

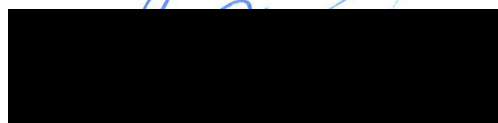


VAN HORN AVIATION, L.L.C.
Tempe, Arizona

RECOVERED DATA ANALYSIS
ACCIDENT WPR19FA109
REPORT WPR19FA109-VHA-001

May 13, 2019

PREPARED BY:



James R. Van Horn

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- 1. INTRODUCTION**

On April 16, 2019, Bell model 206B helicopter N61PH, serial number 3282 crashed while conducting an experimental test flight. The purpose of the flight was to acquire flight loads data on main rotor blades being developed by Van Horn Aviation, LLC (VHA). The flight was conducted as part of FAA STC Project ST17172LA-R under flight test plan 206B-MR-FTP-301 Flight Strain Survey. Installed on the helicopter were two main rotor blade assemblies part number 2063500-501. Serial numbers A001 and A002 were conformed to FAA approved data. The rotor blade installations on the helicopter were conformed. Serial number A001 was instrumented using strain gages to measure blade loads in flight. Measured loads were flap bending, chord bending, and torsion at several stations along the span of the blade.
- 2. DATA ACQUISITION SYSTEM**

Rotating data are acquired using an Advanced Telemetry International rotating telemetry system. Data are transmitted from the telemetry system to the Cosworth data logger located in the helicopter's passenger compartment. Data are transmitted via FM radio signal. The data logger continuously acquires data as soon as power is supplied to the system. Data are streamed real time to the flight test engineer's laptop computer. The flight test engineer occupies the left seat of the helicopter. When commanded by the flight test engineer using a "start recording" button, data may be saved to a file on the data logger. When a "stop recording" command is sent, the data are transferred from the data logger to the laptop's hard drive. The files' title is the date and time the file was created.
- 3. FLIGHT CARDS**

Flight cards are prepared for each test flight. They list the maneuvers that will be performed during the test flight. The maneuver table below, with highlighting, was taken directly from the flight test folder on VHA's server. It was written by the flight test engineer. The file is labeled "Flight Card – 20635000-501 Autorotation Maneuvers – High Altitude Optimized". Optimized is interpreted as meaning that the maneuvers were arranged to allow as many maneuvers as possible to be performed during each autorotative descent. While the flight card is labeled as "high altitude", each maneuver calls for the altitude to be 3000 ft.(low altitude). High altitude maneuvers are performed at 9000 ft. Recorded data and radar data confirm that the maneuvers were performed at low altitude

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Cond. No.	MANEUVER	A/S	FILE	Duration Definition
	Ground zero			
59	Autorotation entry – 3000 ft.	V_{NE} (auto) 100 kt.		Time starts with the reduction of pitch and throttle and ends when stabilized autorotation is established.
44	Autorotation – 3000 ft. steady state descent at 90% Nr.	V_{NE} (auto) 100 kt.		Time is a typical section of the steady state descent.
47	Autorotation – 3000 ft. right turn at 90% Nr.	V_{NE} (auto) 100 kt.		Time starts at the entry to the turn and ends when stabilized autorotation is resumed. Maneuver limit to be 45° bank angle or blade stall.
46	Power recovery from autorotation – 3000 ft. at 90% to 107% Nr.	60 kt.		Time starts with the increase in collective pitch and ends when level flight is obtained.
49	Autorotation – 3000 ft. left turn at 90% Nr.	V_{NE} (auto) 100 kt.		Same as 47
57	Autorotation – 3000 ft. cyclic and collective pull-up at 90% Nr.	.9 V_{NE} (auto) 90 kt.		Time starts with the control application and ends when stabilized autorotation is resumed. The maneuver is performed with simultaneous pull on both the cyclic and collective. Max G.
45	Autorotation – 3000 ft. steady state descent at 107% Nr or collective full down.	V_{NE} (auto) 100 kt.		Time is a typical section of the steady state descent.
48	Autorotation – 3000 ft. right turn at 107% Nr or collective full down.	V_{NE} (auto) 100 kt.		Same as 47
58	Autorotation – 3000 ft. cyclic and collective pull-up at 107% Nr.	.9 V_{NE} (auto) 90 kt.		Same as 57
51	Autorotation – 3000 ft. lateral reversal $\pm 15\%$. 1.0 sec ± 0.5 sec at 90% Nr.	V_{NE} (auto) 100 kt.		Time starts at the start of the reversal and ends when stabilized autorotation is resumed. The maneuver is performed stick right, neutral, left, neutral.
53	Autorotation – 3000 ft. longitudinal reversal $\pm 15\%$. 1.0 sec ± 0.5 sec at 90% Nr.	V_{NE} (auto) 100 kt.		Time starts at the start of the reversal and ends when stabilized autorotation is resumed. The

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				maneuver is performed stick forward, neutral, aft, neutral.
55	Autorotation – 3000 ft. pedal reversal $\pm 15\%$. 1.0 sec ± 0.5 sec at 90% Nr.	V_{NE} (auto) 100 kt.		Time starts at the start of the reversal and ends when stabilized autorotation is resumed. The maneuver is performed pedal right, neutral, left, neutral.
52	Autorotation – 3000 ft. lateral reversal $\pm 15\%$. 1.0 sec ± 0.5 sec at 107% Nr.	V_{NE} (auto) 100 kt.		Same as 51
54	Autorotation – 3000 ft. longitudinal reversal $\pm 15\%$. 1.0 sec ± 0.5 sec at 107% Nr.	V_{NE} (auto) 100 kt.		Same as 53
56	Autorotation – 3000 ft. pedal reversal $\pm 15\%$. 1.0 sec ± 0.5 sec at 107% Nr.	V_{NE} (auto) 100 kt.		Same as 55
43	Simulated power failure – 3000 ft. one second delay.	V_{NE} (auto) 100 kt.		Time starts when the throttle is rolled off and ends in a stabilized autorotation.
50	Autorotation – 3000 ft. left turn at 107% Nr or collective full down.	V_{NE} (auto) 100 kt.		Same as 47

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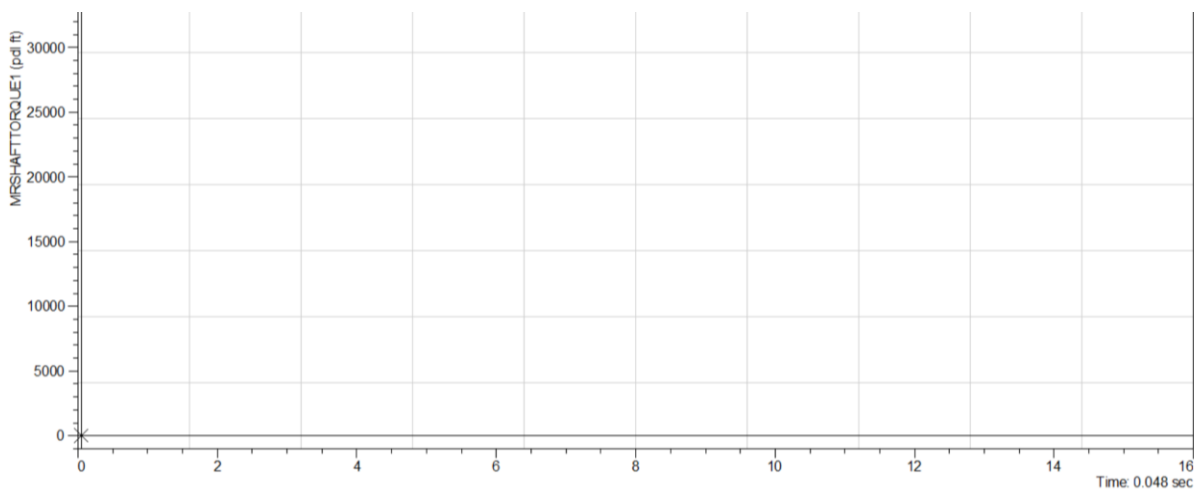
5. DATA ANALYSIS

Data analysis will be performed in two steps. The first step will examine the recovered data files and match data to maneuvers in the flight card. The second step will examine blade loads as the sortie progressed. This examination will determine if any changes in blade structural behavior occurred during the sortie.

5.1. Maneuver Identification:

5.1.1. Ground Zero: File 04-16-2019_06.05.38.pds

The first data recording for a test flight is always a ground zero. This provides a reference point for a “no load” condition. The time history of main rotor shaft torque is shown below. It shows zero torque for the entire length of the file. The rotor was not turning.



5.1.2. Hover Maneuvers:

The crew chief stated that the helicopter spent several minutes on the ramp doing hover maneuvers before it returned to the hangar to load more ballast. Ballast would be required to account for fuel burn during the hover maneuvers. The purpose of the hover maneuvers is not known. The following files were recorded during the hover maneuvers:

04-16-2019_06.19.29.pds

04-16-2019_06.20.55.pds

04-16-2019_06.25.53.pds

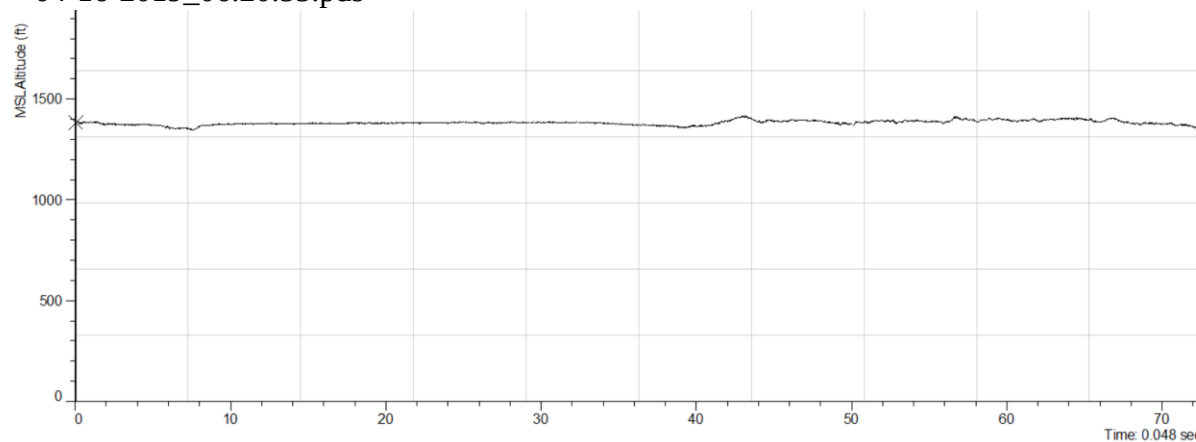
Time histories of helicopter altitude during each of these files are shown below. For reference, the field elevation of Falcon Field in Mesa, AZ is 1394 ft. Altitude data confirm that the three data files were recorded while the helicopter was close to the ground.

