1
00:00:16,630 --> 00:00:23,470
A configuration redesign of the Saturn C-I
space vehicle second, or S-IV stage, was one

2
00:00:23,470 --> 00:00:28,750
of several significant program changes occurring
during the report period April, May, June

3
00:00:28,750 --> 00:00:30,860
1961.

4
00:00:30,860 --> 00:00:40,280
Formerly, four Pratt & Whitney XLR-119 engines
were to have been used, each developing 17,500

5
00:00:40,280 --> 00:00:46,079
pounds of thrust for a stage thrust of 70,000
pounds.

6
00:00:46,079 --> 00:00:54,059
The S-IV stage will now be powered by six
Pratt & Whitney engines designated as RL-10A-3.

7
00:00:54,059 --> 00:01:00,229
Using liquid hydrogen and liquid oxygen, each
develops 15,000 pounds of thrust for a total

8
00:01:00,229 --> 00:01:05,770
stage thrust of 90,000 pounds.

9
00:01:05,770 --> 00:01:10,560
At Douglas Aircraft Company, S-IV contractor,
the effects of the engine change are being

10
00:01:10,560 --> 00:01:14,460
absorbed into the program.

11
00:01:14,460 --> 00:01:19,750
In the manufacturing area, the bulkhead segment

skins, which will be welded into the tank

12
00:01:19,750 --> 00:01:24,070
domes, were being formed on this Sheraton
stretch press.

13
00:01:24,070 --> 00:01:32,729
The stretch forming method has proven to be
the most practical, Douglas reported.

14
00:01:32,729 --> 00:01:38,789
After stretching the skins were welded on
this weld fixture and then chemically milled

15
00:01:38,789 --> 00:01:40,920
to the correct thickness.

16
00:01:40,920 --> 00:01:46,240
This operation has been altered as a result
of the engine change, since a greater internal

17
00:01:46,240 --> 00:01:49,329
tank pressure will be required.

18
00:01:49,329 --> 00:01:54,049
The chemically milled portion of the aft bulkhead
has also changed due to a different point

19
00:01:54,049 --> 00:02:00,139
of tangency of the thrust structure, dictated
by a larger engine mounting diameter requirement

20
00:02:00,139 --> 00:02:03,579
to accommodate six engines.

21
00:02:03,579 --> 00:02:08,590
Fabrication of the forward and aft interstage
panels at Douglas Long Beach Facility was

22

00:02:08,590 --> 00:02:13,240
not effected and is continuing on schedule.

23
00:02:13,240 --> 00:02:19,569
The first RL-10A-3 mockup engine was delivered
to Douglas this quarter by Pratt & Whitney

24
00:02:19,569 --> 00:02:27,560
for necessary modifications, such as addition
of a propellant utilization servo unit and

25
00:02:27,560 --> 00:02:32,610
forward and rear transducer boxes.

26
00:02:32,610 --> 00:02:37,900
Construction and modification of test facilities
at Douglas Sacramento Division were not appreciably

27
00:02:37,900 --> 00:02:41,450
effected by the engine change.

28
00:02:41,450 --> 00:02:46,480
Fabrication of the two, 90,000 gallon liquid
hydrogen storage tanks moved ahead during

29
00:02:46,480 --> 00:02:49,120
the report period.

30
00:02:49,120 --> 00:02:54,310
The inner aluminum sphere was thoroughly checked
for leaks prior to its installation into the

31
00:02:54,310 --> 00:02:56,920
outer steel half shell.

32
00:02:56,920 --> 00:03:02,650
The leak test was accomplished by pressurizing
the sphere and checking the welded seams with

33

00:03:02,650 --> 00:03:07,780
a helium detector probe.

34
00:03:07,780 --> 00:03:14,260
After leak testing, the top hemisphere of
the outer shell was put into place.

35
00:03:14,260 --> 00:03:19,550
A helium sphere burst test was conducted at
the Sacramento facility to determine the sphere’s

36
00:03:19,550 --> 00:03:22,680
biaxial strength under loaded conditions.

