1
00:00:04,470 --> 00:00:02,550
welcome to building nine the space

2
00:00:06,550 --> 00:00:04,480
vehicle mock-up facility here at johnson

3
00:00:08,710 --> 00:00:06,560
space center and as you mentioned the

4
00:00:10,790 --> 00:00:08,720
home of this year's desert or rats

5
00:00:12,789 --> 00:00:10,800
research and technology studies

6
00:00:15,190 --> 00:00:12,799
test going on this year we're having an

7
00:00:16,470 --> 00:00:15,200
asteroid stimulation and that involves

8
00:00:18,550 --> 00:00:16,480
several different elements but one of

9
00:00:21,349 --> 00:00:18,560
them is this multi-mission space

10
00:00:23,990 --> 00:00:21,359
exploration vehicle which actually has

11
00:00:25,750 --> 00:00:24,000
two astronauts or crew members at a time

12
00:00:27,269 --> 00:00:25,760
living in it for about three days at a

13
00:00:30,470 --> 00:00:27,279

time and switching off throughout the

14
00:00:32,069 --> 00:00:30,480
10-day study all this uh to uh

15
00:00:33,830 --> 00:00:32,079
see what it's like to

16
00:00:35,270 --> 00:00:33,840
explore an asteroid and see what uh

17
00:00:37,110 --> 00:00:35,280
technologies we're gonna need for that

18
00:00:39,590 --> 00:00:37,120
in the future and one of them of course

19
00:00:41,350 --> 00:00:39,600
is the powering of the suv the rover

20
00:00:43,190 --> 00:00:41,360
that we're using and here to tell us

21
00:00:45,110 --> 00:00:43,200
about that we have abby ryan who is the

22
00:00:46,470 --> 00:00:45,120
lead engineer on the fuel cell that

23
00:00:47,830 --> 00:00:46,480
we're using to power it this year thanks

24
00:00:49,670 --> 00:00:47,840
for joining us abby yeah no problem

25
00:00:51,350 --> 00:00:49,680
brandi okay well we're gonna walk this

26
00:00:52,709 --> 00:00:51,360
way this is the space exploration

27
00:00:54,069 --> 00:00:52,719
vehicle that we're powering and then

28
00:00:55,990 --> 00:00:54,079
over here

29
00:00:58,709 --> 00:00:56,000
we have the fuel cell itself that abby's

30
00:01:01,349 --> 00:00:58,719
gonna tell us about so what is a fuel

31
00:01:03,590 --> 00:01:01,359
cell a fuel cell is a power source that

32
00:01:05,830 --> 00:01:03,600
we've used in space ever since gemini on

33
00:01:07,910 --> 00:01:05,840
apollo on space shuttle and we're hoping

34
00:01:09,910 --> 00:01:07,920
for future missions what it does is it

35
00:01:11,590 --> 00:01:09,920
takes hydrogen and oxygen and

36
00:01:14,310 --> 00:01:11,600
essentially smushes them together in a

37
00:01:15,590 --> 00:01:14,320
big box and out you get power and water

38
00:01:18,070 --> 00:01:15,600

there's obviously a lot of chemistry

39
00:01:20,710 --> 00:01:18,080
involved in that that's the basic idea

40
00:01:22,950 --> 00:01:20,720
so it's great for space because we get

41
00:01:25,190 --> 00:01:22,960
things that we actually want to use aka

42
00:01:26,789 --> 00:01:25,200
power and water that's safe for the crew

43
00:01:28,230 --> 00:01:26,799
to drink you can use it in vehicle

44
00:01:29,510 --> 00:01:28,240
cooling and you can make your food with

45
00:01:32,390 --> 00:01:29,520
it in the galley

46
00:01:36,069 --> 00:01:32,400
okay so in this case they're using it to

47
00:01:37,910 --> 00:01:36,079
power the displays inside the rover

48
00:01:40,630 --> 00:01:37,920
everything that's running in the mmscb

49
00:01:42,789 --> 00:01:40,640
right now all the displays

50
00:01:44,630 --> 00:01:42,799
and also their air conditioning which we

51
00:01:46,789 --> 00:01:44,640
obviously don't really have in space but

52
00:01:48,789 --> 00:01:46,799
very important here in houston texas

53
00:01:50,550 --> 00:01:48,799
we're powering that as well we're also

54
00:01:52,870 --> 00:01:50,560
powering ourselves so there's absolutely

55
00:01:54,230 --> 00:01:52,880
no wall power being used in this demo

56
00:01:55,510 --> 00:01:54,240
while the fuel cell is running so it's

57
00:01:57,830 --> 00:01:55,520
definitely more of a space like

58
00:01:59,429 --> 00:01:57,840