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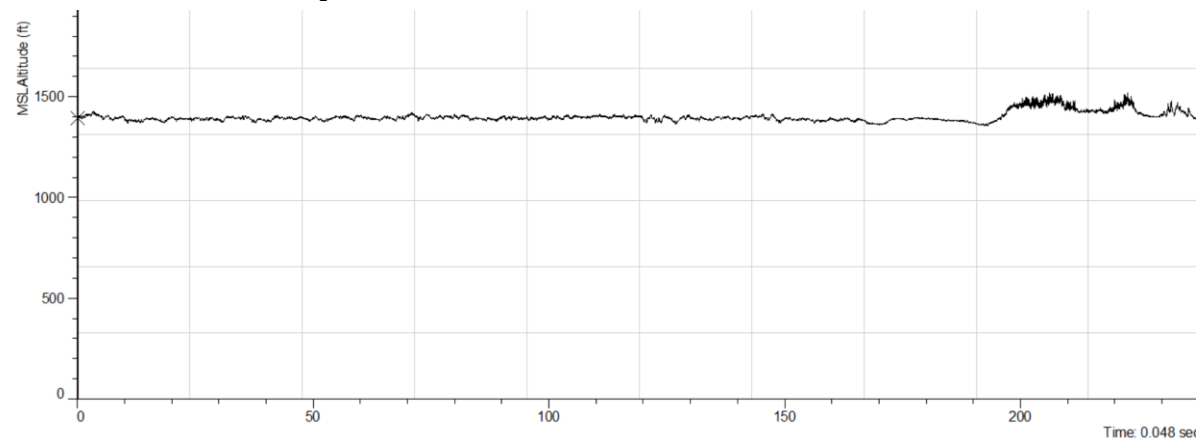
04-16-2019_06.19.29.pds



04-16-2019_06.20.55.pds



04-16-2019_06.25.53.pds



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5.1.3. Data File 04-16-2019_06.41.39

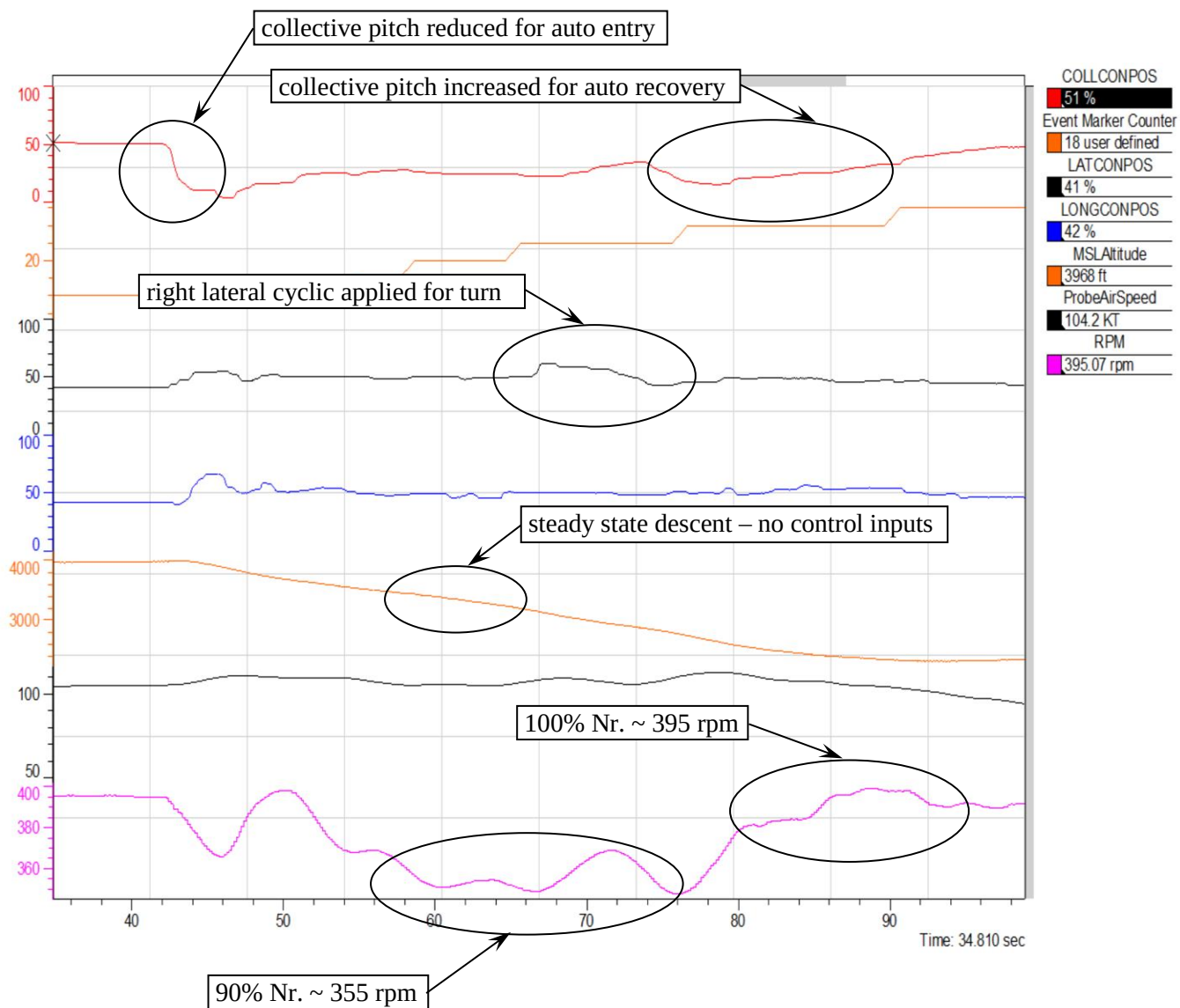
The following maneuvers have been identified:

59 Autorotation entry – 3000 ft.

44 Autorotation – 3000 ft. steady state descent at 90% Nr.

47 Autorotation – 3000 ft. right turn at 90% Nr.

46 Power recovery from autorotation – 3000 ft. at 90% to 107% Nr.



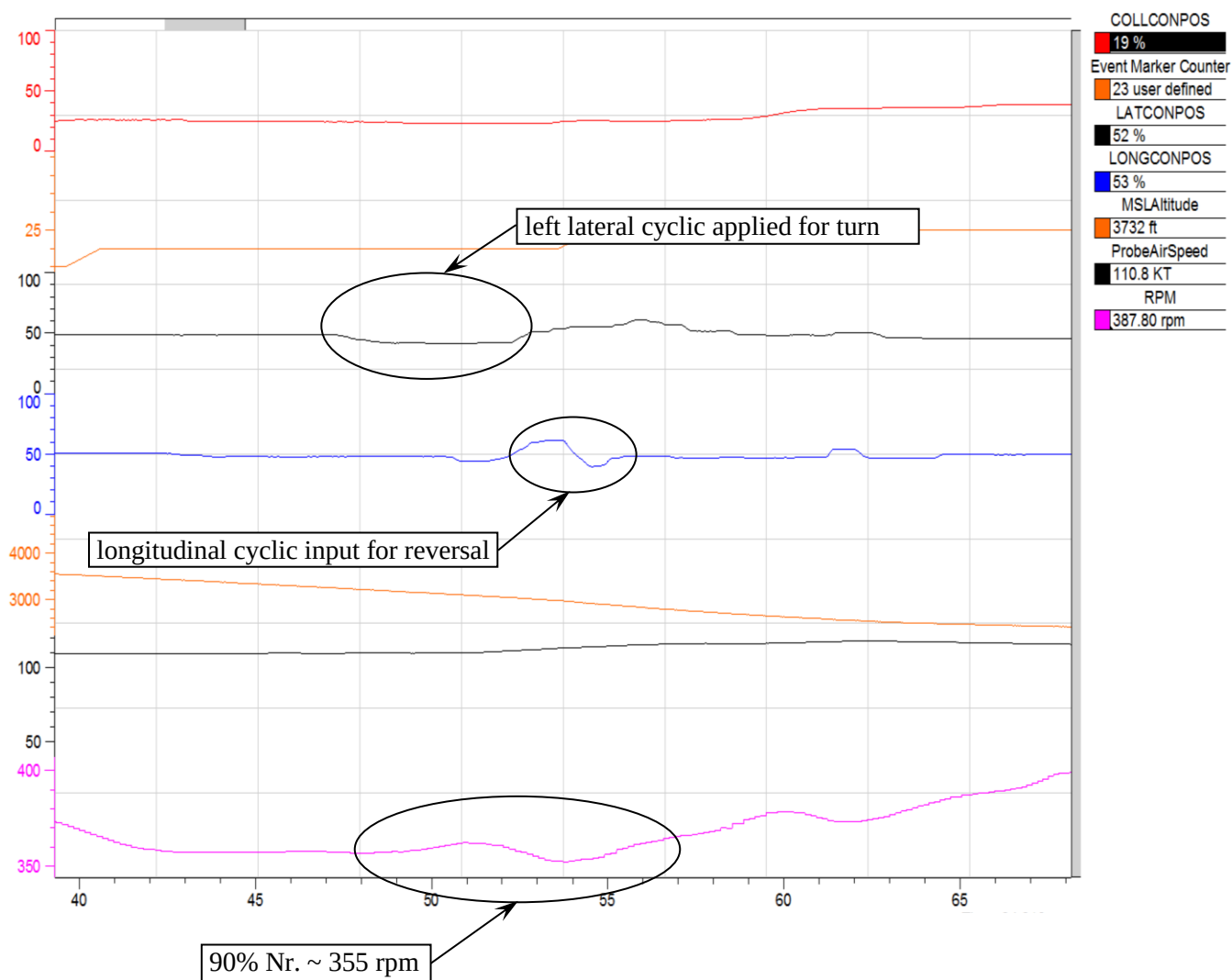
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5.1.4. Data File 04-16-2019_06.49.33 Autorotative Descent 1 of 2

