HANDBOOK FOR AIRCRAFT ACCIDENT INVESTIGATORS

COOPERATING IN CRASH INJURY RESEARCH

CORNELL UNIVERSITY MEDICAL COLLEGE
1300 YORK AVENUE, NEW YORK 21, N. Y.
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CRASH INJURY RESEARCH
Hugh De Haven, Director

CORNELL UNIVERSITY MEDICAL COLLEGE
1300 YORK AVENUE, NEW YORK 21, N. Y.
The material contained in this Handbook is intended for use by aircraft accident investigators cooperating in crash injury research. Permission to reproduce parts of this book may be obtained upon written request to Crash Injury Research.

This Handbook was prepared by A. Howard Hasbrook and Ruth M. Petry of the staff of Crash Injury Research. The assistance of the Civil Aeronautics Board and the Aeronautics Commissions and State Police of the following States is gratefully acknowledged:

Connecticut
Illinois
Indiana
Maryland
Massachusetts
New Hampshire
New Jersey
Pennsylvania
Vermont
Virginia
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>II</td>
<td>Crash Injury Research Classification of Aircraft Accidents</td>
<td>3</td>
</tr>
<tr>
<td>III</td>
<td>Procedure at the Scene of an Accident</td>
<td>9</td>
</tr>
<tr>
<td>IV</td>
<td>Forms Used in Reporting Accident and Injury Details</td>
<td>13</td>
</tr>
<tr>
<td>V</td>
<td>General Accident Data</td>
<td>21</td>
</tr>
<tr>
<td>VI</td>
<td>Details of Aircraft Damage</td>
<td>34</td>
</tr>
<tr>
<td>VII</td>
<td>Injury Details</td>
<td>45</td>
</tr>
<tr>
<td>A</td>
<td>Determination of Height of Object</td>
<td>53</td>
</tr>
<tr>
<td>B</td>
<td>Determination of Flight Path Angle</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>Diagram of Component Parts of an Airplane</td>
<td>8</td>
</tr>
</tbody>
</table>
FOREWORD

Since the earliest days of aviation, aircraft accidents have been investigated solely to determine causes of accidents. Causes of injury have been overlooked. As a result, the reasons why one person is killed, another severely injured, and another unhurt - in the same accident - have remained unknown.

Crash Injury Research was initiated in 1942 to:

1. Broaden the scope of accident investigation to include the observation and reporting of injury causes;

2. Find what caused injuries and fatalities in survivable accidents; and

3. Present this data to manufacturers so that steps could be undertaken to moderate or eliminate causes of needless and excessive injury by improved engineering and design.

Crash Injury Research is sponsored by the Departments of the Navy and the Air Force, and the Civil Aeronautics Administration, and acts under advisement of a joint Navy - Air Force Advisory Committee. The project is in the Department of Public Health and Preventive Medicine at Cornell University Medical College and operates under the auspices of the Cornell Committee for Air Safety Research.

The work of the project is based on accident reports furnished by state and federal investigating groups, without whose cooperation the objectives of Crash Injury Research could not be accomplished. Their cooperation and that of Northwestern University, the Cornell Aeronautical Laboratory, the Flight Safety Foundation, and others concerned with the problems of increasing safety in transportation, is gratefully acknowledged.

This Handbook is intended as a guide for personnel who investigate aircraft accidents and report accident-injury details to Crash Injury Research. Because accurate reports are essential to the drafting of recommendations for modifying dangerous features in aircraft, a discussion of the use of the CIR Report Form AC is an essential part of this Handbook.
CHAPTER I
INTRODUCTION

Safety is the business of forestalling known dangers. In accidents, the danger to which people are exposed is the danger of injury or death.

In all fields of transportation every effort is made to prevent accidents, but when crashes occur, the prime consideration of safety is whether people are killed, seriously injured or unhurt.

In aviation, safety is of the utmost importance because dangers are greater and also because fatal aircraft accidents seriously retard development of the whole aviation industry; this, in turn, adversely affects production, development, and the military resources of the country.

In aircraft accidents of extreme nature, there can be little doubt about resulting injuries. The cabin or cockpit is demolished and the occupants are killed. In such accidents, it can be said that the people were killed by the crash.

The causes of fatal injuries in more moderate accidents, however, - and this holds true in the majority of automobile accidents - cannot be answered by a simple statement that people were killed by the crash, for, in the same accident, one person may be killed while others escape unhurt.

This wide variation in the severity of injury in many aircraft and automobile accidents has opened questions as to why such extremes of injury and non-injury occur, particularly since it is known from accident-injury studies and Air Force deceleration tests that the human body can, with proper protection, tolerate forces that demolish aircraft structure.

When accident-injury reports are analyzed, the reasons for wide variations in severity of crash injuries are not so arbitrary or haphazard
as they seem; the difference between injury and non-injury - life and death - often proves to be dependent upon details of design in cabin structures, landing gear, control wheels, seat-backs, projecting metal knobs, door posts, sharp-edged instrument panels, etc.

In order to get the facts on causes of serious and fatal results, accidents must be carefully investigated so that objects which repeatedly cause needless and excessive injuries and fatalities can be moderated or eliminated in future design. Without knowledge of these facts, engineers can do little to reduce danger of injury.

ACCIDENT INVESTIGATORS WHO OBSERVE AND RECORD CRASH RESULTS ARE THE ONLY PERSONS WHO CAN PROVIDE ENGINEERS WITH THE AUTHORITATIVE, DETAILED KNOWLEDGE WHICH IS NECESSARY FOR IMPROVING SAFETY IN ACCIDENTS.
CHAPTER II
CRASH INJURY RESEARCH CLASSIFICATION
OF AIRCRAFT ACCIDENTS

Aircraft accidents normally are divided into two categories: (1) accidents incident to flight; (2) accidents not incident to flight.

Accidents not incident to flight include such "mishaps" as a plane taxiing into a ditch, going up on its nose and breaking the propeller; or a bystander walking into a spinning propeller, etc. Normally, accidents of this kind do not result in injury to the aircraft's occupants and therefore contain no data useful to the research conducted by CIR.

Accidents incident to flight are those which occur at some time between the beginning of the takeoff run and the end of the intended landing roll. Accidents in this category are divided into four classes according to the general damage sustained by the aircraft: (1) moderate; (2) moderately severe; (3) severe; and (4) extreme. Accidents in the first three classes are defined as being survivable. It should be noted that survivable accidents are not only those which are survived, but are also the ones which, with reasonable protection by improved safety belts, seats, control wheels, etc., could be survived.

Accidents in the 4th classification - extreme - are generally considered to be non-survivable. (See Figs. 1 and 2.) They are the crashes in which the velocity of the plane is so great that the cabin completely collapses or disintegrates around the occupants with resulting multiple, extreme and fatal injuries. Crashes of high speed military aircraft, transports, and high speed personal aircraft, in which a plane flies into the side of a mountain or dives vertically into the ground at or above cruising speed, usually are non-survivable.
Fig. 1. An extreme accident. Note collapsed structure.

Fig. 2. An extreme accident with disintegrated structure.
The accidents which give valuable data on crash injury problems and provide useful information for engineers are the survivable crashes - the moderate, moderately severe, and severe accidents. These are the accidents in which there is a definite exposure to injury, but the total energy of the crash is not great enough to completely collapse the cabin structure around the occupants. They include not only moderate accidents in which people are seriously injured or killed, but also very severe crashes in which no injuries occur.

An excellent example of a very severe accident in which the occupant received only bruises and scratches is shown in Fig. 3. Contact with trees was reported to have been at 90 to 100 miles an hour; with the ground, 50 to 55 mph.

Fig. 3. A severe accident - minor injuries.

Two other severe but survivable accidents are shown in Figs. 4 and 5. In the first, the pilot - who was the only occupant of the plane - received dangerous injuries. The crash shown in Fig. 5 resulted in non-dangerous injuries to the pilot; the passenger was killed.
Fig. 4. A severe accident - dangerous injuries due to partial collapse of cabin structure.

Fig. 5. Moderately severe crash. Pilot - non-dangerous injuries; passenger killed.
CHAPTER III
PROCEDURE AT THE SCENE OF AN ACCIDENT

No significant improvement in the crashworthiness of aircraft can be achieved unless engineers and manufacturers know what structures and objects within the cabin cause injuries in survivable accidents. The accident investigator, in reporting the results of aircraft accidents, is providing information for the engineer, the manufacturer, and the military. If he has an interest in accident investigation, is by nature curious and of analytical mind, has perseverance and sound judgment, his reporting of accident details will provide reliable and authoritative information.

If the accident investigator is a State Police officer he is usually the first person with official status to reach the scene of an accident. For this reason he has unusual opportunities to take photographs before the wreckage is moved, to question the pilot or other occupants, and to note crash-injury details which often become unavailable at a later date.

