



Jill McGuire

Robotic Refueling Mission
(RRM) Project Manager,
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1
00:00:04,789 --> 00:00:02,470
quite a bit of activities going on on

2
00:00:07,030 --> 00:00:04,799
board the station today but not only

3
00:00:07,909 --> 00:00:07,040
inside but also outside

4
00:00:10,070 --> 00:00:07,919
as

5
00:00:11,749 --> 00:00:10,080
this week station controllers here on

6
00:00:13,749 --> 00:00:11,759
the ground at the goddard space flight

7
00:00:16,630 --> 00:00:13,759
center have continued some work that

8
00:00:19,109 --> 00:00:16,640
they started earlier this spring with a

9
00:00:21,189 --> 00:00:19,119
payload on the outboard truss section of

10
00:00:22,870 --> 00:00:21,199
the international space station this

11
00:00:24,790 --> 00:00:22,880
marks the second

12
00:00:27,429 --> 00:00:24,800
round of testings for the robotic

13
00:00:29,189 --> 00:00:27,439

refueling mission and joining me now on

14

00:00:31,990 --> 00:00:29,199

the phone from the goddard space flight

15

00:00:34,470 --> 00:00:32,000

center is joe mcguire who is the robotic

16

00:00:36,630 --> 00:00:34,480

refueling mission project manager

17

00:00:38,709 --> 00:00:36,640

jill i want to thank you first off for

18

00:00:40,150 --> 00:00:38,719

joining me today and was hoping maybe

19

00:00:42,150 --> 00:00:40,160

you could give us a quick overview of

20

00:00:43,750 --> 00:00:42,160

the robotic refueling mission real quick

21

00:00:46,310 --> 00:00:43,760

and what you guys accomplished a little

22

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

bit earlier this spring

23

00:00:50,470 --> 00:00:48,559

yes great thank you for having me i

24

00:00:52,389 --> 00:00:50,480

appreciate the time to talk about the

25

00:00:54,389 --> 00:00:52,399

robotic refueling mission we're very

26

00:00:56,950 --> 00:00:54,399

excited about everything that's been

27

00:00:59,910 --> 00:00:56,960

going on on station the main objective

28

00:01:01,270 --> 00:00:59,920

of the robotic refueling mission is to

29

00:01:03,270 --> 00:01:01,280

demonstrate

30

00:01:04,789 --> 00:01:03,280

that we can manipulate standard

31

00:01:07,109 --> 00:01:04,799

satellite interfaces that weren't

32

00:01:10,230 --> 00:01:07,119

designed to be done robotically so

33

00:01:12,469 --> 00:01:10,240

the rrm hosts a variety of different

34

00:01:14,950 --> 00:01:12,479

standard satellite interfaces as well as

35

00:01:17,109 --> 00:01:14,960

a fill and drain valve on a spacecraft

36

00:01:19,670 --> 00:01:17,119

that in later this year we'll do an

37

00:01:21,190 --> 00:01:19,680

end-to-end task to show that we can

38

00:01:23,350 --> 00:01:21,200

open up the fill and drain valve and

39

00:01:24,230 --> 00:01:23,360

transfer fuel through the fill and drain

40

00:01:26,469 --> 00:01:24,240

valve

41

00:01:28,149 --> 00:01:26,479

but the tasks that we've been doing so

42

00:01:30,069 --> 00:01:28,159

far which we started in march and then

43

00:01:32,870 --> 00:01:30,079

have con been continuing

44

00:01:35,749 --> 00:01:32,880

um the last couple days is to do

45

00:01:37,910 --> 00:01:35,759

to show that we can remove some of

46

00:01:40,069 --> 00:01:37,920

standard caps and valves that you would

47

00:01:43,910 --> 00:01:40,079

find on a satellite and cut some of the

48

00:01:46,069 --> 00:01:43,920

safety wire holding those caps in place

49

00:01:48,310 --> 00:01:46,079

okay well i know you guys are working

50

00:01:51,030 --> 00:01:48,320

with the station's robotic arm and

51
00:01:53,190 --> 00:01:51,040
specifically the dexter or the uh you

52
00:01:55,830 --> 00:01:53,200
know the dexterous robot that likes to

53
00:01:57,670 --> 00:01:55,840
sit out on the end of that thing so why

54
00:01:59,270 --> 00:01:57,680
get a get a little more specific if you

55
00:02:01,109 --> 00:01:59,280
can water i know there are a number of

56
