



1

00:00:19,320 --> 00:00:24,660

Final checkout of the second Saturn flight vehicle, SA-2, was completed during this report

2

00:00:24,660 --> 00:00:29,660

period at the Marshall Space Flight Center in preparation for its scheduled flight testing

3

00:00:29,660 --> 00:00:32,000

at Cape Canaveral next quarter.

4

00:00:32,000 --> 00:00:36,470

The recently completed pressure tests cell facility was placed into operation for the

5

00:00:36,470 --> 00:00:43,260

first time as the SA-2 booster underwent an extensive testing program in which high pressure

6

00:00:43,260 --> 00:00:49,360

air, helium, and nitrogen were used to check tanks and mechanical systems for leakage.

7

00:00:49,360 --> 00:00:54,510

Pressure levels up to 3,000 pounds per square inch above normal atmospheric pressure were

8

00:00:54,510 --> 00:01:04,239

employed in the checkout procedure.

9

00:01:04,239 --> 00:01:09,550

While SA-2 checkout continued, modification work performed at Todd Shipyard, Houston,

10

00:01:09,550 --> 00:01:14,640

Texas, on the Saturn-carrying barge, Promise, formerly named Compromise, included addition

11

00:01:14,640 --> 00:01:20,490

of an arched cargo cover, a pilot house, ballast system, crews quarters, firefighting equipment,

12

00:01:20,490 --> 00:01:26,640

and heating system.

13

00:01:26,640 --> 00:01:31,360

At Wheeler Dam on the Tennessee River, forty-eight miles from Marshall, a mammoth repair job

14

00:01:31,360 --> 00:01:36,840

neared completion on the lock which had collapsed last June, forcing a temporary change in Saturn

15

00:01:36,840 --> 00:01:38,729

transportation plans.

16

00:01:38,729 --> 00:01:44,410

The Tennessee Valley Authority announced that it hopes to reopen the lock by April 23.

17

00:01:44,410 --> 00:01:49,420

Reopening will allow resumption of normal traffic, including barges carrying Saturns,

18

00:01:49,420 --> 00:01:57,780

beginning with SA-3.

19

00:01:57,780 --> 00:02:03,180

By mid-February of this report period, the SA-2 flight vehicle had finished its checkout

20

00:02:03,180 --> 00:02:06,890

and was undergoing final preparation for shipment to the Cape.

21

00:02:06,890 --> 00:02:13,590

Like its predecessor, SA-1, this vehicle consisted of a live booster, or S-I stage, with inert

22

00:02:13,590 --> 00:02:18,239

S-IV stage, S-V stage, and payload.

23

00:02:18,239 --> 00:02:24,620

On February 16, the SA-2 dummy upper stages and payload were loaded onto the Saturn barge,

24

00:02:24,620 --> 00:02:25,620

Palaemon.

25

00:02:25,620 --> 00:02:29,540

These were carried as far as Wheeler Dam early next morning and the barge returned for the

26

00:02:29,540 --> 00:02:35,170

booster.

27

00:02:35,170 --> 00:02:49,770

Loading time for the giant booster at the Marshall dock was on ten minutes.

28

00:02:49,770 --> 00:02:54,270

At Wheeler, the units were transferred by land around the broken lock and put aboard

29

00:02:54,270 --> 00:02:57,549

the waiting Promise, which would take them the rest of the way.

30

00:02:57,549 --> 00:03:02,260

Only about an hour was needed to unload the booster, move it the one mile over land, and

31

00:03:02,260 --> 00:03:14,410

load it again.

32

00:03:14,410 --> 00:03:20,920

On February 27, the Promise reached its destination, ending a 2,200 mile voyage, which had taken

33

00:03:20,920 --> 00:03:25,700

it through waters of the Tennessee, Ohio, and Mississippi Rivers, the Gulf of Mexico,

34

00:03:25,700 --> 00:03:31,230

and the Atlantic seaboard.

35

00:03:31,230 --> 00:03:37,950

At the Cape Canaveral dock, the SA-2 stages were taken off the barge.

36

00:03:37,950 --> 00:03:42,620

After being transported over land to the launching pad about two miles away, the booster was

37

00:03:42,620 --> 00:03:56,310

erected on the launch pedestal.

