1
00:01:38,830 --> 00:00:12,180
[Music]

2
00:01:38,840 --> 00:02:01,940
my

3
00:04:54,830 --> 00:02:13,660
[Music]

4
00:05:01,880 --> 00:04:56,310
do

5
00:05:50,710 --> 00:05:17,870
[Music]

6
00:05:53,830 --> 00:05:52,629
welcome to nasa's jet propulsion

7
00:05:57,029 --> 00:05:53,840
laboratory in

8
00:05:58,550 --> 00:05:57,039
southern california nasa's ingenuity

9
00:06:00,710 --> 00:05:58,560
mars helicopter

10
00:06:03,430 --> 00:06:00,720
hitched a ride to the red planet on the

11
00:06:05,670 --> 00:06:03,440
mars 2020 perseverance rover

12
00:06:07,670 --> 00:06:05,680
which landed in jezreel crater on

13
00:06:10,070 --> 00:06:07,680

14
00:06:11,430 --> 00:06:10,080
now the rover is getting ready to drop

15
00:06:14,070 --> 00:06:11,440
the helicopter off

16
00:06:15,270 --> 00:06:14,080
so it can attempt the first powered

17
00:06:17,990 --> 00:06:15,280
controlled flights

18
00:06:20,790 --> 00:06:18,000
on another planet today we'll bring you

19
00:06:23,830 --> 00:06:20,800
up to speed on the team's plans

20
00:06:25,830 --> 00:06:23,840
i'm your host raquel villanueva to tell

21
00:06:28,870 --> 00:06:25,840
us about the upcoming milestones

22
00:06:32,070 --> 00:06:28,880
and the helicopter's test flights are

23
00:06:33,590 --> 00:06:32,080
lori glaze director of nasa's planetary

24
00:06:37,350 --> 00:06:33,600
science division

25
00:06:41,590 --> 00:06:37,360
bob balaram ingenuity chief engineer

26
00:06:44,550 --> 00:06:41,600
hovard grip ingenuity chief pilot

27
00:06:44,950 --> 00:06:44,560
farah alibay perseverance integration

28
00:06:48,390 --> 00:06:44,960
lead

29
00:06:52,390 --> 00:06:48,400
for ingenuity and bobby braun

30
00:06:54,230 --> 00:06:52,400
director for planetary science at jpl

31
00:06:56,950 --> 00:06:54,240
for anyone watching who'd like to submit

32
00:07:00,150 --> 00:06:56,960
a question you can do so by using

33
00:07:01,909 --> 00:07:00,160
the mars helicopter hashtag

34
00:07:04,309 --> 00:07:01,919
our phone lines are now open to the

35
00:07:04,950 --> 00:07:04,319
media and you can ask questions by

36
00:07:08,550 --> 00:07:04,960
pressing

37
00:07:11,430 --> 00:07:08,560
star one and enter the queue to start

38
00:07:13,830 --> 00:07:11,440

i'd like to welcome lori glaze thanks

39
00:07:16,550 --> 00:07:13,840
for getting us started lori

40
00:07:17,430 --> 00:07:16,560
you bet thank you raquel we're here

41
00:07:20,150 --> 00:07:17,440
today to

42
00:07:21,510 --> 00:07:20,160
celebrate great engineering achievements

43
00:07:25,189 --> 00:07:21,520
that required

44
00:07:28,550 --> 00:07:25,199
hard work perseverance and above all

45
00:07:30,230 --> 00:07:28,560
ingenuity the perseverance rover carries

46
00:07:30,710 --> 00:07:30,240
with it the most advanced suite of

47
00:07:33,029 --> 00:07:30,720
science

48
00:07:33,990 --> 00:07:33,039
instruments we've ever sent to mars as

49
00:07:36,150 --> 00:07:34,000
well as

50
00:07:37,909 --> 00:07:36,160
several technology technology

51
00:07:40,710 --> 00:07:37,919
demonstrations including

52
00:07:41,670 --> 00:07:40,720
the ingenuity helicopter perseverance

53
00:07:44,790 --> 00:07:41,680
and ingenuity

54
00:07:46,150 --> 00:07:44,800
are all of nasa missions and by that i

55
00:07:49,589 --> 00:07:46,160
mean they cut across

56
00:07:51,749 --> 00:07:49,599
science technology human space flight

57
00:07:53,510 --> 00:07:51,759
and aeronautics in fact when the

58
00:07:55,909 --> 00:07:53,520
decision was made to add

59
00:07:57,189 --> 00:07:55,919
a small helicopter to the mars 2020

60
00:07:59,430 --> 00:07:57,199
rover mission

61
00:08:01,029 --> 00:07:59,440
the jet propulsion laboratory looked to

62
00:08:03,189 --> 00:08:01,039
our aeronautics research

63
00:08:05,350 --> 00:08:03,199

mission directorate for their expertise

64
00:08:07,830 --> 00:08:05,360
in rotorcraft aerodynamics

65
00:08:10,070 --> 00:08:07,840
a small team of nasa helicopter experts

66
00:08:12,950 --> 00:08:10,080
assisted jpl in verifying

67
00:08:13,270 --> 00:08:12,960
that ingenuity could fly in mars's super

68
00:08:15,990 --> 00:08:13,280
thin

69
00:08:18,629 --> 00:08:16,000
atmosphere and they also helped analyze

70
00:08:21,110 --> 00:08:18,639
the helicopter's design

71
00:08:21,990 --> 00:08:21,120
when i reflect on perseverance and

72
00:08:24,390 --> 00:08:22,000
ingenuity

73
00:08:26,469 --> 00:08:24,400
i not only think about the future

74
00:08:27,589 --> 00:08:26,479
science and possibilities that will be

75
00:08:30,469 --> 00:08:27,599
enabled by these

76
00:08:31,749 --> 00:08:30,479
two engineering marvels but also about

77
00:08:34,550 --> 00:08:31,759
those two words

78
00:08:35,829 --> 00:08:34,560
and how they represent the core human

79
00:08:38,870 --> 00:08:35,839
characteristics

80
00:08:41,509 --> 00:08:38,880
that got us where we are today

81
00:08:43,990 --> 00:08:41,519
the very first wheeled rover vehicle to

82
00:08:47,030 --> 00:08:44,000
rove on another planet was sojourner

83
00:08:47,590 --> 00:08:47,040
which landed on mars in 1997 and paved

84
00:08:51,030 --> 00:08:47,600
the way

85
00:08:53,350 --> 00:08:51,040
for a new era of mars exploration

86
00:08:55,190 --> 00:08:53,360
sojourner redefined what we thought was

87
00:08:56,070 --> 00:08:55,200
possible on the surface of mars and

88
00:08:58,949 --> 00:08:56,080

completely

89
00:09:00,470 --> 00:08:58,959
transformed our approach to how we

90
00:09:02,949 --> 00:09:00,480
explore there

91
00:09:05,350 --> 00:09:02,959
that small rover enabled all the

92
00:09:06,389 --> 00:09:05,360
missions to follow and now perseverance

93
00:09:09,269 --> 00:09:06,399
the size of a small

94
00:09:10,150 --> 00:09:09,279
car is able to carry other technology

95
00:09:12,870 --> 00:09:10,160
demonstrations

96
00:09:14,870 --> 00:09:12,880
like ingenuity which will further expand

97
00:09:17,269 --> 00:09:14,880
our horizons

98
00:09:18,150 --> 00:09:17,279
at nasa we strive to anticipate what

99
00:09:20,389 --> 00:09:18,160
scientists

100
00:09:21,269 --> 00:09:20,399
are going to need to do great science in

101
00:09:23,030 --> 00:09:21,279
the future

102
00:09:25,190 --> 00:09:23,040
and the technology demonstrations by

103
00:09:28,070 --> 00:09:25,200
their very nature do this

104
00:09:29,910 --> 00:09:28,080
it's a high risk high reward approach

105
00:09:32,710 --> 00:09:29,920
that allows us to test

106
00:09:34,710 --> 00:09:32,720
capabilities we can improve on later

107
00:09:36,710 --> 00:09:34,720
which could also advance science on

108
00:09:39,430 --> 00:09:36,720
future missions

109
00:09:40,070 --> 00:09:39,440
ingenuity is a limited time project it

110
00:09:43,190 --> 00:09:40,080
will have

111
00:09:45,990 --> 00:09:43,200
31 earth days to attempt to be

112
00:09:46,870 --> 00:09:46,000
the first helicopter to fly on another

113
00:09:49,350 --> 00:09:46,880

planet

114
00:09:50,949 --> 00:09:49,360
it isn't intended to collect science but

115
00:09:54,870 --> 00:09:50,959
because its mission is so

116
00:09:58,070 --> 00:09:54,880
focused it is at its core innovative

117
00:10:01,750 --> 00:09:58,080
and that innovation is the heart of tech

118
00:10:04,310 --> 00:10:01,760
demonstrations another technology

119
00:10:07,030 --> 00:10:04,320
demonstration on board perseverance

120
00:10:08,310 --> 00:10:07,040
includes moxie which will test

121
00:10:10,790 --> 00:10:08,320
technology to convert

122
00:10:11,750 --> 00:10:10,800
atmospheric carbon dioxide into oxygen

123
00:10:13,590 --> 00:10:11,760
which could help us

124
00:10:14,870 --> 00:10:13,600
enable human missions to mars in the

125
00:10:16,949 --> 00:10:14,880
future

126
00:10:19,509 --> 00:10:16,959
tech demos related to the rover's entry

127
00:10:21,590 --> 00:10:19,519
descent and landing like range trigger

128
00:10:23,350 --> 00:10:21,600
allowed for precise timing of parachute

129
00:10:25,590 --> 00:10:23,360
deployment and helped us to avoid

130
00:10:28,069 --> 00:10:25,600
hazards on landing day

131
00:10:30,710 --> 00:10:28,079
an earlier demonstration of the medley

132
00:10:33,190 --> 00:10:30,720
technology for curiosities landing

133
00:10:34,069 --> 00:10:33,200
enabled us to advance our understanding

134
00:10:37,430 --> 00:10:34,079
of atmospheric

135
00:10:40,150 --> 00:10:37,440
entry during the perseverance landing

136
00:10:40,870 --> 00:10:40,160
and beyond tech demos perseverance is

137
00:10:43,990 --> 00:10:40,880
loaded with

138
00:10:45,190 --> 00:10:44,000

other amazing technology integral to its

139
00:10:47,829 --> 00:10:45,200
science mission

140
00:10:48,630 --> 00:10:47,839
including a complex sampling and caching

141
00:10:50,550 --> 00:10:48,640
system

142
00:10:52,790 --> 00:10:50,560
that will drill for samples of rock and

143
00:10:56,230 --> 00:10:52,800
soil to be collected by our future

144
00:10:58,630 --> 00:10:56,240
mars sample return missions

145
00:10:59,430 --> 00:10:58,640
ingenuity will open new possibilities

146
00:11:01,110 --> 00:10:59,440
and will spark

147
00:11:03,829 --> 00:11:01,120
questions for the future about what we

148
00:11:05,990 --> 00:11:03,839
could accomplish with an aerial explorer

149
00:11:08,150 --> 00:11:06,000
could we image areas not visible from

150
00:11:10,069 --> 00:11:08,160
space or that a rover couldn't reach

151
00:11:11,590 --> 00:11:10,079
like shadowed craters with seasonal

152
00:11:13,430 --> 00:11:11,600
water flow

153
00:11:15,509 --> 00:11:13,440
could a helicopter scout ahead for

154
00:11:17,829 --> 00:11:15,519
rovers and help plot the most efficient

155
00:11:19,590 --> 00:11:17,839
course for the best science

156
00:11:22,230 --> 00:11:19,600
could we support future human missions

157
00:11:24,069 --> 00:11:22,240
with aerial capabilities

158
00:11:26,470 --> 00:11:24,079
those are questions for another day but

159
00:11:27,670 --> 00:11:26,480
tech demos give us the leeway to be

160
00:11:30,790 --> 00:11:27,680
creative and test

161
00:11:31,670 --> 00:11:30,800
new things without sojourner there is no

162
00:11:33,910 --> 00:11:31,680
perseverance

163
00:11:36,230 --> 00:11:33,920

and without ingenuity there wouldn't be

164
00:11:38,069 --> 00:11:36,240
the future aerial explorers we're hoping

165
00:11:39,350 --> 00:11:38,079
will be enabled by the coming months

166
00:11:41,350 --> 00:11:39,360
flight

167
00:11:43,509 --> 00:11:41,360
we're looking forward to seeing how our

168
00:11:44,389 --> 00:11:43,519
little helicopter does on the surface of

169
00:11:46,630 --> 00:11:44,399
mars and we

170
00:11:49,509 --> 00:11:46,640
know people around the world are eager

171
00:11:52,470 --> 00:11:49,519
to join us for that exciting 31 day

172
00:11:54,470 --> 00:11:52,480
demonstration and now i'm going to turn

173
00:11:56,230 --> 00:11:54,480
it over to bob ballaram to tell us

174
00:11:57,990 --> 00:11:56,240
about some of the engineering milestones

175
00:11:58,870 --> 00:11:58,000
that made it possible for ingenuity to

176
00:12:01,190 --> 00:11:58,880
reach mars

177
00:12:02,629 --> 00:12:01,200
we've already learned a lot just through

178
00:12:05,829 --> 00:12:02,639
that process

179
00:12:07,030 --> 00:12:05,839
thank you bob thank you lori i could i

180
00:12:09,509 --> 00:12:07,040
have the first image please

181
00:12:10,949 --> 00:12:09,519
yes so when we see this image of

182
00:12:12,949 --> 00:12:10,959
ingenuity

183
00:12:14,389 --> 00:12:12,959
what comes to my mind is that it's

184
00:12:17,350 --> 00:12:14,399
really a first

185
00:12:19,509 --> 00:12:17,360
unique aircraft designed to fly a

186
00:12:21,829 --> 00:12:19,519
powered flight on another planet

187
00:12:23,110 --> 00:12:21,839
and of all planets is mars which has the

188
00:12:25,430 --> 00:12:23,120

thinnest atmosphere

189
00:12:26,629 --> 00:12:25,440
just one percent of earth and it's a

190
00:12:29,829 --> 00:12:26,639
very unique

191
00:12:32,310 --> 00:12:29,839
engineering design with its uh four foot

192
00:12:34,949 --> 00:12:32,320
diameter blades counter rotating blades

193
00:12:36,629 --> 00:12:34,959
this little solar panel on top and a

194
00:12:38,790 --> 00:12:36,639
fuselage that's filled with

195
00:12:40,150 --> 00:12:38,800
all kinds of electronics everything from

196
00:12:42,710 --> 00:12:40,160
advanced

197
00:12:44,629 --> 00:12:42,720
items to off-the-shelf items all

198
00:12:47,670 --> 00:12:44,639
carefully tailored and screened for

199
00:12:49,750 --> 00:12:47,680
use on mars it's a very unique

200
00:12:53,030 --> 00:12:49,760
aircraft that is capable of that kind of

201
00:12:55,990 --> 00:12:53,040
flight with the blade spinning at 40 rpm

202
00:12:57,910 --> 00:12:56,000
uh 40 40 times a second and really being

203
00:13:01,269 --> 00:12:57,920
able to take off in that thin air of

204
00:13:04,069 --> 00:13:01,279
mars but i also see a spacecraft

205
00:13:06,069 --> 00:13:04,079
this is in in effect an aircraft that

206
00:13:08,230 --> 00:13:06,079
also happens to be a spacecraft

207
00:13:09,509 --> 00:13:08,240
it has survived launch it has survived

208
00:13:11,829 --> 00:13:09,519
the journey through space

209
00:13:13,110 --> 00:13:11,839
with vacuum and radiation it has

210
00:13:14,949 --> 00:13:13,120
survived the entry

211
00:13:16,710 --> 00:13:14,959
and descent and landing onto the surface

212
00:13:18,470 --> 00:13:16,720
with its on the bottom of the

213
00:13:20,550 --> 00:13:18,480

perseverance rover

214
00:13:21,670 --> 00:13:20,560
and it has survived all the challenges

215
00:13:24,069 --> 00:13:21,680
and design

216
00:13:25,990 --> 00:13:24,079
issues that are necessary for a

217
00:13:28,150 --> 00:13:26,000
spacecraft

218
00:13:29,269 --> 00:13:28,160
but most of all i think of ingenuity

219
00:13:33,110 --> 00:13:29,279
also as an

220
00:13:35,190 --> 00:13:33,120
experimental aircraft here is the

221
00:13:36,389 --> 00:13:35,200
the long tradition of experimental

222
00:13:38,310 --> 00:13:36,399
aircraft

223
00:13:40,949 --> 00:13:38,320
they started all the way from the wright

224
00:13:43,990 --> 00:13:40,959
brothers who are able to like

225
00:13:45,430 --> 00:13:44,000
bring aerial mobility as a dimension for

226
00:13:48,069 --> 00:13:45,440
us to be able to

227
00:13:49,670 --> 00:13:48,079
travel here on earth in the same way we

228
00:13:52,629 --> 00:13:49,680
are hoping that

229
00:13:54,470 --> 00:13:52,639
ingenuity also allows us to ex expand

230
00:13:57,829 --> 00:13:54,480
and open up aerial mobility

231
00:14:00,949 --> 00:13:57,839
on mars now the wright brothers

232
00:14:04,389 --> 00:14:00,959
in 1903 they flew this with

233
00:14:08,310 --> 00:14:04,399
a small spruce wood

234
00:14:10,069 --> 00:14:08,320
and fabric uh system we in ingenuity

235
00:14:11,750 --> 00:14:10,079
with all our high-tech materials and

236
00:14:14,790 --> 00:14:11,760
carbon fiber skins and

237
00:14:18,150 --> 00:14:14,800
exotic metals we are very proud

238
00:14:19,430 --> 00:14:18,160

to honor that experimental aircraft from

239
00:14:22,949 --> 00:14:19,440
long ago

240
00:14:25,910 --> 00:14:22,959
by carrying a small piece of fabric

241
00:14:27,030 --> 00:14:25,920
on ingenuity here you see engineers

242
00:14:32,389 --> 00:14:27,040
installing

243
00:14:36,550 --> 00:14:34,710
is from the original aircraft that flew

244
00:14:38,230 --> 00:14:36,560
at kitty hawk

245
00:14:39,910 --> 00:14:38,240
the wright brothers were auctioning

246
00:14:40,550 --> 00:14:39,920
pieces of this to raise money for their

247
00:14:43,509 --> 00:14:40,560
future

248
00:14:44,150 --> 00:14:43,519
efforts and we thank the folks at dayton

249
00:14:47,350 --> 00:14:44,160
history

250
00:14:48,150 --> 00:14:47,360
who let us honor that original pioneers

251
00:14:54,550 --> 00:14:48,160
with this

252
00:14:55,750 --> 00:14:54,560
ingenuity aircraft it has been a long

253
00:14:58,949 --> 00:14:55,760
journey

254
00:15:00,710 --> 00:14:58,959
and everything from test programs that

255
00:15:03,350 --> 00:15:00,720
had failures in the early

256
00:15:05,030 --> 00:15:03,360
days and you can roll the video all the

257
00:15:08,150 --> 00:15:05,040
way culminating

258
00:15:10,389 --> 00:15:08,160
in actually building a ingenuity

259
00:15:12,230 --> 00:15:10,399
flight model that is flight worthy and

260
00:15:15,590 --> 00:15:12,240
can go to mars

261
00:15:16,230 --> 00:15:15,600
we have done a lot of testing everything

262
00:15:20,550 --> 00:15:16,240
from

263
00:15:22,470 --> 00:15:20,560

the mechanisms to going into our 25 foot

264
00:15:24,230 --> 00:15:22,480
space chamber which simulates the

265
00:15:26,150 --> 00:15:24,240
atmosphere of mars

266
00:15:27,990 --> 00:15:26,160
where we did a number of flights to

267
00:15:29,189 --> 00:15:28,000
characterize the performance of the

268
00:15:30,949 --> 00:15:29,199
system

269
00:15:32,230 --> 00:15:30,959
to understand how well it can control

270
00:15:35,829 --> 00:15:32,240
itself

271
00:15:37,350 --> 00:15:35,839
and to do a whole number of maneuvers to

272
00:15:39,030 --> 00:15:37,360
make sure that we knew how this thing

273
00:15:41,590 --> 00:15:39,040
could fly here on mars

274
00:15:43,350 --> 00:15:41,600
a lot of testing that everything that we

