



1
00:00:04,010 --> 00:00:01,730
so as well Glenn's doing that I'm

2
00:00:06,320 --> 00:00:04,020
walking downstairs to where the tiger

3
00:00:08,030 --> 00:00:06,330
team is forming up as I walked

4
00:00:09,470 --> 00:00:08,040
downstairs I think literally we're going

5
00:00:11,720 --> 00:00:09,480
to have to do in minutes and hours it

6
00:00:13,490 --> 00:00:11,730
normally takes days and weeks we're

7
00:00:15,680 --> 00:00:13,500
going to be working outside all known

8
00:00:17,900 --> 00:00:15,690
design and test boundaries and the

9
00:00:20,359 --> 00:00:17,910
spacecraft walk into the room crowded

10
00:00:21,890 --> 00:00:20,369
noisy smoky a lot of confusion because

11
00:00:23,900 --> 00:00:21,900
many of the people just came in from the

12
00:00:26,089 --> 00:00:23,910
rest period haven't had a chance to get

13
00:00:28,160 --> 00:00:26,099

briefed go to the blackboard and for

14

00:00:30,019 --> 00:00:28,170

about 45 minutes to list the problems we

15

00:00:31,910 --> 00:00:30,029

expect to see our water system a freeze

16

00:00:34,459 --> 00:00:31,920

proponents may freeze batteries may

17

00:00:36,350 --> 00:00:34,469

freeze large numbers survival issues how

18

00:00:38,660 --> 00:00:36,360

do we navigate how do we get back

19

00:00:40,400 --> 00:00:38,670

through the Earth's atmosphere no one we

20

00:00:43,340 --> 00:00:40,410

finally finished this long list of must

21

00:00:45,440 --> 00:00:43,350

do's I give the team their mandate we

22

00:00:46,940 --> 00:00:45,450

have never lost an American in space and

23

00:00:50,420 --> 00:00:46,950

we sure as hell aren't going to lose one

24

00:00:52,340 --> 00:00:50,430

now this crew is coming home you got to

25

00:00:55,369 --> 00:00:52,350

believe it your team must believe it and

26
00:00:57,529 --> 00:00:55,379
we must make it happen and from that

27
00:01:01,099 --> 00:00:57,539
moment forward that team had their

28
00:01:03,560 --> 00:01:01,109
direction and over the next four days

29
00:01:07,399 --> 00:01:03,570
they pulled off a miracle bringing the

30
00:01:09,260 --> 00:01:07,409
crew of Apollo 13 home meanwhile in the

31
00:01:10,850 --> 00:01:09,270
control room upstairs Lenny's team has

32
00:01:13,039 --> 00:01:10,860
had the crew perform a very small

33
00:01:14,750 --> 00:01:13,049
maneuver we hadn't done anything

34
00:01:16,609 --> 00:01:14,760
spacecraft would have gone around the

35
00:01:18,740 --> 00:01:16,619
moon about five days later passed by

36
00:01:21,320 --> 00:01:18,750
earth missing it by roughly about 80,000

37
00:01:22,910 --> 00:01:21,330
miles but now with this maneuver were

38
00:01:25,249 --> 00:01:22,920

bringing the spacecraft back to earth

39

00:01:27,050 --> 00:01:25,259

and we've added some finality to the

40

00:01:29,690 --> 00:01:27,060

mission it's going to be too late but at

41

00:01:31,670 --> 00:01:29,700

least we're bringing the crew home now

42

00:01:33,109 --> 00:01:31,680

the Soviet Union has been listening to

43

00:01:34,940 --> 00:01:33,119

our communications they've been tracking

44

00:01:37,130 --> 00:01:34,950

us they know we got a mission in trouble

45

00:01:38,859 --> 00:01:37,140

they call us up give us our ship

46

00:01:42,319 --> 00:01:38,869

locations and offer their assistance

47

00:01:45,139 --> 00:01:42,329

rescuing the crew of Apollo 13 literally

48

00:01:49,130 --> 00:01:45,149

by now the entire world is helping us

49

00:01:50,960 --> 00:01:49,140

bring this crew home we don't have our

50

00:01:53,149 --> 00:01:50,970

first press conference because the media

51
00:01:55,039 --> 00:01:53,159
believes the crews lost and conclusion

52
00:01:57,080 --> 00:01:55,049