configuration okay and so why is it

59
00:02:01,190 --> 00:01:59,439
important to go ahead and start looking

60
00:02:03,109 --> 00:02:01,200
at how this would work how it would fit

61
00:02:04,550 --> 00:02:03,119
in with other other systems well it's

62
00:02:06,389 --> 00:02:04,560
definitely important for us we're

63
00:02:08,150 --> 00:02:06,399

testing out a lot of new technology for

64
00:02:10,630 --> 00:02:08,160
fuel cells obviously the space shuttle

65
00:02:12,869 --> 00:02:10,640
was our last big fuel cell

66
00:02:14,550 --> 00:02:12,879
program and that technology is about 40

67
00:02:16,710 --> 00:02:14,560
years old by this point so we've got a

68
00:02:18,470 --> 00:02:16,720
lot of new technology in here regulators

69
00:02:20,390 --> 00:02:18,480
that were designed here at nasa so we're

70
00:02:22,470 --> 00:02:20,400
getting a lot of good data on that it's

71
00:02:24,630 --> 00:02:22,480
also important for the mmseb team to be

72
00:02:26,470 --> 00:02:24,640
able to run off of a space power source

73
00:02:28,470 --> 00:02:26,480
we can do things like plot their power

74
00:02:30,790 --> 00:02:28,480
usage over the four or five hours that

75
00:02:32,150 --> 00:02:30,800
we're running and give them good data on

76
00:02:33,830 --> 00:02:32,160
what type of power source they're going

77
00:02:35,430 --> 00:02:33,840
to need how much power they're using on

78
00:02:37,670 --> 00:02:35,440
a daily basis to run all their

79
00:02:38,869 --> 00:02:37,680
operations stuff that wall power just

80
00:02:40,710 --> 00:02:38,879
won't tell you

81
00:02:42,550 --> 00:02:40,720
so if they want to read at night how

82
00:02:44,309 --> 00:02:42,560
much is that light cost exactly every

83
00:02:46,630 --> 00:02:44,319
time they turn on a light we can see a

84
00:02:48,710 --> 00:02:46,640
blip anytime they're

85
00:02:50,470 --> 00:02:48,720
powering an engine up

86
00:02:52,070 --> 00:02:50,480
even though it's all simulated we're

87
00:02:54,390 --> 00:02:52,080
still trying to simulate that power so

88
00:02:57,350 --> 00:02:54,400

we can give them that data okay well and

89
00:02:58,790 --> 00:02:57,360
then you also said um that it creates

90
00:03:01,750 --> 00:02:58,800
when you put the hydrogen and oxygen

91
00:03:03,750 --> 00:03:01,760
together h2o water and that gets us into

92
00:03:05,110 --> 00:03:03,760
kind of the in-situ resource utilization

93
00:03:06,630 --> 00:03:05,120
definitely one of the things we're going

94
00:03:09,030 --> 00:03:06,640
to want to do in the future is bring as

95
00:03:10,790 --> 00:03:09,040
many uh or use as many resources from

96
00:03:11,910 --> 00:03:10,800
what we're exploring as we can so tell

97
00:03:13,430 --> 00:03:11,920
us a little bit about that yeah

98
00:03:15,030 --> 00:03:13,440
absolutely well the fuel cell like i

99
00:03:17,110 --> 00:03:15,040
said yeah it creates water that's it's

100
00:03:19,030 --> 00:03:17,120
only byproduct so a lot like an engine

101
00:03:21,830 --> 00:03:19,040
creates exhaust a fuel cell creates

102
00:03:23,830 --> 00:03:21,840
steam and water um in the water like i

103
00:03:26,390 --> 00:03:23,840
said it's fully potable the crew could

104
00:03:28,710 --> 00:03:26,400
drink it um but you could also use that

105
00:03:30,550 --> 00:03:28,720
water with an electrolyzer system and

106
00:03:32,710 --> 00:03:30,560
what an electrolyzer does is essentially

107
00:03:34,949 --> 00:03:32,720
the opposite of a fuel cell so it takes

108
00:03:37,270 --> 00:03:34,959
water in and splits it back into the two

109
00:03:40,470 --> 00:03:37,280
gases hydrogen oxygen

110
00:03:43,270 --> 00:03:40,480
so it takes power in and puts gas out we

111
00:03:44,869 --> 00:03:43,280
take gas in put power and water out so

112
00:03:46,869 --> 00:03:44,879
you could kind of come up with a system

113
00:03:48,869 --> 00:03:46,879

where now these can work together so

114
00:03:51,030 --> 00:03:48,879
that you're constantly creating power

115
00:03:53,110 --> 00:03:51,040