When guarding aircraft wreckage, the State Police officer should complete as much of the accident injury form as possible, taking particular note of the condition of cockpit structure, safety belts, shoulder harness (if any), and the seats. If possible, the investigator should ask the occupants such questions as: "Was your safety belt (and harness) loose or snug? Was your shoulder harness locked or unlocked? Do you remember any feeling of force during the crash? Do you remember any details of the crash? What objects do you think caused your injuries?" These and other details should be reported in the Remarks section of Form AC; in the case of military aircraft this information will be of value to the military authorities if the pilot is unable to reconstruct details of the accident at a later date due to shock or death.

In the execution of his other duties - giving whatever aid possible, guarding the wreckage and obtaining information required by his own
organization - it is highly desirable that the police officer note the positions of the bodies of the occupants (if unconscious or killed), where they came to rest and the objects within the aircraft which they may have struck. Exact knowledge of the position of each person in the wreckage is important and will furnish valuable help in determining or establishing the probable cause of injury or death.

The investigator should try to reconstruct the basic events that led to the accident. Witnesses, occupants of the plane and others with some knowledge of the accident may be able to provide information which will help in determining how the airplane reached the position and attitude in which it came to rest; the probable flight path, nose-down and wing-down angles and probable impact speed.

Examination of gouge marks in the ground and scars on trees, shrubs, rocks and poles will also assist in estimating the flight path angle with the ground. Wing-tips, propellers and landing gears leave tell-tale marks or bits of evidence indicating the points of contact with fixed objects.

The condition of the aircraft, damage to cabin structure where the occupants were sitting, the condition of seats, seat-backs, safety belts, shoulder harness and other protective equipment should be checked off in the appropriate spaces on the CIR Accident Injury Report Form AC.

Photographs of the accident scene should be made before the plane is moved; good photographs furnish the best possible record of an accident and the causes of injury. They should include the following:

(a) Four general views of the scene taken from four widely separated points showing major parts of the wreckage;

(b) A general view back along the wreckage pattern showing objects struck by the aircraft;

(c) Close-up views of the cabin or cockpit area, showing the instrument panel, seats, seat anchorages, safety belts, shoulder harness (and their anchorages - if damaged), control wheels, control sticks, buckled tubing and other objects in the structure which contributed to injury;

(d) A side view showing the substantially damaged portions of the nose and forward section of the cabin and the point of major
impact with the ground. Information from this view assists CIR in estimating probable crash forces to which the aircraft structure and the occupants were exposed.

Gruesome photographs showing bodies of the victims should be avoided unless they serve a specific, useful purpose.

Sketches that contain appropriate notations are excellent aids to aircraft accident-injury analysis. Such sketches need not be works of art since their value lies entirely in the information they contain, not in their perfection. (See the sample sketch below, Fig. 7.)

![Diagram of accident scene with labeled elements such as wind direction, aircraft movement, and interaction with ground features.](Image)

Fig. 7. Sample sketch of an accident.

When guarding and reporting accident-injury details of military aircraft accidents which occur outside military reservations, the police officer should make such photographs as are permitted by the military officer in charge of the wreckage. In some cases such permission may not be granted, although it is stated in paragraph f (1), section 2, chapter 8 (page 18) of the Air Force Manual 62-5 that: "Outside military reservations, guards will prohibit photographing of classified equipment only. Presence of classified material at the scene of an accident is not a reason for prohibiting the taking of pictures of the entire scene when the classified equipment can be covered or removed or otherwise kept out of any pictures."
When permission is not granted for photographing the accident scene, the police officer can request copies of photographs from appropriate military sources. In all cases, he should obtain the name and address of the military organization which took pictures and note this information on the Accident-Injury Report Form AC.

Preservation of Evidence

When civilian aircraft are involved in accidents in which the safety belts, shoulder harness or control wheels are broken, these objects should be obtained by the police officer before they are picked up by souvenir hunters. If failure of such a piece of equipment is particularly significant, the CAB, CAA, or Crash Injury Research may ask - at a later date - to examine the object.
CHAPTER IV

FORMS USED IN REPORTING ACCIDENT AND INJURY DETAILS

1. Notification Form

After the accident investigator has determined the apparent degree of injury sustained by each person involved in an accident, he should complete the Aircraft Accident Notification Form (see sample on page 14) and mail it as soon as possible to Crash Injury Research. Upon receipt of this form, CIR will mail special medical forms to the attending physicians, hospitals and coroners requesting detailed medical data. Promptness in forwarding the Notification Form to CIR is highly desirable; detailed medical information is sometimes difficult to get if the request is delayed too long.

2. Aircraft Accident-Injury Report Form AC

Each crash, if considered alone, appears to be a general mass of wreckage with little apparent or sensible relationship between injuries and structural causes. To the uninitiated investigator, specific details of structural failure may seem unimportant. But the investigator should not be misled. The specific details which he obtains - when correlated with data from other accidents and analyzed by CIR - show patterns of structural failure which result in excessive and dangerous injuries. These data provide the basis for safety design recommendations.

It is important, therefore, that the investigator complete the accident-injury report (Form AC) in its entirety except where questions are not applicable. The Form AC is mostly a check list which requires a minimum of time; most of the questions are answered by merely checking the appropriate boxes. The sample accident case on pages 15-20 shows a properly completed report.

Note: The investigating officer may complete these forms with pen, pencil, or typewriter. If a typewriter is used, the original typewritten copy should be sent to CIR. Use of a colored typewriter ribbon makes the forms easier to read.
MAIL IMMEDIATELY TO: CRASH INJURY RESEARCH, Cornell University Medical College, 1300 York Ave., New York 21, N.Y.

FROM: Richard F. Horton Vermont Aeronautics Commission

INVESTIGATOR AGENCY

A SEVERE BUT SURVivable ACCIDENT IN A (AIRCRAFT MAKE AND MODEL) Taylorcraft T-2

NC 589999. HAS BEEN INVESTIGATED BY PERSONNEL OF THIS OFFICE. THE ACCIDENT OCCURRED NEAR Fort Mills, VT. ON (DATE) 9-24-50

DETAILS OF THIS ACCIDENT HAVE BEEN OBTAINED WITH PHOTOGRAPHS SHOWING:

☐ A GENERAL VIEW OF THE DAMAGED AIRCRAFT.
☐ INTERIOR OF THE CABIN,
☐ INSTRUMENT PANEL AND CONTROL WHEELS,
☐ BROKEN SEATS OR SAFETY BELTS.

THIS MATERIAL WILL BE FORWARDed TO YOU WITH A COMPLETED ACCIDENT-INJURY REPORT FORM AT AN EARLY DATE.

THERE WERE 2 (NUMBER) PEOPLE INVOLVED IN THIS ACCIDENT. INJURIES WERE:

☐ FATAL ☐ NON-DANGEROUS
☐ DANGEROUS ☐ TRIVIAL OR NONE

CONFIRMATION OF THE NATURE AND DEGREE OF INJURIES SHOULD BE OBTAINED FROM THE HOSPITAL, DOCTOR, CORONER, FUNERAL HOME, OR PERSONS INVOLVED AS FOLLOWS:

PILOT: NAME: John J. Doe
ADDRESS: 324 E. Main St., Dover, VT.

MEDICAL INFORMATION FROM: Dr. A. Irwin Moore
ADDRESS: 82 Ardmore Drive, Port Mills, VT.

PASSENGER: NAME: Arthur L. Doe
ADDRESS: 324 E. Main St., Dover, VT.

MEDICAL INFORMATION FROM: Dr. A. Irwin Moore
ADDRESS: 82 Ardmore Drive, Port Mills, VT.

PASSENGER: NAME:
ADDRESS:

MEDICAL INFORMATION FROM:
ADDRESS:
**AIRCRAFT ACCIDENT AND INJURY REPORT FORM AC**

Mail (with photographs of accident) to:

CRASH INJURY RESEARCH, CORNELL UNIVERSITY MEDICAL COLLEGE, 1300 YORK AVE., NEW YORK 21, N. Y.

**ACCIDENT LOCATION:** Fort Mills, Webster, Vt.
**DATE:** 9-24-50
**TIME:** 10:15

**AIRCRAFT:**
**MAKE:** T-craft
**MODEL:** L-2
**OF MFG.:** 1942
**REG. NO.:** N-58999
**SERIAL NO.:** 23977
**TOTAL HOURS:** 870

**OWNER'S NAME:** Skyways Flying Service
**OWNER'S ADDRESS:** Municipal Airport, Dover, Vt.

**FILL IN PILOT’S TOTAL FLYING HOURS. NAMES, ADDRESSES AND WEIGHTS OF PILOT AND PASSENGERS. CHECK SEATED POSITIONS AND APPARENT DEGREE OF INJURY OF EACH OCCUPANT.**

<table>
<thead>
<tr>
<th>NAME</th>
<th>HOURS</th>
<th>ADDRESS</th>
<th>WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>John R. Doe</td>
<td>190</td>
<td>324 E. Main St., Dover, Vt.</td>
<td>165</td>
</tr>
<tr>
<td>Arthur L. Doe, age 12 (same address)</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GIVE BRIEF DESCRIPTION OF NATURE AND CAUSE OF ACCIDENT:**

Weather clear, unlimited ceiling and visibility, wind northwest, 10 mph. Terrain - flat open fields near Fort Mills Airport. The plane took off toward the north into a quartering headwind. As the plane climbed to 150 feet, the engine quit and the pilot allowed the plane to stall. It fell off to the left in a nose-down attitude and struck the ground in an open field, headed south. The plane was not spinning at the moment of impact; it struck almost simultaneously on the left gear and nose.

