



1  
00:00:04,150 --> 00:00:02,790  
hi welcome to the international space

2  
00:00:06,389 --> 00:00:04,160  
station flight control room it's been a

3  
00:00:08,549 --> 00:00:06,399  
busy day today and we're very very happy

4  
00:00:10,230 --> 00:00:08,559  
to be here for uh

5  
00:00:11,669 --> 00:00:10,240  
talking to some of our

6  
00:00:13,509 --> 00:00:11,679  
students that are actually out here at

7  
00:00:15,190 --> 00:00:13,519  
nasa johnson space student space center

8  
00:00:16,710 --> 00:00:15,200  
they are the high school aerospace

9  
00:00:18,150 --> 00:00:16,720  
scholars and also the pre-service

10  
00:00:21,189 --> 00:00:18,160  
teachers today we're going to be talking

11  
00:00:23,029 --> 00:00:21,199  
about a very very popular topic

12  
00:00:24,710 --> 00:00:23,039  
it's one of the letters of the alphabet

13  
00:00:27,830 --> 00:00:24,720

Imnop

14

00:00:29,990 --> 00:00:27,840

so today i have our guest

15

00:00:32,150 --> 00:00:30,000

julie mitchell she is the project

16

00:00:33,830 --> 00:00:32,160

engineer of the water recovery system

17

00:00:35,430 --> 00:00:33,840

welcome julie and thank you for coming

18

00:00:38,389 --> 00:00:35,440

thank you very much for having me all

19

00:00:41,110 --> 00:00:38,399

right well with that let's get going

20

00:00:43,030 --> 00:00:41,120

do we have our first question samantha

21

00:00:45,910 --> 00:00:43,040

yes hi my name is samantha and i'm with

22

00:00:48,069 --> 00:00:45,920

psti i was wondering if astronauts need

23

00:00:49,670 --> 00:00:48,079

antibiotics in space how would they be

24

00:00:51,750 --> 00:00:49,680

administered

25

00:00:54,069 --> 00:00:51,760

hi samantha um

26

00:00:55,750 --> 00:00:54,079

in terms of any kind of medicine that

27

00:00:56,790 --> 00:00:55,760

the astronauts need when they're in

28

00:00:58,630 --> 00:00:56,800

space

29

00:00:59,830 --> 00:00:58,640

they actually have a medical kit that

30

00:01:01,590 --> 00:00:59,840

they bring up with them and they

31

00:01:04,229 --> 00:01:01,600

actually have medicine stored on the

32

00:01:05,750 --> 00:01:04,239

space station so if they ever get sick

33

00:01:08,149 --> 00:01:05,760

they can actually

34

00:01:09,990 --> 00:01:08,159

use that stockpile of medicine that they

35

00:01:12,149 --> 00:01:10,000

have on orbit now if something were to

36

00:01:14,390 --> 00:01:12,159

come up where the astronauts were very

37

00:01:15,910 --> 00:01:14,400

very sick and the medicine that they had

38

00:01:17,990 --> 00:01:15,920

on orbit wouldn't work there is the

39

00:01:19,749 --> 00:01:18,000

option of bringing the crew members down

40

00:01:21,670 --> 00:01:19,759

for them to receive medical treatment on

41

00:01:23,910 --> 00:01:21,680

earth but they do have

42

00:01:26,630 --> 00:01:23,920

quite a bit of medicine on orbit

43

00:01:33,270 --> 00:01:26,640

to help them if they ever get sick

44

00:01:36,789 --> 00:01:35,749

hi my name is lauren and i was wondering

45

00:01:39,109 --> 00:01:36,799

how does an

46

00:01:41,590 --> 00:01:39,119

astronaut keep safe from pathogens and

47

00:01:43,510 --> 00:01:41,600

bacteria while in space

48

00:01:45,910 --> 00:01:43,520

that's a really good question

49

00:01:47,350 --> 00:01:45,920

before the astronauts go up into space

50

00:01:49,670 --> 00:01:47,360

they actually are quarantined for a

51  
00:01:51,270 --> 00:01:49,680  
certain period of time i believe it's a

52  
00:01:52,870 --> 00:01:51,280  
week or two weeks

53  
00:01:54,950 --> 00:01:52,880  
and that way before they even go into

54  
00:01:56,389 --> 00:01:54,960  
space they've already been isolated from

55  
00:01:58,630 --> 00:01:56,399  
a lot of the bacteria and a lot of the

56  
00:01:59,990 --> 00:01:58,640  
pathogens that might make them sick when

57  
00:02:01,910 --> 00:02:00,000  
they're here on earth so that way they

58  
00:02:03,830 --> 00:02:01,920  
don't carry those bugs up with them into

59  
00:02:08,710 --> 00:02:03,840  
space

60  
00:02:11,190 --> 00:02:08,720  
clean

61  
00:02:13,030 --> 00:02:11,200  
they actually do a lot of disinfection

62  
00:02:15,430 --> 00:02:13,040  
of different surfaces on orbit they have

63  
00:02:17,350 --> 00:02:15,440

filters that filter the air and just to

64

00:02:19,350 --> 00:02:17,360

make sure they actually have different

65

00:02:22,390 --> 00:02:19,360

microbial monitoring kits that they use

66

00:02:24,229 --> 00:02:22,400

to check for any bacteria any pathogens

67

00:02:26,070 --> 00:02:24,239

that might be floating around in the air

68

00:02:28,470 --> 00:02:26,080

they check different surfaces to see if

69

00:02:30,790 --> 00:02:28,480

they have any growth on those surfaces

70

00:02:33,589 --> 00:02:30,800

and they also check all the different

71

00:02:34,949 --> 00:02:33,599

hardware where they might get water or

72

00:02:36,390 --> 00:02:34,959

where their food might touch to make

73

00:02:38,229 --> 00:02:36,400

sure that they don't have any

74

00:02:40,070 --> 00:02:38,239

harmful bacteria or any pathogens

75

00:02:41,430 --> 00:02:40,080

growing on those surfaces as well and so

76

00:02:44,229 --> 00:02:41,440

far there haven't been any issues in

77

00:02:45,589 --> 00:02:44,239

that regard so it's a good thing

78

00:02:50,550 --> 00:02:45,599

a very good question do we have another

79

00:02:55,030 --> 00:02:53,589

hi my name is alexandra daglio from psti

80

00:02:56,790 --> 00:02:55,040

i was wondering what's the most

81

00:02:58,630 --> 00:02:56,800

complicated project you've ever worked

82

00:03:01,910 --> 00:02:58,640

on

83

