
National Aeronautics and
Space Administration
NASA
MARS
PERSEVERANCE

1
00:00:27,830 --> 00:00:25,670
good morning

2
00:00:29,509 --> 00:00:27,840
nasa's fifth rover to the fourth planet

3
00:00:31,830 --> 00:00:29,519
is two days away from landing

4
00:00:33,350 --> 00:00:31,840
the mission's target jezreel crater

5
00:00:34,709 --> 00:00:33,360
holds great promise for the mars

6
00:00:37,190 --> 00:00:34,719
scientific community

7
00:00:38,150 --> 00:00:37,200
however getting to it safely is quite a

8
00:00:40,790 --> 00:00:38,160
challenge

9
00:00:42,229 --> 00:00:40,800
hello i'm dc eagle welcome to nasa's jet

10
00:00:43,270 --> 00:00:42,239
propulsion laboratory in southern

11
00:00:45,430 --> 00:00:43,280
california

12
00:00:47,110 --> 00:00:45,440
this is the first of several informative

13
00:00:49,110 --> 00:00:47,120

landing week media briefings

14
00:00:51,590 --> 00:00:49,120
on the mars 2020 perseverance rover

15
00:00:53,350 --> 00:00:51,600
mission so let's get to it

16
00:00:55,189 --> 00:00:53,360
here to talk about the mission and some

17
00:00:58,549 --> 00:00:55,199
of the cutting edge technology on board

18
00:01:01,349 --> 00:00:58,559
perseverance we have with us today

19
00:01:03,349 --> 00:01:01,359
thomas zurbukin associate administrator

20
00:01:06,950 --> 00:01:03,359
for the science mission directorate

21
00:01:11,590 --> 00:01:06,960
nasa headquarters jennifer trosper

22
00:01:15,030 --> 00:01:11,600
mars 2020 deputy project manager jpl

23
00:01:18,630 --> 00:01:15,040
adam steltzner mars 2020 chief engineer

24
00:01:20,870 --> 00:01:18,640
jpl trudy cortes

25
00:01:22,310 --> 00:01:20,880
director of the technology demonstration

26
00:01:26,469 --> 00:01:22,320
missions program

27
00:01:31,590 --> 00:01:26,479
nasa headquarters arisa stilley

28
00:01:34,469 --> 00:01:31,600
mars 2020 edl operations lead jpl

29
00:01:36,069 --> 00:01:34,479
jeff shihai chief engineer of the space

30
00:01:39,749 --> 00:01:36,079
technology mission directorate

31
00:01:41,830 --> 00:01:39,759
nasa headquarters and mimi young

32
00:01:43,910 --> 00:01:41,840
project manager for the ingenuity mars

33
00:01:45,830 --> 00:01:43,920
helicopter

34
00:01:47,510 --> 00:01:45,840
for anyone who would like to submit a

35
00:01:49,590 --> 00:01:47,520
question you can do so by using the

36
00:01:51,830 --> 00:01:49,600
countdown to mars hashtag

37
00:01:53,990 --> 00:01:51,840
our phone lines are now in for media you

38
00:01:56,230 --> 00:01:54,000

can ask a question by pressing star one

39
00:01:58,870 --> 00:01:56,240
and enter the queue and we'll kick

40
00:02:01,429 --> 00:01:58,880
things off with thomas sir bilkin

41
00:02:03,350 --> 00:02:01,439
well thanks so much i'm so excited to

42
00:02:06,630 --> 00:02:03,360
join the colleagues here from jpl

43
00:02:08,469 --> 00:02:06,640
as we count down to mars and we just

44
00:02:10,229 --> 00:02:08,479
recognize what an amazing journey this

45
00:02:11,190 --> 00:02:10,239
has been and i want to thank at this

46
00:02:13,430 --> 00:02:11,200
time

47
00:02:14,229 --> 00:02:13,440
the team for working so hard on this

48
00:02:17,270 --> 00:02:14,239
mission

49
00:02:20,229 --> 00:02:17,280
and especially in the past year in

50
00:02:21,110 --> 00:02:20,239
adverse circumstances and i want to

51
00:02:23,750 --> 00:02:21,120
recognize the

52
00:02:24,229 --> 00:02:23,760
many sacrifices that the team had to do

53
00:02:27,430 --> 00:02:24,239
and

54
00:02:29,510 --> 00:02:27,440
really exhibited this true spirit of

55
00:02:30,710 --> 00:02:29,520
exploration that we always talk about i

56
00:02:33,430 --> 00:02:30,720
just want to thank them

57
00:02:34,710 --> 00:02:33,440
for that you know mars captivates our

58
00:02:36,869 --> 00:02:34,720
imagination and

59
00:02:37,990 --> 00:02:36,879
has been part of our dreams for many

60
00:02:40,390 --> 00:02:38,000
decades

61
00:02:42,630 --> 00:02:40,400
and perseverance builds on the long

62
00:02:45,350 --> 00:02:42,640
history of systematic

63
00:02:45,830 --> 00:02:45,360

science-driven exploration of mars that

64
00:02:47,990 --> 00:02:45,840
in

65
00:02:50,309 --> 00:02:48,000
has been enabled by ever better

66
00:02:54,229 --> 00:02:50,319
technologies and systems

67
00:02:57,110 --> 00:02:54,239
right now inside is taking measurements

68
00:02:59,270 --> 00:02:57,120
of marsquakes curiosity is focused

69
00:03:00,869 --> 00:02:59,280
on geological and the chemical evolution

70
00:03:03,589 --> 00:03:00,879
here kale crater

71
00:03:05,350 --> 00:03:03,599
and two orbiters are out there new in

72
00:03:07,509 --> 00:03:05,360
the last couple weeks

73
00:03:08,790 --> 00:03:07,519
joining other orbits from nasa and other

74
00:03:13,430 --> 00:03:08,800
agencies

75
00:03:17,990 --> 00:03:16,830
our journey has been from following the

76
00:03:20,390 --> 00:03:18,000
water

77
00:03:21,670 --> 00:03:20,400
to seeing whether this planet was

78
00:03:24,869 --> 00:03:21,680
habitable

79
00:03:27,110 --> 00:03:24,879
to finding complex chemicals

80
00:03:28,070 --> 00:03:27,120
and now we're at the advent of an

81
00:03:31,350 --> 00:03:28,080
entirely new

82
00:03:34,070 --> 00:03:31,360
phase returning samples

83
00:03:35,830 --> 00:03:34,080
an aspirational goal that has been with

84
00:03:39,589 --> 00:03:35,840
the science community

85
00:03:40,869 --> 00:03:39,599
for decades it is novel technologies

86
00:03:43,750 --> 00:03:40,879
that have enabled

87
00:03:45,110 --> 00:03:43,760
those breakthroughs we benefit today and

88
00:03:47,509 --> 00:03:45,120

it's novel technologies

89
00:03:49,030 --> 00:03:47,519
are enabling the next sleeps of

90
00:03:52,630 --> 00:03:49,040
exploration

91
00:03:56,229 --> 00:03:52,640
landing with more precision and safely

92
00:03:58,949 --> 00:03:56,239
learn how to make oxygen from co2

93
00:03:59,750 --> 00:03:58,959
out of the atmosphere and more and a

94
00:04:02,149 --> 00:03:59,760
true

95
00:04:03,589 --> 00:04:02,159
extraterrestrial wright brothers moment

96
00:04:05,830 --> 00:04:03,599
with the ingenuity

97
00:04:07,429 --> 00:04:05,840
mars helicopter riding at the belly of

98
00:04:09,670 --> 00:04:07,439
the river right now

99
00:04:11,589 --> 00:04:09,680
as we demonstrate controlled flight in a

100
00:04:13,670 --> 00:04:11,599
different world

101
00:04:16,469 --> 00:04:13,680
we could in fact not land and chester

102
00:04:19,590 --> 00:04:16,479
crater if it wasn't for the technologies

103
00:04:21,189 --> 00:04:19,600
that are already added to this mars is

104
00:04:24,629 --> 00:04:21,199
hard and we never take

105
00:04:26,629 --> 00:04:24,639
success for granted and as we

106
00:04:28,230 --> 00:04:26,639
want to land on mars it's because it's

107
00:04:31,510 --> 00:04:28,240
of course important

108
00:04:34,790 --> 00:04:31,520
and we'll do so with cameras on so the

109
00:04:37,909 --> 00:04:34,800
entire world is inspired with us

110
00:04:40,310 --> 00:04:37,919
and as we do new and tough things and

111
00:04:42,710 --> 00:04:40,320
demonstrate these new technologies

112
00:04:44,790 --> 00:04:42,720
because whether it's on the red planet

113
00:04:47,430 --> 00:04:44,800

or here at home on our

114
00:04:48,390 --> 00:04:47,440
blue marble science can bring us

115
00:04:51,270 --> 00:04:48,400
together

116
00:04:53,670 --> 00:04:51,280
and create solutions to challenges that

117
00:04:55,430 --> 00:04:53,680
seem impossible at first

118
00:04:57,110 --> 00:04:55,440
and i'm really looking forward to

119
00:04:57,749 --> 00:04:57,120
turning it over to you jennifer who is

120
00:05:00,150 --> 00:04:57,759
of course

121
00:05:02,310 --> 00:05:00,160
the deputy project manager take it away

122
00:05:05,749 --> 00:05:02,320
jennifer thank you well i am so

123
00:05:08,710 --> 00:05:05,759
excited to be here today i can tell you

124
00:05:11,749 --> 00:05:08,720
that perseverance is operating perfectly

125
00:05:14,230 --> 00:05:11,759
right now that all systems are go

126
00:05:15,830 --> 00:05:14,240
for landing last friday night we

127
00:05:17,510 --> 00:05:15,840
actually sent a command to the

128
00:05:21,029 --> 00:05:17,520
spacecraft we call it the do

129
00:05:23,749 --> 00:05:21,039
edl command do entry descent and landing

130
00:05:25,830 --> 00:05:23,759
it makes it sound simple it's not simple

131
00:05:26,550 --> 00:05:25,840
but it enters the spacecraft into the

132
00:05:28,550 --> 00:05:26,560
timeline

133
00:05:29,909 --> 00:05:28,560
where it starts to do the entry descent

134
00:05:32,150 --> 00:05:29,919
and landing activities

135
00:05:34,150 --> 00:05:32,160
so that was a very exciting event the

136
00:05:36,310 --> 00:05:34,160
spacecraft is focused the team is

137
00:05:38,629 --> 00:05:36,320
focused and we are all ready to go

138
00:05:40,790 --> 00:05:38,639

for landing now i want to tell you a

139
00:05:42,150 --> 00:05:40,800
little bit more about where we're at

140
00:05:44,710 --> 00:05:42,160
so if you could bring up my first

141
00:05:45,510 --> 00:05:44,720
graphic this is something that you can

142
00:05:47,990 --> 00:05:45,520
actually look at

143
00:05:48,950 --> 00:05:48,000
it's called eyes on the solar system and

144
00:05:50,550 --> 00:05:48,960
it tells you

145
00:05:52,150 --> 00:05:50,560
where different spacecraft are in the

146
00:05:52,710 --> 00:05:52,160
universe and so we can tell you that

147
00:05:56,230 --> 00:05:52,720
mars

148
00:05:59,909 --> 00:05:56,240
perseverance is 125 million miles

149
00:06:01,350 --> 00:05:59,919
away from earth and we are only 370 000

150
00:06:04,309 --> 00:06:01,360
miles from mars

151
00:06:05,430 --> 00:06:04,319
so we are getting there the time it

152
00:06:09,670 --> 00:06:05,440
actually takes

153
00:06:12,070 --> 00:06:09,680
for a signal to go from earth to mars

154
00:06:15,189 --> 00:06:12,080
is 11 minutes and so that's how we're

155
00:06:17,029 --> 00:06:15,199
communicating with the vehicle right now

156
00:06:19,110 --> 00:06:17,039
and now one of the things that we've

157
00:06:21,029 --> 00:06:19,120
been working towards

158
00:06:23,590 --> 00:06:21,039
is really making sure that the aim

159
00:06:25,830 --> 00:06:23,600
points we're targeted for at mars

160
00:06:26,950 --> 00:06:25,840
so we want to aim like on a dart board

161
00:06:29,670 --> 00:06:26,960
that the aim point

162
00:06:30,550 --> 00:06:29,680
is accurate and so one of the ways that

163
00:06:32,629 --> 00:06:30,560

we do that

164
00:06:33,590 --> 00:06:32,639
is through these plots that you can pull

165
00:06:35,029 --> 00:06:33,600
up the next

166
00:06:37,029 --> 00:06:35,039
graphic there this is called a

167
00:06:39,110 --> 00:06:37,039
navigation b plot

168
00:06:41,510 --> 00:06:39,120
and the actual target the bullseye of

169
00:06:43,909 --> 00:06:41,520
that target is the green box

170
00:06:46,150 --> 00:06:43,919
the green box if if we think we're going

171
00:06:48,309 --> 00:06:46,160
to target anywhere in that green box

172
00:06:49,830 --> 00:06:48,319
everything is great what you see are

173
00:06:51,430 --> 00:06:49,840
some colorful ellipses

174
00:06:53,990 --> 00:06:51,440
in the upper right hand corner of that

175
00:06:55,430 --> 00:06:54,000
box those and the pluses in the middle

176
00:06:56,230 --> 00:06:55,440
the pluses are where we think we're

177
00:06:57,909 --> 00:06:56,240
targeting

178
00:06:59,430 --> 00:06:57,919
and the ellipses are the uncertainties

179
00:07:01,510 --> 00:06:59,440
around those so

180
00:07:03,350 --> 00:07:01,520
that means those ellipses all being

181
00:07:04,070 --> 00:07:03,360
within that green box it means that the

182
00:07:06,710 --> 00:07:04,080
targeting

183
00:07:08,870 --> 00:07:06,720
is on the bullseye and we are headed

184
00:07:11,029 --> 00:07:08,880
exactly where we want to be for mars

185
00:07:13,270 --> 00:07:11,039
now getting those navigation solutions

186
00:07:13,990 --> 00:07:13,280
is not that easy and we need a lot of

187
00:07:16,230 --> 00:07:14,000
support

188
00:07:18,550 --> 00:07:16,240

from the deep space network so you can

189
00:07:21,189 --> 00:07:18,560
go ahead to my next graphic

190
00:07:22,230 --> 00:07:21,199
the deep space network has stations all

191
00:07:25,350 --> 00:07:22,240
over the world

192
00:07:27,029 --> 00:07:25,360
there's some in madrid spain some in

193
00:07:29,029 --> 00:07:27,039
goldstone california and some in

194
00:07:30,390 --> 00:07:29,039
canberra australia you can actually go

195
00:07:32,390 --> 00:07:30,400
to dsn now

196
00:07:34,070 --> 00:07:32,400
and you can see the real-time live shots

197
00:07:36,390 --> 00:07:34,080
just like we're looking at now

198
00:07:38,950 --> 00:07:36,400
to see which stations are operating and

199
00:07:42,230 --> 00:07:38,960
communicating with with which spacecraft

200
00:07:45,029 --> 00:07:42,240
and martini 20 is taking two stations

201
00:07:46,629 --> 00:07:45,039
right now madrid so i want to thank all

202
00:07:48,390 --> 00:07:46,639
of the deep space network operators

203
00:07:49,510 --> 00:07:48,400
across the world who've helped us we've

204
00:07:52,629 --> 00:07:49,520
they've had 24

205
00:07:54,390 --> 00:07:52,639
7 coverage for us for the last several

206
00:07:54,950 --> 00:07:54,400
weeks so that we could get such good

207
00:07:56,469 --> 00:07:54,960
data

208
00:07:58,869 --> 00:07:56,479
to have those perfect navigation

209
00:08:01,909 --> 00:07:58,879
solutions so thank you

210
00:08:04,550 --> 00:08:01,919
and as i uh sit back and

211
00:08:05,990 --> 00:08:04,560
this is my my fifth landing i've been on

212
00:08:08,390 --> 00:08:06,000
every rover that we've

213
00:08:09,589 --> 00:08:08,400

ever sent i get that usual sort of

214
00:08:11,270 --> 00:08:09,599
anxiety but

215
00:08:13,670 --> 00:08:11,280
very much excitement for what we're

216
00:08:15,749 --> 00:08:13,680
going to see i look at

217
00:08:17,670 --> 00:08:15,759
the decades that we've spent building

218
00:08:19,189 --> 00:08:17,680
these rovers and building these teams to

219
00:08:20,790 --> 00:08:19,199
send these missions to mars

220
00:08:22,469 --> 00:08:20,800
and i want to talk about that just for a

221
00:08:24,710 --> 00:08:22,479
minute i think back to

222
00:08:26,950 --> 00:08:24,720
sojourner the very first rover we landed

223
00:08:28,469 --> 00:08:26,960
on mars you can see this next graphic

224
00:08:30,550 --> 00:08:28,479
sojourner was about the size of a

225
00:08:31,430 --> 00:08:30,560
microwave oven very small and even

226
00:08:34,070 --> 00:08:31,440
though it's

227
00:08:35,990 --> 00:08:34,080
our oldest child they're all kind of

228
00:08:37,909 --> 00:08:36,000
like additional children for me it sort

229
00:08:39,589 --> 00:08:37,919
of behaved like a youngest child it had

230
00:08:40,389 --> 00:08:39,599
a very free spirit it was just a fun

231
00:08:41,990 --> 00:08:40,399
mission

232
00:08:43,750 --> 00:08:42,000
to drive around and then you can see the

233
00:08:45,910 --> 00:08:43,760
spirit and opportunity rovers

234
00:08:47,430 --> 00:08:45,920
were the next evolution we built off of

235
00:08:48,710 --> 00:08:47,440
what sojourner had done

236
00:08:50,389 --> 00:08:48,720
spirit and opportunity actually could

237
00:08:51,910 --> 00:08:50,399
talk to earth all by themselves they

238
00:08:54,070 --> 00:08:51,920

still used solar panels

239
00:08:55,269 --> 00:08:54,080
and there were these twins that explored

240
00:08:58,790 --> 00:08:55,279
all over

241
00:09:01,269 --> 00:08:58,800
mars and and outlived their lifetime um

242
00:09:03,509 --> 00:09:01,279
by multiples of 10 and even 100 and and

243
00:09:05,350 --> 00:09:03,519
they were just great rovers and then

244
00:09:07,110 --> 00:09:05,360
we kind of took a pause and we really

245
00:09:08,949 --> 00:09:07,120
upgraded our systems and you can see

246
00:09:11,990 --> 00:09:08,959
curiosity down there in the lower

247
00:09:14,949 --> 00:09:12,000
left hand part of this this graphic

248
00:09:17,110 --> 00:09:14,959
curiosity we went from solar panels to a

249
00:09:19,269 --> 00:09:17,120
radio isotope power source

250
00:09:21,269 --> 00:09:19,279
the wheels increased in size we could

251
00:09:22,630 --> 00:09:21,279
traverse over much larger rocks and

252
00:09:24,949 --> 00:09:22,640
different terrains

253
00:09:25,990 --> 00:09:24,959
we had a sky crane landing system

254
00:09:28,470 --> 00:09:26,000
instead of air

255
00:09:30,470 --> 00:09:28,480
bags i mean we really we really made a

256
00:09:31,590 --> 00:09:30,480
step up and then perseverance

257
00:09:33,590 --> 00:09:31,600
even though it looks a lot like

258
00:09:35,750 --> 00:09:33,600
curiosity is another

259
00:09:37,829 --> 00:09:35,760
technological step forward and adam is

260
00:09:39,030 --> 00:09:37,839
going to talk a lot about that after i'm

261
00:09:41,030 --> 00:09:39,040
finished here

262
00:09:42,470 --> 00:09:41,040
and so in closing the one final thing i

263
00:09:45,350 --> 00:09:42,480

want to talk about is it's not

264
00:09:47,350 --> 00:09:45,360
