KEEPING COOL IN SPACE

1
00:00:05,510 --> 00:00:03,830
imagine you

2
00:00:07,829 --> 00:00:05,520
are on the moon

3
00:00:10,390 --> 00:00:07,839
your job for the next eight hours will

4
00:00:13,270 --> 00:00:10,400
be exploring traversing up and down

5
00:00:14,629 --> 00:00:13,280
lunar hills sampling rocks and setting

6
00:00:17,349 --> 00:00:14,639
up equipment

7
00:00:19,189 --> 00:00:17,359
temperatures can reach a blistering 250

8
00:00:21,349 --> 00:00:19,199
degrees fahrenheit

9
00:00:24,630 --> 00:00:21,359
luckily you have a portable life support

10
00:00:27,670 --> 00:00:24,640
system a backpack that provides oxygen

11
00:00:30,870 --> 00:00:27,680
water power and for the excruciating

12
00:00:33,750 --> 00:00:30,880
temperatures a cooling system

13
00:00:35,670 --> 00:00:33,760

under the artemis program nasa and its

14
00:00:38,389 --> 00:00:35,680
partners are planning to return

15
00:00:41,750 --> 00:00:38,399
astronauts to the moon and the agency is

16
00:00:45,110 --> 00:00:41,760
testing new spacesuit technologies

17
00:00:47,670 --> 00:00:45,120
as a new age of exploration heats up

18
00:00:52,270 --> 00:00:47,680
engineers are looking to improve

19
00:00:56,389 --> 00:00:52,280
how to keep astronauts cool in space

20
00:00:59,029 --> 00:00:56,399
[Music]

