

Evaluation of Sailplane Accidents

Referat IV/3 (Safety Analysis)
Accident Investigation,
Civil Aviation Board, Flughafen
B. Zborolski
Presented at the XVII OSTIV Congress
Paderborn, Germany
May 1981

1. PRELIMINARY RESULTS

Within the scope of flight accident investigation, all occurrences with German, as well as foreign aircraft - as far as they happen in the territory of the Federal Republic of Germany - have been recorded and stored by data processing since 1973. At the moment nearly 5000 records, a/c, sailplanes, helicopters, etc. access to U.S. and Australian data.

A great number of EDP programs will enable evaluation of data under many different aspects. In the meantime, a sufficient data stock is available for several data analyses to be made.

The definition of an accident is given in ICAO Annex 13 as follows:

Accident. An occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which:

a) a person is fatally or seriously injured as a result of being in or upon the aircraft or by direct contact with the aircraft or anything attached thereto, except when the injuries are from natural causes, are self-inflicted, or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or

b) the aircraft incurs damage or structural failure which adversely affects the strength, performance, or flight characteristics of the aircraft, and which would normally require major repair or replacement of the affected component.

For Clarification. The type of accident or occurrence indicates the circumstances under which this occurrence or accident has happened, but not the cause for it.

2. SURVEY OF ACCIDENTS

Tables 1 and 2 give the number of accidents with sailplanes and powered sailplanes for 1973-1980. They show the degree of injury, i.e. whether it is an accident with fatalities or serious or minor injuries. In the case of a collision, all affected sailplanes were counted. In total, 1928 sailplane and 377 powered sailplane accidents were recorded. In the following, only accidents with sailplanes will be dealt with in more detail.

Table 3 gives the numbers of registered sailplanes in the FRG and the estimated number of takeoffs and landings. For the flying clubs, the hours flown per year are recorded.

Tables 4 and 5 show who was affected and what type of flying was involved. As we can see from Table 4, 1,298 accidents happened with sailplanes owned by flying clubs and 470 with privately owned. That is 67.3% and 24.4% respectively.

If we look at the fatal accidents, 61.3% of the ships were owned by flying clubs and 31.5% were privately owned.

Table 5 shows the type of operation versus the type of injury. There were 473 total accidents during instruction or training flights and 1,315 related to pleasure flying (non-commercial).

Table 6 shows what has happened. We have listed the type of occurrence versus the type of injury.

- a) Loss of control on ground. Occurrences in which a loss of directional control or sudden swerve is experienced while taking off or landing. Note. When an intentional swerve is made to avoid overrunning, use "Overrun."
- b) Dragged wing. Occurrences in which an aircraft drags a wing while taking off or landing, without loss of directional control. Note. When this is the result of a "Loss of control on ground/water" or a "Hard landing" use one of these two classifications.
- c) Hard landing. Occurrences in which an aircraft touches down with an abnormally high vertical speed.
- d) Overrun. Occurrences in which an aircraft runs off the end of the runway or the take-off or landing area.
- e) Undershoot. Occurrences in which an aircraft, while approaching to land, makes contact with the ground, water or objects, within the final approach area up to a distance of 5NM from the runway threshold or intended landing area.
- f) Collision aircraft. Occurrences in which an aircraft in flight or on the ground collides with an object on the ground.
- g) Collision objects. Occurrences in which an aircraft in flight or on the ground collides with an object on the ground.
- h) Loss of control in flight. Occurrences in which the aircraft spins, spirals or mushes into the ground or water as a result of a stall.
- i) Airframe failure. Occurrences in which any part of the airframe fails in flight as a result of fatigue, overstress, improper maintenance, etc.
- j) Failure of launch equipment. Any failure of the winch, rope or release mechanism.

This table shows the surviveability of the occurrences. For instance, loss of control in flight results in a higher percentage of fatal accidents.

3. METHODS OF ANALYSIS

In the following analysis we looked at all sailplane accidents and subdivided into 12 different types of sailplanes, i.e. different manufacturers and models. When we found that one particular model had an unusual history, we made a Chisquare calculation.