275
00:15:45,910 --> 00:15:43,360
could possibly do here on earth

276
00:15:47,189 --> 00:15:45,920
has been done and now it's time for us

277
00:15:49,189 --> 00:15:47,199
to take that same

278
00:15:51,350 --> 00:15:49,199
vehicle to mars and subject it to the

279
00:15:54,629 --> 00:15:51,360
ultimate test

280
00:15:55,910 --> 00:15:54,639
so there are still a number of

281
00:15:59,030 --> 00:15:55,920
challenges ahead

282
00:16:00,870 --> 00:15:59,040
we are at a milestone right now where we

283
00:16:03,350 --> 00:16:00,880
are on the surface

284
00:16:06,389 --> 00:16:03,360
we have successfully exposed ourselves

285
00:16:07,829 --> 00:16:06,399
to the atmos to the atmosphere of mars

286
00:16:09,430 --> 00:16:07,839
we are right now in the process of

287
00:16:11,829 --> 00:16:09,440
having the rover drive us to our

288
00:16:14,470 --> 00:16:11,839

location which will be our airfield

289
00:16:17,110 --> 00:16:14,480
there will be a long 10-day sequence of

290
00:16:19,829 --> 00:16:17,120
careful critical deployments

291
00:16:22,230 --> 00:16:19,839
and then there will be the deposition of

292
00:16:23,509 --> 00:16:22,240
the helicopter on the surface

293
00:16:25,590 --> 00:16:23,519
and then there will be that first

294
00:16:27,670 --> 00:16:25,600
exposure to sunlight when we have to

295
00:16:28,949 --> 00:16:27,680
charge the batteries by ourselves

296
00:16:31,749 --> 00:16:28,959
where we're no longer part of the

297
00:16:33,590 --> 00:16:31,759
perseverance rover and connected safely

298
00:16:36,550 --> 00:16:33,600
and we're completely on our own fully

299
00:16:38,470 --> 00:16:36,560
autonomous waiting to receive commands

300
00:16:40,310 --> 00:16:38,480
we will go through a number of days of

301
00:16:42,870 --> 00:16:40,320
commissioning approximately a week

302
00:16:44,470 --> 00:16:42,880
where we test out sensors we test our

303
00:16:46,150 --> 00:16:44,480
server mechanisms

304
00:16:48,870 --> 00:16:46,160
we test the motors to make sure they

305
00:16:51,030 --> 00:16:48,880
spin right and we'll be very methodical

306
00:16:53,030 --> 00:16:51,040
and even driven as this engineering

307
00:16:55,509 --> 00:16:53,040
experiment unfolds

308
00:16:57,590 --> 00:16:55,519
and then we will be at a point where

309
00:16:59,670 --> 00:16:57,600
we'll undertake our first flight

310
00:17:01,350 --> 00:16:59,680
and then we'll progressively undertake

311
00:17:03,829 --> 00:17:01,360
more aggressive flights once we

312
00:17:05,510 --> 00:17:03,839
understand and analyze all the behavior

313
00:17:07,189 --> 00:17:05,520

from that first flight

314
00:17:08,710 --> 00:17:07,199
so with that i would like to turn it

315
00:17:11,189 --> 00:17:08,720
over to hobart who will tell us more

316
00:17:14,230 --> 00:17:11,199
about our first flight

317
00:17:15,429 --> 00:17:14,240
all right thank you i want to talk a

318
00:17:17,350 --> 00:17:15,439
little bit about

319
00:17:19,189 --> 00:17:17,360
where we've chosen uh to fly the

320
00:17:21,990 --> 00:17:19,199
helicopter

321
00:17:23,590 --> 00:17:22,000
immediately after the rover landed on

322
00:17:25,829 --> 00:17:23,600
february 18th

323
00:17:27,510 --> 00:17:25,839
just within a couple of hours we started

324
00:17:30,710 --> 00:17:27,520
to search for a good place

325
00:17:32,950 --> 00:17:30,720
to drop off the helicopter and when i

326
00:17:34,310 --> 00:17:32,960
say good place what i mean specifically

327
00:17:34,789 --> 00:17:34,320
is we wanted to find something that we

328
00:17:37,510 --> 00:17:34,799
called an

329
00:17:39,029 --> 00:17:37,520
airfield which is an area where it is

330
00:17:41,110 --> 00:17:39,039
safe for the helicopter

331
00:17:42,310 --> 00:17:41,120
to take off and also say for the

332
00:17:45,190 --> 00:17:42,320
helicopter to land again

333
00:17:47,029 --> 00:17:45,200
after a flight so that area naturally

334
00:17:47,430 --> 00:17:47,039
needs to be flat and it needs to have

335
00:17:50,630 --> 00:17:47,440
few

336
00:17:51,590 --> 00:17:50,640
obstacles rocks and like that could pose

337
00:17:55,029 --> 00:17:51,600
a danger

338
00:17:57,350 --> 00:17:55,039

to the helicopter on landing and that

339
00:17:58,950 --> 00:17:57,360
area should also be situated within a

340
00:18:00,789 --> 00:17:58,960
larger flight zone

341
00:18:02,070 --> 00:18:00,799
the flight zone is where the flights

342
00:18:03,190 --> 00:18:02,080
themselves will happen

343
00:18:05,590 --> 00:18:03,200
and we're also looking for something

344
00:18:07,510 --> 00:18:05,600
relatively flat there and

345
00:18:09,590 --> 00:18:07,520
we're looking for something that has

346
00:18:11,270 --> 00:18:09,600
enough texture

347
00:18:12,710 --> 00:18:11,280
that means things that the helicopter

348
00:18:14,950 --> 00:18:12,720
can look at with its cameras

349
00:18:17,350 --> 00:18:14,960
while it's flying in order to keep track

350
00:18:21,270 --> 00:18:17,360
of where it's at

351
00:18:23,510 --> 00:18:21,280
so we began to look for an airfield and

352
00:18:26,070 --> 00:18:23,520
a surrounding flight zone

353
00:18:27,190 --> 00:18:26,080
first using satellite imagery and then

354
00:18:30,070 --> 00:18:27,200
as it became available

355
00:18:31,909 --> 00:18:30,080
images taken by the rover itself after

356
00:18:34,150 --> 00:18:31,919
it landed

357
00:18:36,070 --> 00:18:34,160
and we began to realize that we might

358
00:18:38,710 --> 00:18:36,080
just have a really great

359
00:18:40,470 --> 00:18:38,720
airfield right in front of our noses in

360
00:18:43,669 --> 00:18:40,480
fact we have a satellite

361
00:18:46,150 --> 00:18:43,679
image if we can pull that up

362
00:18:48,070 --> 00:18:46,160
that shows where the rover landed as

363
00:18:50,150 --> 00:18:48,080

well as the flight zone and the airfield

364
00:18:53,750 --> 00:18:50,160
and you can see it's just right north of

365
00:18:57,430 --> 00:18:56,070
and once the rover started driving we

366
00:19:00,470 --> 00:18:57,440
were able to get even better

367
00:19:02,070 --> 00:19:00,480
images of this area and we have a second

368
00:19:03,830 --> 00:19:02,080
image here that shows

369
00:19:05,350 --> 00:19:03,840
what the rover saw with this navigation

370
00:19:07,750 --> 00:19:05,360
cameras looking directly

371
00:19:10,230 --> 00:19:07,760
up the airfield or up the flight zone

372
00:19:14,070 --> 00:19:10,240
with the airfield in the foreground

373
00:19:16,070 --> 00:19:14,080
and using these images and other images

374
00:19:17,990 --> 00:19:16,080
we really scoured this area we looked at

375
00:19:19,990 --> 00:19:18,000
every little rock in pebble

376
00:19:21,590 --> 00:19:20,000
within that airfield and measured it

377
00:19:22,230 --> 00:19:21,600
before we finally were comfortable

378
00:19:24,950 --> 00:19:22,240
saying

379
00:19:26,789 --> 00:19:24,960
yes this is this is going to be our home

380
00:19:28,950 --> 00:19:26,799
base for the helicopter

381
00:19:30,230 --> 00:19:28,960
so what you're looking at there is in

382
00:19:33,270 --> 00:19:30,240
fact the first

383
00:19:35,029 --> 00:19:33,280
airfield on another planet and we're

384
00:19:38,070 --> 00:19:35,039
planning to deploy the helicopter right

385
00:19:39,270 --> 00:19:38,080
in the middle of that

386
00:19:40,789 --> 00:19:39,280
so next i want to talk a little bit

387
00:19:42,470 --> 00:19:40,799
about our first flight and what that's

388
00:19:43,110 --> 00:19:42,480

going to look like starting from this

389
00:19:45,750 --> 00:19:43,120
airfield

390
00:19:46,630 --> 00:19:45,760
that we've picked here so first of all

391
00:19:48,870 --> 00:19:46,640
the first flight

392
00:19:52,230 --> 00:19:48,880
is special it's by far the most

393
00:19:54,230 --> 00:19:52,240
important flight that we plan to do

394
00:19:56,470 --> 00:19:54,240
it'll be the first powered flight by an

395
00:19:58,789 --> 00:19:56,480
aircraft in another planet

396
00:19:59,990 --> 00:19:58,799
and we've in fact met most of our goals

397
00:20:01,669 --> 00:20:00,000
for this project

398
00:20:03,270 --> 00:20:01,679
just by getting to the point where we

399
00:20:04,950 --> 00:20:03,280
are right now

400
00:20:06,870 --> 00:20:04,960
and will declare complete mission

401
00:20:08,390 --> 00:20:06,880
success if we do

402
00:20:10,230 --> 00:20:08,400
this first flight that we're going to

403
00:20:13,029 --> 00:20:10,240
attempt

404
00:20:13,750 --> 00:20:13,039
now the flight itself will consist of a

405
00:20:15,909 --> 00:20:13,760
takeoff

406
00:20:18,310 --> 00:20:15,919
and then a climb to an altitude of three

407
00:20:21,270 --> 00:20:18,320
meters

408
00:20:23,029 --> 00:20:21,280
and then we will hover in place uh for

409
00:20:25,029 --> 00:20:23,039
about 30 seconds and make a turn with

410
00:20:28,230 --> 00:20:25,039
the helicopter while we're hovering

411
00:20:30,789 --> 00:20:28,240
and then come down and land again

412
00:20:32,230 --> 00:20:30,799
and we have an engineering simulation uh

413
00:20:34,470 --> 00:20:32,240

here that shows

414
00:20:36,789 --> 00:20:34,480
what that flight might look like above

415
00:20:40,470 --> 00:20:36,799
the airfield that we have just

416
00:20:42,149 --> 00:20:40,480
chosen now when the helicopter goes to

417
00:20:44,070 --> 00:20:42,159
fly like this

418
00:20:45,270 --> 00:20:44,080
a few hours ago it's already received

419
00:20:47,430 --> 00:20:45,280
instructions from us

420
00:20:48,870 --> 00:20:47,440
on earth that describes exactly what

421
00:20:50,710 --> 00:20:48,880
that flight should look like

422
00:20:52,870 --> 00:20:50,720
the detailed trajectory that is going to

423
00:20:54,630 --> 00:20:52,880
follow how fast it's going to follow

424
00:20:56,789 --> 00:20:54,640
that trajectory

425
00:20:58,549 --> 00:20:56,799
where and when it's going to turn when

426
00:21:00,630 --> 00:20:58,559
it's going to take picture etc

427
00:21:03,510 --> 00:21:00,640
so it knows knows at that point exactly

428
00:21:05,510 --> 00:21:03,520
what we would like it to do

429
00:21:07,110 --> 00:21:05,520
but it has to work very hard during the

430
00:21:08,630 --> 00:21:07,120
flight itself in order to make that

431
00:21:10,390 --> 00:21:08,640
happen

432
00:21:12,549 --> 00:21:10,400
in particular it takes images of the

433
00:21:15,190 --> 00:21:12,559
ground below it at a rate of 30

434
00:21:15,990 --> 00:21:15,200
images per second and analyzes those in

435
00:21:18,149 --> 00:21:16,000
order to track

436
00:21:19,029 --> 00:21:18,159
the features on the ground to see how it

437
00:21:22,230 --> 00:21:19,039
is moving

438
00:21:23,830 --> 00:21:22,240

across the ground and it combines that

439
00:21:25,830 --> 00:21:23,840
with other sensor measurements in order

440
00:21:27,510 --> 00:21:25,840
to make tiny adjustments to the controls

441
00:21:29,430 --> 00:21:27,520
500 times per second

442
00:21:30,789 --> 00:21:29,440
to stay exactly on the trajectory that

443
00:21:32,870 --> 00:21:30,799
we've prescribed for it

444
00:21:34,789 --> 00:21:32,880
and to fight off disturbances that tries

445
00:21:38,230 --> 00:21:34,799
to take it away from that trajectory

446
00:21:42,070 --> 00:21:40,470
so with that i'd like to turn it over to

447
00:21:42,710 --> 00:21:42,080
pharah who is going to talk about how

448
00:21:44,549 --> 00:21:42,720
the rover

449
00:21:45,830 --> 00:21:44,559
will be supporting the helicopter during

450
00:21:48,310 --> 00:21:45,840
the flight experiment

451
00:21:49,990 --> 00:21:48,320
thanks hovard so yeah i'm going to be

452
00:21:51,590 --> 00:21:50,000
talking to you a little bit about how we

453
00:21:53,750 --> 00:21:51,600
get from where we are today

454
00:21:55,750 --> 00:21:53,760
to that first flight early in april and

455
00:21:58,310 --> 00:21:55,760
how the rover team is supporting

456
00:21:59,590 --> 00:21:58,320
the ingenuity mission so if we look at

457
00:22:01,830 --> 00:21:59,600
our first picture here

458
00:22:02,950 --> 00:22:01,840
i love this picture we took this picture

459
00:22:05,669 --> 00:22:02,960
on sunday

460
00:22:07,990 --> 00:22:05,679
on mars using our robotic arm and we

461
00:22:09,510 --> 00:22:08,000
peeked under the belly of the rover

462
00:22:11,270 --> 00:22:09,520
and what you're looking at here is the

463
00:22:13,590 --> 00:22:11,280

debris shield on the ground

464
00:22:15,029 --> 00:22:13,600
that's the debris shield that protected

465
00:22:17,430 --> 00:22:15,039
our helicopter

466
00:22:19,110 --> 00:22:17,440
as we were landing on mars last month

467
00:22:19,590 --> 00:22:19,120
but what's the coolest thing is you can

468
00:22:21,750 --> 00:22:19,600
see

469
00:22:23,430 --> 00:22:21,760
engineering there all tucked in below

470
00:22:26,230 --> 00:22:23,440
the rover doing okay

471
00:22:28,870 --> 00:22:26,240
everything is all in place and she's

472
00:22:30,549 --> 00:22:28,880
ready to get to the surface of mars

473
00:22:32,310 --> 00:22:30,559
so what's going on right now is that

474
00:22:34,149 --> 00:22:32,320
we're driving to that helicopter

475
00:22:35,909 --> 00:22:34,159
deployment area that hover just talked

476
00:22:38,390 --> 00:22:35,919
about that's going to take another

477
00:22:40,230 --> 00:22:38,400
couple of days and then when we get

478
00:22:42,710 --> 00:22:40,240
there we're going to

479
00:22:44,870 --> 00:22:42,720
go through a series of steps to get the

480
00:22:45,909 --> 00:22:44,880
helicopter from its current horizontal

481
00:22:47,669 --> 00:22:45,919
position

482
00:22:49,350 --> 00:22:47,679
all the way to being vertical and then

483
00:22:51,909 --> 00:22:49,360
being dropped on the ground

484
00:22:53,430 --> 00:22:51,919
that's a very prescribed and meticulous

485
00:22:55,669 --> 00:22:53,440
process where we

486
00:22:57,590 --> 00:22:55,679
separate there's a number of launch

487
00:22:58,630 --> 00:22:57,600
locks and attachments that we separate

488
00:23:00,310 --> 00:22:58,640

one by one

489
00:23:01,669 --> 00:23:00,320
we're going to be imaging each time

490
00:23:03,029 --> 00:23:01,679
making sure that the helicopter is in

491
00:23:04,470 --> 00:23:03,039
the expected position

492
00:23:06,549 --> 00:23:04,480
before dropping it on the ground so

493
00:23:08,630 --> 00:23:06,559
that's going to take multiple days

494
00:23:09,830 --> 00:23:08,640
with the most stressful day at least

495
00:23:11,750 --> 00:23:09,840
from for me

496
00:23:14,070 --> 00:23:11,760
is going to be that last day while we

497
00:23:16,470 --> 00:23:14,080
finally separate the helicopter

498
00:23:17,909 --> 00:23:16,480
and drop ingenuity on the ground and if

499
00:23:21,029 --> 00:23:17,919
we keep up the video here

500
00:23:24,230 --> 00:23:21,039
you can see um the testing that we did

501
00:23:26,149 --> 00:23:24,240
in the mars yard which is you know our

502
00:23:27,270 --> 00:23:26,159
version of mars here on earth when we do

503
00:23:28,950 --> 00:23:27,280
all our testing

504
00:23:31,190 --> 00:23:28,960
where we dropped that helicopter and

505
00:23:33,590 --> 00:23:31,200
backed away from it very slowly

506
00:23:34,549 --> 00:23:33,600
so on that last day we released the last

507
00:23:35,990 --> 00:23:34,559
restraint

508
00:23:37,830 --> 00:23:36,000
and slowly drive away from the

509
00:23:39,110 --> 00:23:37,840
helicopter making sure that we don't hit

510
00:23:41,350 --> 00:23:39,120
it or anything

511
00:23:43,269 --> 00:23:41,360
and what's most stressful is that once

512
00:23:45,269 --> 00:23:43,279
the helicopter is separated

513
00:23:47,190 --> 00:23:45,279

we actually have to drive away from it

514
00:23:49,669 --> 00:23:47,200
within 25 hours

515
00:23:51,590 --> 00:23:49,679
because as bob mentioned the helicopter

516
00:23:53,350 --> 00:23:51,600
needs photons it needs sun

517
00:23:55,510 --> 00:23:53,360
on its solar panels to charge its

518
00:23:57,590 --> 00:23:55,520
batteries and it can only survive one

519
00:23:59,190 --> 00:23:57,600
martian night without that

520
00:24:01,110 --> 00:23:59,200
so that's going to be a very stressful

521
00:24:01,750 --> 00:24:01,120
period but what i look forward to the

522
00:24:03,750 --> 00:24:01,760
most

523
00:24:06,070 --> 00:24:03,760
is after we do that drive we're going to

524
00:24:08,870 --> 00:24:06,080
get that first shot of ingenuity

525
00:24:09,750 --> 00:24:08,880
on the surface of mars on her own there

526
00:24:12,230 --> 00:24:09,760
and i just

527
00:24:13,510 --> 00:24:12,240
cannot wait uh to get that first picture

528
00:24:15,669 --> 00:24:13,520
i think it's going to be a really great

529
00:24:17,350 --> 00:24:15,679
moment for the entire team

530
00:24:19,350 --> 00:24:17,360
so after we've dropped ingenuity on the

531
00:24:21,269 --> 00:24:19,360
ground as bob mentioned

532
00:24:23,110 --> 00:24:21,279
the helicopter is going to go through a

533
00:24:23,750 --> 00:24:23,120
series of commissioning steps right

534
00:24:26,070 --> 00:24:23,760
wiggling

535
00:24:27,269 --> 00:24:26,080
the the blades check doing a bunch of

536
00:24:29,110 --> 00:24:27,279
checkouts

537
00:24:31,029 --> 00:24:29,120
from our end the rover is going to

538
00:24:33,430 --> 00:24:31,039