38

00:03:56,310 --> 00:04:16,910

Shortly afterwards, mating of the inert S-IV stage to the booster began,

39

00:04:16,910 --> 00:04:33,479

followed by the S-V,

40

00:04:33,479 --> 00:04:45,730

and finally the payload, a Jupiter nosecone and aft section.

41

00:04:45,730 --> 00:04:51,400

The fully assembled SA-2 vehicle was ready to begin undergoing the long series of checkouts

42

00:04:51,400 --> 00:04:59,510

and preparations, which will proceed its flight testing next quarter.

43

00:04:59,510 --> 00:05:04,470

Assembly of the booster for the third Saturn flight vehicle, SA-3, was completed at the

44

00:05:04,470 --> 00:05:10,410

Marshall Center on January 8.

45

00:05:10,410 --> 00:05:21,260

And pre-static checkout of the stage was finished near the end of the report period.

46

00:05:21,260 --> 00:05:25,150

Checkout work included testing to determine mass moment of inertia.

47

00:05:25,150 --> 00:05:29,530

The test is based upon application of the basic spring pendulum principle.

48

00:05:29,530 --> 00:05:35,980

The period of vibration for the booster, suspended on springs of known spring constants, is determined

49

00:05:35,980 --> 00:05:39,300

by a photoelectric cell and electric timer.

50

00:05:39,300 --> 00:05:44,380

The mass moment of inertia is calculated from this data plus weight and center of gravity

51

00:05:44,380 --> 00:05:50,990

data obtained by electronic load cells in previous tests.

52

00:05:50,990 --> 00:06:02,430

[Sound of Engines Firing]

53

00:06:02,430 --> 00:06:09,870

A series of three static test firings was conducted during this report period with the

54

00:06:09,870 --> 00:06:15,530

SA-T-3 booster, a test stage modified to specifications of the SA-3.

55

00:06:15,530 --> 00:06:33,680

Later, this test booster was removed and the actual SA-3 installed for static firing.

56

00:06:33,680 --> 00:06:39,830

Assembly of the booster for the fourth Saturn flight vehicle, SA-4, began on January 2 and

57

00:06:39,830 --> 00:06:43,830

is expected to be completed this summer.

58

00:06:43,830 --> 00:06:50,340

Marshall's Saturn assembly area was being expanded this quarter to make it one-third

59

00:06:50,340 --> 00:06:51,810

again larger.

60

00:06:51,810 --> 00:06:55,500

The expanded area will house a new C-I assembly station.

61

00:06:55,500 --> 00:07:01,550

One of the two present stations will be converted for assembly of C-V ground test vehicles.

62

00:07:01,550 --> 00:07:07,160

The additional area will also provide more office space, a new electrical shop for cable

63

00:07:07,160 --> 00:07:13,560

assembly, and a new clean room facility for cleaning of tubes and other delicate components.

64

00:07:13,560 --> 00:07:18,080

In the Saturn fabrication area, retooling is now underway in preparation for structural

65  
00:07:18,080 --> 00:07:24,950  
fabrication of the SA-5 configuration, or Block II, tail section, spider beam assembly,

66  
00:07:24,950 --> 00:07:27,630  
instrument compartment, and second stage adapter.

67  
00:07:27,630 --> 00:07:33,030  
Work will be performed on five flight boosters plus two test boosters to be used in structural

68  
00:07:33,030 --> 00:07:40,160  
and dynamic testing programs at Marshall.

69  
00:07:40,160 --> 00:07:44,850  
Part of the shop is also being converted for research, looking toward fabrication methods

70  
00:07:44,850 --> 00:07:51,180  
to be used on the advanced, or C-V, Saturn configuration, including out of position,

71  
00:07:51,180 --> 00:07:53,710  
horizontal, and vertical welding.

72  
00:07:53,710 --> 00:08:01,150  
A full-scale mockup of the forward and aft sections of the Block II, or SA-5-type Saturn

73  
00:08:01,150 --> 00:08:06,260  
booster, is nearing completion for use by engineers in design verification and also

74  
00:08:06,260 --> 00:08:10,610  
to familiarize assembly personnel with the new configuration.

75

00:08:10,610 --> 00:08:17,580

Block II vehicles, which will test live S-IV stages and boilerplate Apollo spacecraft,

76

00:08:17,580 --> 00:08:23,389

incorporate design changes necessary to accommodate manned missions.

77

00:08:23,389 --> 00:08:29,270

Modifications include attachment of four large fins at the tail to increase flight stability.