just about the rovers and in fact it's

265
00:09:49,110 --> 00:09:47,360
about the people who build the rovers

266
00:09:50,790 --> 00:09:49,120
and it's not about the individual people

267
00:09:51,110 --> 00:09:50,800
who build the rovers it's about all

268
00:09:53,430 --> 00:09:51,120
those

269
00:09:55,110 --> 00:09:53,440
individual people together working

270
00:09:56,949 --> 00:09:55,120
together to make this

271
00:09:59,030 --> 00:09:56,959
mission work and all of these missions

272
00:10:00,710 --> 00:09:59,040
work there there are several dozen of us

273
00:10:02,150 --> 00:10:00,720
at jpl who've actually worked on all

274
00:10:02,949 --> 00:10:02,160
five of the rover missions if you can

275
00:10:04,870 --> 00:10:02,959
believe it

276
00:10:07,509 --> 00:10:04,880
and this image this next image is of the

277
00:10:09,509 --> 00:10:07,519
team this is the mars 2020 team

278
00:10:10,550 --> 00:10:09,519
and there are many people who aren't

279
00:10:12,310 --> 00:10:10,560
pictured here

280
00:10:14,389 --> 00:10:12,320
but i want to spend this moment to just

281
00:10:17,190 --> 00:10:14,399
thank the team for all of their work

282
00:10:17,990 --> 00:10:17,200
over the last almost decade to bring us

283
00:10:20,710 --> 00:10:18,000
to where we are

284
00:10:22,470 --> 00:10:20,720
today the team isn't just a bunch of

285
00:10:25,590 --> 00:10:22,480
people who are all the same it's

286
00:10:28,150 --> 00:10:25,600
a bunch of different uniquely skilled

287
00:10:29,910 --> 00:10:28,160
personnel who know very deeply

288
00:10:31,350 --> 00:10:29,920

all the technical things they need to

289
00:10:31,990 --> 00:10:31,360
know in order for all those things to

290
00:10:34,550 --> 00:10:32,000
come together

291
00:10:36,550 --> 00:10:34,560
into a complex system like the ones that

292
00:10:40,150 --> 00:10:36,560
we land on mars so thank you

293
00:10:42,470 --> 00:10:40,160
to that team and i will end by saying

294
00:10:44,870 --> 00:10:42,480
both for landing day on thursday and for

295
00:10:47,990 --> 00:10:44,880
the whole surface mission

296
00:10:50,230 --> 00:10:48,000
i wish that team great success

297
00:10:51,910 --> 00:10:50,240
that they have worked so hard to obtain

298
00:10:53,990 --> 00:10:51,920
over the last many years

299
00:10:55,030 --> 00:10:54,000
and with that i will hand it off to our

300
00:10:58,550 --> 00:10:55,040
chief engineer

301
00:11:01,829 --> 00:10:58,560
adam stelzner thanks jennifer

302
00:11:05,190 --> 00:11:01,839
um as jennifer mentions right it is a

303
00:11:05,910 --> 00:11:05,200
huge army of human beings who have been

304
00:11:09,430 --> 00:11:05,920
working

305
00:11:10,389 --> 00:11:09,440
um for decades in their careers to put

306
00:11:13,030 --> 00:11:10,399
us in a position

307
00:11:13,670 --> 00:11:13,040
to be able to put such a technological

308
00:11:16,870 --> 00:11:13,680
marvel as

309
00:11:18,870 --> 00:11:16,880
perseverance on the surface of mars

310
00:11:20,870 --> 00:11:18,880
here we see an image this is on our

311
00:11:23,269 --> 00:11:20,880
first image here we see a great shot the

312
00:11:26,310 --> 00:11:23,279
hero shot of percy

313
00:11:27,590 --> 00:11:26,320

she is uh looks a lot like curiosity but

314
00:11:30,870 --> 00:11:27,600
she's

315
00:11:33,110 --> 00:11:30,880
packed with a whole bunch of new

316
00:11:34,550 --> 00:11:33,120
instruments science instruments those

317
00:11:36,870 --> 00:11:34,560
will be discussed a bit in

318
00:11:38,230 --> 00:11:36,880
depth next week but we've got raman

319
00:11:42,389 --> 00:11:38,240
spectrometers

320
00:11:44,949 --> 00:11:42,399
we've got a a technology uh for

321
00:11:46,069 --> 00:11:44,959
future human uh explorations to mars

322
00:11:48,069 --> 00:11:46,079
which jeff will

323
00:11:50,069 --> 00:11:48,079
speak about a little later on today

324
00:11:53,350 --> 00:11:50,079
she's big she's a little bigger

325
00:11:56,629 --> 00:11:53,360
than uh curiosity although she is a

326
00:11:57,110 --> 00:11:56,639
twin she's a few inches longer a couple

327
00:12:00,550 --> 00:11:57,120
of

328
00:12:04,069 --> 00:12:00,560
about 250 pounds heavier

329
00:12:06,870 --> 00:12:04,079
and uh and she's a lot more capable

330
00:12:08,069 --> 00:12:06,880
uh next image please as you watch the

331
00:12:10,550 --> 00:12:08,079
two of them together

332
00:12:12,069 --> 00:12:10,560
curiosity and perseverance uh they look

333
00:12:13,509 --> 00:12:12,079
similar but you can notice immediately

334
00:12:14,710 --> 00:12:13,519
that the wheels are different i'll speak

335
00:12:15,509 --> 00:12:14,720
a little bit about the wheels in a

336
00:12:18,949 --> 00:12:15,519
moment

337
00:12:21,670 --> 00:12:18,959
but percy's got a new set of kicks

338
00:12:22,949 --> 00:12:21,680

and she is um ready for trouble on this

339
00:12:26,310 --> 00:12:22,959
martian surface with

340
00:12:27,990 --> 00:12:26,320
with her new new wheels she's also much

341
00:12:30,790 --> 00:12:28,000
more capable at driving

342
00:12:31,110 --> 00:12:30,800
you know curiosity needs to either drive

343
00:12:33,269 --> 00:12:31,120
or

344
00:12:34,550 --> 00:12:33,279
think about driving but not do both at

345
00:12:36,550 --> 00:12:34,560
the same time

346
00:12:38,150 --> 00:12:36,560
and we have used a piece of technology

347
00:12:40,470 --> 00:12:38,160
that we originally brought

348
00:12:41,269 --> 00:12:40,480
on for train relative navigation a

349
00:12:44,949 --> 00:12:41,279
special

350
00:12:47,269 --> 00:12:44,959
visual processor to allow us to move

351
00:12:48,550 --> 00:12:47,279
curio uh perseverance at three times the

352
00:12:51,590 --> 00:12:48,560
rate of curiosity

353
00:12:54,310 --> 00:12:51,600
now with all that movement we had to

354
00:12:55,670 --> 00:12:54,320
reinforce her wheels this is an image of

355
00:12:58,069 --> 00:12:55,680
curiosity's wheels

356
00:12:59,990 --> 00:12:58,079
she took a beating on the surface of

357
00:13:01,190 --> 00:13:00,000
mars because of these sharp rocks called

358
00:13:04,790 --> 00:13:01,200
vent effects

359
00:13:06,870 --> 00:13:04,800
i have a model of perseverance's wheel

360
00:13:08,069 --> 00:13:06,880
right here and you can see it looks

361
00:13:12,870 --> 00:13:08,079
quite different than

362
00:13:16,150 --> 00:13:12,880
curiosities as you see from this model

363
00:13:18,389 --> 00:13:16,160

perseverance has a gentle tread pattern

364
00:13:19,430 --> 00:13:18,399
next image please and that tread pattern

365
00:13:22,790 --> 00:13:19,440
not only makes

366
00:13:24,710 --> 00:13:22,800
her wheels more strong if we go to the

367
00:13:29,350 --> 00:13:24,720
next image

368
00:13:34,629 --> 00:13:33,590
these uh the soft uh tread redesign we

369
00:13:36,470 --> 00:13:34,639
call that tread

370
00:13:38,470 --> 00:13:36,480
the grousers you can go to the next

371
00:13:41,030 --> 00:13:38,480
image um

372
00:13:41,990 --> 00:13:41,040
uh allow uh the wheels to be much more

373
00:13:44,870 --> 00:13:42,000
strong against

374
00:13:45,670 --> 00:13:44,880
rocks maybe we don't have that image and

375
00:13:48,389 --> 00:13:45,680
um

376
00:13:51,990 --> 00:13:48,399
and also to have better performance in

377
00:13:58,389 --> 00:13:55,269
and of course driving is not the

378
00:14:01,269 --> 00:13:58,399
the reason for the season we have

379
00:14:02,710 --> 00:14:01,279
a sampling system on board and this is

380
00:14:04,710 --> 00:14:02,720
why we're actually on the surface of

381
00:14:08,069 --> 00:14:04,720
mars you can roll this

382
00:14:09,990 --> 00:14:08,079
you can see the robot arm and the coring

383
00:14:13,350 --> 00:14:10,000
drill that it has

384
00:14:15,750 --> 00:14:13,360
at the end of it we of our mission

385
00:14:16,790 --> 00:14:15,760
is specifically to be the first piece of

386
00:14:20,230 --> 00:14:16,800
a mars

387
00:14:24,230 --> 00:14:20,240
sample return campaign and in this leg

388
00:14:26,790 --> 00:14:24,240

we need to take samples of martian rocks

389
00:14:27,430 --> 00:14:26,800
inside that golden bit is a sample tube

390
00:14:29,509 --> 00:14:27,440
that looks

391
00:14:30,629 --> 00:14:29,519
just like this this is one of the

392
00:14:33,670 --> 00:14:30,639
world's cleanest

393
00:14:34,790 --> 00:14:33,680
items even though i just touched it this

394
00:14:37,829 --> 00:14:34,800
is a model of course

395
00:14:41,110 --> 00:14:37,839
uh hyper clean

396
00:14:42,150 --> 00:14:41,120
inside that uh coring bit once we've

397
00:14:44,949 --> 00:14:42,160
cored it we bring

398
00:14:45,750 --> 00:14:44,959
the sample tube and the bit inside the

399
00:14:49,670 --> 00:14:45,760
robot

400
00:14:53,509 --> 00:14:49,680
the rover and you can roll this image

401
00:14:55,590 --> 00:14:53,519
this is our adaptive caching assembly

402
00:14:57,829 --> 00:14:55,600
this is a small little robot inside the

403
00:14:58,870 --> 00:14:57,839
spacecraft inside the belly of the rover

404
00:15:01,509 --> 00:14:58,880
that manipulates

405
00:15:03,590 --> 00:15:01,519
that sample tube with the sample in it

406
00:15:06,069 --> 00:15:03,600
moves it from station to station

407
00:15:06,629 --> 00:15:06,079
confirms that we've got the right volume

408
00:15:08,710 --> 00:15:06,639
of sample

409
00:15:10,550 --> 00:15:08,720
takes images of the sample eventually

410
00:15:11,509 --> 00:15:10,560
seals the sample and returns it for

411
00:15:13,509 --> 00:15:11,519
storage

412
00:15:15,030 --> 00:15:13,519
until we've accumulated a big enough

413
00:15:17,910 --> 00:15:15,040

cash to be ready

414
00:15:18,949 --> 00:15:17,920
to put it on the surface of mars now

415
00:15:22,150 --> 00:15:18,959
this

416
00:15:25,350 --> 00:15:22,160
technology

417
00:15:27,189 --> 00:15:25,360
has not been a monolithic march it's

418
00:15:30,150 --> 00:15:27,199
sometimes two steps forward

419
00:15:31,749 --> 00:15:30,160
and one step back we know how hard the

420
00:15:34,949 --> 00:15:31,759
last year has been

421
00:15:36,550 --> 00:15:34,959
we've over the development of uh

422
00:15:38,550 --> 00:15:36,560
perseverance we've struggled

423
00:15:39,990 --> 00:15:38,560
with some technology challenges please

424
00:15:41,590 --> 00:15:40,000
roll this film

425
00:15:44,710 --> 00:15:41,600
this is an example of an early

426
00:15:48,310 --> 00:15:44,720
technology test for parachutes

427
00:15:51,189 --> 00:15:48,320
called the ldsd

428
00:15:52,550 --> 00:15:51,199
and you can watch a parachute failure

429
00:15:55,509 --> 00:15:52,560
here

430
00:15:55,910 --> 00:15:55,519
that unfortunately caused into question

431
00:16:03,509 --> 00:15:55,920
the

432
00:16:06,550 --> 00:16:03,519
of mars so we needed to stand up

433
00:16:08,230 --> 00:16:06,560
supersonic testing qualification program

434
00:16:10,230 --> 00:16:08,240
for our parachute which we did

435
00:16:11,269 --> 00:16:10,240
and over the skies waltz island please

436
00:16:14,870 --> 00:16:11,279
roll

437
00:16:16,470 --> 00:16:14,880
we had this image and you can see our

438
00:16:19,509 --> 00:16:16,480

beautiful perseverances

439
00:16:21,430 --> 00:16:19,519
um uh parachute the same size as

440
00:16:25,829 --> 00:16:21,440
curiosities but stronger

441
00:16:29,430 --> 00:16:25,839
made of technora kevlar nylon

442
00:16:32,150 --> 00:16:29,440
beautiful strong canopy is ready to

443
00:16:32,629 --> 00:16:32,160
slow perseverance down in just a few

444
00:16:35,990 --> 00:16:32,639
short

445
00:16:38,150 --> 00:16:36,000
hours so as we move

446
00:16:39,990 --> 00:16:38,160
forward you can roll this as we move

447
00:16:43,749 --> 00:16:40,000
forward through technology

448
00:16:47,189 --> 00:16:43,759
we have um overcome challenges

449
00:16:48,710 --> 00:16:47,199
much as the nation has in this last year

450
00:16:50,949 --> 00:16:48,720
nasa over the last year getting

451
00:16:55,749 --> 00:16:50,959
perseverance to this place

452
00:16:57,509 --> 00:16:55,759
has persevered our nation has persevered

453
00:16:58,870 --> 00:16:57,519
our world has persevered through these

454
00:17:02,230 --> 00:16:58,880
tough times

455
00:17:04,150 --> 00:17:02,240
and and this journey this persevering

456
00:17:07,510 --> 00:17:04,160
journey of technology development

457
00:17:10,949 --> 00:17:07,520
is teamwork it is a nasa-wide

458
00:17:14,069 --> 00:17:10,959
teamwork and here to talk a bit about

459
00:17:16,829 --> 00:17:14,079
that uh the um

460
00:17:18,549 --> 00:17:16,839
technology development directorate is

461
00:17:21,750 --> 00:17:18,559
trudy uh please

462
00:17:22,870 --> 00:17:21,760
take it away trudy okay well thank you

463
00:17:25,029 --> 00:17:22,880

adam

464
00:17:26,549 --> 00:17:25,039
um you know i just want to express a

465
00:17:28,390 --> 00:17:26,559
little bit of the sentiment that's

466
00:17:30,150 --> 00:17:28,400
already been expressed by jennifer and

467
00:17:31,990 --> 00:17:30,160
adam you know on behalf of nasa space

468
00:17:33,350 --> 00:17:32,000
technology mission directorate

469
00:17:35,669 --> 00:17:33,360
we're absolutely thrilled to be

470
00:17:37,430 --> 00:17:35,679
partnered with our colleagues

471
00:17:38,710 --> 00:17:37,440
in the science mission directorate you

472
00:17:42,549 --> 00:17:38,720
know leading this mission

473
00:17:46,630 --> 00:17:42,559
and jpl the multiple nasa centers

474
00:17:48,390 --> 00:17:46,640
who worked on this industry academia

475
00:17:49,990 --> 00:17:48,400
some international collaboration went

476
00:17:51,830 --> 00:17:50,000
into this mission

477
00:17:53,430 --> 00:17:51,840
um and so we're just thrilled to be a

478
00:17:56,070 --> 00:17:53,440
partner with this on this next

479
00:17:58,230 --> 00:17:56,080
really truly groundbreaking mars mission

480
00:18:00,710 --> 00:17:58,240
um stmd is quite proud

481
00:18:02,390 --> 00:18:00,720
to have four technologies a record

482
00:18:05,110 --> 00:18:02,400
number for us flying along

483
00:18:07,029 --> 00:18:05,120
on the spacecraft and on the rover um

484
00:18:08,549 --> 00:18:07,039
there are two technologies that are

485
00:18:10,870 --> 00:18:08,559
landing instruments

486
00:18:12,870 --> 00:18:10,880
uh one is a suite of sensors called the

487
00:18:14,950 --> 00:18:12,880
mars entry descent and landing

488
00:18:16,150 --> 00:18:14,960

instrumentation it's the second version

489
00:18:18,870 --> 00:18:16,160
that we're sending

490
00:18:19,830 --> 00:18:18,880
uh the first flew on our science lab in

491
00:18:23,430 --> 00:18:19,840
2012

492
00:18:25,350 --> 00:18:23,440
uh with curiosity and it measures the

493
00:18:28,390 --> 00:18:25,360
conditions that the aeroshell will see

494
00:18:30,950 --> 00:18:28,400
so it's about 28 sensors on both the

495
00:18:32,630 --> 00:18:30,960
uh the heat shield and the back shell

496
00:18:34,230 --> 00:18:32,640
and it'll give us data about the

497
00:18:35,510 --> 00:18:34,240
conditions that that are seen with the

498
00:18:37,990 --> 00:18:35,520
hot gases

499
00:18:38,710 --> 00:18:38,000
uh some of the the winds that that are

500
00:18:40,310 --> 00:18:38,720
seen

501
00:18:41,750 --> 00:18:40,320
and it's really going to help engineers

502
00:18:45,990 --> 00:18:41,760
to

503
00:18:47,990 --> 00:18:46,000
the future

504
00:18:49,909 --> 00:18:48,000
and then the new really quite

505
00:18:52,070 --> 00:18:49,919
extraordinary capability that provides

506
00:18:55,029 --> 00:18:52,080
both hazard avoidance

507
00:18:56,630 --> 00:18:55,039
and precision landing at a site that's

508
00:18:58,470 --> 00:18:56,640
determined autonomously by the

509
00:19:00,630 --> 00:18:58,480
spacecraft called terrain relative

510
00:19:03,669 --> 00:19:00,640
navigation or trn

511
00:19:05,830 --> 00:19:03,679
um and this technology is a

512
00:19:07,669 --> 00:19:05,840
critical part of operations it's

513
00:19:09,750 --> 00:19:07,679

actually operational during the entry

514
00:19:11,590 --> 00:19:09,760
descent landing phase

515
00:19:13,830 --> 00:19:11,600
we also then have two technology

516
00:19:14,950 --> 00:19:13,840
demonstrations on board during surface

517
00:19:17,669 --> 00:19:14,960
operations

518
00:19:20,390 --> 00:19:17,679
uh one is to take data on the martian

519
00:19:22,310 --> 00:19:20,400
weather in a variety of conditions

520
00:19:23,510 --> 00:19:22,320
i like to call it the rover's onboard

521
00:19:25,110 --> 00:19:23,520
weather channel

522
00:19:27,029 --> 00:19:25,120
i'm coming to you today from west lake

523
00:19:30,470 --> 00:19:27,039
ohio we had 12 inches

524
00:19:32,710 --> 00:19:30,480
of snow overnight and we could

525
00:19:34,150 --> 00:19:32,720
just a little bit of martian weather

526
00:19:35,110 --> 00:19:34,160
sounds pretty good to us right now just

527
00:19:36,470 --> 00:19:35,120
a little bit drier and a little bit

528
00:19:38,070 --> 00:19:36,480
hotter

529
00:19:39,909 --> 00:19:38,080
the other technology that's part of

530
00:19:42,150 --> 00:19:39,919
surface operations is

531
00:19:43,830 --> 00:19:42,160