and water and gases

116
00:03:54,710 --> 00:03:53,120
you could add in based on where you're

117
00:03:57,270 --> 00:03:54,720
going

118
00:03:59,030 --> 00:03:57,280
either systems that take water from the

119
00:04:00,630 --> 00:03:59,040
ground we've for instance found there's

120
00:04:02,229 --> 00:04:00,640
a lot more water on the moon than we

121
00:04:04,229 --> 00:04:02,239
thought there was we think the same with

122
00:04:05,589 --> 00:04:04,239
mars and we don't know yet about an

123
00:04:07,350 --> 00:04:05,599
asteroid

124
00:04:08,949 --> 00:04:07,360
but we think that we can actually take

125
00:04:11,270 --> 00:04:08,959
water from the dirt that we find in the

126
00:04:12,710 --> 00:04:11,280
ground by heating it up and extracting

127
00:04:15,429 --> 00:04:12,720
the water that way

128
00:04:17,509 --> 00:04:15,439
you can also find hydrogen in martian

129
00:04:19,590 --> 00:04:17,519
atmosphere it's a methane atmosphere so

130
00:04:21,670 --> 00:04:19,600
you can break apart that methane use

131
00:04:23,510 --> 00:04:21,680
that hydrogen in the fuel cell so it's

132
00:04:25,670 --> 00:04:23,520
all about what you said in situ resource

133
00:04:27,670 --> 00:04:25,680
utilization finding

134
00:04:29,590 --> 00:04:27,680
what you can get that's helpful to us

135
00:04:31,909 --> 00:04:29,600
out of the product that's already there

136
00:04:34,230 --> 00:04:31,919
which is atmosphere and dirt

137
00:04:35,590 --> 00:04:34,240
we have a lot of that so how can we get

138
00:04:37,510 --> 00:04:35,600

things that we want out of it especially

139
00:04:39,350 --> 00:04:37,520
as we start going further out into the

140
00:04:41,510 --> 00:04:39,360
solar system or

141
00:04:42,629 --> 00:04:41,520
further distant planets we're not going

142
00:04:44,629 --> 00:04:42,639
to want to bring this stuff with us

143
00:04:46,950 --> 00:04:44,639
because it's heavy right and you know

144
00:04:48,950 --> 00:04:46,960
even a cargo mission you know to get to

145
00:04:50,629 --> 00:04:48,960
mars it takes about eight months so if

146
00:04:52,070 --> 00:04:50,639
you want water now you need to figure

147
00:04:54,310 --> 00:04:52,080
out how to make it where you are right

148
00:04:55,909 --> 00:04:54,320
okay well how is the test going so far

149
00:04:57,749 --> 00:04:55,919
so far it's been going great this is our

150
00:04:59,189 --> 00:04:57,759
third day running with the mmsev and

151
00:05:01,189 --> 00:04:59,199
we've done about four and a half hour

152
00:05:02,790 --> 00:05:01,199
runs each time um basically we're

153
00:05:05,909 --> 00:05:02,800
limited by the amount of reactant we can

154
00:05:07,749 --> 00:05:05,919
put in these tanks um and they're kind

155
00:05:09,990 --> 00:05:07,759
of small but it's what we had in the lab

156
00:05:12,710 --> 00:05:10,000
so so far everything's been great um

157
00:05:14,870 --> 00:05:12,720
we've been able to run all of their um

158
00:05:17,510 --> 00:05:14,880
their power for the days we've gotten

159
00:05:19,110 --> 00:05:17,520
some great graphs and um i just really

160
00:05:21,029 --> 00:05:19,120
couldn't be asking for it to go better

161
00:05:24,710 --> 00:05:21,039
so i'm very excited well and all this

162
00:05:27,110 --> 00:05:24,720
was built by nasa yeah here at jsc um

163
00:05:29,270 --> 00:05:27,120

all of the material inside is a fuel

164
00:05:30,950 --> 00:05:29,280
cells that we built here in our lab

165
00:05:32,629 --> 00:05:30,960
it's the propulsion and power division

166
00:05:35,029 --> 00:05:32,639
and we work on this in the energy

167
00:05:36,870 --> 00:05:35,039
systems test area here at jsc the

168
00:05:38,390 --> 00:05:36,880
housing medicine was built by langley

169
00:05:40,150 --> 00:05:38,400
out in virginia

170
00:05:42,790 --> 00:05:40,160
it's called the pup or the portable

171
00:05:45,270 --> 00:05:42,800
utility palette and it's basically part

172
00:05:47,590 --> 00:05:45,280
of the mmscb architecture

173