78

00:08:29,270 --> 00:08:35,419

The launch pedestal will be modified to accept the fins.

79

00:08:35,419 --> 00:08:41,490

Four so-called stub fins, actually support structures with aerodynamic fairing, are incorporated

80

00:08:41,490 --> 00:08:43,950

to provide additional support points.

81

00:08:43,950 --> 00:08:52,240

The leading edges of three of the stubs will carry hydrogen ducts through the inside.

82

00:08:52,240 --> 00:08:58,080

Elongated fuel and LOX tanks will hold some 100,000 pounds more propellant for a longer

83

00:08:58,080 --> 00:09:00,640

burning time.

84

00:09:00,640 --> 00:09:06,180

Two large spheres filled with gaseous nitrogen will replace the forty-eight smaller spheres

85

00:09:06,180 --> 00:09:12,880

used on Block I to pressurize the booster's fuel tanks.

86  
00:09:12,880 --> 00:09:18,460  
The booster's honeycomb faring used to fare in between the booster and S-IV stage is mounted

87  
00:09:18,460 --> 00:09:22,150  
to the eye beam, as are the four retrorockets.

88  
00:09:22,150 --> 00:09:26,850  
Attaching the upper stage directly to the spider beam eliminates need for the Block

89  
00:09:26,850 --> 00:09:36,270  
I upper stage adapter.

90  
00:09:36,270 --> 00:09:41,190  
Another model, this one built to a scale of one to ten, depicts a Block II booster and

91  
00:09:41,190 --> 00:09:50,050  
a cutaway version of the S-IV stage carrying an Apollo spacecraft on top.

92  
00:09:50,050 --> 00:09:55,420  
Fabrication of the seventy and 105 inch fuel and LOX tanks for Block II Saturn vehicles

93  
00:09:55,420 --> 00:10:04,890  
is now underway by the contractor, Ling-Timco-Vought at its plant near Dallas, Texas.

94  
00:10:04,890 --> 00:10:07,170  
Manufacturing begins at this skin mill.

95  
00:10:07,170 --> 00:10:13,150  
Flat material is properly dressed prior to rolling it into cylindrical skin configurations.

96  
00:10:13,150 --> 00:10:18,650  
The tank dome bulkheads are shaped by using a technique called hydrospinning.

97  
00:10:18,650 --> 00:10:25,589  
Then, the finished units are carefully inspected for uniform thickness by using this semiautomatic

98  
00:10:25,589 --> 00:10:28,000  
vivi gauge.

99  
00:10:28,000 --> 00:10:33,190  
Prior to inline assembly, each tank section is trimmed to a specified close tolerance

100  
00:10:33,190 --> 00:10:38,060  
using this modified lathe.

101  
00:10:38,060 --> 00:10:43,370  
Z frames are uniformly spaced between the tank segments, then joined by spot welding

102  
00:10:43,370 --> 00:10:48,950  
the frames to the segments to this precision welder.

103  
00:10:48,950 --> 00:10:53,930  
To prevent assembly line bottlenecks, a portable X-ray unit is used to check the condition

104  
00:10:53,930 --> 00:10:56,000  
of smaller parts.

105  
00:10:56,000 --> 00:11:00,820  
Weld specimens and tank segments are inspected at each station point of the tank just before

106  
00:11:00,820 --> 00:11:08,200  
final cleaning and testing.

107

00:11:08,200 --> 00:11:12,860

Meticulous care is exercise during the cleaning of these LOX and fuel tanks.

108

00:11:12,860 --> 00:11:22,380

Then they are rigorously tested in the hydrostatic test stand as a final proof of overall reliability.

109

00:11:22,380 --> 00:11:27,350

Activation of Marshall's Michoud Operations Plant near New Orleans was underway this quarter.

110

00:11:27,350 --> 00:11:32,270

The huge facility is being made ready for use by Chrysler Corporation, contractor for

111

00:11:32,270 --> 00:11:38,850

production of future C-I boosters and by Boeing Company, contractor for development and production

112

00:11:38,850 --> 00:11:42,480

of the advanced Saturn booster, S-IC.

113

00:11:42,480 --> 00:11:53,970

The activation job is being done by the New Orleans firm of Gerkler, Aber, and Company.