00:03:04,070 --> 00:03:01,920

um we do a lot of complicated projects

84

00:03:05,830 --> 00:03:04,080

so the area i work in is actually

85

00:03:08,149 --> 00:03:05,840

advanced water recovery systems

86

00:03:10,630 --> 00:03:08,159

technology development and so we

87

00:03:12,710 --> 00:03:10,640

actually do the next generation of water

88

00:03:14,949 --> 00:03:12,720

recycling technologies for space flight

89

00:03:16,710 --> 00:03:14,959

so right now we have a distillation

90

00:03:17,670 --> 00:03:16,720

system that we use on the space station

91

00:03:19,430 --> 00:03:17,680

but

92

00:03:20,949 --> 00:03:19,440

the work that i do actually looks at

93

00:03:22,630 --> 00:03:20,959

what we're going to do next and if there

94

00:03:24,869 --> 00:03:22,640

are other technologies that might work

95

00:03:27,430 --> 00:03:24,879

better once we're on a planetary surface

96

00:03:28,869 --> 00:03:27,440

for instance so the most complicated

97

00:03:30,630 --> 00:03:28,879

project i would say is actually one that

98

00:03:33,270 --> 00:03:30,640

i'm working on right now and it's called

99

00:03:36,070 --> 00:03:33,280

the alternative water processor and what

100

00:03:38,309 --> 00:03:36,080

it does is it actually combines a

101  
00:03:39,270 --> 00:03:38,319  
biological water processor in a membrane

102  
00:03:42,149 --> 00:03:39,280  
system

103  
00:03:44,550 --> 00:03:42,159  
to get the water from waste water to

104  
00:03:46,309 --> 00:03:44,560  
potable and so the way that biological

105  
00:03:49,750 --> 00:03:46,319  
water processor works is we actually

106  
00:03:51,509 --> 00:03:49,760  
have specific species of bacteria that

107  
00:03:53,350 --> 00:03:51,519  
actually feed off of the contaminants

108  
00:03:55,670 --> 00:03:53,360  
that you find in wastewater so they feed

109  
00:03:57,429 --> 00:03:55,680  
off of the urea that you find in urine

110  
00:04:00,550 --> 00:03:57,439  
they feed off of the surfactants that

111  
00:04:02,309 --> 00:04:00,560  
you find in soap and gray water and so

112  
00:04:04,630 --> 00:04:02,319  
those bacteria

113  
00:04:07,350 --> 00:04:04,640

are specially selected so that they can

114

00:04:09,670 --> 00:04:07,360

actually convert those contaminants into

115

00:04:11,509 --> 00:04:09,680

nitrogen gas carbon dioxide and water

116

00:04:13,350 --> 00:04:11,519

which is like

117

00:04:15,110 --> 00:04:13,360

excellent for space flight

118

00:04:17,349 --> 00:04:15,120

downstream of that we have a membrane

119

00:04:18,710 --> 00:04:17,359

system that deals with all the inorganic

120

00:04:21,349 --> 00:04:18,720

so all the salts that you have in your

121

00:04:23,110 --> 00:04:21,359

urine like calcium sodium sulfates

122

00:04:24,629 --> 00:04:23,120

phosphates that kind of thing those

123

00:04:26,070 --> 00:04:24,639

things get removed by the membrane

124

00:04:27,590 --> 00:04:26,080

system and so

125

00:04:30,310 --> 00:04:27,600

what comes out of that system we're

126  
00:04:32,550 --> 00:04:30,320  
expecting uh will be water that's nearly

127  
00:04:34,629 --> 00:04:32,560  
potable and so that's an incredibly

128  
00:04:37,270 --> 00:04:34,639  
large complex piece of hardware our

129  
00:04:38,950 --> 00:04:37,280  
entire team is working on it and so um

130  
00:04:41,030 --> 00:04:38,960  
it's it's very complex but it's also

131  
00:04:47,670 --> 00:04:41,040  
very exciting as well

132  
00:04:51,990 --> 00:04:49,270  
hi my name is stephanie carroll and i'm

133  
00:04:53,670 --> 00:04:52,000  
from psti program and my question is

134  
00:04:55,430 --> 00:04:53,680  
what is the process of pre-treating

135  
00:04:58,230 --> 00:04:55,440  
urine

136  
00:04:59,510 --> 00:04:58,240  
that's a really good question um

137  
00:05:00,870 --> 00:04:59,520  
so when

138  
00:05:04,310 --> 00:05:00,880

let me step back a little bit and

139

00:05:07,270 --> 00:05:04,320

explain why we pre-treat urine so

140

00:05:08,710 --> 00:05:07,280

when a astronaut urine urinates

141

00:05:10,790 --> 00:05:08,720

in space

142

00:05:12,950 --> 00:05:10,800

we don't necessarily get to recycle the

143

00:05:15,029 --> 00:05:12,960

water from that urine immediately and so

144

00:05:17,510 --> 00:05:15,039

sometimes that urine can sit around for

145

00:05:19,830 --> 00:05:17,520

a couple of days up to a couple of weeks

146

00:05:21,590 --> 00:05:19,840

and so what we want to do is we want to

147

00:05:23,270 --> 00:05:21,600

make sure that that urine doesn't break

148

00:05:24,870 --> 00:05:23,280

down chemically

149

00:05:25,830 --> 00:05:24,880

because when it breaks down it can

150

00:05:27,749 --> 00:05:25,840

produce

151  
00:05:29,189 --> 00:05:27,759  
toxic gases like ammonia gas that you

152  
00:05:30,790 --> 00:05:29,199  
don't want building up on your

153  
00:05:33,189 --> 00:05:30,800  
spacecraft

154  
00:05:35,350 --> 00:05:33,199  
also we don't want microbial growth on

155  
00:05:37,270 --> 00:05:35,360  
the spacecraft so if you've ever put a

156  
00:05:38,950 --> 00:05:37,280  
piece of pizza or something in your

157  
00:05:40,469 --> 00:05:38,960  
fridge and you let it sit there for a

158  
00:05:42,870 --> 00:05:40,479  
long time and you get a piece of you

159  
00:05:43,830 --> 00:05:42,880  
know a big mold growing on the surface

160  
00:05:44,870 --> 00:05:43,840  
of it

161  
00:05:46,150 --> 00:05:44,880  
that's the kind of thing we want to

162  
00:05:47,590 --> 00:05:46,160  
avoid on the space station if you

163  
00:05:49,830 --> 00:05:47,600

imagine a big

164

00:05:52,550 --> 00:05:49,840

fungal mat or a piece of mold in a tube

