47,130 --> 00:20:40,480
days of data acquisition on a variety of

488
00:20:49,500 --> 00:20:47,140

astronomical objects here we are on what

489
00:20:51,450 --> 00:20:49,510
we thought was landing day we got a

490
00:20:56,039 --> 00:20:51,460
tremendous amount of practice that

491
00:20:58,080 --> 00:20:56,049
deorbit preparation but story and I were

492
00:21:00,029 --> 00:20:58,090
responsible for suiting up our crew

493
00:21:02,399 --> 00:21:00,039
members and then of course ourselves and

494
00:21:06,539 --> 00:21:02,409
here you can see we have our commanders

495
00:21:08,370 --> 00:21:06,549
suited up in preparation for his landing

496
00:21:11,430 --> 00:21:08,380
of the shuttle actually a couple days

497
00:21:14,039 --> 00:21:11,440
later and we're all very proud of him

498
00:21:17,100 --> 00:21:14,049
and as you can see the smile on stories

499
00:21:22,330 --> 00:21:17,110
face he's very excited about the

500
00:21:26,960 --> 00:21:24,890
all good things have to come to an end

501
00:21:29,800 --> 00:21:26,970
we didn't have to land on flight to 18

502
00:21:33,790 --> 00:21:29,810
we actually had enough fuel on board

503
00:21:37,250 --> 00:21:33,800
Columbia to fly through four more days

504
00:21:39,110 --> 00:21:37,260
we were out of some of the undergarments

505
00:21:43,430 --> 00:21:39,120
that you might want to use for

506
00:21:45,260 --> 00:21:43,440
successful days and we were also running

507
00:21:47,960 --> 00:21:45,270
a little bit of short on food we had

508
00:21:49,430 --> 00:21:47,970
lots of food that maybe you'll Givens

509
00:21:52,670 --> 00:21:49,440
would like but we were kind of short on

510
00:21:54,770 --> 00:21:52,680
the basics and entrees but we weren't

511
00:21:56,720 --> 00:21:54,780
ready to land we were we were happy

512
00:22:00,290 --> 00:21:56,730
where we were we'd I think by around the

513
00:22:03,110 --> 00:22:00,300

10th or 11th day we were very a'kla

514
00:22:05,540 --> 00:22:03,120
mated to zero-g into living in this

515
00:22:08,360 --> 00:22:05,550
little environment of the space shuttle

516
00:22:09,920 --> 00:22:08,370
and enjoying it very much and having

517
00:22:12,980 --> 00:22:09,930
such a great time that we could have

518
00:22:15,290 --> 00:22:12,990
gone on for much longer the landing that

519
00:22:18,050 --> 00:22:15,300
we were given was about 15 minutes prior

520
00:22:21,470 --> 00:22:18,060
to sunrise it goes in the books

521
00:22:23,270 --> 00:22:21,480
efficiently as a day day landing but it

522
00:22:25,070 --> 00:22:23,280
looked dark enough to me to log it in my

523
00:22:29,210 --> 00:22:25,080
personal log book is a night landing and

524
00:22:30,590 --> 00:22:29,220
so it did give us a beautiful view and

525
00:22:33,200 --> 00:22:30,600
here we are as we are approaching

526
00:22:35,570 --> 00:22:33,210
touchdown with the xenon lights

527
00:22:37,160 --> 00:22:35,580
illuminating us from behind and you can

528
00:22:40,820 --> 00:22:37,170
see the humidity in the Florida air is

529
00:22:43,130 --> 00:22:40,830
has turned into some vapor before you

530
00:22:45,080 --> 00:22:43,140
switch off the slide talker I just like

531
00:22:47,750 --> 00:22:45,090
to add that the as pilots talk and I

532
00:22:49,820 --> 00:22:47,760
train for months and months hundreds of

533
00:22:54,080 --> 00:22:49,830
landings and practices to try to touch

534
00:22:55,940 --> 00:22:54,090
down hopefully within plus 10-15 knots

535
00:22:58,100 --> 00:22:55,950
of the speed that were supposed to touch

536
00:22:59,240 --> 00:22:58,110
down and the point we touch down can

537
00:23:01,370 --> 00:22:59,250
vary on this day we were supposed to

538
00:23:03,440 --> 00:23:01,380

touch down around 30 100 feet though

539
00:23:04,850 --> 00:23:03,450
taco won't mention it that I'm what I'd

540
00:23:08,150 --> 00:23:04,860
like to tell you is he absolutely nailed

541
00:23:09,920 --> 00:23:08,160
it we touch down at 30 100 feet we touch

542
00:23:12,740 --> 00:23:09,930
down inside the two knots of the

543
00:23:14,450 --> 00:23:12,750
touchdown speed I what along came with

544
00:23:16,880 --> 00:23:14,460
that was a touchdown that was so smooth

545
00:23:19,580 --> 00:23:16,890
that the as i was calling off the speeds

546
00:23:22,490 --> 00:23:19,590
I really wasn't certain if we touched an

547
00:23:25,040 --> 00:23:22,500
turn up but I knew because my HUD voted

548
00:23:26,390 --> 00:23:25,050
into the touchdown mode and I felt a

549
00:23:28,610 --> 00:23:26,400
little bit of vibration which were the

550
00:23:40,169 --> 00:23:28,620
wheels spinning up on the ax Rolla so I

551
00:23:49,810 --> 00:23:42,700
absolutely nailed that it's worth 100

552
00:23:51,609 --> 00:23:49,820
more points out of a twine thats it for

553
00:23:52,899 --> 00:23:51,619
our slide presentation and as soon as

554
00:24:02,919 --> 00:23:52,909
you can cue it up we're ready for the

555
00:24:05,590 --> 00:24:02,929
video there it is well columbia said on

556
00:24:07,169 --> 00:24:05,600
the launchpad the five of us were having

557
00:24:11,710 --> 00:24:07,179
breakfast and then getting suited up

558
00:24:13,629 --> 00:24:11,720
Here I am waving to the kids rommel is

559
00:24:16,269 --> 00:24:13,639
just about to go through the pressure

560
00:24:18,060 --> 00:24:16,279
check of his launch and entry suit and

561
00:24:20,200 --> 00:24:18,070
that's what Tammy is doing here as well

562
00:24:21,460 --> 00:24:20,210
these suits are not totally

563
00:24:23,409 --> 00:24:21,470

uncomfortable but they're not the kind

564
00:24:26,019 --> 00:24:23,419
of thing that you'd like to wear here's

565
00:24:28,089 --> 00:24:26,029
Tom for any extended period of time and

566
00:24:29,710 --> 00:24:28,099
getting into and out of them is not real

567
00:24:32,889 --> 00:24:29,720
pleasant so it was nice that we launched

568
00:24:35,289 --> 00:24:32,899
on the first day it would have been well

569
00:24:36,639 --> 00:24:35,299
it was a is a reasonable trade to have

570
00:24:39,729 --> 00:24:36,649
to get in and out of the suit two or

571
00:24:42,879 --> 00:24:39,739
three times in order to get the extra

572
00:24:44,889 --> 00:24:42,889
couple days on orbit it lost it was

573
00:24:47,169 --> 00:24:44,899
absolutely a beautiful day something

574
00:24:48,489 --> 00:24:47,179
that new to me on the last flight time

575
00:24:50,259 --> 00:24:48,499
of the vehicle several times before we

576
00:24:52,330 --> 00:24:50,269
win anywhere here the engines are light

577
00:24:54,609 --> 00:24:52,340
and six seconds prior to liftoff that

578
00:24:56,950 --> 00:24:54,619
the vehicle stat goes through its twang

579
00:24:58,779 --> 00:24:56,960
but when the solid when the solids light

580
00:25:00,549 --> 00:24:58,789
like this there's no doubt in your mind

581
00:25:03,219 --> 00:25:00,559
you're going somewhere we had a cadence

582
00:25:04,869 --> 00:25:03,229
Tom started it he said 10 to 10 to the

583
00:25:07,060 --> 00:25:04,879
computers run mode one or two I said

584
00:25:09,399 --> 00:25:07,070
Otto Otto pitch and will yes we're in

585
00:25:11,109 --> 00:25:09,409
Auto and Nazi SS and taco was supposed

586
00:25:12,310 --> 00:25:11,119
to say go there goes the tower but by

587
00:25:15,969 --> 00:25:12,320
the time he could say there goes the

588
00:25:17,320 --> 00:25:15,979

tower the tower already gone and we're

589
00:25:19,359 --> 00:25:17,330
doing a more than hundred miles an hour

590
00:25:22,210 --> 00:25:19,369
to hear the solids what's interesting

591
00:25:24,099 --> 00:25:22,220
they've got 550 tons of propellant and

592
00:25:26,710 --> 00:25:24,109
they're burning that propellant at the

593
00:25:28,479 --> 00:25:26,720
rate of about five tons per second so

594
00:25:30,039 --> 00:25:28,489
that explains why they're giving us

595
00:25:34,149 --> 00:25:30,049
about six million pounds of thrust at

596
00:25:36,460 --> 00:25:34,159
this point about 150,000 feet they

597
00:25:39,879 --> 00:25:36,470
detach we're going about 3,000 miles an

598
00:25:43,389 --> 00:25:39,889
hour here and once they detach on the

599
00:25:45,249 --> 00:25:43,399
solids it's a pretty rough vibrant ride

600
00:25:45,950 --> 00:25:45,259
and then it becomes a very smooth ride

601
00:25:48,390 --> 00:25:45,960
from there

602
00:25:50,850 --> 00:25:48,400
first order of business after getting to

603
00:25:52,590 --> 00:25:50,860
orbit is to convert our rocket ship into

604
00:25:54,450 --> 00:25:52,600
a laboratory or a satellite deployment

605
00:25:56,670 --> 00:25:54,460
platform in this case and so we swing

606
00:25:59,100 --> 00:25:56,680
open the payload bay doors about an hour

607
00:26:00,920 --> 00:25:59,110
and a half after getting orbit taco is

608
00:26:03,210 --> 00:26:00,930
working with rommel to convert the

609
00:26:04,680 --> 00:26:03,220
computers over to an orbit mode while

610
00:26:06,120 --> 00:26:04,690
we're getting ready in the back to check

611
00:26:10,770 --> 00:26:06,130
out the arm and get the satellite out of

612
00:26:12,270 --> 00:26:10,780
the bay we are we grapple the spa

613
00:26:14,790 --> 00:26:12,280

satellite about three and a half hours

614
00:26:16,530 --> 00:26:14,800
into the flight and some checks were

615
00:26:19,560 --> 00:26:16,540
performed both by the crew and the

616
00:26:21,510 --> 00:26:19,570
ground and here we are taking the

617
00:26:25,470 --> 00:26:21,520
satellite out of the payload bay and

618
00:26:27,570 --> 00:26:25,480
maneuvering to the release position Tom

619
00:26:29,520 --> 00:26:27,580
of course is assisting me here with the

620
00:26:31,830 --> 00:26:29,530
arm there everyone in the crew was

621
00:26:35,610 --> 00:26:31,840
involved in the rendezvous in the RMS

622
00:26:39,330 --> 00:26:35,620
deploys but spas was a model satellite

623
00:26:40,980 --> 00:26:39,340
the spacecraft performed flawlessly the

624
00:26:43,860 --> 00:26:40,990
group of folks that we work with in

625
00:26:45,690 --> 00:26:43,870
Germany were just incredible to work

626
00:26:47,700 --> 00:26:45,700
with incredibly professional and

627
00:26:50,070 --> 00:26:47,710
enjoyable to work with so we were

628
00:26:53,340 --> 00:26:50,080
pleased to be part of the the spas that

629
00:26:55,290 --> 00:26:53,350
were phia spas mission here we are

630
00:26:59,760 --> 00:26:55,300
maneuvering again the spas to the

631
00:27:01,890 --> 00:26:59,770
release position once spas is in the

632
00:27:05,430 --> 00:27:01,900
release position in our window for

633
00:27:08,370 --> 00:27:05,440
release opens this is the in defector

634
00:27:10,410 --> 00:27:08,380
view we maneuvered the arm we release a

635
00:27:13,170 --> 00:27:10,420
spacecraft maneuver the arm away from

636
00:27:16,110 --> 00:27:13,180
the spas and then very shortly

637
00:27:18,180 --> 00:27:16,120
thereafter approximately one minute taco

638
00:27:20,550 --> 00:27:18,190

fire some jets on the orbiter so that we

639
00:27:23,010 --> 00:27:20,560
would induce a separation velocity

640
00:27:24,840 --> 00:27:23,020
between the orbiter and spas and send

641
00:27:31,240 --> 00:27:24,850
it's on its two-week mission of

642
00:27:36,710 --> 00:27:33,620
here we are on the mid deck and this is

643
00:27:39,169 --> 00:27:36,720
the same secondary I'd mentioned earlier

644
00:27:41,029 --> 00:27:39,179
running the capillary pumped loop

645
00:27:44,770 --> 00:27:41,039
experiment and here you can see it and

646
00:27:47,990 --> 00:27:44,780
this is about as exciting as it ever got

647
00:27:50,180 --> 00:27:48,000
but it was a tremendous experiment run

648
00:27:52,970 --> 00:27:50,190
by the University of Maryland at

649
00:27:55,850 --> 00:27:52,980
michaela bay we had the space experiment

650
00:27:57,770 --> 00:27:55,860
module gas can type experiment with ten

651
00:27:58,970 --> 00:27:57,780
experiments provided by students in high

652
00:28:02,000 --> 00:27:58,980
schools and colleges around the country

653
00:28:05,720 --> 00:28:02,010
and they use microgravity to a great

654
00:28:07,340 --> 00:28:05,730
effect on our 18-day flight now here you

655
00:28:09,860 --> 00:28:07,350
see the sequence of bringing the wake

656
00:28:11,299 --> 00:28:09,870
shield out of the protective cone in the

657
00:28:13,669 --> 00:28:11,309
back of the payload Bay protecting the

658
00:28:15,560 --> 00:28:13,679
source cells that spray material onto

659
00:28:18,770 --> 00:28:15,570
the wafer growth surfaces on the the

660
00:28:20,750 --> 00:28:18,780
wakes side of wake shield this is again

661