00:05:49,909 --> 00:05:47,600
it's detachable from the mms cv so you

174
00:05:51,510 --> 00:05:49,919
could leave it at the deep space hub and

175
00:05:53,670 --> 00:05:51,520
you know just put in it maybe what you

176
00:05:55,749 --> 00:05:53,680
want so if you're going on a week-long

177
00:05:58,150 --> 00:05:55,759
mission and you want power and water

178
00:05:59,670 --> 00:05:58,160
maybe you take the fuel cell with you or

179
00:06:01,510 --> 00:05:59,680
if you're going somewhere else just for

180
00:06:03,270 --> 00:06:01,520
a day or two maybe you want something

181
00:06:05,830 --> 00:06:03,280
else to bring with you instead extra

182
00:06:07,990 --> 00:06:05,840
tools or whatever so the idea is that

183
00:06:10,070 --> 00:06:08,000
you can kind of detach what you want or

184
00:06:11,350 --> 00:06:10,080
don't want so langley is working on that

185
00:06:13,270 --> 00:06:11,360
project and they built this whole

186
00:06:14,870 --> 00:06:13,280
housing for us so we were kind of

187
00:06:16,710 --> 00:06:14,880
constrained by that and ended up

188
00:06:17,670 --> 00:06:16,720

building the system up from there and i

189
00:06:19,029 --> 00:06:17,680
think you were telling me you think you

190
00:06:21,350 --> 00:06:19,039
can actually get it a little smaller

191
00:06:23,830 --> 00:06:21,360
right definitely we're working on a

192
00:06:25,430 --> 00:06:23,840
newer technology like i said it's always

193
00:06:28,230 --> 00:06:25,440
you know we're definitely always pushing

194
00:06:30,150 --> 00:06:28,240
for lighter meaner faster all of those

195
00:06:31,590 --> 00:06:30,160
things and with fuel cells the biggest

196
00:06:33,430 --> 00:06:31,600
change that we can make is getting rid

197
00:06:35,990 --> 00:06:33,440
of what we call the balance of plant or

198
00:06:37,909 --> 00:06:36,000
the bop and that's all of these tubes

199
00:06:39,590 --> 00:06:37,919
and pumps that you see right here we

200
00:06:41,110 --> 00:06:39,600
think that we can make that system a lot

201
00:06:43,270 --> 00:06:41,120
smaller one of the ways that we're

202
00:06:45,670 --> 00:06:43,280
working on doing that is by getting rid

203
00:06:47,189 --> 00:06:45,680
of all of our water management right now

204
00:06:48,870 --> 00:06:47,199
the way that the fuel cell gets water to

205
00:06:50,950 --> 00:06:48,880
come out of this tube right here is just

206
00:06:52,870 --> 00:06:50,960
by shoving extra gas through the fuel

207
00:06:54,309 --> 00:06:52,880
cell to move it through and then you

208
00:06:56,230 --> 00:06:54,319
need pumps to kind of pump it through

209
00:06:57,670 --> 00:06:56,240
the system to get it out so what we're

210
00:06:59,749 --> 00:06:57,680
working on is what we would call a

211
00:07:01,589 --> 00:06:59,759
non-flow through fuel cell meaning that

212
00:07:03,670 --> 00:07:01,599
we aren't flowing through the gases to

213
00:07:05,430 --> 00:07:03,680

move the water instead what we would be

214
00:07:07,110 --> 00:07:05,440
doing would be wicking the water out of

215
00:07:08,390 --> 00:07:07,120
each cell kind of like water off of a

216
00:07:10,150 --> 00:07:08,400
duck's back

217
00:07:11,110 --> 00:07:10,160
where it just wants to go

218
00:07:12,230 --> 00:07:11,120
that way

219
00:07:13,749 --> 00:07:12,240
so that's what we're working on what

220
00:07:15,110 --> 00:07:13,759
that would do is get rid of two of the

221
00:07:17,510 --> 00:07:15,120
pumps that we have in this system it

222
00:07:19,510 --> 00:07:17,520
would get rid of three different tanks

223
00:07:21,110 --> 00:07:19,520
so we're working on just getting rid of

224
00:07:23,270 --> 00:07:21,120
all the ancillary components and making

225
00:07:24,550 --> 00:07:23,280
it a smaller system great and i guess

226
00:07:25,830 --> 00:07:24,560
you know smaller is better probably for

227
00:07:27,830 --> 00:07:25,840
here on earth too or the ways we could

228
00:07:29,510 --> 00:07:27,840
use it here absolutely right now this is

229
