



1

00:00:19,260 --> 00:00:24,770

Progress on the Saturn Space System Program during the period January, February, and March

2

00:00:24,770 --> 00:00:32,570

1961 is divided for this report into four categories dealing with the booster, or first

3

00:00:32,570 --> 00:00:42,030

stage, called S-I, the S-IV, or second stage, the S-V, or third stage of the Saturn C-I

4

00:00:42,030 --> 00:00:52,290

configuration, and facilities and equipment in support of Saturn research and development.

5

00:00:52,290 --> 00:00:56,940

The Saturn booster is under development at the George C. Marshall Space Flight Center

6

00:00:56,940 --> 00:01:03,300

in Huntsville, Alabama, which exercises over all direction of the entire Saturn Program.

7

00:01:03,300 --> 00:01:08,620

Due to the vast scope of the program, Marshall has called upon the specialized technical

8

00:01:08,620 --> 00:01:14,140

competence of four major contractors,

9

00:01:14,140 --> 00:01:21,780

Douglas Aircraft Corporation of Santa Monica, California, contractor for the S-IV,

10

00:01:21,780 --> 00:01:26,930

Convair Astronautics Division of General Dynamics of San Diego, California, which is performing

11

00:01:26,930 --> 00:01:29,300

work on S-V

12

00:01:29,300 --> 00:01:36,110

the Rocketdyne Division of North American Aviation Company at Canoga Park, California,

13

00:01:36,110 --> 00:01:43,890

which furnishes the eight H-1 engines for the Saturn booster,

14

00:01:43,890 --> 00:01:49,210

and Pratt & Whitney Division of United Aircraft at West Palm Beach, Florida, which will provide

15

00:01:49,210 --> 00:01:58,490

the liquid hydrogen engines for both the S-IV and S-V.

16

00:01:58,490 --> 00:02:03,820

Marshall and its contractors are being supported by hundreds of subcontractor firms and government

17

00:02:03,820 --> 00:02:05,070

facilities.

18

00:02:05,070 --> 00:02:10,409

S-I development work at Marshall this quarter was highlighted by completion of assembly

19

00:02:10,409 --> 00:02:15,120

of the first Saturn flight booster.

20

00:02:15,120 --> 00:02:21,310

Begun on May 28, 1960, the booster for SA-1, the initial flight vehicle, had progressed

21

00:02:21,310 --> 00:02:30,040

early this year to the point of being declared ready for checkout.

22
00:02:30,040 --> 00:02:35,340
On January 16, the twenty-two foot diameter, eighty-one foot long booster was moved from

23
00:02:35,340 --> 00:02:39,739
the assembly area the short distance to Marshall's Quality Division.

24
00:02:39,739 --> 00:02:45,569
Here the stage, which initially will generate 1.3 million pounds of thrust, was to undergo

25
00:02:45,569 --> 00:02:58,269
an exhaustive series of mechanical and electrical checkouts.

26
00:02:58,269 --> 00:03:02,989
Long before the complete booster arrived, however, Quality Division personnel had been

27
00:03:02,989 --> 00:03:10,569
checking out materials, components, subsystems, and systems designated for the vehicle.

28
00:03:10,569 --> 00:03:16,730
This Radiflow machine, for example, was used in acceptance testing of relays in semiconductors.

29
00:03:16,730 --> 00:03:22,980
The parts were placed inside and pressurized to several atmospheres in a radioactive gas.

30
00:03:22,980 --> 00:03:26,590
Pressure was removed and the parts surfaces air washed.

31
00:03:26,590 --> 00:03:31,389
With a radiation detector, the amount of gas leakage could be determined and an analysis

32

00:03:31,389 --> 00:03:38,709

made of the conductor's hermetic seals.

33

00:03:38,709 --> 00:03:44,059

This aptly named SMART machine, its initials stand for Sequential Mechanism for Automatic

34

00:03:44,059 --> 00:03:49,659

Recording and Testing, provided a functional test of all the stage's semiconductors.

35

00:03:49,659 --> 00:03:55,549

In addition, a printed record of the exact DC parameters of each item was made on IBM

36

00:03:55,549 --> 00:03:57,049

punch cards.

