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crashworthy fuel system

mishap data



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AVIATION SAFETY HIGHLIGHTS
SERIES FROM THE AVIATION SAFETY
CRASHWORTHY FUEL SYSTEM MISHAP DATA

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Commanding Officer

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Crashworthy Fuel System Mishap Data

I. ABSTRACT. This report compares aircraft mishap data for UH-1D/H helicopters with and without crashworthy fuel systems (CWFS) installed. The purpose of the comparison was to determine, on the basis of actual mishap data, whether the CWFS has reduced the hazard of postcrash fires in aircraft accidents. Data used were taken from records of mishaps that occurred during the period 1 June 1970 through 31 August 1971.

II. SUMMARY. *Method.* Study data were obtained from the USAAAVS files of crash facts messages and aircraft accident reports for the period 1 June 1970 through 31 August 1971. Those mishaps that could have been affected by the CWFS were studied. These included incidents and major and minor accidents: forced landings and precautionary landings were omitted. Also considered in the study was the current status of the program to equip the UH-1D/H fleet with the CWFS.

Results. Thirty-eight postcrash fires occurred in 731 mishaps involving UH-1D/H aircraft without the CWFS (one fire in 19 mishaps) as opposed to six in 128 accidents involving UH-1D/H's

equipped with the CWFS (one in 21). The six fires were of the progressive type, usually originating around the engine deck area, and were not considered cataclysmic. There were no thermal injuries or fatalities in the CWFS-equipped aircraft, while 37 fatalities and 12 injuries attributable to thermal causes occurred in the 731 mishaps involving aircraft without the CWFS. See appendix A for detailed statistics.

As of 31 August 1971, there were approximately 3,450 UH-1D/H aircraft in the inventory. Approximately 1,400 helicopters had been equipped with CWFS's, either on the production line or by retrofit. (Attrition is not considered in these numbers.)

In an effort to reduce the incidence of post-crash fires originating in the UH-1 engine-deck area, Engineering Change Proposal 536 has been initiated that will add breakaway and fuel-vent check valves around this area.

III. CONCLUSIONS. The CWFS has reduced thermal injuries and fatalities resulting from crash damage and has also reduced the hazard of postcrash fires in the UH-1D/H.

Further refinement of the CWFS should sub-



This UH-1H crashed at night in instrument meteorological conditions (IMC). The pilot and copilot survived with injuries. The crashworthy fuel system functioned as designed. Note the right forward fuel cell in the foreground, which tore loose from the aircraft and prevented fuel spillage. There was no post-crash fire.

stantially reduce the number of postcrash fires.

IV. DISCUSSION. Mishaps Compared. During the period 1 June 1970 through 31 August 1971, 2,544 UH-1D/H mishaps of all classifications were reported. Of these, 327 involved CWFS-equipped aircraft. However, only those mishaps in which the CWFS was challenged--major (including total loss) and minor accidents and incidents--were compared against mishaps of the same classifications involving aircraft not equipped with the CWFS. Since injuries and fatalities are not sustained in precautionary and forced landings, these classifications were omitted. No attempt was made to distinguish between survivable and nonsurvivable accidents.

Mishaps compared are listed by category as follows (see appendix A for further breakdown):

| MISHAP CATEGORY | UH-1D/H WITH- OUT CWFS | UH-1D/H WITH CWFS |
|-----------------|---------------------------|----------------------|
| Major accidents | 240 | 52 |
| Minor accidents | 18 | 2 |
| Incidents | 473 | 74 |
| TOTAL | 731 | 128 |

Mishaps Involving Postcrash Fires. Seven fires in UH-1D/H helicopters equipped with CWFS were reported in the study period. Six were classified as "postcrash fires." That these fires were not of a cataclysmic nature is attributed to the containment feature of the fuel system. The incidence of postcrash fires involving the two types of fuel systems is shown below:

| | UH-1D/H WITHOUT CWFS | UH-1D/H WITH CWFS |
|-------------------|-------------------------|----------------------|
| Total No. Mishaps | 731 | 128 |
| Postcrash fires | 38 | 6 |

Mishaps Involving Casualties. Casualties sustained in the 859 mishaps studied are listed below:

| | UH-1D/H w/o CWFS (731 mishaps) | UH-1D/H WITH CWFS (128 mishaps) |
|-------------------------------|--------------------------------------|---------------------------------------|
| Thermal casualties: | | |
| Fatalities | 37 | 0 |
| Injuries | 12 | 0 |
| Nonthermal casualties: | | |
| Fatalities | 142 | 6 |
| Injuries | 321 | 54 |

The CWFS was intended to provide increased strength for fuel containment, a self-sealing capability, and improved plumbing. These features were designed to minimize fuel cell rupture or failure resulting from a crash. The ultimate goal of the CWFS is to provide maximum protection from fuel fires caused by combat or crash damage. Study has revealed that postcrash fires occurring on CWFS-equipped aircraft have been of the progressive type. Thus, the primary benefit derived from the CWFS as presently designed is that it allows crew and passengers sufficient time to escape from a crash-damaged aircraft without sustaining injuries associated with a cataclysmic fire.