00:28:22,399 --> 00:28:20,760
flight day four and the first place we

662
00:28:24,590 --> 00:28:22,409
took the wig shield satellite was over

663
00:28:27,020 --> 00:28:24,600

the port side pointing into the RAM

664
00:28:28,760 --> 00:28:27,030
direction so that the contamination on

665
00:28:33,070 --> 00:28:28,770
the bottom of the shield here would be

666
00:28:38,210 --> 00:28:35,899
after a couple of hours during free

667
00:28:40,310 --> 00:28:38,220
drift while we cleaned the wake side of

668
00:28:42,289 --> 00:28:40,320
the satellite we then swung it over to

669
00:28:43,549 --> 00:28:42,299
the other side of the payload bay and

670
00:28:45,980 --> 00:28:43,559
check out the attitude control system

671
00:28:48,470 --> 00:28:45,990
and so we were doing a constant series

672
00:28:50,870 --> 00:28:48,480
of RMS maneuvers with some pauses in

673
00:28:53,419 --> 00:28:50,880
between while the shuttle oscillated

674
00:28:55,460 --> 00:28:53,429
slowly in free drift getting ready for

675
00:28:56,710 --> 00:28:55,470
the deploy sequence here we go over to

676
00:28:58,730 --> 00:28:56,720
the other side of the payload Bay

677
00:29:01,039 --> 00:28:58,740
towards the attacks checkout or the

678
00:29:02,750 --> 00:29:01,049
attitude system check out to location

679
00:29:06,080 --> 00:29:02,760
you can see the Sahara sweeping by in

680
00:29:09,380 --> 00:29:06,090
the background tom was saying here we

681
00:29:11,090 --> 00:29:09,390
maneuver the arm and study where the way

682
00:29:13,610 --> 00:29:11,100
she'll thinks it is in terms of its

683
00:29:17,630 --> 00:29:13,620
attitude determination system and we

684
00:29:21,470 --> 00:29:17,640
watch the responses of the satellite to

685
00:29:23,570 --> 00:29:21,480
the RMS after going to the attacks

686
00:29:26,539 --> 00:29:23,580
deploy and then we go to a deployed

687
00:29:28,909 --> 00:29:26,549
position tom has dropped it here we

688
00:29:31,190 --> 00:29:28,919

study the attitude determination and

689
00:29:34,909 --> 00:29:31,200
control system its performance for one

690
00:29:37,250 --> 00:29:34,919
minute we did get into a little higher

691
00:29:38,899 --> 00:29:37,260
reaction speed here than planned and as

692
00:29:42,200 --> 00:29:38,909
well we had an eight degree roll

693
00:29:44,450 --> 00:29:42,210
excursion and so what the wakes your

694
00:29:47,300 --> 00:29:44,460
community wanted to study this respond

695
00:29:50,300 --> 00:29:47,310
for a few minutes longer we did observe

696
00:29:54,410 --> 00:29:50,310
to watch the clearance with the f TV

697
00:29:56,210 --> 00:29:54,420
cameras I'm waiting here too to start

698
00:29:59,000 --> 00:29:56,220
the thrusters their coal gas nitrogen

699
00:30:01,040 --> 00:29:59,010
thrusters and hira the wake shield is

700
00:30:05,870 --> 00:30:01,050
thrust and away from the orbiter it's a

701
00:30:08,030 --> 00:30:05,880
20 minute burn here the two satellites

702
00:30:11,090 --> 00:30:08,040
in formation with each other after wake

703
00:30:13,070 --> 00:30:11,100
shield has been deployed there about 15

704
00:30:14,960 --> 00:30:13,080
or 18 miles apart at that point and

705
00:30:19,910 --> 00:30:14,970
we're going to fly between those two to

706
00:30:22,010 --> 00:30:19,920
rendezvous with wake shield as you can

707
00:30:24,290 --> 00:30:22,020
see we we do need to eat on board but

708
00:30:28,370 --> 00:30:24,300
you can define your own kitchen table

709
00:30:30,410 --> 00:30:28,380
upside down or or not and we do have to

710
00:30:31,880 --> 00:30:30,420
keep things clean we Rommel here is

711
00:30:33,260 --> 00:30:31,890
vacuuming one of the filters that

712
00:30:35,780 --> 00:30:33,270
collects a little bit of dust on it we

713
00:30:37,400 --> 00:30:35,790

just vacuumed the desk top of it one of

714
00:30:40,040 --> 00:30:37,410
several filters and the payload in the

715
00:30:41,990 --> 00:30:40,050
end crew compartment you're on a flight

716
00:30:45,080 --> 00:30:42,000
deck we have all of our TV recording

717
00:30:46,970 --> 00:30:45,090
studio set up for separate recorders to

718
00:30:48,680 --> 00:30:46,980
record SD acid data that Tammy talked

719