the press conference they are given the

53
00:01:58,940 --> 00:01:57,090
opportunity to come over into Mission

54
00:02:01,280 --> 00:01:58,950
Control set up business over there we

55
00:02:05,359 --> 00:02:01,290
patch all the voice communications into

56
00:02:07,639 --> 00:02:05,369
the communications booth where the press

57
00:02:09,139 --> 00:02:07,649
is so we're literally living in a

58
00:02:09,830 --> 00:02:09,149
fishbowl everything that we are saying

59
00:02:12,140 --> 00:02:09,840
and everything

60
00:02:15,740 --> 00:02:12,150
we're doing is being reported live to

61
00:02:17,360 --> 00:02:15,750
the world as it is happening plus 10

62
00:02:19,100 --> 00:02:17,370
hours we have accomplished team hand

63
00:02:21,380 --> 00:02:19,110

over one more time and Mission Control

64

00:02:24,380 --> 00:02:21,390

this was one of the real miracles of 13

65

00:02:27,110 --> 00:02:24,390

these teams kept changing like clockwork

66

00:02:29,119 --> 00:02:27,120

so that each one of the teams would pick

67

00:02:30,680 --> 00:02:29,129

up their set of responsibilities carry

68

00:02:33,050 --> 00:02:30,690

the problems forward to the next shift

69

00:02:35,240 --> 00:02:33,060

work the problem so they came about and

70

00:02:37,970 --> 00:02:35,250

Miller's maroon team now has the helm

71

00:02:39,410 --> 00:02:37,980

and things have settled down to the

72

00:02:41,750 --> 00:02:39,420

point where he got plenty of time to

73

00:02:43,490 --> 00:02:41,760

talk to the crew but most importantly

74

00:02:46,370 --> 00:02:43,500

we're gone through the events leading up

75

00:02:47,870 --> 00:02:46,380

to and after the explosion trying to

76
00:02:49,580 --> 00:02:47,880
figure out what on board the damaged

77
00:02:53,900 --> 00:02:49,590
spacecraft will be useful in coming up

78
00:02:55,970 --> 00:02:53,910
with our return plan 24 hours after the

79
00:02:58,520 --> 00:02:55,980
explosion my team is back on console

80
00:03:01,670 --> 00:02:58,530
again get home fast maneuver is on board

81
00:03:03,770 --> 00:03:01,680
the spacecraft power management plan is

82
00:03:05,660 --> 00:03:03,780
in work we figured out how to navigate

83
00:03:07,940 --> 00:03:05,670
that was one of the difficulties that we

84
00:03:09,910 --> 00:03:07,950
had because with this debris cloud

85
00:03:12,589 --> 00:03:09,920
surrounding the spacecraft we no longer

86
00:03:14,210 --> 00:03:12,599
could see our navigational star so we

87
00:03:17,960 --> 00:03:14,220
had to come up with new techniques to

88
00:03:19,670 --> 00:03:17,970

navigate using Sun Earth and Moon and we

89

00:03:22,400 --> 00:03:19,680

voiced this instruction up to the crew

90

00:03:23,809 --> 00:03:22,410

so the crews all set up for the maneuver

91

00:03:25,490 --> 00:03:23,819

very tight limits upon all the

92

00:03:27,500 --> 00:03:25,500

propulsion parameters crew calls out

93

00:03:29,440 --> 00:03:27,510

engines start and the engines

94

00:03:32,300 --> 00:03:29,450

fishtailing it's not steering properly I

95

00:03:33,949 --> 00:03:32,310

say prep what the hell's going on he

96

00:03:36,170 --> 00:03:33,959

says give it a few more seconds late

97

00:03:38,720 --> 00:03:36,180

let's just watch it and we watch that

98

00:03:41,059 --> 00:03:38,730

engine settles down starts thrusting

99

00:03:44,390 --> 00:03:41,069

correctly four and a half minutes later

100

00:03:45,860 --> 00:03:44,400

crew call shutdown and then they start

101
00:03:48,440 --> 00:03:45,870
their post burn report and we

102
00:03:50,000 --> 00:03:48,450
immediately recognize our mistake when

103
00:03:51,559 --> 00:03:50,010
it computed the engine trim for the

104
00:03:53,210 --> 00:03:51,569