165

00:05:54,469 --> 00:05:52,560

that's about this big around

166

00:05:56,629 --> 00:05:54,479

it can get clogged very quickly and so

167

00:05:58,870 --> 00:05:56,639

that can actually damage the hardware to

168

00:06:01,430 --> 00:05:58,880

the point where we can't recycle water

169

00:06:03,909 --> 00:06:01,440

so we pre-treat the urine to prevent the

170

00:06:06,629 --> 00:06:03,919

chemical breakdown of the urine and to

171

00:06:08,309 --> 00:06:06,639

inhibit microbial growth so

172

00:06:09,830 --> 00:06:08,319

the pre-treatment process is actually

173

00:06:11,270 --> 00:06:09,840

pretty straightforward we have a tank

174

00:06:15,029 --> 00:06:11,280

that's filled with the pre-treatment

175

00:06:17,029 --> 00:06:15,039

fluid which is about the most

176

00:06:18,469 --> 00:06:17,039

one of the most powerful disinfectants

177

00:06:20,550 --> 00:06:18,479

that you can have

178

00:06:22,469 --> 00:06:20,560

it's a mixture of sulfuric acid and

179

00:06:23,909 --> 00:06:22,479

chromic acid so you don't want to get

180

00:06:26,309 --> 00:06:23,919

this on your skin you don't want to

181

00:06:28,629 --> 00:06:26,319

drink it the astronauts don't drink it

182

00:06:30,629 --> 00:06:28,639

but we put it in the urine to prevent

183

00:06:32,550 --> 00:06:30,639

microbial growth until we can extract

184

00:06:34,710 --> 00:06:32,560

the water from that urine and so we have

185

00:06:36,790 --> 00:06:34,720

a tank full of that fluid and whenever

186

00:06:38,550 --> 00:06:36,800

an astronaut urinates a certain amount

187

00:06:40,070 --> 00:06:38,560

of that fluid is injected into the urine

188

00:06:42,629 --> 00:06:40,080

each time and then it goes into the

189

00:06:43,749 --> 00:06:42,639

storage tank um to wait until it's

190

00:06:45,110 --> 00:06:43,759

processed

191

00:06:47,029 --> 00:06:45,120

very good question and that was a

192

00:06:49,029 --> 00:06:47,039

fascinating answer and i bet none of you

193

00:06:50,710 --> 00:06:49,039

have ever seen the moldy pizza in your

194

00:06:53,270 --> 00:06:50,720

fridge

195

00:06:55,749 --> 00:06:53,280

next question

196

00:06:57,270 --> 00:06:55,759

hi my name is whitney my question is how

197

00:06:58,950 --> 00:06:57,280

is the urine contained until it's

198

00:07:01,830 --> 00:06:58,960

processed from the time it leaves the

199

00:07:05,110 --> 00:07:01,840

astronaut to when it is

200

00:07:07,909 --> 00:07:05,120

uh that's a good question actually

201  
00:07:10,150 --> 00:07:07,919  
so when the astronaut urinates there is

202  
00:07:11,589 --> 00:07:10,160  
a fan that actually sucks the urine down

203  
00:07:13,589 --> 00:07:11,599  
through the tube

204  
00:07:15,029 --> 00:07:13,599  
where the astronaut urinates and that

205  
00:07:16,870 --> 00:07:15,039  
goes through

206  
00:07:19,350 --> 00:07:16,880  
a separator that removes the gas from

207  
00:07:22,629 --> 00:07:19,360  
the urine and then it goes into a

208  
00:07:24,790 --> 00:07:22,639  
storage tank and depending on

209  
00:07:26,150 --> 00:07:24,800  
how much urine we've collected

210  
00:07:27,830 --> 00:07:26,160  
that tank

211  
00:07:30,070 --> 00:07:27,840  
will actually

212  
00:07:32,950 --> 00:07:30,080  
feed urine into our water processing

213  
00:07:35,110 --> 00:07:32,960

hardware and so

214

00:07:37,510 --> 00:07:35,120

like i mentioned before that tank that

215

00:07:40,150 --> 00:07:37,520

water uh the urine that's in the tank

216

00:07:42,469 --> 00:07:40,160

can sit for a few days up to a few weeks

217

00:07:43,430 --> 00:07:42,479

before it's processed and so

218

00:07:45,189 --> 00:07:43,440

um

219

00:07:47,830 --> 00:07:45,199

you know the pre-treatment does its work

220

00:07:49,589 --> 00:07:47,840

really in that tank and then

221

00:07:51,270 --> 00:07:49,599

from there it feeds into our distiller

222

00:07:53,510 --> 00:07:51,280

that actually removes the water from the

223

00:07:58,790 --> 00:07:53,520

urine

224

00:08:04,230 --> 00:08:01,510

uh hello there i'm jerry george and

225

00:08:06,790 --> 00:08:04,240

we're from the haas program and i would

226

00:08:09,270 --> 00:08:06,800

like to know what happens if someone has

227

00:08:12,070 --> 00:08:09,280

an infection that goes to their urine is

228

00:08:13,749 --> 00:08:12,080

it safe to drink and more specifically

229

00:08:15,430 --> 00:08:13,759

how do they figure out how to drink

230

00:08:17,749 --> 00:08:15,440

urine

231

00:08:20,629 --> 00:08:17,759

that's a good question

232

00:08:22,390 --> 00:08:20,639

so like i mentioned before

233

00:08:24,710 --> 00:08:22,400

the pre-treatment does an excellent job

234

00:08:25,510 --> 00:08:24,720

of preventing any microbial growth and

235

00:08:26,950 --> 00:08:25,520

so

236

00:08:28,150 --> 00:08:26,960

it pretty much kills everything that's

237

00:08:30,790 --> 00:08:28,160

in the urine

238

00:08:32,709 --> 00:08:30,800

we haven't had any issues in terms of

239

00:08:34,630 --> 00:08:32,719

pathogens making their way through the

240

00:08:36,310 --> 00:08:34,640

water recovery system so that chronic

241

00:08:39,350 --> 00:08:36,320

acid and that sulfuric acid does a

242

00:08:42,070 --> 00:08:39,360

really good job of killing any pathogens

243

00:08:44,870 --> 00:08:42,080

if you've ever seen erin brockovich

244

00:08:46,470 --> 00:08:44,880

the people in that movie who get sick

245

00:08:48,790 --> 00:08:46,480

they actually have hexavalent chromium

246

00:08:50,710 --> 00:08:48,800

in their water that's the stuff that we

247

00:08:53,590 --> 00:08:50,720