00:30:51,220 --> 00:30:48,690
about earlier and all of this data was

720
00:30:54,080 --> 00:30:51,230
shipped back to the ground after landing

721
00:30:55,550 --> 00:30:54,090
we had a number of orbit adjust burns to

722
00:30:56,900 --> 00:30:55,560
keep us in the proper position with

723
00:30:59,390 --> 00:30:56,910
these two satellites some of them were

724
00:31:02,360 --> 00:30:59,400
fairly long as you can see that from the

725
00:31:04,430 --> 00:31:02,370
exhaust over the nose there and we we

726
00:31:05,800 --> 00:31:04,440
use the computers to tell us what to

727
00:31:09,680 --> 00:31:05,810
burn but then we make the bearings

728
00:31:11,510 --> 00:31:09,690
manually and you can see how the firing

729
00:31:13,550 --> 00:31:11,520
of these little rockets shake the

730
00:31:17,320 --> 00:31:13,560
vehicle you can see the computer on the

731
00:31:19,370 --> 00:31:17,330
glare shield sliding around a little bit

732
00:31:21,080 --> 00:31:19,380
what we're looking through there is the

733
00:31:22,670 --> 00:31:21,090
little gun sight we got the reticle

734
00:31:24,530 --> 00:31:22,680
turned down fairly dim so that we can

735
00:31:27,200 --> 00:31:24,540
see outside well and wake shield was

736
00:31:30,710 --> 00:31:27,210
showing up in the gun sight and we're

737
00:31:32,690 --> 00:31:30,720
flying up closer to it again we manually

738
00:31:35,210 --> 00:31:32,700

are flying and you can see Tammy in the

739
00:31:40,070 --> 00:31:35,220
window next to me taking sightings with

740
00:31:41,750 --> 00:31:40,080
the police laser when we get it down

741
00:31:44,540 --> 00:31:41,760
over the payload Bay it's time for Tom

742
00:31:46,610 --> 00:31:44,550
to go to work and grapple it it's

743
00:31:48,650 --> 00:31:46,620
remarkable how smoothly our pilots

744
00:31:50,300 --> 00:31:48,660
brought this spacecraft into the payload

745
00:31:51,890 --> 00:31:50,310
bay envelope I'd never seen another

746
00:31:53,990 --> 00:31:51,900
spacecraft in orbit before and this one

747
00:31:56,420 --> 00:31:54,000
was remarkable in its stability taco

748
00:31:57,860 --> 00:31:56,430
practice right underneath it and then we

749
00:31:59,990 --> 00:31:57,870
rotate the RMS end effector

750
00:32:01,490 --> 00:32:00,000
get it into the right orientation for

751
00:32:04,030 --> 00:32:01,500
grapple and then it's just a matter of

752
00:32:06,290 --> 00:32:04,040
going and closing the grapple pin and

753
00:32:08,740 --> 00:32:06,300
not bumping the satellite out of the way

754
00:32:10,670 --> 00:32:08,750
in the process so here we are closing

755
00:32:12,799 --> 00:32:10,680
over the grapple pin with the end

756
00:32:14,960 --> 00:32:12,809
effector we trigger the snares and then

757
00:32:20,000 --> 00:32:14,970
bring the wake shield back aboard after

758
00:32:21,770 --> 00:32:20,010
it's three days of material science one

759
00:32:23,630 --> 00:32:21,780
scrapple to the arm we can bring it back

760
00:32:24,890 --> 00:32:23,640
down into the payload bay and we even

761
00:32:30,740 --> 00:32:24,900
use it the next day for some space

762
00:32:32,419 --> 00:32:30,750
vision system experiments a flight deck

763
00:32:34,370 --> 00:32:32,429

teamwork is very important as we bring

764
00:32:36,169 --> 00:32:34,380
it down into the payload Bay we even had

765
00:32:38,480 --> 00:32:36,179
space vision system here providing us

766
00:32:41,600 --> 00:32:38,490
birthing cues in addition to the usual

767
00:32:44,690 --> 00:32:41,610
TV camera and RMS digital's that we use

768
00:32:47,140 --> 00:32:44,700
for standard payloads wake shield was

769
00:32:50,660 --> 00:32:47,150
really a joy to operate on the arm

770
00:32:54,590 --> 00:32:50,670
Tammy's here with one of our long lens

771
00:32:55,820 --> 00:32:54,600
telephotos hasselblad camera and we'll

772
00:33:03,140 --> 00:32:55,830
show you a few views of the earth in the

773
00:33:05,540 --> 00:33:03,150
movie here to notice IG IG is important

774
00:33:07,000 --> 00:33:05,550
in space also so destroyer was getting a

775
00:33:14,180 --> 00:33:07,010
little bit shaggy so he's getting a

776
00:33:19,169 --> 00:33:16,860
also I think you can define our crews