slowly be backing away

539
00:24:34,789 --> 00:24:33,440
imaging ingenuity every step of the way

540
00:24:37,669 --> 00:24:34,799
to what we call

541
00:24:39,269 --> 00:24:37,679
the rover observation location think of

542
00:24:40,789 --> 00:24:39,279
it as a lookout point like if you ever

543
00:24:42,549 --> 00:24:40,799
go to a national park and you have a

544
00:24:43,350 --> 00:24:42,559
beautiful view you want to park there

545
00:24:44,789 --> 00:24:43,360
and look

546
00:24:46,950 --> 00:24:44,799
our rover's going to do that and our

547
00:24:49,269 --> 00:24:46,960
beautiful view is going to be ingenuity

548
00:24:51,029 --> 00:24:49,279
and we are going to do our very best to

549
00:24:51,750 --> 00:24:51,039
capture ingenuity in flight we're going

550
00:24:54,310 --> 00:24:51,760
to be taking

551
00:24:55,990 --> 00:24:54,320
images we're hoping to take video now

552
00:24:57,669 --> 00:24:56,000
i'm going to warn you it's hard

553
00:24:59,350 --> 00:24:57,679
you know space is hard and in this case

554
00:25:00,950 --> 00:24:59,360
we have two missions

555
00:25:02,950 --> 00:25:00,960
that have their own separate clocks and

556
00:25:05,269 --> 00:25:02,960
we gotta get that timing right

557
00:25:07,110 --> 00:25:05,279
to get that first flight uh but we're uh

558
00:25:09,990 --> 00:25:07,120
we're trying very very hard um

559
00:25:11,110 --> 00:25:10,000
to catch that and get that so before i

560
00:25:12,789 --> 00:25:11,120
hand it over here

561
00:25:14,710 --> 00:25:12,799
i just wanted to give you a little bit

562
00:25:15,350 --> 00:25:14,720
of an anecdote a little bit of a

563
00:25:17,909 --> 00:25:15,360

personal

564
00:25:18,710 --> 00:25:17,919
uh side to this so on the on the rover

565
00:25:20,310 --> 00:25:18,720
side we're

566
00:25:21,990 --> 00:25:20,320
we're kind of a small team supporting

567
00:25:24,310 --> 00:25:22,000
the ingenuity team

568
00:25:26,390 --> 00:25:24,320
all of us have our own day jobs

569
00:25:28,070 --> 00:25:26,400
supporting the rover mission itself

570
00:25:30,230 --> 00:25:28,080
and all of us were asked at some point

571
00:25:31,990 --> 00:25:30,240
hey can you help make this mission

572
00:25:33,350 --> 00:25:32,000
happen i still remember the phone call

573
00:25:35,510 --> 00:25:33,360
where i was told hey far

574
00:25:37,510 --> 00:25:35,520
you know we know you're busy but that's

575
00:25:39,750 --> 00:25:37,520
this helicopter do you want to help

576
00:25:42,870 --> 00:25:39,760
with operations and of course my answer

577
00:25:46,149 --> 00:25:42,880
was absolutely yes uh and it's been

578
00:25:48,470 --> 00:25:46,159
such fun uh you know hovard and and bob

579
00:25:50,870 --> 00:25:48,480
it's it's been an honor for our team

580
00:25:52,630 --> 00:25:50,880
to be able to support you to and your

581
00:25:53,350 --> 00:25:52,640
team and to be part of this historic

582
00:25:55,430 --> 00:25:53,360
event i

583
00:25:57,510 --> 00:25:55,440
you know really appreciate you you

584
00:25:59,350 --> 00:25:57,520
taking us on your journey and i just

585
00:26:01,510 --> 00:25:59,360
cannot wait to spend the next you know

586
00:26:02,950 --> 00:26:01,520
40 or so days with you here

587
00:26:04,710 --> 00:26:02,960
getting ingenuity on the ground and

588
00:26:06,149 --> 00:26:04,720

supporting you on that first play thank

589
00:26:08,390 --> 00:26:06,159
you farah and the entire

590
00:26:10,549 --> 00:26:08,400
mars 2020 perseverance team for being so

591
00:26:12,470 --> 00:26:10,559
helpful and giving us those precious

592
00:26:14,390 --> 00:26:12,480
month on mars for us to do our

593
00:26:16,070 --> 00:26:14,400
engineering experiment thank you so much

594
00:26:18,230 --> 00:26:16,080
absolutely it's been a it's been a great

595
00:26:19,590 --> 00:26:18,240
collaboration and um so with that i'll

596
00:26:21,110 --> 00:26:19,600
hand it over to bobby

597
00:26:23,029 --> 00:26:21,120
who's gonna tell you a little bit more

598
00:26:25,909 --> 00:26:23,039
about the team and wrap things up

599
00:26:26,870 --> 00:26:25,919
well thank you appreciate that before i

600
00:26:28,789 --> 00:26:26,880
get started

601
00:26:30,470 --> 00:26:28,799
i just wanted to say a little bit about

602
00:26:33,430 --> 00:26:30,480
my former community

603
00:26:34,070 --> 00:26:33,440
in boulder i've been at jpl for about a

604
00:26:36,230 --> 00:26:34,080
year now

605
00:26:37,990 --> 00:26:36,240
and prior to that i had the privilege of

606
00:26:40,870 --> 00:26:38,000
serving as the dean of engineering

607
00:26:41,990 --> 00:26:40,880
at the university of colorado boulder

608
00:26:43,669 --> 00:26:42,000
and i just want to say

609
00:26:45,190 --> 00:26:43,679
that you know from all of us here that

610
00:26:47,750 --> 00:26:45,200
our our hearts go out

611
00:26:48,630 --> 00:26:47,760
to that community today boulder is a

612
00:26:50,710 --> 00:26:48,640
special place

613
00:26:52,789 --> 00:26:50,720

for many reasons one of which is the

614
00:26:55,750 --> 00:26:52,799
connection to aerospace

615
00:26:57,909 --> 00:26:55,760
and and space exploration in fact jpl

616
00:26:58,870 --> 00:26:57,919
has many partners in boulder and across

617
00:27:01,510 --> 00:26:58,880
colorado

618
00:27:03,510 --> 00:27:01,520
and so to my former students the faculty

619
00:27:05,669 --> 00:27:03,520
and staff that i worked with every day

620
00:27:06,630 --> 00:27:05,679
and the whole boulder community i just

621
00:27:08,630 --> 00:27:06,640
want to say that

622
00:27:09,909 --> 00:27:08,640
we stand with you and know that you'll

623
00:27:13,590 --> 00:27:09,919
get through this

624
00:27:15,909 --> 00:27:13,600
thank you this past year

625
00:27:17,590 --> 00:27:15,919
our world and the lab has largely been

626
00:27:19,909 --> 00:27:17,600
about perseverance

627
00:27:21,750 --> 00:27:19,919
but as we approach april while we

628
00:27:24,310 --> 00:27:21,760
continue persevering

629
00:27:25,909 --> 00:27:24,320
it feels a lot to me like the month of

630
00:27:31,269 --> 00:27:25,919
ingenuity

631
00:27:31,990 --> 00:27:31,279
are primed to make space history in

632
00:27:33,990 --> 00:27:32,000
april

633
00:27:36,389 --> 00:27:34,000
marking humanity's wright brothers

634
00:27:37,029 --> 00:27:36,399
moment the first flight of a powered

635
00:27:40,310 --> 00:27:37,039
craft

636
00:27:41,590 --> 00:27:40,320
on mars ingenuity is an apt descriptor

637
00:27:44,230 --> 00:27:41,600
for the helicopter

638
00:27:45,190 --> 00:27:44,240

but also for this team i've watched them

639
00:27:48,230 --> 00:27:45,200
closely they're

640
00:27:51,990 --> 00:27:48,240
close knit resourceful creative

641
00:27:53,590 --> 00:27:52,000
imaginative a diverse team of innovators

642
00:27:55,830 --> 00:27:53,600
and i want to take just a moment on

643
00:27:56,230 --> 00:27:55,840
behalf of the lab to thank the whole

644
00:27:58,070 --> 00:27:56,240
team

645
00:27:59,669 --> 00:27:58,080
for what they've already accomplished

646
00:28:02,310 --> 00:27:59,679
what they've already taught us

647
00:28:03,269 --> 00:28:02,320
about perseverance and ingenuity as they

648
00:28:05,909 --> 00:28:03,279
traveled the road

649
00:28:07,909 --> 00:28:05,919
to mars now this team would be the first

650
00:28:08,630 --> 00:28:07,919
to tell you that while they may be able

651
00:28:11,190 --> 00:28:08,640
to fly

652
00:28:12,630 --> 00:28:11,200
in a near vacuum they couldn't build

653
00:28:14,870 --> 00:28:12,640
ingenuity in one

654
00:28:17,110 --> 00:28:14,880
and in fact we've had a great set of

655
00:28:20,230 --> 00:28:17,120
partners in this endeavor

656
00:28:22,389 --> 00:28:20,240
with their deep knowledge of rotocraft

657
00:28:24,470 --> 00:28:22,399
the nasa ames research center has been a

658
00:28:25,669 --> 00:28:24,480
source of invaluable assistance to this

659
00:28:27,510 --> 00:28:25,679
project

660
00:28:29,269 --> 00:28:27,520
nasa langley research center made

661
00:28:31,029 --> 00:28:29,279
significant contributions

662
00:28:33,350 --> 00:28:31,039
in the area of computational fluid

663
00:28:35,269 --> 00:28:33,360

dynamics and in addition i'd like to

664
00:28:38,149 --> 00:28:35,279
thank some of our partners

665
00:28:40,070 --> 00:28:38,159
at aerovironment at qualcomm and at

666
00:28:43,269 --> 00:28:40,080
lockheed martin

667
00:28:46,389 --> 00:28:43,279
as dr glaze mentioned earlier ingenuity

668
00:28:48,950 --> 00:28:46,399
is a tech demo and historically speaking

669
00:28:49,990 --> 00:28:48,960
it wasn't that long ago that another

670
00:28:52,870 --> 00:28:50,000
martian tech

671
00:28:54,149 --> 00:28:52,880
demo was assembled in a clean room only

672
00:28:57,029 --> 00:28:54,159
a few hundred meters

673
00:28:59,190 --> 00:28:57,039
from where we are today sojourner

674
00:29:02,230 --> 00:28:59,200
sojourner demonstrated the value

675
00:29:02,710 --> 00:29:02,240
of surface mobility and that tech demo

676
00:29:05,029 --> 00:29:02,720
mission

677
00:29:06,070 --> 00:29:05,039
was followed by the great scientific

678
00:29:09,830 --> 00:29:06,080
discoveries

679
00:29:11,669 --> 00:29:09,840
of spirit opportunity and curiosity

680
00:29:12,950 --> 00:29:11,679
now we've now added the name of

681
00:29:16,710 --> 00:29:12,960
perseverance to that

682
00:29:19,430 --> 00:29:16,720
impressive list a series of increasingly

683
00:29:20,389 --> 00:29:19,440
sophisticated science emissaries that

684
00:29:22,389 --> 00:29:20,399
have advanced

685
00:29:23,510 --> 00:29:22,399
our knowledge of mars and taught us a

686
00:29:25,590 --> 00:29:23,520
little bit more

687
00:29:26,789 --> 00:29:25,600
about our home planet earth they've

688
00:29:29,909 --> 00:29:26,799

brought mars home

689
00:29:32,070 --> 00:29:29,919
to all of us and to think it all started

690
00:29:34,789 --> 00:29:32,080
with a tech demo

691
00:29:36,389 --> 00:29:34,799
in this same spirit i can only imagine

692
00:29:39,350 --> 00:29:36,399
where we may be a decade

693
00:29:40,870 --> 00:29:39,360
or so from now if we can scout and

694
00:29:43,669 --> 00:29:40,880
scientifically survey

695
00:29:44,870 --> 00:29:43,679
mars from the air with its thin

696
00:29:47,269 --> 00:29:44,880
atmosphere

697
00:29:49,430 --> 00:29:47,279
we can certainly do the same in a number

698
00:29:49,909 --> 00:29:49,440
of other destinations across the solar

699
00:29:53,269 --> 00:29:49,919
system

700
00:29:55,350 --> 00:29:53,279
like titan or venus we can provide

701
00:29:56,870 --> 00:29:55,360
higher resolution measurements perhaps

702
00:29:59,430 --> 00:29:56,880
from orbit

703
00:30:00,149 --> 00:29:59,440
fly farther perhaps than a rover could

704
00:30:03,110 --> 00:30:00,159
traverse

705
00:30:03,750 --> 00:30:03,120
or access sites that are difficult to

706
00:30:06,230 --> 00:30:03,760
reach

707
00:30:08,789 --> 00:30:06,240
by these other means the future of

708
00:30:13,029 --> 00:30:08,799
powered flight in space exploration

709
00:30:16,630 --> 00:30:13,039
is solid and strong now i'd like to

710
00:30:19,750 --> 00:30:16,640
take a moment to talk about the location

711
00:30:21,990 --> 00:30:19,760
that perseverance is headed towards

712
00:30:22,950 --> 00:30:22,000
and from which it will watch over

713
00:30:26,149 --> 00:30:22,960

ingenuity's

714
00:30:27,990 --> 00:30:26,159
historic flight the team has decided to

715
00:30:31,269 --> 00:30:28,000
name this location on mars

716
00:30:34,630 --> 00:30:31,279
in honor of our long time colleague

717
00:30:37,990 --> 00:30:34,640
mentor and leader here at jpl

718
00:30:39,590 --> 00:30:38,000
jacob vanzil jacob passed away

719
00:30:42,710 --> 00:30:39,600
unexpectedly

720
00:30:44,630 --> 00:30:42,720
in august of 2020 about a month after

721
00:30:47,830 --> 00:30:44,640
the perseverance launch

722
00:30:51,110 --> 00:30:47,840
he joined jpl in 1986

723
00:30:51,990 --> 00:30:51,120
and served crucial roles over a 33-year

724
00:30:54,630 --> 00:30:52,000
career

725
00:30:57,029 --> 00:30:54,640
that touched nearly all aspects of the

726
00:30:59,029 --> 00:30:57,039
science operations that we conduct at

727
00:31:01,029 --> 00:30:59,039
jpl

728
00:31:03,350 --> 00:31:01,039
from ushering in the use of synthetic

729
00:31:05,350 --> 00:31:03,360
aperture radars for earth science

730
00:31:07,190 --> 00:31:05,360
to leading the teams responsible for

731
00:31:10,710 --> 00:31:07,200
making breakthrough discoveries

732
00:31:11,430 --> 00:31:10,720
in the cosmos jacob was a renaissance

733
00:31:14,310 --> 00:31:11,440
man

734
00:31:15,350 --> 00:31:14,320
he seemed to do it all he contributed to

735
00:31:17,350 --> 00:31:15,360
the success

736
00:31:18,630 --> 00:31:17,360
of the spitzer and kepler space

737
00:31:21,509 --> 00:31:18,640
telescopes

738
00:31:23,750 --> 00:31:21,519

to juno's mission to jupiter to the dawn

739
00:31:24,710 --> 00:31:23,760
mission to the asteroids cassini to

740
00:31:28,870 --> 00:31:24,720
saturn

741
00:31:29,669 --> 00:31:28,880
and insight mars lander jacob was also a

742
00:31:32,549 --> 00:31:29,679
pioneer

743
00:31:33,669 --> 00:31:32,559
and an innovator himself who helped

744
00:31:36,470 --> 00:31:33,679
develop

745
00:31:37,509 --> 00:31:36,480
the marco mission with the which were

746
00:31:40,389 --> 00:31:37,519
the world's first

747
00:31:42,389 --> 00:31:40,399
interplanetary small spacecraft which

748
00:31:45,350 --> 00:31:42,399
flew as a tech companion

749
00:31:45,990 --> 00:31:45,360
along with the insight lander when

750
00:31:49,509 --> 00:31:46,000
ingenuity

751
00:31:52,630 --> 00:31:49,519
was conceived here at jpl it was jacob

752
00:31:53,430 --> 00:31:52,640
who pushed this team forward a native of

753
00:31:56,230 --> 00:31:53,440
namibia

754
00:31:58,470 --> 00:31:56,240
jacob came to america in 1982 as a

755
00:32:00,870 --> 00:31:58,480
graduate student at caltech

756
00:32:02,149 --> 00:32:00,880
where he earned a masters and phd in

757
00:32:04,789 --> 00:32:02,159
electrical engineering

758
00:32:06,070 --> 00:32:04,799
and he began to work at jpl immediately

759
00:32:08,230 --> 00:32:06,080
thereafter

760
00:32:10,310 --> 00:32:08,240
he was passionate about sharing the

761
00:32:13,990 --> 00:32:10,320
excitement of space exploration

762
00:32:16,389 --> 00:32:14,000
with the people of namibia across africa

763
00:32:18,549 --> 00:32:16,399

and across the globe with his wife

764
00:32:21,669 --> 00:32:18,559
khalfie he returned again and again

765
00:32:24,950 --> 00:32:21,679
to his homeland to conduct stem outreach

766
00:32:26,710 --> 00:32:24,960
on behalf of the space program now jacob

767
00:32:29,830 --> 00:32:26,720
was a dear friend

768
00:32:33,430 --> 00:32:29,840
a mentor and a devoted teammate to me

769
00:32:35,590 --> 00:32:33,440
and to all of us across jpl

770
00:32:37,830 --> 00:32:35,600
it remains hard for many of us to

771
00:32:41,430 --> 00:32:37,840
imagine our community without

772
00:32:44,070 --> 00:32:41,440
his light and smile ingenuity was one of

773
00:32:46,950 --> 00:32:44,080
jacob's final projects at jpl

774
00:32:47,750 --> 00:32:46,960
and it would not exist today without his

775
00:32:50,950 --> 00:32:47,760
leadership

776
00:32:52,389 --> 00:32:50,960
dedication and patience he was the

777
00:32:56,230 --> 00:32:52,399
guiding force

778
00:32:59,430 --> 00:32:56,240
watching over this team his team

779
00:33:03,029 --> 00:32:59,440
and he would have been so proud to see

780
00:33:05,990 --> 00:33:03,039
the product of this team's hard work

781
00:33:06,870 --> 00:33:06,000
on behalf of all of us at nasa at

782
00:33:09,830 --> 00:33:06,880
caltech

783
00:33:12,070 --> 00:33:09,840
and at jpl and in particular on behalf

784
00:33:12,789 --> 00:33:12,080
of the perseverance and ingenuity teams

785
00:33:15,990 --> 00:33:12,799
it's

786
00:33:18,630 --> 00:33:16,000
my honor to announce that today

787
00:33:19,430 --> 00:33:18,640
we are recognizing jacob's sustained and

788
00:33:22,310 --> 00:33:19,440

significant

789
00:33:24,070 --> 00:33:22,320
contributions to space science by naming

790
00:33:27,509 --> 00:33:24,080
the location on mars

791
00:33:30,549 --> 00:33:27,519
from which perseverance will look over

792
00:33:31,269 --> 00:33:30,559
ingenuity's historic flight as the van

793
00:33:34,310 --> 00:33:31,279
zeel

794
00:33:35,430 --> 00:33:34,320
overlook may he continue to watch over

795
00:33:38,630 --> 00:33:35,440
this team

796
00:33:41,110 --> 00:33:38,640
and may his memory continue to guide us

797
00:33:43,269 --> 00:33:41,120
encourage us to be bolder and dare

798
00:33:45,750 --> 00:33:43,279
mighty things

799
00:33:47,990 --> 00:33:45,760
thank you raquel back to you thank you

800
00:33:50,310 --> 00:33:48,000
for that beautiful tribute bobby

801
00:33:51,350 --> 00:33:50,320
and we are now ready to take media

802
00:33:53,669 --> 00:33:51,360
questions

803
00:33:54,389 --> 00:33:53,679
remember to press star one to get put in

804
00:33:56,470 --> 00:33:54,399
the queue

805
00:33:57,990 --> 00:33:56,480
and please direct your questions to one

806
00:34:00,149 --> 00:33:58,000
of our panelists

807
00:34:02,549 --> 00:34:00,159
we're also taking questions through the