put in the urine to kill

248

00:08:55,509 --> 00:08:53,600

everything that could grow in that urine

249

00:08:57,110 --> 00:08:55,519

so as soon as it gets dosed with that

250

00:08:58,870 --> 00:08:57,120

pre-treatment

251  
00:09:00,870 --> 00:08:58,880  
any pathogens or any infections that

252  
00:09:03,110 --> 00:09:00,880  
might have been in there are essentially

253  
00:09:05,990 --> 00:09:03,120  
eliminated and so

254  
00:09:07,350 --> 00:09:06,000  
from that wastewater tank it goes into a

255  
00:09:11,110 --> 00:09:07,360  
distiller

256  
00:09:13,030 --> 00:09:11,120  
urine slightly to the point where you

257  
00:09:15,750 --> 00:09:13,040  
have water vapor that's produced and

258  
00:09:17,269 --> 00:09:15,760  
that vapor is actually what's extracted

259  
00:09:19,670 --> 00:09:17,279  
from the urine and condensed in a

260  
00:09:21,190 --> 00:09:19,680  
separate container and then from there

261  
00:09:23,829 --> 00:09:21,200  
it's not completely potable we still

262  
00:09:25,829 --> 00:09:23,839  
have a few more steps that are followed

263  
00:09:27,350 --> 00:09:25,839

there are ion exchange beds that that

264

00:09:29,269 --> 00:09:27,360

water goes through

265

00:09:31,350 --> 00:09:29,279

and then we add a biocide just to make

266

00:09:33,430 --> 00:09:31,360

sure that once it is potable we still

267

00:09:36,070 --> 00:09:33,440

don't have any downstream contamination

268

00:09:39,030 --> 00:09:36,080

of that water and so that's that's the

269

00:09:41,030 --> 00:09:39,040

full series of events um

270

00:09:42,870 --> 00:09:41,040

to to remove any pathogens from the

271

00:09:45,350 --> 00:09:42,880

urine and to get it from

272

00:09:49,990 --> 00:09:45,360

wastewater to potable

273

00:09:53,910 --> 00:09:51,910

hi i'm colton and i'm from the the haas

274

00:09:55,670 --> 00:09:53,920

program and stepping away from urine for

275

00:09:57,590 --> 00:09:55,680

a second um if there's an emergency

276

00:09:59,030 --> 00:09:57,600

situation that requires astronauts to

277

00:10:01,590 --> 00:09:59,040

evacuate on the iss what are the

278

00:10:03,829 --> 00:10:01,600

procedures for them to follow

279

00:10:05,509 --> 00:10:03,839

um that's a really good question

280

00:10:06,790 --> 00:10:05,519

as part of their training actually here

281

00:10:09,269 --> 00:10:06,800

at jsc

282

00:10:10,630 --> 00:10:09,279

they do a lot of emergency evacuation

283

00:10:12,870 --> 00:10:10,640

procedures and they have different

284

00:10:15,509 --> 00:10:12,880

procedures they follow depending on the

285

00:10:19,190 --> 00:10:15,519

type of emergency if they have a fire if

286

00:10:20,870 --> 00:10:19,200

they have a cabin leak things like that

287

00:10:22,870 --> 00:10:20,880

they practice that quite a bit here on

288

00:10:25,030 --> 00:10:22,880

the ground now the first thing they're

289

00:10:26,790 --> 00:10:25,040

going to try to do is recover the space

290

00:10:29,030 --> 00:10:26,800

station in the case of an emergency so

291

00:10:30,949 --> 00:10:29,040

that they don't have to evacuate but in

292

00:10:32,949 --> 00:10:30,959

the instance they do have to evacuate

293

00:10:34,230 --> 00:10:32,959

they do always have

294

00:10:37,190 --> 00:10:34,240

a lifeboat

295

00:10:38,870 --> 00:10:37,200

we call it so a soyuz spacecraft that's

296

00:10:40,790 --> 00:10:38,880

docked to the space station for them to

297

00:10:42,310 --> 00:10:40,800

get into and return to earth in case of

298

00:10:45,430 --> 00:10:42,320

an emergency

299

00:10:48,230 --> 00:10:45,440

very good and also they do periodically

300

00:10:50,470 --> 00:10:48,240

while they're on board they uh they also

301  
00:10:52,949 --> 00:10:50,480  
participate in onboard training so they

302  
00:10:55,750 --> 00:10:52,959  
can maintain that proficiency and their

303  
00:10:56,470 --> 00:10:55,760  
skills and be ready for if an emergency

304  
00:10:58,829 --> 00:10:56,480  
were

305  
00:11:01,750 --> 00:10:58,839  
to occur good

306  
00:11:04,230 --> 00:11:01,760  
question hi my name is deanna and i'm

307  
00:11:06,150 --> 00:11:04,240  
with the haas program and my question is

308  
00:11:08,230 --> 00:11:06,160  
what are you currently doing to improve

309  
00:11:10,310 --> 00:11:08,240  
the efficiency rate of the

310  
00:11:13,030 --> 00:11:10,320  
urine recycling system

311  
00:11:14,790 --> 00:11:13,040  
that's a really good question too

312  
00:11:15,990 --> 00:11:14,800  
we actually have a project going on

313  
00:11:18,630 --> 00:11:16,000

right now

314

00:11:21,110 --> 00:11:18,640

um to help increase the water recovery

315

00:11:23,110 --> 00:11:21,120

rate on the space station up to 85

316

00:11:25,350 --> 00:11:23,120

percent originally we were planning to

317

00:11:27,750 --> 00:11:25,360

start out with 85 but what actually

318

00:11:30,389 --> 00:11:27,760

happened was the astronauts urine had a

319

00:11:33,350 --> 00:11:30,399

lot more calcium than we expected and so

320

00:11:35,590 --> 00:11:33,360

that calcium combined with the sulfate

321

00:11:37,269 --> 00:11:35,600

from our sulfuric acid pre-treatment and

322

00:11:39,509 --> 00:11:37,279

actually precipitated out in our

323

00:11:42,550 --> 00:11:39,519

distiller and

324

00:11:44,069 --> 00:11:42,560

that precipitate is called gypsum and

325

00:11:46,630 --> 00:11:44,079

it's the same stuff you have in like

326  
00:11:48,790 --> 00:11:46,640  
drywall for instance so everybody's seen

327  
00:11:49,910 --> 00:11:48,800  
gypsum

328  
00:11:51,509 --> 00:11:49,920  
and so

329  
00:11:53,750 --> 00:11:51,519  
