

COMANDO DA AERONÁUTICA
CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE
ACIDENTES AERONÁUTICOS



FINAL REPORT
A - 091/CENIPA/2014

OCCURRENCE:	ACCIDENT
AIRCRAFT:	PT-HTQ
MODEL:	206L-3
DATE:	03MAY2014



NOTICE

According to the Law no 7565, dated 19 December 1986, the Aeronautical Accident Investigation and Prevention System – SIPAER – is responsible for the planning, guidance, coordination and execution of the activities of investigation and prevention of aeronautical accidents.

The elaboration of this Final Report was conducted taking into account the contributing factors and hypotheses raised. The report is, therefore, a technical document which reflects the result obtained by SIPAER regarding the circumstances that contributed or may have contributed to triggering this occurrence.

The document does not focus on quantifying the degree of contribution of the different factors, including the individual, psychosocial or organizational variables that conditioned the human performance and interacted to create a scenario favorable to the accident.

The exclusive objective of this work is to recommend the study and the adoption of provisions of preventative nature, and the decision as to whether they should be applied belongs to the President, Director, Chief or the one corresponding to the highest level in the hierarchy of the organization to which they are being forwarded.

This Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with Appendix 2, Annex 13 to the 1944 Chicago Convention, which was incorporated in the Brazilian legal system by virtue of the Decree no 21713, dated 27 August 1946.

Thus, it is worth highlighting the importance of protecting the persons who provide information regarding an aeronautical accident. The utilization of this report for punitive purposes maculates the principle of “non-self-incrimination” derived from the “right to remain silent” sheltered by the Federal Constitution.

Consequently, the use of this report for any purpose other than that of preventing future accidents, may induce to erroneous interpretations and conclusions.

N.B.: This English version of the report has been written and published by the CENIPA with the intention of making it easier to be read by English speaking people. Taking into account the nuances of a foreign language, no matter how accurate this translation may be, readers are advised that the original Portuguese version is the work of reference.

SYNOPSIS

This is the Final Report of the 03MAY2014 accident with the 206L-3 aircraft, registration PT-HTQ. The accident was classified as "System/Component Failure".

During a panoramic flight, the pilot heard an abnormal noise of great intensity coming from the transmission of the helicopter, occurring in sequence, a difficulty in the control of the lateral inclination of the aircraft. It was performed a hard landing on the sea.

The aircraft suffered substantial damage.

The pilot and the passengers were unharmed.

An Accredited Representative of the NTSB - National Transportation Safety Board, USA (State where the aircraft was manufactured), was designated for participation in the investigation.



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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CG	Center of Gravity
CIV	Pilot's Flight Logbook
CMA	Aeronautical Medical Certificate
DCTA	Aeronautics' Science and Technology Department
IAM	Annual Maintenance Inspection
NTSB	National Transportation Safety Board
PLH	Airline Pilot License - Helicopter
PPH	Private Pilot License– Helicopter
RS	Safety Recommendation
SERIPA	Regional Aeronautical Accident Investigation and Prevention Service
SIPAER	Aeronautical Accidents Investigation and Prevention System
TPP	Aircraft Registration Category of Private Air Service
UTC	Universal Time Coordinated

1. FACTUAL INFORMATION.

Aircraft	Model: 206L-3I	Operator: Private
	Registration: PT-HTQ	
	Manufacturer: Bell Helicopter	
Occurrence	Date/time: 03MAY2014 - 1510 UTC	Type(s): "System/Component Failure" Subtype(s):
	Location: Presídio Beach	
	Lat. 03°53'09"S Long. 038°20'40"W	
	Municipality – State: Aquiraz - CE	

1.1 History of the flight.

The aircraft took off from the Dragão do Ar Helipad (SIHM), located in the city of Fortaleza - CE, to perform a panoramic flight near the city of Aquiraz - CE, with one pilot and five passengers on board.

With about 20 minutes of flight, the pilot heard a high-intensity noise coming from the transmission of the helicopter. Then, the control of the lateral inclination (bearing), made by the cyclic command, was compromised. The commander led the aircraft in the direction of the sea and made a forced landing.