808
00:34:05,029 --> 00:34:02,559
mars helicopter hashtag

809
00:34:06,070 --> 00:34:05,039
to start off on the phone lines is

810
00:34:09,190 --> 00:34:06,080
marcia dunn

811
00:34:12,470 --> 00:34:09,200
from the associated press yes hi

812
00:34:14,550 --> 00:34:12,480
um good afternoon um two quick questions

813
00:34:16,629 --> 00:34:14,560

um what could i have a little bit of a

814
00:34:18,550 --> 00:34:16,639
timeline in april as to when you think

815
00:34:21,109 --> 00:34:18,560
you'll be meeting your milestones and

816
00:34:23,109 --> 00:34:21,119
what target date at this point no

817
00:34:24,869 --> 00:34:23,119
earlier than date do you think the first

818
00:34:26,950 --> 00:34:24,879
flight might occur

819
00:34:28,389 --> 00:34:26,960
and the fabric sample from the right

820
00:34:30,710 --> 00:34:28,399
flyer could you tell me how

821
00:34:34,389 --> 00:34:30,720
how large of a piece of sample that is

822
00:34:36,310 --> 00:34:34,399
that flew on ingenuity thank you

823
00:34:38,470 --> 00:34:36,320
yes so let me take that so our current

824
00:34:38,950 --> 00:34:38,480
best estimate of when the flight could

825
00:34:41,829 --> 00:34:38,960
happen

826
00:34:42,710 --> 00:34:41,839
is no earlier than about april 8th but

827
00:34:44,629 --> 00:34:42,720
things are fluid

828
00:34:46,069 --> 00:34:44,639
as i mentioned we are very event and

829
00:34:48,069 --> 00:34:46,079
experiment driven

830
00:34:49,510 --> 00:34:48,079
so that could be changed by a few days

831
00:34:51,829 --> 00:34:49,520
in either direction

832
00:34:53,829 --> 00:34:51,839
but uh that's the best guess that we

833
00:34:55,990 --> 00:34:53,839
have right now is april 8th

834
00:34:57,910 --> 00:34:56,000
the the piece of fabric is about the

835
00:35:00,230 --> 00:34:57,920
size of a postage stamp

836
00:35:01,430 --> 00:35:00,240
and so it's really a small little

837
00:35:04,230 --> 00:35:01,440
element that's been

838
00:35:04,950 --> 00:35:04,240

sealed and wrapped in appropriately and

839
00:35:07,349 --> 00:35:04,960
has been

840
00:35:09,190 --> 00:35:07,359
attached to a small cable on the

841
00:35:10,950 --> 00:35:09,200
underside of the solar panel

842
00:35:12,630 --> 00:35:10,960
and it's called pride of the west that's

843
00:35:16,790 --> 00:35:12,640
the kind of fabric that was used

844
00:35:18,390 --> 00:35:16,800
on the original flyer and this like

845
00:35:23,670 --> 00:35:18,400
that's what's there on ingenuity right

846
00:35:28,829 --> 00:35:27,030
great and up next we have bob brinkman

847
00:35:31,030 --> 00:35:28,839
from

848
00:35:34,310 --> 00:35:31,040
upi

849
00:35:36,230 --> 00:35:34,320
hi yeah this is paul um i

850
00:35:37,750 --> 00:35:36,240
was wondering i know nasa doesn't like

851
00:35:41,109 --> 00:35:37,760
to get ahead of itself

852
00:35:43,190 --> 00:35:41,119
but if engine ingenuity is a total

853
00:35:44,870 --> 00:35:43,200
success

854
00:35:47,910 --> 00:35:44,880
how soon do you do you think we could

855
00:35:50,390 --> 00:35:47,920
see another helicopter on mars um

856
00:35:51,190 --> 00:35:50,400
i guess this would be for for laurie or

857
00:35:53,190 --> 00:35:51,200
bobby

858
00:35:55,510 --> 00:35:53,200
um i mean i'm wondering if nasa would

859
00:35:57,829 --> 00:35:55,520
seek to add a new mission for that

860
00:35:59,190 --> 00:35:57,839
or uh is it possible that the sample

861
00:36:03,750 --> 00:35:59,200
return mission could

862
00:36:07,510 --> 00:36:05,829
i can take that one if you like at least

863
00:36:08,150 --> 00:36:07,520

start and then maybe bobby might want to

864
00:36:11,430 --> 00:36:08,160
expand

865
00:36:13,349 --> 00:36:11,440
but from the nasa experience perspective

866
00:36:14,870 --> 00:36:13,359
i think this is going to be really uh

867
00:36:16,230 --> 00:36:14,880
like i said an enabling

868
00:36:17,990 --> 00:36:16,240
uh capability that we're going to

869
00:36:19,190 --> 00:36:18,000
demonstrate um hopefully with the

870
00:36:23,030 --> 00:36:19,200
flights over the next

871
00:36:25,030 --> 00:36:23,040
several weeks um as far as uh you know

872
00:36:26,710 --> 00:36:25,040
identifying a specific opportunity in

873
00:36:28,870 --> 00:36:26,720
the near future

874
00:36:31,270 --> 00:36:28,880
what we like to do within nasa is to

875
00:36:34,310 --> 00:36:31,280
provide competitive opportunities to

876
00:36:36,390 --> 00:36:34,320
our community and so we do offer those

877
00:36:39,190 --> 00:36:36,400
on a periodic basis

878
00:36:39,990 --> 00:36:39,200
and would hope that the the community

879
00:36:42,710 --> 00:36:40,000
will see this as a

880
00:36:44,470 --> 00:36:42,720
great opportunity uh to start thinking

881
00:36:45,109 --> 00:36:44,480
about aerial platforms as a potential

882
00:36:47,670 --> 00:36:45,119
way

883
00:36:48,710 --> 00:36:47,680
uh to to really expand our mars

884
00:36:50,630 --> 00:36:48,720
exploration

885
00:36:51,829 --> 00:36:50,640
um so that's that's the most likely

886
00:36:54,550 --> 00:36:51,839
pathway in the

887
00:36:55,030 --> 00:36:54,560
in the immediate future yeah and if i

888
00:36:57,670 --> 00:36:55,040

could just

889
00:36:58,710 --> 00:36:57,680
add to that um it's a very analogous

890
00:37:02,069 --> 00:36:58,720
situation

891
00:37:04,230 --> 00:37:02,079
to when uh sojourner uh first flew

892
00:37:05,349 --> 00:37:04,240
uh and did its thing on mars um at that

893
00:37:07,589 --> 00:37:05,359
time

894
00:37:09,030 --> 00:37:07,599
um you know spirit and opportunity were

895
00:37:11,510 --> 00:37:09,040
not in the plan

896
00:37:14,310 --> 00:37:11,520
but after the sojourner's success which

897
00:37:17,430 --> 00:37:14,320
proved the ability of surface mobility

898
00:37:18,470 --> 00:37:17,440
uh you know there was a change in plans

899
00:37:21,030 --> 00:37:18,480
and an evolution

900
00:37:22,550 --> 00:37:21,040
in people's thinking and i you know it's

901
00:37:26,150 --> 00:37:22,560
quite possible that we could

902
00:37:28,790 --> 00:37:26,160
have a similar evolution here uh where

903
00:37:32,630 --> 00:37:28,800
future autonomous aerial systems could

904
00:37:35,990 --> 00:37:34,310
thank you for your answers up next we

905
00:37:39,270 --> 00:37:36,000
have mike wahl from

906
00:37:44,310 --> 00:37:41,589
thank you all for doing this um just a

907
00:37:45,829 --> 00:37:44,320
quick question is that like 31 day kind

908
00:37:47,190 --> 00:37:45,839
of mission length for ingenuity is that

909
00:37:48,870 --> 00:37:47,200
a hard deadline or

910
00:37:50,950 --> 00:37:48,880
is there a world that you could where

911
00:37:51,589 --> 00:37:50,960
you could see ingenuity operating beyond

912
00:37:53,430 --> 00:37:51,599
that

913
00:37:54,630 --> 00:37:53,440

and if it performs really well on those

914
00:37:56,950 --> 00:37:54,640
initial flights like

915
00:37:58,550 --> 00:37:56,960
actually doing some some work for

916
00:38:01,910 --> 00:37:58,560
perseverance helping it scout

917
00:38:03,030 --> 00:38:01,920
and so far thanks bobby would you like

918
00:38:05,190 --> 00:38:03,040
to take that

919
00:38:06,310 --> 00:38:05,200
yeah i'll take that it's the month of

920
00:38:08,870 --> 00:38:06,320
ingenuity

921
00:38:10,230 --> 00:38:08,880
right and uh we're very confident that

922
00:38:13,109 --> 00:38:10,240
we can conduct

923
00:38:15,750 --> 00:38:13,119
our technology demonstration uh and meet

924
00:38:17,510 --> 00:38:15,760
all of its objectives in that month

925
00:38:19,109 --> 00:38:17,520
we also have a science mission to

926
00:38:21,190 --> 00:38:19,119
conduct a very important

927
00:38:23,190 --> 00:38:21,200
science mission that's going to gather

928
00:38:24,950 --> 00:38:23,200
the samples that will eventually

929
00:38:27,030 --> 00:38:24,960
come back to earth as part of the mars

930
00:38:30,950 --> 00:38:27,040
sample return campaign

931
00:38:33,270 --> 00:38:30,960
so that month is our window to conduct

932
00:38:37,670 --> 00:38:33,280
the technology demonstration experiment

933
00:38:43,430 --> 00:38:39,670
thank you bobby up next we have irene

934
00:38:46,150 --> 00:38:43,440
klotz from aviation weekly

935
00:38:47,270 --> 00:38:46,160
thanks very much my question is for bob

936
00:38:50,390 --> 00:38:47,280
balaram

937
00:38:51,990 --> 00:38:50,400
um you mentioned the fluid testing in

938
00:38:54,470 --> 00:38:52,000

the chamber of course

939
00:38:55,349 --> 00:38:54,480
what do you think is the riskiest part

940
00:38:58,790 --> 00:38:55,359
of actually

941
00:39:01,990 --> 00:38:58,800
flying this on mars is it dust or

942
00:39:03,990 --> 00:39:02,000
is there some other element that

943
00:39:06,310 --> 00:39:04,000
obviously you couldn't test for on earth

944
00:39:08,390 --> 00:39:06,320
that kind of has the team

945
00:39:10,630 --> 00:39:08,400
most curious about what's going to

946
00:39:12,470 --> 00:39:10,640
happen

947
00:39:14,150 --> 00:39:12,480
yeah i think the biggest challenge will

948
00:39:16,310 --> 00:39:14,160
be that we are flying in

949
00:39:18,550 --> 00:39:16,320
the atmosphere of mars which has its own

950
00:39:20,790 --> 00:39:18,560
dynamics its own winds

951
00:39:22,390 --> 00:39:20,800
uh wind gusts and so forth and these are

952
00:39:24,230 --> 00:39:22,400
things which we

953
00:39:25,750 --> 00:39:24,240
tested with wind tunnels in our chamber

954
00:39:27,430 --> 00:39:25,760
we have some confidence that

955
00:39:28,950 --> 00:39:27,440
everything will be good but there's

956
00:39:30,470 --> 00:39:28,960
nothing that bees actually being in the

957
00:39:32,390 --> 00:39:30,480
real environment of mars

958
00:39:34,230 --> 00:39:32,400
to actually like uh you know see how

959
00:39:35,670 --> 00:39:34,240
well the flight in the aerodynamics

960
00:39:37,270 --> 00:39:35,680
actually works out

961
00:39:38,870 --> 00:39:37,280
there are also other challenges related

962
00:39:40,950 --> 00:39:38,880
to surviving the night

963
00:39:42,870 --> 00:39:40,960

we have a thermal system for this very

964
00:39:44,630 --> 00:39:42,880
small system which is

965
00:39:45,990 --> 00:39:44,640
difficult to keep a small system warm

966
00:39:48,390 --> 00:39:46,000
through the night as uh

967
00:39:50,150 --> 00:39:48,400
as you can imagine and so just to see

968
00:39:51,270 --> 00:39:50,160
how well that thermal system protects us

969
00:39:52,950 --> 00:39:51,280
through the night

970
00:39:54,710 --> 00:39:52,960
how well does our solar panel work there

971
00:39:56,710 --> 00:39:54,720
are number of engineering aspects

972
00:39:58,550 --> 00:39:56,720
before you even get to the flight but

973
00:40:00,950 --> 00:39:58,560
when it comes to the actual flying

974
00:40:02,710 --> 00:40:00,960
it's the really the winds and the

975
00:40:04,309 --> 00:40:02,720
dynamics of how all of that interacts

976
00:40:07,990 --> 00:40:04,319
with the helicopter that would be the

977
00:40:11,030 --> 00:40:10,069
thank you bob up next we have joey

978
00:40:14,069 --> 00:40:11,040
roulette from

979
00:40:16,069 --> 00:40:14,079
the verge hey thanks

980
00:40:18,069 --> 00:40:16,079
um i was just wondering and this is for

981
00:40:19,270 --> 00:40:18,079
anybody who would like to answer

982
00:40:22,150 --> 00:40:19,280
is there anything that you guys have

983
00:40:23,990 --> 00:40:22,160
learned or anything that perseverance

984
00:40:26,230 --> 00:40:24,000
has experienced on mars since

985
00:40:28,790 --> 00:40:26,240
it landed that has changed your

986
00:40:30,230 --> 00:40:28,800
expectations for engineering's flight

987
00:40:32,950 --> 00:40:30,240
and also is there anything that would

988
00:40:34,390 --> 00:40:32,960

prevent um ingenuity or save ingenuity

989
00:40:35,990 --> 00:40:34,400
from blowing over

990
00:40:38,069 --> 00:40:36,000
if there's a gust of wind or something

991
00:40:40,710 --> 00:40:38,079
once perseverance backs away from it

992
00:40:44,550 --> 00:40:42,230
so we're learning more and more about

993
00:40:46,710 --> 00:40:44,560
the specific winds and atmosphere

994
00:40:48,390 --> 00:40:46,720
and temperatures and how you know how

995
00:40:49,910 --> 00:40:48,400
dusty the place is how much

996
00:40:51,430 --> 00:40:49,920
so we're getting a lot of information

997
00:40:53,750 --> 00:40:51,440
that is helping us

998
00:40:54,630 --> 00:40:53,760
finalize our plans but there is really

999
00:40:55,990 --> 00:40:54,640
no concern

1000
00:40:58,309 --> 00:40:56,000
in the sense of you know anything

1001
00:41:00,390 --> 00:40:58,319
blowing over the forces are really

1002
00:41:02,470 --> 00:41:00,400
quite small in terms of you know having

1003
00:41:04,790 --> 00:41:02,480
the helicopter topple over when it's

1004
00:41:06,150 --> 00:41:04,800
uh on the ground so really all the

1005
00:41:08,470 --> 00:41:06,160
challenges are related to

1006
00:41:09,510 --> 00:41:08,480
aerial flight and we will get more

1007
00:41:11,829 --> 00:41:09,520
information

1008
00:41:13,990 --> 00:41:11,839
all the way up to the day of the flight

1009
00:41:15,829 --> 00:41:14,000
we have a weather forecast team that is

1010
00:41:16,390 --> 00:41:15,839
telling us every day what the winds will

1011
00:41:17,990 --> 00:41:16,400
look like

1012
00:41:20,309 --> 00:41:18,000
as to the best estimate and the best

1013
00:41:21,510 --> 00:41:20,319

knowledge we will know what the solar

1014
00:41:23,430 --> 00:41:21,520
power looks like

1015
00:41:25,190 --> 00:41:23,440
during our commissioning phase so we'll

1016
00:41:26,470 --> 00:41:25,200
be fully prepped up for that first day

1017
00:41:27,829 --> 00:41:26,480
of flight and

1018
00:41:29,829 --> 00:41:27,839
right now things are looking fairly

1019
00:41:30,790 --> 00:41:29,839
reasonable there's nothing that stands

1020
00:41:33,109 --> 00:41:30,800
out as a

1021
00:41:35,990 --> 00:41:33,119
unique challenge or a unique hazard in

1022
00:41:39,109 --> 00:41:37,990
thank you and up next on the phone lines

1023
00:41:42,790 --> 00:41:39,119
is assam

1024
00:41:49,270 --> 00:41:45,829
yeah hi um thanks for

1025
00:41:53,190 --> 00:41:49,280
taking my question um yeah

1026
00:41:56,550 --> 00:41:53,200
my question um was uh about that most

1027
00:41:59,990 --> 00:41:56,560
um uh perilous phase which um

1028
00:42:01,750 --> 00:42:00,000
um uh pharah alibay described what what

1029
00:42:03,829 --> 00:42:01,760
might happen could you just

1030
00:42:05,829 --> 00:42:03,839
dig into that a bit more about um what

1031
00:42:06,550 --> 00:42:05,839
the issues are and what might happen if

1032
00:42:08,390 --> 00:42:06,560
um

1033
00:42:11,030 --> 00:42:08,400
ingenuity doesn't get the charge it

1034
00:42:15,030 --> 00:42:11,040
requires does it just die then is it

1035
00:42:17,190 --> 00:42:15,040
irretrievable yeah sure so okay so that

1036
00:42:18,150 --> 00:42:17,200
that last sort of stressful phase that i

1037
00:42:20,550 --> 00:42:18,160
was talking about

1038
00:42:21,190 --> 00:42:20,560

is is the deployment of ingenuity to the

1039
00:42:23,510 --> 00:42:21,200
ground so

1040
00:42:25,589 --> 00:42:23,520
think of it as ingenuity is vertical

1041
00:42:28,309 --> 00:42:25,599
below the rover and we separate

1042
00:42:29,750 --> 00:42:28,319
its last connection to the rover and

1043
00:42:32,710 --> 00:42:29,760
that's the connection that gives it

1044
00:42:35,829 --> 00:42:32,720
energy that keeps it warm overnight

1045
00:42:36,230 --> 00:42:35,839
so that that timeline that i talked

1046
00:42:39,510 --> 00:42:36,240
about

1047
00:42:41,109 --> 00:42:39,520
is is 25 hours in terms of how long our

1048
00:42:43,990 --> 00:42:41,119
batteries will last

1049
00:42:45,910 --> 00:42:44,000
from our models without getting any

1050
00:42:48,390 --> 00:42:45,920
sunlight on the helicopter

1051
00:42:50,150 --> 00:42:48,400
so from the rover point of view that's a

1052
00:42:51,829 --> 00:42:50,160
reasonable timeline we're not talking

1053
00:42:53,349 --> 00:42:51,839
about you know we just have to drive

1054
00:42:54,790 --> 00:42:53,359
five meters it's not

1055
00:42:56,390 --> 00:42:54,800
it's not it's something that we do every

1056
00:42:59,510 --> 00:42:56,400
day on mars right now

1057
00:43:01,829 --> 00:42:59,520
but still we are giving ourselves as

1058
00:43:02,150 --> 00:43:01,839
many shots as we can to get that drive

1059
00:43:04,069 --> 00:43:02,160
off

1060
00:43:05,910 --> 00:43:04,079
because it has such huge implications on

1061
00:43:07,270 --> 00:43:05,920
the helicopter

1062
00:43:08,870 --> 00:43:07,280
so what we're doing is that we're

1063
00:43:10,150 --> 00:43:08,880

dropping the helicopter on the ground

1064
00:43:10,630 --> 00:43:10,160
we're actually going to have ground in

1065
00:43:12,790 --> 00:43:10,640
the loop

1066
00:43:14,870 --> 00:43:12,800
as humans here are going to be able to

1067
00:43:15,990 --> 00:43:14,880
uh to interact and see what happened

1068
00:43:18,150 --> 00:43:16,000
with that drop

1069
00:43:19,109 --> 00:43:18,160
and then we'll command a drive away from

1070
00:43:21,430 --> 00:43:19,119
that helicopter

1071
00:43:23,270 --> 00:43:21,440
if that drive doesn't happen on that day

1072
00:43:24,230 --> 00:43:23,280