The following maneuvers have been identified:

49 Autorotation – 3000 ft. left turn at 90% Nr.

53 Autorotation – 3000 ft. longitudinal reversal $\pm 15\%$ at 90% Nr.



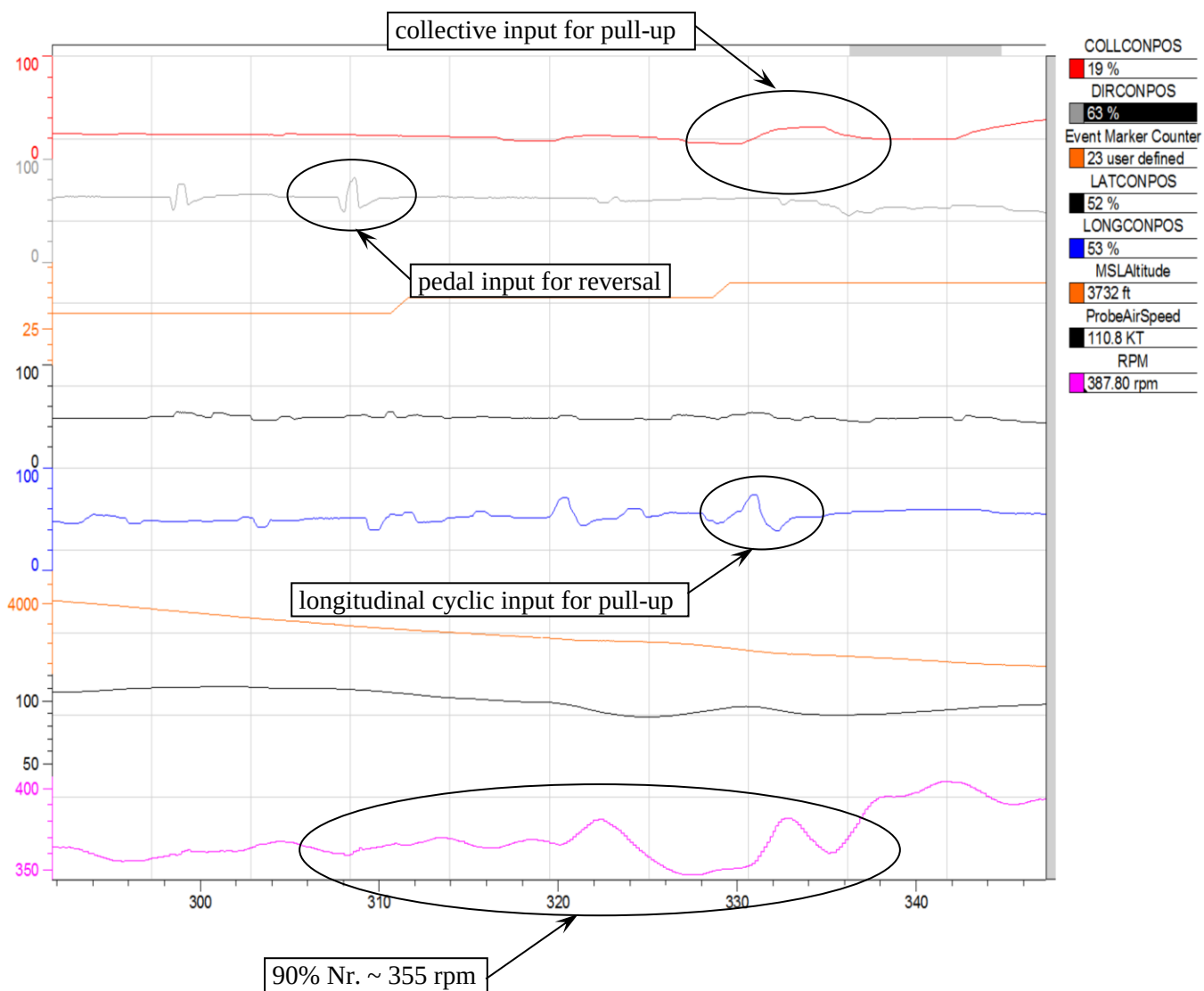
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5.1.5. Data File 04-16-2019_06.49.33 Autorotative Descent 2 of 2

The following maneuvers have been identified:

55 Autorotation – 3000 ft. pedal reversal $\pm 15\%$ at 90% Nr.

57 Autorotation – 3000 ft. cyclic and collective pull-up at 90% Nr.



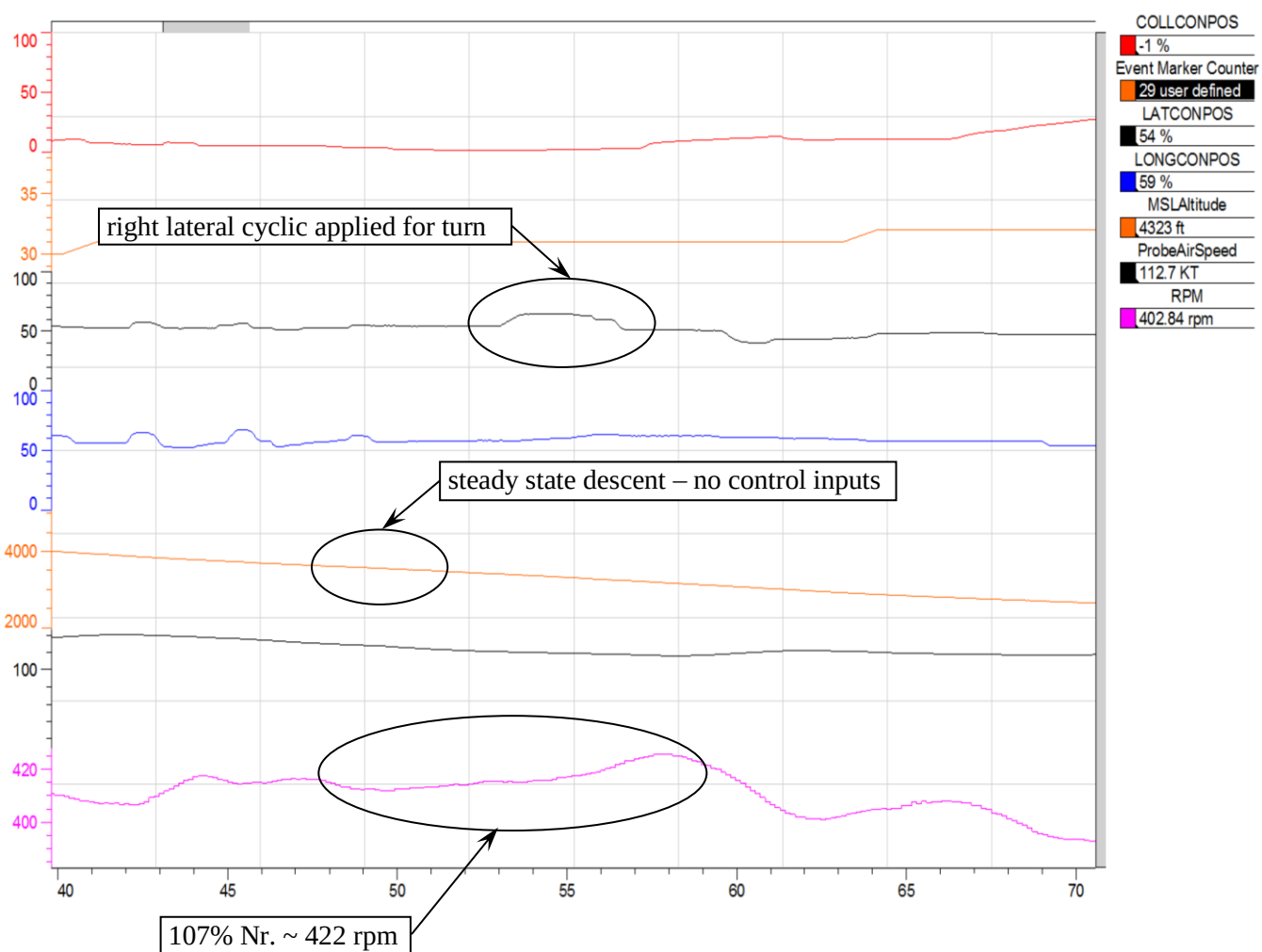
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5.1.6. Data File 04-16-2019_06.58.17 Autorotative Descent 1 of 2

The following maneuvers have been identified:

45 Autorotation – 3000 ft. at 107% Nr.

48 Autorotation – 3000 ft. right turn at 107% Nr.

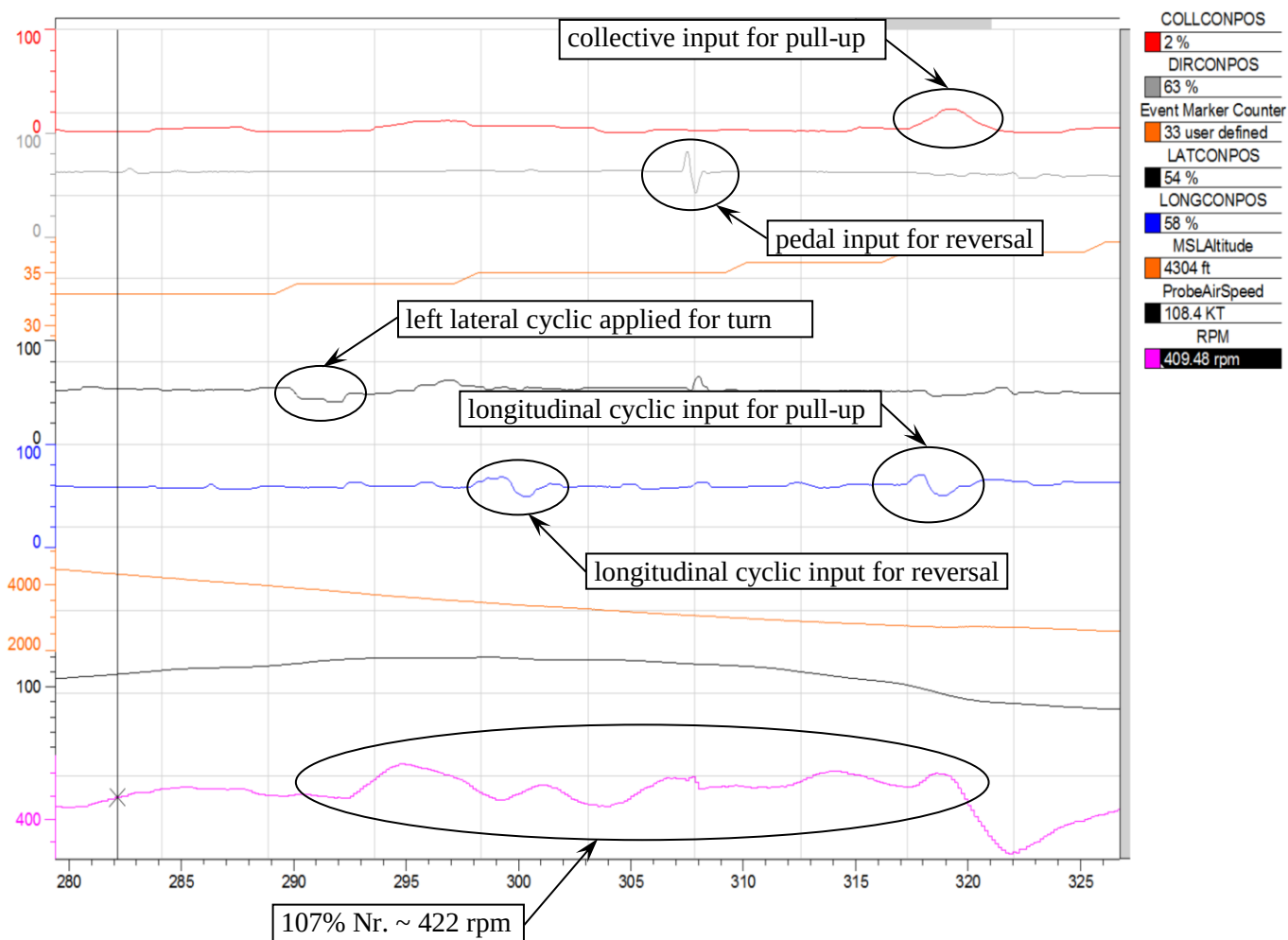


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5.1.7. Data File 04-16-2019_06.58.17 Autorotative Descent 2 of 2

The following maneuvers have been identified:

- 50 Autorotation – 3000 ft. left turn at 107% Nr.
- 54 Autorotation – 3000 ft. longitudinal reversal $\pm 15\%$ at 107% Nr.
- 56 Autorotation – 3000 ft. pedal reversal $\pm 15\%$ at 107% Nr.
- 58 Autorotation – 3000 ft. cyclic and collective pull-up at 107% Nr.



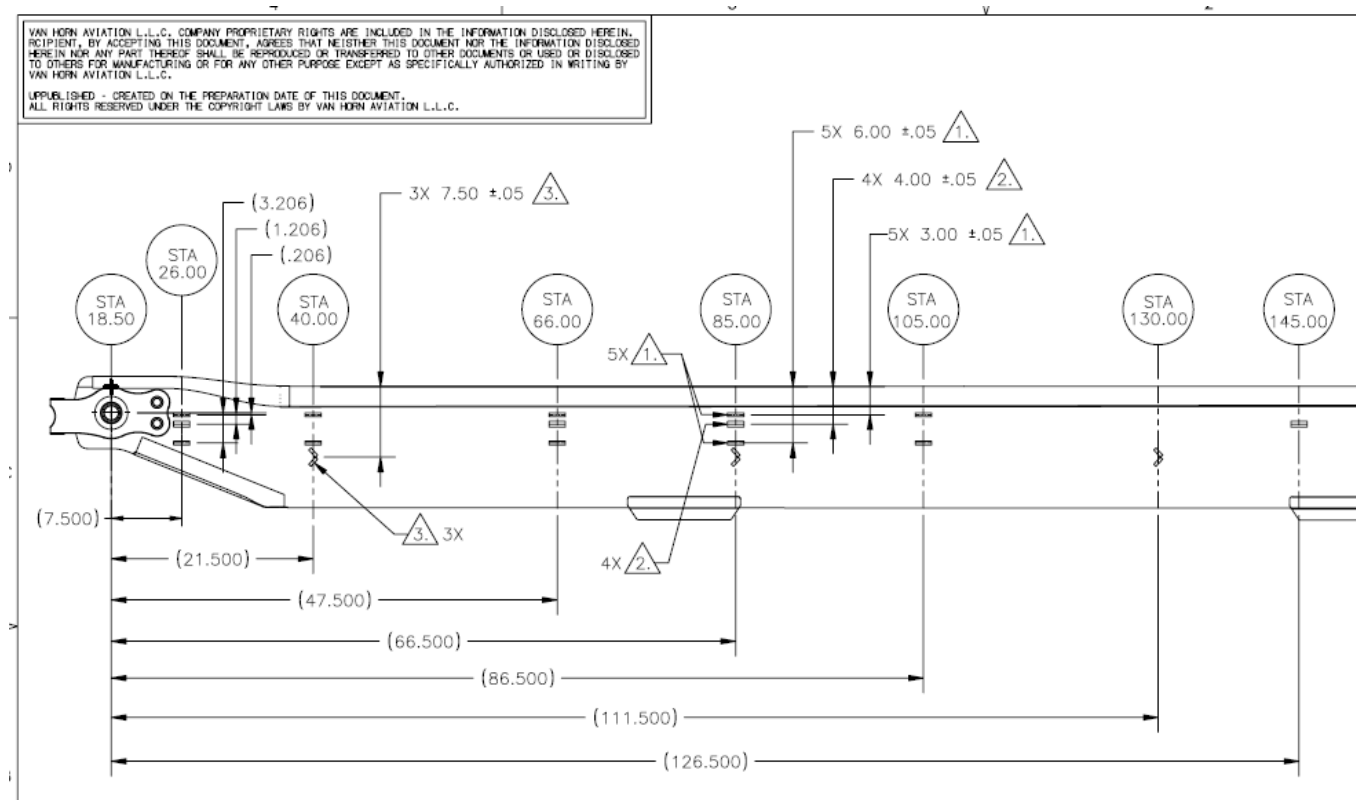
5.1.8. The following maneuvers have not been identified:

- 43 Simulated power failure – 3000 ft. one second delay
- 51 Autorotation – 3000 ft. lateral reversal $\pm 15\%$ at 90% Nr.
- 52 Autorotation – 3000 ft. lateral reversal $\pm 15\%$ at 107% Nr.

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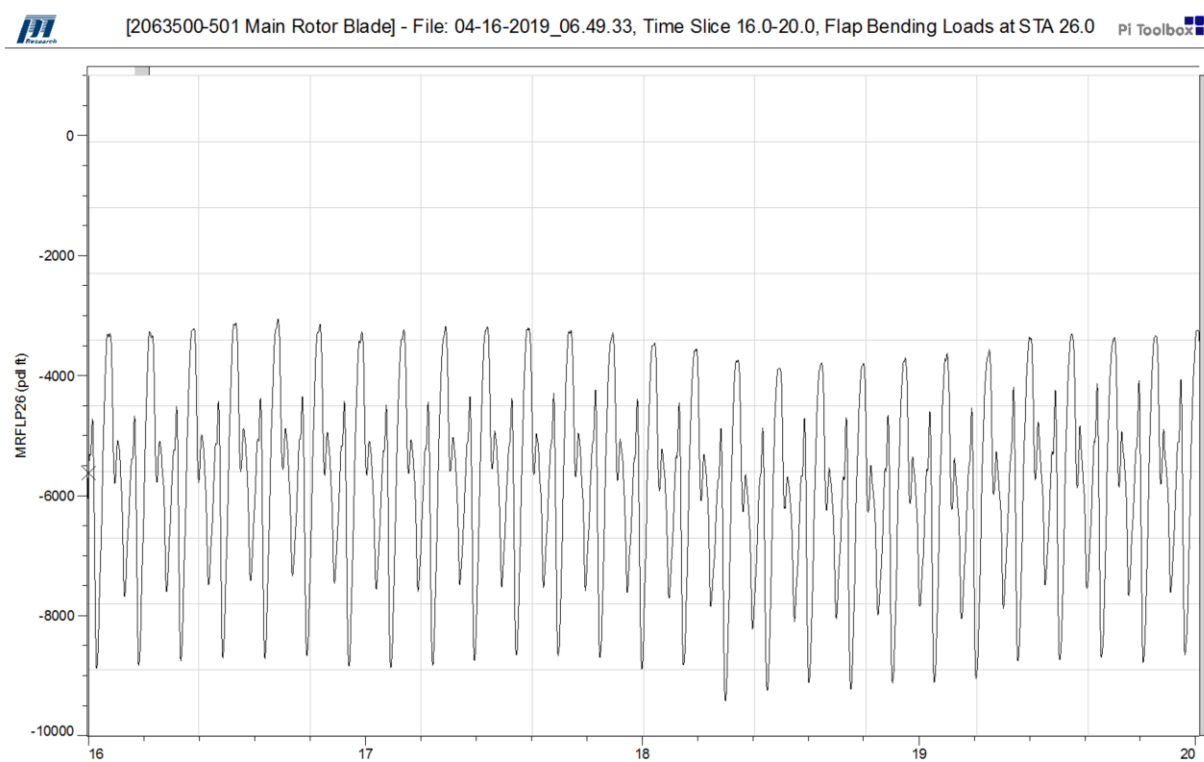
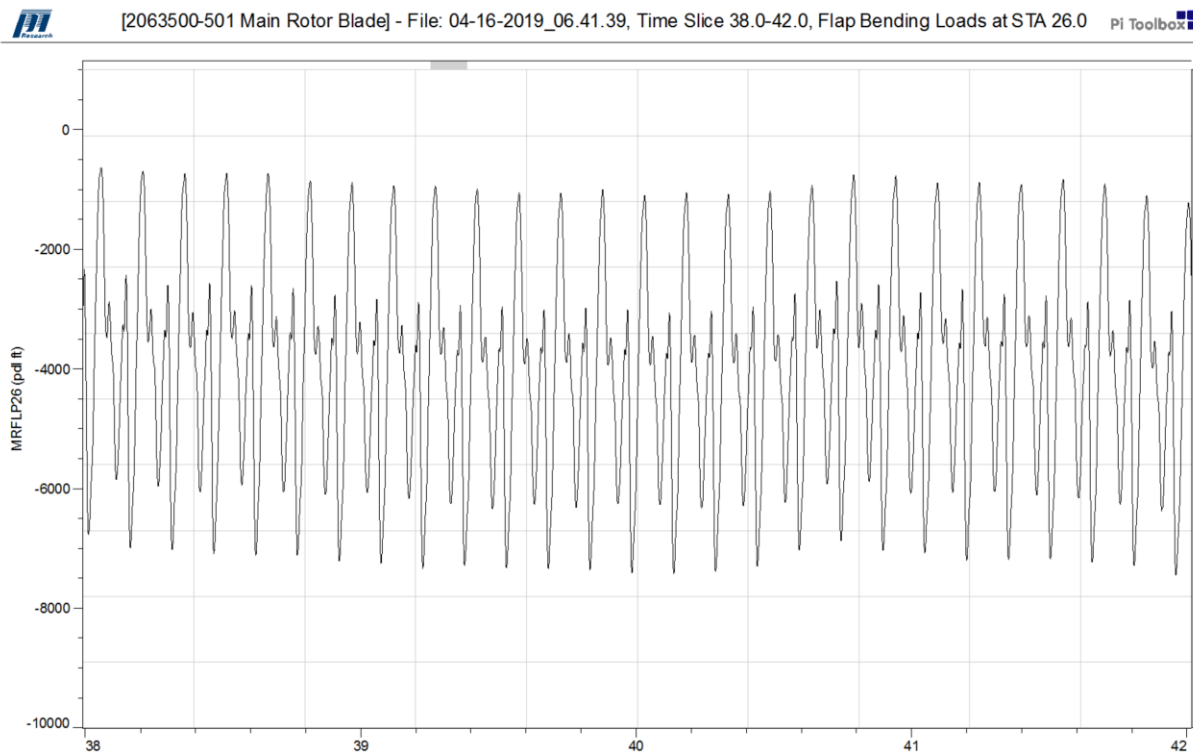
5.2. Blade Loads

The figure below shows a portion of the strain gage installation drawing for main rotor blade assembly 206B35000-501, serial number A001. Data for flap bending and chord bending at STA 26.0, and torsion at STA 40.0 will be presented. Data at these locations will capture any anomaly along the entire span of the rotor blade as the flight progressed. Data will be a trim point prior to each autorotative descent

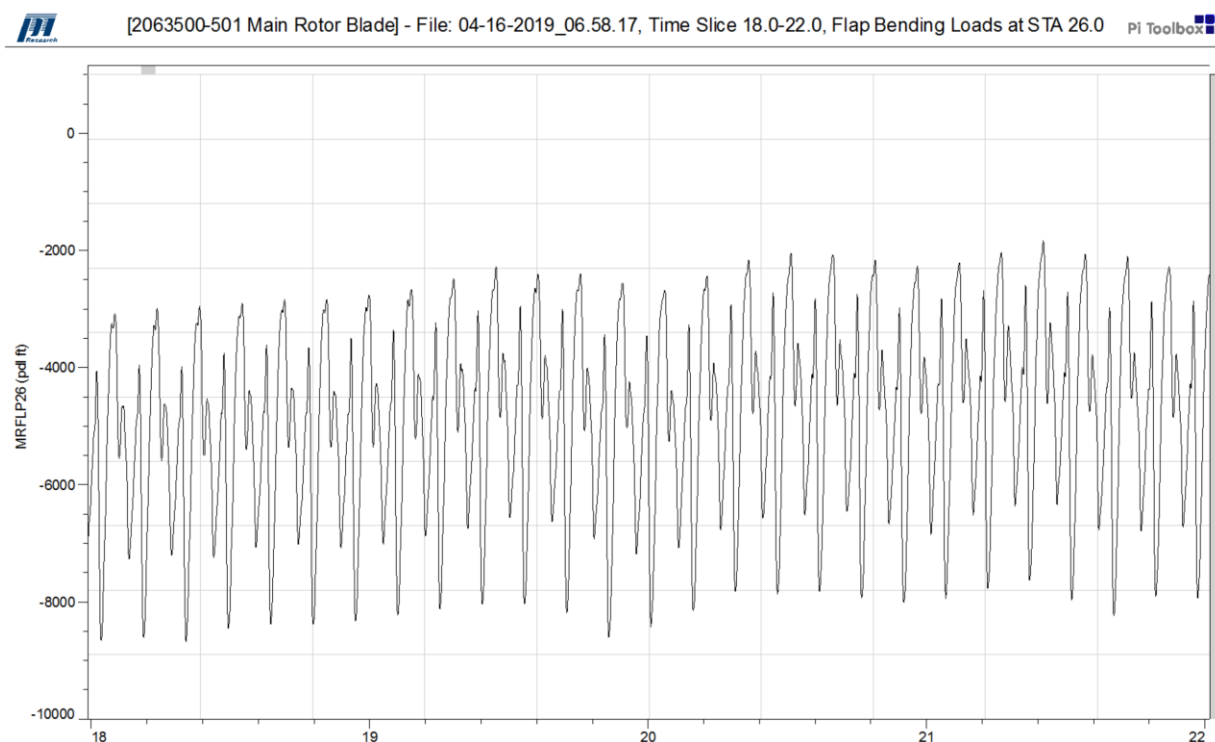
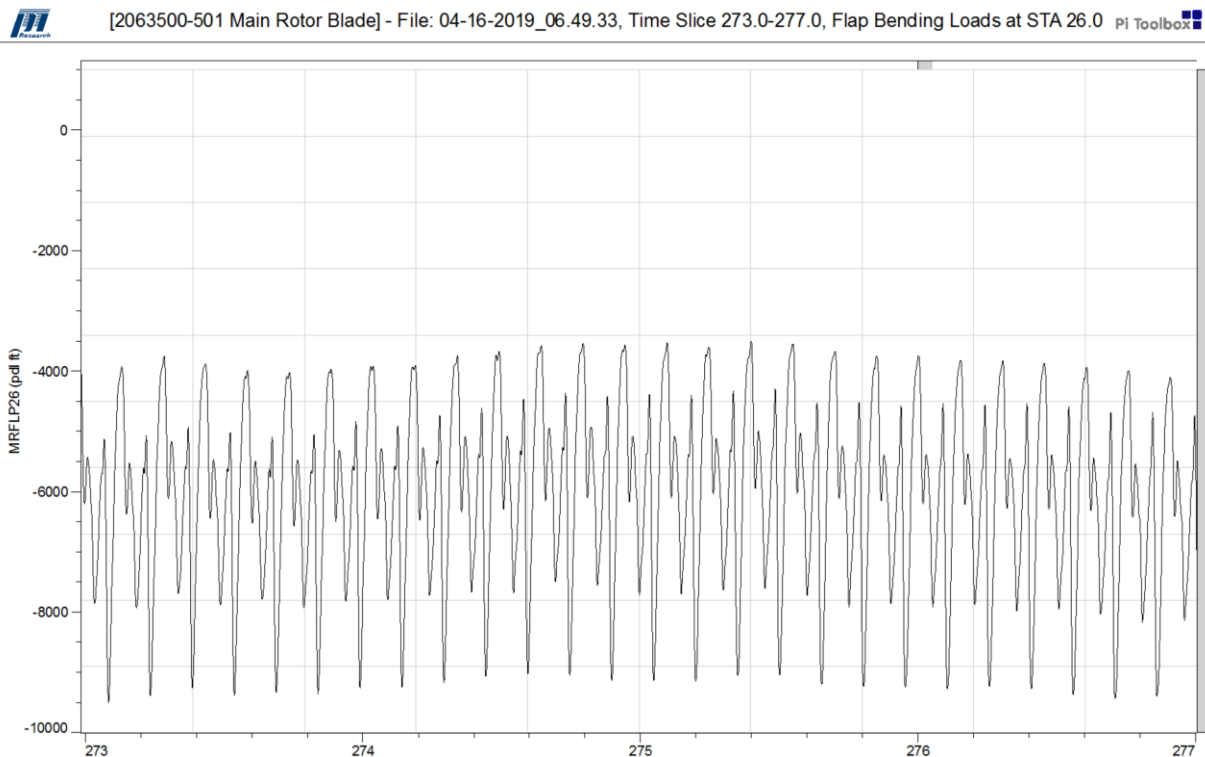


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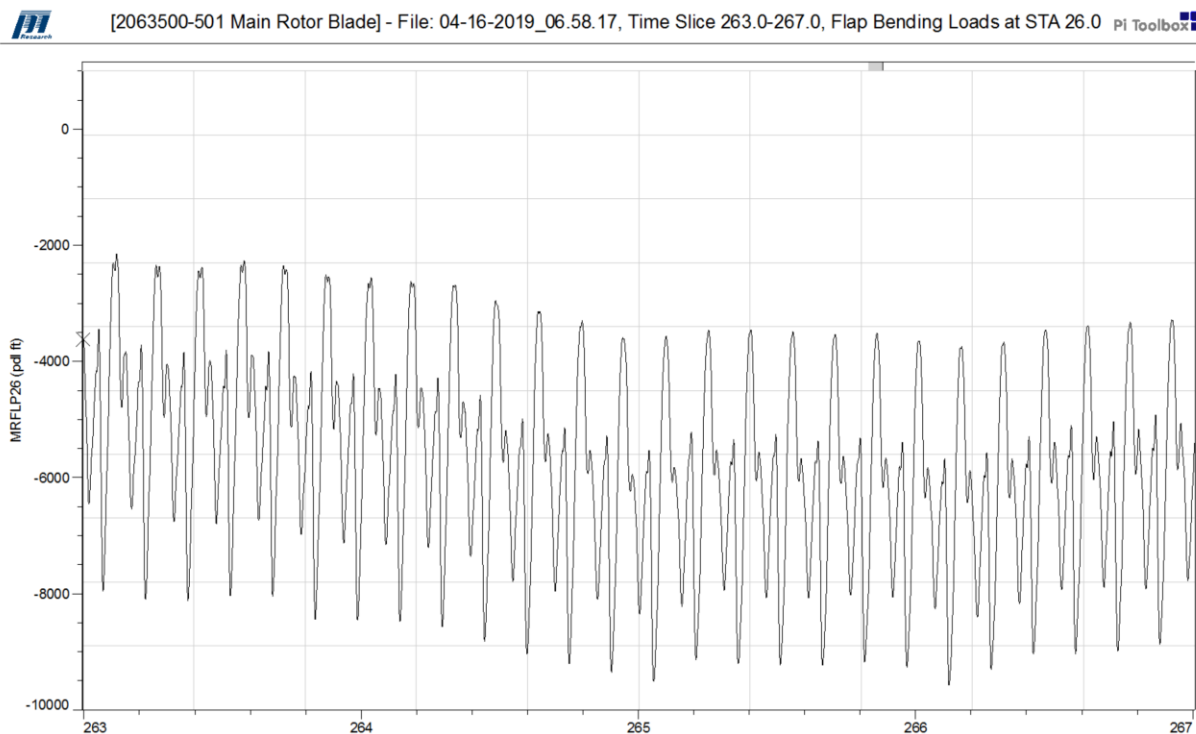
5.2.1. Flap Bending at STA 26.0



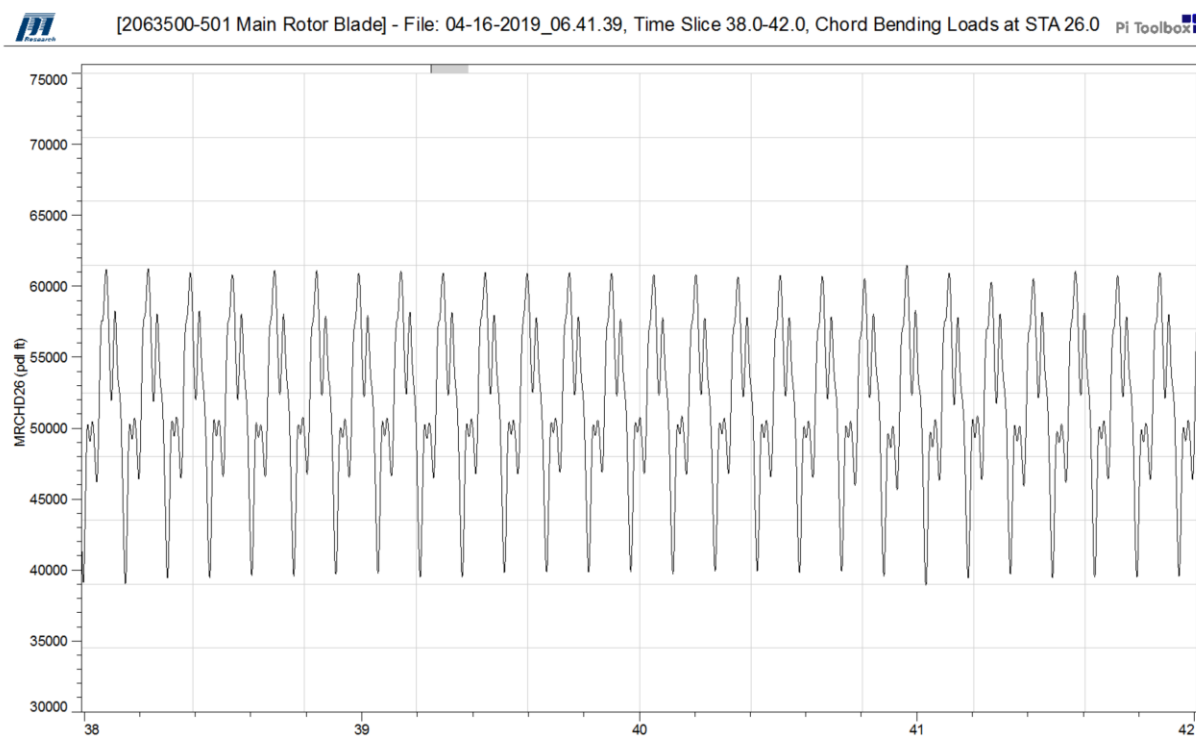
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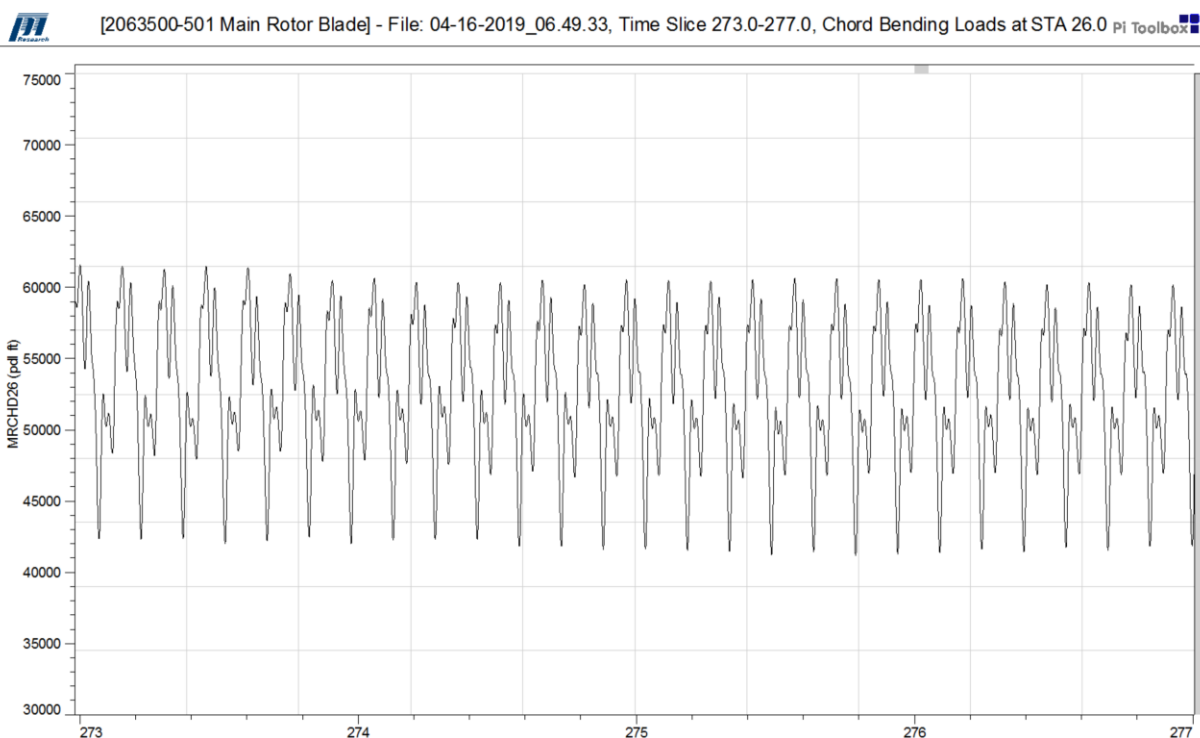
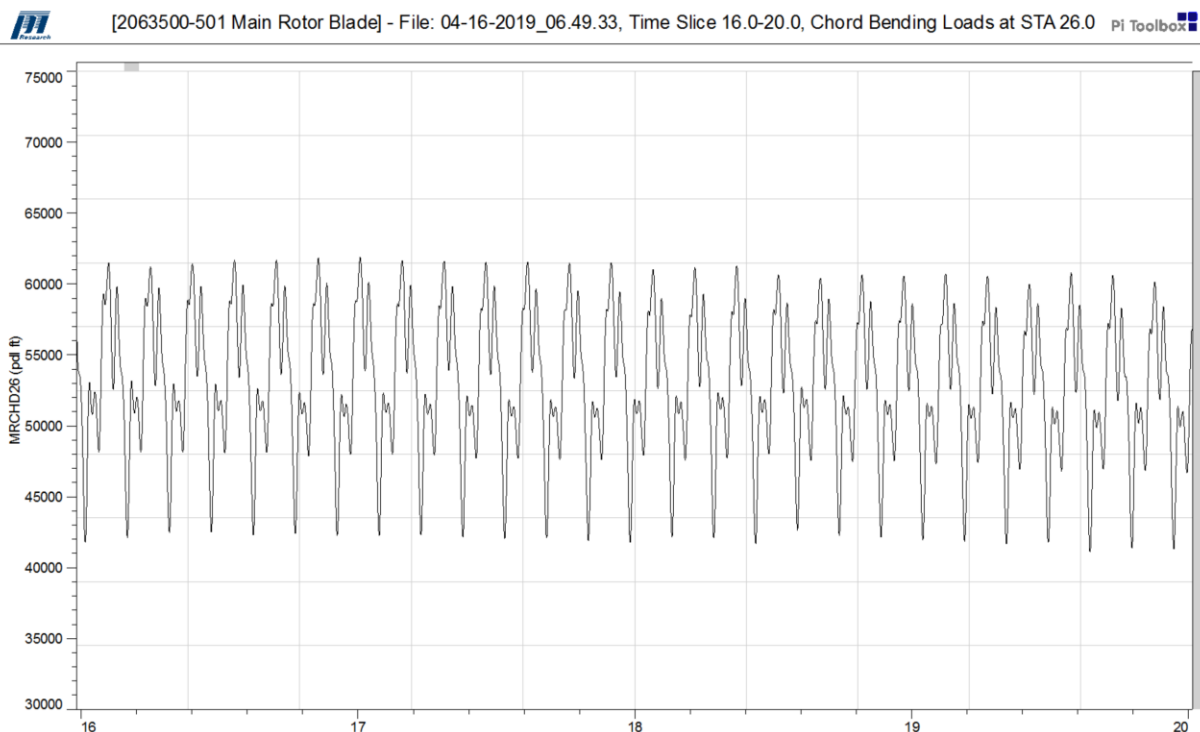
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5.2.2. Chord Bending at STA 26.0