00:02:02,310 --> 00:02:01,119
tools on board the robotic refueling

57
00:02:04,469 --> 00:02:02,320
mission what are some of the tools you

58
00:02:06,389 --> 00:02:04,479
guys been working with this week

59
00:02:09,430 --> 00:02:06,399
okay this week we have been mainly

60
00:02:12,150 --> 00:02:09,440
working with our multi-function tool

61
00:02:14,229 --> 00:02:12,160
the spdm robot on the international

62
00:02:16,869 --> 00:02:14,239
space station

63
00:02:17,670 --> 00:02:16,879

on we started on tuesday night of this

64

00:02:18,390 --> 00:02:17,680

week

65

00:02:23,910 --> 00:02:18,400

the

66

00:02:27,270 --> 00:02:23,920

tool from

67

00:02:28,790 --> 00:02:27,280

the rrm housing and we went to pick up a

68

00:02:30,550 --> 00:02:28,800

series of different adapters that we

69

00:02:32,710 --> 00:02:30,560

have on board the multi-function tool is

70

00:02:33,910 --> 00:02:32,720

basically like a standard socket wrench

71

00:02:35,830 --> 00:02:33,920

that you can change out different

72

00:02:37,990 --> 00:02:35,840

sockets on the ground well we have a

73

00:02:41,830 --> 00:02:38,000

multi-function tool that can change out

74

00:02:43,750 --> 00:02:41,840

different adapters on board so the spdm

75

00:02:46,630 --> 00:02:43,760

robot pulled out the multi-function tool

76

00:02:48,390 --> 00:02:46,640

from the housing and then went and

77

00:02:51,110 --> 00:02:48,400

picked up the first adapter which we

78

00:02:53,990 --> 00:02:51,120

call the t-valve adapter and

79

00:02:58,949 --> 00:02:54,000

removed the

80

00:03:01,509 --> 00:02:58,959

the panel and then stowed the t-valve

81

00:03:03,110 --> 00:03:01,519

into the receptacle

82

00:03:04,390 --> 00:03:03,120

the only tool that we intend to use

83

00:03:06,309 --> 00:03:04,400

during this go around is the

84

00:03:08,790 --> 00:03:06,319

multi-function tool we have three other

85

00:03:11,430 --> 00:03:08,800

tools on board a safety cap removal tool

86

00:03:14,470 --> 00:03:11,440

a wire cutter tool which we used to do

87

00:03:16,949 --> 00:03:14,480

the tasks in march and then we have a

88

00:03:20,309 --> 00:03:16,959

refueling tool that we'll use to do the

89

00:03:21,670 --> 00:03:20,319

refueling task later this year

90

00:03:23,589 --> 00:03:21,680

okay we're taking a look at this

91

00:03:25,270 --> 00:03:23,599

animation right now and

92

00:03:27,030 --> 00:03:25,280

and again this is all controlled

93

00:03:29,030 --> 00:03:27,040

robotically from down here on the ground

94

00:03:30,229 --> 00:03:29,040

it's pretty fascinating stuff and i

95

00:03:31,750 --> 00:03:30,239

believe we're looking at the the

96

00:03:33,670 --> 00:03:31,760

multi-function tools so it's going

97

00:03:34,470 --> 00:03:33,680

through and removing a system of caps

98

00:03:37,990 --> 00:03:34,480

and

99

00:03:39,990 --> 00:03:38,000

that you would expect to find on a

100

00:03:41,750 --> 00:03:40,000

satellite and these are things that you

101

00:03:43,830 --> 00:03:41,760

know aren't built to actually be

102

00:03:46,949 --> 00:03:43,840

manipulated

103

00:03:48,949 --> 00:03:46,959

correct so the whole goal of rrm was to

104

00:03:50,949 --> 00:03:48,959

show that we can build an innovative

105

00:03:53,110 --> 00:03:50,959

tool to bridge the gap between the end

106

00:03:55,910 --> 00:03:53,120

of the robot and the satellite interface

107

00:03:58,390 --> 00:03:55,920

that wasn't designed to be

108

00:04:00,149 --> 00:03:58,400

manipulated robotically so the first

109

00:04:01,990 --> 00:04:00,159

task you see in the animation was the

110

00:04:03,830 --> 00:04:02,000

t-valve where you saw the multi-function

111

00:04:06,470 --> 00:04:03,840

tool grab the t-valve adapter remove the

112

00:04:09,110 --> 00:04:06,480

t-valve the second thing you saw in the

113

00:04:10,710 --> 00:04:09,120

animation was the ambient the

114

00:04:12,070 --> 00:04:10,720

multi-function tool grabbed the ambient

115

00:04:13,750 --> 00:04:12,080

cap adapter

116

00:04:16,469 --> 00:04:13,760

and that happened last night we

117

00:04:19,110 --> 00:04:16,479

successfully removed the ambient cap and

118

00:04:22,230 --> 00:04:19,120

restowed it into its receptacle

119

00:04:24,629 --> 00:04:22,240

and then also last night we grabbed the

120

00:04:26,870 --> 00:04:24,639

plug manipulation adapter and released

121

00:04:29,270 --> 00:04:26,880

it from its receptacle and later today

122

00:04:31,030 --> 00:04:29,280

when operations resume we will then

123

00:04:33,670 --> 00:04:31,040

transfer over to

124

00:04:37,590 --> 00:04:33,680

the payload and

125

00:04:39,350 --> 00:04:37,600

pull out a plug that is down in the

126
00:04:41,110 --> 00:04:39,360
inside the receptacle where the ambient

127
00:04:43,350 --> 00:04:41,120
cap that we removed last night is there

128
00:04:45,350 --> 00:04:43,360
is now a plug that's housed inside there

129
00:04:46,870 --> 00:04:45,360
we want to show that we can robotically

130
00:04:49,270 --> 00:04:46,880
remove that plug so the plug

131
00:04:50,550 --> 00:04:49,280
manipulation adapter is designed

132
00:04:55,189 --> 00:04:50,560
to

133
00:04:57,830 --> 00:04:55,199
plug and we will

134
00:05:01,110 --> 00:04:57,840
retract that plug just a few inches not

135
00:05:03,270 --> 00:05:01,120
or i mean half of an inch about

136
00:05:05,110 --> 00:05:03,280
it is safely controlled so that we don't

137
00:05:06,629 --> 00:05:05,120
have any debris flying on station but we

138
00:05:09,189 --> 00:05:06,639

will be able to show that we can get it

139

00:05:10,390 --> 00:05:09,199

past the o-ring that is installed in

140

00:05:12,629 --> 00:05:10,400

there

141

00:05:14,950 --> 00:05:12,639

okay and as you mentioned this is all

142

00:05:16,950 --> 00:05:14,960

kind of in preparation of some upcoming

143

00:05:17,990 --> 00:05:16,960

activities later this summer where you

144

00:05:19,830 --> 00:05:18,000

guys are actually going to be

145

00:05:21,350 --> 00:05:19,840

transferring some fuel over can you give

146

00:05:23,430 --> 00:05:21,360

us a quick preview

147

00:05:24,710 --> 00:05:23,440

of what's going to happen uh when that

148

00:05:26,870 --> 00:05:24,720

occurs

149

00:05:29,110 --> 00:05:26,880

yes the the hope is in the end of august

150

00:05:31,350 --> 00:05:29,120

we will get scheduled for another set of

151
00:05:33,350 --> 00:05:31,360
operations and

152
00:05:36,150 --> 00:05:33,360
we have a standard fill and drain valve

153
00:05:38,870 --> 00:05:36,160
or a fueling valve on a spacecraft on

154
00:05:41,749 --> 00:05:38,880
board the rrm and it is fully closed out

155
00:05:43,909 --> 00:05:41,759
like you would find it on a spacecraft

156
00:05:45,029 --> 00:05:43,919
before a spacecraft launches

157
00:05:47,430 --> 00:05:45,039
at the cape

158
00:05:49,189 --> 00:05:47,440
they fill the spacecraft with hydrazine

159
00:05:50,550 --> 00:05:49,199
and then because hydrazine is so highly

160
00:05:52,870 --> 00:05:50,560
combustible

161
00:05:55,590 --> 00:05:52,880
the fill and drain valve is closed out

162
00:05:57,350 --> 00:05:55,600
with a series of caps and the caps are

163
00:06:00,790 --> 00:05:57,360

then closed out with the series with

164

00:06:04,550 --> 00:06:00,800

safety wire in order to ensure that the

165

00:06:05,590 --> 00:06:04,560

valve does not open during launch

166

00:06:08,390 --> 00:06:05,600

so

167

00:06:10,710 --> 00:06:08,400

once that's all great for ground safety

168

00:06:12,710 --> 00:06:10,720

but now if you wanted to try to refuel

169

00:06:14,469 --> 00:06:12,720

that satellite in orbit you have to be

170

00:06:16,629 --> 00:06:14,479

able to cut all that safety wire and

171

00:06:19,510 --> 00:06:16,639

remove all of those caps

172

00:06:21,670 --> 00:06:19,520

so in august we will start

173

00:06:24,150 --> 00:06:21,680