we as a team will have overnight to

1073
00:43:25,910 --> 00:43:24,240
debug and to

1074
00:43:27,910 --> 00:43:25,920
to figure out what happened and drive

1075
00:43:29,109 --> 00:43:27,920
off the next morning and ingenuity will

1076
00:43:30,950 --> 00:43:29,119
still be okay

1077
00:43:32,630 --> 00:43:30,960
um you know we have a great team of

1078
00:43:33,589 --> 00:43:32,640
engineers and i'm sure that whatever

1079
00:43:35,829 --> 00:43:33,599
mars throws

1080
00:43:38,150 --> 00:43:35,839
at us uh we'll we'll be able to deal

1081
00:43:39,670 --> 00:43:38,160
with it and we sure have practiced a lot

1082
00:43:42,710 --> 00:43:39,680
for that day to make sure that

1083
00:43:46,309 --> 00:43:42,720
we get ingenuity safe on the ground

1084
00:43:50,309 --> 00:43:48,630
if it as long as they do get off

1085
00:43:51,910 --> 00:43:50,319
eventually during the next day we have a

1086
00:43:53,589 --> 00:43:51,920
pretty good chance of

1087
00:43:55,510 --> 00:43:53,599
charging up a battery it may not be a

1088
00:43:57,589 --> 00:43:55,520

full day of charge but it'll be

1089
00:43:59,109 --> 00:43:57,599
partial so if there's any delay over and

1090
00:44:01,030 --> 00:43:59,119
beyond 25 hours it's not

1091
00:44:02,230 --> 00:44:01,040
necessarily that but that's what the

1092
00:44:03,829 --> 00:44:02,240
team is

1093
00:44:06,150 --> 00:44:03,839
making sure that we don't get shaded

1094
00:44:08,309 --> 00:44:06,160
under the rover for that longer time

1095
00:44:10,150 --> 00:44:08,319
that's so but if they can get off the

1096
00:44:13,190 --> 00:44:10,160
next day even if it's a little bit late

1097
00:44:17,910 --> 00:44:15,510
thank you for your answers and we have

1098
00:44:21,589 --> 00:44:17,920
social media questions coming in as well

1099
00:44:23,990 --> 00:44:21,599
on youtube from gamingnerd353

1100
00:44:25,510 --> 00:44:24,000
asks how high do you think it will go up

1101
00:44:27,910 --> 00:44:25,520
in mars atmosphere

1102
00:44:31,270 --> 00:44:27,920
and if it works how will it help in

1103
00:44:34,150 --> 00:44:31,280
future missions to mars

1104
00:44:35,829 --> 00:44:34,160
hard yeah so the first flight that we're

1105
00:44:37,990 --> 00:44:35,839
going to do that i talked about earlier

1106
00:44:40,150 --> 00:44:38,000
we're gonna go three meters high

1107
00:44:41,990 --> 00:44:40,160
and then our nominal flight out height

1108
00:44:43,030 --> 00:44:42,000
for the remaining flights is five meters

1109
00:44:44,710 --> 00:44:43,040
above the ground

1110
00:44:46,069 --> 00:44:44,720
so that's that's mostly where we're

1111
00:44:49,510 --> 00:44:46,079
going to be

1112
00:44:50,790 --> 00:44:49,520
now as far as the potential that this

1113
00:44:52,870 --> 00:44:50,800

has for future

1114
00:44:53,910 --> 00:44:52,880
exploration you can kind of think of it

1115
00:44:56,710 --> 00:44:53,920
as you know we use

1116
00:44:58,230 --> 00:44:56,720
drones and helicopters here on earth for

1117
00:45:00,630 --> 00:44:58,240
all sorts of things

1118
00:45:02,069 --> 00:45:00,640
that they're more suitable for than

1119
00:45:03,589 --> 00:45:02,079
land-based vehicles right so you can

1120
00:45:05,510 --> 00:45:03,599
just imagine being able to have that

1121
00:45:06,390 --> 00:45:05,520
same capability on mars flying around on

1122
00:45:08,309 --> 00:45:06,400
mars

1123
00:45:11,510 --> 00:45:08,319
and that could be for reconnaissance

1124
00:45:13,990 --> 00:45:11,520
purposes uh taking pictures to scout out

1125
00:45:14,950 --> 00:45:14,000
areas potential science targets for

1126
00:45:18,150 --> 00:45:14,960
future rovers

1127
00:45:20,230 --> 00:45:18,160
or even future astronauts on mars

1128
00:45:21,829 --> 00:45:20,240
or it could be carrying its own science

1129
00:45:23,510 --> 00:45:21,839
instruments into areas where you can't

1130
00:45:24,790 --> 00:45:23,520
get with a land-based vehicle so that's

1131
00:45:27,589 --> 00:45:24,800
the kind of potential

1132
00:45:29,030 --> 00:45:27,599
that this technology could have for the

1133
00:45:31,030 --> 00:45:29,040
future

1134
00:45:33,910 --> 00:45:31,040
and hovard for our american audiences

1135
00:45:35,829 --> 00:45:33,920
could you convert the meters too please

1136
00:45:37,190 --> 00:45:35,839
yeah so it's about you know it's about

1137
00:45:40,230 --> 00:45:37,200
15 feet

1138
00:45:41,589 --> 00:45:40,240

uh it's the height of the of the most of

1139
00:45:43,829 --> 00:45:41,599
the flights

1140
00:45:45,030 --> 00:45:43,839
great thank you and up next on the phone

1141
00:45:46,950 --> 00:45:45,040
lines is

1142
00:45:49,829 --> 00:45:46,960
robert hopps with the wall street

1143
00:45:56,550 --> 00:45:53,510
hi can you hear me all right yes we can

1144
00:45:59,829 --> 00:45:56,560
great so i thank you for uh the briefing

1145
00:46:01,030 --> 00:45:59,839
um i have uh two questions um and the

1146
00:46:03,589 --> 00:46:01,040
first perhaps to

1147
00:46:04,710 --> 00:46:03,599
uh uh bobby brown um can you just give

1148
00:46:08,150 --> 00:46:04,720
us a

1149
00:46:08,790 --> 00:46:08,160
program cost for ingenuity um separate

1150
00:46:11,990 --> 00:46:08,800
from

1151
00:46:14,230 --> 00:46:12,000
the overall mission cost of perseverance

1152
00:46:16,870 --> 00:46:14,240
uh number one number two can and as a

1153
00:46:19,270 --> 00:46:16,880
subset of that can you give us any idea

1154
00:46:20,630 --> 00:46:19,280
about the development cost of these

1155
00:46:23,750 --> 00:46:20,640
remarkable

1156
00:46:24,790 --> 00:46:23,760
uh helicopter blades that you all have

1157
00:46:27,030 --> 00:46:24,800
developed

1158
00:46:28,150 --> 00:46:27,040
to handle the very thin martian

1159
00:46:30,550 --> 00:46:28,160
atmosphere

1160
00:46:32,630 --> 00:46:30,560
so number one the cost question and then

1161
00:46:33,430 --> 00:46:32,640
number two is there any technology

1162
00:46:36,230 --> 00:46:33,440
transfer or

1163
00:46:37,990 --> 00:46:36,240

relationship in an engineering sense

1164
00:46:40,870 --> 00:46:38,000
between the development of the

1165
00:46:41,349 --> 00:46:40,880
rotorcraft for mars and the development

1166
00:46:45,109 --> 00:46:41,359
of the

1167
00:46:48,710 --> 00:46:45,119
rotorcraft hovercraft that's uh uh

1168
00:46:52,069 --> 00:46:48,720
being prepared for the dragonfly

1169
00:46:54,309 --> 00:46:52,079
mission to tighten thank you

1170
00:46:55,750 --> 00:46:54,319
so yeah i'll take the first question and

1171
00:46:55,990 --> 00:46:55,760
then i'll i'll turn the rest over i

1172
00:46:59,750 --> 00:46:56,000
think

1173
00:47:02,630 --> 00:46:59,760
to bob but the program cost

1174
00:47:04,630 --> 00:47:02,640
uh for ingenuity was on the order of 80

1175
00:47:05,990 --> 00:47:04,640
million dollars

1176
00:47:09,109 --> 00:47:06,000
and that's separate from the

1177
00:47:11,430 --> 00:47:09,119
perseverance cost itself

1178
00:47:12,470 --> 00:47:11,440
bob do you want to talk about the the

1179
00:47:14,550 --> 00:47:12,480
blades and

1180
00:47:15,589 --> 00:47:14,560
there's yes it's a little bit difficult

1181
00:47:17,510 --> 00:47:15,599
to separate out

1182
00:47:19,349 --> 00:47:17,520
you know a particular element because

1183
00:47:21,589 --> 00:47:19,359
this design was done in a very

1184
00:47:23,030 --> 00:47:21,599
integrated holistic sense where a lot of

1185
00:47:26,150 --> 00:47:23,040
engineering trades

1186
00:47:28,950 --> 00:47:26,160
across multiple subsystems power

1187
00:47:31,430 --> 00:47:28,960
blade design fuselage design thermal so

1188
00:47:33,670 --> 00:47:31,440

it's very difficult to isolate the cost

1189
00:47:35,430 --> 00:47:33,680
um so i don't think there's an easy way

1190
00:47:37,270 --> 00:47:35,440
for anybody to come up with an answer as

1191
00:47:39,829 --> 00:47:37,280
to what the particular blade

1192
00:47:40,950 --> 00:47:39,839
you know technology work ended up

1193
00:47:42,710 --> 00:47:40,960
costing

1194
00:47:44,390 --> 00:47:42,720
uh with regard to your second question

1195
00:47:45,990 --> 00:47:44,400
about dragonfly

1196
00:47:47,750 --> 00:47:46,000
so yes we have been in conversations

1197
00:47:49,349 --> 00:47:47,760
with them uh they've been especially

1198
00:47:51,750 --> 00:47:49,359
interested in getting some of our early

1199
00:47:53,829 --> 00:47:51,760
thoughts on what kind of testing we did

1200
00:47:55,190 --> 00:47:53,839
after all uh part of the invention here

1201
00:47:57,109 --> 00:47:55,200
was not only to

1202
00:48:00,230 --> 00:47:57,119
build ingenuity but to build a test

1203
00:48:02,790 --> 00:48:00,240
program for a first of a kind system

1204
00:48:03,910 --> 00:48:02,800
there are no you know places to go to to

1205
00:48:05,750 --> 00:48:03,920
sort of look up what

1206
00:48:07,510 --> 00:48:05,760
what should you test next so they have

1207
00:48:08,710 --> 00:48:07,520
uh some of the engineers have been in

1208
00:48:10,309 --> 00:48:08,720
consultation with us

1209
00:48:12,390 --> 00:48:10,319
as to what kind of testing would make

1210
00:48:12,950 --> 00:48:12,400
sense so we've given them some of our

1211
00:48:15,190 --> 00:48:12,960
inputs

1212
00:48:16,870 --> 00:48:15,200
um and so those that's the nature of the

1213
00:48:19,109 --> 00:48:16,880

interaction at this point

1214
00:48:20,309 --> 00:48:19,119
and i'm sure as their program matures

1215
00:48:22,710 --> 00:48:20,319
and they go into

1216
00:48:24,150 --> 00:48:22,720
other phases of their development uh

1217
00:48:25,589 --> 00:48:24,160
there will be folks on the ingenuity

1218
00:48:27,990 --> 00:48:25,599
team will be able to offer

1219
00:48:29,750 --> 00:48:28,000
help and you know guidance to the extent

1220
00:48:32,309 --> 00:48:29,760
that we can

1221
00:48:33,829 --> 00:48:32,319
and we can also get lori in here lori

1222
00:48:35,270 --> 00:48:33,839
would you like to answer some of the

1223
00:48:37,670 --> 00:48:35,280
questions as well we can also get it

1224
00:48:40,069 --> 00:48:37,680
repeated for you

1225
00:48:41,990 --> 00:48:40,079
sure no i'll i'll just expand a little

1226
00:48:45,670 --> 00:48:42,000
bit on on bob's comment there

1227
00:48:47,430 --> 00:48:45,680
um that yeah i i i'm really glad to see

1228
00:48:49,109 --> 00:48:47,440
you know across nasa we like to learn

1229
00:48:51,109 --> 00:48:49,119
from each other and we've got this great

1230
00:48:53,829 --> 00:48:51,119
experience and expertise here

1231
00:48:55,589 --> 00:48:53,839
uh from the ingenuity team and of course

1232
00:48:57,510 --> 00:48:55,599
the dragonfly team is just getting

1233
00:49:00,549 --> 00:48:57,520
started on their development

1234
00:49:02,230 --> 00:49:00,559
uh of working on the the quadcopter the

1235
00:49:04,230 --> 00:49:02,240
the large rotor crop that they're

1236
00:49:05,670 --> 00:49:04,240
planning to send to titan

1237
00:49:07,829 --> 00:49:05,680
it's going to be really interesting to

1238
00:49:09,109 --> 00:49:07,839

see how this kind of capability will

1239
00:49:11,109 --> 00:49:09,119
scale up

1240
00:49:12,630 --> 00:49:11,119
of course there are are similarities and

1241
00:49:14,390 --> 00:49:12,640
differences between both of the

1242
00:49:15,829 --> 00:49:14,400
the different flight systems and of

1243
00:49:16,950 --> 00:49:15,839
course the environments are very very

1244
00:49:18,790 --> 00:49:16,960
different but i think

1245
00:49:21,030 --> 00:49:18,800
uh you know what we learned from this

1246
00:49:21,430 --> 00:49:21,040
experiment will definitely feed forward

1247
00:49:25,190 --> 00:49:21,440
and

1248
00:49:26,870 --> 00:49:25,200
having this uh ability to

1249
00:49:28,230 --> 00:49:26,880
to take the information that we learned

1250
00:49:31,670 --> 00:49:28,240
from one mission and move it on

1251
00:49:34,309 --> 00:49:31,680
and take that to the next mission

1252
00:49:34,710 --> 00:49:34,319
thank you lori and we also have costs in

1253
00:49:37,270 --> 00:49:34,720
the

1254
00:49:38,710 --> 00:49:37,280
ingenuity press kit that is available

1255
00:49:40,950 --> 00:49:38,720
online as well

1256
00:49:42,150 --> 00:49:40,960
and up next on the phone line is bill

1257
00:49:45,589 --> 00:49:42,160
harwood with

1258
00:49:47,430 --> 00:49:45,599
cbs news yeah hey thank you i think i

1259
00:49:50,470 --> 00:49:47,440
think this is probably for bob is the

1260
00:49:53,349 --> 00:49:50,480
is the limit the five meter uh

1261
00:49:55,349 --> 00:49:53,359
maximum altitude is that just based on

1262
00:49:57,270 --> 00:49:55,359
general principle being safe or is there

1263
00:49:58,870 --> 00:49:57,280

anything to do with the

1264
00:50:00,630 --> 00:49:58,880
nature of the martian atmosphere that

1265
00:50:03,109 --> 00:50:00,640
makes you not want to go higher

1266
00:50:03,670 --> 00:50:03,119
and a second question real quick you

1267
00:50:06,230 --> 00:50:03,680
know if the

1268
00:50:08,470 --> 00:50:06,240
if the if the device flips over on its

1269
00:50:10,230 --> 00:50:08,480
side or something during the landing is

1270
00:50:12,309 --> 00:50:10,240
would it even be possible to use the

1271
00:50:14,150 --> 00:50:12,319
rover and its robot arm to maybe

1272
00:50:15,910 --> 00:50:14,160
come to the rescue and flip it back over

1273
00:50:17,109 --> 00:50:15,920
or would that just be all she wrote if

1274
00:50:20,309 --> 00:50:17,119
something like that happens

1275
00:50:22,069 --> 00:50:20,319
thanks yeah let me uh ask hobart to

1276
00:50:23,670 --> 00:50:22,079
comment on the exactly on the

1277
00:50:26,069 --> 00:50:23,680
height limitations and then i'll get

1278
00:50:27,910 --> 00:50:26,079
back to the flip over question

1279
00:50:29,990 --> 00:50:27,920
yeah so the nominal height of five

1280
00:50:30,549 --> 00:50:30,000
meters is there are a couple of factors

1281
00:50:32,309 --> 00:50:30,559
there

1282
00:50:34,549 --> 00:50:32,319
one of them is that we have a laser

1283
00:50:35,750 --> 00:50:34,559
range finder that measures the distance

1284
00:50:37,349 --> 00:50:35,760
to the ground

1285
00:50:38,790 --> 00:50:37,359
and we've characterized that up to a

1286
00:50:40,950 --> 00:50:38,800
certain range and we want to have you

1287
00:50:42,630 --> 00:50:40,960
know sufficient amount of margin on that

1288
00:50:44,069 --> 00:50:42,640

so that we're completely safe for our

1289
00:50:46,549 --> 00:50:44,079
nominal flights

1290
00:50:47,990 --> 00:50:46,559
uh so that that's part of where that

1291
00:50:48,710 --> 00:50:48,000
comes from it's not really the

1292
00:50:50,710 --> 00:50:48,720
atmosphere

1293
00:50:51,750 --> 00:50:50,720
the helicopter you know physically would

1294
00:50:53,750 --> 00:50:51,760
be capable

1295
00:50:55,589 --> 00:50:53,760
of of you know attaining higher

1296
00:50:57,910 --> 00:50:55,599
altitudes and

1297
00:50:59,270 --> 00:50:57,920
it could in principle go higher you know

1298
00:51:01,030 --> 00:50:59,280
currently as design

1299
00:51:02,870 --> 00:51:01,040
and there may be cases where if

1300
00:51:04,390 --> 00:51:02,880
everything goes well

1301
00:51:06,150 --> 00:51:04,400
during our nominal flights where we

1302
00:51:09,190 --> 00:51:06,160
might stretch things a little bit

1303
00:51:10,710 --> 00:51:09,200
beyond you know the nominal heights yeah

1304
00:51:12,150 --> 00:51:10,720
and regarding the question if for

1305
00:51:14,230 --> 00:51:12,160
whatever reason there is

1306
00:51:15,990 --> 00:51:14,240
a unfortunate case where the ingenuity

1307
00:51:17,030 --> 00:51:16,000
doesn't land quite right and you know

1308
00:51:19,030 --> 00:51:17,040
tips over

1309
00:51:20,790 --> 00:51:19,040
uh it's quite likely that the damage

1310
00:51:22,630 --> 00:51:20,800
especially to our blades would be such

1311
00:51:24,710 --> 00:51:22,640
that it really doesn't make sense to

1312
00:51:25,910 --> 00:51:24,720
you know try to do anything further at

1313
00:51:28,630 --> 00:51:25,920

that point

1314
00:51:30,309 --> 00:51:28,640
um so there really is no merit to

1315
00:51:32,630 --> 00:51:30,319
actually having perseverance come back

1316
00:51:34,230 --> 00:51:32,640
and right side it up uh it would be

1317
00:51:36,069 --> 00:51:34,240
most probably be so damaged at that

1318
00:51:38,390 --> 00:51:36,079
point that uh it's really not

1319
00:51:40,309 --> 00:51:38,400
flyable anymore of course it's all been

1320
00:51:42,150 --> 00:51:40,319
designed so that it doesn't do that so

1321
00:51:43,750 --> 00:51:42,160
we don't have that expectation unless

1322
00:51:46,950 --> 00:51:43,760
it's a really bad day for

1323
00:51:49,030 --> 00:51:46,960
during the test test flight program

1324
00:51:50,069 --> 00:51:49,040
great thank you and up next we have

1325
00:51:53,750 --> 00:51:50,079
leonard david

1326
00:51:55,430 --> 00:51:53,760
from inside outer space

1327
00:51:57,349 --> 00:51:55,440
thanks very much i think we touched a

1328
00:51:59,430 --> 00:51:57,359
little bit on this but uh

1329
00:52:01,030 --> 00:51:59,440
maybe for bobby and thanks being here in

1330
00:52:03,150 --> 00:52:01,040
boulder i appreciate the

1331
00:52:04,309 --> 00:52:03,160
nod to the community

1332
00:52:08,150 --> 00:52:04,319
[Music]

