WEBVTT

1
00:00:00.025 --> 00:00:02.125
Uh, we've had two, uh, presentations here.

2
00:00:02.465 --> 00:00:05.925
Um, one on the F 35 and one's on the F 16, I guess.

3
00:00:06.345 --> 00:00:07.365
Uh, we're gonna go to kind

4
00:00:07.365 --> 00:00:08.685
of big wing stuff here a little bit.

5
00:00:09.145 --> 00:00:12.125
So our next, uh, presenter is Jerry Whites.

6
00:00:12.305 --> 00:00:14.205
Uh, in addition to being the next presenter,

7
00:00:14.205 --> 00:00:16.045
he's also the August Chairman

8
00:00:16.145 --> 00:00:17.685
of the Flight Test Safety Committee,

9
00:00:17.685 --> 00:00:19.845
and he's been serving that capacity for about five years.

10
00:00:20.505 --> 00:00:22.645
Uh, he's certainly no stranger to this forum

11
00:00:22.825 --> 00:00:23.925
to flight test in general.

12
00:00:24.665 --> 00:00:27.605
Uh, he's got an excess of 34 years of, uh,

13
00:00:27.605 --> 00:00:30.925
experience at the Boeing Company, is type rated in, uh,

14
00:00:30.925 --> 00:00:34.325
more airplanes than I can even count on this piece of paper,

15
00:00:34.385 --> 00:00:38.525
but lots of 7 0 7 and beyond series all the way to 7 8 7.

16
00:00:39.545 --> 00:00:43.125
Uh, he is an expert in, uh, air vehicle flight test,

17
00:00:43.195 --> 00:00:47.885
primarily, uh, handling qualities, uh, loads, flutter,

18
00:00:47.885 --> 00:00:50.845
performance envelope expansion, propulsions, et cetera.

19
00:00:51.585 --> 00:00:55.205
Um, notably he has survived two major flutter incidents

20
00:00:56.225 --> 00:00:57.525
and, uh, live to tell the tale

21
00:00:57.755 --> 00:00:59.005
some of which we're gonna hear today.

22
00:00:59.085 --> 00:01:01.685
I think he's A-F-A-A-D-E-R.

23
00:01:02.625 --> 00:01:04.645
Uh, he's a mentor, as I said.

24
00:01:04.645 --> 00:01:07.245
He's the chairman of, uh, the flight test Safety committee.

25
00:01:08.225 --> 00:01:10.685
And, uh, he's currently working as a consultant test pilot

26
00:01:10.705 --> 00:01:13.965
for both the Boeing Company and for, for Virgin Orbital.

27
00:01:14.585 --> 00:01:18.085

Uh, he's gonna give us a presentation today on the E six

28
00:01:18.085 --> 00:01:20.925
program and how it taught him the realities of flight test.

29
00:01:21.345 --> 00:01:23.285
Please welcome Jerry Whites.

30
00:01:34.605 --> 00:01:37.695
Okay, we're gonna talk about fly by wire airplanes,

31
00:01:38.075 --> 00:01:43.055
the stranded kind, and about, uh, airplanes

32
00:01:43.055 --> 00:01:44.495
that have reversible flight controls.

33
00:01:45.155 --> 00:01:47.135
So, go way back, historical.

34
00:01:47.165 --> 00:01:51.855
This is somewhere beyond the B 17 and, uh, and current jets,

35
00:01:52.635 --> 00:01:55.575
but it's a grandfather of all Boeing

36
00:01:56.415 --> 00:01:59.255
airplanes when you refer to the, uh, the jet fleet.

37
00:01:59.995 --> 00:02:03.495
And it's where if you trace current Boeing airplanes back,

38
00:02:03.495 --> 00:02:04.615
it's a legacy airplane.

39
00:02:05.955 --> 00:02:10.455
But what I really could talk about here is this,

40
00:02:13.155 --> 00:02:15.735
you really don't understand flutter until it happens to you

41
00:02:18.065 --> 00:02:19.695
again, this is a step back in time.

42
00:02:20.315 --> 00:02:23.375
The time period is 1989.

43
00:02:25.555 --> 00:02:27.095
The E six is the airplane.

44
00:02:27.115 --> 00:02:30.855
It was a E 7 0 7 derivative for the Navy, uh,

45
00:02:30.875 --> 00:02:34.695
to replace a Taco Bell fleet of eec one thirties.

46
00:02:37.115 --> 00:02:38.935
It had CFM 56 engines,

47
00:02:40.115 --> 00:02:43.615
and notably it has a different rudder, PCU

48
00:02:45.125 --> 00:02:46.215
than the rest of the fleet.

49
00:02:46.595 --> 00:02:49.335
And it was done so in order

50
00:02:49.335 --> 00:02:51.295
to meet field leak requirements in the Navy had.

51
00:02:55.915 --> 00:02:57.495
So let's look at the airplane a little bit

52
00:02:59.225 --> 00:03:01.285
and talk about where we were programmatically.

53
00:03:03.625 --> 00:03:05.925
So the flight test program was complete

54
00:03:06.305 --> 00:03:07.845

and we were in the transition

55
00:03:07.945 --> 00:03:10.245
to systems testing, mission testing.

56
00:03:12.075 --> 00:03:15.805
However, during flight test,

57
00:03:16.265 --> 00:03:17.325
air vehicle testing,

58
00:03:18.305 --> 00:03:21.645
we discovered we had some fatigue issues, one of which was

59
00:03:22.865 --> 00:03:24.125
we had some skin panels

60
00:03:24.125 --> 00:03:26.005
that weren't gonna meet fatigue life for the program.