37
00:03:22,680 --> 00:03:28,430
The test sphere was made in the same manor
and of the same titanium material as the production

38
00:03:28,430 --> 00:03:32,910
items now being fabricated.

39
00:03:32,910 --> 00:03:40,930
The sphere was placed in a test container
and submerged in liquid hydrogen, as it will

40
00:03:40,930 --> 00:03:43,940
be in the S-IV vehicle tank.

41
00:03:43,940 --> 00:03:48,040
Helium gas was then pumped into the sphere
until burst occurred [Sound of Explosion]

42
00:03:48,040 --> 00:03:55,020
as shown in these high-speed sequences.

43
00:03:55,020 --> 00:04:02,620
Predicted burst pressure was 9,500 psi, but
the pressure reached 9,750 psi before the

44

00:04:02,620 --> 00:04:04,460
test sphere failed.

45
00:04:04,460 --> 00:04:10,170
Similar tests will be conducted on the production
spheres.

46
00:04:10,170 --> 00:04:15,150
Tests were also made of the S-IV helium heater,
which will pressurize the liquid oxygen tank

47
00:04:15,150 --> 00:04:17,450
in flight.

48
00:04:17,450 --> 00:04:23,169
After a series of cold flow tests and preliminary
hot firings, a test was run to check the chamber

49
00:04:23,169 --> 00:04:24,650
ignition time.

50
00:04:24,650 --> 00:04:32,039
A propane torch was placed outside the chamber
to ignite any escaping gas.

51
00:04:32,039 --> 00:04:37,590
At the beginning of the test, the heater ignited
normally but went out, possibly due to a fuel-rich

52
00:04:37,590 --> 00:04:38,590
mixture.

53
00:04:38,590 --> 00:04:43,510
Unfortunately, the fuel supply valves were
not shut off and the cryogenic propellants

54
00:04:43,510 --> 00:04:48,850
quickly cooled the ducting and began entering
the combustion chamber as liquids.

55
00:04:48,850 --> 00:04:51,950
The propane torch supplied an ignition source
[Sound of Explosion].

56
00:04:51,950 --> 00:04:56,950
This blowout was not a setback to the S-IV
program, however, since the heater had already

57
00:04:56,950 --> 00:05:01,830
successfully proven the concept.

58
00:05:01,830 --> 00:05:07,380
Work being done at the Marshall Space Flight
Center on S-IV included this testing of a

59
00:05:07,380 --> 00:05:14,170
dummy stage to determine its mass moment of
inertia, that is reluctance to angular acceleration

60
00:05:14,170 --> 00:05:17,680
about pitch, yaw, and roll axes.

61
00:05:17,680 --> 00:05:23,320
The test is based upon application of the
basic spring pendulum principle.

62
00:05:23,320 --> 00:05:29,650
The period of vibration for the stage suspended
on springs of known spring constants is determined

63
00:05:29,650 --> 00:05:33,320
by a photoelectric cell and electric timer.

64
00:05:33,320 --> 00:05:39,130
The mass moment of inertia is calculated from
this data plus stage weight and center of

65
00:05:39,130 --> 00:05:50,710
gravity data obtained by electronic load cells

in previous tests.

66
00:05:50,710 --> 00:05:56,400
In addition to the S-IV engine change, approval
was received this quarter for a Marshall Center

67
00:05:56,400 --> 00:06:03,710
proposal to establish a two stage vehicle
as the basic Saturn C-I.

68
00:06:03,710 --> 00:06:11,750
This eliminates for the orbital missions vehicles
the requirement for an S-V stage, shown here

69
00:06:11,750 --> 00:06:13,420
in dummy form.

70
00:06:13,420 --> 00:06:21,100
However, for special deep space missions,
a modified Centaur stage could be used.

71
00:06:21,100 --> 00:06:27,919
The S-V dummy stage will be flown on the first
four Saturn vehicles, but SA-5 and subsequent

72
00:06:27,919 --> 00:06:33,840
R&D vehicles will have no third stage.

73
00:06:33,840 --> 00:06:38,300
In order to meet structural requirements for
possible future Saturn missions, a number

74
00:06:38,300 --> 00:06:45,410
of redesigns will be incorporated in the booster
for SA-5 and subsequent vehicles.