1333
00:52:11,510 --> 00:52:08,160
the potential of

1334
00:52:14,390 --> 00:52:11,520
kind of a device like this being used

1335
00:52:15,670 --> 00:52:14,400
in an astronaut toolkit i mean what kind

1336
00:52:19,750 --> 00:52:15,680
of range

1337
00:52:22,390 --> 00:52:19,760
might be possible given a successful

1338
00:52:24,790 --> 00:52:22,400

test of this demonstration and then the

1339
00:52:27,990 --> 00:52:24,800
other thing is how long lived

1340
00:52:29,750 --> 00:52:28,000
is this vehicle and is it conceivable

1341
00:52:35,030 --> 00:52:29,760
that it could be used

1342
00:52:42,309 --> 00:52:38,870
okay that was to me uh thanks leonard

1343
00:52:44,790 --> 00:52:42,319
uh so as you know we have uh robotic

1344
00:52:46,309 --> 00:52:44,800
assistants that are paired with

1345
00:52:48,150 --> 00:52:46,319
astronauts today like

1346
00:52:49,589 --> 00:52:48,160
on the international space station for

1347
00:52:51,589 --> 00:52:49,599
example

1348
00:52:52,950 --> 00:52:51,599
and so we there has been a quite a bit

1349
00:52:55,829 --> 00:52:52,960
of work done

1350
00:52:56,950 --> 00:52:55,839
in you know how humans and robots could

1351
00:52:59,430 --> 00:52:56,960
work together

1352
00:53:00,470 --> 00:52:59,440
for exploration purposes we've been path

1353
00:53:02,710 --> 00:53:00,480
finding some of that

1354
00:53:04,470 --> 00:53:02,720
on the international space station but

1355
00:53:07,190 --> 00:53:04,480
certainly as humans

1356
00:53:11,109 --> 00:53:07,200
venture out at some point you could

1357
00:53:15,670 --> 00:53:13,030
i dropped the other part of your

1358
00:53:19,190 --> 00:53:15,680
question i apologize

1359
00:53:22,470 --> 00:53:19,200
how long lived with the vehicle

1360
00:53:22,950 --> 00:53:22,480
be and is it conceivable if everything

1361
00:53:26,309 --> 00:53:22,960
is still

1362
00:53:28,309 --> 00:53:26,319
operational on it can it survive for

1363
00:53:29,829 --> 00:53:28,319

years before the mars sample return

1364
00:53:31,910 --> 00:53:29,839
mission gets underway

1365
00:53:33,030 --> 00:53:31,920
yeah so i'm sorry yeah let me address

1366
00:53:35,270 --> 00:53:33,040
that um

1367
00:53:36,790 --> 00:53:35,280
it's not conceivable let's just be

1368
00:53:40,470 --> 00:53:36,800
straight about it

1369
00:53:44,150 --> 00:53:40,480
um so j you know sojourner by the way

1370
00:53:45,030 --> 00:53:44,160
uh lasted about uh if i remember right

1371
00:53:48,470 --> 00:53:45,040
it lasted about

1372
00:53:49,109 --> 00:53:48,480
a few months on mars uh it was a tech

1373
00:53:51,670 --> 00:53:49,119
demo

1374
00:53:52,950 --> 00:53:51,680
right and it did not have the lan the

1375
00:53:56,790 --> 00:53:52,960
long life

1376
00:53:59,589 --> 00:53:56,800
that spirit opportunity uh curiosity and

1377
00:54:01,349 --> 00:53:59,599
and we believe perseverance will have

1378
00:54:04,470 --> 00:54:01,359
and in much the same way

1379
00:54:06,549 --> 00:54:04,480
this is a tech demo uh it's being

1380
00:54:07,910 --> 00:54:06,559
it's been sent to mars to prove the

1381
00:54:09,910 --> 00:54:07,920
capability

1382
00:54:11,750 --> 00:54:09,920
and we believe we can prove that

1383
00:54:13,109 --> 00:54:11,760
capability we can meet all the flight

1384
00:54:15,829 --> 00:54:13,119
test objectives

1385
00:54:17,990 --> 00:54:15,839
in the month of ingenuity so there's not

1386
00:54:20,790 --> 00:54:18,000
really a need for that long life

1387
00:54:22,710 --> 00:54:20,800
it hasn't been designed for that purpose

1388
00:54:24,710 --> 00:54:22,720

and so there's really

1389
00:54:25,990 --> 00:54:24,720
no way i could conceive that it could

1390
00:54:28,470 --> 00:54:26,000
last

1391
00:54:29,990 --> 00:54:28,480
through the harsh conditions on mars for

1392
00:54:32,950 --> 00:54:30,000
the length of time it would take to

1393
00:54:36,069 --> 00:54:32,960
participate in some future mission

1394
00:54:37,270 --> 00:54:36,079
okay thanks so much thanks bobby lori

1395
00:54:39,750 --> 00:54:37,280
would you like to weigh in on this

1396
00:54:41,270 --> 00:54:39,760
question as well

1397
00:54:43,910 --> 00:54:41,280
um i think bobby's done a really good

1398
00:54:45,109 --> 00:54:43,920
job of of answering both aspects of the

1399
00:54:47,510 --> 00:54:45,119
questions i'm not sure i have much

1400
00:54:48,710 --> 00:54:47,520
to add but you know as he said it's not

1401
00:54:50,150 --> 00:54:48,720
designed to last

1402
00:54:51,910 --> 00:54:50,160
for very long it's a technology

1403
00:54:53,190 --> 00:54:51,920
demonstration it's designed to last as

1404
00:54:55,750 --> 00:54:53,200
long as we need to

1405
00:54:57,030 --> 00:54:55,760
to prove out uh this incredible

1406
00:55:00,630 --> 00:54:57,040
capability

1407
00:55:04,069 --> 00:55:00,640
all right thank you and up next is a

1408
00:55:06,710 --> 00:55:04,079
social media question akashan on twitter

1409
00:55:07,589 --> 00:55:06,720
asks when can we expect to see some

1410
00:55:10,230 --> 00:55:07,599
results

1411
00:55:12,470 --> 00:55:10,240
videos or pics from the ingenuity

1412
00:55:15,430 --> 00:55:12,480
helicopter

1413
00:55:16,549 --> 00:55:15,440

vara so we'll be taking videos and

1414
00:55:18,789 --> 00:55:16,559
images

1415
00:55:20,950 --> 00:55:18,799
you know as soon every day every step of

1416
00:55:21,829 --> 00:55:20,960
the way um but obviously videos and

1417
00:55:24,710 --> 00:55:21,839
images are

1418
00:55:26,630 --> 00:55:24,720
high um high volume high bandwidth you

1419
00:55:27,910 --> 00:55:26,640
know to get down to earth so

1420
00:55:29,510 --> 00:55:27,920
on the days when we're flying for

1421
00:55:31,510 --> 00:55:29,520
example we're going to prioritize

1422
00:55:33,109 --> 00:55:31,520
getting the helicopter data down

1423
00:55:34,390 --> 00:55:33,119
first and that's the most important

1424
00:55:35,589 --> 00:55:34,400
that's what tells us if we've been

1425
00:55:37,109 --> 00:55:35,599
successful or not

1426
00:55:38,710 --> 00:55:37,119
and then behind that will come the

1427
00:55:40,789 --> 00:55:38,720
images and videos so

1428
00:55:41,829 --> 00:55:40,799
so for every major milestone we're

1429
00:55:44,789 --> 00:55:41,839
expecting

1430
00:55:45,430 --> 00:55:44,799
probably within the day or two depending

1431
00:55:47,510 --> 00:55:45,440
on how

1432
00:55:48,950 --> 00:55:47,520
uh how our bandwidth looks that we'll be

1433
00:55:51,030 --> 00:55:48,960
getting those images and

1434
00:55:53,510 --> 00:55:51,040
and sharing them with the public

1435
00:55:54,150 --> 00:55:53,520
everything is available on mars.nasa.gov

1436
00:55:57,430 --> 00:55:54,160
for

1437
00:56:02,030 --> 00:56:00,069
great thank you and up next we have paul

1438
00:56:05,430 --> 00:56:02,040

gross from

1439
00:56:07,349 --> 00:56:05,440
wdiv-tv in detroit

1440
00:56:08,789 --> 00:56:07,359
well thank you very much for taking my

1441
00:56:10,470 --> 00:56:08,799
question i actually have two and i'll

1442
00:56:13,510 --> 00:56:10,480
ask them separately because they're

1443
00:56:15,670 --> 00:56:13,520
different questions first question is

1444
00:56:17,430 --> 00:56:15,680
what was the greatest engineering

1445
00:56:19,750 --> 00:56:17,440
challenge in designing

1446
00:56:21,349 --> 00:56:19,760
ingenuity was it for example getting

1447
00:56:22,230 --> 00:56:21,359
enough lift in the thin martian

1448
00:56:24,390 --> 00:56:22,240
atmosphere

1449
00:56:25,910 --> 00:56:24,400
or maintaining enough power so it could

1450
00:56:27,270 --> 00:56:25,920
even fly i mean what was the greatest

1451
00:56:28,789 --> 00:56:27,280
engineering challenge and then i'll have

1452
00:56:31,030 --> 00:56:28,799
one more question

1453
00:56:33,270 --> 00:56:31,040
yeah i can take that um yeah i think the

1454
00:56:34,309 --> 00:56:33,280
biggest challenge was to control the

1455
00:56:36,789 --> 00:56:34,319
mass

1456
00:56:39,109 --> 00:56:36,799
the total weight of this uh aircraft so

1457
00:56:41,270 --> 00:56:39,119
that it would be as light as possible

1458
00:56:43,190 --> 00:56:41,280
the gravity on mars helps a bit in terms

1459
00:56:45,829 --> 00:56:43,200
of flying it's about 40

1460
00:56:46,789 --> 00:56:45,839
of what you have here on earth but

1461
00:56:48,630 --> 00:56:46,799
anything that

1462
00:56:50,549 --> 00:56:48,640
gets heavy just won't be able to lift

1463
00:56:52,470 --> 00:56:50,559

off in that thin atmosphere despite your

1464
00:56:55,109 --> 00:56:52,480
best attempted aerodynamics

1465
00:56:56,069 --> 00:56:55,119
so to keep a design that where every

1466
00:56:58,390 --> 00:56:56,079
part

1467
00:57:00,309 --> 00:56:58,400
was carefully you know weighed and

1468
00:57:01,990 --> 00:57:00,319
managed and constraints were put on the

1469
00:57:02,309 --> 00:57:02,000
design process to make sure we didn't

1470
00:57:05,750 --> 00:57:02,319
get

1471
00:57:07,910 --> 00:57:05,760
a mass growth that would make flight

1472
00:57:10,829 --> 00:57:07,920
not possible that was the major

1473
00:57:13,270 --> 00:57:10,839
challenge uh through the entire design

1474
00:57:15,510 --> 00:57:13,280
process

1475
00:57:16,549 --> 00:57:15,520
and my second question and i'm asking

1476
00:57:18,630 --> 00:57:16,559
this because

1477
00:57:19,829 --> 00:57:18,640
one of you alluded to this earlier and

1478
00:57:22,150 --> 00:57:19,839
i'm asking you this because i'm a

1479
00:57:24,630 --> 00:57:22,160
meteorologist but you mentioned

1480
00:57:26,630 --> 00:57:24,640
about a weather forecast team providing

1481
00:57:28,470 --> 00:57:26,640
you forecasts on mars now i know we get

1482
00:57:30,870 --> 00:57:28,480
some weather data from mars

1483
00:57:32,390 --> 00:57:30,880
i was not aware that you were trying to

1484
00:57:34,150 --> 00:57:32,400
forecast the weather on mrs can you

1485
00:57:35,670 --> 00:57:34,160
discuss that process

1486
00:57:37,349 --> 00:57:35,680
and like how often are you getting

1487
00:57:38,710 --> 00:57:37,359
briefings and just describe that whole

1488
00:57:41,270 --> 00:57:38,720

part of the process

1489
00:57:41,829 --> 00:57:41,280
let me discuss uh part of it and then i

1490
00:57:43,910 --> 00:57:41,839
can uh

1491
00:57:45,829 --> 00:57:43,920
turn to hobart as a pilot of the

1492
00:57:48,309 --> 00:57:45,839
ingenuity to talk more

1493
00:57:50,470 --> 00:57:48,319
so we look to weather for two main

1494
00:57:52,150 --> 00:57:50,480
reasons one is we want to

1495
00:57:54,470 --> 00:57:52,160
get some sense of how much energy we're

1496
00:57:56,789 --> 00:57:54,480
going to use keeping things warm is it a

1497
00:57:57,750 --> 00:57:56,799
breezy day on mars is it breezy night on

1498
00:57:59,910 --> 00:57:57,760
mars

1499
00:58:02,230 --> 00:57:59,920
so that allows us to forecast you know

1500
00:58:03,910 --> 00:58:02,240
what thermostat settings we need

1501
00:58:05,430 --> 00:58:03,920
and how much power we're going to use to

1502
00:58:07,510 --> 00:58:05,440
keep ourselves warm

1503
00:58:09,030 --> 00:58:07,520
the second one which you know is what a

1504
00:58:10,630 --> 00:58:09,040
pilot would care about and in that

1505
00:58:12,549 --> 00:58:10,640
context uh hobart do you want to talk

1506
00:58:13,990 --> 00:58:12,559
about you as the ingenuity pilot what

1507
00:58:14,870 --> 00:58:14,000
what are you looking for and how are you

1508
00:58:17,349 --> 00:58:14,880
getting it

1509
00:58:19,349 --> 00:58:17,359
yeah so we have there are two particular

1510
00:58:22,230 --> 00:58:19,359
weather products that we look to

1511
00:58:23,030 --> 00:58:22,240
uh one is the density at the time of

1512
00:58:25,510 --> 00:58:23,040
light

1513
00:58:27,430 --> 00:58:25,520

and fortunately on mars things tend to

1514
00:58:28,870 --> 00:58:27,440
be very repeatable from one day to the

1515
00:58:30,789 --> 00:58:28,880
next and so we get these

1516
00:58:32,150 --> 00:58:30,799
density curves that show us how the

1517
00:58:34,230 --> 00:58:32,160
density varies

1518
00:58:35,589 --> 00:58:34,240
throughout us all and it allows us to

1519
00:58:35,990 --> 00:58:35,599
project into the future what it's going

1520
00:58:39,270 --> 00:58:36,000
to look

1521
00:58:40,870 --> 00:58:39,280
like when the time to fly comes

1522
00:58:42,710 --> 00:58:40,880
and the way that we use that is first of

1523
00:58:44,710 --> 00:58:42,720
all that nc has to be within

1524
00:58:46,230 --> 00:58:44,720
a range where it's viable and then we

1525
00:58:47,750 --> 00:58:46,240
also adjust the rotor speed of the

1526
00:58:49,349 --> 00:58:47,760
helicopter according to what the

1527
00:58:49,990 --> 00:58:49,359
predicted density is at the time of

1528
00:58:52,390 --> 00:58:50,000
flight to be

1529
00:58:53,910 --> 00:58:52,400
optimal for that and the second weather

1530
00:58:57,910 --> 00:58:53,920
product that we're interested in

1531
00:58:59,270 --> 00:58:57,920
is wind correct say it again

1532
00:59:00,710 --> 00:58:59,280
for the benefit of the others that are

1533
00:59:01,589 --> 00:59:00,720
listening you're talking about the air

1534
00:59:03,109 --> 00:59:01,599
density

1535
00:59:05,510 --> 00:59:03,119
that's correct yes the atmospheric

1536
00:59:07,030 --> 00:59:05,520
density

1537
00:59:08,630 --> 00:59:07,040
and then the second thing that we're