After landing, the occupants left the aircraft and proceeded to the beach with the help of bathers, who were near the place. The helicopter remained submerged to a depth of approximately 9 meters.

The aircraft suffered substantial damage. The pilot and the 5 passengers were unharmed.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
Minor	-	1	-
None	1	5	-

1.3 Damage to the aircraft.

The aircraft suffered substantial damage in the engine, transmission, main rotor, tail rotor, cockpit and also in the rear fuselage.

1.4 Other damage.

Nil.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Hours Flown	
	Pilot
Total	16.000:00
Total in the last 30 days	40:30
Total in the last 24 hours	00:25
In this type of aircraft	5.000:00
In this type in the last 30 days	10:45
In this type in the last 24 hours	00:25

N.B.: The Data on flown hours were obtained from the Pilot's Flight Logbook (CIV).

1.5.2 Personnel training.

The pilot took the Private Pilot course - Helicopter (PPH) at the *Prática Escola de Pilotos de Helicópteros* Ltd, in Nova Iguaçu – RJ, in 1984.

1.5.3 Category of licenses and validity of certificates.

The pilot had the Airline Pilot License - Helicopter (PLH) and had valid technical qualifications for BH06 Aircraft.

1.5.4 Qualification and flight experience.

The pilot was qualified and had experience in that kind of flight.

1.5.5 Validity of medical certificate.

The pilot had valid Aeronautical Medical Certificate (CMA).

1.6 Aircraft information.

The aircraft, serial number 51197, was manufactured by Bell Helicopter, in 1986, and was registered at the Private Air Service category (TPP).

The aircraft had valid Airworthiness Certificate (CA).

The airframe, engine and rotors logbook records were updated.

The last inspection of the aircraft, the "100h / IAM" type was performed on 02JUL2013 by TC Helicopter Maintenance shop Ltd, in Fortaleza - CE, having flown 26 hours and 5 minutes after the inspection.

On 28SEPT2002, the helicopter was involved in an aeronautical accident at Serra da Ibiapaba, in the city of São Benedito - CE. According to Final Report A-63 / CENIPA / 2012, the aircraft suffered serious damage after colliding with the ground in an uncontrolled way.

1.7 Meteorological information.

The weather conditions were favorable for the visual flight.

1.8 Aids to navigation.

Nil.

1.9 Communications.

Nil.

1.10 Aerodrome information.

The occurrence took place outside the Aerodrome.

1.11 Flight recorders.

Neither required nor installed.

1.12 Wreckage and impact information.

The aircraft made a hard landing on the sea, at a distance of approximately 200 meters from the beach. Before the impact against water, the helicopter was in a pitch up attitude, which caused the initial touch of the tail rotor in the sea.

After the impact, the helicopter fell to the left and sank up to approximately 9 meters. Some parts of the aircraft, such as the tail rotor, were released from the fuselage and were recovered by bathers who were on-site; being delivered to the helicopter operator.

The wreckage of the aircraft remained submerged for approximately 48 hours, being removed from the sea by the team of the Military Fire Brigade of the State of Ceará (Figures 1 and 2).



Figure 1 – Removal of the aircraft's wreckage from the sea.



Figure 2 - Damage to the aircraft.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

Not investigated.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

Not investigated.

1.14 Fire.

No signs of either inflight or post-impact fire.

1.15 Survival aspects.

After the hard landing on the sea, the occupants abandoned the helicopter through the main doors and were helped by bathers that were in the region, in their displacement to the beach.

1.16 Tests and research.

After the removal from the sea, the aircraft's wreckage was inspected, and no abnormalities (locking) were found in the cyclic and collective commands of the helicopter.

During the analysis of the whole transmission of the helicopter, it was observed that the right front Link Assembly (P / N 206-033-554-101) item was fractured. The component consisted of an aluminum alloy rod, which fixed the aircraft cell to the main rotor transmission through the Arm Assembly (P / N 206-033-505-001) (Figure 3).