75
00:06:45,410 --> 00:06:53,040
As shown in this one-tenth scale model, four
large fins will be attached at the tail to

76
00:06:53,040 --> 00:06:55,940
increase flight stability.

77
00:06:55,940 --> 00:07:01,570
Four so-called stub fins, actually support
structures with aerodynamic faring, will be

78
00:07:01,570 --> 00:07:05,800
incorporated to provide additional support
points.

79
00:07:05,800 --> 00:07:11,250
These eight combination arms will replace
the four retractable support arms and four

80
00:07:11,250 --> 00:07:16,510
hold down arms used in launching SA-1 through
-4.

81
00:07:16,510 --> 00:07:22,610
Tail shroud redesign for modified clover leaf
to cylindrical shape eliminates need to retract

82
00:07:22,610 --> 00:07:25,880
support arms for takeoff clearance.

83
00:07:25,880 --> 00:07:30,760
A plan to exhaust turbine gases of the four
inboard engines by means of pipes through

84
00:07:30,760 --> 00:07:39,930
the four large fins is being considered to
decrease the base heating rate.

85
00:07:39,930 --> 00:07:45,460
Another important feature of the SA-5 redesign
is the lengthening of the fuel and liquid

86
00:07:45,460 --> 00:07:52,410

oxygen tanks by approximately six feet from
fifty to fifty-six to accommodate some 100,000

87
00:07:52,410 --> 00:08:02,800
pounds more propellant for a longer burning
time.

88
00:08:02,800 --> 00:08:07,930
The S-IV stage will be attached directly to
the booster’s spider beam, thus eliminating

89
00:08:07,930 --> 00:08:11,350
need for the present upper stage adapter.

90
00:08:11,350 --> 00:08:17,030
A honeycomb faring mounted to the high beams
at forty-five degree angles will we use dot

91
00:08:17,030 --> 00:08:22,300
fare in between the two stages.

92
00:08:22,300 --> 00:08:35,180
Also mounted from the high beams are the booster’s
four retrorockets and the four antenna panels.

93
00:08:35,180 --> 00:08:39,860
Indicative of continuing research efforts
relative to Saturn, Marshall’s engineers

94
00:08:39,860 --> 00:08:45,900
have been working recently on a new method
of engine or explosives ignition known as

95
00:08:45,900 --> 00:08:53,520
the exploding bridgewire, or EDW system, designed
to replace conventional ordinance items such

96
00:08:53,520 --> 00:08:57,320
as initiators presently used.

97
00:08:57,320 --> 00:09:03,300
Possible uses of the EDW, which may have application
in the Saturn Program as well as in other

98
00:09:03,300 --> 00:09:09,210
programs, include ignition of engines on the
ground, separation of stages, ignition of

99
00:09:09,210 --> 00:09:13,080
upper stages, and ignition of retrorockets.

100
00:09:13,080 --> 00:09:17,820
Designed to increase safety to personnel,
the bridgewire is relatively insensitive to

101
00:09:17,820 --> 00:09:21,100
temperature and shock environments.

102
00:09:21,100 --> 00:09:25,700
Another safety factor is that it requires
a tremendous amount of current within a very

103
00:09:25,700 --> 00:09:30,200
short period of time to cause the bridgewire
to explode.

104
00:09:30,200 --> 00:09:36,970
The EDW firing unit has the capability of
replacing twelve safing and arming blocks.

105
00:09:36,970 --> 00:09:44,230
The current in a typical EDW will rise to
or exceed 500 amperes depending on cable length

106
00:09:44,230 --> 00:09:47,510
and type in one microsecond.

107
00:09:47,510 --> 00:09:54,630
The EDW will explode one microsecond after

the energy is applied.

108
00:09:54,630 --> 00:09:59,700
Work moved forward at the Marshall Center
this quarter on the first Saturn flight vehicle,

109
00:09:59,700 --> 00:10:02,910
SA-1, scheduled for launch in October.