one that will convert carbon dioxide to

532
00:19:45,669 --> 00:19:43,840
usable oxygen

533
00:19:48,630 --> 00:19:45,679
um this technology is called called

534
00:19:51,270 --> 00:19:48,640
moxie um and i find that that's very

535
00:19:54,789 --> 00:19:51,280
apropos because if any rover we've sent

536
00:19:56,710 --> 00:19:54,799
to mars has moxie it's perseverance um

537
00:19:58,150 --> 00:19:56,720
so with more science and technology on

538
00:19:59,669 --> 00:19:58,160

board than ever before the

539
00:20:02,549 --> 00:19:59,679
the number that i keep hearing is about

540
00:20:03,909 --> 00:20:02,559
50 percent um i do mean that literally

541
00:20:05,029 --> 00:20:03,919
and figuratively

542
00:20:07,990 --> 00:20:05,039
and you're going to hear more about

543
00:20:09,909 --> 00:20:08,000
moxie in a few minutes from jeff shihai

544
00:20:11,669 --> 00:20:09,919
uh the stmd chief engineer who's going

545
00:20:14,149 --> 00:20:11,679
to talk to you about that

546
00:20:16,149 --> 00:20:14,159
so for myself as the director of a

547
00:20:18,230 --> 00:20:16,159
program that advances technologies for

548
00:20:19,590 --> 00:20:18,240
future exploration needs

549
00:20:21,750 --> 00:20:19,600
personally i think one of the most

550
00:20:24,230 --> 00:20:21,760
interesting aspects is how

551
00:20:25,669 --> 00:20:24,240
the nasa team tested these technologies

552
00:20:27,990 --> 00:20:25,679
on the ground here on earth

553
00:20:29,510 --> 00:20:28,000
to get them ready for flight um for

554
00:20:31,190 --> 00:20:29,520
example with trn

555
00:20:33,029 --> 00:20:31,200
uh that i just talked about the

556
00:20:35,110 --> 00:20:33,039
precision landing technology

557
00:20:36,230 --> 00:20:35,120
the jpl project team used some pretty

558
00:20:38,470 --> 00:20:36,240
unique ways

559
00:20:39,750 --> 00:20:38,480
um to prove out the system performance

560
00:20:41,990 --> 00:20:39,760
here you know first

561
00:20:43,669 --> 00:20:42,000
they put the the system through some

562
00:20:45,430 --> 00:20:43,679
typical environmental testing so

563
00:20:47,430 --> 00:20:45,440

whatever the spacecraft is going to see

564
00:20:49,909 --> 00:20:47,440
on the way to its destination

565
00:20:51,669 --> 00:20:49,919
mechanical vibration from launch

566
00:20:54,390 --> 00:20:51,679
temperatures and pressures which we call

567
00:20:56,149 --> 00:20:54,400
thermal vacuum testing

568
00:20:58,230 --> 00:20:56,159
and then electrical compatibility to

569
00:20:59,669 --> 00:20:58,240
make sure when components are powered on

570
00:21:01,510 --> 00:20:59,679
they don't interfere with each other

571
00:21:03,669 --> 00:21:01,520
that type of thing that's pretty pro

572
00:21:05,669 --> 00:21:03,679
forma for us it's pretty standard

573
00:21:07,350 --> 00:21:05,679
um the second thing they did was focus

574
00:21:09,029 --> 00:21:07,360
on the software and algorithms which are

575
00:21:10,870 --> 00:21:09,039
a huge part of trn

576
00:21:12,630 --> 00:21:10,880
so they did simulations in the lab to

577
00:21:13,990 --> 00:21:12,640
model the different scenarios that the

578
00:21:17,110 --> 00:21:14,000
system will see

579
00:21:17,510 --> 00:21:17,120
um you know when landing on mars and

580
00:21:19,350 --> 00:21:17,520
then

581
00:21:20,710 --> 00:21:19,360
next if you could roll this video here

582
00:21:23,350 --> 00:21:20,720
please uh

583
00:21:25,669 --> 00:21:23,360
the team installed the system on a

584
00:21:26,390 --> 00:21:25,679
helicopter and flew it out over death

585
00:21:28,630 --> 00:21:26,400
valley

586
00:21:31,190 --> 00:21:28,640
um in the mojave desert it's really is a

587
00:21:31,830 --> 00:21:31,200
good simulator a simulation as we can

588
00:21:33,510 --> 00:21:31,840

get

589
00:21:35,270 --> 00:21:33,520
where the system will identify known

590
00:21:36,789 --> 00:21:35,280
hazards that have been mapped

591
00:21:39,590 --> 00:21:36,799
and then the maps are carried on board

592
00:21:41,350 --> 00:21:39,600
the system uh really close as we can get

593
00:21:43,190 --> 00:21:41,360
and quite conveniently then close

594
00:21:45,990 --> 00:21:43,200
closely located to jpl

595
00:21:47,990 --> 00:21:46,000
uh so that so that was uh easy to run

596
00:21:49,510 --> 00:21:48,000
just like it has to do the system has to

597
00:21:50,630 --> 00:21:49,520
do on thursday to get us to a safe

598
00:21:53,029 --> 00:21:50,640
landing spot in

599
00:21:53,909 --> 00:21:53,039
uh spot on the in the uh just jezreel

600
00:21:55,990 --> 00:21:53,919
crater

601
00:21:57,510 --> 00:21:56,000
so then the final step in all this and

602
00:21:58,310 --> 00:21:57,520
if you you can show this next video

603
00:22:01,029 --> 00:21:58,320
please

604
00:22:02,470 --> 00:22:01,039
the team uh used suborbital rockets uh

605
00:22:04,390 --> 00:22:02,480
to take a next step

606
00:22:06,630 --> 00:22:04,400
um this was through stmd's flight

607
00:22:07,110 --> 00:22:06,640
opportunities program in fact it was the

608
00:22:11,830 --> 00:22:07,120
mast

609
00:22:13,190 --> 00:22:11,840
vehicle which is a vertical takeoff and

610
00:22:16,710 --> 00:22:13,200
landing vehicle

611
00:22:18,710 --> 00:22:16,720
um and really that was the final step to

612
00:22:20,310 --> 00:22:18,720
give decision makers uh you know the

613
00:22:22,230 --> 00:22:20,320

comfort that they need to green light

614
00:22:23,270 --> 00:22:22,240
the system to be used as the primary

615
00:22:27,430 --> 00:22:23,280
system for

616
00:22:29,029 --> 00:22:27,440
mars 2020s larger lander vision system

617
00:22:31,430 --> 00:22:29,039
and those tests by the way i'll mention

618
00:22:33,750 --> 00:22:31,440
took place back in 2014

619
00:22:35,350 --> 00:22:33,760
uh over six years ago which is another

620
00:22:35,990 --> 00:22:35,360
just in closing i want to make this

621
00:22:37,909 --> 00:22:36,000
point

622
00:22:39,350 --> 00:22:37,919
you know this this development that

623
00:22:41,590 --> 00:22:39,360
takes place

624
00:22:43,750 --> 00:22:41,600
over multiple years you know all the

625
00:22:45,270 --> 00:22:43,760
technology development that goes into

626
00:22:47,990 --> 00:22:45,280
leading up to the mission and then the

627
00:22:51,510 --> 00:22:48,000
demonstrations that actually take place

628
00:22:51,909 --> 00:22:51,520
on the rover when we land they're really

629
00:22:54,230 --> 00:22:51,919
the

630
00:22:56,070 --> 00:22:54,240
primary way for us to continue to make

631
00:22:57,270 --> 00:22:56,080
these advancement advancements that are

632
00:22:59,669 --> 00:22:57,280
so critical

633
00:23:01,990 --> 00:22:59,679
and required to send you know more

634
00:23:04,070 --> 00:23:02,000
sophisticated robotic explorers

635
00:23:05,669 --> 00:23:04,080
um as well as humans to places in the

636
00:23:07,350 --> 00:23:05,679
solar system we've never been able to

637
00:23:10,149 --> 00:23:07,360
send them before

638
00:23:12,390 --> 00:23:10,159

and in just in closing i'll say stmd and

639
00:23:13,909 --> 00:23:12,400
stmd we say and we say it often because

640
00:23:17,270 --> 00:23:13,919
we really truly believe it

641
00:23:19,750 --> 00:23:17,280
technology drives exploration and

642
00:23:20,870 --> 00:23:19,760
what i think is so great about mars 2020

643
00:23:23,430 --> 00:23:20,880
perseverance and

644
00:23:24,230 --> 00:23:23,440
ingenuity is that they're all excellent

645
00:23:27,669 --> 00:23:24,240
examples

646
00:23:29,830 --> 00:23:27,679
of that happening in you know inaction

647
00:23:32,710 --> 00:23:29,840
and we look forward to seeing all that

648
00:23:33,990 --> 00:23:32,720
action start on thursday and taking

649
00:23:36,789 --> 00:23:34,000
place then

650
00:23:38,549 --> 00:23:36,799
um and so now i'd like to turn it over

651
00:23:39,350 --> 00:23:38,559
to arisa who's going to talk to you

652
00:23:45,590 --> 00:23:39,360
about

653
00:23:47,430 --> 00:23:45,600
hi um i have the pleasure of coming to

654
00:23:48,230 --> 00:23:47,440
you from the mission support area here

655
00:23:49,990 --> 00:23:48,240
at jpl

656
00:23:52,710 --> 00:23:50,000
so i'm just a few steps away from where

657
00:23:53,750 --> 00:23:52,720
i will take in perseverance's landing on

658
00:23:56,710 --> 00:23:53,760
thursday with

659
00:23:57,510 --> 00:23:56,720
some of my edl colleagues here at jpl

660
00:23:59,029 --> 00:23:57,520
each team

661
00:24:00,390 --> 00:23:59,039
on perseverance has a different

662
00:24:01,430 --> 00:24:00,400
perspective when we look at this

663
00:24:03,110 --> 00:24:01,440

beautiful

664
00:24:05,590 --> 00:24:03,120
ancient river delta that we see in

665
00:24:07,269 --> 00:24:05,600
jezreel crater and the lake bed

666
00:24:09,350 --> 00:24:07,279
the first two images i wanted to share

667
00:24:11,669 --> 00:24:09,360
with you kind of demonstrate this the

668
00:24:13,669 --> 00:24:11,679
left side is a spectral

669
00:24:14,789 --> 00:24:13,679
data image from the mars reconnaissance

670
00:24:16,470 --> 00:24:14,799
orbiter

671
00:24:18,310 --> 00:24:16,480
so the scientists right they see the

672
00:24:21,350 --> 00:24:18,320
geologic diversity

673
00:24:23,190 --> 00:24:21,360
and the biosignature potential um that

674
00:24:25,909 --> 00:24:23,200
we're looking for with this mission

675
00:24:27,110 --> 00:24:25,919
the right side is an example of the edl

676
00:24:29,909 --> 00:24:27,120
hazard map

677
00:24:30,630 --> 00:24:29,919
and so for edl we ask the question what

678
00:24:33,750 --> 00:24:30,640
could kill us

679
00:24:37,590 --> 00:24:33,760
on landing day um in the

680
00:24:40,549 --> 00:24:37,600
south uh east are rocks that are strewn

681
00:24:42,070 --> 00:24:40,559
throughout the um the the jezreel crater

682
00:24:43,990 --> 00:24:42,080
landing site for us

683
00:24:45,190 --> 00:24:44,000
uh the southwest and to the north we

684
00:24:47,190 --> 00:24:45,200
have sand dunes

685
00:24:48,630 --> 00:24:47,200
and then that beautiful river delta we

686
00:24:51,430 --> 00:24:48,640
keep talking about well that looks like

687
00:24:52,789 --> 00:24:51,440
a 250 foot cliff to us as we're landing

688
00:24:55,990 --> 00:24:52,799

and we certainly don't want to land

689
00:24:58,950 --> 00:24:56,000
on that this this map

690
00:25:00,549 --> 00:24:58,960
is the best hazard map we have ever

691
00:25:02,310 --> 00:25:00,559
created for a flight mission

692
00:25:03,830 --> 00:25:02,320
and it has to be because this is the

693
00:25:05,669 --> 00:25:03,840
information that seeds

694
00:25:08,390 --> 00:25:05,679
the decisions that trn is going to be

695
00:25:09,909 --> 00:25:08,400
making during perseverance's landing

696
00:25:11,510 --> 00:25:09,919
so what other improvements have we had

697
00:25:13,350 --> 00:25:11,520
to make to be able to go to a place like

698
00:25:15,669 --> 00:25:13,360
jezreel crater

699
00:25:17,669 --> 00:25:15,679
over several missions uh you let's go

700
00:25:19,830 --> 00:25:17,679
ahead and show the next slide actually

701
00:25:21,029 --> 00:25:19,840
you can see an improvement in the size

702
00:25:22,630 --> 00:25:21,039
of the landing ellipse

703
00:25:23,830 --> 00:25:22,640
so some of those earlier improvements

704
00:25:25,430 --> 00:25:23,840
were based on the way that we do

705
00:25:27,990 --> 00:25:25,440
navigation

706
00:25:28,549 --> 00:25:28,000
curiosity had a smaller landing ellipse

707
00:25:30,070 --> 00:25:28,559
than

708
00:25:32,230 --> 00:25:30,080
historic missions because of something

709
00:25:33,990 --> 00:25:32,240
we call entry guidance which is uh the

710
00:25:35,750 --> 00:25:34,000
spacecraft waking up when we start to

711
00:25:37,590 --> 00:25:35,760
sense the martian atmosphere

712
00:25:39,110 --> 00:25:37,600
and start to steer our way through the

713
00:25:41,430 --> 00:25:39,120

atmosphere to a target

714
00:25:42,390 --> 00:25:41,440
and this is actually a an algorithm

715
00:25:44,230 --> 00:25:42,400
adopted from

716
00:25:45,669 --> 00:25:44,240
apollo guidance that was used on the

717
00:25:47,990 --> 00:25:45,679
apollo missions

718
00:25:49,669 --> 00:25:48,000
the biggest difference for perseverance

719
00:25:51,909 --> 00:25:49,679
since the curiosity mission

720
00:25:53,269 --> 00:25:51,919
is using what we call range trigger so

721
00:25:53,830 --> 00:25:53,279
this is a change in the way that we

722
00:25:58,230 --> 00:25:53,840
deploy

723
00:25:59,669 --> 00:25:58,240
on an estimated velocity

724
00:26:02,630 --> 00:25:59,679
and for perseverance we're using an

725
00:26:04,710 --> 00:26:02,640
estimated range that allows us to more

726
00:26:06,310 --> 00:26:04,720
precisely control the distance from the

727
00:26:08,310 --> 00:26:06,320
target that we're doing that

728
00:26:10,710 --> 00:26:08,320
and the effect it has is to shorten the

729
00:26:11,990 --> 00:26:10,720
long longer axis or the major axis of

730
00:26:13,669 --> 00:26:12,000
our landing ellipse which is why the

731
00:26:14,549 --> 00:26:13,679
perseverance ellipse looks much more

732
00:26:16,789 --> 00:26:14,559
circular than

733
00:26:18,230 --> 00:26:16,799
than previous missions and this is also

734
00:26:19,830 --> 00:26:18,240
what allowed us to then start looking at

735
00:26:20,470 --> 00:26:19,840
places like jezreel where it's harder

736
00:26:22,789 --> 00:26:20,480
for us to

737
00:26:23,510 --> 00:26:22,799
avoid the hazards but as you saw in the

738
00:26:26,070 --> 00:26:23,520

hazard map

739
00:26:26,630 --> 00:26:26,080
our ellipse is full of hazards uh so

740
00:26:28,710 --> 00:26:26,640
let's get

741
00:26:29,669 --> 00:26:28,720
uh let's move on through edl and get to

742
00:26:31,269 --> 00:26:29,679
that part um

743
00:26:32,710 --> 00:26:31,279
where we where we start to see tierra

744
00:26:34,470 --> 00:26:32,720
and do its work

745
00:26:35,990 --> 00:26:34,480
um so i just mentioned parachute deploy

746
00:26:37,350 --> 00:26:36,000
now that we're on the parachute if we

747
00:26:39,190 --> 00:26:37,360
can roll the footage

748
00:26:41,110 --> 00:26:39,200
we've got one more beautiful parachute

749
00:26:42,870 --> 00:26:41,120
to play video for you from the aspire

750
00:26:44,390 --> 00:26:42,880
testing that adam talked about

751
00:26:47,110 --> 00:26:44,400
a few details about our parachute that

752
00:26:49,110 --> 00:26:47,120
we're flying the materials are hand sewn

753
00:26:51,510 --> 00:26:49,120
and a mix of super lightweight nylon and

754
00:26:53,669 --> 00:26:51,520
really strong technora that has a better

755
00:26:55,830 --> 00:26:53,679
strength to weight ratio than steel when

756
00:26:58,310 --> 00:26:55,840
our parachute is packed in its

757
00:26:59,990 --> 00:26:58,320
mortar tube it has the density of oak

758
00:27:01,350 --> 00:27:00,000
and when we deploy it it comes out at

759
00:27:03,269 --> 00:27:01,360
100 miles per hour

760
00:27:05,110 --> 00:27:03,279
has to inflate to a 70 foot diameter

761
00:27:08,789 --> 00:27:05,120
parachute in about half a second

762
00:27:10,390 --> 00:27:08,799
and we'll put up to 60 000 pounds 60 000

763
00:27:12,630 --> 00:27:10,400

pounds on the spacecraft and the

764
00:27:13,669 --> 00:27:12,640
parachute and like so many other things

765
00:27:16,630 --> 00:27:13,679
within edl

766
00:27:17,909 --> 00:27:16,640
the parachute has to work if it doesn't

767
00:27:19,430 --> 00:27:17,919
it's not going to be a very good day for

768
00:27:21,110 --> 00:27:19,440
any of us

769
00:27:22,950 --> 00:27:21,120
once perseverance is descending on the

770
00:27:24,789 --> 00:27:22,960
parachute we can now release that heat

771
00:27:26,549 --> 00:27:24,799
shield that protected us during entry

772
00:27:28,230 --> 00:27:26,559
and for the first time turn on the radar

773
00:27:29,909 --> 00:27:28,240
and start to look at the ground

774
00:27:32,630 --> 00:27:29,919
and this is when we're ready to let tear

775
00:27:34,630 --> 00:27:32,640
in loose trn works in two parts

776
00:27:35,909 --> 00:27:34,640
so if we go ahead and roll the next

777
00:27:38,149 --> 00:27:35,919
video um

778
00:27:39,830 --> 00:27:38,159
so the first thing we do is take images

779
00:27:42,149 --> 00:27:39,840
with a camera on board

780
00:27:44,310 --> 00:27:42,159
compare those to a map on board and then

781
00:27:45,750 --> 00:27:44,320
that allows perseverance to reduce the

782
00:27:48,870 --> 00:27:45,760
error in where it thinks it is

783
00:27:51,269 --> 00:27:48,880
from kilometers to tens of meters

784
00:27:53,750 --> 00:27:51,279
we do that with a really capable camera

785
00:27:55,750 --> 00:27:53,760
the camera has a 90 degree field of view

786
00:27:57,269 --> 00:27:55,760
and uh can you go ahead and roll the

787
00:27:58,149 --> 00:27:57,279
next footage that shows the feature

788
00:28:00,630 --> 00:27:58,159

matching

789
00:28:02,549 --> 00:28:00,640
um 90 degree field of view and it has a

790
00:28:04,070 --> 00:28:02,559
one oh sorry

791
00:28:06,230 --> 00:28:04,080
okay i don't think i don't think we have

792
00:28:08,710 --> 00:28:06,240