21
00:01:01,510 --> 00:00:59,039
outside the international space station

22
00:01:02,709 --> 00:01:01,520
astronauts perform extra-vehicular

23
00:01:03,990 --> 00:01:02,719
activities

24
00:01:07,109 --> 00:01:04,000
evas

25
00:01:09,750 --> 00:01:07,119
also known as spacewalks

26
00:01:12,310 --> 00:01:09,760
during the apollo era spacewalks took

27
00:01:14,630 --> 00:01:12,320
place on the lunar surface and with the

28
00:01:17,510 --> 00:01:14,640
artemis program humankind will once

29
00:01:20,310 --> 00:01:17,520
again return to live and work in the

30
00:01:23,109 --> 00:01:20,320
harsh environment of the moon

31
00:01:25,990 --> 00:01:23,119
future plans call for spacewalks to last

32
00:01:28,070 --> 00:01:26,000
longer and be more demanding not just on

33
00:01:30,710 --> 00:01:28,080
the astronauts but also on the

34
00:01:34,789 --> 00:01:30,720
spacesuits and systems that protect them

35
00:01:39,190 --> 00:01:36,950
nasa has been working on advanced

36
00:01:40,550 --> 00:01:39,200
technologies needed for next generation

37
00:01:43,510 --> 00:01:40,560
spacesuits

38
00:01:46,149 --> 00:01:43,520

nasa's reference design the exploration

39
00:01:49,190 --> 00:01:46,159
extra vehicular mobility unit or the

40
00:01:52,069 --> 00:01:49,200
xemu features greater mobility

41
00:01:54,389 --> 00:01:52,079
visibility and flexibility this

42
00:01:56,550 --> 00:01:54,399
prototype is just the beginning

43
00:01:59,190 --> 00:01:56,560
to meet the needs of future exploration

44
00:02:01,749 --> 00:01:59,200
as part of the artemis program nasa will

45
00:02:04,630 --> 00:02:01,759
share its newest designs research and

46
00:02:06,870 --> 00:02:04,640
data with commercial industry whom nasa

47
00:02:09,270 --> 00:02:06,880
will partner with to build the next

48
00:02:11,110 --> 00:02:09,280
generation spacesuit it is an effort

49
00:02:14,309 --> 00:02:11,120
that will benefit from nasa's most

50
00:02:17,990 --> 00:02:14,319
recent studies and the agency's 50-plus

51
00:02:20,790 --> 00:02:18,000
years of spacewalk experience

52
00:02:23,030 --> 00:02:20,800
spacesuits are essentially a spacecraft

53
00:02:25,030 --> 00:02:23,040
made for one they have many important

54
00:02:27,910 --> 00:02:25,040
life preserving components

55
00:02:29,830 --> 00:02:27,920
but none is more complex than the system

56
00:02:32,309 --> 00:02:29,840
to regulate the temperature of the

57
00:02:35,030 --> 00:02:32,319
astronaut engineers call this cooling

58
00:02:37,750 --> 00:02:35,040
system the thermal control loop

59
00:02:40,150 --> 00:02:37,760
the thermal control loop is part of the

60
00:02:42,869 --> 00:02:40,160
portable life support system

61
00:02:45,589 --> 00:02:42,879
or the backpack that the astronaut wears

62
00:02:47,750 --> 00:02:45,599
when they do an eva the thermal control

63
00:02:49,190 --> 00:02:47,760

loop is designed to keep the astronauts

64
00:02:51,750 --> 00:02:49,200
cool when the astronauts are doing

65
00:02:54,390 --> 00:02:51,760
spacewalks they can be exposed to

66
00:02:57,270 --> 00:02:54,400
extreme temperature swings

67
00:02:59,509 --> 00:02:57,280
say up to 250 degrees fahrenheit

68
00:03:02,470 --> 00:02:59,519
the thermal control loop is part of a

69
00:03:04,869 --> 00:03:02,480
system that consists of a liquid cooling

70
00:03:06,550 --> 00:03:04,879
ventilation garment or lcbg that the

71
00:03:09,750 --> 00:03:06,560
astronauts wear

72
00:03:11,270 --> 00:03:09,760
under the spacesuit it consists of tubes

73
00:03:13,430 --> 00:03:11,280
that are filled with water that

74
00:03:16,390 --> 00:03:13,440
circulate from water pumps in the

75
00:03:18,630 --> 00:03:16,400
backpack to keep the astronauts cool

76
00:03:21,270 --> 00:03:18,640
during the gemini program engineers

77
00:03:22,869 --> 00:03:21,280
realized that astronauts not only needed

78
00:03:25,670 --> 00:03:22,879
protection from the temperatures of

