Flight & Closeout Crew Use Diving Board for Vehicle Access

1
00:00:07,130 --> 00:00:05,030
this video shows the combined lessons

2
00:00:09,020 --> 00:00:07,140
learned of crew interior access to the

3
00:00:11,749 --> 00:00:09,030
Apollo shuttle and constellation

4
00:00:13,610 --> 00:00:11,759
spacecraft at the pad using mock-ups and

5
00:00:15,950 --> 00:00:13,620
design visualization tools it is

6
00:00:17,480 --> 00:00:15,960
possible to identify costly issues with

7
00:00:20,000 --> 00:00:17,490
the pad interface early in the

8
00:00:21,830 --> 00:00:20,010
development cycle green screen video was

9
00:00:23,810 --> 00:00:21,840
generated of tests performed by the

10
00:00:26,179 --> 00:00:23,820
flight and emergency crew and especially

11
00:00:28,040 --> 00:00:26,189
build crew access our mock-up it was

12
00:00:31,220 --> 00:00:28,050
then combined with 3d models to

13
00:00:33,590 --> 00:00:31,230

visualize the scenarios at the pad crew

14
00:00:36,970 --> 00:00:33,600
access to manned spacecraft is normally

15
00:00:39,440 --> 00:00:36,980
established at the pad after roll up an

16
00:00:41,180 --> 00:00:39,450
environmental chamber commonly called a

17
00:00:43,280 --> 00:00:41,190
white room is needed to protect the

18
00:00:45,950 --> 00:00:43,290
vehicle cleanliness here's the shuttle

19
00:00:47,690 --> 00:00:45,960
white room interface the orbiter crew

20
00:00:49,700 --> 00:00:47,700
access arm interface relies on the

21
00:00:51,889 --> 00:00:49,710
geometry of the integrated stack and

22
00:00:54,170 --> 00:00:51,899
presses an inflatable dock seal against

23
00:00:56,180 --> 00:00:54,180
the side of the vehicle the orbiter skin

24
00:00:58,250 --> 00:00:56,190
is relatively durable incapable of

25
00:01:01,849 --> 00:00:58,260
absorbing surface friction associated

26
00:01:04,789 --> 00:01:01,859
with the inflatable dog seal here's how

27
00:01:06,950 --> 00:01:04,799
Apollo managed the interface Apollo's

28
00:01:08,899 --> 00:01:06,960
interface used a remotely operated clamp

29
00:01:14,630 --> 00:01:08,909
that removed any gaps for the crew to

30
00:01:20,180 --> 00:01:18,230
crew access arm connection in the case

31
00:01:22,910 --> 00:01:20,190
of this vehicle the seal is mechanically

32
00:01:24,710 --> 00:01:22,920
attached to the spacecraft no threaded

33
00:01:27,680 --> 00:01:24,720
fasteners should be required during

34
00:01:29,480 --> 00:01:27,690
launch countdown or crew egress any

35
00:01:31,400 --> 00:01:29,490
steps required to build this interface

36
00:01:33,499 --> 00:01:31,410
must also account for fall hazards

37
00:01:36,350 --> 00:01:33,509
weather and relative movement of the

38
00:01:38,149 --> 00:01:36,360

vehicle and white room often this task

39
00:01:39,649 --> 00:01:38,159
has to be performed during a scrub

40
00:01:41,359 --> 00:01:39,659
turnaround where the launch has been

41
00:01:43,520 --> 00:01:41,369
canceled due to inclement weather and

42
00:01:46,460 --> 00:01:43,530
the crew cannot leave until access is

43
00:01:48,200 --> 00:01:46,470
established access to service panels

44
00:01:50,990 --> 00:01:48,210
needs to be accounted for in the

45
00:01:53,150 --> 00:01:51,000
interface design the crew access arm

46
00:01:54,859 --> 00:01:53,160
design provides environmental protection

47
00:01:57,380 --> 00:01:54,869
to the interior of the spacecraft if

48
00:01:59,800 --> 00:01:57,390
needed several types of requirements

49
00:02:02,840 --> 00:01:59,810
have driven previous designs including

50
00:02:04,639 --> 00:02:02,850
spacecraft cleanliness levels humidity

51
00:02:07,639 --> 00:02:04,649
that can cause condensation on critical

52
00:02:10,100 --> 00:02:07,649
components precipitation which is a

53
00:02:12,530 --> 00:02:10,110
particular concern at the spacecraft CIA

54