one by one we will cut the safety wire

174

00:06:25,670 --> 00:06:24,160

on the tertiary cap remove the tertiary

175

00:06:27,990 --> 00:06:25,680

cap and stow it then we will cut the

176
00:06:31,590 --> 00:06:28,000
safety wire on the safety cap remove the

177
00:06:34,950 --> 00:06:31,600
safety cap and stow it and then we will

178
00:06:36,950 --> 00:06:34,960
the spdm robot will acquire our nozzle

179
00:06:38,550 --> 00:06:36,960
tool the nozzle tool will interface to

180
00:06:41,189 --> 00:06:38,560
the fill and drain valve

181
00:06:44,309 --> 00:06:41,199
and through a series of

182
00:06:48,390 --> 00:06:44,319
operations using the torque advance on

183
00:06:50,870 --> 00:06:48,400
the otc band effector on the spdm robot

184
00:06:52,710 --> 00:06:50,880
we will then be able to

185
00:06:54,469 --> 00:06:52,720
acquire the thread onto the fill and

186
00:06:56,710 --> 00:06:54,479
drain valve

187
00:06:59,110 --> 00:06:56,720
open up the actuation nut and transfer

188
00:07:02,469 --> 00:06:59,120

fuel through that interface

189

00:07:04,390 --> 00:07:02,479

so we have a half a gallon of ethanol

190

00:07:06,629 --> 00:07:04,400

on board in our fuel transfer system

191

00:07:08,950 --> 00:07:06,639

that the back half of our payload has

192

00:07:13,029 --> 00:07:08,960

the the fuel tran what we call the fuel

193

00:07:13,990 --> 00:07:13,039

transfer system it has all of the

194

00:07:15,670 --> 00:07:14,000

the

195

00:07:17,990 --> 00:07:15,680

required hardware to

196

00:07:19,270 --> 00:07:18,000

pump and transfer the fuel through the

197

00:07:20,790 --> 00:07:19,280

interface

198

00:07:22,629 --> 00:07:20,800

okay well we are definitely going to be

199

00:07:24,150 --> 00:07:22,639

looking out for those operations when

200

00:07:25,029 --> 00:07:24,160

they occur a little bit later this

201
00:07:27,589 --> 00:07:25,039
summer

202
00:07:29,430 --> 00:07:27,599
and just kind of kind of as a conclusion

203
00:07:31,350 --> 00:07:29,440
what what kind of missions could

204
00:07:33,270 --> 00:07:31,360
something like this enable in the future

205
00:07:35,110 --> 00:07:33,280
i mean robotically refueling satellites

206
00:07:37,029 --> 00:07:35,120
isn't something that we really have the

207
00:07:40,150 --> 00:07:37,039
capability to do right now what what

208
00:07:43,029 --> 00:07:40,160
kind of possibilities would this open up

209
00:07:45,510 --> 00:07:43,039
well the the goal is that once we can

210
00:07:48,070 --> 00:07:45,520
demonstrate the technology on

211
00:07:48,950 --> 00:07:48,080
space station that we buy down the risk

212
00:07:52,150 --> 00:07:48,960
for

213
00:07:54,230 --> 00:07:52,160

future applications such as any

214

00:07:56,710 --> 00:07:54,240

government or commercial birds that

215

00:07:57,510 --> 00:07:56,720

would need refueling we could extend the

216

00:07:59,749 --> 00:07:57,520

life

217

00:08:01,749 --> 00:07:59,759

we could robotically interface to that

218

00:08:03,589 --> 00:08:01,759

spacecraft through like grabbing on

219

00:08:05,670 --> 00:08:03,599

autonomously grabbing on to say the

220

00:08:08,070 --> 00:08:05,680

launch adapter ring or the marmon ring

221

00:08:09,430 --> 00:08:08,080

then once we acquired that satellite we

222

00:08:11,270 --> 00:08:09,440

could then go through the robotic

223

00:08:13,510 --> 00:08:11,280

operations similar to what we're doing

224

00:08:15,430 --> 00:08:13,520

on station we can go through the robotic

225

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

operations to

226

00:08:21,430 --> 00:08:17,759

refuel the spacecraft or we could in

227

00:08:23,830 --> 00:08:21,440

some cases maybe repair or

228

00:08:25,749 --> 00:08:23,840

deploy an appendage that you know didn't

229

00:08:27,670 --> 00:08:25,759

deploy such as a solar ray that got

230

00:08:29,189 --> 00:08:27,680

stuck after deployment we could go and

231