it um that's fine

793
00:28:10,630 --> 00:28:08,720
um the feature matching you saw trudy

794
00:28:12,870 --> 00:28:10,640
talk about where it's comparing uh

795
00:28:15,669 --> 00:28:12,880
features back and forth between the map

796
00:28:17,110 --> 00:28:15,679
on board and the photos that are taken

797
00:28:19,510 --> 00:28:17,120
we're able to do that quickly because

798
00:28:19,990 --> 00:28:19,520
the camera has like a 1 1000th of a

799
00:28:21,669 --> 00:28:20,000
second

800
00:28:23,029 --> 00:28:21,679
exposure which allows us to get clean

801
00:28:24,630 --> 00:28:23,039
images while we're

802
00:28:26,950 --> 00:28:24,640
well perseverance is swinging around on

803
00:28:28,710 --> 00:28:26,960
the parachute and it has about a 0.1

804
00:28:30,549 --> 00:28:28,720
second readout which allows us to spend

805
00:28:32,950 --> 00:28:30,559
less time taking or waiting on the foot

806
00:28:35,110 --> 00:28:32,960
on the image and more time processing it

807
00:28:37,430 --> 00:28:35,120
the computer on board is also

808
00:28:39,110 --> 00:28:37,440
specifically built to do this work

809
00:28:41,510 --> 00:28:39,120
so it's one of the fastest that we've

810
00:28:43,750 --> 00:28:41,520
ever sent on an interplanetary mission

811
00:28:45,669 --> 00:28:43,760
built for space and for image-based

812
00:28:46,470 --> 00:28:45,679
navigation which also gets to do some of

813
00:28:47,990 --> 00:28:46,480

that work

814
00:28:49,909 --> 00:28:48,000
again as you heard adam talk about on

815
00:28:51,510 --> 00:28:49,919
the surface when perseverance is driving

816
00:28:55,350 --> 00:28:51,520
around

817
00:28:57,110 --> 00:28:55,360
um the second part of trn is once we

818
00:28:59,590 --> 00:28:57,120
once perseverance has a better sense of

819
00:29:00,710 --> 00:28:59,600
where she's at she then uses a second

820
00:29:03,029 --> 00:29:00,720
on-board map

821
00:29:04,710 --> 00:29:03,039
based on where we can currently divert

822
00:29:06,389 --> 00:29:04,720
to at that point in time

823
00:29:08,950 --> 00:29:06,399
and searches that area to find the

824
00:29:12,149 --> 00:29:08,960
safest place that she can fly to

825
00:29:13,750 --> 00:29:12,159
that search is worth over 120 football

826
00:29:15,909 --> 00:29:13,760
fields worth of real estate on the

827
00:29:19,350 --> 00:29:15,919
martian surface at that point

828
00:29:21,669 --> 00:29:19,360
so perseverance chooses that that target

829
00:29:23,669 --> 00:29:21,679
and then um and that all happens in the

830
00:29:25,510 --> 00:29:23,679
the 2.4 seconds it takes for

831
00:29:25,990 --> 00:29:25,520
perseverance to send commands for us to

832
00:29:27,830 --> 00:29:26,000
separate

833
00:29:30,310 --> 00:29:27,840
from the back shell and start a free

834
00:29:31,990 --> 00:29:30,320
fall so when we have that knowledge and

835
00:29:32,950 --> 00:29:32,000
we're done with our free fall we fire up

836
00:29:35,110 --> 00:29:32,960
the rockets

837
00:29:37,029 --> 00:29:35,120
uh we like to i like to think of it as

838
00:29:38,389 --> 00:29:37,039

the pack or the descent stage that's

839
00:29:40,149 --> 00:29:38,399
attached to the rover

840
00:29:43,350 --> 00:29:40,159
and start to divert to that safe landing

841
00:29:46,230 --> 00:29:43,360
point we go from 170 miles per hour

842
00:29:48,070 --> 00:29:46,240
at that point down to around two as we

843
00:29:49,110 --> 00:29:48,080
slow down and get ready for the sky

844
00:29:51,110 --> 00:29:49,120
crane maneuver

845
00:29:53,269 --> 00:29:51,120
so if we go ahead and roll the next um

846
00:29:53,990 --> 00:29:53,279
we throttle down eight four out of the

847
00:29:55,590 --> 00:29:54,000
eight engines

848
00:29:57,350 --> 00:29:55,600
so that we don't impinge the rover door

849
00:29:59,029 --> 00:29:57,360
and deploy and this gives you a view of

850
00:30:02,070 --> 00:29:59,039
how that deploy looks

851
00:30:04,389 --> 00:30:02,080
um during landing where we

852
00:30:05,830 --> 00:30:04,399
uh both release the rover and then fire

853
00:30:08,070 --> 00:30:05,840
pyros that are gonna release

854
00:30:10,549 --> 00:30:08,080
the landing gear or the wheels to get

855
00:30:12,870 --> 00:30:10,559
perseverance ready to touch down

856
00:30:13,750 --> 00:30:12,880
once we're safely on the surface the

857
00:30:16,230 --> 00:30:13,760
final

858
00:30:17,029 --> 00:30:16,240
eight out of 158 pyro is fired to

859
00:30:19,269 --> 00:30:17,039
release the

860
00:30:20,389 --> 00:30:19,279
the bridles and the umbilical the uh the

861
00:30:21,750 --> 00:30:20,399
electrical cable

862
00:30:23,909 --> 00:30:21,760
that have been connecting the descent

863
00:30:25,590 --> 00:30:23,919

stage and the rover throughout edl so

864
00:30:27,110 --> 00:30:25,600
that the sense stage can then fly away

865
00:30:29,430 --> 00:30:27,120
to a safe distance

866
00:30:31,590 --> 00:30:29,440
and now we're on the surface of mars we

867
00:30:34,630 --> 00:30:31,600
have a brand new baby spacecraft

868
00:30:38,710 --> 00:30:34,640
in its new environment ready to start

869
00:30:40,789 --> 00:30:38,720
rolling around um if we're lucky

870
00:30:42,549 --> 00:30:40,799
uh the edl camera suite that we've also

871
00:30:43,990 --> 00:30:42,559
got on board perseverance this time

872
00:30:46,230 --> 00:30:44,000
will have been taking some amazing

873
00:30:49,430 --> 00:30:46,240
photos during those seven terrifying

874
00:30:51,430 --> 00:30:49,440
or exciting minutes and will give us

875
00:30:53,430 --> 00:30:51,440
some some images video that we've never

876
00:30:55,430 --> 00:30:53,440
seen before

877
00:30:57,029 --> 00:30:55,440
with that um i'd like to pass it off to

878
00:31:00,070 --> 00:30:57,039
jeff shihai who's going to talk to you

879
00:31:06,310 --> 00:31:03,590
oh thank you versa coming to you from

880
00:31:08,470 --> 00:31:06,320
northern virginia the suburbs of dc

881
00:31:11,029 --> 00:31:08,480
under normal circumstances i would have

882
00:31:11,669 --> 00:31:11,039
loved sitting at the table there with

883
00:31:14,950 --> 00:31:11,679
the group

884
00:31:18,549 --> 00:31:14,960
and uh being at jpl to celebrate uh

885
00:31:19,110 --> 00:31:18,559
moxie landing on mars with perseverance

886
00:31:21,590 --> 00:31:19,120
but

887
00:31:22,470 --> 00:31:21,600
these are not normal circumstances so

888
00:31:25,509 --> 00:31:22,480

here i am

889
00:31:28,630 --> 00:31:25,519
i'd like to talk about what moxie is

890
00:31:29,430 --> 00:31:28,640
how it works how who designed and built

891
00:31:31,269 --> 00:31:29,440
moxie

892
00:31:32,789 --> 00:31:31,279
how we'll operate it on mars and what

893
00:31:35,590 --> 00:31:32,799
we'll learn from

894
00:31:37,029 --> 00:31:35,600
so the full name of the technology

895
00:31:40,549 --> 00:31:37,039
demonstration is

896
00:31:42,710 --> 00:31:40,559
the mars oxygen in situ resource

897
00:31:44,789 --> 00:31:42,720
utilization experiment

898
00:31:46,389 --> 00:31:44,799
now that's a bit of a mouthful so we

899
00:31:49,350 --> 00:31:46,399
pull a few letters out of that

900
00:31:51,269 --> 00:31:49,360
and we just call it moxie in situ

901
00:31:54,870 --> 00:31:51,279
resource utilization

902
00:31:56,549 --> 00:31:54,880
or isru means using the resources we

903
00:31:59,190 --> 00:31:56,559
find at the destination

904
00:32:00,549 --> 00:31:59,200
to produce useful commodities if we're

905
00:32:02,070 --> 00:32:00,559
going to the moon we'd have the

906
00:32:04,630 --> 00:32:02,080
resources that are on

907
00:32:05,350 --> 00:32:04,640
the surface on mars we have that but we

908
00:32:08,950 --> 00:32:05,360
also have an

909
00:32:09,990 --> 00:32:08,960
atmosphere that we can use atmosphere is

910
00:32:12,630 --> 00:32:10,000
about a hundred times

911
00:32:13,110 --> 00:32:12,640
thinner than earth's atmosphere and it

912
00:32:16,710 --> 00:32:13,120
is

913
00:32:20,389 --> 00:32:16,720

mainly of carbon dioxide about 95 96

914
00:32:23,190 --> 00:32:20,399
co2 but we can use it so moxi

915
00:32:24,549 --> 00:32:23,200
is a small scale proof-of-concept

916
00:32:27,110 --> 00:32:24,559
demonstration

917
00:32:29,509 --> 00:32:27,120
of atmospheric institute resource

918
00:32:31,509 --> 00:32:29,519
utilization or isru

919
00:32:33,110 --> 00:32:31,519
we have an animation of the moxie design

920
00:32:36,070 --> 00:32:33,120
that we can show

921
00:32:38,549 --> 00:32:36,080
um there it is we can see that packed

922
00:32:40,070 --> 00:32:38,559
inside this gold colored box are three

923
00:32:42,789 --> 00:32:40,080
main subsystems

924
00:32:44,070 --> 00:32:42,799
there's a compressor to pull in the gas

925
00:32:46,389 --> 00:32:44,080
from the atmosphere

926
00:32:49,029 --> 00:32:46,399
and feed it into the system there's a

927
00:32:52,070 --> 00:32:49,039
solid oxide electrolysis

928
00:32:54,149 --> 00:32:52,080
system we call the soxy assembly

929
00:32:56,149 --> 00:32:54,159
that does the chemical conversion and

930
00:32:59,430 --> 00:32:56,159
then there's a collection of process

931
00:33:00,789 --> 00:32:59,440
monitoring and control sensors moxie

932
00:33:03,509 --> 00:33:00,799
uses a thermal

933
00:33:04,870 --> 00:33:03,519
and electrochemical process to convert

934
00:33:07,430 --> 00:33:04,880
carbon dioxide

935
00:33:09,590 --> 00:33:07,440
into oxygen but the cathodes in the

936
00:33:10,549 --> 00:33:09,600
electrolytic cells co2 plus two

937
00:33:13,909 --> 00:33:10,559
electrons

938
00:33:14,470 --> 00:33:13,919

become co carbon monoxide plus doubly

939
00:33:17,509 --> 00:33:14,480
charged

940
00:33:18,310 --> 00:33:17,519
o anions these anions migrate to the

941
00:33:20,389 --> 00:33:18,320
anodes

942
00:33:21,350 --> 00:33:20,399
where two of them combine to become the

943
00:33:24,149 --> 00:33:21,360
familiar

944
00:33:26,230 --> 00:33:24,159
o2 molecule with four electrons returned

945
00:33:28,230 --> 00:33:26,240
to the electrochemical system

946
00:33:30,710 --> 00:33:28,240
that the carbon monoxide byproduct is

947
00:33:32,870 --> 00:33:30,720
exhausted to the atmosphere

948
00:33:34,549 --> 00:33:32,880
something like moxie any any instrument

949
00:33:37,430 --> 00:33:34,559
you want to put on a spacecraft

950
00:33:39,430 --> 00:33:37,440
starts out as a vision in the mind of a

951
00:33:42,789 --> 00:33:39,440
principal investigator

952
00:33:44,870 --> 00:33:42,799
hecht from mit

953
00:33:47,110 --> 00:33:44,880
he had a plan for what he wanted moxie

954
00:33:49,990 --> 00:33:47,120
to accomplish on mars

955
00:33:51,590 --> 00:33:50,000
jeff melstrom at jpl led a team of

956
00:33:54,149 --> 00:33:51,600
clever engineers

957
00:33:56,630 --> 00:33:54,159
who worked extremely hard and came up

958
00:33:59,110 --> 00:33:56,640
with several innovative solutions

959
00:34:00,870 --> 00:33:59,120
to implement mike's vision in a way that

960
00:34:03,190 --> 00:34:00,880
would fit on the rover

961
00:34:04,870 --> 00:34:03,200
survive the trip including those seven

962
00:34:07,509 --> 00:34:04,880
minutes of terror that we

963
00:34:09,589 --> 00:34:07,519

heard so much about and and work once it

964
00:34:11,510 --> 00:34:09,599
gets on the surface of mars

965
00:34:13,589 --> 00:34:11,520
we worked with a company called oxyon

966
00:34:16,149 --> 00:34:13,599
energy they led a team that worked

967
00:34:16,869 --> 00:34:16,159
collaboratively with jpl and with mike

968
00:34:19,349 --> 00:34:16,879
heck to

969
00:34:20,629 --> 00:34:19,359
develop the guts of moxie that that

970
00:34:23,190 --> 00:34:20,639
solid oxide

971
00:34:25,030 --> 00:34:23,200
electrolysis stack that i mentioned a

972
00:34:28,550 --> 00:34:25,040
company called air squared

973
00:34:31,030 --> 00:34:28,560
led the development of the compressor

974
00:34:32,310 --> 00:34:31,040
that takes in the carbon monoxide

975
00:34:34,149 --> 00:34:32,320
atmosphere

976
00:34:35,430 --> 00:34:34,159
part of that effort was funded through

977
00:34:37,349 --> 00:34:35,440
the nasa

978
00:34:38,710 --> 00:34:37,359
small business innovative research

979
00:34:41,109 --> 00:34:38,720
program

980
00:34:42,230 --> 00:34:41,119
there's uh jennifer highlighted the the

981
00:34:45,109 --> 00:34:42,240
big team that

982
00:34:46,710 --> 00:34:45,119
that worked on uh march 2020 and in

983
00:34:49,270 --> 00:34:46,720
perseverance earlier

984
00:34:50,550 --> 00:34:49,280
there's no question that the team that

985
00:34:53,669 --> 00:34:50,560
designed

986
00:34:56,149 --> 00:34:53,679
built and tested moxie

987
00:34:57,430 --> 00:34:56,159
needed a lot of moxie to overcome all

988
00:35:00,150 --> 00:34:57,440

the challenges that

989
00:35:01,510 --> 00:35:00,160
were encountered along the way there

990
00:35:04,630 --> 00:35:01,520
there were times when

991
00:35:06,310 --> 00:35:04,640
some of the managers worried that the

992
00:35:08,950 --> 00:35:06,320
technology couldn't be

993
00:35:09,589 --> 00:35:08,960
developed in time to get it on the rover

994
00:35:13,510 --> 00:35:09,599
for

995
00:35:16,310 --> 00:35:13,520
in the next video

996
00:35:18,470 --> 00:35:16,320
and i think it's it's up there there's

997
00:35:21,109 --> 00:35:18,480
the beautiful gold box

998
00:35:22,710 --> 00:35:21,119
being lowered into the rover so this is

999
00:35:26,390 --> 00:35:22,720
the day in march

1000
00:35:29,990 --> 00:35:26,400
2019 when moxie was installed

1001
00:35:32,150 --> 00:35:30,000
into the belly of the rover

1002
00:35:34,150 --> 00:35:32,160
so there's a filter on the outside of

1003
00:35:35,910 --> 00:35:34,160
the rover that takes in the atmosphere

1004
00:35:38,230 --> 00:35:35,920
and feeds it to this box

1005
00:35:39,190 --> 00:35:38,240
the box utilizes the power system on the

1006
00:35:42,630 --> 00:35:39,200
rover

1007
00:35:45,510 --> 00:35:42,640
to power its operations and

1008
00:35:46,230 --> 00:35:45,520
so moxie was built and and delivered on

1009
00:35:49,349 --> 00:35:46,240
time

1010
00:35:53,430 --> 00:35:49,359
and it's in the rover on its way to mars

1011
00:35:54,150 --> 00:35:53,440
it'll land about 40 50 hours from now i

1012
00:35:57,190 --> 00:35:54,160
think

1013
00:35:59,990 --> 00:35:57,200

just about um when

1014
00:36:00,870 --> 00:36:00,000
we get it to mars moxie is scheduled to

1015
00:36:03,829 --> 00:36:00,880
be turned on

1016
00:36:05,990 --> 00:36:03,839
three times in the first 30 days or so

1017
00:36:07,829 --> 00:36:06,000
of the perseverance mission

1018
00:36:09,430 --> 00:36:07,839
the first time we'll be mainly to see if

1019
00:36:10,710 --> 00:36:09,440
moxie responds to commands and the

1020
00:36:12,870 --> 00:36:10,720
second time will be to

1021
00:36:14,710 --> 00:36:12,880
thoroughly check out all the subsystems

1022
00:36:17,030 --> 00:36:14,720
we'll heat it to the

1023
00:36:18,710 --> 00:36:17,040
target operational temperature and apply

1024
00:36:21,109 --> 00:36:18,720
operational voltages

1025
00:36:21,990 --> 00:36:21,119
now the third run will actually make

1026
00:36:23,670 --> 00:36:22,000
oxygen

1027
00:36:25,030 --> 00:36:23,680
under some conservative operating

1028
00:36:27,750 --> 00:36:25,040
conditions

1029
00:36:29,349 --> 00:36:27,760
after that during the mission of

1030
00:36:31,270 --> 00:36:29,359
perseverance on mars

1031
00:36:33,910 --> 00:36:31,280
we expect moxie to have at least 10

1032
00:36:36,470 --> 00:36:33,920
opportunities to produce oxygen

1033
00:36:37,109 --> 00:36:36,480
those operations will be distributed

1034
00:36:39,829 --> 00:36:37,119
across

1035
00:36:41,349 --> 00:36:39,839
times of the year times of day and

1036
00:36:44,630 --> 00:36:41,359
seasons of the year

1037
00:36:46,550 --> 00:36:44,640
because the mars atmosphere varies with

1038
00:36:48,310 --> 00:36:46,560

time of day and season of the year so we

1039
00:36:50,470 --> 00:36:48,320
want to see how moxie works

1040
00:36:51,750 --> 00:36:50,480
under different conditions of the mars

1041
00:36:53,990 --> 00:36:51,760
atmosphere

1042
00:36:56,310 --> 00:36:54,000
for each of those operations we expect

1043
00:36:59,829 --> 00:36:56,320
to produce oxygen for about an hour

1044
00:37:03,270 --> 00:36:59,839
at a rate of about 6 to 10 grams an hour

1045
00:37:03,750 --> 00:37:03,280
so you might wonder why are we doing all

1046
00:37:05,990 --> 00:37:03,760
this

1047
00:37:08,310 --> 00:37:06,000
what will we learn from moxie what is

1048
00:37:10,230 --> 00:37:08,320
this tech demo going to teach us

1049
00:37:11,589 --> 00:37:10,240
you can see in the image there a

1050
00:37:14,790 --> 00:37:11,599
depiction of a

1051
00:37:16,470 --> 00:37:14,800
first human landing on mars and

1052
00:37:19,349 --> 00:37:16,480
one one thing that stands out in that

1053
00:37:21,190 --> 00:37:19,359
image other than the obvious

1054
00:37:23,030 --> 00:37:21,200
fact that humans are on the surface of

1055
00:37:25,750 --> 00:37:23,040
mars in that in that image

1056
00:37:27,349 --> 00:37:25,760
that's a big deal but you can see on the

1057
00:37:30,710 --> 00:37:27,359