**INDICATE ESTIMATED SPEED OF AIRCRAFT BEFORE HITTING OBSTACLES:** 50 MPH.
**INDICATE ESTIMATED SPEED OF AIRCRAFT AT PRINCIPAL IMPACT:** 40 MPH.

---

<table>
<thead>
<tr>
<th>OBSTACLES AIRCRAFT HIT BEFORE FINAL IMPACT:</th>
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<tbody>
<tr>
<td>Wires</td>
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<tr>
<td></td>
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</tbody>
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<table>
<thead>
<tr>
<th>PARTS OF AIRCRAFT INVOLVED IN COLLISION WITH OBSTACLES:</th>
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<tbody>
<tr>
<td>Nose</td>
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</table>

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<table>
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<tr>
<th>INDICATE DIRECTION OF WIND IN RELATION TO DIRECTION OF AIRCRAFT AT PRINCIPAL IMPACT:</th>
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<tr>
<td>Headwind</td>
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**INDICATE DIRECTION OF WIND IN RELATION TO DIRECTION OF AIRCRAFT AT PRINCIPAL IMPACT:**

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<th>PRINCIPAL IMPACT WAS AGAINST:</th>
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<tr>
<td>Trees</td>
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**INDICATE STOPPING DISTANCE OF PLANE:**

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<tr>
<th>SLID:</th>
<th>CARTWHEELED:</th>
<th>ROLLED:</th>
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<tbody>
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</tbody>
</table>

**INDICATE LENGTH AND DEPTH OF GOUGE MARKS:**

<table>
<thead>
<tr>
<th>LENGTH (IN FEET)</th>
<th>DEPTH (IN INCHES)</th>
</tr>
</thead>
<tbody>
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<td></td>
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</table>

**INDICATE DISTANCE NOSE TELESCOPED TOWARD PILOT’S SEAT:**

<table>
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<tr>
<th>WERE FLAPS:</th>
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</tbody>
</table>

**INDICATE DISTANCE NOSE TELESCOPED TOWARD PILOT’S SEAT:**

<table>
<thead>
<tr>
<th>DEGREES</th>
</tr>
</thead>
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</table>
## SECTION 2
### DETAILS OF DAMAGE TO AIRCRAFT

<table>
<thead>
<tr>
<th>Indicate Distance Engine Displaced:</th>
<th>FEET: 1</th>
<th>Inches: 2</th>
<th>Torn Free: 3</th>
<th>Intact: 4</th>
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</thead>
<tbody>
<tr>
<td>Engine Displaced (Direction)</td>
<td>LEFT: 5</td>
<td>RIGHT: 6</td>
<td>REARWARD: 7</td>
<td>FORWARD: 8</td>
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<tr>
<td>Indicate Condition Of:</td>
<td>ENGINE MOUNT: INTACT: 9</td>
<td>BENT: 10</td>
<td>BUCKLED: 11</td>
<td>COLLAPSED: 12</td>
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<tr>
<td></td>
<td>ENGINE COWLING: INTACT: 13</td>
<td>BENT: 14</td>
<td>BUCKLED: 15</td>
<td>DISINTEGRATED: 16</td>
</tr>
<tr>
<td></td>
<td>FIREWALL: INTACT: 17</td>
<td>BENT: 18</td>
<td>BUCKLED: 19</td>
<td>DISINTEGRATED: 20</td>
</tr>
<tr>
<td>C (Or Cockpit) Area: INTACT: 24</td>
<td>DISTORTED: 25</td>
<td>PARTLY COLL. 26</td>
<td>COLLAPSED: 27</td>
<td>DISINTEGRATED: 28</td>
</tr>
<tr>
<td>Fuselage (Aft of Cabin Area): INTACT: 29</td>
<td>DISTORTED: 30</td>
<td>PARTLY COLL. 31</td>
<td>COLLAPSED: 32</td>
<td>DISINTEGRATED: 33</td>
</tr>
<tr>
<td>Tail Surfaces: INTACT: 34</td>
<td>DISTORTED: 35</td>
<td>PARTLY COLL. 36</td>
<td>COLLAPSED: 37</td>
<td>DISINTEGRATED: 38</td>
</tr>
<tr>
<td>Windshield (Plexiglas, etc.): INTACT: 44</td>
<td>KNOCKED OUT IN ONE PIECE: 45</td>
<td>BROKEN: 46</td>
<td>DISINTEGRATED: 47</td>
<td></td>
</tr>
<tr>
<td>Front Diagonal Braces: INTACT: 48</td>
<td>BENT: 49</td>
<td>BROKEN: 50</td>
<td>TORN FREE: 51</td>
<td></td>
</tr>
<tr>
<td>Rudder Pedals: INTACT: 52</td>
<td>BENT: 53</td>
<td>BROKEN: 54</td>
<td>TORN FREE: 55</td>
<td></td>
</tr>
<tr>
<td>Overhead Cabin Structure: INTACT: 60</td>
<td>BENT: 61</td>
<td>PARTLY COLL. 62</td>
<td>COLLAPSED: 63</td>
<td>DISINTEGRATED: 64</td>
</tr>
<tr>
<td>Left Wing(s): INTACT: 65</td>
<td>DISTORTED: 66</td>
<td>CRUMPLED: 67</td>
<td>TORN FREE: 68</td>
<td>DISINTEGRATED: 69</td>
</tr>
<tr>
<td>Right Wing(s): INTACT: 70</td>
<td>DISTORTED: 71</td>
<td>CRUMPLED: 72</td>
<td>TORN FREE: 73</td>
<td>DISINTEGRATED: 74</td>
</tr>
<tr>
<td>Left Control Wheel: INTACT: 75</td>
<td>BENT: 76</td>
<td>BROKEN: 77</td>
<td>JAGGED SPOKES EXPOSED: 78</td>
<td></td>
</tr>
<tr>
<td>Right Control Wheel: INTACT: 79</td>
<td>BENT: 80</td>
<td>BROKEN: 81</td>
<td>JAGGED SPOKES EXPOSED: 82</td>
<td></td>
</tr>
<tr>
<td>Left Control Column (Shaft): INTACT: 83</td>
<td>BENT: 84</td>
<td>BROKEN: 85</td>
<td>COLUMN END EXPOSED: 86</td>
<td></td>
</tr>
<tr>
<td>Right Control Column (Shaft): INTACT: 87</td>
<td>BENT: 88</td>
<td>BROKEN: 89</td>
<td>COLUMN END EXPOSED: 90</td>
<td></td>
</tr>
<tr>
<td>Left (Or Front) Control Stick: INTACT: 91</td>
<td>BENT: 92</td>
<td>BROKEN: 93</td>
<td>TORN FREE: 94</td>
<td></td>
</tr>
<tr>
<td>Right (Or Rear) Control Stick: INTACT: 95</td>
<td>BENT: 96</td>
<td>BROKEN: 97</td>
<td>TORN FREE: 98</td>
<td></td>
</tr>
<tr>
<td>Nose Landing Gear: INTACT: 99</td>
<td>BENT: 100</td>
<td>BUCKLED: 101</td>
<td>COLLAPSED: 102</td>
<td>TORN FREE: 103</td>
</tr>
<tr>
<td>Right Main Landing Gear: INTACT: 109</td>
<td>BENT: 110</td>
<td>BUCKLED: 111</td>
<td>COLLAPSED: 112</td>
<td>TORN FREE: 113</td>
</tr>
<tr>
<td>Left Gear Was Displaced: UP: 119</td>
<td>BACK: 120</td>
<td>FORWARD: 121</td>
<td>LEFT: 122</td>
<td>RIGHT: 123</td>
</tr>
</tbody>
</table>

### ADDITIONAL INFORMATION AND/OR REMARKS:

2. Right diagonal tube bent forward, possibly by pilot's head.

---

**IF ACCIDENT WAS SURVIVED OR REGARDED AS SURVIVABLE, FILL OUT SECTIONS 1, 2, AND 3.**

---

*ADDITIONAL INFORMATION AND/OR REMARKS:

---

**WERE PHOTOGRAPHS TAKEN OF ACCIDENT?** Yes
**BY WHOM? NAME** Richard P. Horton
**ADDRESS** Vermont Aeronautics Commission

---

**INVESTIGATOR'S SIGNATURE** Montpelier, Vt.
**ADDRESS** Vermont Aeronautics Commission
**AGENCY** Vermont Aeronautics Commission
**DATE OF REPORT** 10-1-50.
INJURY DETAIL: THIS SECTION TO BE FILLED OUT FOR ONE PERSON WHETHER INJURED OR NOT.

NAME: John R. Doe
ADDRESS: 324 E. Main St., Dover, Vt.