1538
00:59:10,710 --> 00:59:08,640

interested in is wind

1539
00:59:12,069 --> 00:59:10,720
and we don't use wind directly for

1540
00:59:15,510 --> 00:59:12,079
planning a flight

1541
00:59:17,190 --> 00:59:15,520
other than to say to make a go no-go

1542
00:59:19,589 --> 00:59:17,200
decision so we want to have

1543
00:59:21,990 --> 00:59:19,599
reasonable amount of confidence that the

1544
00:59:24,230 --> 00:59:22,000
wind is within a certain range

1545
00:59:25,430 --> 00:59:24,240
where we don't exceed the air speeds

1546
00:59:28,789 --> 00:59:25,440
that the helicopter

1547
00:59:30,309 --> 00:59:28,799
is designed for well i hope those

1548
00:59:32,309 --> 00:59:30,319
forecasts are reliable thank you all

1549
00:59:35,270 --> 00:59:32,319
very much

1550
00:59:35,990 --> 00:59:35,280
great thank you and up next we have gina

1551
00:59:39,910 --> 00:59:36,000
cinceri

1552
00:59:41,430 --> 00:59:39,920
from abc news uh good afternoon

1553
00:59:42,950 --> 00:59:41,440
i'm just curious when you make the

1554
00:59:45,030 --> 00:59:42,960
decision to fly

1555
00:59:46,069 --> 00:59:45,040
what will the audio loops be like will

1556
00:59:48,630 --> 00:59:46,079
you have a no go

1557
00:59:51,589 --> 00:59:48,640
countdown like we get for launches and

1558
00:59:55,030 --> 00:59:51,599
other events how does that work

1559
00:59:58,870 --> 00:59:55,040
yes yeah i can take that

1560
01:00:01,109 --> 00:59:58,880
so basically since infinity operations

1561
01:00:02,069 --> 01:00:01,119
are done a day ahead of the actual

1562
01:00:04,150 --> 01:00:02,079
flight

1563
01:00:05,109 --> 01:00:04,160

so we will be looking at weather

1564
01:00:07,109 --> 01:00:05,119
patterns

1565
01:00:08,870 --> 01:00:07,119
our engineering performance on the days

1566
01:00:10,549 --> 01:00:08,880
leading up to the flight

1567
01:00:12,470 --> 01:00:10,559
and then we will make a go-no-go

1568
01:00:13,190 --> 01:00:12,480
decision as to whether we want to uplink

1569
01:00:15,030 --> 01:00:13,200
commands

1570
01:00:17,109 --> 01:00:15,040
to the helicopter to fly the next

1571
01:00:18,309 --> 01:00:17,119
morning or late in the morning or very

1572
01:00:19,910 --> 01:00:18,319
early in the afternoon those are the

1573
01:00:20,789 --> 01:00:19,920
kinds of decisions we'll be taking here

1574
01:00:22,710 --> 01:00:20,799
on earth

1575
01:00:23,910 --> 01:00:22,720
but they will all be decided on the day

1576
01:00:25,990 --> 01:00:23,920
before

1577
01:00:26,950 --> 01:00:26,000
and then the helicopter will execute

1578
01:00:28,390 --> 01:00:26,960
those while

1579
01:00:30,150 --> 01:00:28,400
theoretically i suppose we'll all be

1580
01:00:31,030 --> 01:00:30,160
asleep but i somehow don't think that'll

1581
01:00:33,349 --> 01:00:31,040
be the case

1582
01:00:34,230 --> 01:00:33,359
at least for the first flight and so

1583
01:00:36,309 --> 01:00:34,240
then we get the

1584
01:00:38,069 --> 01:00:36,319
products back in the downlink that comes

1585
01:00:40,150 --> 01:00:38,079
from mars in the afternoon

1586
01:00:42,230 --> 01:00:40,160
and we make an assessment as to how we

1587
01:00:44,390 --> 01:00:42,240
did so it's not uh

1588
01:00:45,270 --> 01:00:44,400

you know the real-time responsive sort

1589
01:00:47,109 --> 01:00:45,280
of countdown

1590
01:00:48,710 --> 01:00:47,119
gonna go kinds of things that you would

1591
01:00:49,670 --> 01:00:48,720
see in a launch where everything is very

1592
01:00:51,829 --> 01:00:49,680
immediate

1593
01:00:53,670 --> 01:00:51,839
this is a much more deliberative process

1594
01:00:56,549 --> 01:00:53,680
that happens the day before

1595
01:00:59,589 --> 01:00:56,559
and an assessment of the results on the

1596
01:01:05,829 --> 01:01:01,349
great thank you and up next on the phone

1597
01:01:07,430 --> 01:01:05,839
lines is justin silverman with vice news

1598
01:01:09,190 --> 01:01:07,440
hey there thanks for taking my call this

1599
01:01:11,030 --> 01:01:09,200
is all super interesting stuff

1600
01:01:13,190 --> 01:01:11,040
i'm wondering uh regardless of how the

1601
01:01:14,710 --> 01:01:13,200
technology demonstration goes what other

1602
01:01:16,470 --> 01:01:14,720
kinds of powered flight have been

1603
01:01:17,430 --> 01:01:16,480
considered for the atmospheres of other

1604
01:01:18,950 --> 01:01:17,440
planets have

1605
01:01:20,950 --> 01:01:18,960
has there been discussion about jet

1606
01:01:31,750 --> 01:01:20,960
engines or

1607
01:01:36,710 --> 01:01:35,030
i'll speak to it a little bit um so uh

1608
01:01:39,270 --> 01:01:36,720
just to be clear there actually has

1609
01:01:42,309 --> 01:01:39,280
already been a flight on another

1610
01:01:43,990 --> 01:01:42,319
non-powered flight on another planet uh

1611
01:01:45,829 --> 01:01:44,000
the europeans and the soviet union

1612
01:01:48,230 --> 01:01:45,839
actually conducted a balloon

1613
01:01:49,190 --> 01:01:48,240

experiment on in the atmosphere of venus

1614
01:01:52,230 --> 01:01:49,200
uh way back

1615
01:01:53,910 --> 01:01:52,240
uh in the 1980s um and so

1616
01:01:56,870 --> 01:01:53,920
so that has been done and certainly

1617
01:01:58,630 --> 01:01:56,880
balloons are are a possible platform

1618
01:02:00,069 --> 01:01:58,640
in various atmospheres if you've got

1619
01:02:01,990 --> 01:02:00,079
sufficient uh

1620
01:02:03,430 --> 01:02:02,000
you know the the right the right density

1621
01:02:06,470 --> 01:02:03,440
conditions there

1622
01:02:08,470 --> 01:02:06,480
you could also have a glider planes have

1623
01:02:11,270 --> 01:02:08,480
been considered and thought about

1624
01:02:13,190 --> 01:02:11,280
um so you know i think there are a

1625
01:02:15,510 --> 01:02:13,200
variety of different um

1626
01:02:17,349 --> 01:02:15,520
you know types of aerial vehicles that

1627
01:02:20,470 --> 01:02:17,359
have been considered but

1628
01:02:23,750 --> 01:02:20,480
i do think that this uh this powered

1629
01:02:25,589 --> 01:02:23,760
controllable aerial flight uh is

1630
01:02:27,109 --> 01:02:25,599
is really going to be an enabling

1631
01:02:29,910 --> 01:02:27,119
capability that allows us to

1632
01:02:31,910 --> 01:02:29,920
not just access different parts of a

1633
01:02:33,910 --> 01:02:31,920
planetary surface or atmosphere

1634
01:02:35,349 --> 01:02:33,920
you know from from within the air but

1635
01:02:37,349 --> 01:02:35,359
control that

1636
01:02:39,430 --> 01:02:37,359
that exploration and be able to be more

1637
01:02:42,630 --> 01:02:39,440
deliberate in how we in how we do that

1638
01:02:50,150 --> 01:02:45,750

thank you lori and up next we have rick

1639
01:02:53,990 --> 01:02:53,589
i'm a numbers guy and i have i'm looking

1640
01:02:55,589 --> 01:02:54,000
for

1641
01:02:57,430 --> 01:02:55,599
something on the scale of the landing

1642
01:02:58,789 --> 01:02:57,440
zone like how big is it how far is the

1643
01:03:01,430 --> 01:02:58,799
rover going to drive

1644
01:03:02,710 --> 01:03:01,440
to drop the helicopter how far does it

1645
01:03:04,630 --> 01:03:02,720
go away to the overlook

1646
01:03:08,150 --> 01:03:04,640
how high is the overlook so that type of

1647
01:03:14,390 --> 01:03:11,510
okay yeah yeah so

1648
01:03:15,990 --> 01:03:14,400
uh currently we're looking at the the uh

1649
01:03:19,670 --> 01:03:16,000
the van sale overlook that

1650
01:03:23,029 --> 01:03:19,680
was shown earlier and

1651
01:03:25,750 --> 01:03:23,039
that is i believe about

1652
01:03:26,309 --> 01:03:25,760
60 meters away from where the helicopter

1653
01:03:29,589 --> 01:03:26,319
will get

1654
01:03:30,950 --> 01:03:29,599
dropped off um so so that's the distance

1655
01:03:32,710 --> 01:03:30,960
that the rover will have to drive

1656
01:03:34,309 --> 01:03:32,720
after it has uh dropped off the

1657
01:03:36,710 --> 01:03:34,319
helicopter

1658
01:03:38,390 --> 01:03:36,720
that's about 200 feet thank you how big

1659
01:03:40,870 --> 01:03:38,400
is the landing zone

1660
01:03:41,990 --> 01:03:40,880
so the the airfield that i discussed

1661
01:03:44,549 --> 01:03:42,000
which uh

1662
01:03:46,470 --> 01:03:44,559
uh is the area where the helicopter will

1663
01:03:49,589 --> 01:03:46,480

take off from and then land back in

1664
01:03:51,510 --> 01:03:49,599
that's a 10 by 10 meter area

1665
01:03:53,589 --> 01:03:51,520
and then the entire flight zone from one

1666
01:03:57,029 --> 01:03:53,599
end to another is on the order of about

1667
01:03:59,349 --> 01:03:57,039
90 meters thank you

1668
01:04:00,309 --> 01:03:59,359
yeah and i just want to add as shown in

1669
01:04:02,950 --> 01:04:00,319
the image the

1670
01:04:03,349 --> 01:04:02,960
the vanzil overlook is about a meter or

1671
01:04:08,470 --> 01:04:03,359
so

1672
01:04:10,950 --> 01:04:08,480
an elevated view if you will of the

1673
01:04:13,349 --> 01:04:10,960
flight zone

1674
01:04:13,990 --> 01:04:13,359
okay thank you and up next we have john

1675
01:04:18,309 --> 01:04:14,000
amos

1676
01:04:19,109 --> 01:04:18,319
from the bbc um thanks very much uh for

1677
01:04:22,069 --> 01:04:19,119
doing this

1678
01:04:24,230 --> 01:04:22,079
um can i just confirm you've actually

1679
01:04:24,789 --> 01:04:24,240
driven past the airfield haven't you

1680
01:04:28,390 --> 01:04:24,799
you've

1681
01:04:31,510 --> 01:04:28,400
you're driving back

1682
01:04:32,789 --> 01:04:31,520
uh is that correct and and also that

1683
01:04:35,190 --> 01:04:32,799
final fight i think you're going to

1684
01:04:37,510 --> 01:04:35,200
attempt five what is the

1685
01:04:38,309 --> 01:04:37,520
likely profile of assuming everything is

1686
01:04:40,950 --> 01:04:38,319
successful

1687
01:04:43,589 --> 01:04:40,960
what is the likely profile of that fifth

1688
01:04:48,150 --> 01:04:46,470

how far do you want to take that yeah so

1689
01:04:48,789 --> 01:04:48,160
it is correct that we drove past the

1690
01:04:50,789 --> 01:04:48,799
airfield

1691
01:04:52,390 --> 01:04:50,799
and and part of the reason we wanted to

1692
01:04:54,630 --> 01:04:52,400
do that is we were able to get these

1693
01:04:55,349 --> 01:04:54,640
really nice images that we looked at

1694
01:04:57,270 --> 01:04:55,359
earlier

1695
01:04:58,390 --> 01:04:57,280
right from the corner of the airfield

1696
01:05:01,349 --> 01:04:58,400
that allowed us

1697
01:05:01,990 --> 01:05:01,359
to actually measure centimeter-sized

1698
01:05:03,750 --> 01:05:02,000
rocks

1699
01:05:05,750 --> 01:05:03,760
and and really map out what the

1700
01:05:09,190 --> 01:05:05,760
potential hazards are

1701
01:05:12,470 --> 01:05:09,200
in that area and so now we will be uh

1702
01:05:15,190 --> 01:05:12,480
driving back to that airfield to

1703
01:05:16,630 --> 01:05:15,200
to drop it off again and let's see the

1704
01:05:19,829 --> 01:05:16,640
other part of the question could

1705
01:05:21,349 --> 01:05:19,839
uh what was that again yeah it was

1706
01:05:22,630 --> 01:05:21,359
i mean you're going to do a sequence of

1707
01:05:24,230 --> 01:05:22,640
flights aren't you i think up to a

1708
01:05:26,150 --> 01:05:24,240
maximum of five

1709
01:05:27,910 --> 01:05:26,160
i'm just kind of wondering what the most

1710
01:05:31,109 --> 01:05:27,920
complex flight

1711
01:05:33,109 --> 01:05:31,119
would look like so currently the way

1712
01:05:33,750 --> 01:05:33,119
that we're planning it right now is we

1713
01:05:37,109 --> 01:05:33,760

have

1714
01:05:38,309 --> 01:05:37,119
sort of a set uh set of flights for the

1715
01:05:41,430 --> 01:05:38,319
first three

1716
01:05:43,510 --> 01:05:41,440
where we're focusing on on uh

1717
01:05:44,470 --> 01:05:43,520
on demonstrating basic capability to

1718
01:05:46,789 --> 01:05:44,480
hover

1719
01:05:48,549 --> 01:05:46,799
and then uh traversing and going

1720
01:05:49,349 --> 01:05:48,559
slightly you know longer distance where

1721
01:05:53,029 --> 01:05:49,359
we go down

1722
01:05:55,430 --> 01:05:53,039
the flight zone and back again and then

1723
01:05:57,349 --> 01:05:55,440
if we get past those we will assess did

1724
01:05:58,950 --> 01:05:57,359
we meet all our objectives during those

1725
01:06:02,150 --> 01:05:58,960
flights do we want to go back

1726
01:06:03,430 --> 01:06:02,160
and and retry some of those things or if

1727
01:06:06,069 --> 01:06:03,440
everything goes

1728
01:06:07,430 --> 01:06:06,079
really well then we might try to stretch

1729
01:06:10,390 --> 01:06:07,440
our capabilities beyond

1730
01:06:12,150 --> 01:06:10,400
those basic capabilities but we haven't

1731
01:06:13,910 --> 01:06:12,160
uh planned that in detail

1732
01:06:15,430 --> 01:06:13,920
at this point we're going to play a

1733
01:06:18,710 --> 01:06:15,440
little bit of ier and see

1734
01:06:20,710 --> 01:06:18,720
how things go as we get into flying

1735
01:06:22,630 --> 01:06:20,720
so you could do something quite dramatic

1736
01:06:23,829 --> 01:06:22,640
as your last flight because it wouldn't

1737
01:06:25,589 --> 01:06:23,839
matter

1738
01:06:27,109 --> 01:06:25,599

i don't want to speculate here on what

1739
01:06:27,829 --> 01:06:27,119
we'll do for that flight we're going to

1740
01:06:30,309 --> 01:06:27,839
see

1741
01:06:32,150 --> 01:06:30,319
as we proceed yeah i think i want to

1742
01:06:33,029 --> 01:06:32,160