vehicle the landing vehicle

1058
00:37:32,950 --> 00:37:30,720
these big propellant tanks covered in

1059
00:37:34,870 --> 00:37:32,960
gold colored foil that serves as part of

1060
00:37:38,630 --> 00:37:34,880
the insulation system on the

1061
00:37:39,030 --> 00:37:38,640
on the liquid propellant liquid oxygen

1062
00:37:41,589 --> 00:37:39,040
is an

1063
00:37:44,310 --> 00:37:41,599

excellent rocket propellant and for the

1064
00:37:46,470 --> 00:37:44,320
return trip on eventual human missions

1065
00:37:48,069 --> 00:37:46,480
if we could make it on mars we wouldn't

1066
00:37:49,510 --> 00:37:48,079
have to pack it into a launch vehicle

1067
00:37:51,349 --> 00:37:49,520
fairing

1068
00:37:53,349 --> 00:37:51,359
launch it from the surface of earth push

1069
00:37:57,270 --> 00:37:53,359
it all the way to the destination

1070
00:37:58,790 --> 00:37:57,280
and land it on the plant moxie's

1071
00:38:01,190 --> 00:37:58,800
i might say that you know when i first

1072
00:38:02,470 --> 00:38:01,200
heard of this notion

1073
00:38:04,390 --> 00:38:02,480
i thought you know i wouldn't want to be

1074
00:38:06,310 --> 00:38:04,400
the first astronaut

1075
00:38:08,069 --> 00:38:06,320
that's told you get to come home if you

1076
00:38:08,950 --> 00:38:08,079
can make the propellants for the return

1077
00:38:11,589 --> 00:38:08,960
trip

1078
00:38:13,510 --> 00:38:11,599
but actually the the moxie the the

1079
00:38:14,230 --> 00:38:13,520
production capability for making the

1080
00:38:16,790 --> 00:38:14,240
oxygen

1081
00:38:18,470 --> 00:38:16,800
propel will be put in place before we

1082
00:38:21,430 --> 00:38:18,480
ever launched uh

1083
00:38:23,349 --> 00:38:21,440
astronauts tomorrow so the vehicle that

1084
00:38:25,589 --> 00:38:23,359
they needed for the return trip would be

1085
00:38:26,950 --> 00:38:25,599
fueled up and ready for them before they

1086
00:38:30,230 --> 00:38:26,960
even got there

1087
00:38:33,430 --> 00:38:30,240
now moxie as implemented on the rover

1088
00:38:35,030 --> 00:38:33,440

is about one percent of the scale

1089
00:38:37,670 --> 00:38:35,040
that would be needed to produce enough

1090
00:38:40,069 --> 00:38:37,680
oxygen to fill up the

1091
00:38:40,950 --> 00:38:40,079
liquid oxygen tank on a mars ascent

1092
00:38:43,589 --> 00:38:40,960
vehicle

1093
00:38:45,270 --> 00:38:43,599
so the reason we're doing a moxie is

1094
00:38:45,990 --> 00:38:45,280
we'll take the lessons we learned in

1095
00:38:47,670 --> 00:38:46,000
developing

1096
00:38:49,510 --> 00:38:47,680
it and everything we learn from

1097
00:38:52,790 --> 00:38:49,520
operating it on mars

1098
00:38:54,950 --> 00:38:52,800
and we'll put together a plan to scale

1099
00:38:57,030 --> 00:38:54,960
up the underlying technology

1100
00:38:58,870 --> 00:38:57,040
test that out and then deliver it to

1101
00:39:01,510 --> 00:38:58,880
mars

1102
00:39:03,270 --> 00:39:01,520
ultimately as we build up a sustainable

1103
00:39:04,870 --> 00:39:03,280
presence first on the moon and

1104
00:39:07,270 --> 00:39:04,880
eventually on mars

1105
00:39:08,870 --> 00:39:07,280
various institute resource utilization

1106
00:39:11,670 --> 00:39:08,880
processes will be used

1107
00:39:14,550 --> 00:39:11,680
to produce propellants or construction

1108
00:39:17,589 --> 00:39:14,560
materials or life support consumables

1109
00:39:18,950 --> 00:39:17,599
even energy to power payloads but

1110
00:39:22,710 --> 00:39:18,960
leading the way

1111
00:39:24,550 --> 00:39:22,720
will be moxie which is the first ever

1112
00:39:25,910 --> 00:39:24,560
in situ resource utilization

1113
00:39:28,870 --> 00:39:25,920

demonstration

1114
00:39:29,829 --> 00:39:28,880
on another planet now i'll turn it over

1115
00:39:33,510 --> 00:39:29,839
to mimiong

1116
00:39:36,470 --> 00:39:33,520
who will talk about the mars helicopter

1117
00:39:37,990 --> 00:39:36,480
thank you jeff so like moxie mars

1118
00:39:39,589 --> 00:39:38,000
helicopter is the technology

1119
00:39:41,990 --> 00:39:39,599
demonstration

1120
00:39:42,790 --> 00:39:42,000
motivated by the potential to add aerial

1121
00:39:46,470 --> 00:39:42,800
dimension

1122
00:39:49,670 --> 00:39:46,480
to space exploration so our team started

1123
00:39:52,950 --> 00:39:49,680
the question of whether it is possible

1124
00:39:54,950 --> 00:39:52,960
to fly a helicopter at mars because

1125
00:39:56,630 --> 00:39:54,960
the atmosphere there is extremely thin

1126
00:39:59,349 --> 00:39:56,640
one percent compared to what we

1127
00:40:01,349 --> 00:39:59,359
have at earth so we systematically work

1128
00:40:03,510 --> 00:40:01,359
through a series of technical steps

1129
00:40:04,950 --> 00:40:03,520
and so if we started with first

1130
00:40:08,390 --> 00:40:04,960
demonstrating lift

1131
00:40:11,030 --> 00:40:08,400
please roll the video with

1132
00:40:13,589 --> 00:40:11,040
a one third scale vehicle here in a

1133
00:40:15,030 --> 00:40:13,599
chamber of mars-like atmospheric density

1134
00:40:16,630 --> 00:40:15,040
and somebody's outside trying to

1135
00:40:19,910 --> 00:40:16,640
joystick this to fly

1136
00:40:23,750 --> 00:40:19,920
we achieved lift but

1137
00:40:23,990 --> 00:40:23,760
not control we learned that the dynamics

1138
00:40:26,309 --> 00:40:24,000

on

1139
00:40:27,190 --> 00:40:26,319
mars in this thin atmosphere is very

1140
00:40:30,710 --> 00:40:27,200
different

1141
00:40:31,430 --> 00:40:30,720
and so next we built a full-scale

1142
00:40:34,150 --> 00:40:31,440
vehicle

1143
00:40:35,030 --> 00:40:34,160
with on-board real-time closed-loop

1144
00:40:36,870 --> 00:40:35,040
control

1145
00:40:39,589 --> 00:40:36,880
and demonstrated successfully for the

1146
00:40:42,550 --> 00:40:39,599
first time ever a power control fly

1147
00:40:42,950 --> 00:40:42,560
in mars like atmospheric density from

1148
00:40:47,030 --> 00:40:42,960
there

1149
00:40:50,630 --> 00:40:47,040
we went on to build a mars helicopter

1150
00:40:53,829 --> 00:40:50,640
which will not only fly at mars but

1151
00:40:58,470 --> 00:40:53,839
can operate and survive autonomously

1152
00:41:01,589 --> 00:40:58,480
at mars and uh let's roll this video

1153
00:41:03,990 --> 00:41:01,599
and all the while weighing under 1.8

1154
00:41:06,309 --> 00:41:04,000
kilograms that's four pounds

1155
00:41:07,829 --> 00:41:06,319
so what you're seeing on the video here

1156
00:41:10,950 --> 00:41:07,839
is one of our

1157
00:41:14,710 --> 00:41:10,960
many many flights that we experimented

1158
00:41:16,550 --> 00:41:14,720
with this 1.8 kilogram mars helicopter

1159
00:41:18,710 --> 00:41:16,560
and you see the helicopter flying it

1160
00:41:20,710 --> 00:41:18,720
looks very easy when you look at it

1161
00:41:22,790 --> 00:41:20,720
but you're looking at a room with

1162
00:41:24,069 --> 00:41:22,800
atmosphere about one percent compared to

1163
00:41:25,510 --> 00:41:24,079

the room that you're sitting in right

1164
00:41:27,190 --> 00:41:25,520
now and those plates are

1165
00:41:29,589 --> 00:41:27,200
working very hard being controlled

1166
00:41:32,470 --> 00:41:29,599
hundreds of times per second

1167
00:41:33,589 --> 00:41:32,480
so at this time the engineering mars

1168
00:41:35,990 --> 00:41:33,599
helicopter

1169
00:41:37,589 --> 00:41:36,000
has been fully tested as much as we can

1170
00:41:39,750 --> 00:41:37,599
on earth we have flown

1171
00:41:40,630 --> 00:41:39,760
with test flown and we have tested for

1172
00:41:43,750 --> 00:41:40,640
environment

1173
00:41:46,870 --> 00:41:43,760
and next it's time to demonstrate proof

1174
00:41:48,230 --> 00:41:46,880
and learn how it operates at mars so to

1175
00:41:51,589 --> 00:41:48,240
do that at this moment

1176
00:41:53,829 --> 00:41:51,599
ingenuity is approaching mars carefully

1177
00:41:56,150 --> 00:41:53,839
held by perseverance rover

1178
00:41:57,670 --> 00:41:56,160
and is accompanied by a space station

1179
00:42:00,309 --> 00:41:57,680
which is also riding on the

1180
00:42:02,630 --> 00:42:00,319
rover and so far so good in cruise we've

1181
00:42:05,750 --> 00:42:02,640
turned on the helicopter

1182
00:42:07,510 --> 00:42:05,760
temperature kept maintained as designed

1183
00:42:08,630 --> 00:42:07,520
by the base station we're maintaining

1184
00:42:11,829 --> 00:42:08,640
the helicopter

1185
00:42:13,430 --> 00:42:11,839
battery through the base station and we

1186
00:42:15,589 --> 00:42:13,440
are ready for adl

1187
00:42:18,870 --> 00:42:15,599
and the day after landing we'll turn on

1188
00:42:21,190 --> 00:42:18,880

to check confirm that the health is good

1189
00:42:23,349 --> 00:42:21,200
after that the next major milestone will

1190
00:42:25,589 --> 00:42:23,359
be when perseverance rover delivers

1191
00:42:28,790 --> 00:42:25,599
ingenuity to the surface of mars

1192
00:42:31,109 --> 00:42:28,800
if we could play this video

1193
00:42:32,870 --> 00:42:31,119
you'll see that the debris shield that

1194
00:42:34,710 --> 00:42:32,880
protects the helicopter and descent is

1195
00:42:38,550 --> 00:42:34,720
first deployed

1196
00:42:39,430 --> 00:42:38,560
and then the helicopter is deployed by

1197
00:42:42,630 --> 00:42:39,440
what's called the

1198
00:42:45,190 --> 00:42:42,640
mars helicopter delivery system

1199
00:42:46,950 --> 00:42:45,200
it's a very intricate system that's

1200
00:42:48,630 --> 00:42:46,960
going to take about 10 days

1201
00:42:50,870 --> 00:42:48,640
to go through these series that you're

1202
00:42:53,270 --> 00:42:50,880
seeing to drop

1203
00:42:55,109 --> 00:42:53,280
ingenuity to the surface and that drop

1204
00:42:57,030 --> 00:42:55,119
the moment that drop happens is the

1205
00:42:59,510 --> 00:42:57,040
moment that ingenuity

1206
00:43:01,030 --> 00:42:59,520
has to start operating on its own in a

1207
00:43:03,589 --> 00:43:01,040
standalone fashion

1208
00:43:05,750 --> 00:43:03,599
so this little four pounder remember

1209
00:43:06,950 --> 00:43:05,760
this entire vehicle is 1.8 kilograms

1210
00:43:09,030 --> 00:43:06,960
about four pounds

1211
00:43:11,190 --> 00:43:09,040
has to survive the cold frigid nights of

1212
00:43:12,150 --> 00:43:11,200
mars minus 90 degrees celsius keep

1213
00:43:14,470 --> 00:43:12,160

itself warm

1214
00:43:16,470 --> 00:43:14,480
it has to garner energy from the sun

1215
00:43:18,069 --> 00:43:16,480
through a solar panel to charges very it

1216
00:43:19,910 --> 00:43:18,079
has to talk to a space station

1217
00:43:21,430 --> 00:43:19,920
it has to do all of that in this little

1218
00:43:23,510 --> 00:43:21,440
four pound and

1219
00:43:25,270 --> 00:43:23,520
we will be the helicopter team will be

1220
00:43:26,150 --> 00:43:25,280
working with the rover team and the

1221
00:43:29,109 --> 00:43:26,160
scientists

1222
00:43:29,589 --> 00:43:29,119
to look for the appropriate experimental

1223
00:43:32,630 --> 00:43:29,599
site

1224
00:43:35,430 --> 00:43:32,640
for our flight experiments and then next

1225
00:43:39,589 --> 00:43:38,470
and now after that you'll see after the

1226
00:43:41,670 --> 00:43:39,599
river

1227
00:43:44,309 --> 00:43:41,680
deploys and drives away there is

1228
00:43:47,990 --> 00:43:44,319
ingenuity helicopter will have some

1229
00:43:50,710 --> 00:43:48,000
tests of the rotor system for readiness

1230
00:43:52,230 --> 00:43:50,720
and then we will go for that very

1231
00:43:54,790 --> 00:43:52,240
important first flight

1232
00:43:56,230 --> 00:43:54,800
rover will stay at least 100 meters away

1233
00:43:58,710 --> 00:43:56,240
and we'll be watching

1234
00:43:59,829 --> 00:43:58,720
ingenuity and engineering will take his

1235
00:44:03,670 --> 00:43:59,839
first flight

1236
00:44:08,230 --> 00:44:03,680
three meters

1237
00:44:11,589 --> 00:44:08,240
in height and hover for about 20 seconds

1238
00:44:16,790 --> 00:44:11,599

and it will be performed the very first

1239
00:44:20,630 --> 00:44:16,800
ever powered control flight

1240
00:44:23,990 --> 00:44:22,870
and as thomas mentioned at the beginning

1241
00:44:26,230 --> 00:44:24,000
of this event

1242
00:44:35,190 --> 00:44:26,240
it will be truly a wright brothers

1243
00:44:39,990 --> 00:44:38,390
so after each of and then if we can go

1244
00:44:41,510 --> 00:44:40,000
on to the next step please so this is

1245
00:44:43,510 --> 00:44:41,520
what we're looking for so this is a

1246
00:44:45,829 --> 00:44:43,520
picture of our mars helicopter team

1247
00:44:47,670 --> 00:44:45,839
uh as jennifer mentioned it really takes

1248
00:44:49,829 --> 00:44:47,680
teamwork we're extremely tight we've

1249
00:44:53,430 --> 00:44:49,839
been working on this for over six years

1250
00:44:56,309 --> 00:44:53,440
members from jpl nasa ames nasa langley

1251
00:44:57,829 --> 00:44:56,319
of the armd revolutionary vertical lift

1252
00:45:00,309 --> 00:44:57,839
technology program

1253
00:45:01,349 --> 00:45:00,319
industrial partners air environment

1254
00:45:03,990 --> 00:45:01,359
qualcomm

1255
00:45:04,790 --> 00:45:04,000
solero and other companies we've worked

1256
00:45:07,109 --> 00:45:04,800
so hard

1257
00:45:09,589 --> 00:45:07,119
and so shout out to our team we're

1258
00:45:12,870 --> 00:45:09,599
getting to mars on thursday

1259
00:45:15,030 --> 00:45:12,880
and uh every step going forward will be

1260
00:45:16,150 --> 00:45:15,040
first of a kind and first step so it'll

1261
00:45:18,390 --> 00:45:16,160
be nail biting

1262
00:45:20,230 --> 00:45:18,400
nearly exciting so for all of you out

1263
00:45:20,630 --> 00:45:20,240

there on behalf of the mars helicopter

1264
00:45:23,829 --> 00:45:20,640
team

1265
00:45:26,550 --> 00:45:23,839
please join our journey back to you dc

1266
00:45:28,550 --> 00:45:26,560
thank you mimi uh we are ready to take

1267
00:45:30,470 --> 00:45:28,560
media questions remember to press star

1268
00:45:32,309 --> 00:45:30,480
one to get put in the queue

1269
00:45:33,589 --> 00:45:32,319
and please direct your questions to one

1270
00:45:35,349 --> 00:45:33,599
of our panelists

1271
00:45:37,510 --> 00:45:35,359
we're also taking questions through

1272
00:45:38,710 --> 00:45:37,520
pound the pound countdown to mars

1273
00:45:40,870 --> 00:45:38,720
hashtag

1274
00:45:41,829 --> 00:45:40,880
uh and we have our first question from

1275
00:45:45,030 --> 00:45:41,839
marcia dunn

1276
00:45:48,790 --> 00:45:45,040
at ap marcia yes hi

1277
00:45:51,270 --> 00:45:48,800
um can you hear me yes we can yes for dr

1278
00:45:53,750 --> 00:45:51,280
serbukin i'm wondering um if all goes

1279
00:45:55,750 --> 00:45:53,760
well what is the earliest year

1280
00:45:56,870 --> 00:45:55,760
that you would anticipate getting these

1281
00:46:00,230 --> 00:45:56,880
samples back

1282
00:46:02,069 --> 00:46:00,240
um we hear just 20 30s but i'm wondering

1283
00:46:03,270 --> 00:46:02,079
what's the soonest year in the next

1284
00:46:05,910 --> 00:46:03,280
decade

1285
00:46:06,390 --> 00:46:05,920
does that compare it to when the first

1286
00:46:09,430 --> 00:46:06,400
time

1287
00:46:12,150 --> 00:46:09,440
crew might arrive and lastly

1288
00:46:12,710 --> 00:46:12,160

you know mars landings are always so

1289
00:46:16,150 --> 00:46:12,720
full of

1290
00:46:18,470 --> 00:46:16,160
tension and stress adding on top of that

1291
00:46:20,950 --> 00:46:18,480
the attempt to bring back samples how

1292
00:46:21,750 --> 00:46:20,960
much more is that magnifying amplifying

1293
00:46:24,470 --> 00:46:21,760
all the tension

1294
00:46:26,550 --> 00:46:24,480
thank you thank you so much for your

1295
00:46:28,870 --> 00:46:26,560
question so let me do them in reverse

1296
00:46:30,069 --> 00:46:28,880
uh the first one is it's not adding

1297
00:46:33,750 --> 00:46:30,079
stress i mean we

1298
00:46:35,990 --> 00:46:33,760
always spend all of our kind of

1299
00:46:37,030 --> 00:46:36,000
we do always the best job we can we bet

1300
00:46:39,190 --> 00:46:37,040
on success

1301
00:46:40,069 --> 00:46:39,200
that's just what we do and whether or

1302
00:46:42,309 --> 00:46:40,079
not we want to turn

1303
00:46:43,109 --> 00:46:42,319
uh return these samples is not adding to

1304
00:46:44,950 --> 00:46:43,119
it we're

1305
00:46:46,950 --> 00:46:44,960
of course planning for that that's

1306
00:46:49,910 --> 00:46:46,960
exactly what we should be doing

1307
00:46:50,950 --> 00:46:49,920
for this amazing mission and uh and for

1308
00:46:53,030 --> 00:46:50,960
me uh we're

1309
00:46:54,710 --> 00:46:53,040
entirely focused on one thing right now

1310
00:46:56,790 --> 00:46:54,720
which is successful landing

1311
00:46:58,309 --> 00:46:56,800
very frankly we're not doing anything

1312
00:47:01,190 --> 00:46:58,319
else with this team right now they're

1313
00:47:04,470 --> 00:47:01,200

focused on the successful landing

1314
00:47:05,430 --> 00:47:04,480
in terms of uh the earliest return you

1315
00:47:07,910 --> 00:47:05,440
of course have read

1316
00:47:09,910 --> 00:47:07,920
uh both uh the work that we did and the

1317
00:47:11,109 --> 00:47:09,920