79
00:03:28,390 --> 00:03:25,680
space but also from the heat generated

80
00:03:29,670 --> 00:03:28,400
inside the suit from their own bodies as

81
00:03:31,350 --> 00:03:29,680
they worked

82
00:03:34,070 --> 00:03:31,360
originally the suit designers thought

83
00:03:36,470 --> 00:03:34,080
that air flow over the astronauts body

84
00:03:38,869 --> 00:03:36,480
would keep temperatures regulated what

85
00:03:41,589 --> 00:03:38,879
they discovered was that air cooling in

86
00:03:43,190 --> 00:03:41,599
a spacesuit is insufficient to do that

87
00:03:45,589 --> 00:03:43,200
job

88
00:03:47,910 --> 00:03:45,599

during the apollo era it was decided

89
00:03:50,070 --> 00:03:47,920
running cool water through a garment

90
00:03:52,710 --> 00:03:50,080
that covers the body could help keep the

91
00:03:55,110 --> 00:03:52,720
astronauts from overheating

92
00:03:57,589 --> 00:03:55,120
the means of cooling the astronaut was

93
00:04:01,350 --> 00:03:57,599
now an essential life-sustaining element

94
00:04:03,509 --> 00:04:01,360
to the spacesuit and was here to stay

95
00:04:06,789 --> 00:04:03,519
the space suit currently in use on the

96
00:04:09,350 --> 00:04:06,799
space station developed in the 1970s

97
00:04:11,670 --> 00:04:09,360
also uses a water cooled garment

98
00:04:13,670 --> 00:04:11,680
circulating water is still the best way

99
00:04:16,310 --> 00:04:13,680
to cool an astronaut however

100
00:04:18,789 --> 00:04:16,320
improvements can be made on how to move

101
00:04:21,189 --> 00:04:18,799
that water through the system using new

102
00:04:23,350 --> 00:04:21,199
technologies and materials to test how

103
00:04:26,550 --> 00:04:23,360
to make the essential cooling system

104
00:04:29,430 --> 00:04:26,560
safer and more reliable than ever before

105
00:04:31,830 --> 00:04:29,440
the result of this research is surfy the

106
00:04:34,230 --> 00:04:31,840
spacesuit evaporation rejection flight

107
00:04:37,749 --> 00:04:34,240
experiment all the critical elements of

108
00:04:40,469 --> 00:04:37,759
a spacesuit cooling system in one box

109
00:04:43,030 --> 00:04:40,479
two surfy units have been built one to

110
00:04:45,590 --> 00:04:43,040
work here on earth in our gravity and

111
00:04:47,749 --> 00:04:45,600
another surfer unit meant to be tested

112
00:04:52,150 --> 00:04:47,759
in the absence of gravity

113
00:04:56,070 --> 00:04:54,390

onboard the international space station

114
00:04:58,469 --> 00:04:56,080
astronauts take advantage of the

115
00:05:01,029 --> 00:04:58,479
microgravity environment to perform a

116
00:05:03,510 --> 00:05:01,039
variety of science experiments and to

117
00:05:05,749 --> 00:05:03,520
test exploration technologies

118
00:05:08,469 --> 00:05:05,759
when engineers developed the spacesuits

119
00:05:10,870 --> 00:05:08,479
for the apollo and space shuttle eras

120
00:05:12,310 --> 00:05:10,880
nasa did not have a space station in

121
00:05:14,870 --> 00:05:12,320
operation

122
00:05:17,110 --> 00:05:14,880
today the station presents a perfect

123
00:05:19,670 --> 00:05:17,120
platform for engineers to use

124
00:05:21,990 --> 00:05:19,680
microgravity to put the surfy cooling

125
00:05:24,390 --> 00:05:22,000
system to the test

126
00:05:26,550 --> 00:05:24,400
in that experiment we will test

127
00:05:28,390 --> 00:05:26,560
a couple different versions of

128
00:05:30,790 --> 00:05:28,400
the water pump

129
00:05:32,550 --> 00:05:30,800
that will be used to circulate the water

130
00:05:34,310 --> 00:05:32,560
through the system we'll test

131
00:05:36,310 --> 00:05:34,320
temperature sensors we'll test pressure

132
00:05:38,550 --> 00:05:36,320
sensors integrate all those into one

133
00:05:40,390 --> 00:05:38,560
little package and test them for long

134
00:05:43,029 --> 00:05:40,400
duration to see how they'll perform over

135
00:05:44,870 --> 00:05:43,039
the expected life of a spacesuit surfy