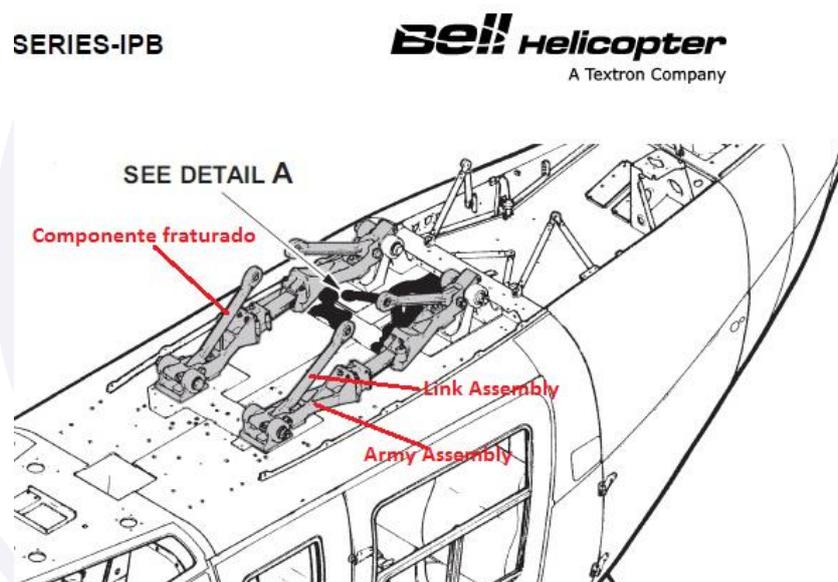


Figure 3 - Assembled components on the aircraft.

The component was sent to the laboratories of the DCTA, in order to be submitted to component failure analysis (Figure 4).

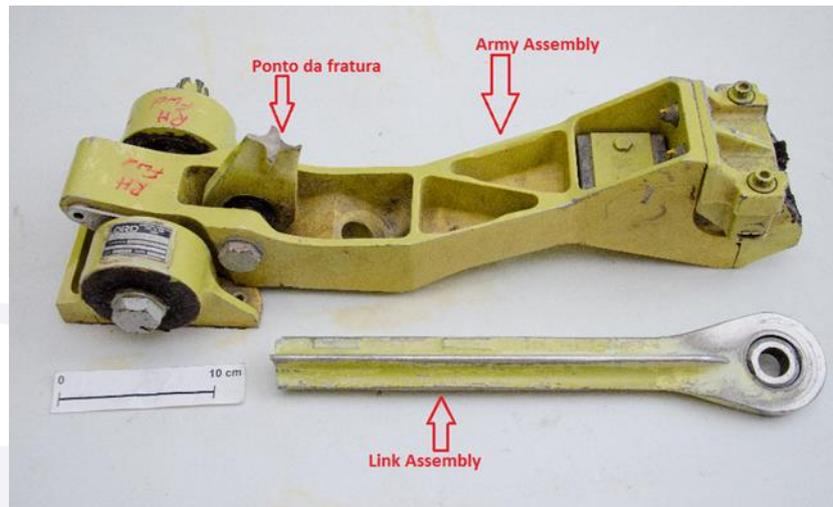


Figure 4 - Overview of the fractured component sent to the DCTA.

A report of the component failure analysis of the PT-HTQ aircraft's Transmission Box was prepared by the DCTA. The visual analysis of the fractured rod (link assembly) indicated the presence of impact marks, dents and wear on the surface (Figure 5)

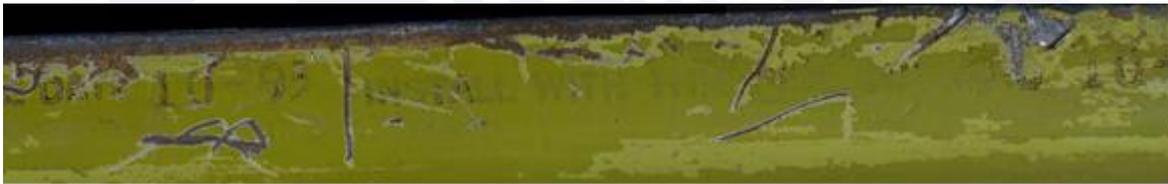


Figure 5 - Surface details of one side of the rod with the presence of impact marks, dents and wear.

The scanning electron microscopy (MEV) analysis on the surface of the fracture indicated the probable onset of rupture (Figure 6).

