

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



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MEDICAL

Specialist's Factual Report

December 13, 2022

TABLE OF CONTENTS

A. ACCIDENT.....	3
B. MEDICAL SPECIALIST.....	3
C. DETAILS OF THE INVESTIGATION	3
1.0 PURPOSE	3
2.0 METHODS.....	3
D. FACTUAL INFORMATION.....	3
1.0 PILOT-IN-COMMAND	3
2.0 SECOND-IN-COMMAND.....	4
2.1 FAA Medical Case Review	4
2.2 Autopsy	4
2.3 Toxicology	4
2.3.1 NC OCME Toxicology Results.....	4
2.3.2 FAA Toxicology Results	4
2.3.3 Descriptions of Detected Substances	5
E. SUMMARY OF MEDICAL FACTS.....	7
1.0 PILOT-IN-COMMAND	7
2.0 SECOND-IN-COMMAND.....	7

A. ACCIDENT

Location: Raeford, North Carolina
Date: July 29, 2022

B. MEDICAL SPECIALIST

Specialist Turan Kayagil, MD, FACEP
National Transportation Safety Board
Washington, DC

C. DETAILS OF THE INVESTIGATION

1.0 Purpose

This investigation was performed to evaluate the pilots for medical conditions and substance use.

2.0 Methods

The Federal Aviation Administration (FAA) medical case review, containing information on the pilot-in-command (PIC) and second-in-command (SIC), was reviewed. The autopsy and postmortem toxicology reports for the SIC were reviewed. Selected National Transportation Safety Board (NTSB) investigator reports and relevant regulation and medical literature were also reviewed.

D. FACTUAL INFORMATION

1.0 Pilot-In-Command

According to the FAA medical case review, the 51-year-old male PIC had his last aviation medical examination on April 7, 2022. At that time, he reported 1850 total civilian flight hours. He was 73 inches tall and weighed 235 pounds. He reported no medication use or active medical conditions. No significant issues were identified, and he was issued a first-class medical certificate limited by a requirement to wear corrective lenses.

According to the NTSB investigator in charge, the PIC did not undergo post-accident toxicological testing.

2.0 Second-In-Command

2.1 FAA Medical Case Review

According to the FAA medical case review, the 23-year-old male SIC had his last aviation medical examination on January 18, 2022. At that time, he reported 772 total civilian flight hours. He was 69 inches tall and weighed 166 pounds. He reported no medication use or active medical conditions. No significant issues were identified, and he was issued a first-class medical certificate without limitation.

2.2 Autopsy

The North Carolina Office of the Chief Medical Examiner (NC OCME) performed the autopsy of the SIC. According to the autopsy report, the cause of death was multiple blunt force injuries, and the manner of death was accident. The autopsy examination was somewhat limited by the severity of injuries. Within this limitation, the autopsy did not identify significant natural disease.

2.3 Toxicology

2.3.1 NC OCME Toxicology Results

The NC OCME performed toxicological testing of postmortem urine from the SIC. This testing was negative for ethanol and other tested-for substances.¹

2.3.2 FAA Toxicology Results

The FAA Forensic Sciences Laboratory performed toxicological testing of postmortem specimens from the SIC.² Ethanol was detected at 0.396 g/dL in liver tissue and at 0.011 g/dL in urine, and was not detected in brain tissue. Acetone was detected at a low level in brain tissue, and was not detected in liver tissue or urine.³ Mitragynine was detected in liver tissue and urine. No blood was available for FAA testing.

¹ The NC OCME toxicology report listed tested-for substances as ethanol, amphetamines, benzodiazepines, cocaine metabolite, gabapentin/pregabalin, and opiates/opioids.

² The FAA Forensic Sciences laboratory has the capability to test for well over 1300 substances including toxins, prescription and over-the-counter medications, and illicit drugs. Some of these substances are listed at <https://jag.cami.jccbi.gov/toxicology>.

³ According to the [FAA Forensic Sciences Laboratory methodology website](#), the qualitative positive acetone result in brain tissue indicates that the acetone level was less than 0.0025 g/dL in brain tissue.