The Chisquare test is used to test the statistical independence between 2 variables, each of which is classified into a number of types or attributes. For instance, all types of sailplanes that had an accident are classified into some special types of sailplanes, and all types of occurrences are subdivided into special types of occurrences.

The null hypothesis to be tested is that the 2 variables (for instance: type of occurrence; type of sailplane) are independent; that is, there is no association or relation between the 2 variables. The result given by the Chisquare calculation will then be that the so-called null hypothesis can be rejected or not. If it can be rejected, we always get a certain significance level. That means that there remains a specific probability of error. In most cases the significance level is 1% or 5%, but sometimes even 0.1%. That means in the last case the 2 variables are not independent with a probability of 99.9%. In general, the so called 2X2 contingency table was used where one type of occurrence was compared with all other types, etc.

Our next step was to try to identify the reasons behind the incidents. For instance, if a sailplane is involved in more undershoots or overruns than expected the reason could be that this sailplane is used more frequently for training or is flown more frequently by less experienced pilots.

This analysis has not been done to blame any manufacturer; for this reason I have not named the different types of sailplanes investigated. The study has been made to show the information we can compile with our data. We welcome requests for detailed studies, for instance, comparing sailplanes of similar constructive characteristics.

4. RESULTS OF ANALYSIS OF ALL SAILPLANE ACCIDENTS

A total of 1,928 accidents from 1973 to 1980 were analysed.

Tables 7 to 11 show some detailed information. Table 7 - Type of sailplane vs type of occurrence. Table 8 - Total flight experience vs type of occurrence. Table 9 - Type of sailplane vs phase of operation. Table 10 - Type of sailplane vs type of operation. Table 11 - Total flight experience vs phase of operation.

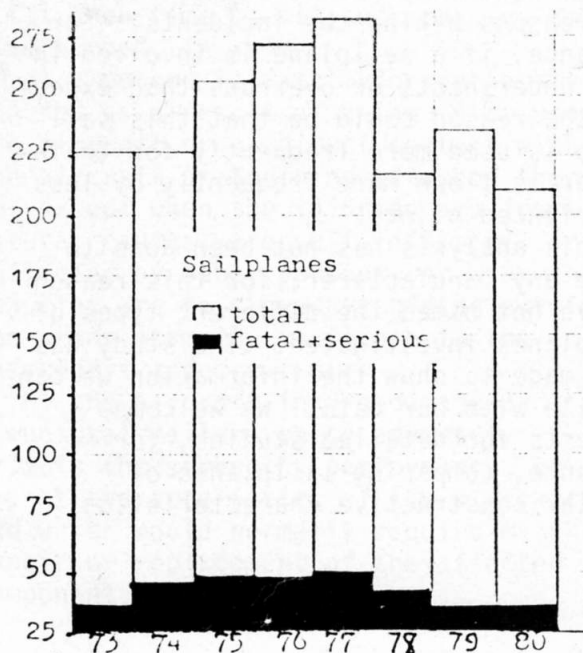
5. OUTLANDINGS

We found a total of 752 outlanding acci-

SAILPLANES

TABLE 1. YEAR OF THE ACCIDENT VS TYPE OF INJURY

YEAR	FATAL	SERIOUS	MINOR	NONE	TOTAL
1973	14	22	22	169	227
1974	16	28	20	163	227
1975	10	39	20	187	256
1976	15	32	35	191	273
1977	21	29	20	212	282
1978	10	31	19	158	218
1979	14	17	22	181	234
1980	11	23	23	154	211
TOTAL:	111	221	181	1414	1928



dents between 1973 and 1980. Again, we made a survey of types of sailplanes versus types of occurrences. In several cases there is a dependence between certain models and the occurrence. Table 13 shows the total flight experience versus type of occurrence.

6. INSTRUCTIONAL & TRAINING FLIGHTS

A specific dependence between type of sailplane and type of occurrence can be seen in Table 14.