37

00:03:57,049 --> 00:04:08,689

These records will be most valuable in future Saturn design work.

38

00:04:08,689 --> 00:04:13,439

Another among the numerous and thorough component tests, which were run by Quality Division,

39

00:04:13,439 --> 00:04:18,239

took place in this low pressure room where every valve in the complex space vehicle was

40

00:04:18,239 --> 00:04:27,450

subjected to a precise pressure check.

41

00:04:27,450 --> 00:04:32,490

Each assembled Saturn component, such as this main measuring distributor, underwent final

42

00:04:32,490 --> 00:04:36,170

acceptance tests prior to installation on the booster.

43
00:04:36,170 --> 00:04:40,780
The distributor was functionally checked to verify that each measuring circuit was properly

44
00:04:40,780 --> 00:04:48,210
channeled and that resistance values conformed to design specifications.

45
00:04:48,210 --> 00:04:55,900
Then, after the SA-1 booster arrived at Quality Division and was position in the checkout

46
00:04:55,900 --> 00:05:01,280
area, work began on conducting a complete continuity check of the entire electrical

47
00:05:01,280 --> 00:05:04,660
system.

48
00:05:04,660 --> 00:05:09,530
A pneumatic control system was installed in a room nearby the checkout area.

49
00:05:09,530 --> 00:05:14,640
From here, as personnel monitored the operation by means of closed circuit television, the

50
00:05:14,640 --> 00:05:19,290
booster's pneumatic and hydraulic systems, such as those which actuate gimbaling of the

51
00:05:19,290 --> 00:05:27,030
four outboard engines, could be controlled for testing.

52
00:05:27,030 --> 00:05:32,381
After discovery of cracked liquid oxygen domes

in the stages Rocketdyne H-1 engines, these

53

00:05:32,381 --> 00:05:36,950

engines were removed in order to exchange domes and then reinstalled.

54

00:05:36,950 --> 00:05:45,920

Now, the SA-1 booster was ready for Test Division.

55

00:05:45,920 --> 00:05:51,960

Assembly of the second, or SA-2, flight booster, which began December 27 of last year, was

56

00:05:51,960 --> 00:05:58,940

also progressing this quarter with clustering of tanks completed.

57

00:05:58,940 --> 00:06:04,380

Assembly of a new-type booster, designated as SA-D, started March 7.

58

00:06:04,380 --> 00:06:09,180

Using components from structural tests in Structures and Mechanics Division, SA-D is

59

00:06:09,180 --> 00:06:15,840

being made for use in dynamic testing.

60

00:06:15,840 --> 00:06:21,000

The structural testing program continued during this report period with testing of this short

61

00:06:21,000 --> 00:06:26,460

booster assembly with second stage adapter attached.

62

00:06:26,460 --> 00:06:31,710

Due to height limitations imposed by presently available facilities, tanks in the booster

63

00:06:31,710 --> 00:06:38,500

test facility are only 184 inches long as compared to the actual 677.

64

00:06:38,500 --> 00:06:44,900

However, these load cylinders positioned at the same points as the booster's eight engines,

65

00:06:44,900 --> 00:06:51,080

provide accurate simulation of all static and flight loads.

66

00:06:51,080 --> 00:06:57,030

This load maintainer regulates correct pressures of hydraulic fluid to load cylinders.

67

00:06:57,030 --> 00:07:01,220

Pressure ratios are kept constant throughout the tests.

68

00:07:01,220 --> 00:07:06,810

Test information is transmitted from strain gauges, deflection indicators, and load cells

69

00:07:06,810 --> 00:07:09,930

back to data acquisition equipment.

70

00:07:09,930 --> 00:07:14,680

The information is stored on tape and then fed into a computer, which calculates and

71

00:07:14,680 --> 00:07:19,110

tabulates deflection and load data.

72

00:07:19,110 --> 00:07:24,650

During this quarter, the current series of static firing of the modified test booster,

73

00:07:24,650 --> 00:07:27,710

SA-T-1, was successfully concluded.