777
00:33:21,330 --> 00:33:19,179
works well together when we had an

778
00:33:29,370 --> 00:33:21,340
oyster you spill everybody chipped in to

779
00:33:31,770 --> 00:33:29,380
help clean that spill up as many no

780
00:33:34,680 --> 00:33:31,780
story was making his sixth flight on the

781
00:33:37,020 --> 00:33:34,690
US Space Shuttle and and while we were

782
00:33:39,990 --> 00:33:37,030
on orbit he passed over a thousand hours

783
00:33:41,789 --> 00:33:40,000
of time in this space shuttle so we came

784
00:33:44,000 --> 00:33:41,799
up with this patch that says master of

785
00:33:48,870 --> 00:33:44,010
space and presented it to him in a

786
00:33:51,240 --> 00:33:48,880
little ceremony on board here we are in

787
00:33:54,600 --> 00:33:51,250
the mid dec the day before the flight

788
00:33:57,840 --> 00:33:54,610

day 10 schedule dva applying anna fog to

789
00:33:59,370 --> 00:33:57,850
our helmets and also getting our tools

790
00:34:01,320 --> 00:33:59,380
in the proper configuration and

791
00:34:03,960 --> 00:34:01,330
anticipation on the EV for the EV a of

792
00:34:05,909 --> 00:34:03,970
the next day Tom here has the shuttle

793
00:34:08,430 --> 00:34:05,919
power tool and I'm holding the news

794
00:34:10,379 --> 00:34:08,440
station power tool that has some

795
00:34:12,030 --> 00:34:10,389
enhanced a capability but as you can see

796
00:34:14,369 --> 00:34:12,040
is quite a bit larger than the shuttle

797
00:34:15,810 --> 00:34:14,379
power tool we spent several hours

798
00:34:18,119 --> 00:34:15,820
getting our tools in the proper

799
00:34:20,669 --> 00:34:18,129
configuration and everything laid out to

800
00:34:23,310 --> 00:34:20,679
make EV a day go much more smoothly and

801
00:34:25,859 --> 00:34:23,320
efficiently tom is donning his lower

802
00:34:29,730 --> 00:34:25,869
torso assembly and it's always a bit of

803
00:34:32,040 --> 00:34:29,740
a squeeze getting into those pants and

804
00:34:37,919 --> 00:34:32,050
shortly you'll see my head pop out of

805
00:34:40,080 --> 00:34:37,929
the the upper torso and story of course

806
00:34:45,780 --> 00:34:40,090
was instrumental in getting a suited up

807
00:34:47,550 --> 00:34:45,790
and prepared to go out the door the crew

808
00:34:50,399 --> 00:34:47,560
got into the airlock we depressed the

809
00:34:54,080 --> 00:34:50,409
airlock the RMS got in position to view

810
00:34:57,390 --> 00:34:54,090
crew egress we went to open the hatch

811
00:34:59,670 --> 00:34:57,400
the handle rotated about 35 degrees and

812
00:35:02,130 --> 00:34:59,680
came to a hard stopped this happened

813
00:35:04,530 --> 00:35:02,140

over and over again more times than I

814
00:35:06,780 --> 00:35:04,540
can count and unfortunately we were

815
00:35:09,120 --> 00:35:06,790
never able to open the outer airlock

816
00:35:11,470 --> 00:35:09,130
hatch and the EVS were cancelled for the

817
00:35:17,000 --> 00:35:14,570
well we wanted to I get off on time so

818
00:35:18,920 --> 00:35:17,010
that we could get you all home for

819
00:35:21,020 --> 00:35:18,930
Thanksgiving but you can probably blame

820
00:35:23,000 --> 00:35:21,030
me on that because this is my third

821
00:35:25,640 --> 00:35:23,010
thanksgiving in space but here we are

822
00:35:28,550 --> 00:35:25,650
eating a traditional turkey i had flown

823
00:35:31,790 --> 00:35:28,560
during thanksgiving with john blaha back

824
00:35:33,230 --> 00:35:31,800
in 89 I wanted to fly in space again and

825
00:35:35,750 --> 00:35:33,240
I did get to fly with him but on

826
00:35:38,900 --> 00:35:35,760
different vehicles you're nice enough to

827
00:35:40,580 --> 00:35:38,910
our patch us in with him the moon from

828
00:35:42,740 --> 00:35:40,590
out there in space is very similar to

829
00:35:44,810 --> 00:35:42,750
the moon down here on earth it goes

830
00:35:53,850 --> 00:35:44,820
through the same phases and we watch

831
00:35:58,740 --> 00:35:56,910
this is a shot of flight day 15 and this

832
00:36:01,200 --> 00:35:58,750
is a day we rendezvous in with Orpheus

833
00:36:02,880 --> 00:36:01,210
to bring it back the taco was kind

834
00:36:04,740 --> 00:36:02,890
enough we swapped roles during this