00:02:15,259 --> 00:02:12,540
interface seal during high winds and

55
00:02:17,330 --> 00:02:15,269
inclement weather oxygen deficiency in

56
00:02:21,650 --> 00:02:17,340
confined spaces that may result from

57
00:02:23,300 --> 00:02:21,660
spacecraft purges the crew access arm

58
00:02:27,319 --> 00:02:23,310
should remotely attached to the vehicle

59
00:02:29,330 --> 00:02:27,329
structure during Apollo a strong

60
00:02:31,520 --> 00:02:29,340
interface was achieved by attaching a

61
00:02:33,789 --> 00:02:31,530
compliant portion of the crew access arm

62
00:02:36,710 --> 00:02:33,799
directly to the spacecraft structure a

63
00:02:38,569 --> 00:02:36,720

remotely operated clamp located on the

64
00:02:40,580 --> 00:02:38,579
roof of the crew access on white room

65
00:02:43,130 --> 00:02:40,590
engage the vehicle at the base of the

66
00:02:44,569 --> 00:02:43,140
launch escape system relative motion was

67
00:02:46,670 --> 00:02:44,579
absorbed within the crew access arm

68
00:02:48,710 --> 00:02:46,680
rather than at the interface the

69
00:02:50,750 --> 00:02:48,720
remotely operated clamp also permitted

70
00:02:52,640 --> 00:02:50,760
firing room personnel to connect to the

71
00:02:56,210 --> 00:02:52,650
vehicle during an emergency while the

72
00:02:58,009 --> 00:02:56,220
crew focused on hatch operations a key

73
00:03:00,110 --> 00:02:58,019
factor that needs to be resolved early

74
00:03:02,330 --> 00:03:00,120
in the design process is how the crew

75
00:03:06,050 --> 00:03:02,340
access arm will attach to the spacecraft

76
00:03:08,479 --> 00:03:06,060
itself in general the goal of attaching

77
00:03:10,069 --> 00:03:08,489
the vehicle to the crew access arm is to

78
00:03:12,380 --> 00:03:10,079
eliminate the relative motion between

79
00:03:13,840 --> 00:03:12,390
the two assemblies and allow a better

80
00:03:15,840 --> 00:03:13,850
chance of achieving the desired

81
00:03:18,750 --> 00:03:15,850
environmental seal at the inner

82
00:03:24,050 --> 00:03:18,760
face however this must be done without

83
00:03:29,670 --> 00:03:27,840
crew ingress access and the vehicle

84
00:03:31,830 --> 00:03:29,680
should be designed to minimize any

85
00:03:35,040 --> 00:03:31,840
damage or contamination to hatch seals

86
00:03:37,950 --> 00:03:35,050
or mechanisms in this case a diving

87
00:03:40,200 --> 00:03:37,960
board is used crew access for manned

88
00:03:42,540 --> 00:03:40,210

spacecraft is a secondary concern for

89
00:03:45,450 --> 00:03:42,550
designers compared to on-orbit vehicle

90
00:03:47,490 --> 00:03:45,460
performance however the components

91
00:03:49,710 --> 00:03:47,500
impacted by crew egress are substantial

92
00:03:52,620 --> 00:03:49,720
and include the crew hatch the outer

93
00:03:56,000 --> 00:03:52,630
surfaces the launch abort system and all

94
00:03:59,820 --> 00:03:56,010
crew equipment that could impede escape

95
00:04:02,070 --> 00:03:59,830
assisted emergency egress the vehicle

96
00:04:03,720 --> 00:04:02,080
and pad designs need to support rapid

97
00:04:07,680 --> 00:04:03,730
removal of crew that are incapacitated

98
00:04:10,380 --> 00:04:07,690
during emergency egress hatch size must

99
00:04:12,390 --> 00:04:10,390
not only accommodate crew and cargo but

100
00:04:19,380 --> 00:04:12,400
rescue and breathing equipment used by

101
00:04:21,360 --> 00:04:19,390
emergency personnel the ability of a

102
00:04:23,370 --> 00:04:21,370
crew to rapidly exit their spacecraft

103
00:04:25,500 --> 00:04:23,380
and escape the pad emergency is perhaps

104
00:04:29,400 --> 00:04:25,510
the strongest driver in the crew access

105
00:04:31,200 --> 00:04:29,410
arm design crews should be oriented with

106
00:04:41,080 --> 00:04:31,210
their heads toward the hatch if possible

107
00:04:46,100 --> 00:04:43,969