It was not possible to detect striations due to the oxidation action on the surface of the fracture. There was evidence of wear, probably due to sanding, in the region of the beginning of the fracture.

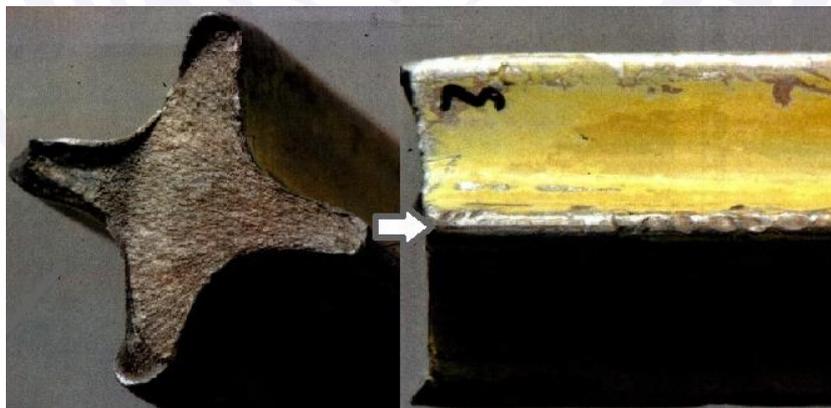


Figure 6 - General view of the fractured rod in the region of probable beginning of fatigue with the presence of kneading.

The stereoscopic analysis of the fractured surface showed the presence of "beach marks" indicative of material fatigue (Figure 7).



Figure 7 - Detail of the fracture with the presence of fatigue.

The stereoscopic analysis of the eyebolt region showed wear of the polymer material as well as the eccentric position of the fractured rod. Loss of polymer material, metal component clearance and degradation of the polymeric material can also be observed (Figure 8).



Figure 8 - Wear and degradation of the polymeric material.

Thus, the analyzes report carried out at the Aeronautics' Science and Technology Department presented the following result:

The failure of the aluminum rod occurred due to fatigue. Impact marks, kneading, and wear have been observed on the rod surface. In the region of the beginning of the fatigue, the presence of a thinning, probably by sanding, was observed.

The elastomer showed degradation with loss of material, which can cause clearance in the working region, inducing vibrations to the assembly and introducing unplanned efforts in the rod, which associated with the thinning observed in the region of onset, can facilitate the occurrence of the fatigue process. It should further be noted that the region of the fatigue rupture is a region of variation of the component section, in other words, a natural region of stress concentration.

1.17 Organizational and management information.

Nil.

1.18 Operational information.

The aircraft was within the weight and balance parameters specified by the manufacturer.

On the day of the accident, the aircraft was prepared for a panoramic flight near the city of Aquiraz and the beaches of the region. All helicopter pre-flight procedures were

performed and no discrepancy was identified. It was the pilot and the aircraft's first flight of the day.

The take-off and the climb until 500ft of altitude occurred normally. After approximately 20 minutes of flight, the pilot reported having heard an abnormal noise of great intensity coming from the transmission of the helicopter.

Soon after, the control of lateral inclination (bearing) of the helicopter by the cyclic command was impaired. The pilot could only perform curves aided by the performance of the pedals with great amplitude. Moreover, when the collective command was actuated, increasing the pitch angle of the blades, the helicopter tilted to the left.

The engine normally responded to step variation commands, adjusting power as necessary to keep RPM constant. The commander had difficulty maintaining control of the aircraft in relation to the longitudinal axis (bearing) in flight. Even though it was difficult to maintain the bearing control, the pilot was able to take the helicopter to the sea and made a hard landing.

1.19 Additional information.

The helicopter had four Links Assembly (front right and left, rear left and right). The rods were positioned on top of the aircraft, interconnected to the main rotor drive shaft box.

The aircraft maintenance program prescribed that the Link Assembly should be inspected every 100 hours for damage and deterioration.

It was observed that a layer of sealant covered the Link Assembly and Arm Assembly elastomers.



Figure 9 - Presence of sealant on the Arm Assembly and Link Assembly elastomers.