835
00:36:09,060 --> 00:36:04,750
rendezvous so I was at the app station

836
00:36:12,090 --> 00:36:09,070
and taco was in the Ford station until

837
00:36:14,100 --> 00:36:12,100
and now you notice tacos in there in the

838
00:36:15,690 --> 00:36:14,110

picture until we got within 100 feet and

839
00:36:19,350 --> 00:36:15,700
then he took it for their prox ops in

840
00:36:21,390 --> 00:36:19,360
the ground from Ramallah and taco did an

841
00:36:24,290 --> 00:36:21,400
outstanding job with the rendezvous they

842
00:36:26,910 --> 00:36:24,300
put this face craft very very steady

843
00:36:30,270 --> 00:36:26,920
into the in defector camera all that was

844
00:36:33,510 --> 00:36:30,280
left to do was a quick maneuver and a

845
00:36:36,570 --> 00:36:33,520
grapple of the Orpheus Paz a post

846
00:36:38,520 --> 00:36:36,580
grapple we did do a number of maneuvers

847
00:36:41,930 --> 00:36:38,530
in support of some space station

848
00:36:44,160 --> 00:36:41,940
experiments testing our SVS system and

849
00:36:46,020 --> 00:36:44,170
making sure that we could get very good

850
00:36:47,670 --> 00:36:46,030
position in attitude information out of

851
00:36:49,350 --> 00:36:47,680
the space vision system in order to

852
00:36:52,290 --> 00:36:49,360
facilitate some of the space station

853
00:37:00,260 --> 00:36:52,300
construction activities and this is our

854
00:37:03,860 --> 00:37:02,360
let's take you back outside we're going

855
00:37:06,110 --> 00:37:03,870
to give you some camera views of the

856
00:37:08,720 --> 00:37:06,120
earth always in the background is we

857
00:37:11,690 --> 00:37:08,730
maneuvered the spacecraft during our

858
00:37:13,610 --> 00:37:11,700
long flight looking down we can see some

859
00:37:16,310 --> 00:37:13,620
very delicate linear dunes in western

860
00:37:18,230 --> 00:37:16,320
Algeria in the great western sansi of

861
00:37:21,800 --> 00:37:18,240
the Sahara this is a very early morning

862
00:37:23,750 --> 00:37:21,810
view you can see the delicate sculpting

863
00:37:25,790 --> 00:37:23,760

of the dunes by the wind a little bit

864
00:37:28,820 --> 00:37:25,800
farther to the east is a big outcropping

865
00:37:30,320 --> 00:37:28,830
of black volcanic rock it's dark grey

866
00:37:32,630 --> 00:37:30,330
because of iron and manganese and the

867
00:37:33,890 --> 00:37:32,640
rocks and the Tiffany dunes that are

868
00:37:36,770 --> 00:37:33,900
there on the right side the thumb-shaped

869
00:37:39,020 --> 00:37:36,780
dune field is red because of the iron in

870
00:37:40,370 --> 00:37:39,030
the sand grains reflecting light in a

871
00:37:42,740 --> 00:37:40,380
different way and it's a very beautiful

872
00:37:47,630 --> 00:37:42,750
dune field bumping up against the Hard

873
00:37:49,460 --> 00:37:47,640
Rock of the mountains there over Central

874
00:37:51,040 --> 00:37:49,470
Africa we saw a lot of burning going on

875
00:37:54,260 --> 00:37:51,050
you can see several smoke plumes

876
00:37:56,150 --> 00:37:54,270
emanating from the rain forest area in

877
00:37:58,310 --> 00:37:56,160
central Africa combined with the

878
00:38:00,170 --> 00:37:58,320
grasslands there and this is one of the

879
00:38:01,730 --> 00:38:00,180
hot topics we were looking for from

880
00:38:04,040 --> 00:38:01,740
space we saw a lot of burning not only

881
00:38:06,380 --> 00:38:04,050
here but also in Australia because it's

882
00:38:10,280 --> 00:38:06,390
the dry season they're beautiful

883
00:38:12,320 --> 00:38:10,290
real-time sunset from Earth orbit and

884
00:38:13,850 --> 00:38:12,330
now it's time for entry we've got a

885
00:38:15,980 --> 00:38:13,860
small camera handheld in the cockpit

886
00:38:17,960 --> 00:38:15,990
that allows us to pan around and show

887
00:38:19,880 --> 00:38:17,970
you the orange pink aerodynamic heating

888
00:38:22,550 --> 00:38:19,890

outside the front cockpit windows as we

889
00:38:24,770 --> 00:38:22,560
go through Mach 15 out the back windows

890
00:38:27,890 --> 00:38:24,780
he could see the plasma tail trailing us

891
00:38:29,450 --> 00:38:27,900
behind as the hot plasma streams around

892
00:38:32,210 --> 00:38:29,460