136
00:05:47,270 --> 00:05:44,880
shows how the water will move through

137
00:05:49,909 --> 00:05:47,280
the system as if it were inside a

138
00:05:51,909 --> 00:05:49,919

spacesuit cooling the astronaut

139
00:05:54,870 --> 00:05:51,919
but the spacesuit cooling system needs

140
00:05:56,629 --> 00:05:54,880
to do more than just circulate water

141
00:05:59,189 --> 00:05:56,639
as the astronaut works their body

142
00:06:01,029 --> 00:05:59,199
generates heat which is transferred into

143
00:06:03,590 --> 00:06:01,039
the liquid cooling and ventilation

144
00:06:05,830 --> 00:06:03,600
garment a thermal control loop needs a

145
00:06:08,150 --> 00:06:05,840
way to remove the heat from the water

146
00:06:10,629 --> 00:06:08,160
that is circulating through the system

147
00:06:13,110 --> 00:06:10,639
that's where swimmy comes in spacesuit

148
00:06:16,309 --> 00:06:13,120
water membrane evaporator

149
00:06:19,270 --> 00:06:16,319
swimming consists of some porous hollow

150
00:06:21,510 --> 00:06:19,280
fiber membranes that are contained in a

151
00:06:23,350 --> 00:06:21,520
metal manifold when warm water flows

152
00:06:25,990 --> 00:06:23,360
through the pores membranes

153
00:06:28,230 --> 00:06:26,000
and then is exhausted into space the

154
00:06:30,550 --> 00:06:28,240
cool water continues through the porous

155
00:06:33,670 --> 00:06:30,560
fibers and continues to flow through the

156
00:06:35,029 --> 00:06:33,680
lcvg liquid ventilation garment to cool

157
00:06:37,350 --> 00:06:35,039
the astronaut

158
00:06:39,749 --> 00:06:37,360
with the means to run a cooling system

159
00:06:42,309 --> 00:06:39,759
and offload heat and gases the surfy

160
00:06:45,110 --> 00:06:42,319
unit runs for eight hours at a time the

161
00:06:46,950 --> 00:06:45,120
span of what a spacewalk might last in

162
00:06:48,629 --> 00:06:46,960
space or on the moon

163
00:06:50,390 --> 00:06:48,639

the tests are run again and again

164
00:06:52,469 --> 00:06:50,400
simulating the rigors of what a

165
00:06:55,029 --> 00:06:52,479
spacesuit thermal control loop might

166
00:06:57,510 --> 00:06:55,039
encounter during its life cycle

167
00:06:58,870 --> 00:06:57,520
astronauts take water samples from surfy

168
00:07:01,189 --> 00:06:58,880
for analysis

169
00:07:03,589 --> 00:07:01,199
just as a spacesuit might sit in storage

170
00:07:06,309 --> 00:07:03,599
for a time between spacewalks like

171
00:07:08,950 --> 00:07:06,319
during a trip to the moon or mars surfy

172
00:07:11,270 --> 00:07:08,960
is sometimes switched off this time of

173
00:07:12,390 --> 00:07:11,280
dormancy is when contaminants can grow

174
00:07:15,110 --> 00:07:12,400
in the system

175
00:07:16,950 --> 00:07:15,120
that's when the bugs microbes grow in

176
00:07:20,070 --> 00:07:16,960
the water system and those little guys

177
00:07:21,749 --> 00:07:20,080
grow and they reproduce and they can

178
00:07:23,589 --> 00:07:21,759
grow through the system they'll clog

179
00:07:25,430 --> 00:07:23,599
your filters and once your filters get

180
00:07:27,670 --> 00:07:25,440
clogged the water stops flowing when the

181
00:07:30,070 --> 00:07:27,680
water stops flowing the suit stops

182
00:07:32,309 --> 00:07:30,080
cooling contaminants in the water are

183
00:07:34,550 --> 00:07:32,319
such a problem for current spacesuits

184
00:07:37,189 --> 00:07:34,560
that astronauts set aside time for

185
00:07:39,670 --> 00:07:37,199
regular water maintenance chores every

186
00:07:41,510 --> 00:07:39,680
90 days the surfy tests hope to

187
00:07:44,230 --> 00:07:41,520
demonstrate that new technologies and

188
00:07:46,070 --> 00:07:44,240

materials will be far more robust in

189
00:07:47,029 --> 00:07:46,080
working through water contamination

190
00:07:49,270 --> 00:07:47,039
issues

191
00:07:51,430 --> 00:07:49,280
reducing the risk of the cooling loop

192
00:07:53,430 --> 00:07:51,440