PLACE OF ACCIDENT: Fort Mills, Vt.
DATE: 9-24-50

TREATMENT GIVEN:
DOCTOR'S NAME: A. Irwin Moore
NAME OF HOSPITAL: Memorial Hospital
UNDERTAKER'S NAME: Harry D. Kline

NAME: John R. Doe
ADDRESS: 324 E. Main St., Dover, Vt.

SAMPLE
PLACE OF ACCIDENT: Fort Mills, Vt.
DATE: 9-24-50

TREATMENT GIVEN:
DOCTOR'S NAME: A. Irwin Moore
NAME OF HOSPITAL: Memorial Hospital
UNDERTAKER'S NAME: Harry D. Kline

BRIEFLY DESCRIBE APPARENT INJURIES SUSTAINED BY THIS PERSON:


SEAT OCCUPIED BY THIS PERSON:
TYPE OF SEAT: FIXED
CONDITION OF SEAT:
CONDITION OF SEAT-BACK:
CONDITION OF SEAT ANCHORAGES:
CABIN CONDITION NEAR THIS SEAT:
DURING CRASH THIS PERSON WAS THROWN:

INSIDE CABIN
OUTSIDE CABIN

DESCRIBE WHERE PERSON CAME TO REST:
On forward edge of seat, chest against instrument panel, head against right doorpost.

WAS THERE ANY INDICATION THAT THIS PERSON HIT:

DIAGONAL BRACES
OVERHEAD BRACES
CONTROL WHEEL SPEAKERS
Rudder Pedals
Brake Pedals
Instruments
Instrument Panel
Windshield Frame
Canopy
Knobs

MAKE: Flyco
MODEL NO.: A-12
MFG. DATE: 1946

WEARING SAFETY BELT? NO
 WIDTH OF SAFETY BELT 2"

SAFETY BELT INTACT
PARTLY TORN
IF SO, WHERE?

Buckle
Adjusting Adapter
End Attachment
Broken
Torn Out

SHOULDER (OR CHEST) HARNESS INSTALLED? NO
HARNESS: INTACT
DAMAGED

HARNESS ANCHORAGE: INTACT
BROKEN

WAS THIS PERSON INJURED BY OBJECTS OR OTHER OCCUPANTS BEING THROWN ON HIM?
YES

ADDITIONAL INFORMATION AND/OR REMARKS:

1. Top bent forward about 1" to 2", probably from rear seat occupant bracing himself on forward seat-back. (Canvas over backrest was ripped off when removing front seat occupant.)

2. A piece of tubing (near left front window post) broke and projected into the cabin; fortunately it caused no serious injury. The cabin was in bad shape but remained sufficiently intact to afford some protection.

Failure of safety belt probably contributed to overall injuries, particularly of the legs. A stronger safety belt and use of shoulder harness would probably have prevented the dangerous head injuries.
CIR H-2

Jan. 1951

INJURY DETAIL: THIS SECTION TO BE FILLED OUT FOR ONE PERSON WHETHER INJURED OR NOT. (USE ADDITIONAL SECTION 3'S FOR ADDITIONAL PERSONS)

NAME: Arthur L. Doe

ADDRESS: 324 E. Main St., Dover, Vt.

PLACE OF ACCIDENT: Fort Mills, Vt.

DATE: 9-24-50

TREATMENT GIVEN: FIRST AID [X] HOSPITALIZED [ ] TAKEN TO UNDERTAKER [ ]

DOCTOR'S NAME: A. Irvin Moore

NAME OF HOSPITAL: [ ]

UNDERTAKER'S NAME: [ ]

BRIEFLY DESCRIBE APPARENT INJURIES SUSTAINED BY THIS PERSON: Cuts of left ankle, bruise on back of right hand, sprained right wrist.

SEAT OCCUPIED BY THIS PERSON: FRONT [ ] REAR [X] LEFT [ ] CENTER [ ] RIGHT [ ]

TYPE OF SEAT: FIXED [ ] ADJUSTABLE FORE AND AFT [ ] ADJUSTABLE UP AND DOWN [ ]

CONDITION OF SEAT: INTACT [ ] DISTORTED [ ] PARTLY COLLAPSED [ ] COLLAPSED [ ] TORN [ ]

CONDITION OF SEAT-BACK: INTACT [ ] DISTORTED [ ] PARTLY COLLAPSED [ ] COLLAPSED [ ] TORN [ ]

CABIN CONDITION NEAR THIS SEAT: INTACT [X] DISTORTED [ ] PARTLY COLLAPSED [ ] COLLAPSED [ ] DISINTEGRATED [ ]

DURING CRASH THIS PERSON WAS THROWN UP [ ] DOWN [ ] FORWARD [ ] LEFT [ ] RIGHT [X]

INSIDE CABIN [ ] OUTSIDE CABIN [ ] DESCRIBE WHERE PERSON CAME TO REST: In seat.

WAS THERE ANY INDICATION THAT THIS PERSON HIT: DIAGONAL BRACES [ ] WINDSHIELD [ ] OVERHEAD BRACES [ ] DOORPOSTS [ ] CONTROL WHEEL SPOKES [ ] BRAKES [X]

IF OTHER, EXPLAIN: INSTRUMENT PANEL [ ] WINDSHIELD FRAME [ ] HUB [ ] CONTROL COLUMN (SHAFT) [ ] END OF SHAFT [ ] CONTROL STICK [ ]

MAKE: Flyco

MODEL NO.: A-12

MFG. DATE: 1946

LICENSED FOR 1 PERSON [ ] FOR 2 PERSONS [X]

WAS SAFETY BELT INTACT [ ] DISTORTED [ ] TORN THROUGH [ ] TORN [X]

PARTLY TORN [X]

IF SO, WHERE?

DID WEBBING SHOW DEETERIORATION? YES [X]

NO [ ]

IF SO, WHERE?

ADJUSTING ADAPTER (L) [ ] (R) [X] END ATTACHMENT (L) [ ] (R) [ ]

BUCKLE [ ] ADJUSTING ADAPTER (L) [X] (R) [ ]

BELT ANCHORAGES: INTACT [ ] REMOVED [ ] TORN OUT (L) [ ] (R) [ ]

BENT [ ]

SHOULDER (OR CHEST) HARNESS INSTALLED YES [X]

NO [ ]

IF YES, DESCRIBE:

DID PERSON WEAR HARNESS? YES [X]

NO [ ]

IF YES, DESCRIBE:

HARNESS ANCHORAGE: INTACT [ ] BROKEN [X]

DESCRIBE:

SHOULDER (OR CHEST) HARNESS INSTALLED YES [X]

NO [ ]

IF YES, DESCRIBE:

HARNESS ANCHORAGE: INTACT [ ] BROKEN [X]

DESCRIBE:

WAS THIS PERSON INJURED BY OBJECTS OR OTHER OCCUPANTS BEING THROWN ON HIM? YES [X]

NO [ ]

IF YES, DESCRIBE:

ADDITIONAL INFORMATION AND/OR REMARKS: (IN THE LAST ANALYSIS, THE INVESTIGATOR'S EVALUATION OF A CRASH GIVES MANUFACTURERS AND OTHER GROUPS CONCERNED WITH SAFETY A DEPENDABLE BASIS FOR JUDGING SAFETY NEEDS. WERE INJURIES CAUSED PRIMARY BY THE TELESCOPING OF STRUCTURE OR BY BEING THROWN AGAINST OBJECTS INSIDE THE CABIN? IF YOU HAD BEEN IN THIS ACCIDENT, WHAT IMPROVEMENTS DO YOU FEEL MIGHT HAVE DECREASED DANGER OF INJURY?)

Boy stated that he braced himself by holding onto backrest of front seat when he "saw ground coming up at him".
CHAPTER V

GENERAL ACCIDENT DATA

(Section 1)

Some crash-injury details of an accident are not always readily apparent and may be overlooked. To forestall this possibility, the Form AC has been arranged so that the investigation can be conducted in logical order. All the items listed are important. Since the reasons for requesting certain information may not be apparent, descriptions and explanations of items on the check list are outlined in the following pages. Diagrams, illustrations and explanatory material are given in the order in which the items appear on the Aircraft Accident-Injury Report Form AC. (See sample Form AC, pages 15-18.)

DATE and TIME of accident: - These are important factors in CIR's determination of degree of injury, for if a person dies more than 24 hours after an accident the injury is classed as critical; if death occurs within 24 hours the degree of injury is given a higher value. "Date and Time" also are frequently related to cause of accident and make it possible to check back later on such factors as wind direction, visibility, darkness and other weather conditions.

![Sample Registration Certificate](image)

**Fig. 8.** Sample Registration Certificate carried in aircraft.
AIRCRAFT: - The Make (manufacturer - i.e., "Piper, Temco, Stinson", etc.); Model ("170", "35-A", etc.); CAA Registration Number, and Serial Number are extremely important - particularly the Serial Number. This data may be found on the Registration Certificate which is usually displayed prominently in the cabin or cockpit. (See Fig. 8.) If the Certificate is lost or destroyed the information may be obtained from a metal identification plate attached to cabin structure. The CAA Registration Number is also painted on the wings and tail of the aircraft.