2.3.3 Descriptions of Detected Substances

Ethanol is a type of alcohol. It is the intoxicating alcohol in beer, wine, and liquor, and, if consumed, can impair judgment, psychomotor performance, cognition, and vigilance.⁴ FAA regulation imposes strict limits on flying after consuming ethanol, including prohibiting pilots from flying with a blood ethanol level of 0.04 g/dL or greater.⁵ However, consumption is not the only possible source of ethanol in postmortem specimens. Ethanol can be produced by microbes in a person's body after death. Postmortem ethanol production is made more likely by extensive traumatic injury, and can cause an affected toxicological specimen to test positive for ethanol (sometimes at a high level) while another specimen from the same person tests negative.^{6,7}

Acetone is an organic compound that is used industrially and occurs naturally, including as a byproduct of fat metabolism by living cells.⁸ Acetone at the low level detected in the SIC's brain tissue does not have specific significance and would not be expected to have impairing effects.

Mitragynine is a predominant active substance in the drug kratom. Kratom comes from the leaves of a tropical tree species native to Southeast Asia. In the United States, kratom use has grown over the past two decades, and kratom products are now widely available for online and retail purchase. Users typically consume kratom by chewing the leaves, brewing the leaves into a tea, or consuming extracts, powder, or pills derived from the leaves. Less commonly, users may smoke or vape kratom. Kratom users seek various effects, ranging from recreational (such as relaxation, mood elevation, increased energy, social enhancement, or sexual enhancement) to medicinal. Americans who self-medicate with kratom commonly do so with the intention of relieving pain, anxiety, depression, or opioid withdrawal symptoms. Various other medicinal effects might be sought by users, including treating cough, diabetes, diarrhea, insomnia, or alcohol withdrawal. However, kratom's medicinal efficacy remains scientifically uncertain. The United States Food and Drug Administration has not approved kratom for any use, and warns consumers

⁴ Cook CCH. Alcohol and aviation. *Addiction*. 1997;92(5):539-555.

⁵ [14 CFR § 91.17](#).

⁶ Spitz WU. Forensic aspects of alcohol. In: Spitz WU, Spitz DJ, eds. *Spitz and Fisher's Medicolegal Investigation of Death: Guidelines for the Application of Pathology to Crime Investigation*. 4th ed. Springfield, IL: Charles C Thomas; 2006:1218-1229.

⁷ Kugelberg FC, Jones AW. Interpreting results of ethanol analysis in postmortem specimens: a review of the literature. *Forensic Sci Int*. 2007;165(1):10-29. doi:10.1016/j.forsciint.2006.05.004.

⁸ Agency for Toxic Substances and Disease Registry. ToxFAQs for Acetone. Toxic Substances Portal. <https://wwwn.cdc.gov/TSP/ToxFAQs/ToxFAQsDetails.aspx?faqid=4&toxid=1>. Updated June 30, 2022. Accessed December 2, 2022.

not to use the drug, citing safety concerns that need further research, including risk of abuse and addiction. The United States Drug Enforcement Administration has identified kratom as a “Drug of Concern,” but has not listed it as a federally controlled substance. State laws vary.⁹⁻¹⁶ North Carolina law does not prohibit kratom sales to adults. The FAA medical case review for this accident indicates that kratom use is considered disqualifying for pilots under internal FAA policy.

The mechanisms of action of kratom are complex and incompletely understood, involving some of the same pathways as opioids, along with other actions on the nervous system. Kratom effects generally depend on the dose of its active ingredients; this dose can be unpredictable for users because of unreliable potency and purity of kratom products. At lower doses, kratom typically has stimulant effects, which may include increased energy, stamina, and alertness, as well as elevated mood and decreased anxiety, although increased anxiety and agitation may occur in some users. At higher doses, kratom typically has more opioid-like effects, including sedation and euphoria, although dysphoria may also occur. Nausea and dizziness can occur across a range of doses, being more likely as dose increases, and coordination/balance may be adversely affected. Prolonged use of kratom at high doses may contribute to psychosis and seizures. When kratom use is discontinued, withdrawal may occur, with symptoms that may include anxiety/mood disturbance, nausea/vomiting, pain, fatigue, chills/hot flashes, diarrhea, and drug craving. Kratom withdrawal typically lasts 3-7 days, beginning 12-24 hours after last kratom use. Mitragynine can remain in circulation for days after last kratom use. Detecting

⁹ Kerrigan S, Basiliere S. Kratom: A systematic review of toxicological issues. *WIREs Forensic Sci.* 2022;4(1):e1420. doi:10.1002/wfs2.1420.

¹⁰ Eastlack SC, Cornett EM, Kaye AD. Kratom—pharmacology, clinical implications, and outlook: a comprehensive review. *Pain Ther.* 2020;9(1):55-69. doi:10.1007/s40122-020-00151-x.