7. EXPERIENCED PILOTS - NONTRAINING

Tables 15 & 16 show type of sailplane versus type of occurrence, and type of sailplane versus phase of operation. In this case we specifically looked at accidents involving experienced pilots with more than 100 flight hours (non training).

MOTORED SAILPLANES

TABLE 2. YEAR OF THE ACCIDENT VS TYPE OF INJURY

YEAR	FATAL	SERIOUS	MINOR	NONE	TOTAL
1973	2	8	3	34	47
1974	4	10	6	40	60
1975	2	10	1	40	53
1976	4	5	3	38	50
1977	2	5	2	38	47
1978	1	5	2	31	39
1979	3	8	2	35	48
1980	1	9	1	22	33
TOTAL:	19	60	20	278	377

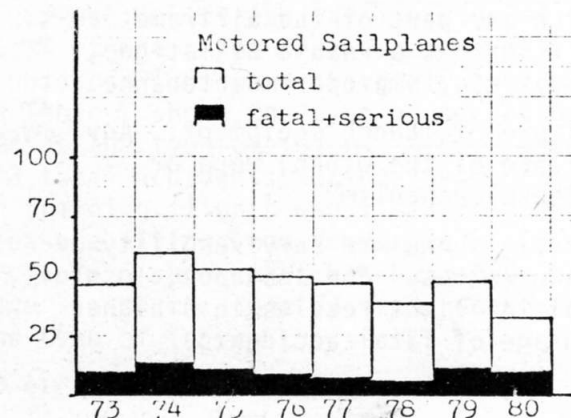
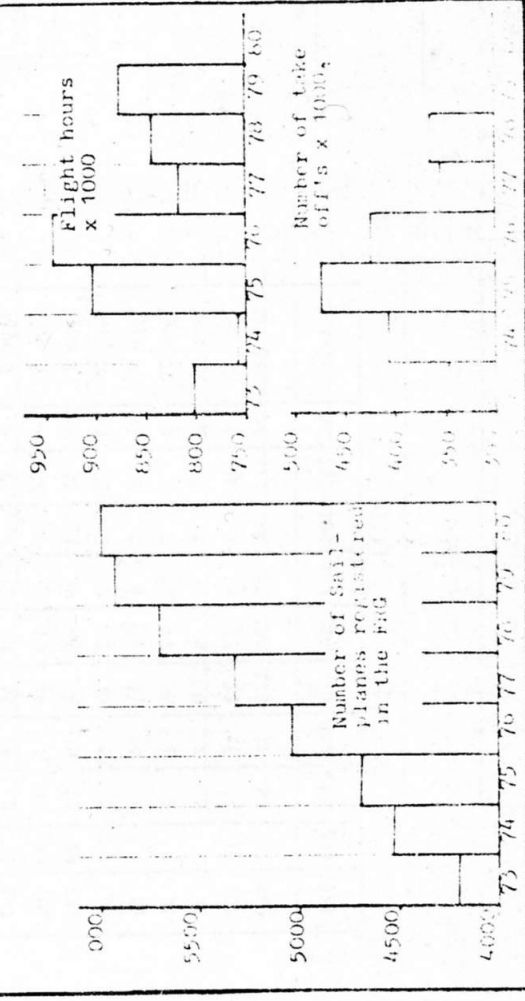


TABLE 3. STATISTICS ON SOARING IN THE FEDERAL REPUBLIC OF GERMANY

Year	Number of Sailplanes registered in the FRG	Number of Take Off's x 1000	Flight Hours x 1000	*
73	4205	803	348	
74	4525	759	417	
75	4694	904	474	
76	5046	943	425	
77	5325	818	355	
78	5699	844	366	
79	5917	876		
80	5984			

* Numbers are related to members of the German Aero Club (DAeC), which represents about 39 % of the German glider pilots.