A manufacturer may make changes in design or materials of seat fastenings, control wheels, safety belts and their anchorages, and other equipment during the production of one model. Often these changes cannot be detected by the accident investigator, but the serial number will indicate to CIR whether the airplane does or does not have certain improved structures or installations.

PILOT'S TOTAL FLYING HOURS: - This information is not always available, but if obtainable is often helpful in evaluating the accident.

APPROXIMATE WEIGHT OF PILOT AND PASSENGERS: - This information is extremely important as it enables CIR to judge the forces exerted on safety belts, seats, seat anchorages and shoulder harness.

SEATED POSITIONS AND APPARENT DEGREE OF INJURY: - Characteristic "patterns of injury" are often caused by specific structures in certain types of planes. In order that these patterns may be identified and evaluated, it is very important to know where each person was sitting at the time of impact and the apparent extent of injury (or lack of injury) of each occupant. (See Fig. 9.)
In a plane crash some of the passengers may be exposed to greater injury than others. Generally the occupants of the front seats of tandem and four-place aircraft are more likely to be injured than the people in the rear seats.

Although the accident investigator need not get detailed, specific medical data on each person, it is essential that he report the full name and address of the physicians, hospitals, or undertakers who took charge of the accident victims. Upon receipt of the Notification Form or Form AC, Crash Injury Research will mail special medical forms to the attending physicians or coroner with a request for detailed injury data.

The investigator should classify the injuries broadly as Minor-None, Non-Dangerous, Dangerous, or Fatal. A general classification of apparent injuries is given below:

- **Minor injuries** - Minor contusions, lacerations, abrasions and sprains; fractures of the fingers, toes, or nose.

- **Non-Dangerous injuries** - Moderate or severe contusions (bruises), lacerations (cuts), abrasions, severe sprains; fractures of the feet, legs, hands, arms, jaw, facial bones; loss of consciousness up to 30 minutes; sprains of the back and neck.

- **Dangerous injuries** - Fractures of the back, neck, or skull with or without paralysis; crushing injuries of arms or legs, multiple fractures, multiple lacerations with hemorrhage, loss of consciousness of more than 30 minutes.

- **Fatal injuries** - Injuries which cause death within 24 hours. Common causes of fatality in survivable accidents are head injuries, crushing injuries of the chest, fracture of the neck or back, severe hemorrhages and puncture injuries of the head or body.

**BRIEF DESCRIPTION OF NATURE AND CAUSE OF ACCIDENT:** - Factors such as weather and terrain often cause accidents or contribute to accident results. Wind frequently influences accident results and it is therefore important to give wind direction and velocity and the compass direction in which the plane was headed at the time of principal impact. If the accident occurred on sloping terrain, mention whether the plane hit going uphill or downhill or parallel to the side of the hill.
Information on maneuvers prior to the accident is valuable in estimating the impact angle and speed of the plane at impact.

Whenever a plane hits an obstruction, try to get the approximate height of the point where the plane struck. In cases where a plane goes out of control near the ground and spins or spirals into the ground, try to get an estimate of the altitude at which it went out of control. This is sometimes rather difficult since witnesses who are not pilots often give very erroneous and conflicting altitude estimates. For purposes of comparison, 100 feet is the height of an average 8 to 10-story building, or the 45° sightline on the back cover of this Handbook can be used to find the height of objects. See Appendix A and explanation.

Obstacles Aircraft Hit before Final Impact: - Striking wires, trees, and other obstacles at flying speed usually will absorb a good deal of energy and slow down a plane prior to the principal impact. Information as to what part of the plane hit the obstruction will give indication of the forces imposed upon various parts of the plane and sometimes will indicate the direction in which the occupants were "thrown".

Indicate Estimated Flight Path Angle of Aircraft with Ground before Hitting Obstacles: - The flight path angle of an airplane as it descends toward the ground may be quite different from the angle of the fuselage to the ground. Just before hitting an obstacle, a plane may be "pulled up" into a nose-high attitude (see Fig. 10) in an attempt to avoid a collision, but may continue to "mush" downward toward the ground.

![Fig. 10. Flight path angle is angle of descent, often differing from nose-down or nose-up angle.](image-url)
Sighting from the point of first ground impact to the damaged part of the obstruction will often help in estimating the flight path angle. (See Fig. 11 and Appendix B.)

Fig. 11. "Sighting" flight path angle.

Indicate Flight Path Angle of Aircraft with Ground at Principal Impact:
- The flight path angle of a plane with the ground at the moment of impact may be quite different from the angle of the fuselage to the ground. For example, a plane may be "tripped" by catching its landing gear on a tree or wire, and then strike the ground vertically on the nose, although its flight path angle is much less than vertical (see Fig. 12).

Fig. 12. Difference between flight path and nose-down angles at impact.

Flight path angles may also vary according to the slope of the ground itself. (See Figs. 13 and 14.)
Differences in flight path angles due to different ground angles.

An airplane descending and hitting on a downhill slope would have a very different flight path angle with the ground from that of a plane hitting on an uphill slope (see Fig. 15). An airplane flying along a horizontal flight path into a vertical cliff would have a flight path angle of 90° to the cliff (see Fig. 16).

**Speed of Aircraft before Hitting Obstacles:**

**Speed of Aircraft at Principal Impact:** It is generally possible to estimate the speed of the airplane before hitting obstacles and at impact by questioning qualified witnesses and by considering the cruising, approach, and stalling speeds of the plane, its maneuvers, and the wind.

If the plane strikes wires, trees, or other obstacles at flying speed, a great deal of energy may be absorbed, slowing down the plane before impact with the ground. In such cases it is difficult to make more than
an "educated guess" as to the final (impact) speed. Make the best possible estimate of the probable crash speed. CIR will then check the details of the accident, the structural collapse, and other factors against similar cases to "average out" any discrepancy which may occur in estimating probable impact speed.

The effect of wind on impact speed can be estimated by use of the diagram below.

![Diagram for estimating wind effect on impact speed.](image)

**Fig. 17.** Diagram for estimating wind effect on impact speed.

For example, if a plane with a stalling speed of 50 mph were headed into a wind of 20 mph prior to, and at, impact, the impact speed would be approximately 30 mph. If, however, the plane were headed downwind (with the wind), the velocity of the wind would be added to that of the plane and would result in an impact speed of 70 mph. If the wind were from the side, a lesser amount would be added or subtracted depending on the direction of the wind in relation to that of the aircraft.

**Nose-Down Angle (With Ground) at Principal Impact:** The nose-down

![Diagram for nose-down angle.](image)
angle is the attitude of the plane at the moment it hits the ground or other object of principal impact. This angle is often different from the flight path angle (see Figs. 19 and 20).

Fig. 19.  
Nose-down angle (with ground) at principal impact.  
(Note difference between nose-down and flight path angles.)

Occasionally a plane will hit at a steep angle and "stick like an arrow", but more often it will bounce, cartwheel, or slide after initial impact, coming to rest in some other attitude. If this occurs, check such items as the deflection angle of the landing gear, damage to the wings (especially the wing-tips), buckling of the cowling, displacement of the engine, and damage to the bottom of the firewall. (See Fig. 21.) If witnesses are available, they may be of assistance in estimating the nose-
down angle if they are shown the illustrations in the Form AC (Fig. 18).

If the plane was past vertical (inverted) at the principal impact, indicate this fact in the proper space with an estimate of the nose-down angle.

Wing-Down Angle (With Ground) at Principal Impact: - Damage to the wings, landing gear, distortion of the fuselage and other parts of the plane, plus witnesses' statements, will assist in estimating whether the plane struck heavily on one wing and if so, the angle of the wings to the ground. Note that the planes in the diagram are shown as "left wing down" or "right wing down" as seen from behind the airplane. If the wing-down angle is other than those indicated above the boxes, as for example 50°, either place "X"s in both the 40° and 60° boxes or write in the numeral "50" between the appropriate boxes.

A plane descending in a wing-level attitude and striking one wing tip against sloping terrain, as in Fig. 23, would be reported as having a "wing-down" angle of, in this case, 30° due to the fact that the slope of the ground is 30° to the wing.

![Diagram of aircraft level with left wing strikes sloping ground]

Fig. 23. Effect of sloping ground on "wing-down" angle.

Indicate Direction of Wind in Relation to Direction of Aircraft at Principal Impact: - It is important, in calculating impact speeds, to know whether the airplane was going with, across, or against the prevailing surface wind at the time of impact. (See Fig. 24.) If the wind direction
was between those indicated by the boxes, put "X"s in the two most appropriate boxes. For example, if the wind was between a direct headwind and a 45° headwind, put "X"s in those two boxes.

![Diagram of wind direction](image)

Fig. 24. Wind direction in relation to direction of aircraft at principal impact.

**Principal Impact Was Against:** There is a tremendous variation in the energy absorbing characteristics of various objects struck by airplanes in accidents. For instance, soft ground will absorb a great deal more energy than pavement. It is therefore important that you indicate what the principal impact was against, so that the probable crash forces exerted on the plane and occupants can be more closely estimated by CIR.

**Stopping Distance of Plane:** Everyone knows that it’s not how fast you are going that counts, it’s how fast you stop. The distance through which a plane’s speed is stopped is most important. A crash is an absorption of kinetic energy. Crash energy is dissipated by (1) sliding, rolling, bouncing, or cartwheeling along the ground; (2) by gouging into the ground; (3) by deformation, buckling, or crushing of aircraft structures; and (4) by crumpling or breaking of objects the airplane strikes.

In low-angle accidents, planes frequently slide, bounce or cartwheel for 100 feet or more. On the other hand, in a very high-angle accident (steep nose-down angle) a plane may not move from the point of principal impact, the nose of the ship burying itself in the ground. In such accidents, the speed is stopped and the energy is absorbed in the
collapse of structure and in gouging into the ground. This distance can usually be quite accurately measured.

Length and Depth of Gouge Marks: - The length and depth of gouge marks are items of extreme importance, especially in high-angle accidents, for they provide valuable information which is used, along with other data, to estimate the crash forces transmitted to cabin structure, seats, safety belts, shoulder harness and to the occupants. Deep gouges in the ground most frequently occur in very high-angle accidents but also are found occasionally in low-angle accidents. Fig. 25 shows the type of gouging that occurs in low-angle accidents. This plane hit on the nose and landing gear with sufficient force to break the gear and buckle the bottom cowling up against the engine. This exposed the firewall of the plane which "plowed a furrow" in the ground, causing a very abrupt deceleration. Accidents of this type are misleading, for although the plane may sustain relatively little damage, the force may be very severe and cause the occupants to be thrown against dangerous objects in the cabin causing fatal or serious injuries.

In measuring the length and depth of gouges do not include the distance the airplane bounced, slid, or cartwheeled, since a plane stops much more abruptly when gouging in than it does when sliding. For ex-
ample, in Fig. 26 the total distance from the point where the plane first struck the ground to the point where it came to rest is 102 feet. Of this, only 32 feet was gouging. In Fig. 27 the plane gouged in, bounced, gouged in again, and then slid. When two separate gouges occur, as in this case, the length of both gouge marks should be added together. Although the plane bounced 26 feet and slid 42 feet, the total gouging distance was only 7 feet with a maximum depth of 5 inches.

Fig. 26. Length and depth of gouge mark should be measured accurately.

Fig. 27. Length of individual gouges should be added together.

Distance the Nose Telescoped Toward Pilot's Seat: - This provides information on the amount of energy which was absorbed by the structure of the airplane, and is determined by measuring the amount of shortening of the forward sections of the plane. If the amount of telescoping is difficult to determine because the engine has been pushed up, down, or to the side, measure the distance between the nose of the plane and some intact section of the fuselage. Or, a free-hand sketch of the plane can be drawn in the "Remarks" section showing the approximate displacement of the engine and giving a measurement from a line parallel to the nose to a specific point behind the area of damage. (See Fig. 28.) CIR can then compare your measurements with those of an intact plane of the same model and fill in the figures on "distance nose telescoped".
Fig. 28. Sample sketch (to show telescoping of nose).

Gear and Flaps: - The position of the landing gear and the flaps will often assist in determining the events that preceded the accident and also will be helpful in estimating the flight path and nose-down angles and the speed of the aircraft at impact. For example, the use of full flaps during an approach to a landing will usually result in a steeper flight path angle, a steeper nose-down angle and - if the plane is stalled into the ground - less forward speed at impact.
CHAPTER VI

DETAILS OF DAMAGE TO AIRCRAFT
(Section 2)

When reporting the type of damage to various parts of the airplane, particularly tubes and structural members, reference to Fig. 29 may be of assistance. A tube or other member with a long-radius bend would be indicated as BENT. A tube with a sharp bend of not more than $90^\circ$ (a right angle) is BUCKLED. A tube is COLLAPSED (or kinked) when it is bent sharply back on itself at an angle of more than $90^\circ$.

![Fig. 29. Terms used to define varying degrees of damage.](image)

Indicate Distance Engine Displaced: - As noted in the preceding chapter, it is essential that engine displacement be measured and recorded. However, the distance displaced refers to rearward displacement. In some accidents the engine will be displaced and then torn free. In such cases, buckling of the engine support structure and dents in the firewall may provide some indication of the distance the engine was 'pushed back' before being torn out of the airplane.
In pusher aircraft, the engine may break loose during a crash and move forward into the cabin. If this occurs, the forward displacement of the engine should be measured, as well as the rearward displacement of the cabin nose section and the instrument panel.

Engine Displaced (Direction): - The direction the engine is displaced often gives some indication of the nose-down and wing-down angles at principal impact. Usually the engine will be displaced in a direction other than directly rearward as, for example, rearward, up, and to the left. When this occurs the appropriate boxes should be checked as shown in Fig. 30.

Fig. 30.

Indicate Condition of: Engine Mounts: - Engine mounts on most aircraft are constructed of welded steel tubes or of metal channel structure. A steel tube mount is almost always connected to the fuselage at the front of the firewall. The channel-type engine mount is usually an integral part of the forward fuselage structure. In determining whether the mount is bent, buckled or collapsed, it is sufficient to indicate the condition of the mount as a whole unit. However, if one side of the mount is bent and the other side is torn free, the appropriate boxes should be checked, along with explanatory words such as "right", "left", etc. (See Fig. 31)

Fig. 31.

Condition of Firewall:
Firewall Displaced: Feet ______ Inches ______ - The distance the firewall is displaced is important to CIR in evaluating deceleration and resultant crash forces, as well as providing data for future design of aircraft structures. If the condition of the wreckage permits such accuracy, the distance of displacement should be judged by the investigator and reported within 2 inches, plus or minus.
Condition of: Cabin (or Cockpit) Area:
Fuselage (aft of Cabin Area):
Tail Surfaces: - Due to the fact that no two airplanes ever crash in exactly the same way, crash forces exerted on aircraft structure cause many different degrees and kinds of damage. For purposes of simplicity, however, four general categories of damage are used: DISTORTED, PARTLY COLLAPSED, COLLAPSED, and DISINTEGRATED.

DISTORTED means that damage is confined to slight bending or twisting, and the structure, as a whole, retains its size and shape.

PARTLY COLLAPSED means that structural members are bent, twisted or deformed so that the section, as a whole, has changed in general shape and decreased in volume. This collapse may be due, depending on the type and make of airplane - to high crash force and crash resistant structure, or low crash force in combination with uncrashworthy structure. In some accidents, one part of the cabin may be partly collapsed while another section is completely collapsed. If such a condition is observed, the areas of different damage should be identified by using words such as "front", "rear", etc., next to the appropriate boxes. (See Fig. 32.)

COLLAPSED means that the structure retains little of its original shape or volume. When the cabin or cockpit collapses on or around the occupants, injuries are usually severe or fatal. (See Fig. 33.) In many accidents to tandem aircraft, the front of the cabin collapses, causing dangerous or fatal injuries to the occupant of the front seat; the rear portion of the cabin, on the other hand, may be only distorted, permitting the rear seat occupant to escape with only minor injuries.

DISINTEGRATED means that the structure is torn, twisted or broken into fragments or small sections. Disintegration usually results from high speed, high-angle accidents or when some portion of the aircraft, such as a wing tip or nose section, is subjected to extremely high crash force.
Fig. 33. Rear cockpit collapsed to about 1/3 normal size.

There usually are no survivors in accidents in which cabin structure disintegrates since the cabin can offer no basic protection and the occupants are exposed to multiple, fatal and extreme injuries. However, in rare cases such as that shown in Fig. 34, the rear portion of the cabin structure may be only distorted while the front of the plane is

Fig. 34. Front cockpit disintegrated; rear cockpit distorted.
disintegrated. In this accident, the pilot died instantly from fatal, crushing injuries; the rear seat passenger, who was held securely by a safety belt and shoulder harness, escaped unhurt!

Condition of Tail Surfaces: - Inspection of the tail surfaces of the aircraft will sometimes indicate whether the aircraft has cartwheeled violently and slid backward, or nosed over (and subsequently been pulled upright to facilitate removal of the occupants).

Condition of Instrument Panel: - Damage to the instrument panel can provide invaluable information on causes of injury since it is struck by front seat occupants more often than other cabin structures. If it is impossible to get good photographs of the interior of the cabin and of the instrument panel, additional information should be given in the 'Remarks' space at the bottom of Section 2, as for example: 'It appears that John Doe's head dented the lower left portion of the panel at a point 4 inches from left door post to a depth of approximately 3 inches. It seems probable that the primer knob located at this point caused the skull fracture.' Fig. 35 shows how a photograph can provide excellent information on instrument panel damage.

Fig. 35. Informative photograph of instrument panel damage.

It is generally possible to tell whether a dent in an instrument panel was made by the head or body of the person who struck it. A head dent
is usually localized and definite; a dent made by a person's chest is not so sharply defined and often is indicated only by a broad forward bending of the panel.

