



1

00:00:17,869 --> 00:00:22,910

Saturn launch vehicle film report number thirty-six combines the former separate reports on the

2

00:00:22,910 --> 00:00:26,029

Saturn IB and the Saturn V Programs.

3

00:00:26,029 --> 00:00:37,519

It cover progress during the period April, May, and June 1968.

4

00:00:37,519 --> 00:00:42,930

With delivery of the instrument unit by super guppy aircraft on April 11, all elements of

5

00:00:42,930 --> 00:00:49,760

the fifth Saturn IB flight vehicle, designated SA-205, had arrived at the Kennedy Space Center

6

00:00:49,760 --> 00:00:52,809

from the contractor production plants.

7

00:00:52,809 --> 00:01:00,020

SIU-205 was shipped from the IBM facility at Huntsville, Alabama.

8

00:01:00,020 --> 00:01:07,390

The second, or S-IV stage for SA-205 had arrived at KSC on the same airplane three days earlier

9

00:01:07,390 --> 00:01:12,590

from the McDonnell-Douglas Corporation's Sacramento test center in California.

10

00:01:12,590 --> 00:01:19,050

The first, or S-IB, stage for SA-205 had been delivered by ship from Chrysler-Michoud, New

11

00:01:19,050 --> 00:01:23,640

Orleans late last quarter.

12
00:01:23,640 --> 00:01:27,550
Erection of the vehicle, which is scheduled to launch the first manned Apollo spacecraft

13
00:01:27,550 --> 00:01:35,140
flight late this year, was begun on April 15 and completed three days later.

14
00:01:35,140 --> 00:01:40,599
Spillage of a small amount of a hypergolic oxidizer, nitrogen tetroxide, by technicians

15
00:01:40,599 --> 00:01:47,160
during a facility checkout of the spacecraft propellant loading system on April 21 necessitated

16
00:01:47,160 --> 00:01:53,190
removal of the IU and forward skirt of the S-IVB stage to allow a detailed inspection

17
00:01:53,190 --> 00:01:54,410
for corrosion.

18
00:01:54,410 --> 00:02:00,129
Only very minor damage was revealed and corrective actions were taken.

19
00:02:00,129 --> 00:02:05,910
During a neutralization flushing operation, some of the oxidizer was washed onto the vehicle's

20
00:02:05,910 --> 00:02:12,540
S-IB stage, necessitating replacement of a fin and several other first stage components.

21
00:02:12,540 --> 00:02:17,560
The IU and S-IVB forward skirt were re-erected on May 11.

22
00:02:17,560 --> 00:02:25,800
And at the end of the quarter, SA-205 prelaunch preparations were continuing on schedule.

23
00:02:25,800 --> 00:02:31,510
At the Marshall Space Flight Center prior to acceptance static testing of the S-IB-11

24
00:02:31,510 --> 00:02:38,079
stage in April, LOX pump shaft shields, both lip and bellows types, were installed in the

25
00:02:38,079 --> 00:02:43,999
stage's H-1 engines to determine the best fix for a LOX leakage problem, which last

26
00:02:43,999 --> 00:02:49,890
quarter had caused termination of an engine stability test by fire detection sensors after

27
00:02:49,890 --> 00:02:52,499
only three seconds.

28
00:02:52,499 --> 00:03:00,410
A successful short duration, thirty-five seconds, static test of S-IB-11 was conducted on April

29
00:03:00,410 --> 00:03:01,799
9.

30
00:03:01,799 --> 00:03:07,219
Inspection of LOX seals following the initial test resulted in a decision to install bellows-type

31
00:03:07,219 --> 00:03:13,930
seals on all engines for the long duration firing, 145 seconds, which was conducted on

32

00:03:13,930 --> 00:03:15,920

April 23.

33

00:03:15,920 --> 00:03:20,430

Later inspection revealed no abnormal chipping or wear.

34

00:03:20,430 --> 00:03:25,129

Bellows-type seals will now be installed on all S-IB stages.