00:07:31,990 --> 00:07:29,520
kind of an intimidating system to stick

230
00:07:34,150 --> 00:07:32,000
in your car in your house but if we can

231
00:07:36,230 --> 00:07:34,160
make this smaller then maybe folks will

232
00:07:38,629 --> 00:07:36,240
want to actually start really looking at

233
00:07:40,070 --> 00:07:38,639
fuel cell cars as an option

234
00:07:41,990 --> 00:07:40,080
people are you know i think starting to

235
00:07:43,670 --> 00:07:42,000
get on board with hybrid and electric

236
00:07:45,270 --> 00:07:43,680
cars and i think fuel cell cars in the

237
00:07:47,189 --> 00:07:45,280
next step there's already a few

238
00:07:48,309 --> 00:07:47,199

companies honda and toyota to make fuel

239
00:07:49,589 --> 00:07:48,319
cell cars

240
00:07:51,589 --> 00:07:49,599
it's great because here on earth you

241
00:07:54,230 --> 00:07:51,599
don't need the oxygen tank the air has

242
00:07:55,749 --> 00:07:54,240
enough oxygen to run a fuel cell

243
00:07:56,790 --> 00:07:55,759
and so all you would need is hydrogen

244
00:07:58,869 --> 00:07:56,800
with you

245
00:08:00,070 --> 00:07:58,879
it's you know a gas that kind of scares

246
00:08:02,230 --> 00:08:00,080
people but

247
00:08:04,950 --> 00:08:02,240
i think they get hindenburg images in

248
00:08:06,950 --> 00:08:04,960
mind but um but it's definitely safe if

249
00:08:08,390 --> 00:08:06,960
you handle it correctly and

250
00:08:10,230 --> 00:08:08,400
it's one of those things that when you

251
00:08:12,469 --> 00:08:10,240
educate people and kind of you know

252
00:08:14,869 --> 00:08:12,479
introduce a new technology to them and

253
00:08:16,710 --> 00:08:14,879
show them all the ways it can benefit um

254
00:08:19,029 --> 00:08:16,720
i think that it can really take off like

255
00:08:21,029 --> 00:08:19,039
i said the only you know exhaust from

256
00:08:22,950 --> 00:08:21,039
our system is steam and so that's a lot

257
00:08:24,790 --> 00:08:22,960
better for the environment if we can you

258
00:08:27,029 --> 00:08:24,800
know start working on that so you can

259
00:08:28,390 --> 00:08:27,039
have the steam also you can get water

260
00:08:30,150 --> 00:08:28,400
straight from the tap here right yeah

261
00:08:31,430 --> 00:08:30,160
absolutely right this is our fill plate

262
00:08:32,870 --> 00:08:31,440
right down here

263
00:08:34,550 --> 00:08:32,880

it makes it easy to be able to fill up

264
00:08:36,709 --> 00:08:34,560
our tanks there's a hydrogen port and

265
00:08:39,029 --> 00:08:36,719
oxygen port and that spout down below

266
00:08:40,630 --> 00:08:39,039
empties our water tank inside so you

267
00:08:42,149 --> 00:08:40,640
could stick a cup underneath there open

268
00:08:43,909 --> 00:08:42,159
up the spout and drink the water if you

269
00:08:45,990 --> 00:08:43,919
wanted we don't have a cup with this but

270
00:08:48,150 --> 00:08:46,000
you have tried it and it's safe and

271
00:08:50,150 --> 00:08:48,160
personally perfectly drinkable yeah i am

272
00:08:51,910 --> 00:08:50,160
i one time kept about three gatorade

273
00:08:53,670 --> 00:08:51,920
bottles of fuel cell water and had a

274
00:08:56,470 --> 00:08:53,680
fish living in a fish tank with fuel

275
00:08:59,110 --> 00:08:56,480
cell water for a few days so um it

276
00:09:01,430 --> 00:08:59,120
didn't die it's fine so yeah it's fully

277
00:09:03,910 --> 00:09:01,440
drinkable it's actually um in order for

278
00:09:05,750 --> 00:09:03,920
the human body to really use it the way

279
00:09:07,910 --> 00:09:05,760
that we are used to using water we

280
00:09:10,630 --> 00:09:07,920
actually have to add biocides to it it's

281
00:09:12,310 --> 00:09:10,640
too clean for our bodies to deal with um

282
00:09:13,990 --> 00:09:12,320
so that's kind of an interesting fact

283
00:09:15,829 --> 00:09:14,000
all right so we should have lots of uses

284
00:09:17,110 --> 00:09:15,839
for that in the future i hope so thanks

285
00:09:19,190 --> 00:09:17,120
so much for talking with us again this