one of the technologies actually several

330  
00:11:57,030 --> 00:11:53,760  
of the technologies we're looking at now

331  
00:11:59,110 --> 00:11:57,040  
are to either remove the calcium or

332  
00:12:01,110 --> 00:11:59,120  
replace that sulfuric acid with a

333  
00:12:03,190 --> 00:12:01,120  
different pre-treatment so that we don't

334  
00:12:05,590 --> 00:12:03,200  
have that precipitation problem

335  
00:12:07,750 --> 00:12:05,600  
we actually have two technologies one

336  
00:12:09,590 --> 00:12:07,760  
for calcium and one to kind of mitigate

337  
00:12:11,590 --> 00:12:09,600  
the sulfate that have both been

338  
00:12:13,750 --> 00:12:11,600

demonstrated to work very well and allow

339

00:12:15,430 --> 00:12:13,760

us to get up to 85 percent

340

00:12:16,710 --> 00:12:15,440

the space station program is leaning

341

00:12:19,030 --> 00:12:16,720

towards the

342

00:12:20,230 --> 00:12:19,040

the alternative to the sulfate and so

343

00:12:22,150 --> 00:12:20,240

we're actually in the process of

344

00:12:23,590 --> 00:12:22,160

pursuing that for flight right now so

345

00:12:24,389 --> 00:12:23,600

we're hoping that within the next year

346

00:12:26,470 --> 00:12:24,399

or two

347

00:12:30,230 --> 00:12:26,480

we can get the space station from 75

348

00:12:34,470 --> 00:12:30,240

percent up to 85 percent water recovery

349

00:12:39,350 --> 00:12:36,389

hello my name is james kwon from haas

350

00:12:41,110 --> 00:12:39,360

program and you said the after

351

00:12:44,069 --> 00:12:41,120

filtration of urine which is eighty

352

00:12:46,870 --> 00:12:44,079

percent required recycled um what are

353

00:12:48,389 --> 00:12:46,880

they using the final twenty percent

354

00:12:50,389 --> 00:12:48,399

for

355

00:12:53,030 --> 00:12:50,399

that's a good question um so the

356

00:12:55,269 --> 00:12:53,040

remainder of what doesn't get removed

357

00:12:56,310 --> 00:12:55,279

from the urine is called a brine

358

00:12:59,509 --> 00:12:56,320

and

359

00:13:02,790 --> 00:12:59,519

right now that brine put it's put into

360

00:13:05,350 --> 00:13:02,800

brine storage containers and those are

361

00:13:07,509 --> 00:13:05,360

thrown in the trash we get rid of those

362

00:13:09,509 --> 00:13:07,519

but if you think about it there's a lot

363

00:13:11,030 --> 00:13:09,519

of water in that brain that we could get

364

00:13:13,990 --> 00:13:11,040

and so one of the active areas of

365

00:13:16,230 --> 00:13:14,000

research in my group is called brine

366

00:13:18,230 --> 00:13:16,240

water recovery which is looking at

367

00:13:19,110 --> 00:13:18,240

different ways to extract water from the

368

00:13:20,949 --> 00:13:19,120

brine

369

00:13:23,670 --> 00:13:20,959

and the reason that

370

00:13:26,470 --> 00:13:23,680

is a unique challenge

371

00:13:29,670 --> 00:13:26,480

is because once you go past you know

372

00:13:32,069 --> 00:13:29,680

80 85 percent water recovery you start

373

00:13:34,069 --> 00:13:32,079

precipitating solids out

374

00:13:35,910 --> 00:13:34,079

even with some of these new technologies

375

00:13:37,829 --> 00:13:35,920

like i just mentioned you still are

376

00:13:39,910 --> 00:13:37,839

going to precipitate at some point and

377

00:13:41,990 --> 00:13:39,920

so with this brine water recovery

378

00:13:43,829 --> 00:13:42,000

technology uh we have to specifically

379

00:13:46,389 --> 00:13:43,839

design it to be tolerant to solids

380

00:13:49,110 --> 00:13:46,399

formation and so we're hoping that we

381

00:13:51,269 --> 00:13:49,120

can extract the remaining water from

382

00:13:53,829 --> 00:13:51,279

that to continue to close the water loop

383

00:13:55,509 --> 00:13:53,839

and hopefully get to you know in the 90s

384

00:13:56,790 --> 00:13:55,519

or even higher

385

00:13:58,550 --> 00:13:56,800

you know full

386

00:14:02,470 --> 00:13:58,560

loop closure

387

00:14:04,230 --> 00:14:02,480

for future spacecraft beyond iss

388

00:14:08,550 --> 00:14:04,240

okay thank you

389

00:14:11,110 --> 00:14:10,150

hi my name is katie from the haas

390

00:14:13,030 --> 00:14:11,120

program

391

00:14:15,509 --> 00:14:13,040

and we were wondering what's done with

392

00:14:18,470 --> 00:14:15,519

the waste that cannot be recycled and

393

00:14:21,829 --> 00:14:18,480

how is it transported back to earth

394

00:14:24,150 --> 00:14:21,839

so um a lot of the brine that actually

395

00:14:26,550 --> 00:14:24,160

gets generated like i said before gets

396

00:14:27,829 --> 00:14:26,560

thrown in the trash and so

397

00:14:29,269 --> 00:14:27,839

a lot of that gets burned up in the

398

00:14:31,829 --> 00:14:29,279

atmosphere

399

00:14:34,310 --> 00:14:31,839

we do bring back samples of that brine

400

00:14:36,949 --> 00:14:34,320

to actually analyze to see what is left

401  
00:14:38,550 --> 00:14:36,959  
over after we've removed water

402  
00:14:41,189 --> 00:14:38,560  
from the urine

403  
00:14:42,629 --> 00:14:41,199  
and so one thing we've done as engineers

404  
00:14:45,670 --> 00:14:42,639  
is look at some of the chemical data of

405  
00:14:48,389 --> 00:14:45,680  
that brine and use that to design our

406  
00:14:51,430 --> 00:14:48,399  
hardware so astronaut urine is a lot

407  
00:14:52,790 --> 00:14:51,440  
more concentrated in general than

408  
00:14:53,670 --> 00:14:52,800  
the urine that we have here on the

409  
00:14:55,590 --> 00:14:53,680  
ground

410  
00:14:57,509 --> 00:14:55,600  
and so we'll actually collect urine for

411  
00:14:59,670 --> 00:14:57,519  
our testing and we'll add chemicals to

412  
00:15:01,829 --> 00:14:59,680  
it to make it mimic

413  
00:15:03,670 --> 00:15:01,839

the concentrations that you would see on

414

00:15:05,350 --> 00:15:03,680

orbit and so

415

00:15:07,350 --> 00:15:05,360

those brine samples really help us with

416

00:15:09,670 --> 00:15:07,360

that and they also help us especially

417

00:15:11,430 --> 00:15:09,680

with testing that brine water recovery

418

00:15:12,870 --> 00:15:11,440

hardware i talked about

419

00:15:14,629 --> 00:15:12,880

so hopefully we'll get to the point

420

00:15:16,470 --> 00:15:14,639

where

421

00:15:18,470 --> 00:15:16,480

we can actually recycle the water from

422

00:15:21,750 --> 00:15:18,480

the brine as well but right now we throw

423

00:15:21,760 --> 00:15:26,069

thank you

424

00:15:29,430 --> 00:15:27,750

hi my name is brandy poycher from the

425

00:15:31,030 --> 00:15:29,440

psti program

426  
00:15:35,269 --> 00:15:31,040  
and i want to know are there any major

427  
00:15:40,629 --> 00:15:37,829  
there are some differences

428  
00:15:42,069 --> 00:15:40,639  
like i mentioned before the urine that's

429  
00:15:43,749 --> 00:15:42,079  
in space we've noticed is more

430  
00:15:44,949 --> 00:15:43,759  
concentrated than what we have here on

431  
00:15:46,470 --> 00:15:44,959  
the ground

432  
00:15:48,069 --> 00:15:46,480  
and the reason for that is when you go

433  
00:15:49,910 --> 00:15:48,079  
into space

434  
00:15:52,150 --> 00:15:49,920  
the fluids in your body get

435  
00:15:53,749 --> 00:15:52,160  
redistributed because here on earth the

436  
00:15:55,829 --> 00:15:53,759  
fluids are kind of drawn toward your

437  
00:15:57,829 --> 00:15:55,839  
feet because of gravity in space we

438  
00:16:00,150 --> 00:15:57,839

don't have that and so the fluids kind

439

00:16:01,749 --> 00:16:00,160

of go up into your head and so when

440

00:16:03,110 --> 00:16:01,759

astronauts first get on orbit you can

441

00:16:04,470 --> 00:16:03,120

actually see that their faces are very

442

00:16:06,150 --> 00:16:04,480

puffy

443

00:16:08,389 --> 00:16:06,160

and so what happens in that case is

444

00:16:10,710 --> 00:16:08,399

their brain interprets that as no i have

445

00:16:13,030 --> 00:16:10,720

way too much fluid altogether i need to

446

00:16:15,030 --> 00:16:13,040

get rid of it so

447

00:16:16,230 --> 00:16:15,040

that causes the astronauts to urinate a

448

00:16:17,990 --> 00:16:16,240

lot more

449

00:16:21,350 --> 00:16:18,000

well that can actually cause the

450

00:16:22,710 --> 00:16:21,360

astronauts to get dehydrated and so

451  
00:16:24,310 --> 00:16:22,720  
you know they're very careful in terms

452  
00:16:25,430 --> 00:16:24,320  
of how much water they drink but we

453  
00:16:27,670 --> 00:16:25,440  
still see

454  
00:16:29,430 --> 00:16:27,680  
higher concentrations across the board

455  
00:16:30,389 --> 00:16:29,440  
of you know calcium like i mentioned

456  
00:16:32,949 --> 00:16:30,399  
before

457  
00:16:34,949 --> 00:16:32,959  
um all the different

458  
00:16:37,269 --> 00:16:34,959  
minerals and all the compounds you find

459  
00:16:39,110 --> 00:16:37,279  
in urine are higher concentrations and

460  
00:16:40,870 --> 00:16:39,120  
so when we test hardware here on the

461  
00:16:42,389 --> 00:16:40,880  
ground we have to take that into account

462  
00:16:44,310 --> 00:16:42,399  
to make sure that you know for things

463  
00:16:46,790 --> 00:16:44,320

like calcium for instance we have the

464

00:16:49,350 --> 00:16:46,800

right amount to appropriately challenge

465

00:16:51,030 --> 00:16:49,360

our hardware

466

00:16:52,790 --> 00:16:51,040

thank you

467

00:16:56,949 --> 00:16:52,800

i think we have time for a few more

468

00:17:00,389 --> 00:16:58,790

uh hello my name is eric williams and

469

00:17:02,150 --> 00:17:00,399

i'm here with the haas program

470

00:17:03,910 --> 00:17:02,160

and my question was what are some of the

471

00:17:05,590 --> 00:17:03,920

challenges you've encountered in working

472

00:17:07,350 --> 00:17:05,600

with other nations

473

00:17:09,429 --> 00:17:07,360

for systems and stuff like this on the

474

00:17:10,710 --> 00:17:09,439

iss

475

00:17:12,789 --> 00:17:10,720

that's actually that's a really good

476

00:17:16,230 --> 00:17:12,799

question too

477

00:17:18,789 --> 00:17:16,240

our team personally doesn't work

478

00:17:20,549 --> 00:17:18,799

with international partners as much but

479

00:17:22,309 --> 00:17:20,559

we do work with the space station

480

00:17:24,309 --> 00:17:22,319

program a lot and the program kind of

481

00:17:26,870 --> 00:17:24,319

coordinates between all the different

482

00:17:29,190 --> 00:17:26,880

international partners and so

483

00:17:30,950 --> 00:17:29,200

the project that i mentioned with the

484

00:17:33,350 --> 00:17:30,960

precipitation issue in the water

485

00:17:34,870 --> 00:17:33,360

recycling system on iss

486

00:17:38,150 --> 00:17:34,880

is something that has to be worked

487

00:17:40,150 --> 00:17:38,160

between the us and russia

488

00:17:42,310 --> 00:17:40,160

and if we do end up replacing that

489

00:17:43,830 --> 00:17:42,320

sulfuric acid pre-treatment with

490

00:17:45,510 --> 00:17:43,840

something else

491

00:17:47,430 --> 00:17:45,520

we have to work that with the russians

492

00:17:48,950 --> 00:17:47,440

to make sure that when it gets installed

493

00:17:51,270 --> 00:17:48,960

in their system

494

00:17:52,070 --> 00:17:51,280

that their hardware is compatible with

495

00:17:55,830 --> 00:17:52,080

that

496

00:17:58,150 --> 00:17:55,840

appropriately sized and so on and so we