It was not possible to identify when the sealant was placed on the elastomers of the Link Assembly and the Arm Assembly of the aircraft. The Aircraft Maintenance Manual did not contain any mention of the use of sealant in the Arm and Link Assemblies. There was no traceability of the Arm Assembly and Link Assembly in the helicopter documentation.

The helicopter bearing control was performed by moving the Hub Assembly Main Rotor, a component located in the transmission assembly that interconnected the main rotor-oscillating disc to the main rotor blades (Figure 10).

The pilot, by moving the cyclic control laterally, moves the oscillating disc from the main rotor to the desired side and, consequently, the Hub Assembly Main Rotor will accompany it.

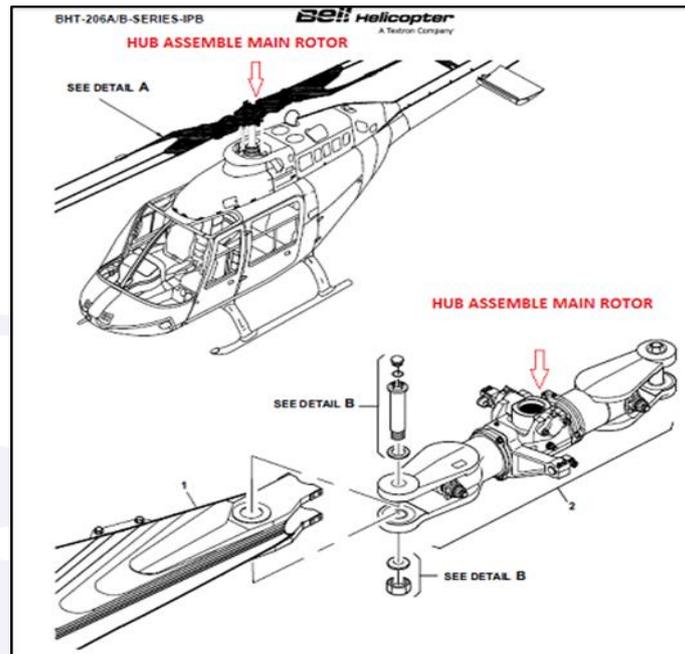


Figure 10 - Hub Assemble Main Rotor Bell 206.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

It was a panoramic flight carried out in the municipality of Aquiraz and beaches of the region. The flight was under normal conditions until the pilot heard an abnormal and intense noise from the transmission of the helicopter.

The lateral tilt control (bearing) of the helicopter by the cyclic command was compromised and the aircraft could only make curves with the aid of the pedals, using them with great amplitude. In addition, when the collective command was actuated, increasing the pitch of the blades, the aircraft tilted to the left.

There were no indications of incorrect operation of the helicopter engine that could have contributed to the occurrence.

Despite finding it difficult to maintain control of the scroll axis, the pilot was able to take the helicopter to the sea and perform a hard landing.

Examining the wreckage of the aircraft, a rupture was found in the Right Front Link Assembly, component that secured the aircraft cell to the main rotor transmission through the Arm Assembly.

Under normal flight conditions, the helicopter bearing control was performed by the cyclic command, causing the Hub Assembly Main Rotor to move, which connected the swashplate to the main rotor blades.

The support vectors of the helicopter were shifted according to the position of the oscillating disc of the main rotor. By moving the cyclic control laterally, the oscillating disc went to the desired side and consequently, the Hub Assembly Main Rotor was accompanying it.

The disruption of the Link Assembly altered the balance of the helicopter, mainly damaging the aircraft's rolling control.

The fractured rod was examined in the laboratory and it was verified the presence of impact marks, kneading and abrasions on the surface. Regarding the deteriorated condition of the rod, the following hypotheses were elaborated:

- Inadequate maintenance procedures; and
- Impacts suffered after the part rupture.

Another result of the laboratory analyzes found that the rupture in the Right Front Link Assembly occurred due to fatigue, and that the fractured region was a point of concentration of tensions. In addition, in the region of the beginning of the fatigue, the presence of a thinning probably caused by sanding was observed.

The tests also showed degradation of the polymer material (elastomer), causing metal component clearance in the right front Link Assembly bearings. The degraded state of the elastomers (including loss of material) could have caused clearance in the working region of the component, inducing vibrations to the assembly and introducing unplanned forces into the rod, facilitating the fatigue process and subsequent in-flight rupture.