independent review team and uh they're

1318
00:47:13,910 --> 00:47:11,119
telling us

1319
00:47:15,430 --> 00:47:13,920
that basically launching in 26 and 28

1320
00:47:17,030 --> 00:47:15,440
kind of time frame

1321
00:47:19,190 --> 00:47:17,040
is the right time to go there which

1322
00:47:21,670 --> 00:47:19,200
would bring the samples back in 31

1323
00:47:23,750 --> 00:47:21,680
and that of course is because of the

1324
00:47:25,589 --> 00:47:23,760
planetary alignment style you know the

1325
00:47:26,470 --> 00:47:25,599
home on orbits going this way and in

1326
00:47:28,470 --> 00:47:26,480
reverse

1327
00:47:29,750 --> 00:47:28,480
that set some of these windows that

1328
00:47:31,670 --> 00:47:29,760
limit a part of that

1329
00:47:33,510 --> 00:47:31,680
as to some of the propulsion

1330
00:47:35,030 --> 00:47:33,520
characteristics of the spacecraft that

1331
00:47:38,790 --> 00:47:35,040
are under conservation

1332
00:47:41,030 --> 00:47:38,800
so the early 31 is is their 11th time

1333
00:47:42,470 --> 00:47:41,040
uh they of course i just want to say

1334
00:47:45,670 --> 00:47:42,480
where we are right now

1335
00:47:47,589 --> 00:47:45,680
is uh you know in the middle like

1336
00:47:49,430 --> 00:47:47,599
two every year and there's certainly uh

1337
00:47:52,549 --> 00:47:49,440
in conditions and trying to

1338
00:47:54,309 --> 00:47:52,559

make sure that we uh kind of bring all

1339
00:47:55,589 --> 00:47:54,319
of our stakeholders along and

1340
00:47:57,430 --> 00:47:55,599
make sure that we have the same

1341
00:47:59,589 --> 00:47:57,440
enthusiasm for this mission that

1342
00:48:02,069 --> 00:47:59,599
includes the international stakeholders

1343
00:48:03,670 --> 00:48:02,079
get this done in this time indeed that

1344
00:48:07,030 --> 00:48:03,680
the same is true for our

1345
00:48:08,950 --> 00:48:07,040
human exploration of mars

1346
00:48:11,270 --> 00:48:08,960
where you know number of discussions are

1347
00:48:13,270 --> 00:48:11,280
happening you know of course the key

1348
00:48:14,950 --> 00:48:13,280
element of the priority right now is to

1349
00:48:19,990 --> 00:48:14,960
take humans out of

1350
00:48:21,430 --> 00:48:20,000
low earth orbit and and really go

1351
00:48:23,190 --> 00:48:21,440
towards uh the moon

1352
00:48:25,349 --> 00:48:23,200
and kind of really make sure as part of

1353
00:48:28,309 --> 00:48:25,359
our artemis program we land

1354
00:48:28,950 --> 00:48:28,319
uh on the moon and and then uh built

1355
00:48:32,069 --> 00:48:28,960
from there

1356
00:48:34,309 --> 00:48:32,079
so so basically the the earliest that

1357
00:48:36,150 --> 00:48:34,319
we've talked in various plans and that

1358
00:48:37,990 --> 00:48:36,160
that have been talked about and

1359
00:48:40,069 --> 00:48:38,000
also in the previous administration it's

1360
00:48:42,069 --> 00:48:40,079
kind of late 30s where

1361
00:48:43,109 --> 00:48:42,079
such a thing could happen but i just

1362
00:48:44,470 --> 00:48:43,119
want to tell you the

1363
00:48:46,470 --> 00:48:44,480

what i'm talking about bringing the

1364
00:48:48,870 --> 00:48:46,480
community along is really

1365
00:48:50,150 --> 00:48:48,880
right still happening right we have not

1366
00:48:51,270 --> 00:48:50,160
had all the discussion with all

1367
00:48:53,109 --> 00:48:51,280
stakeholders

1368
00:48:55,030 --> 00:48:53,119
at the level of detail to really answer

1369
00:48:57,430 --> 00:48:55,040
that question fully and uh

1370
00:48:58,710 --> 00:48:57,440
with a lot of confidence technically uh

1371
00:49:01,589 --> 00:48:58,720
that's i can often

1372
00:49:03,109 --> 00:49:01,599
know earlier than that that we have

1373
00:49:04,470 --> 00:49:03,119
talked about in the past

1374
00:49:06,630 --> 00:49:04,480
so that's how i would talk about those

1375
00:49:09,829 --> 00:49:06,640
three

1376
00:49:18,470 --> 00:49:09,839
okay thank you uh next up we have bill

1377
00:49:22,630 --> 00:49:20,630
uh bill harwood from cbs news bill are

1378
00:49:25,510 --> 00:49:22,640
you on the line

1379
00:49:26,069 --> 00:49:25,520
i am on the line dc can you yes we can

1380
00:49:27,910 --> 00:49:26,079
thank you

1381
00:49:29,510 --> 00:49:27,920
uh sorry about that so much for my

1382
00:49:31,030 --> 00:49:29,520
airpods

1383
00:49:33,190 --> 00:49:31,040
this is for jennifer trosper can you

1384
00:49:35,270 --> 00:49:33,200
give us a sense of what we can expect

1385
00:49:37,670 --> 00:49:35,280
after touchdown in terms of

1386
00:49:39,670 --> 00:49:37,680
telemetry and imagery that would concern

1387
00:49:41,030 --> 00:49:39,680
confirming a successful landing i mean

1388
00:49:42,630 --> 00:49:41,040

some of this is in the press kit but i'm

1389
00:49:44,230 --> 00:49:42,640
trying to understand what we can expect

1390
00:49:45,829 --> 00:49:44,240
that afternoon

1391
00:49:47,750 --> 00:49:45,839
that might we might get in time for

1392
00:49:48,950 --> 00:49:47,760
evening newscast for example just kind

1393
00:49:51,510 --> 00:49:48,960
of in general

1394
00:49:52,549 --> 00:49:51,520
and in a related question can you talk a

1395
00:49:54,950 --> 00:49:52,559
little bit about how

1396
00:49:56,069 --> 00:49:54,960
losing data or not receiving data for

1397
00:49:57,990 --> 00:49:56,079
some reason

1398
00:49:59,670 --> 00:49:58,000
might not mean something bad happen in

1399
00:50:01,109 --> 00:49:59,680
other words you know if you went into a

1400
00:50:04,230 --> 00:50:01,119
safe motor something why

1401
00:50:05,270 --> 00:50:04,240
we shouldn't all be oh no oh no um you

1402
00:50:06,870 --> 00:50:05,280
guys would obviously

1403
00:50:08,069 --> 00:50:06,880
try a lot of recovery and all of that

1404
00:50:09,829 --> 00:50:08,079
can you just kind of address that a

1405
00:50:12,710 --> 00:50:09,839
little bit for us thanks

1406
00:50:15,030 --> 00:50:12,720
sure i'd love to so we have several

1407
00:50:16,950 --> 00:50:15,040
telemetry streams that come down during

1408
00:50:18,230 --> 00:50:16,960
entry descent and landing the mars

1409
00:50:20,790 --> 00:50:18,240
reconnaissance orbiter

1410
00:50:22,870 --> 00:50:20,800
is watching and we call it a pseudo bent

1411
00:50:24,549 --> 00:50:22,880
pipe so we get almost real-time data

1412
00:50:26,950 --> 00:50:24,559
with the one-way light time from mars

1413
00:50:30,069 --> 00:50:26,960

reconnaissance orbiter through uhf

1414
00:50:31,990 --> 00:50:30,079
that should give us the most information

1415
00:50:33,910 --> 00:50:32,000
there are reasons that that could drop

1416
00:50:35,190 --> 00:50:33,920
off during dynamic events

1417
00:50:36,549 --> 00:50:35,200
while we're going through the entry

1418
00:50:38,630 --> 00:50:36,559
descent and landing in particular you

1419
00:50:41,030 --> 00:50:38,640
saw with erisa the mobility deploy

1420
00:50:42,950 --> 00:50:41,040
so it's possible we will lose data in

1421
00:50:44,710 --> 00:50:42,960
that link but it's also possible we'll

1422
00:50:47,589 --> 00:50:44,720
get the data that has the most data and

1423
00:50:50,230 --> 00:50:47,599
that's where we would get some final

1424
00:50:51,510 --> 00:50:50,240
possibly camera images from the hazcams

1425
00:50:54,390 --> 00:50:51,520
on the front and rear

1426
00:50:56,470 --> 00:50:54,400
in that data we also have x-band data

1427
00:50:58,630 --> 00:50:56,480
that goes direct to earth and in that we

1428
00:50:59,910 --> 00:50:58,640
get some tones those tones just tell you

1429
00:51:01,670 --> 00:50:59,920
what key events

1430
00:51:04,069 --> 00:51:01,680
have happened parachute deploy for

1431
00:51:06,470 --> 00:51:04,079
example so we hope to get that

1432
00:51:09,349 --> 00:51:06,480
earth does set shortly after landing and

1433
00:51:10,950 --> 00:51:09,359
so depending on horizon masks

1434
00:51:12,790 --> 00:51:10,960
it's possible that we would lose that

1435
00:51:15,829 --> 00:51:12,800
link as well

1436
00:51:17,270 --> 00:51:15,839
after we land we we hope to get

1437
00:51:19,430 --> 00:51:17,280
either of those links we also are

1438
00:51:20,549 --> 00:51:19,440

recording data with the maven orbiter so

1439
00:51:22,470 --> 00:51:20,559
we will have

1440
00:51:25,109 --> 00:51:22,480
data that we have to process and we'll

1441
00:51:26,630 --> 00:51:25,119
get within several hours after landing

1442
00:51:28,069 --> 00:51:26,640
but then if even if we don't hear

1443
00:51:28,950 --> 00:51:28,079
anything at landing if some of those

1444
00:51:32,069 --> 00:51:28,960
data links drop

1445
00:51:34,069 --> 00:51:32,079
out we do have our first overflight of

1446
00:51:35,990 --> 00:51:34,079
another orbiter the odyssey orbiter

1447
00:51:38,309 --> 00:51:36,000
about three and a half hours later

1448
00:51:39,349 --> 00:51:38,319
and that's a small data volume pass but

1449
00:51:41,270 --> 00:51:39,359
getting that pass

1450
00:51:42,950 --> 00:51:41,280
would get a lot of information about the

1451
00:51:45,190 --> 00:51:42,960
state of the vehicle if it's able to

1452
00:51:47,670 --> 00:51:45,200
communicate then land was safe

1453
00:51:49,750 --> 00:51:47,680
after that we have another pass in a few

1454
00:51:51,990 --> 00:51:49,760
hours it's about 6 30

1455
00:51:54,150 --> 00:51:52,000
on on landing day where we would get

1456
00:51:57,190 --> 00:51:54,160
some more data so if all goes well

1457
00:52:00,069 --> 00:51:57,200
we could potentially see some images

1458
00:52:01,030 --> 00:52:00,079
by the end of the day if not it's

1459
00:52:02,710 --> 00:52:01,040
possible

1460
00:52:04,630 --> 00:52:02,720
that something happened that caused the

1461
00:52:05,670 --> 00:52:04,640
vehicle to go maybe into a safety mode

1462
00:52:07,990 --> 00:52:05,680
after landing

1463
00:52:09,589 --> 00:52:08,000

if we're in a safeing mode then we have

1464
00:52:11,510 --> 00:52:09,599
fewer passes we send

1465
00:52:13,910 --> 00:52:11,520
less data and some of our fault

1466
00:52:16,309 --> 00:52:13,920
responses so the rover's programmed and

1467
00:52:17,589 --> 00:52:16,319
spend a lot of our time thinking about

1468
00:52:20,390 --> 00:52:17,599
what could go wrong

1469
00:52:22,549 --> 00:52:20,400
and how do we help it save itself and so

1470
00:52:24,150 --> 00:52:22,559
one example is if something went wrong

1471
00:52:26,870 --> 00:52:24,160
with the main computer

1472
00:52:28,950 --> 00:52:26,880
it could take up to a week for the rover

1473
00:52:30,549 --> 00:52:28,960
to go through all the autonomous actions

1474
00:52:31,270 --> 00:52:30,559
that it's programmed to do

1475
00:52:33,430 --> 00:52:31,280
switch through all the

1476
00:52:35,270 --> 00:52:33,440
telecommunications hardware and then

1477
00:52:36,549 --> 00:52:35,280
switch to the other computer

1478
00:52:38,790 --> 00:52:36,559
so there's a there's a lot of

1479
00:52:40,309 --> 00:52:38,800
investigation we will look at everything

1480
00:52:41,430 --> 00:52:40,319
look at all these different we'll look

1481
00:52:44,470 --> 00:52:41,440
we have

1482
00:52:46,630 --> 00:52:44,480
earth

1483
00:52:48,549 --> 00:52:46,640
looking at the spacecraft so we will

1484
00:52:50,309 --> 00:52:48,559
work very hard to understand

1485
00:52:51,990 --> 00:52:50,319
the success and if something went wrong

1486
00:52:56,390 --> 00:52:52,000
to to figure out how to

1487
00:52:59,990 --> 00:52:58,950
thank you jennifer okay next up we have

1488
00:53:03,270 --> 00:53:00,000

chelsea gold from

1489
00:53:04,870 --> 00:53:03,280
space.com chelsea

1490
00:53:07,109 --> 00:53:04,880
hi thanks so much for taking the

1491
00:53:09,990 --> 00:53:07,119
question uh my question is

1492
00:53:11,270 --> 00:53:10,000
for jennifer you know everyone talks

1493
00:53:13,030 --> 00:53:11,280
about the kevin

1494
00:53:14,790 --> 00:53:13,040
terror which obviously sounds

1495
00:53:15,990 --> 00:53:14,800
intimidating but as someone who has

1496
00:53:17,990 --> 00:53:16,000
worked through

1497
00:53:19,589 --> 00:53:18,000
all of the rover landings from nasa thus

1498
00:53:22,630 --> 00:53:19,599
far you've been

1499
00:53:23,510 --> 00:53:22,640
more than prepared for the couple days

1500
00:53:26,069 --> 00:53:23,520
ahead of us

1501
00:53:27,030 --> 00:53:26,079
how are you feeling two days out that

1502
00:53:29,990 --> 00:53:27,040
anticipated

1503
00:53:32,309 --> 00:53:30,000
yet another fingers crossed successful

1504
00:53:33,990 --> 00:53:32,319
rover landing on mars

1505
00:53:35,829 --> 00:53:34,000
i'm feeling great there are no

1506
00:53:37,190 --> 00:53:35,839
guarantees in this business there are

1507
00:53:38,950 --> 00:53:37,200
lots of we always talk about

1508
00:53:40,470 --> 00:53:38,960
what mars might throw at us this time

1509
00:53:42,230 --> 00:53:40,480
and it's never the thing it threw the

1510
00:53:43,109 --> 00:53:42,240
last time and so we have to be prepared

1511
00:53:44,230 --> 00:53:43,119
for that

1512
00:53:46,309 --> 00:53:44,240
but i tell you i look at those

1513
00:53:49,430 --> 00:53:46,319

navigation solutions we did

1514
00:53:51,270 --> 00:53:49,440
a tr our last time to target mars

1515
00:53:52,630 --> 00:53:51,280
was trajectory correction maneuver

1516
00:53:54,630 --> 00:53:52,640
number three we've never

1517
00:53:56,069 --> 00:53:54,640
been able to not do the last two

1518
00:53:58,150 --> 00:53:56,079
maneuvers and still be

1519
00:54:00,470 --> 00:53:58,160
within our bullseye target so the team

1520
00:54:01,349 --> 00:54:00,480
is doing a great job the spacecraft is

1521
00:54:03,750 --> 00:54:01,359
solid

1522
00:54:05,349 --> 00:54:03,760
i led the test program i feel very

1523
00:54:06,309 --> 00:54:05,359
confident that it will do the things we

1524
00:54:10,950 --> 00:54:06,319
do but again

1525
00:54:13,190 --> 00:54:10,960
no guarantees but i'm feeling great

1526
00:54:14,870 --> 00:54:13,200
thank you jennifer again uh let's see we

1527
00:54:18,790 --> 00:54:14,880
have jill palka from npr

1528
00:54:19,910 --> 00:54:18,800
joe hi there um quick question about the

1529
00:54:22,390 --> 00:54:19,920
uh

1530
00:54:25,109 --> 00:54:22,400
the navigation system the terrain

1531
00:54:27,990 --> 00:54:25,119
relative navigation system

1532
00:54:29,190 --> 00:54:28,000
where is does that have a dedicated

1533
00:54:32,549 --> 00:54:29,200
camera

1534
00:54:33,109 --> 00:54:32,559
and um if so is there a similar sort of

1535
00:54:35,270 --> 00:54:33,119
camera

1536
00:54:36,390 --> 00:54:35,280
doing the same thing for the rover once

1537
00:54:38,630 --> 00:54:36,400
it's on the ground and

1538
00:54:39,589 --> 00:54:38,640

and where is that camera is it on the is

1539
00:54:42,950 --> 00:54:39,599
it on the

1540
00:54:45,109 --> 00:54:42,960
know who should

1541
00:54:49,990 --> 00:54:45,119
maybe i i'm not quite sure trudy or

1542
00:54:53,430 --> 00:54:52,870
i'm not sure if arisa wants to take that

1543
00:54:56,470 --> 00:54:53,440
either right

1544
00:54:58,150 --> 00:54:56,480
yes it does have yes it does have a

1545
00:55:03,670 --> 00:54:58,160
camera system on it but erisa might be

1546
00:55:07,670 --> 00:55:07,030
yeah so um as we said uh or as i said

1547
00:55:09,990 --> 00:55:07,680
before

1548
00:55:11,750 --> 00:55:10,000
there is a dedicated camera for the

1549
00:55:14,069 --> 00:55:11,760
entry descent landing part uh

1550
00:55:14,789 --> 00:55:14,079
for terrain relative navigation um that

1551
00:55:17,910 --> 00:55:14,799
we called the

1552
00:55:19,589 --> 00:55:17,920
lvs camera or laner vision system camera

1553
00:55:21,589 --> 00:55:19,599
and if you looked at a picture of the

1554
00:55:22,390 --> 00:55:21,599
rover it would be sort of under the

1555
00:55:25,990 --> 00:55:22,400
front left

1556
00:55:28,470 --> 00:55:26,000
armpit of the rover um looking down

1557
00:55:30,470 --> 00:55:28,480
and the computer that is in charge of

1558
00:55:32,309 --> 00:55:30,480
doing the image processing and helping

1559
00:55:35,190 --> 00:55:32,319
to get us to a solution we refer to as

1560
00:55:37,109 --> 00:55:35,200
the bce or i think the visual

1561
00:55:38,470 --> 00:55:37,119
um and i'm gonna get in trouble enough i

1562
00:55:39,910 --> 00:55:38,480
misremember but i think it's a visual

1563
00:55:42,549 --> 00:55:39,920

compute element

1564
00:55:44,390 --> 00:55:42,559
um and that that computer is the same

1565
00:55:44,950 --> 00:55:44,400
one that's used on the surface on the

1566
00:55:47,589 --> 00:55:44,960
rover

1567
00:55:48,710 --> 00:55:47,599
for um when it does autonomous

1568
00:55:50,789 --> 00:55:48,720
navigation

1569
00:55:52,390 --> 00:55:50,799
the cameras that the rover uses to do

1570
00:55:53,910 --> 00:55:52,400
that are different so we have navigation

1571
00:55:54,549 --> 00:55:53,920
cameras that are on the mast of the

1572
00:55:56,069 --> 00:55:54,559
rover

1573
00:55:58,390 --> 00:55:56,079
so they're the ones um similar to what

1574
00:56:00,630 --> 00:55:58,400
curiosity does

1575
00:56:01,589 --> 00:56:00,640
those will take photos of where the

1576
00:56:03,750 --> 00:56:01,599