in some cases special equipment is

108
00:04:48,439 --> 00:04:46,110
required to assist the rescue team the

109
00:04:52,010 --> 00:04:48,449
vehicle geometry impairs extraction of

110
00:04:54,140 --> 00:04:52,020
injured crew events such as the Apollo 1

111
00:04:56,059 --> 00:04:54,150
pad fire elevate the importance of a

112
00:04:57,890 --> 00:04:56,069
coordinated solution that allows the

113
00:05:00,850 --> 00:04:57,900

crew to get out of the vehicle rapidly

114
00:05:03,379 --> 00:05:00,860
without penalizing on-orbit capability

115
00:05:06,350 --> 00:05:03,389
several design details can significantly

116
00:05:08,330 --> 00:05:06,360
improve emergency extraction times such

117
00:05:11,089 --> 00:05:08,340
as rapid release flight crew equipment

118
00:05:13,100 --> 00:05:11,099
suits with handles built in and cabin

119
00:05:14,779 --> 00:05:13,110
layouts to provide emergency personnel

120
00:05:19,700 --> 00:05:14,789
with working volume around the crew

121
00:05:21,740 --> 00:05:19,710
seats flight suits and breathing

122
00:05:23,480 --> 00:05:21,750
apparatus worn by the emergency rescue

123
00:05:25,460 --> 00:05:23,490
personnel should be considered when

124
00:05:28,219 --> 00:05:25,470
planning minimum space requirements of

125
00:05:30,080 --> 00:05:28,229
interior compartments to ensure no

126
00:05:31,820 --> 00:05:30,090
obstacles impede the crew careful

127
00:05:34,189 --> 00:05:31,830
attention must also be paid to the

128
00:05:36,320 --> 00:05:34,199
egress route in order to remove

129
00:05:37,820 --> 00:05:36,330
incapacitated or injured crew from the

130
00:05:39,710 --> 00:05:37,830
crew compartment and away from the

131
00:05:41,779 --> 00:05:39,720
vehicle support equipment must be

132
00:05:54,070 --> 00:05:41,789
designed to minimize interference with

133
00:06:00,770 --> 00:05:58,520
unassisted emergency egress in

134
00:06:02,600 --> 00:06:00,780
situations where the crew must egress

135
00:06:04,850 --> 00:06:02,610
without assistance handrails and

136
00:06:06,860 --> 00:06:04,860
footholds are critical for quickly

137
00:06:09,110 --> 00:06:06,870
crossing the gap between the vehicle and

138
00:06:11,870 --> 00:06:09,120

white room tools should not be required

139
00:06:14,000 --> 00:06:11,880
to enable crew egress the limited

140
00:06:15,740 --> 00:06:14,010
mobility within a crew suit increases

141
00:06:17,270 --> 00:06:15,750
the need for mobility aids within the

142
00:06:21,020 --> 00:06:17,280
vehicle and at the edge of the white

143
00:06:23,150 --> 00:06:21,030
room this egress method and landing are

144
00:06:24,620 --> 00:06:23,160
the two primary driving cases for

145
00:06:28,879 --> 00:06:24,630
placement of handles around the hatch

146
00:06:30,740 --> 00:06:28,889
area vehicle perch design should

147
00:06:34,129 --> 00:06:30,750
minimize over pressure required at the

148
00:06:36,379 --> 00:06:34,139
crew access arm vehicle interface purged

149
00:06:38,689 --> 00:06:36,389
areas of the spacecraft must include a

150
00:06:40,879 --> 00:06:38,699
recovery plan for loss of perch in other

151
00:06:45,200 --> 00:06:40,889
words what happens if the perch is lost

152
00:06:46,969 --> 00:06:45,210
or the mission is scrubbed the kse

153
00:06:48,830 --> 00:06:46,979
mock-up team has presented a series of

154
00:06:52,070 --> 00:06:48,840
design considerations or crew

155
00:06:53,659 --> 00:06:52,080
compartment access this area is right

156
00:06:55,790 --> 00:06:53,669
for new and innovative approaches

157
00:06:57,469 --> 00:06:55,800
particularly if the workers that will be

158
00:06:59,150 --> 00:06:57,479
using the hardware and the emergency

159
00:07:00,879 --> 00:06:59,160
personnel to protect the crew are

160
00:07:03,560 --> 00:07:00,889
involved early in the design process