61
00:03:26.425 --> 00:03:29.165
So that set about some thinking as to whether

62
00:03:29.185 --> 00:03:32.325
or not we need to revisit flutter just to be sure

63
00:03:32.515 --> 00:03:33.805
that the airplane was still good,

64
00:03:33.875 --> 00:03:37.165
that we hadn't affected any of the amping characteristics

65
00:03:37.165 --> 00:03:40.365
of the plane, Had

66
00:03:41.125 --> 00:03:42.245
previous testing, had no issues.

67
00:03:44.065 --> 00:03:45.325
In fact, there was a lot of discussion

68
00:03:45.325 --> 00:03:47.165
of whether we really even needed to do that testing.

69
00:03:50.465 --> 00:03:53.165
And we had a lot of confidence what could go wrong.

70
00:03:55.285 --> 00:03:57.805
Interestingly, program management had changed from an air

71
00:03:57.805 --> 00:03:59.765
vehicle person to a systems person

72
00:03:59.985 --> 00:04:02.245
who had no clue about airplane testing.

73
00:04:03.265 --> 00:04:04.285
That's just an aside,

74
00:04:06.705 --> 00:04:07.965
but I had high confidence

75
00:04:07.965 --> 00:04:08.965
that everything was gonna be just fine.

76
00:04:09.125 --> 00:04:12.405
'cause I had cleared other 7 0 7 derivative airplanes,

77
00:04:12.665 --> 00:04:13.805
the flutter I'd been there

78
00:04:13.805 --> 00:04:16.485
before, been fast, been slow, all that stuff.

79
00:04:16.505 --> 00:04:18.325
And so I wasn't too concerned about it.

80
00:04:19.115 --> 00:04:21.695
And so I thought, okay, we'll get it done.

81
00:04:22.025 --> 00:04:25.295

We'll go fast, we'll clear the airplane, what can go wrong?

82
00:04:27.785 --> 00:04:28.375
Let's see here.

83
00:04:33.035 --> 00:04:35.375
So let's talk about how we did fluttering the day.

84
00:04:35.375 --> 00:04:37.015
And we still do some of this today,

85
00:04:37.315 --> 00:04:39.135
but we now have the advantage of being able

86
00:04:39.135 --> 00:04:41.135
to do forcing function generators

87
00:04:41.135 --> 00:04:44.255
and other devices that, uh, worked through the, uh, flight

88
00:04:44.255 --> 00:04:47.615
and curl computers and can do a lot of the flutter sweeps

89
00:04:47.635 --> 00:04:50.535
for us back in the day, it was all by wrap,

90
00:04:52.215 --> 00:04:56.625
flutter wraps, elevator, bang, nose down, nose up,

91
00:04:57.455 --> 00:04:59.785
left right, and rudder cakes.

92
00:05:00.805 --> 00:05:04.145
So what we're doing is we're saying that the airplane

93
00:05:04.965 --> 00:05:06.065
is flutter clear.

94
00:05:07.045 --> 00:05:11.145
That's a spectrum of speeds all the way out to VDMD.

95
00:05:17.015 --> 00:05:18.265
What happens if something goes wrong?

96
00:05:18.575 --> 00:05:19.825
What do you do for a knock it off?

97
00:05:21.005 --> 00:05:23.745
So the stick wraps verify the absence

98
00:05:23.745 --> 00:05:26.465
of flutter in the airplane, but what happens if you

99
00:05:27.185 --> 00:05:30.985
actually have flutter or even an LCO?

100
00:05:32.645 --> 00:05:33.825
How do you get away from it?

101
00:05:33.935 --> 00:05:36.185
Well, the pilot actions are simply things like,

102
00:05:36.215 --> 00:05:37.265
well, we're gonna slow down.

103
00:05:37.885 --> 00:05:39.505
I'm gonna g the airplane a little bit, maybe.

104
00:05:39.805 --> 00:05:43.465
Uh, but the big thing is we're gonna get the airplane out of

105
00:05:43.465 --> 00:05:45.785
that envelope, that flutter spectrum.

106
00:05:46.775 --> 00:05:50.905
However, none of these things can really work

107
00:05:51.045 --> 00:05:53.705
or may really work because if you have explosive

108
00:05:53.705 --> 00:05:56.305

flutter, all bets are off.

109
00:06:00.225 --> 00:06:02.725
So the date, February 16th, 1989.

110
00:06:04.115 --> 00:06:07.805
Typical, no, February, February in Seattle. Imagine that.

111
00:06:09.745 --> 00:06:12.285
So the chase aircraft at the time was an F 86,

112
00:06:13.695 --> 00:06:18.565
which we would recover many times in IFR conditions on the

113
00:06:18.565 --> 00:06:21.325
wing because he really didn't have,

114
00:06:21.345 --> 00:06:23.165
he was an IFR capable airplane,

115
00:06:23.745 --> 00:06:27.685
but really not a safe IFR airplane in a lot of respects.

116
00:06:28.345 --> 00:06:29.685
So they would recover on the wing with,

117
00:06:29.755 --> 00:06:31.485
with us, we would go, Mr.

118
00:06:31.515 --> 00:06:33.805
We'd drop them off, come back around land.

119
00:06:35.745 --> 00:06:37.245
So he aborts

120
00:06:37.245 --> 00:06:39.365
because the weather's just not good enough for him.

121
00:06:39.635 --> 00:06:43.005
It's 600 overcast. It's kind of a drizzly day.

122
00:06:44.475 --> 00:06:48.045
Tops are about 3000 feet, maybe 4,000 feet, but clear

123
00:06:48.045 --> 00:06:50.525
and a million above nice, stable air mass.

124
00:06:53.495 --> 00:06:55.805
Again, we weren't expecting anything.

125
00:06:56.555 --> 00:06:58.965
Everybody was convinced there was not gonna be an issue.

126
00:06:59.665 --> 00:07:02.205
So we went off and we flew.

127
00:07:04.045 --> 00:07:07.405
Everything's fine to the last point of the day.

128
00:07:10.625 --> 00:07:15.245
Max Q 460 knots about 0.89 mark

129
00:07:15.995 --> 00:07:17.165
15,000 feet.

130
00:07:23.585 --> 00:07:27.525
If you look at this trace, if you look at the scale here,

131
00:07:29.985 --> 00:07:34.645
so look at the G there, that's the fin cap.

132
00:07:35.795 --> 00:07:40.165
There's the kick timeframe's about 2.75 seconds.

133
00:07:44.225 --> 00:07:45.085
And then flat line.

134
00:07:54.215 --> 00:07:54.855
I don't have chase,

135
00:07:59.325 --> 00:07:59.935

what do I know?

136
00:08:00.015 --> 00:08:01.535
I know that something happened.

137
00:08:02.955 --> 00:08:05.215
We Had a little over three Gs peak tope

138
00:08:05.235 --> 00:08:06.975
and y uh,

139
00:08:07.835 --> 00:08:10.455
at the seat rail, but it stopped.

140
00:08:13.715 --> 00:08:17.185
We're still flying. We slow down.

141
00:08:18.765 --> 00:08:23.675
All is good. Remember I

142
00:08:23.675 --> 00:08:26.755
said we had a pretty big shake and you saw the traces.

143
00:08:28.055 --> 00:08:32.875
We knocked telemetry off the air radio room has flat lines.

144
00:08:37.555 --> 00:08:39.375
That's A very interesting radio call

145
00:08:42.485 --> 00:08:46.735
because you, and you can tell this is a certain amount

146
00:08:46.735 --> 00:08:50.815
of concern in the, in the tm, uh, control room, uh,

147
00:08:50.815 --> 00:08:51.895
when they make that call.

148
00:08:54.235 --> 00:08:55.095
So, what am I thinking?

149
00:08:59.045 --> 00:09:03.055
It's better to have chase and not need it than not have it.

150
00:09:03.155 --> 00:09:04.375
And really wish you did.

151
00:09:09.205 --> 00:09:10.975
What did I know? Well, I slowed down,

152
00:09:12.615 --> 00:09:14.095
I did a controllability check.

153
00:09:16.375 --> 00:09:20.875
I had pitch rolling off and the airplane felt normal.

154
00:09:22.535 --> 00:09:25.075
But given, think back to 1989,

155
00:09:25.075 --> 00:09:29.395
test pellet culture, airplane's flying.

156
00:09:29.995 --> 00:09:31.835
Everything's good, everything's working.

157
00:09:34.375 --> 00:09:35.845
Don't need no stinking emergency.

158
00:09:39.185 --> 00:09:41.005
So everything's fine. So we recover.

159
00:09:43.235 --> 00:09:47.405
Weather's still marginal, still 600 overcast,

160
00:09:47.405 --> 00:09:50.045
about a half mile visibility right at the field limit

161
00:09:50.305 --> 00:09:51.365
for the, at that time,

162
00:09:51.365 --> 00:09:53.365

what was a localizer back course approach?

163
00:09:53.695 --> 00:09:55.725
There was an i, there was an ILS to the other runway,

164
00:09:55.945 --> 00:09:58.165
but we were not an emergency aircraft

165
00:10:03.365 --> 00:10:05.945
and about 20 knots above approach speed.

166
00:10:06.965 --> 00:10:08.105
It became very obvious

167
00:10:08.295 --> 00:10:11.705
that I had lost stability in the longitudinal axis.

168
00:10:12.565 --> 00:10:13.025
La dur.

169
00:10:16.485 --> 00:10:17.665
It would not hold a heading.

170
00:10:18.685 --> 00:10:21.065
We were flying a basically a contact approach looking

171
00:10:21.065 --> 00:10:22.185
outside, looking down.

172
00:10:22.515 --> 00:10:24.345
Every time I looked back up, the heading had changed.

173
00:10:29.325 --> 00:10:30.505
And so guess what?

174
00:10:33.045 --> 00:10:35.345
The first missed approach I'd ever made at Boeing Field.

175
00:10:40.045 --> 00:10:44.385
So we knew that about V Ref 20, the airplane felt okay,

176
00:10:45.165 --> 00:10:49.825
so we stayed fast this time we're on the ILS

177
00:10:52.365 --> 00:10:57.105
on final, at about a thousand feet,

178
00:10:58.645 --> 00:10:59.865
you get this radio call

179
00:11:00.005 --> 00:11:03.465
and said, uh, did approach controls, uh, mentioned to you

180
00:11:03.465 --> 00:11:06.705
that somebody on the ground said that you were missing, uh,

181
00:11:06.885 --> 00:11:08.745
either your rudder or large parts of it.

182
00:11:09.885 --> 00:11:12.065
And we said, uh, right here we're gonna land.

183
00:11:16.415 --> 00:11:20.115
And after landing, uh, notice that if a shift change

184
00:11:21.615 --> 00:11:24.595
and the, the cars in the parking lot were having difficulty,

185
00:11:24.935 --> 00:11:26.915
uh, extracting themselves from the parking lot.