35

00:03:25,129 --> 00:03:32,029

S-IB-5 seals will be replaced on the launch pad at KSC.

36

00:03:32,029 --> 00:03:37,719

Previously qualified LOX sensors had been installed in S-IB-11 before the acceptance

37

00:03:37,719 --> 00:03:38,719

firings.

38

00:03:38,719 --> 00:03:43,959

Designed to provide additional safety for manned flights, these sensors will shut down

39

00:03:43,959 --> 00:03:49,370

engines prior to liftoff in case of a LOX seal failure.

40

00:03:49,370 --> 00:03:57,129

S-IB-11 was returned to Michoud from Marshall on May 11 and post static repairs and modification

41

00:03:57,129 --> 00:04:01,840

are underway, scheduled for completion in late July.

42

00:04:01,840 --> 00:04:09,099

S-IB-12, the last S-IB scheduled for static

firing arrived at Marshall from Michoud on

43

00:04:09,099 --> 00:04:12,920

May 4 for acceptance firing in July.

44

00:04:12,920 --> 00:04:18,790

S-IB-12 is the last of the twelve S-IB stages authorized in the Marshall Center's first

45

00:04:18,790 --> 00:04:22,290

order with the Chrysler Corporation.

46

00:04:22,290 --> 00:04:30,130

Fabrication work on subsystems for the follow-on contract, S-IB stages thirteen through sixteen,

47

00:04:30,130 --> 00:04:35,750

was in progress at Michoud throughout the report period.

48

00:04:35,750 --> 00:04:41,961

Post storage reverification checkout of S-IB-7, a series of hydraulic, pneumatic, and electrical

49

00:04:41,961 --> 00:04:46,750

systems tests was virtually complete at Michoud in late June.

50

00:04:46,750 --> 00:04:52,349

The checkout was to ensure that the stage is still in flight ready condition.

51

00:04:52,349 --> 00:04:58,979

S-IB stages 6, 8, 9, and 10 remained in storage at Michoud.

52

00:04:58,979 --> 00:05:05,650

A new type of enclosure for housing stages and storage was successfully demonstrated

53
00:05:05,650 --> 00:05:11,650
this quarter and in July, S-IB-8 will become
the first stage to be moved into one of the

54
00:05:11,650 --> 00:05:12,880
enclosures.

55
00:05:12,880 --> 00:05:17,889
Other stages will be prepared for similar
storage as schedules allow.

56
00:05:17,889 --> 00:05:23,139
Manufactured at MSFC, the plastic enclosures
will be air conditioned to maintain the proper

57
00:05:23,139 --> 00:05:27,310
temperature and humidity environment.

58
00:05:27,310 --> 00:05:35,430
Saturn IB second, or S-IV, stage -206, -208,
and -209 remained in storage at McDonnell-Douglas

59
00:05:35,430 --> 00:05:41,199
SACTO during the quarter as did stages -210
and -211 at the contractor's Huntington

60
00:05:41,199 --> 00:05:43,169
Beach facility.

61
00:05:43,169 --> 00:05:48,849
In mid-August, -208 and -209 are slated to
be moved into the first two of eight long-term

62
00:05:48,849 --> 00:05:54,139
storage plastic containers, now being manufactured
at McDonnell-Douglas.

63
00:05:54,139 --> 00:05:57,560
Other stages will follow as schedules permit.

64
00:05:57,560 --> 00:06:02,940
S-IB-212 completed Apollo modifications in April and was placed in temporary storage

65
00:06:02,940 --> 00:06:10,000
awaiting Headquarters approval to initiate orbital workshop mods.

66
00:06:10,000 --> 00:06:15,740
Modification work begun on S-IVB-207 at SACTO last quarter is continuing with completion

67
00:06:15,740 --> 00:06:19,039
due in August.