start of the maneuver we assume two

105
00:03:55,520 --> 00:03:53,220
crewmembers would be in the lunar module and

106
00:03:58,250 --> 00:03:55,530
one crewmember would be in the command

107
00:04:00,140 --> 00:03:58,260
module well that assumption was wrong so

108
00:04:03,409 --> 00:04:00,150
from now on and Mission Control there

109
00:04:04,789 --> 00:04:03,419
will be no more assumptions well the

110
00:04:07,400 --> 00:04:04,799
maneuver cut a day off the return

111
00:04:09,080 --> 00:04:07,410
journey it also changed our landing

112
00:04:11,870 --> 00:04:09,090
point we're now going to land in the

113
00:04:14,330 --> 00:04:11,880

South Pacific just east of Samoa so we

114

00:04:16,940 --> 00:04:14,340

send the aircraft carry evo Jima to the

115

00:04:20,479 --> 00:04:16,950

new landing location now the only

116

00:04:22,399 --> 00:04:20,489

management flap of Apollo 13 begins deke

117

00:04:23,660 --> 00:04:22,409

slayton comes up to me at the console

118

00:04:25,610 --> 00:04:23,670

leans over and says look

119

00:04:26,780 --> 00:04:25,620

I want you to get my crew to sleep but

120

00:04:29,930 --> 00:04:26,790

you damn tired they're going to make a

121

00:04:31,700 --> 00:04:29,940

mistake about the time I got his input

122

00:04:33,170 --> 00:04:31,710

my boss Chris Kraft gets me and he said

123

00:04:36,350 --> 00:04:33,180

nope using too much energy you ought to

124

00:04:39,110 --> 00:04:36,360

get that spacecraft power down well the

125

00:04:41,210 --> 00:04:39,120

third guy was max was a he's chief of

126
00:04:42,590 --> 00:04:41,220
engineering Max's nope don't listen to

127
00:04:44,000 --> 00:04:42,600
those two what you got to do is you got

128
00:04:46,430 --> 00:04:44,010
to restore thermal balance to the

129
00:04:48,350 --> 00:04:46,440
spacecraft well that was the direction

130
00:04:49,730 --> 00:04:48,360
that we are already going because we've

131
00:04:51,830 --> 00:04:49,740
been tracking temperatures for the

132
00:04:55,340 --> 00:04:51,840
previous 24 hours and the Sun side it

133
00:04:57,890 --> 00:04:55,350
was like plus 150 dark side minus 180 so

134
00:05:00,350 --> 00:04:57,900
he had a 330 degree temperature gradient

135
00:05:01,820 --> 00:05:00,360
across spacecraft systems in the dark

136
00:05:03,320 --> 00:05:01,830
side were freezing up but most

137
00:05:04,490 --> 00:05:03,330
importantly they were concerned about

138
00:05:08,210 --> 00:05:04,500

the structural integrity of the

139

00:05:10,400 --> 00:05:08,220

spacecraft so now we have no source of

140

00:05:12,560 --> 00:05:10,410

energy except the Sun so what we must do

141

00:05:14,570 --> 00:05:12,570

is invent a barbecue type maneuver we

142

00:05:17,390 --> 00:05:14,580

call it a passive thermal control role

143

00:05:19,220 --> 00:05:17,400

but we've never done this using the

144

00:05:21,380 --> 00:05:19,230

lunar module clusters because there does

145

00:05:23,510 --> 00:05:21,390

not locate in a favorable situation to

146

00:05:25,520 --> 00:05:23,520

do this probably one of the best

147

00:05:27,320 --> 00:05:25,530

teamwork examples of teamwork I've seen

148

00:05:29,420 --> 00:05:27,330

in Mission Control because for about a

149

00:05:31,280 --> 00:05:29,430

45-minute period of time we're literally

150

00:05:33,440 --> 00:05:31,290

conducting a physics experiment it's

151

00:05:35,090 --> 00:05:33,450

race pace we're trying to figure out

152

00:05:36,920 --> 00:05:35,100

what's trusts are such a thrusters or

153

00:05:38,840 --> 00:05:36,930

combinations of thrusters fired in which

154

00:05:41,870 --> 00:05:38,850

direction for how long will set up spin

155

00:05:43,370 --> 00:05:41,880

up condition we need after about 45

156

00:05:46,040 --> 00:05:43,380

minutes work we feel we got all the

157

00:05:48,470 --> 00:05:46,050

proper pieces we voice it up to the crew

158

00:05:50,360 --> 00:05:48,480

crew execute sit doesn't work were

159

00:05:51,710 --> 00:05:50,370

convinced we had the procedure right

160

00:05:53,330 --> 00:05:51,720

they must have missed one of the steps

161

00:05:55,490 --> 00:05:53,340

so we tell them to try it a second time

162

00:05:57,440 --> 00:05:55,500

and this time it works like a champ

163

00:06:01,130 --> 00:05:57,450

spacecraft is spitting perfectly on its

164

00:06:02,810 --> 00:06:01,140

axis Sun heating all sides now they can

165

00:06:04,370 --> 00:06:02,820

power down the spacecraft we bring it

166

00:06:06,650 --> 00:06:04,380

down to a level of just a couple hundred

167

00:06:08,420 --> 00:06:06,660

watts which isn't up just enough to

168

00:06:10,670 --> 00:06:08,430

operate a small fan provide power for

169

00:06:12,350 --> 00:06:10,680

communications now you know it's going

170

00:06:14,180 --> 00:06:12,360

to get as cold as a meat locker inside

171

00:06:15,860 --> 00:06:14,190

the spacecraft we can also go off and

172

00:06:18,230 --> 00:06:15,870

get some rest because we've been

173

00:06:22,070 --> 00:06:18,240

operating over 60 hours continuously by

174

00:06:23,690 --> 00:06:22,080

this time now our arresting engineering

175

00:06:25,310 --> 00:06:23,700

comes up with the solution to another

176

00:06:28,280 --> 00:06:25,320

problem we got this was very well

177

00:06:32,180 --> 00:06:28,290

depicted in the movie Apollo 13 our crew

178

00:06:35,090 --> 00:06:32,190

is about 10 hours from suffocation we

179

00:06:36,980 --> 00:06:35,100

backs basically re breathe the oxygen in

180

00:06:38,810 --> 00:06:36,990

the spacecraft we run it through a

181

00:06:41,000 --> 00:06:38,820

canister containing chemical called

182

00:06:42,740 --> 00:06:41,010

lithium hydroxide which basically

183

00:06:45,050 --> 00:06:42,750

removes the carbon dioxide's from the

184

00:06:46,550 --> 00:06:45,060

crew breathing and the atmosphere we

185

00:06:48,770 --> 00:06:46,560

only had enough of these cylindrical

186

00:06:50,180 --> 00:06:48,780

canisters in the lunar module for two

187

00:06:52,280 --> 00:06:50,190

people for two days so the carbon

188

00:06:54,230 --> 00:06:52,290

dioxide partial pressure is building up

189

00:06:56,390 --> 00:06:54,240

and they feel the crews about ten hours

190

00:06:58,970 --> 00:06:56,400

from asphyxiation due to carbon dioxide

191

00:07:00,410 --> 00:06:58,980

poisoning engineering comes up with the

192

00:07:03,440 --> 00:07:00,420

idea however we got plenty of square

193

00:07:04,910 --> 00:07:03,450

scrubbers over in the command module so

194

00:07:06,740 --> 00:07:04,920

they come up the idea building an

195

00:07:08,390 --> 00:07:06,750

adaptor made out of the cardboard cover

196

00:07:10,790 --> 00:07:08,400

from the flight plan a big plastic

197

00:07:12,980 --> 00:07:10,800

baggie we had on board we use a sock as

198

00:07:15,320 --> 00:07:12,990

a filter eyelash this thing together

199

00:07:17,540 --> 00:07:15,330

with duct tape and some hoses tested the

200

00:07:19,160 --> 00:07:17,550

labs voice the instructions up to the

201
00:07:20,510 --> 00:07:19,170
crew not only to build one of these guys

202
00:07:22,250 --> 00:07:20,520
but to build two of them put them in

203
00:07:25,490 --> 00:07:22,260
series so we can clean the atmosphere as

204
00:07:27,260 --> 00:07:25,500
rapidly as possible another example of

205
00:07:32,180 --> 00:07:27,270
the just-in-time engineering that we

206