74
00:07:27,710 --> 00:07:33,010
When the series began in December 1960, it was estimated that six to eight firings would

75
00:07:33,010 --> 00:07:34,850
be needed.

76
00:07:34,850 --> 00:07:41,360
[Sound of Engines Firing]

77
00:07:41,360 --> 00:07:48,300
However, test objectives were declared fully satisfied after only four firings on December

78
00:07:48,300 --> 00:07:52,380
2, December 20, January 31, and February 14.

79
00:07:52,380 --> 00:07:59,110
The January and February firings were for 113 and 110 seconds duration, respectively,

80
00:07:59,110 --> 00:08:03,380
each generating approximately 1.3 million pounds of thrust.

81
00:08:03,380 --> 00:08:13,030
All eight engines were fired in each test.

82
00:08:13,030 --> 00:08:17,450
Following completion of static testing, the test booster was removed from the stand on

83
00:08:17,450 --> 00:08:23,580
March 2 in order to make way for installation of the first flight booster, SA-1, on March

84
00:08:23,580 --> 00:08:24,580

6.

85

00:08:24,580 --> 00:08:34,750

Static firing of the SA-1 booster is due in mid-April.

86

00:08:34,750 --> 00:08:39,990

The test booster was moved to the nearby Tennessee River docks and rolled aboard the Saturn barge

87

00:08:39,990 --> 00:08:44,110

in an exercise to gain experience in loading and handling techniques.

88

00:08:44,110 --> 00:08:49,620

The barge, named Palaemon, will be used later for transporting Saturn stages from Marshall

89

00:08:49,620 --> 00:08:57,420

to the launch site at Cape Canaveral.

90

00:08:57,420 --> 00:09:02,550

Carrying the booster, the Palaemon left March 15 on a successful three day trial cruise

91

00:09:02,550 --> 00:09:08,150

down river to a point near the Alabama-Tennessee boundary and back, passing through locks of

92

00:09:08,150 --> 00:09:11,610

TVA's Wheeler and Wilson dams en route.

93

00:09:11,610 --> 00:09:16,950

The test booster will be reinstalled in the static test stand shortly after removal of

94

00:09:16,950 --> 00:09:29,860

the SA-1 booster in mid-May for a new series of firings.

95
00:09:29,860 --> 00:09:35,610
Buildup of facilities and equipment in support
of Saturn research and development continued

96
00:09:35,610 --> 00:09:37,440
this quarter.

97
00:09:37,440 --> 00:09:43,010
At Marshall, the new dynamic test tower, in
which Saturn stages will be excited to simulate

98
00:09:43,010 --> 00:09:45,800
flight conditions, neared completion.

99
00:09:45,800 --> 00:09:51,990
The SA-D booster will be installed in the
tower in May and assembly finished there,

100
00:09:51,990 --> 00:09:55,700
while the test facility itself is being instrumented.

101
00:09:55,700 --> 00:10:02,430
Dynamic tests are scheduled for June.

102
00:10:02,430 --> 00:10:06,690
Electrical ground support equipment designed
to checkout and verify circuits within the

103
00:10:06,690 --> 00:10:14,450
Saturn booster was completed this quarter
by Marshall's Guidance and Control Division.

104
00:10:14,450 --> 00:10:19,560
Shown here as an entire unit, the equipment
was later moved to Quality Division where

105
00:10:19,560 --> 00:10:26,779
individual components performed SA-1 booster
checkout.

106

00:10:26,779 --> 00:10:31,860

This rack, known as the ground equipment test set, simulates electrical circuits of the

107

00:10:31,860 --> 00:10:37,210

booster and thus enables the electrical ground support equipment to be completely qualified

108

00:10:37,210 --> 00:10:43,580

prior to mating with the vehicle.

109

00:10:43,580 --> 00:10:49,060

The equipment is also used during launch to monitor and sequence countdown operations

110

00:10:49,060 --> 00:10:50,870

until liftoff.

111

00:10:50,870 --> 00:10:55,680

From Quality Division, the equipment will follow the booster to the static test stand

112

00:10:55,680 --> 00:11:00,560

and then on to Cape Canaveral.

113

00:11:00,560 --> 00:11:06,050

Saturn launch equipment consisting of four support arms and four hold down arms are not

114

00:11:06,050 --> 00:11:08,770

undergoing checkout tests at Marshall.

115

00:11:08,770 --> 00:11:16,470

They will later be installed on the launching pedestal at the Cape.

116

00:11:16,470 --> 00:11:21,980

The retractable support arms are shown in

this slow motion sequence moving to the retract

117

00:11:21,980 --> 00:11:26,160

position sixty-two inches in eight-tenths of a second.

118

00:11:26,160 --> 00:11:32,960

Retraction allows takeoff clearance for the booster's tail shroud section.

119

00:11:32,960 --> 00:11:37,930

The hold down arms then receive an electrical signal from the support arms to release the

120

00:11:37,930 --> 00:11:41,490

booster.

121

00:11:41,490 --> 00:11:46,529

At the Cape Canaveral Saturn launch site, the launch pedestal is complete except for

122

00:11:46,529 --> 00:11:55,900

the addition of the support and hold down arms and other firing accessories.

123

00:11:55,900 --> 00:12:01,010

This torus ring emplaced in February, will be used for water cooling of the launched

124

00:12:01,010 --> 00:12:05,880

and deflector during vehicle liftoff.

125

00:12:05,880 --> 00:12:09,150

The base of the umbilical tower is almost finished.

126

00:12:09,150 --> 00:12:17,330

The tower itself will not be erected until after the third Saturn flight vehicle is fired.

127

00:12:17,330 --> 00:12:19,940

Construction on the blockhouse is finished.

128

00:12:19,940 --> 00:12:23,589

Installation of interior equipment will continue through July.

129

00:12:23,589 --> 00:12:29,800

The 310 foot tall service structure is virtually complete, with installation of platforms accomplished

130

00:12:29,800 --> 00:12:31,190

this quarter.

131

00:12:31,190 --> 00:12:39,370

The RP-1 fuel storage area and liquid oxygen storage facilities will be ready by May for

132

00:12:39,370 --> 00:12:47,930

the first flow tests in which fuel and LOX will be run to the launch pedestal.

133

00:12:47,930 --> 00:12:52,300

This skimming basin will be used for collection of spilled propellants.

134

00:12:52,300 --> 00:12:58,190

Nearby, the sixty-five acre launch site, the Saturn barge dock and unloading facility has

135

00:12:58,190 --> 00:13:06,670

been completed and is ready to receive the first flight vehicle late this summer.

136

00:13:06,670 --> 00:13:12,940

The feasibility of transporting the S-IV stage and possibly the booster piggybacking on a

137

00:13:12,940 --> 00:13:17,580

C-133 is under study by Douglas Aircraft Company.

138

00:13:17,580 --> 00:13:26,570

Wind tunnel testing of this scale model is being done at NASA's Lewis Research Center.

139

00:13:26,570 --> 00:13:32,070

Also featured in detail in this quarter's film report is developmental work on the Saturn's

140

00:13:32,070 --> 00:13:37,990

second, or S-IV, stage, being accomplished by the contractor, Douglas Aircraft, at its

141

00:13:37,990 --> 00:13:42,120

facilities in California.

142

00:13:42,120 --> 00:13:47,930

This one-tenth scale model depicts the actual S-IV, approximately forty-one feet long and

143

00:13:47,930 --> 00:13:55,160

eighteen feet in diameter, as it will appear upon completion.

144

00:13:55,160 --> 00:14:03,459

Plastic cutaways reveal significant portions of vehicle structure, such as engine assembly

145

00:14:03,459 --> 00:14:08,110

and the common bulkhead and oxygen tank.

146

00:14:08,110 --> 00:14:18,510

Shown in close-up are the S-IV's retrorockets, ullage rockets, and pressurized helium spheres.

147

00:14:18,510 --> 00:14:24,149

A full-scale engineering mockup of one of the stage's four liquid hydrogen-liquid

148

00:14:24,149 --> 00:14:30,390

oxygen 17,500 pound thrust engines was received in February from Pratt & Whitney.