68
00:06:19,039 --> 00:06:25,169
Saturn IB instrument units 206, 7, 8, and 9 remained in storage at IBM's Huntsville

69
00:06:25,169 --> 00:06:29,680
facility during the report period.

70
00:06:29,680 --> 00:06:34,449
Special storage stands were installed in the storage area to allow the stacking of up to

71
00:06:34,449 --> 00:06:39,879
six IUs at any one time for long-term safe keeping.

72
00:06:39,879 --> 00:06:48,810
SIU-209 was the first to be placed into one of the new storage stands in early June.

73
00:06:48,810 --> 00:06:53,400
Structural segments for SIU-211 have been removed from storage and hardware averted

74

00:06:53,400 --> 00:06:57,909

to use in a dynamic test unit at the Manned Spacecraft Center, Houston.

75

00:06:57,909 --> 00:07:03,159

Fabrication of an additional set of segments is planned for 211.

76

00:07:03,159 --> 00:07:09,570

Subsystems manufacturing continues for SIU-212.

77

00:07:09,570 --> 00:07:19,110

Highlight of Saturn V Program for the report period was the launching of the second Saturn

78

00:07:19,110 --> 00:07:26,650

V flight vehicle, designated AS-502, from Launch Complex 39 of the Kennedy Space Center

79

00:07:26,650 --> 00:07:28,639

on April 4.

80

00:07:28,639 --> 00:07:34,090

After a flawless final countdown, the vehicle lifted off smoothly from Pad A at exactly

81

00:07:34,090 --> 00:07:36,790

7AM Easter Standard Time.

82

00:07:36,790 --> 00:07:43,030

AS-502 served as launch vehicle for the Apollo 6 mission, an unmanned flight to qualify the

83

00:07:43,030 --> 00:07:46,150

Saturn V for future manned flights.

84

00:07:46,150 --> 00:07:51,659

First stage performance was as programmed except for the occurrence at T+100 seconds

85
00:07:51,659 --> 00:07:57,760
of a longitudinal vibration phenomenon referred
to as the pogo effect, which continued for

86
00:07:57,760 --> 00:08:00,190
approximately forty seconds.

87
00:08:00,190 --> 00:08:05,250
At two minutes twenty-three seconds into the
mission, the S-IC stage's center engine

88
00:08:05,250 --> 00:08:11,189
cut off as programmed, and at 2:29, the four
outboard engines cut off.

89
00:08:11,189 --> 00:08:19,810
The S-IC engines burned for 148 seconds, only
one second longer than planned.

90
00:08:19,810 --> 00:08:25,349
Second stage separation and ignition were
satisfactory and second stage performance

91
00:08:25,349 --> 00:08:32,099
was as programmed until T+215 seconds, when
the stage's number 2 engine performance

92
00:08:32,099 --> 00:08:34,070
started to degrade.

93
00:08:34,070 --> 00:08:40,479
Degradation continued until T+412 seconds
when the engine prematurely shut down.

94
00:08:40,479 --> 00:08:46,940
This was followed within two seconds by premature
cutoff of engine number 3.

95
00:08:46,940 --> 00:08:51,440

The remaining three engines burned for about fifty-nine seconds longer than programmed

96

00:08:51,440 --> 00:08:56,680

to partially compensate for the early cutoff of the other two engines.

97

00:08:56,680 --> 00:09:03,130

S-IVB stage separation and ignition occurred as scheduled and the stage met all operational

98

00:09:03,130 --> 00:09:08,820

requirements during its first burn of 170 seconds.

99

00:09:08,820 --> 00:09:13,750

Stage shutoff and orbital coast performance were also satisfactory, except for a pressure

100

00:09:13,750 --> 00:09:17,410

decay in the helium gas system.

101

00:09:17,410 --> 00:09:23,180

Stage restart procedure was normal up to and including ignition command, but the J-2 engine

102

00:09:23,180 --> 00:09:25,100

failed to restart.