rover is

1577
00:56:04,870 --> 00:56:03,760
along with the hazard avoidance cameras

1578
00:56:06,470 --> 00:56:04,880
that are on the front

1579
00:56:08,230 --> 00:56:06,480
lower on the front and rear of the rover

1580
00:56:11,030 --> 00:56:08,240
and can combine those images

1581
00:56:12,390 --> 00:56:11,040
um to do to to enable the autonomous

1582
00:56:12,870 --> 00:56:12,400
driving on the surface so there's

1583
00:56:16,470 --> 00:56:12,880
different

1584
00:56:22,309 --> 00:56:16,480
the same

1585
00:56:24,069 --> 00:56:22,319
thank you great thank you arisa and now

1586
00:56:25,030 --> 00:56:24,079
we're going to go to a question from

1587
00:56:28,309 --> 00:56:25,040
social media

1588
00:56:30,230 --> 00:56:28,319

gs on instagram asks how does nasa test

1589
00:56:31,910 --> 00:56:30,240
for the different atmosphere of mars

1590
00:56:32,710 --> 00:56:31,920
when practicing on earth this might be

1591
00:56:35,829 --> 00:56:32,720
good for

1592
00:56:38,390 --> 00:56:35,839
both adam and mimi

1593
00:56:39,109 --> 00:56:38,400
sure okay so for helicopter flight what

1594
00:56:41,750 --> 00:56:39,119
we did

1595
00:56:43,270 --> 00:56:41,760
is we use the space simulator jpl it's a

1596
00:56:46,470 --> 00:56:43,280
25 foot diameter

1597
00:56:48,950 --> 00:56:46,480
chamber about 70 80 foot high

1598
00:56:49,589 --> 00:56:48,960
and we pump that chamber down to near

1599
00:56:52,230 --> 00:56:49,599
vacuum

1600
00:56:52,870 --> 00:56:52,240
and then we backfill with carbon dioxide

1601
00:56:55,109 --> 00:56:52,880
to

1602
00:56:56,950 --> 00:56:55,119
the about one percent uh density in

1603
00:56:58,069 --> 00:56:56,960
atmospheric density compared to outside

1604
00:56:59,349 --> 00:56:58,079
of the chamber you know compared to

1605
00:57:01,510 --> 00:56:59,359
earth and that is

1606
00:57:03,589 --> 00:57:01,520
representative of mars and we've been

1607
00:57:05,510 --> 00:57:03,599
doing all of our flight tests in that

1608
00:57:06,710 --> 00:57:05,520
so that takes care for flying a

1609
00:57:08,069 --> 00:57:06,720
helicopter that takes care of the

1610
00:57:11,030 --> 00:57:08,079
atmospheric density

1611
00:57:12,069 --> 00:57:11,040
the second part is the gravity the mars

1612
00:57:15,109 --> 00:57:12,079
helicopter will

1613
00:57:16,630 --> 00:57:15,119

experience only about 40 gravity at mars

1614
00:57:18,630 --> 00:57:16,640
you know and when we're testing on earth

1615
00:57:20,870 --> 00:57:18,640
it's a lot it weighs a lot more so what

1616
00:57:23,109 --> 00:57:20,880
we do is we attach a gravity offload

1617
00:57:24,870 --> 00:57:23,119
on the top uh to take care of the

1618
00:57:27,190 --> 00:57:24,880
difference between mars and

1619
00:57:29,589 --> 00:57:27,200
mars and earth gravity so that's how we

1620
00:57:32,789 --> 00:57:29,599
simulate mars on earth

1621
00:57:34,549 --> 00:57:32,799
uh thanks um for uh parachute testing we

1622
00:57:37,670 --> 00:57:34,559
go to very high altitudes

1623
00:57:39,190 --> 00:57:37,680
in the earth's atmosphere um so we get

1624
00:57:41,030 --> 00:57:39,200
the right atmospheric density

1625
00:57:42,549 --> 00:57:41,040
of course because we're here at earth we

1626
00:57:45,030 --> 00:57:42,559
have the wrong

1627
00:57:45,589 --> 00:57:45,040
ratio of specific heat heats we have the

1628
00:57:47,990 --> 00:57:45,599
wrong

1629
00:57:50,630 --> 00:57:48,000
speed of sound so we need to adjust our

1630
00:57:53,589 --> 00:57:50,640
testing program as best we can

1631
00:57:54,230 --> 00:57:53,599
to get the parachutes to open up in the

1632
00:57:57,430 --> 00:57:54,240
right

1633
00:58:00,470 --> 00:57:57,440
uh fluid mechanical configuration and

1634
00:58:02,549 --> 00:58:00,480
uh and uh states um

1635
00:58:05,030 --> 00:58:02,559
here on earth and we do the best we can

1636
00:58:08,549 --> 00:58:05,040
uh very high altitudes with supersonic

1637
00:58:10,710 --> 00:58:08,559
uh rockets that get us up there

1638
00:58:12,390 --> 00:58:10,720

thank you adam and uh next we're gonna

1639
00:58:14,470 --> 00:58:12,400
go back to the media on the phone

1640
00:58:18,150 --> 00:58:14,480
and next up we have paul brickman with

1641
00:58:22,549 --> 00:58:20,829
yes thanks uh hi can you hear me yes we

1642
00:58:26,150 --> 00:58:22,559
can okay

1643
00:58:26,789 --> 00:58:26,160
um so regarding uh coming in through the

1644
00:58:30,230 --> 00:58:26,799
atmosphere

1645
00:58:32,309 --> 00:58:30,240
um so perseverance is like curiosity but

1646
00:58:33,349 --> 00:58:32,319
heavier um can you describe how the

1647
00:58:36,470 --> 00:58:33,359
capsule um

1648
00:58:38,549 --> 00:58:36,480
fears itself during entry and um or if

1649
00:58:41,589 --> 00:58:38,559
it does steer itself

1650
00:58:44,470 --> 00:58:41,599
i know that it has at least um one

1651
00:58:45,510 --> 00:58:44,480
ballast device that it drops and so

1652
00:58:48,870 --> 00:58:45,520
wondering if uh

1653
00:58:51,109 --> 00:58:48,880
someone could say how those work and um

1654
00:58:53,190 --> 00:58:51,119
is if that is what dictates the angle of

1655
00:58:54,630 --> 00:58:53,200
entry and uh can the castle make any

1656
00:58:58,630 --> 00:58:54,640
adjustments during that

1657
00:59:01,910 --> 00:58:58,640
time uh erisa

1658
00:59:04,630 --> 00:59:01,920
question for you yep um so

1659
00:59:06,390 --> 00:59:04,640
uh the the the way that we do that um is

1660
00:59:07,270 --> 00:59:06,400
very similar to curiosity the main

1661
00:59:10,230 --> 00:59:07,280
differences

1662
00:59:11,349 --> 00:59:10,240
are when those devices were designed uh

1663
00:59:13,670 --> 00:59:11,359

for the vehicle

1664
00:59:15,589 --> 00:59:13,680
at lockheed martin they have some

1665
00:59:17,910 --> 00:59:15,599
flexibility and how much

1666
00:59:19,430 --> 00:59:17,920
mass you put into them so before we

1667
00:59:21,829 --> 00:59:19,440
start entry

1668
00:59:22,710 --> 00:59:21,839
i think shortly after we separate from

1669
00:59:24,789 --> 00:59:22,720
the cruise stage

1670
00:59:25,990 --> 00:59:24,799
about 10 minutes before entry we

1671
00:59:27,910 --> 00:59:26,000
actually will eject

1672
00:59:29,109 --> 00:59:27,920
two masses that are called cruise

1673
00:59:30,789 --> 00:59:29,119
balance masses

1674
00:59:32,710 --> 00:59:30,799
and that's what allows us to shift the

1675
00:59:34,150 --> 00:59:32,720
cg um so on the way to mars we're

1676
00:59:36,470 --> 00:59:34,160
spinning right our cg is

1677
00:59:37,510 --> 00:59:36,480
centered as it can be um and then we

1678
00:59:39,670 --> 00:59:37,520
release those

1679
00:59:40,710 --> 00:59:39,680
cruise balance masses that cause our cg

1680
00:59:41,349 --> 00:59:40,720
to have an offset and that's what

1681
00:59:44,150 --> 00:59:41,359
provides

1682
00:59:45,750 --> 00:59:44,160
the lift vector that we use to steer

1683
00:59:45,990 --> 00:59:45,760
both curiosity and now perseverance

1684
00:59:48,390 --> 00:59:46,000
through

1685
00:59:50,150 --> 00:59:48,400
the atmosphere when we get to the end of

1686
00:59:53,510 --> 00:59:50,160
that phase

1687
00:59:55,990 --> 00:59:53,520
we eject similarly eject now

1688
00:59:57,190 --> 00:59:56,000

six smaller masses called the entry

1689
00:59:59,349 --> 00:59:57,200
balance masses

1690
01:00:00,789 --> 00:59:59,359
and that's to put that center of gravity

1691
01:00:02,630 --> 01:00:00,799
back to the center

1692
01:00:04,230 --> 01:00:02,640
um pretty closely before we deploy the

1693
01:00:06,230 --> 01:00:04,240
parachute so that we're not deploying

1694
01:00:07,750 --> 01:00:06,240
the parachute at a big angle

1695
01:00:09,030 --> 01:00:07,760
um so the the way that we do that is

1696
01:00:10,069 --> 01:00:09,040
very similar to curiosity we just

1697
01:00:12,630 --> 01:00:10,079
adjusted um

1698
01:00:15,270 --> 01:00:12,640
the masses and took uh and and did it

1699
01:00:17,990 --> 01:00:15,280
that way for perseverance

1700
01:00:18,950 --> 01:00:18,000
thank you erisa uh next up is gina

1701
01:00:22,549 --> 01:00:18,960
sinceri with

1702
01:00:23,670 --> 01:00:22,559
abc news gina i'm not sure who can take

1703
01:00:26,309 --> 01:00:23,680
this but i know you have

1704
01:00:27,349 --> 01:00:26,319
other assets from other countries

1705
01:00:33,030 --> 01:00:27,359
orbiting mars

1706
01:00:36,549 --> 01:00:35,990
yes so yes there's a number of assets

1707
01:00:38,789 --> 01:00:36,559
from other

1708
01:00:40,789 --> 01:00:38,799
countries uh basically the in this entry

1709
01:00:43,109 --> 01:00:40,799
descendant landing the only assets that

1710
01:00:43,829 --> 01:00:43,119
actively contribute our us assets we do

1711
01:00:46,950 --> 01:00:43,839
not

1712
01:00:49,589 --> 01:00:46,960
uh at this afford the immediate um

1713
01:00:51,750 --> 01:00:49,599

uh entry descendant landing activity uh

1714
01:00:53,030 --> 01:00:51,760
uh relying on other assets but jennifer

1715
01:00:54,549 --> 01:00:53,040
i'm going to kick it to you to see

1716
01:00:55,910 --> 01:00:54,559
whether there's fullback solutions and

1717
01:00:57,030 --> 01:00:55,920
which other assets would be used

1718
01:00:59,990 --> 01:00:57,040
jennifer go ahead

1719
01:01:01,190 --> 01:01:00,000
yeah the uh so on the first saw we call

1720
01:01:03,670 --> 01:01:01,200
it cell zero

1721
01:01:05,510 --> 01:01:03,680
the latest afternoon pass that we get

1722
01:01:08,230 --> 01:01:05,520
will be about 6 30 pm

1723
01:01:08,630 --> 01:01:08,240
pacific time that will be with the trace

1724
01:01:10,710 --> 01:01:08,640
gas

1725
01:01:13,349 --> 01:01:10,720
orbiter european asset and so they are

1726
01:01:14,150 --> 01:01:13,359
supporting this mission by relaying uhf

1727
01:01:17,750 --> 01:01:14,160
data

1728
01:01:20,549 --> 01:01:17,760
to us so we appreciate that

1729
01:01:21,430 --> 01:01:20,559
okay thank you next up we have jonathan

1730
01:01:24,710 --> 01:01:21,440
amos

1731
01:01:28,069 --> 01:01:24,720
with the bbc jonathan

1732
01:01:31,990 --> 01:01:28,079
uh hi dc uh greetings everybody from

1733
01:01:35,910 --> 01:01:32,000
london here uh can i just check jennifer

1734
01:01:38,630 --> 01:01:35,920
that you're not gonna do a

1735
01:01:40,710 --> 01:01:38,640
correction at all going into thursday

1736
01:01:42,069 --> 01:01:40,720
now you you tucked right up in that top

1737
01:01:44,230 --> 01:01:42,079
right hand corner

1738
01:01:45,190 --> 01:01:44,240

of that box so you're obviously

1739
01:01:47,750 --> 01:01:45,200
comfortable

1740
01:01:51,190 --> 01:01:47,760
with that and then the other question i

1741
01:01:52,950 --> 01:01:51,200
had just going back to curiosity

1742
01:01:54,390 --> 01:01:52,960
what's going to happen on on thursday

1743
01:01:57,349 --> 01:01:54,400
what should we expect

1744
01:01:59,349 --> 01:01:57,359
to see we we remember adam walking

1745
01:02:01,750 --> 01:01:59,359
around the uh the control room

1746
01:02:03,910 --> 01:02:01,760
uh and alan chen was the voice that we

1747
01:02:06,069 --> 01:02:03,920
heard calling curiosity down

1748
01:02:07,510 --> 01:02:06,079
and alan tells me he's not going to call

1749
01:02:10,069 --> 01:02:07,520
it down this time i wonder

1750
01:02:13,109 --> 01:02:10,079
whose voice we're going to hear calling

1751
01:02:15,109 --> 01:02:13,119
perseverance down on thursday

1752
01:02:16,870 --> 01:02:15,119
okay i'll i'll take the second one i

1753
01:02:19,990 --> 01:02:16,880
will answer uh swati

1754
01:02:21,750 --> 01:02:20,000
mohan will be calling perseverance down

1755
01:02:24,069 --> 01:02:21,760
she's a guidance navigation control

1756
01:02:25,829 --> 01:02:24,079
engineer who's been working tirelessly

1757
01:02:28,710 --> 01:02:25,839
on entry descent and landing

1758
01:02:30,789 --> 01:02:28,720
she is one of al chen's deputies al chen

1759
01:02:33,270 --> 01:02:30,799
will be in there as well he'll be giving

1760
01:02:34,950 --> 01:02:33,280
the final calls of touchdown nominal

1761
01:02:36,950 --> 01:02:34,960
and things like that and swati will be

1762
01:02:39,990 --> 01:02:36,960
giving the intermediate calls

1763
01:02:41,589 --> 01:02:40,000

so that's our edl team the yeah you'll

1764
01:02:43,029 --> 01:02:41,599
notice a few differences we'll be

1765
01:02:44,950 --> 01:02:43,039
socially distanced

1766
01:02:46,950 --> 01:02:44,960
we'll have masks on there will be fewer

1767
01:02:47,670 --> 01:02:46,960
people in the in the mission support

1768
01:02:49,589 --> 01:02:47,680
area

1769
01:02:51,430 --> 01:02:49,599
we actually fortunately you know have a

1770
01:02:53,349 --> 01:02:51,440
second floor where we have a large

1771
01:02:54,150 --> 01:02:53,359
number of folks as well the surface team

1772
01:02:56,150 --> 01:02:54,160
and the edl

1773
01:02:57,990 --> 01:02:56,160
the entrance and landing teams will be

1774
01:03:01,109 --> 01:02:58,000
on site as well so we're spread out

1775
01:03:02,549 --> 01:03:01,119
but we have a lot of folks here back to

1776
01:03:04,789 --> 01:03:02,559
your first question

1777
01:03:07,190 --> 01:03:04,799
about the are you really not going to do

1778
01:03:09,270 --> 01:03:07,200
another maneuver you're up in the upper

1779
01:03:10,870 --> 01:03:09,280
right hand corner of your targeted box

1780
01:03:14,069 --> 01:03:10,880
is that good enough

1781
01:03:15,910 --> 01:03:14,079
well yes we believe it is now we have if

1782
01:03:17,990 --> 01:03:15,920
if we got it really wrong we still have

1783
01:03:18,630 --> 01:03:18,000
the ability to do another maneuver if we

1784
01:03:21,430 --> 01:03:18,640
need to

1785
01:03:23,589 --> 01:03:21,440
but those ellipses are the uncertainty

1786
01:03:24,870 --> 01:03:23,599
ellipses on our estimates and all those

1787
01:03:26,390 --> 01:03:24,880
ellipses are still

1788
01:03:28,470 --> 01:03:26,400

well within the green box and the green

1789
01:03:30,789 --> 01:03:28,480
box is conservative so

1790
01:03:32,710 --> 01:03:30,799
we have high confidence that we won't

1791
01:03:35,190 --> 01:03:32,720
have to do another maneuver but

1792
01:03:37,029 --> 01:03:35,200
we're always ready we have daily tag ups

1793
01:03:39,029 --> 01:03:37,039
twice a day to talk about

1794
01:03:40,789 --> 01:03:39,039
whether there's something that we don't

1795
01:03:43,670 --> 01:03:40,799
like about the navigation data

1796
01:03:45,430 --> 01:03:43,680
the plots are coming out all the time so

1797
01:03:47,029 --> 01:03:45,440
we are looking very closely and if we

1798
01:03:50,870 --> 01:03:47,039
need to do something we will but we

1799
01:03:55,270 --> 01:03:52,950
thank you jennifer okay next up we have

1800
01:03:58,630 --> 01:03:55,280
irish television's leo enright

1801
01:04:00,630 --> 01:03:58,640
leo uh thanks very much indeed d.c

1802
01:04:03,750 --> 01:04:00,640
uh i wanted to ask a couple of questions

1803
01:04:07,029 --> 01:04:03,760
about the terrain relative navigation

1804
01:04:08,069 --> 01:04:07,039
this is a technology demonstrator yet it

1805
01:04:10,789 --> 01:04:08,079
is also

1806
01:04:12,309 --> 01:04:10,799
mission critical uh so i'm wondering how

1807
01:04:13,990 --> 01:04:12,319
unusual is that

1808
01:04:16,470 --> 01:04:14,000
um is this something that's happened

1809
01:04:19,109 --> 01:04:16,480
before regularly perhaps

1810
01:04:20,549 --> 01:04:19,119
and i'm wondering uh with a technology

1811
01:04:24,710 --> 01:04:20,559
demonstrator

1812
01:04:25,589 --> 01:04:24,720
is there a plan b has the sky crane been

1813
01:04:28,309 --> 01:04:25,599

told

1814
01:04:29,270 --> 01:04:28,319
that if something goes wrong with the

1815
01:04:31,109 --> 01:04:29,280
trm

1816
01:04:32,549 --> 01:04:31,119
that it should make some sort of hail

1817
01:04:36,150 --> 01:04:32,559
mary landing

1818
01:04:39,430 --> 01:04:36,160
um and if i may also very briefly ask

1819
01:04:42,710 --> 01:04:39,440
about this 120 football field size

1820
01:04:45,750 --> 01:04:42,720
area that orisa spoke about um

1821
01:04:47,190 --> 01:04:45,760
could you just clarify the the hover

1822
01:04:50,150 --> 01:04:47,200
time available

1823
01:04:51,750 --> 01:04:50,160
um with this system uh if you obviously

1824
01:04:53,270 --> 01:04:51,760
if you're coming down if the sky crane

1825
01:04:56,230 --> 01:04:53,280
is coming down on the home

1826
01:04:57,910 --> 01:04:56,240
touchdown line you just plonk it down

1827
01:04:59,910 --> 01:04:57,920
but if you have to go all the way over

1828
01:05:01,910 --> 01:04:59,920
to the other end of the field

1829
01:05:03,190 --> 01:05:01,920
long can you stay in the air is my

1830
01:05:05,990 --> 01:05:03,200
question well

1831
01:05:06,789 --> 01:05:06,000
leo as always a very detailed question

1832
01:05:08,630 --> 01:05:06,799
and

1833
01:05:10,069 --> 01:05:08,640
thank you for that let's first start off

1834
01:05:11,750 --> 01:05:10,079
with thomas derbouken

1835
01:05:13,190 --> 01:05:11,760
yeah i'm just gonna before we go into

1836
01:05:15,510 --> 01:05:13,200
technology which i'm not the right

1837