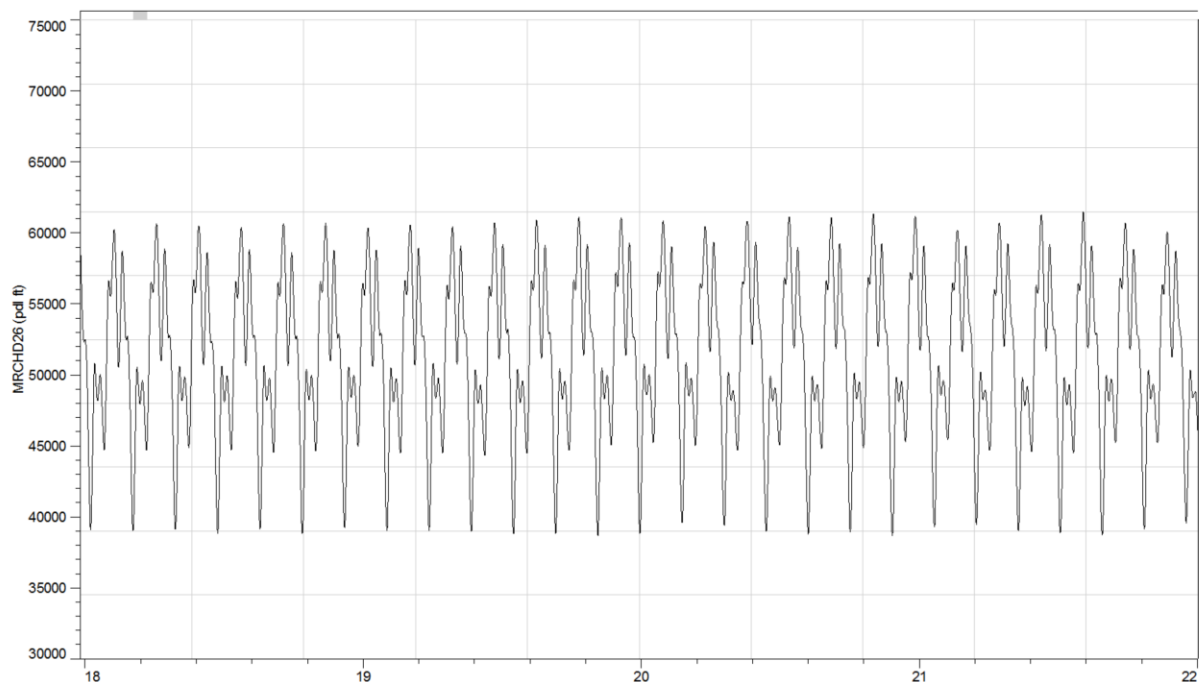
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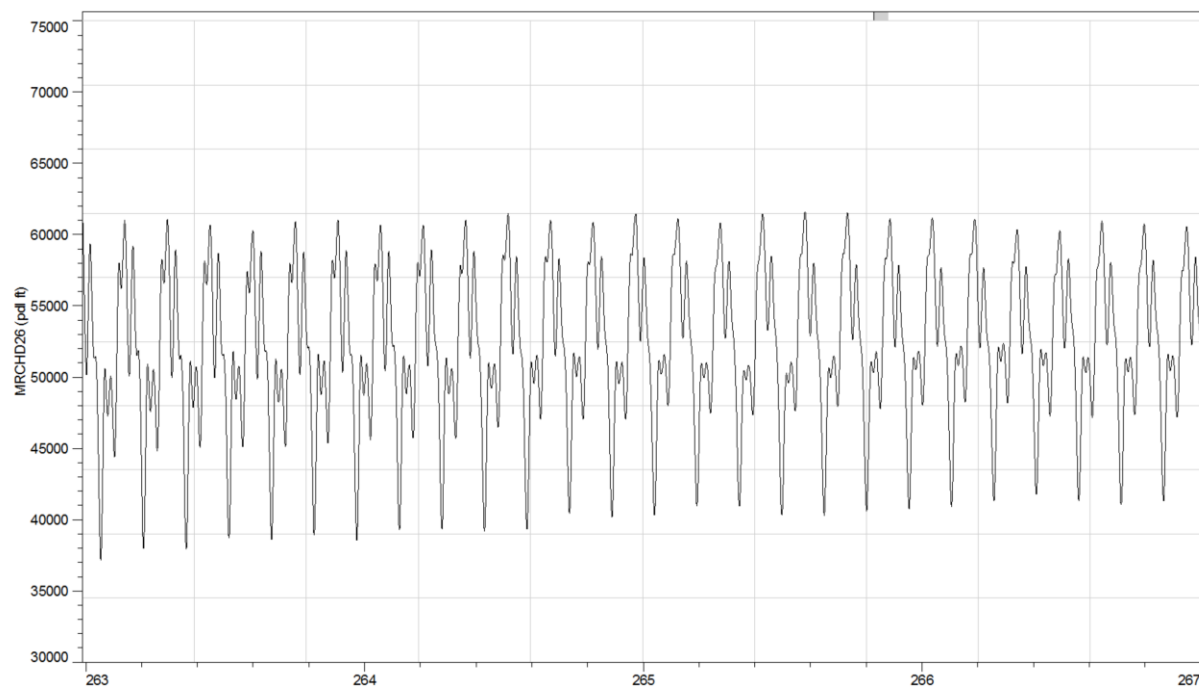
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[2063500-501 Main Rotor Blade] - File: 04-16-2019_06.58.17, Time Slice 18.0-22.0, Chord Bending Loads at STA 26.0 PI Toolbox

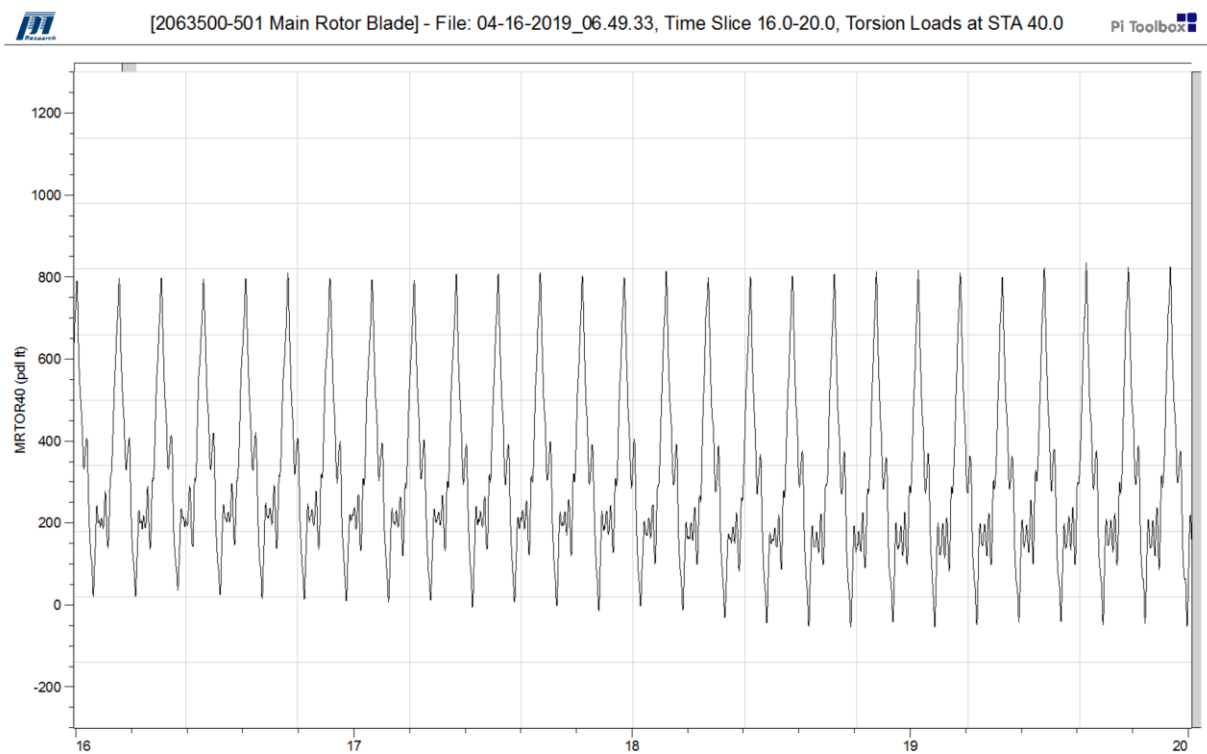
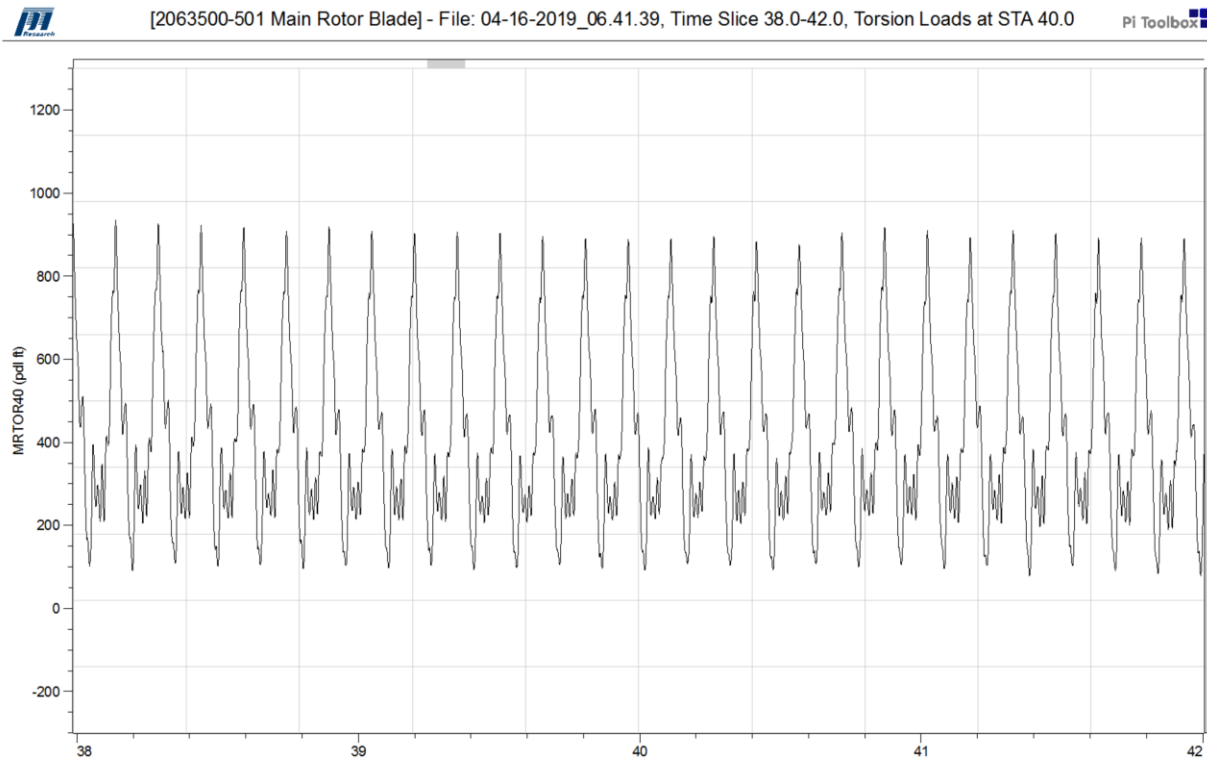