110
00:10:02,910 --> 00:10:08,440
As part of the booster flight qualification
program, three static test firings were held,

111
00:10:08,440 --> 00:10:12,600
each generating some 1.3 million pounds of
thrust.

112
00:10:12,600 --> 00:10:18,230
[Sound of Engines Firing]

113
00:10:18,230 --> 00:10:27,660
A short duration test of thirty seconds was
conducted on April 29 with successful results.

114
00:10:27,660 --> 00:10:40,310
[Sound of Engines Firing]

115
00:10:40,310 --> 00:10:49,010
A second static test was accomplished on May
5, scheduled as a long duration firing.

116
00:10:49,010 --> 00:10:55,440
The test was terminated prematurely at forty-eight
seconds because of a leaking pressure pickup.

117
00:10:55,440 --> 00:11:00,100
Designed to sense hot gas pressure, the pickup
is part of the test equipment rather than

118

00:11:00,100 --> 00:11:01,370
of the booster itself.

119
00:11:01,370 --> 00:11:04,070
The problem, therefore, was considered minor.

120
00:11:04,070 --> 00:11:10,230
An investigation indicated the pickup could
be disconnected for the next firing.

121
00:11:10,230 --> 00:11:17,060
[Sound of Engines Firing]

122
00:11:17,060 --> 00:11:27,740
A third and final static test was held in
order to get a run to LOX depletion.

123
00:11:27,740 --> 00:11:34,170
This long duration firing, 112 seconds, was
successfully completed on May 11.

124
00:11:34,170 --> 00:11:38,750
The next time these powerful engines are tested,
they will actually push the mammoth Saturn

125
00:11:38,750 --> 00:11:59,209
vehicle into flight.

126
00:11:59,209 --> 00:12:06,030
The SA-1 booster was removed from the Static
Test Stand on May 25 and taken to Marshall’s

127
00:12:06,030 --> 00:12:10,899
Fabrication and Assembly Engineering Division
for necessary final modification and repair

128
00:12:10,899 --> 00:12:11,899
work.

129

00:12:11,899 --> 00:12:16,580
A final thorough six week long checkout of
this initial flight booster began on June

130
00:12:16,580 --> 00:12:19,830
12 in Quality Division.

131
00:12:19,830 --> 00:12:30,900
Preparation for shipping to Cape Canaveral
launch site is due to start in early August.

132
00:12:30,900 --> 00:12:37,371
The Saturn barge, Palaemon, has now been modified
to accommodate either and S-IV or S-V stage

133
00:12:37,371 --> 00:12:46,960
behind the booster so both can be shipped
in one trip.

134
00:12:46,960 --> 00:12:52,490
In a trial run, the Palaemon left Marshall
on April 17 carrying a booster simulator with

135
00:12:52,490 --> 00:13:01,930
water ballast and the S-V dummy stag, which
will be flown on SA-1.

136
00:13:01,930 --> 00:13:07,060
The barge reached the Cape safely on April
30, although it had been delayed several days

137
00:13:07,060 --> 00:13:17,660
after suffering minor damage in a collision
with a tanker near New Orleans.

138
00:13:17,660 --> 00:13:22,630
The Palaemon ended its return trip to home
port on May 15, to await its scheduled August

139
00:13:22,630 --> 00:13:29,940

departure date carrying to first flight booster
and dummy second stage.

140
00:13:29,940 --> 00:13:37,120
However, on June 2, the collapse of a lock
of the TVA’s Wheeler Dam, through which

141
00:13:37,120 --> 00:13:42,680
the barge passes on its Tennessee River route,
caused a quick change in plans.

142
00:13:42,680 --> 00:13:47,510
The Palaemon will now carry the Saturn stages
from Marshall to the dam where they will be

143
00:13:47,510 --> 00:13:53,240
hauled over land about a mile around the dam,
then reloaded onto a specially modified Navy

144
00:13:53,240 --> 00:13:56,089
barge for the rest of the trip.

145
00:13:56,089 --> 00:14:06,730
After the dam is repaired, the Palaemon will
make the entire voyage.

146
00:14:06,730 --> 00:14:11,519
Saturn launch equipment consisting of the
support and hold down arms and short cable

147
00:14:11,519 --> 00:14:16,800
masts underwent testing as a complete system
this quarter at Marshall.