TYPE OF OPERATOR	FATAL	SERIOUS	MINOR	NONE	TOTAL
Flying School	4	17	15	56	92
Private Owner	35	60	44	331	470
Flying Club	68	135	114	981	1298
Other	4	9	9	46	68
Total:	111	221	182	1414	1928

TABLE 4. TYPE OF OPERATOR VS TYPE OF INJURY

TYPE OF OPERATION	FATAL	SERIOUS	MINOR	NONE	TOTAL
Instructional and Training	21	64	47	341	473
Non-Commercial	78	145	120	972	1315
Miscellaneous	12	12	15	101	140
Total:	111	221	182	1414	1928

TABLE 5. TYPE OF OPERATION VS TYPE OF INJURY

TABLE 6. TYPE OF OCCURRENCE VS TYPE OF INJURY

TYPE OF OCCURRENCE	FATAL	SERIOUS	MINOR	NONE	TOTAL
Loss of control on ground/water	1	3	4	48	56
Dragged wing	1	12	20	206	239
Hard landing	1	33	15	139	188
Overrun	1	6	14	161	182
Undershoot	3	32	34	249	318
Collision aircraft	20	5	8	57	90
Collision object	10	29	35	336	410
Loss of control in flight	42	43	20	37	142
Airframe failure	14	6	10	25	55
Failure of launch equipment and/or take-off disturbance	11	36	16	96	159
Other	7	16	6	60	89
Total:	111	231	182	1414	1928

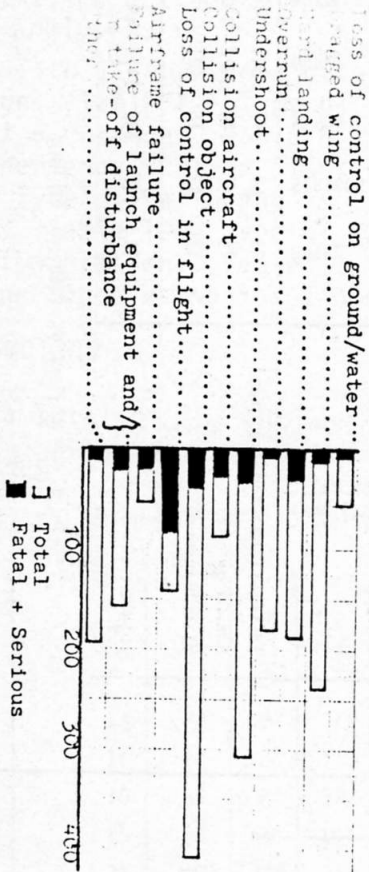


TABLE 7. TYPE OF SAILPLANE VS TYPE OF OCCURRENCE

TYPE OF SAILPLANE	LOSS OF CONTROL ON GROUND/WATER	DRAGGED WING	HARD LANDING	VERRUN	UNDERSHOOT	COLLISION OBJECT	LOSS OF CONTROL IN FLIGHT	FAILURE OF LAUNCH EQUIPMENT AND/OR TAKE-OFF DISTURBANCE	OTHER	TOTAL
Type 1	5	1	9	8	26	10	1	13	11	84
Type 2	0	16	12	10	10	17	19	7	6	87
Type 3	0	0	2	4	11	5	3	3	5	33
Type 4	1	4	3	5	1	5	1	2	1	23
Type 5	4	29	4	22	24	55	14	8	17	177
Type 6	2	2	26	5	20	14	3	16	13	101
Type 7	6	31	29	39	48	58	10	23	29	273
Type 8	3	9	5	2	11	12	6	5	7	60
Type 9	5	12	4	4	8	11	4	4	4	56
Type 10	0	5	0	4	7	8	1	2	4	31
Type 11	0	1	4	3	9	9	2	5	3	36
Type 12	4	16	6	5	13	33	16	4	10	107
All other	26	113	84	71	130	173	72	67	124	860
Total:	56	239	188	182	318	410	142	159	234	1928

TABLE 8. TOTAL FLIGHT EXPERIENCE VS TYPE OF OCCURRENCE

TOTAL FLIGHT EXPERIENCE	LOSS OF CONTROL ON GROUND/WATER	DRAGGED WING	HARD LANDING	OVERRUN	UNDERSHOOT	COLLISION OBJECT	LOSS OF CONTROL IN FLIGHT	FAILURE OF LAUNCH EQUIPMENT AND/OR TAKE-OFF DISTURBANCE	OTHER	TOTAL
0 - 100	26	65	93	77	144	121	38	52	85	701
101 - 100 000	27	166	87	100	169	275	96	97	133	1150
Unknown	3	8	8	5	5	14	8	10	16	77
Total:	56	239	188	182	318	410	142	159	234	1928

TABLE 9. TYPE OF SAILPLANE VS PHASE OF OPERATION

TYPE OF SAILPLANE	TAKE-OFF	IN FLIGHT	LANDING	OTHER	TOTAL
Type 1	15	6	63	0	84
Type 2	12	12	62	1	87
Type 3	6	2	25	0	33
Type 4	8	1	14	0	23
Type 5	15	17	145	0	177
Type 6	19	7	75	0	101
Type 7	38	18	217	0	273
Type 8	12	2	45	1	60
Type 9	12	3	41	0	56
Type 10	4	2	24	1	31
Type 11	6	3	27	0	36
Type 12	12	12	83	0	107
All other	157	98	604	1	860
Total:	316	183	1425	4	1928

TABLE 10. TYPE OF SAILPLANE VS TYPE OF OPERATION

TYPE OF SAILPLANE	INSTRUCTIONAL AND TRAINING	NON-COMMERCIAL	MISCELLANEOUS	TOTAL
Type 1	53	29	2	84
Type 2	5	79	3	87
Type 3	14	18	1	33
Type 4	3	16	4	23
Type 5	13	143	21	177
Type 6	62	38	1	101
Type 7	141	127	5	273
Type 8	18	41	1	60
Type 9	0	51	5	56
Type 10	0	30	1	31
Type 11	1	32	3	36
Type 12	1	97	9	107
All other	162	614	84	860
Total:	473	1315	140	1928

TABLE 11. TOTAL FLIGHT EXPERIENCE VS PHASE OF OPERATION

TOTAL FLIGHT EXPERIENCE	TAKE-OFF	IN FLIGHT	LANDING	OTHER	TOTAL
0 - 100	100	46	555	0	701
101 - 100 000	198	121	828	3	1150
Unknown	180	16	42	1	77
Total:	316	183	1425	4	1928

SAILPLANES - OUTLANDINGS

TABLE 12. TYPE OF SAILPLANE VS TYPE OF OCCURRENCE

TYPE OF SAILPLANE	LOSS OF CONTROL ON GROUND/WATER	DRAGGED WING	HARD LANDING	OVERRUN	UNDERSHOOT	COLLISION OBJECT	LOSS OF CONTROL IN FLIGHT	FAILURE OF LAUNCH EQUIPMENT AND/OR TAKE-OFF DISTURBANCE	OTHER	TOTAL
Type 1	1	0	0	2	1	3	0	0	0	7
Type 2	0	10	3	10	3	7	2	0	0	35
Type 3	0	0	0	2	0	2	0	0	1	5
Type 4	0	1	1	5	1	3	0	0	0	11
Type 5	1	25	2	19	9	47	11	0	4	118
Type 6	0	0	1	2	1	4	1	0	0	9
Type 7	0	24	5	28	7	41	4	0	2	111
Type 8	0	6	2	2	1	11	1	0	3	26
Type 9	0	5	3	3	0	8	2	0	0	21
Type 10	0	3	0	4	3	8	0	0	0	18
Type 11	0	1	4	3	1	8	1	0	0	18
Type 12	1	9	4	4	4	32	3	0	0	57
All other	2	59	31	47	21	124	21	0	11	316
Total:	5	143	56	131	52	298	46	0	21	752