186
00:11:27.615 --> 00:11:31.235
And, uh, rusty Lowry once had a, a comment that I heard, uh,

187
00:11:31.275 --> 00:11:33.435
a few years later, which was from

188
00:11:33.435 --> 00:11:34.835
motorcycle racing, which he does.

189
00:11:35.255 --> 00:11:40.115

Um, when the crowd at the fence is standing there pointing

190
00:11:40.115 --> 00:11:43.915
at you, it's not always a good thing.

191
00:11:50.985 --> 00:11:51.275
Okay?

192
00:12:09.945 --> 00:12:12.685
So let's talk about this picture a little bit.

193
00:12:14.305 --> 00:12:17.355
If you look here, that's a hinge.

194
00:12:18.975 --> 00:12:22.155
If that hinge goes, that goes away.

195
00:12:23.655 --> 00:12:25.195
So we would've lost half the elevator

196
00:12:26.415 --> 00:12:29.995
If Right there is the rudder, PCU.

197
00:12:30.895 --> 00:12:34.075
If that goes, we have nowhere to control.

198
00:12:37.055 --> 00:12:39.355
So we really had a really good day, actually.

199
00:12:42.375 --> 00:12:45.555
So a lot of funny things happened.

200
00:12:45.595 --> 00:12:47.635
I went home that, that night afterwards and I'm,

201
00:12:47.695 --> 00:12:50.235
and I was kinda like, we walked out, okay, this is really,

202
00:12:50.535 --> 00:12:52.275
you know, what happened, this happens, this flight, tell

203
00:12:52.275 --> 00:12:53.475
what knows what goes on.

204
00:12:55.335 --> 00:12:59.435
But I had this really weird compelling

205
00:13:02.335 --> 00:13:04.515
desire, feeling that I needed to go out

206
00:13:04.735 --> 00:13:06.595
and collect my airplane.

207
00:13:08.235 --> 00:13:11.725
That it was a visceral response that I had

208
00:13:11.725 --> 00:13:12.965
to go pick up the pieces.

209
00:13:13.765 --> 00:13:18.045
I broke it. I have to go get this. I screwed this up.

210
00:13:24.025 --> 00:13:26.925
You have to realize that this gentleman in today's world

211
00:13:27.125 --> 00:13:28.205
would be a millionaire.

212
00:13:30.385 --> 00:13:35.165
Um, that is the HF pro off the vertical fan was sitting next

213
00:13:35.165 --> 00:13:40.085
to his duck blind like a harpoon right in his backyard.

214
00:13:43.555 --> 00:13:44.885
What did you want? He wanted

215
00:13:44.885 --> 00:13:45.965
to go for a ride in the helicopter.

216
00:13:49.505 --> 00:13:50.845

It would not happen today.

217
00:13:53.425 --> 00:13:55.445
So we gathered up the pieces

218
00:13:55.665 --> 00:13:58.045
and this is a right hand horizontal.

219
00:14:01.575 --> 00:14:02.635
That's the vertical fin.

220
00:14:05.695 --> 00:14:09.195
And we're trying to find out just exactly if we can come up

221
00:14:09.195 --> 00:14:12.555
with a mechanism for what the hell happened.

222
00:14:17.575 --> 00:14:20.555
But Let's step away a bit and say, okay, I rich

223
00:14:20.555 --> 00:14:23.755
and I would had this urge to go get the pieces.

224
00:14:28.815 --> 00:14:29.875
Did I do something wrong?

225
00:14:33.095 --> 00:14:35.035
My wife needed to know what happened.

226
00:14:35.095 --> 00:14:36.755
And, and that picture in the hangar,

227
00:14:37.235 --> 00:14:38.715
I took her into the hangar and,

228
00:14:38.715 --> 00:14:40.115
and got her up on the cherry picker.

229
00:14:40.115 --> 00:14:42.195
And we walked around the airplane and we talked about stuff

230
00:14:42.195 --> 00:14:43.595
and we talked to people in the room.

231
00:14:44.855 --> 00:14:48.475
And it was really important to share that with her

232
00:14:49.295 --> 00:14:51.685
and have had that opportunity to share that with her.

233
00:14:51.755 --> 00:14:53.765
Because this doesn't happen just to you.

234
00:14:55.775 --> 00:14:58.945
This happens to your family, happens to your friends,

235
00:14:59.535 --> 00:15:01.825
happens to everybody involved in the test.

236
00:15:06.605 --> 00:15:08.055
Like I said, I needed to pick up the wreck.

237
00:15:09.995 --> 00:15:14.055
Did we know what happened? How are we gonna fix it?

238
00:15:15.835 --> 00:15:16.455
What's next?

239
00:15:20.715 --> 00:15:23.015
So we came up with this great plan

240
00:15:23.035 --> 00:15:25.055
and I mentioned we had a, a new program manager

241
00:15:25.155 --> 00:15:26.255
who was learning.

242
00:15:28.275 --> 00:15:32.055
Um, so we had tiger teams in the basement of one of the, uh,

243
00:15:32.855 --> 00:15:35.775

engineering buildings at 6:00 AM every morning for

244
00:15:37.235 --> 00:15:40.135
enough time that basically I stopped going to them.

245
00:15:43.955 --> 00:15:47.215
So they analyzed the data, really couldn't find, come up

246
00:15:47.215 --> 00:15:50.335
with anything that was a mechanism for the event, uh,

247
00:15:50.895 --> 00:15:53.215
repaired the damage and essentially put the airplane back

248
00:15:53.375 --> 00:15:56.855
together again and, and submitted the hell out of things.