148
00:14:16,800 --> 00:14:21,690
Individual components had been tested previously.

149
00:14:21,690 --> 00:14:26,180
The short cable masts provide electrical and
pneumatic service for the booster ad launcher

150
00:14:26,180 --> 00:14:30,600
accessories for prelaunch checkout and launch.

151
00:14:30,600 --> 00:14:35,019
Upon thrust commit, they are pneumatically
disconnected and pushed away.

152
00:14:35,019 --> 00:14:42,730
Upon disconnect, an electrical signal is sent
to the support arms to begin retraction.

153
00:14:42,730 --> 00:14:48,110
These slow motion scenes show how the system
would operate during a normal Saturn launching.

154
00:14:48,110 --> 00:14:54,829
The entire sequence takes place in four-tenths
of a second.

155
00:14:54,829 --> 00:14:59,829
This malfunction test was also run, simulating
conditions in the event the booster fails

156
00:14:59,829 --> 00:15:02,300
to generate full thrust.

157
00:15:02,300 --> 00:15:08,089
Shown in slow motion, the support arms begin
retraction then return to the support position

158
00:15:08,089 --> 00:15:11,950
without signaling the hold down arms to release
the booster.

159
00:15:11,950 --> 00:15:18,570
This action requires nine-tenths of a second.

160
00:15:18,570 --> 00:15:23,160

Following successful tests, the equipment
was sent to Cape Canaveral for installation

161
00:15:23,160 --> 00:15:30,959
on the Saturn launching pedestal in preparation
for the first firing.

162
00:15:30,959 --> 00:15:36,010
At the Saturn blockhouse, or control center,
installation of interior equipment, such as

163
00:15:36,010 --> 00:15:41,050
racks, panels, consoles, and wiring, was accomplished.

164
00:15:41,050 --> 00:15:46,810
On June 5, the two year long construction
program on the massive forty-five acre Saturn

165
00:15:46,810 --> 00:15:53,600
launch facility was declared completed and
Complex 34 was officially turned over to NASA

166
00:15:53,600 --> 00:15:58,600
by the Army Corps of Engineers.

167
00:15:58,600 --> 00:16:02,980
At the Marshall Center, work proceeded this
quarter on assembly of the booster for the

168
00:16:02,980 --> 00:16:06,120
second flight vehicle, SA-2.

169
00:16:06,120 --> 00:16:15,110
Begun in December of 1960, the booster is
slated for Quality Division checkout in August.

170
00:16:15,110 --> 00:16:22,399
Fabrication work on SA-3 is continuing with
assembly scheduled to begin July 31.

171
00:16:22,399 --> 00:16:28,660
The Saturn test booster, called SA-T, underwent
modification this quarter to make it identical

172
00:16:28,660 --> 00:16:30,290
to the SA-2.

173
00:16:30,290 --> 00:16:39,550
Following completion, a new series of static
test firings began in late June.

174
00:16:39,550 --> 00:16:45,070
Construction on Marshall’s new 204 foot
tall dynamic test tower, in which Saturn stages

175
00:16:45,070 --> 00:16:52,610
will be excited to simulate flight conditions,
was finished in mid-April.

176
00:16:52,610 --> 00:16:59,730
On May 9, the dynamic test booster, known
as SA-D-1, was emplaced in the tower.

177
00:16:59,730 --> 00:17:04,240
Assembly work on the booster was completed
here while the test facility itself was being

178
00:17:04,240 --> 00:17:13,910
instrumented.

179
00:17:13,910 --> 00:17:20,339
Early in June, the S-IV and S-V upper stages
were also installed in the tower and attached

180
00:17:20,339 --> 00:17:22,360
to the booster.

181
00:17:22,360 --> 00:17:27,290
Dynamic vibration tests conducted by the Structures

and Mechanics Division are scheduled to start

182
00:17:27,290 --> 00:17:28,640
in July.

183
00:17:28,640 --> 00:17:33,520
The stages will be filled with water to simulate
liftoff weight conditions.