failing we don't have to worry about

193
00:07:55,430 --> 00:07:53,440
water quality we want to be able we've

194
00:07:56,950 --> 00:07:55,440
joked among the team we want to be able

195
00:07:59,270 --> 00:07:56,960
to pour chicken soup into the

196
00:08:01,110 --> 00:07:59,280
exploration eu and it'll still run the

197
00:08:03,589 --> 00:08:01,120
way it's supposed to run even if there's

198
00:08:05,589 --> 00:08:03,599
microbes in there that the system

199
00:08:07,270 --> 00:08:05,599
doesn't care so we want the filters to

200
00:08:09,029 --> 00:08:07,280
catch the microbes and if the filters

201
00:08:10,629 --> 00:08:09,039
don't catch the microbes and they flow

202
00:08:12,550 --> 00:08:10,639
through the pumps the pumps don't even

203
00:08:14,230 --> 00:08:12,560
notice the microbes or the contamination

204
00:08:15,430 --> 00:08:14,240
or whatever's in the water they keep

205
00:08:17,749 --> 00:08:15,440
operating the way they're supposed to

206
00:08:20,150 --> 00:08:17,759
operate we want our crews to be spending

207
00:08:23,189 --> 00:08:20,160
their time exploring not running

208
00:08:25,430 --> 00:08:23,199
maintenance procedures on our spacesuits

209
00:08:28,710 --> 00:08:25,440
all the testing for surfing in space is

210
00:08:30,469 --> 00:08:28,720
duplicated on earth with the twin surfi

211
00:08:33,310 --> 00:08:30,479
running in one g

212
00:08:35,350 --> 00:08:33,320
earth's gravity by testing here and

213
00:08:37,589 --> 00:08:35,360

simultaneously testing in the

214
00:08:40,389 --> 00:08:37,599
microgravity of the space station

215
00:08:42,870 --> 00:08:40,399
engineers can infer how the cooling unit

216
00:08:45,910 --> 00:08:42,880
will run in the one-sixth gravity of the

217
00:08:47,829 --> 00:08:45,920
moon the one-third gravity of mars and

218
00:08:49,990 --> 00:08:47,839
all points in between

219
00:08:52,150 --> 00:08:50,000
the knowledge gained from building and

220
00:08:55,110 --> 00:08:52,160
testing the twin surface units is

221
00:08:57,990 --> 00:08:55,120
already paying off as work is underway

222
00:09:00,949 --> 00:08:58,000
building a full-size backpack for nasa's

223
00:09:02,790 --> 00:09:00,959
prototype exploration spacesuit how's it

224
00:09:05,190 --> 00:09:02,800
going to perform in microgravity well by

225
00:09:06,470 --> 00:09:05,200
sending surfy to space station we can

226
00:09:09,110 --> 00:09:06,480
actually test how it's going to perform

227
00:09:11,190 --> 00:09:09,120
in microgravity that in itself

228
00:09:13,430 --> 00:09:11,200
buys down the risk so now there's one

229
00:09:15,509 --> 00:09:13,440
less unknown that we have to worry about

230
00:09:19,030 --> 00:09:15,519
when we send our hardware off to do what

231
00:09:21,110 --> 00:09:19,040
it's supposed to do i am so excited that

232
00:09:23,350 --> 00:09:21,120
surfy swimmy is on orbit that we're

233
00:09:24,310 --> 00:09:23,360
working great our ground unit is working

234
00:09:26,630 --> 00:09:24,320
great

235
00:09:30,310 --> 00:09:26,640
surfy has made a difference we've had

236
00:09:33,790 --> 00:09:30,320
engineers scientists thermal analysis

237
00:09:36,389 --> 00:09:33,800
water experts it's been an exciting

238
00:09:38,310 --> 00:09:36,399

multi-discipline collaboration

239
00:09:41,030 --> 00:09:38,320
it's a collaboration that will inform

240
00:09:42,230 --> 00:09:41,040
spacesuit technologies for the moon and

241
00:09:44,550 --> 00:09:42,240
beyond

242
00:09:46,230 --> 00:09:44,560
a new design for a thermal control loop

243
00:09:48,070 --> 00:09:46,240
and its ability to help regulate

244
00:09:49,269 --> 00:09:48,080
temperatures for astronauts during

245
00:09:51,829 --> 00:09:49,279
exploration

246
00:09:52,790 --> 00:09:51,839
can benefit from the data gathered from

247
00:09:56,110 --> 00:09:52,800
surfy

248
00:10:10,949 --> 00:09:56,120
making it one cool little experiment