249
00:15:59.145 --> 00:16:00.605
And so we came up with this plan

250
00:16:00.605 --> 00:16:01.765
that we were all comfortable with,

251
00:16:01.785 --> 00:16:03.125
how we were going to examine.

252
00:16:04.445 --> 00:16:06.685
'cause the event happened above the stability bucket

253
00:16:06.705 --> 00:16:08.605
for flutter, uh, which is

254
00:16:08.605 --> 00:16:11.925
around 8 6, 8 4 mock right in that TRANSONIC region.

255
00:16:12.345 --> 00:16:13.925
The event happened out eight, nine, or,

256
00:16:14.105 --> 00:16:15.445
and at really at the Max Q.

257
00:16:15.705 --> 00:16:20.485
So we're thinking, got through that point, obviously

258
00:16:21.025 --> 00:16:22.085
we can go through there again

259
00:16:22.085 --> 00:16:24.005
and maybe we can see some things in the data

260
00:16:24.005 --> 00:16:28.165
that will allow us to, to, to data mine, if you would,

261
00:16:29.355 --> 00:16:32.765
that area where something could go wrong

262
00:16:34.105 --> 00:16:35.485
so we can understand the mechanism

263
00:16:35.585 --> 00:16:37.445
and not have all that energy in the airplane

264
00:16:37.585 --> 00:16:38.765
so that we break it again.

265
00:16:41.105 --> 00:16:44.805
So very careful build up program, very

266
00:16:45.635 --> 00:16:50.085
careful analysis of what we knew, but we really didn't know.

267
00:16:50.825 --> 00:16:53.725
Nobody knew, and we had the best fluter minds,

268
00:16:53.725 --> 00:16:55.405
I think available at the time.

269
00:16:55.465 --> 00:16:57.725
And the company involved in this, this question.

270
00:16:59.785 --> 00:17:01.445

So we were comfortable with the plan.

271
00:17:03.345 --> 00:17:07.885
So in September, February, September

272
00:17:10.055 --> 00:17:13.475
we go up and we go test again this time.

273
00:17:14.545 --> 00:17:17.235
Beautiful blue sky chase.

274
00:17:18.325 --> 00:17:19.355
We're doing all the right things,

275
00:17:19.365 --> 00:17:22.155
0.01 mock increments very carefully building up,

276
00:17:22.755 --> 00:17:24.475
trolling down through altitudes, coming back down

277
00:17:24.475 --> 00:17:28.275
to 15,000 feet until about eight four m at.

278
00:17:29.655 --> 00:17:34.555
And I can't tell you if it's premonition, if it is,

279
00:17:34.955 --> 00:17:39.075
I really was feeling something or something was changing,

280
00:17:39.175 --> 00:17:41.995
but my, in my mind, I felt something was changing.

281
00:17:42.095 --> 00:17:45.475
And we talked about what was going on for quite a while

282
00:17:46.095 --> 00:17:48.595
and about 20 minutes of discussion of

283
00:17:49.565 --> 00:17:50.805
replaying data and all that stuff.

284
00:17:50.805 --> 00:17:55.645
We said, okay, fine, we're good. Really, we're good.

285
00:18:02.065 --> 00:18:03.605
So a couple things happened here,

286
00:18:05.065 --> 00:18:07.045
and this is anybody that's flown Chase,

287
00:18:07.045 --> 00:18:08.245
this is for you guys.

288
00:18:10.995 --> 00:18:15.845
What we were doing is the Chase pilot had a camera in the

289
00:18:15.845 --> 00:18:17.325
canopy bow shooting straight up.

290
00:18:18.025 --> 00:18:20.445
And so he was flying essentially in refueling position,

291
00:18:20.445 --> 00:18:22.805
maybe a little bit ahead of that shooting, straight up the,

292
00:18:22.865 --> 00:18:24.125
uh, trailing edge of the fin.

293
00:18:26.985 --> 00:18:31.645
The F 86 didn't have the same piece of s as the E six does.

294
00:18:32.505 --> 00:18:34.365
So when we accelerated to the point,

295
00:18:35.785 --> 00:18:37.885
he really couldn't accelerate as fast as we could.

296
00:18:38.345 --> 00:18:41.645
And so his call was, I said, we cleared clear foot

297
00:18:41.645 --> 00:18:43.885

to maneuver control room says, we're clear.

298
00:18:44.745 --> 00:18:46.845
He says, I'll be there,

299
00:18:49.575 --> 00:18:51.125
clear to kick, I'll be there.

300
00:18:52.905 --> 00:18:56.125
So when I kicked in good radio discipline,

301
00:18:56.185 --> 00:18:57.885
his first call was, whoa, whoa,

302
00:18:57.885 --> 00:18:59.165
whoa, whoa, whoa, whoa, whoa.

303
00:19:05.985 --> 00:19:10.885
And I really regret missing probably some

304
00:19:10.885 --> 00:19:15.045
of the most valuable photo footage we would've ever seen,

305
00:19:15.045 --> 00:19:19.165
which would've been capturing pictorially that event.

306
00:19:21.065 --> 00:19:22.165
He was very fortunate

307
00:19:22.165 --> 00:19:24.805
because large pieces of aluminum flew right by him.

308
00:19:33.485 --> 00:19:35.945
So what the heck just happened?

309
00:19:39.685 --> 00:19:40.665
The good news is, well,

310
00:19:44.535 --> 00:19:45.505
we'd already flown it

311
00:19:51.125 --> 00:19:53.145
and as you can see, nice blue skies

312
00:19:53.375 --> 00:19:54.505
doesn't get better than that.

313
00:19:54.755 --> 00:19:58.545
Everything is fine. We land. So what happened?

314
00:19:59.965 --> 00:20:01.345
It didn't do that last time.

315
00:20:01.405 --> 00:20:05.385
If you look here, you can see hopefully trying

316
00:20:05.385 --> 00:20:06.705
to see here, right?

317
00:20:06.705 --> 00:20:09.345
There is the second flight, right there is the first flight.

318
00:20:09.925 --> 00:20:11.145
That's your stability line.

319
00:20:11.215 --> 00:20:14.025
This is negative margin, that's positive damping.

320
00:20:14.525 --> 00:20:16.105
And it wasn't out until here.

321
00:20:17.125 --> 00:20:18.345
So we have the event the first time.

322
00:20:18.365 --> 00:20:20.145
Now we're back here where we've been before.

323
00:20:21.405 --> 00:20:22.265
So what's different?

324
00:20:30.245 --> 00:20:31.705

The kick was 20 pounds stronger.

325
00:20:34.205 --> 00:20:36.905
Now, when you kick an airplane, nine to 7 0 7,

326
00:20:37.165 --> 00:20:38.305
it is really a kick.

327
00:20:38.305 --> 00:20:40.705
It's about 180 pounds, 160 pound kick,

328
00:20:41.205 --> 00:20:44.105
and you literally pull back and kick it.

329
00:20:49.075 --> 00:20:50.365
What the heck just happened?

330
00:20:50.705 --> 00:20:55.605
Why 20 pounds makes a difference. So guess what?

331
00:20:59.365 --> 00:21:01.005
I didn't have any confidence in the engineering staff.

332
00:21:01.005 --> 00:21:02.245
You guys told me it was all gonna be good.

333
00:21:02.245 --> 00:21:03.525
This was safe, wonderful.

334
00:21:05.265 --> 00:21:07.885
The good news for me at the time was I'd already

335
00:21:07.885 --> 00:21:09.045
been assigned to my next project.

336
00:21:09.145 --> 00:21:10.805
In fact, I was already involved with it.

337
00:21:11.305 --> 00:21:14.325
And I was gonna go to the UK for a couple years and go over

338
00:21:14.325 --> 00:21:16.405
and have one of those great tours that you get

339
00:21:16.405 --> 00:21:17.405
to do every once in a while.

340
00:21:17.665 --> 00:21:20.885
Go be the chief pilot in England for, for Vincent, uh, uh,

341
00:21:20.885 --> 00:21:23.405
installation and checkout production type program.

342
00:21:24.345 --> 00:21:27.405
And so somebody else was gonna have to go fly the, the,

343
00:21:27.785 --> 00:21:29.485
the final configuration, whatever that was,

344
00:21:29.625 --> 00:21:30.645
and figure out what happened.

345
00:21:32.565 --> 00:21:34.765
Parallel to this is what you have to realize,

346
00:21:35.385 --> 00:21:37.685
the engineering staff involved

347
00:21:39.315 --> 00:21:41.965
also lost confidence in their ability to predict.

348
00:21:43.835 --> 00:21:46.165
They too had that

349
00:21:46.765 --> 00:21:49.005
PTSD if you would, of the event.

350
00:21:49.585 --> 00:21:52.525
And they too were going through a lot of the things I felt.

351
00:21:58.935 --> 00:22:01.835

So what the analysis showed was that

352
00:22:03.925 --> 00:22:07.195
right there at a speed less than vd, which is a dash line,

353
00:22:07.305 --> 00:22:11.355
dash vertical line there, uh, that one mode went unstable,

354
00:22:11.495 --> 00:22:14.315
but previous predictions hadn't shown that.

355
00:22:20.165 --> 00:22:23.025
So what's different? Well, remember I mentioned that rudder,

356
00:22:23.065 --> 00:22:26.825
PCU people were really concerned

357
00:22:26.825 --> 00:22:27.985
about the difference in thrust.

358
00:22:28.135 --> 00:22:30.625
They were fair amount higher thrust than a

359
00:22:30.625 --> 00:22:31.825
normal 7 0 7 engine.

360
00:22:31.965 --> 00:22:35.065
And so the throw rates were pretty high.

361
00:22:35.765 --> 00:22:39.025
If you look at that degrees per second throw rate in the

362
00:22:39.025 --> 00:22:42.945
rudder, 65 degrees per second, that that's,

363
00:22:42.945 --> 00:22:44.105
that's a pretty good drill rate.

364
00:22:44.765 --> 00:22:46.665
Uh, 7.0 has about 40 something.

365
00:22:47.365 --> 00:22:52.225
Uh, the force, uh, opposing load is about, uh, what is that?

366
00:22:52.225 --> 00:22:54.705
20,000 pounds.

367
00:22:54.925 --> 00:22:57.625
And the for the six is about 25,000 pounds.

368
00:22:58.485 --> 00:22:59.825
So significant difference there.

369
00:23:03.165 --> 00:23:05.625
So when they finally got into the analysis,

370
00:23:05.815 --> 00:23:09.425
what they found was when they looked at the data,

371
00:23:09.485 --> 00:23:12.785
the front spa acceleration had phase lead.

372
00:23:13.525 --> 00:23:15.745
The rudder PCU piston was 90 degrees out

373
00:23:15.745 --> 00:23:17.265
of phase from the surface.

374
00:23:19.765 --> 00:23:20.985
Why? Well,

375
00:23:24.325 --> 00:23:28.945
we overpowered the structure, the rod, the PCU mounted

376
00:23:28.945 --> 00:23:30.905
to the, to the spar, vertical spar in the fin,

377
00:23:31.805 --> 00:23:33.985
and you kick the rudder, the rudder moves.

378
00:23:34.695 --> 00:23:36.945

That structure has to be stable and strong.

379
00:23:37.635 --> 00:23:41.555
While we were torquing the spar.

380
00:23:43.375 --> 00:23:46.885
And a couple things happened when you did that mechanically,

381
00:23:46.885 --> 00:23:49.085
we unlocked the, the manual tab,

382
00:23:49.735 --> 00:23:51.765
which also drove the rudder.

383
00:23:54.495 --> 00:23:57.115
And once that action happened, you get this torquing

384
00:23:57.835 --> 00:24:02.075
reactive, uh, fin deflection reacts again the other way,

385
00:24:02.575 --> 00:24:04.235
and then, uh, one cycle.

386
00:24:04.335 --> 00:24:06.035
And, and it's really on its way

387
00:24:06.035 --> 00:24:07.315
to going away at that point in time.

388
00:24:12.375 --> 00:24:13.755
So what'd they do? Well, we

389
00:24:14.695 --> 00:24:17.435
put a pressure reducer saying we can't kick it that hard.

390
00:24:20.255 --> 00:24:25.075
And they beefed up the spar and made it stronger.

391
00:24:25.895 --> 00:24:29.835
In the meantime, we delivered, uh, the airplane to the navy

392
00:24:30.135 --> 00:24:32.435
so they could all start operating with a reduced VMO.

393
00:24:32.735 --> 00:24:37.595
And, uh, that didn't significantly affect the, the mission.

394
00:24:37.815 --> 00:24:39.555
And then over time we fixed it.

395
00:24:40.615 --> 00:24:43.555
And if you look here and this, you can see in the code area,

396
00:24:43.575 --> 00:24:45.675
we cleared the entire envelope a few months later,

397
00:24:47.675 --> 00:24:48.715
18 months later.

398
00:24:53.815 --> 00:24:55.915
So what we change in our methodology,

399
00:24:56.025 --> 00:24:57.635
well, we chase everything.

400
00:24:57.855 --> 00:24:58.915
We chase everything in,

401
00:24:58.915 --> 00:25:01.315
in the first flutter series of flights.

402
00:25:02.895 --> 00:25:04.275
We make sure the weather's VFR,

403
00:25:05.775 --> 00:25:07.635
and we worked on the communication in the control room.

404
00:25:07.775 --> 00:25:09.035
We tried to deal,

405
00:25:09.265 --> 00:25:11.115

make the control room more like the airplane.

406
00:25:11.215 --> 00:25:13.115
At the time the test happened, we weren't

407
00:25:13.115 --> 00:25:14.795
as much like the, like we are today.

408
00:25:15.495 --> 00:25:19.115
We didn't consider necessarily the control room

409
00:25:19.115 --> 00:25:20.275
was actually flying with you.

410
00:25:21.975 --> 00:25:25.115
And so the, there was some discipline in the control room

411
00:25:25.115 --> 00:25:26.235
that wasn't quite the same.

412
00:25:26.815 --> 00:25:27.955
And we moved the flood track.

413
00:25:34.695 --> 00:25:36.155
So sorting myself out, I I,

414
00:25:36.795 --> 00:25:39.235
whenever I did the ax project in, in the uk

415
00:25:39.655 --> 00:25:42.155
and when I used that time to reflect

416
00:25:43.575 --> 00:25:46.195
and evaluate about every six weeks, I was coming back

417
00:25:46.195 --> 00:25:48.115
to states and I'd use that time to talk.

418
00:25:48.535 --> 00:25:50.115
I'd make a visit to Everett to talk

419
00:25:50.115 --> 00:25:53.115
to the engineering staff, to flutter staff, talk

420
00:25:53.115 --> 00:25:54.355
to my friends and colleagues

421
00:25:54.895 --> 00:25:57.195
and regain that confidence,

422
00:25:57.195 --> 00:25:58.795
if you would, in what was going on.

423
00:25:58.795 --> 00:26:02.155
Because I had some decisions to make a really big one.

424
00:26:03.135 --> 00:26:04.995
And a big part of that decision was my family

425
00:26:05.015 --> 00:26:07.475
and my wife talking together

426
00:26:08.215 --> 00:26:11.235
and Did I really wanna be a test pilot?

427
00:26:12.655 --> 00:26:14.955
And importantly, was she okay with that?

428
00:26:19.785 --> 00:26:22.475
Basically she told me, you're a test pilot.

429
00:26:23.295 --> 00:26:26.165
That's what you do. It's part of who you are.

430
00:26:29.145 --> 00:26:31.645
And I said, yeah, but you don't really mean that.

431
00:26:32.745 --> 00:26:34.405
You're just saying that to make me feel good.

432
00:26:34.745 --> 00:26:37.605

So over time I got back to where it was.

433
00:26:39.065 --> 00:26:40.885
So I came back in 92

434
00:26:43.945 --> 00:26:46.205
and at the time I wrote this paper, uh,

435
00:26:47.865 --> 00:26:51.925
I'd done nine different models of the born aircraft

436
00:26:52.065 --> 00:26:53.165
and flutter clearance.

437
00:26:54.665 --> 00:26:55.765
Worked with developing

438
00:26:55.765 --> 00:26:57.725
and training for our control room people

439
00:26:57.825 --> 00:26:59.565
and engineers, test engineers.

440
00:27:01.825 --> 00:27:05.765
And that part of me became really, really important.