¹¹ Veltri C, Grundmann O. Current perspectives on the impact of Kratom use. *Subst Abuse Rehabil.* 2019;10:23-31. doi:10.2147/SAR.S164261.

¹² Grundmann O. Patterns of kratom use and health impact in the US—results from an online survey. *Drug Alcohol Depend.* 2017;176:63-70. doi:10.1016/j.drugalcdep.2017.03.007.

¹³ Warner ML, Kaufman NC, Grundmann O. The pharmacology and toxicology of kratom: from traditional herb to drug of abuse. *Int J Legal Med.* 2016;130(1):127-138. doi:10.1007/s00414-015-1279-y.

¹⁴ Prozialeck WC, Jivan JK, Andurkar SV. Pharmacology of kratom: an emerging botanical agent with stimulant, analgesic and opioid-like effects. *J Am Osteopath Assoc.* 2012;112(12):792-799.

¹⁵ United States Food and Drug Administration. FDA and Kratom. Public Health Focus. <https://www.fda.gov/news-events/public-health-focus/fda-and-kratom>. Updated April 27, 2022. Accessed December 9, 2022.

¹⁶ United States Drug Enforcement Administration. Kratom. Drug Fact Sheets. <https://www.dea.gov/factsheets>. Updated June 15, 2020. Accessed December 9, 2022.

mitragynine on toxicological testing requires a specialized approach outside the scope of routine testing for drugs of abuse.^{9-14,17-19}

Notably, some of the symptoms of kratom use and/or withdrawal may overlap with symptoms of conditions that kratom users may seek to treat. For example, anxiety control is a common motivation for kratom use, and anxiety itself may predispose people to heightened physiological responses to stress, which sometimes manifest with nausea, dizziness, or feeling hot or smothered.²⁰ The reason the SIC had used kratom/mitragynine is unknown.

E. SUMMARY OF MEDICAL FACTS

1.0 Pilot-In-Command

The 51-year-old male pilot-in-command (PIC) had his last aviation medical examination on April 7, 2022. At that time, he reported no medication use or active medical conditions. No significant issues were identified, and he was issued a first-class medical certificate limited by a requirement to wear corrective lenses.

2.0 Second-In-Command

The 23-year-old male second-in-command (SIC) had his last aviation medical examination on January 18, 2022. At that time, he reported no medication use or active medical conditions. No significant issues were identified, and he was issued a first-class medical certificate without limitation.

According to the SIC's autopsy report, his cause of death was multiple blunt force injuries, and his manner of death was accident. His autopsy examination was somewhat limited by the severity of his injuries. Within this limitation, the autopsy did not identify significant natural disease.

Postmortem toxicological testing of the SIC's urine performed by the North Carolina Office of the Chief Medical Examiner (NC OCME) was negative for tested-for-substances. Postmortem toxicological testing by the Federal Aviation

¹⁷ Stanciu CN, Gnanasegaram SA, Ahmed S, Penders T. Kratom withdrawal: a systematic review with case series. *J Psychoactive Drugs*. 2019;51(1):12-18. doi:10.1080/02791072.2018.1562133.

¹⁸ Trakulsrichai S, Sathirakul K, Auparakkitanon S, et al. Pharmacokinetics of mitragynine in man. *Drug Des Devel Ther*. 2015;9:2421-2429. doi:10.2147/DDDT.S79658.

¹⁹ Grewal KS. The effect of mitragynine on man. *Br J Med Psychol*. 1932;12(1):41-58. doi:10.1111/j.2044-8341.1932.tb01062.x.

²⁰ Roy-Byrne PP. Panic disorder in adults: epidemiology, clinical manifestations, and diagnosis. In: Post TW, ed. *UpToDate*. Waltham, MA: UpToDate Inc. <https://www.uptodate.com/contents/panic-disorder-in-adults-epidemiology-clinical-manifestations-and-diagnosis>. Updated February 9, 2022. Accessed December 9, 2022.

Administration (FAA) Forensic Sciences Laboratory detected ethanol at 0.396 g/dL in the SIC's liver tissue and at 0.011 g/dL in his urine, and did not detect ethanol in his brain tissue. Acetone was detected at a low level in his brain tissue, and was not detected in his liver tissue or urine. Mitragynine was detected in his liver tissue and urine.

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