**Condition of Windshield:** Damage to the windshield will sometimes show the direction the occupants were thrown during the crash. One make of plane has a windshield mounted in rubber so that if struck by a person's head or body, it tends to "pop out" of the frame in one piece instead of breaking.

**Condition of Front Diagonal Braces:** The front diagonal braces are steel tubes located just behind the windshield. They usually extend from the top of the front doorposts to a point just behind the windshield and ahead of the instrument panel. These diagonal brace tubes are found in most high-wing cabin type aircraft of tube and fabric construction; a few metal monocoque planes also have them to strengthen the front cabin area.

There are two common types of damage to diagonal braces. The first is the result of impact of the head or body; it is usually indicated as a broad outward bend, occasionally with flattening of the tube at the center of the bend. (See Fig. 36.) The second type of failure is buckling or kinking due to compression force and resulting structural collapse. As shown in Fig. 37, diagonal braces which buckle or kink into the cabin are extremely dangerous, particularly if struck by the head or chest.
Condition of Rudder Pedals: - Rudder pedals seldom break in crashes but their design may contribute to incapacitating injuries of the ankles and feet. Common injuries resulting from rudder pedals are broken foot and ankle bones and compound dislocations of the ankle (caused by twisting of the ankle on the pedal at the moment of impact). Occasionally a pilot will brace himself against the rudder pedals rigidly enough to cause fractures and dislocation of the ankles, legs, or hips.

Condition of Flooring:
Floors Material: - Plywood flooring splinters easily, often causing painful shearing injuries of the feet and lower legs if they are pushed through the bottom of the plane; it may also trap people in wreckage by pinning their feet and ankles. Metal flooring generally provides better protection for the feet, ankles, and legs.

Condition of Overhead Cabin Structure: - Overhead cabin structure can inflict severe head injuries if the occupant is thrown upward and forward (after breaking his safety belt); if the overhead structure collapses into the cabin, dangerous or fatal injury may result. The investigator should look for collapsed overhead structure and record it on the Form regardless of whether it resulted in injury.

Condition of Wings: - The damage to the wings is of value to CIR in judging the speed and angle of impact as well as crash force transmitted to the cabin structure, extent of cartwheeling, and other factors. If a plane strikes the ground at a steep angle on one wing-tip, the wing will usually crumple progressively from the tip toward the cabin, absorbing much of the energy of the crash.

In high-angle accidents, wings often crumple progressively from the leading edges to the trailing edges. Accidents involving unusually heavy downward or forward forces will often cause the wings to break downward or forward. (See Fig. 38.) Photographs of the wreckage normally will give the necessary data on damage to the wings, but any additional facts which the investigator believes important should be noted in the "Remarks" portion at the bottom of Section 2.

Condition of Control Wheels: - A control wheel can provide considerable protection in an accident or it can be the cause of severe chest injuries, depending upon the design of the wheel and the supporting control column. Many of the control wheels now in use are of fairly recent design and manufacturers are therefore particularly interested in knowing how
they stand up in accidents. If there are signs of damage or distortion, check the possibility that they contributed to head or chest injury. Common types of wheel failures are (1) breaking of the rim from the hub - this leaves jagged spokes and may cause puncture wounds; and (2) bending of the spokes from the hub - causing a heavy concentration of force on a small area of the chest. (See Fig. 39.)

Placement of the control wheels seems to influence the nature of injuries to some extent; a high wheel position tends to cause a large proportion of head and face injuries. A lower position of the wheel causes...
occa\n
Condition of Control Column: - The control column, to which the control wheel is attached, sometimes breaks off during a crash and exposes the occupants to puncture wounds of the head, throat, or chest. (See Fig. 40.) Information as to whether the tube fractured or the hub of the wheel broke loose from the shaft should be noted in the "Remarks" section at the bottom of Section 2.

Condition of the Control Stick: - The control stick can cause injury of the lower extremities, the pelvic region, the chest and sometimes of the face or head. Head and chest injuries - if caused by the control stick - usually result from striking the upper end of the stick. If the control stick is bent, broken, or torn free the investigator should consider the possibility that injury may have been caused by the stick.

Condition of the Landing Gear: - The condition of the landing gear and the direction in which it was displaced assists in judging the angle and nature of the initial impact. If a plane strikes at a very steep angle, the gear may be damaged only slightly or not at all (see Fig. 41). A plane stalled into the ground at a relatively flat angle, however, may completely flatten the landing gear (see Fig. 6, page 7). In some makes of planes,
collapse of the gear often contributes to injury of the lower spine. This is due to the fact that the gear absorbs relatively little energy before collapsing, and a great deal of crash energy is transmitted to the seats and occupants when the bottom of the plane strikes the ground.

Where was Battery Found after Accident? - In some planes the battery is installed in the rear of the cabin behind the occupants, or in the luggage compartment. If it tears loose in a crash, the battery can cause severe injury; the direction and distance it is thrown will give some indication of the flight path angle, impact speed, and forces transmitted by structure to the area where the battery was located.

When the battery is thrown free of a plane in a crash, the fire hazard from short circuits is eliminated. On the other hand, batteries which break away from their mountings may come to rest in the wreckage and cause fires several minutes or even several hours after the accident.

Stall Warning Indicator Installed? - Stall warning indicators are found on only a small proportion of aircraft at the present time. This instrument warns the pilot (by a horn and a red light on the panel) when he is flying the plane too slowly and is in danger of stalling. A common type
consists of a small metal vane mounted on the leading edge of one wing. Another type, which is relatively rare, consists of a stall detector device mounted near the trailing edge on the top surface of one or both wings.

Indicator Operating? - Whenever possible, ask the pilot, the owner, or someone familiar with the plane, whether the indicator was ordinarily kept in working order and was properly installed. If the circuits are intact and there is no danger of fire, a Safe Flight Indicator can be tested by turning on the master switch (if the plane has a battery), holding the wing vane in the up position, and noting whether the light comes on and the horn blows.

Additional Information and/or Remarks: - Any additional information concerning damage to the aircraft, events leading to the accident, or sketches explaining details may be included in the spaces provided near the bottom of Sections 2 and 3, or on additional sheets.

Were Photographs Taken of Accident? By Whom? - If the photographs were taken by a person other than the investigator, the photographer's name and address should be listed in the space provided at the bottom of the page.

Note: Good, clear photographs are an extremely important part of any accident report, for they provide:

1. Information on structural damage, which often cannot be adequately described by words;

2. A descriptive record which is of great assistance to engineers in evaluating the need of, and/or effectiveness of, improved structures; and

3. A photographic record which allows grouping of similar crashes for study of injury causes.
CHAPTER VII

INJURY DETAIL
(Section 3)

A complete sheet (Section 3) is to be filled out for each occupant of the plane whether unhurt, injured, or killed. Lack of injury in a severe but survivable accident is very informative, for it may indicate the effectiveness of design improvements in structure, seats, control wheels, etc., and their location in the plane. If there are more than two persons involved, use extra "Section 3" sheets.

Name and Address: - The full name and complete address of each person in the accident should be recorded. This information is needed in case CIR finds it necessary to correspond directly with the survivors concerning such details as whether they braced themselves before impact, whether safety belts were worn, etc.

Briefly Describe Apparent Injuries Sustained by this Person: - As explained in Section 1, the investigator need not get a medical report in order to answer this question - he should report the principal injuries he observes and any other medical information obtained in the course of his routine investigation. CIR will, upon receipt of Form AC or the Notification Form, request detailed medical data from the attending doctor, hospital, or undertaker.

When people are killed in an accident, the coroner or undertaker should be informed that he will receive a request from Crash Injury Research for detailed medical information - for research purposes - on all the observed injuries sustained by the victims, not just the injury which caused death.

Seat in Aircraft Occupied by this Person: - In most accidents, exposure to injury varies considerably according to where a person is sitting at the moment of impact. This is especially true in tandem and four-place aircraft where the occupants of the front seats are usually two or three feet closer to the area of damage. In many accidents the front seat oc-
cupants receive fatal crushing injuries from collapse of structure while the passengers in the back seat sustain minor or non-dangerous injuries.

If there is any doubt where a person was sitting at the time of the accident a question mark should be put in the space indicating his probable position. In cases of survival, CIR can usually verify this detail by corresponding with the survivors.

Type of Seat: - There are three types of seats commonly used in light planes: (1) fixed seats, (2) seats which can be moved forward and backward, usually by sliding on tracks, and (3) seats which slide up and down on vertical tubes. (See Fig. 42.) In four- and five-place airplanes there is an increasing trend toward an adjustable seat for the pilot and fixed seats for the passengers.

There are two other types of seats which, though not adjustable, are of interest in crash-injury studies. One is a seat with a hinged backrest, used in the front of some four- and five-place planes. The backrests are designed to tilt forward, out of range of the heads of rear seat passengers during a crash. A few types of planes are equipped with front seats which tilt forward as a complete unit, being attached to the floor by the front supports only. When this type of seat is used, the safety belts are anchored to the floor or to primary cabin structure.

