

NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

June 30, 2016

Turbine Engine Monitor and Limiter

Specialist's Factual Report
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1. EVENT SUMMARY

Location: Monroe, Nebraska
Date: August 27, 2015
Aircraft: Air Tractor, AT-502B
Registration: N61267
NTSB Number: CEN15LA389

On August 27, 2015, about 1200 central daylight time, an Air Tractor, AT-502B, single-engine turboprop airplane, N61267, had a partial loss of engine power during low-altitude maneuvering flight and impacted terrain near Monroe, Nebraska. The pilot was not injured. The airplane sustained substantial damage to both wings, and to the horizontal stabilizer and elevator. The airplane was registered to, and was operated by Red Willow Aviation Spraying, Inc. McCook, Nebraska, as a 14 *Code of Federal Regulations* Part 137 agricultural application flight. Day visual meteorological conditions prevailed at the accident site and a flight plan had not been filed for the local flight which had departed about 1130 from Genoa Municipal Airport (97Y), Genoa, Nebraska.

2. RECORDED FLIGHT DATA GROUP

A recorded flight data group was not convened.

3. DETAILS OF FLIGHT DATA INVESTIGATION

The National Transportation Safety Board's Vehicle Recorder Division received the following devices:

Recorder Manufacturer:	USB thumb drive
Recorder Serial Number:	N/A
Recorder Manufacturer/Model:	VR Avionics TSLM-M601
Recorder Serial Number:	6006

The USB thumb drive contained GPS data from a Satloc Bantam onboard GPS device; however, the data files present in the USB drive did not include the accident flight. The last recorded flight appeared to be on May 16, 2015. No further efforts were pursued to extract additional data from the onboard device.

A screen capable of displaying data recorded by the TSLM was also received; however, this unit does not record data and no work was performed on this device.

3.1. VR Avionics TSLM-M601

The VR Avionics Turbine Start Limit and Monitor (TSLM) is an automated start controller with integrated engine limiting functions during startup and beta mode. The unit contains three functions for gas turbine operations¹:

- Start Sequence Controller
- Engine Protection Limiter
- Engine Monitor/Data Recorder

The TSLM monitors Internal Turbine Temperature (ITT), N1, N2, torque, oil pressure and bus voltage. The device records under two circumstances: at engine startup and at parameter exceedance events. An exceedance event is defined as: a monitored parameter goes over a defined limit and recording continues until the exceedance goes under the limit for a duration of 5 seconds. Data is recorded at a rate of 10 samples per second (10Hz).

3.1.1. Recorder Condition

An external examination of the device showed no signs of damage. The device was powered normally and the data was downloaded using the manufacturer's recommended procedure.



Figure 1. VR Avionics TSLM as received.

¹ Further information regarding TSLM operations can be found in the installation and user manual available on the website www.vravionics.com.

3.1.2. Recording Description

The data downloaded contained 74 recorded events with a total device time of 1154.40 hours. The last successful engine start was observed to be at a flight time of 1151.78 hours and starting at event 61. Table 1 lists the events, duration of recording, and their associated flight times during the last successful engine start.

Table 1. Event Summary.

Event Number	Type	Duration (seconds)	Flight Time (hours)
61	Engine Start	30	1511.78
62	Exceed	61.7	1151.79
63	Exceed	58.4	1152.13
64	Exceed	43.6	1152.58
65	Exceed	41.2	1152.88
66	Exceed	50.5	1153.14
67	Exceed	7	1153.16
68	Exceed	12.9	1153.17
69	Exceed	15.8	1153.18
70	Exceed	94	1153.18
71	Exceed	50.1	1153.49
72	Exceed	56.5	1153.90
73	Exceed	58.2	1154.21
74	Exceed	6.4	1154.40