103

00:09:25,100 --> 00:09:31,680

A detailed analysis of the major anomalies encountered during the AS-502 mission was

104

00:09:31,680 --> 00:09:34,410

initiated immediately after the flight.

105

00:09:34,410 --> 00:09:39,401

Although some eighty percent of the 502 mission was considered successfully achieved, the

106

00:09:39,401 --> 00:09:44,740

other twenty percent occupied the concerted attention of NASA and industry engineers throughout

107

00:09:44,740 --> 00:09:49,540

the remained of the period, seeking causes and corrections of the problems.

108

00:09:49,540 --> 00:09:54,670

The pogo effect, which occurred during first stage burn, is an up and down motion caused

109

00:09:54,670 --> 00:09:59,370

by the self-induced engine and propulsion system vibration frequencies coupling with

110

00:09:59,370 --> 00:10:04,510

the vibrational frequencies of the vehicle structure, resulting in a closed loop, ever

111

00:10:04,510 --> 00:10:09,480

increasing oscillatory system.

112

00:10:09,480 --> 00:10:14,760

Engineers studied three possible fixes for the pogo effect in the S-IC stage in an effort

113

00:10:14,760 --> 00:10:18,990

to alter the vibration frequencies of the propulsive system.

114

00:10:18,990 --> 00:10:23,690

If the pogo effect should become severe enough, it could prevent astronauts from functioning

115

00:10:23,690 --> 00:10:29,320

adequately or cause failure of the vehicle structure.

116

00:10:29,320 --> 00:10:33,850

The three fixes under consideration included addition of a helium filled accumulator to

117

00:10:33,850 --> 00:10:40,930

the F-1 engine's LOX propulsion system feed line to act as a shock absorber.

118

00:10:40,930 --> 00:10:45,430

Helium injection into the LOX propulsion system through a port on existing LOX suction line

119

00:10:45,430 --> 00:10:51,930

inlets and gaseous oxygen injection at the LOX turbopump inlet aimed at changing the

120

00:10:51,930 --> 00:10:55,920

engine's natural frequencies.

121

00:10:55,920 --> 00:11:00,810

Static firing tests of F-1 engines incorporating these fixes were underway by the Marshall

122

00:11:00,810 --> 00:11:07,290

Center and by the F-1 developer, Rocketdyne Division of North American-Rockwell at the

123

00:11:07,290 --> 00:11:10,029

Edwards test site in California.

124

00:11:10,029 --> 00:11:15,570

Extensive tests and evaluations, coupled with a math model analysis, are expected to verify

125

00:11:15,570 --> 00:11:21,010

the corrective action necessary for the pogo fix.

126

00:11:21,010 --> 00:11:28,310

J-2 engine failure tests have adequately demonstrated

the failure mode of AS-502's S-II and S-IVB

127

00:11:28,310 --> 00:11:33,610

stages as a rupture of fuel lines feeding the J-2 engine ignitors.

128

00:11:33,610 --> 00:11:37,870

Readout of 502 flight data had indicated this failure mode.

129

00:11:37,870 --> 00:11:42,670

In the case of the S-II stage, the fuel line rupture resulted in a fire, which caused the

130

00:11:42,670 --> 00:11:45,270

number 2 engine to shut down.

131

00:11:45,270 --> 00:11:50,110

In the S-IVB stage, it prevented the engine from reigniting.

132

00:11:50,110 --> 00:11:55,480

Electrical connections for engines number 2 and 3 of the S-II stage had been switched

133

00:11:55,480 --> 00:11:57,079

during modification.

134

00:11:57,079 --> 00:12:03,079

As a result, during flight, the oxidizer cutoff signal for the damaged engine, number 2, was

135

00:12:03,079 --> 00:12:08,440

erroneously received by engine number 3.

136

00:12:08,440 --> 00:12:13,170

Improved designs for the rupture fuel lines have been completed and new lines are being

137

00:12:13,170 --> 00:12:14,170
manufactured.