149

00:14:30,390 --> 00:14:38,190

A varied testing program was a vital part of Douglas' development efforts.

150

00:14:38,190 --> 00:14:42,550

Insulation testing at its Sacramento facility determined properties of insulation to be

151

00:14:42,550 --> 00:14:45,050

used in liquid hydrogen tanks.

152

00:14:45,050 --> 00:14:51,560

In this test, the insulation sample is exposed to a liquid hydrogen environment on one side

153

00:14:51,560 --> 00:14:55,490

and a high temperature provided by a hot plate on the other.

154

00:14:55,490 --> 00:15:07,800

The test is run to show heat transfer characteristics of the sample.

155

00:15:07,800 --> 00:15:13,790

Other insulation test consisted of determining the effects of vacuum jacket pressure on liquid

156

00:15:13,790 --> 00:15:18,950

hydrogen boil off rates and heat transfer coefficients with a simulated section of the

157

00:15:18,950 --> 00:15:23,040

vehicle tank to engine low pressure fuel ducting.

158

00:15:23,040 --> 00:15:28,250

Heat transfer and boil off rate data were as expected and an analysis of test results

159

00:15:28,250 --> 00:15:33,580

is being accomplished to correlate them with theories on cryogenic pumping at very low

160

00:15:33,580 --> 00:15:36,280

pressures.

161

00:15:36,280 --> 00:15:40,990

Structural testing included a compression test of an eight foot diameter, ten foot long

162

00:15:40,990 --> 00:15:46,500

cylinder, which was integrally stiffened with a Saturn S-IV waffle pattern.

163

00:15:46,500 --> 00:15:54,560

Test showed that the inner patterned buckling began at an actual compression load of 252,000

164

00:15:54,560 --> 00:15:57,860

pounds.

165

00:15:57,860 --> 00:16:02,480

Testing was initiated on a prototype model of the helium heat exchanger, which will heat

166

00:16:02,480 --> 00:16:08,120

cold helium gas during flight for pressurization of the liquid oxygen tank.

167

00:16:08,120 --> 00:16:13,060

After installation of the heat exchanger on the stand, cold flow tests of the liquid hydrogen

168

00:16:13,060 --> 00:16:18,950

began to gain experience on the transfer of liquid hydrogen between the storage tank,

169

00:16:18,950 --> 00:16:26,600

run tank, and helium heater.

170

00:16:26,600 --> 00:16:30,779

Scale model combustion engines for the Base Heating Program were received from Marquardt

171

00:16:30,779 --> 00:16:35,830

Corporation and shipped the Air Force's Arnold Engineering Development Center at Tullahoma,

172

00:16:35,830 --> 00:16:40,050

Tennessee for testing.

173

00:16:40,050 --> 00:16:44,990

Water slosh tests were conducted at the Santa Monica facility on the three foot diameter

174

00:16:44,990 --> 00:16:51,620

liquid oxygen slosh test model to find sloshing parameters and to determine optimum design

175

00:16:51,620 --> 00:16:58,620

and location of baffles for the liquid oxygen tank.

176

00:16:58,620 --> 00:17:04,260

Testing was begun on the 300 gallon cryogenic container in the interim liquid hydrogen test

177

00:17:04,260 --> 00:17:07,890

area at Santa Monica.

178

00:17:07,890 --> 00:17:12,980

The liquid hydrogen surface level has been successfully recorded using an optical tunnel

179

00:17:12,980 --> 00:17:18,280

to photograph a still well interior.

180

00:17:18,280 --> 00:17:23,290

Observation of the liquid hydrogen surface via a close circuit TV camera looking through

181

00:17:23,290 --> 00:17:29,010

a one inch Plexiglas window in the tank has also been successful.

182

00:17:29,010 --> 00:17:34,280

It is expected that liquid level determination to an accuracy of plus or minus one-eighth

183

00:17:34,280 --> 00:17:45,960

of an inch may be accomplished using a step-type gauge in conjunction with the TV setup.