3.2. Time Correlation

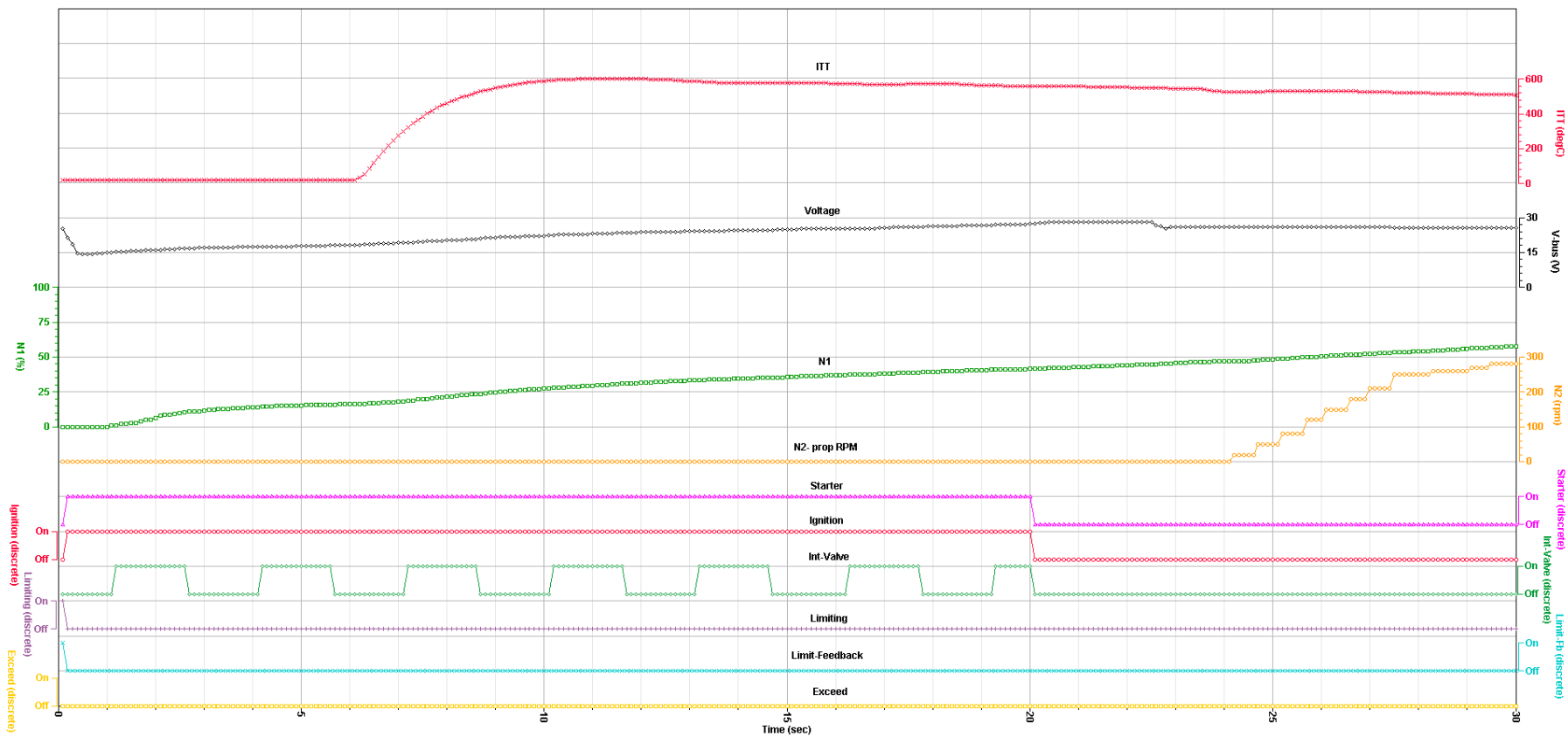
The TSLM records time based on operational time. No additional data existed to correlate the time to local time.

3.3. Plots and Corresponding Tabular Data

The following two plots contain data recorded by the TSLM. Figure 2 is a plot of the TSLM engine startup, event number 61. Figure 3 is a plot of the TSLM exceedance event number 74, triggered by the N1 parameter being above the user set upper limit. The exceedance ended 1.5 seconds into the event. Following the exceedance discrete changing to zero, the ITT, propeller RPM (N2), and N1, decrease over time, consistent with a lower power output by the engine.

The corresponding tabular data used to create Figures 2 and 3 are provided in electronic (*.csv²) format as attachment 1 to this report, respectively.