441
00:27:10.345 --> 00:27:13.245
I'm gonna use this fellow title, uh, universally

442
00:27:13.245 --> 00:27:14.725
because we have tech fellows here,

443
00:27:14.785 --> 00:27:17.205
we have fellows in Society of Flight test engineer.

444
00:27:17.205 --> 00:27:19.845
We have fellows in this general test pilot in this room.

445
00:27:21.665 --> 00:27:25.765
We have a mission and a service to provide our industry.

446
00:27:27.345 --> 00:27:31.405
We need to mentor, we need to tell stories

447
00:27:31.665 --> 00:27:34.565
and past events because a lot

448
00:27:34.565 --> 00:27:37.485
of times those stories are best told out in the lobby here

449
00:27:37.585 --> 00:27:39.405
and around the drink and that sort of thing.

450
00:27:40.535 --> 00:27:42.885
Share the lessons learned through symposia,

451
00:27:43.515 --> 00:27:44.765
through events like this.

452
00:27:47.335 --> 00:27:50.665
This is a big one. You need to build relationships

453
00:27:51.415 --> 00:27:54.305
with your manager, with your engineering staff

454
00:27:55.205 --> 00:27:58.425
and your pilots be and tell those stories.

455
00:27:58.485 --> 00:28:00.425
And we have those sorts of dialogue

456
00:28:00.425 --> 00:28:02.825
because they know what the test plan says,

457
00:28:02.885 --> 00:28:04.305
but they don't know why sometimes

458
00:28:04.455 --> 00:28:07.465
because historically it's buried back somewhere,

459
00:28:09.035 --> 00:28:10.985

which is why I do what I do today.

460
00:28:12.325 --> 00:28:13.465
You need to present papers.

461
00:28:13.795 --> 00:28:18.205
We've had great papers include the emotion

462
00:28:18.205 --> 00:28:20.445
because the science is one thing.

463
00:28:21.385 --> 00:28:23.445
The science alone is not the reality

464
00:28:24.595 --> 00:28:29.525
because the bottom line is

465
00:28:29.565 --> 00:28:30.485
I really didn't understand what

466
00:28:30.485 --> 00:28:31.805
flutter was until it happened.

467
00:28:33.555 --> 00:28:34.725
Flutter flights are really cool.

468
00:28:34.725 --> 00:28:37.005
You get to go really fast, faster than anybody else goes.

469
00:28:37.075 --> 00:28:39.445
It's really noisy. Sometimes you have to really work hard

470
00:28:39.445 --> 00:28:41.045
to get to the end points, but

471
00:28:42.115 --> 00:28:43.565
what happens if something doesn't work?

472
00:28:44.155 --> 00:28:47.245
What happens if you have a bad day? I was lucky.

473
00:28:48.645 --> 00:28:50.045
I know other people that had flutter

474
00:28:50.275 --> 00:28:53.805
that woke up in parachutes, didn't know how they got there

475
00:28:54.745 --> 00:28:56.445
and other people who aren't here anymore.

476
00:28:59.355 --> 00:29:00.355
Thank you.

477
00:29:11.405 --> 00:29:14.405
Questions for Jerry? The second rot

478
00:29:14.435 --> 00:29:15.485
land in the same field?

479
00:29:18.465 --> 00:29:20.045
No, it actually is on Mount Olympus

480
00:29:20.305 --> 00:29:21.845
and we went to try to go get it

481
00:29:22.705 --> 00:29:26.845
and uh, when we had to put one, I shouldn't tell this

482
00:29:26.845 --> 00:29:28.125
around people, uh, but anyway, we had

483
00:29:28.125 --> 00:29:31.405
to put one skid on the side of a scree slope to

484
00:29:31.705 --> 00:29:34.205
and hop out with the airplane and hover on the scree slope.

485
00:29:34.585 --> 00:29:37.925
Uh, we decided that maybe when we picked it up we decided it

486
00:29:37.925 --> 00:29:39.205

was gonna be really kind of hard

487
00:29:39.205 --> 00:29:40.605
to get it in the helicopter.

488
00:29:40.865 --> 00:29:42.405
And so maybe it could just stay there.

489
00:29:47.175 --> 00:29:47.925
Other questions?

490
00:29:52.195 --> 00:29:53.765
Okay, we'll save for the technical.

491
00:30:05.725 --> 00:30:07.545
You certainly could have heard a pin drop, uh,

492
00:30:07.545 --> 00:30:10.985
as Jerry described, not only, oh,

493
00:30:11.365 --> 00:30:12.705
um, sorry.

494
00:30:14.405 --> 00:30:15.665
No, I, I think Ken Ken's just

495
00:30:15.665 --> 00:30:16.705
gonna use the microphone up here.

496
00:30:17.015 --> 00:30:19.505
Next speaker. I was saying you could have hear heard a pin

497
00:30:19.505 --> 00:30:21.905
drop when, uh, Jerry was describing that, uh,

498
00:30:21.965 --> 00:30:23.745
and including the emotion in that as well.

499
00:30:24.085 --> 00:30:27.065
Uh, excellent presentation. Thank you. Okay.

500
00:30:27.205 --> 00:30:29.345
Um, our last presentation of the day

501
00:30:29.345 --> 00:30:32.745
before the technical panel, uh, will be given by, uh,

502
00:30:32.965 --> 00:30:34.105
Ken McGillivray.

503
00:30:34.335 --> 00:30:37.105
He's a Navy captain, retired. Where are you, Ken? Here.

504
00:30:37.265 --> 00:30:38.865
Around here. There you're, okay. Great.

505
00:30:38.965 --> 00:30:42.025
Um, he currently is an adjunct faculty member.