Aviation Investigation Final Report

Location:	Hopland, California	**Accident Number:**	LAX01GA291
Date & Time:	August 27, 2001, 18:40 Local	**Registration:**	N442DF
Aircraft:	Grumman TS-2A	**Aircraft Damage:**	Destroyed
Defining Event:		**Injuries:**	1 Fatal
Flight Conducted Under:	Public aircraft		

Analysis

During an aerial fire suppression mission for the California Department of Forestry (CDF), two Grumman TS-2A airplanes, operating as Tanker 92 (N442DF) and Tanker 87 (N450DF), collided in flight while in a holding pattern awaiting a retardant drop assignment on the fire. All of the airplanes fighting the fire were TS-2A's, painted in identical paint schemes. The Air Tactical Group Supervisor (AirTac) was orbiting clockwise 1,000 feet above the tankers, who were in a counterclockwise orbit at 3,000 feet mean sea level (msl). The pilots of both aircraft involved in the collision had previously made several drops on the fire. Records from the Air Tac show that Tankers 86, 91, and 92 were in orbit, and investigation found that Tanker 87 was inbound to enter the orbit after reloading at a nearby airport base. AirTac would write down the tanker numbers as they made their 3-minutes-out call, and usually ordered their drops in the same order as their check-in. The AirTac's log recorded the sequence 86, 91, 21, and 92. The log did not contain an entry for Tanker 87. Other pilots on frequency did not recall hearing Tanker 87 check in. Based on clock codes with 12-o'clock being north, the tankers were in the following approximate positions of the orbit when the collision occurred. Tanker 92 was at the 2-o'clock position; Tanker 86 was turning in at the 5-o'clock position; and Tanker 91 was in the 7-o'clock position. The AirTac's log indicated that Tanker 92 was going to move up in sequence and follow Tanker 86 in order to drop immediately after him. Post accident examination determined that Tanker 92's flaps were down, indicating that the pilot had configured the airplane for a drop. Tanker 92 swung out of the orbit wide (in an area where ground witnesses had not seen tankers all day) to move behind Tanker 86, and the pilot would likely have been focusing on Tanker 86 out of his left side window. Tanker 87 was on line direct to the center of the fire on a path that witnesses had not observed tankers use that day. Reconstruction of the positions of the airplanes disclosed that Tankers 86 and 91 would have been directly in front of Tanker 87, and Tanker 92 would have been wide to his left. Ground witnesses said that Tanker 87 had cleared a ridgeline just prior to the collision, and this ridgeline could have masked both collision aircraft from the visual perspective of the respective pilots. The right propeller, engine, and cockpit of Tanker 92 contacted and separated the empennage of Tanker

87. The propeller chop was about 47 degrees counterclockwise to the longitudinal axis of Tanker 87 as viewed from the top. The collision appeared to have occurred about 2,500 feet, which was below orbit altitude. CDF had no standard operating manual, no established reporting or entry point for the holding orbits, and a tanker could enter any point of the orbit from any direction. While no standardized procedures were encoded in an operating manual, a CDF training syllabus noted that a tanker was not to enter an orbit until establishing positive radio contact with the AirTac. The entering tanker would approach 1,000 feet below AirTac's altitude and stay in a left orbit that was similar to a salad bowl, high and wide enough to see and clear all other tankers until locating the tanker that it was to follow, then adjust speed and altitude to fall in behind the preceding airplane.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: the failure of both pilots to maintain an adequate visual lookout. The failure of the pilot in Tanker 87 to comply with suggested procedures regarding positive radio contact and orbit entry was a factor.

Findings

Occurrence #1: MIDAIR COLLISION
Phase of Operation: MANEUVERING

Findings
1. (C) VISUAL LOOKOUT - INADEQUATE - PILOTS OF BOTH AIRCRAFT
2. (F) PROCEDURES/DIRECTIVES - NOT COMPLIED WITH - PILOT OF OTHER AIRCRAFT

Factual Information

1.1 HISTORY OF FLIGHT

On August 27, 2001, about 1840 Pacific daylight time, Tanker 87, a Grumman TS-2A, N450DF, collided with Tanker 92, a Grumman TS-2A, N442DF, near Hopland, California. The California Department of Forestry (CDF) was operating the airplanes as public-use fire suppression flights under the provisions of 14 CFR Part 91. Tanker 87's pilot held an airline transport pilot certificate; Tanker 92's pilot held an airline transport pilot certificate. The collision sequence and post crash fires destroyed both airplanes. Tanker 92 departed Ukiah, California, at 1830, and Tanker 87 departed Ukiah at 1834. Visual meteorological conditions prevailed, and no flight plans had been filed. The primary wreckage for Tanker 87 was at 39 degrees 00.878 minutes north latitude and 123 degrees 11.603 minutes west longitude, at an estimated elevation of 1,955 feet. The primary wreckage for Tanker 92 was at 39 degrees 01.089 minutes north latitudeand 123 degrees 11.65 minutes west longitude, at an estimated elevation of 2,150 feet.

WITNESSES

1.1.1 AirTac

An airborne observer who was not a pilot served as the Air Tactical Group Supervisor (AirTac). AirTac orbited the fire in a clockwise pattern about 2,000 feet above ground level (agl). The tankers orbited in a counterclockwise pattern about 1,000 agl. AirTac remained in contact with the incident commander on the ground, and directed the tanker drops on the fire. AirTac directed the tankers on their drop order, and described the desired target point for the drop.

The first tankers arrived on scene prior to AirTac, and established a tanker pattern altitude of 3,000 feet mean sea level (msl). AirTac arrived and began an orbit at 3,500 feet. He moved up to 4,000 feet msl by the end of the day. As tankers approached the scene, they made a 3-minutes-out call; if the frequency was congested, they made a 2-minute or 1-minute call. Most tanker pilots reported that they made a direct path from Ukiah to the fire, and entered the orbit about 150 knots. Several pilots noted that the air-to-air frequency was heavily congested.

AirTac said that three helicopters and eight tankers were working the fire. Not all aircraft were on scene at the same time. Tanker 92 had already made five drops, and Tanker 87 had already made six drops. Tankers 92, 86, and 91 were in orbit.

Based on clock codes with 12-o'clock being north, the tankers were in the following approximate positions of the orbit when AirTac called Tanker 86 in to drop. Tanker 92 was at the 2-o'clock position; Tanker 86 was turning in at the 5-o'clock position; and Tanker 91 was in

the 7-o'clock position. AirTac's log indicated that Tanker 92 was going to move up in sequence and follow Tanker 86 in order to drop immediately after him in what the tanker crews call a daisy chain. The AirTac was heading westbound in the 6- to 7-o'clock position.

1.1.2 Tanker 86

As Tanker 86 set up to enter the drop pattern, he heard Tanker 92's pilot say that he had him in sight and was going to swing wide. He assumed that Tanker 92's reference was to himself. At this point, Tanker 86 was south of Bus McGall Peak and turning to the west about 2,500 feet msl. During the left turn, the pilot of Tanker 86 reached up to prepare his airplane for the drop. As he looked to his front right position, he observed the two airplanes collide.

1.1.3 Tanker 91

Tanker 91 departed runway 33 at Ukiah. The pilot stated that he had just entered the orbit, and had not made a complete pattern. Tanker 92 was physically ahead of Tanker 86 in the orbit. He heard Tanker 92's pilot say: "I've got you in sight. I'll go wide." He initially thought that 92 was referring to Tanker 86, and swinging wide of the dropping tanker would be the proper thing to do. However, he became unsure of whom 92's pilot was referencing since he now saw another tanker in Tanker 92's proximity. Although Tanker 92 said that he was going wide, the airplane never went right. It continued in a continuous left turn, like tankers always are. Tanker 91 only saw the approaching tanker for about 5 to 6 seconds. He did not see any evasive action. The approaching tanker was either in a climb or pulled up a split second prior to the collision.

1.1.4 Tanker 21

The aircrew in Tanker 21 reported that they were coming from Medford, Oregon, and checked in over Lake Mendocino. They fell about 2 miles in trail of Tanker 87 as it left Ukiah on a right downwind departure. They followed it in a southerly direction along the hills east of the Ukiah valley, and as it turned to a southwesterly heading toward the fire. As they headed toward the fire, the copilot said that AirTac was talking to Tanker 92 and explaining the drop. To the copilot, this meant that Tanker 92 was preparing to drop.

Tanker 21's altitude was about 3,500 feet, and they estimated that Tanker 87 was at 3,000 feet or below. Tanker 87 was entering the orbit directly toward the center of the fire rather than making a wide orbit. They observed a second tanker approach from southeast to west. The pilot estimated that the two airplanes were converging at a 60-degree angle. The copilot said that Tanker 87 cleared a ridgeline, and pulled up just prior to impact. He did not observe any avoidance maneuver by the westbound tanker, whose right wing was up. They observed Tanker 87 continue in a southerly direction, and it rolled left. The other tanker rolled 90 degrees wing low and nosed down about 60 degrees as it continued toward the west.

1.1.5 Ground Witness 1

A ground witness was on a promontory point observing the horizon to the west for signs of the fire. This observation point was about 1,900 feet elevation and 1 mile east of the accident site. This witness observed a tanker northwest of her position that was proceeding southbound on a track that she had observed other tankers use during the day. As she looked back to the west, she observed another tanker south of her position that was proceeding in a westerly direction. She had not seen a tanker in this area during the day. She observed the tankers as they converged and collided. The westbound tanker went under the southbound tanker. She could see the top of Goat Rock (about 2,400 feet elevation) above the two airplanes.

1.1.6 Ground Witnesses 2, 3, and 4

Several ground witnesses (including the incident commander) were together at the edge of a meadow in a saddle (about 2,000 feet elevation) between Goat Rock and Bus McGall Peak (about 2,200 feet elevation and 1/2 mile southeast of Goat Rock).

The incident commander was also a relief air attack pilot. He was facing east with maps on the hood of a car as he was briefing other ground commanders. He looked east, and saw two tankers in the orbit; this was the orbit that he had been observing other airplanes use during the aerial firefight. He estimated that the tanker farthest away was on a 45-degree angle from the closest airplane. Based on his experience, he felt that the airplane on the inside was preparing to make a drop. He felt that the pilot of the far airplane was watching the closer airplane so that the far pilot would know where to drop. He thought that the far airplane was in a slight left turn. With his peripheral vision, he detected a third airplane. All three airplanes appeared to be about the same altitude. He estimated that the airplanes were only a few hundred feet away horizontally, and several hundred feet vertically from his location. He had not seen an airplane enter the pattern at the third airplane's location. Most pilots entered a wide pattern north of Goat Rock and gradually tightened their radius as they descended into the orbit. He expected the pilot of the third airplane to make a hard right to enter the left orbit; however, it did not.

All of the witnesses in the saddle observed the southbound tanker heading straight for them, and then observed the westbound tanker. The westbound tanker slid below the southbound tanker. A spherical cluster of debris emanated from the collision point, which was about 400 yards away on the opposite side of a meadow. The westbound tanker continued westbound and did not seem to have a tail. The southbound tanker continued straight toward them; it seemed to one witness that the nose pitched down, then slightly back up, and pitched down until the nose was vertical to the ground. They observed the tail of the southbound tanker twirl and separate. This airplane exploded on ground contact about 200 feet from their location. They observed smoke coming from the direction of the other tanker.