00:08:31,510 --> 00:08:29,199

grab the solar array

232

00:08:33,509 --> 00:08:31,520

and do a final deployment of that so the

233

00:08:35,269 --> 00:08:33,519

idea is is that we could

234

00:08:37,589 --> 00:08:35,279

change the paradigm of satellite

235

00:08:39,670 --> 00:08:37,599

servicing where

236

00:08:41,909 --> 00:08:39,680

we could then send a robot vehicle up

237

00:08:43,350 --> 00:08:41,919

and do this with a robot and extend the

238

00:08:46,070 --> 00:08:43,360

life of

239

00:08:49,190 --> 00:08:46,080

spacecraft either again by refueling or

240

00:08:51,590 --> 00:08:49,200

servicing them and the hope is that

241

00:08:55,110 --> 00:08:51,600

we will also be able to aid in like the

242

00:08:57,590 --> 00:08:55,120

future exploration goals of nasa when to

243

00:08:58,949 --> 00:08:57,600

have robots and humans working together

244

00:09:01,110 --> 00:08:58,959

in space where

245

00:09:02,630 --> 00:09:01,120

you can extend the time that you can

246

00:09:05,829 --> 00:09:02,640

have

247

00:09:07,990 --> 00:09:05,839

servicing and exploration done with

248

00:09:09,509 --> 00:09:08,000

robots doing you know the jobs while the

249

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

astronauts are sleeping similar to what

250

00:09:11,990 --> 00:09:11,040

we're doing on the international space

251
00:09:13,990 --> 00:09:12,000
station

252
00:09:16,310 --> 00:09:14,000
you can mult you can

253
00:09:17,910 --> 00:09:16,320
have accomplish more in a shorter amount

254
00:09:19,990 --> 00:09:17,920
of time by having the robots and the

255
00:09:21,509 --> 00:09:20,000
humans working together so we're hoping

256
00:09:24,150 --> 00:09:21,519
by doing these demonstrations that we're

257
00:09:25,190 --> 00:09:24,160
enabling the technology to move forward

258
00:09:27,190 --> 00:09:25,200
and do

259
00:09:29,750 --> 00:09:27,200
you think these things outside of space

260
00:09:32,470 --> 00:09:29,760
station in low earth orbit or in

261
00:09:34,389 --> 00:09:32,480
geosynchronous orbit or you know places

262
00:09:36,550 --> 00:09:34,399
asteroids you know places where further

263
00:09:37,590 --> 00:09:36,560

exploration where nasa wants to go in

264

00:09:39,190 --> 00:09:37,600

the future

265

00:09:41,269 --> 00:09:39,200

so really just adding a whole other

266

00:09:42,470 --> 00:09:41,279

dimension to human space flight even

267

00:09:45,509 --> 00:09:42,480

though everything's being controlled

268

00:09:47,430 --> 00:09:45,519

robotically and also giving a lot of

269

00:09:49,030 --> 00:09:47,440

satellites a second chance at life and

270

00:09:50,949 --> 00:09:49,040

potentially saving

271

00:09:53,269 --> 00:09:50,959

you know millions of dollars of

272

00:09:54,550 --> 00:09:53,279

replacing satellites for communications

273

00:09:56,310 --> 00:09:54,560

and other any

274

00:09:57,910 --> 00:09:56,320

uh function that satellites are put into

275

00:09:59,910 --> 00:09:57,920

orbit for nowadays

276

00:10:02,069 --> 00:09:59,920

well jill i want to thank you for coming

277

00:10:03,590 --> 00:10:02,079

on with us today we're really excited to

278

00:10:05,190 --> 00:10:03,600

be following along with the robotic

279

00:10:06,470 --> 00:10:05,200

refueling mission we'll definitely be

280

00:10:08,310 --> 00:10:06,480

looking out for you a little bit later

281

00:10:10,069 --> 00:10:08,320

this summer when you guys actually start

282

00:10:11,910 --> 00:10:10,079

fueling up

283

00:10:13,670 --> 00:10:11,920

sounds great thank you so much again for

284

00:10:16,069 --> 00:10:13,680

the opportunity and and thanks to the

285

00:10:17,670 --> 00:10:16,079

robot operators at johnson space center

286

00:10:19,910 --> 00:10:17,680

and the canadian space agency who have

287

00:10:22,069 --> 00:10:19,920

been doing a wonderful job working

288

00:10:23,750 --> 00:10:22,079

through all of our tasks and and being