emphasize that this is an engineering

1743
01:06:35,109 --> 01:06:33,039
experiment

1744
01:06:37,430 --> 01:06:35,119
and we will expect to learn from each of

1745
01:06:39,270 --> 01:06:37,440
these flights and that will inform

1746
01:06:41,190 --> 01:06:39,280
the decisions we take for successive

1747
01:06:42,870 --> 01:06:41,200
flights whether it's retry attempts

1748
01:06:44,470 --> 01:06:42,880
whether it's stretch goals

1749
01:06:46,309 --> 01:06:44,480
those are all things that come as part

1750
01:06:47,430 --> 01:06:46,319
and parcel of doing a technology

1751
01:06:50,390 --> 01:06:47,440
demonstration

1752
01:06:51,190 --> 01:06:50,400
and so we'll see where we are you know

1753
01:06:55,029 --> 01:06:51,200
tune

1754
01:06:57,430 --> 01:06:55,039
follow us on a journey

1755
01:06:58,150 --> 01:06:57,440
and we'll keep you posted uh both on the

1756
01:07:00,230 --> 01:06:58,160
web and in

1757
01:07:03,510 --> 01:07:00,240
other new media outlets to let you know

1758
01:07:06,630 --> 01:07:05,829
that's right thank you and up next on

1759
01:07:11,270 --> 01:07:06,640
our phone lines

1760
01:07:13,109 --> 01:07:11,280
is leo enright from irish television

1761
01:07:14,789 --> 01:07:13,119
thanks very much uh gabrielle i'm with

1762
01:07:16,150 --> 01:07:14,799
jonathan on going for one of those

1763
01:07:17,910 --> 01:07:16,160

craters i'm sure

1764
01:07:19,270 --> 01:07:17,920
that's what he's thinking and i

1765
01:07:22,549 --> 01:07:19,280
definitely think that would be

1766
01:07:24,950 --> 01:07:22,559
cool north or sorry east or west of the

1767
01:07:25,750 --> 01:07:24,960
the landing site my question though is

1768
01:07:27,829 --> 01:07:25,760
um

1769
01:07:29,910 --> 01:07:27,839
somebody on the team at a technical

1770
01:07:33,270 --> 01:07:29,920
meeting i was at recently

1771
01:07:36,710 --> 01:07:33,280
said that this vehicle has is

1772
01:07:38,710 --> 01:07:36,720
has more computer power than all

1773
01:07:40,309 --> 01:07:38,720
as i remember i don't have the notes in

1774
01:07:43,029 --> 01:07:40,319
front of me than all

1775
01:07:44,950 --> 01:07:43,039
previous american interplanetary

1776
01:07:47,510 --> 01:07:44,960
missions combined

1777
01:07:49,190 --> 01:07:47,520
uh can somebody i mean is that right

1778
01:07:53,029 --> 01:07:49,200
that seems extraordinary

1779
01:07:55,029 --> 01:07:53,039
i can take that uh so yes uh so

1780
01:07:56,789 --> 01:07:55,039
what we are comparing is the general

1781
01:07:58,390 --> 01:07:56,799
purpose computers that are there on

1782
01:08:00,069 --> 01:07:58,400
every spacecraft

1783
01:08:02,390 --> 01:08:00,079
which you know control how the

1784
01:08:03,829 --> 01:08:02,400
spacecraft behaves how it responds to

1785
01:08:05,589 --> 01:08:03,839
commands and so forth

1786
01:08:07,190 --> 01:08:05,599
so the particular computer that we are

1787
01:08:10,789 --> 01:08:07,200
using here uh

1788
01:08:12,630 --> 01:08:10,799

on ingenuity is about 150 times faster

1789
01:08:15,349 --> 01:08:12,640
than the one on perseverance and that's

1790
01:08:17,030 --> 01:08:15,359
just a reflection of the fact that

1791
01:08:18,870 --> 01:08:17,040
we are able to exploit in this

1792
01:08:19,590 --> 01:08:18,880
technology demonstrations some of the

1793
01:08:21,510 --> 01:08:19,600
latest

1794
01:08:23,590 --> 01:08:21,520
bleeding edge cutting edge products that

1795
01:08:25,590 --> 01:08:23,600
are out there in the commercial industry

1796
01:08:27,269 --> 01:08:25,600
the processor that we have is very

1797
01:08:28,070 --> 01:08:27,279
comparable to what you have on your cell

1798
01:08:30,789 --> 01:08:28,080
phone

1799
01:08:32,870 --> 01:08:30,799
from a couple three years ago and that

1800
01:08:34,870 --> 01:08:32,880
is something that we as a technology

1801
01:08:35,669 --> 01:08:34,880
demonstration are able to take advantage

1802
01:08:38,390 --> 01:08:35,679
of

1803
01:08:39,749 --> 01:08:38,400
and it's not designed for space but we

1804
01:08:41,189 --> 01:08:39,759
went through a process where we

1805
01:08:42,630 --> 01:08:41,199
convinced ourselves that for this

1806
01:08:45,030 --> 01:08:42,640
technology demonstration

1807
01:08:46,950 --> 01:08:45,040
and our risks posture that we take with

1808
01:08:48,870 --> 01:08:46,960
these kinds of demonstrations

1809
01:08:50,870 --> 01:08:48,880
it provides the computing which is

1810
01:08:52,149 --> 01:08:50,880
necessary for a lot of the navigation

1811
01:08:54,229 --> 01:08:52,159
and image processing

1812
01:08:56,550 --> 01:08:54,239
functions that you know hovard mentioned

1813
01:08:58,470 --> 01:08:56,560

so yes if you actually add up all the

1814
01:08:59,910 --> 01:08:58,480
computers all the way back that have

1815
01:09:01,910 --> 01:08:59,920
flown out

1816
01:09:03,189 --> 01:09:01,920
into the solar system and you sum it all

1817
01:09:05,669 --> 01:09:03,199
up we do

1818
01:09:06,709 --> 01:09:05,679
dwarf it by a large or two orders of

1819
01:09:08,789 --> 01:09:06,719
magnitude

1820
01:09:10,470 --> 01:09:08,799
just because we are at that place in

1821
01:09:11,990 --> 01:09:10,480
technology here on earth

1822
01:09:14,390 --> 01:09:12,000
and we have those kinds of processes

1823
01:09:15,990 --> 01:09:14,400
available

1824
01:09:21,749 --> 01:09:16,000
and do you rule out going for one of

1825
01:09:23,510 --> 01:09:21,759
those lovely craters

1826
01:09:24,870 --> 01:09:23,520
is that a question there i think so

1827
01:09:26,550 --> 01:09:24,880
could you repeat the question again

1828
01:09:28,149 --> 01:09:26,560
please

1829
01:09:30,709 --> 01:09:28,159
sorry i was just wondering do you rule

1830
01:09:31,829 --> 01:09:30,719
out going uh for one of those craters on

1831
01:09:37,349 --> 01:09:31,839
your fifth flight

1832
01:09:42,630 --> 01:09:40,709
yeah so um as was uh mentioned earlier

1833
01:09:43,990 --> 01:09:42,640
we're gonna talk about the subsequent

1834
01:09:47,749 --> 01:09:44,000
flights when we get there

1835
01:09:49,510 --> 01:09:47,759
we have uh we're focused here today on

1836
01:09:51,110 --> 01:09:49,520
you know that wright brothers moment

1837
01:09:54,229 --> 01:09:51,120
frankly getting

1838
01:09:55,350 --> 01:09:54,239

uh powered controlled flight uh then

1839
01:09:58,229 --> 01:09:55,360
adding mobility

1840
01:09:59,270 --> 01:09:58,239
uh and adding other capabilities like

1841
01:10:02,310 --> 01:09:59,280
any flight test

1842
01:10:03,350 --> 01:10:02,320
program uh would put forward and so

1843
01:10:06,630 --> 01:10:03,360
that's the path that we're going to

1844
01:10:13,030 --> 01:10:09,910
and we have a social media question up

1845
01:10:14,070 --> 01:10:13,040
next it is from shelby on facebook who

1846
01:10:18,709 --> 01:10:14,080
asks

1847
01:10:22,310 --> 01:10:18,719
what will ingenuity sound like on mars

1848
01:10:25,030 --> 01:10:22,320
hovard so when we've done

1849
01:10:27,990 --> 01:10:25,040
flight tests here uh in our 25-foot

1850
01:10:30,390 --> 01:10:28,000
spice in a space simulator

1851
01:10:32,070 --> 01:10:30,400
we've had microphones inside the chamber

1852
01:10:33,990 --> 01:10:32,080
and what it sounds like is pretty much

1853
01:10:35,350 --> 01:10:34,000
like a small airplane taking off it's

1854
01:10:37,270 --> 01:10:35,360
about the same rpm

1855
01:10:38,470 --> 01:10:37,280
as as you would hear if you're standing

1856
01:10:40,229 --> 01:10:38,480
you know next to to an

1857
01:10:41,910 --> 01:10:40,239
airstrip and you know listening to

1858
01:10:43,510 --> 01:10:41,920
propeller airplanes

1859
01:10:45,910 --> 01:10:43,520
and so you can actually uh you can

1860
01:10:47,510 --> 01:10:45,920
actually go online and see some you know

1861
01:10:47,830 --> 01:10:47,520
videos of our flight test and you'll

1862
01:10:50,390 --> 01:10:47,840
hear

1863
01:10:51,590 --> 01:10:50,400

exactly what i'm talking about there

1864
01:10:53,510 --> 01:10:51,600
what it will sound like

1865
01:10:55,590 --> 01:10:53,520
when you're standing you know say where

1866
01:10:58,070 --> 01:10:55,600
the rover is going to observe us

1867
01:11:00,310 --> 01:10:58,080
uh at a distance we don't frankly know

1868
01:11:01,830 --> 01:11:00,320
exactly you know how powerful that sound

1869
01:11:05,430 --> 01:11:01,840
how well it's going to carry

1870
01:11:07,990 --> 01:11:05,440
you know on mars as a compared to

1871
01:11:11,510 --> 01:11:08,000
in a metal box like the vacuum chamber

1872
01:11:15,270 --> 01:11:13,430
thank you and we have another social

1873
01:11:17,590 --> 01:11:15,280
media question as a reminder that

1874
01:11:18,550 --> 01:11:17,600
people of all ages are tuning in blair

1875
01:11:22,149 --> 01:11:18,560
on twitter asks

1876
01:11:22,950 --> 01:11:22,159
on behalf of his son logan age six years

1877
01:11:25,030 --> 01:11:22,960
old

1878
01:11:26,950 --> 01:11:25,040
does this mean one day that i'll be able

1879
01:11:30,870 --> 01:11:26,960
to fly my drone

1880
01:11:33,270 --> 01:11:30,880
on an obstacle course on mars

1881
01:11:35,110 --> 01:11:33,280
bob yeah i think i would first encourage

1882
01:11:36,950 --> 01:11:35,120
your

1883
01:11:38,630 --> 01:11:36,960
you should first design and help build

1884
01:11:40,070 --> 01:11:38,640
us that drone that will be much more

1885
01:11:41,590 --> 01:11:40,080
capable in ingenuity and can do all

1886
01:11:44,229 --> 01:11:41,600
those wonderful things

1887
01:11:46,229 --> 01:11:44,239
and once you help us do that then yes

1888
01:11:47,669 --> 01:11:46,239

and then you get to mars please fly it i

1889
01:11:48,790 --> 01:11:47,679
would love to see that moment that would

1890
01:11:50,709 --> 01:11:48,800
be the

1891
01:11:54,709 --> 01:11:50,719
really good outcome of all our early

1892
01:11:57,110 --> 01:11:54,719
path finding work out here

1893
01:11:58,070 --> 01:11:57,120
great thank you and we have one more

1894
01:12:01,910 --> 01:11:58,080
social

1895
01:12:04,950 --> 01:12:01,920
um media question coming in

1896
01:12:07,030 --> 01:12:04,960
let's see this is from steve on facebook

1897
01:12:10,070 --> 01:12:07,040
do the cold temperatures on mars impact

1898
01:12:12,229 --> 01:12:10,080
the lithium-ion battery life

1899
01:12:14,229 --> 01:12:12,239
bob yeah so what we do with our

1900
01:12:15,110 --> 01:12:14,239
lithium-ion batteries is we actually

1901
01:12:16,870 --> 01:12:15,120
keep them

1902
01:12:19,030 --> 01:12:16,880
warm enough through the night so that

1903
01:12:19,430 --> 01:12:19,040
they supply enough power for the heaters

1904
01:12:21,430 --> 01:12:19,440
that

1905
01:12:22,950 --> 01:12:21,440
you know keep the whole spacecraft

1906
01:12:25,669 --> 01:12:22,960
aircraft warm through the night

1907
01:12:26,550 --> 01:12:25,679
so they're not let these are commercial

1908
01:12:29,110 --> 01:12:26,560
off-the-shelf

1909
01:12:30,630 --> 01:12:29,120
lithium-ion batteries uh they've not

1910
01:12:32,229 --> 01:12:30,640
been specifically tailored for

1911
01:12:33,590 --> 01:12:32,239
low-temperature applications

1912
01:12:35,590 --> 01:12:33,600
even though that could have been done we

1913
01:12:37,350 --> 01:12:35,600

didn't go that route so we basically

1914
01:12:38,229 --> 01:12:37,360
keep our batteries warm enough so that

1915
01:12:40,550 --> 01:12:38,239
they can generate

1916
01:12:41,510 --> 01:12:40,560
enough power that we need for through

1917
01:12:42,870 --> 01:12:41,520
the night

1918
01:12:45,030 --> 01:12:42,880
and then when it comes to the actual

1919
01:12:46,630 --> 01:12:45,040
flight we warm them up so that

1920
01:12:48,950 --> 01:12:46,640
even more so that they can provide all

1921
01:12:53,110 --> 01:12:48,960
the high power that the ingenuity

1922
01:12:55,350 --> 01:12:53,120
motors need to operate the aircraft

1923
01:12:57,590 --> 01:12:55,360
great thank you bob now we have no

1924
01:12:59,270 --> 01:12:57,600
shortage of questions coming in but we

1925
01:13:01,350 --> 01:12:59,280
unfortunately can't answer

1926
01:13:03,189 --> 01:13:01,360
all of the media questions on air for

1927
01:13:05,910 --> 01:13:03,199
those of you with additional questions

1928
01:13:06,870 --> 01:13:05,920
please call jpl's digital news and media

1929
01:13:08,709 --> 01:13:06,880
office

1930
01:13:10,470 --> 01:13:08,719
we'll also continue to answer social

1931
01:13:12,870 --> 01:13:10,480
media questions online

1932
01:13:14,870 --> 01:13:12,880
and thank you for all your questions and

1933
01:13:16,070 --> 01:13:14,880
thank you to our panelists for joining

1934
01:13:17,830 --> 01:13:16,080
us today

1935
01:13:20,189 --> 01:13:17,840
to learn more about the ingenuity

1936
01:13:23,350 --> 01:13:20,199
helicopter visit

1937
01:13:25,110 --> 01:13:23,360
go.nasa.gov ingenuity

1938
01:13:26,990 --> 01:13:25,120

to learn more about the perseverance

1939
01:13:29,990 --> 01:13:27,000
rover visit

1940
01:13:32,390 --> 01:13:30,000
mars.nasa.gov perseverance

1941
01:13:34,550 --> 01:13:32,400
where you can also see the latest images

1942
01:13:36,950 --> 01:13:34,560
coming down from the rover

1943
01:13:38,950 --> 01:13:36,960
and if you're on social media join the

1944
01:13:42,470 --> 01:13:38,960
conversation about the helicopter

1945
01:13:43,350 --> 01:13:42,480
by following at nasa jpl and use the