1.1.7 Ground Witness 5

Another ground witness observed the westbound tanker fly over him. He was getting water

from a pond. When he first observed the tanker, it was just rolling out of a bank. It continued up the valley that he was in, and remained in a level attitude as it flew away from him. He observed the southbound tanker moving from his right to left. Just prior to impact, it appeared to him that the westbound tanker turned left, and the southbound tanker tried to climb.

1.5 PERSONNEL INFORMATION

1.5.1 Tanker 92 Pilot

A review of Federal Aviation Administration (FAA) airman records revealed that the pilot of Tanker 92 held an airline transport pilot certificate with an airplane multiengine land rating. He held a commercial pilot certificate with an airplane single engine land rating. He held type ratings in the CE-500 and G-S2. The pilot held a second-class medical certificate issued on May 11, 2001. It had the limitations that the pilot must wear corrective lenses for near and distant vision. The operator reported that he had 12,725 hours of total flight time with 340 in this make and model. He accumulated 2 hours in the previous 24 hours.

1.5.2 Tanker 87 Pilot

A review of FAA airman records revealed that the pilot of Tanker 87 held an airline transport pilot certificate with an airplane multiengine land rating. He held a commercial pilot certificate with an airplane single engine land rating. He held type ratings in the L-382 and G-S2. The pilot held a first-class medical certificate issued on March 21, 2001. It had the limitation that the pilot must wear corrective lenses. The operator reported that he had 4,639 hours of total flight time with 1,294 in this make and model. He accumulated 4 hours in the previous 24 hours.

1.6 AIRCRAFT INFORMATION

1.6.1 Tanker 92

Tanker 92 was a Grumman TS-2A, serial number 255. CDF reported a total airframe time of 9,868 hours. CDF maintenance technicians completed a 175-hour inspection on August 23, 2001, at a total time of 9,860 hours. The airplane had a Curtiss-Wright R-1820-82B engine installed on both sides.

1.6.2 Tanker 87

Tanker 87 was a Grumman TS-2A, serial number 421. CDF reported a total airframe time of 10,354 hours. CDF maintenance technicians completed a 175-hour inspection on August 21, 2001, at a total time of 10,345 hours. The airplane had a Curtiss-Wright R-1820-82B engine installed on both sides.

1.7 METEOROLOGICAL INFORMATION

An aviation routine weather report (METAR) for Ukiah was issued at 1856. It stated: skies clear; visibility 10 miles; winds from 340 degrees at 9 knots; temperature 86 degrees Fahrenheit; dew point 43 degrees Fahrenheit; altimeter 29.87 inches of mercury.

1.12 WRECKAGE AND IMPACT INFORMATION

1.12.1 General Information

San Joaquin Helicopters provided the contract pilots for the tankers. The National Transportation Safety Board investigator-in-charge (IIC) and investigators from the CDF and San Joaquin Helicopters examined the wreckage on scene. Both propellers rotate clockwise as seen from the rear. The propeller diameter was 11 feet, the blade tips were red; the propeller domes were black; and the leading edges of both engine cowlings were black.

The debris field for both airplanes was in hilly terrain and encompassed an area about 1/2 mile in diameter. Pieces from both airplanes commingled under the area that witness described as the collision point.

1.12.2 Commingled Debris Field

Cockpit pieces from Tanker 92 in the commingled area included overhead hatches, the windscreen, and control levers located on the forward overhead section of the cockpit. Pieces of the right engine nose case torque meter cavity were in this area. Two propeller blade tips from Tanker 92's right propeller were in this area. Pieces in this area were not charred. The nose landing gear was about 75 feet east of the estimated impact point.

Empennage pieces from Tanker 87 were in the commingled debris field. The horizontal stabilizers, elevators, trim tabs, and vertical stabilizer separated from the fuselage just forward of the dorsal fin.

The outboard portion of the left horizontal stabilizer, its elevator, and trim tab separated from the rest of the empennage components. This piece came to rest on top of a knoll. The separation line began about midspan at the leading edge, and traversed along a relatively straight line to the inboard trailing edge of the stabilizer. The separation line continued along the same line across the elevator and trim tab. It had structural members that bent and curled in an upward direction. Some segments exhibited red paint transfer marks. The straight separation surface also went up about 2/3 of the vertical stabilizer.

The remainder of the left horizontal stabilizer, the vertical stabilizer, the right horizontal stabilizer, and right elevator remained together. This section was at the bottom of the knoll about 50 yards from the separated left outboard horizontal stabilizer piece. None of these components were charred. The fracture surface on the inboard portion of the left horizontal stabilizer was smoother looking than its mating part on the outboard piece.

Both segments of the left horizontal stabilizer and the vertical stabilizer had separation surfaces that were along a similar angle. This angle was about 47 degrees counterclockwise from the longitudinal axis as viewed from the top.

The two-segment rudder for Tanker 87 fragmented into several pieces, which were scattered throughout the commingled debris field. All of these pieces were deformed, bent, and twisted with irregular separation surfaces. A black, viscous liquid covered some of these pieces; bottom pieces were wetter than top pieces. The left side was wetter than the right side. The lower left side of the rudder exhibited a black paint transfer mark, which had dimensions similar to a propeller dome. None of these components were charred.

The lower left fuselage structure near the arresting hook attachment exhibited more damage than other airframe areas. All of the airframe pieces in lower aft fuselage region contained thick deposits of a black, viscous liquid.

1.12.3 Tanker 92 Main Wreckage

Major components for Tanker 92 (including wings, engines, fuselage, and empennage) fragmented and separated, but were within feet of their respective positions. Sections of cockpit in the main wreckage area included sections below the level of the windshield and aft upper ceiling pieces. The wings and engines were inverted and both wings exhibited similar leading edge crush damage that went aft to the main spar. Investigators accounted for the wing control surfaces in the main wreckage area. The empennage came to rest on its left side so that the right horizontal stabilizer was pointing up vertically. The vertical stabilizer and rudder exhibited aft and down crush damage. Fire charred all components and vegetation in the main wreckage area. Several bomb bay doors and the nose gear separated and were within 40 yards of the main wreckage; these pieces were outside of the burn area and not charred.

Tanker 92's right propeller exhibited more damage than the left propeller. The right propeller hub assembly, propeller shaft, and nose case reduction assembly separated and came to rest about 150 yards downhill from the main wreckage; these pieces was not charred. The inner sections of all three blades remained attached to this unit. CDF maintenance personnel identified a piece of structure imbedded at the hub/blade root, and opined that it was a piece of rudder. All three blades separated about 24 inches from the tips. One blade tip was between the main wreckage and the propeller. This tip piece was leaning against a tree, which exhibited several debarked areas along its trunk. Gouges in the ground that were about 6 feet apart went downhill from this tip piece to the remainder of the propeller. The other two blade tips for the right engine were in the commingled debris field; these tips exhibited chordwise striations. Two blades remained attached to the left propeller; the third blade separated and was near the hub.

1.12.3 Tanker 87 Main Wreckage

The main wreckage for Tanker 87 was about 400 yards from the commingled area. The debris field for the main wreckage of Tanker 87 covered several hundred feet; all of the main wreckage pieces and grass in this area were charred. Proceeding from an east-to-west direction, investigators identified the sonar area, wings, and landing gear, engines, propellers, bomb bay area, and cockpit area. Investigators accounted for the wing control surfaces in the main wreckage area.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

The Mendocino County Coroner completed an autopsy for the pilot of each airplane.

The FAA Toxicology and Accident Research Laboratory performed toxicological testing of specimens of the pilot of each airplane.

1.13.1 Tanker 92 Toxicology

For Tanker 92's pilot, tests for carbon monoxide and cyanide were not performed. The results of analysis of the specimens had no findings for ethanol detected in muscle and tested drugs.

1.13.2 Tanker 87 Toxicology

For Tanker 87's pilot, tests for carbon monoxide and cyanide were not performed. The results of analysis of the specimens had no findings for tested drugs. The report contained the following finding: 41 (mg/dL, mg/hg) ethanol detected in muscle.

1.16 TESTS AND RESEARCH

1.16.1 Tanker Operations

AirTac said that he was responsible for monitoring separation of the tankers in their orbit, but not during entry. He would write down the tanker numbers as they made their 3-minutes-out call, and usually ordered their drops in the same order as their check-in. A review of AirTac's log recorded the sequence 86, 91, 21 (who checked in prior to reaching Ukiah), and 92. The log did not contain an entry for Tanker 87.

The CDF training syllabus noted that tanker pilots should check in while 3 minutes out, and they should not approach any closer until checked in by the on scene AirTac. CDF had no standard operating manual, no established reporting or entry point, and a tanker could enter any point of the orbit from any direction. The syllabus indicated that the AirTac would provide tail numbers of the tankers on scene, and specify the tanker that the entering airplane would follow.

The entering tanker would approach 1,000 feet below the AirTac altitude, and stay in a left orbit

that was similar to a salad bowl. The tanker would enter wide enough to see and clear all other tankers until locating the tanker that it was to follow. The entering tanker was to adjust speed and altitude to fall in behind its target to the outside and above. It would maintain the highest and widest orbit.

When the AirTac called a tanker in for a drop, the tanker would slide inside the orbit and descend as it set up for its drop. The pilot would select the third flap position, and slow to about 130 knots. The tanker pilot preparing to drop would focus on the inside of the pattern toward the fire. The dropping tanker would be in the lowest and tightest orbit. The dropping tanker pilot would call downwind, base, and final before dropping the load at 200 feet agl.

One pilot stated that they were not supposed to enter the orbit without establishing contact. Several pilots reported that they would not know how many tankers had been dispatched to work a fire. Most thought that this fire was rather routine regarding the terrain features. Several remarked that the turn around time for the tankers was low since Ukiah was so close to the fire. Several pilots noted the heavy volume of radio traffic, and felt that this AirTac was at the maximum operating limit. Several pilots remembered Tanker 21 checking in. One pilot recalled hearing Tanker 87 check in, but was not sure if it was the accident flight or a previous flight. Some pilots made as many as nine trips to the fire.

1.16.2 Follow-up Wreckage Examination

Investigators examined the wreckage at a vacant plant storage lot in Ukiah on September 1 and 2, 2001.

1.16.2.1 Tanker 92

With the technical assistance of CDF maintenance personnel, the investigation determined that the flap actuator was in the extended position, indicating that the flaps were in the down position at impact. They could not determine the landing gear position. They could not identify any powerplant or flight control systems malfunctions that might have existed prior to the collision.

1.16.2.2 Tanker 87

With the technical assistance of CDF maintenance personnel, the investigation could not determine the position of the landing gear. The flap actuator was in the retracted position, indicating that the flaps were up. They removed the spark plugs and observed normal combustion patterns. They could not identify any powerplant or flight control systems malfunctions that might have existed prior to the collision.

ADDITIONAL INFORMATION

The Safety Board IIC released the wreckage to the CDF.