[2063500-501 Main Rotor Blade] - File: 04-16-2019_06.58.17, Time Slice 263.0-267.0, Chord Bending Loads at STA 26.0 PI Toolbox

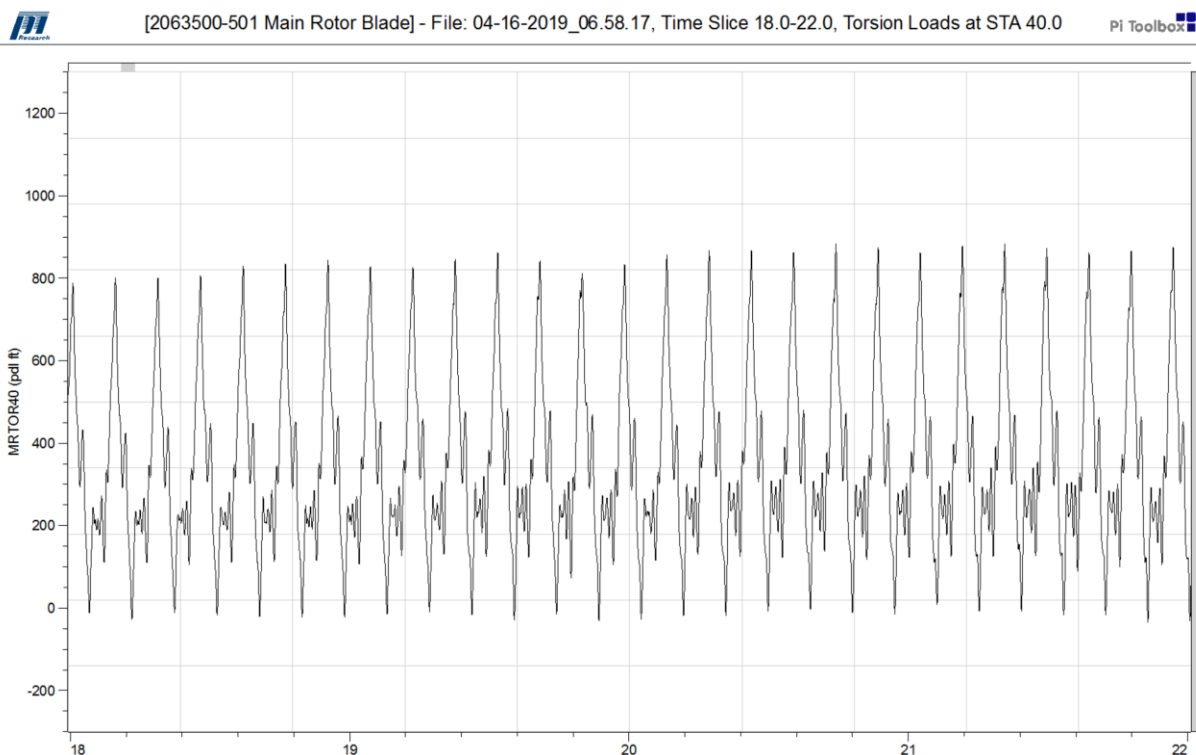
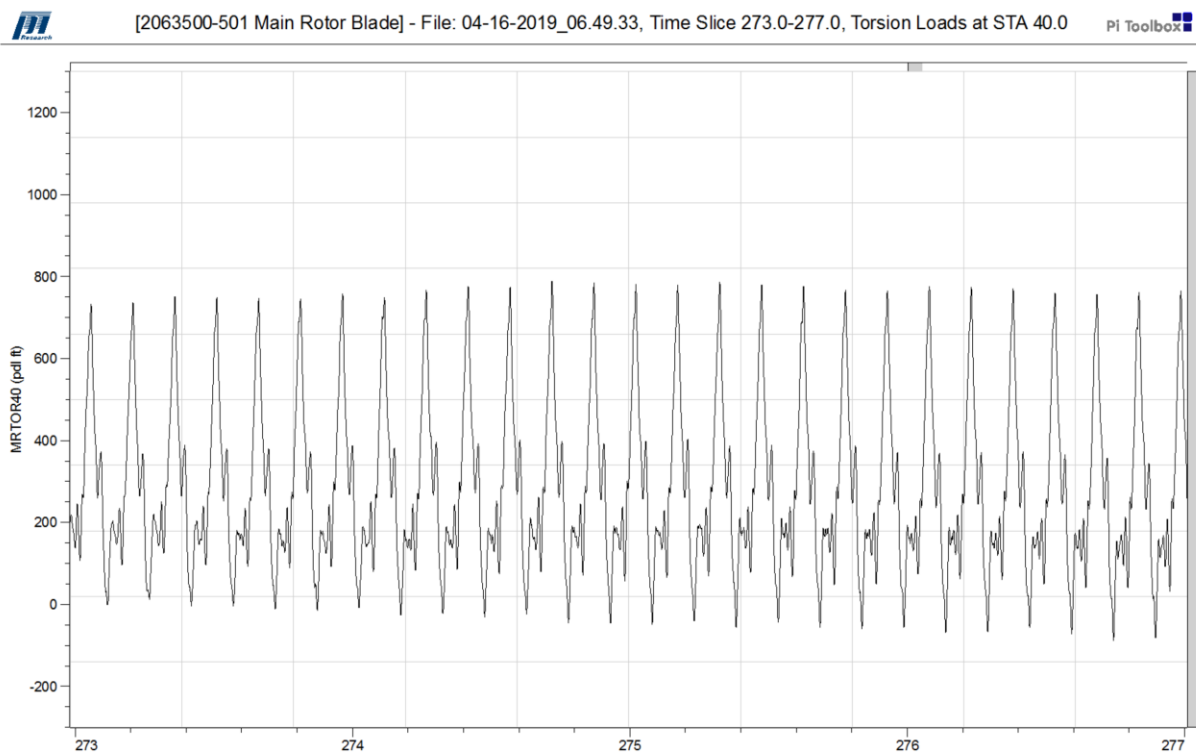


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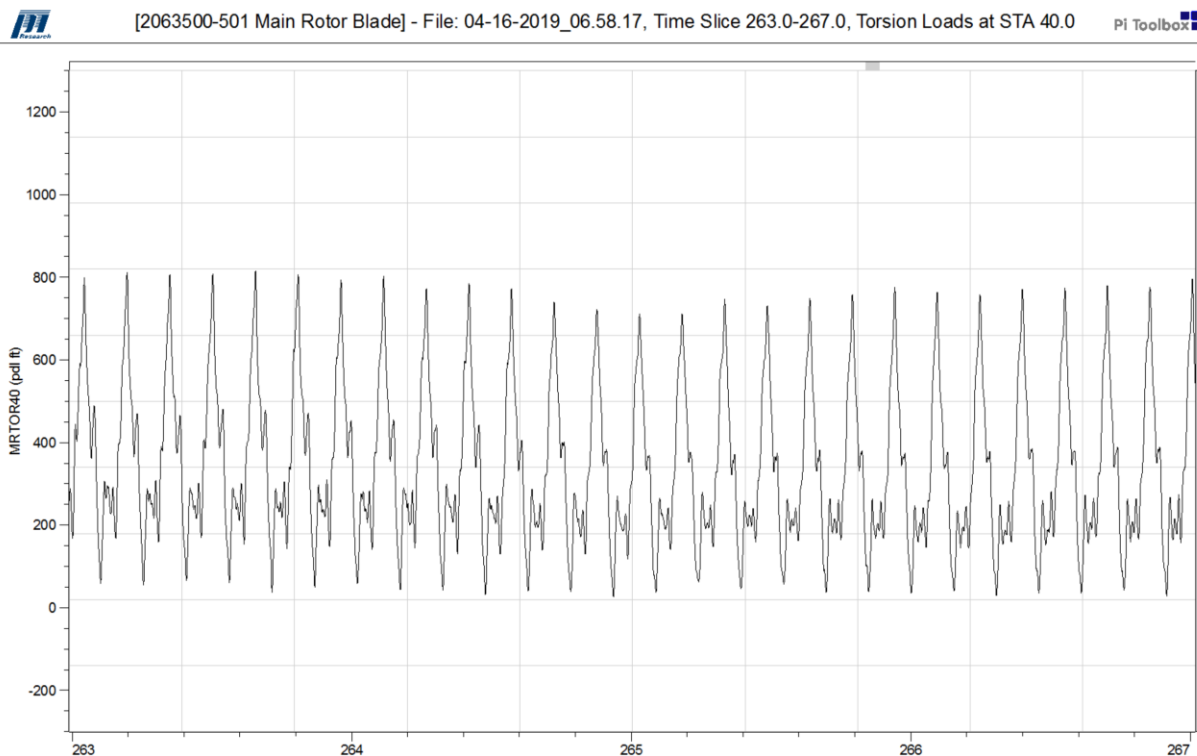
5.2.3. Torsion at STA 40.0



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6. CONCLUSION

- 6.1. Seven flight test data files from helicopter N61PH's flight test engineer's laptop computer were successfully recovered and analyzed. Data files were created on 04-16-19. The last file was recorded at 06.58.17.
- 6.2. A forensic data recovery effort identified a data file from N61PH's flight test engineer's laptop computer that was modified at 07.05.26. File modification was the start of data recording. No data were recovered from the file.
- 6.3. Eighteen maneuvers were scheduled to be flown on 04-16-19. Fifteen of the eighteen maneuvers have been identified. The following maneuvers were not identified:
 - 43 Simulated power failure v3000 ft. one second delay
 - 51 Autorotation – 3000 ft. lateral reversal $\pm 15\%$ at 90% Nr.
 - 52 Autorotation – 3000 ft. lateral reversal $\pm 15\%$ at 107% Nr.
- 6.4. Main rotor blade loads data from blade STA 26.0 and STA 40.0 at the start of the five autorotative descents recorded were analyzed. Data show consistent load behavior at the start of each of the five descents. The main rotor blades were operating normally.