During the investigation of the occurrence, it was observed that the elastomers of the Link and Arm Assemblies were covered by a layer of sealant, a procedure not contemplated by the Maintenance Manual of the aircraft.

The aircraft maintenance program prescribed that the Link Assembly should be inspected every 100 hours for damage and deterioration. Although performed, maintenance interventions were impaired, because the presence of the sealant prevented the visualization and evaluation of the elastomers' state of conservation.

3. CONCLUSIONS.

3.1 Facts.

- a) the pilot had valid Aeronautical Medical Certificate (CMA);
- b) the pilot had valid Technical Qualification for the BH06 aircraft type;
- c) the pilot was qualified and had experience in that kind of flight;
- d) the aircraft had valid Airworthiness Certificate (CA);
- e) the aircraft was within the weight and balance parameters specified by the manufacturer.
- f) the airframe, engine and rotors logbook records were updated;
- g) the helicopter was carrying out a panoramic flight on the beaches of the region of Aquiraz - CE;
- h) with approximately 20 minutes of flight, the pilot heard an abnormal noise of great intensity coming from the transmission of the helicopter;
- i) the control of lateral inclination (bearing) of the helicopter using the cyclic command was impaired;
- j) when the collective command was actuated, increasing the power of the engine, the helicopter tilted to the left;
- k) the pilot took the helicopter to a hard landing on the sea;
- l) after landing, the occupants left the aircraft and proceeded to the beach with the help of people who were near the scene of the accident;
- m) the helicopter remained submerged to a depth of approximately 9 meters for about 48 hours;

- n) the right front Link Assembly of the helicopter broke in flight due to fatigue;
- o) impact marks, kneading and wear on the rod surface were observed;
- p) in the region of the beginning of the fatigue, the presence of a thinning, probably by sanding, was observed;
- q) the Link Assembly and Arm Assembly elastomers were covered by a layer of sealant;
- r) the use of sealant in the elastomer was not contemplated in the Aircraft Maintenance Manual;
- s) the presence of sealant prevented the visualization and evaluation of the state of conservation of the elastomers;
- t) the aircraft suffered substantial damage; and
- u) the pilot and the passengers were unharmed.

3.2 Contributing factors.

- Aircraft maintenance – a contributor.

Improper application of sealant to the elastomer of the right front Link Assembly of the aircraft prevented the visualization of the deterioration of the polymer material, with the metallic component having a clearance in the bearings, which associated to the thinning in the part, resulted in the fracture of the item in flight.

- Managerial oversight – a contributor.

The physical conditions of the Aerodrome, with the presence of an X-shaped wood marking, located at runway's threshold 33, together with the presence of a power grid installed near the thresholds may have played a relevant role in the occurrence of the accident.

4. SAFETY RECOMMENDATION.

A measure of preventative/corrective nature issued by a SIPAER Investigation Authority or by a SIPAER-Link within respective area of jurisdiction, aimed at eliminating or mitigating the risk brought about by either a latent condition or an active failure. It results from the investigation of an aeronautical occurrence or from a preventative action, and shall never be used for purposes of blame presumption or apportion of civil, criminal, or administrative liability.

In consonance with the Law n°7565/1986, recommendations are made solely for the benefit of the air activity operational safety, and shall be treated as established in the NSCA 3-13 "Protocols for the Investigation of Civil Aviation Aeronautical Occurrences conducted by the Brazilian State".

Recommendations issued at the publication of this report:

To the Brazil's National Civil Aviation Agency (ANAC):

A-091/CENIPA/2014 - 01

Issued on 17/05/2018

Act next to the TC Helicopter Maintenance shop Ltd. (shop that performed the last inspection of the aircraft) to ensure that the maintenance procedures performed on Bell 206L-3 aircraft are in accordance with the manufacturer's manual.

A-091/CENIPA/2014 - 02**Issued on 17/05/2018**

Act with the TC Helicopter Maintenance shop Ltd., in order to improve the supervision mechanisms of the work performed in the aircraft maintenance.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

Nil.

On May 17th, 2018.