184

00:17:45,960 --> 00:17:51,870

In addition to it testing program, Douglas continued manufacturing work, including fabrication

185

00:17:51,870 --> 00:17:55,040

of special tooling needed for S-IV.

186

00:17:55,040 --> 00:17:59,410

This hemispheric bulkhead weld fixture is now nearing completion.

187

00:17:59,410 --> 00:18:04,590

It will be used to weld the six hemispheric segments of the forward and aft bulkheads

188

00:18:04,590 --> 00:18:10,950

and the inner and outer domes of the common bulkhead.

189

00:18:10,950 --> 00:18:16,270

Also in the manufacturing area, a Saturn test tank was constructed to test techniques of

190

00:18:16,270 --> 00:18:19,370

installing insulation.

191

00:18:19,370 --> 00:18:29,260

The waffle pattern is identical to that employed in the S-IV liquid hydrogen tank.

192

00:18:29,260 --> 00:18:34,370

Manufacturing progress included milling and forming of the initial tank skins for the

193

00:18:34,370 --> 00:18:36,780

actual S-IV stage.

194

00:18:36,780 --> 00:18:41,770

Milling work was performed in the Santa Monica plant,

195

00:18:41,770 --> 00:18:48,750

followed by shipment of components to Douglas' El Segundo facility for the forming operation.

196

00:18:48,750 --> 00:18:55,450

As testing and manufacturing proceeded, Douglas amended its facilities to keep pace with anticipated

197

00:18:55,450 --> 00:18:56,450

development.

198

00:18:56,450 --> 00:19:01,140

For example, this permanent liquid hydrogen test facility now under construction at Santa

199

00:19:01,140 --> 00:19:05,740

Monica will enable much larger scale testing of materials.

200

00:19:05,740 --> 00:19:12,250

A hydrostatic test tower is being built, also at Santa Monica, to be used for hydrostatic

201

00:19:12,250 --> 00:19:16,700

testing of S-IV tanks.

202

00:19:16,700 --> 00:19:21,929

At the Sacramento facility, the foundation for the 90,000 gallon liquid hydrogen tanks

203

00:19:21,929 --> 00:19:29,720

has been constructed and aluminum tank sections have been received and welded to form hemispherical

204

00:19:29,720 --> 00:19:33,040

sections.

205

00:19:33,040 --> 00:19:36,830

Modifications to test stand Number 1 at Sacramento were started.

206

00:19:36,830 --> 00:19:40,370

The stand will be used initially for battleship testing.

207

00:19:40,370 --> 00:19:47,799

Modifications include installation of an overhead crane and a new exhaust deflector plate.

208

00:19:47,799 --> 00:19:52,460

Looking forward to transportation of the completed S-IV to Marshall Space Flight Center, Douglas

209

00:19:52,460 --> 00:19:59,230

is now negotiating with shipping concerns with probable movement by barge.

210

00:19:59,230 --> 00:20:05,230

At the Marshall Center, fabrication of the first dummy S-IV was completed in January

211

00:20:05,230 --> 00:20:13,300

and the stage was mechanically mated to the incomplete SA-2 booster for fitting purposes.

212

00:20:13,300 --> 00:20:18,360

Extension of Convair's S-V study contract was authorized this quarter.

213

00:20:18,360 --> 00:20:22,780

Pending evaluation, it was decided to delay development contracting.

214

00:20:22,780 --> 00:20:29,130

At the Convair plant in San Diego, fabrication of the first dummy S-V stage has been completed.

215

00:20:29,130 --> 00:20:34,850

Convair's continuing study, however, is expected to reemphasize possible Saturn use

216

00:20:34,850 --> 00:20:40,620

of the Centaur stage with minimum changes to existing hardware rather than development

217

00:20:40,620 --> 00:20:45,740

of a new S-V stage.

218

00:20:45,740 --> 00:20:53,570

Convair's dummy stage arrived at the Marshall Center in late January.

219

00:20:53,570 --> 00:20:58,660

The S-V was mechanically mated to the dummy S-IV stage, which was previously mated to

220

00:20:58,660 --> 00:21:04,340

the booster.