138

00:12:14,170 --> 00:12:19,029
The lines are made of stainless steel tubing
without the three flexible bellows sections

139

00:12:19,029 --> 00:12:21,850
believed to have weakened the former design.

140

00:12:21,850 --> 00:12:28,089
The new lines are being installed on all S-II
and S-IVB stages.

141

00:12:28,089 --> 00:12:34,870
A special cryogenic loading test of the S-IVB-505
stage at SACTO was part of investigations

142

00:12:34,870 --> 00:12:41,339
by McDonnell-Douglas and MSFC into the pressure
decay problem in the S-IVB cold helium gas

143

00:12:41,339 --> 00:12:44,880
system during the AS-502 flight.

144

00:12:44,880 --> 00:12:49,440
Although the pressure loss was not considered
enough to preclude engine's second burn,

145

00:12:49,440 --> 00:12:57,009
it was determined that some helium leakage
did occur around certain mechanical connections.

146

00:12:57,009 --> 00:13:02,240
As a precautionary measure, Teflon covered
conoseals will replace the present uncoated

147

00:13:02,240 --> 00:13:10,199
seals and additional torque check requirements
will be placed on all S-IVB stages.

148

00:13:10,199 --> 00:13:16,100

The scheduled launch late this year of the third Saturn V flight vehicle, AS-503, which

149

00:13:16,100 --> 00:13:24,000

was erected at KSC last quarter, is not expected to be adversely effected by the AS-502 investigations.

150

00:13:24,000 --> 00:13:29,520

If all problem areas are resolved as anticipated, then a decision very likely will be made to

151

00:13:29,520 --> 00:13:33,980

man the Apollo spacecraft to be launched by 503.

152

00:13:33,980 --> 00:13:41,350

Consequently, the -503 vehicle was partially de-erected early this quarter and the S-II

153

00:13:41,350 --> 00:13:46,019

stage was returned to the Mississippi Test Facility for cryogenic testing required for

154

00:13:46,019 --> 00:13:47,570

man rating.

155

00:13:47,570 --> 00:13:53,130

Selected guidance components of the instrument unit were pulled and returned to IBM Huntsville

156

00:13:53,130 --> 00:13:55,990

for modification to support a manned mission.

157

00:13:55,990 --> 00:14:00,779

By the end of the quarter, these mods had been completed and the components delivered

158

00:14:00,779 --> 00:14:01,779
again to KSC.

159

00:14:01,779 --> 00:14:08,350
The S-II-3 stage arrived at MTF on May 5.

160

00:14:08,350 --> 00:14:13,720
Pretest inspection of liquid hydrogen tank
welds was completed four days later and the

161

00:14:13,720 --> 00:14:16,810
stage was installed in the test stand on May
11.

162

00:14:16,810 --> 00:14:20,889
The cryogenic proof test was successfully
completed on June 9.

163

00:14:20,889 --> 00:14:29,390
The stage was returned to KSC on June 27 and
expected to be restacked by late July.

164

00:14:29,390 --> 00:14:36,279
The S-II stage for the fourth Saturn V flight
vehicle, AS-504, arrived at KSC on May 15

165

00:14:36,279 --> 00:14:38,130
from MTF.

166

00:14:38,130 --> 00:14:44,190
Delivery of the vehicle's S-IC stage, S-IVB
stage, and instrument unit will be delayed

167

00:14:44,190 --> 00:14:49,870
until late August based on KSC's need date.

168

00:14:49,870 --> 00:14:55,810
The S-IC-4 stage continued to undergo mod
work by the contractor, Boeing-Michoud, During

169

00:14:55,810 --> 00:14:57,839

this report period.

170

00:14:57,839 --> 00:15:05,360

S-IC-5 has been placed in temporary storage with post static checkout due early next quarter

171

00:15:05,360 --> 00:15:09,410

and shipment to KSC in late October.

172

00:15:09,410 --> 00:15:16,380

Cryogenic pressure testing of the S-II-5 stage was performed at MTF during this quarter,

173

00:15:16,380 --> 00:15:23,620

and shipment to KSC is due in October after completion of captive firing.