497

00:18:01,029 --> 00:17:58,160

have to work very closely with them and

498

00:18:02,870 --> 00:18:01,039

we have individuals on our team who have

499

00:18:04,390 --> 00:18:02,880

traveled to russia several times and we

500

00:18:06,710 --> 00:18:04,400

have a lot of telecons and a lot of

501  
00:18:07,510 --> 00:18:06,720  
meetings to talk to them to make sure

502  
00:18:11,029 --> 00:18:07,520  
that

503  
00:18:13,430 --> 00:18:11,039  
fly this to iss

504  
00:18:15,029 --> 00:18:13,440  
we don't have any issues so it can be a

505  
00:18:16,630 --> 00:18:15,039  
challenge but

506  
00:18:18,150 --> 00:18:16,640  
you know we all want to recycle more

507  
00:18:21,430 --> 00:18:18,160  
water on the space station so we're all

508  
00:18:21,440 --> 00:18:25,510  
thank you

509  
00:18:29,590 --> 00:18:27,110  
hi my name is thomas mckenna i'm here

510  
00:18:32,630 --> 00:18:29,600  
with psti and my question is does

511  
00:18:36,630 --> 00:18:32,640  
microgravity have an impact on ph levels

512  
00:18:41,669 --> 00:18:39,430  
the ph levels specifically we don't see

513  
00:18:43,669 --> 00:18:41,679

a major difference between

514

00:18:44,789 --> 00:18:43,679

what's on orbit and what we see on the

515

00:18:46,710 --> 00:18:44,799

ground

516

00:18:48,870 --> 00:18:46,720

there's a pretty wide range it really

517

00:18:51,510 --> 00:18:48,880

depends on your diet depends on how much

518

00:18:53,510 --> 00:18:51,520

water you drink that kind of thing

519

00:18:55,270 --> 00:18:53,520

and so we have some people with

520

00:18:57,669 --> 00:18:55,280

fairly acidic urine

521

00:19:00,070 --> 00:18:57,679

like ph in the fives and then some

522

00:19:01,830 --> 00:19:00,080

people with higher ph you know into the

523

00:19:04,950 --> 00:19:01,840

mid 6

524

00:19:07,510 --> 00:19:04,960

you know 6.5 or so ph and so really what

525

00:19:09,350 --> 00:19:07,520

we've seen on orbit are ph's that fall

526

00:19:17,270 --> 00:19:09,360

into that range so it's nothing outside

527

00:19:21,270 --> 00:19:18,950

hi my name is chelsea weber and i'm here

528

00:19:22,950 --> 00:19:21,280

with the psti program and i have more of

529

00:19:24,789 --> 00:19:22,960

a general question

530

00:19:29,190 --> 00:19:24,799

is going to the restroom in space a

531

00:19:35,110 --> 00:19:32,310

um that's a really good question too

532

00:19:38,230 --> 00:19:35,120

i've personally never used the iss

533

00:19:39,830 --> 00:19:38,240

toilet so i can't speak firsthand

534

00:19:42,390 --> 00:19:39,840

but i have seen

535

00:19:44,470 --> 00:19:42,400

footage and i've heard from crew members

536

00:19:45,430 --> 00:19:44,480

that it can be a challenge

537

00:19:54,470 --> 00:19:45,440

the

538

00:19:56,950 --> 00:19:54,480

one um it's a it's you know maybe this

539

00:19:59,270 --> 00:19:56,960

about this big diameter um and so you

540

00:20:01,510 --> 00:19:59,280

have to have good aim

541

00:20:04,230 --> 00:20:01,520

uh there's a fan in there to to kind of

542

00:20:06,230 --> 00:20:04,240

help suction it in but um you know i've

543

00:20:08,630 --> 00:20:06,240

heard that it can be messy and so right

544

00:20:12,470 --> 00:20:08,640

next to the toilet they have actually a

545

00:20:14,630 --> 00:20:12,480

series of you know baby wipes um gloves

546

00:20:18,070 --> 00:20:14,640

that you can put on in case you

547

00:20:22,230 --> 00:20:19,510

lots of you know several different kinds

548

00:20:24,070 --> 00:20:22,240

of toilet paper that kind of thing um

549

00:20:25,909 --> 00:20:24,080

and so it can be a challenge but i've

550

00:20:27,029 --> 00:20:25,919

heard that once you get to once you get

551

00:20:29,830 --> 00:20:27,039

used to it and once you get the

552

00:20:31,830 --> 00:20:29,840

technique down it's not too bad

553

00:20:34,149 --> 00:20:31,840

okay thank you people want to know about

554

00:20:37,350 --> 00:20:34,159

the lmnop

555

00:20:40,149 --> 00:20:37,360

good question do we have another one

556

00:20:41,909 --> 00:20:40,159

uh yes i'm katie schneider with haas and

557

00:20:43,350 --> 00:20:41,919

i'd like to know how much education and

558

00:20:45,270 --> 00:20:43,360

training did you go through to get your

559

00:20:47,830 --> 00:20:45,280

position

560

00:20:49,590 --> 00:20:47,840

um so i actually

561

00:20:51,510 --> 00:20:49,600

i have two degrees i have one in

562

00:20:54,230 --> 00:20:51,520

aerospace engineering and another degree

563

00:20:55,990 --> 00:20:54,240

in geology

564

00:20:58,789 --> 00:20:56,000

those aren't directly applicable to what

565

00:21:00,310 --> 00:20:58,799

i do but it's really the problem solving

566

00:21:02,470 --> 00:21:00,320

mindset

567

00:21:04,789 --> 00:21:02,480

and the background knowledge in

568

00:21:06,789 --> 00:21:04,799

engineering principles in chemistry and

569

00:21:09,669 --> 00:21:06,799

physics that have really helped me with

570

00:21:11,830 --> 00:21:09,679

my job so if you look at the entire

571

00:21:13,990 --> 00:21:11,840

water recovery systems team

572

00:21:15,669 --> 00:21:14,000

we have civil engineers we have

573

00:21:16,870 --> 00:21:15,679

mechanical engineers electrical

574

00:21:18,950 --> 00:21:16,880

engineers

575

00:21:20,669 --> 00:21:18,960

we also have several chemists

576

00:21:23,750 --> 00:21:20,679

that work in the lab with us we have a

577

00:21:26,310 --> 00:21:23,760

microbiologist who helps us for instance

578

00:21:28,470 --> 00:21:26,320

where when we're evaluating

579

00:21:29,750 --> 00:21:28,480

whether pre-treatment is working or not

580

