1
00:00:01,071 --> 00:00:02,642
Greg Barnett: This injector is a

2
00:00:02,677 --> 00:00:05,673
LOX - Liquid Oxygen/Hydrogen

3
00:00:05,708 --> 00:00:07,331
injector built by the direct

4
00:00:07,366 --> 00:00:09,065
metal laser sintering process

5
00:00:09,100 --> 00:00:10,898
or DMLS process. The main thing

6
00:00:10,933 --> 00:00:13,027
we'll be monitoring here will

7
00:00:13,062 --> 00:00:14,569
be the combustion chamber

8
00:00:14,604 --> 00:00:16,131
pressure, the fuel temperatures

9
00:00:16,166 --> 00:00:17,755
for both the liquid oxygen and

10
00:00:17,790 --> 00:00:18,970
the hydrogen, and other

11
00:00:19,005 --> 00:00:20,521
pressures throughout the system

12
00:00:20,556 --> 00:00:21,746
such as the manifold pressures

13
00:00:21,781 --> 00:00:22,994

and the injectors. It's an

14
00:00:23,029 --> 00:00:24,346
important objective for the

15
00:00:24,381 --> 00:00:25,666
Space Launch System because we

16
00:00:25,701 --> 00:00:27,146
haven't tested something this

17
00:00:27,181 --> 00:00:29,091
scale before: a 20,000 pound

18
00:00:29,126 --> 00:00:30,786
thrust level. What we want to

19
00:00:30,821 --> 00:00:32,427
do is take this test data and

20
00:00:32,462 --> 00:00:33,914
compare it to test data for a

21
00:00:33,949 --> 00:00:37,290
conventional machined injector

22
00:00:37,325 --> 00:00:38,362
and see what the differences

23
00:00:38,397 --> 00:00:39,993
are in performance and what

24
00:00:40,028 --> 00:00:41,618
kind of flow differences there

25
00:00:41,653 --> 00:00:44,114
are. Traditionally, the engine

26
00:00:44,149 --> 00:00:45,738
has been one of the longest lead

27
00:00:45,773 --> 00:00:47,810
items for the vehicle. This

28
00:00:47,845 --> 00:00:50,120
process then allows the

29
00:00:50,155 --> 00:00:52,322
potential to be able to produce

30
00:00:52,357 --> 00:00:54,530
parts much faster and less

31
00:00:54,565 --> 00:00:56,130
expensively.

32
00:00:56,165 --> 00:00:57,994
Ken Cooper: We want to build

33
00:00:58,029 --> 00:00:59,425
rocket parts and test them

34
00:00:59,460 --> 00:01:00,930
with additive manufacturing

35
00:01:00,965 --> 00:01:02,298
because it's a new class of

36
00:01:02,333 --> 00:01:03,938
fabrication technology that

37
00:01:03,973 --> 00:01:05,506
really hasn't been tested out,

38
00:01:05,541 --> 00:01:06,874

but the benefits are great in

39
00:01:06,909 --> 00:01:08,602
that you can build structures

40
00:01:08,637 --> 00:01:10,169
not only that you couldn't build

41
00:01:10,204 --> 00:01:11,961
before, but you can build

42
00:01:11,996 --> 00:01:13,410
existing structures a lot faster

43
00:01:13,445 --> 00:01:15,265
and cheaper. There's a lot of

44
00:01:15,300 --> 00:01:16,986
qualification effort that goes

45
00:01:17,021 --> 00:01:18,707
into - even just testing a new

46
00:01:18,742 --> 00:01:20,674
variation on a material. Since

47
00:01:20,709 --> 00:01:22,290
this is a new manufacturing

48
00:01:22,325 --> 00:01:24,122
process, we've got to put the

49
00:01:24,157 --> 00:01:27,290
techniques down from cradle to

50
00:01:27,325 --> 00:01:28,706
grave, from the design to build

51
00:01:28,741 --> 00:01:31,059
to test to qualify to certify

52
00:01:31,094 --> 00:01:34,170
for this whole new fabrication

53
00:01:34,205 --> 00:01:36,017
technology. Marshall's goal

54
00:01:36,052 --> 00:01:38,033
with all the work we're doing

55
00:01:38,068 --> 00:01:39,514
in 3-D printing or additive

56
00:01:39,549 --> 00:01:40,954
manufacturing of rocket engine

57
00:01:40,989 --> 00:01:43,082
parts is to develop a

58
00:01:43,117 --> 00:01:44,778
collective set of guidelines

59
00:01:44,813 --> 00:01:47,138
or a handbook, so when we go

60
00:01:47,173 --> 00:01:49,106
out to American manufacturers

61
00:01:49,141 --> 00:01:50,714
or our contractors and say

62
00:01:50,749 --> 00:01:52,362
"We want a 3-D printed rocket

63
00:01:52,397 --> 00:01:54,538

engine part," they've got

64
00:01:54,573 --> 00:01:56,186
guidelines to follow so they

65
00:01:56,221 --> 00:01:58,394
know they're going to make us

66
00:01:58,429 --> 00:01:59,122
a good part. It's not to

67
00:01:59,157 --> 00:02:00,162
qualify a part, it's to qualify

68
00:02:00,197 --> 00:02:01,369
the process.

69
00:02:01,404 --> 00:02:03,098
Barnett: One of the advantages

70
00:02:03,133 --> 00:02:05,386
that additive manufacturing allows

71
00:02:05,421 --> 00:02:07,442
is it allows designers to

72
00:02:07,477 --> 00:02:09,178
incorporate complex internal

73
00:02:09,213 --> 00:02:10,690
flow geometry into the injectors

74
00:02:10,725 --> 00:02:12,690
that they would not be able to do

75
00:02:12,725 --> 00:02:14,090
with conventional machining

76
00:02:14,125 --> 00:02:16,106
processes. Conventionally, a part

77
00:02:16,141 --> 00:02:17,570
of this size, an injector of this

78
00:02:17,605 --> 00:02:19,674
size, would have hundreds of parts.

79
00:02:19,709 --> 00:02:21,050
The additive manufacturing allows

80
00:02:21,085 --> 00:02:22,786
us to do all of that in really

81
00:02:22,821 --> 00:02:25,378
two parts. We want to see if

82
00:02:25,413 --> 00:02:27,618
there is any difference in

83
00:02:27,653 --> 00:02:29,442
injector performance by

84
00:02:29,477 --> 00:02:31,002
consolidating all these parts.

85
00:02:31,037 --> 00:02:33,025
This is important for all of

86
00:02:33,060 --> 00:02:35,378
liquid propulsion systems because

87
00:02:35,413 --> 00:02:37,610
we can determine what parts are

88
00:02:37,645 --> 00:02:39,162

going to be feasible to use