Pilot Information

Certificate:	Airline transport	**Age:**	45,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 Valid Medical--w/ waivers/lim	**Last FAA Medical Exam:**	May 1, 2001
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	May 1, 2001
Flight Time:	12725 hours (Total, all aircraft), 340 hours (Total, this make and model), 2 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Grumman	**Registration:**	N442DF
Model/Series:	TS-2A	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Restricted (Special)	**Serial Number:**	255
Landing Gear Type:	Retractable - Tricycle	**Seats:**	2
Date/Type of Last Inspection:	August 23, 2001 Continuous airworthiness	**Certified Max Gross Wt.:**	27000 lbs
Time Since Last Inspection:	8 Hrs	**Engines:**	2 Reciprocating
Airframe Total Time:	9868 Hrs	**Engine Manufacturer:**	Curtis Wright
ELT:	Installed, not activated	**Engine Model/Series:**	R1820-82B
Registered Owner:	CALIFORNIA DEPARTMENT OF FORESTRY	**Rated Power:**	1200 Horsepower
Operator:		**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	UKI,614 ft msl	**Distance from Accident Site:**	
Observation Time:	18:56 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	9 knots / 0 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	340°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.87 inches Hg	**Temperature/Dew Point:**	30°C / 6°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	UKIAH, CA (UKI)	**Type of Flight Plan Filed:**	None
Destination:		**Type of Clearance:**	None
Departure Time:	18:30 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	On-ground
Total Injuries:	1 Fatal	**Latitude, Longitude:**	39.018054,-123.194168

Administrative Information

Investigator In Charge (IIC):	Plagens, H.
Additional Participating Persons:	James Ramage; California Department of Forestry; Sacramento, CA Antonio Agosta, Jr.; San Jouquin Helicopters; McClellan, CA
Original Publish Date:	September 13, 2005
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=53123

Aviation Investigation Final Report

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Defining Event:		**Injuries:**	1 Fatal
Flight Conducted Under:	Part 91: General aviation - Public aircraft		

Analysis

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87. The propeller chop was about 47 degrees counterclockwise to the longitudinal axis of Tanker 87 as viewed from the top. The collision appeared to have occurred about 2,500 feet, which was below orbit altitude. CDF had no standard operating manual, no established reporting or entry point for the holding orbits, and a tanker could enter any point of the orbit from any direction. While no standardized procedures were encoded in an operating manual, a CDF training syllabus noted that a tanker was not to enter an orbit until establishing positive radio contact with the AirTac. The entering tanker would approach 1,000 feet below AirTac's altitude and stay in a left orbit that was similar to a salad bowl, high and wide enough to see and clear all other tankers until locating the tanker that it was to follow, then adjust speed and altitude to fall in behind the preceding airplane.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: the failure of both pilots to maintain an adequate visual lookout. The failure of the pilot in Tanker 87 to comply with suggested procedures regarding positive radio contact and orbit entry was a factor.

Findings

Occurrence #1: MIDAIR COLLISION
Phase of Operation: MANEUVERING

Findings
1. (C) VISUAL LOOKOUT - INADEQUATE - PILOTS OF BOTH AIRCRAFT
2. (F) PROCEDURES/DIRECTIVES - NOT COMPLIED WITH - PILOT IN COMMAND

Factual Information

1.1 HISTORY OF FLIGHT

On August 27, 2001, about 1840 Pacific daylight time, Tanker 87, a Grumman TS-2A, N450DF, collided with Tanker 92, a Grumman TS-2A, N442DF, near Hopland, California. The California Department of Forestry (CDF) was operating the airplanes as public-use fire suppression flights under the provisions of 14 CFR Part 91. Tanker 87's pilot held an airline transport pilot certificate; Tanker 92's pilot held an airline transport pilot certificate. The collision sequence and post crash fires destroyed both airplanes. Tanker 92 departed Ukiah, California, at 1830, and Tanker 87 departed Ukiah at 1834. Visual meteorological conditions prevailed, and no flight plans had been filed. The primary wreckage for Tanker 87 was at 39 degrees 00.878 minutes north latitude and 123 degrees 11.603 minutes west longitude, at an estimated elevation of 1,955 feet. The primary wreckage for Tanker 92 was at 39 degrees 01.089 minutes north latitudeand 123 degrees 11.65 minutes west longitude, at an estimated elevation of 2,150 feet.

WITNESSES

1.1.1 AirTac

An airborne observer who was not a pilot served as the Air Tactical Group Supervisor (AirTac). AirTac orbited the fire in a clockwise pattern about 2,000 feet above ground level (agl). The tankers orbited in a counterclockwise pattern about 1,000 agl. AirTac remained in contact with the incident commander on the ground, and directed the tanker drops on the fire. AirTac directed the tankers on their drop order, and described the desired target point for the drop.

The first tankers arrived on scene prior to AirTac, and established a tanker pattern altitude of 3,000 feet mean sea level (msl). AirTac arrived and began an orbit at 3,500 feet. He moved up to 4,000 feet msl by the end of the day. As tankers approached the scene, they made a 3-minutes-out call; if the frequency was congested, they made a 2-minute or 1-minute call. Most tanker pilots reported that they made a direct path from Ukiah to the fire, and entered the orbit about 150 knots. Several pilots noted that the air-to-air frequency was heavily congested.

AirTac said that three helicopters and eight tankers were working the fire. Not all aircraft were on scene at the same time. Tanker 92 had already made five drops, and Tanker 87 had already made six drops. Tankers 92, 86, and 91 were in orbit.

Based on clock codes with 12-o'clock being north, the tankers were in the following approximate positions of the orbit when AirTac called Tanker 86 in to drop. Tanker 92 was at the 2-o'clock position; Tanker 86 was turning in at the 5-o'clock position; and Tanker 91 was in

the 7-o'clock position. AirTac's log indicated that Tanker 92 was going to move up in sequence and follow Tanker 86 in order to drop immediately after him in what the tanker crews call a daisy chain. The AirTac was heading westbound in the 6- to 7-o'clock position.

1.1.2 Tanker 86

As Tanker 86 set up to enter the drop pattern, he heard Tanker 92's pilot say that he had him in sight and was going to swing wide. He assumed that Tanker 92's reference was to himself. At this point, Tanker 86 was south of Bus McGall Peak and turning to the west about 2,500 feet msl. During the left turn, the pilot of Tanker 86 reached up to prepare his airplane for the drop. As he looked to his front right position, he observed the two airplanes collide.