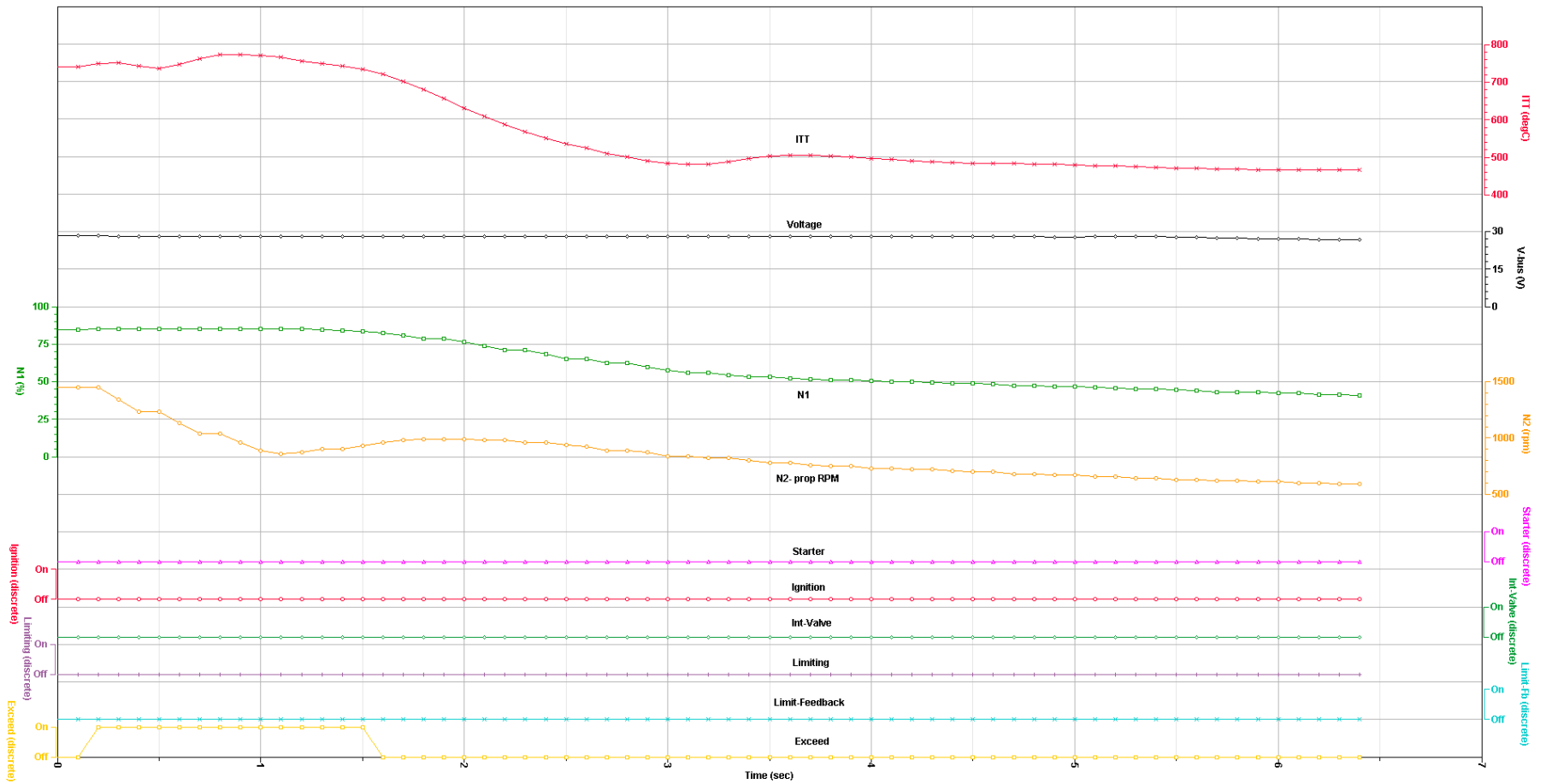
² Comma Separated Value format.



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Figure 2. Plot of TSLM recorded parameters during engine startup.



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Figure 3. Plot of TSLM recorded parameters during event 74.

APPENDIX A

This appendix describes the parameters provided and verified in this report. Table A-1 lists the parameters and table A-2 describes the unit abbreviations used in this report.

Table A-1. Verified and provided parameters.

Parameter Name	Parameter Description
1. ITT (degC)	Engine Inter Turbine Temperature
2. N1 (%RPM)	Engine Gas Generator Speed
3. N2 (rpm)	Engine Propeller Speed
4. Volt (V)	Battery Voltage
5. Exceed (discrete)	Exceedance detected
6. Int-Valve (discrete)	Start Interrupter Valve
7. Starter Motor (discrete)	Engine Starter Motor
8. Ignition (discrete)	Engine Ignition
9. Limit (discrete)	TSLM activated engine limiting
10. Limit –Fb (discrete)	TSLM activated engine limiting feedback line

Table A-2. Unit abbreviations.

Units Abbreviation	Description
degC	degrees celsius
%RPM	percent revolutions per minute
rpm	revolutions per minute
discrete	discrete
V	voltage

NOTE: For parameters with a unit description of discrete, a discrete is typically a 1-bit parameter that is either a 0 state or a 1 state where each state is uniquely defined for each parameter.