01:05:18,150 --> 01:05:15,520
person i just want to tell you that uh

1838
01:05:19,109 --> 01:05:18,160

uh yes uh we have when we landed with

1839
01:05:20,710 --> 01:05:19,119
curiosity it

1840
01:05:22,870 --> 01:05:20,720
could have done a number of technologies

1841
01:05:24,870 --> 01:05:22,880
for the first time terrain relative

1842
01:05:27,430 --> 01:05:24,880
navigation is not an exception what i

1843
01:05:30,309 --> 01:05:27,440
want to want to tell you how we did this

1844
01:05:31,589 --> 01:05:30,319
when we chose jazz roster as the place

1845
01:05:33,589 --> 01:05:31,599
to go because of its

1846
01:05:35,589 --> 01:05:33,599
amazing science promise we actually did

1847
01:05:36,230 --> 01:05:35,599
so with an asterix attitude to it which

1848
01:05:38,309 --> 01:05:36,240
is

1849
01:05:39,990 --> 01:05:38,319
basically we said we want to do an

1850
01:05:41,750 --> 01:05:40,000
independent review

1851
01:05:43,990 --> 01:05:41,760
based on the data and the planning that

1852
01:05:47,109 --> 01:05:44,000
the the team had put ahead of them

1853
01:05:49,190 --> 01:05:47,119
to make sure that this technology works

1854
01:05:51,109 --> 01:05:49,200
and if the answer would have been from

1855
01:05:51,589 --> 01:05:51,119
that review well we're not quite sure we

1856
01:05:54,309 --> 01:05:51,599
would have

1857
01:05:55,270 --> 01:05:54,319
backed off into another landing site and

1858
01:05:57,829 --> 01:05:55,280
we were convinced

1859
01:05:58,309 --> 01:05:57,839
i was convinced that the technology was

1860
01:06:00,789 --> 01:05:58,319
ready

1861
01:06:02,230 --> 01:06:00,799
uh to go so so the way we're doing this

1862
01:06:05,589 --> 01:06:02,240
is using the rigor

1863
01:06:07,109 --> 01:06:05,599

and reusing data to drive uh processes

1864
01:06:09,190 --> 01:06:07,119
in a way that we can include these

1865
01:06:11,029 --> 01:06:09,200
technologies and we're proudly doing so

1866
01:06:13,589 --> 01:06:11,039
now what we're to uh to the specialist

1867
01:06:16,710 --> 01:06:13,599
on technology

1868
01:06:18,150 --> 01:06:16,720
okay uh leo did you uh have a follow-up

1869
01:06:19,829 --> 01:06:18,160
i think there were yeah i was just

1870
01:06:22,230 --> 01:06:19,839
wondering about a plan b

1871
01:06:24,549 --> 01:06:22,240
is there some sort of hail mary landing

1872
01:06:26,789 --> 01:06:24,559
that can be done if for some reason

1873
01:06:28,309 --> 01:06:26,799
say the trn cameras don't work or

1874
01:06:32,069 --> 01:06:28,319
something like that

1875
01:06:35,270 --> 01:06:32,079
uh adam stalson the chief issue um

1876
01:06:38,390 --> 01:06:35,280
leo we have uh if

1877
01:06:40,470 --> 01:06:38,400
trn does not work does not converge and

1878
01:06:43,870 --> 01:06:40,480
we don't get a trn solution

1879
01:06:46,870 --> 01:06:43,880
we would go to a normal msl

1880
01:06:49,670 --> 01:06:46,880
curiosity-like divert maneuver

1881
01:06:51,109 --> 01:06:49,680
and we would have a increased risk of

1882
01:06:54,630 --> 01:06:51,119
terrain hazards

1883
01:06:59,270 --> 01:06:54,640
but a a risk that that we um

1884
01:07:03,190 --> 01:06:59,280
took eyes open at the jezro landing site

1885
01:07:05,750 --> 01:07:03,200
so yeah there you go okay

1886
01:07:06,789 --> 01:07:05,760
thank you leo and thank you adam next up

1887
01:07:10,069 --> 01:07:06,799
we have jacquie

1888
01:07:12,870 --> 01:07:10,079

goddard with the times of london

1889
01:07:13,990 --> 01:07:12,880
hello thank you um so we've grown to

1890
01:07:16,630 --> 01:07:14,000
know a lot about how

1891
01:07:17,190 --> 01:07:16,640
the spacecraft work um i wondered if you

1892
01:07:19,190 --> 01:07:17,200
can give us

1893
01:07:20,309 --> 01:07:19,200
a little insight one of you into how you

1894
01:07:22,150 --> 01:07:20,319
folks work

1895
01:07:24,309 --> 01:07:22,160
um i'm referring particularly to what

1896
01:07:25,990 --> 01:07:24,319
you have to do over the next few

1897
01:07:28,549 --> 01:07:26,000
weeks and months to keep yourselves on

1898
01:07:30,710 --> 01:07:28,559
martian time so the sleep shifting

1899
01:07:32,549 --> 01:07:30,720
i think some of you wear special watches

1900
01:07:34,390 --> 01:07:32,559
could one of you talk about

1901
01:07:36,230 --> 01:07:34,400
that really what adjustments do you have

1902
01:07:41,109 --> 01:07:36,240
to make to how you live and work

1903
01:07:47,349 --> 01:07:44,069
i will take that uh the surface team so

1904
01:07:49,349 --> 01:07:47,359
there are about 350 people

1905
01:07:51,510 --> 01:07:49,359
and and some additional scientists who

1906
01:07:53,910 --> 01:07:51,520
will be working on mars time

1907
01:07:54,950 --> 01:07:53,920
so right now they are adjusting their

1908
01:07:58,069 --> 01:07:54,960
clocks they

1909
01:07:58,870 --> 01:07:58,079
the way that we work is um we typically

1910
01:08:01,750 --> 01:07:58,880
will

1911
01:08:03,829 --> 01:08:01,760
show up in the afternoon on mars because

1912
01:08:06,230 --> 01:08:03,839
that's when the data comes to earth

1913
01:08:08,150 --> 01:08:06,240

and then we will work for 12 14 hours

1914
01:08:08,870 --> 01:08:08,160
until we get the uplink to send to the

1915
01:08:10,470 --> 01:08:08,880
rover

1916
01:08:12,470 --> 01:08:10,480
based on the data that we received now

1917
01:08:15,349 --> 01:08:12,480
the mars day is 40 minutes longer

1918
01:08:15,829 --> 01:08:15,359
so that's what makes mars time hard so

1919
01:08:20,309 --> 01:08:15,839
if you're

1920
01:08:21,269 --> 01:08:20,319
be 2 2 pm will be our start time and

1921
01:08:23,910 --> 01:08:21,279
then that will

1922
01:08:25,430 --> 01:08:23,920
adjust by 40 minutes every day which for

1923
01:08:28,470 --> 01:08:25,440
a while it works we've

1924
01:08:30,149 --> 01:08:28,480
kind of found that we only ask people to

1925
01:08:33,030 --> 01:08:30,159
do this for three months

1926
01:08:34,229 --> 01:08:33,040
the first cycle there's a 37 day cycle

1927
01:08:35,189 --> 01:08:34,239
that you go through and then you're kind

1928
01:08:36,390 --> 01:08:35,199
of back to the

1929
01:08:38,789 --> 01:08:36,400
original time the first cycle

1930
01:08:40,229 --> 01:08:38,799
everybody's excited they're this is cool

1931
01:08:42,709 --> 01:08:40,239
i'm on mars time

1932
01:08:43,829 --> 01:08:42,719
and you know in fact last on curiosity

1933
01:08:47,110 --> 01:08:43,839
one of our

1934
01:08:48,789 --> 01:08:47,120
family on mars time because it was

1935
01:08:51,030 --> 01:08:48,799
summer and they weren't in school and so

1936
01:08:53,269 --> 01:08:51,040
we had this whole family on mars time

1937
01:08:55,269 --> 01:08:53,279
by the next cycle people start to get a

1938
01:08:58,229 --> 01:08:55,279

little bit tired and by the third

1939
01:08:59,030 --> 01:08:58,239
you know by the time we finish mars time

1940
01:09:01,189 --> 01:08:59,040
they are

1941
01:09:02,709 --> 01:09:01,199
well ready to be finished with mars time

1942
01:09:04,550 --> 01:09:02,719
it's it's hard on your body it's like

1943
01:09:07,110 --> 01:09:04,560
being jet lagged

1944
01:09:09,110 --> 01:09:07,120
and so everybody we we have different

1945
01:09:11,349 --> 01:09:09,120
things that we allow folks to do if they

1946
01:09:12,950 --> 01:09:11,359
need to stay local or you know we can

1947
01:09:14,550 --> 01:09:12,960
we have cots in offices and things like

1948
01:09:17,110 --> 01:09:14,560
that to just help people

1949
01:09:17,749 --> 01:09:17,120
um manage in mars time the reason we do

1950
01:09:20,149 --> 01:09:17,759
mars time

1951
01:09:22,470 --> 01:09:20,159
is because it is the most efficient way

1952
01:09:23,669 --> 01:09:22,480
to make have the rover make progress on

1953
01:09:25,590 --> 01:09:23,679
a day-to-day basis

1954
01:09:27,269 --> 01:09:25,600
and that's really important early in the

1955
01:09:29,510 --> 01:09:27,279
mission to get it kind of

1956
01:09:32,149 --> 01:09:29,520
unbuckled and ready to go for the great

1957
01:09:34,950 --> 01:09:32,159
science mission that we have

1958
01:09:36,470 --> 01:09:34,960
all right great thank you jennifer uh

1959
01:09:38,149 --> 01:09:36,480
let's see we're gonna go to a few more

1960
01:09:40,229 --> 01:09:38,159
social media questions uh

1961
01:09:41,829 --> 01:09:40,239
jeff uh apparently social media really

1962
01:09:43,510 --> 01:09:41,839
is interested in moxie

1963
01:09:45,590 --> 01:09:43,520

we've got two of them uh for you the

1964
01:09:47,749 --> 01:09:45,600
first one is from glenn

1965
01:09:52,470 --> 01:09:47,759
on facebook who asks could moxie

1966
01:09:55,590 --> 01:09:54,790
no moxie is specifically designed with

1967
01:10:02,870 --> 01:09:55,600
the

1968
01:10:05,430 --> 01:10:02,880
elements in that to take carbon dioxide

1969
01:10:07,910 --> 01:10:05,440
and and generate o2 molecule

1970
01:10:09,510 --> 01:10:07,920
um there's all sorts of electrochemical

1971
01:10:12,790 --> 01:10:09,520
processes that are used

1972
01:10:15,110 --> 01:10:12,800
industrial even very large scale here on

1973
01:10:16,630 --> 01:10:15,120
earth to to make all sorts of things but

1974
01:10:18,310 --> 01:10:16,640
each of them are tailored for a

1975
01:10:20,790 --> 01:10:18,320
particular purpose and

1976
01:10:23,430 --> 01:10:20,800
this one's designed not only to make

1977
01:10:26,950 --> 01:10:23,440
oxygen from co2 but to do it under mars

1978
01:10:29,669 --> 01:10:26,960
conditions great and uh the follow-up

1979
01:10:34,630 --> 01:10:29,679
daniel from facebook asks is nasa

1980
01:10:39,350 --> 01:10:36,790
yeah that's a good interesting question

1981
01:10:40,709 --> 01:10:39,360
good question um

1982
01:10:43,350 --> 01:10:40,719
and then there's a lot you know in the

1983
01:10:45,590 --> 01:10:43,360
literature about terraforming uh

1984
01:10:47,750 --> 01:10:45,600
ranging from you know fairly serious

1985
01:10:48,790 --> 01:10:47,760
studies to science fiction sorts of

1986
01:10:51,669 --> 01:10:48,800
works and

1987
01:10:54,550 --> 01:10:51,679
um it's a dream of a lot of people to

1988
01:10:59,110 --> 01:10:56,790

another world and turn it into something

1989
01:11:01,350 --> 01:10:59,120
that's more habitable or more

1990
01:11:02,229 --> 01:11:01,360
like we're familiar something we're more

1991
01:11:05,110 --> 01:11:02,239
familiar with

1992
01:11:06,070 --> 01:11:05,120
um you know we i talked about scaling up

1993
01:11:08,390 --> 01:11:06,080
moxie the

1994
01:11:10,310 --> 01:11:08,400
moxie is we're sending it to mars on

1995
01:11:11,510 --> 01:11:10,320
perseverance is very small scale it's

1996
01:11:13,990 --> 01:11:11,520
going to make a little bit of

1997
01:11:15,910 --> 01:11:14,000
oxygen it's really improved the concept

1998
01:11:18,630 --> 01:11:15,920
um i talked about scaling it up

1999
01:11:19,590 --> 01:11:18,640
a hundred fold or so to fill a

2000
01:11:22,950 --> 01:11:19,600
propellant tank

2001
01:11:25,030 --> 01:11:22,960
um if you were going to try to produce

2002
01:11:28,630 --> 01:11:25,040
large amounts of oxygen or

2003
01:11:29,590 --> 01:11:28,640
to take large amounts of co2 out of the

2004
01:11:31,669 --> 01:11:29,600
atmosphere

2005
01:11:32,950 --> 01:11:31,679
boxing wouldn't be the the type of

2006
01:11:34,630 --> 01:11:32,960
technology that

2007
01:11:36,229 --> 01:11:34,640
that you'd use it's a fairly power

2008
01:11:38,830 --> 01:11:36,239
intensive technology

2009
01:11:42,390 --> 01:11:38,840
it's good for the purpose that you know

2010
01:11:46,149 --> 01:11:42,400
nasa envisions for atmospheric iru

2011
01:11:47,910 --> 01:11:46,159
uh atmospheric isru uh on mars

2012
01:11:49,270 --> 01:11:47,920
but um there are a lot of other

2013
01:11:50,470 --> 01:11:49,280

technologies that people have written

2014
01:11:54,149 --> 01:11:50,480
about i'm not an expert

2015
01:11:56,390 --> 01:11:54,159
in in those but uh in terms of

2016
01:11:57,350 --> 01:11:56,400
either carbon sequestration which is

2017
01:12:00,470 --> 01:11:57,360
something

2018
01:12:02,790 --> 01:12:00,480
we may be

2019
01:12:03,750 --> 01:12:02,800
interested in here on earth or or

2020
01:12:07,510 --> 01:12:03,760
generating

2021
01:12:10,870 --> 01:12:07,520
um life support consumables to

2022
01:12:14,470 --> 01:12:10,880
change the atmosphere of another world

2023
01:12:18,950 --> 01:12:14,480
the solid oxide electrolysis

2024
01:12:21,350 --> 01:12:18,960
wouldn't scale well uh to that sort of

2025
01:12:22,229 --> 01:12:21,360
implementation thank you jeff and thomas

2026
01:12:23,990 --> 01:12:22,239
rebukin

2027
01:12:25,750 --> 01:12:24,000
yeah let me just add a couple uh

2028
01:12:28,070 --> 01:12:25,760
comments so first of all the uh

2029
01:12:29,590 --> 01:12:28,080
the answer is no uh this is this

2030
01:12:30,390 --> 01:12:29,600
instrument and i think you said that

2031
01:12:32,149 --> 01:12:30,400
with uh

2032
01:12:34,310 --> 01:12:32,159
more words the answer is we're not

2033
01:12:35,910 --> 01:12:34,320
terraforming we're terraforming or we're

2034
01:12:37,910 --> 01:12:35,920
shaping the environment of mars as

2035
01:12:38,790 --> 01:12:37,920
little as a mouse in nevada is changing

2036
01:12:41,750 --> 01:12:38,800
the earth

2037
01:12:43,910 --> 01:12:41,760
right it really is not uh it's not a

2038
01:12:44,790 --> 01:12:43,920

substantial kind of global impact of

2039
01:12:47,510 --> 01:12:44,800
what we're going to do

2040
01:12:48,630 --> 01:12:47,520
and we have no intent we think mars is a

2041
01:12:51,669 --> 01:12:48,640
beautiful planet

2042
01:12:54,229 --> 01:12:51,679
uh that uh that remains uh uh to be

2043
01:12:56,950 --> 01:12:54,239
discovered and then i just i love

2044
01:12:58,470 --> 01:12:56,960
the path ahead that you just outlined of

2045
01:13:01,669 --> 01:12:58,480
uh trying to scale that up

2046
01:13:04,709 --> 01:13:01,679
so we can do more exploration uh with

2047
01:13:06,709 --> 01:13:04,719
uh with more people with more systems

2048
01:13:09,350 --> 01:13:06,719
and uh even with those uh

2049
01:13:11,350 --> 01:13:09,360
you know the overall system of mars uh

2050
01:13:12,709 --> 01:13:11,360
would not substantially change and no

2051
01:13:14,229 --> 01:13:12,719
plans that we have

2052
01:13:17,430 --> 01:13:14,239
in a large scale would create a

2053
01:13:20,709 --> 01:13:17,440
large-scale change on on this planet

2054
01:13:22,070 --> 01:13:20,719
thank you dr zubukin okay that's it for

2055
01:13:24,310 --> 01:13:22,080
this morning's news briefing

2056
01:13:25,910 --> 01:13:24,320
on the mars 2020 perseverance rover

2057
01:13:27,750 --> 01:13:25,920
mission if you're a member of the media

2058
01:13:31,030 --> 01:13:27,760
and have further questions please call

2059
01:13:33,510 --> 01:13:31,040
jpl's digital news and media office

2060
01:13:35,030 --> 01:13:33,520
we'll also continue to answer questions

2061
01:13:37,590 --> 01:13:35,040
on social media

2062
01:13:38,790 --> 01:13:37,600
as well as online thank you for your

2063
01:13:39,910 --> 01:13:38,800

questions and thank you for the

2064
01:13:43,189 --> 01:13:39,920
panelists

2065
01:13:44,790 --> 01:13:43,199
for joining us today a reminder at 12 30

2066
01:13:46,550 --> 01:13:44,800
p.m pacific today

2067
01:13:49,030 --> 01:13:46,560
there is a media briefing that takes a

2068
01:13:51,030 --> 01:13:49,040
deeper dive into the science of the mars

2069
01:13:52,390 --> 01:13:51,040
2020 perseverance rover mission

2070
01:13:54,470 --> 01:13:52,400
and then tomorrow we have two more

2071
01:13:56,070 --> 01:13:54,480
briefings uh both in pacific time the

2072
01:13:58,950 --> 01:13:56,080
first ones at 10 am

2073
01:14:00,630 --> 01:13:58,960
when we will have an overview actually

2074
01:14:02,630 --> 01:14:00,640
more deeper dive into

2075
01:14:05,990 --> 01:14:02,640
what's going to happen during landing

2076
01:14:08,310 --> 01:14:06,000
and then uh there will be one at 12 p.m

2077
01:14:09,910 --> 01:14:08,320
where we will be talking about searching

2078
01:14:13,030 --> 01:14:09,920
for signs of ancient life

2079
01:14:14,550 --> 01:14:13,040
and mars sample return perseverance is

2080
01:14:16,950 --> 01:14:14,560
set to land

2081
01:14:19,590 --> 01:14:16,960
on mars on february 18th with commentary

2082
01:14:22,070 --> 01:14:19,600
beginning at 11 15 a.m pacific

2083
01:14:23,110 --> 01:14:22,080
standard time nasa is offering a lot of

2084
01:14:25,030 --> 01:14:23,120
options for

2085
01:14:26,310 --> 01:14:25,040
you to ride along with us to join the

2086
01:14:29,110 --> 01:14:26,320
virtual nasa

2087
01:14:30,870 --> 01:14:29,120
social and virtual guest events register

2088
01:14:31,590 --> 01:14:30,880

for the mission to mars student

2089
01:14:34,229 --> 01:14:31,600
challenge

2090
01:14:34,830 --> 01:14:34,239
and live stream the mars landing visit

2091
01:14:41,990 --> 01:14:34,840
go

2092
01:15:05,410 --> 01:14:42,000
mars 2020 toolkit i'm bc eagle

2093
01:15:13,189 --> 01:15:09,910
[Music]

2094
01:15:15,510 --> 01:15:13,199
i'm dr ellen stofan also known as dr e