1.1.3 Tanker 91

Tanker 91 departed runway 33 at Ukiah. The pilot stated that he had just entered the orbit, and had not made a complete pattern. Tanker 92 was physically ahead of Tanker 86 in the orbit. He heard Tanker 92's pilot say: "I've got you in sight. I'll go wide." He initially thought that 92 was referring to Tanker 86, and swinging wide of the dropping tanker would be the proper thing to do. However, he became unsure of whom 92's pilot was referencing since he now saw another tanker in Tanker 92's proximity. Although Tanker 92 said that he was going wide, the airplane never went right. It continued in a continuous left turn, like tankers always are. Tanker 91 only saw the approaching tanker for about 5 to 6 seconds. He did not see any evasive action. The approaching tanker was either in a climb or pulled up a split second prior to the collision.

1.1.4 Tanker 21

The aircrew in Tanker 21 reported that they were coming from Medford, Oregon, and checked in over Lake Mendocino. They fell about 2 miles in trail of Tanker 87 as it left Ukiah on a right downwind departure. They followed it in a southerly direction along the hills east of the Ukiah valley, and as it turned to a southwesterly heading toward the fire. As they headed toward the fire, the copilot said that AirTac was talking to Tanker 92 and explaining the drop. To the copilot, this meant that Tanker 92 was preparing to drop.

Tanker 21's altitude was about 3,500 feet, and they estimated that Tanker 87 was at 3,000 feet or below. Tanker 87 was entering the orbit directly toward the center of the fire rather than making a wide orbit. They observed a second tanker approach from southeast to west. The pilot estimated that the two airplanes were converging at a 60-degree angle. The copilot said that Tanker 87 cleared a ridgeline, and pulled up just prior to impact. He did not observe any avoidance maneuver by the westbound tanker, whose right wing was up. They observed Tanker 87 continue in a southerly direction, and it rolled left. The other tanker rolled 90 degrees wing low and nosed down about 60 degrees as it continued toward the west.

1.1.5 Ground Witness 1

A ground witness was on a promontory point observing the horizon to the west for signs of the fire. This observation point was about 1,900 feet elevation and 1 mile east of the accident site. This witness observed a tanker northwest of her position that was proceeding southbound on a track that she had observed other tankers use during the day. As she looked back to the west, she observed another tanker south of her position that was proceeding in a westerly direction. She had not seen a tanker in this area during the day. She observed the tankers as they converged and collided. The westbound tanker went under the southbound tanker. She could see the top of Goat Rock (about 2,400 feet elevation) above the two airplanes.

1.1.6 Ground Witnesses 2, 3, and 4

Several ground witnesses (including the incident commander) were together at the edge of a meadow in a saddle (about 2,000 feet elevation) between Goat Rock and Bus McGall Peak (about 2,200 feet elevation and 1/2 mile southeast of Goat Rock).

The incident commander was also a relief air attack pilot. He was facing east with maps on the hood of a car as he was briefing other ground commanders. He looked east, and saw two tankers in the orbit; this was the orbit that he had been observing other airplanes use during the aerial firefight. He estimated that the tanker farthest away was on a 45-degree angle from the closest airplane. Based on his experience, he felt that the airplane on the inside was preparing to make a drop. He felt that the pilot of the far airplane was watching the closer airplane so that the far pilot would know where to drop. He thought that the far airplane was in a slight left turn. With his peripheral vision, he detected a third airplane. All three airplanes appeared to be about the same altitude. He estimated that the airplanes were only a few hundred feet away horizontally, and several hundred feet vertically from his location. He had not seen an airplane enter the pattern at the third airplane's location. Most pilots entered a wide pattern north of Goat Rock and gradually tightened their radius as they descended into the orbit. He expected the pilot of the third airplane to make a hard right to enter the left orbit; however, it did not.

All of the witnesses in the saddle observed the southbound tanker heading straight for them, and then observed the westbound tanker. The westbound tanker slid below the southbound tanker. A spherical cluster of debris emanated from the collision point, which was about 400 yards away on the opposite side of a meadow. The westbound tanker continued westbound and did not seem to have a tail. The southbound tanker continued straight toward them; it seemed to one witness that the nose pitched down, then slightly back up, and pitched down until the nose was vertical to the ground. They observed the tail of the southbound tanker twirl and separate. This airplane exploded on ground contact about 200 feet from their location. They observed smoke coming from the direction of the other tanker.

1.1.7 Ground Witness 5

Another ground witness observed the westbound tanker fly over him. He was getting water

from a pond. When he first observed the tanker, it was just rolling out of a bank. It continued up the valley that he was in, and remained in a level attitude as it flew away from him. He observed the southbound tanker moving from his right to left. Just prior to impact, it appeared to him that the westbound tanker turned left, and the southbound tanker tried to climb.

1.5 PERSONNEL INFORMATION

1.5.1 Tanker 92 Pilot

A review of Federal Aviation Administration (FAA) airman records revealed that the pilot of Tanker 92 held an airline transport pilot certificate with an airplane multiengine land rating. He held a commercial pilot certificate with an airplane single engine land rating. He held type ratings in the CE-500 and G-S2. The pilot held a second-class medical certificate issued on May 11, 2001. It had the limitations that the pilot must wear corrective lenses for near and distant vision. The operator reported that he had 12,725 hours of total flight time with 340 in this make and model. He accumulated 2 hours in the previous 24 hours.

1.5.2 Tanker 87 Pilot

A review of FAA airman records revealed that the pilot of Tanker 87 held an airline transport pilot certificate with an airplane multiengine land rating. He held a commercial pilot certificate with an airplane single engine land rating. He held type ratings in the L-382 and G-S2. The pilot held a first-class medical certificate issued on March 21, 2001. It had the limitation that the pilot must wear corrective lenses. The operator reported that he had 4,639 hours of total flight time with 1,294 in this make and model. He accumulated 4 hours in the previous 24 hours.

1.6 AIRCRAFT INFORMATION

1.6.1 Tanker 92

Tanker 92 was a Grumman TS-2A, serial number 255. CDF reported a total airframe time of 9,868 hours. CDF maintenance technicians completed a 175-hour inspection on August 23, 2001, at a total time of 9,860 hours. The airplane had a Curtiss-Wright R-1820-82B engine installed on both sides.

1.6.2 Tanker 87

Tanker 87 was a Grumman TS-2A, serial number 421. CDF reported a total airframe time of 10,354 hours. CDF maintenance technicians completed a 175-hour inspection on August 21, 2001, at a total time of 10,345 hours. The airplane had a Curtiss-Wright R-1820-82B engine installed on both sides.

1.7 METEOROLOGICAL INFORMATION

An aviation routine weather report (METAR) for Ukiah was issued at 1856. It stated: skies clear; visibility 10 miles; winds from 340 degrees at 9 knots; temperature 86 degrees Fahrenheit; dew point 43 degrees Fahrenheit; altimeter 29.87 inches of mercury.

1.12 WRECKAGE AND IMPACT INFORMATION

1.12.1 General Information

San Joaquin Helicopters provided the contract pilots for the tankers. The National Transportation Safety Board investigator-in-charge (IIC) and investigators from the CDF and San Joaquin Helicopters examined the wreckage on scene. Both propellers rotate clockwise as seen from the rear. The propeller diameter was 11 feet, the blade tips were red; the propeller domes were black; and the leading edges of both engine cowlings were black.

The debris field for both airplanes was in hilly terrain and encompassed an area about 1/2 mile in diameter. Pieces from both airplanes commingled under the area that witness described as the collision point.

1.12.2 Commingled Debris Field

Cockpit pieces from Tanker 92 in the commingled area included overhead hatches, the windscreen, and control levers located on the forward overhead section of the cockpit. Pieces of the right engine nose case torque meter cavity were in this area. Two propeller blade tips from Tanker 92's right propeller were in this area. Pieces in this area were not charred. The nose landing gear was about 75 feet east of the estimated impact point.

Empennage pieces from Tanker 87 were in the commingled debris field. The horizontal stabilizers, elevators, trim tabs, and vertical stabilizer separated from the fuselage just forward of the dorsal fin.

The outboard portion of the left horizontal stabilizer, its elevator, and trim tab separated from the rest of the empennage components. This piece came to rest on top of a knoll. The separation line began about midspan at the leading edge, and traversed along a relatively straight line to the inboard trailing edge of the stabilizer. The separation line continued along the same line across the elevator and trim tab. It had structural members that bent and curled in an upward direction. Some segments exhibited red paint transfer marks. The straight separation surface also went up about 2/3 of the vertical stabilizer.

The remainder of the left horizontal stabilizer, the vertical stabilizer, the right horizontal stabilizer, and right elevator remained together. This section was at the bottom of the knoll about 50 yards from the separated left outboard horizontal stabilizer piece. None of these components were charred. The fracture surface on the inboard portion of the left horizontal stabilizer was smoother looking than its mating part on the outboard piece.

Both segments of the left horizontal stabilizer and the vertical stabilizer had separation surfaces that were along a similar angle. This angle was about 47 degrees counterclockwise from the longitudinal axis as viewed from the top.

The two-segment rudder for Tanker 87 fragmented into several pieces, which were scattered throughout the commingled debris field. All of these pieces were deformed, bent, and twisted with irregular separation surfaces. A black, viscous liquid covered some of these pieces; bottom pieces were wetter than top pieces. The left side was wetter than the right side. The lower left side of the rudder exhibited a black paint transfer mark, which had dimensions similar to a propeller dome. None of these components were charred.

The lower left fuselage structure near the arresting hook attachment exhibited more damage than other airframe areas. All of the airframe pieces in lower aft fuselage region contained thick deposits of a black, viscous liquid.

1.12.3 Tanker 92 Main Wreckage

Major components for Tanker 92 (including wings, engines, fuselage, and empennage) fragmented and separated, but were within feet of their respective positions. Sections of cockpit in the main wreckage area included sections below the level of the windshield and aft upper ceiling pieces. The wings and engines were inverted and both wings exhibited similar leading edge crush damage that went aft to the main spar. Investigators accounted for the wing control surfaces in the main wreckage area. The empennage came to rest on its left side so that the right horizontal stabilizer was pointing up vertically. The vertical stabilizer and rudder exhibited aft and down crush damage. Fire charred all components and vegetation in the main wreckage area. Several bomb bay doors and the nose gear separated and were within 40 yards of the main wreckage; these pieces were outside of the burn area and not charred.

Tanker 92's right propeller exhibited more damage than the left propeller. The right propeller hub assembly, propeller shaft, and nose case reduction assembly separated and came to rest about 150 yards downhill from the main wreckage; these pieces was not charred. The inner sections of all three blades remained attached to this unit. CDF maintenance personnel identified a piece of structure imbedded at the hub/blade root, and opined that it was a piece of rudder. All three blades separated about 24 inches from the tips. One blade tip was between the main wreckage and the propeller. This tip piece was leaning against a tree, which exhibited several debarked areas along its trunk. Gouges in the ground that were about 6 feet apart went downhill from this tip piece to the remainder of the propeller. The other two blade tips for the right engine were in the commingled debris field; these tips exhibited chordwise striations. Two blades remained attached to the left propeller; the third blade separated and was near the hub.

1.12.3 Tanker 87 Main Wreckage

The main wreckage for Tanker 87 was about 400 yards from the commingled area. The debris field for the main wreckage of Tanker 87 covered several hundred feet; all of the main wreckage pieces and grass in this area were charred. Proceeding from an east-to-west direction, investigators identified the sonar area, wings, and landing gear, engines, propellers, bomb bay area, and cockpit area. Investigators accounted for the wing control surfaces in the main wreckage area.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

The Mendocino County Coroner completed an autopsy for the pilot of each airplane.

The FAA Toxicology and Accident Research Laboratory performed toxicological testing of specimens of the pilot of each airplane.

1.13.1 Tanker 92 Toxicology

For Tanker 92's pilot, tests for carbon monoxide and cyanide were not performed. The results of analysis of the specimens had no findings for ethanol detected in muscle and tested drugs.

1.13.2 Tanker 87 Toxicology

For Tanker 87's pilot, tests for carbon monoxide and cyanide were not performed. The results of analysis of the specimens had no findings for tested drugs. The report contained the following finding: 41 (mg/dL, mg/hg) ethanol detected in muscle.

1.16 TESTS AND RESEARCH

1.16.1 Tanker Operations

AirTac said that he was responsible for monitoring separation of the tankers in their orbit, but not during entry. He would write down the tanker numbers as they made their 3-minutes-out call, and usually ordered their drops in the same order as their check-in. A review of AirTac's log recorded the sequence 86, 91, 21 (who checked in prior to reaching Ukiah), and 92. The log did not contain an entry for Tanker 87.

The CDF training syllabus noted that tanker pilots should check in while 3 minutes out, and they should not approach any closer until checked in by the on scene AirTac. CDF had no standard operating manual, no established reporting or entry point, and a tanker could enter any point of the orbit from any direction. The syllabus indicated that the AirTac would provide tail numbers of the tankers on scene, and specify the tanker that the entering airplane would follow.

The entering tanker would approach 1,000 feet below the AirTac altitude, and stay in a left orbit

that was similar to a salad bowl. The tanker would enter wide enough to see and clear all other tankers until locating the tanker that it was to follow. The entering tanker was to adjust speed and altitude to fall in behind its target to the outside and above. It would maintain the highest and widest orbit.

When the AirTac called a tanker in for a drop, the tanker would slide inside the orbit and descend as it set up for its drop. The pilot would select the third flap position, and slow to about 130 knots. The tanker pilot preparing to drop would focus on the inside of the pattern toward the fire. The dropping tanker would be in the lowest and tightest orbit. The dropping tanker pilot would call downwind, base, and final before dropping the load at 200 feet agl.

One pilot stated that they were not supposed to enter the orbit without establishing contact. Several pilots reported that they would not know how many tankers had been dispatched to work a fire. Most thought that this fire was rather routine regarding the terrain features. Several remarked that the turn around time for the tankers was low since Ukiah was so close to the fire. Several pilots noted the heavy volume of radio traffic, and felt that this AirTac was at the maximum operating limit. Several pilots remembered Tanker 21 checking in. One pilot recalled hearing Tanker 87 check in, but was not sure if it was the accident flight or a previous flight. Some pilots made as many as nine trips to the fire.

1.16.2 Follow-up Wreckage Examination

Investigators examined the wreckage at a vacant plant storage lot in Ukiah on September 1 and 2, 2001.

1.16.2.1 Tanker 92

With the technical assistance of CDF maintenance personnel, the investigation determined that the flap actuator was in the extended position, indicating that the flaps were in the down position at impact. They could not determine the landing gear position. They could not identify any powerplant or flight control systems malfunctions that might have existed prior to the collision.

1.16.2.2 Tanker 87

With the technical assistance of CDF maintenance personnel, the investigation could not determine the position of the landing gear. The flap actuator was in the retracted position, indicating that the flaps were up. They removed the spark plugs and observed normal combustion patterns. They could not identify any powerplant or flight control systems malfunctions that might have existed prior to the collision.

ADDITIONAL INFORMATION

The Safety Board IIC released the wreckage to the CDF.

Pilot Information

Certificate:	Airline transport; Commercial	**Age:**	55,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 Valid Medical--w/ waivers/lim	**Last FAA Medical Exam:**	March 1, 2001
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	May 1, 2000
Flight Time:	4639 hours (Total, all aircraft), 1294 hours (Total, this make and model), 4 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Grumman	**Registration:**	N450DF
Model/Series:	TS-2A	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Restricted (Special)	**Serial Number:**	421
Landing Gear Type:	Retractable - Tricycle	**Seats:**	2
Date/Type of Last Inspection:	August 21, 2001 Continuous airworthiness	**Certified Max Gross Wt.:**	27000 lbs
Time Since Last Inspection:	8 Hrs	**Engines:**	2 Reciprocating
Airframe Total Time:	10354 Hrs at time of accident	**Engine Manufacturer:**	Curtis Wright
ELT:	Installed, not activated	**Engine Model/Series:**	R1820-82B
Registered Owner:	CALIFORNIA DEPARTMENT OF FORESTRY	**Rated Power:**	1200 Horsepower
Operator:		**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	UKI,614 ft msl	**Distance from Accident Site:**	
Observation Time:	18:56 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	9 knots / 0 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	340°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.87 inches Hg	**Temperature/Dew Point:**	30°C / 6°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	UKIAH, CA (UKI)	**Type of Flight Plan Filed:**	None
Destination:		**Type of Clearance:**	None
Departure Time:	18:34 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	On-ground
Total Injuries:	1 Fatal	**Latitude, Longitude:**	39.018054,-123.194168

Administrative Information

Investigator In Charge (IIC):	Plagens, H.
Additional Participating Persons:	James Ramage; California Department of Forestry; Sacramento, CA Antonio Agosta, Jr.; San Jouquin Helicopters; McClellan, CA
Original Publish Date:	September 13, 2005
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=53123