00:21:31,830 --> 00:21:29,760

they're able to actually plate those

581

00:21:34,149 --> 00:21:31,840

samples out on petri dishes and see

582

00:21:35,350 --> 00:21:34,159

what's growing and how much

583

00:21:36,789 --> 00:21:35,360

and so

584

00:21:39,909 --> 00:21:36,799

you know pretty much any kind of

585

00:21:43,029 --> 00:21:39,919

engineering or science discipline

586

00:21:44,630 --> 00:21:43,039

would get someone to this position

587

00:21:46,390 --> 00:21:44,640

to be able to do this kind of work but

588

00:21:49,510 --> 00:21:46,400

for me personally i did aerospace

589

00:21:53,270 --> 00:21:49,520

engineering and geology

590

00:21:56,230 --> 00:21:55,430

hi my name is katrina catron similar to

591

00:21:57,750 --> 00:21:56,240

that

592

00:21:59,350 --> 00:21:57,760

how did you get into this profession

593

00:22:00,470 --> 00:21:59,360

because i know maybe at like five years

594

00:22:02,870 --> 00:22:00,480

old you didn't know you're going to be a

595

00:22:04,789 --> 00:22:02,880

urine specialist so how did you how was

596

00:22:06,950 --> 00:22:04,799

the process of that

597

00:22:11,029 --> 00:22:06,960

um

598

00:22:13,110 --> 00:22:11,039

been interested in space since i was a

599

00:22:14,710 --> 00:22:13,120

kid space travel has always been

600

00:22:16,950 --> 00:22:14,720

fascinating to me

601  
00:22:20,310 --> 00:22:16,960  
as i got older though

602  
00:22:23,430 --> 00:22:20,320  
it became more of a question of survival

603  
00:22:26,870 --> 00:22:23,440  
and what can we do to make sure our

604  
00:22:28,630 --> 00:22:26,880  
species is around long term and so

605  
00:22:31,830 --> 00:22:28,640  
uh going through school i started

606  
00:22:34,549 --> 00:22:31,840  
thinking about human space flight and

607  
00:22:36,870 --> 00:22:34,559  
the fact that we have to set up habitats

608  
00:22:38,549 --> 00:22:36,880  
on the moon and on mars and

609  
00:22:40,630 --> 00:22:38,559  
like we have on the space station right

610  
00:22:43,350 --> 00:22:40,640  
now we need

611  
00:22:45,750 --> 00:22:43,360  
permanent habitats in space if we're

612  
00:22:47,110 --> 00:22:45,760  
going to continue as a species

613  
00:22:49,909 --> 00:22:47,120

and so

614

00:22:51,590 --> 00:22:49,919

that actually drove me towards

615

00:22:53,510 --> 00:22:51,600

spacecraft engineering so i did

616

00:22:56,470 --> 00:22:53,520

aerospace engineering

617

00:22:59,669 --> 00:22:56,480

initially and i added geology after that

618

00:23:02,070 --> 00:22:59,679

i found out about a program called the

619

00:23:03,270 --> 00:23:02,080

cooperative education program

620

00:23:05,510 --> 00:23:03,280

at least that's what it was called at

621

00:23:07,029 --> 00:23:05,520

the time

622

00:23:08,789 --> 00:23:07,039

and that actually allows students who

623

00:23:10,789 --> 00:23:08,799

are in college to come and work

624

00:23:13,350 --> 00:23:10,799

full-time

625

00:23:16,549 --> 00:23:13,360

at a nasa center and so i had the

626

00:23:19,190 --> 00:23:16,559

opportunity to come to jsc

627

00:23:21,990 --> 00:23:19,200

and i learned about a group called the

628

00:23:23,750 --> 00:23:22,000

crew and thermal systems division and

629

00:23:26,710 --> 00:23:23,760

this is a group within engineering that

630

00:23:28,390 --> 00:23:26,720

just focuses on they have thermal you

631

00:23:29,350 --> 00:23:28,400

know thermal control as well which is

632

00:23:31,190 --> 00:23:29,360

cool

633

00:23:33,110 --> 00:23:31,200

but i really like the crew side and how

634

00:23:35,190 --> 00:23:33,120

do we keep people alive in space because

635

00:23:37,110 --> 00:23:35,200

to me that comes back to that survival

636

00:23:39,029 --> 00:23:37,120

question of you know

637

00:23:40,710 --> 00:23:39,039

how do we continue the species and how

638

00:23:43,830 --> 00:23:40,720

do we keep ourselves around for a long

639

00:23:46,310 --> 00:23:43,840

time and so within that crew aspect

640

00:23:48,549 --> 00:23:46,320

there are a number of different groups

641

00:23:50,870 --> 00:23:48,559

people that work on atmosphere

642

00:23:53,430 --> 00:23:50,880

revitalization so recycling the air on

643

00:23:55,510 --> 00:23:53,440

the spacecraft people who work on

644

00:23:57,190 --> 00:23:55,520

habitability so the people who actually

645

00:23:59,190 --> 00:23:57,200

designed the toilet

646

00:24:01,110 --> 00:23:59,200

they designed the galley and so on on

647

00:24:03,430 --> 00:24:01,120

the space station

648

00:24:05,909 --> 00:24:03,440

and then also the water recycling team

649

00:24:07,830 --> 00:24:05,919

and so i was able to kind of work my way

650

00:24:09,990 --> 00:24:07,840

in there and they had an opening on the

651  
00:24:12,549 --> 00:24:10,000  
water team and so i was able to come on

652  
00:24:14,470 --> 00:24:12,559  
board and start with them so

653  
00:24:16,549 --> 00:24:14,480  
that working

654  
00:24:18,310 --> 00:24:16,559  
full-time at jsc as a student really

655  
00:24:20,390 --> 00:24:18,320  
helped me to kind of pinpoint what area

656  
00:24:22,549 --> 00:24:20,400  
i wanted to go in

657  
00:24:24,870 --> 00:24:22,559  
excellent excellent question and

658  
00:24:26,630 --> 00:24:24,880  
excellent answer thank you very much for

659  
00:24:28,390 --> 00:24:26,640  
coming out and talk i think that's all

660  
00:24:30,230 --> 00:24:28,400  
the time that we have

661  
00:24:31,909 --> 00:24:30,240  
um guys

662  
00:24:33,909 --> 00:24:31,919  
thank you for uh coming in and thanks

663  
00:24:35,590 --> 00:24:33,919

for the excellent questions