Condition of Seat: - The seats in aircraft, like safety belts and shoulder harness, can be fundamental safety devices if designed to withstand crash force. In order to be effective, however, seats must be designed with sufficient strength to remain relatively intact and in place while supporting the body under heavy crash loads. In accidents with heavy forward force, seats may tear loose from their anchorages (particularly if they
are on tracks) allowing the occupants to be thrown against forward structures or out of the plane. When a plane is subjected to heavy downward force, the seats may be partially collapsed, causing spinal injuries.

In some aircraft accidents the seat-back may be torn loose from the seat-bottom. If this type of failure is found it should be reported in the "Remarks" section.

**Condition of Seat-Back (Backrest):** In tandem aircraft equipped with rigidly attached seats, persons in the back seat often strike the backrest of the front seat with their heads or necks as they jackknife over the safety belt (see Fig. 43) or with their bodies if the safety belt breaks. When this occurs the seat-back may be bent forward or broken, or the entire seat may be torn free.

**Condition of Seat Anchorages:** Seats are anchored in various ways, depending upon the make and model of aircraft (see Fig. 44). They may be bolted to plates which are welded to primary structure, bolted to clips around primary structure, or attached by sliding clips to rails. Seats anchored to primary structure are less likely to tear completely loose in a crash. For example, the rear legs of a seat may break loose from their anchorages in an accident with abrupt forward force; in a cartwheeling crash the anchorages on one side of the seat may be strained or broken. Seats mounted on tracks sometimes tear free due to distortion of the flooring.
Cabin Condition near this Seat: - The extent of collapse of surrounding structure greatly limits and determines the magnitude of crushing injuries which may occur in serious accidents. Information on the extent of structural damage adjacent to each seat is therefore very valuable in correlating accident-injury details, and providing data for future design of more crashworthy structures, as well as for judging crash forces imposed on the seats and the occupants.

During Crash this Person was Thrown: - Actually people are not "thrown" in a crash, - they continue their "line of flight" while the airplane stops or rotates around them. The motions of a plane in a crash are frequently very complex; a person in the front seat may be thrown heavily to the right while a person in the rear seat is thrown to the left. The attitude and flight path angle of the plane at impact and marks on the instrument panel or other parts of the cabin will provide some indication of where the people were thrown during the crash.

Describe where Person Came to Rest: - When safety belts are used and remain intact, it is generally possible to tell where the occupants came to rest after the crash. However, safety belts frequently fail in severe accidents and it is not uncommon to find that occupants of the rear seats have been thrown onto the front seat occupants or even through the side of the plane.

Was there any Indication that this Person Hit: - This question is in the form of a checklist of all the structures the pilot or passengers might strike in a crash. Most of them have been defined in Chapter VI. The rest are defined below.

Overhead braces are structural members (usually tubes or channel pieces) which form the roof of the cabin.

Side braces are structural members forming the sides of the cabin. (See Fig. 45.)

A canopy is a movable plexiglas cabin enclosure which slides forward or backward on tracks or swings upward on hinges.
Brake pedals - In most planes the brakes are operated by the rudder pedals; in a few they are operated by a brake handle. There are several makes of planes which have small separate brake pedals on the floor just behind and to the side of the rudder pedals.

SAFETY BELT - The term "safety belt" refers to the whole installation - buckle, webbing, adjusting adapters, and end attachments (see Fig. 46). The safety belt anchorage is a part of the aircraft structure to which the end attachments of the belt are fastened.

The safety belts normally used in civilian planes are two inches in width, with a holding capacity of 2000 pounds, and are licensed for use by 1 or 2 persons. Belts manufactured after January, 1951, are to have holding capacities of 3000 pounds.

Most military planes (and some surplus military trainers) have 3-inch safety belts. (See Fig. 47.)

CIR studies have shown that people frequently break 2000-pound belts without any resulting injuries, and that safety belt webbings fail in nearly half the severe accidents reported to CIR.

Was this Person Wearing Safety Belt? - If a belt is completely undamaged, check whether or not it was being worn.
Make, Model No., Date of Manufacture, Licensed for 1 or 2 Persons:  
This information is usually given on a cloth label which is sewed on the webbing between the buckle and the end attachment. If the belt is old the label may be illegible. Some makes of belts also have this information stamped on the buckle.

Was Safety Belt Intact, etc.: To report that a safety belt was "torn" or "failed" gives the manufacturer very little information. It is essential to state the location and type of failure, (see Fig. 48) whether the webbing was partly torn or torn through and where; whether the end attachments were strained, deformed or broken; whether the buckle, adjusting adapters, or end attachments cut the webbing.

Fig. 48. Webbing broken in crash.  
Fig. 49. Webbing cut to remove pilot.

Sometimes safety belts which appear to be cleanly broken through the webbing have actually been cut to facilitate removal of victims from the wreckage (see Fig. 49). Check this point with witnesses.

Note: Through an error the line indicated by arrows (below)
was omitted from Section 3 of Form AC. If end attachments are bent or broken, cross out the words "belt anchorages", substitute the words "end attachments" and use this line to report damage to end attachments as shown below.

SHOULDER HARNESS - Shoulder harness (see Fig. 50) can provide exceptional protection from dangerous or fatal injury in a crash if cabin or cockpit structure does not collapse. However, harness is not standard equipment in civilian planes. Most military planes and some surplus trainers are equipped with harness, but pilots often fail to use it.

Several new types of civilian shoulder harness have been put on the market, but to date there is no information on the effectiveness of these harnesses or their anchorages. It is important that data on the various types of shoulder harness and harness anchorages be reported to CIR.

Fig. 50. Four types of shoulder harness.

If the harness or its anchorages fail, the investigator should try to get a good photograph or make a sketch of the section which failed.

Was this Person Injured by Objects or Other Occupants Being Thrown onto Him? - When safety belts fail in severe crashes the occupants of rear seats are sometimes thrown onto people in the front seats, increasing their injuries. In the same way, luggage or batteries located behind the
rear seat may be catapulted into the cabin. One civilian plane has an auxiliary gas tank located just behind the pilot and passenger; this tank occasionally comes loose in a crash, causing injuries to the backs or heads of the occupants.

Additional Information and/or Remarks: - The investigator's additional comments on dangerous cabin design, factors which provide or could provide greater crash protection, and his recommendations for improvements are invaluable to engineers when modifying present models or designing new aircraft.
HOW TO FIND APPROXIMATE HEIGHT OF OBJECT.

1. Hold card vertically as shown in illustration on inside of back cover; tilt card up or down until 45° line is level.

2. While holding 45° line level, walk toward or away from object until it lines up with edge A-B of card.

3. From this point, pace off or measure distance to base of object. A pace (two steps) is approximately 5 feet.

4. Add 5 feet to measured (or paced) distance to get approximate height of object.

Example (see illustration above): The measured distance from sighting point to base of tree is 15 feet.

\[
\frac{15 \text{ feet (measured distance)}}{+ 5 \text{ feet (height of man's eye above the ground)}}\]

\[
\frac{20 \text{ feet} = \text{approximate height of damaged area above the ground.}}{}
\]
APPENDIX B

HOW TO FIND APPROXIMATE FLIGHT PATH ANGLE
(WHEN AIRCRAFT HAS STRUCK AND DAMAGED OBJECTS)

1. HOLD CARD AS INSTRUCTED (SEE INSIDE OF BACK COVER) AND
SIGHT ALONG EDGE OF CARD TOWARD OBJECT AT A POINT APPROXIMATELY 5 FEET ABOVE DAMAGED AREA.

2. WHILE HOLDING CARD AS DESCRIBED ABOVE, LOOK TOWARD HORIZON AND READ NUMBER (DEGREES) ON WHICHEVER LINE APPEARS TO BE LEVEL.

In this example, the 30° line is level; therefore the approximate flight path angle of the airplane, after striking the tree, was 30°.
HOW TO USE SIGHTING DIAGRAM ON BACK COVER

(1) HOLD CARD VERTICALLY

(2) PLACE POINT (A) CLOSE TO INNER CORNER OF RIGHT EYE (NEAR NOSE)

(3) SIGHT ALONG EDGE A-B TOWARD OBJECT

(4) WHILE KEEPING OBJECT IN LINE WITH EDGE A-B, LOOK TOWARD HORIZON AND READ NUMBER (DEGREES) ON WHICHEVER LINE APPEARS TO BE LEVEL.

(The number read is the angle in degrees of the object above the horizon, from the point at which the "sight" is made.)
(1) HOLD CARD VERTICALLY

(2) PLACE POINT (A) CLOSE TO INNER CORNER OF RIGHT EYE (NEAR NOSE)

(3) SIGHT ALONG EDGE A-B TOWARD OBJECT

(4) WHILE KEEPING OBJECT IN LINE WITH EDGE A-B LOOK TOWARD HORIZON AND READ NUMBER (DEGREES) ON WHICHEVER LINE APPEARS TO BE LEVEL.

SIGHT ALONG THIS EDGE TOWARDS OBJECT