the orbiter and goes back over the tail

893
00:38:33,920 --> 00:38:32,220
it's a spectacular light show during

894
00:38:36,290 --> 00:38:33,930
that time where you saw the plasma trail

895
00:38:38,750 --> 00:38:36,300
behind us we were tilted up at an angle

896
00:38:40,280 --> 00:38:38,760
attack of about 40 degrees here we are

897
00:38:43,100 --> 00:38:40,290
looking out through a camera over the

898
00:38:44,540 --> 00:38:43,110
nose of the vehicle and and now the

899
00:38:47,060 --> 00:38:44,550
angle of attack is much lower and we're

900
00:38:49,130 --> 00:38:47,070
flying more like an airplane it is dark

901
00:38:50,900 --> 00:38:49,140
overhead so the only way to see us was

902
00:38:53,240 --> 00:38:50,910
with an infrared camera and that's what

903
00:38:56,900 --> 00:38:53,250
you see in the upper right inset in this

904
00:38:58,610 --> 00:38:56,910
view we continue to have the camera

905
00:38:59,800 --> 00:38:58,620
that's looking over the nose operate all

906
00:39:01,600 --> 00:38:59,810
the way to landing

907
00:39:03,910 --> 00:39:01,610
and you see some lights on the ground

908
00:39:06,490 --> 00:39:03,920
and you can see clearly why I called it

909
00:39:09,040 --> 00:39:06,500
a night landing and just up towards the

910
00:39:12,820 --> 00:39:09,050
upper right and moving to Center you can

911
00:39:15,550 --> 00:39:12,830
see a dim outline of a long thin light

912
00:39:17,800 --> 00:39:15,560
area which is the runway we are diving

913
00:39:19,360 --> 00:39:17,810

towards a set of lights about a mile and

914
00:39:22,000 --> 00:39:19,370
a half short of the runway which are lit

915
00:39:24,580 --> 00:39:22,010
up by strobe lights and at about 2,000

916
00:39:27,130 --> 00:39:24,590
feet we start to pull out to shallow our

917
00:39:29,500 --> 00:39:27,140
steep dive angle which is 18 degrees up

918
00:39:33,130 --> 00:39:29,510
to that point to more of an airliner

919
00:39:35,440 --> 00:39:33,140
type glide slope so we can land at about

920
00:39:37,000 --> 00:39:35,450
300 feet Ron will put the landing gear

921
00:39:40,060 --> 00:39:37,010
down and this is our view as we were

922
00:39:43,510 --> 00:39:40,070
finishing that that pre flare on the

923
00:39:45,670 --> 00:39:43,520
left is a string of lights with a little

924
00:39:47,560 --> 00:39:45,680
ball next to it which we're trying to

925
00:39:48,940 --> 00:39:47,570
line up and keep in the center so is to

926
00:39:54,100 --> 00:39:48,950
cross the runway at the right height at

927
00:39:56,860 --> 00:39:54,110
the threshold and with the xenon lights

928
00:39:59,830 --> 00:39:56,870
providing the the bright glow on each

929
00:40:01,660 --> 00:39:59,840
side of us here's the touchdown viewed

930
00:40:04,960 --> 00:40:01,670
from the run the camera at the far end

931
00:40:06,850 --> 00:40:04,970
of the runway you can see the vapor

932
00:40:09,970 --> 00:40:06,860
trails being turned up in the humid

933
00:40:11,800 --> 00:40:09,980
Florida air at about 200 knots on the

934
00:40:14,140 --> 00:40:11,810
ground rommel deployed the drag chute

935
00:40:17,950 --> 00:40:14,150
and at 185 knots we started the nose

936
00:40:19,300 --> 00:40:17,960
down to make a to get all three wheels

937
00:40:21,700 --> 00:40:19,310
on the runway and we'll start steering

938
00:40:23,350 --> 00:40:21,710

down trying to stay on the center line

939
00:40:25,150 --> 00:40:23,360
of the runway because it's nothing more

940
00:40:31,070 --> 00:40:25,160
embarrassing that have the final photos

941
00:40:38,520 --> 00:40:34,350
it's also helpful to stay out of the mud

942
00:40:40,200 --> 00:40:38,530
in the weeds and at about 60 knots we

943
00:40:41,880 --> 00:40:40,210
release the drag chute so that it still

944
00:40:43,740 --> 00:40:41,890
has a good aerodynamic force on it pose

945
00:40:45,750 --> 00:40:43,750
it cleanly away from the vehicle so that

946
00:40:47,700 --> 00:40:45,760
it doesn't damage the engine bells this

947
00:40:49,470 --> 00:40:47,710
is after all a reusable spacecraft it

948
00:40:51,390 --> 00:40:49,480
was a twenty first flight of Columbia

949
00:40:55,800 --> 00:40:51,400
the 80th flight of the space shuttle