174

00:15:23,620 --> 00:15:28,580

In the three part S-II lightweight structural test program, during testing of the C structure

175

00:15:28,580 --> 00:15:35,550

at the Marshall Center, a failure occurred around the number 3 engine block area at 124

176

00:15:35,550 --> 00:15:40,440

percent load condition of the 130 percent load, which is required.

177

00:15:40,440 --> 00:15:44,959

The lower inner and outer cap rings of the thrust structure, as well as several stiffeners

178

00:15:44,959 --> 00:15:49,220

and rivets, were broken.

179

00:15:49,220 --> 00:15:54,720

Repair of the failed area of the C structure,

which is made up of an S-II-4-type aft skirt,

180

00:15:54,720 --> 00:15:59,139

thrust cone, and center engine beam, is now underway.

181

00:15:59,139 --> 00:16:03,360

Analysis of failure has indicated a rivet material problem may exist.

182

00:16:03,360 --> 00:16:08,060

Flight fixes, such as doublers to increase thickness, will be installed next quarter

183

00:16:08,060 --> 00:16:12,410

and the structure will then be retested.

184

00:16:12,410 --> 00:16:18,540

Another S-II test item, the A structure, consisting of an S-II-4 -type LOX tank, aft skirt, and

185

00:16:18,540 --> 00:16:25,680

cylinders 1 and 2, was installed in a test stand at Marshall in May, and testing in underway.

186

00:16:25,680 --> 00:16:27,889

Results so far are satisfactory.

187

00:16:27,889 --> 00:16:31,639

The tests will continue into the next quarter.

188

00:16:31,639 --> 00:16:38,480

Similar testing of the B structure, an S-IV-2-type upper tank section, forward dome, and forward

189

00:16:38,480 --> 00:16:46,690

skirt, is also continuing at North American-Rockwell's Santa Susana facility.

190

00:16:46,690 --> 00:16:53,670

Installation of the S-IVB-504 LOX tank non-propulsive vent system, which will eliminate the necessity

191

00:16:53,670 --> 00:16:58,269

of going through specific vent schedules during the flight sequence, was accomplished this

192

00:16:58,269 --> 00:17:00,230

quarter at SACTO.

193

00:17:00,230 --> 00:17:06,760

The system had been installed on S-IVB-503 at KSC last quarter and will later be installed

194

00:17:06,760 --> 00:17:11,080

on all S-IVB stages.

195

00:17:11,080 --> 00:17:16,790

The third post-static checkout and modifications were completed on the S-IVB-5 stage in late

196

00:17:16,790 --> 00:17:19,580

May.

197

00:17:19,580 --> 00:17:24,630

The instrument unit for the fourth Saturn V flight vehicle underwent retrofit operations

198

00:17:24,630 --> 00:17:28,780

during the quarter at IBM Huntsville.

199

00:17:28,780 --> 00:17:34,770

SIU-505 completed systems testing and began mod kitting.

200

00:17:34,770 --> 00:17:39,480

Instrument units in stages for subsequent Saturn V flight vehicles are continuing in

201

00:17:39,480 --> 00:17:45,700

various phases of fabrication, assembly, checkout, and testing at the various NASA contractor

202

00:17:45,700 --> 00:17:48,929

facilities.

203

00:17:48,929 --> 00:17:54,290

The highlight of this report period, the launching of the second Saturn V flight vehicle was

204

00:17:54,290 --> 00:17:59,430

indicative of both the progress achieved and the problems encountered in NASA's Saturn

205

00:17:59,430 --> 00:18:01,660

Launch Vehicle Program.

206

00:18:01,660 --> 00:18:07,409

By the close of the quarter, NASA and industry's intensive search for solutions to those problems

207

00:18:07,409 --> 00:18:13,220

in both Saturn V and the Saturn IB was already bearing results, which promised confidence