00:07:34,100 --> 00:07:32,190
execute it on Apollo 13 at the time this

207
00:07:35,690 --> 00:07:34,110
device is coming in my team comes in

208
00:07:38,510 --> 00:07:35,700
from a risk period we got about six

209
00:07:40,460 --> 00:07:38,520
hours here return status is not very

210
00:07:42,020 --> 00:07:40,470
encouraging the water system is freezing

211
00:07:45,590 --> 00:07:42,030
up it's getting colder the spacecraft

212
00:07:47,270 --> 00:07:45,600
than we had expected it to so we have

213
00:07:48,560 --> 00:07:47,280

the crew transferring water to baggage

214

00:07:50,990 --> 00:07:48,570

so that has something to drink and

215

00:07:52,880 --> 00:07:51,000

rehydrate the food the Navy tells me a

216

00:07:54,500 --> 00:07:52,890

typhoon is building up in the exact

217

00:07:56,690 --> 00:07:54,510

landing area in bringing the spacecraft

218

00:07:59,300 --> 00:07:56,700

back to they want me to change the

219

00:08:00,830 --> 00:07:59,310

landing point but the problem that gets

220

00:08:02,720 --> 00:08:00,840

the immediate attention is the

221

00:08:04,010 --> 00:08:02,730

trajectory team tells me we're going to

222

00:08:06,710 --> 00:08:04,020

miss the earth were to skip out

223

00:08:08,300 --> 00:08:06,720

trajectory now only fly back to earth

224

00:08:10,280 --> 00:08:08,310

they have to fly down a two and a half

225

00:08:11,780 --> 00:08:10,290

degree wide cone-shaped corridor if you

226

00:08:13,430 --> 00:08:11,790

come in too shallow we're going to skip

227

00:08:15,290 --> 00:08:13,440

off the Earth's atmosphere and go into

228

00:08:17,480 --> 00:08:15,300

an eternal orbit between Earth and Moon

229

00:08:19,970 --> 00:08:17,490

come in too steep we're going to burn up

230

00:08:21,460 --> 00:08:19,980

about 45 to 60 seconds just like the

231

00:08:23,990 --> 00:08:21,470

shuttle Columbia did a couple years ago

232

00:08:27,050 --> 00:08:24,000

now we have no computer we have no

233

00:08:28,820 --> 00:08:27,060

display system but we figured out a way

234

00:08:30,830 --> 00:08:28,830

to perform maneuver we tell the crew to

235

00:08:32,930 --> 00:08:30,840

rotate the spacecraft so they can see

236

00:08:35,480 --> 00:08:32,940

the earth outside the two triangular

237

00:08:37,910 --> 00:08:35,490

windows and lunar module and on these

238

00:08:39,950 --> 00:08:37,920

when each window is a gunsight type

239

00:08:42,800 --> 00:08:39,960

optics that we use during rendezvous

240

00:08:45,500 --> 00:08:42,810

docking and for lunar navigation we tell

241

00:08:47,150 --> 00:08:45,510

the crew to align the y axis crosshair

242

00:08:49,670 --> 00:08:47,160

which is a horizontal one on the Earth's

243

00:08:50,870 --> 00:08:49,680

Terminator which is the light between

244

00:08:53,030 --> 00:08:50,880

day light and dark

245

00:08:54,620 --> 00:08:53,040

as you view the Earth from space and in

246

00:08:56,720 --> 00:08:54,630

this orientation the engine will be

247

00:09:00,110 --> 00:08:56,730

properly position to correct the

248

00:09:01,490 --> 00:09:00,120

trajectory we say to Jim Lovell gym when

249

00:09:03,710 --> 00:09:01,500

the engine starts looking through your

250

00:09:05,360 --> 00:09:03,720

sighting device at the earth you take

251

00:09:07,970 --> 00:09:05,370

your hand controller and keep deer from

252

00:09:09,680 --> 00:09:07,980

moving up and down and Fred Hayes and

253

00:09:11,300 --> 00:09:09,690

your side of spacecraft with the backup

254

00:09:13,700 --> 00:09:11,310

hand controller you keep the Earth from

255

00:09:15,530 --> 00:09:13,710

moving from left to right we tell Jack

256

00:09:17,150 --> 00:09:15,540

Swigert what 14 seconds in his