114

00:11:53,970 --> 00:11:59,430

The work consists, generally, of inspecting, repairing, and returning to usable condition

115

00:11:59,430 --> 00:12:04,370

the vast manufacturing building, covering nearly two million square feet of floor area

116

00:12:04,370 --> 00:12:11,250

and an adjoining office building plus certain work on the grounds.

117

00:12:11,250 --> 00:12:16,959

At Douglas Aircraft Company, contractor for the S-IV stage, initial clod flow tests have

118

00:12:16,959 --> 00:12:22,580

been successfully accomplished with both liquid oxygen and liquid hydrogen.

119

00:12:22,580 --> 00:12:27,540

Designed to check out the fuel and oxidizer systems, these tests consisted of transferring

120

00:12:27,540 --> 00:12:34,750

LOX and LH2 from the storage area to the ducting and valve complexes into the battleship tank.

121

00:12:34,750 --> 00:12:39,399

All aspects of the system performed properly.

122

00:12:39,399 --> 00:12:44,610

This full-scale engineering mockup of the S-IV stage will be used to functionally check

123

00:12:44,610 --> 00:12:50,010

the vehicle's electrical system and its compatibility with ground support equipment.

124

00:12:50,010 --> 00:12:54,810

Many of the mockup's electrical wiring harnesses have been completed, and a large percentage

125

00:12:54,810 --> 00:13:04,390

of the wiring has been installed in preparation for the system's integration testing program.

126

00:13:04,390 --> 00:13:10,120

Completed in January, this hydrostatic test vehicle is the first S-IV stage using manufacturing

127

00:13:10,120 --> 00:13:13,120

techniques designed for flight vehicles.

128

00:13:13,120 --> 00:13:17,640

It is currently being put through a series of hydrostatic filling and pressurization

129

00:13:17,640 --> 00:13:21,529

test operations using water for the test liquid.

130

00:13:21,529 --> 00:13:25,480

On the final test, it will be pressurized to destruction.

131

00:13:25,480 --> 00:13:30,740

At Marshall, a comprehensive liquid hydrogen test program indicative of the increasing

132

00:13:30,740 --> 00:13:35,170

importance of LH2 was underway this quarter.

133

00:13:35,170 --> 00:13:42,110

This metal tensile strength test is conducted by immersing test samples into LH2.

134

00:13:42,110 --> 00:13:48,230

Metals used for S-Iv stage fuel tanks, transfer ducts, and fuel pumps are tested and evaluated

135

00:13:48,230 --> 00:13:51,420

by moding them in this cryostat.

136

00:13:51,420 --> 00:13:56,950

The cover is then securely attached

137

00:13:56,950 --> 00:14:04,840

and the sample is precooled, by use of liquid nitrogen, to minus 320 degrees Fahrenheit.

138

00:14:04,840 --> 00:14:10,000

After desired temperature has been obtained, the liquid nitrogen is drained and the sample

139

00:14:10,000 --> 00:14:16,660

is further cooled to minus 420 degrees by using liquid hydrogen.

140

00:14:16,660 --> 00:14:23,230

The liquid hydrogen is drained and the sample is subjected to a tensile strength test.

141

00:14:23,230 --> 00:14:27,959

Since the use of liquid hydrogen in rocket propulsion is still relatively new, extensive

142

00:14:27,959 --> 00:14:35,149

experimentation is necessary to determine its compatibility with related components.

143

00:14:35,149 --> 00:14:41,330

At another facility, liquid hydrogen pressurization tests are run to determine the effect of varying

144

00:14:41,330 --> 00:14:47,000

the temperature of the pressure and gas and drain time on the tank of the amount of pressurization

145

00:14:47,000 --> 00:14:48,940

gas required.

146

00:14:48,940 --> 00:14:55,310

LH2 is transferred from the storage area through vacuum-jacketed lines to the test tank, a

147

00:14:55,310 --> 00:15:05,470

double walled aluminum container with vacuum space between walls for insulation purposes.

148

00:15:05,470 --> 00:15:12,270

The pressurization gas is cooled by liquid nitrogen when low temperature gas is required,

149

00:15:12,270 --> 00:15:17,760

and heated by a DC current electric heater when high temperature gas is needed.

150

00:15:17,760 --> 00:15:24,720

Flow rates, temperatures, liquid level, and pressures are recorded to obtain data, which

151

00:15:24,720 --> 00:15:29,930

indicates the most efficient pressurization method.

152

00:15:29,930 --> 00:15:35,410

Another liquid hydrogen test facility is now being used to familiarize Marshall personnel

153

00:15:35,410 --> 00:15:41,450

with handling LH2 in large quantities, and will be used next quarter for static firings

154

00:15:41,450 --> 00:15:50,040

of Pratt & Whitney RL-10 liquid oxygen-liquid hydrogen engines.

155

00:15:50,040 --> 00:15:54,830

Cold flow tests, in which propellants are run through the engine but not ignited, were

156

00:15:54,830 --> 00:16:00,510

carried out this quarter to measure propellant flow rates, pressures, and other vital functions.

157

00:16:00,510 --> 00:16:06,550

Flow tests had been conducted previously to transfer the liquid hydrogen from a 7,800

158

00:16:06,550 --> 00:16:11,540

gallon trailer tank to the test stand's  
2,200 gallon run tank.

159

00:16:11,540 --> 00:16:13,540

[Sound of Steam Test]

160

00:16:13,540 --> 00:16:20,090

In conjunction with engine cold tests, steam  
evacuation system tests were also run, in

161

00:16:20,090 --> 00:16:25,709

which steam was used to pull a vacuum on the  
test stand's diffuser system, simulating

162

00:16:25,709 --> 00:16:29,790

outer space pressure conditions.

163

00:16:29,790 --> 00:16:35,260

Looking to the future, this artist's conception  
shows a new test stand scheduled to be built

164

00:16:35,260 --> 00:16:43,230

at Marshall for work with liquid oxygen-liquid  
hydrogen engines.

165

00:16:43,230 --> 00:16:48,270

This large low pressure environmental chamber  
is being used at Marshall to simulate outer

166

00:16:48,270 --> 00:16:54,029

space conditions for the RL-10 engine in a  
series of tests studying means of gasifying

167

00:16:54,029 --> 00:16:59,790

pre-ignition liquid oxygen chill down flow  
to reduce explosion hazards.

168

00:16:59,790 --> 00:17:05,610

The method being evaluated is the injection  
of gaseous nitrogen through a manifold into

169

00:17:05,610 --> 00:17:12,240

the LOX exhaust stream at the engine's nozzle exit.

170

00:17:12,240 --> 00:17:18,150

Due to ease of handling, liquid nitrogen is being used in these tests to simulate LOX.

171

00:17:18,150 --> 00:17:24,379

During flight, before engines start up, propellant flows are necessary to precool pump and feed

172

00:17:24,379 --> 00:17:25,379

lines.

173

00:17:25,379 --> 00:17:30,480

The liquid hydrogen chill down flow will be vented overboard and LOX will be exhausted

174

00:17:30,480 --> 00:17:33,649

into the booster S-IV interstage area.

175

00:17:33,649 --> 00:17:40,039

Ambient pressure there may be below the triple point of oxygen, forming solid particles.

176

00:17:40,039 --> 00:17:45,250

It is anticipated that the oxygen, whether solid or liquid, can be evaporated using the

177

00:17:45,250 --> 00:17:55,299

sensible heat from gaseous nitrogen injected just below the thrust chamber.

178

00:17:55,299 --> 00:18:00,790

This test, photographed at about three times normal speed, shows liquid nitrogen being

179

00:18:00,790 --> 00:18:02,869  
exhausted in the form of solid particles.

180

00:18:02,869 --> 00:18:10,330  
While a specified gaseous nitrogen flow rate  
is injected into the solid stream, the result

181

00:18:10,330 --> 00:18:15,889  
is a heat transfer between the gas and solid,  
causing evaporation.

182

00:18:15,889 --> 00:18:21,080  
After optimum gaseous nitrogen flow requirements  
are reached in future tests, the system will

183

00:18:21,080 --> 00:18:30,029  
be tested on a hot fire engine at Douglas  
or Pratt & Whitney.

184

00:18:30,029 --> 00:18:36,320  
Typical of continuing varied research projects  
at Marshall are experiments in magnetic forming

185

00:18:36,320 --> 00:18:40,470  
and electric discharge forming in a fluid  
state.

186

00:18:40,470 --> 00:18:46,220  
Ultrafast discharge of voltage from this capacitor  
bank and supporting circuits through this

187

00:18:46,220 --> 00:18:52,110  
large coil provides the shockwave to form  
metal into predetermined shapes.

188

00:18:52,110 --> 00:18:59,019  
In preparation for magnetic forming, a blank  
piece of metal stock is placed over the coil.

189

00:18:59,019 --> 00:19:03,350

Then the system is energized.

190

00:19:03,350 --> 00:19:09,149

Because of the overload of current, the system discharges rapidly, and the resulting shockwave

191

00:19:09,149 --> 00:19:12,640

shapes the metal stock.

192

00:19:12,640 --> 00:19:18,139

This method promises to be valuable in forming metals for advanced Saturn vehicles as well

193

00:19:18,139 --> 00:19:27,360

as providing means for making space vacuum seals and facilitating fabrication in space.

194

00:19:27,360 --> 00:19:32,960

This equipment is part of a new photographic instrumentation system, known as fiber optics,

195

00:19:32,960 --> 00:19:34,799

being developed for Saturn.

196

00:19:34,799 --> 00:19:40,239

It will be flown for the first time aboard SA-5.

197

00:19:40,239 --> 00:19:44,679

Filming during slight will be accomplished through use of a Millican instrumentation

198

00:19:44,679 --> 00:19:46,929

camera.

199

00:19:46,929 --> 00:19:52,259

The optical cable consists of a bundle of extremely fine glass fibers arranged so that

200

00:19:52,259 --> 00:19:57,230

when an image is imposed on the face of one end of the cable, the image is conducted to

201

00:19:57,230 --> 00:20:08,519

the opposite end and reconstructed on its face.

202

00:20:08,519 --> 00:20:14,490

The objective lens must be accurately focused to ensure a clear image of the subject.

203

00:20:14,490 --> 00:20:20,190

In this test, a small propeller.

204

00:20:20,190 --> 00:20:24,460

Camera lens adjustments are made by using the bursite [not sure of spelling] fixture,

205

00:20:24,460 --> 00:20:30,960

allowing for a clear picture between camera and near-end lens.

206

00:20:30,960 --> 00:20:36,809

The use of optics cables allows cable mounting other than at the point of image.

207

00:20:36,809 --> 00:20:42,000

Useful applications in flight are filming the forward sections from the booster, where

208

00:20:42,000 --> 00:20:47,549

several fields of view are required to determine rate of separation and to study behavior of

209

00:20:47,549 --> 00:20:51,190

the forward section relative to the booster.

210

00:20:51,190 --> 00:20:55,529

The camera is now filming the motion of the

solar cell driven propeller.

211

00:20:55,529 --> 00:21:00,350

The optics cable has carried the image back to the camera for film recording.

212

00:21:00,350 --> 00:21:06,039

Saturn flights will be monitored by eight of these systems.

213

00:21:06,039 --> 00:21:12,019

A new approach to attaining three phase, 400 cycle per second power from batteries, is

214

00:21:12,019 --> 00:21:14,720

being developed and refined at Marshall.

215

00:21:14,720 --> 00:21:20,970

This static converter will supply power for the ST-124 stabilized platform carried aboard

216

00:21:20,970 --> 00:21:23,529

the SA-3 vehicle.

217

00:21:23,529 --> 00:21:29,369

The circuitry consists of a frequency standard binary countdown flip flops, logic elements,

218

00:21:29,369 --> 00:21:35,629

power amplifiers, output transformers, and a magnetic amplifier-type voltage regulator.

219

00:21:35,629 --> 00:21:41,019

The static convertor has no moving parts, consequently, no mechanical wear.

220

00:21:41,019 --> 00:21:46,200

Cabling requirements are reduced as well as physical size of the battery.

221

00:21:46,200 --> 00:21:51,659

Pound for pound, the static convertor is much more efficient than a rotating convertor.

222

00:21:51,659 --> 00:21:56,289

This breadboard circuit is a higher powered version of the static convertor, and when

223

00:21:56,289 --> 00:22:00,980

properly packaged, will be used on future Saturn vehicles.

224

00:22:00,980 --> 00:22:07,029

Power transistors are used in their most efficient mode of operation, that is, as switches.

225

00:22:07,029 --> 00:22:12,679

The output voltage wave is stepped and closely follows a sin wave, having only a ten percent

226

00:22:12,679 --> 00:22:21,529

total harmonic distortion without fluttering.

227

00:22:21,529 --> 00:22:27,240

As research and development for future Saturn vehicles moved ahead at Marshall and its contractors

228

00:22:27,240 --> 00:22:34,460

across the nation, the ultimate test, actual flight, was nearing for SA-2, poised for its