SAILPLANES - INSTRUCTIONAL & TRAINING

TABLE 14. TYPE OF SAILPLANE VS TYPE OF OCCURRENCE

TYPE OF SAILPLANE	LOSS OF CONTROL ON GROUND/WATER	DRAGGED WING	HARD LANDING	OVERRUN	UNDERSHOOT	COLLISION OBJECT	LOSS OF CONTROL IN FLIGHT	FAILURE OF LAUNCH EQUIPMENT AND/OR TAKE-OFF DISTURBANCE	OTHER	TOTAL
Type 1	4	1	8	4	14	4	1	10	7	53
Type 2	0	1	0	1	1	0	1	1	0	5
Type 3	0	0	2	1	3	3	1	2	2	14
Type 4	0	0	1	1	0	1	0	0	0	3
Type 5	0	1	0	0	5	4	1	0	2	13
Type 6	2	1	18	1	16	7	0	11	6	62
Type 7	4	7	21	19	25	27	4	16	18	141
Type 8	1	3	2	1	5	1	1	2	2	18
Type 9	0	0	0	0	0	0	0	0	0	0
Type 10	0	0	0	0	0	0	0	0	0	0
Type 11	0	0	0	0	1	0	0	0	0	1
Type 12	0	0	0	0	0	1	0	0	0	1
All other	9	8	22	14	39	14	5	23	28	162
Total:	20	22	74	42	109	62	14	65	65	473

SAILPLANES - OUTLANDINGS

TABLE 13. TOTAL FLIGHT EXPERIENCE VS TYPE OF OCCURRENCE

TOTAL FLIGHT EXPERIENCE	LOSS OF CONTROL ON GROUND/WATER	DRAGGED WING	HARD LANDING	OVERRUN	UNDERSHOOT	COLLISION OBJECT	LOSS OF CONTROL IN FLIGHT	FAILURE OF LAUNCH EQUIPMENT AND/OR TAKE-OFF DISTURBANCE	OTHER	TOTAL
0 - 100	1	38	16	49	11	73	13	0	6	207
101 - 100 000	4	101	39	78	38	214	33	0	15	524
Unknown	0	4	1	4	1	11	0	0	0	21
Total:	5	143	56	131	52	298	46	0	21	752

TYPE OF SAILPLANE	LOSS OF CONTROL ON GROUND/WATER	DRAGGED WING	HARD LANDING	OVERRUN	UNDERSHOOT	COLLISION OBJECT	LOSS OF CONTROL IN FLIGHT	FAILURE OF LAUNCH EQUIPMENT AND/OR TAKE-OFF DISTURBANCE	OTHER	TOTAL
Type 1	0	0	1	3	7	4	0	3	3	21
Type 2	0	13	8	8	8	16	6	4	5	68
Type 3	0	0	0	1	6	1	1	1	2	12
Type 4	1	3	1	3	1	4	1	1	0	15
Type 5	2	16	1	12	14	31	10	4	9	99
Type 6	0	0	2	2	4	4	1	4	3	20
Type 7	1	9	2	8	9	8	0	1	3	41
Type 8	0	2	2	0	2	6	2	1	3	18
Type 9	5	10	4	3	7	10	3	3	4	49
Type 10	0	5	0	4	7	7	1	2	3	29
Type 11	0	1	2	3	6	8	1	3	2	26
Type 12	4	14	6	5	12	30	15	3	9	98
All other	13	88	47	44	67	136	52	37	69	553
Total:	26	161	76	96	150	265	93	67	115	1049

SAILPLANES - EXPERIENCED PILOTS, NONTRAINING

TABLE 15. TYPE OF SAILPLANE VS TYPE OF OCCURRENCE

TYPE OF SAILPLANE	TAKE-OFF	IN FLIGHT	LANDING	OTHER	TOTAL
Type 1	3	5	13	0	21
Type 2	6	11	50	1	68
Type 3	2	1	9	0	12
Type 4	6	1	8	0	15
Type 5	5	10	84	0	99
Type 6	4	2	14	0	20
Type 7	4	0	37	0	41
Type 8	2	0	15	1	18
Type 9	11	3	35	0	49
Type 10	4	1	23	1	29
Type 11	4	1	21	0	26
Type 12	11	11	76	0	98
All other	92	67	394	0	553
Total:	154	113	779	3	1049

SAILPLANES - EXPERIENCED PILOTS, NONTRAINING

TABLE 16. TYPE OF SAILPLANE VS PHASE OF OPERATION