The most recent of the six postcrash fires that occurred in aircraft equipped with the CWFS illustrates this point. Six persons were on board a UH-1D. The pilot apparently suffered spatial disorientation under instrument meteorological conditions. The helicopter impacted with no apparent forward motion. After impact, the engine continued to run with flames emitting from the tail pipe section. The occupants, who were initially stunned, escaped from the aircraft in ample time to preclude thermal injuries, and the pilot had time to return to shut the aircraft down.

MISHAP COMPARATIVE COSTS

| Mishaps Involving Postcrash Fires (1) | | |
|---------------------------------------|--------------------------|-------------------------------|
| NUMBER MISHAPS | TOTAL DAMAGE COSTS | AVERAGE COST PER MISHAP |
| UH-1D/H w/o CWFS | 38 | \$9,264,627 |
| UH-1D/H with CWFS | 6 | \$1,459,229 |
| | | \$244,000 |
| | | \$244,000 |

| Mishaps Not Involving Postcrash Fires (2) | | |
|---|--------|--------------------------|
| UH-1D/H w/o CWFS | NUMBER | TOTAL DAMAGE COSTS |
| UH-1D/H w/o CWFS | 693 | \$84,132,182 |
| UH-1D/H with CWFS | 122 | \$5,875,191 |
| | | \$121,114 |
| | | \$48,157 |

As can be seen from the above, the average damage cost of (2) is significantly less than that of (1). It should also be noted that the CWFS reduces the probability of total loss of aircraft to fire by about 10 percent. As a result of these two factors, some reduction in the average dam-

age cost per mishap (1) should be realized from the installation of the CWFS. Of greater significance, however, is the nonquantifiable fact that no thermal injuries or fatalities have been sustained in mishaps involving CWFS-equipped UH-1D/H aircraft.

Status of CWFS installation. As of 31 August

1971, there were approximately 3,450 UH-1D/H helicopters in the fleet. Beginning with helicopter SN 69-15292, 1,060 aircraft had factory-installed CWFS's and 482 had been retrofitted with the system. About 2,100 remain to be retrofitted. (These numbers do not include attrition.) The projected production schedule for September 1971-December 1972 is shown in appendix B.

APPENDIX A

UH-1D/H CRASHWORTHY FUEL SYSTEM COMPARISON STUDY
(1 JUNE 1970-31 AUGUST 1971)

Mishap Experience Data

| | NUMBER MISHAPS | NUMBER CWFS | NUMBER POSTCRASH FIRES | PERCENT OF TOTAL MISHAPS | INJURIES | | FATALITIES | |
|---------------|----------------|-------------|------------------------|--------------------------|---------------------|---------------------|------------|-----|
| | | | | | THERMAL/NON-THERMAL | THERMAL/NON-THERMAL | | |
| A/C w/o CWFS | 731 | NO | 38 | 4.4 | 12 | 321 | 37 | 142 |
| A/C with CWFS | 128 | YES | 6(1) | 0.7 | 0(2) | 54 | 0(2) | 6 |
| TOTAL | 859(3) | | 44(4) | | | | | |

NOTES:

- (1) The six postcrash fires that occurred in mishaps involving CWFS-equipped aircraft were non-cataclysmic in nature.
- (2) The absence of thermal injuries and fatalities in postcrash fires involving CWFS-equipped aircraft is significant.
- (3) Total includes major and minor accidents as well as incidents. No attempt was made to distinguish between survivable and nonsurvivable accidents.
- (4) Of the 44 helicopters involved in postcrash fires, 86.4 percent was not equipped with CWFS, and 13.6 percent had the CWFS installed.

APPENDIX B

STATUS OF CWFS INSTALLATION
AS OF 31 AUGUST 1971

| Total Inventory UH-1D/H | Factory Installed | Retrofitted | Remainder to be Retrofitted |
|----------------------------|-------------------|-------------|--------------------------------|
| Approximately 3,450 | 1,060* | 482** | Approximately 2,100 |

* First Bell Helicopter Company installation, April 1970, SN 69-15292

**SN 69-15291 and Prior-MWO 55-1520-210-50/1

Attrition has not been included in these numbers.

CWFS UH-1H PROJECTED PRODUCTION SCHEDULE
(September 1971-December 1972)

| SEP 71 | OCT | NOV | DEC | JAN 72 | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|--------|-----|-----|-----|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 40 | 40 | 40 | 34 | 30 | 32 | 32 | 32 | 29 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |