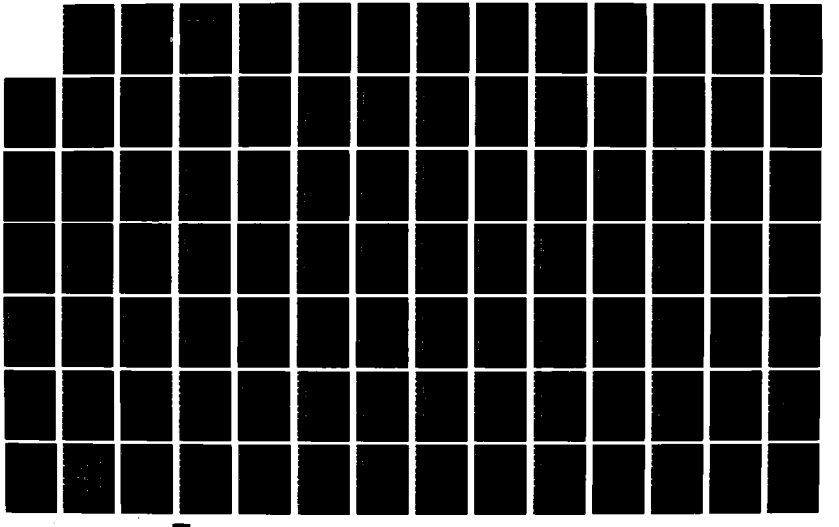
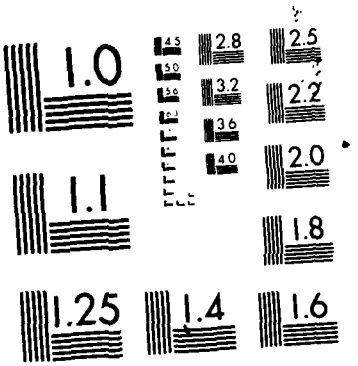
AD-A171 657 AIRCREW AUTOMATED ESCAPE SYSTEMS (AAES) DATA ANALYSIS PROGRAM SYMPOSIUM H.. (U) NAVAL SAFETY CENTER NORFOLK VA 1981 1/3

UNCLASSIFIED F/G 1/3 NL





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AD-A171 657

DTIC ACCESSION NUMBER

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INVENTORY

AIRCREW AUTOMATED ESCAPE SYSTEMS DATA ANALYSIS PROGRAM SYMPOSIUM VOL. II

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AIRCREW AUTOMATED ESCAPE SYSTEMS (AAES)

DATA ANALYSIS PROGRAM SYMPOSIUM

VOL II

(COPIES OF VISUAL PRESENTATION AIDS & ADDITIONAL INFORMATION)

Presented by:

NAVAL AIR SYSTEMS COMMAND
NAVAL SAFETY CENTER
NAVAL WEAPONS ENGINEERING SUPPORT ACTIVITY

6,7,8 OCTOBER, 1981
NAVAL SAFETY CENTER
NORFOLK, VIRGINIA

Assumption:

The cause of death for recovered fatalities is from the same distribution as those which are lost.

Thus, given X out of 17 deaths are caused by the canopy (for lost category) the probability of observing 0 out of 41 (recovered category) which were caused by the canopy is:

$$(1 - X/17)^{41}$$

Let $p = X/17$

$(1 - p)^{41}$ is displayed below.

e.g. $(1 - 1/17)^{41} = .083$

$(1 - 2/17)^{41} = .0059$

.
.
.

$(1 - 16/17)^{41} = 0.35 \times 10^{-51}$

$(1 - 17/17)^{41} = 0$

P
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
(1-P)**4

AIRCREW AUTOMATED ESCAPE SYSTEMS (AAES)

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6,7,8 OCTOBER, 1981
NAVAL SAFETY CENTER
NORFOLK, VIRGINIA

DEPARTMENT OF THE NAVY
NAVAL SAFETY CENTER
NAVAL AIR STATION
NORFOLK, VIRGINIA 23511

IN REPLY REFER TO:
122:gc
3750
Ser 4223
4 September 1981

From: Commander, Naval Safety Center
To: Distribution

Subj: Automated Airborne Escape Systems (AAES) Symposium

Encl: (1) Agenda for subject symposium

1. At the request of the Chief of Naval Operations and with the cooperation and support of Commander, Naval Air Systems Command, Commander, Naval Safety Center, will co-host a two-day symposium to review selected topics associated with Automated Airborne Escape Systems (AAES).

2. The symposium will be held at the Naval Air Station, Norfolk, Virginia, on 6, 7 and 8 October 1981. The symposium's format will consist of informative presentations, 30 - 40 minutes in length, followed by open question-and-answer periods. Representatives of the Naval Air Systems Command (Aircrew Systems Division), Naval Weapons Engineering Support Activity (Systems Analysis), and the Naval Safety Center (Aviation Directorate) will present results of selected studies conducted for the purpose of evaluating or monitoring AAES usage, performance and/or maintenance trends. Source data has been derived from historical mishap data files maintained by the Naval Safety Center.

3. The identification, assessment and effective resolution of problem areas related to the effective use, maintainability and operation of AAES has been and will continue to be a major objective of the Navy. Systematic analysis of long-term mishap data is one approach to identifying reliability and maintainability degradation trends, as well as potential system deficiencies. The utility of such analyses in escape system design, acquisition and modification processes is considered to have significant value to both industry and DOD organizations having a direct interest in AAES and their subsystems.

4. The proposed agenda, enclosure (1), is provided for your interest and review. If your organization desires representation at the AAES symposium, please provide names, grade/rate (as appropriate), social security numbers, job title, and security clearance to this Command no later than 15 September 1981. Additional information on approved agenda, time schedule, conference location and travel directions will be forwarded. Due to space limitations, each organization/command will be limited to no more than three representatives.

5. Naval Safety Center points of contact are: CDR V. Voge (Code 14, Autovon 690-7341) and LCDR R. Moe (Code 122, Autovon 690-3494). COMNAVAIRSYSCOM/ NAVWESA points of contact are: Mr. F. Guill/Mr. C. Stokes (Autovon 288-3621 or Commercial 202 433-3621).

T. C. STEELE

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NAVPRO LONG BEACH CA
NAVPRO COLUMBUS OH
HAWKER SIDDELEY, UK
AFPRO ST LOUIS MO
AFPRO SEATTLE WA
AFPRO FT WORTH TX
AFPRO FARMINGDALE, NY
GENERALDYNAMICS
APPLIED COMBUSTION TECHNOLOGY
MANTECH INTERNATIONAL CORP

AGENDA DAY 1

0800-0850	Registration
0900-0915	Opening Remarks - Welcome
	RADM T. C. Steele
0915-0945	Introduction of Host Reps
	Area Orientation
0945-1000	Break
1000-1050	AAES Data System Program Introduction
1100-1150	Review of AAES Use and Non-use
1200-1330	Lunch Break
1330-1420	Through vs Jettison Canopy Injuries
1430-1520	Helmet Retention/Loss Factors

AGENDA DAY 2

0900-0950	Flail/Tumbling Factors
1000-1150	In-Service System Reliability
1200-1330	Lunch Break
1330-1420	Overwater Survivability
1430-1520	Aircrew Size/Anthropometry
1530-1620	Expected Impact of AAES Data System Usage

AGENDA DAY 3

To be used as necessary based on progress during days 1 and 2

Enclosure (1)

PRESENTATION TOPICS

1. Introduction to AAES Data System Program NAVAIR/NAVWESA

   Objectives

   Interface NAVSAFECEN/NAVAIR

   Present Status - Future Plans

   Constraints

2. Review of historical use and non-use of AAES NAVSAFECEN/NAVAIR

   Results: Survivability

   Trends in Usage Rates

   Non-survived Ejection Cause Factors

   Usage Conditions

   AAES non-use trends

   Success Criteria

3. Through-canopy vs Jettisoned-canopy Injuries NAVAIR/NAVSAFECEN

   Vertebral

   Upper-lower limbs

   Head/neck

4. Helmet Retention/Loss Factors NAVAIR/NAVSAFECEN

   Vertebral Injury

   Varying levels of consciousness

   Head/Neck Injury

5. Ejection Flail-tumbling Factors NAVWESA/NAVAIR

   As a function of airspeed

   As a function of system design

   As a function of Escape initiation method

6. In-service Reliability NAVWESA/NAVAIR

   Ejections attempted but not accomplished

   Other failure/malfunction modes

7. Ejection Survivability in Low Altitude Overwater Environment NAVSAFECEN/NAVAIR

   . Land vs Water Survival

   . Overwater Fatalities

   . Parachute/RSSK Divestment and LPA Inflation Variables

8. Aircrew Restraint Factors NAVSAFECEN/NAVAIR

   . Negative "G" Environment

   . Research on "G" Restraint Systems

9. Expected Impact of AAES Data System Program NAVAIR/NAVWESA

   . Short Range

   . Long Range

PROPOSED ATTENDEES

U. S. NAVY; Representation from:

OPNAV - 05F, 506N
CHNAVMAT
COMNAVAIRSYSCOM
NAVAIRDEVCEN
NAVWPNCEN CHINA LAKE
BUMED
MONTEREY
CNET
ONR
NAVAIRTESTCEN
NAVORDSTA
NAMRL PNCLA
NAMI PNCLA
NAVAL BIODYNAMICS LAB
NAVAIREWORKFACS (6)
TYCOM - Safety; Flight Surgeons; Physiologists
OPTEVFOR

USAF; Representation from:

NORTON AFB
WRIGHT PATTERSON AFB
BROOKS AFB
ANDREWS AFB
KELLEY AFB

ARMY; Representation from:

FORT RUCKER
ST LOUIS

NASA

LANGLEY AFB
MANNED SPACE CENTER

CONTRACTORS

PRIME AIRFRAME
Grumman; Boeing; Vought; Douglas; McDonnell; Republic; Fairchild-Miller; Lockhead; Convair; Martin-Baker LTD, U.K.

OTHERS
Teldyne Ryan; Stencel Aero Engineering Corp.; Pacific Scientific; Talley; Biotechnology; Humanoid Systems; Dayton T. Brown; East-West Industries; Explosive Technology; Space Ordnance Systems; Person-System Integration; Advanced Logistics Management Inc.; University of Cincinati; Wayne State University; University of Southern California

FOREIGN GOVERNMENTS (having similar AAES)

CANADA
GREAT BRITAIN
FEDERAL REPUBLIC OF GERMANY

AIRTASK/WORK UNIT ASSIGNMENT
NAVAIR FORM 3930/1 (REV. 2-77)

DEPARTMENT OF THE NAVY
NAVAL AIR SYSTEMS COMMAND
WASHINGTON, D.C. 20361

See NAVAIR 3900.8 or superseder for applicable details on completing this form.

CLASSIFICATION: UNCLASSIFIED

05 NOV 1980 PAGE 1 OF 3

ADDRESSEE: Director, Naval Weapons Engineering Support Activity Systems Analysis Dept. (ESA-31) Washington Navy Yard, Wash.D.C. 20374	AIRTASK NO.: A512-512C/184-4/1512-000-055	AMEND NO
	WORK UNIT NO.: A5312B-04	AMEND NO
NAVAIR PROJECT ENGINEER: Mr. Frederick C. Guill AV 222-7486	CODE: AIR-531C	EFFORT LEVEL: NORMAL CLASSIFICATION OF AT/WU: UNCLASSIFIED

1. The XXXXXXX WORK UNIT ASSIGNMENT described below is assigned in accordance with the indicated effort level and schedule. Funding authorization for XXXXXXX will be provided in separate correspondence. If this XXXXXXX WORK UNIT ASSIGNMENT cannot be accomplished as assigned, advise the NAVAIR HQ cognizant code. No work beyond the planning phase will be accomplished unless the addressee has funds in hand or written assurance thereof.

2. Cancellation, References and/or Enclosures.

Cancellation: Work Unit A5312B-04 dated 13 Dec 1979 and subsequent amendments under AIRTASK A512-512C/184/0512-000-055 amend. 1.

Encl: (1) NAVAIR Consolidated Priority List - Aircraft Systems Fleet Support Projects 10 October 1980
(2) Schedule

3. Technical Instructions.

a. Title. IDENTIFICATION AND REVIEW OF AIRCREW AUTOMATED ESCAPE SYSTEM (AAES), IN-SERVICE RELIABILITY AND MAINTAINABILITY PROBLEMS

b. Purpose. To establish a systematic investigation of in-service AAES data, such as that contained in the 3-M System, Unsatisfactory Reports, Medical Officer Reports of Aircraft Accidents, and Naval Air Rework Facility Data Systems, to identify for potential corrective action the many daily low-grade problems which contribute to the general lowering of AAES in-service reliability and cause the general worsening of AAES in-service maintainability.

c. Background. At present there exist special arrangements for investigating and correcting spectacular AAES in-service problems, particularly those which cause fatalities. This effort is intended for reviewing the pervasive non-spectacular low-grade AAES in-service reliability and/or a general degradation of AAES in-service maintainability. These problems, vastly overshadowed by the spectacular ones, nonetheless are important, and if left unmonitored and uncorrected, occasionally manifest themselves in fatalities, serious injuries and/or very great difficulties experienced by the ejectee, which under slightly different conditions could have caused serious injuries. Some problems also manifest themselves in increased

SIGNATURE (By Direction COMNAVAIR): W. R. BURRIS By direction
DATE: 11/5/80

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Previous issues of this form are obsolete

W.U. A5312B-04
AIRTASK A512-512C/184-4/1512-000-055

maintenance efforts and costs and/or increased hazards to maintenance personnel. Since there at present is no systematic review of in-service AAES data, there is no valid method of identifying AAES in-service problems deserving management attention short of awaiting death, serious injury or major complaints. Thus NAVAIR is forced into a "squeaky wheel" reaction mode of operation versus the more desirable mode of allocating resources based on a continuous analysis of the total AAES in-service experience.

d. Detailed Requirements/Cost Estimates. $90.0 K for FY-81 in support of applicable projects listed on enclosure (1) Priority List, to be obligated quarterly as follows: first quarter $30.0 K, second quarter $30.0 K, third quarter $30.0 K. Program element - 78012N (O & MN).

Continue establishment of a system for the systematic review of such sources of AAES in-service data as 3-M Systems, Unsatisfactory Reports, Medical Officer Reports of Aircraft Accidents, and Naval Air Rework Facility data systems, in a manner designed to identify and assess the significance of the many commonly occuring in-service problems affecting AAES in-service reliability and maintainability. The system outputs shall be structured to provide data of assistance to NAVAIR Headquarters in the management of the scarce AAES resources; e.g., problems experienced, frequency of occurrence, experience severity, potential severity, and range of activities and/or AAES experiencing the problems. Once established and documented the system(s) can be integrated into regular reporting systems to assure regular, early notification to NAVAIR Headquarters concerning in-service problems being experienced and should assist considerably in the identification of causes and development of remedial actions. In addition, perform specific analytical tasks of high priority as assigned.

e. Detailed Program Plan. Not applicable.

f. Field Activity Contact. Mr. G. Opresko, NAVWESA (ESA-31).

g. Headquarters Technical Support. None.

4. Schedule. See Enclosure (2).

5. Reports and Documentation.

a. Reports.

(1) Upon completion of each task, present data and findings in letter-type reports to NAVAIR Headquarters (AIR-531).

(2) A semi-annual program review shall be held at NAVAIR in February and August with NAVAIR publishing a report of findings in March and September.

W.U. A5312B-04
AIRTASK A512-512C/184-4/1512-000-055

(3) NAVWESA shall report to the Commander, Naval Air Systems Command (AIR-512C) the man years and associated cost, cost of materials, travel and cost of contracts awarded by NAVWESA for this project. This report shall be submitted 1 May 1981 and 1 November 1981 for final status.

b. Requirements for Future Planning Information. Prepare and submit to NAVAIRHQ (AIR-531) for approval, a letter-type project plan. The primary effort shall be for establishment of baseline data to aid in subsequent identification of trends and specific problems. Subsequent tasks shall be for extending previous analytical techniques and data sources investigating efforts to identify specific AAES in-service reliability and maintainability problems.

6. Contractual Authority. Contracts to perform all or portions of the Work Unit are hereby authorized within the funding indicated by the Work Unit cost estimate.

7. Source and Disposition of Equipment. Not applicable.

8. Aircraft Requirements. None.

9. Status of Applicable Funds. Funds for this Work Unit will be provided separately.

10. Security Classification. All prescribed work under this Work Unit is unclassified. In performing the prescribed work, access to information which is classified and/or to areas containing classified equipment may be required. Any reference to such classified material shall be in accordance with the applicable materials security classification. Particularly, reference to information concerning survivability/ vulnerability shall be classified in accordance with OPNAVINST. C5513.2A, Encl. (63); OPNAVINST. S5513.8, Encl. (7).

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Addressee (3)
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NAVAIRDEVCEN (CSD),Warminster
NAVAIRTESTCEN (SY-70), PAXRIV
NAVORDSTA (Code 5123), Indian Head
NAVORDSTA (Code 515), Indian Head
NAVWPNCEN, China Lake (Code 64)
NAVSAFECEN, Norfolk
COMNAVAIRPAC, North Island
CGFMFLANT
CGFMFPAC
NAVPLANTREPO, Bethpage
NAVPLANTREPO, Dallas
NAVPLANTREPO, Burbank
NAVPLANTREPO, Long Beach
AFPRO, St. Louis
DCASMA (DCRA-GACB), Marietta

NAVY EJECTIONS BY SEAT TYPE, SEAT FAMILIES & SEAT GROUPS

1 JANUARY 1969 THROUGH 31 DECEMBER 1979

NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979

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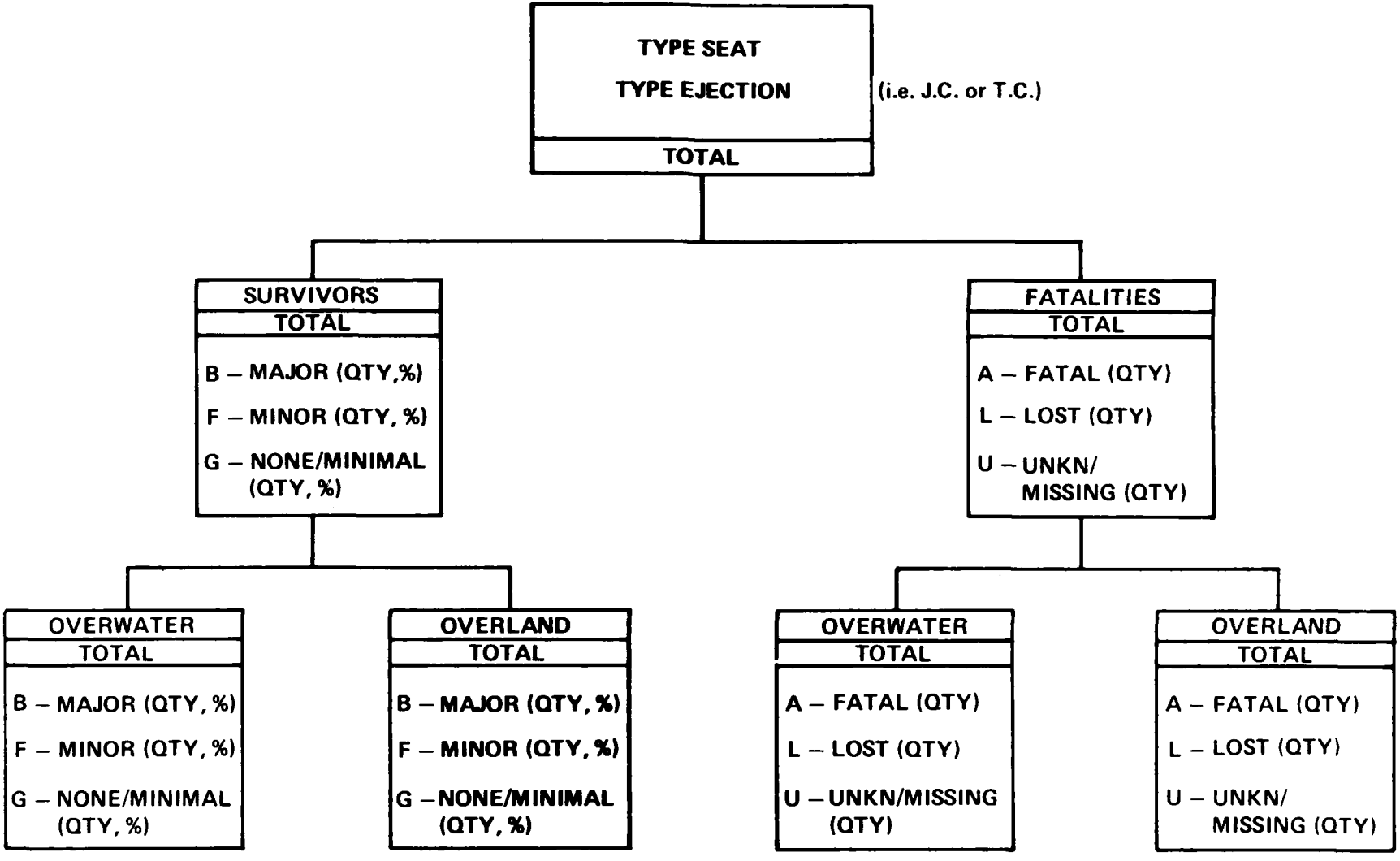

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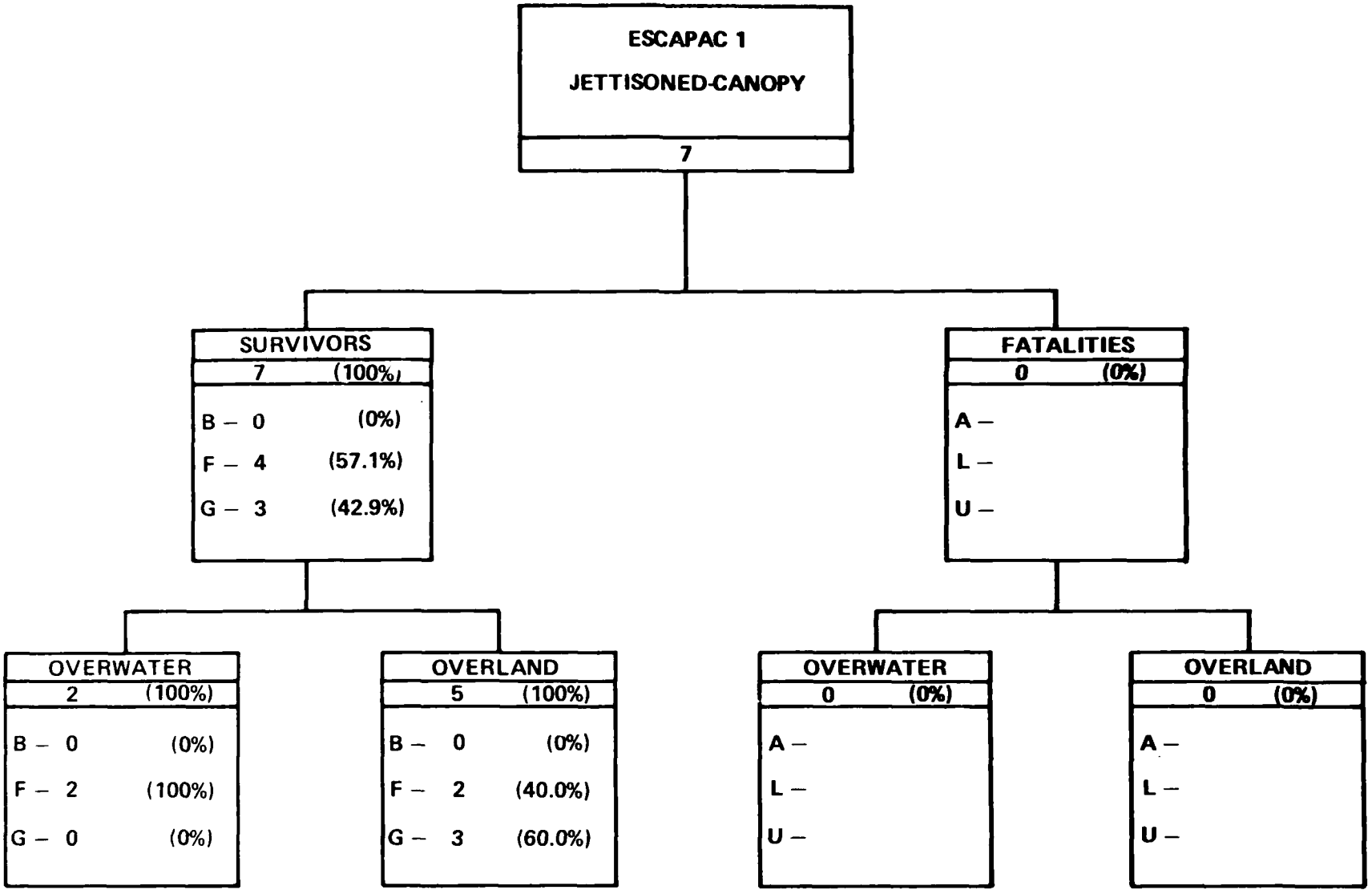

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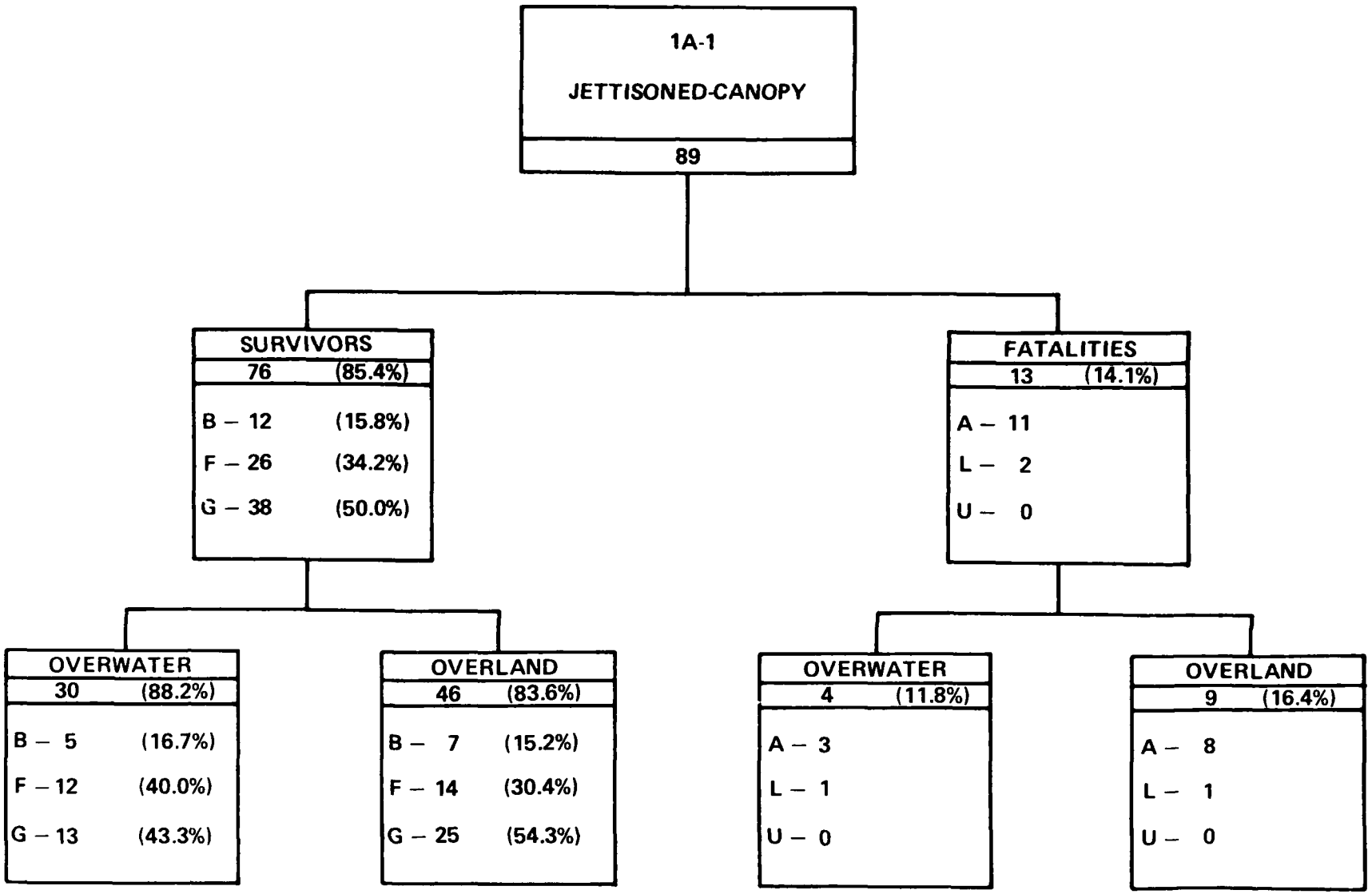

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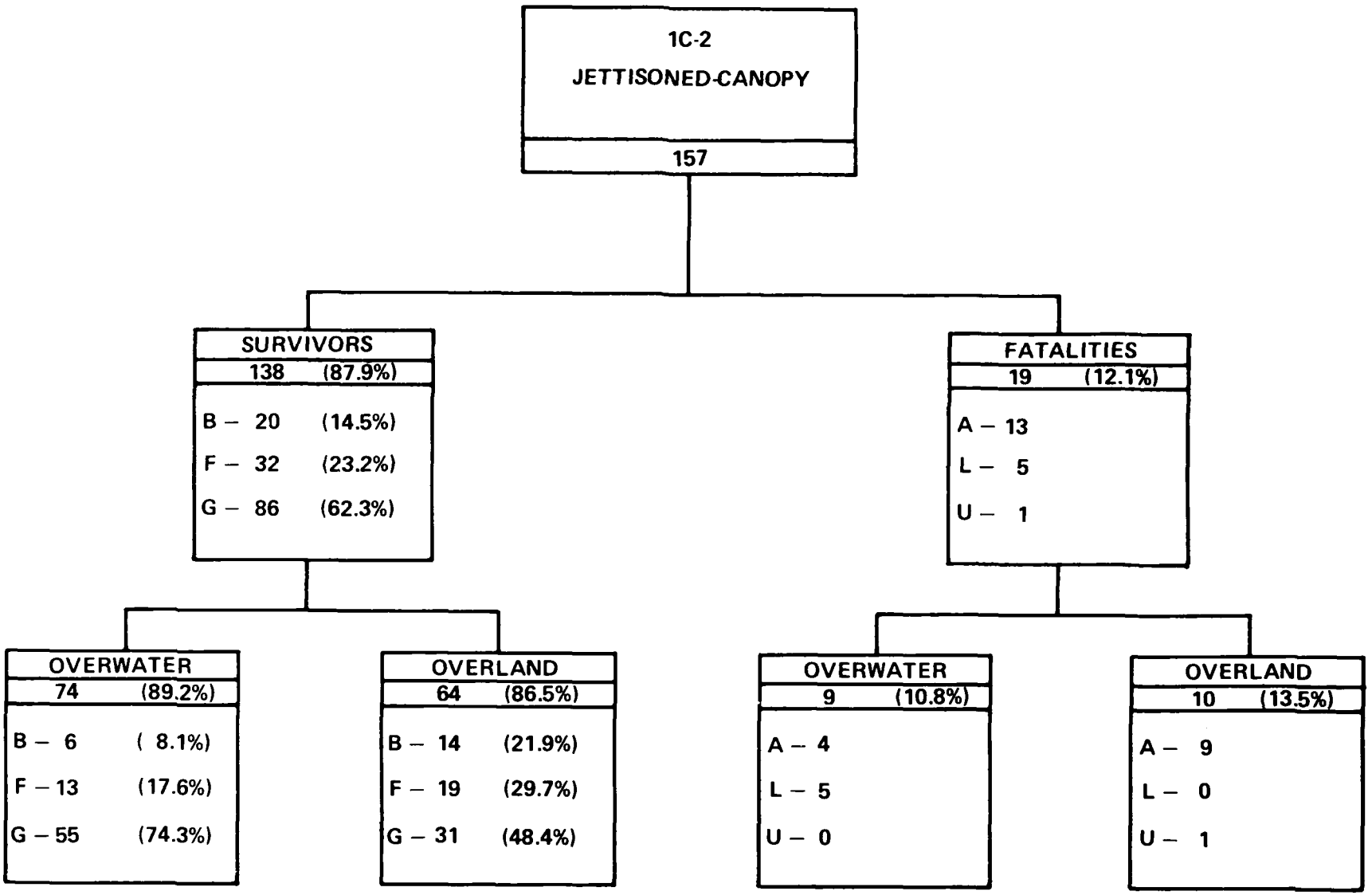

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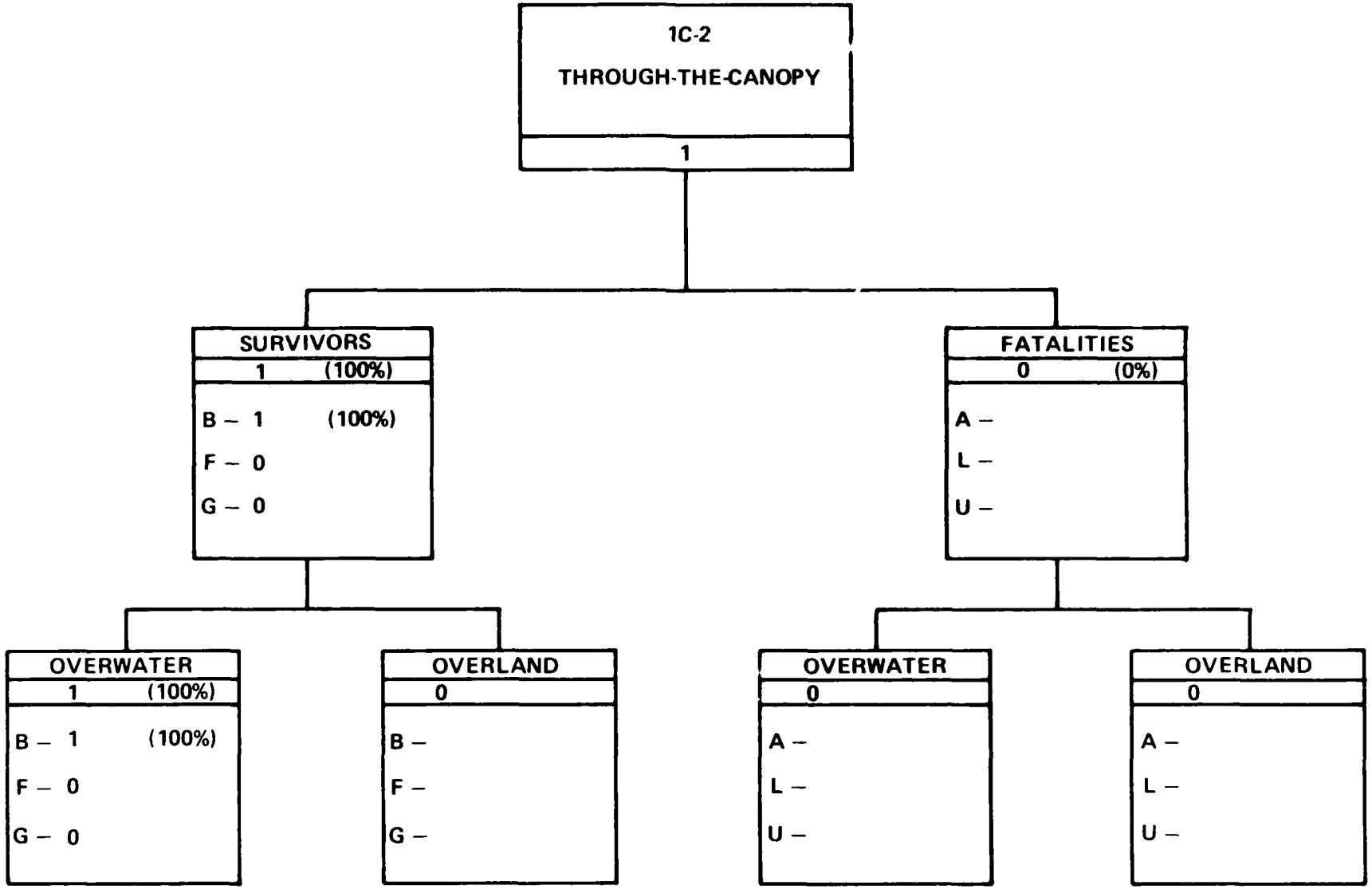

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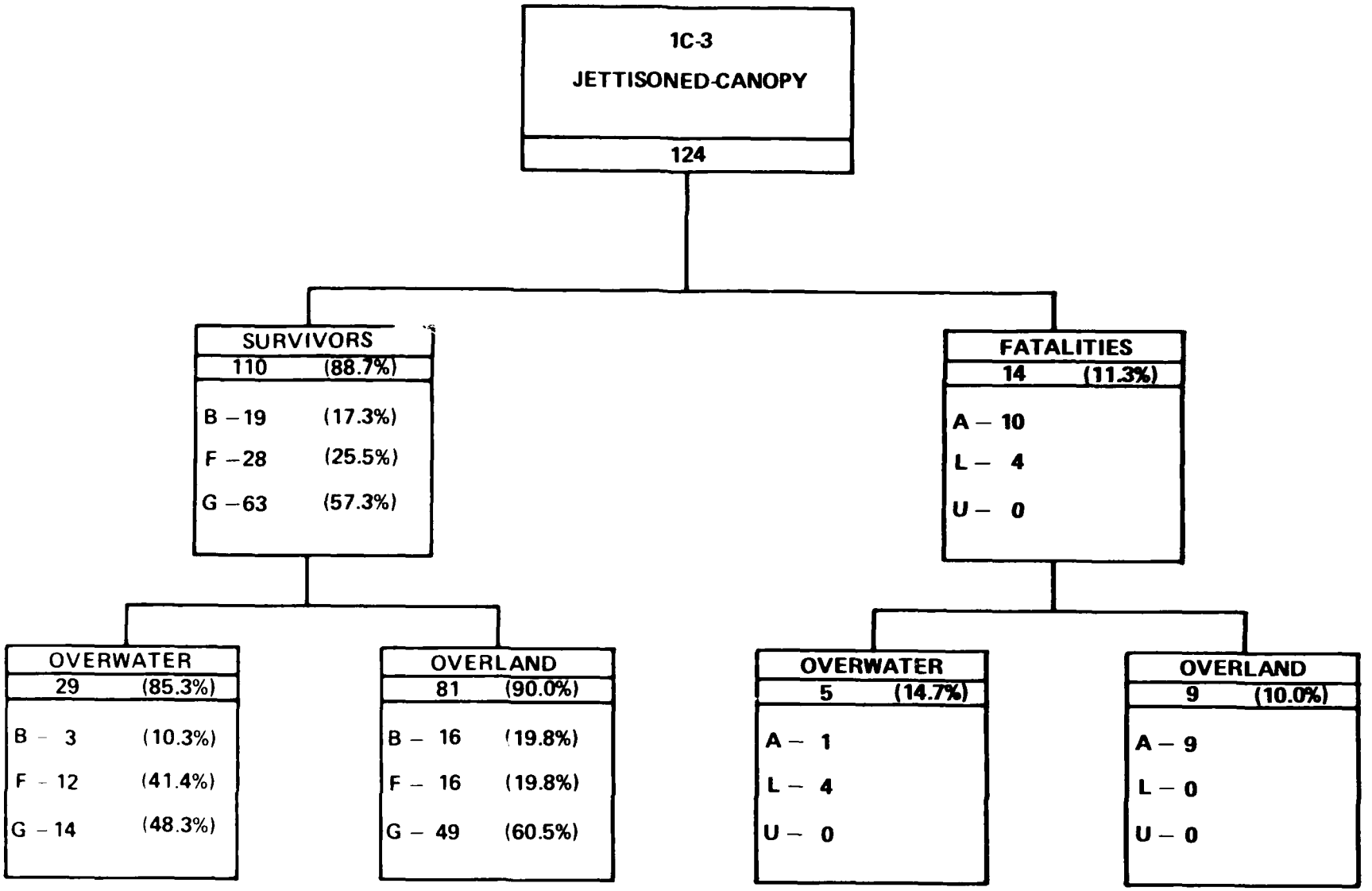

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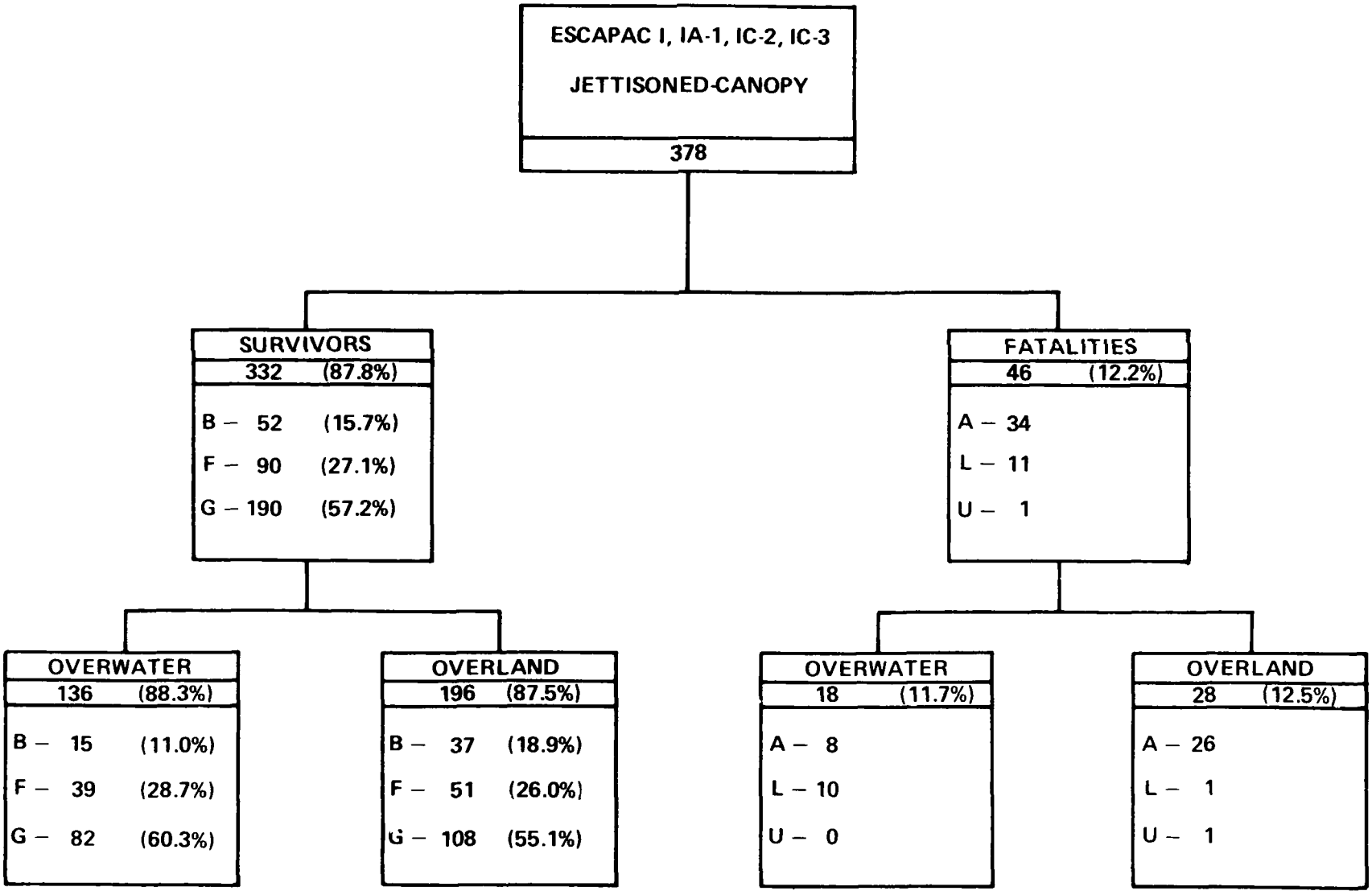

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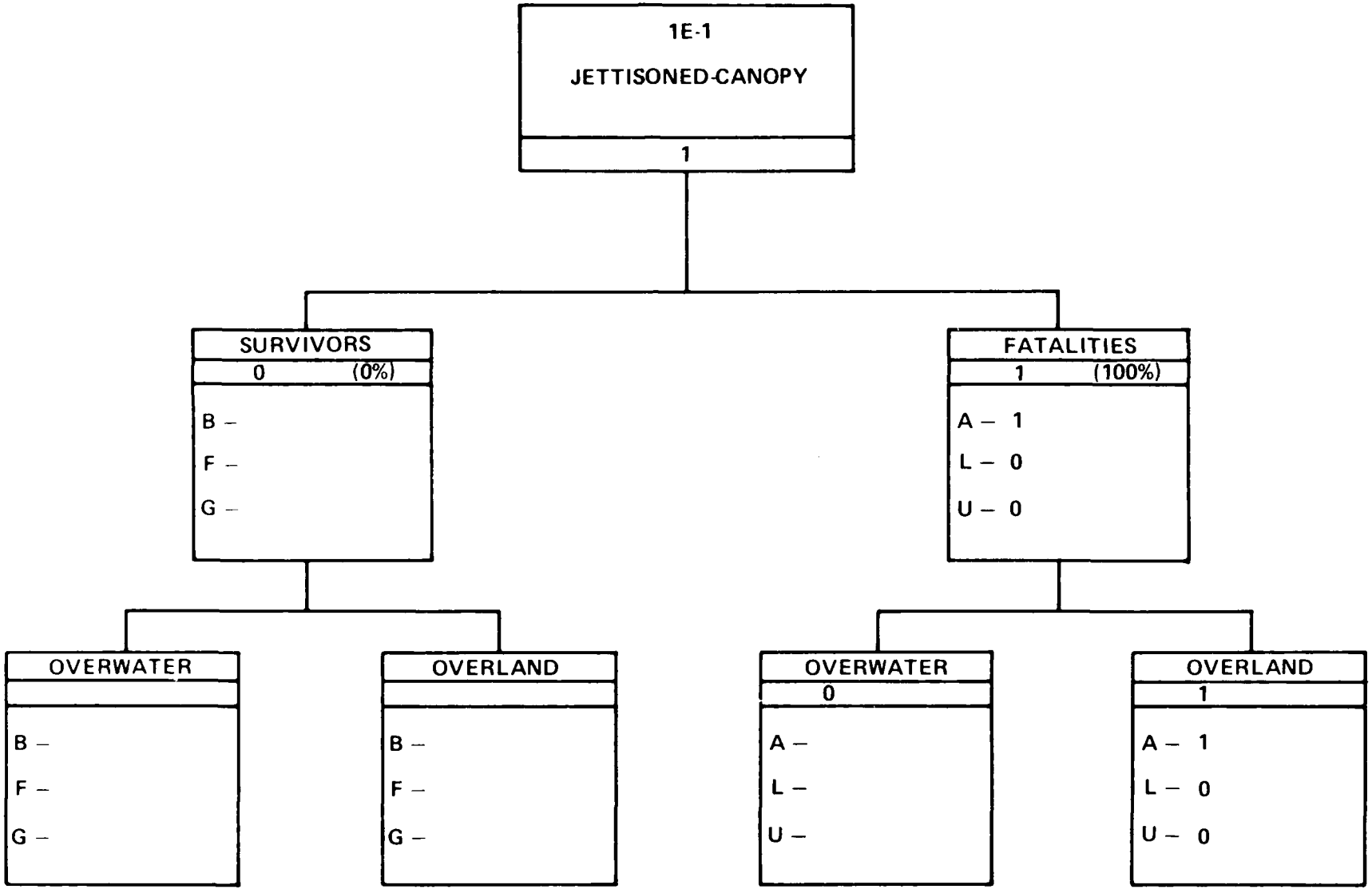

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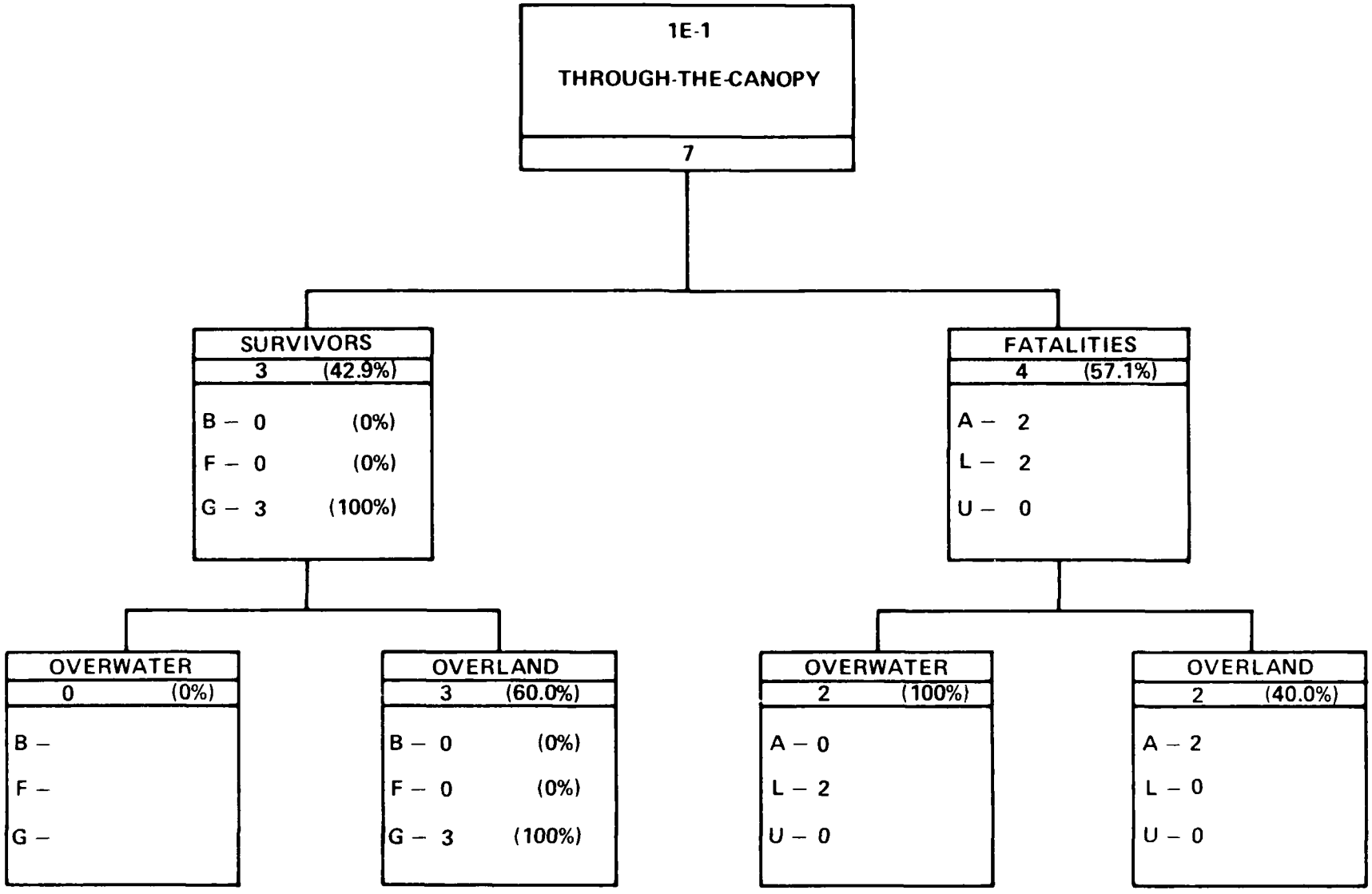

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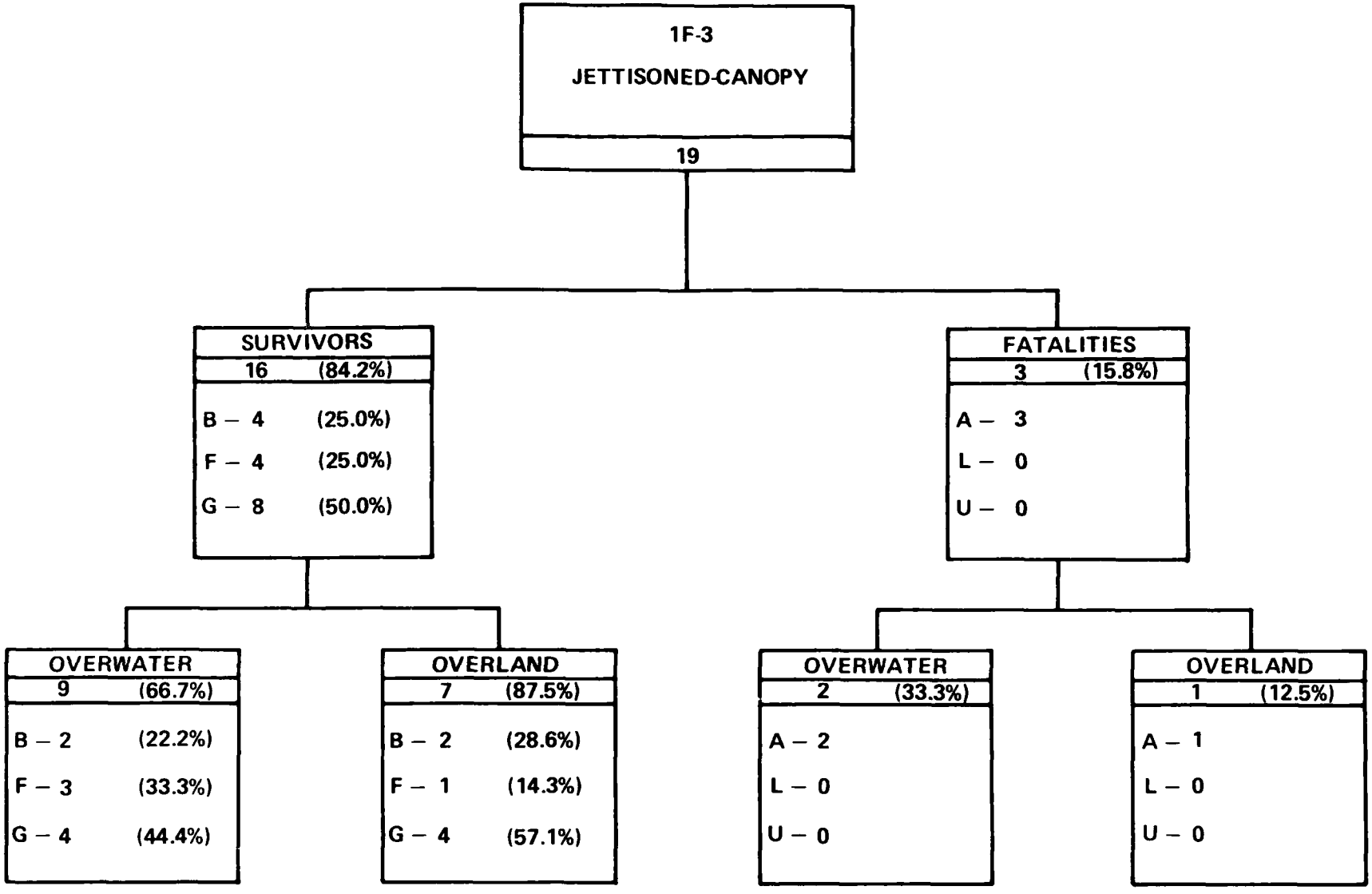

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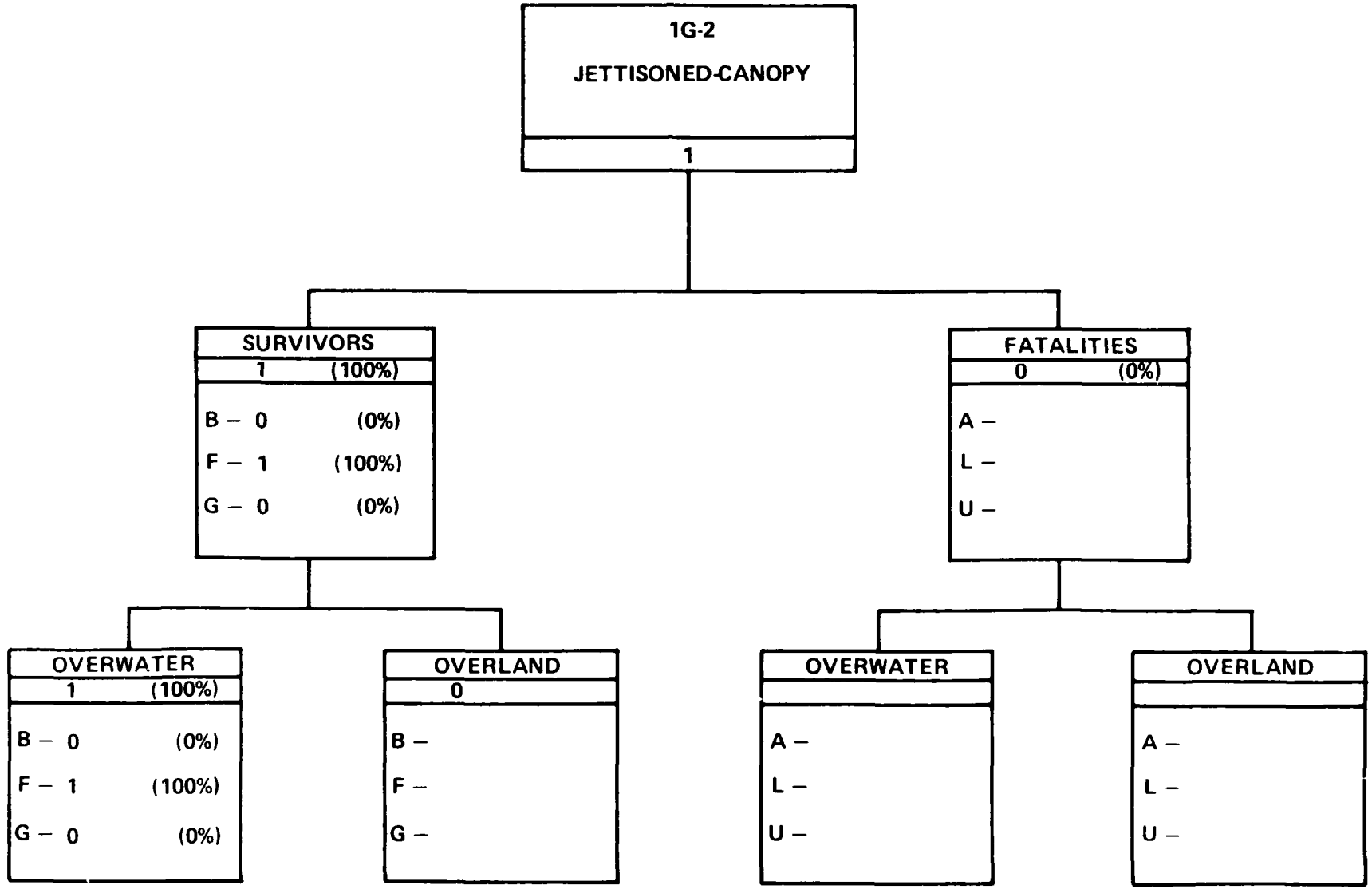

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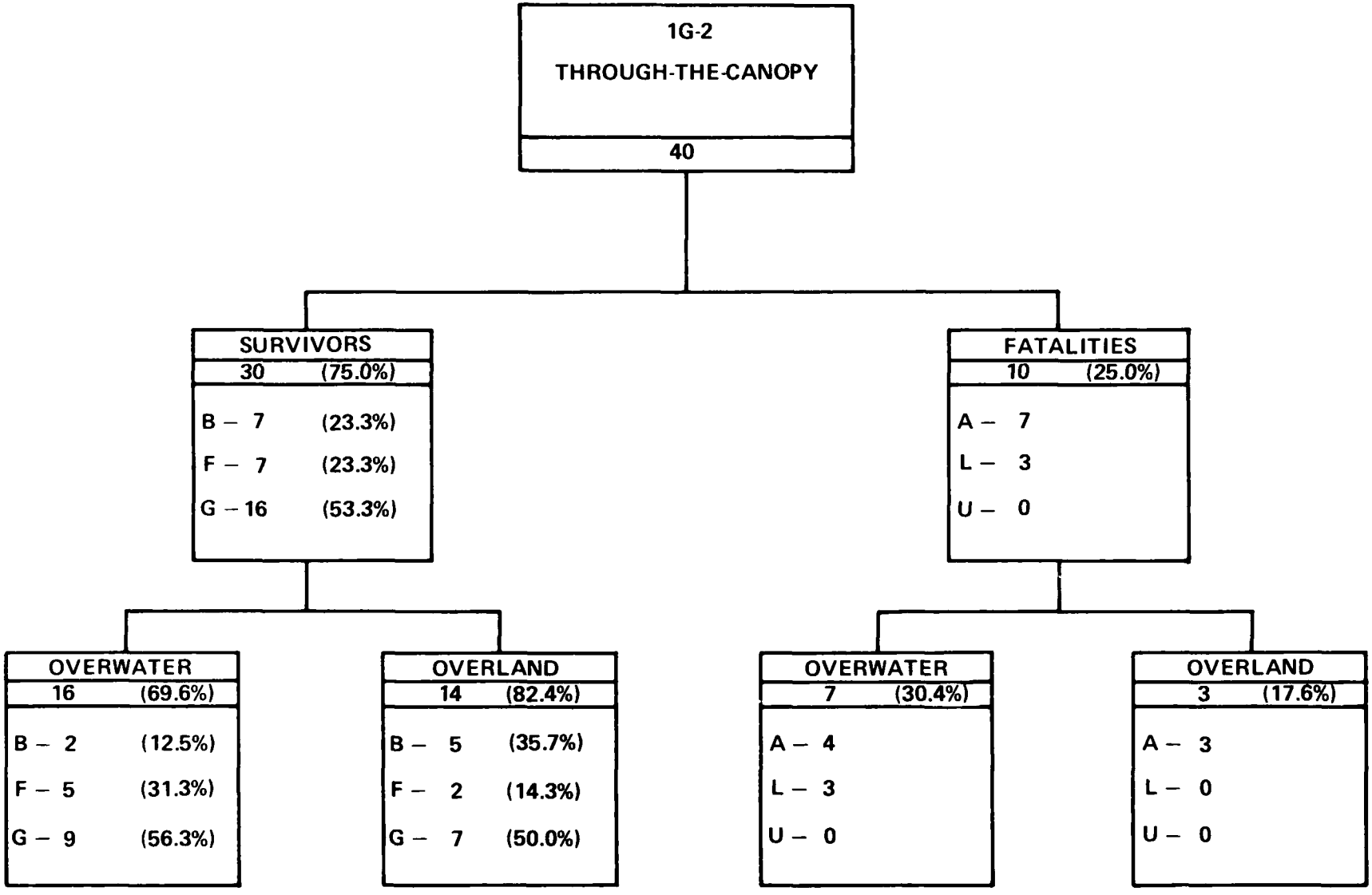

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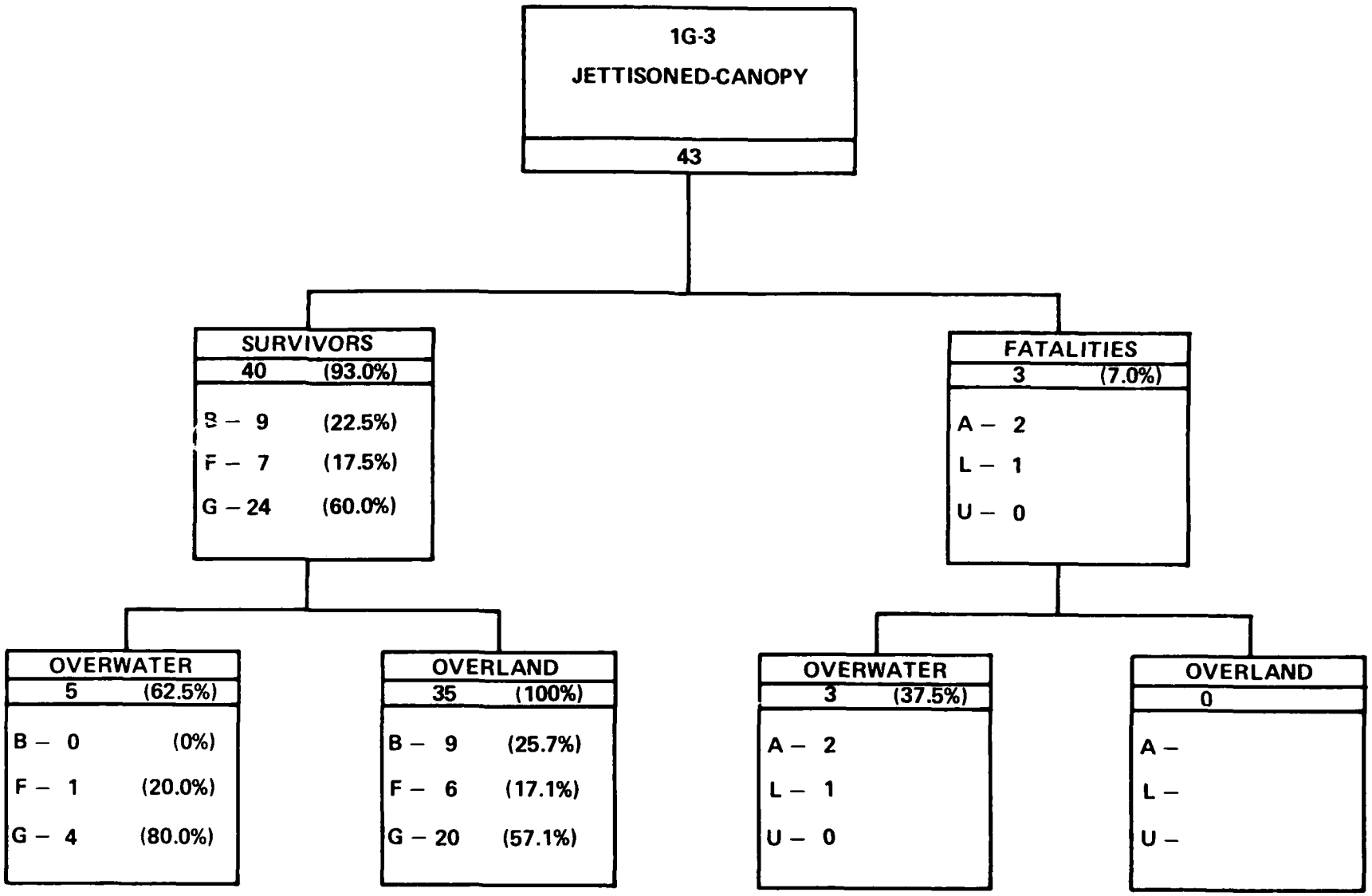

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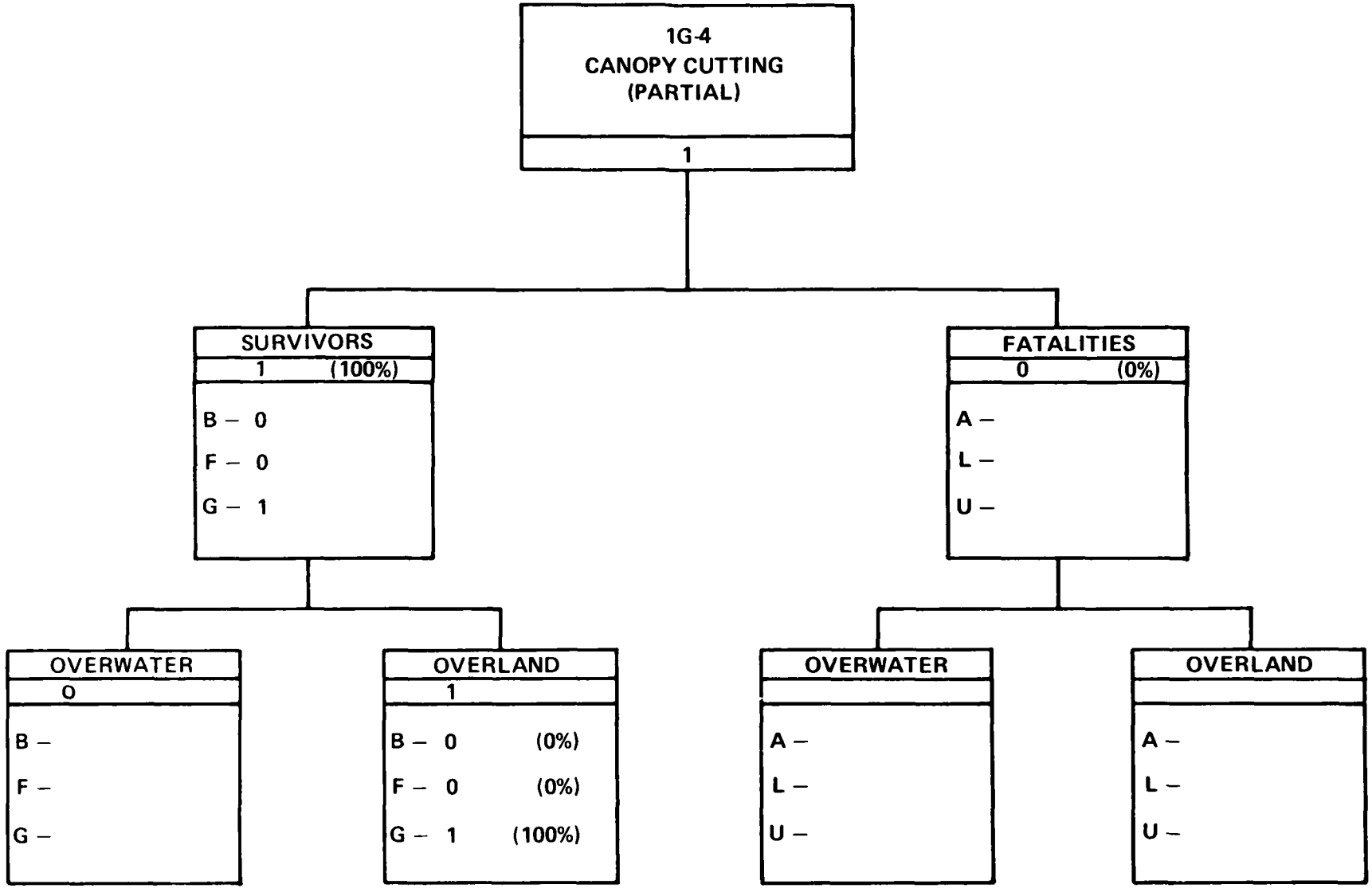

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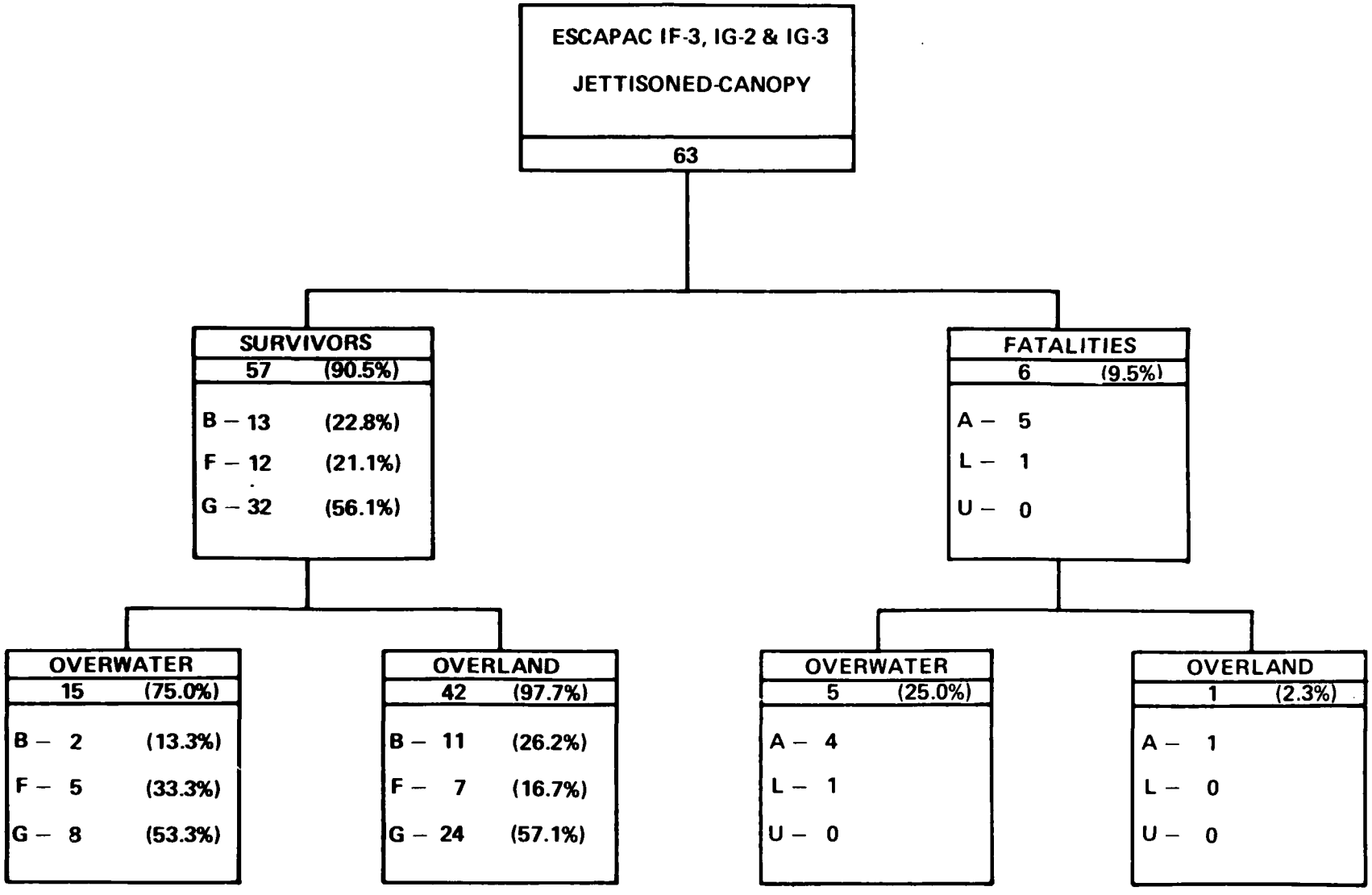
1 JANUARY 1969 THROUGH 31 DECEMBER 1979



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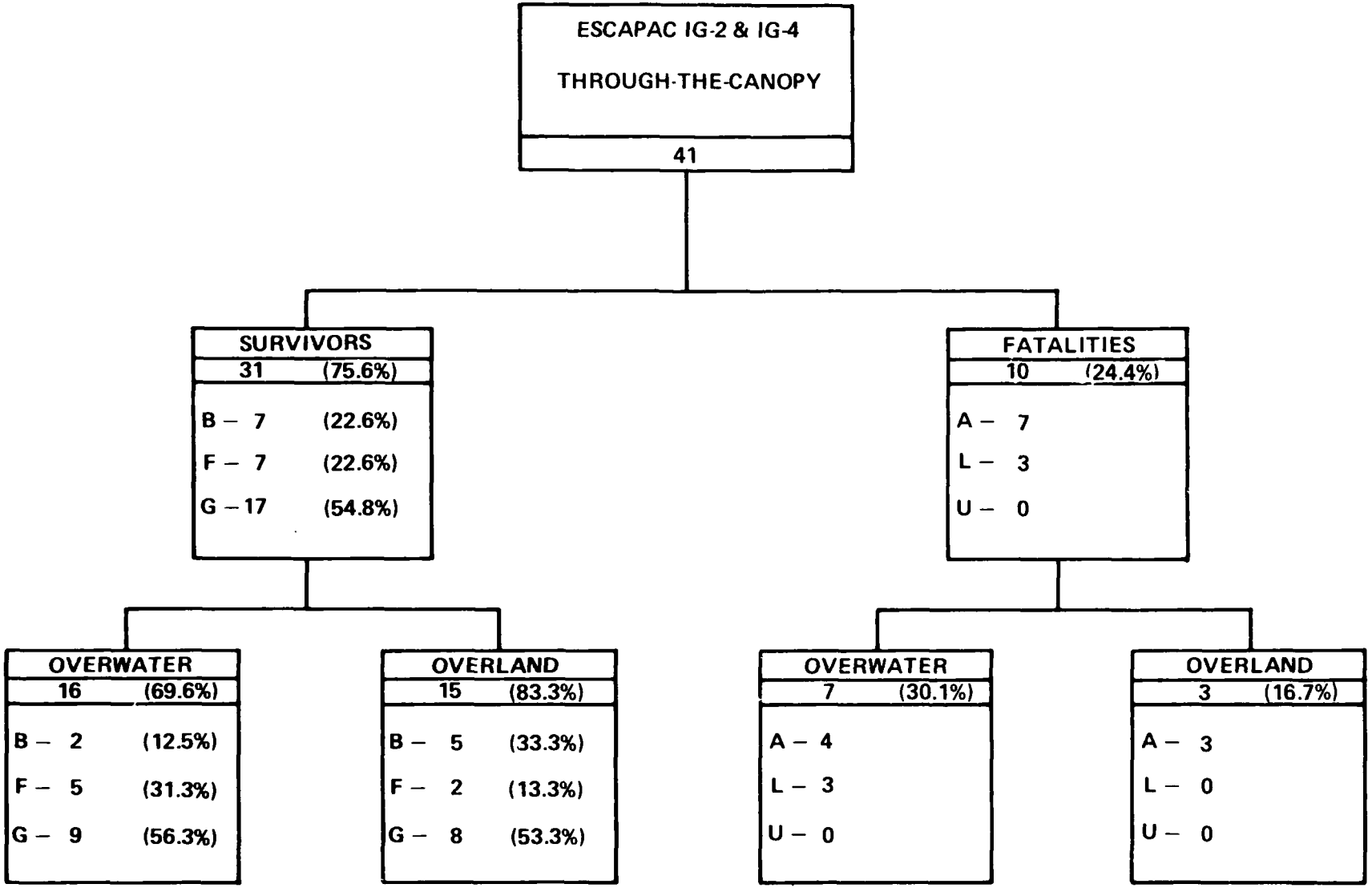

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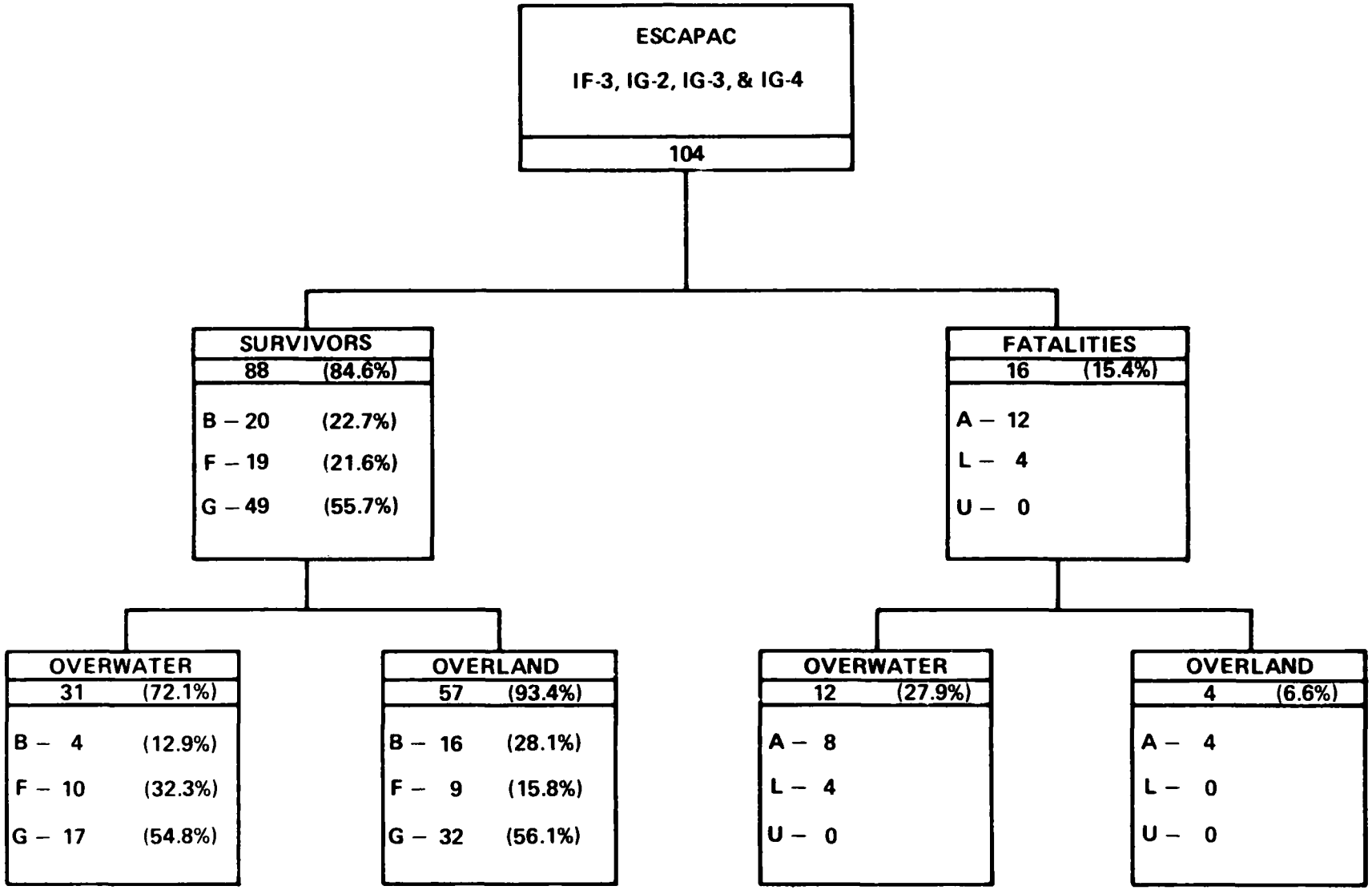

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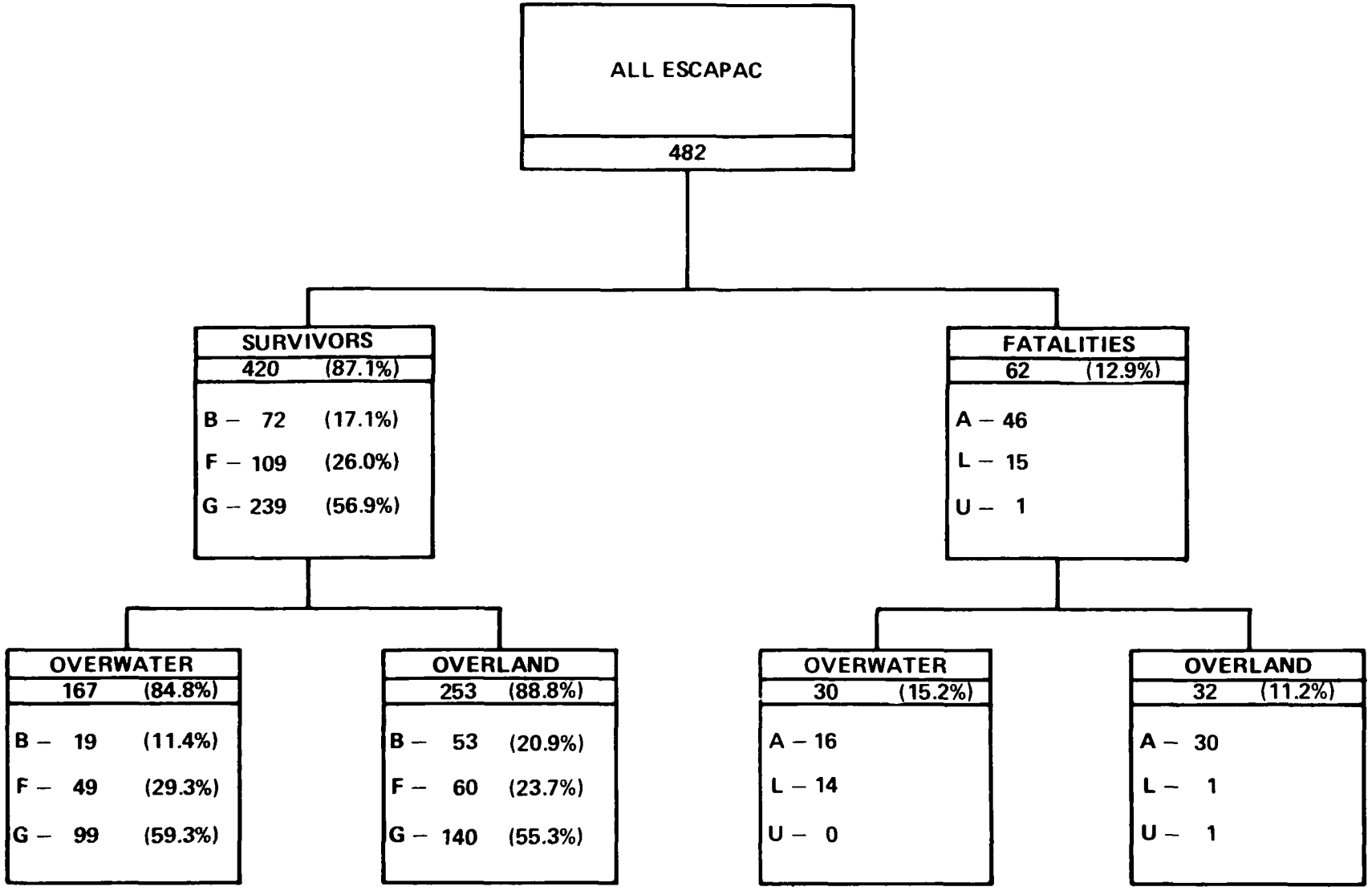

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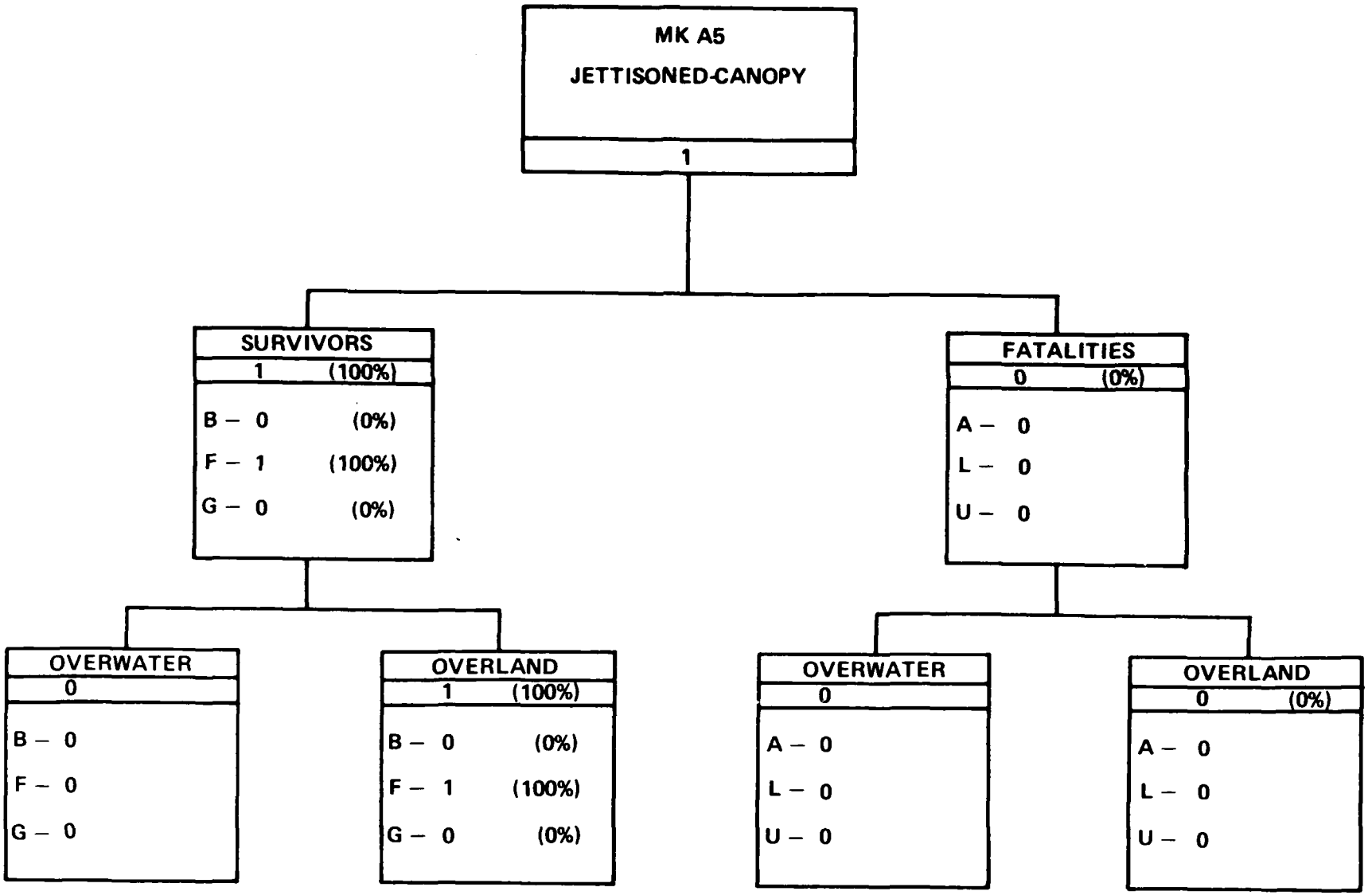

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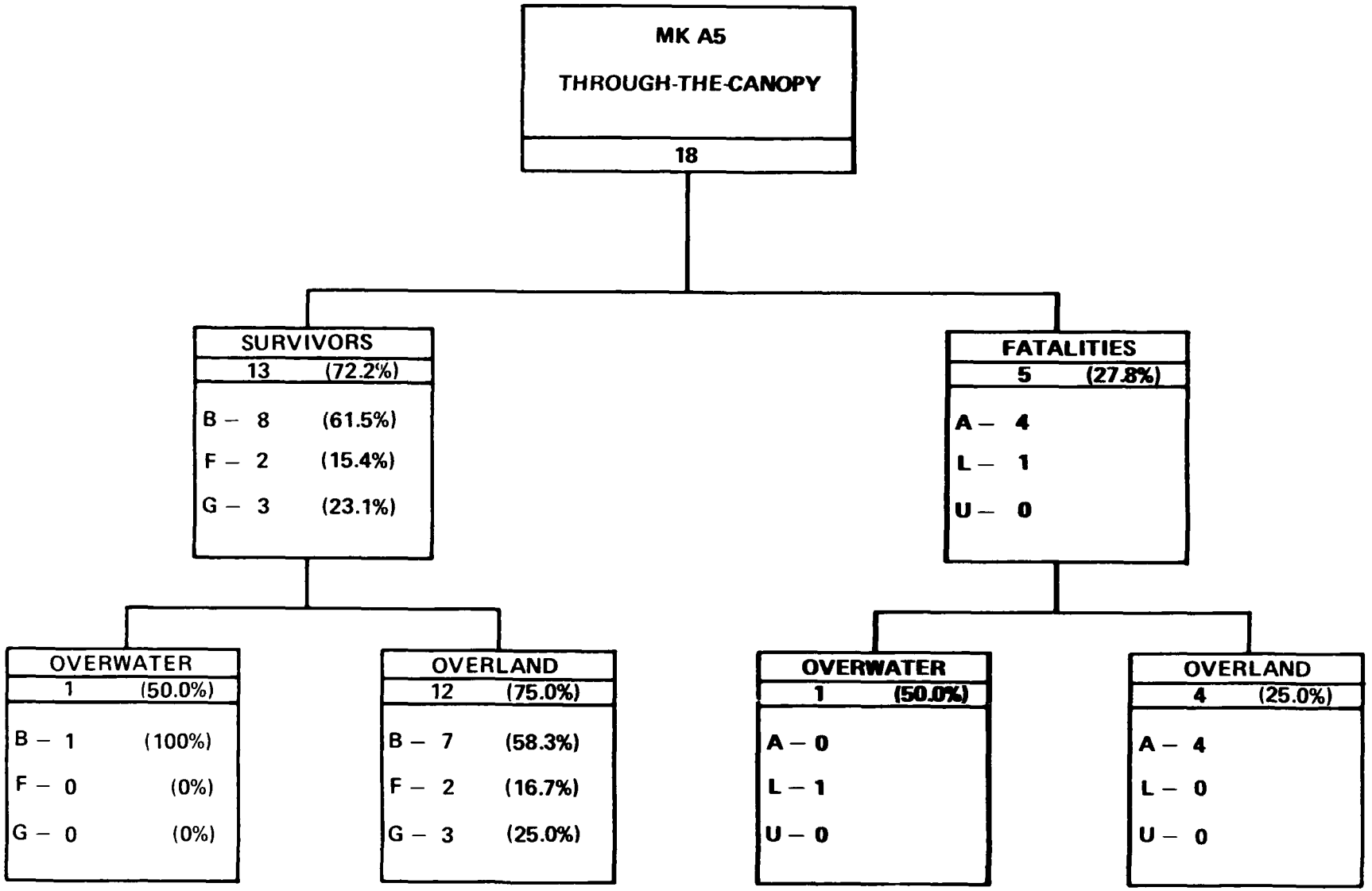

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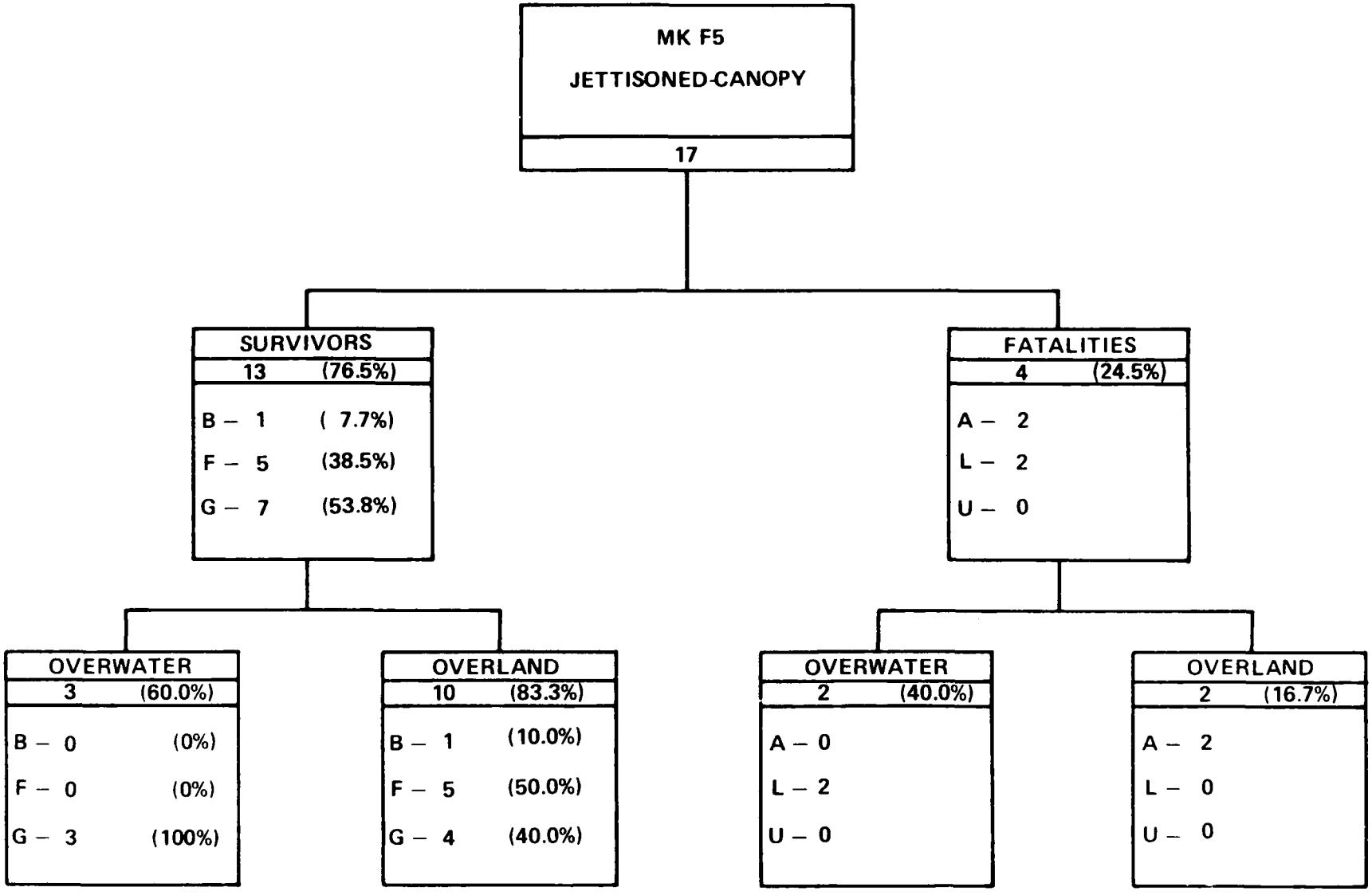

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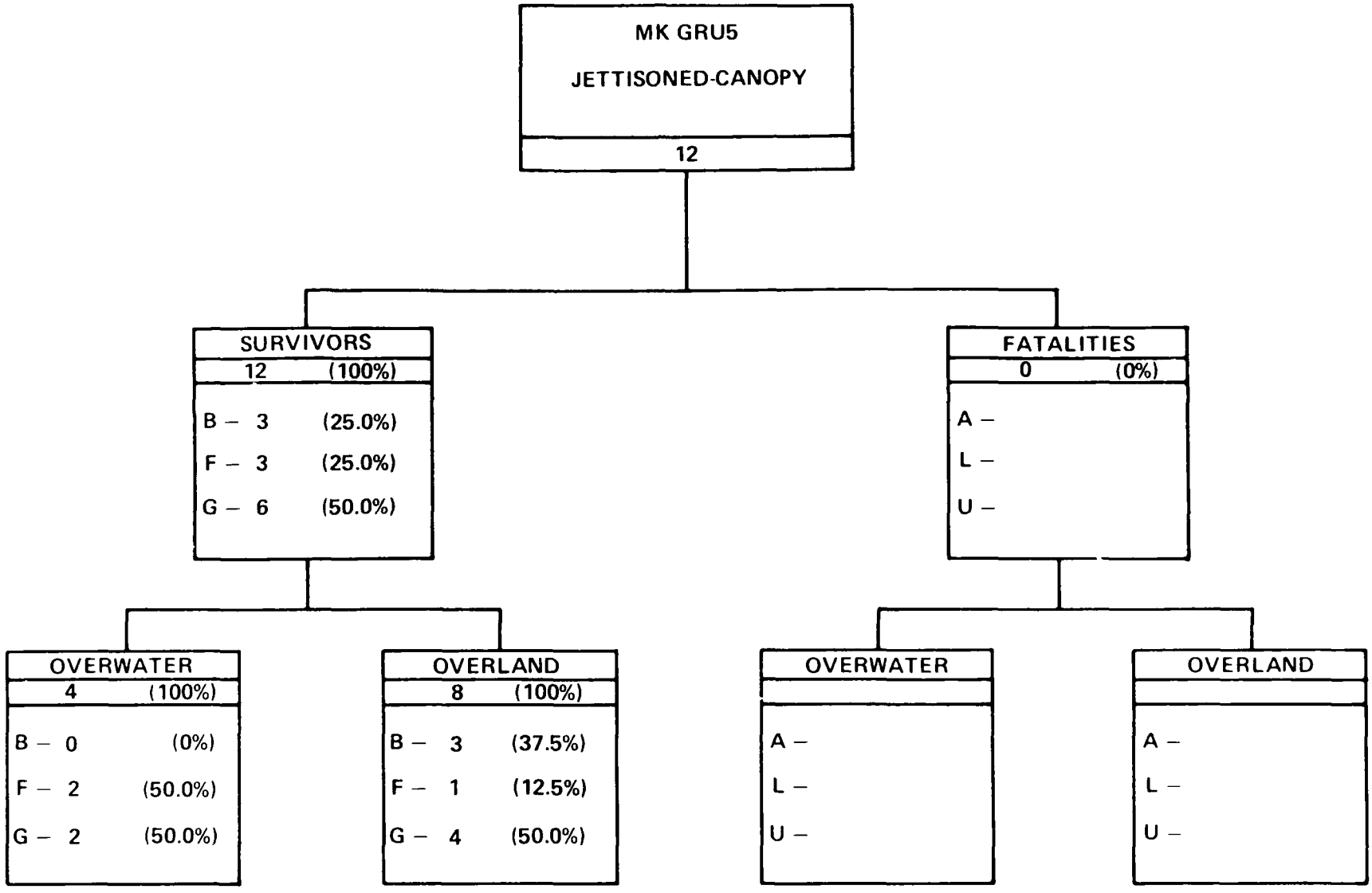

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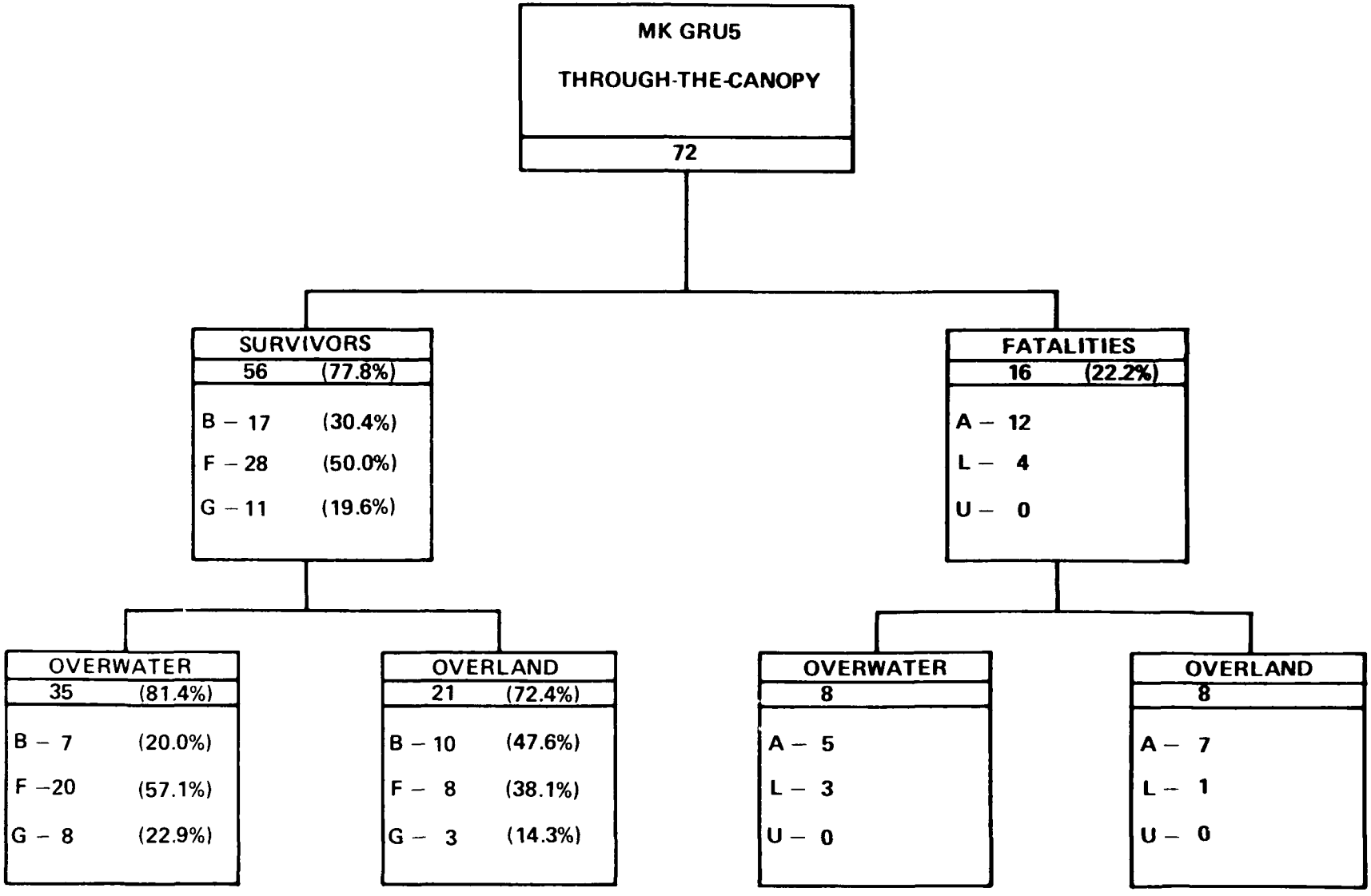

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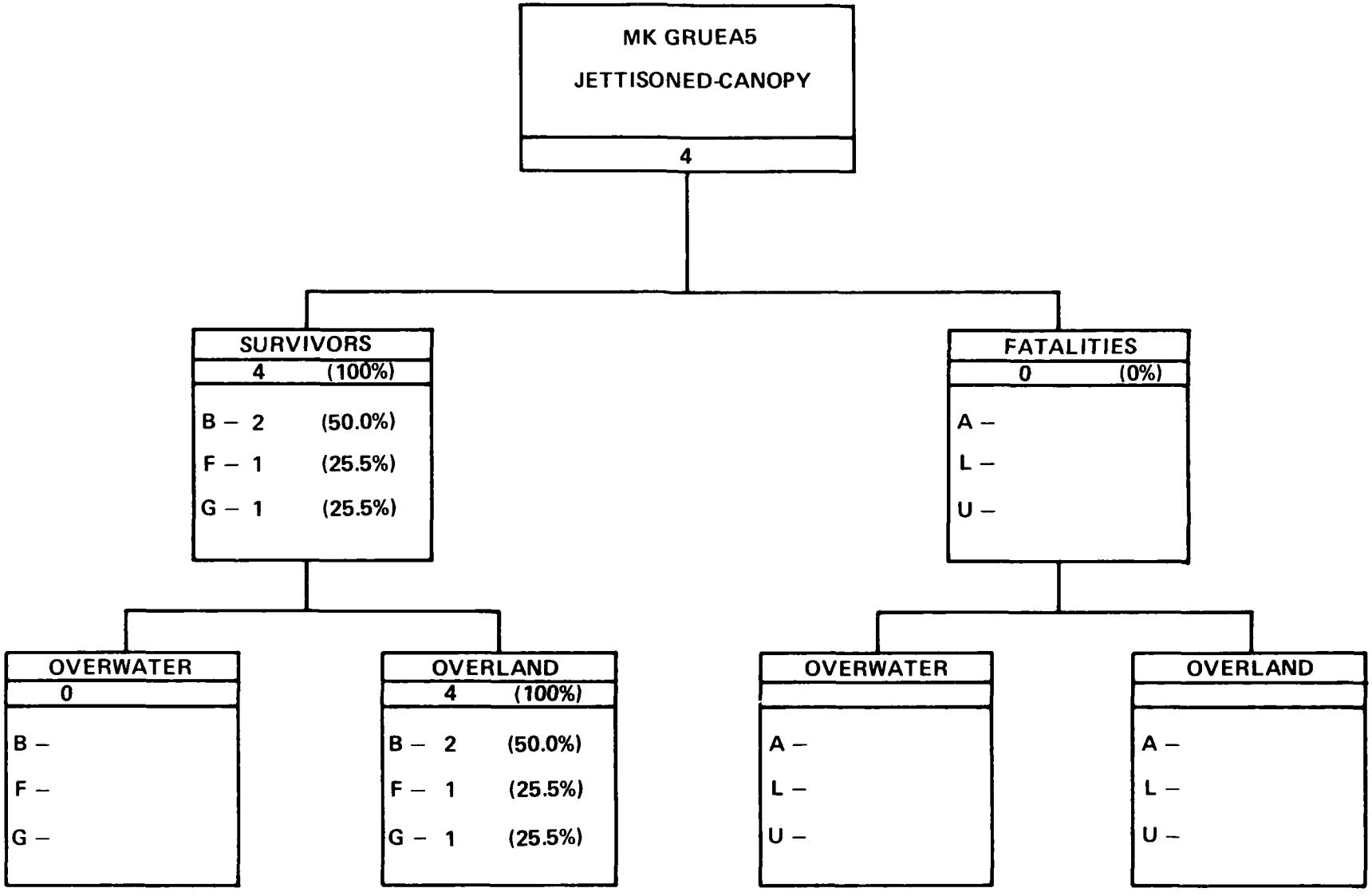

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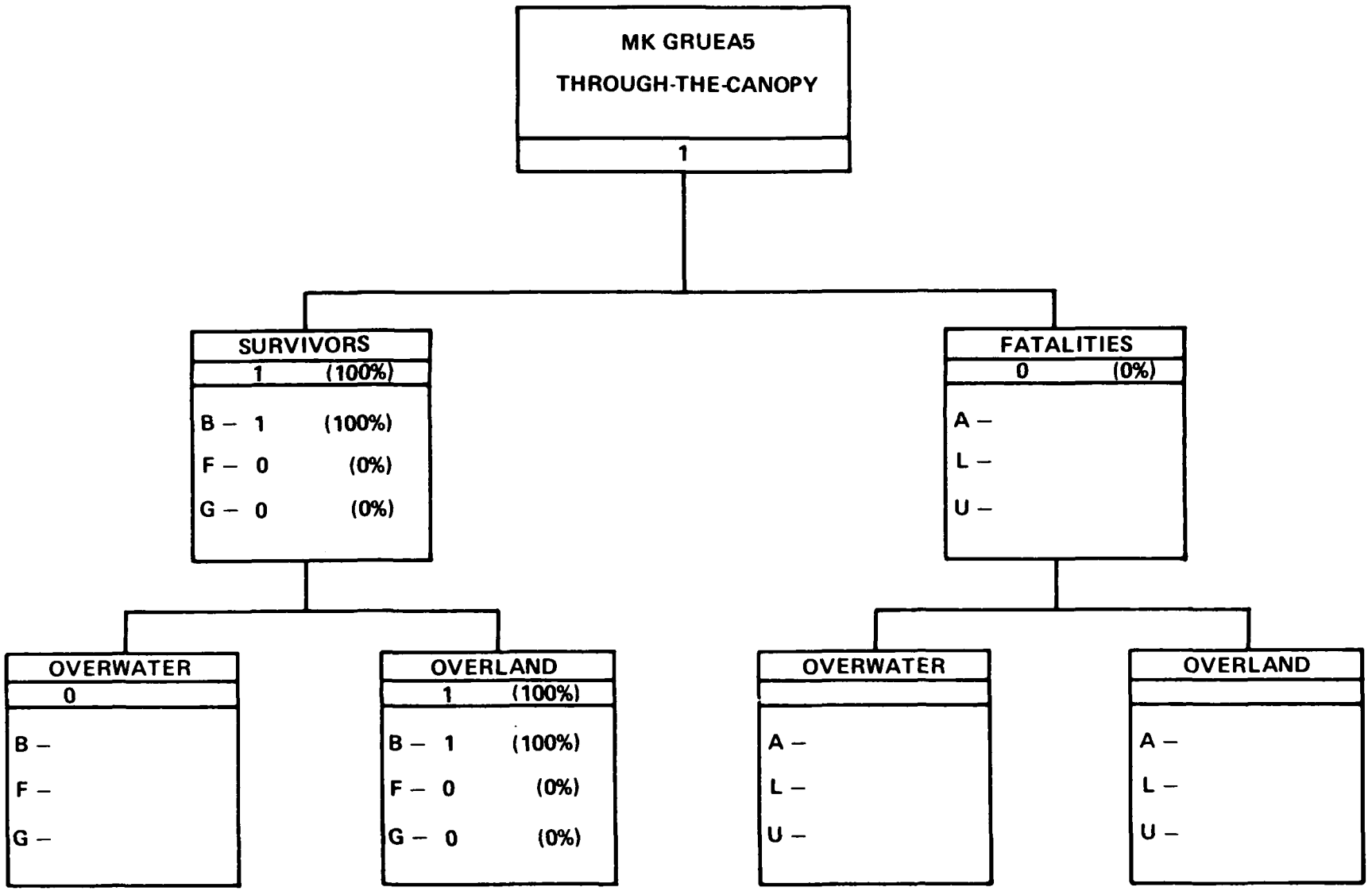

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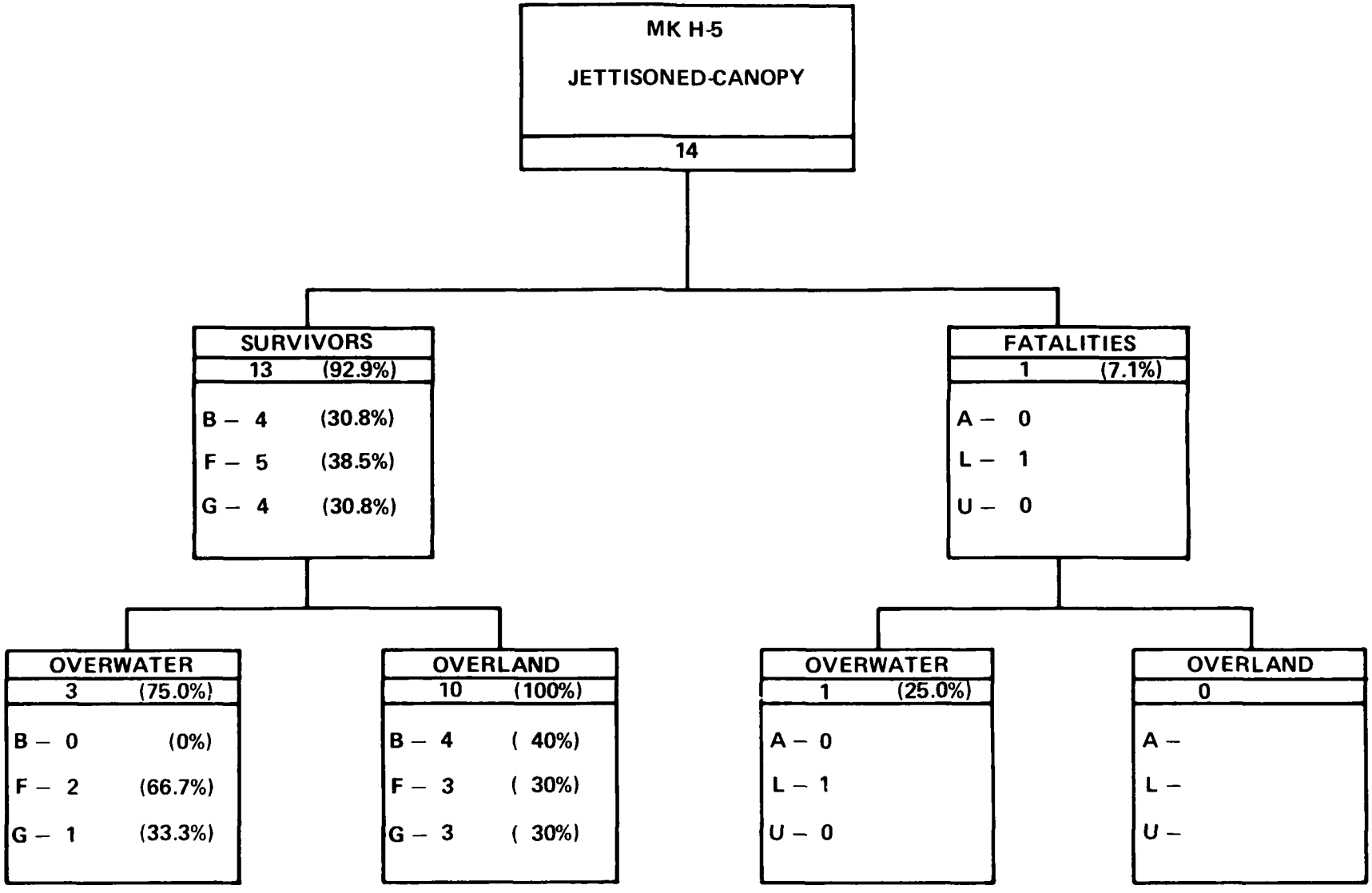

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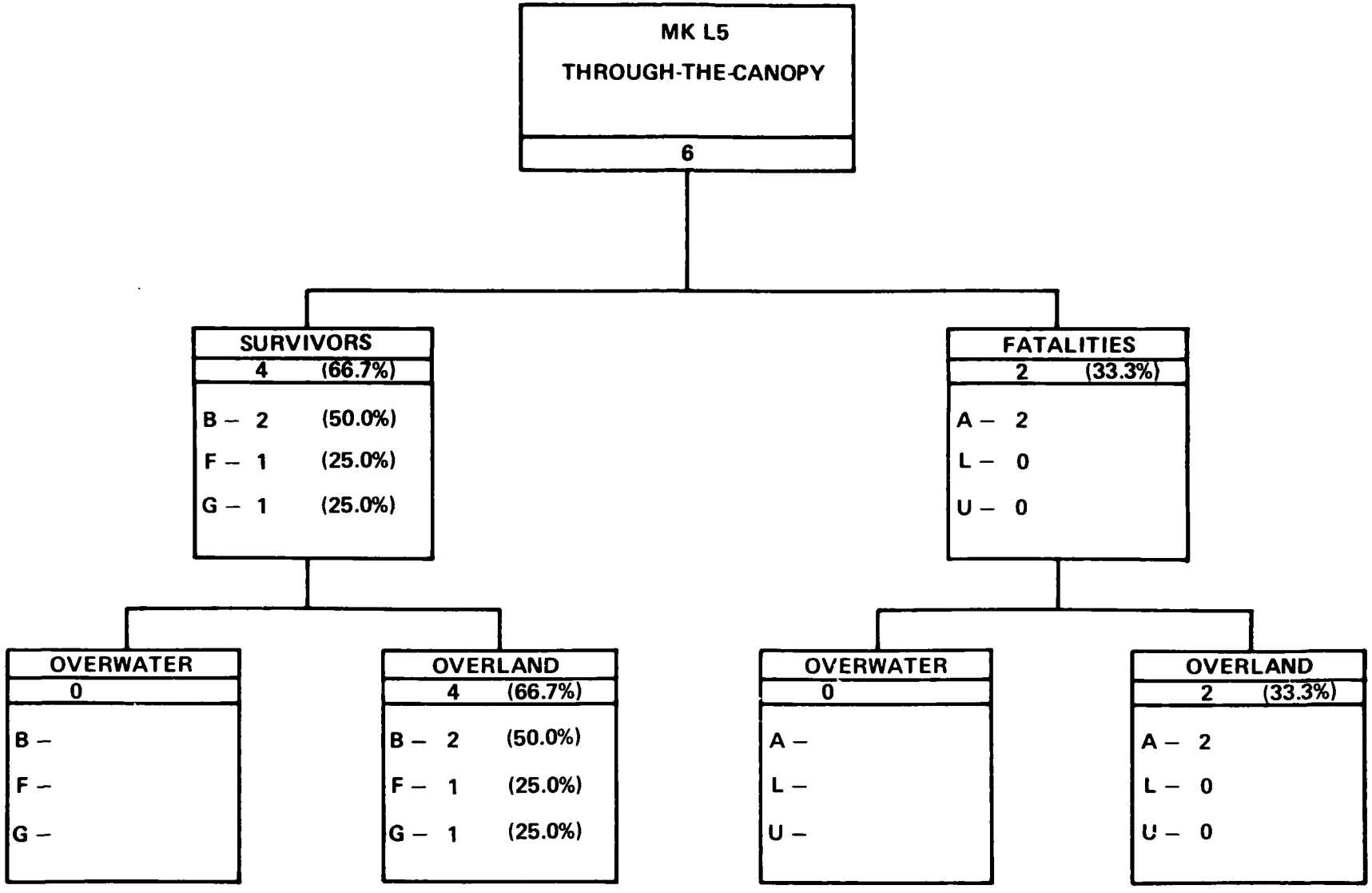

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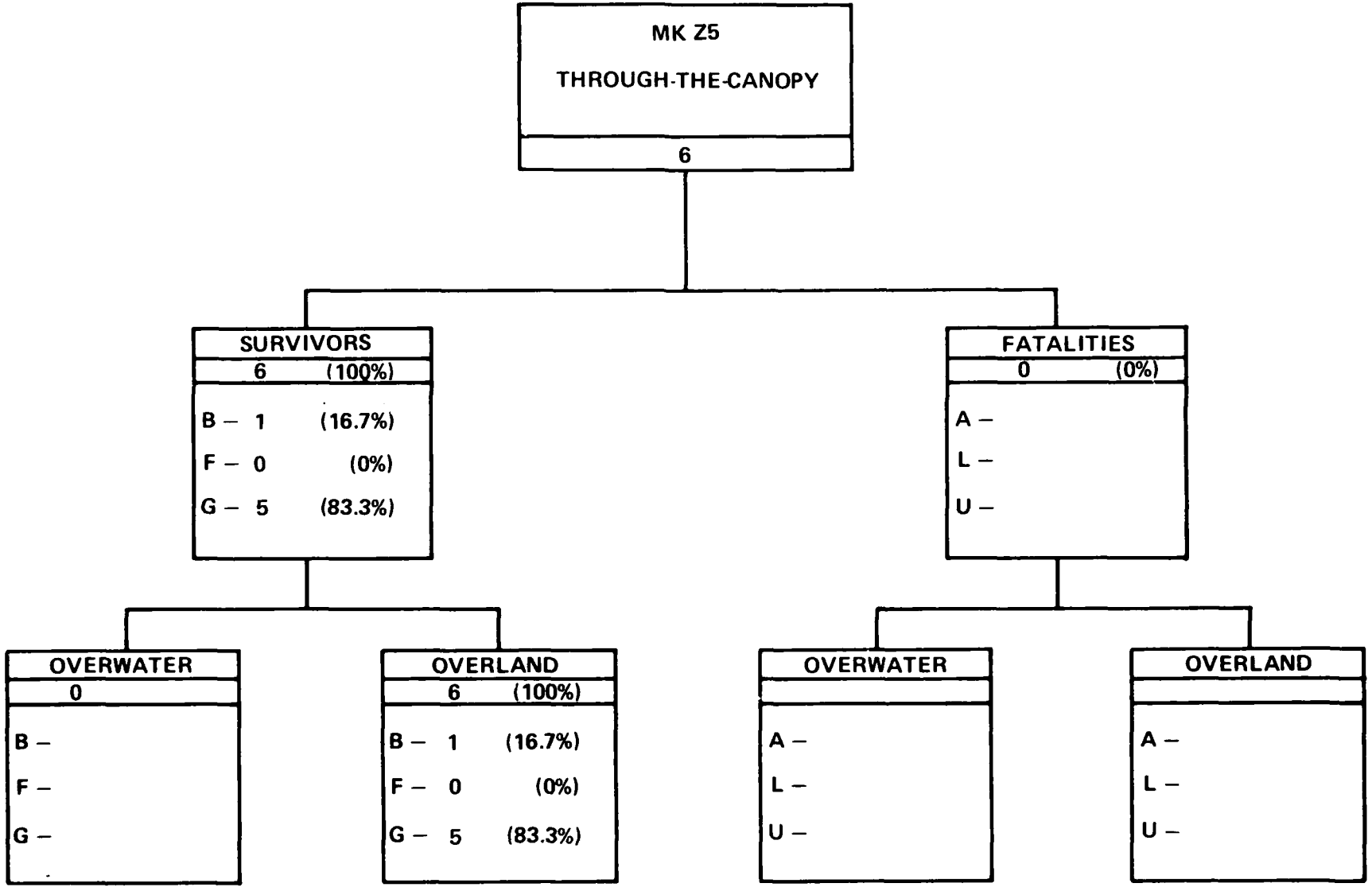

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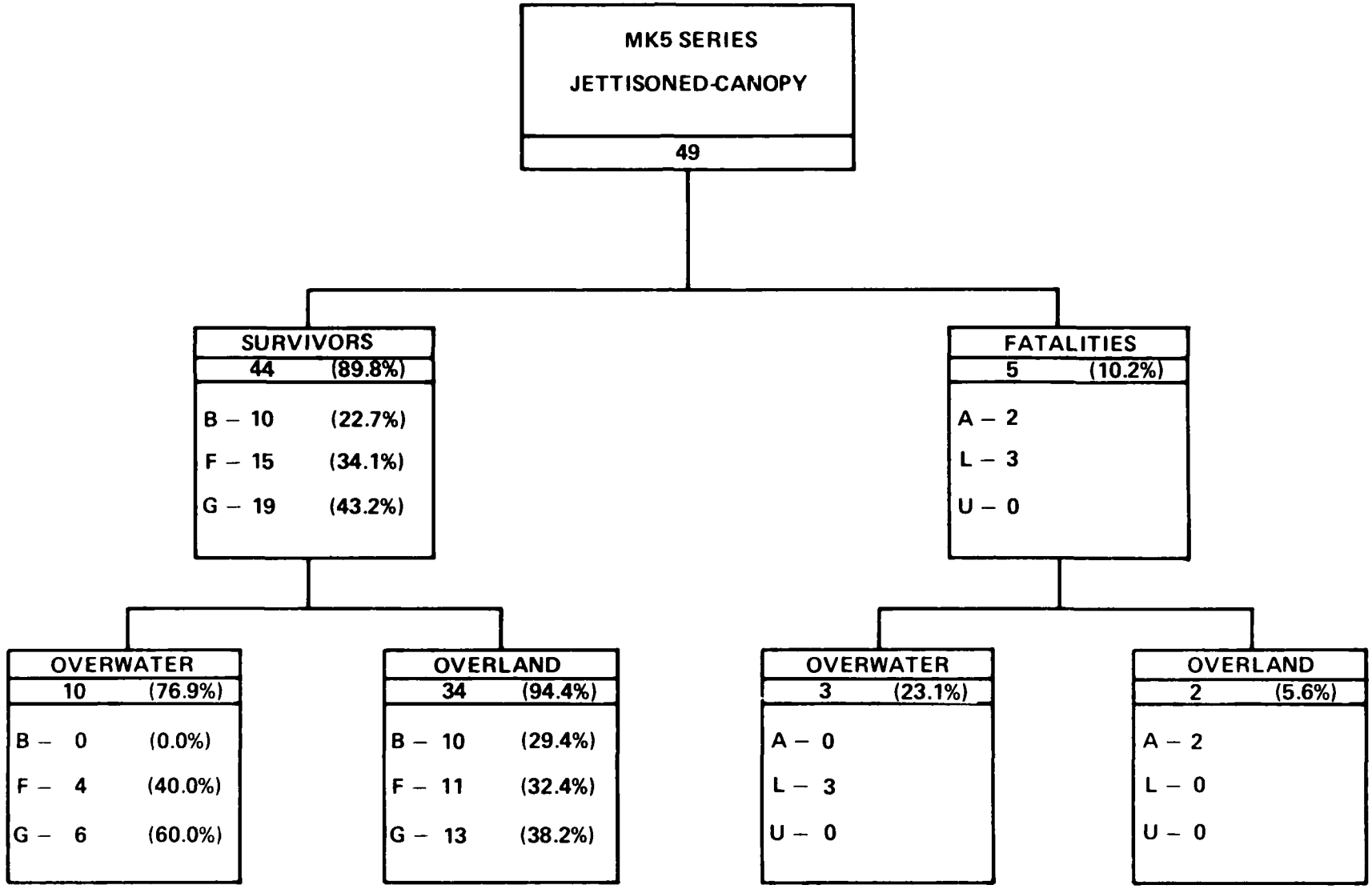

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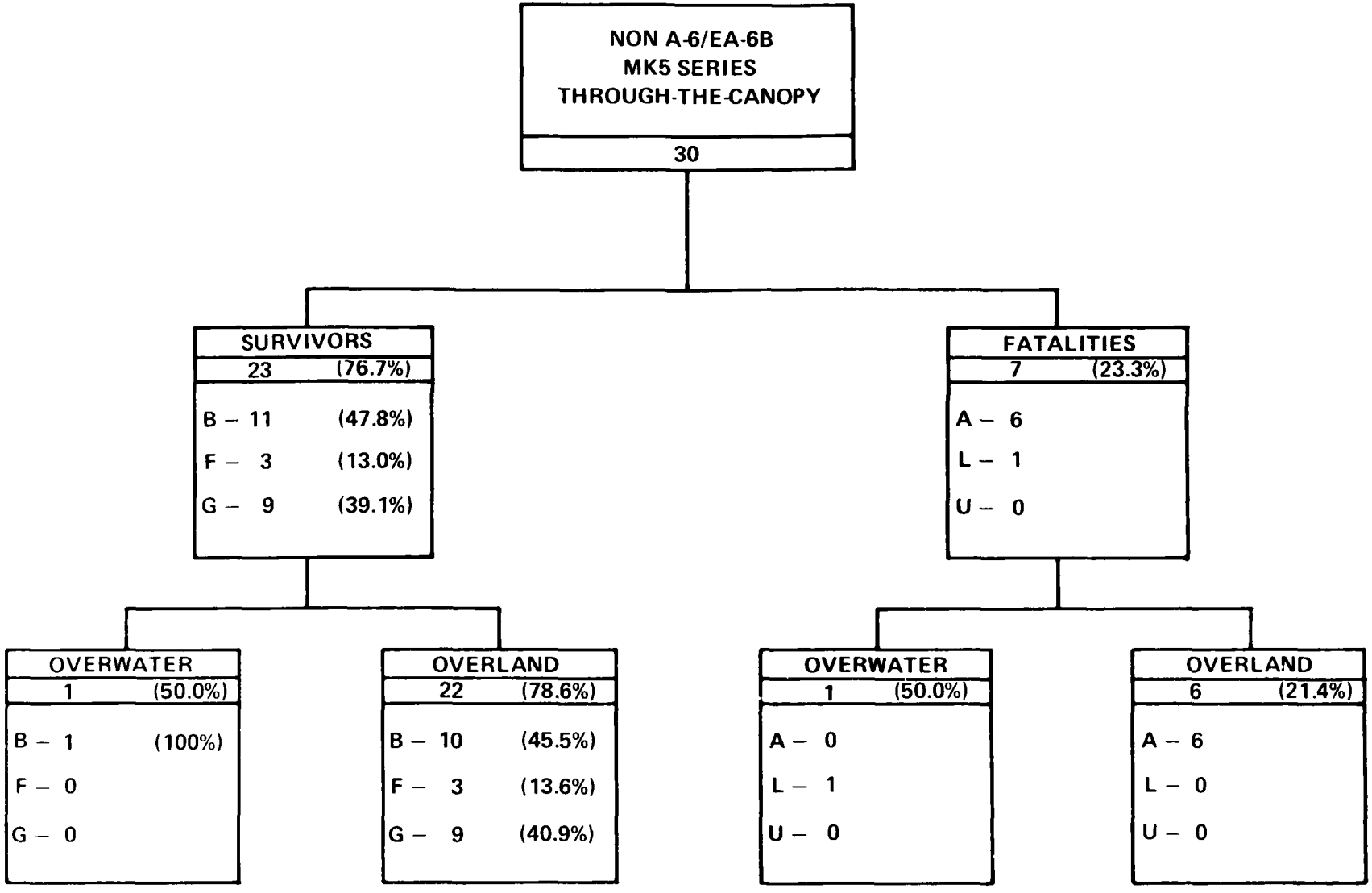

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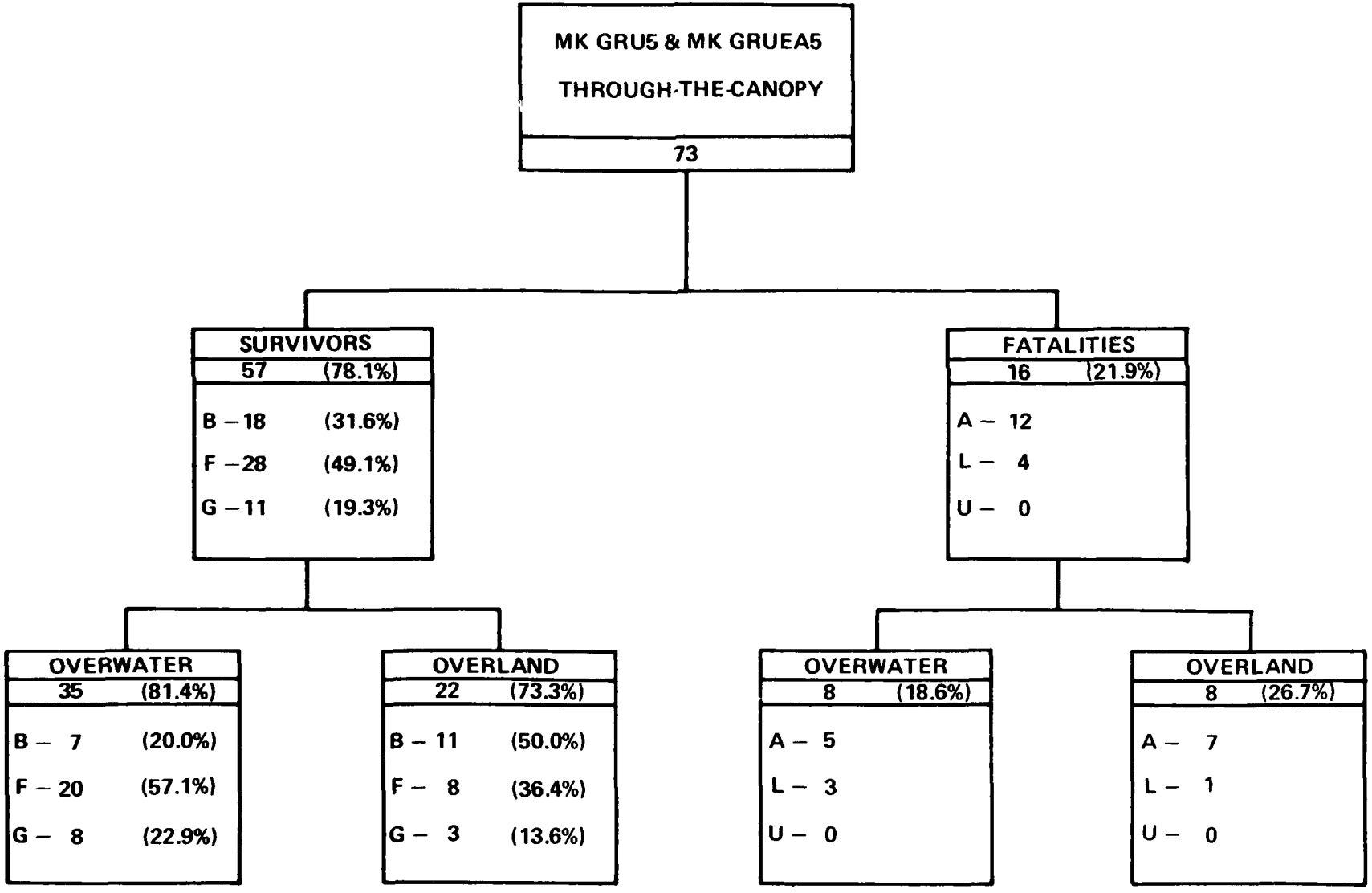

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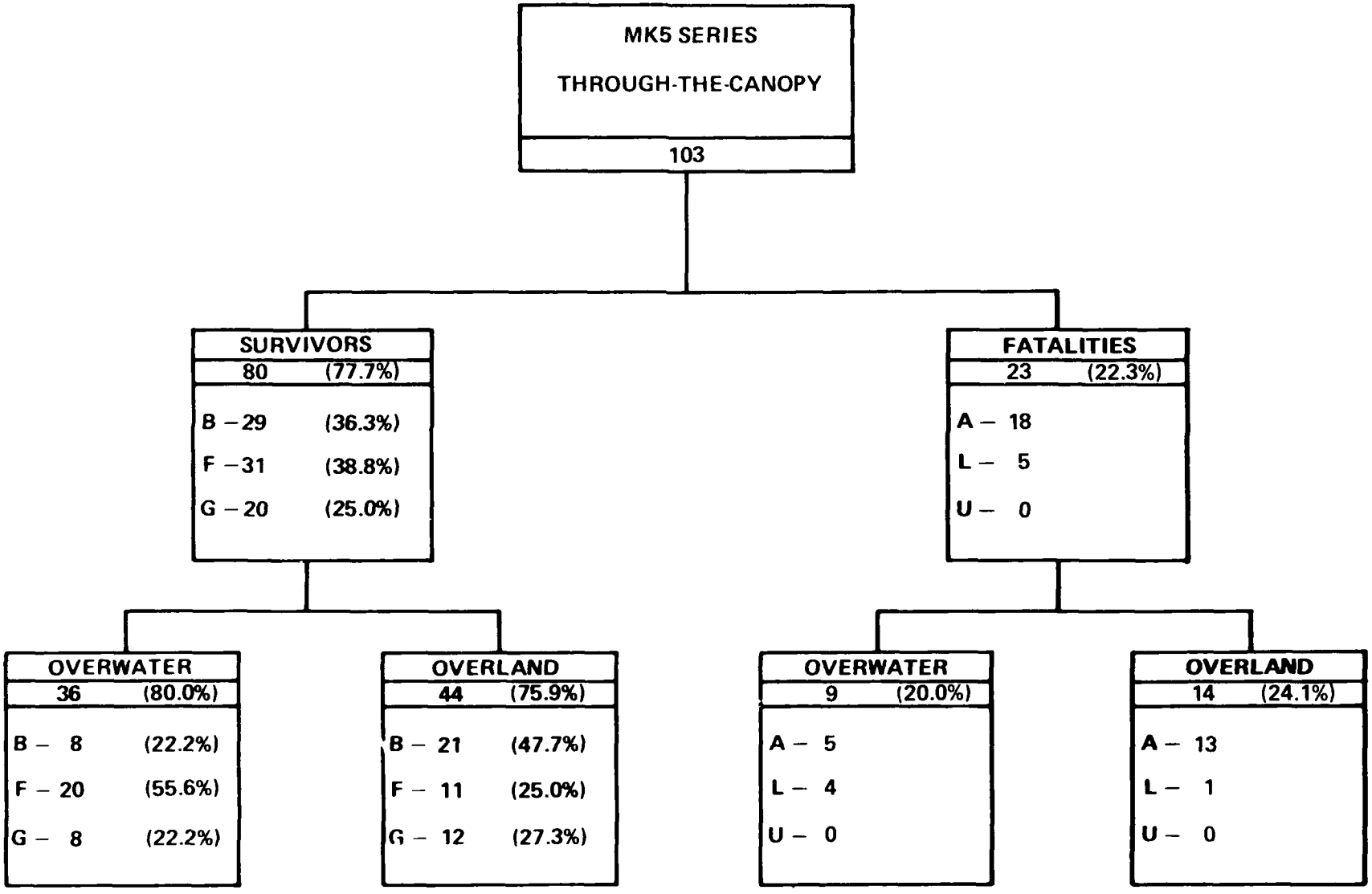

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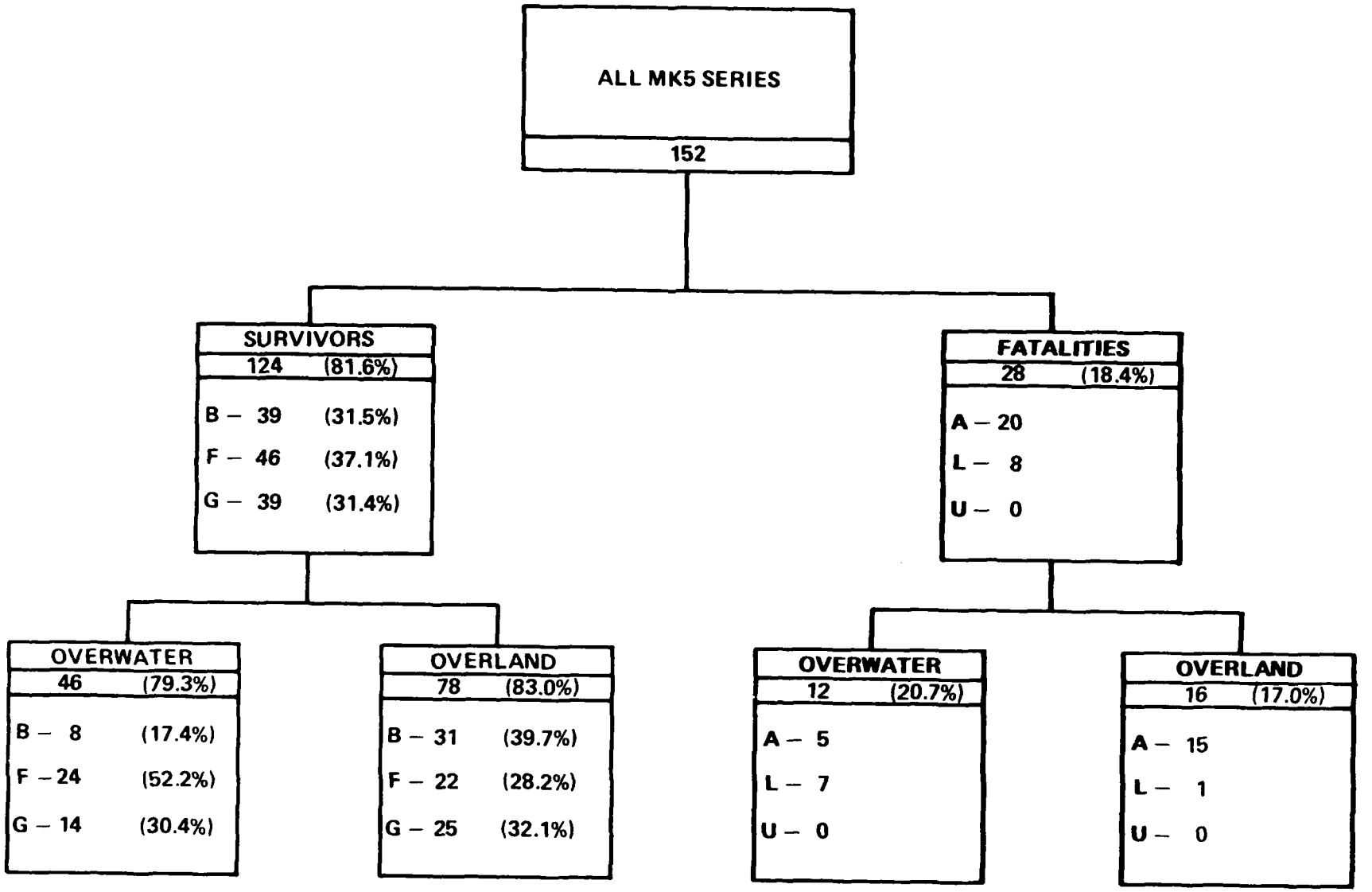

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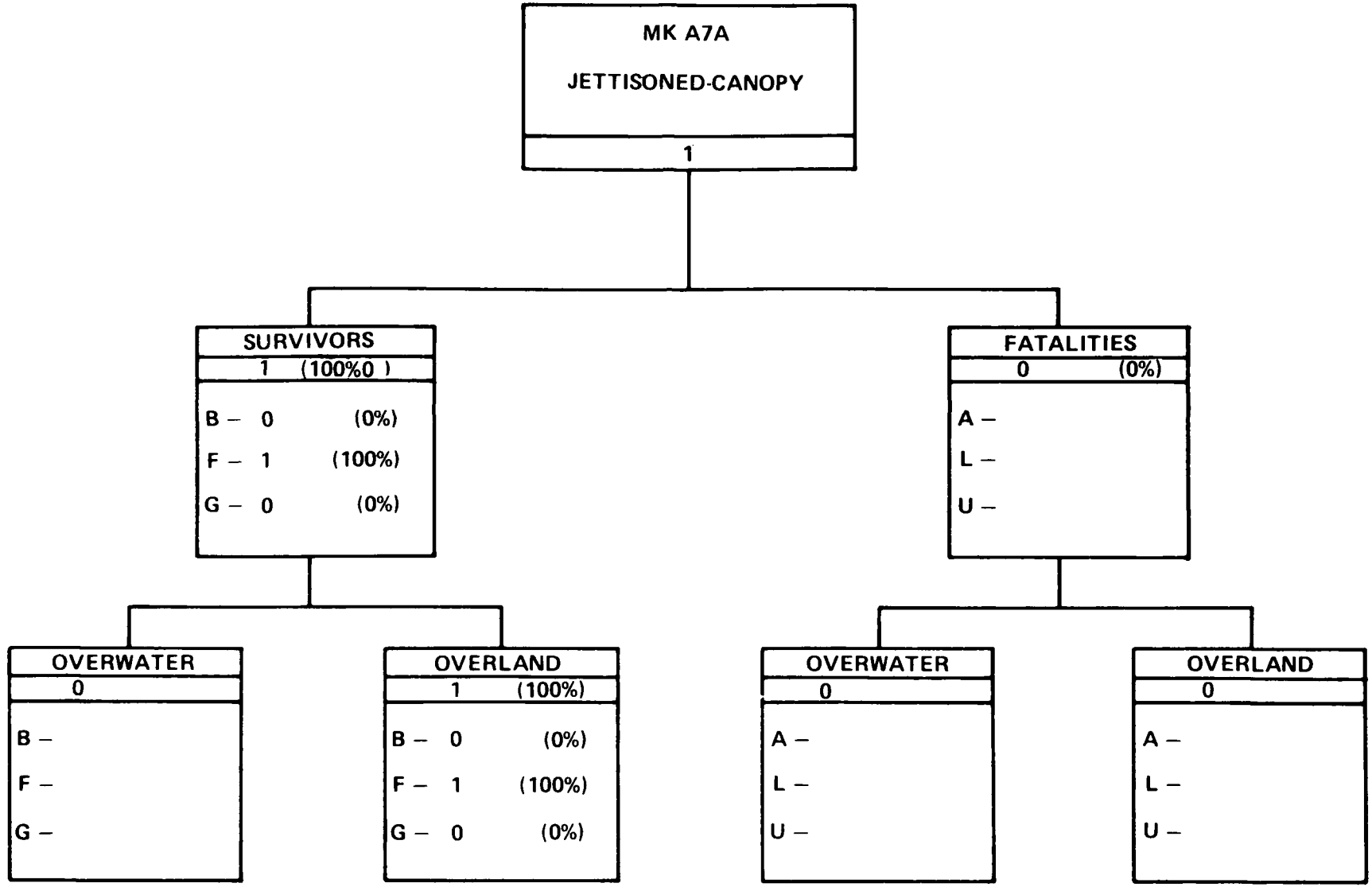

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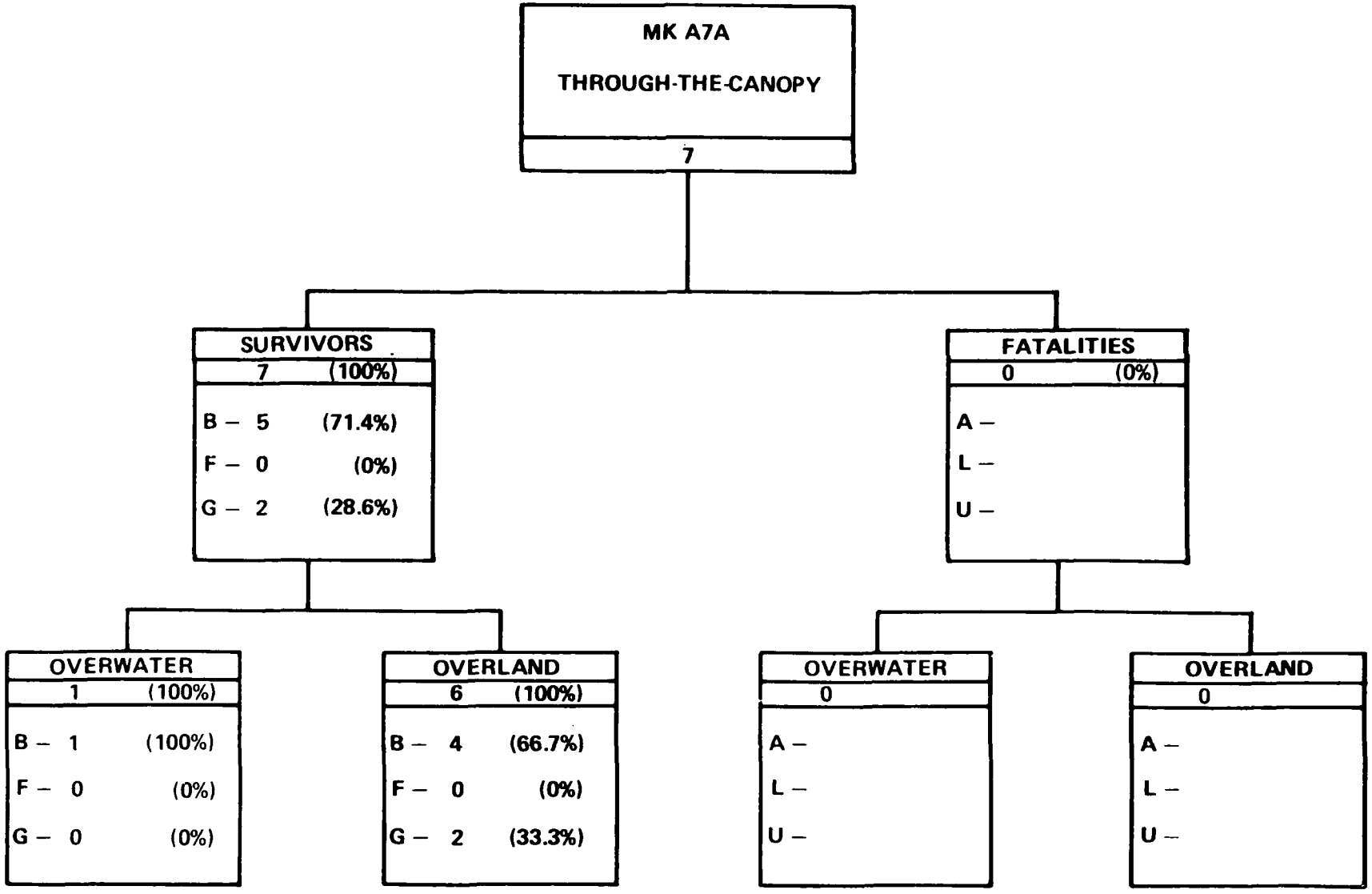

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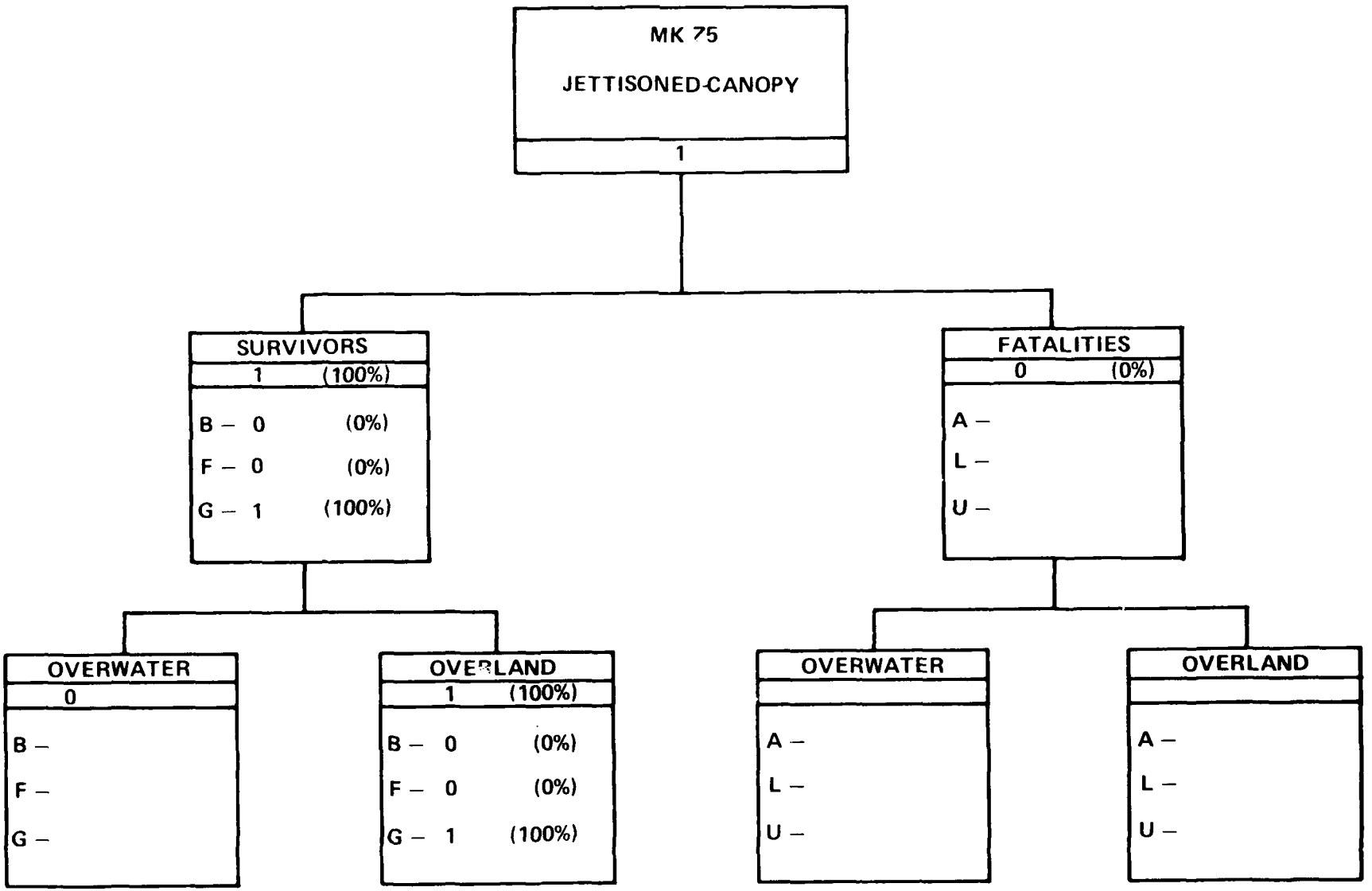

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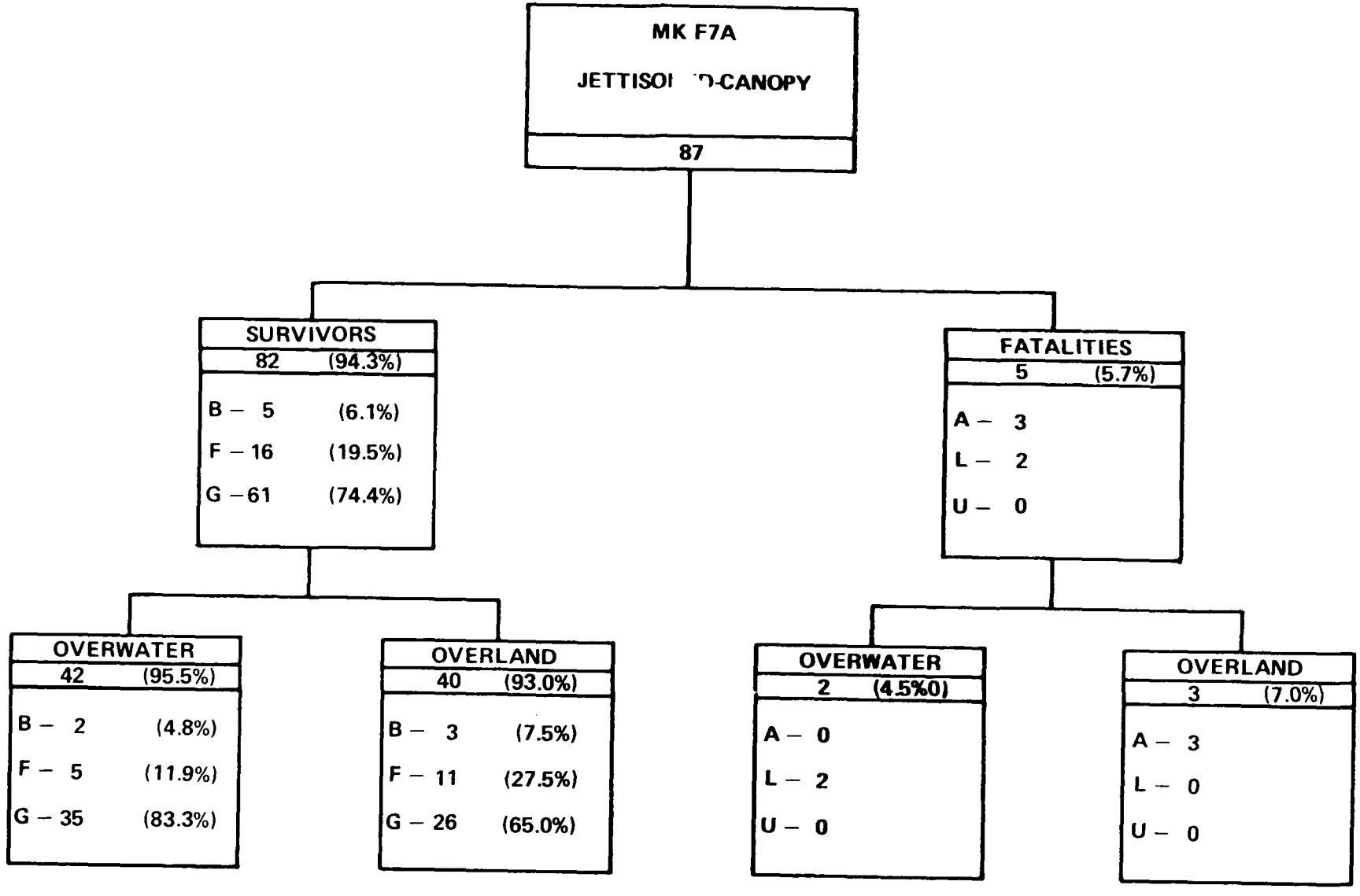

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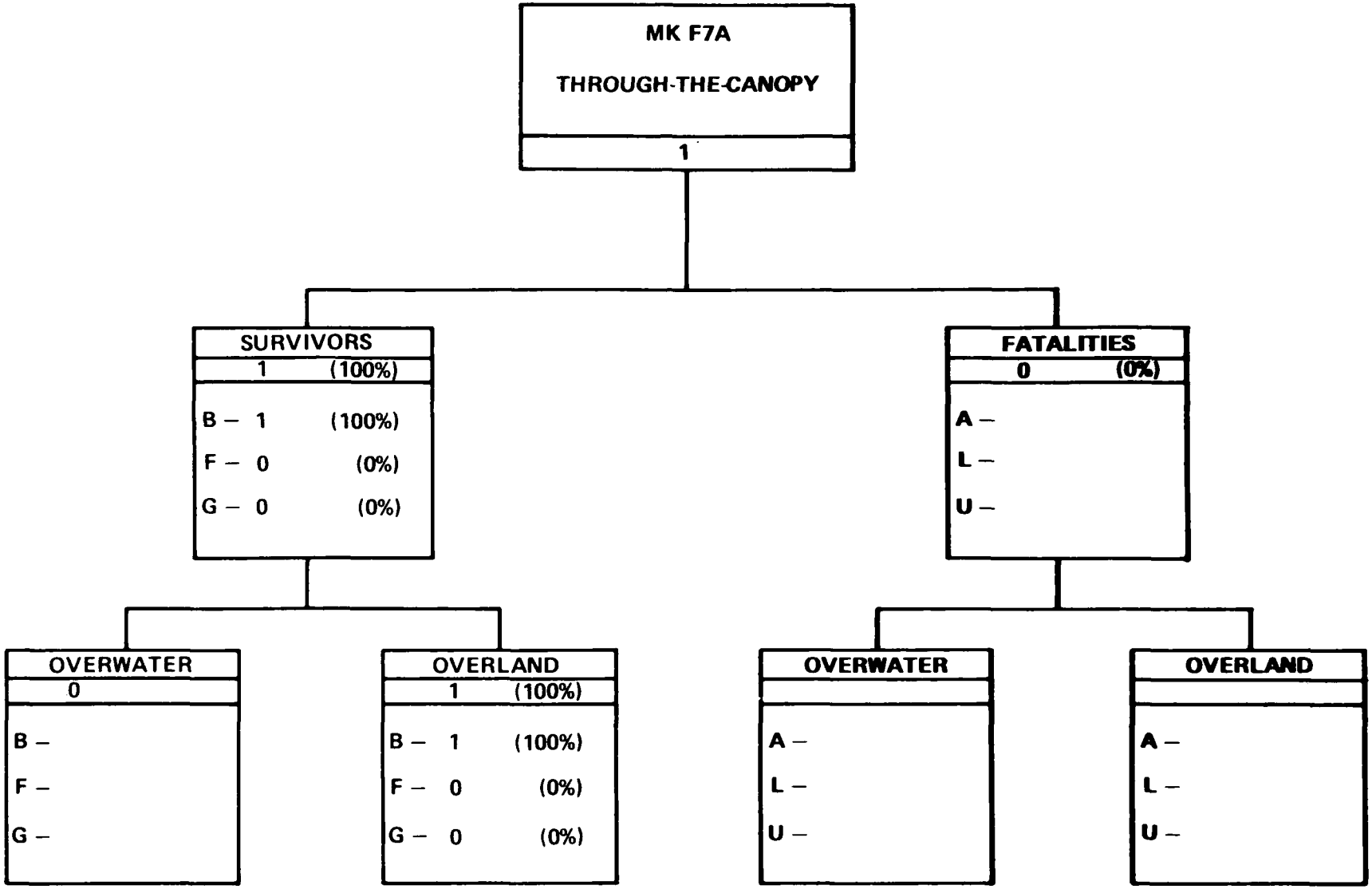

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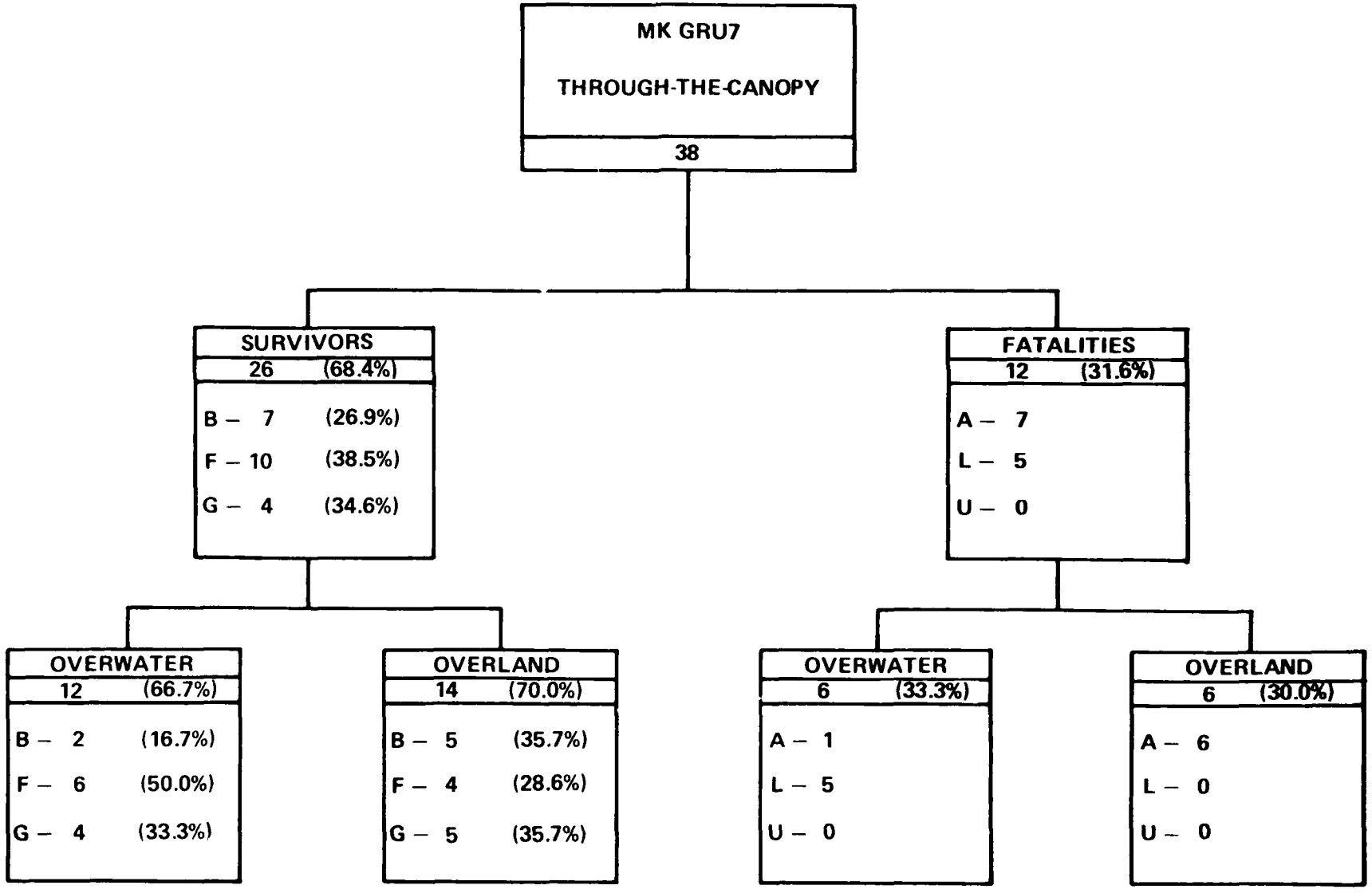

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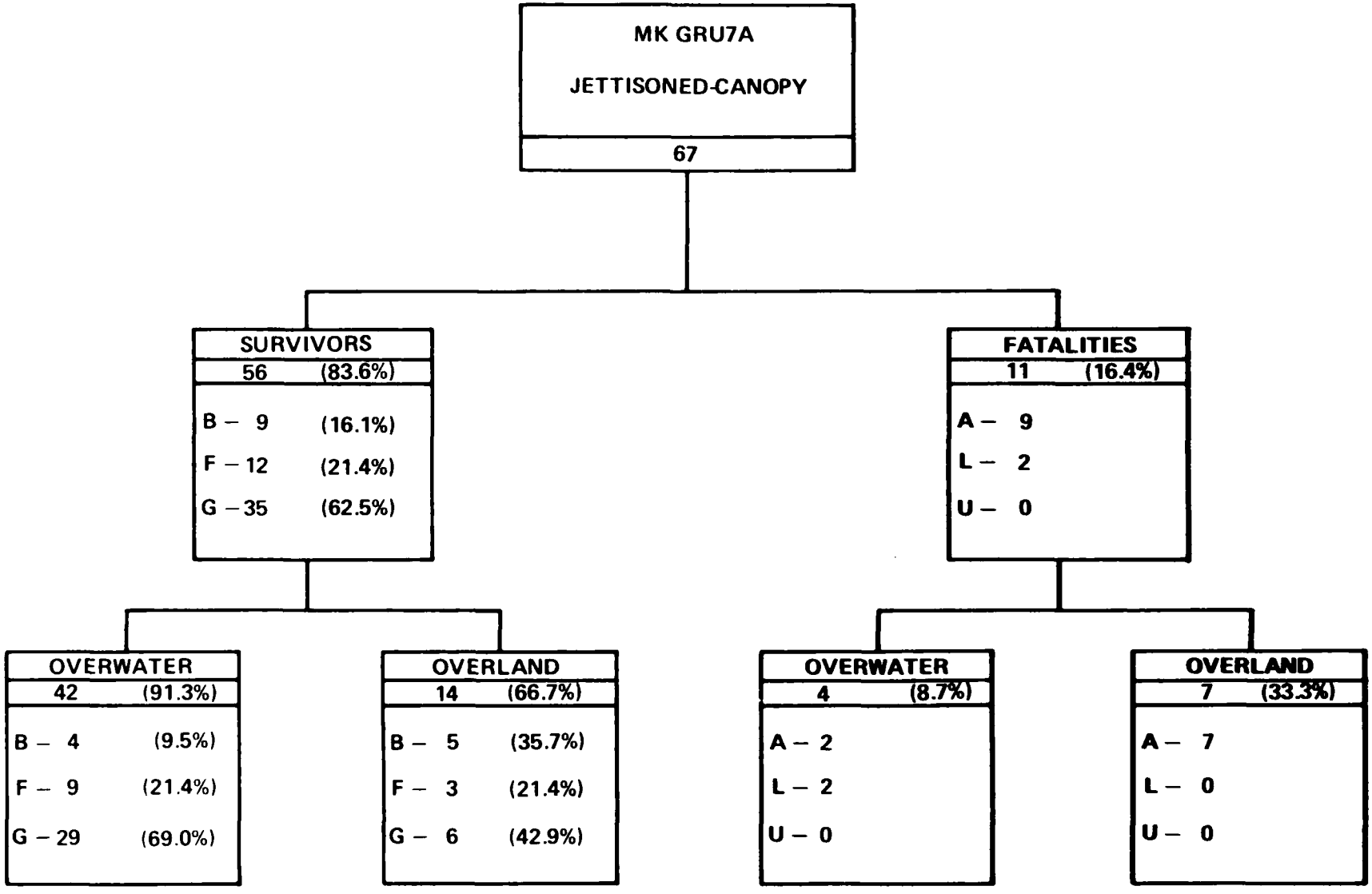

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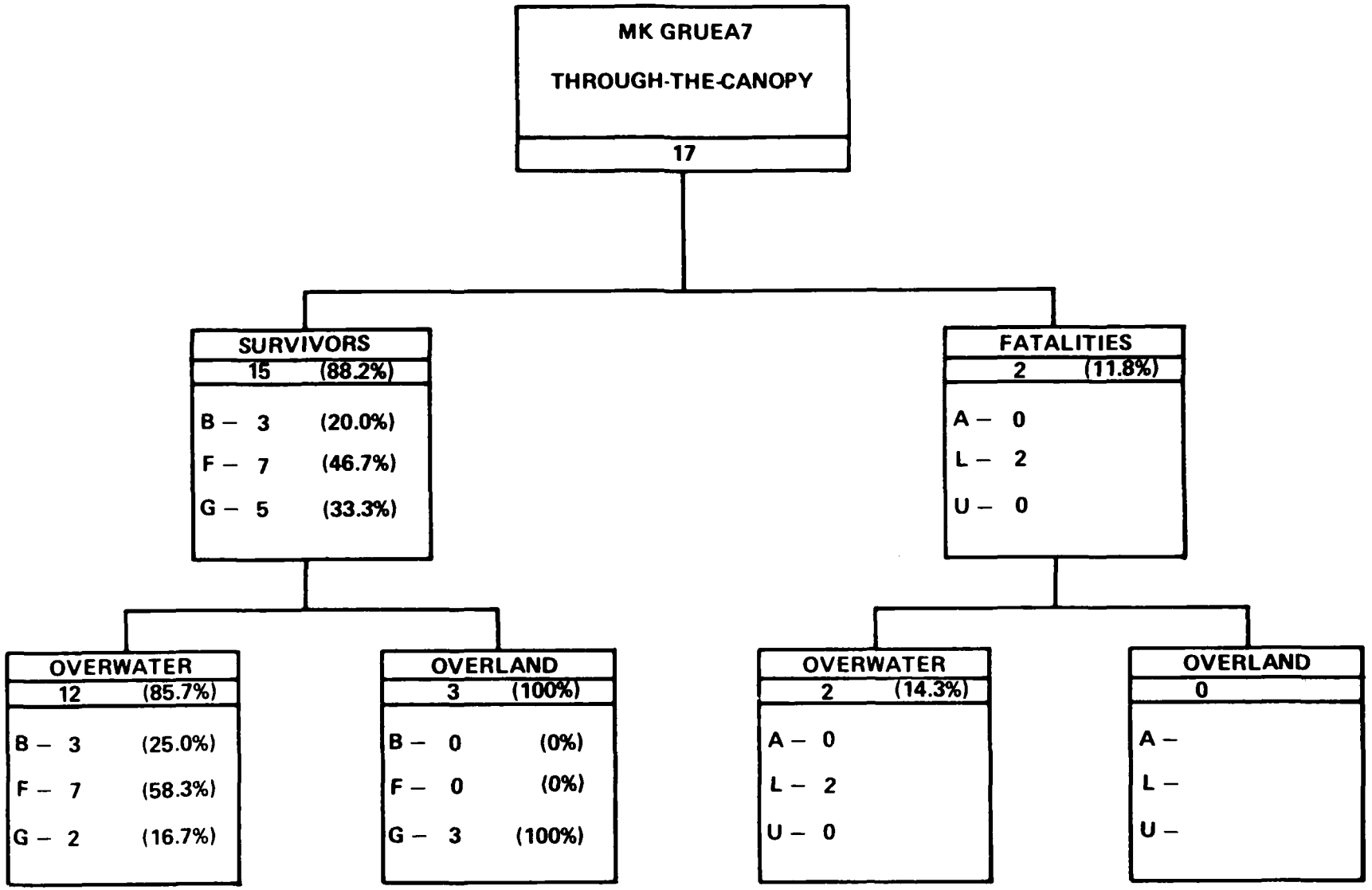

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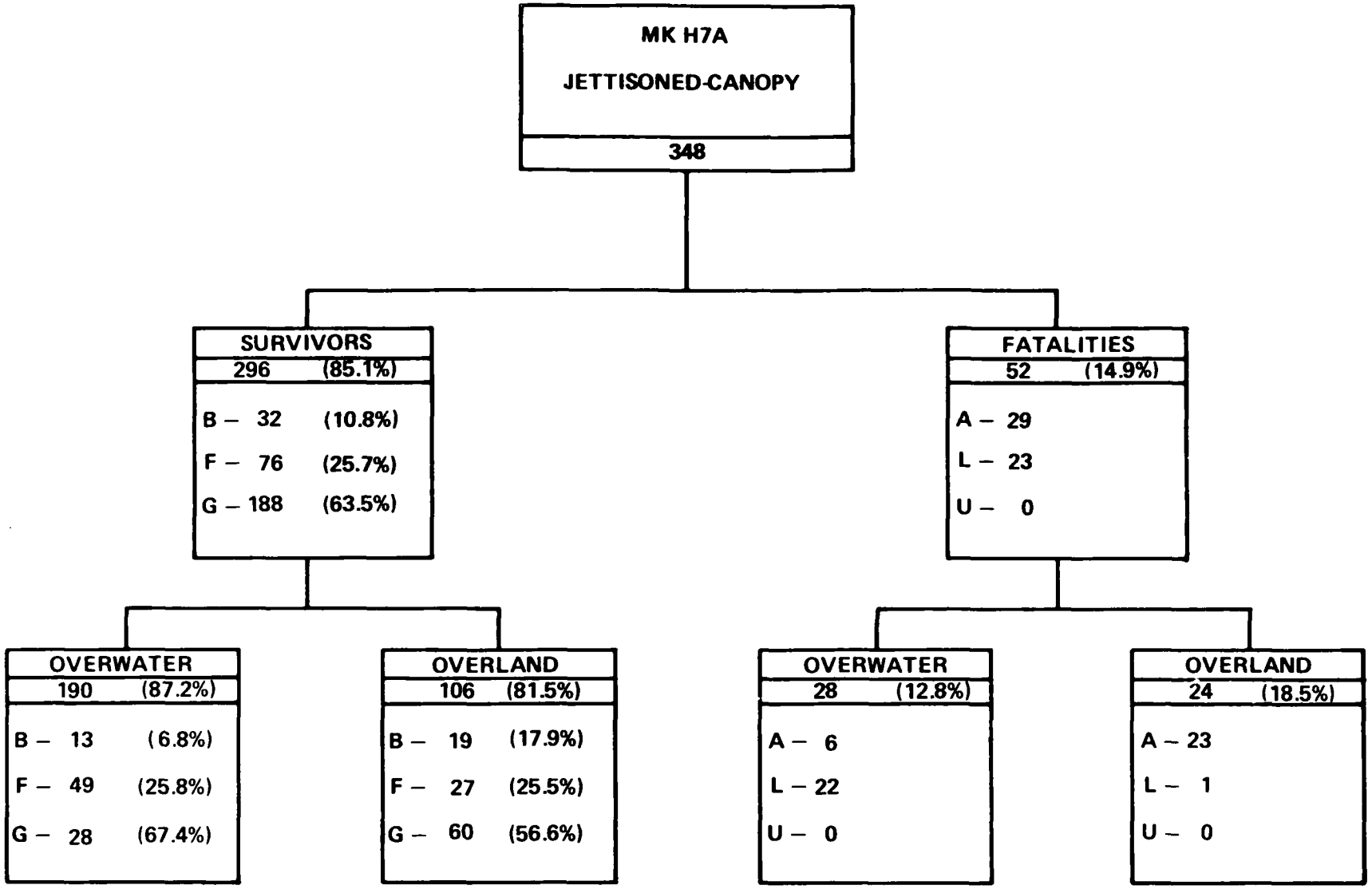

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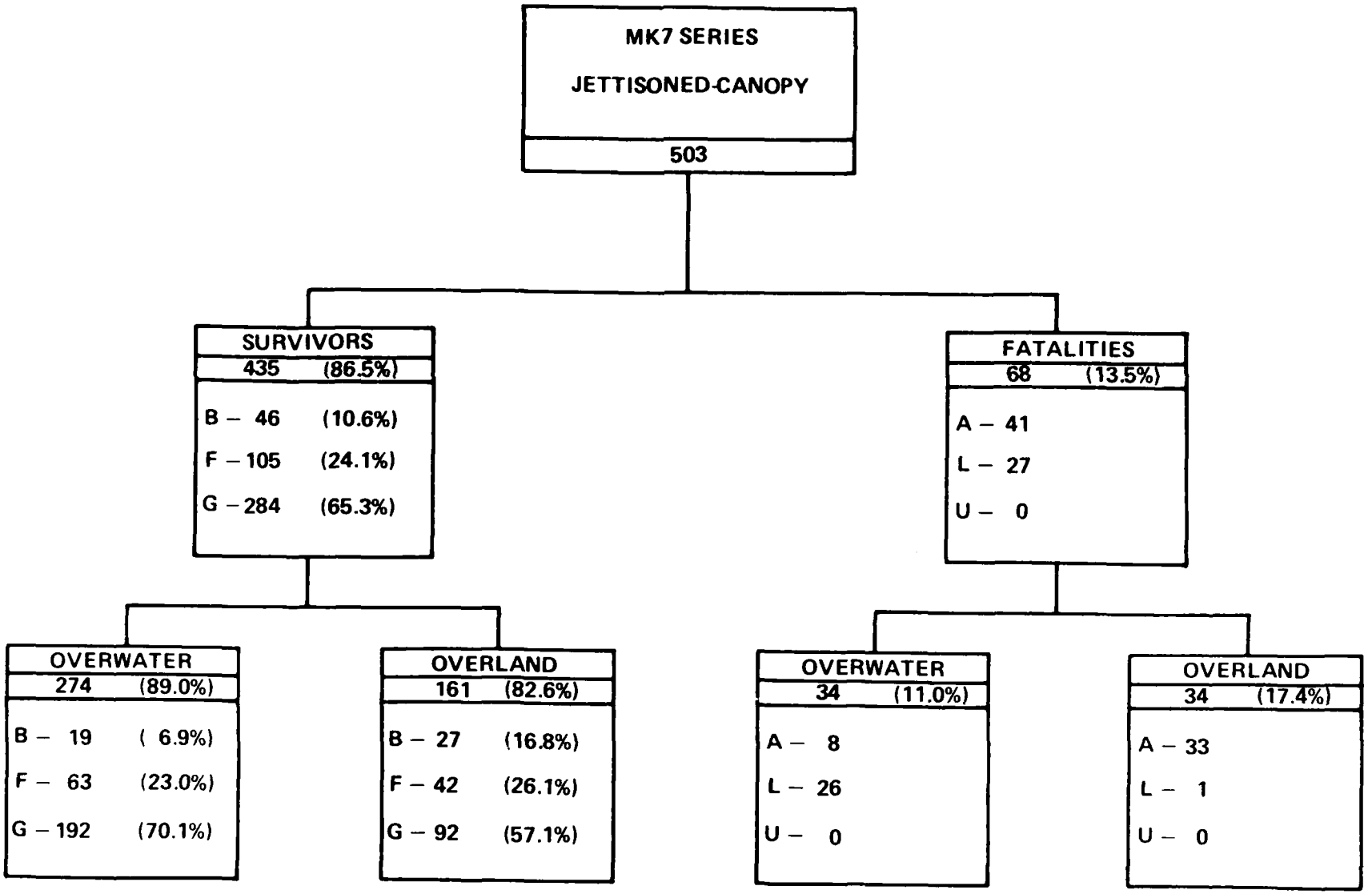

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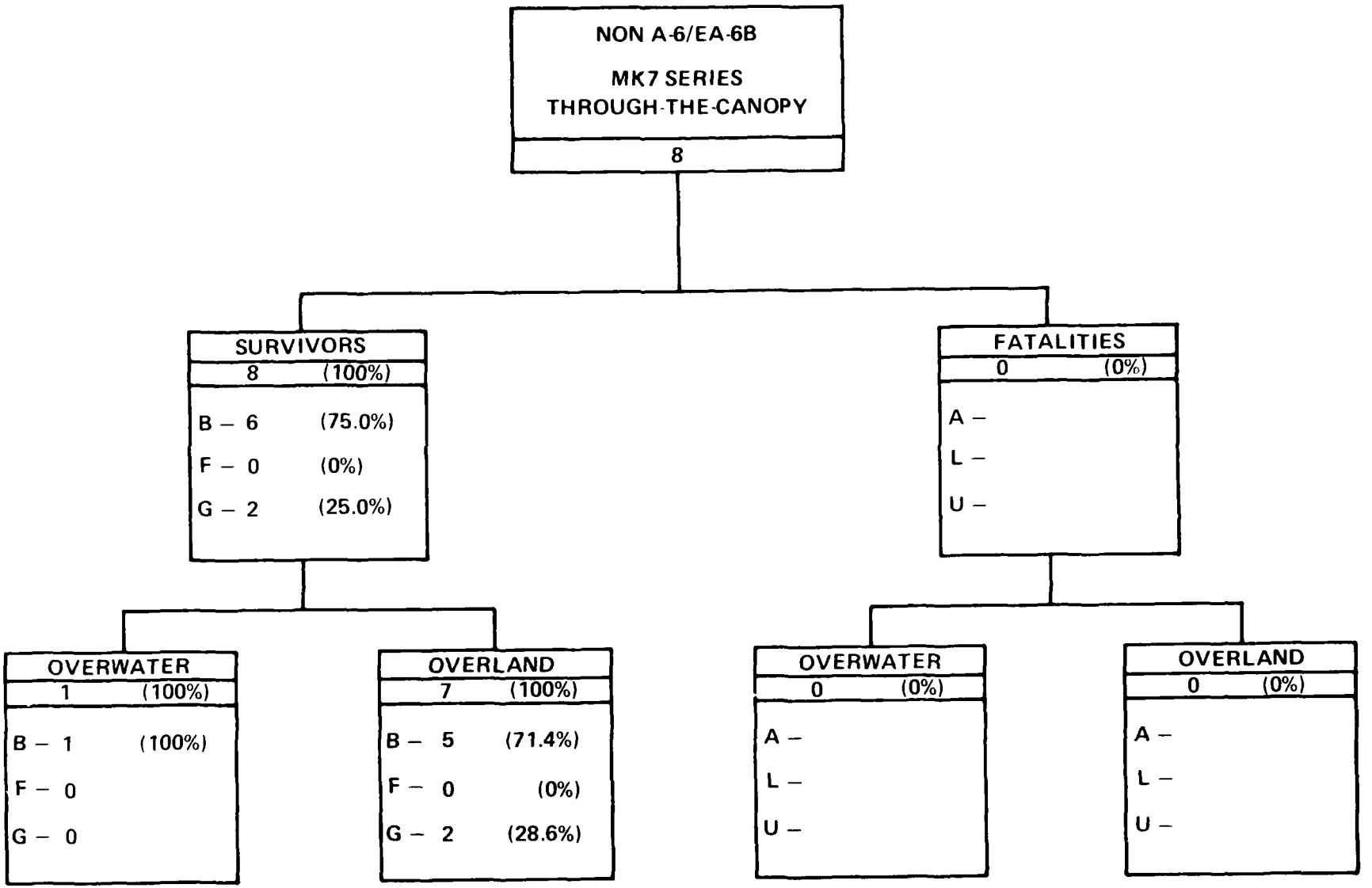

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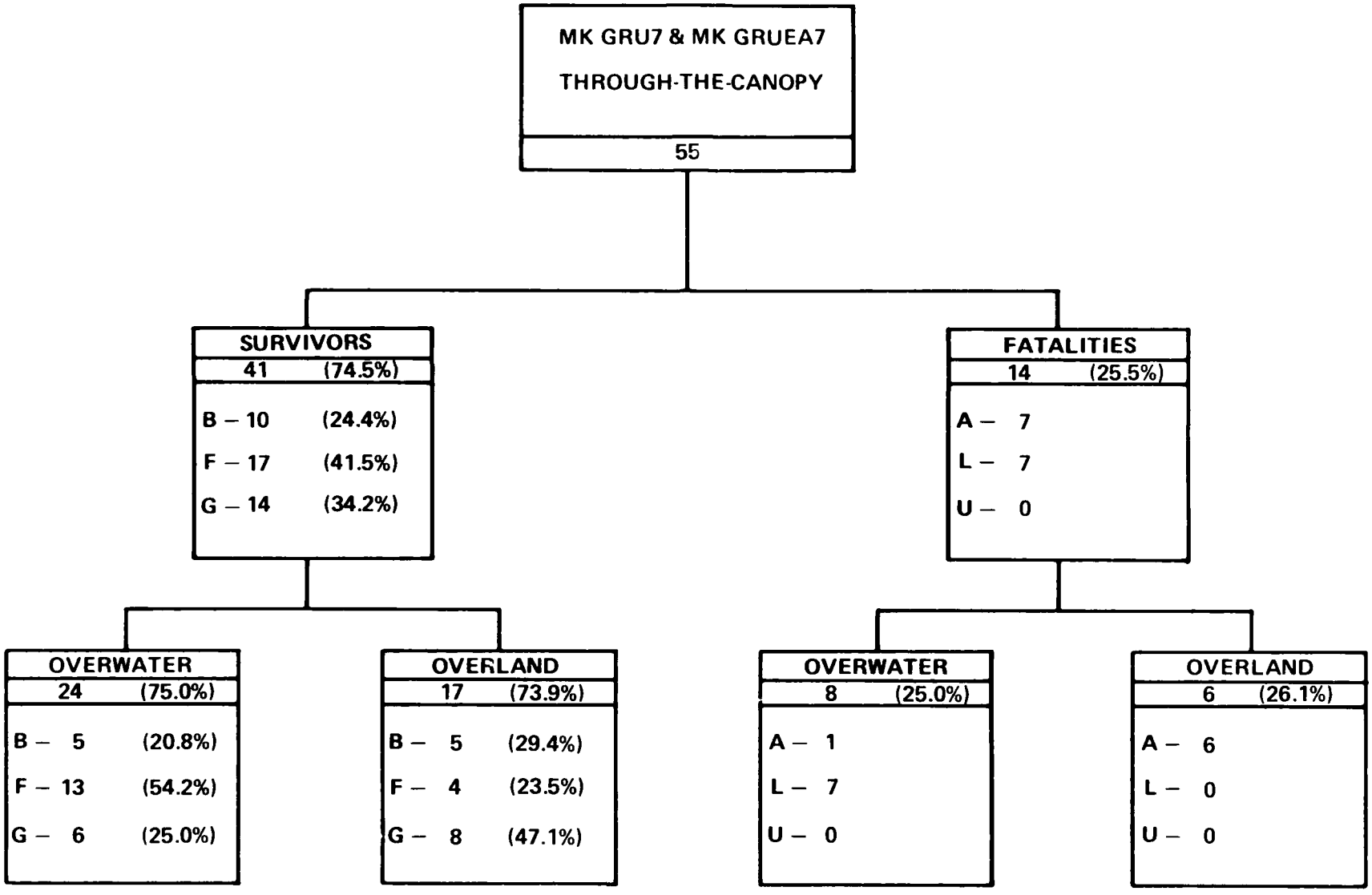

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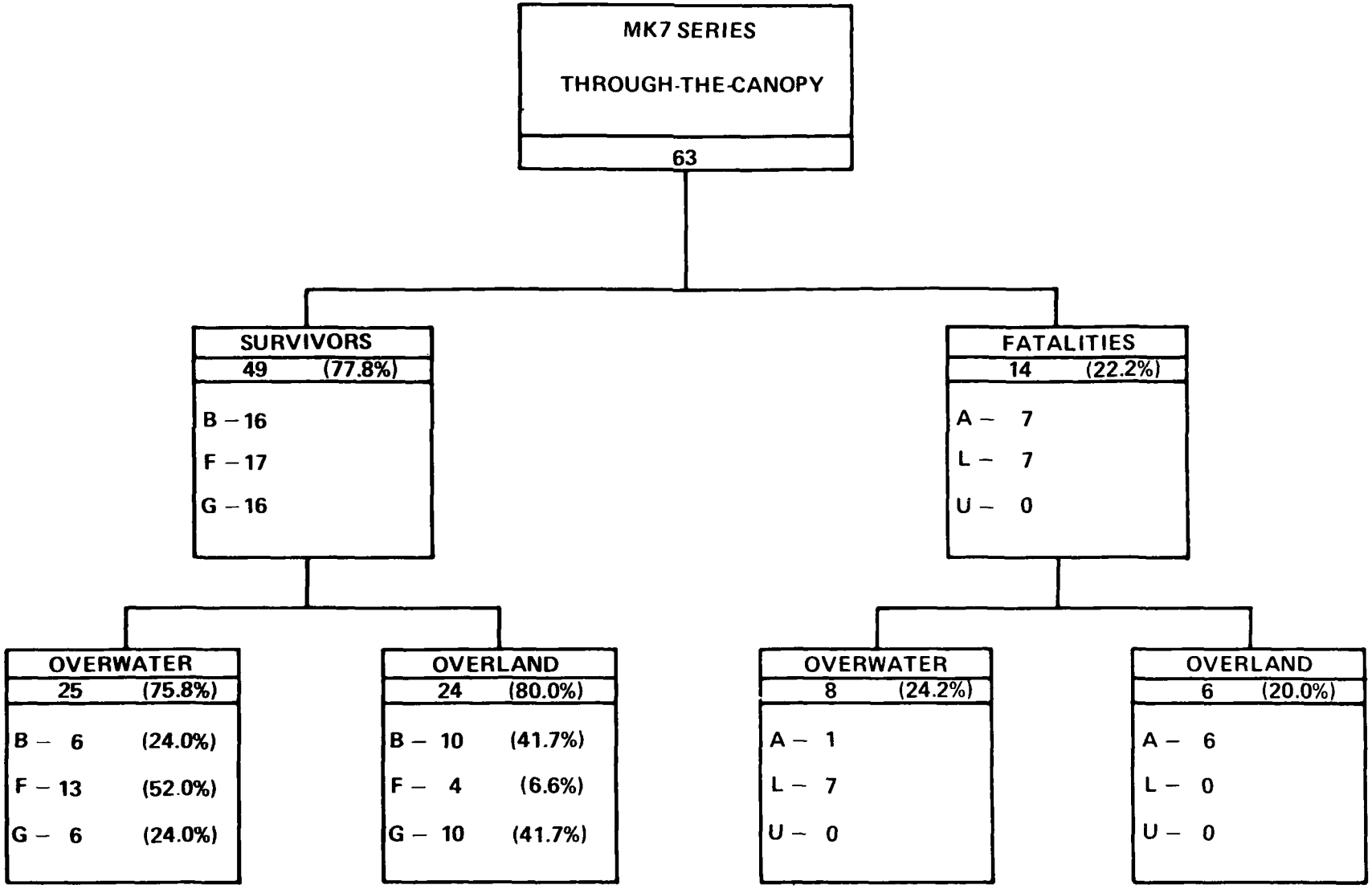

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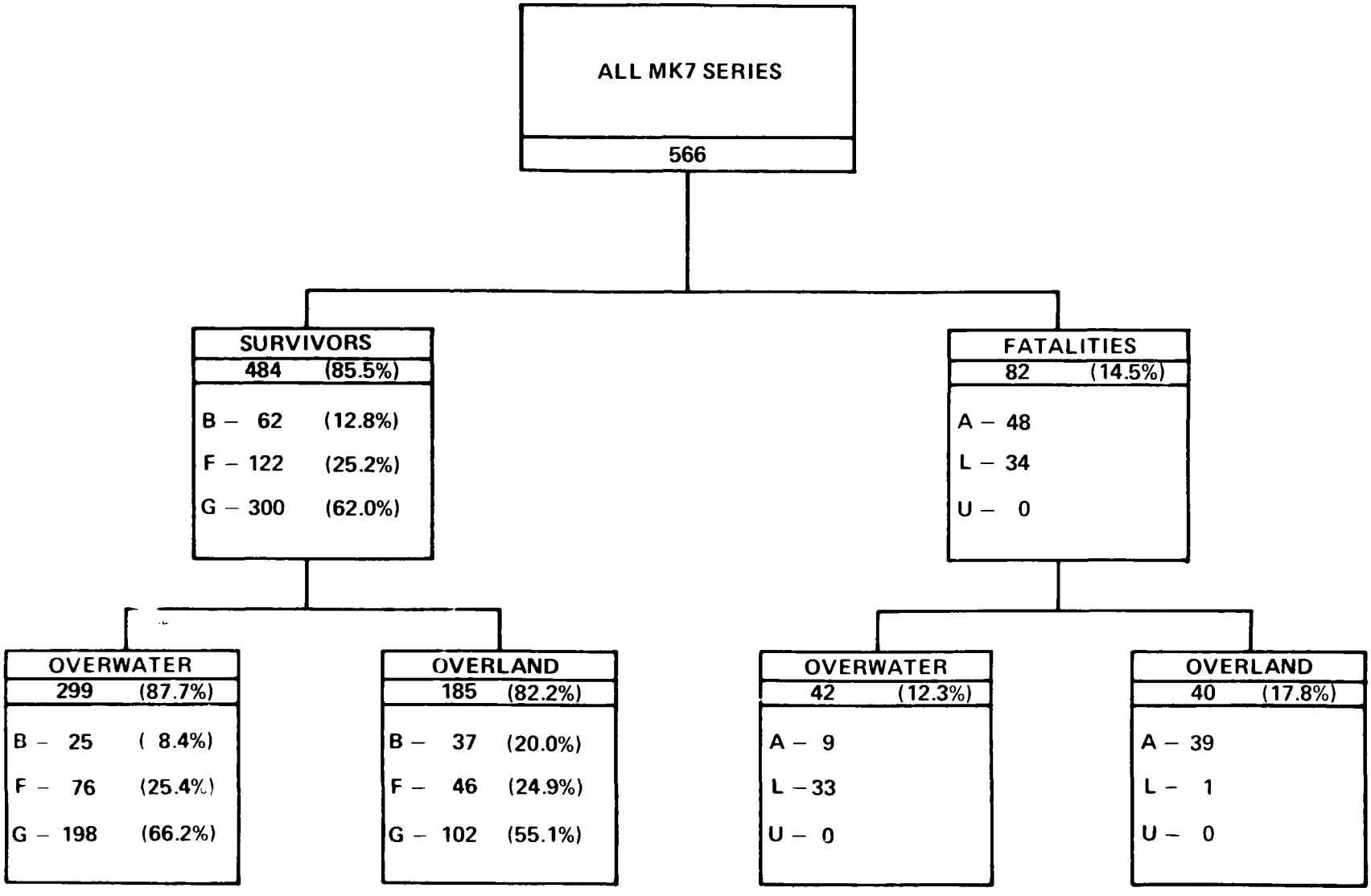

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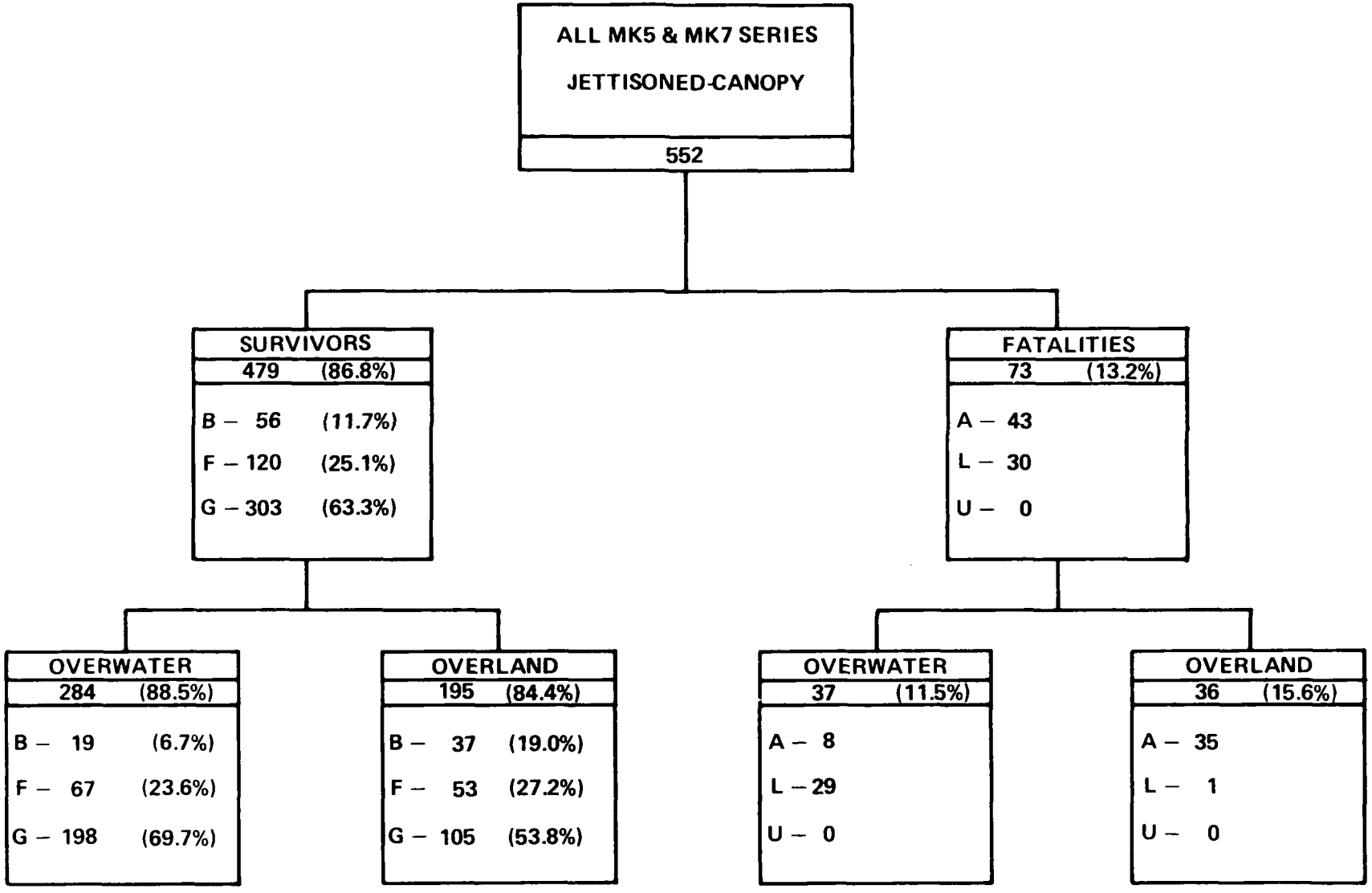

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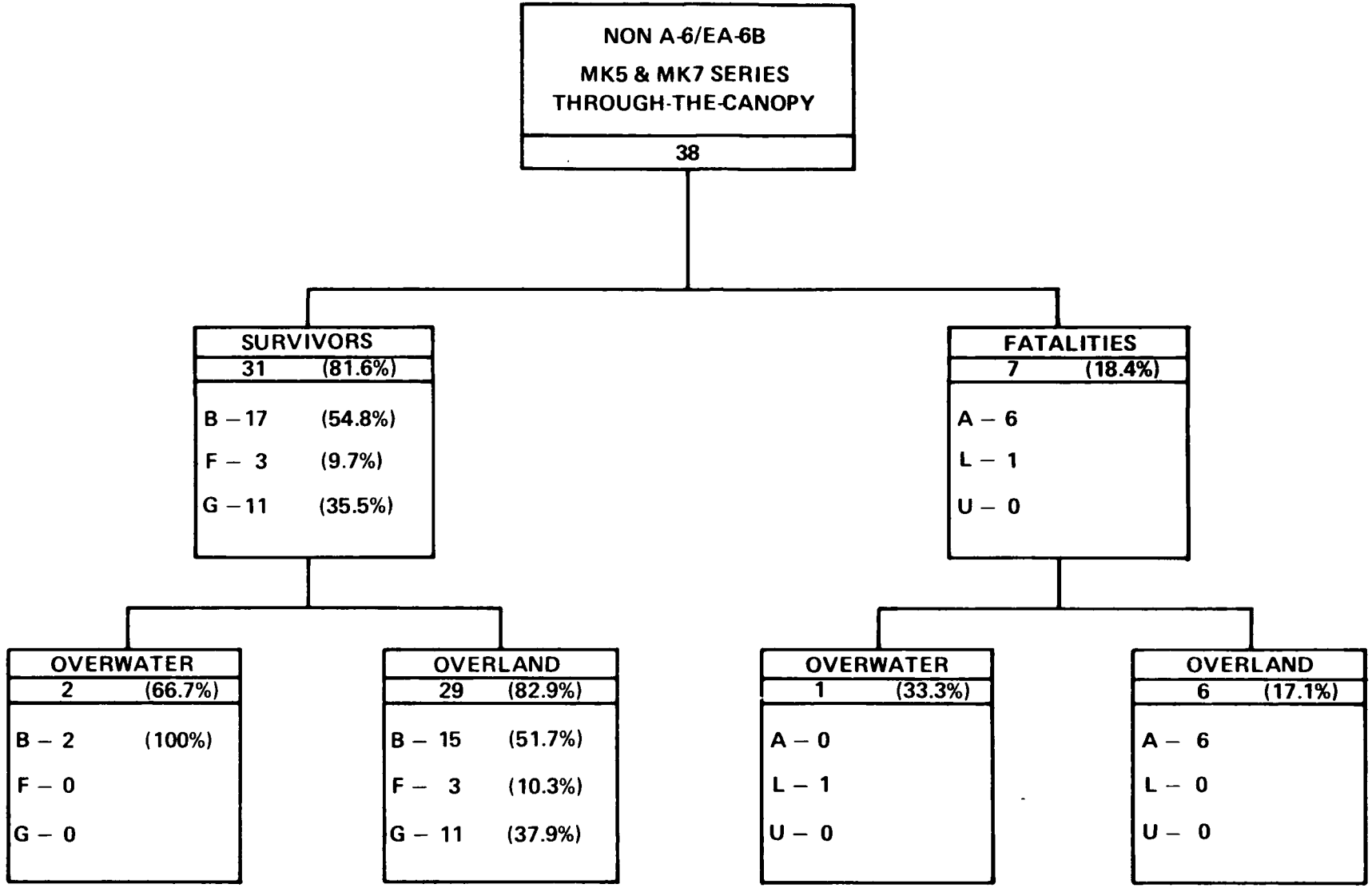

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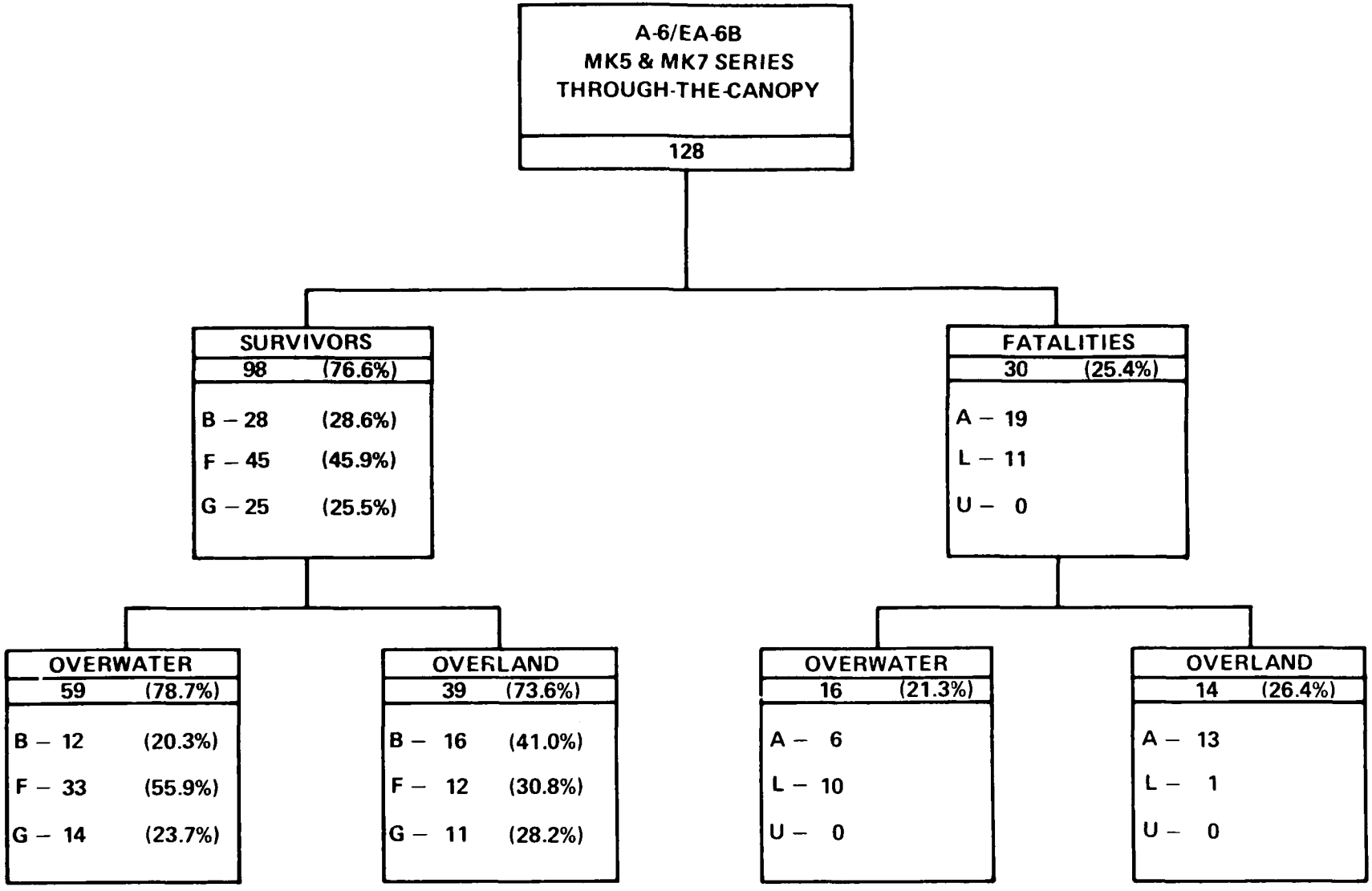

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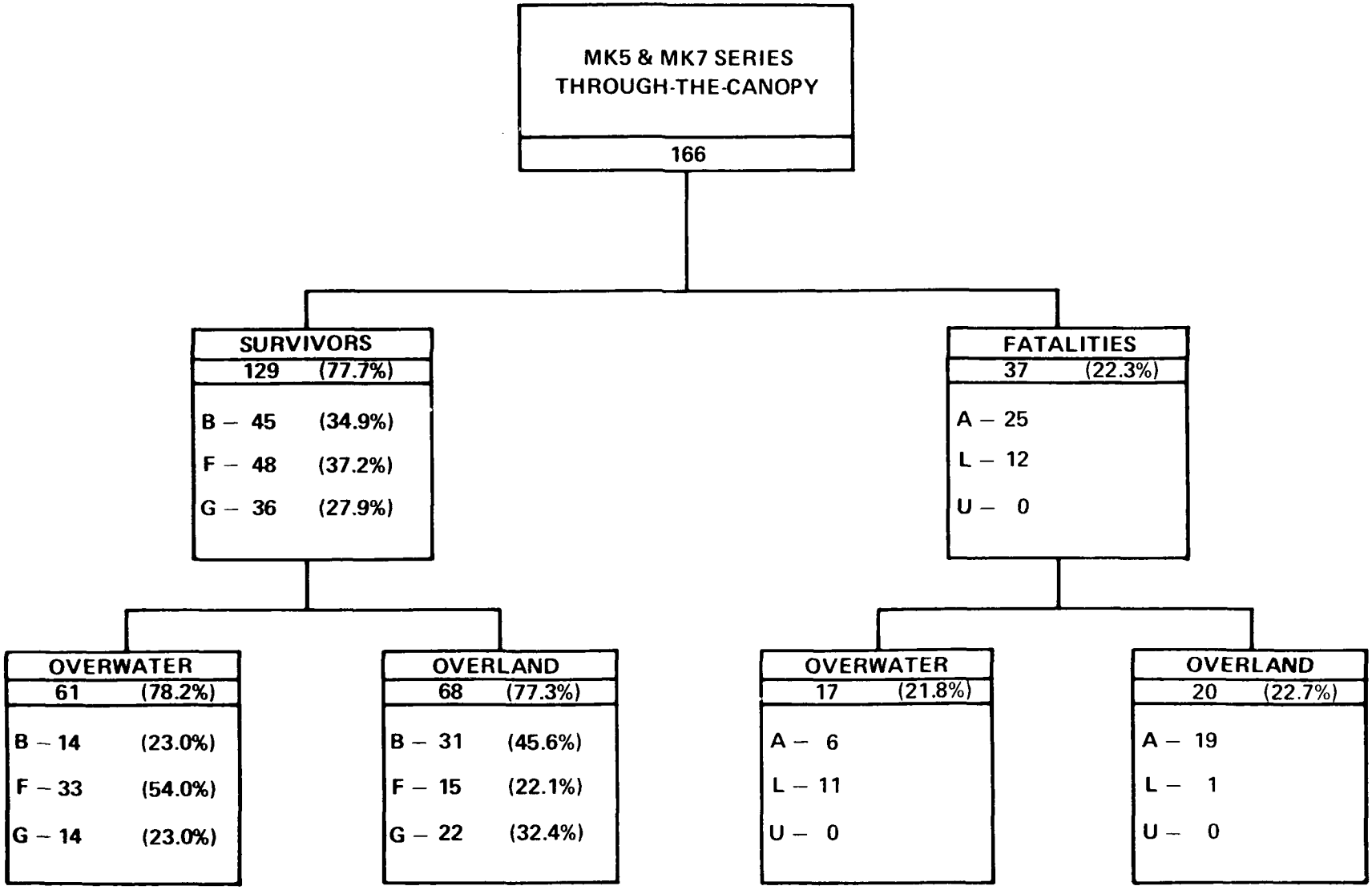

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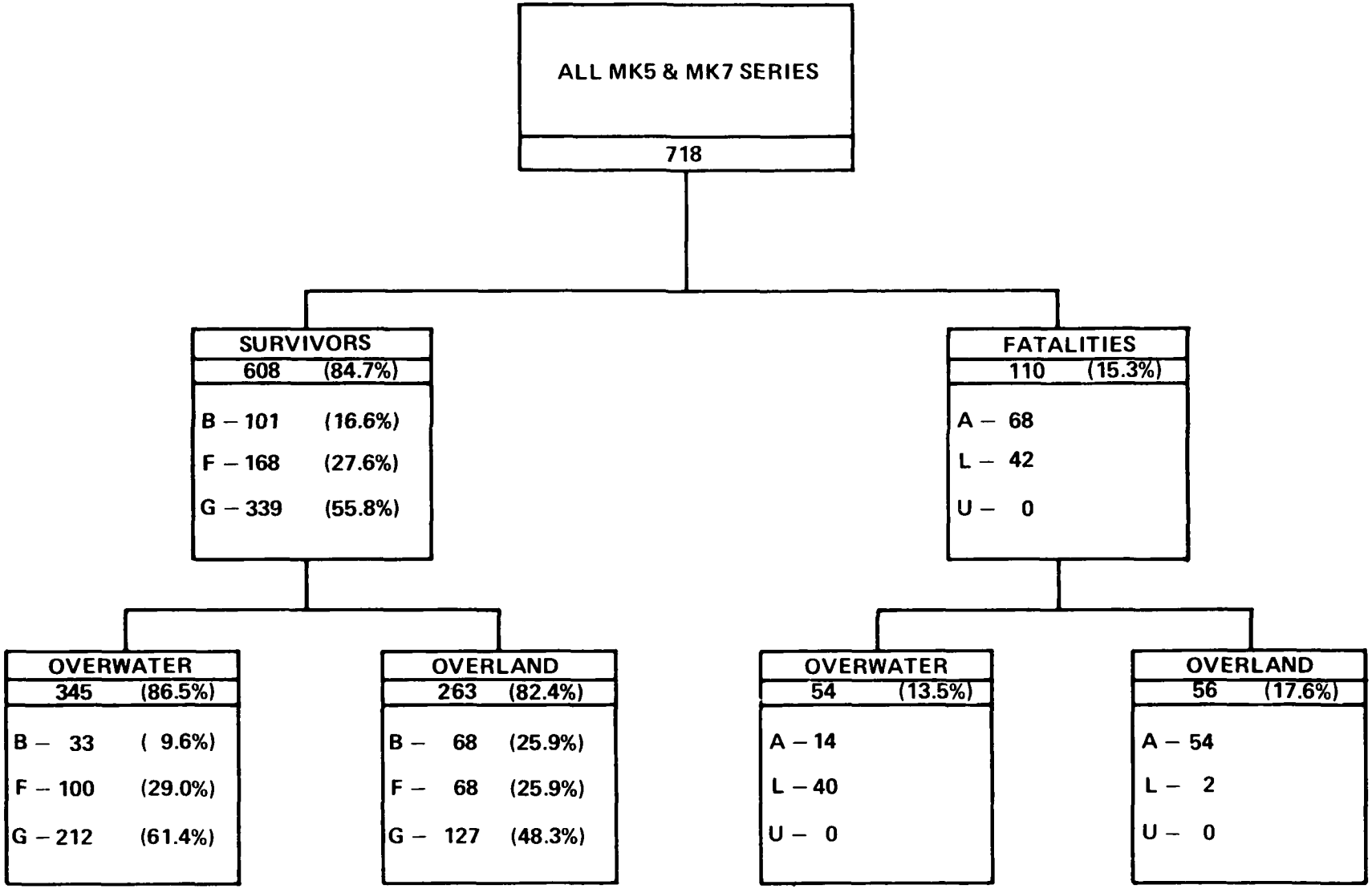

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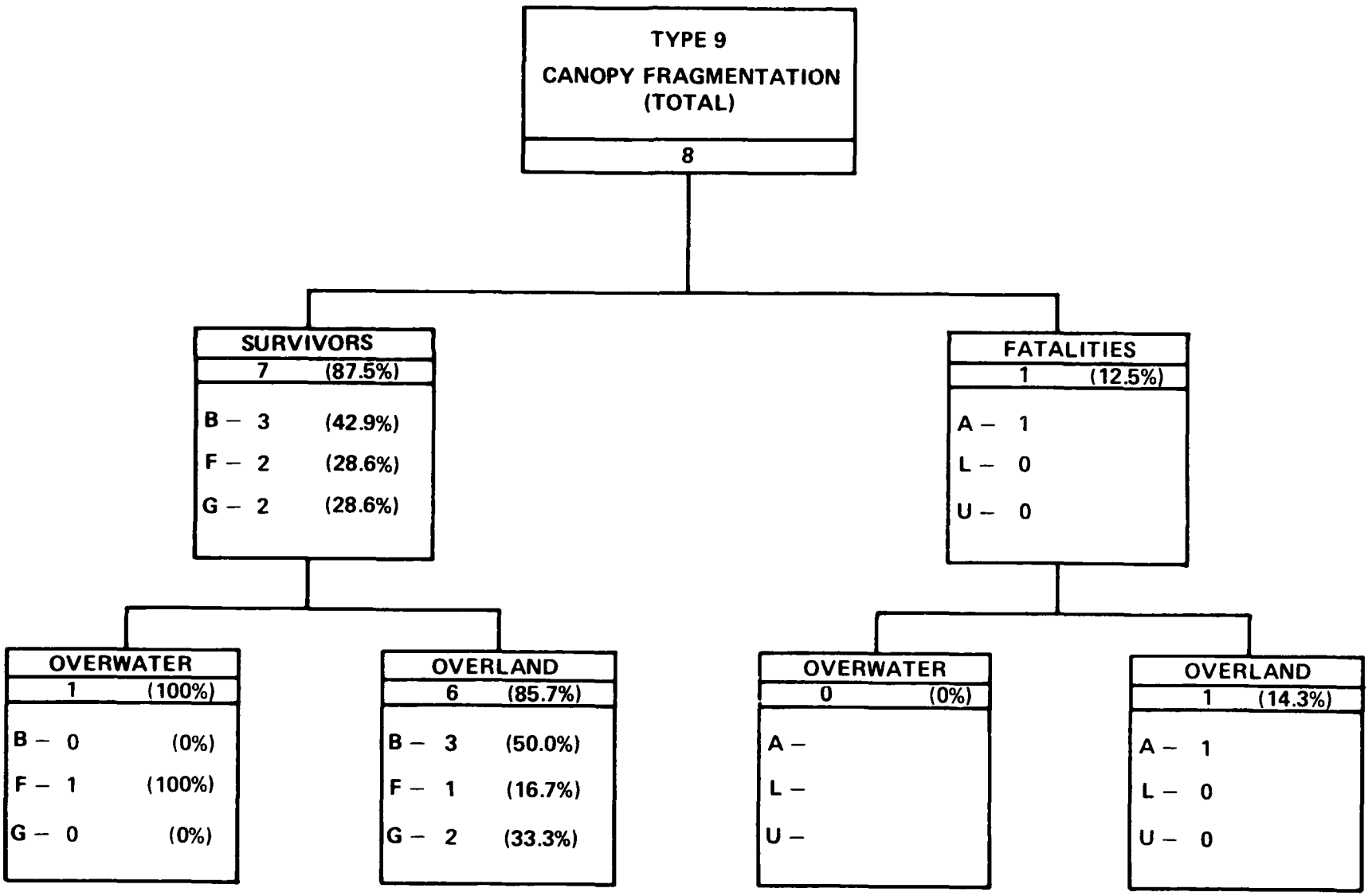

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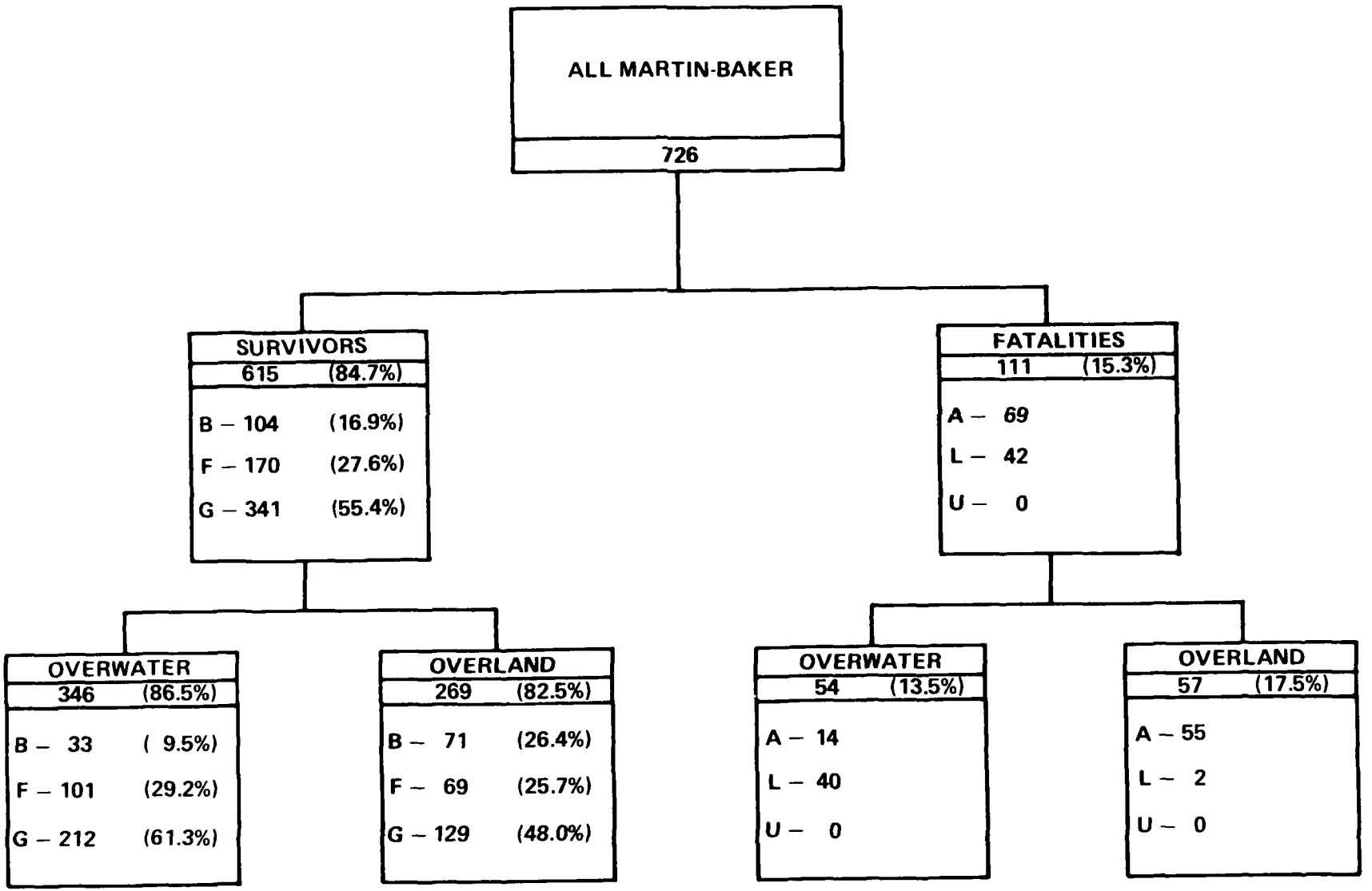

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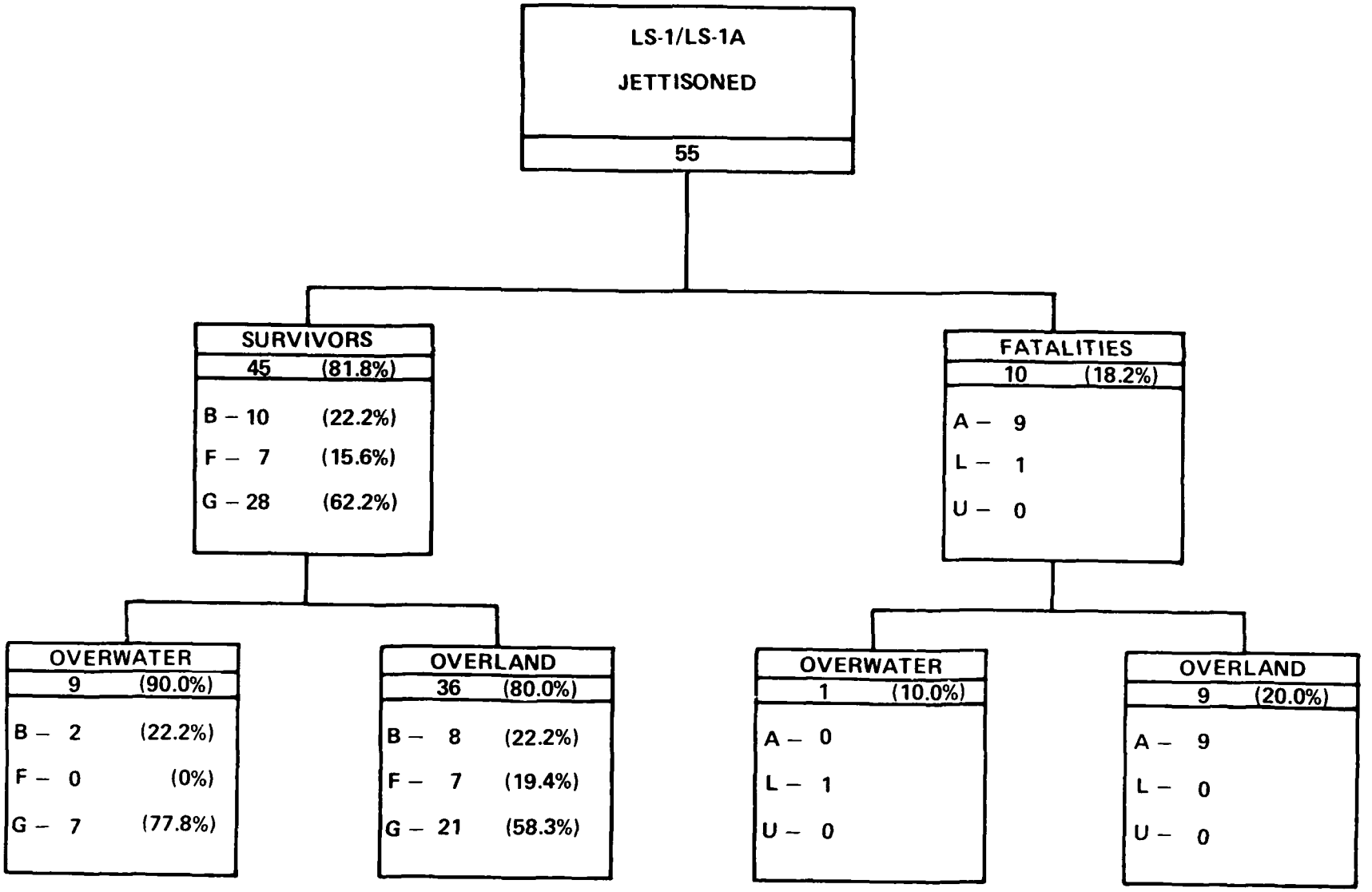

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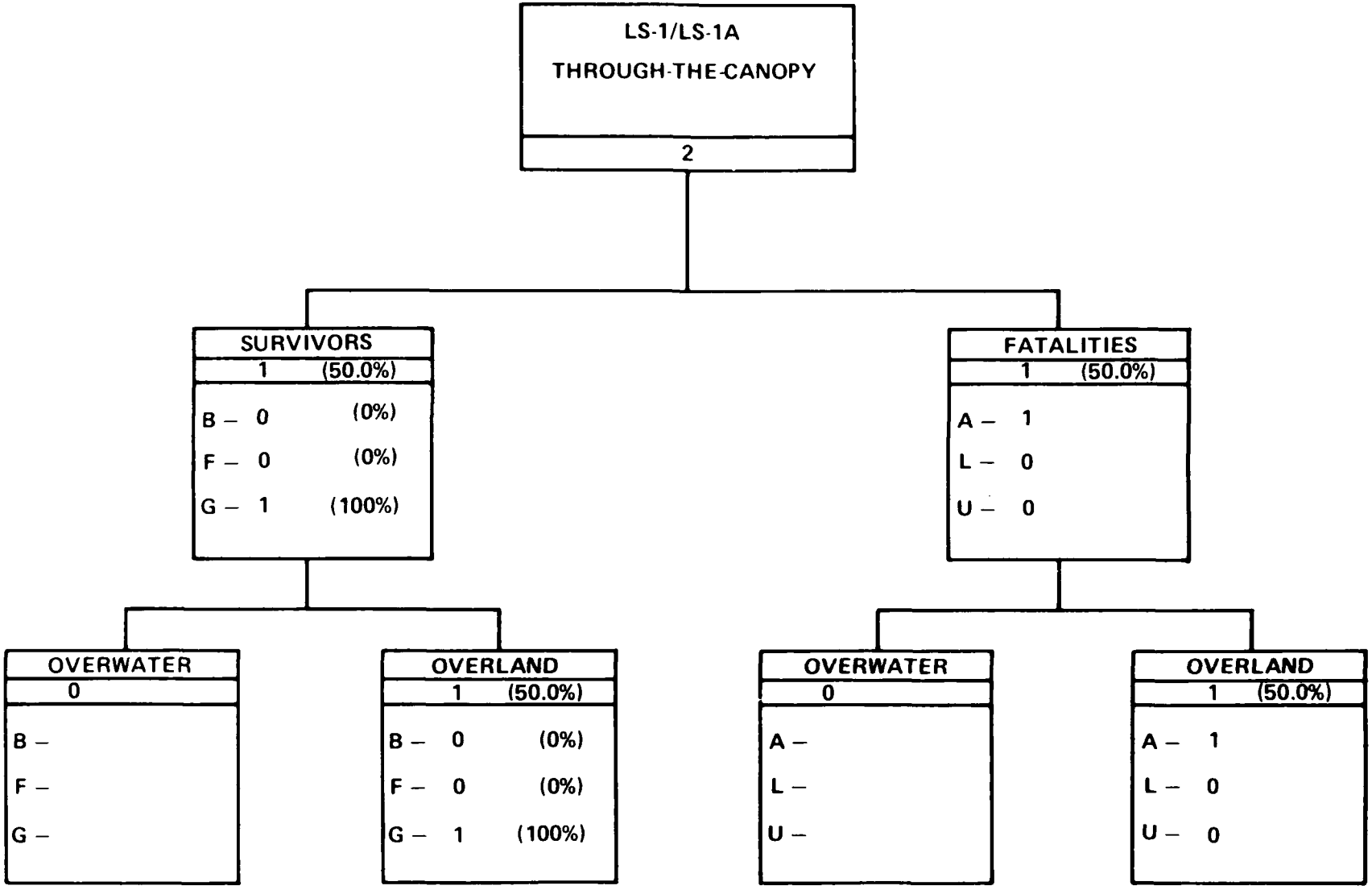

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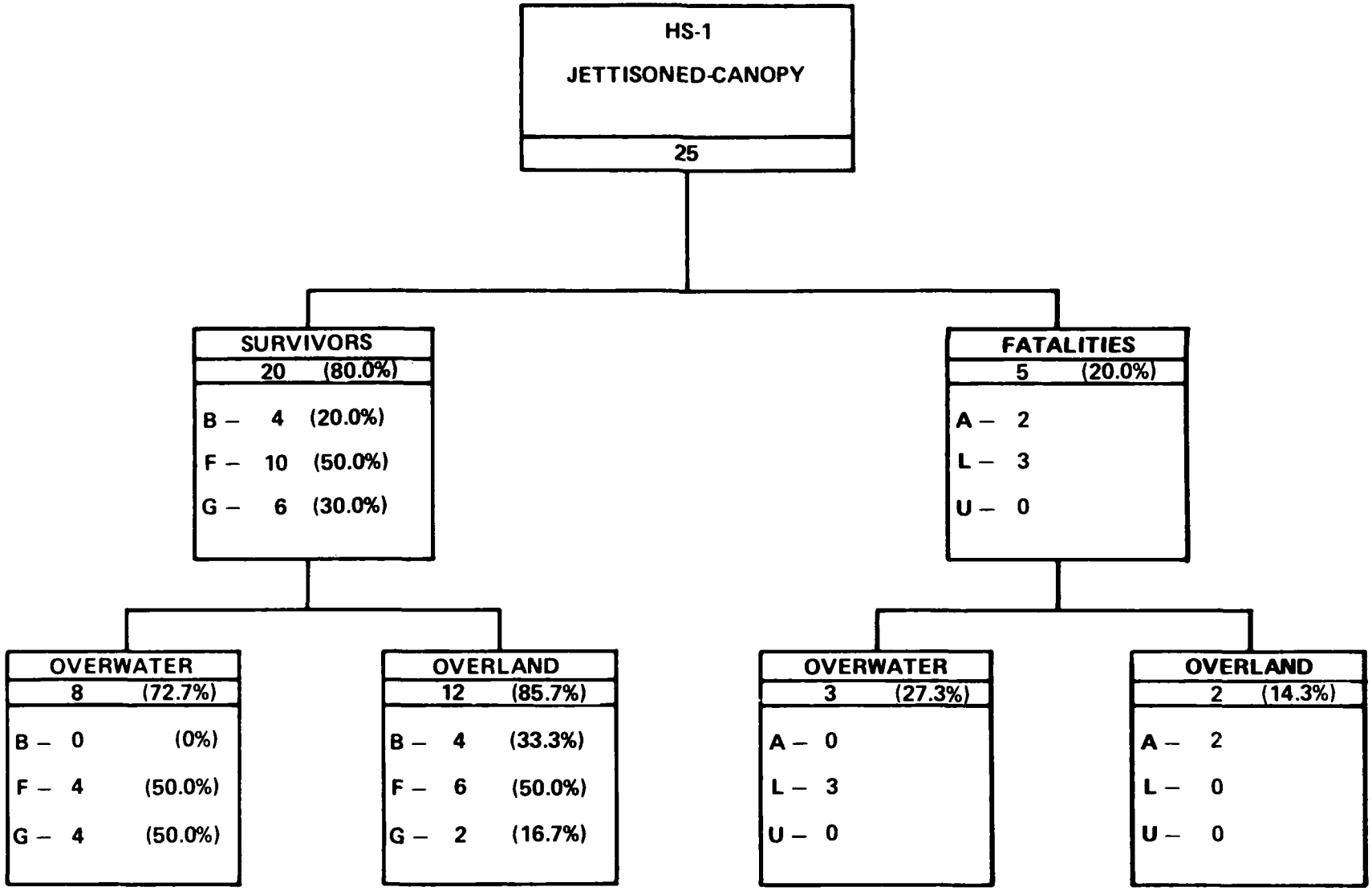

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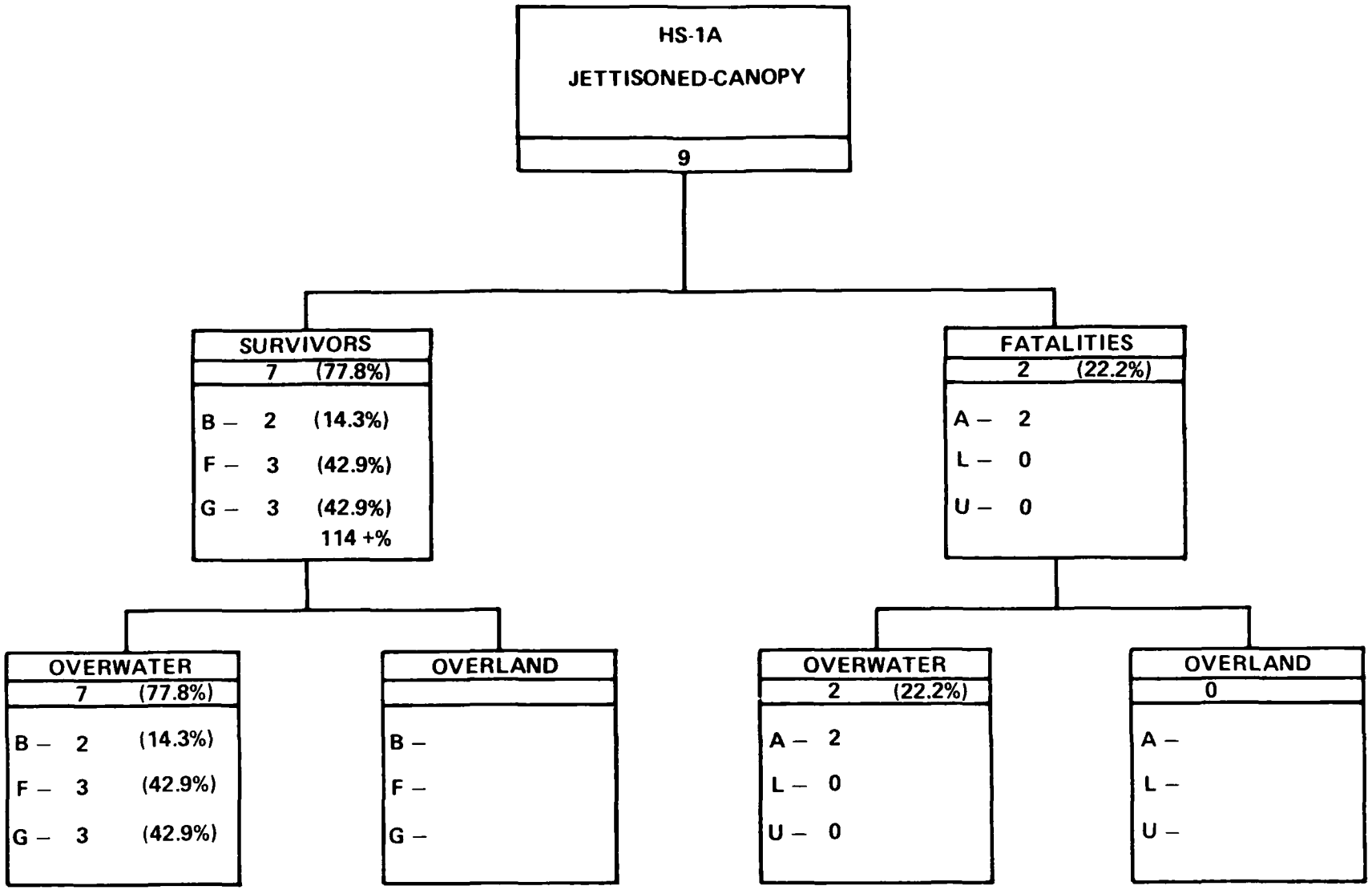

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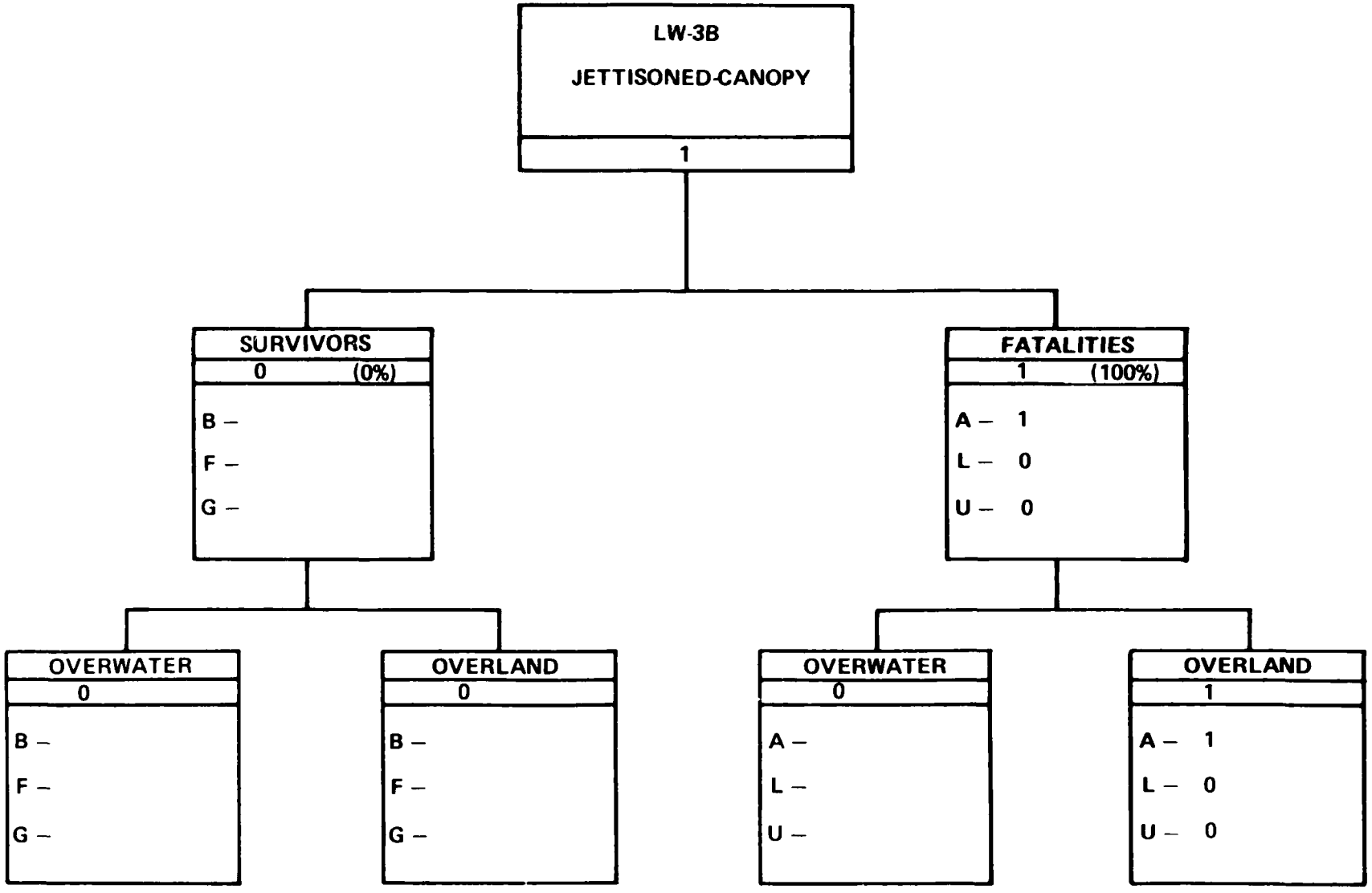

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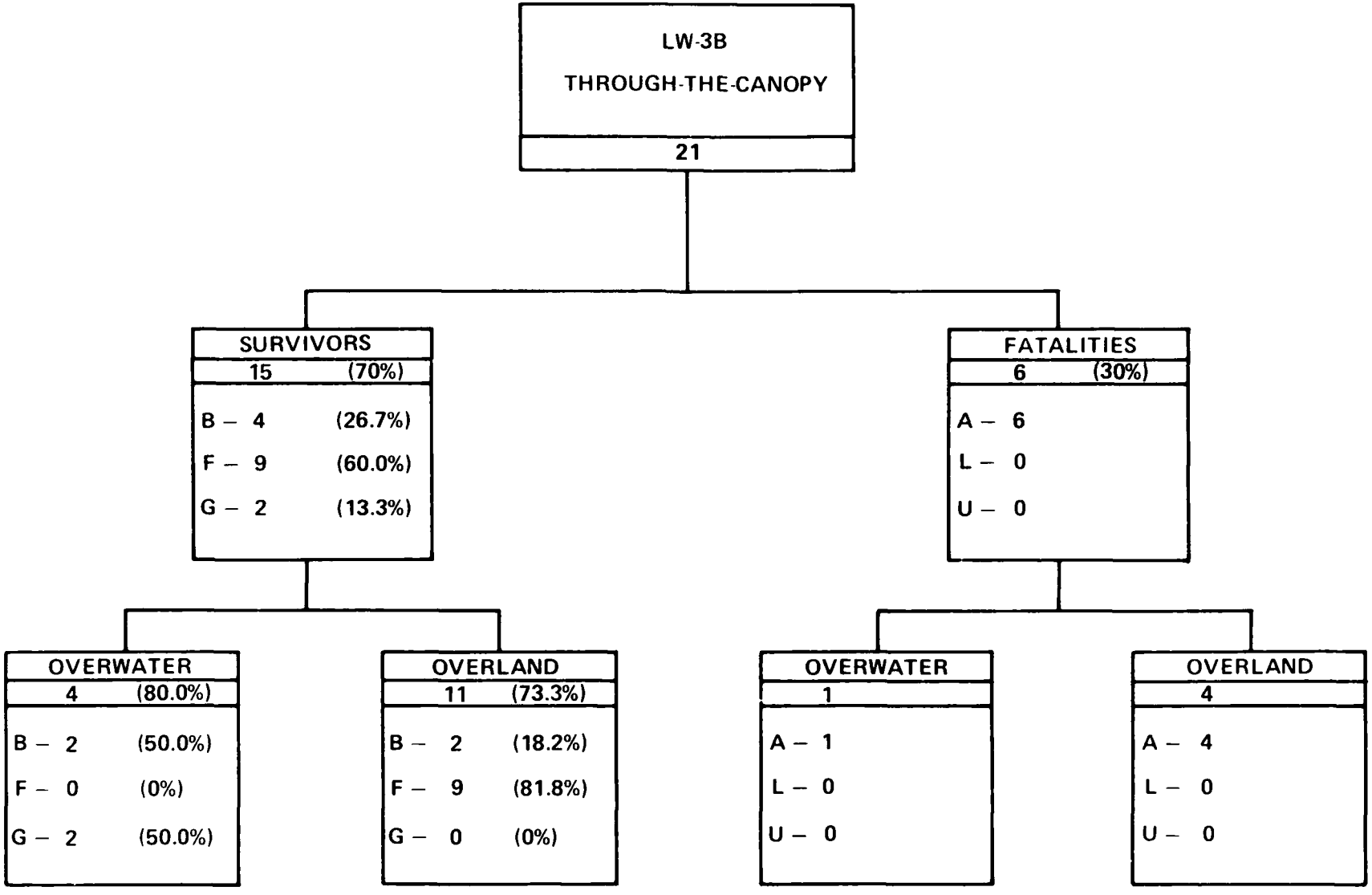

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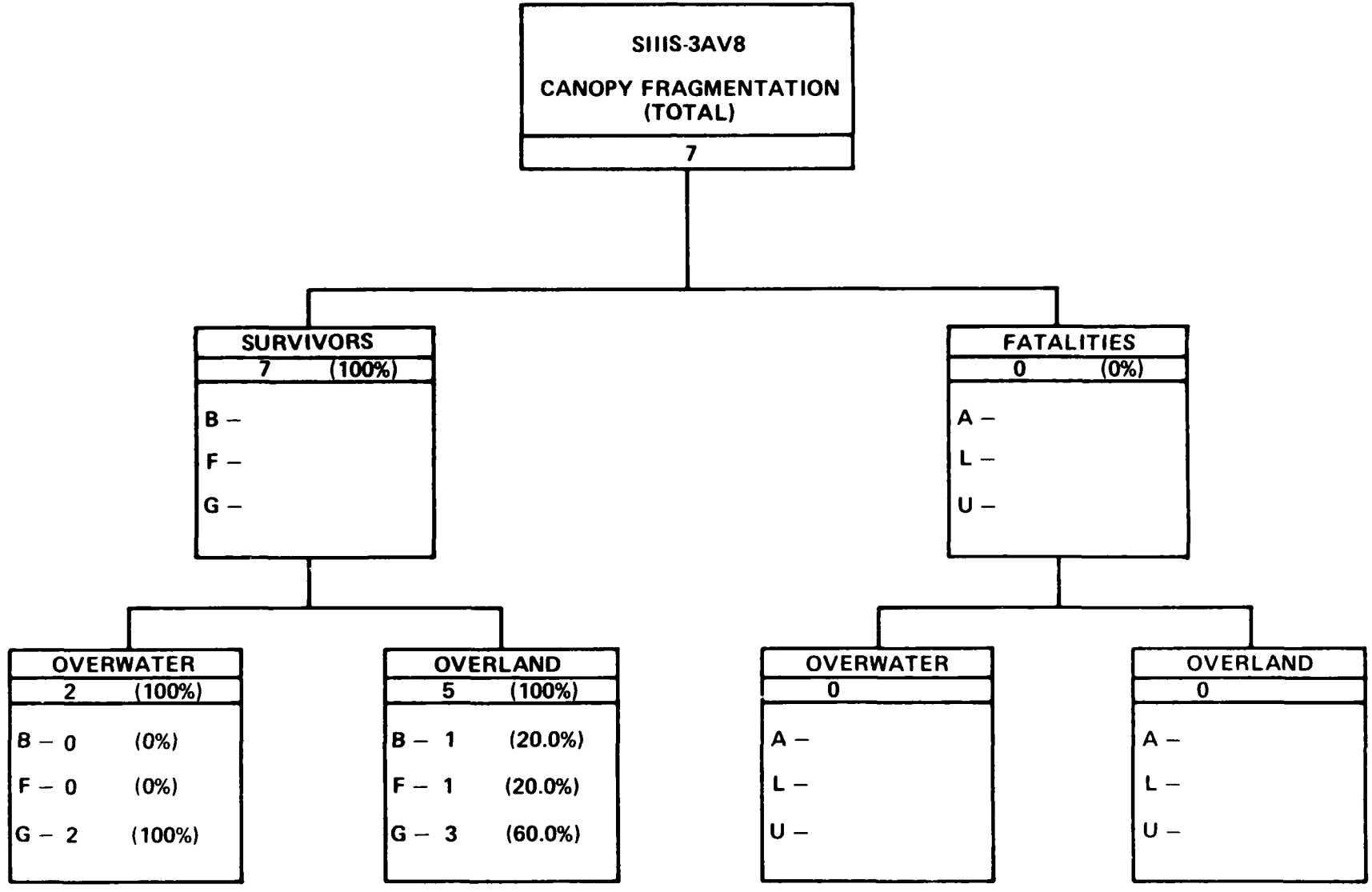
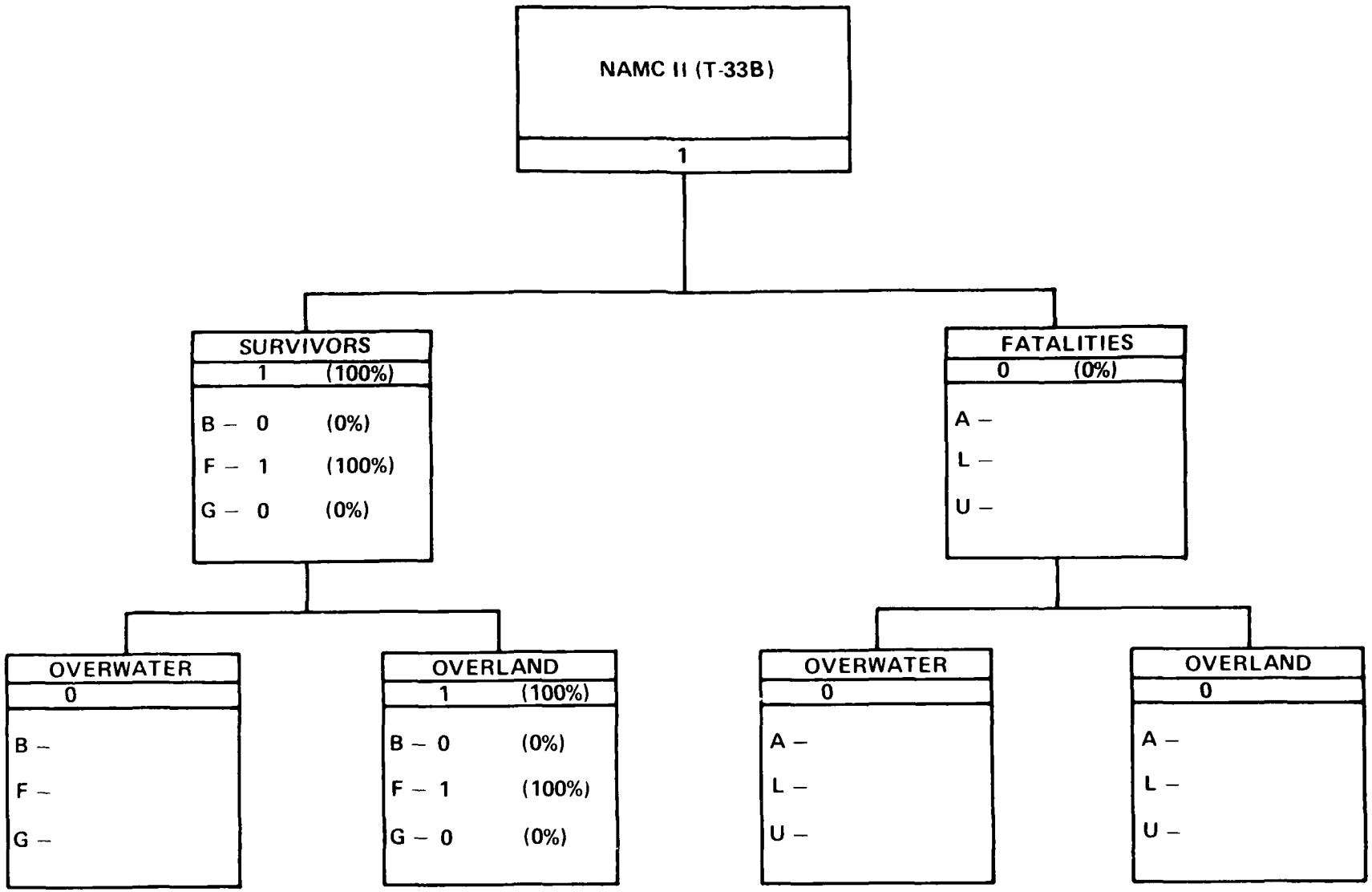
1 JANUARY 1969 THROUGH 31 DECEMBER 1979



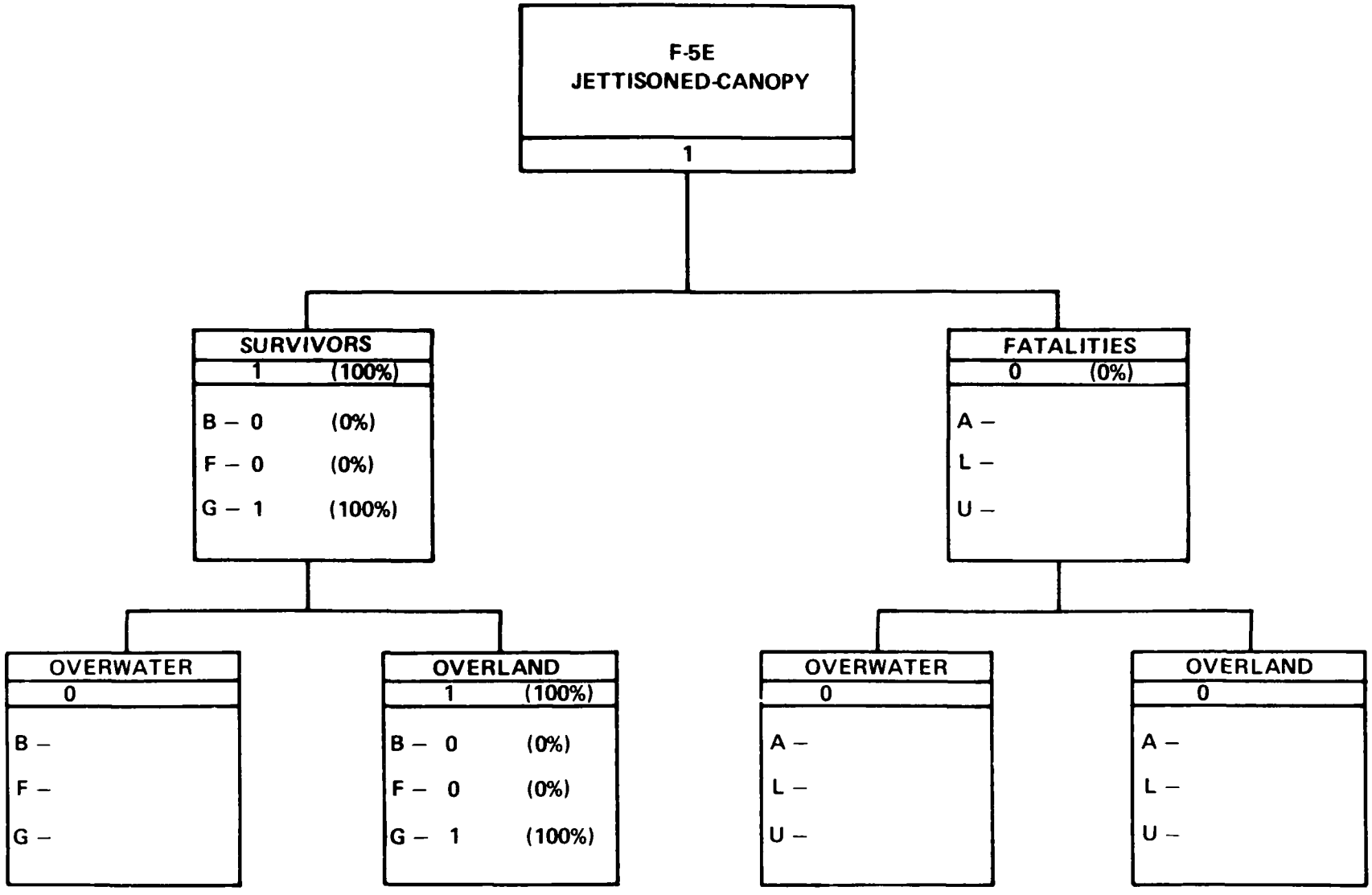
NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979



NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979



THROUGH-THE-CANOPY EJECTIONS
VS.
JETTISONED-CANOPY EJECTIONS,
CANOPY FRAGMENTATION(TOTAL) EJECTIONS,
CANOPY CUTTING(PARTIAL) EJECTIONS

U.S. NAVY FATALITIES
EJECTIONS ACCOMPLISHED CLEAR OF AIRCRAFT
AND
INADVERTENT EJECTIONS
(1 JAN 1969 - 31 DEC 1979)

	OVERWATER			OVERLAND			ALL		
TYPE EJECTION	EJECTEES	FATALITIES (A/L,U)	(RATE)	EJECTEES	FATALITIES (A/L,U)	(RATE)	EJECTEES	FATALITIES (A/L,U)	(RATE)
JETTISONED CANOPY	524	22/44	12.6%	560	74/3	13.8%	1084	96/47	13.2%
THROUGH-THE-CANOPY	109	11/16	24.8%	128	30/1	24.2%	237	41/17	24.5%
CANOPY FRAGMENTATION (TOTAL)	3	0/0	0%	12	1/0	8.3%	15	1/0	6.7%
CANOPY CUTTING (PARTIAL)	0	—	—	1	0/0	0%	1	0/0	0%
TOTALS	636	33/60	14.6%	701	105/4	15.5%	1,337	138/64	15.1%

U.S. NAVY MAJOR INJURIES
EJECTIONS ACCOMPLISHED CLEAR OF AIRCRAFT
AND
INADVERTENT EJECTIONS
(1 JAN 1969 - 31 DEC 1979)

	OVERWATER			OVERLAND			ALL		
TYPE EJECTION	EJECTEES	MAJOR INJURIES	(RATE)	EJECTEES	MAJOR INJURIES	(RATE)	EJECTEES	MAJOR INJURIES	(RATE)
JETTISONED CANOPY	524	39	7.4%	560	97	17.3%	1084	136	12.5%
THROUGH-THE-CANOPY	109	19	17.4%	128	28	21.9%	237	47	19.8%
CANOPY FRAGMENTATION (TOTAL)	3	0	0%	12	4	25.0%	15	4	26.7%
CANOPY CUTTING (PARTIAL)	0	–	–	1	0	0%	1	0	0%
TOTALS	637	58	9.1%	701	129	18.4%	1,337	187	14.0%

U.S. NAVY
EJECTIONS ACCOMPLISHED CLEAR OF AIRCRAFT
AND
INADVERTENT EJECTIONS

(1 JAN 1969 - 31 DEC 1979)

JETTISONED CANOPY EJECTIONS

JETISONED CANOPY EJECTIONS

1 JAN 69 - 31 DEC 79

	OVERWATER			OVERLAND		
TYPE EJECTION SEAT	TOTAL EJECTEES	FATAL (A/L,U)	RATE	TOTAL EJECTEES	FATAL (A/L,U)	RATE
ESCAPAC 1	2	0/0	0%	5	0/0	0%
ESCAPAC 1A-1	34	3/1	11.8%	55	8/1	16.4%
ESCAPAC 1C-2	83	4/5	10.8%	74	9/1	13.5%
ESCAPAC 1C-3	34	1/4	14.7%	90	9/0	10.0%
SUBTOTAL	153	8/10	11.8%	224	26/2	12.5%
ESCAPAC 1E-1	0	—	—	1	1/0	100%
ESCAPAC 1F-3	11	2/0	18.2%	8	1/0	12.5%
ESCAPAC 1G-2	1	0/0	0%	0	—	—
ESCAPAC 1G-3	8	2/1	37.5%	35	0/0	0%
SUBTOTAL	20	4/1	25.0%	44	2/0	4.6%
MK A5	0	—	—	1	0/0	0%
MK F5	5	0/2	40.0%	12	2/0	16.7%
MK GRU5	4	0/0	0%	8	0/0	0%
MK GRUEA5	0	—	—	4	0/0	0%
MK H5	4	0/1	25.0%	10	0/0	0%
MK Z5	0	—	—	1	0/0	0%
SUBTOTAL	13	0/3	23.1%	36	2/0	5.6%
MK A7	0	—	—	1	0/0	0%
MK F7	44	0/2	4.5%	43	3/0	7.0%
MK GRU7A	46	2/2	8.7%	21	7/0	33.3%
MK H7	218	6/22	12.8%	130	23/1	18.5%
SUBTOTAL	308	8/26	11.0%	195	33/1	17.4%
LS-1/LS-1A	10	0/1	10.0%	45	9/0	20.0%
HS-1	11	0/3	27.3%	14	2/0	14.3%
HS-1A	9	2/0	22.2%	0	—	—
NAMC II (T-33B)	0	—	—	1	0/0	0%
F-5E	0	—	—	1	0/0	0%
SUBTOTAL	30	2/4	20.0%	61	11/0	18.0%
TOTALS	524	22/44	12.6%	560	74/3	13.8%
OVERALL TOTALS	1084	96/47	13.2%			

JETTISONED CANOPY EJECTIONS

1 JAN 69 - 31 DEC 79

	OVERWATER			OVERLAND		
TYPE EJECTION SEAT	TOTAL EJECTEES	MAJOR INJURIES	RATE	TOTAL EJECTEES	MAJOR INJURIES	RATE
ESCAPAC 1	2	0	0%	5	0	0%
ESCAPAC 1A-1	34	5	14.7%	55	7	12.7%
ESCAPAC 1C-2	83	6	7.2%	74	14	18.9%
ESCAPAC 1C-3	34	3	8.8%	90	16	17.8%
SUBTOTAL	153	14	9.2%	224	37	16.5%
ESCAPAC 1E-1	0	—	—	1*	—	—
ESCAPAC 1F-3	11	2	18.2%	8	2	25.0%
ESCAPAC 1G-2	1	0	0%	0	—	—
ESCAPAC 1G-3	8	0	0%	35	9	25.7%
SUBTOTAL	20	2	10.0%	44	11	25.0%
MK A5	0	—	—	1	0	0%
MK F5	5	0	0%	12	1	8.3%
MK GRU5	4	0	0%	8	3	37.5%
MK GRUEA5	0	—	—	4	2	50.0%
MK H5	4	0	0%	10	4	40.0%
MK Z5	0	—	—	1	0	0%
SUBTOTAL	13	0	0%	36	10	27.8%
MK A7	0	—	—	1	0	0%
MK F7	44	2	4.5%	43	3	7.0%
MK GRU7A	46	4	8.7%	21	5	23.8%
MK H7	218	13	6.0%	130	19	14.6%
SUBTOTAL	308	19	6.2%	195	27	13.8%
LS-1/LS-1A	10	2	20.0%	45	8	17.8%
HS-1	11	0	0%	14	4	28.6%
HS-1A	9	2	22.2%	0	—	—
NAMC II (T-33B)	0	—	—	1	0	0%
F-5E	0	—	—	1	0	0%
SUBTOTAL	30	4	13.3%	61	12	19.7%
TOTALS	524	39	7.4%	560	97	17.3%
OVERALL TOTALS	1084	136	12.5%			

* 100% FATAL

JETTISONED CANOPY EJECTIONS

1 JAN 69 - 31 DEC 79

	OVERWATER			OVERLAND		
TYPE EJECTION SEAT	TOTAL EJECTEES	MINOR INJURIES	RATE	TOTAL EJECTEES	MINOR INJURIES	RATE
ESCAPAC 1	2	2	100%	5	2	40.0%
ESCAPAC 1A-1	34	12	35.3%	55	14	25.5%
ESCAPAC 1C-2	83	13	15.7%	74	19	25.7%
ESCAPAC 1C-3	34	12	35.3%	90	16	17.8%
SUBTOTAL	153	39	25.5%	224	51	22.8%
ESCAPAC 1E-1	0	—	—	1*	—	—
ESCAPAC 1F-3	11	3	27.3%	8	1	12.5%
ESCAPAC 1G-2	1	1	100%	0	—	—
ESCAPAC 1G-3	8	1	12.5%	35	6	17.1%
SUBTOTAL	20	5	25%	44	7	15.9%
MK A5	0	—	—	1	1	100%
MK F5	5	0	0%	12	5	41.7%
MK GRU5	4	2	50.0%	8	1	12.5%
MK GRUEA5	0	—	—	4	1	25.0%
MK H5	4	2	50.0%	10	3	30.0%
MK Z5	0	—	—	1	0	0%
SUBTOTAL	13	4	30.8%	36	11	30.6%
MK A7	0	—	—	1	1	100%
MK F7	44	5	11.4%	43	11	25.6%
MK GRU7A	46	9	19.6%	21	3	14.3%
MK H7	218	49	22.5%	130	27	20.8%
SUBTOTAL	308	63	20.5%	195	42	21.5%
LS-1/LS-1A	10	0	0%	45	7	15.6%
HS-1	11	4	36.4%	14	6	42.9%
HS-1A	9	3	33.3%	0	—	—
NAMC II(T-33B)	0	—	—	1	1	100%
F-5E	0	—	—	1	0	0%
SUBTOTAL	30	7	23.3%	61	14	23.0%
TOTALS	524	118	22.5%	560	115	20.5%
OVERALL TOTALS	1084	233	21.5%			

* 100% FATAL

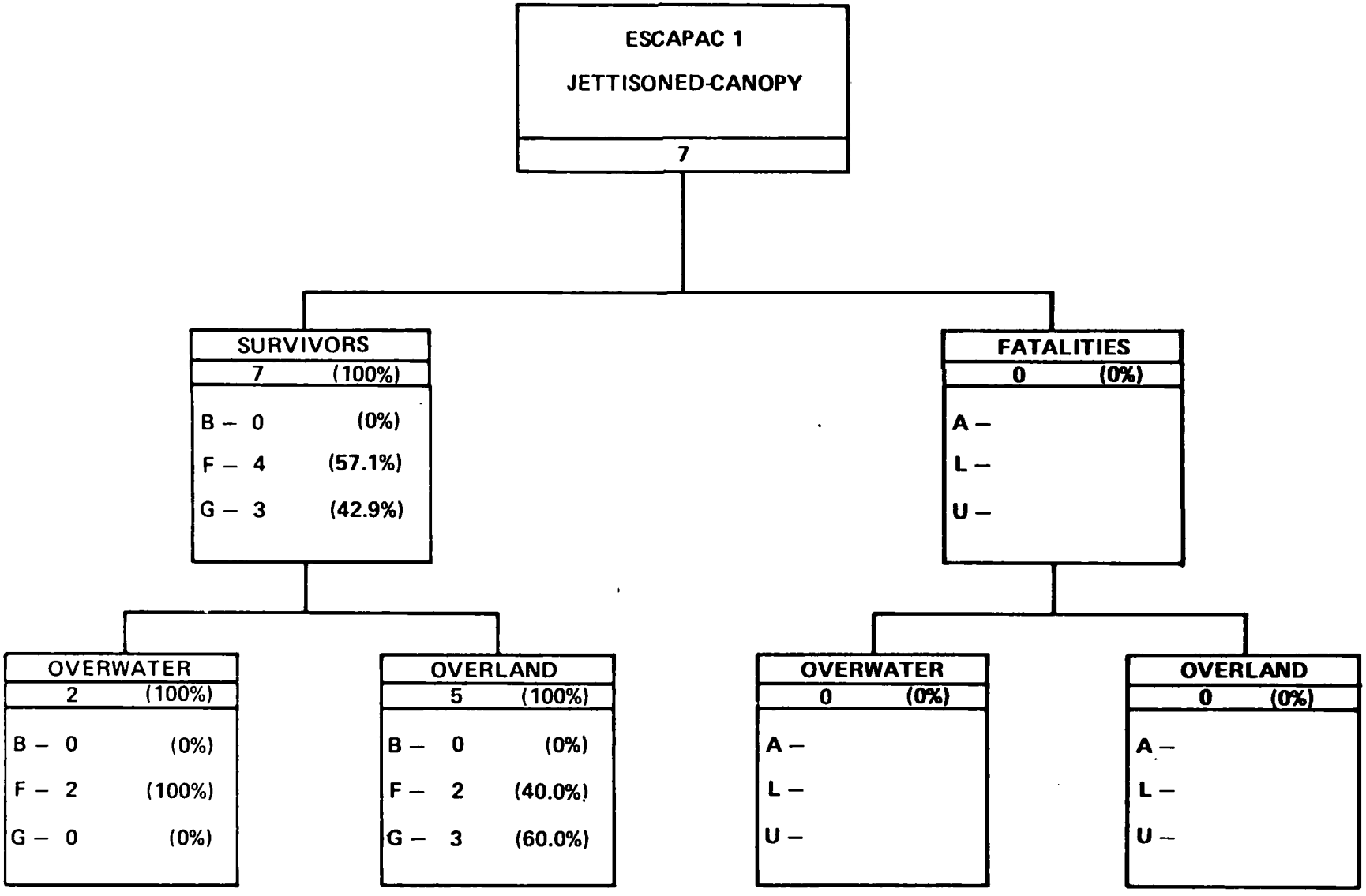
JETTISONED CANOPY EJECTIONS

1 JAN 69 - 31 DEC 79

TYPE EJECTION SEAT	OVERWATER					OVERLAND				
	TOTAL EJECTEES	RATES (%)				TOTAL EJECTEES	RATES (%)			
		A/L,U	B	F	G		A/L,U	B	F	G
ESCAPAC 1	2	0	0	100	—	5	0	0	40.0	60.0
ESCAPAC 1A-1	34	11.8	14.7	35.3	38.2	55	16.4	12.7	25.5	45.4
ESCAPAC 1C-2	83	10.8	7.2	15.7	66.3	74	13.5	18.9	25.7	41.9
ESCAPAC 1C-3	34	14.7	8.8	35.3	41.2	90	10.0	17.8	17.8	54.4
SUBTOTAL	153	11.8	9.2	25.5	53.5	224	12.1	16.5	22.8	48.6
ESCAPAC 1E-1	0	—	—	—	—	1	100	—	—	—
ESCAPAC 1F-3	11	18.2	18.2	27.3	36.3	8	12.5	25.0	12.5	25.0
ESCAPAC 1G-2	1	0	0	100	—	0	—	—	—	—
ESCAPAC 1G-3	8	37.5	0	12.5	50.0	35	0	25.7	17.1	51.2
SUBTOTAL	20	25.0	10.0	25.0	40.0	44	4.6	25.0	15.9	54.5
MK A5	0	—	—	—	—	1	0	0	100	—
MK F5	5	40.0	0	0	60.0	12	16.7	8.3	41.7	33.3
MK GRU5	4	0	0	50.0	50.0	8	0	37.5	12.5	50.0
MK GRUEA5	0	—	—	—	—	4	0	50.0	25.0	25.0
MK H5	4	25.0	0	50.0	25.0	10	0	40.0	30.0	30.0
MK Z5	0	—	—	—	—	1	0	0	0	100
SUBTOTAL	13	23.1	0	30.8	46.1	36	5.6	27.8	30.6	36.0
MK A7	0	—	—	—	—	1	0	0	100	—
MK F7	44	4.5	4.5	11.4	79.6	43	7.0	7.0	25.6	60.4
MK GRU7A	46	8.7	8.7	19.6	63.0	21	33.3	23.8	14.3	28.6
MK H7	218	12.8	6.0	22.5	58.7	130	18.5	14.6	20.8	46.1
SUBTOTAL	308	11.0	6.2	20.5	62.3	195	17.4	13.8	21.5	47.3
LS-1/LS-1A	10	10.0	20.0	0	70.0	45	20.0	17.8	15.6	48.6
HS-1	11	27.3	0	36.4	66.3	14	14.3	28.6	42.9	14.2
HS-1A	9	22.2	22.2	33.3	22.3	0	—	—	—	—
NAMC II (T-33B)	0	—	—	—	—	1	0	0	100	—
F-5E	0	—	—	—	—	1	0	0	0	100
SUBTOTAL	30	20.0	13.3	23.3	43.4	61	18.0	19.7	23.0	39.3
TOTALS	524	12.6	7.4	22.5	57.5	560	13.6	17.3	20.5	48.6
OVERALL TOTALS	1084	13.1	12.5%	21.5	52.9					

NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979



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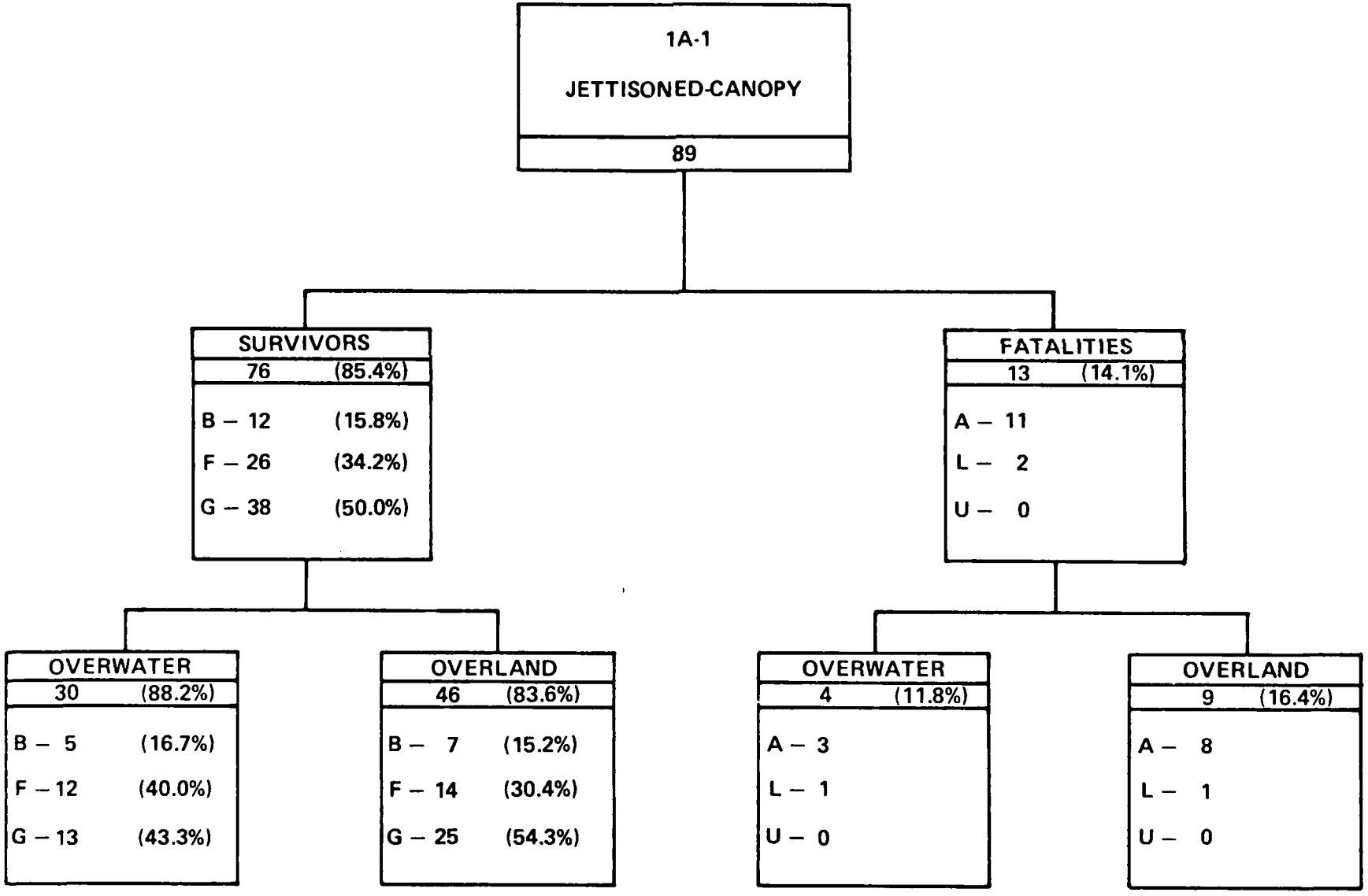
1 JANUARY 1969 THROUGH 31 DECEMBER 1979



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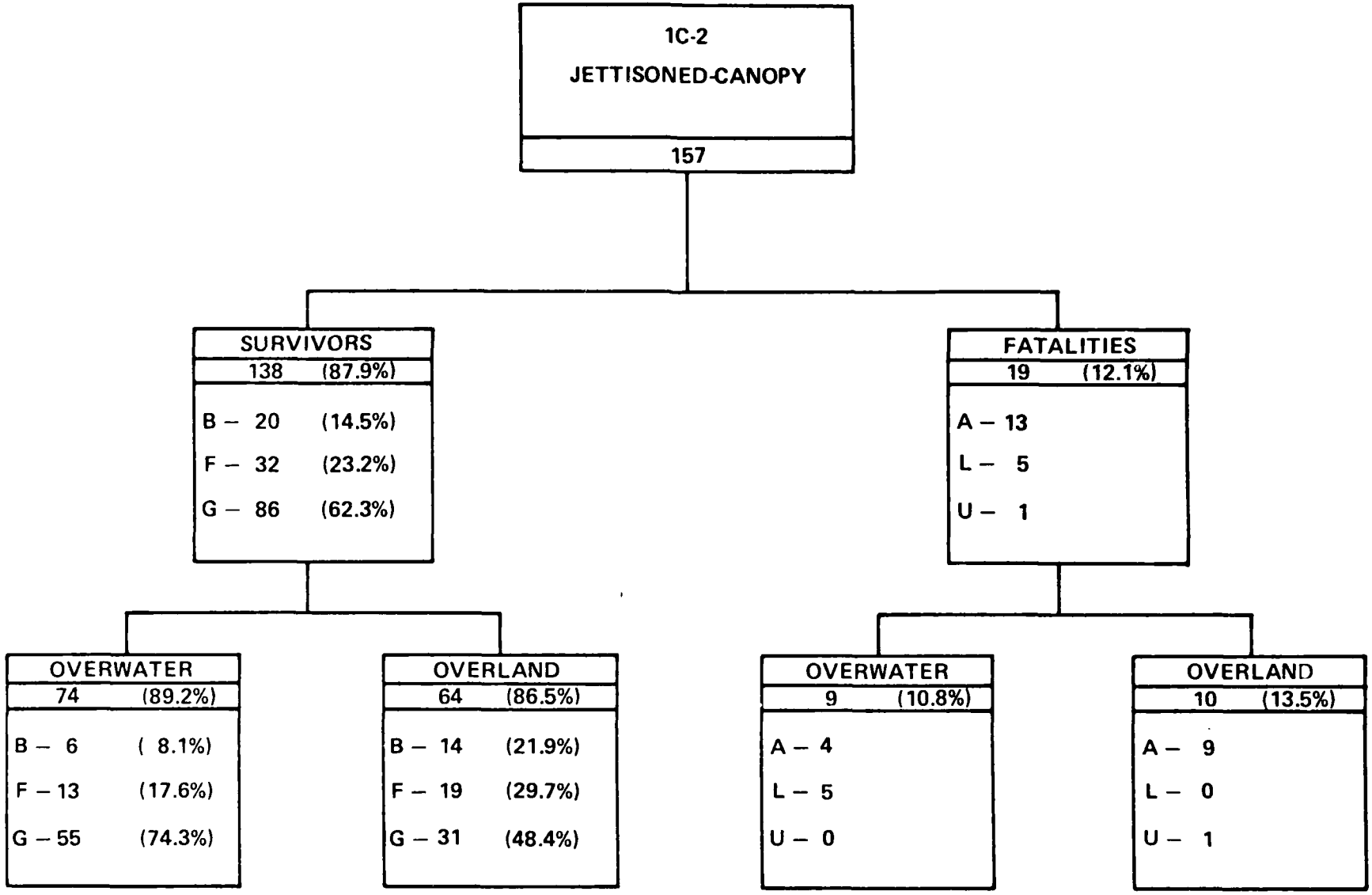

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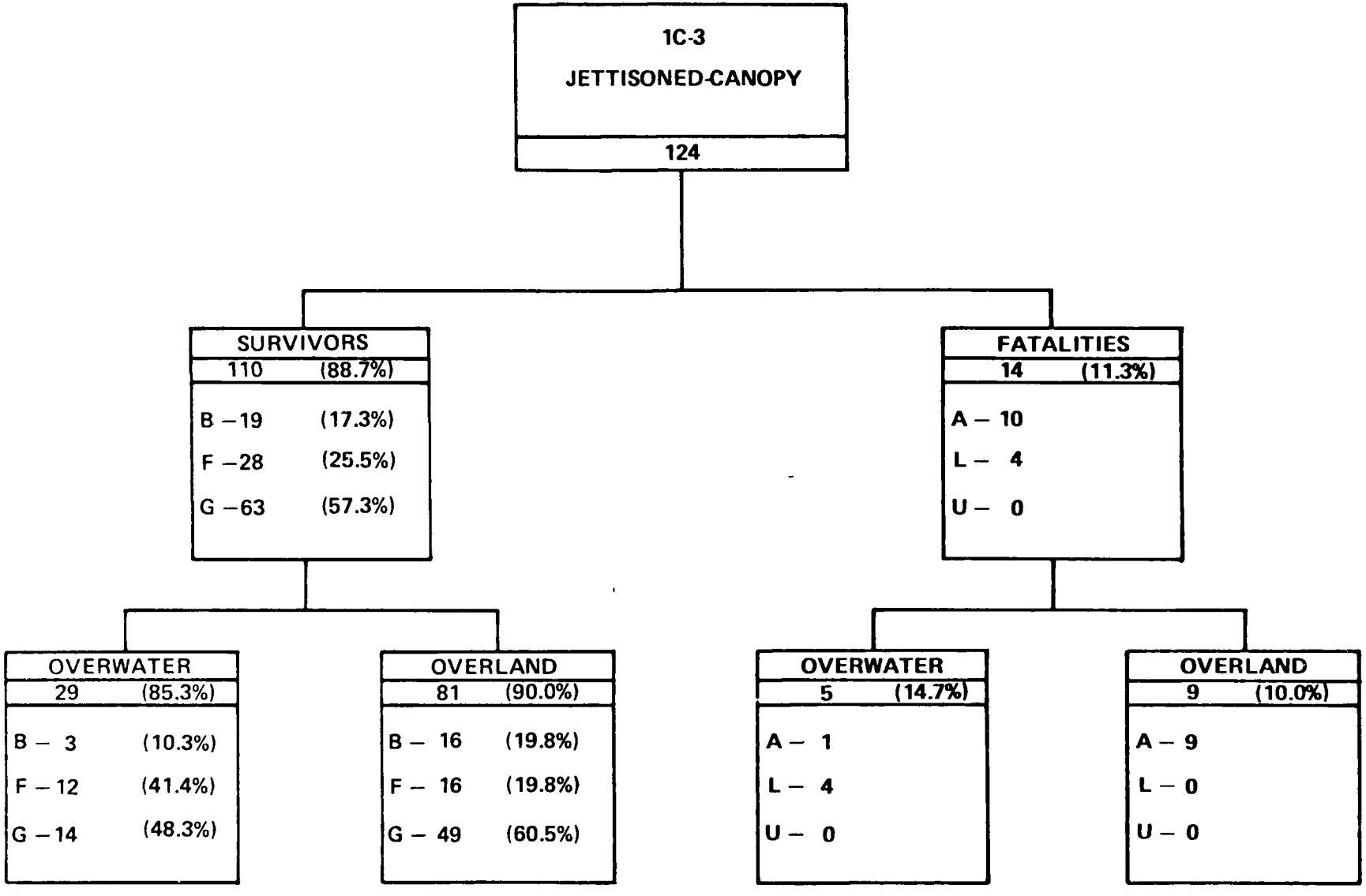

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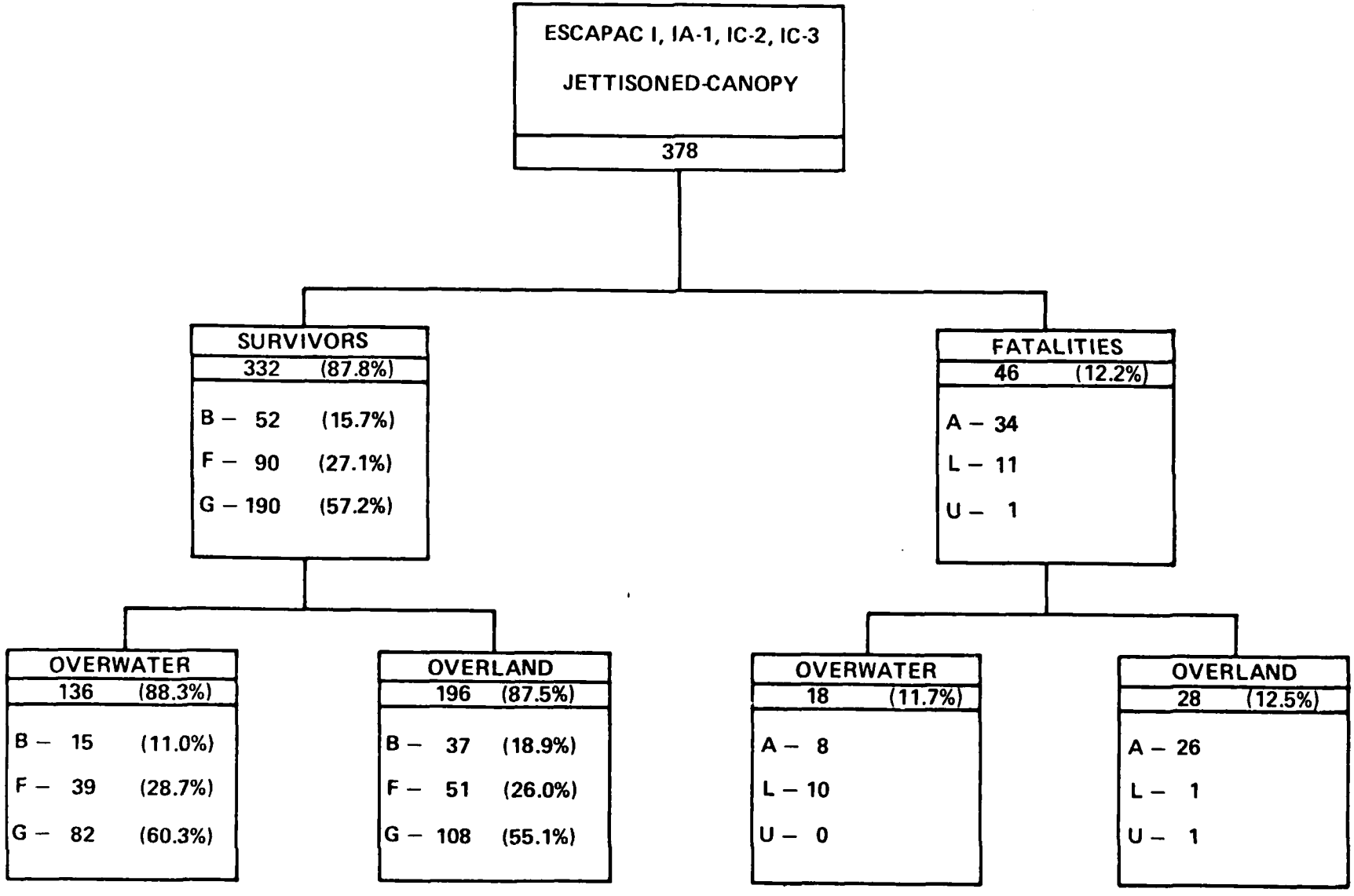

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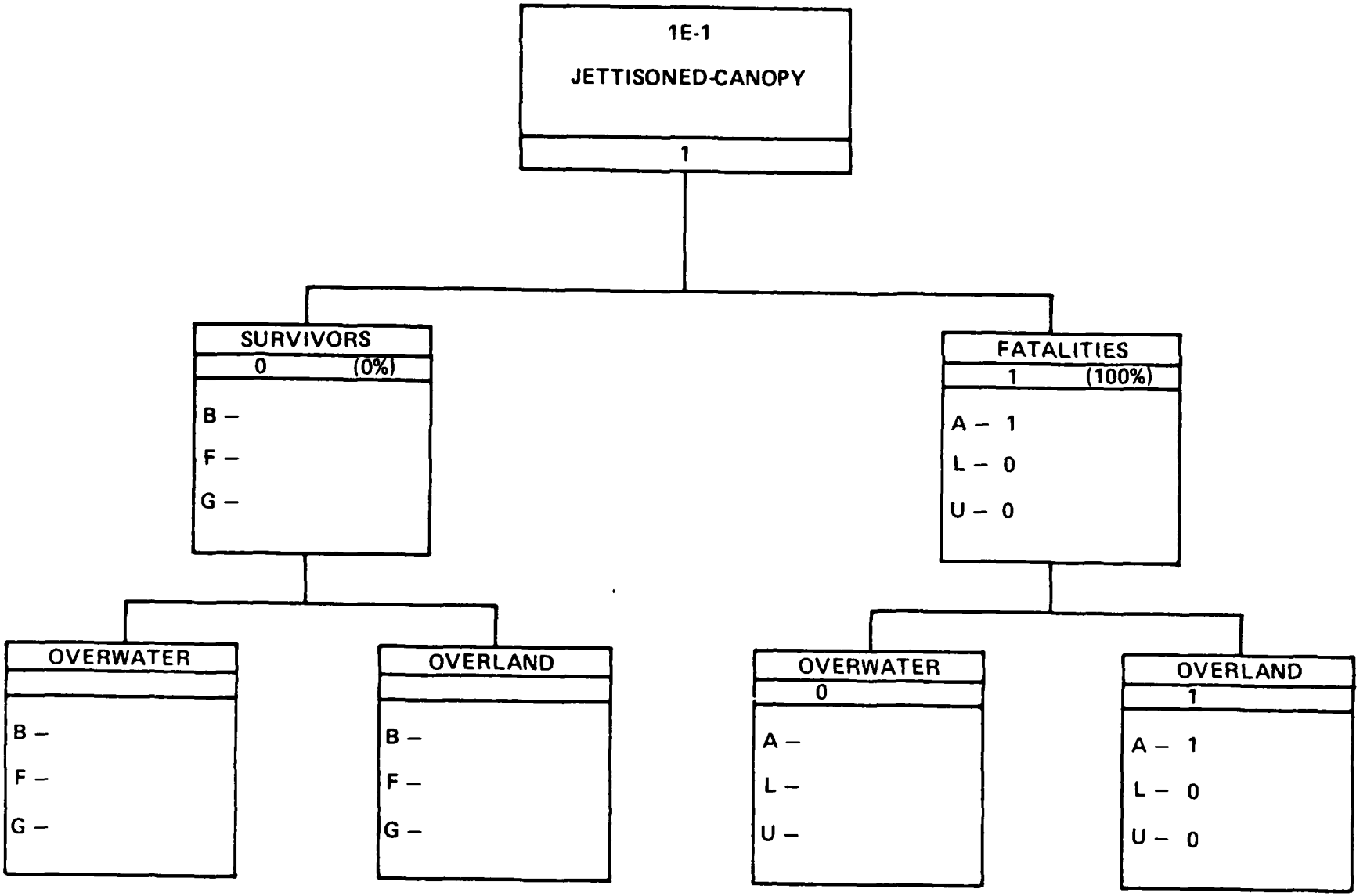
1 JANUARY 1969 THROUGH 31 DECEMBER 1979



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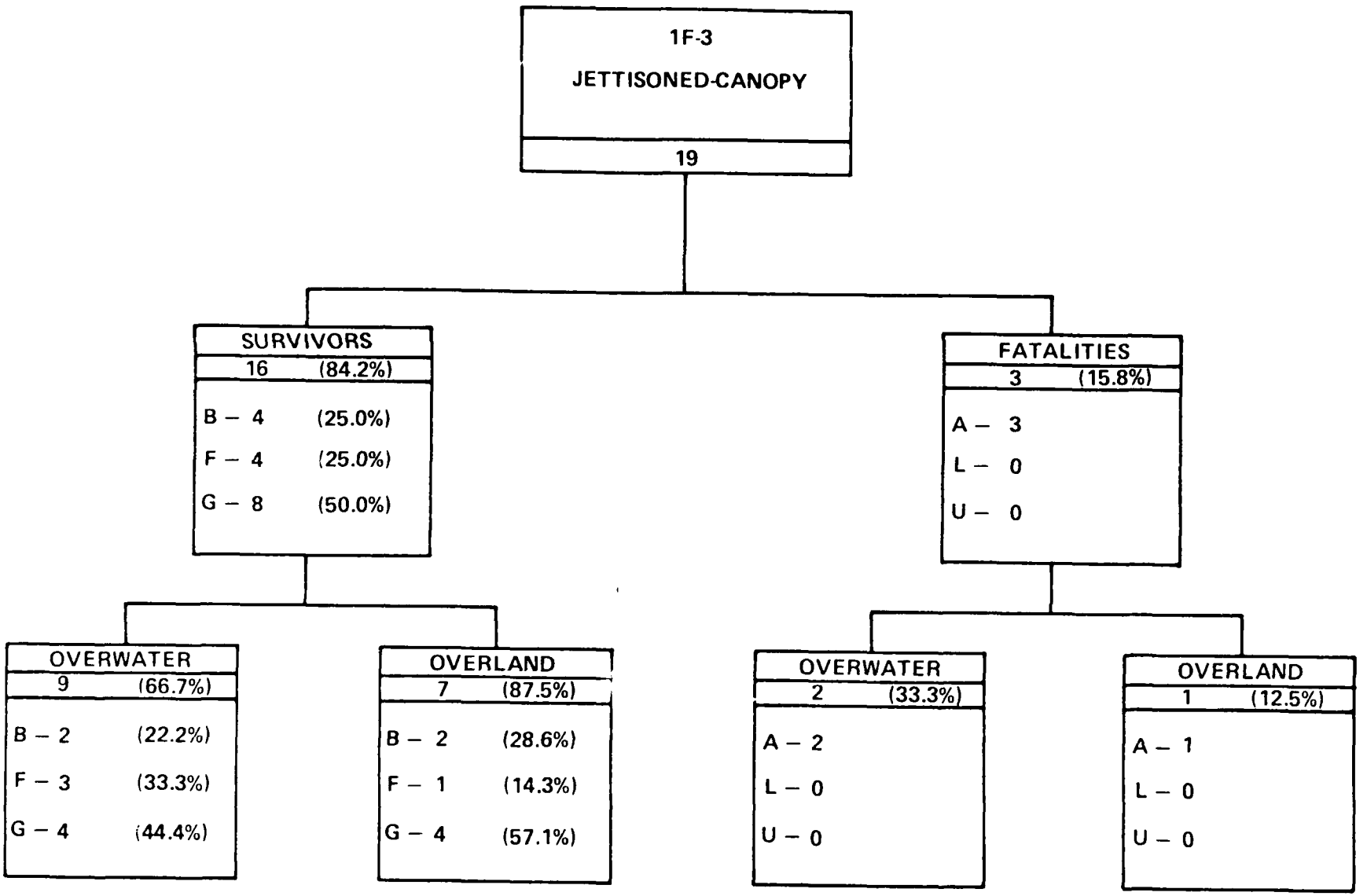
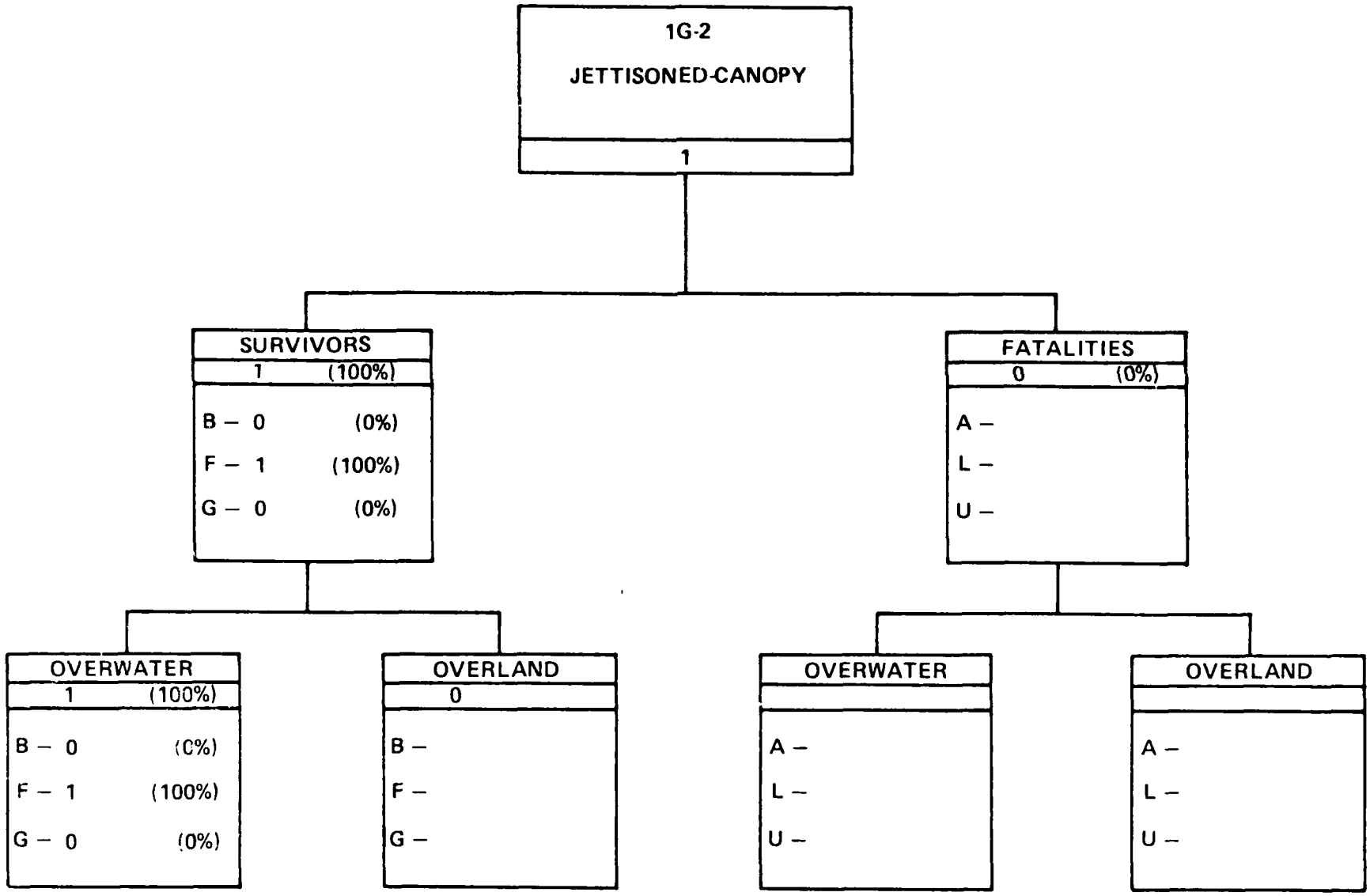
1 JANUARY 1969 THROUGH 31 DECEMBER 1979



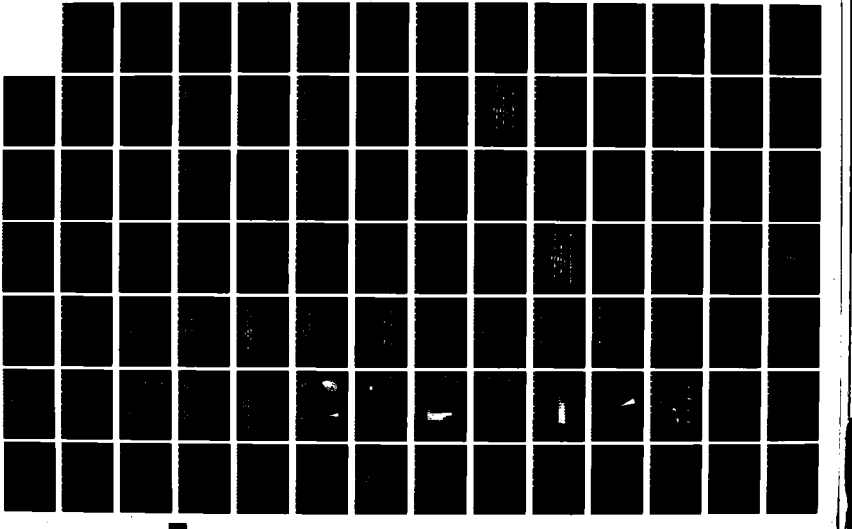
NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

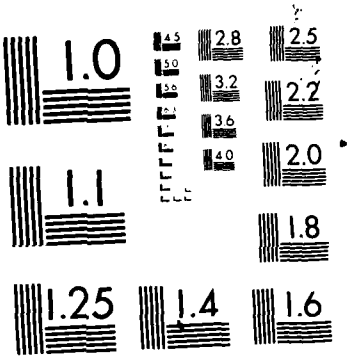
1 JANUARY 1969 THROUGH 31 DECEMBER 1979



AD-A171 657 AIRCREW AUTOMATED ESCAPE SYSTEMS (AAES) DATA ANALYSIS 2/3
PROGRAM SYMPOSIUM H.. (U) NAVAL SAFETY CENTER NORFOLK VA
1981

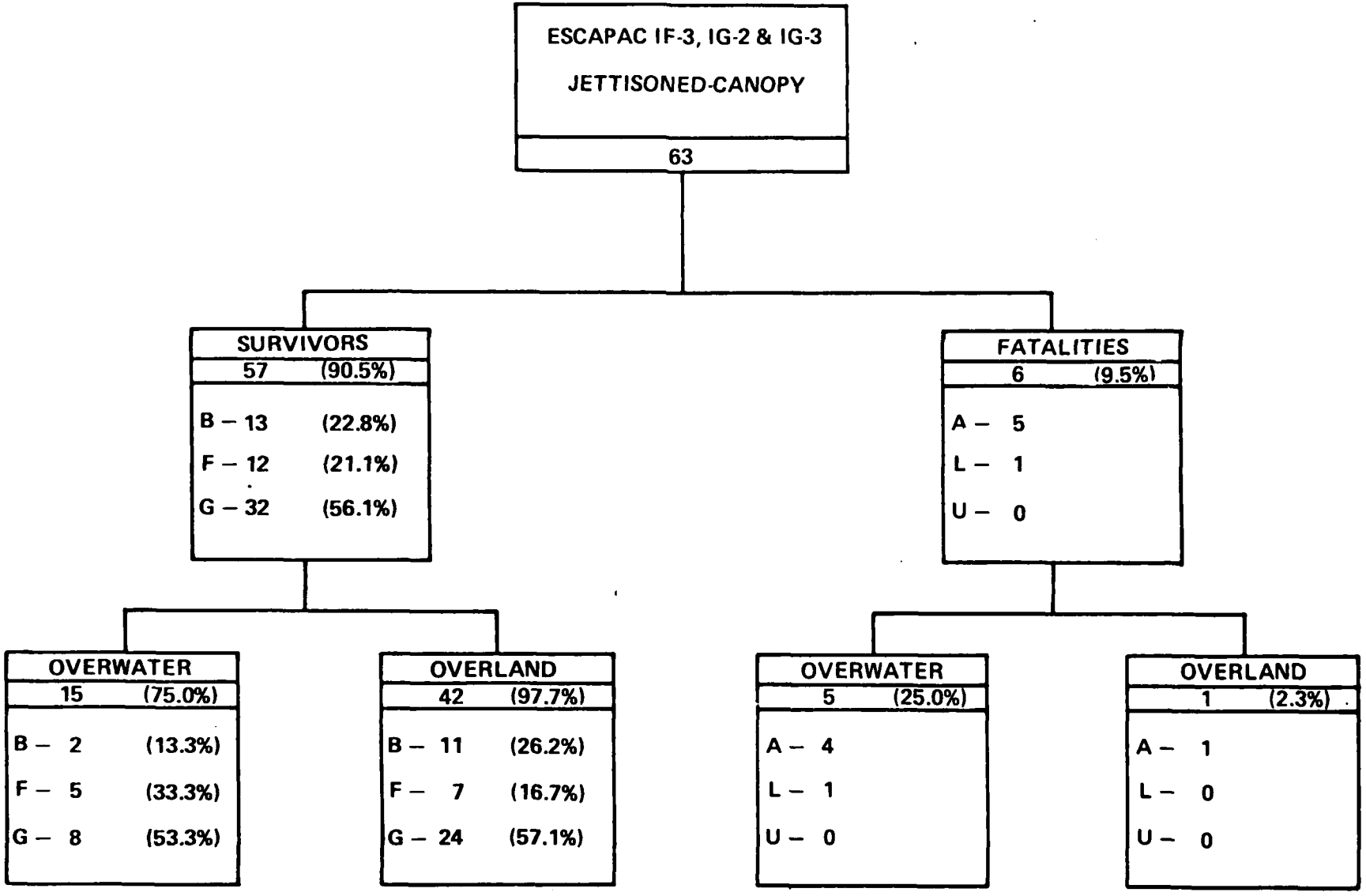
UNCLASSIFIED F/G 1/3 NL





NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979



NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

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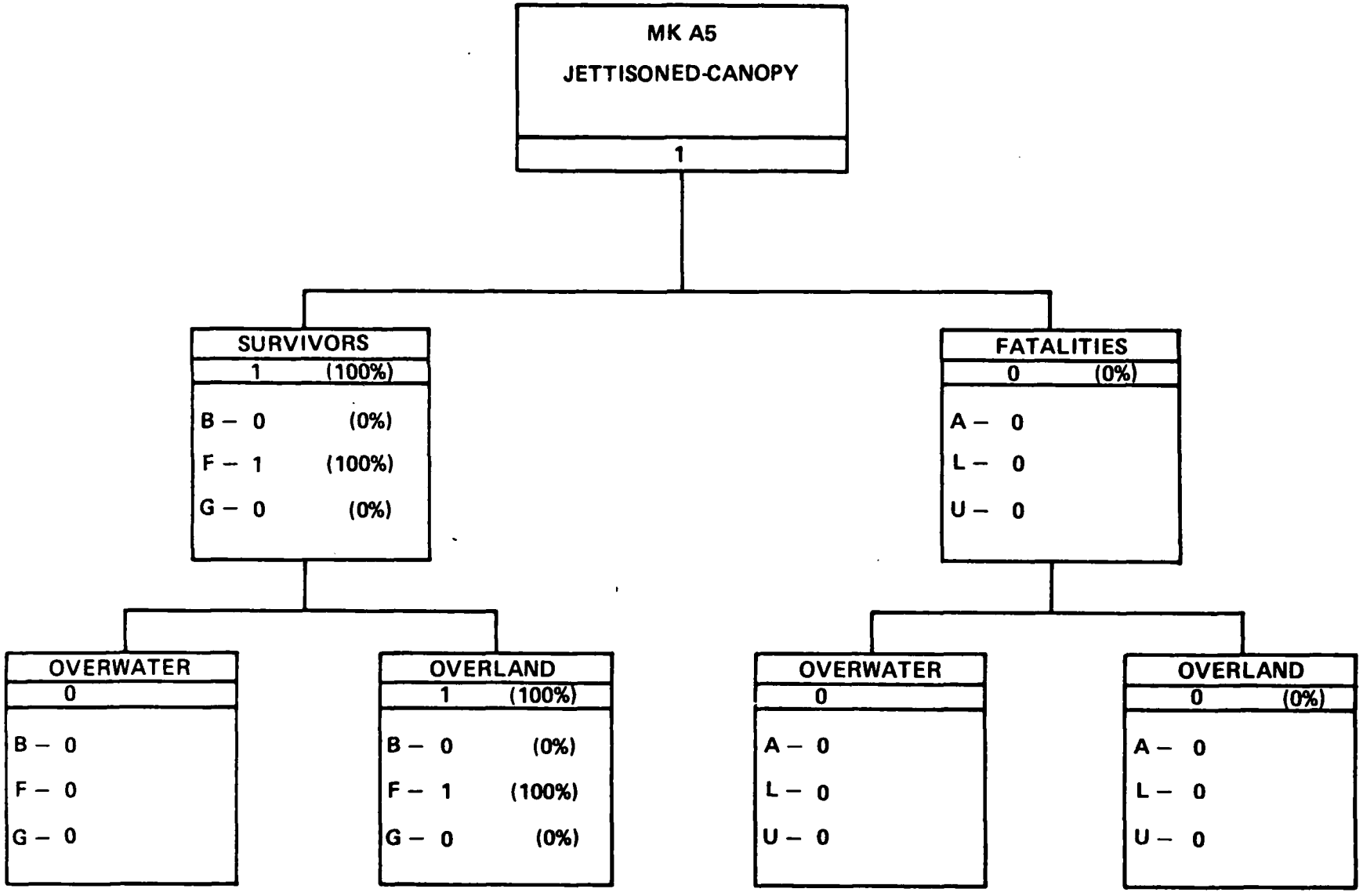

NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

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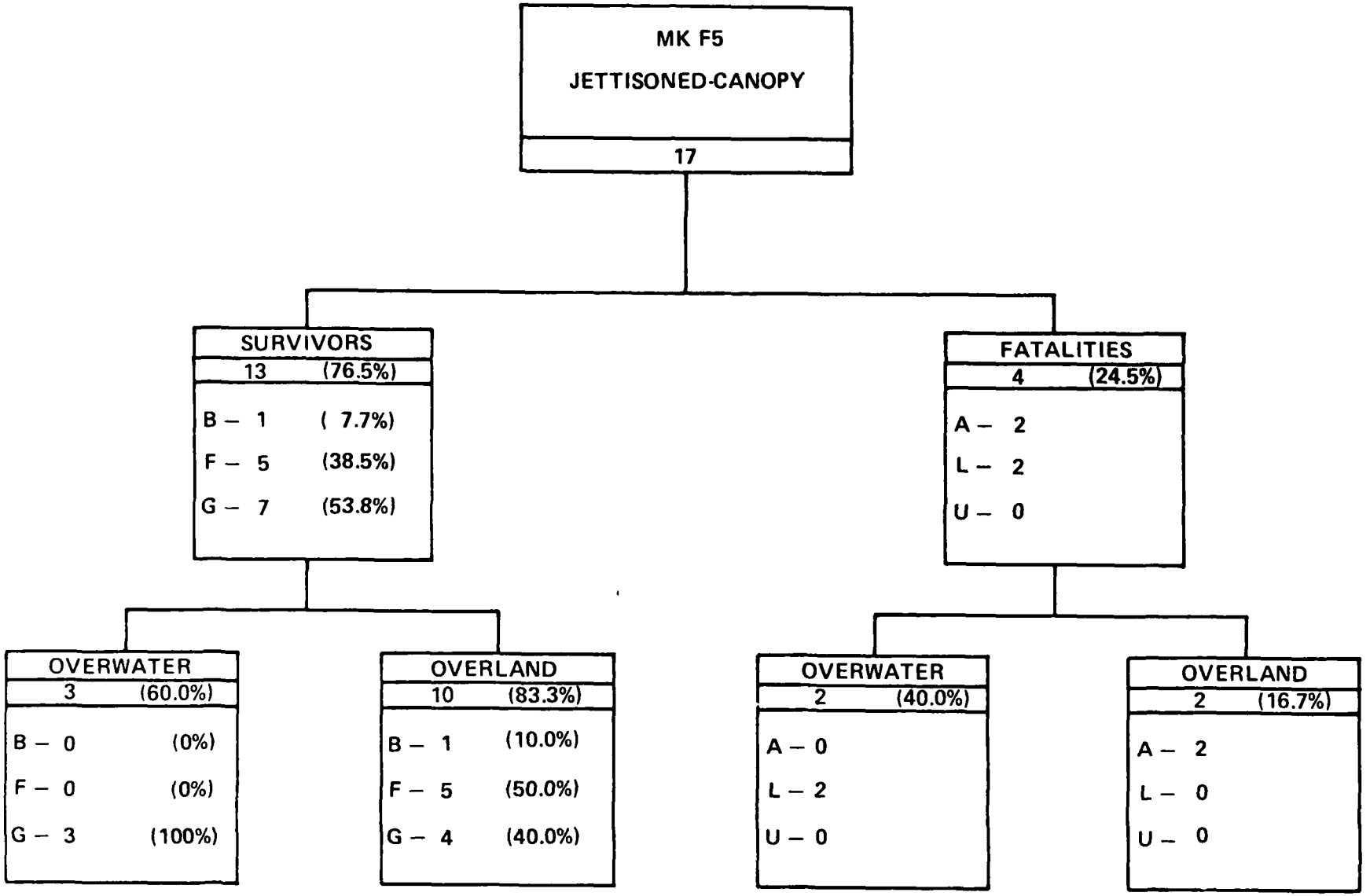

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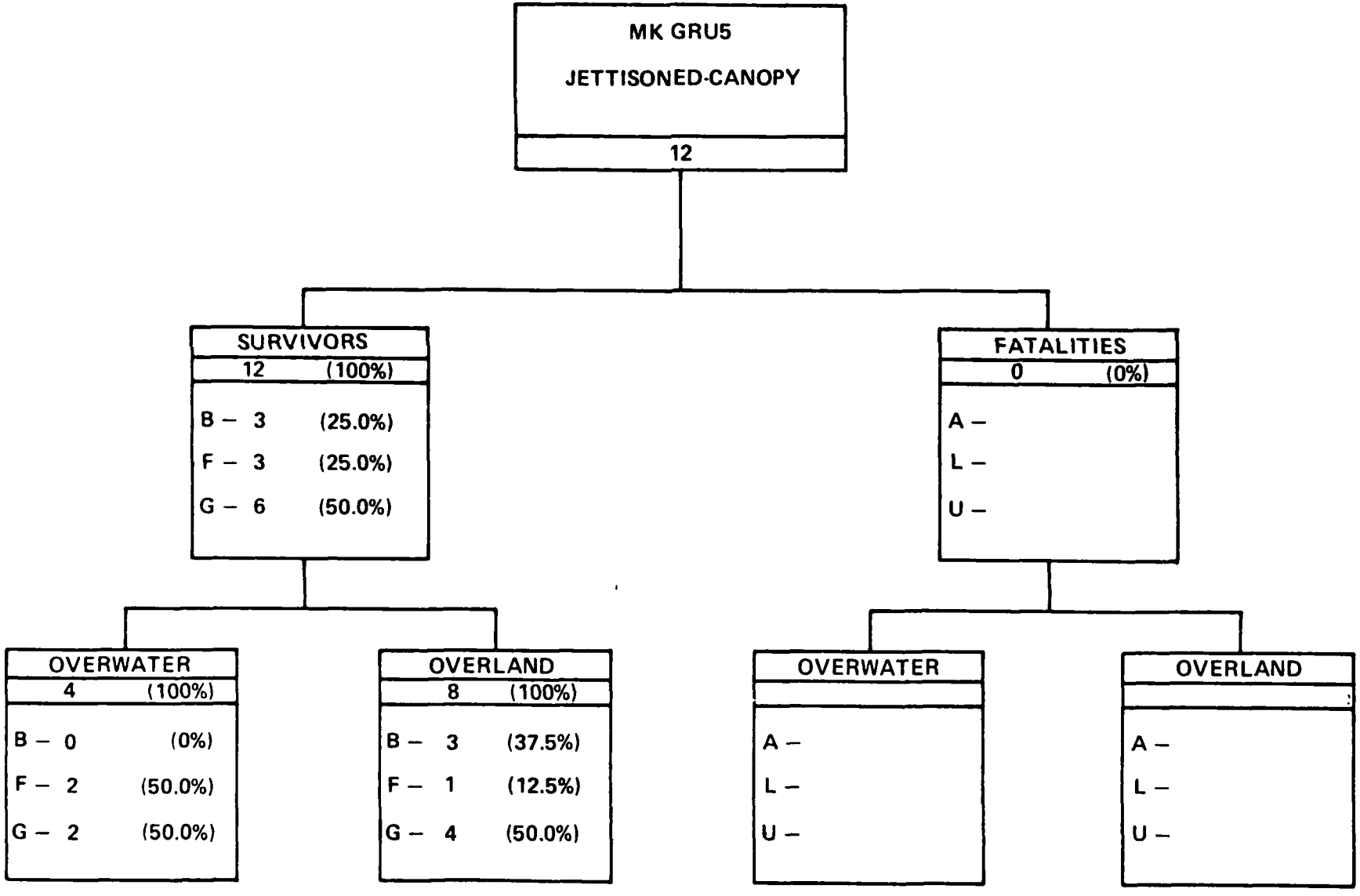

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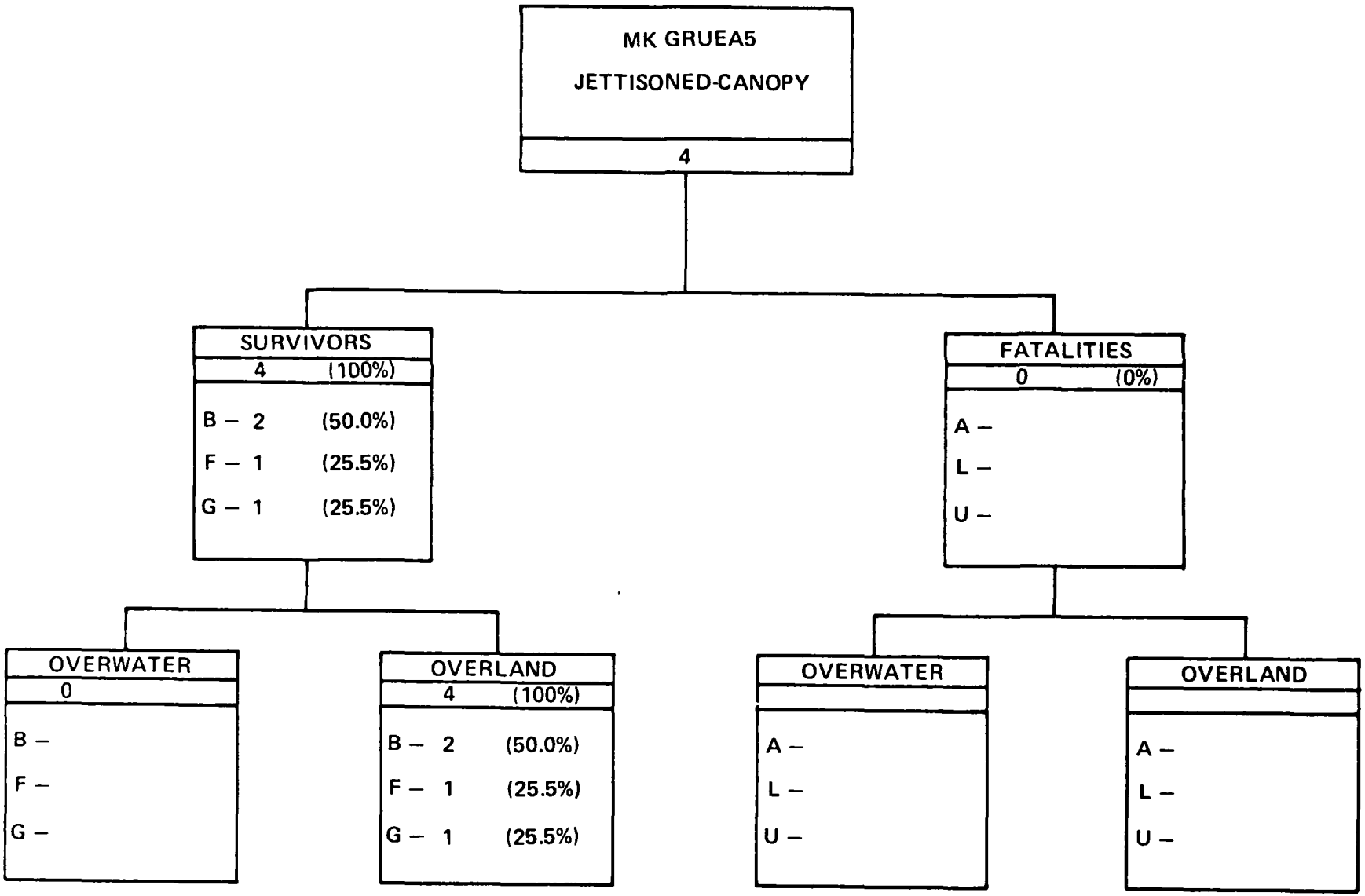

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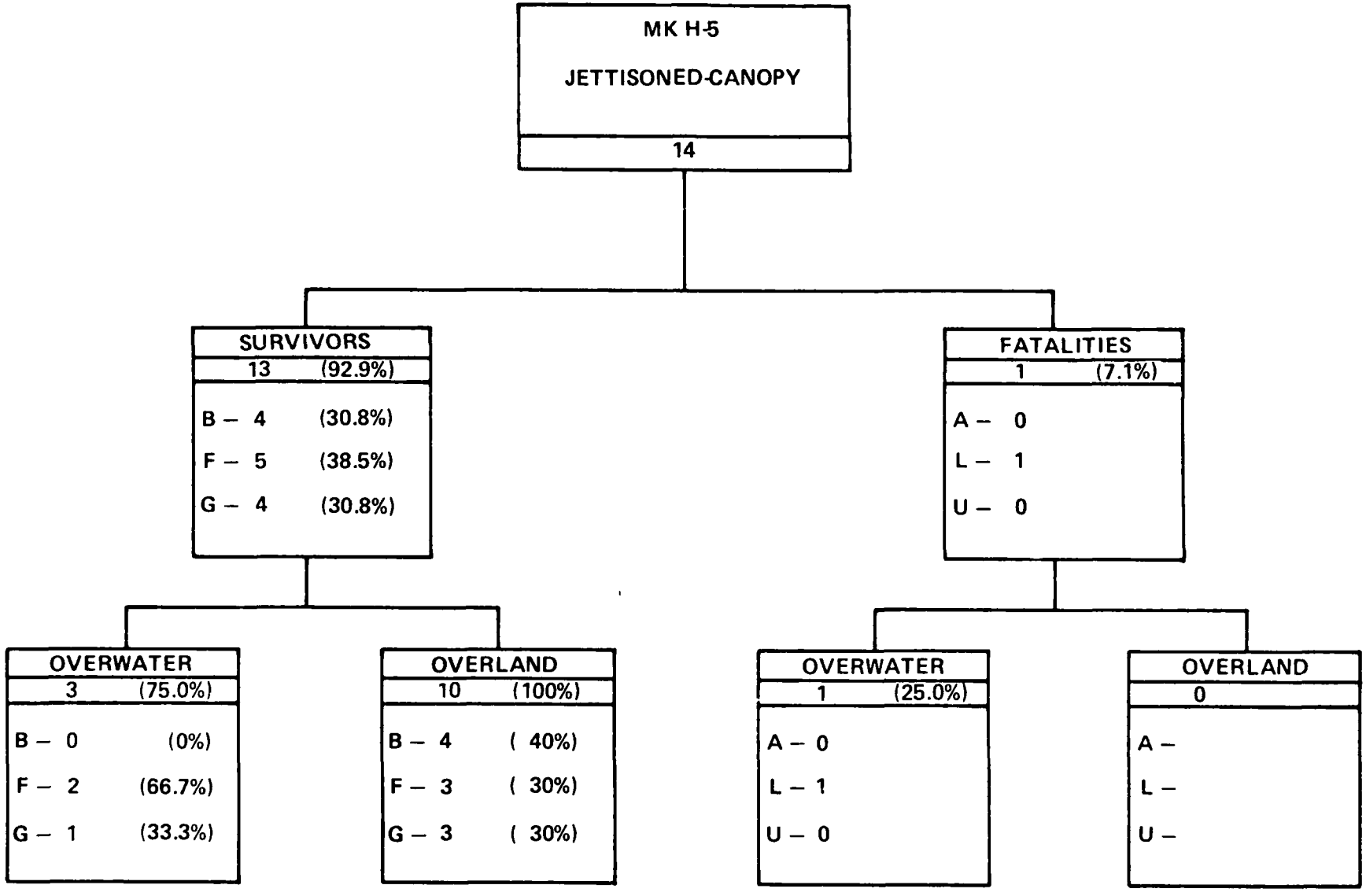

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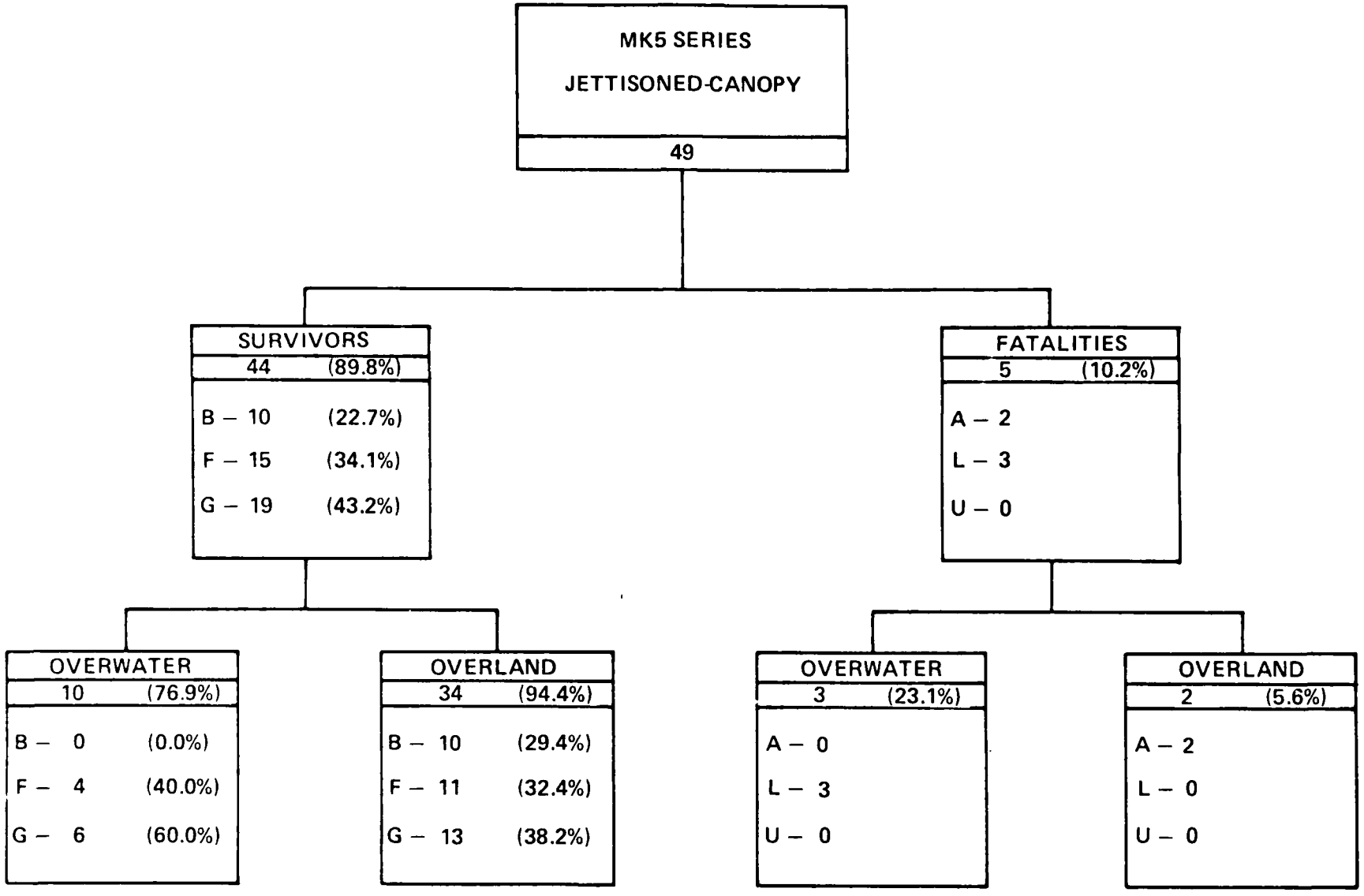
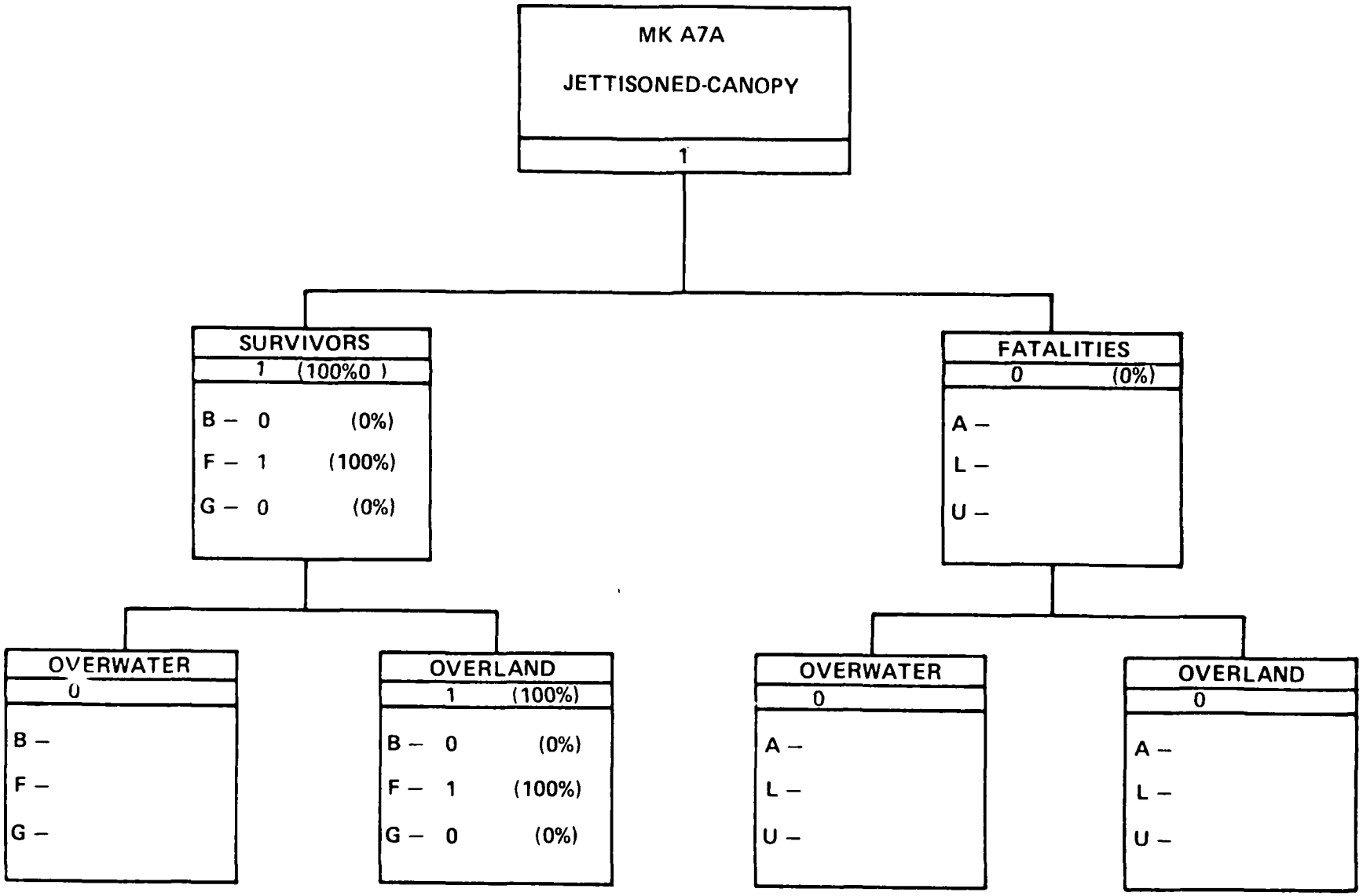


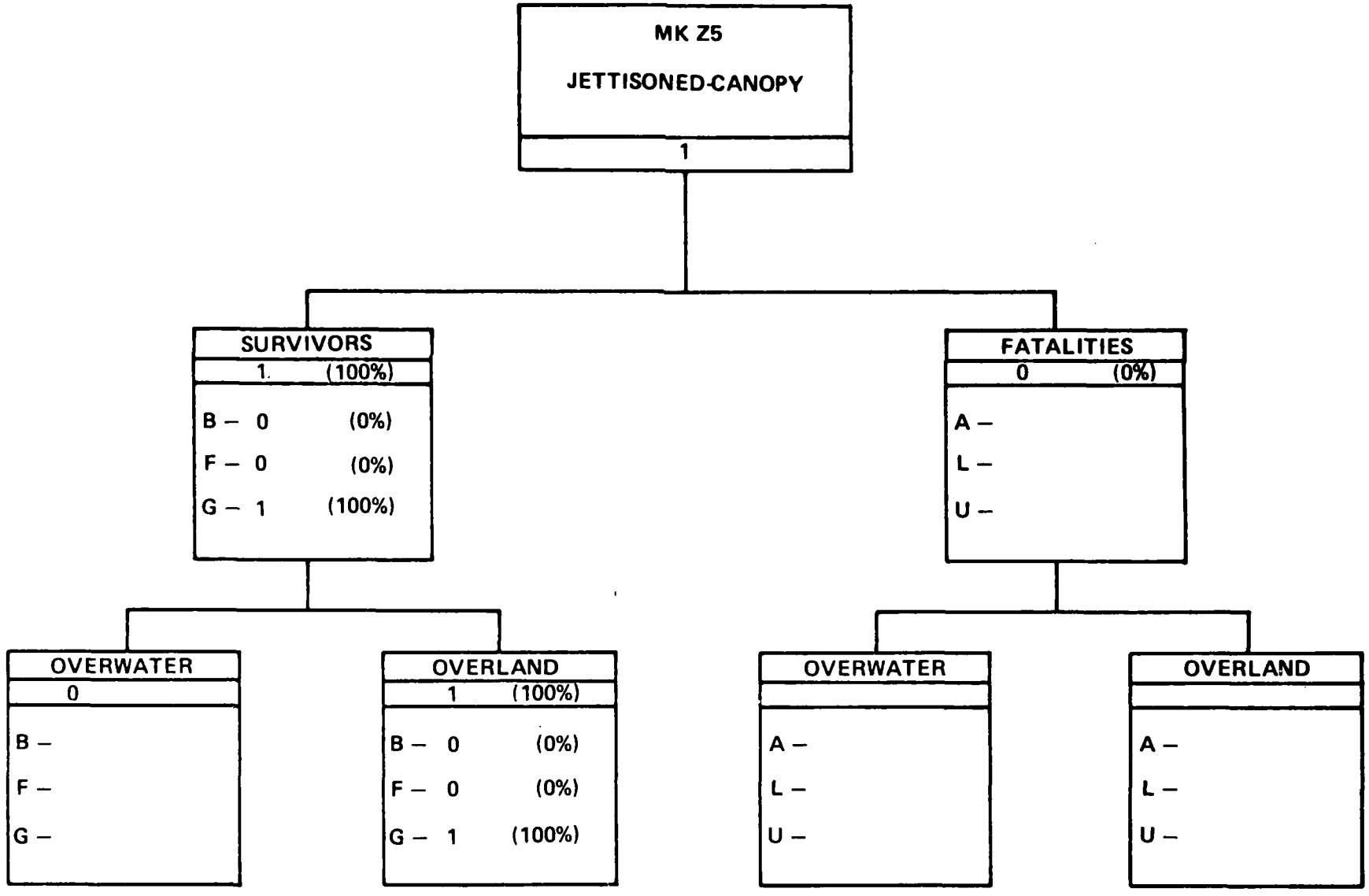
NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979



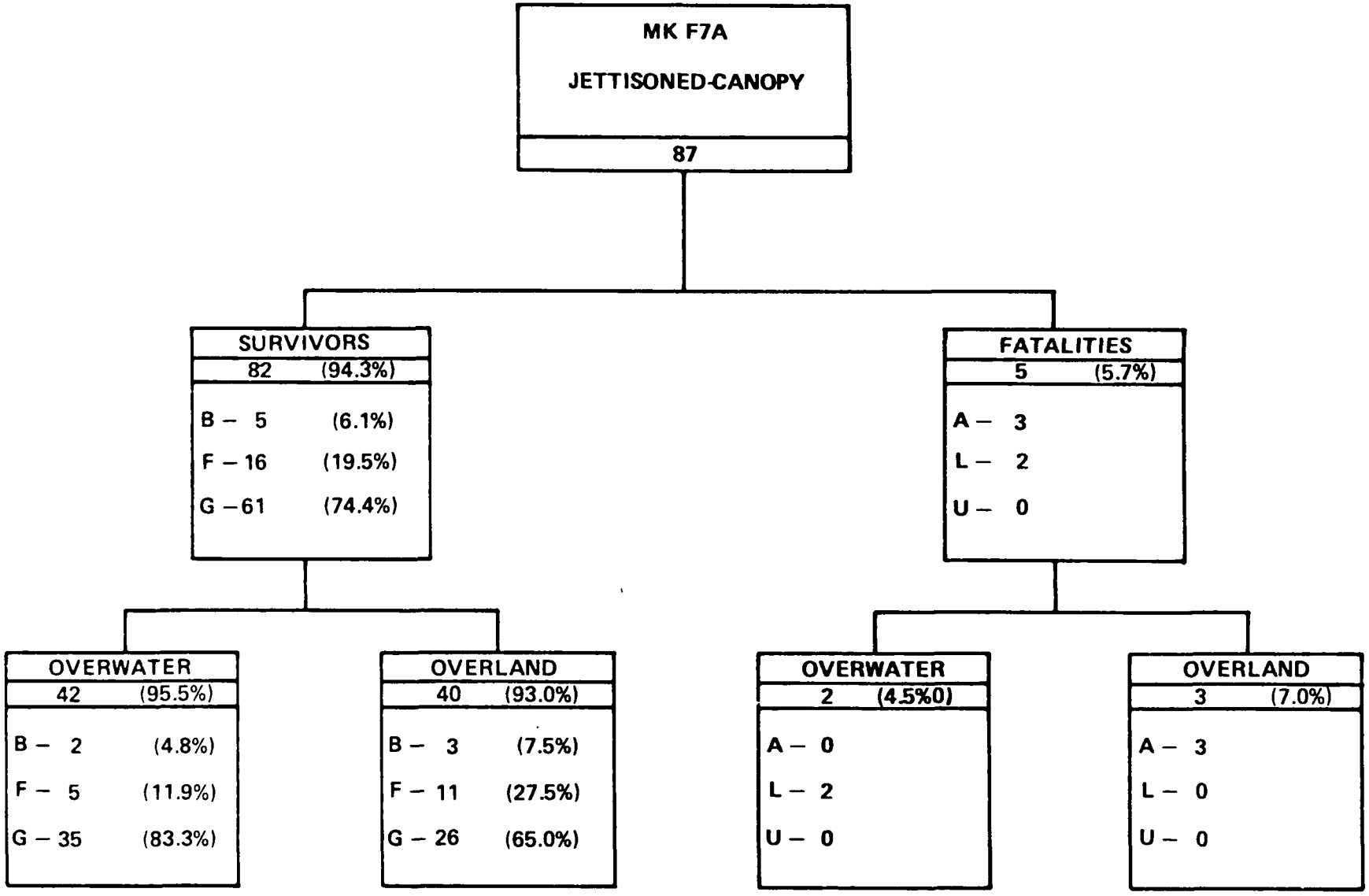
NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979



NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979



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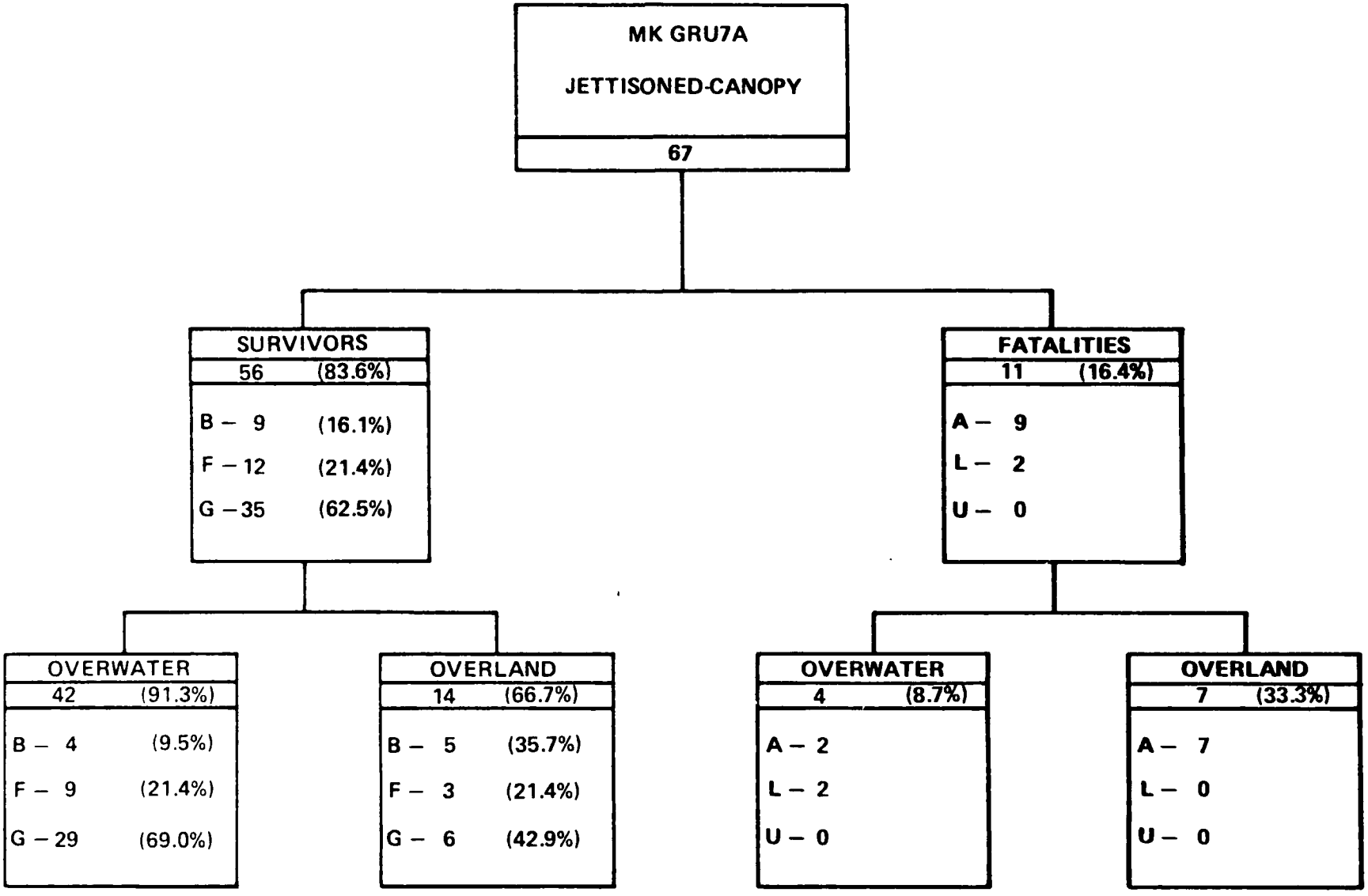

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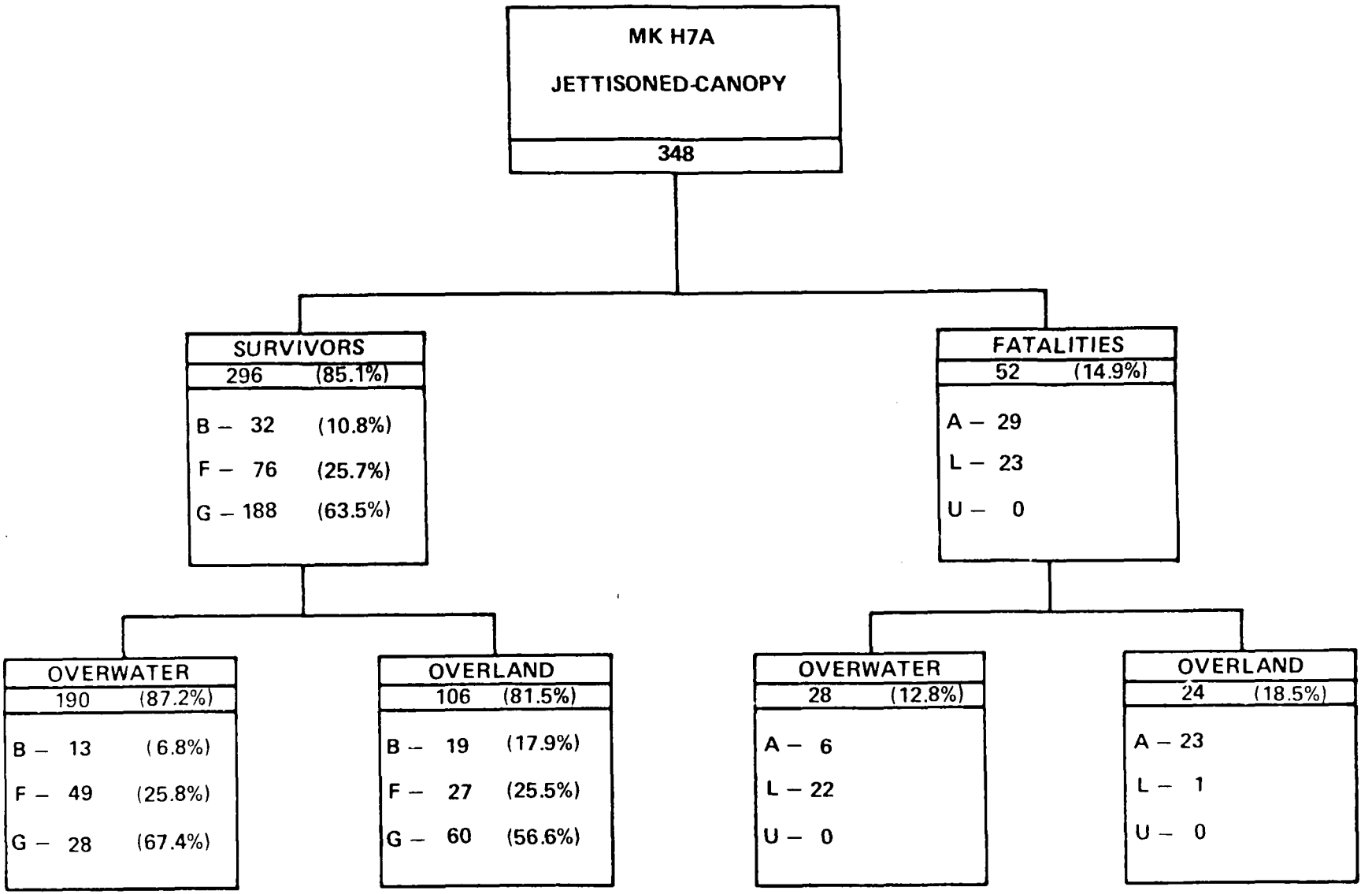

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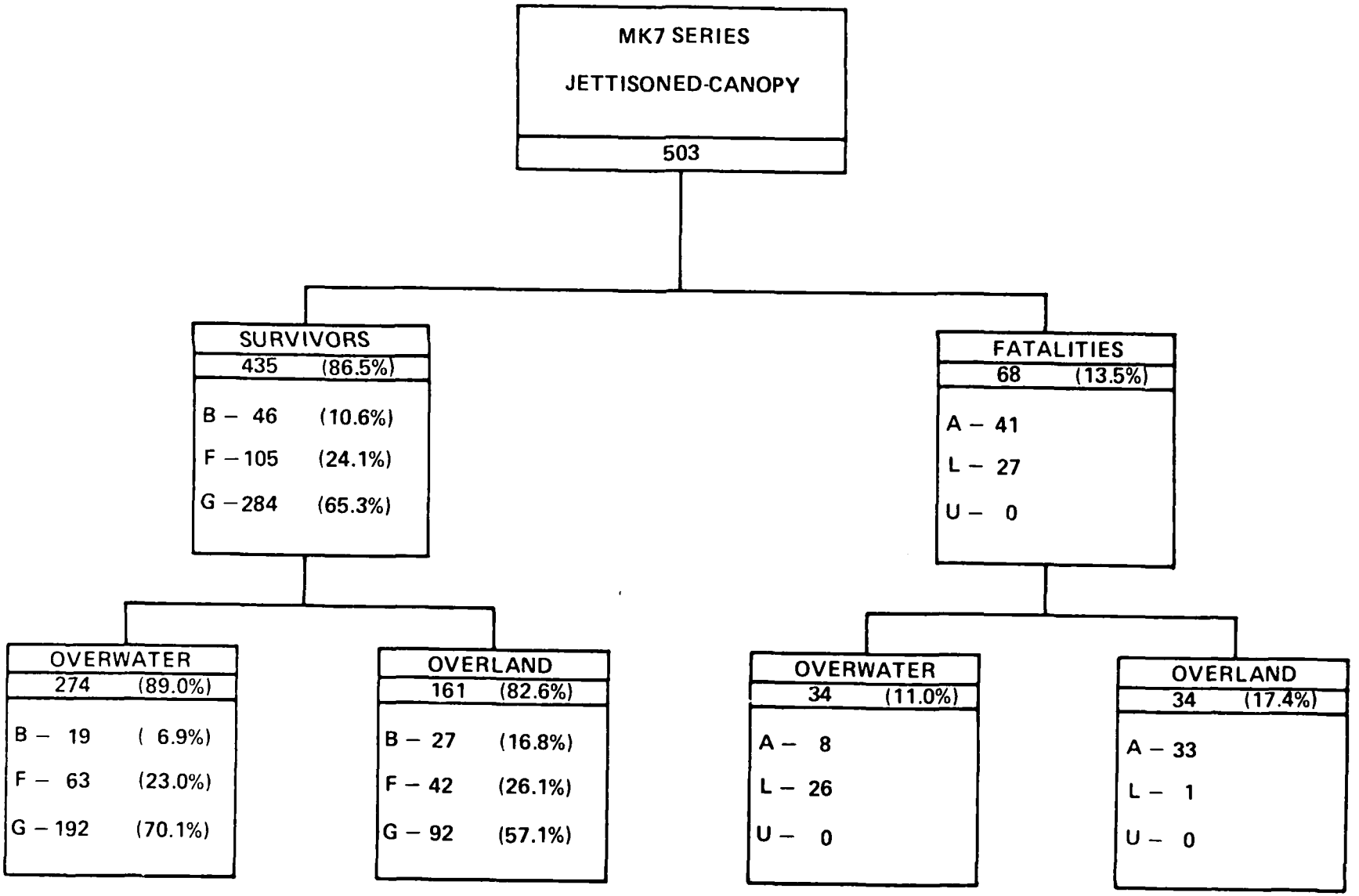

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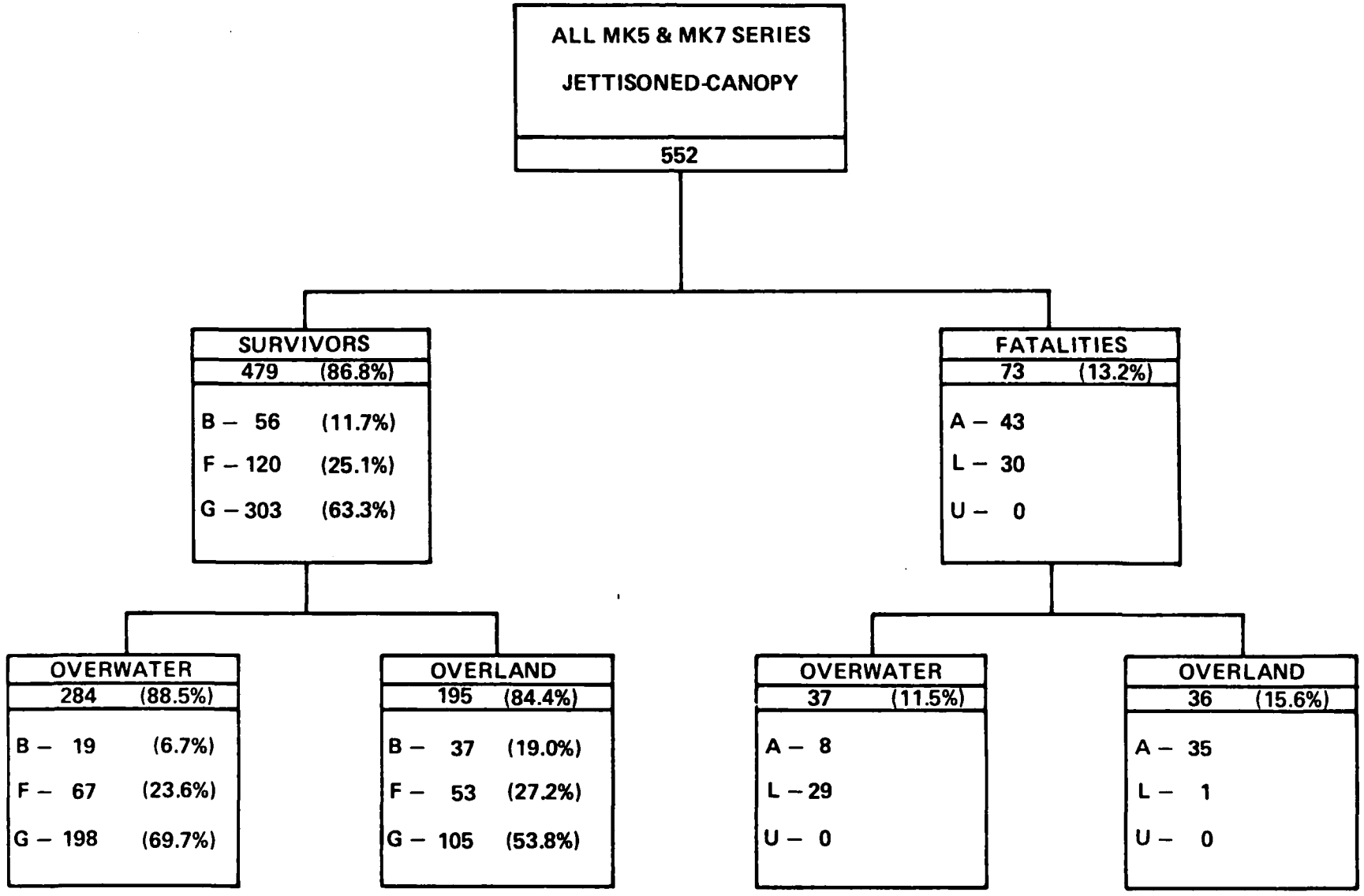

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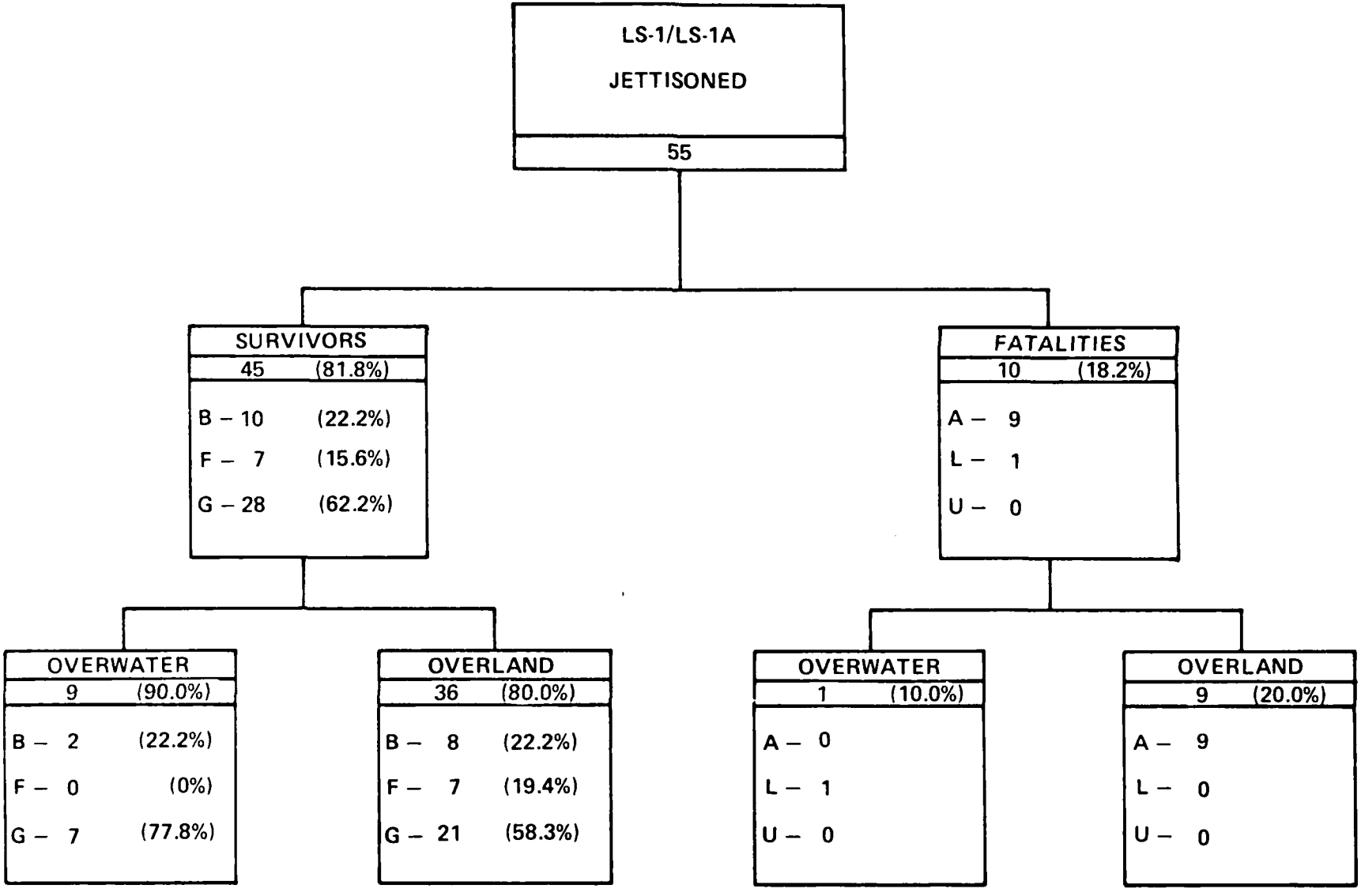

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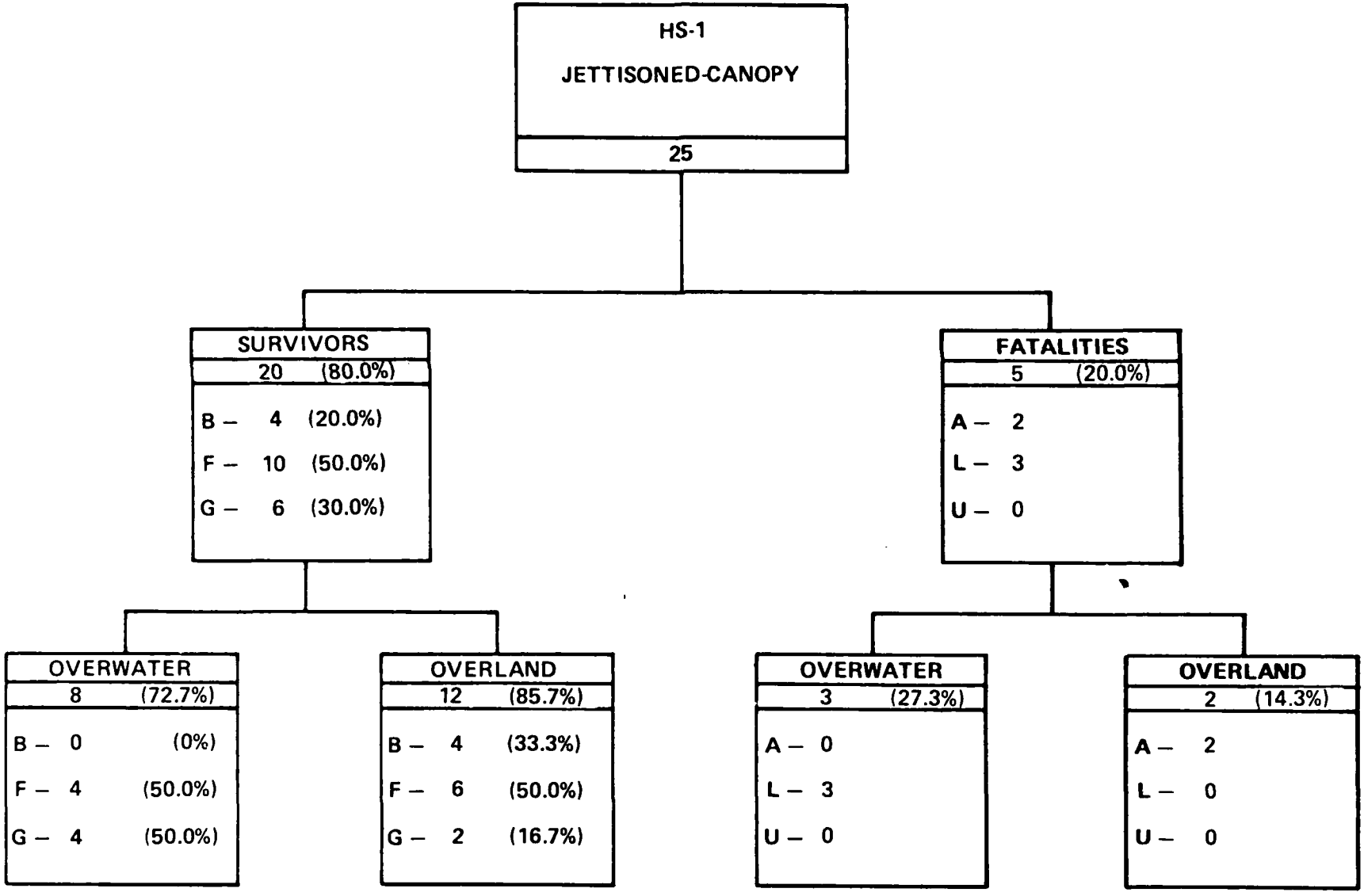

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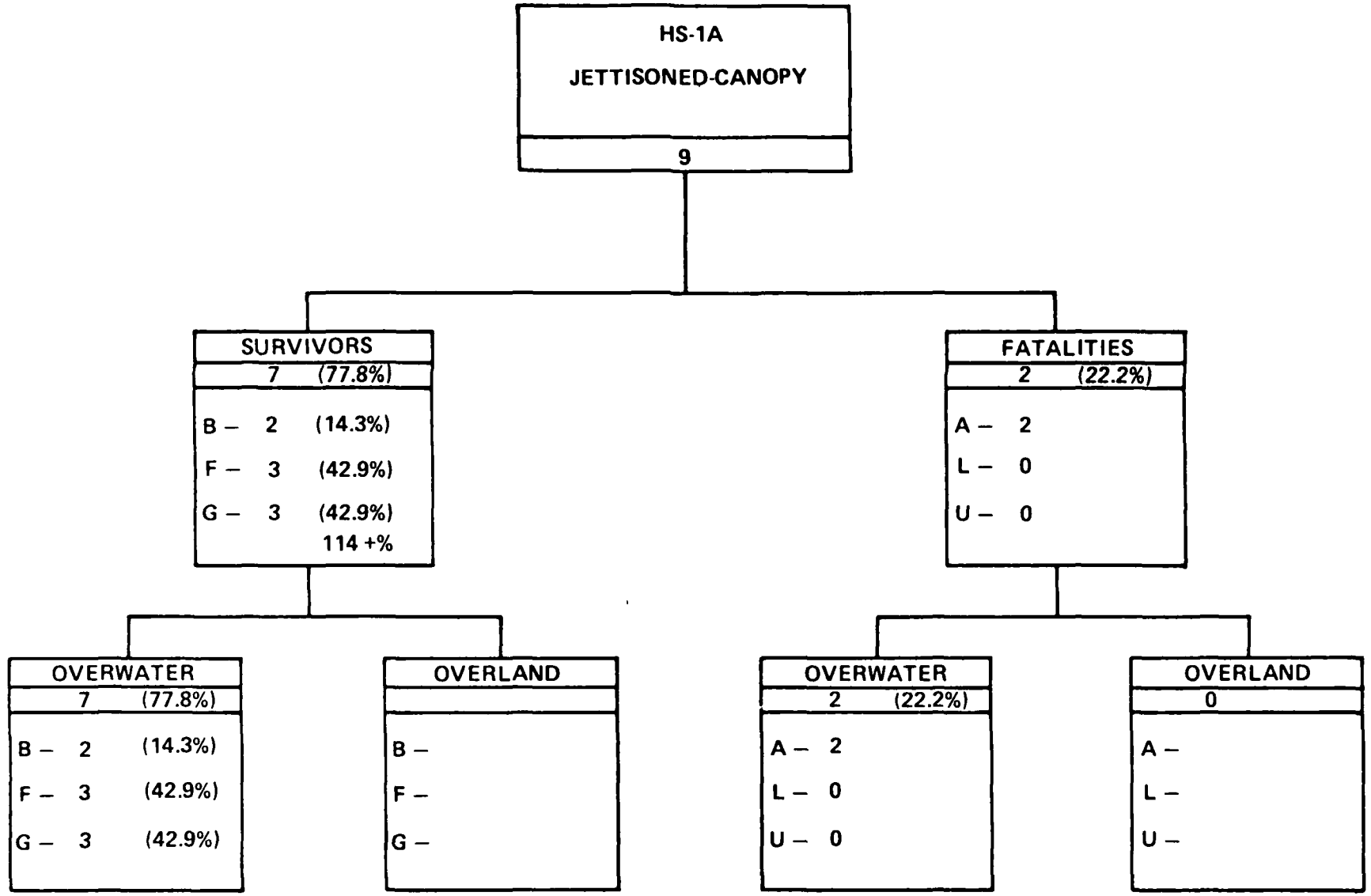

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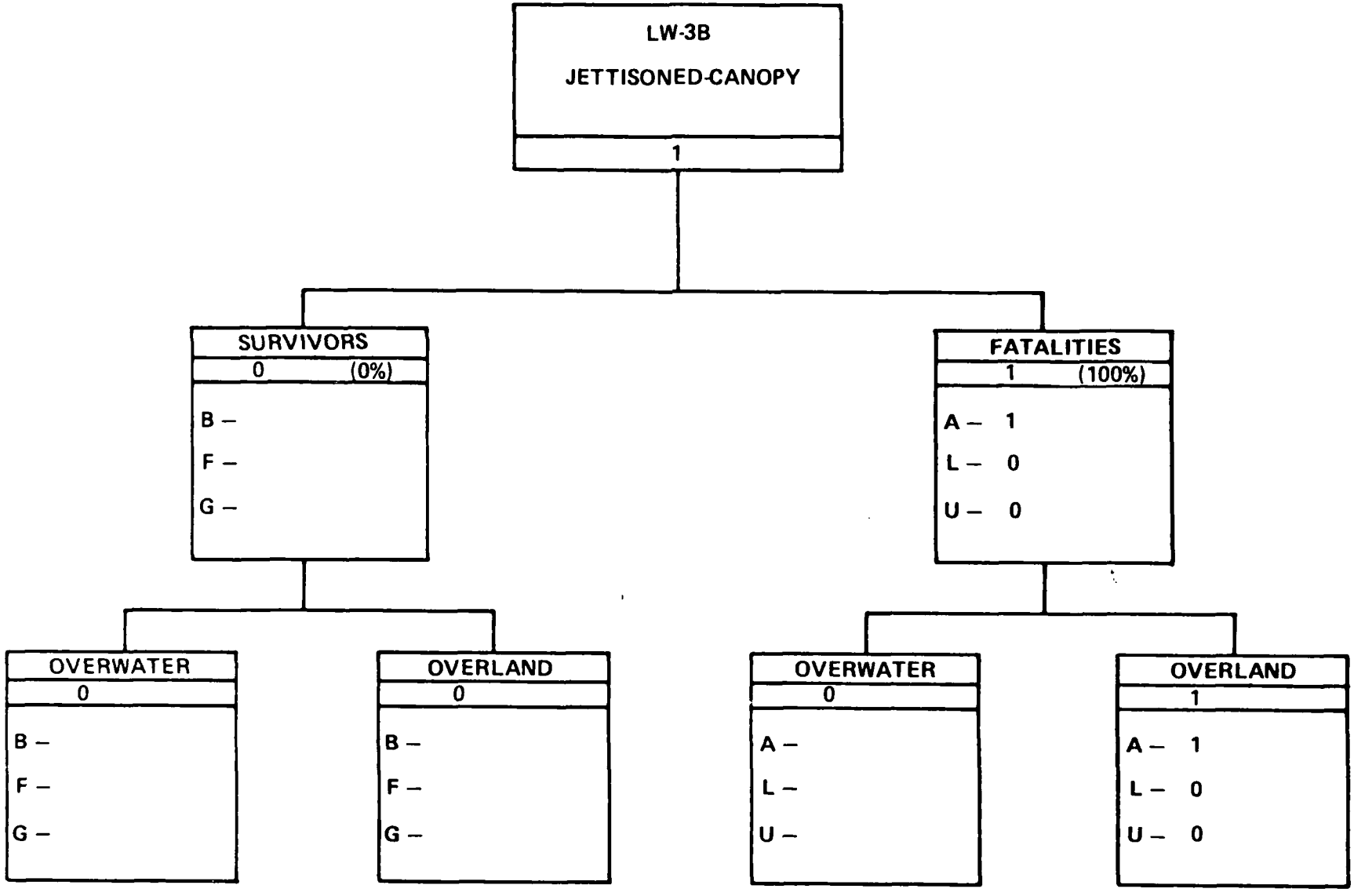

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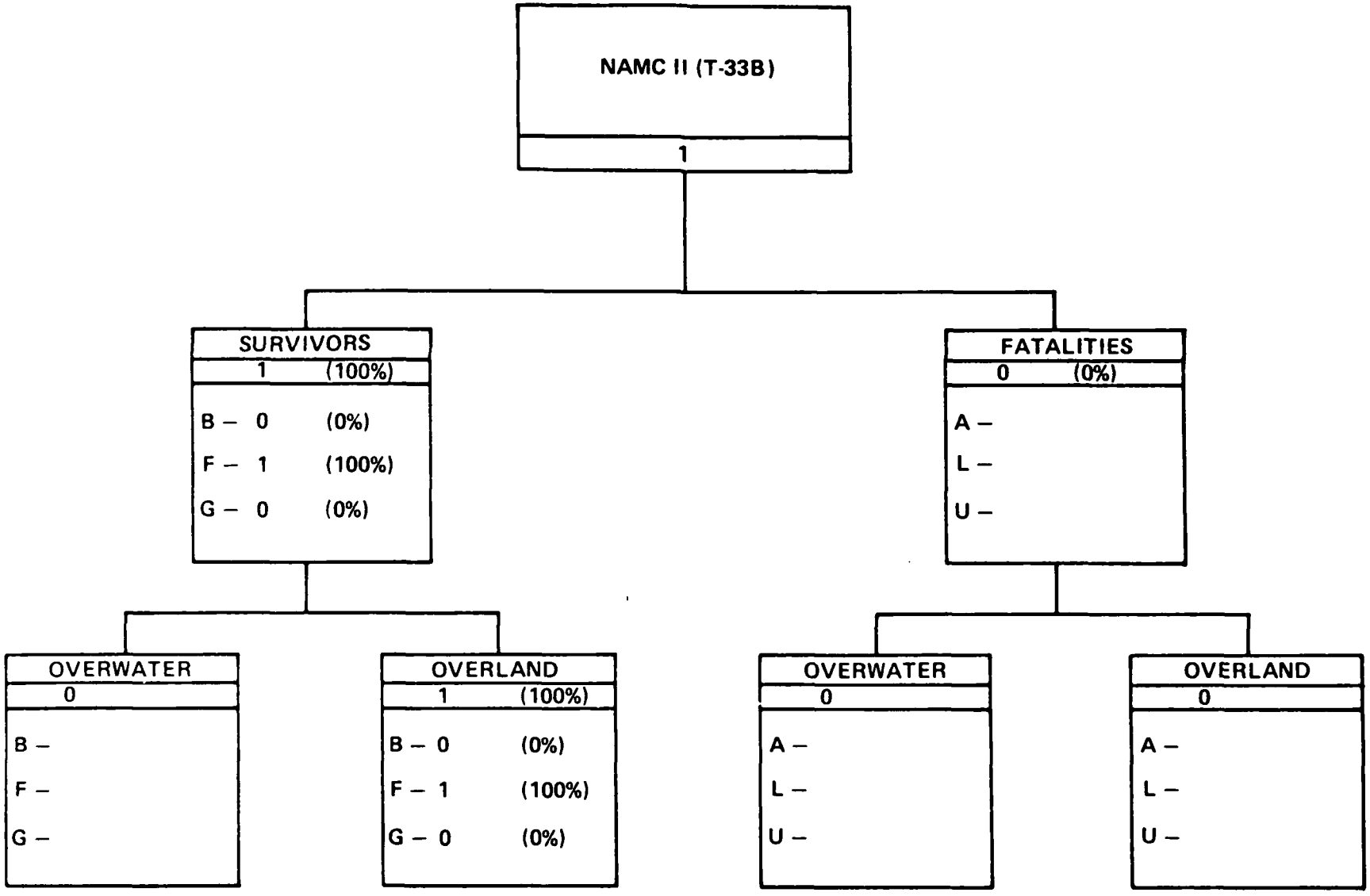

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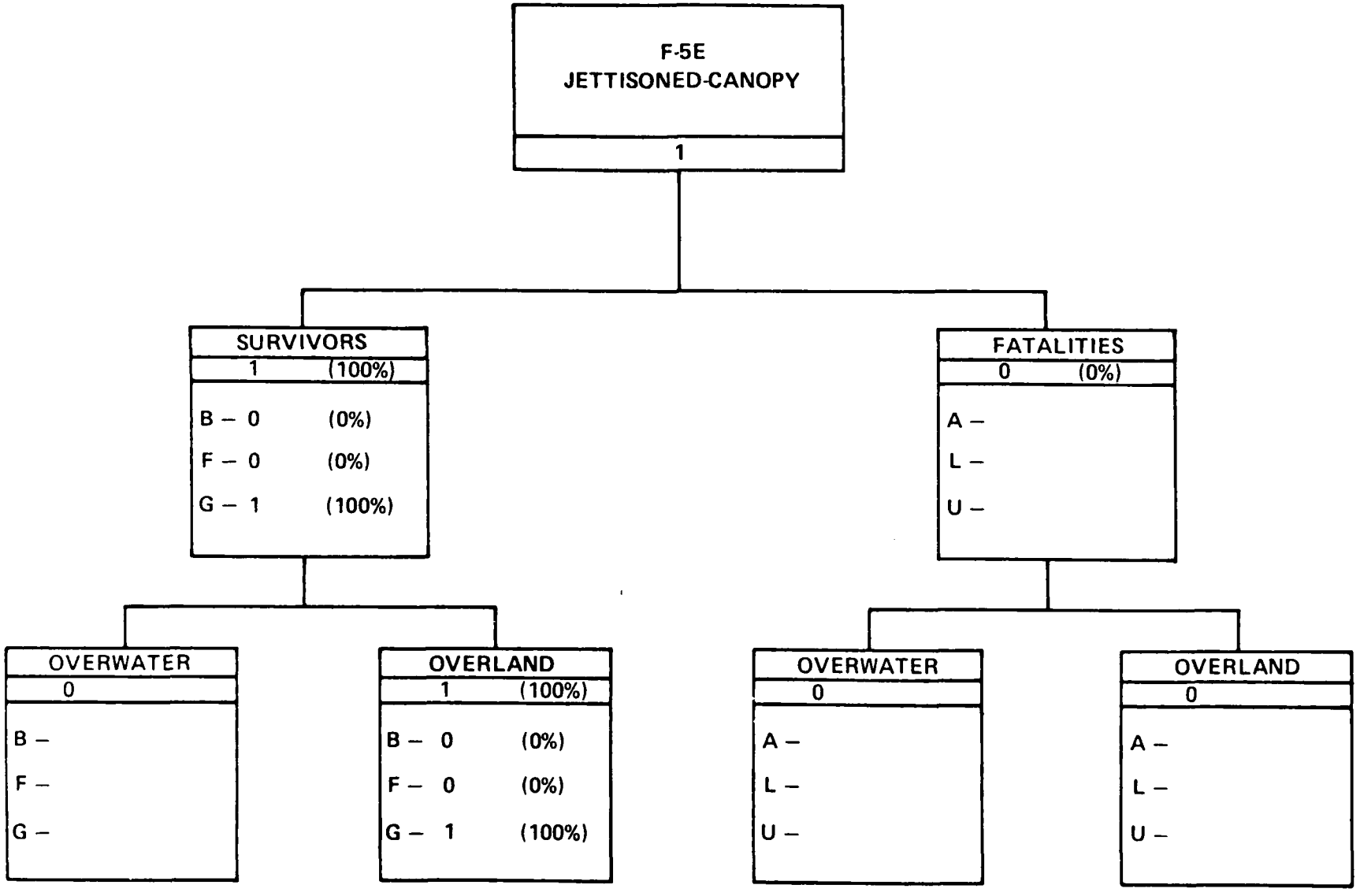


U.S. NAVY
EJECTIONS ACCOMPLISHED CLEAR OF AIRCRAFT
AND
INADVERTENT EJECTIONS

(1 JAN 1969 - 31 DEC 1979)

THROUGH-THE-CANOPY EJECTIONS

THROUGH-THE-CANOPY EJECTIONS

1 JAN 69 - 31 DEC 79

	OVERWATER			OVERLAND		
TYPE EJECTION SEAT	TOTAL EJECTEES	FATAL (A/L,U)	RATE	TOTAL EJECTEES	FATAL (A/L,U)	RATE
ESCAPAC 1C-2	1	0/0	0%	0	—	—
ESCAPAC 1E-1	2	0/2	100%	5	2/0	40.0%
ESCAPAC 1G-2	23	4/3	30.4%	17	3/0	17.6%
SUBTOTAL	26	4/5	34.6%	22	5/0	22.7%
MK A5	2	0/1	50.0%	16	4/0	25.0%
MK GRU5	43	5/3	18.6%	29	7/1	27.6%
MK GRUEA5	0	—	—	1	0/0	0%
MK L5	0	—	—	6	2/0	33.3%
MK Z5	0	—	—	6	0/0	0%
SUBTOTAL	45	5/4	20.0%	58	13/1	24.1%
MK A7	1	0/0	0%	6	0/0	0%
MK F7	0	—	—	1	0/0	0%
MK GRU7	18	1/5	33.3%	20	6/0	30.0%
MK GRUEA7	14	0/2	14.3%	3	0/0	0%
SUBTOTAL	33	1/7	24.2%	30	6/0	20.0%
LS-1/LS-1A	0	—	—	2	1/0	50.0%
LW-3B	5	1/0	20.0%	16	5/0	31.3%
SUBTOTAL	5	1/0	20.0%	18	6/0	33.3%
TOTALS	109	11/16	24.8%	128	30/1	24.2%
OVERALL TOTALS	237	41/17	24.5%			

THROUGH-THE-CANOPY EJECTIONS

1 JAN 69 - 31 DEC 79

	OVERWATER			OVERLAND		
TYPE EJECTION SEAT	TOTAL EJECTEES	MAJOR INJURIES	RATE	TOTAL EJECTEES	MAJOR INJURIES	RATE
ESCAPAC 1C-2	1	1	100%	0	—	—
ESCAPAC 1E-1	2	0	0%	5	0	0%
ESCAPAC 1G-2	23	2	8.7%	17	5	29.4%
SUBTOTAL	26	3	11.5%	22	5	22.7%
MK A5	2	1	50.0%	16	7	43.8%
MK GRU5	43	7	16.3%	29	10	34.5%
MK GRUEA5	0	—	—	1	1	100%
MK L5	0	—	—	6	2	33.3%
MK Z5	0	—	—	6	1	16.7%
SUBTOTAL	45	8	17.8%	58	21	36.2%
MK A7	1	1	100%	6	4	66.7%
MK F7	0	—	—	1	1	100%
MK GRU7	18	2	11.1%	20	5	25.0%
MK GRUEA7	14	3	21.4%	3	0	0%
SUBTOTAL	33	6	18.2%	30	10	33.3%
LS-1/LS-1A	0	—	—	2	1	50.0%
LW-3B	5	2	40.0%	16	2	12.5%
SUBTOTAL	5	2	40.0%	18	3	16.7%
TOTALS	109	19	17.4%	128	39	30.5%
OVERALL TOTALS	237	51	21.5%			

THROUGH-THE-CANOPY EJECTIONS

1 JAN 69 - 31 DEC 79

	OVERWATER			OVERLAND		
TYPE EJECTION SEAT	TOTAL EJECTEES	MINOR INJURIES	RATE	TOTAL EJECTEES	MINOR INJURIES	RATE
ESCAPAC 1C-2	1	0	0%	0	—	—
ESCAPAC 1E-1	2	0	0%	5	0	0%
ESCAPAC 1G-2	23	5	21.7%	17	2	11.8%
SUBTOTAL	26	5	19.2%	22	2	9.1%
MK A5	2	0	0%	16	2	12.5%
MK GRU5	43	20	46.5%	29	8	27.6%
MK GRUEA5	0	—	—	1	0	0%
MK L5	0	—	—	6	1	16.7%
MK Z5	0	—	—	6	0	0%
SUBTOTAL	45	20	44.4%	58	11	19.0%
MK A7	1	0	0%	6	0	0%
MK F7	0	—	—	1	0	0%
MK GRU7	18	6	33.3%	20	4	20.0%
MK GRUEA7	14	7	50.0%	3	0	0%
SUBTOTAL	33	13	39.4%	30	4	13.3%
LS-1/LS-1A	0	—	—	2	0	0%
LW-3B	5	0	0%	16	9	56.3%
SUBTOTAL	5	0	0%	18	9	50.0%
TOTALS	109	38	34.9%	128	26	20.3%
OVERALL TOTALS	237	64	27.0%			

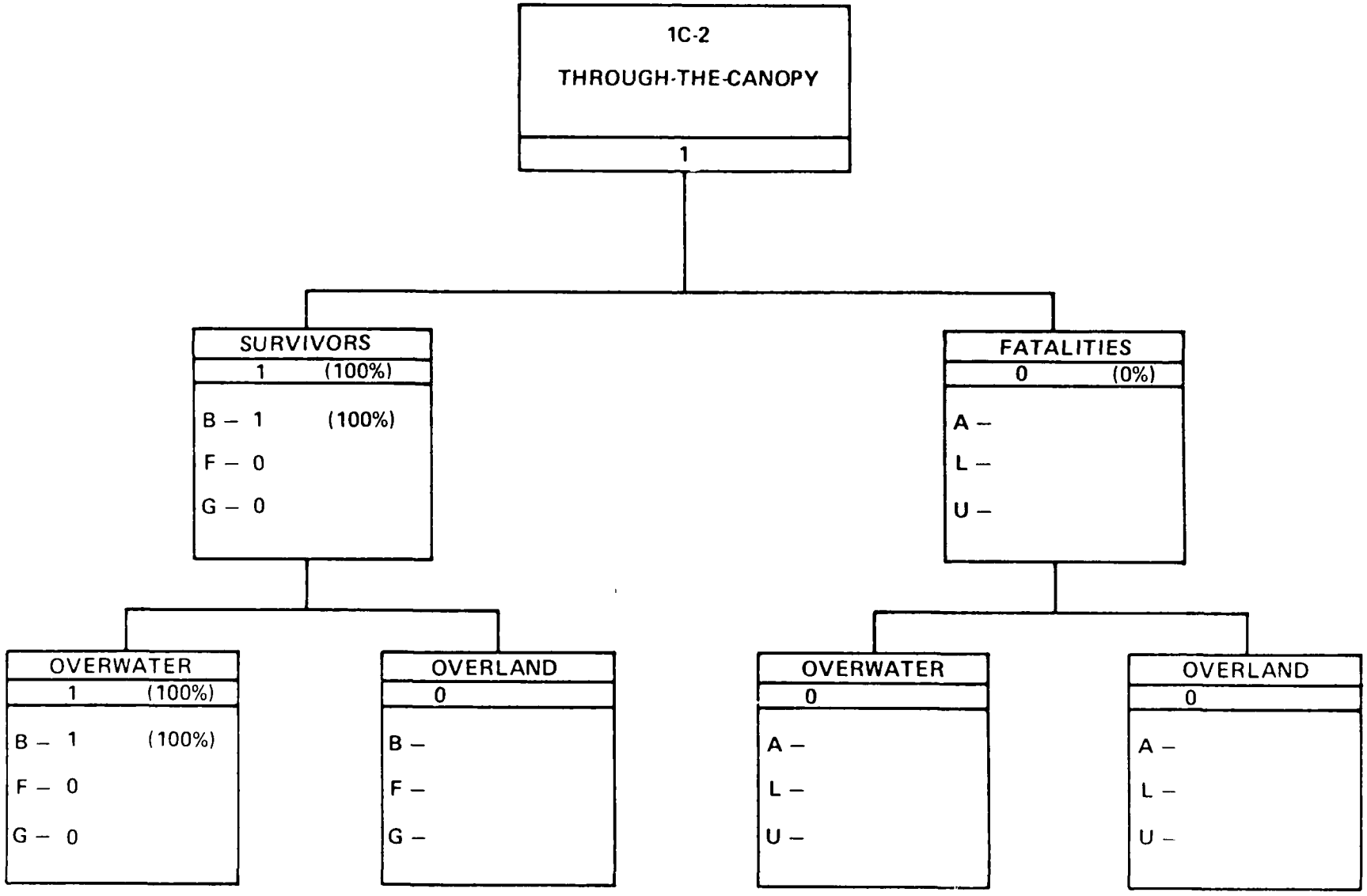
THROUGH-THE-CANOPY EJECTIONS

1 JAN 69 - 31 DEC 79

TYPE EJECTION SEAT	OVERWATER					OVERLAND				
	TOTAL EJECTEES	A/L,U	RATE % B	F	G	TOTAL EJECTEES	A/L,U	RATES (%) B	F	G
ESCAPAC 1C-2	1	0	100	—	—	0	—	—	—	—
ESCAPAC 1E-1	2	100	—	—	—	5	40.0	0	0	60.0
ESCAPAC 1G-2	23	30.4	8.7	21.7	39.2	17	17.6	29.4	11.8	41.2
SUBTOTAL	26	34.6	11.5	19.2	34.7	22	22.7	22.7	9.1	45.5
MK A5	2	50.0	50.0	—	—	16	25.0	43.8	12.5	18.7
MK GRU5	43	18.6	16.3	46.5	18.6	29	27.6	34.5	27.6	10.3
MK GRUEA5	0	—	—	—	—	1	0	100	—	—
MK L5	0	—	—	—	—	6	33.3	33.3	16.7	16.7
MK Z5	0	—	—	—	—	6	0	16.7	0	83.3
SUBTOTAL	45	20.0	17.8	44.4	17.8	58	24.1	24.1	19.0	32.8
MK A7	1	0	100	—	—	6	0	66.7	0	33.3
MK F7	0	—	—	—	—	1	0	100	—	—
MK GRU7	18	33.3	11.1	33.3	22.3	20	30.0	25.0	20.0	25.0
MK GRUEA7	14	14.3	21.4	50.0	14.3	3	0	0	0	100
SUBTOTAL	33	24.2	18.2	39.4	18.2	30	20.0	33.3	13.3	46.7
LS-1/LS-1A	0	—	—	—	—	2	50.0	50.0	—	—
LW-3B	5	20.0	40.0	0	40.0	16	31.3	12.5	56.3	—
SUBTOTAL	5	20.0	40.0	0	40.0	18	33.3	16.7	50.0	—
TOTALS	109	24.8	17.4	34.9	22.9	128	24.2	25.0	20.3	30.5
OVERALL TOTALS	237	24.5	21.5	27.0	27.0					

NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979



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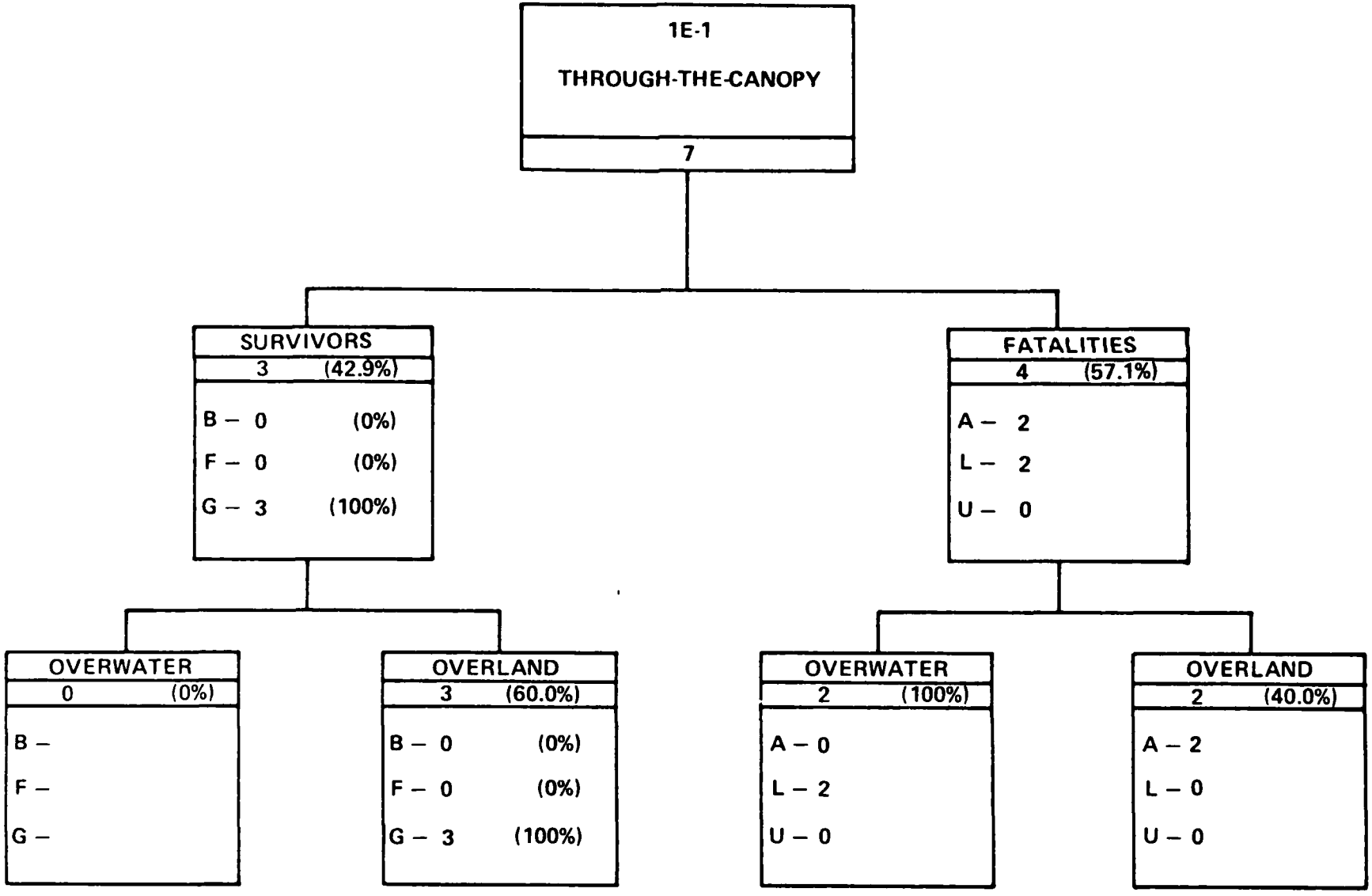

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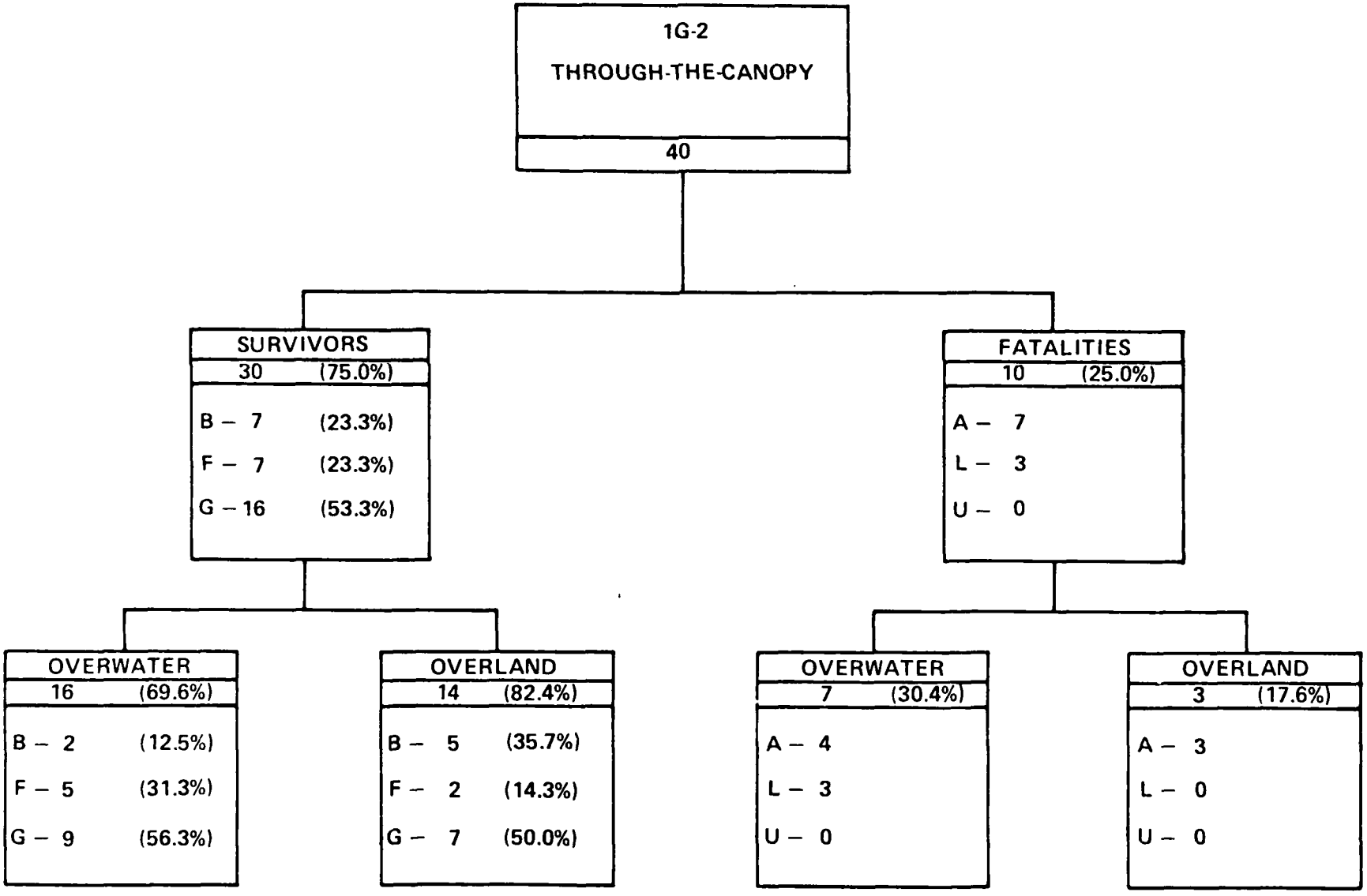

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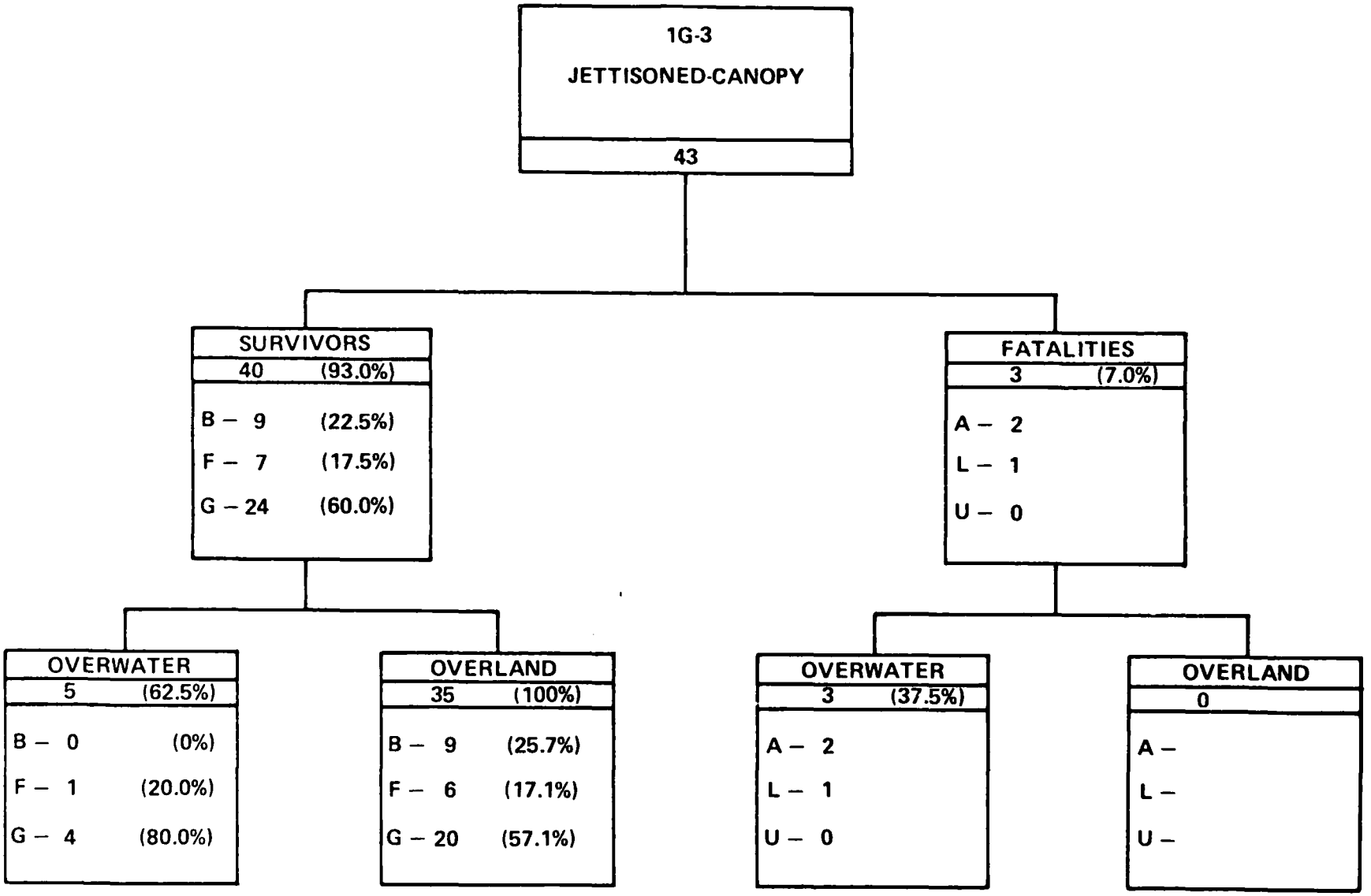

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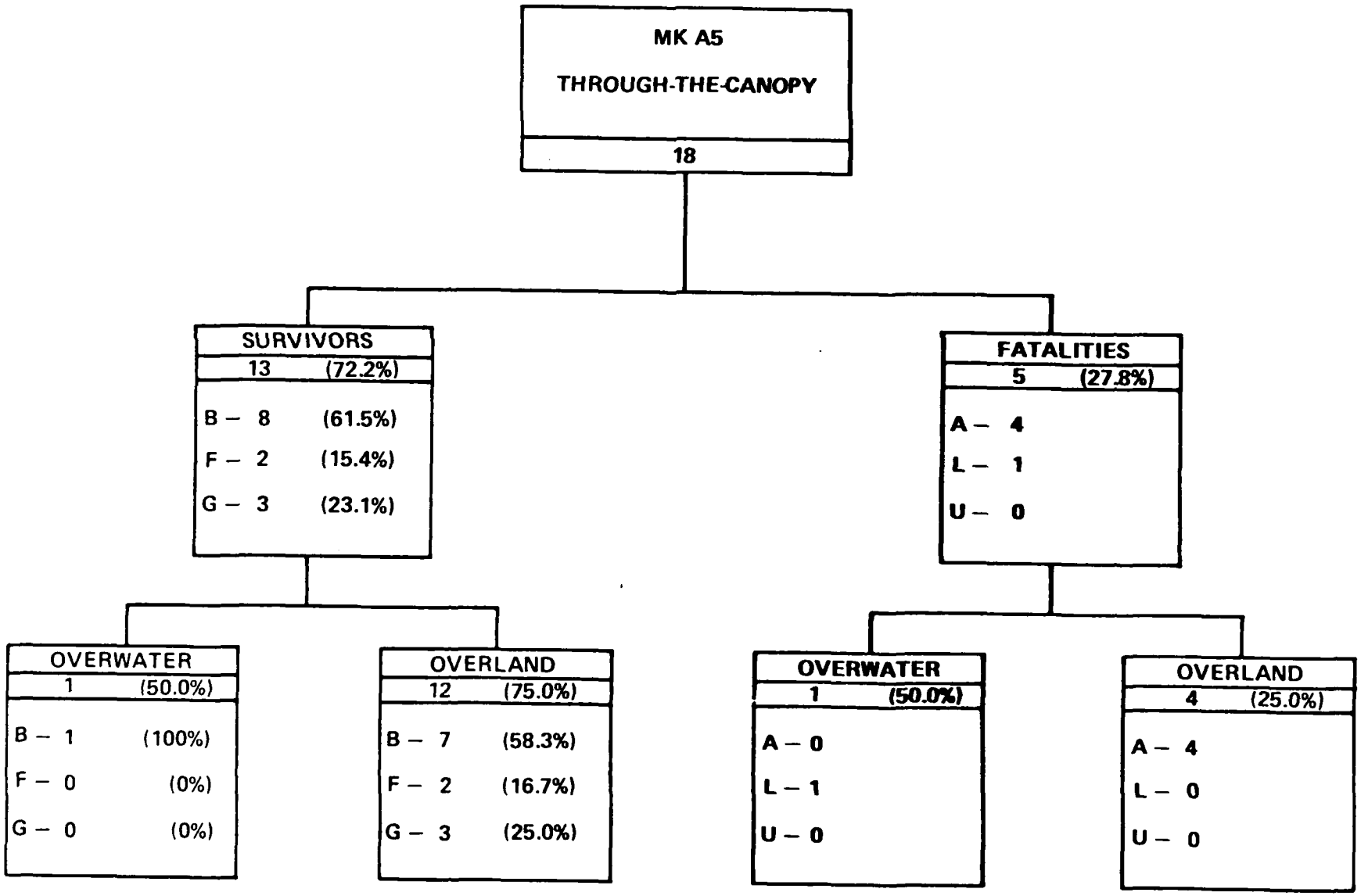

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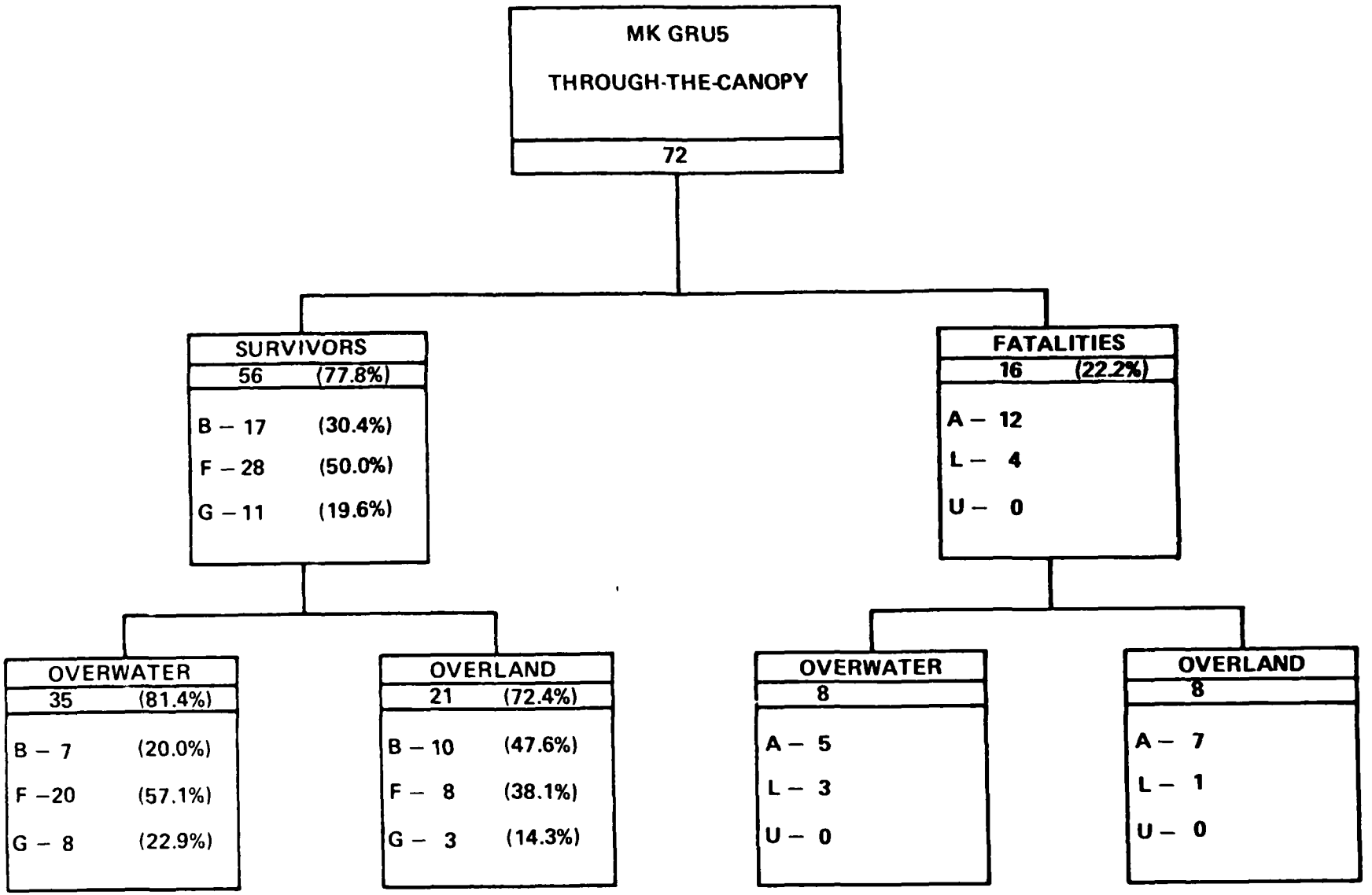

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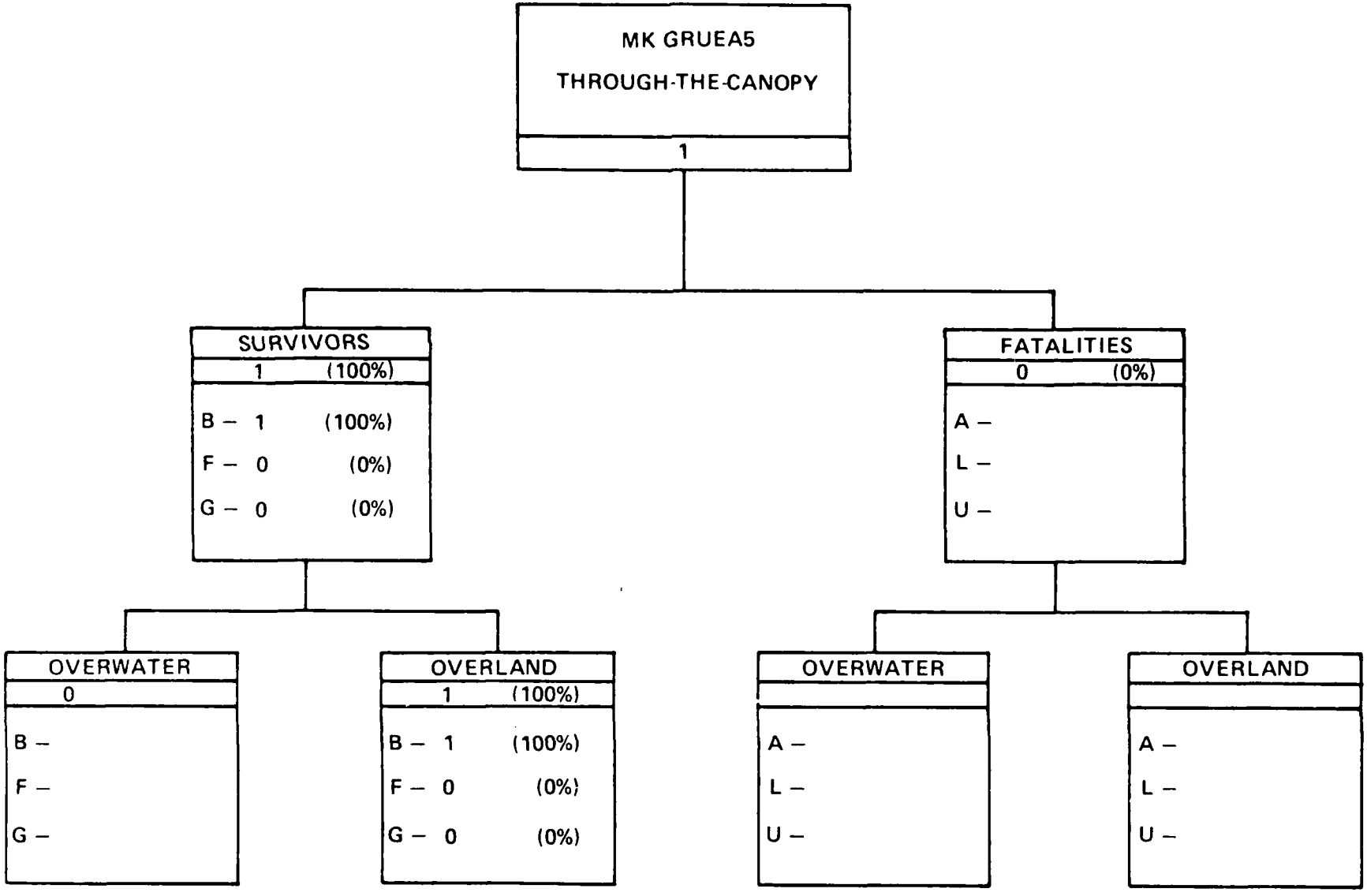

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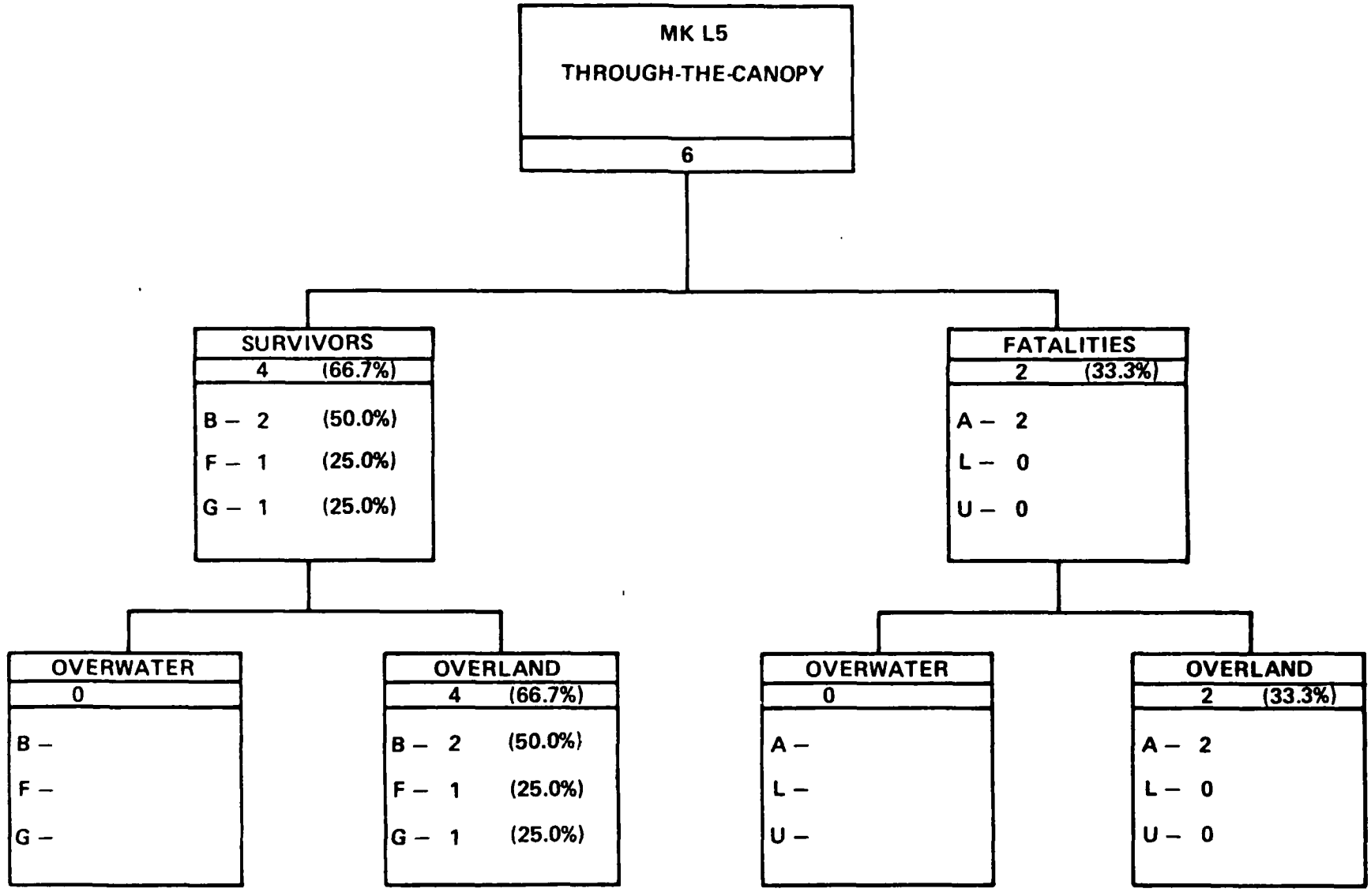

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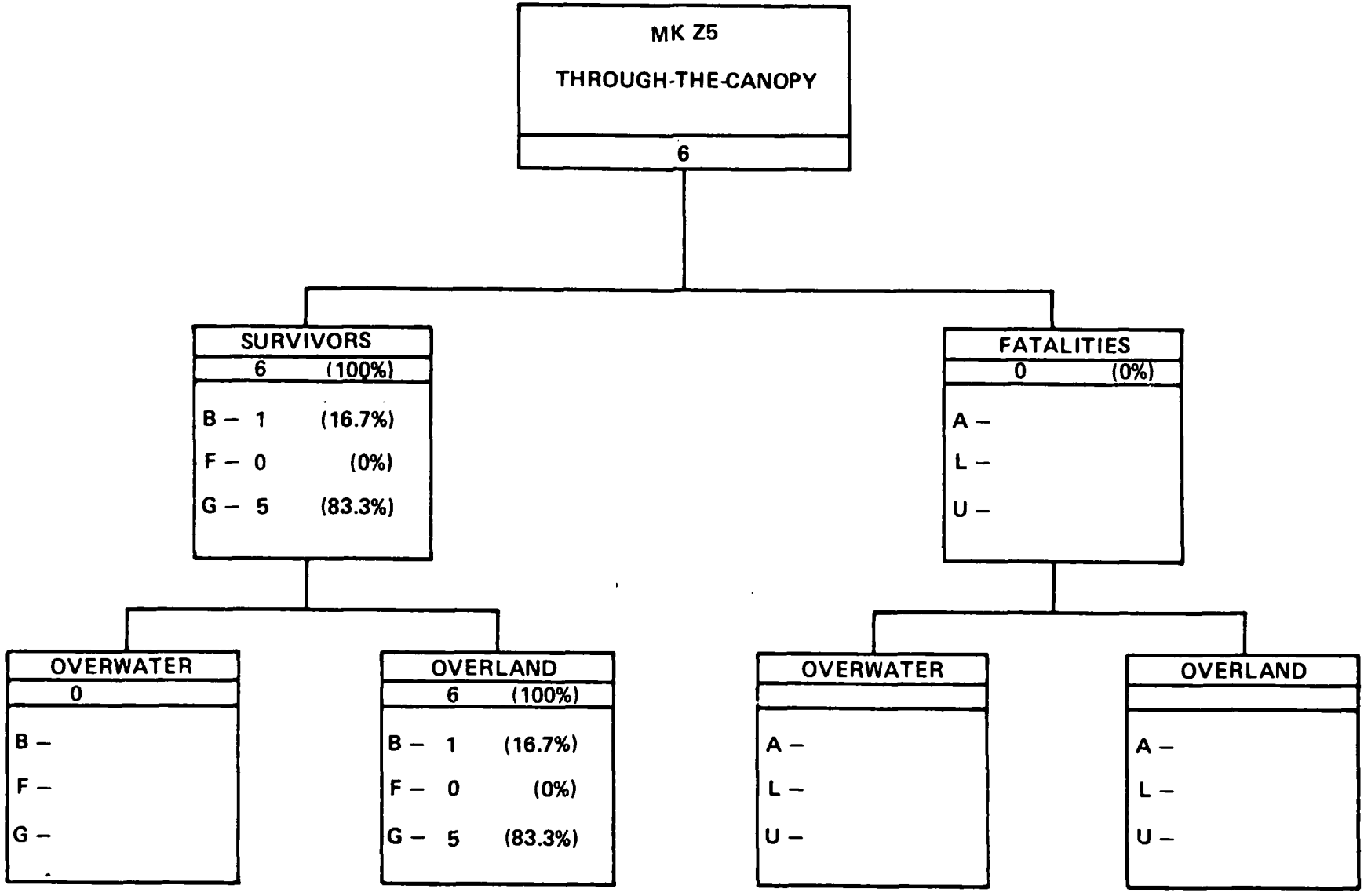

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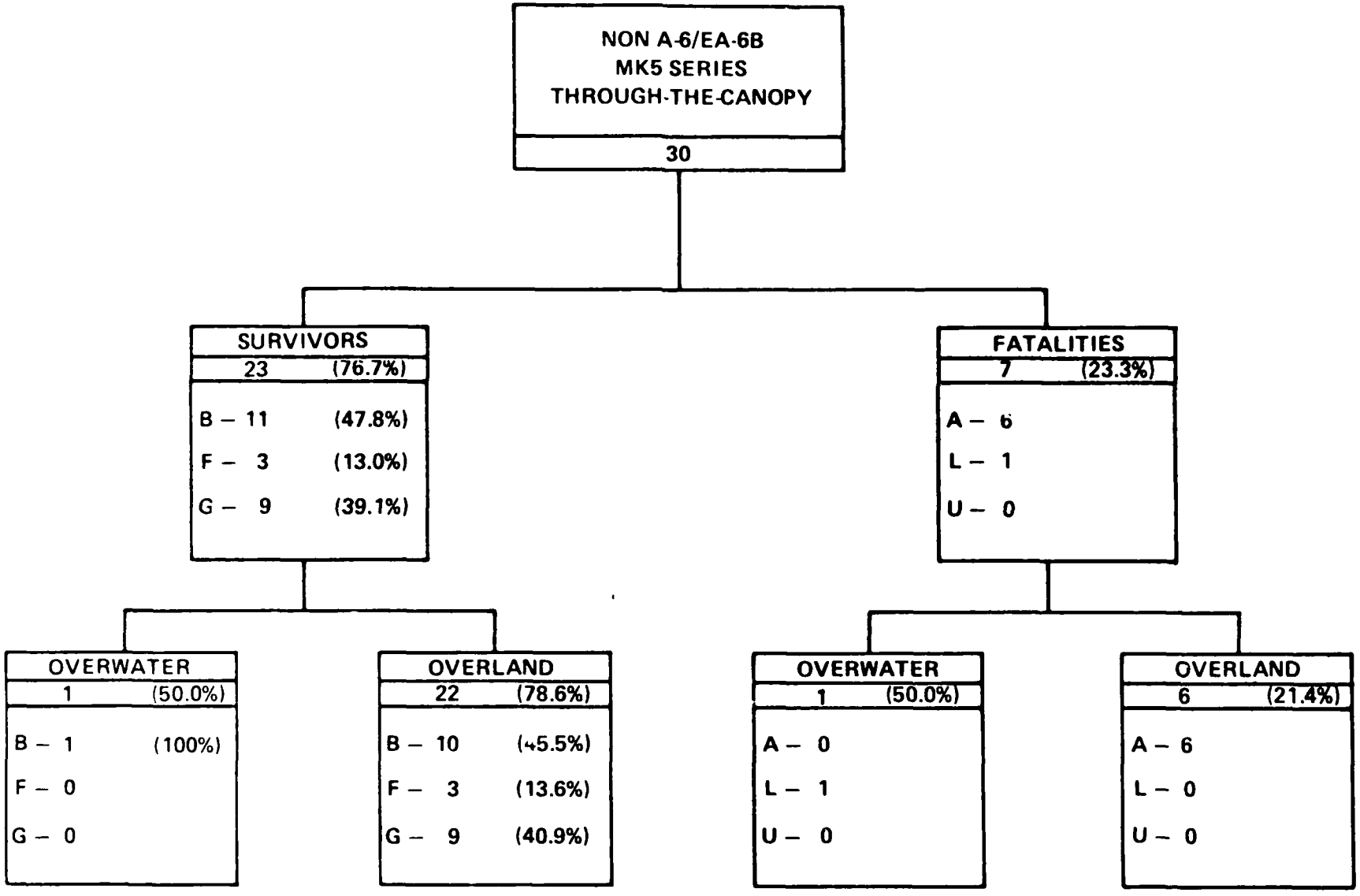

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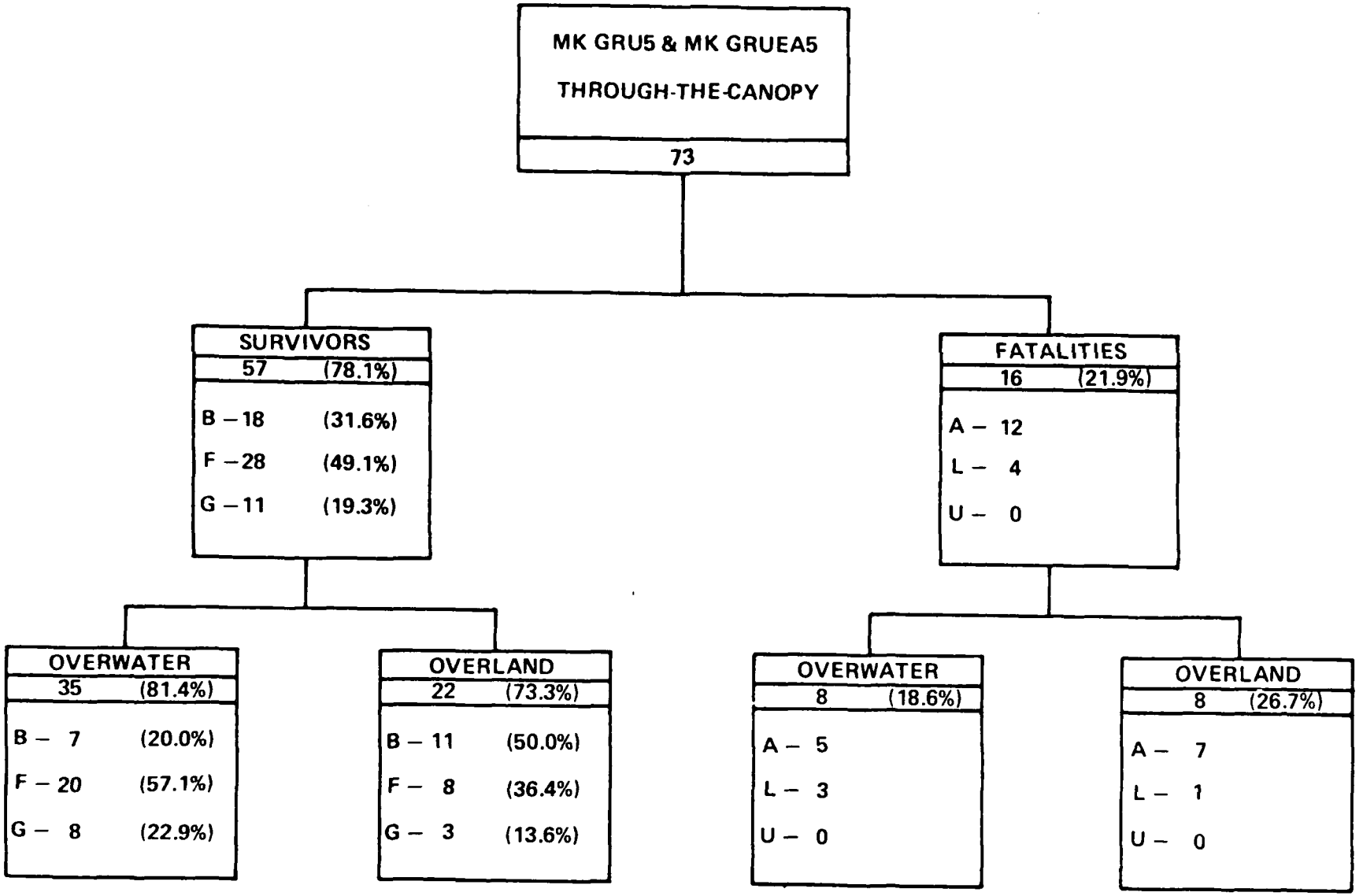

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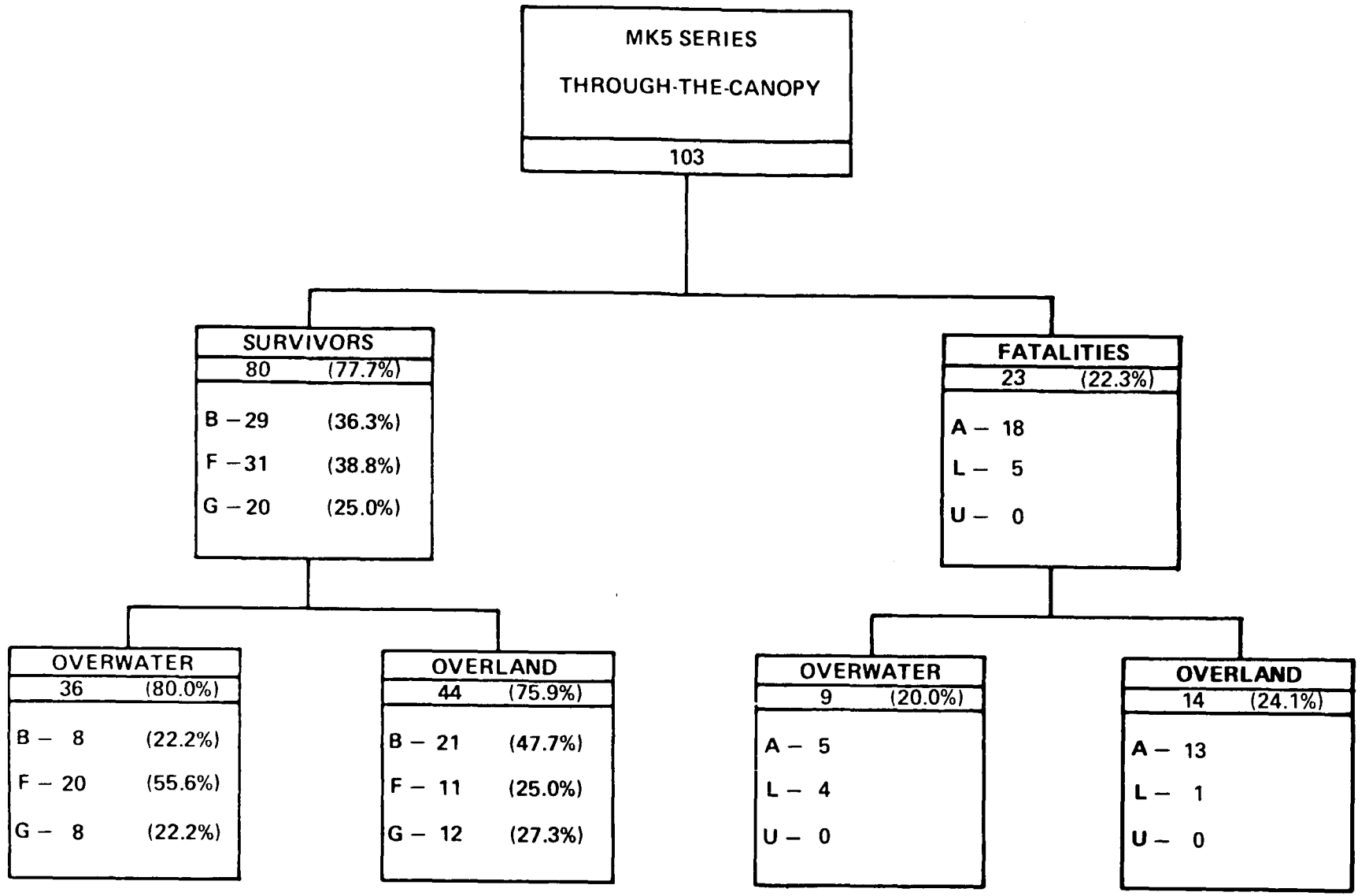

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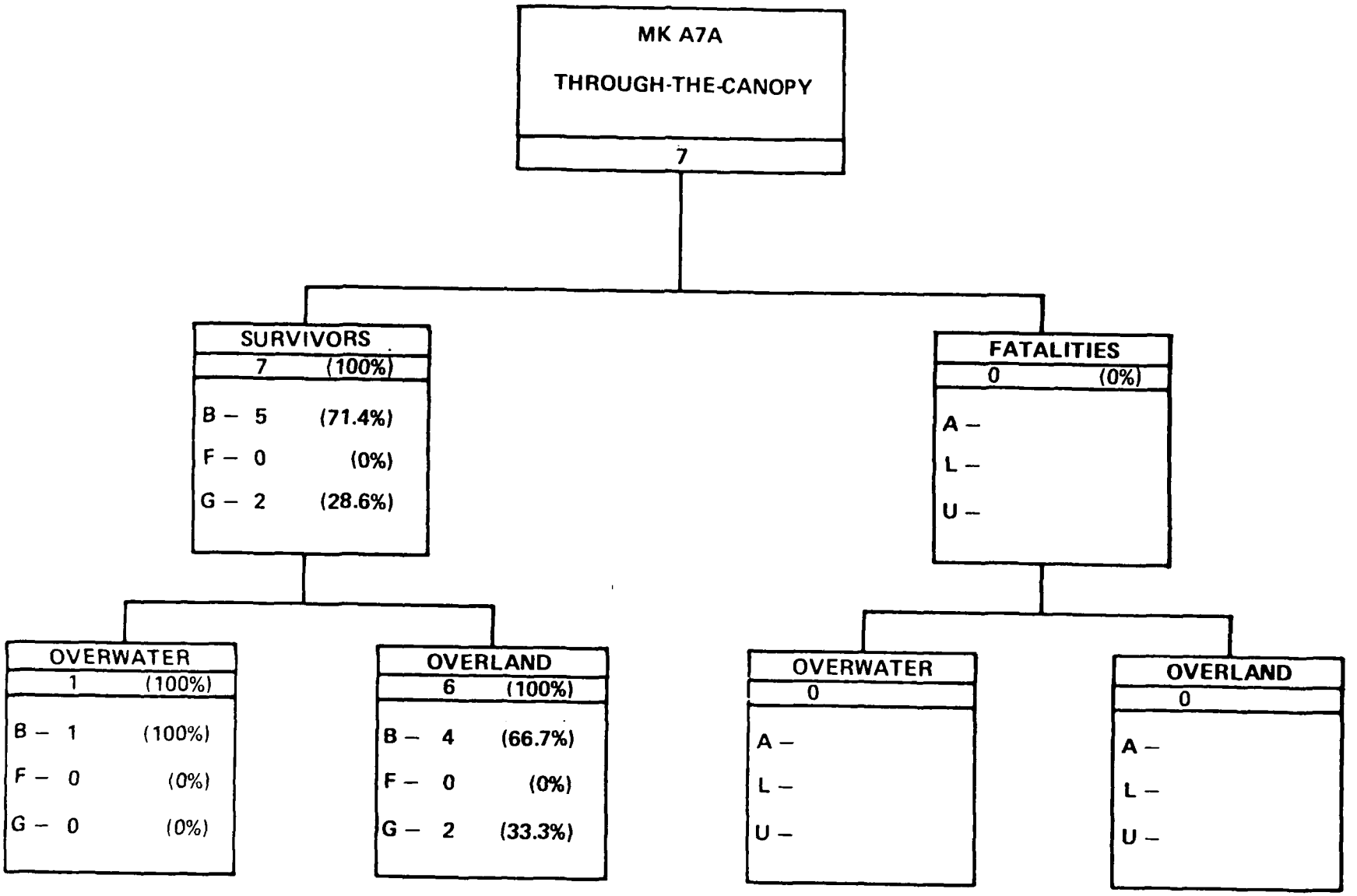

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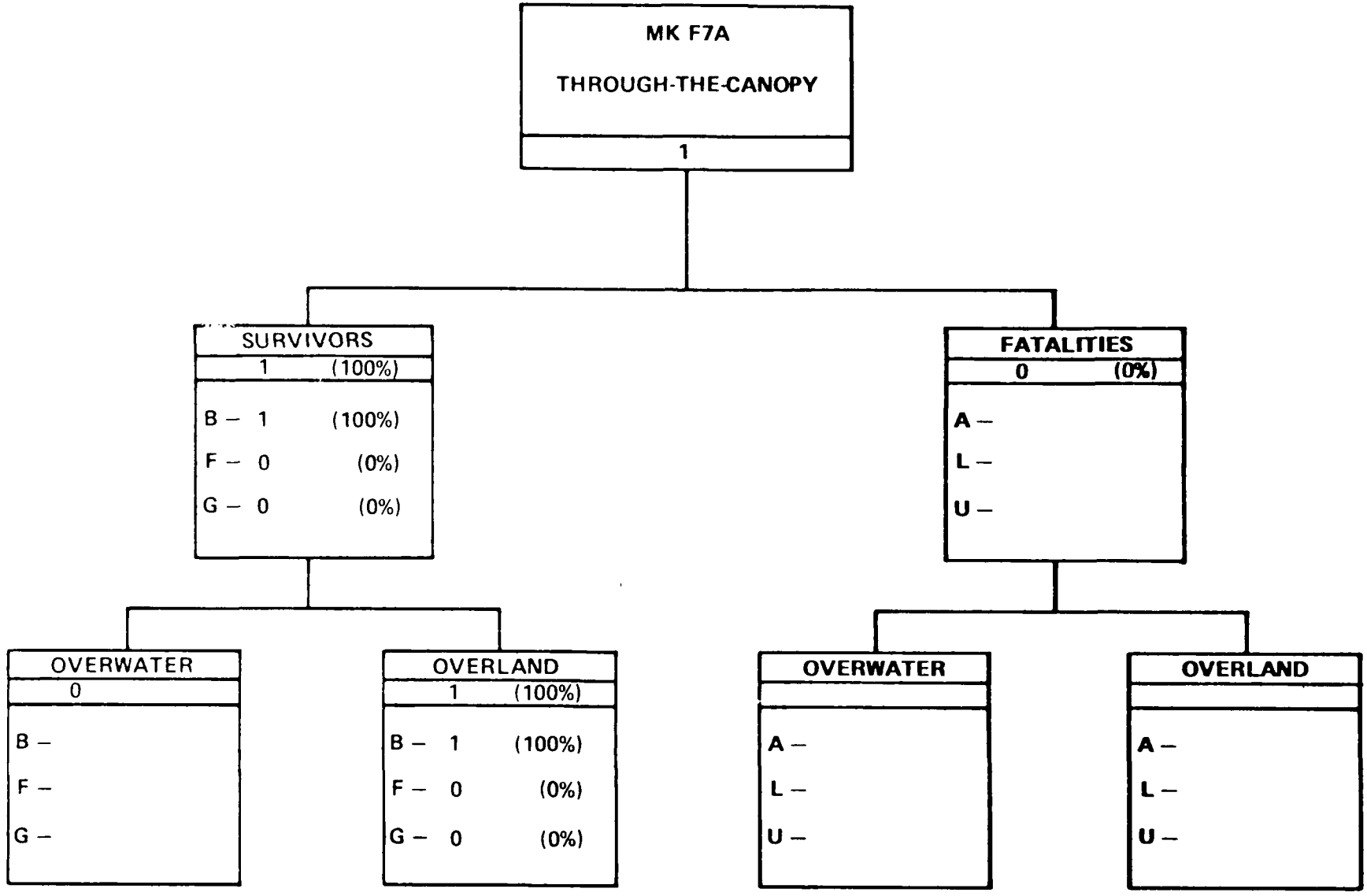

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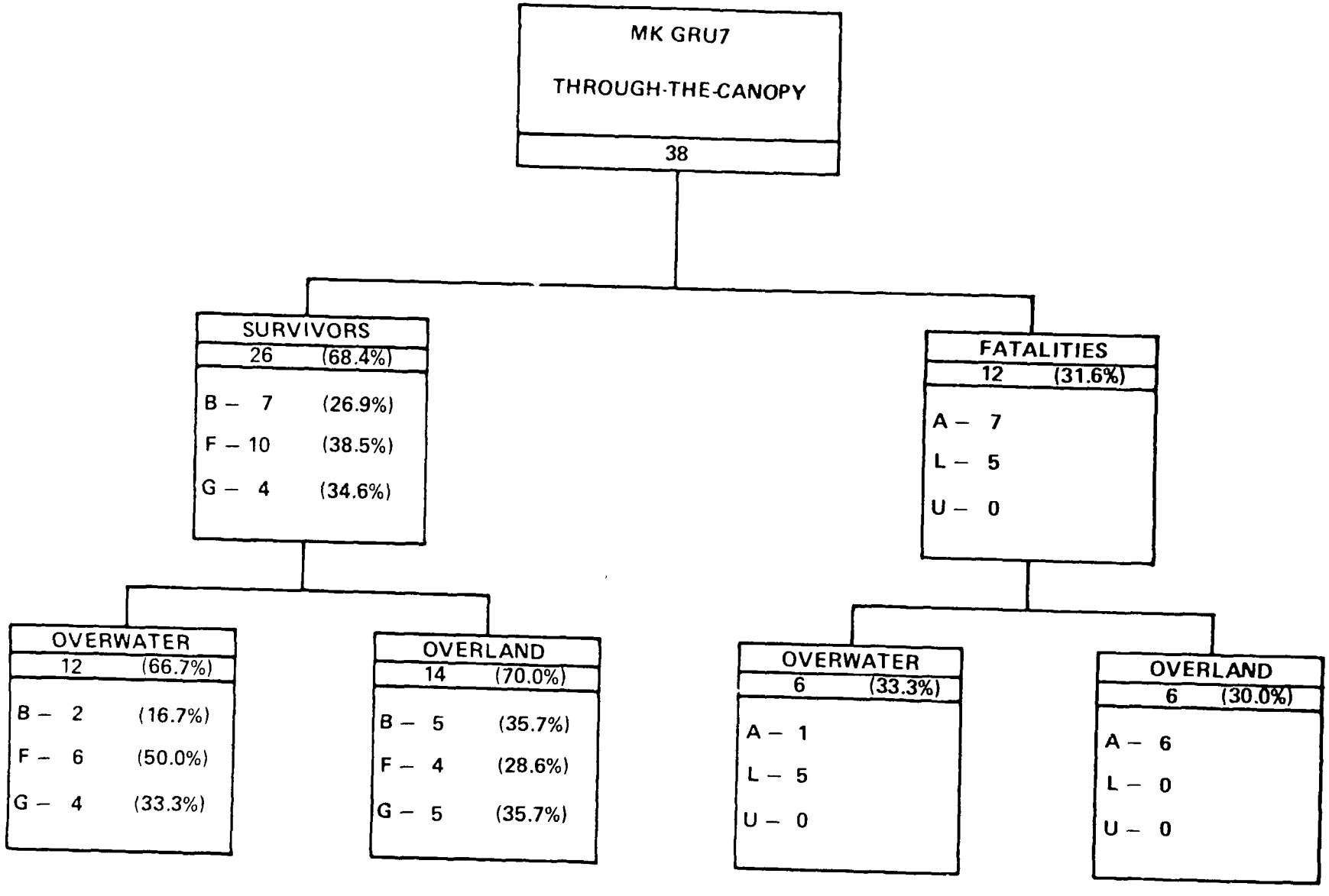

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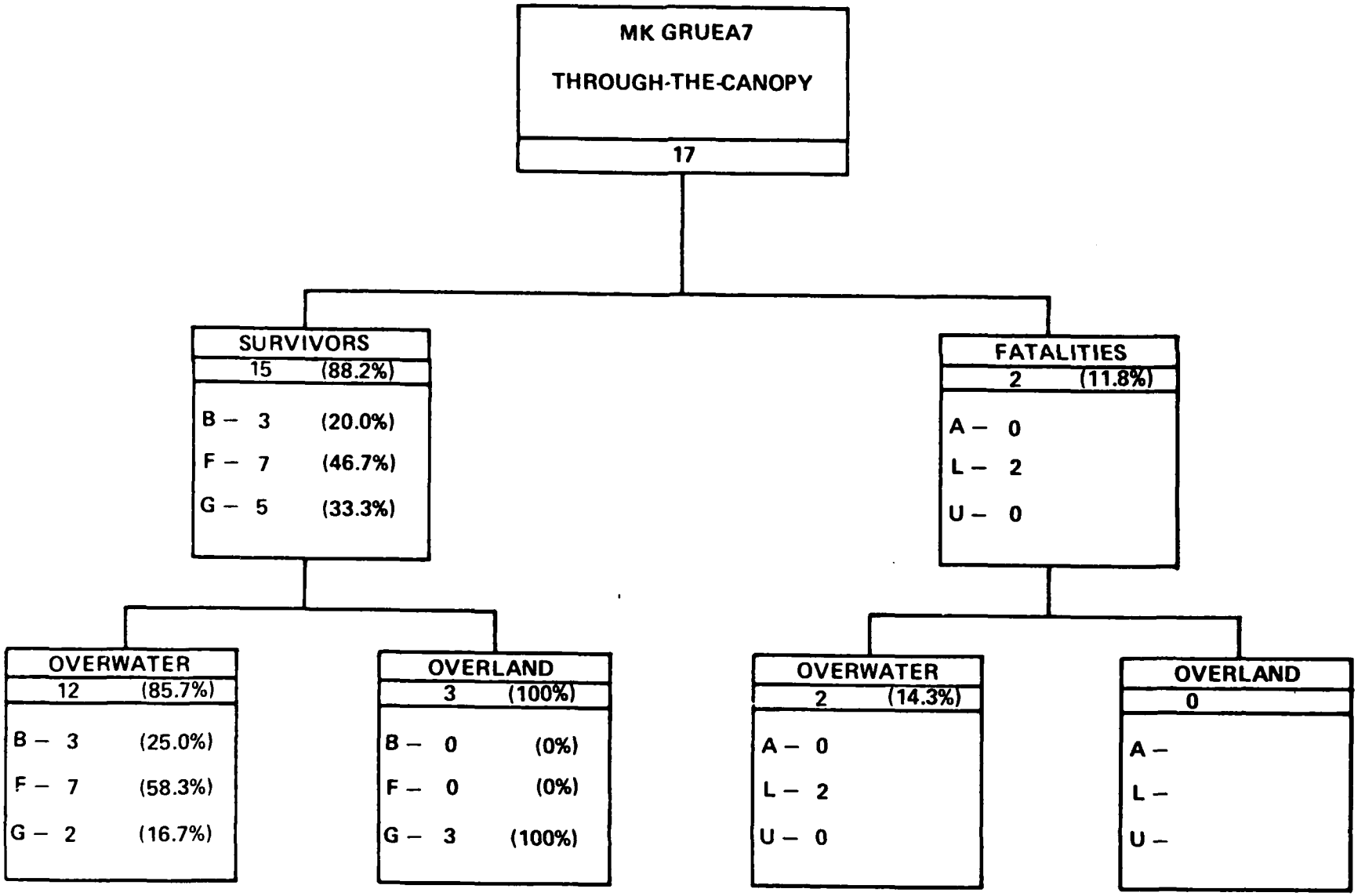

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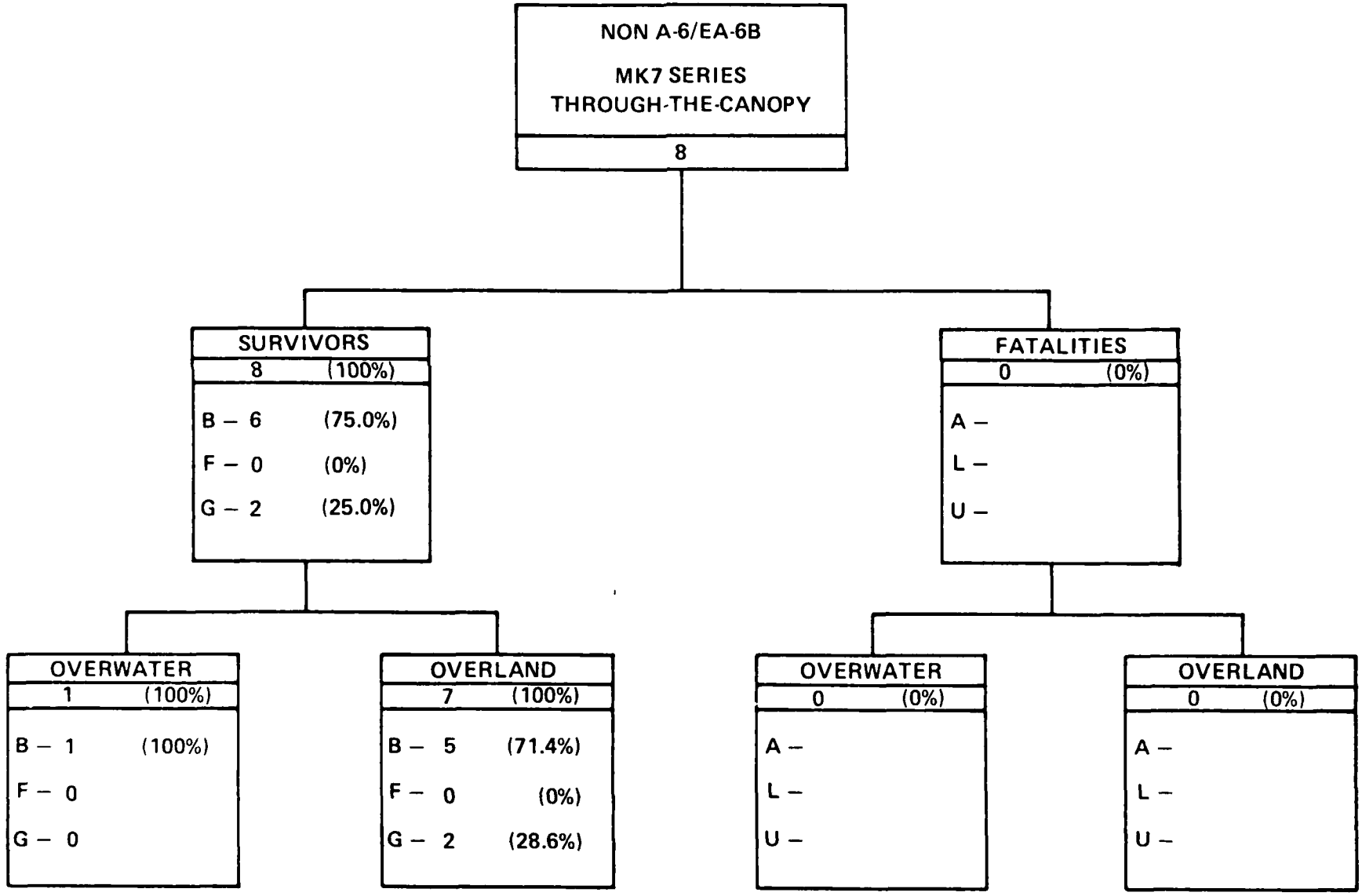

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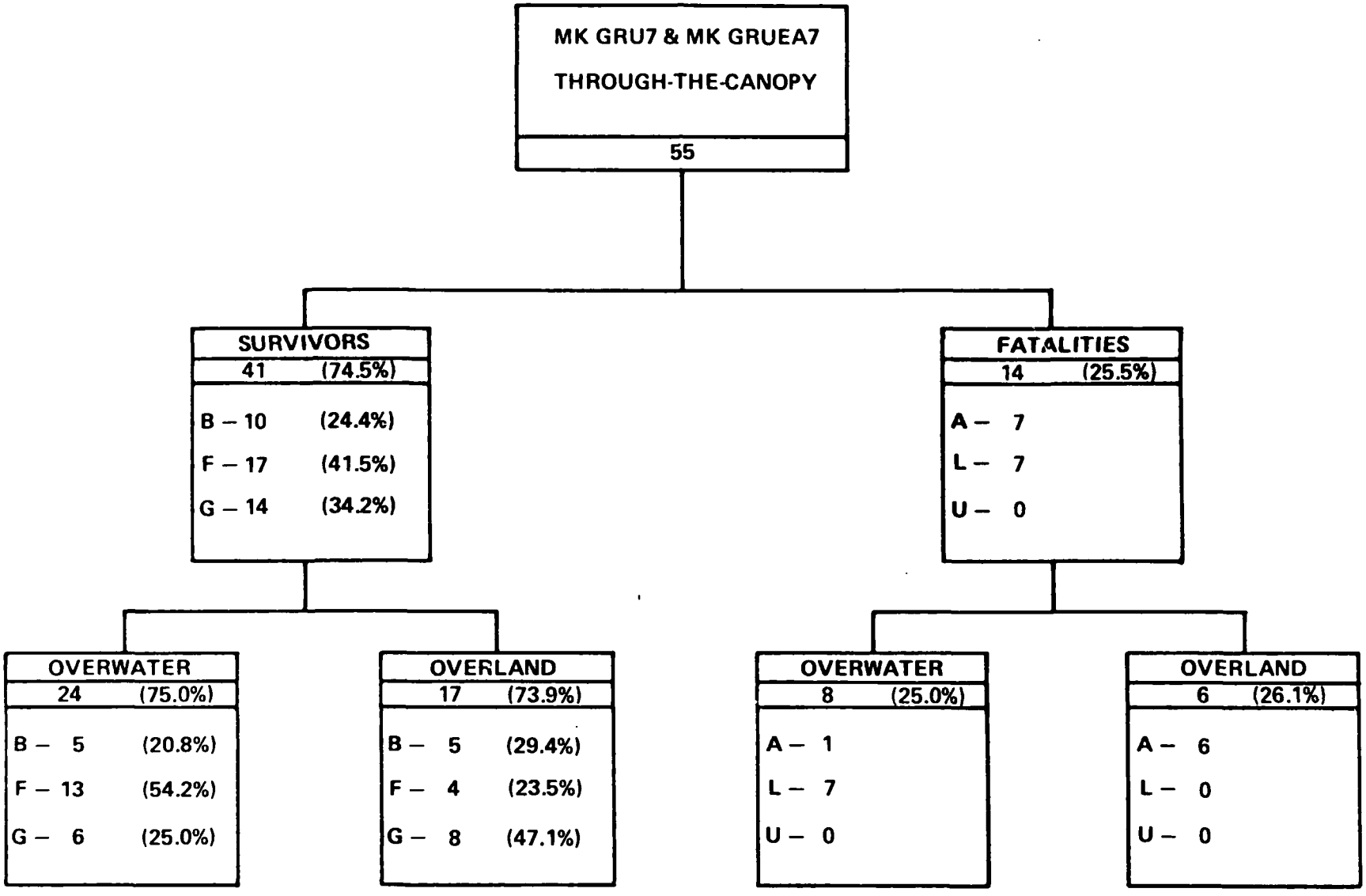

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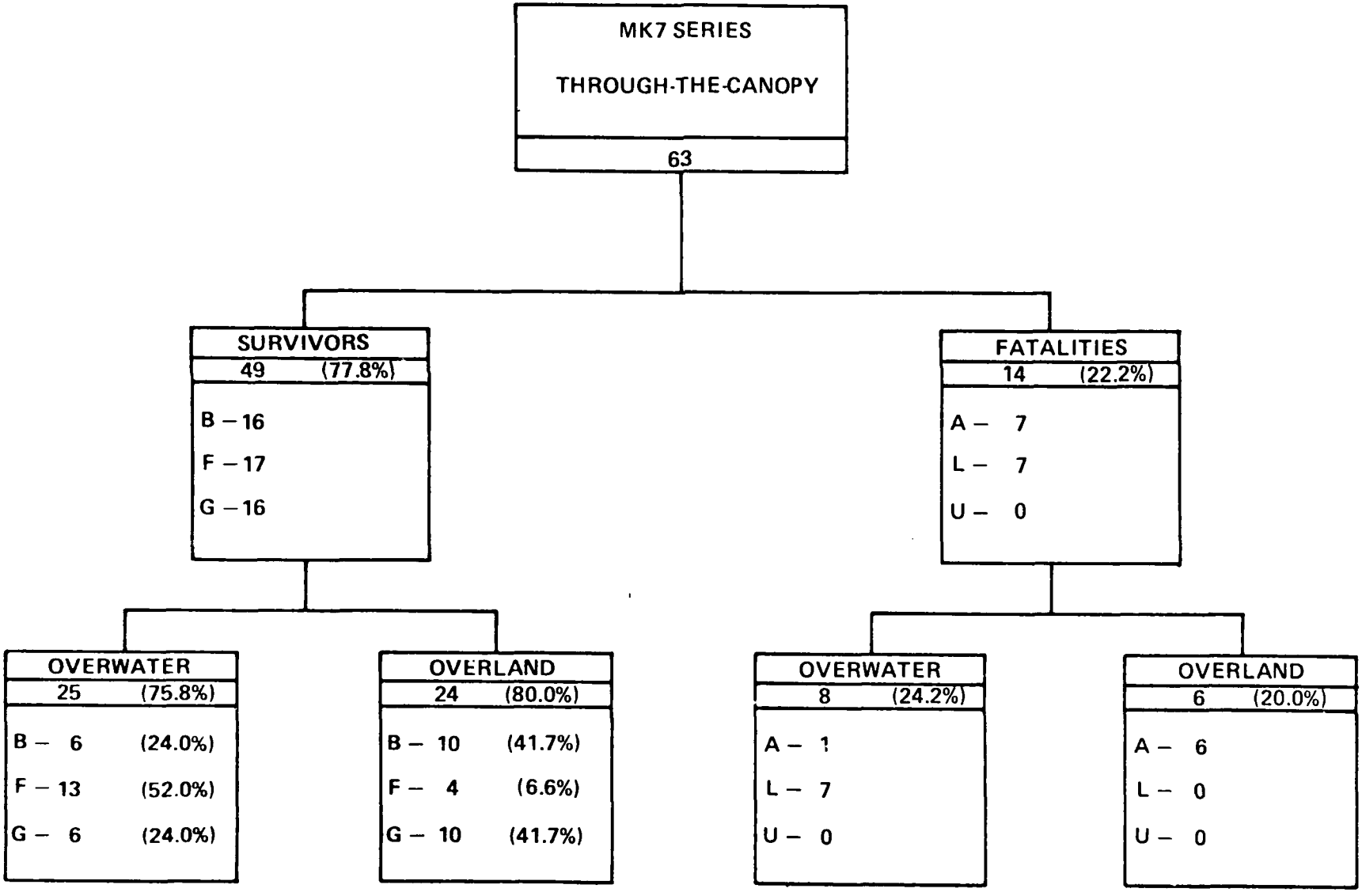

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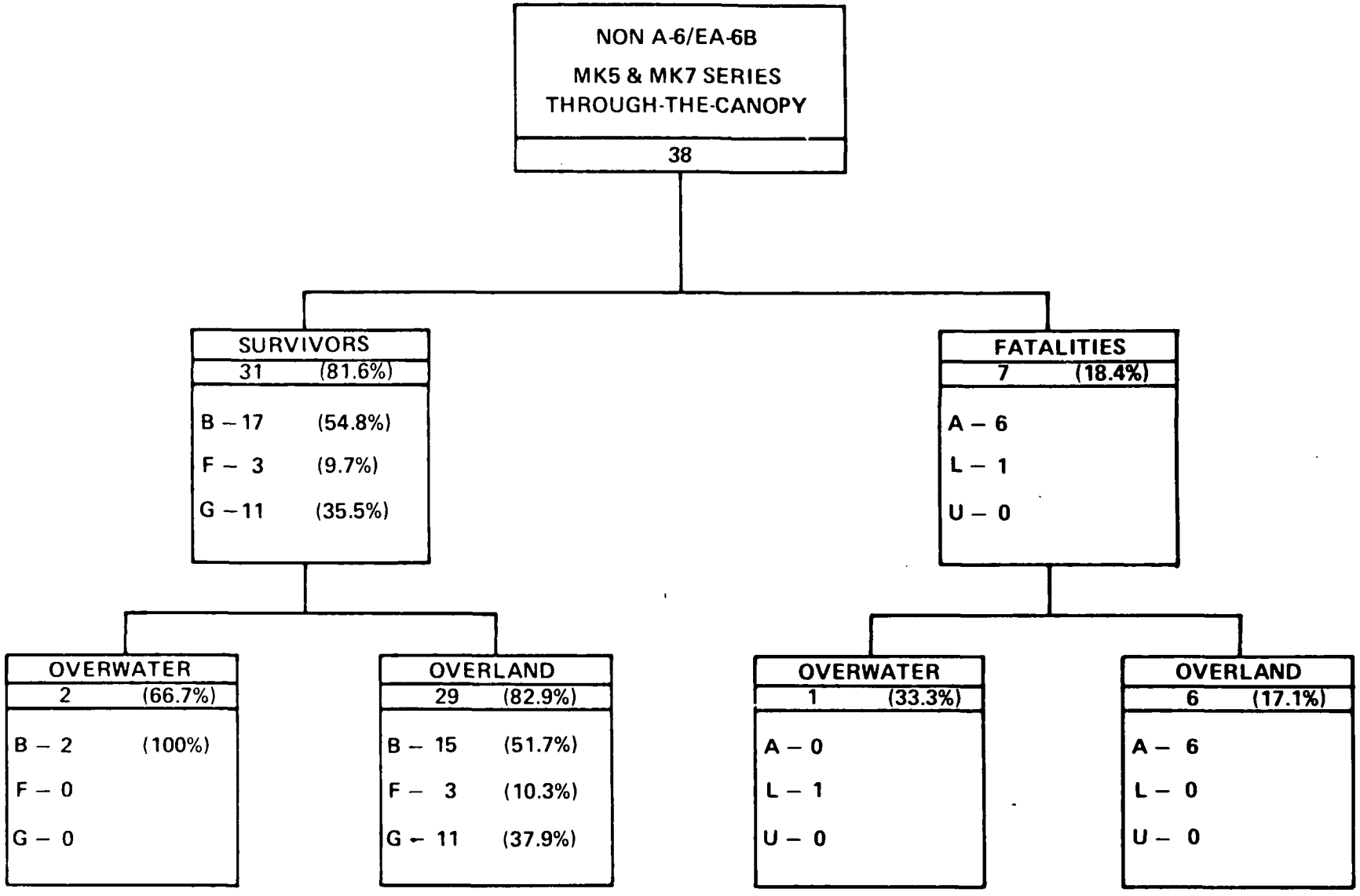

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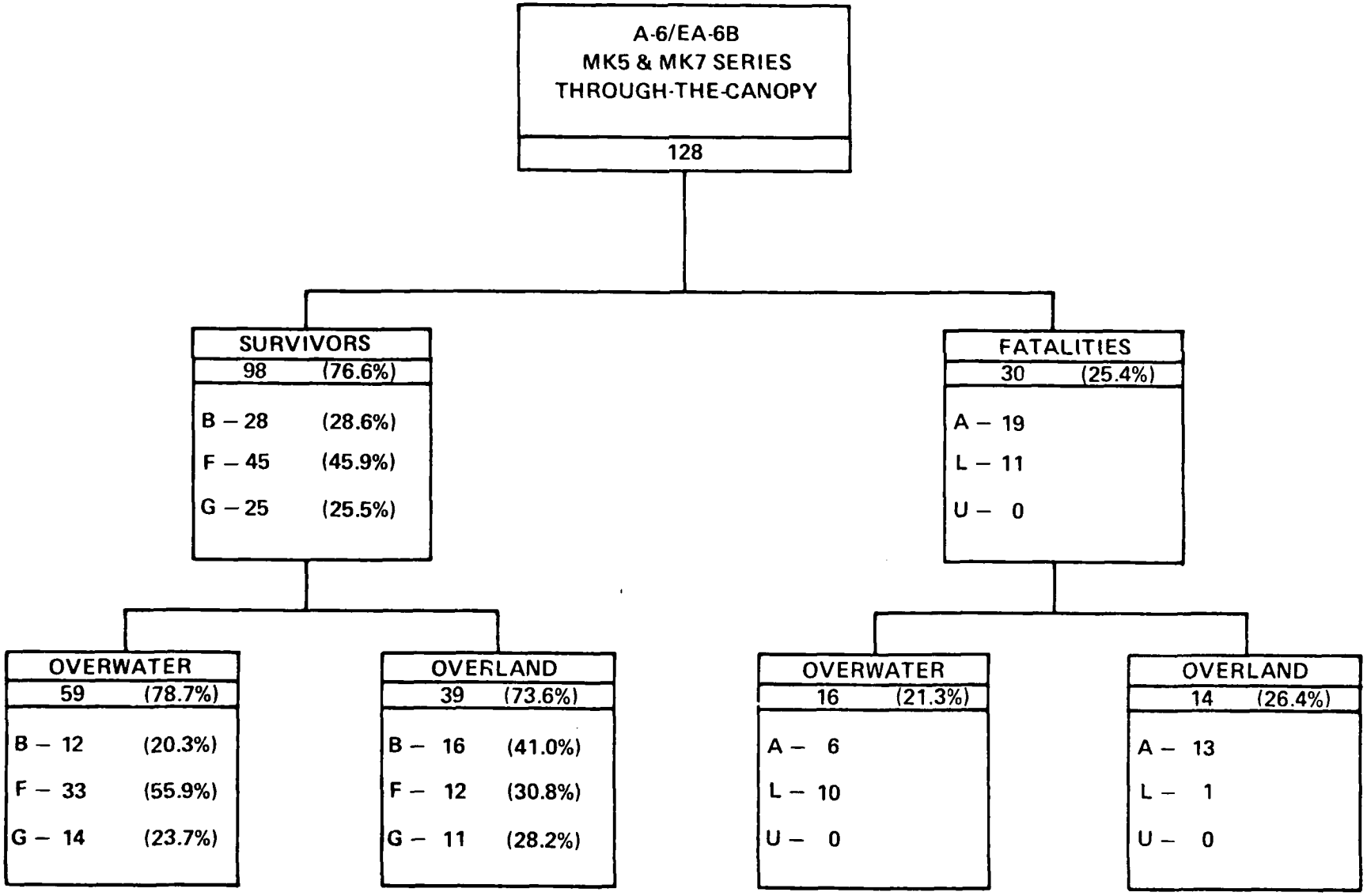
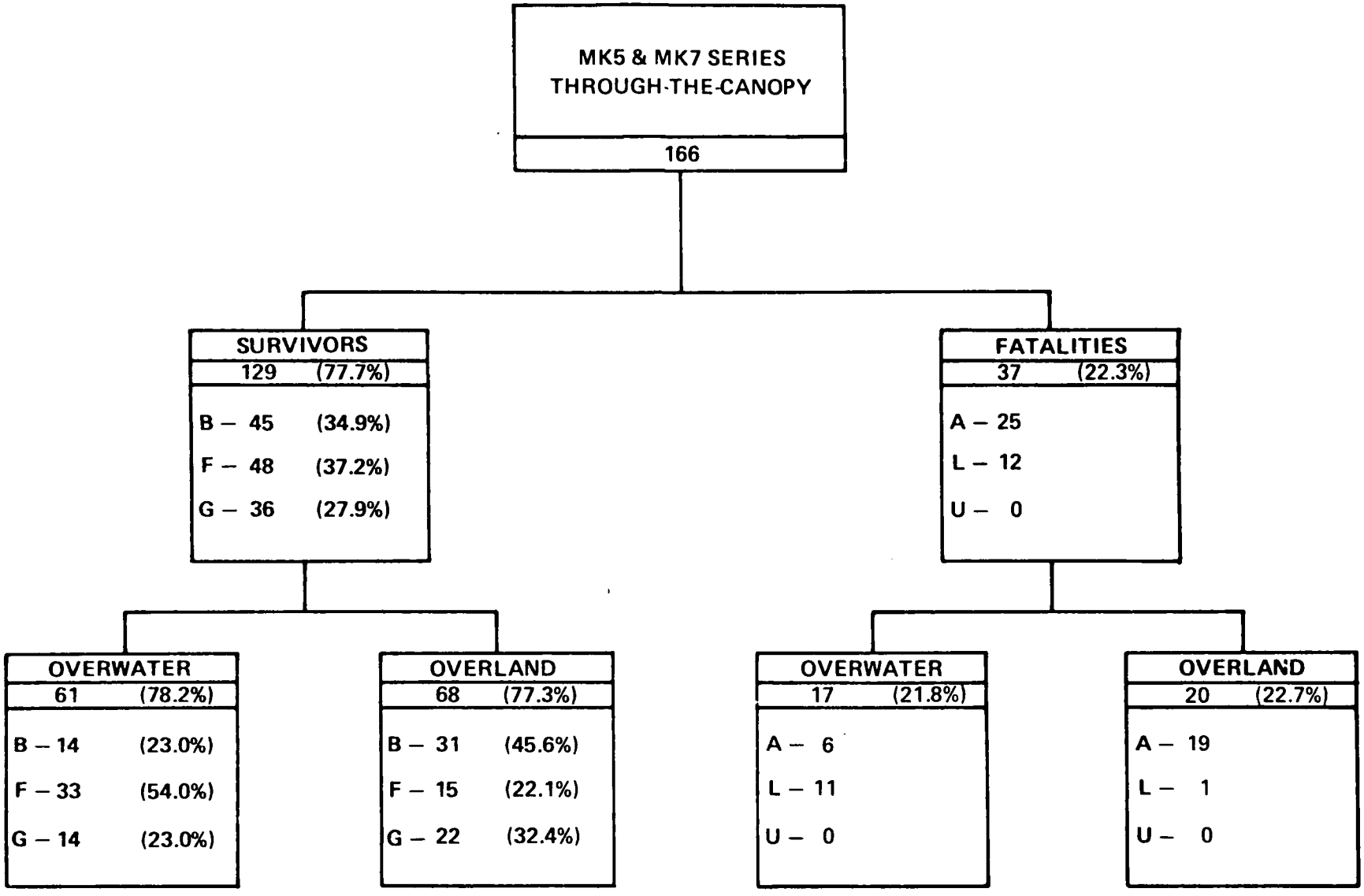


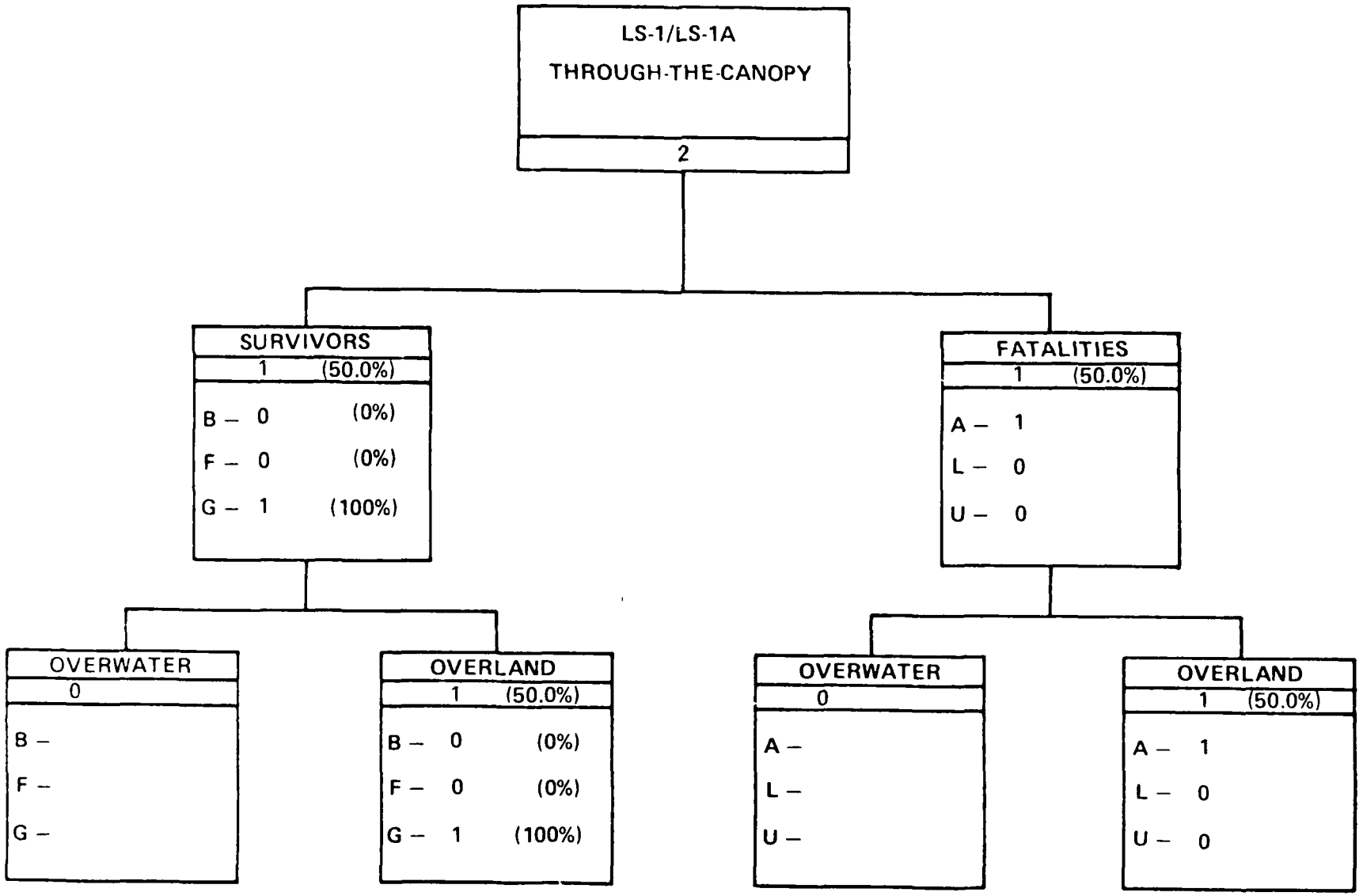
NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979



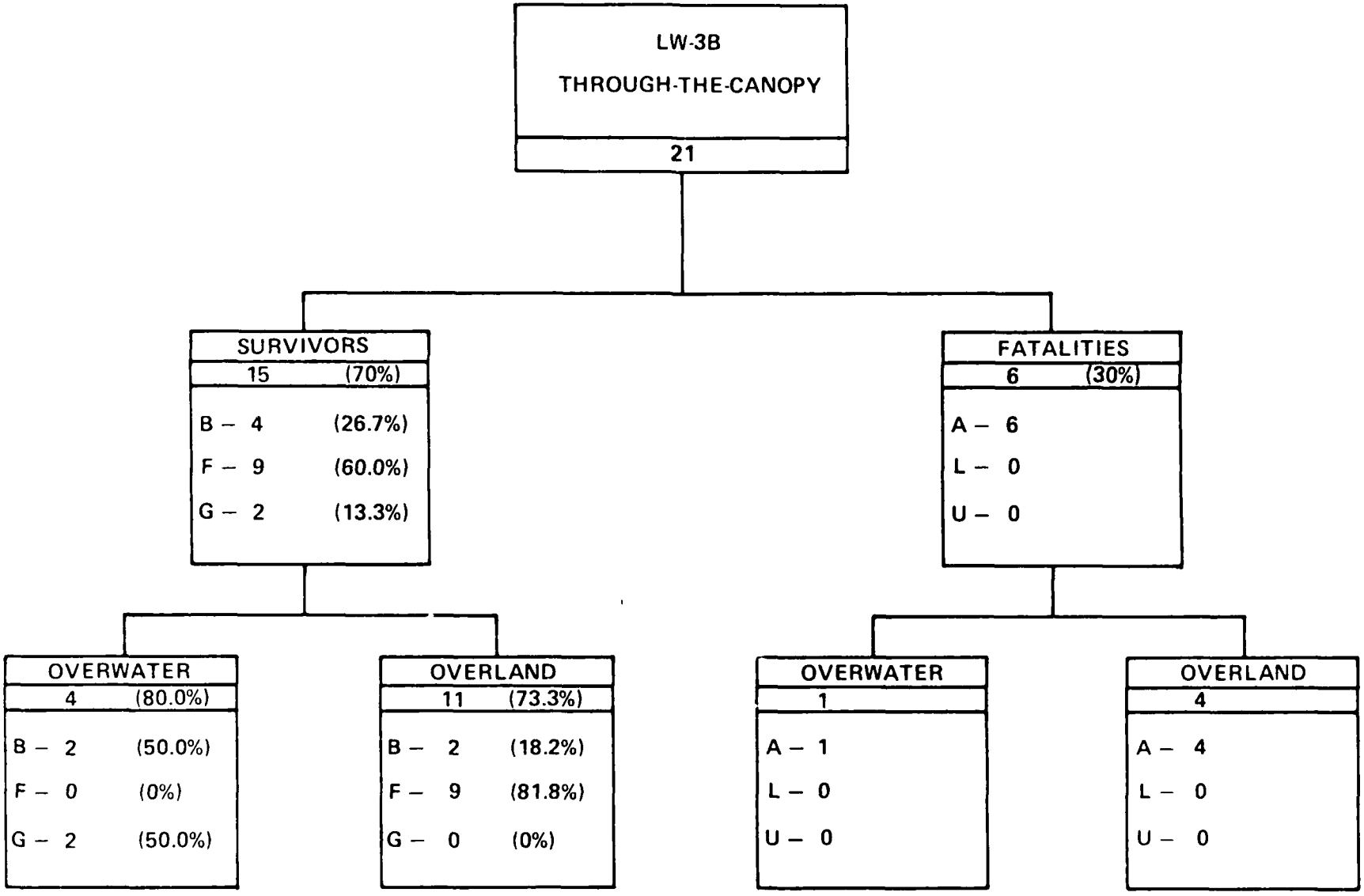
NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979



NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979



U.S. NAVY
EJECTIONS ACCOMPLISHED CLEAR OF AIRCRAFT
AND
INADVERTENT EJECTIONS

(1 JAN 1969 - 31 DEC 1979)

CANOPY FRAGMENTATION (TOTAL) EJECTIONS

CANOPY FRAGMENTATION (TOTAL)
EJECTIONS
1 JAN 1969 - 31 DEC 1979

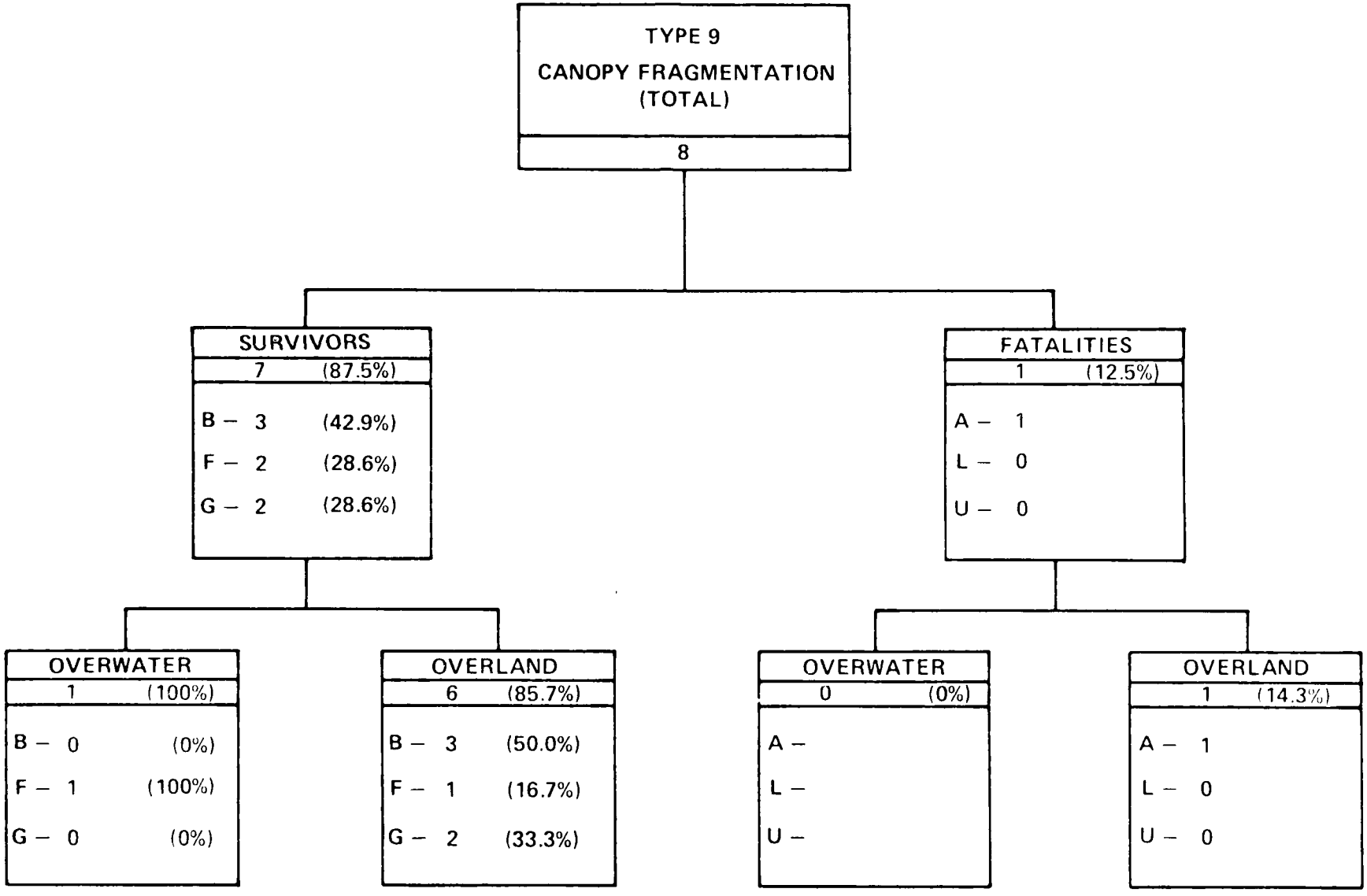
	OVERWATER		OVERLAND	
EJECTION SEAT	TOTAL EJECTEES	FATAL (A/L,U)	TOTAL EJECTEES	FATAL (A/L,U)
TYPE 9	1	0/0	7	1/0
S111S-3AV8	2	0/0	5	0/0
	3	0/0	12	1/0
		15	1/0	(6.7%)

	OVERWATER			OVERLAND		
EJECTION SEAT	TOTAL EJECTEES	MAJ INJ	(RATE)	TOTAL EJECTEES	MAJ INJ	(RATE)
TYPE 9	1	0	(0%)	7	3	(42.9%)
S111S-3AV8	2	0	(0%)	5	1	(20%)
	3	0	(0%)	12	4	(25%)
		15		4	(26.7%)	

		MINOR INJ			MINOR INJ	
TYPE 9	1	1	(100%)	7	1	(14.3%)
S111S-3AV8	2	0	(0%)	5	1	(20%)
	3	1	(33.3%)	12	2	(16.7%)
		15		3	(20%)	

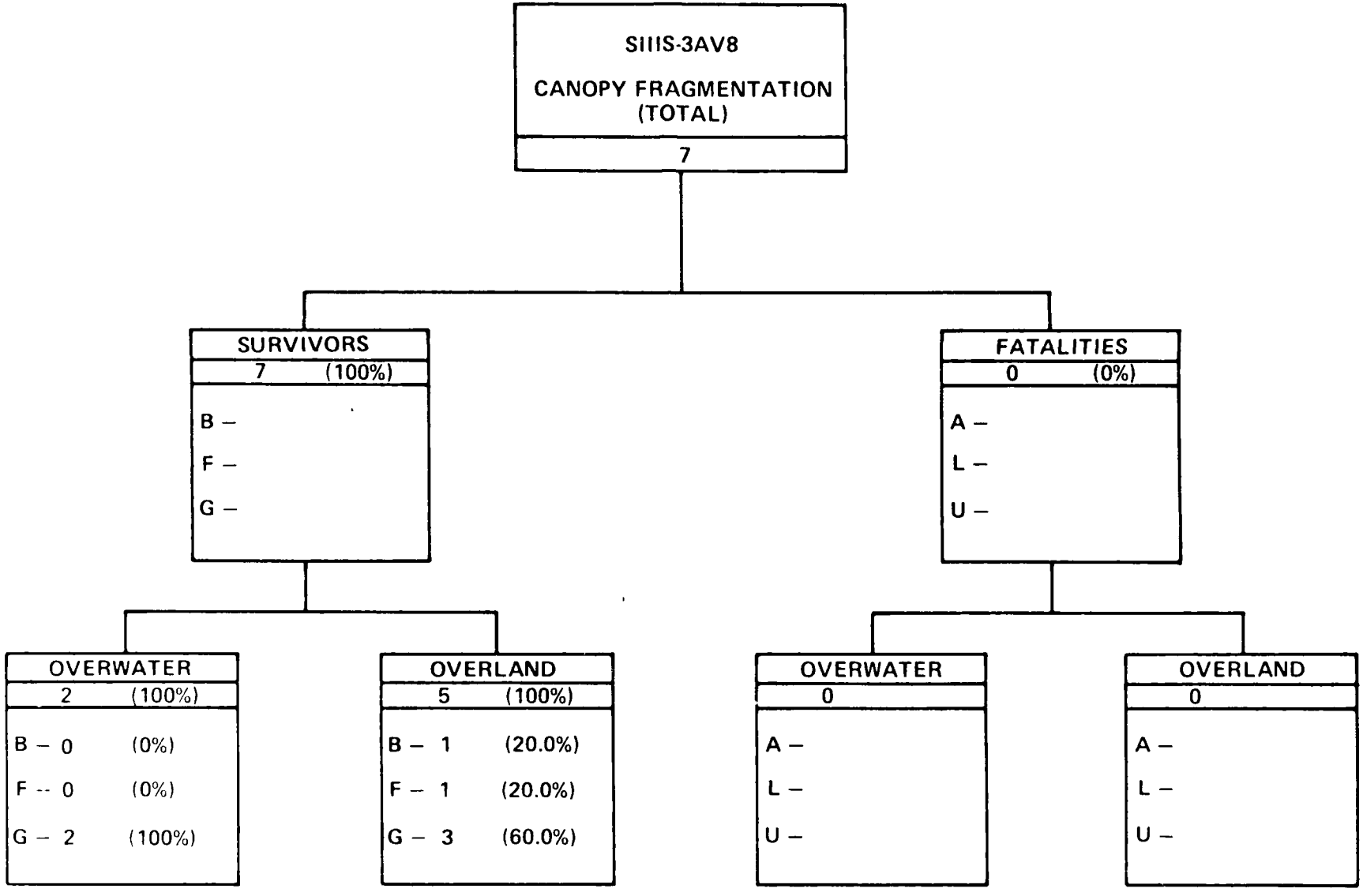
NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979



NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979



U.S. NAVY
EJECTIONS ACCOMPLISHED CLEAR OF AIRCRAFT
AND
INADVERTENT EJECTIONS

(1 JAN 1969 - 31 DEC 1979)

CANOPY CUTTING (PARTIAL) EJECTIONS

CANOPY CUTTING (PARTIAL) EJECTIONS

1 JAN 1969 - 31 DEC 1979

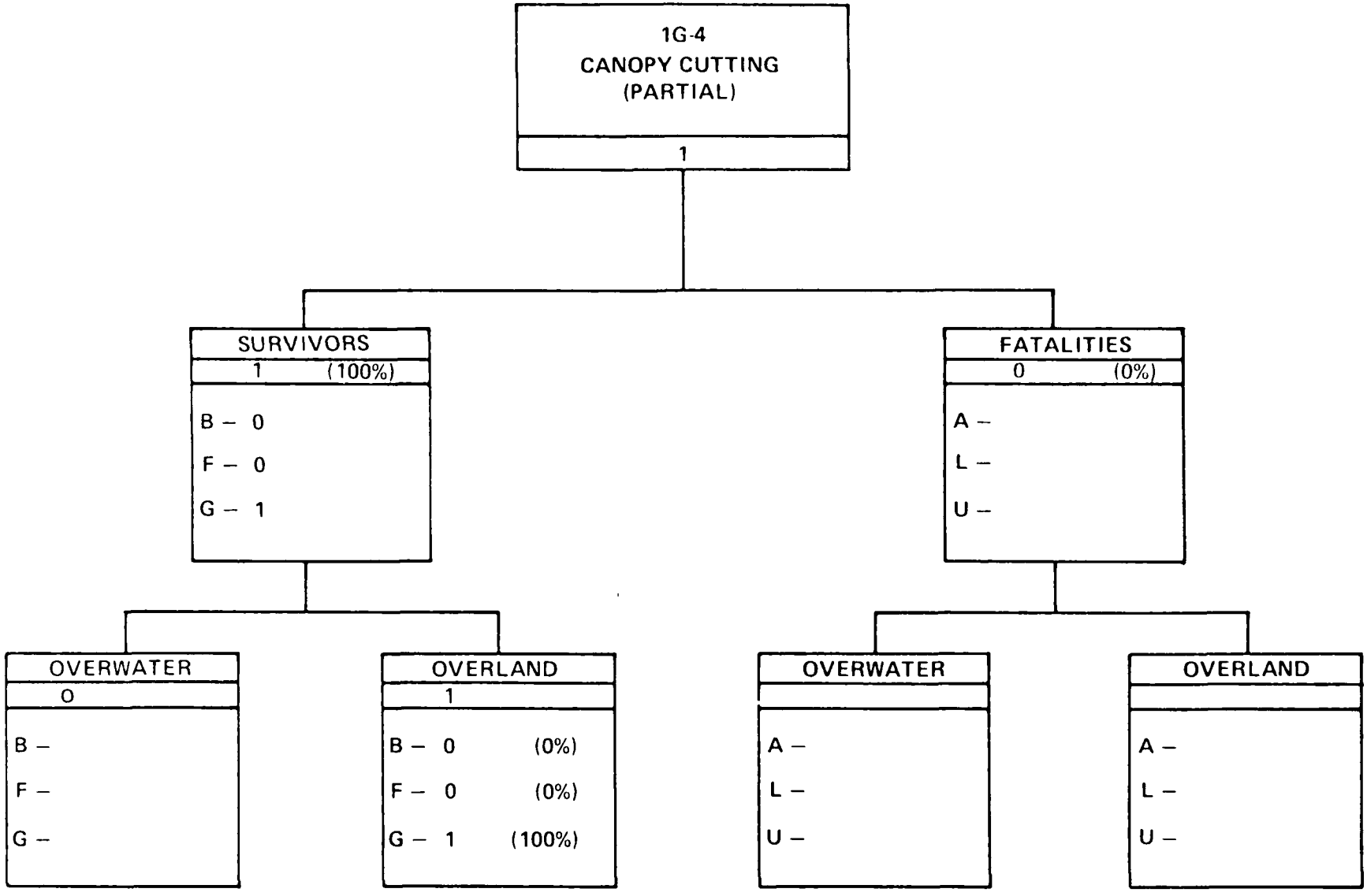
	OVERWATER		OVERLAND	
EJECTION SEAT	TOTAL EJECTEES	FATAL (A/L,U)	TOTAL EJECTEES	FATAL (A/L,U)
ESCAPAC 1G-4	1	0/0	0	0/0
		1	0/0	(0.0%)

NO MAJOR INJURIES

NO MINOR INJURIES

NAVY EJECTIONS (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979



U.S. NAVY
FATALITIES
TYPES 2,3&6 EJECTIONS

	OVERWATER			OVERLAND			ALL		
TYPE EJECTION	EJECTEES	FATAL (A/L, U)	(RATE)	EJECTEES	FATAL (A/L, U)	(RATE)	EJECTEES	FATAL (A/L, U)	(RATE)
JETTISONED CANOPY	17	13	76.5%	33	19	57.6%	50	32	64.0%
THROUGH – THE – CANOPY	4	2	50.0%	–	–	–	4	2	50.0%
CANOPY FRAGMENTATION (TOTAL)									
CANOPY CUTTING (PARTIAL)									
TOTALS	21	15	71.4%	33	19	57.6%	54	34	63.0%

U.S. NAVY
FATALITIES
TYPES 1,2,3,5&6 EJECTIONS

	OVERWATER			OVERLAND			ALL		
TYPE EJECTION	EJECTEES	FATAL (A/L, U)	(RATE)	EJECTEES	FATAL (A/L, U)	(RATE)	EJECTEES	FATAL (A/L, U)	(RATE)
JETTISONED CANOPY	542	79	14.6%	592	96	16.2%	1134	175	15.4%
THROUGH – THE – CANOPY	113	29	25.7%	128	31	24.2%	241	60	24.9%
CANOPY FRAGMEN-TATION (TOTAL)	3	0	0%	12	2	16.7%	15	1	6.7%
CANOPY CUTTING (PARTIAL)				1	0	0%	1	0	0%
TOTALS	658	108	16.4%	733	128	17.5%	1391	236	17.0%

EJECTION ENVELOPE
ACCOMPLISHED AND INADVERTENT EJECTIONS
(BY CANOPY REMOVAL SYSTEM)

	OVERWATER			OVERLAND			ALL		
	TOTAL	FATAL	%	TOTAL	FATAL	%	TOTAL	FATAL	%
JETTISONED – CANOPY ENVELOPE									
– IN	486	32	6.6	493	24	4.9	979	56	5.7
– OUT	31	28	90.3	58	53	91.4	89	81	91.0
– POS	8	6	75.0	8	0	00.0	16	6	37.5
THROUGH – THE – CANOPY ENVELOPE									
– IN	91	11	21.1	103	9	8.7	194	20	10.3
– OUT	16	15	93.8	24	22	91.7	40	37	92.5
– POS	2	1	50.0	1	0	00.0	3	1	33.3
CANOPY FRAG-MENTATION									
– IN	3	0	00.0	11	0	00.0	14	0	00.0
– OUT	0	–	00.0	1	1	100.0	1	1	100.0
– POS	0	–	00.0	0	–	00.0	0	0	00.0
CANOPY CUT									
– IN	–			1	–	00.0	1	0	00.0
– OUT	–			0	–	00.0	0	–	00.0
– POS	–			0	–	00.0	0	–	00.0
TOTALS	637	93		700	109		1337	202	

U.S. NAVY
FATALITIES
TYPES 4,7,8,0 & BLANK EJECTIONS

	OVERWATER			OVERLAND			ALL		
TYPE EJECTION	EJECTEES	FATAL (A/L, U)	(RATE)	EJECTEES	FATAL (A/L, U)	(RATE)	EJECTEES	FATAL (A/L, U)	(RATE)
JETTISONED CANOPY	137	137	100%	191	133	69.6%	328	270	82.3%
THROUGH – THE – CANOPY	29	28	96.6%	51	35	68.6%	80	63	78.8%
CANOPY FRAGMENTATION (TOTAL)	6	5	83.3%	9	6	66.7%	15	11	73.3%
CANOPY CUTTING (PARTIAL)	–			2	2	100%	2	2	100%
TOTALS	172	170	98.8%	253	176	69.6%	425	346	81.4%

DETAILED DISCUSSION

CONCERNING VERTEBRAL COMPRESSION

FRACTURES ASSOCIATED WITH EJECTION

EJECTION ASSOCIATED VERTEBRAL INJURIES

- VERTEBRAL COMPRESSION FRACTURES
- PARAVERTEBRAL MUSCULAR STRAINS/SPRAINS

EJECTION FORCES

$$F_{CATAPULT} = p \cdot A_{(CATAPULT\ PISTON)} = m_{(SEAT\ +\ EJECTEE)} \cdot a_{(SEAT\ +\ EJECTEE)}$$

$$= \frac{W_{(SEAT\ +\ EJECTEE)}}{g} \cdot a_{(SEAT\ +\ EJECTEE)}$$

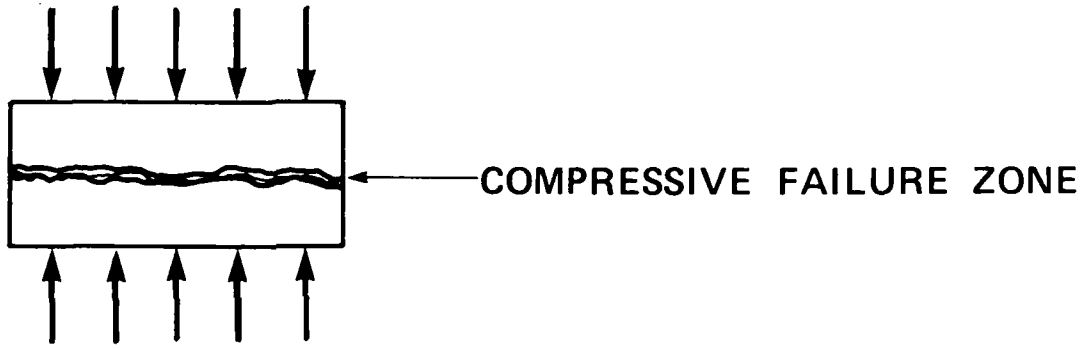
$$a_{(SEAT\ +\ EJECTEE)} = p \cdot \frac{A_{(CATAPULT\ PISTON)} \cdot g}{W_{(SEAT\ +\ EJECTEE)}}$$

WHERE

- p IS PRESSURE INSIDE CATAPULT (PSF)
- g IS GRAVITY CONSTANT (32.2 FT/SEC^2)
- A IS CATAPULT PISTON AREA (FT^2)
- m IS EJECTED MASS (LBS-SEC^2/FT)
- W IS EJECTED WEIGHT (LBS)
- a IS ACCELERATION (FT/SEC^2)

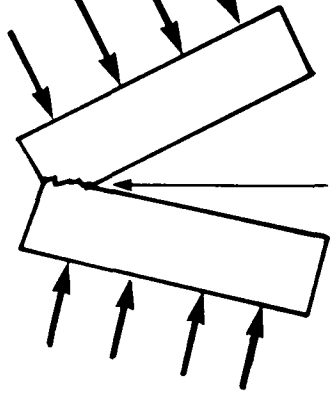
VERTEBRAL COMPRESSION FRACTURE MECHANISMS

- IMMEDIATE CAUSE OF MATERIAL COMPRESSIVE FAILURE IS OVERSTRESS. THIS MAY BE GENERAL, I.E.:



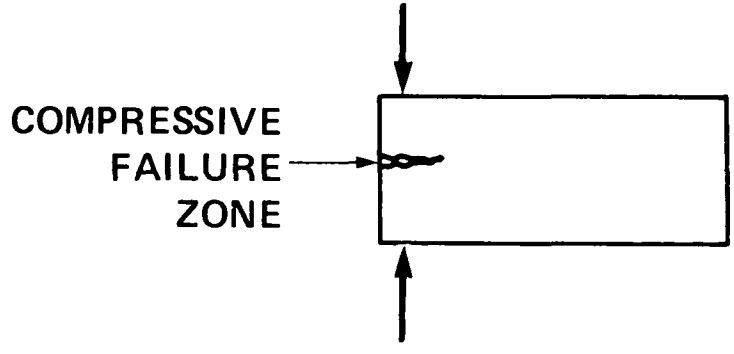
OR IT MAY BE LOCALIZED (CONCENTRATED IN SMALL AREA) EITHER BY

ALIGNMENT



OR

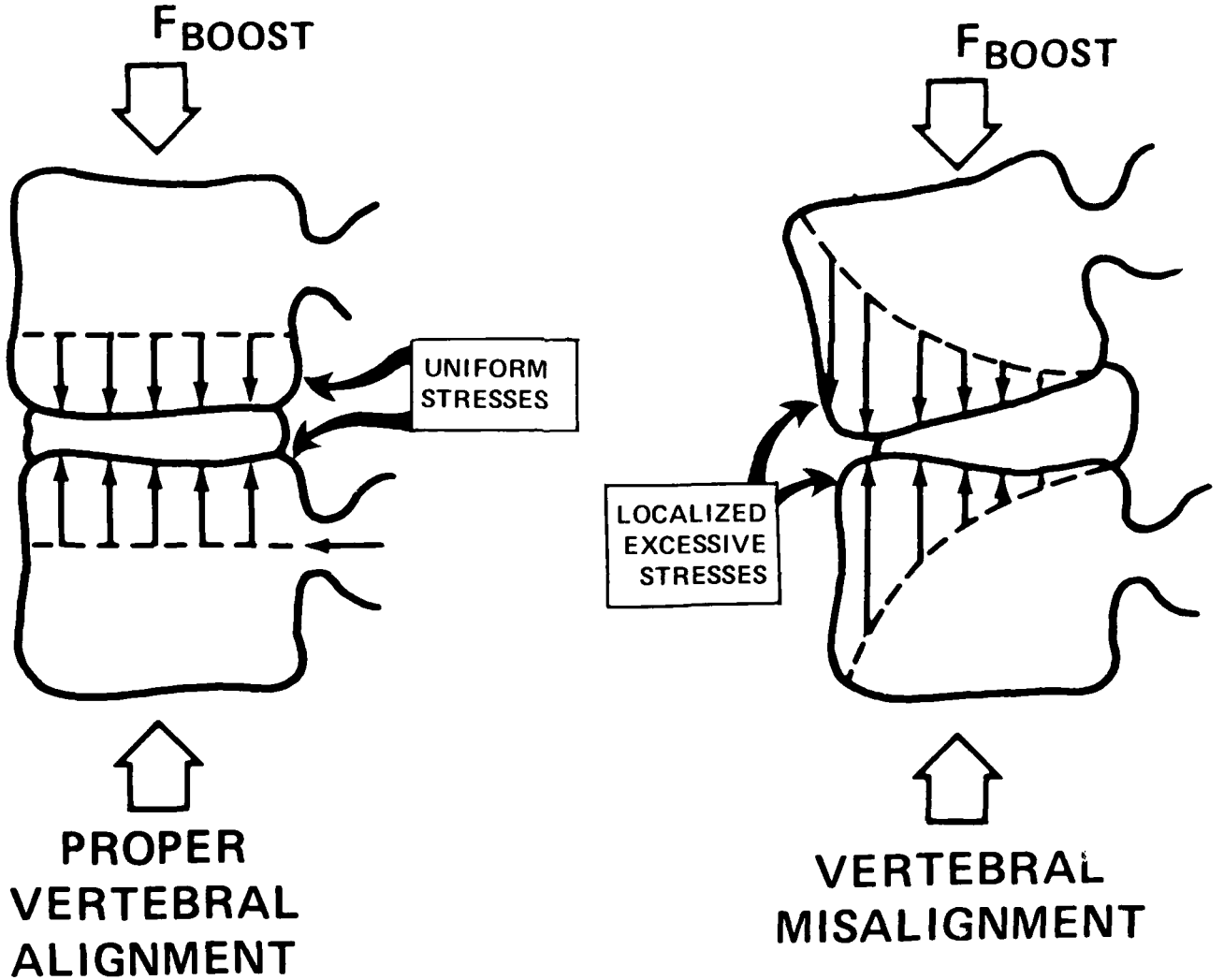
FORCE CONCENTRATION



WHICH INDUCE LOCALIZED EXCESSIVE STRESS

VERTEBRAL COMPRESSION FRACTURE MECHANISMS

EFFECT OF VERTEBRAL ALIGNMENT



- USE OF MARTIN-BAKER MK 5 SERIES EJECTION SEATS WAS ACCOMPANIED BY EXTRAORDINARY INCREASE IN VERTEBRAL COMPRESSION FRACTURE AND PARAVERTEBRAL MUSCLE STRAIN/SPRAIN INCIDENCE RATES.

- ANALYSES REVEALED PREDOMINANT CAUSE FOR INCREASED INCIDENCE RATES WAS CONCURRENT CHANGE TO EJECTING THROUGH THE CANOPY FROM EJECTING FOLLOWING CANOPY JETTISONING.

- SUBSEQUENT ANALYSES HAVE DEMONSTRATED THAT INTRODUCTION OF POWERED HAUL BACK INERTIA REELS SIGNIFICANTLY REDUCES VERTEBRAL INJURY INCIDENCE RATES BOTH FOR JETTISONED CANOPY AND FOR THROUGH-THE-CANOPY EJECTIONS.

APPENDIX D
SEATS INCLUDED BY

A. NAVY STANDARD WITH NAMC TYPE II CATAPULT

1. F4D-1
2. FJ-3, -3D, -3M, -4, -4B
3. F3H-2, -2M, -2N
4. F9F-5, -6, -8, -8B, -8P, -8T
5. F11F-1
6. F2H-4
7. A4D-1

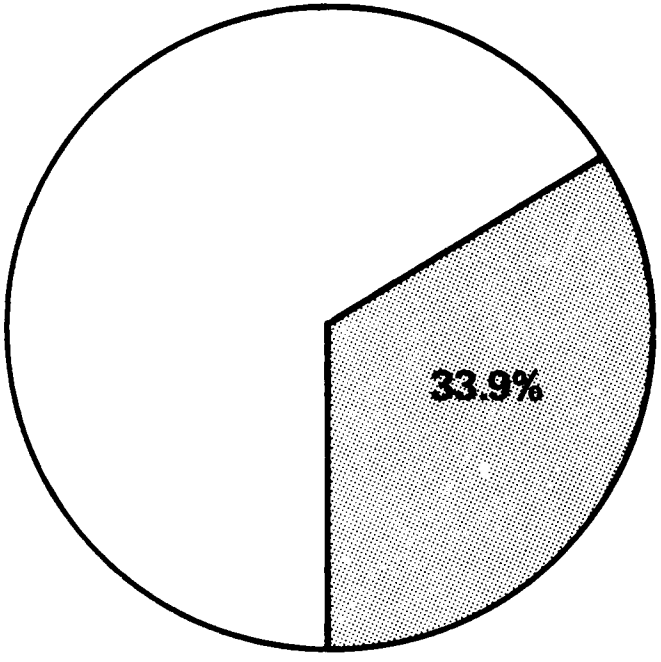
(F8U EXCLUDED)

B. MARTIN–BAKER MK 5 SERIES

1.	F9F-8T	MK A5
2.	F8U SERIES	MK F5
3.	F4H	MK H5
4.	F3H-2	MK M5
5.	FJ-4B	MK N5
6.	F4D-1	MK P5
7.	F11F-1	MK X5
8.	F9F-8B	MK Z5

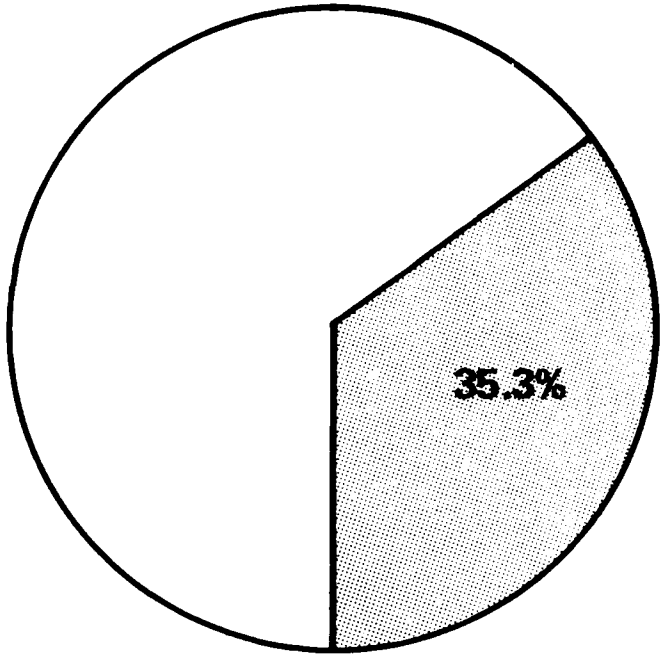
RATE OF VERTEBRAL INJURIES SUSTAINED DURING THROUGH-THE-CANOPY EJECTIONS

(BASED ON SURVIVORS DURING THE PERIOD 1 SEPTEMBER 1958 THROUGH 31 DECEMBER 1961)



MARTIN–BAKER EJECTION SEATS

(18 VERTEBRAL INJURIES/
56 THROUGH–THE–CANOPY
EJECTIONS)

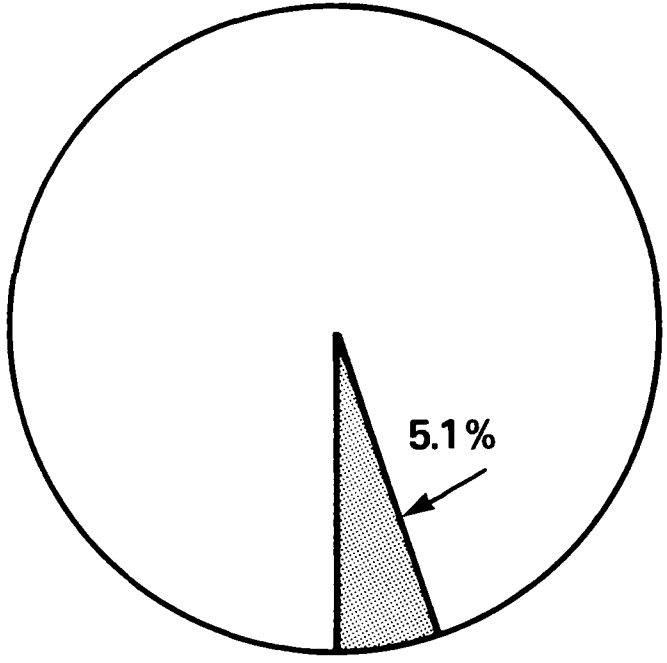


NAVY STANDARD EJECTION SEATS
(NAMC II)

(6 VERTEBRAL INJURIES/
17 THROUGH–THE–CANOPY
EJECTIONS)

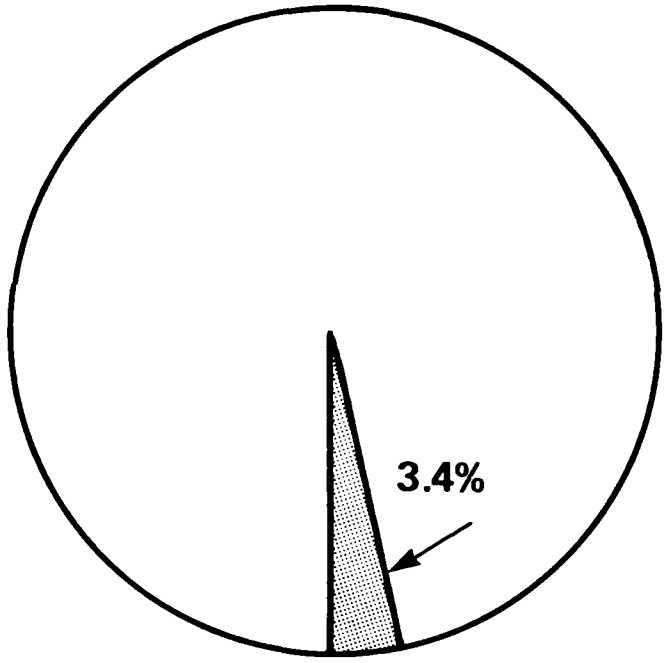
VERTEBRAL INJURIES SUSTAINED DURING CANOPY JETTISONED EJECTIONS

(BASED ON SURVIVORS DURING THE PERIOD 1 SEPTEMBER 1958 THROUGH 31 DECEMBER 1961)



MARTIN–BAKER EJECTION SEATS

(2 VERTEBRAL INJURIES DURING 39 EJECTIONS)

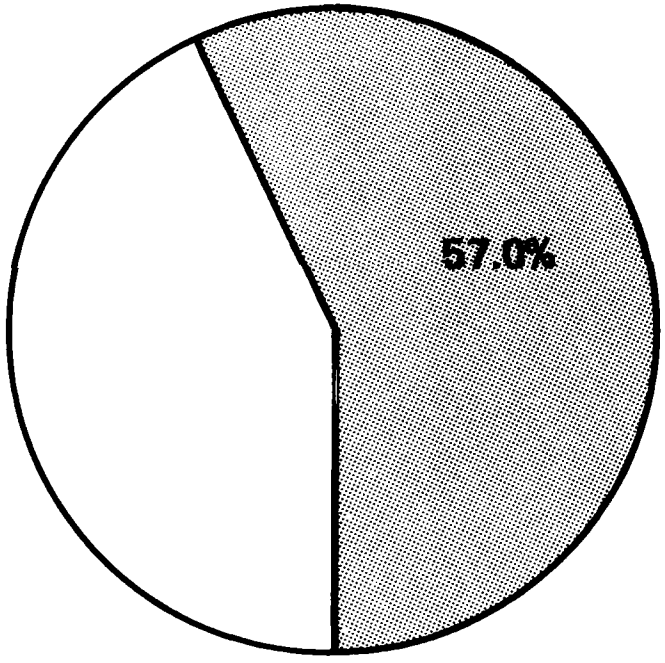


NAVY STANDARD EJECTION SEATS (NAMC II)

(4 VERTEBRAL INJURIES DURING 117 EJECTIONS)

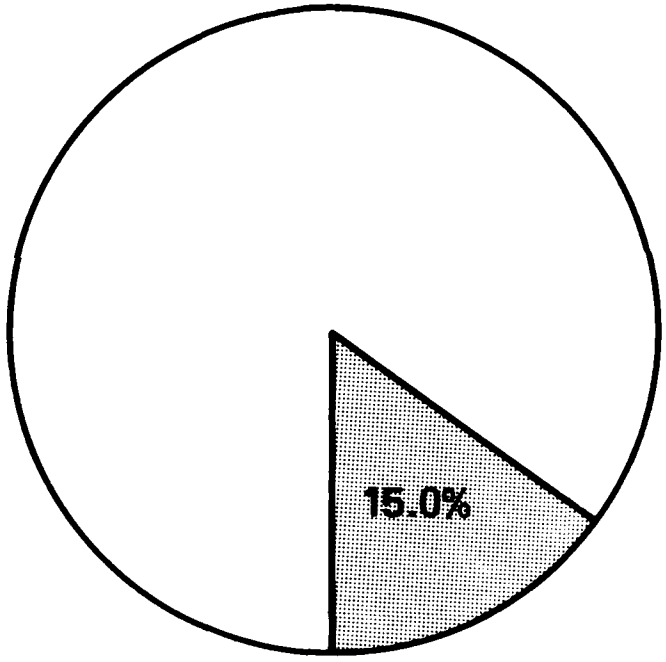
THROUGH-THE-CANOPY EJECTION RATES

(BASED ON TOTAL EJECTIONS DURING THE PERIOD 1 SEPTEMBER 1958 THROUGH 31 DECEMBER 1961)



MARTIN–BAKER EJECTION SEAT

(65 THROUGH–THE–CANOPY EJECTIONS OUT OF 114 EJECTIONS TOTAL)

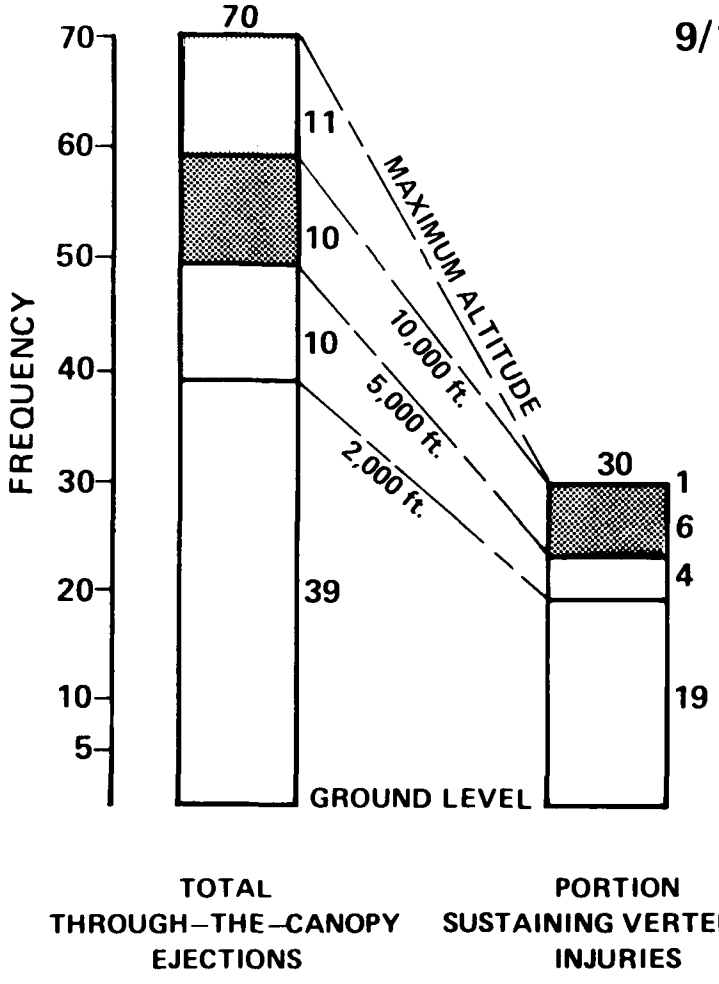


NAVY STANDARD EJECTION SEATS (NAMC II)

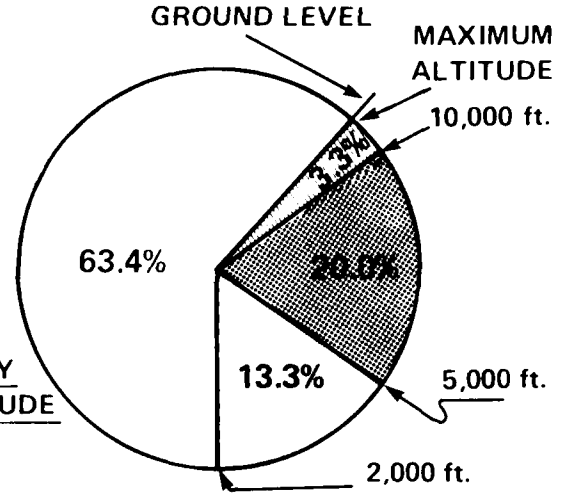
(22 THROUGH-THE-CANOPY EJECTIONS OUT OF 148 EJECTIONS TOTAL)

U.S. NAVY MARTIN-BAKER SEAT USAGE VERTEBRAL INJURIES & THROUGH-THE-CANOPY EJECTIONS VS. EJECTION ALTITUDE

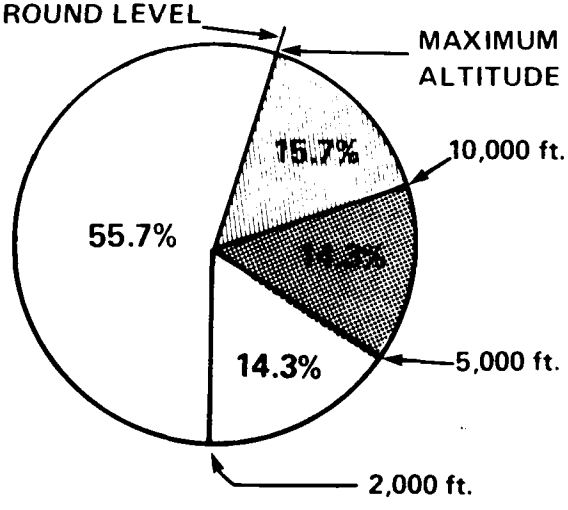
DATA COVERS PERIOD
9/1/58 – 3/31/63



PERCENTAGE EJECTEES SUSTAINING VERTEBRAL INJURY BY EJECTION ALTITUDE

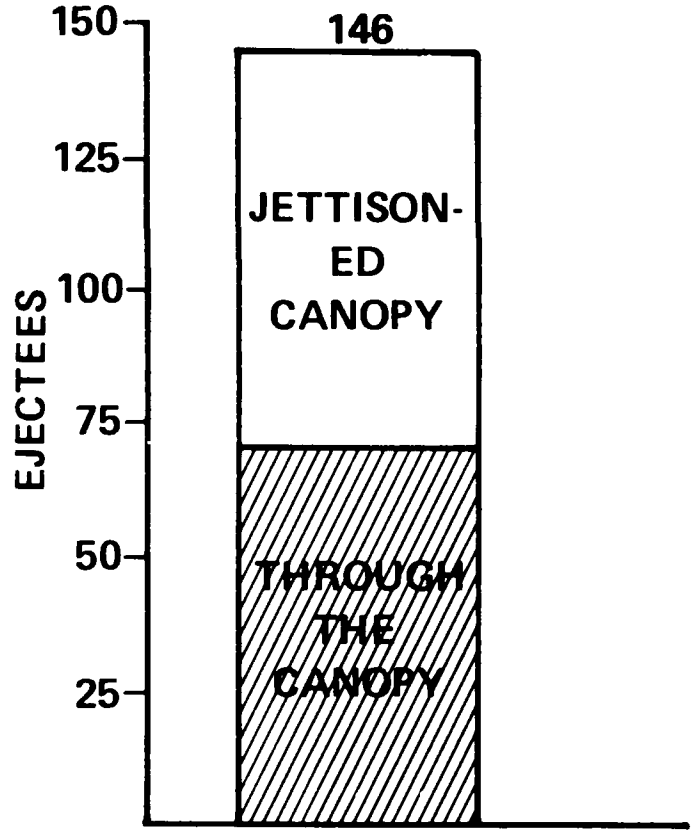


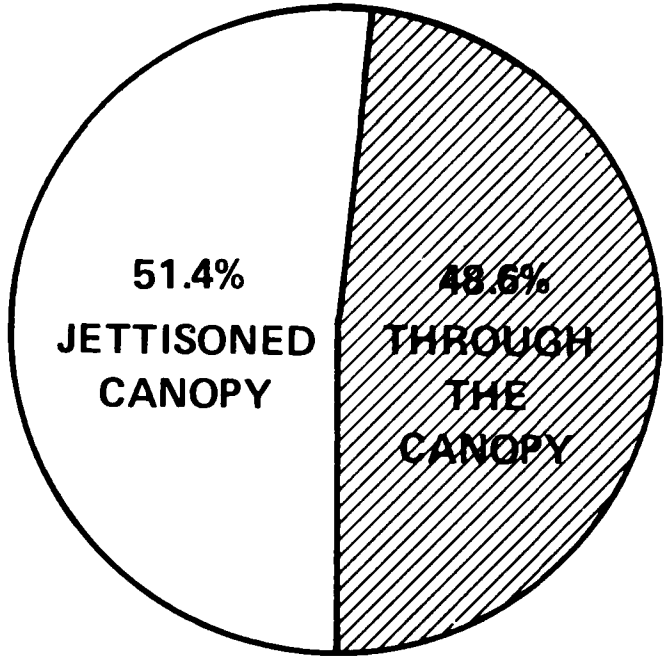
DISTRIBUTION OF EJECTEES BY EJECTION ALTITUDE



U.S. NAVY MARTIN-BAKER SEAT USAGE COMPARISON OF EJECTION METHODS USED BY SURVIVING EJECTEES

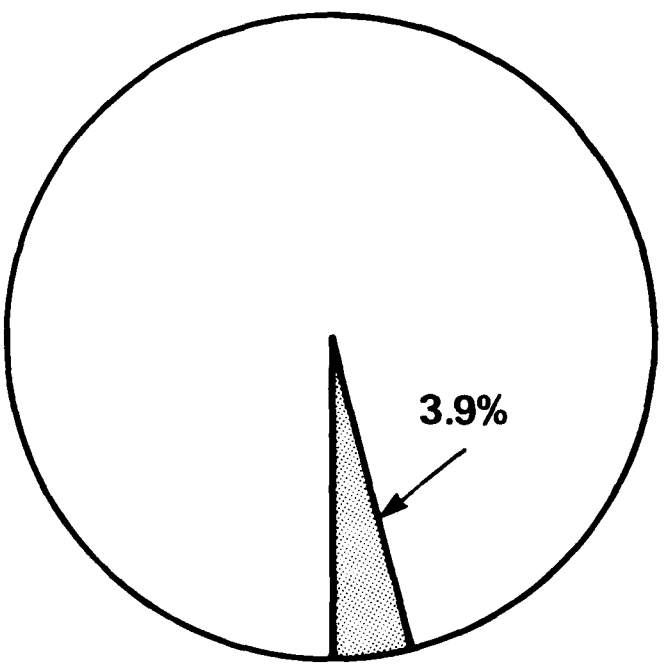
(DATA FOR THE PERIOD 9/1/58 - 3/31/63)



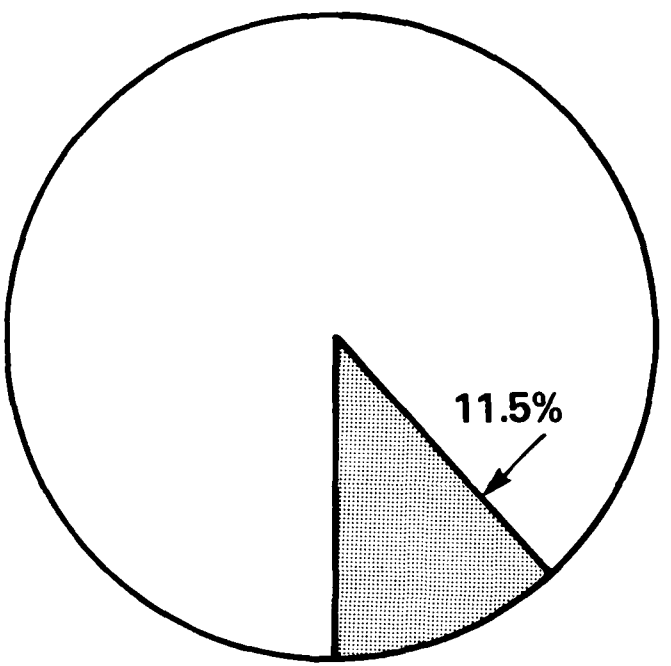


REPORTED CONTRIBUTORY CAUSES OF VERTEBRAL INJURIES SUSTAINED DURING EJECTION WITH MARTIN-BAKER EJECTION SEATS

(BASED ON VERTEBRAL INJURIES DURING THE PERIOD 1 SEPTEMBER 1958 THROUGH 13 APRIL 1962)



LOOSE RESTRAINT HARNESS

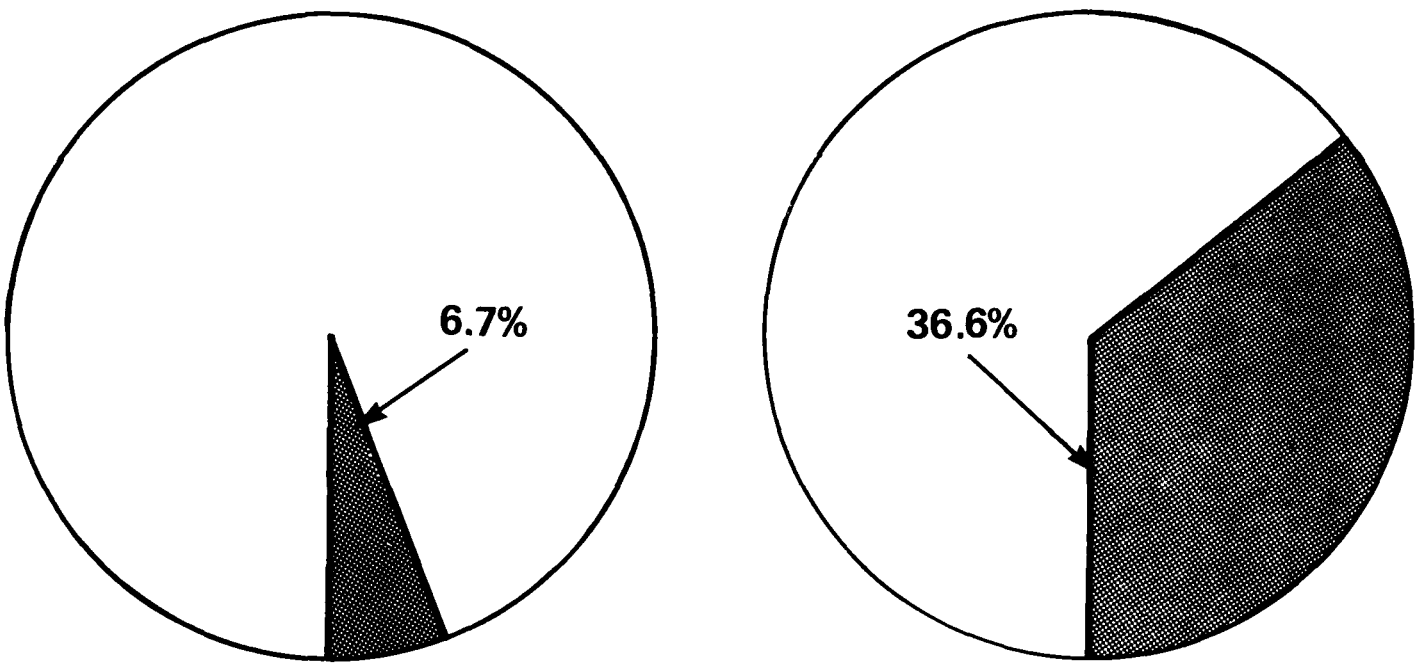


POOR POSITION

THESE INJURIES WERE SUSTAINED DURING THROUGH-THE-CANOPY EJECTIONS

U.S. NAVY MARTIN-BAKER SEAT USAGE COMPARISON OF VERTEBRAL INJURY RATES BY EJECTION METHOD

(DATA COVERS PERIOD 9/1/58 - 3/31/63 SURVIVORS ONLY)

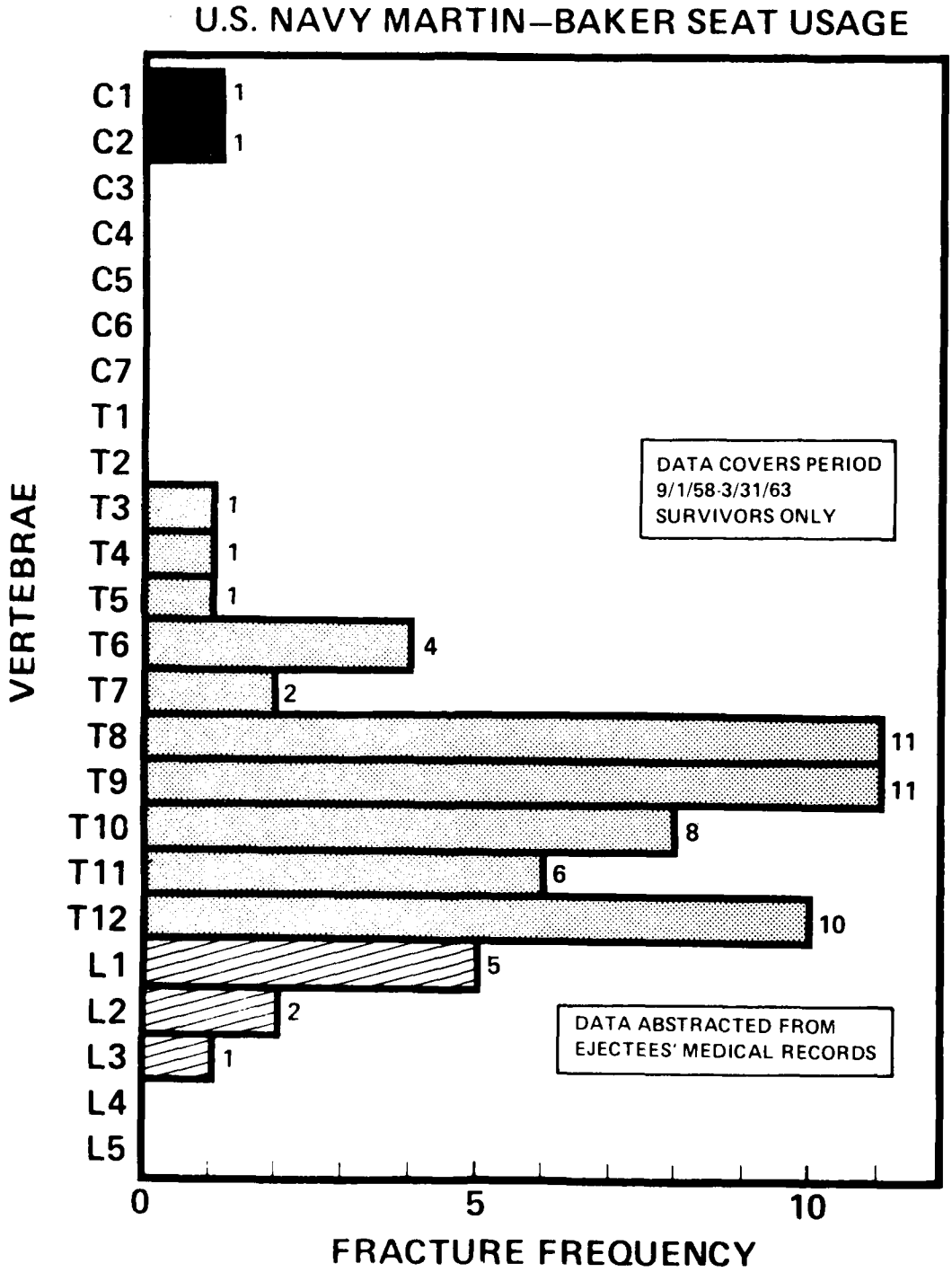


JETTISONED CANOPY

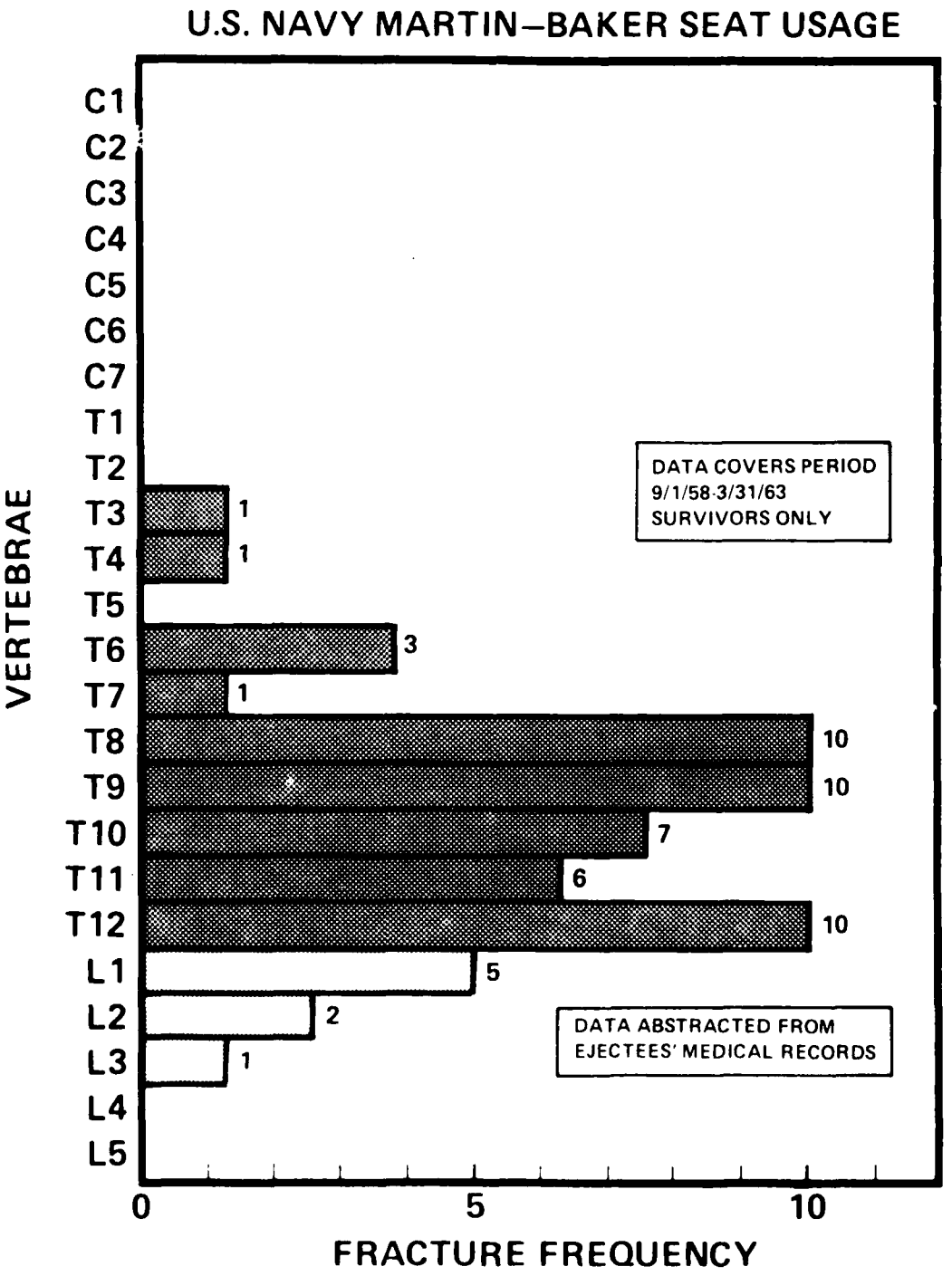
THROUGH-THE-CANOPY

VERTEBRAL INJURY RATE REPRESENTED
BY CROSS-HATCHED AREAS

DISTRIBUTION OF ALL EJECTION-ASSOCIATED VERTEBRAL FRACTURES

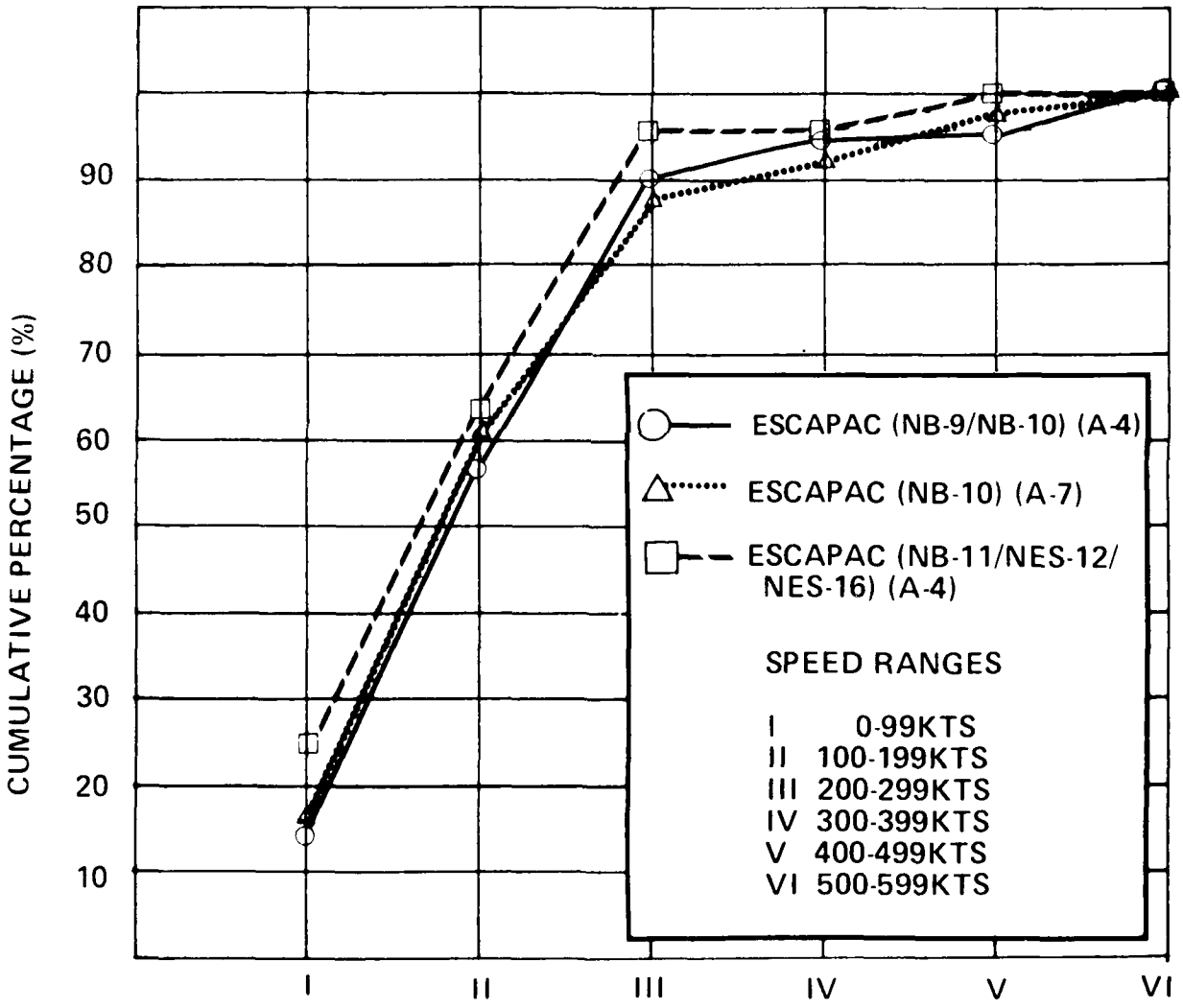


DISTRIBUTION OF VERTEBRAL FRACTURES ASSOCIATED WITH THROUGH-THE-CANOPY EJECTIONS



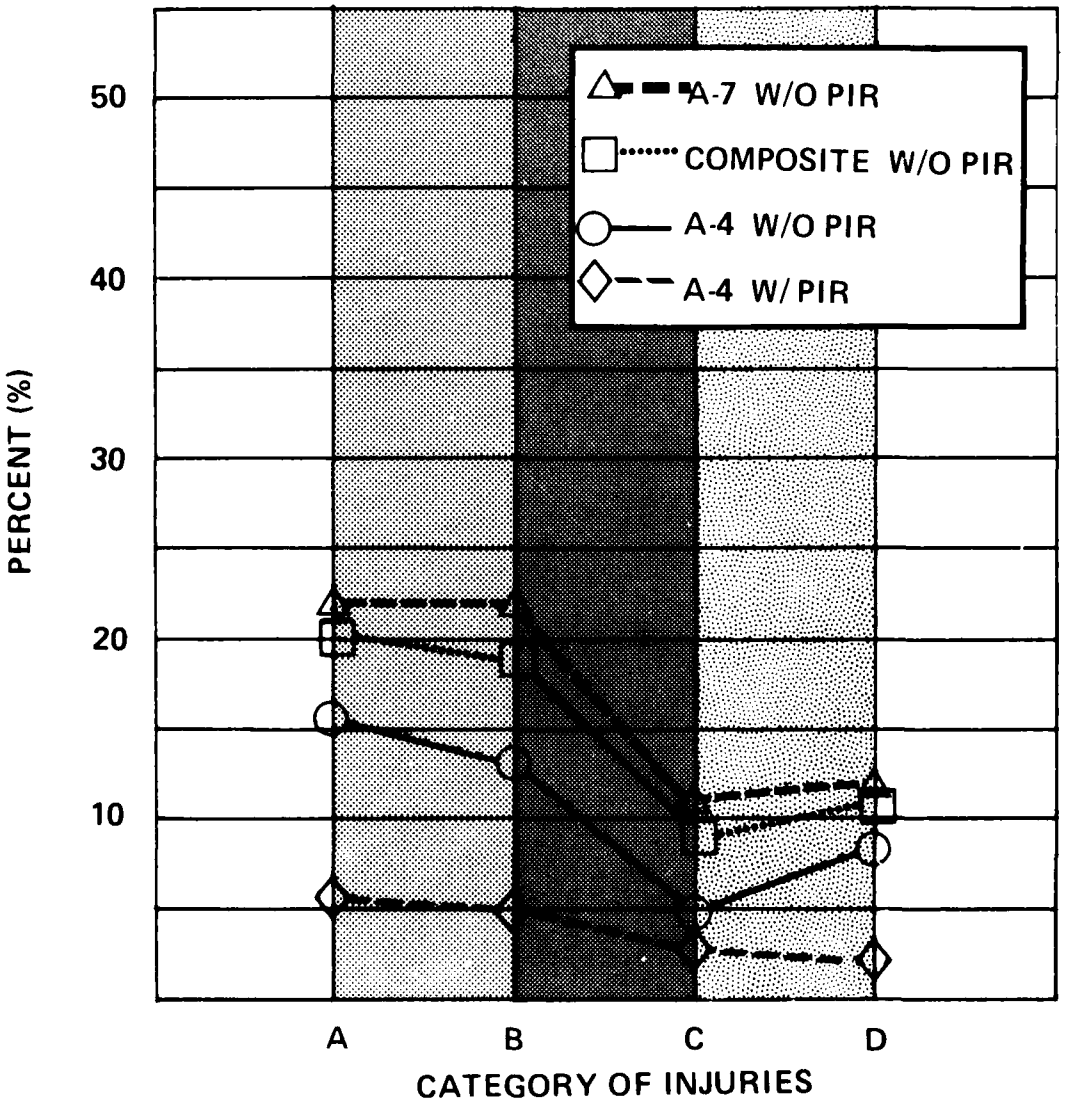
CUMULATIVE DISTRIBUTION OF PERCENTAGE EJECTEES UNINJURED VS AIRSPEED RANGE

JAN 1969 THROUGH JUL 1974



TYPE NECK INJURY VS TYPE INERTIA REEL BY TYPE ESCAPAC SEAT A–4/A–7

JAN 1969 THROUGH JUL 1974



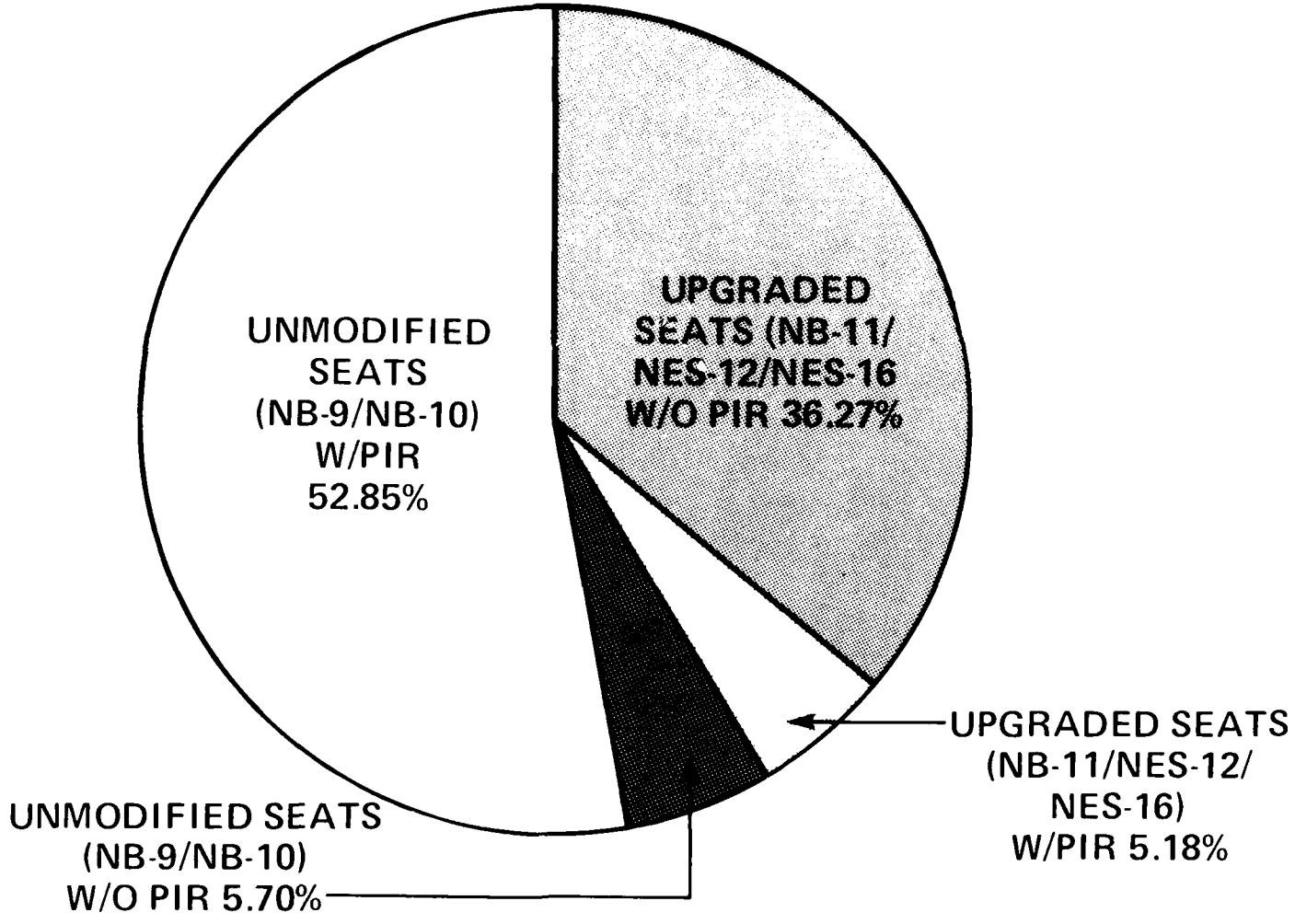
A. ALL NECK & VERTEBRAL

B. ALL NECK LESS TRANSECTIONS

C. VERTEBRAL

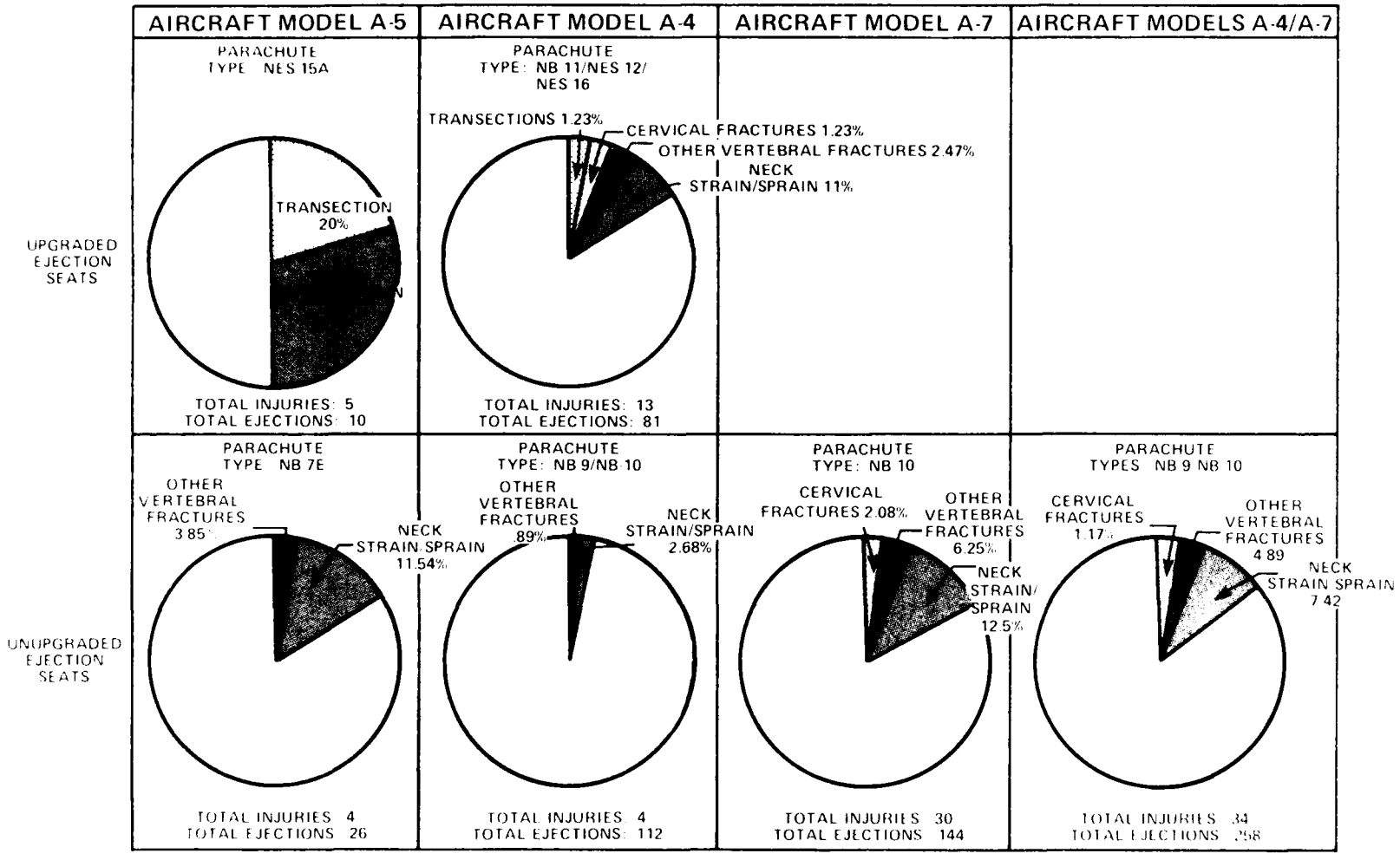
D. NECK SPRAIN/STRAIN

A-4 AIRCRAFT
ESCAPAC SERIES EJECTION SEATS
EJECTION DISTRIBUTION BY PARACHUTE TYPE AND INERTIA REEL TYPE



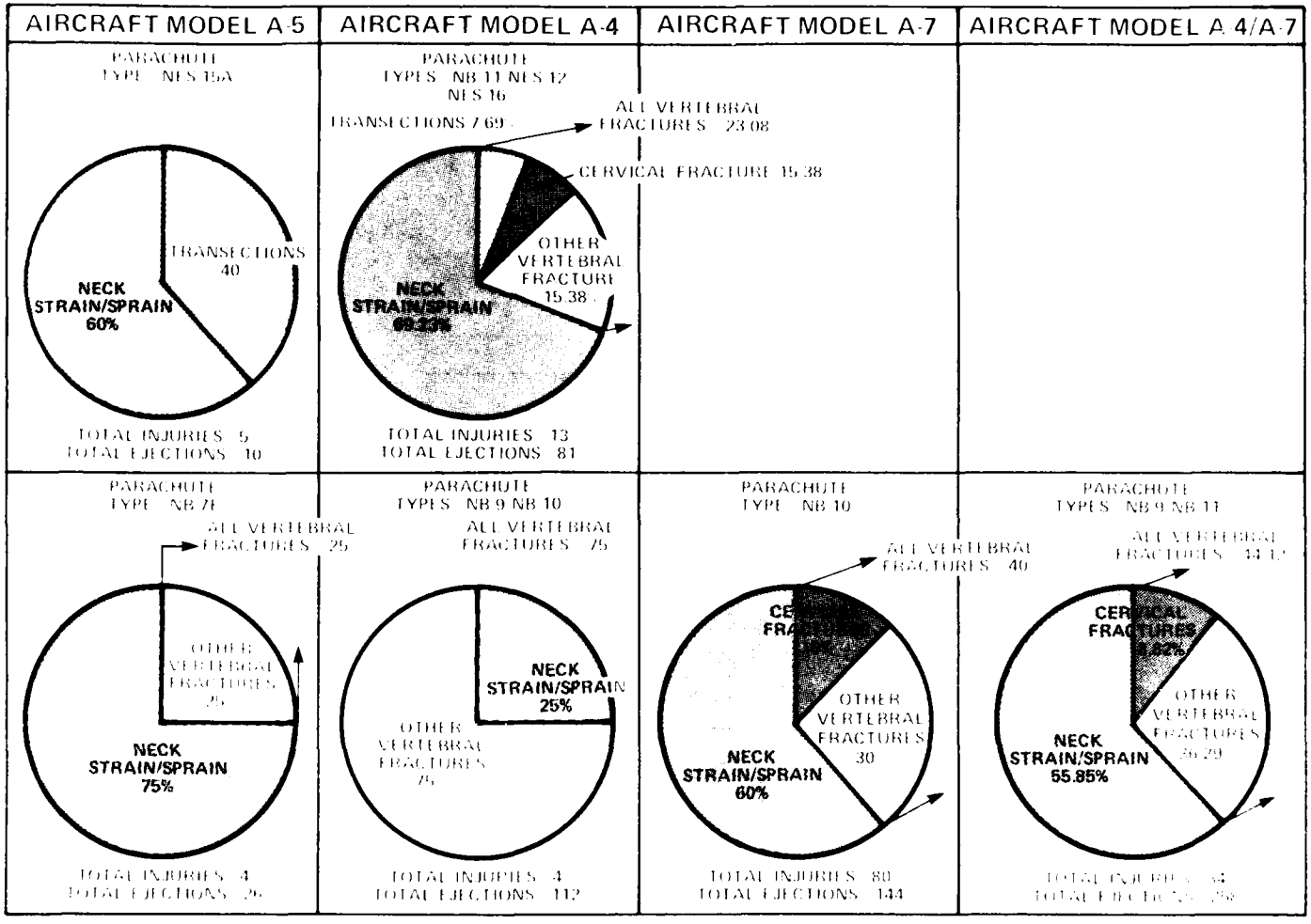
DISTRIBUTION OF MAJOR NECK AND VERTEBRAL INJURIES AS PERCENTAGE OF TOTAL NUMBER OF EJECTEES

1 JANUARY 1969 THROUGH 31 AUGUST 1974



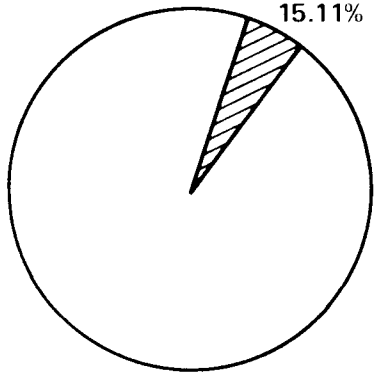
INJURY DISTRIBUTIONS OF TYPES OF MAJOR NECK AND VERTEBRAL INJURIES AS PERCENT OF TOTAL MAJOR INJURIES

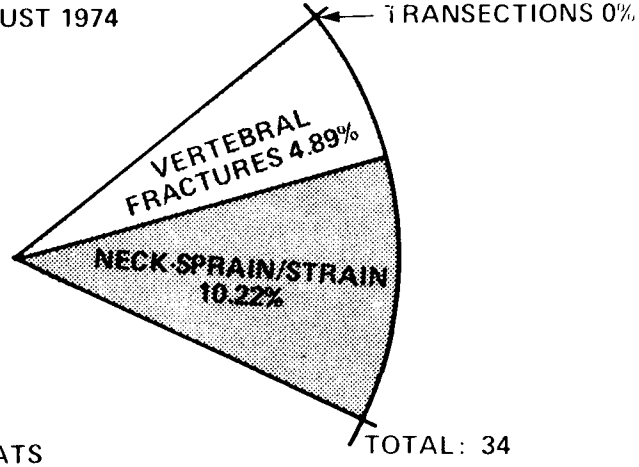
1 JANUARY 1969 THROUGH 31 AUGUST 1974



MAJOR NECK AND VERTEBRAL INJURY RATES
ASCRIBABLE TO EJECTION FORCES AND/OR PARACHUTE OPENING FORCES VS USE OF POWERED INERTIA REELS

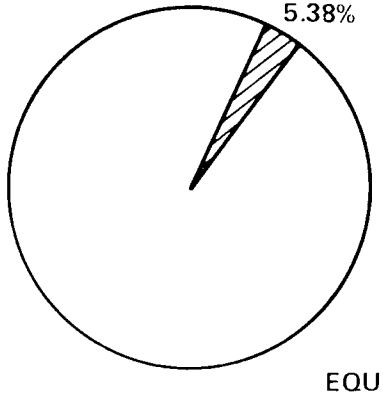
1 JANUARY 1969 THROUGH 31 AUGUST 1974

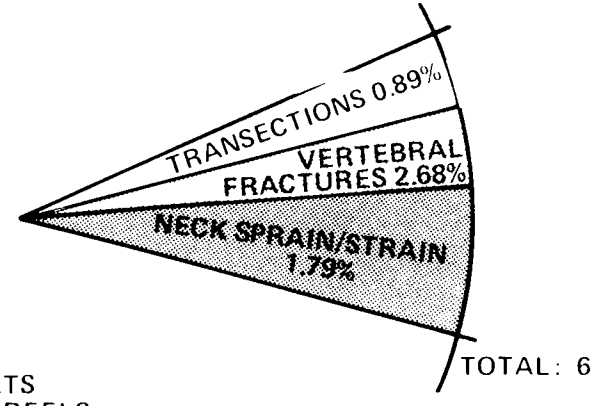




TOTAL: 225
ESCAPAC SERIES EJECTION SEATS
NOT EQUIPPED WITH POWERED INERTIA REELS

TOTAL: 34





TOTAL: 112
ESCAPAC SERIES EJECTION SEATS
EQUIPPED WITH POWERED INERTIA REELS

TOTAL: 6

TABLE IX
GROSS REPORTED MAJOR NECK AND VERTEBRAL INJURIES VS USE OF POWERED INERTIA REEL ESCAPAC SERIES EJECTION SEATS

1 JANUARY 1969 THROUGH 31 AUGUST 1974

	A-4 W/O PIR	A-7 W/O PIR	A-4 & A-7 W/O PIR	A-4 W/PIR
EJECTIONS	81	144	225	112
INJURIES	13	31	44	6
TRANSECTIONS	2	0	2	1
VERTEBRAL FRACTURES NECK SPRAIN/STRAIN	11	31	42	5
VERTEBRAL FRACTURES	4	15	19	3
NECK SPRAIN/STRAIN	7	16	23	2

NOTE: (1) PIR = POWERED INERTIA REEL
(2) A-4 W/PIR ARE A-4F, A-4M, TA-4F, AND TA-4J

TABLE X
GROSS INJURY RATES FOR MAJOR NECK AND VERTEBRAL INJURIES VS USE OF POWERED REEL ESCAPAC SERIES EJECTION SEATS

1 JANUARY 1969 THROUGH 31 AUGUST 1974

	A-4 W/O PIR	A-7 W/O PIR	A-4 & A-7 W/O PIR	A-4 W/PIR
INJURY RATES (A)	16.05%	21.53%	19.56%	5.36%
TRANSECTION RATES	2.47%	0%	0.89%	0.89%
VERTEBRAL FRACTURE AND NECK SPRAIN/STRAIN RATES (B)	13.58%	21.53%	18.67%	4.46%
VERTEBRAL FRACTURE RATES (C)	4.94%	10.42%	8.44%	2.68%
NECK SPRAIN/STRAIN RATES (D)	8.64%	11.11%	10.22%	1.79%

NOTE: (1) PIR = POWERED INERTIA REEL

(2) A-4 W/PIR ARE A-4F, A-4M, TA-4F, AND TA-4J

(3) PARENTHETICAL LETTERS (A), (B), (C), AND (D) ARE FOR ASSISTANCE IN REFERRING TO THE FOLLOWING GRAPHICAL PRESENTATION (FIGURE 10)

TABLE XI

MAJOR NECK AND VERTEBRAL INJURIES ASCRIBABLE TO EJECTION AND/OR PARACHUTE OPENING FORCES VS USE OF POWERED INERTIA REEL

1 JANUARY 1969 THROUGH 31 AUGUST 1974

	A-4 W/O PIR	A-7 W/O PIR	A-4 & A-7 W/O PIR	A-4 W/PIR
EJECTION	81	144	225	112
INJURIES	10	25	35	6
TRANSECTIONS	1	0	1	0
VERTEBRAL FRACTURES NECK SPRAIN/STRAIN	9	25	34	5
VERTEBRAL FRACTURES	2	9	11	3
NECK SPRAIN/STRAIN	7	16	23	2

NOTE: (1) PIR = POWERED INERTIA REEL
(2) A-4 W/PIR ARE A-4F, A-4M, TA-4F, AND TA-4J
(3) FIGURES HAVE BEEN CORRECTED TO REMOVE ALL GROUND IMPACT VERTEBRAL FRACTURES, MAN-SEAT COLLISION INJURIES, AND EPC ENTANGLEMENT TRANSECTION

TABLE XII
MAJOR NECK AND VERTEBRAL INJURY RATES ASCRIBABLE TO EJECTION AND/OR PARACHUTE OPENING FORCES VS USE OF POWERED INERTIA REEL

1 JANUARY 1969 THROUGH 31 AUGUST 1974

	A-4 W/O PIR	A-7 W/O PIR	A-4 & A-7 W/O PIR	A-4 W/PIR
INJURIES	12.35%	17.36%	15.56%	5.38%
TRANSECTIONS	1.23%	0%	0.44%	0%
VERTEBRAL FRACTURES NECK SPRAIN/STRAIN	11.11%	17.36%	15.11%	4.64%
VERTEBRAL FRACTURES	2.47%	6.25%	4.89%	2.68%
NECK SPRAIN/STRAIN	8.64%	11.11%	10.22%	1.79%

NOTE: (1) PIR = POWERED INERTIA REEL
(2) A-4 W/PIR ARE A-4F, A-4M, TA-4F, AND TA-4J
(3) FIGURES HAVE BEEN CORRECTED TO REMOVE ALL GROUND IMPACT VERTEBRAL FRACTURES, MAN-SEAT COLLISION INJURIES, AND EPC ENTANGLEMENT TRANSECTION

ESCAPAC SERIES EJECTION SEATS
(A–4 AND A–7 AIRCRAFT)
VERTEBRAL COMPRESSION FRACTURE DISTRIBUTION

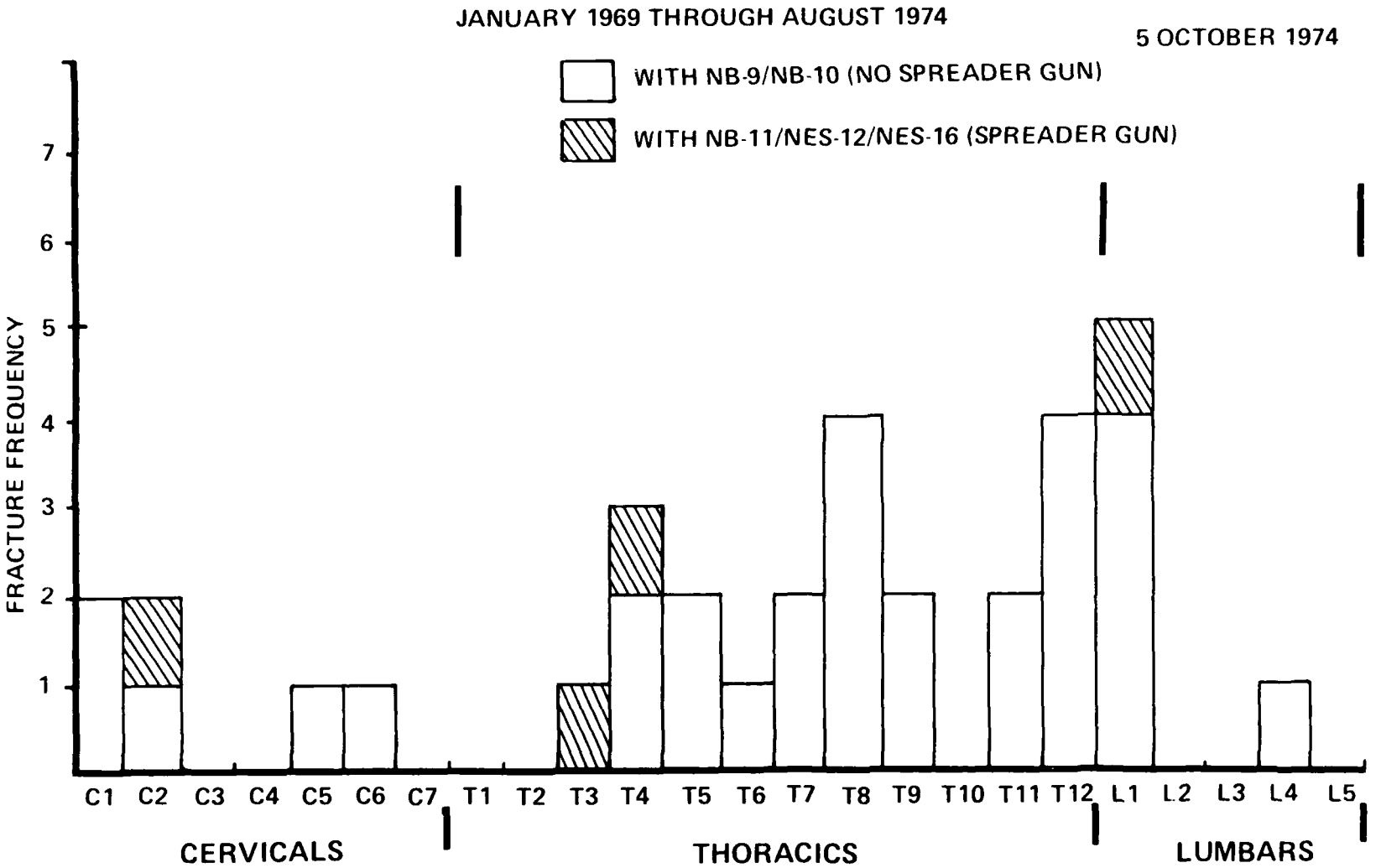


TABLE XIII

A–4 AIRCRAFT ESCAPAC SERIES EJECTION SEATS
EJECTION DISTRIBUTION BY PARACHUTE TYPE AND INERTIA REEL TYPE

	NB-11/NES-12/NES-16 (UPGRADED SEATS)	NB-9/NB-10 (UNMODIFIED SEATS)
W/O PIR	70	11
W/PIR	10	102

TABLE XIV

A–4 AIRCRAFT
ESCAPAC SERIES EJECTION SEATS
EJECTEE INJURY TYPE DISTRIBUTION
BY PARACHUTE TYPE AND INERTIA REEL TYPE

	NB-11/NES-12/NES-16 (UPGRADED SEATS)		NB-9/NB-10 (UNMODIFIED SEATS)	
W/O PIR	TRANSECTIONS:	2	TRANSECTIONS:	0
	CERVICAL FX.:	1	CERVICAL FX.:	0
	CERVICAL & OTHER:	0	CERVICAL & OTHER:	0
	THORACIC & LUMBAR:	3	THORACIC & LUMBAR:	0
	STRAIN/SPRAIN:	7	STRAIN/SPRAIN:	1
	TOTAL EJECTEES:	70	TOTAL EJECTEES:	11
W/PIR	TRANSECTIONS:	0	TRANSECTIONS:	1
	CERVICAL FX.:	0	CERVICAL FX.:	0
	CERVICAL & OTHER:	0	CERVICAL & OTHER:	0
	THORACIC & LUMBAR:	0	THORACIC & LUMBAR:	3
	STRAIN/SPRAIN:	2	STRAIN/SPRAIN:	0
	TOTAL EJECTEES:	10	TOTAL EJECTEES:	102

TABLE XV

A–4 AIRCRAFT ESCAPAC SERIES EJECTION SEATS EJECTEE INJURY RATE DISTRIBUTION BY PARACHUTE TYPE AND INERTIA REEL TYPE

	NB-11/NES-12/NES-16 (UPGRADED SEATS)		NB-9/NB-10 (UNMODIFIED SEATS)	
W/O PIR	TRANSECTIONS:	2.86%	TRANSECTIONS:	0%
	CERVICAL FX.:	1.43%	CERVICAL FX.:	1.29%
	CERVICAL & OTHER:	0%	CERVICAL & OTHER:	0.65%
	THORACIC & LUMBAR:	4.29%	THORACIC & LUMBAR:	6.45%
	STRAIN/SPRAIN:	10.00%	STRAIN/SPRAIN:	9.68%
	TOTAL EJECTIONS:	70	TOTAL EJECTIONS:	11
W/PIR	TRANSECTIONS:	0%	TRANSECTIONS:	0.98%
	CERVICAL FX.:	0%	CERVICAL FX.:	0%
	CERVICAL & OTHER:	0%	CERVICAL & OTHER:	0%
	THORACIC & LUMBAR:	0%	THORACIC & LUMBAR:	2.94%
	STRAIN/SPRAIN:	20.00%	STRAIN/SPRAIN:	0%
	TOTAL EJECTIONS:	10	TOTAL EJECTIONS:	102

TABLE XVI

A–4 AIRCRAFT TYPES OF ESCAPAC SERIES EJECTION SEATS VS PARACHUTE TYPE AND INERTIA REEL TYPE

	NB-11/NES-12/NES-16 (UPGRADED SEATS)	NB-9/NB-10 (UNMODIFIED SEATS)
W/O PIR	ESCAPAC IA-1*	ESCAPAC I*
W/PIR	(ESCAPAC IF-3) (ESCAPAC IG-3)	ESCAPAC IC-3*

NOTE:

COMPARATIVE INFORMATION FOR THESE EJECTION SEATS IS PROVIDED IN APPENDIX G (1)

* COMPARISON OF THE MAJOR ASPECTS OF THESE EJECTION SEATS ALSO IS PROVIDED IN APPENDIX G (2) AND (3)

TABLE XVII

A–4 AND A–7 AIRCRAFT
TYPES OF ESCAPAC SERIES EJECTION SEATS VS PARACHUTE TYPE AND INERTIA REEL TYPE

	A-4 AIRCRAFT		A-7 AIRCRAFT
	NB-11/NES-12/NES-16 (UPGRADED SEATS)	NB-9/NB-10 (UNMODIFIED SEATS)	NB-10 (UNMODIFIED SEATS)
W/O PIR	ESCAPAC IA-1*	ESCAPAC I*	ESCAPAC IC-2*
W/PIR	ESCAPAC IF-3 ESCAPAC IG-3	ESCAPAC IC-3*	(NONE)

NOTE:

COMPARATIVE INFORMATION FOR THESE EJECTION SEATS IS PROVIDED IN APPENDIX G (1)

* COMPARISON OF THE MAJOR ASPECTS OF THESE EJECTION SEATS ALSO IS PROVIDED IN APPENDIX G (2) AND (3)

COMPARISON OF ESCAPAC I, ESCAPAC IA–1 (A–4A/B/C/E/L AIRCRAFT), ESCAPAC IC–3 (A–4F/M, TA–4F/J AIRCRAFT) AND ESCAPAC IC–2 (A–7 AIRCRAFT)

DESIGN ASPECT	A-4 ESCAPAC IA-1	A-4 ESCAPAC I	A-4 ESCAPAC IC-3	A-7 ESCAPAC IC-2
PARACHUTE TYPE	NB-11/NES-12 (BALLISTIC SPREADER GUN) W/Mk5 & ZDL	NB-9 W/Mk5 & ZDL	NB-10/NB-10-2 1/	NB-10/NB-10-2 1/
SURVIVAL KIT	PK-2	PK-2	RSSK-8A	RSSK-8A
INERTIA REEL TYPE	NON-PIR	NON-PIR	PIR	NON-PIR
ROCKET CATAPULT	RAPEC I	RAPEC I	P/N 2174-522	P/N 2174-520
SYSTEM STABILIZATION	SNUBBER/DART	(NONE)	DART	DART
MAN-SEAT SEPARATION	BLADDERS	BLADDERS	BLADDERS	BLADDERS

1/ SEE ESCAPAC IC PARACHUTE SUBSYSTEM TIMING, APPENDIX G

2/ ABBREVIATIONS:
ZDL = ZERO DELAY LANYARD
Mk5 = 2.0 SEC. DELAY CARTRIDGE
PIR = BALLISTIC POWERED INTERTIA REEL

TABLE XVIII

ESCAPAC SERIES EJECTION SEATS
EJECTION DISTRIBUTION BY PARACHUTE TYPE
AND INERTIA REEL TYPE AND AIRCRAFT

	A-4 AIRCRAFT		A-7 AIRCRAFT
	NB-11/NES-12/NES-16 (UPGRADED SEATS)	NB-9/NB-10 (UNMODIFIED SEATS)	NB-10 (UNMODIFIED SEATS)
W/O PIR	70	11	144
W/PIR	10	102	0

TABLE XIX
ESCAPAC SERIES EJECTION SEATS
EJECTEE INJURY TYPE DISTRIBUTION
BY PARACHUTE TYPE AND INERTIA REEL TYPE AND AIRCRAFT

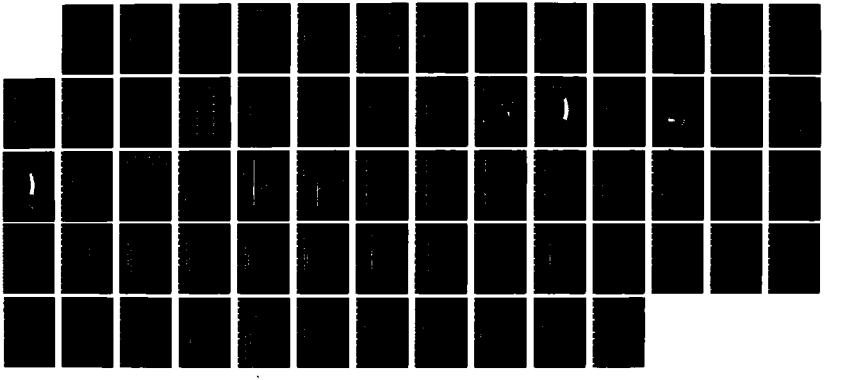
	A-4 AIRCRAFT				A-7 AIRCRAFT	
	NB-11/NES-12/NES-16 UPGRADED SEATS		NB-9/NB-10 UNMODIFIED SEATS		NB-10 UNMODIFIED SEATS	
W/O PIR	TRANSECTIONS:	2	TRANSECTIONS:	0	TRANSECTIONS:	0
	CERVICAL FX.:	1	CERVICAL FX.:	0	CERVICAL FX.:	2
	CERVICAL & OTHER:	0	CERVICAL & OTHER:	0	CERVICAL & OTHER:	1
	THORACIC & LUMBAR:	3	THORACIC & LUMBAR:	0	THORACIC & LUMBAR:	10
	STRAIN/SPRAIN:	7	STRAIN/SPRAIN:	1	STRAIN/SPRAIN:	14
	TOTAL EJECTIONS:	70	TOTAL EJECTIONS:	11	TOTAL EJECTIONS:	144
W/PIR	TRANSECTIONS:	0	TRANSECTIONS:	1		
	CERVICAL FX.:	0	CERVICAL FX.:	0		
	CERVICAL & OTHER:	0	CERVICAL & OTHER:	0		
	THORACIC & LUMBAR:	0	THORACIC & LUMBAR:	3		
	STRAIN/SPRAIN:	2	STRAIN/SPRAIN:	0	(NO PIR IN A-7)	
	TOTAL EJECTIONS:	10	TOTAL EJECTIONS:	102		

TABLE XX
ESCAPAC SERIES EJECTION SEATS
EJECTEE INJURY TYPE RATES BY PARACHUTE TYPE AND INERTIA REEL TYPE AND AIRCRAFT

	A-4 AIRCRAFT				A-7 AIRCRAFT	
	NB-11/NES-12/NES-16 UPGRADED SEATS		NB-9/NB-10 UNMODIFIED SEATS		NB-10	
W/C PIR	TRANSECTIONS:	2.86%	TRANSECTIONS:	0	TRANSECTIONS:	0
	CERVICAL FX.:	1.43%	CERVICAL FX.:	0	CERVICAL FX.:	1.39%
	CERVICAL & OTHER:	0	CERVICAL & OTHER:	0	CERVICAL & OTHER:	0.69%
	THORACIC & LUMBAR:	4.29%	THORACIC & LUMBAR:	0	THORACIC & LUMBAR:	6.94%
	STRAIN/SPRAIN:	10.00%	STRAIN/SPRAIN:	9.09%	STRAIN/SPRAIN:	9.72%
	TOTAL EJECTIONS:	70	TOTAL EJECTIONS:	11	TOTAL EJECTIONS:	144
W/PIR	TRANSECTIONS:	0	TRANSECTIONS:	0.98%		
	CERVICAL FX.:	0	CERVICAL FX.:	0		
	CERVICAL & OTHER:	0	CERVICAL & OTHER:	0	(NONE)	
	THORACIC & LUMBAR:	0	THORACIC & LUMBAR:	2.94%	(NO EJECTIONS)	
	STRAIN/SPRAIN:	20.00%	STRAIN/SPRAIN:	0		
	TOTAL EJECTIONS:	10	TOTAL EJECTIONS:	102		

AD-A171 657 AIRCREW AUTOMATED ESCAPE SYSTEMS (AAES) DATA ANALYSIS PROGRAM SYMPOSIUM H.. (U) NAVAL SAFETY CENTER NORFOLK VA 1981 3/3

UNCLASSIFIED F/G 1/3 NL



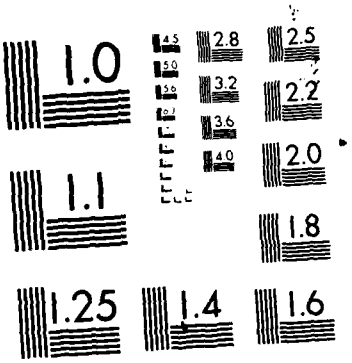


TABLE XXI

EFFECT UPON INJURY RATES OF INCORPORATING BALLISTIC POWERED INERTIA REEL IN ESCAPAC IC CONFIGURATION EJECTION SEATS

	EXCAPAC IC-2	ESCAPAC IS-3	EFFECT OF ADDING PIR
TOTAL EJECTIONS	144	102	N/A
<u>INJURY TYPES</u>			
TRANSECTIONS:	0	0.98%	+0.98%
CERVICAL FX.:	1.39%	0	-1.39%
CERVICAL & OTHER FX.:	0.69%	0	-0.69%
THORACIC & LUMBAR FX.:	6.94%	2.94%	-4.00%
NECK STRAIN/SPRAIN:	9.72%	0	-9.72%
ALL CERVICAL FX.:	2.08%	0	-2.08%
ALL VERTEBRAL FX.:	9.02%	2.94%	-6.08%

TABLE XXII

EFFECT UPON INJURY RATES OF INTRODUCING NON–INERTIA REEL VARIATIONS IN ESCAPAC EJECTION SEAT CONFIGURATIONS

	A-7 ESCAPAC IC-2	A-4 ESCAPAC IA-1	EFFECT OF DIFFERENCES BETWEEN
TOTAL EJECTIONS	144	70	· PROPULSION · SURVIVAL KIT · SYSTEM STABILIZATION · PARACHUTE SUBSYSTEM
INJURY TYPES			
TRANSECTIONS:	0	2.86%	+2.86%
CERVICAL FX.:	1.39%	1.43%	+0.04%
CERVICAL & OTHER FX.:	0.69%	0	-0.69%
THORACIC & LUMBAR FX.:	6.94%	4.29%	-2.65%
NECK STRAIN/SPRAIN:	9.72%	10.00%	+0.28%
ALL CERVICAL FX.:	2.08%	1.43%	-0.65%
ALL VERTEBRAL FX.:	9.02%	5.72%	-3.30%

CONTINGENCY ANALYSIS OF A–4 ESCAPE DATA

IN AN INDEPENDENT REVIEW OF THE A-4 EJECTION DATA, THE SYSTEMS ANALYSIS DEPARTMENT, NAVAL WEAPONS ENGINEERING SUPPORT ACTIVITY, WASHINGTON, D. C., SUBJECTED THE DATA TO A 2 X 2 CONTINGENCY TEST.

AS REPORTED IN THE FOLLOWING PAGES, THIS ANALYSIS FOUND THE FOLLOWING:

- NO INFERENCE CAN BE DRAWN FROM A-4 EJECTION DATA ALONE CONCERNING THE ROLE OF SPREADER GUN OR BALLISTIC POWERED INERTIA REEL IN THE PRODUCTION OR PREVENTION OF NECK INJURIES.
- THE A-7 EJECTION DATA APPEARS TO BE FROM THE SAME POPULATION AS THE EJECTION DATA FOR A-4 WITH THE SPREADER GUN BUT WITHOUT THE POWERED INERTIA REEL.
- THE CONTINGENCY TEST INDICATES THAT THE SPREADER GUN HAS NO EFFECT UPON NECK INJURIES.
- THE A-7 EJECTION DATA APPEARS NOT TO BE FROM THE SAME POPULATION AS THE EJECTION DATA FOR A-4 WITHOUT THE SPREADER GUN BUT WITH THE POWERED INERTIA REEL.
- THE CONTINGENCY TEST INDICATES THAT THE POWERED INERTIA REEL HAS AN EFFECT UPON NECK INJURIES.
- THE SPREADER GUN IS NOT CAUSING NECK INJURIES.
- THE POWERED INTERTIA REEL AIDS IN PREVENTING NECK INJURIES.

A–4 CONTINGENCY TEST

2 X 2 CONTINGENCY TEST

USED FOR TESTING SAMPLES CLASSIFIED AS TO TWO ATTRIBUTES, I. E., INJURIES VS. NO INJURIES

$$X^2 = \Sigma (f - F)^2/F$$

WHERE:

f = OBSERVED FREQUENCY
F = CALCUALTED OR EXPECTED FREQUENCY

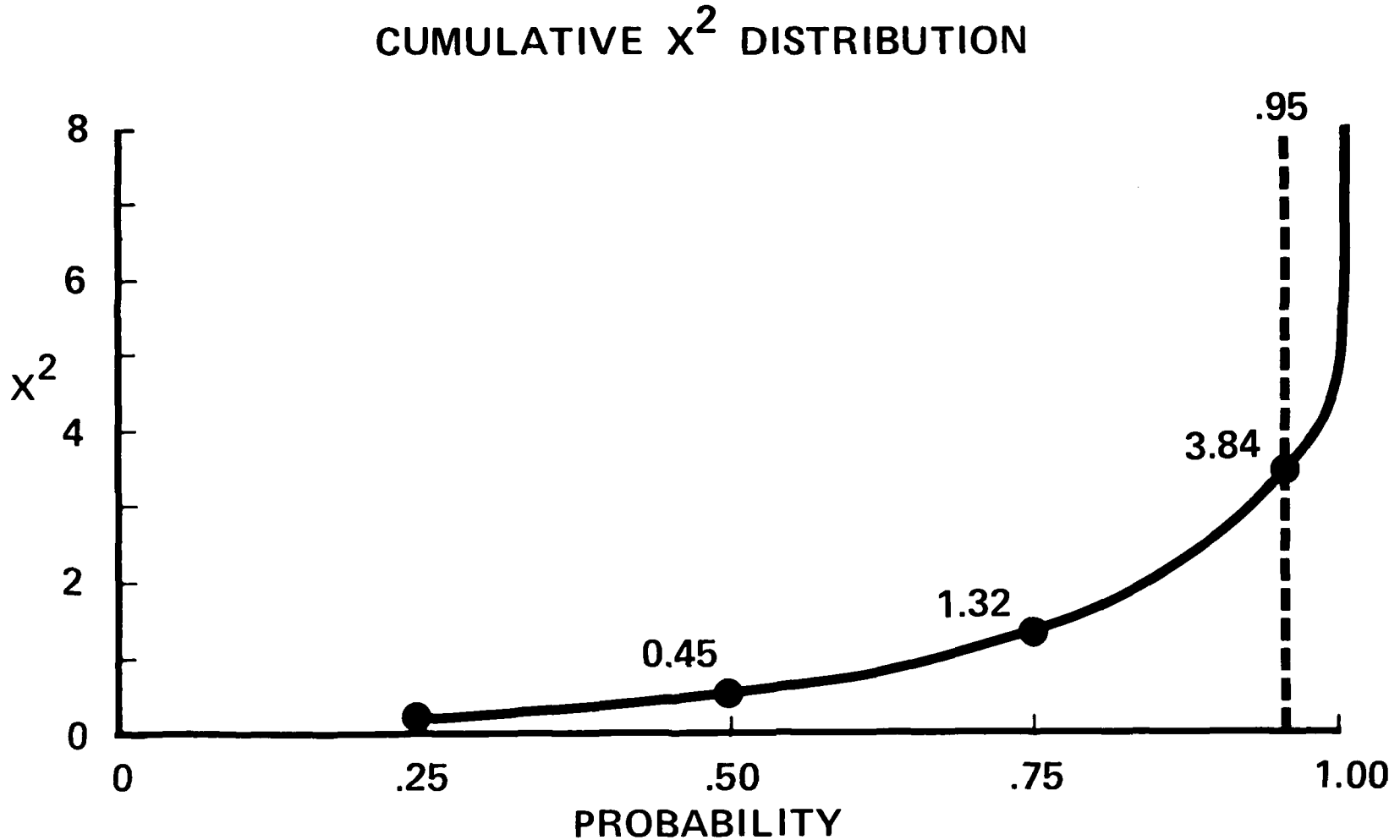
SO THAT:

THE DEVIATION FROM THE EXPECTED IS MEASURED

NULL HYPOTHESIS: SAMPLES TESTED ARE FROM THE SAME POPULATION:

ACCEPT IF $X^2 < 3.84$ $(p < .05)$
REJECT IF $X^2 \geqslant 3.84$

A–4 CONTINGENCY TEST



A–4 CONTINGENCY TEST

A-4 DATA (NECK INJURY ONLY)
(DATA POINTS ARE THE SAME AS USED FOR CORRELATION ANALYSIS)

		SPREADER GUN	NO SPREADER GUN	TOTAL
POWER INERTIAL REEL	NO INJURY	6	101	107
	INJURY	1	1	2
	TOTAL	7	102	109
NO POWER INERTIAL REEL	NO INJURY	59	10	69
	INJURY	8	1	9
	TOTAL	67	11	78
TOTAL	NO INJURY	65	111	176
	INJURY	9	2	11
	TOTAL	74	113	187

A–4 CONTINGENCY TEST

X^2 RESULTS

		NECK INJURIES	ALL INJURIES
SPREADER VS NO SPREADER	A-4 TOTAL	6.95*	8.85*
	A-4 NO PIR	0.10	0.80
	A-4 PIR	1.17	2.01
PIR VS NO PIR	A-4 TOTAL	6.08*	5.97*
	A-4 SPREADER	0.18	1.05
	A-4 NO SPREADER	0.54	0.0004

NULL HYPOTHESIS: SAMPLES ARE FROM SAME POPULATION

(*) INDICATES REJECTION; ALL OTHERS ACCEPTED

PIR = POWER INERTIAL REEL

A–4 CONTINGENCY TEST

X^2 RESULTS

		NECK INJURIES	ALL INJURIES
SPREADER VS NO SPREADER	A-4 TOTAL	6.95*	8.86*
	A-4 NO PIR	0.10	0.80
	A-4 PIR	1.17	2.01
PIR VS NO PIR	A-4 TOTAL	6.08*	5.97*
	A-4 SPREADER	0.18	1.05
	A-4 NO SPREADER	0.54	0.0004
A-7 (NO SPREADER, NO PIR) VS A-4 (SPREADER, NO PIR)		2.21	0.0025
A-7 (NO SPREADER, NO PIR) VS A-4 (NO SPREADER, PIR)		12.86*	10.51*

NULL HYPOTHESIS: SAMPLES ARE FROM SAME POPULATION

(*) INDICATES REJECTION; ALL OTHERS ACCEPTED

PIR = POWER INERTIAL REEL

A–4 CONTINGENCY TEST

A-7 DATA (NECK INJURY ONLY)
(DATA SAME AS THAT USED FOR CORRELATION ANALYSIS)

		SPREADER GUN	NO SPREADER GUN
POWER INERTIAL REEL	NO INJURY	-	-
	INJURY	-	-
	TOTAL	-	-
NO POWER INERTIAL REEL	NO INJURY	-	115
	INJURY	-	21
	TOTAL	-	136
TOTAL	NO INJURY	-	115
	INJURY	-	21
	TOTAL	-	136

A–4 CONTINGENCY TEST

CONCLUSIONS:

(1) NO INFERENCE CAN BE DRAWN FROM A-4 DATA ALONE, I. E.:

(A) SPREADER GUN MAY BE CAUSING INJURIES

(B) PIR MAY BE PREVENTING INJURIES

(2) A-7 DATA APPEARS TO BE FROM THE SAME POPULATION AS A-4 (WITH SPREADER BUT NO PIR). THE CONTINGENCY TEST INDICATES THAT THE SPREADER HAS NO EFFECT.

(3) A-7 DATA APPEARS NOT TO BE FROM THE SAME POPULATION AS A-4 (WITH NO SPREADER, BUT WITH PIR). THE CONTINGENCY TEST INDICATES THAT THE PIR HAS AN EFFECT.

(4) ANALYSIS INDICATES THAT THE SPREADER GUN IS NOT CAUSING INJURIES, BUT THE PIR IS PREVENTING GUN INJURIES.

VERTEBRAL COMPRESSION FRACTURE MECHANISMS

- GIVEN GEOMETRY AND YIELD STRESS OF VERTEBRAE AND CURRENT CATAPULT BOOST ACCELERATIONS, MOST CURRENT EJECTION ASSOCIATED VERTEBRAL COMPRESSION FRACTURES, WITH THE POSSIBLE SIGNIFICANT EXCEPTION OF THOSE ASSOCIATED WITH THROUGH-THE-CANOPY EJECTIONS, ARE BELIEVED TO RESULT FROM POOR VERTEBRAL ALIGNMENT.

- CAUSES SUGGESTED FOR VERTEBRAL MISALIGNMENT INCLUDE:
  - PERSONAL EQUIPMENT INFLUENCES
  - NONSTABLE EJECTION PLATFORM
  - INADEQUATE THIGH SUPPORT
  - POOR TORSO RESTRAINT
  - CATAPULT BOOST ACCELERATION VECTOR INDUCED FORWARD TORSO ROTATION
  - POOR SEAT BACK SUPPORT

  AS WELL AS MANY OTHER CAUSES FOR UPPER TORSO MOVEMENT

VERTEBRAL COMPRESSION FRACTURE MECHANISMS

THROUGH–THE–CANOPY EJECTION

PRODUCES MULTIPHASIC ABRUPT CHANGES IN EJECTEE ACCELERATIONS AND RESULTING FORCES IMPOSED UPON VERTEBRAE:

- INITIAL BOOST PHASE
  - INITIAL BODY LOADING, BODY ELEMENTS SHIFT DOWNWARD
  - DUE TO BODY'S "MASS-SPRING-DAMPER SYSTEM" CHARACTERISTICS
    - BODY SEGMENT VELOCITIES ARE NONUNIFORM
    - BODY SEGMENT VELOCITIES LOWER THAN SEAT VELOCITY

- SEAT-CANOPY IMPACT PHASE
  - SEAT DECELERATES RAPIDLY
  - BODY SEGMENTS TEND TO CONTINUE AT UNCHANGING VELOCITY

- CANOPY YIELDING PHASE
  - SEAT MOVEMENT SMALL
    - SEAT VELOCITY DECREASING RAPIDLY
    - CATAPULT INTERNAL PRESSURES RISING RAPIDLY
  - BODY SHIFTS UPWARD WITHIN SEAT AND VELOCITIES DECREASE
    - REDUCES BUTTOCK AND VERTEBRAL LOADING
    - BODY LOADS SHOULDER HARNESS/SHOULDER GIRDLE
      - POSSIBLY REVERSING VERTEBRAL LOADING
    - HEAD CONTACTS CANOPY
      - POSSIBLY REVERSING VERTEBRAL LOADING
      - POSSIBLY INDUCING VERTEBRAL MISALIGNMENT

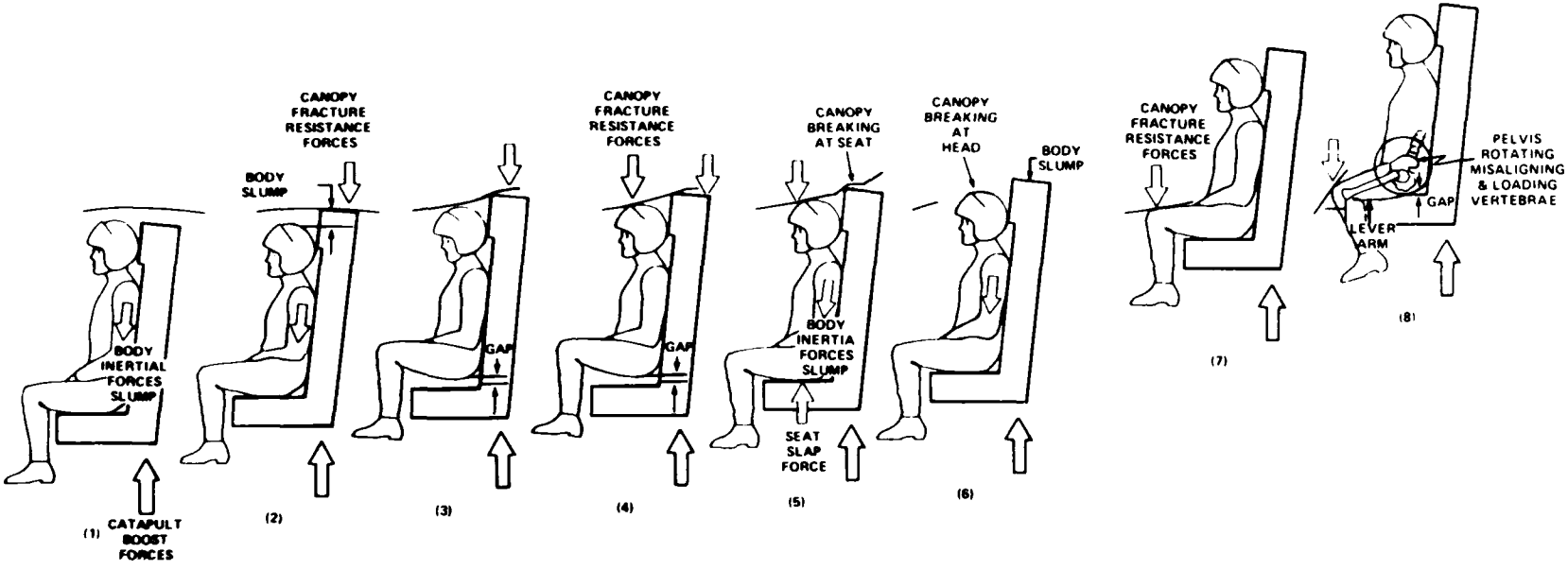
(CONTINUED NEXT CHART)

VERTEBRAL COMPRESSION FRACTURE MECHANISMS

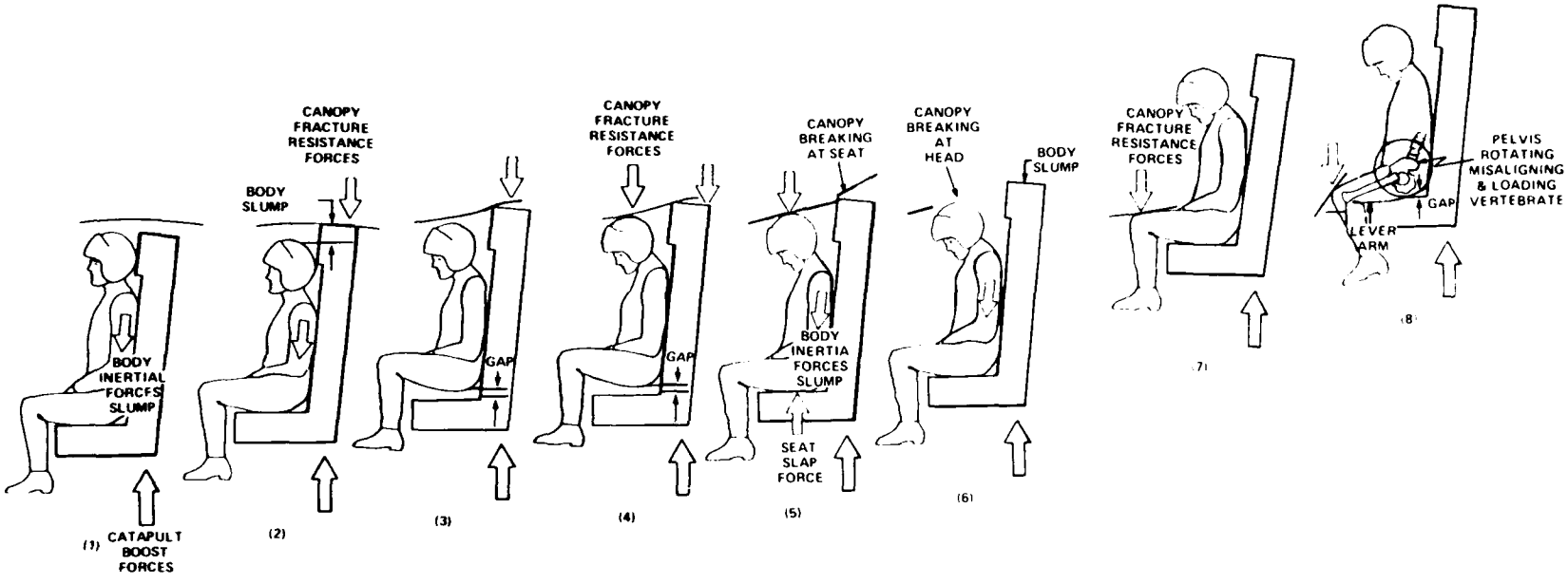
THROUGH–THE–CANOPY EJECTION (CONT'D)

- CANOPY PENETRATION PHASE
  - SEAT ACCELERATES RAPIDLY DUE TO:
    - HIGHER CATAPULT INTERNAL PRESSURES
    - EFFECTIVE REDUCED EJECTED WEIGHT (TEMPORARY MAN-SEAT SEPARATION DURING CANOPY YIELDING PHASE)
  - SEAT MOVES UPWARD RELATIVE TO BODY
    - SEAT MOVEMENT MAY INDUCE "OVERSHOOT" ACCELERATION IN BODY
    - BODY MOVEMENT MAY BE TEMPORARILY RETARDED BY CANOPY CONTACT WITH HEAD
      - EXACERBATING VERTEBRAL LOADINGS
      - EXACERBATING VERTEBRAL MISALIGNMENT
- SEAT CLEAR PHASE

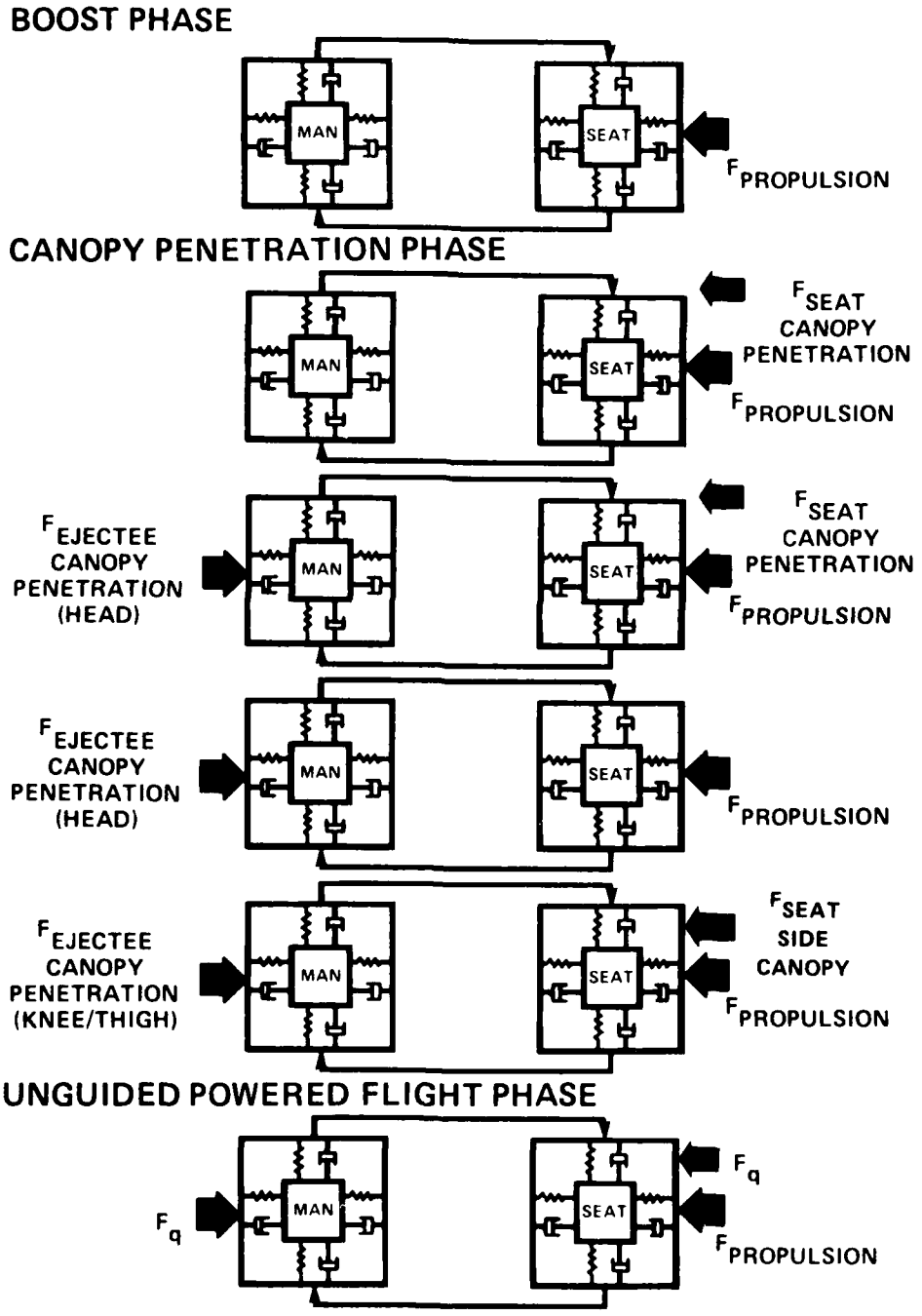
GENERALIZED CONCEPTUALIZATION OF BODY MOTIONS AND FORCES ASSOCIATED WITH THROUGH-THE-CANOPY EJECTION (GOOD RESTRAINT/POSTURE)



GENERALIZED CONCEPTUALIZATION OF BODY MOTIONS AND FORCES ASSOCIATED WITH THROUGH-THE-CANOPY EJECTION (POOR RESTRAINT/POSTURE)

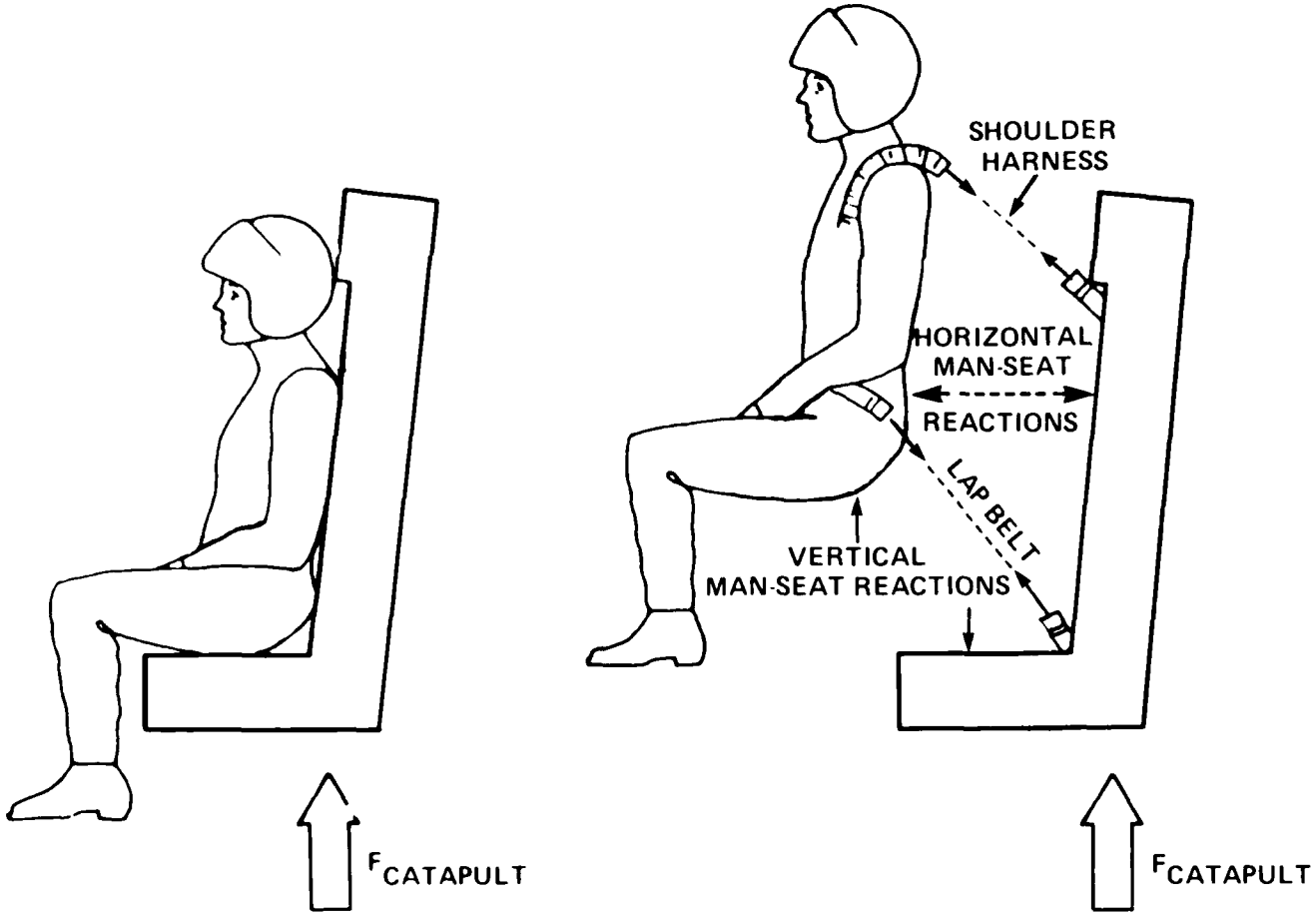


GENERALIZED CONCEPTUALIZATION OF MAN-SEAT INTERACTIONS AND EXTERNAL FORCES OPERATING ON COMBINATION



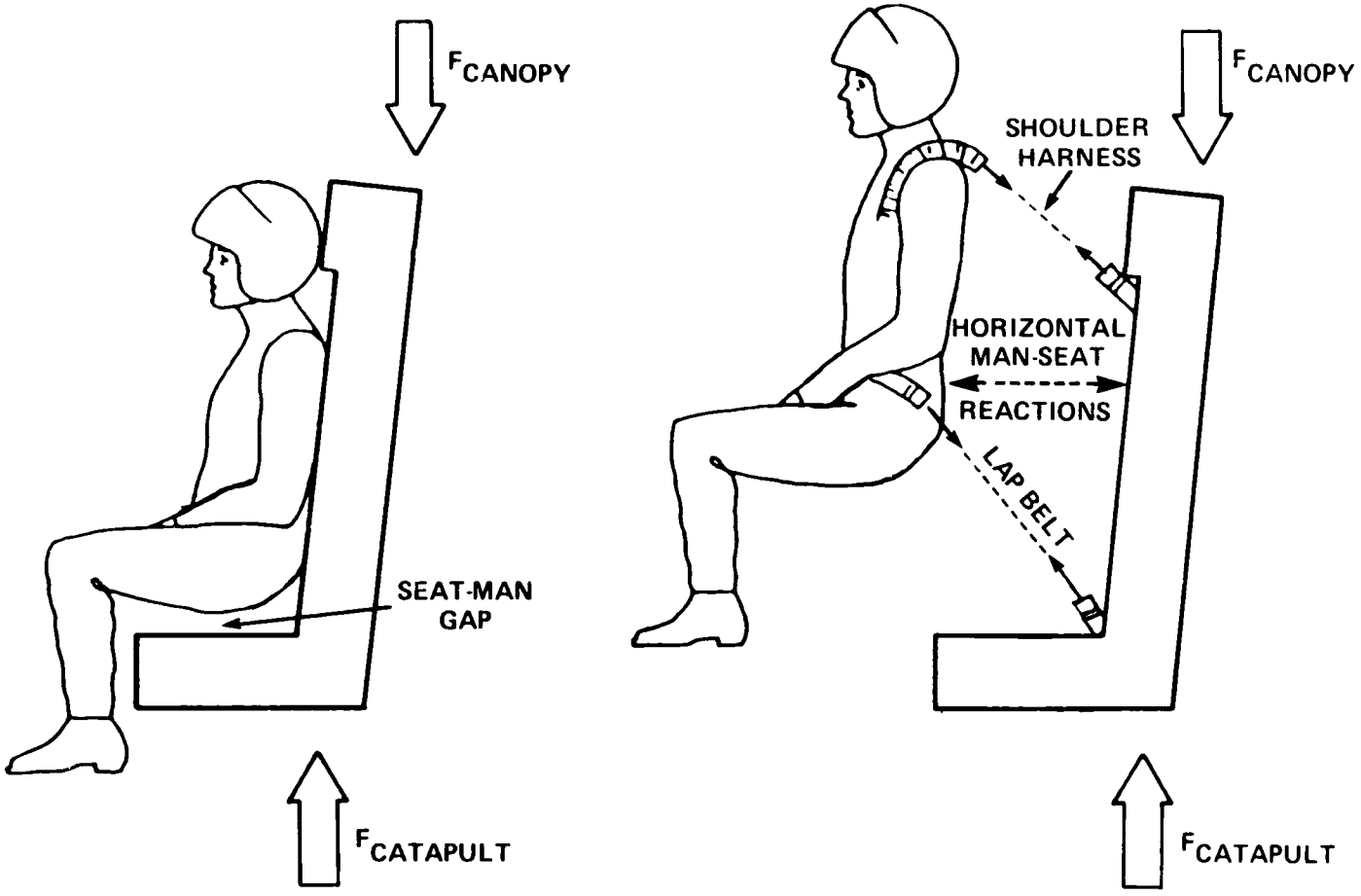
GENERALIZED CONCEPTUALIZATION OF MAN-SEAT INTERACTIONS AND EXTERNAL FORCES OPERATING ON COMBINATION

INITIAL SEAT TRAVEL PHASE



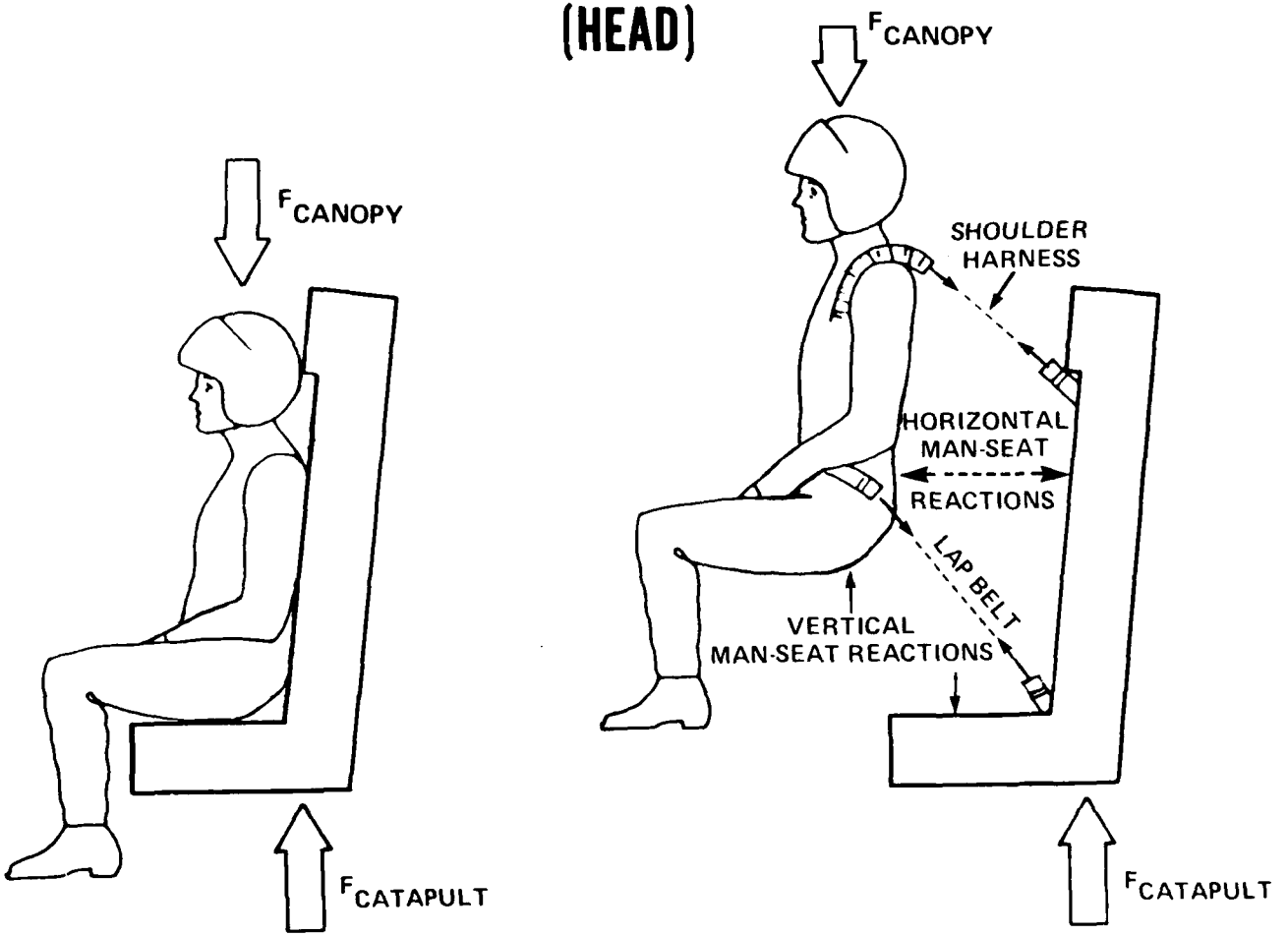
GENERALIZED CONCEPTUALIZATION OF MAN-SEAT INTERACTIONS AND EXTERNAL FORCES OPERATING ON COMBINATION

SEAT CANOPY PENTRATION PHASE



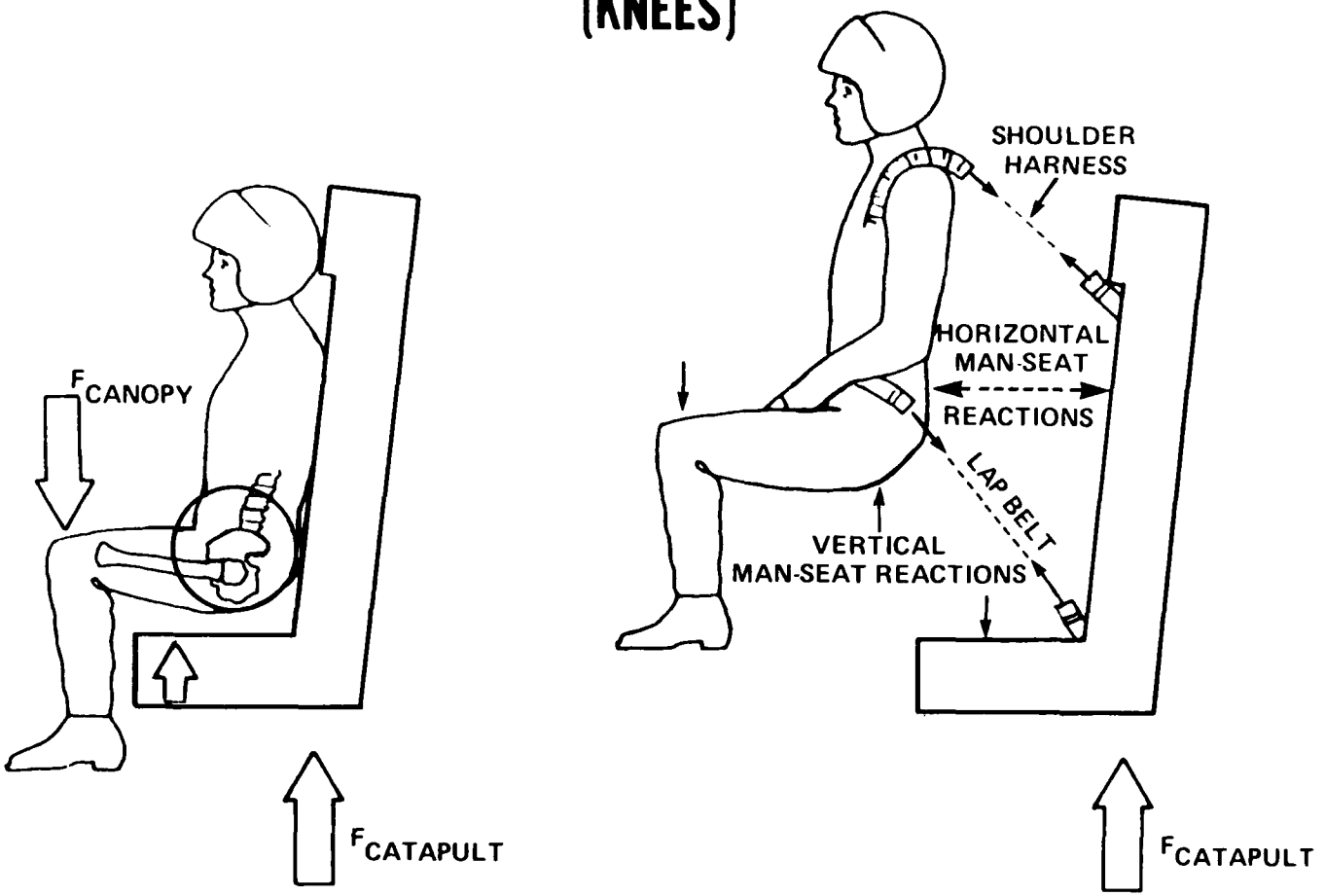
GENERALIZED CONCEPTUALIZATION OF MAN-SEAT INTERACTIONS AND EXTERNAL FORCES OPERATING ON COMBINATION

EJECTEE CANOPY PENETRATION PHASE (HEAD)



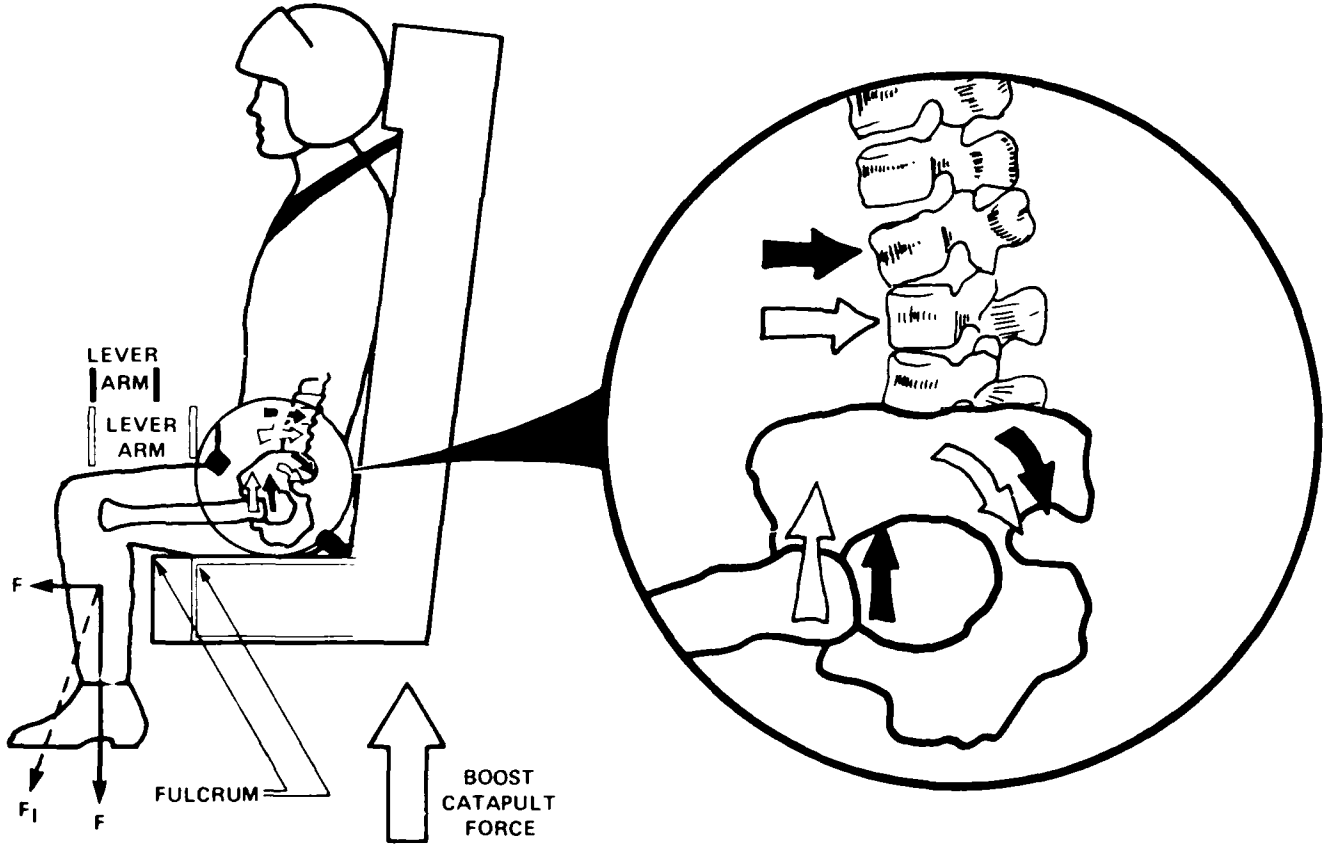
GENERALIZED CONCEPTUALIZATION OF MAN-SEAT INTERACTIONS AND EXTERNAL FORCES OPERATING ON COMBINATION

EJECTEE CANOPY PENETRATION PHASE (KNEES)

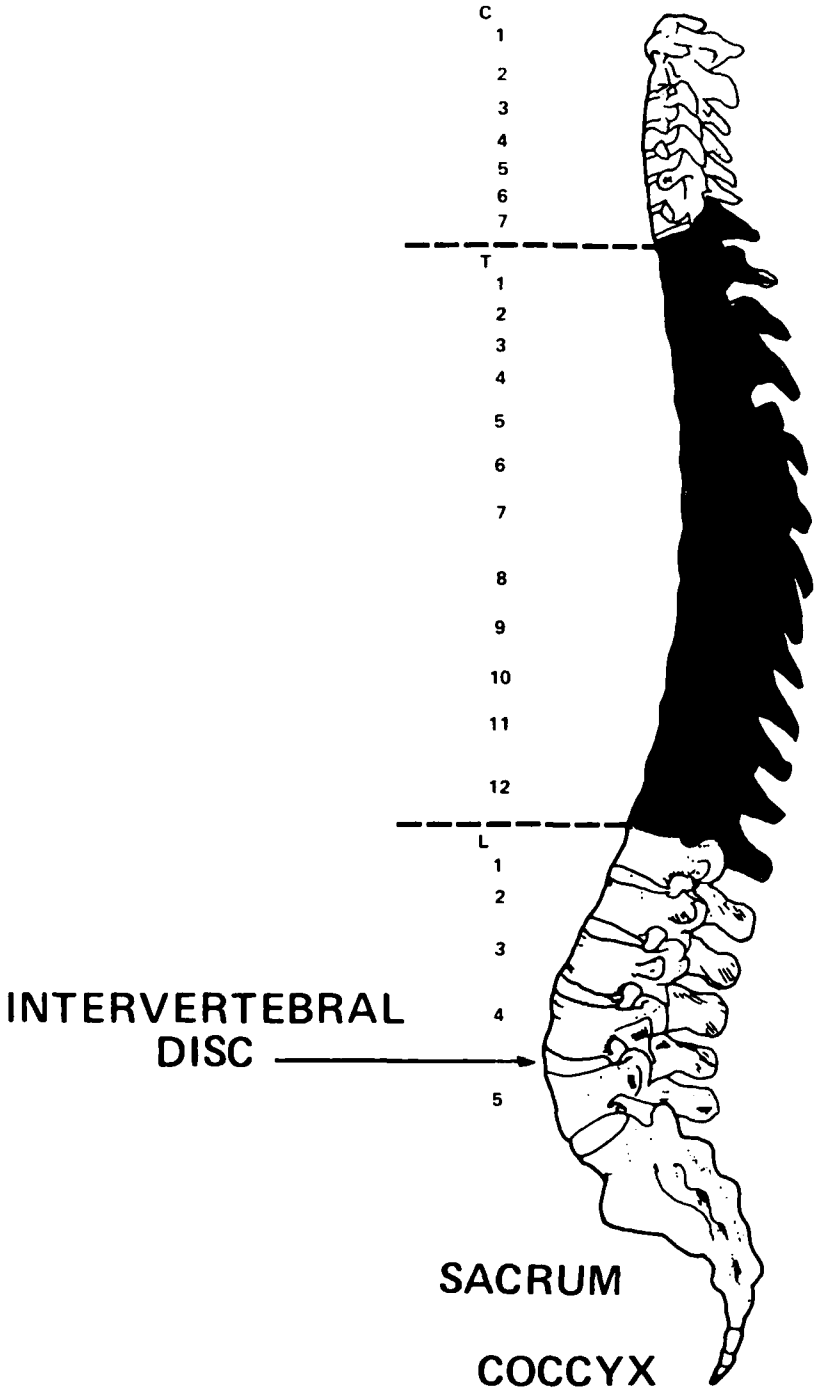


VERTEBRAL COMPRESSION FRACTURES MECHANISMS

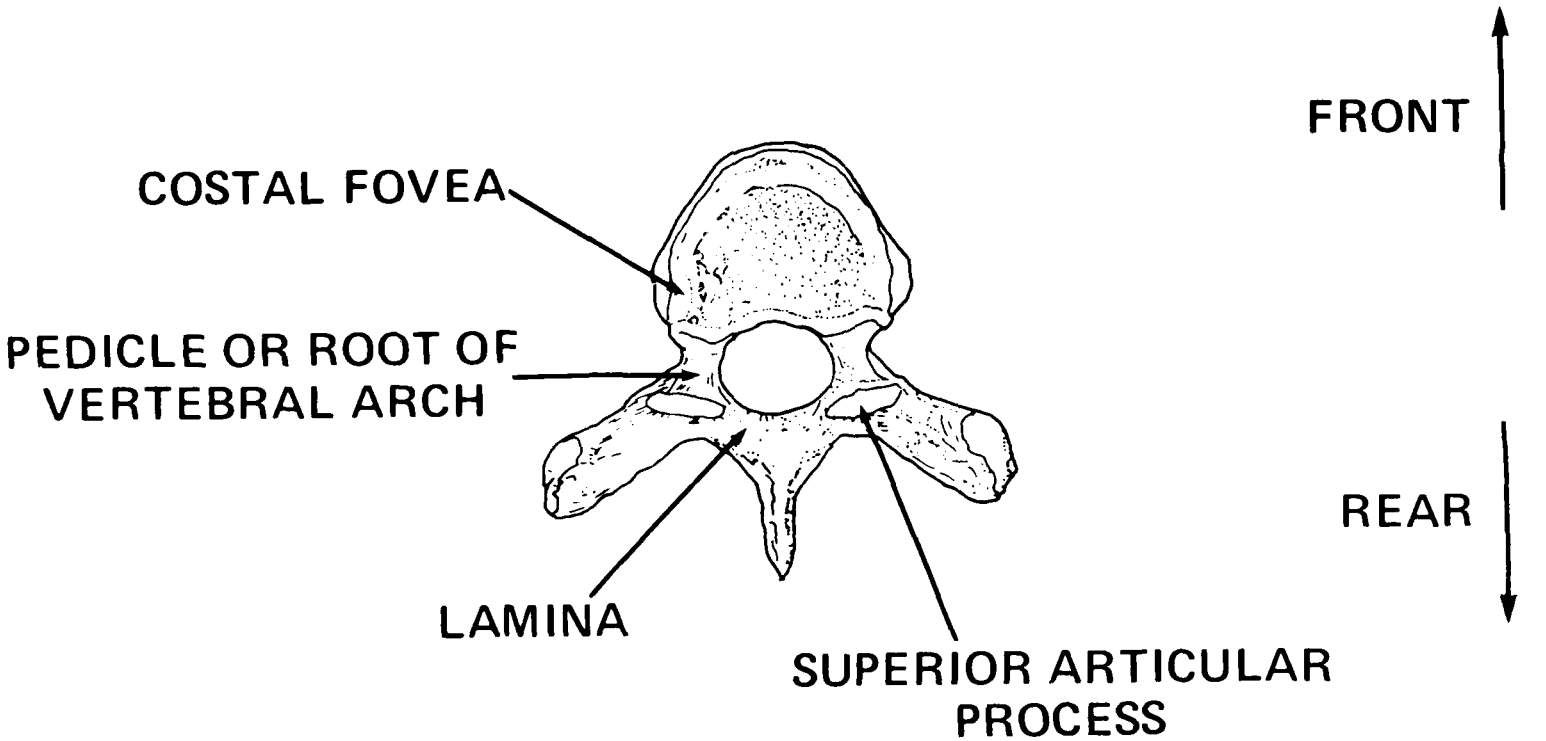
INADEQUATE THIGH SUPPORT



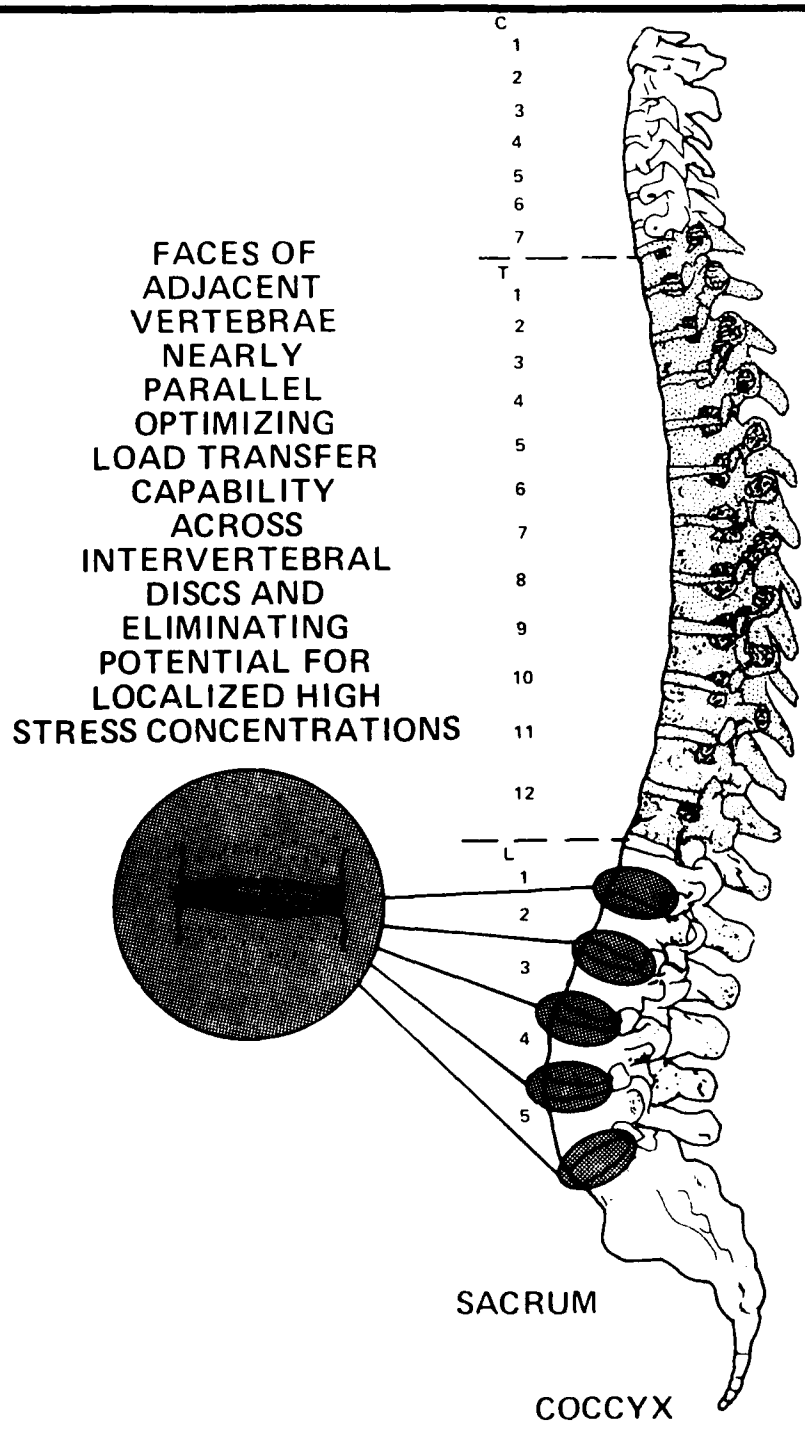
THE VERTEBRAE
SHOWING NORMAL CURVATURE

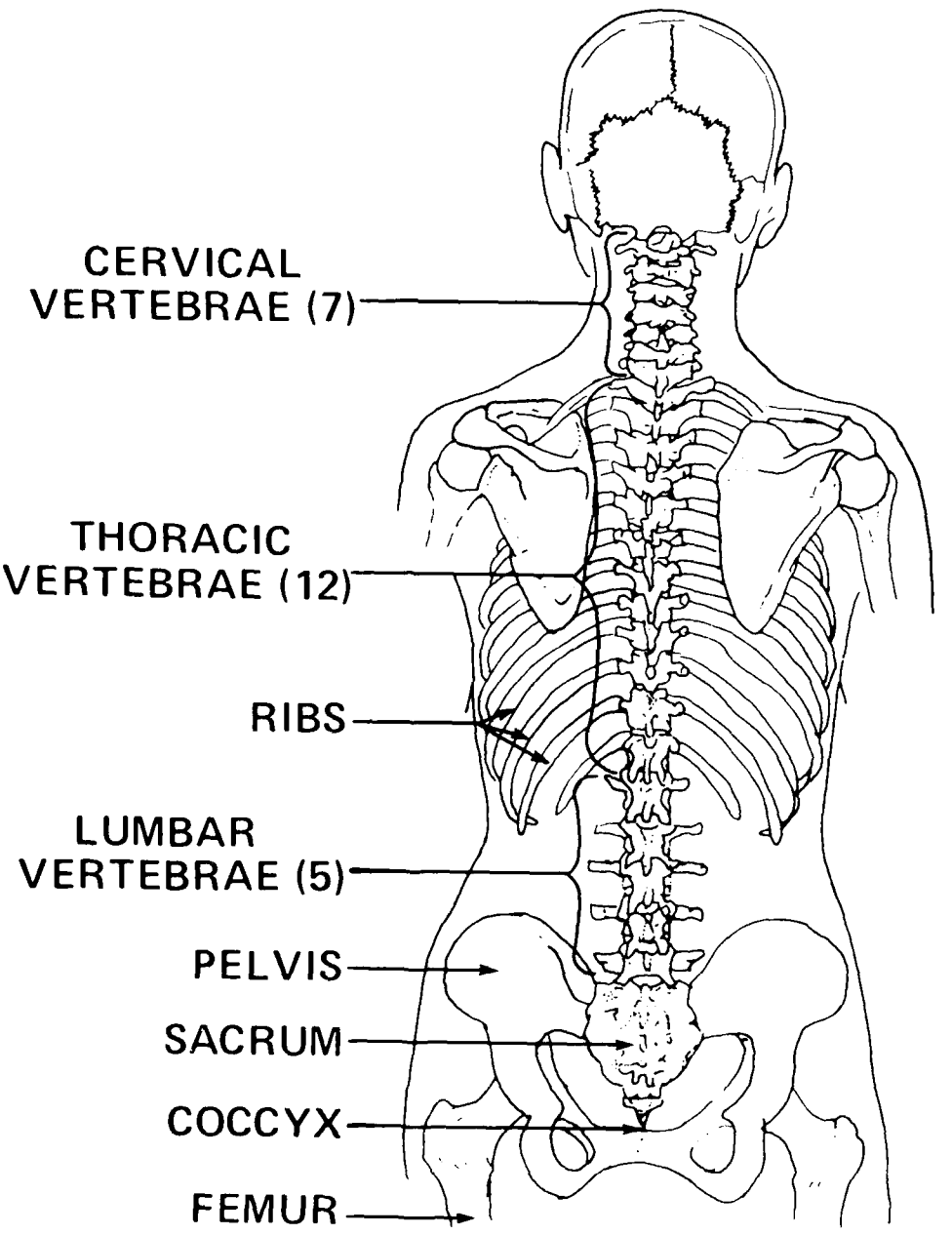


A TYPICAL THORACIC VERTEBRA, VIEWED FROM ABOVE

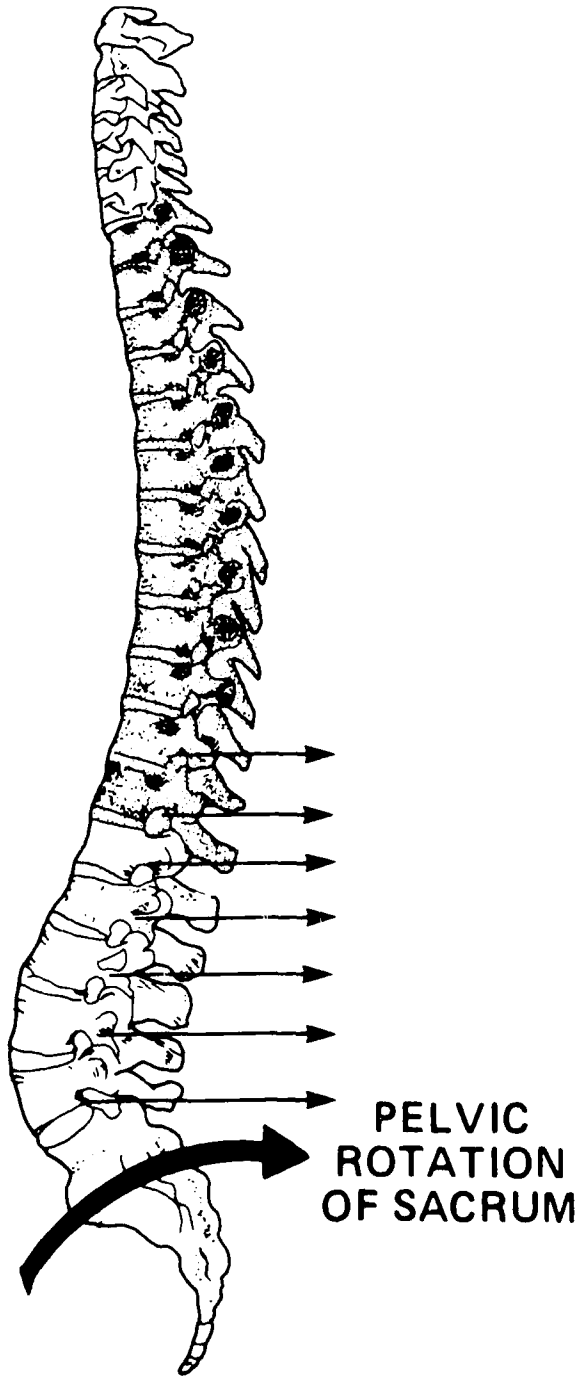


THE VERTEBRAE SHOWING NORMAL CURVATURE

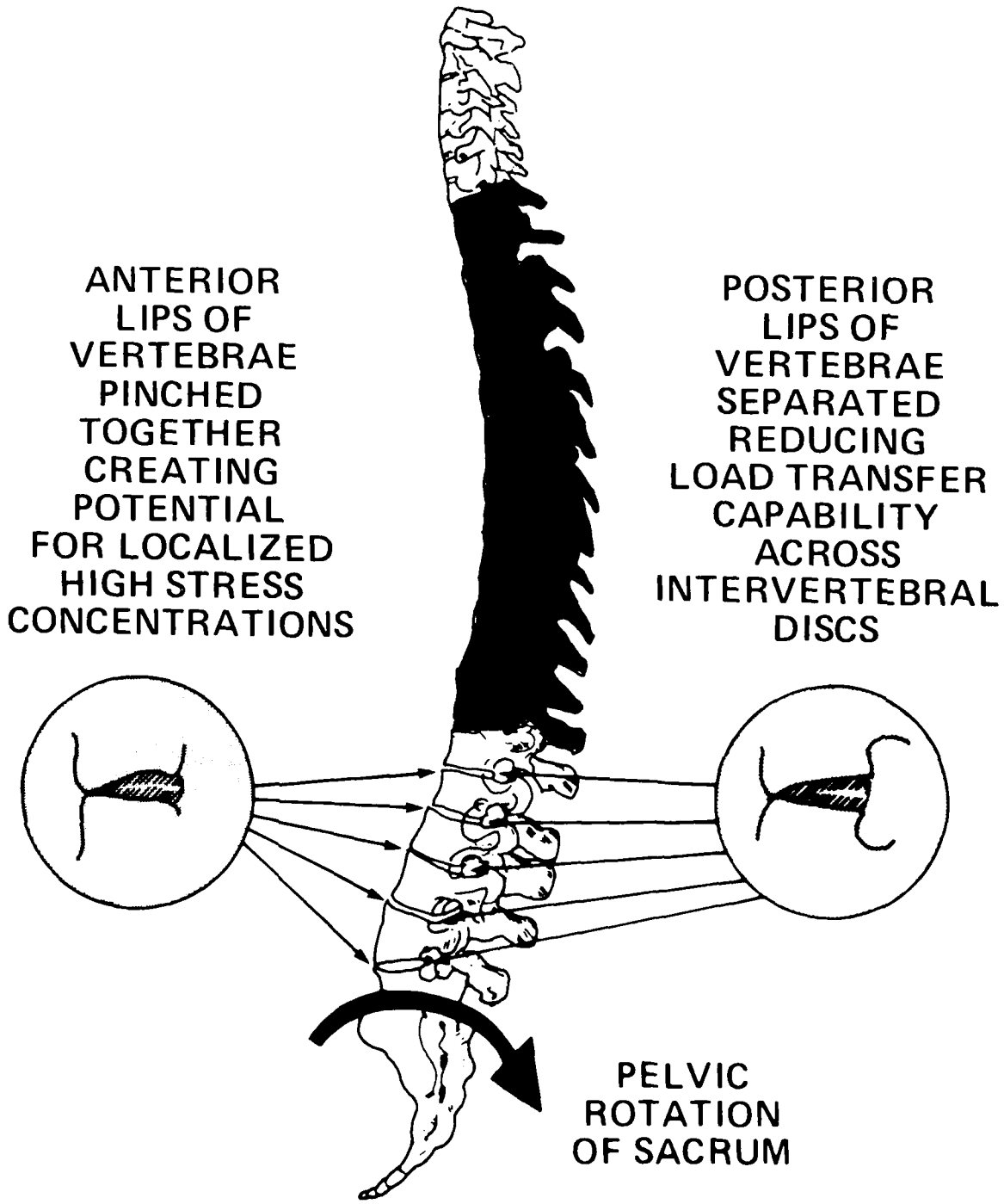



CERVICAL VERTEBRAE (7)
THORACIC VERTEBRAE (12)
RIBS
LUMBAR VERTEBRAE (5)
PELVIS
SACRUM
COCCYX
FEMUR

EFFECTS OF FEMUR LEVERAGING PELVIS

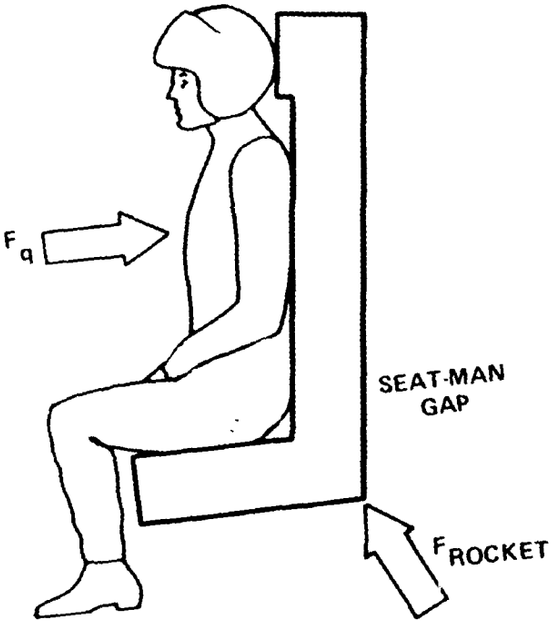


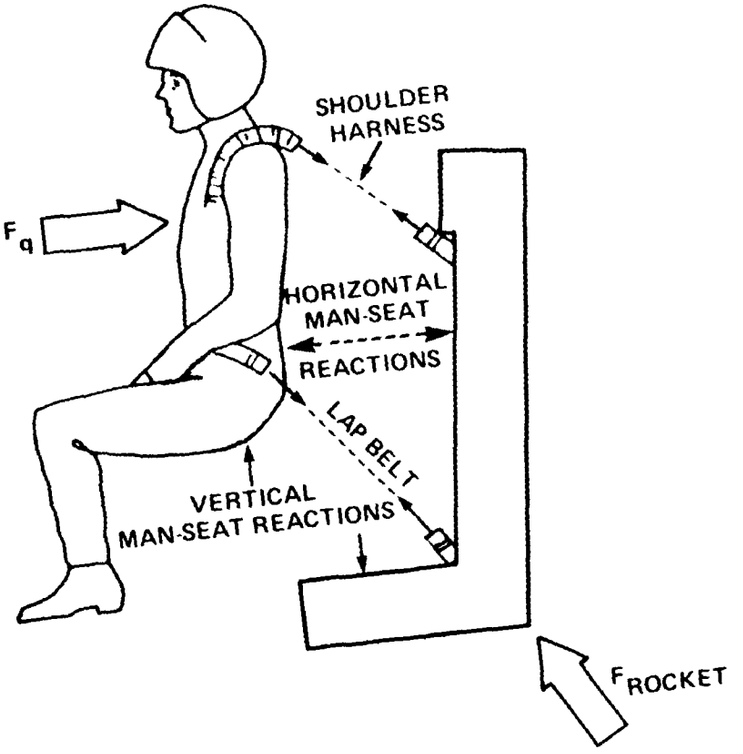
EFFECTS OF FEMUR LEVERAGING PELVIS



GENERALIZED CONCEPTUALIZATION OF MAN-SEAT INTERACTIONS AND EXTERNAL FORCES OPERATING ON COMBINATION

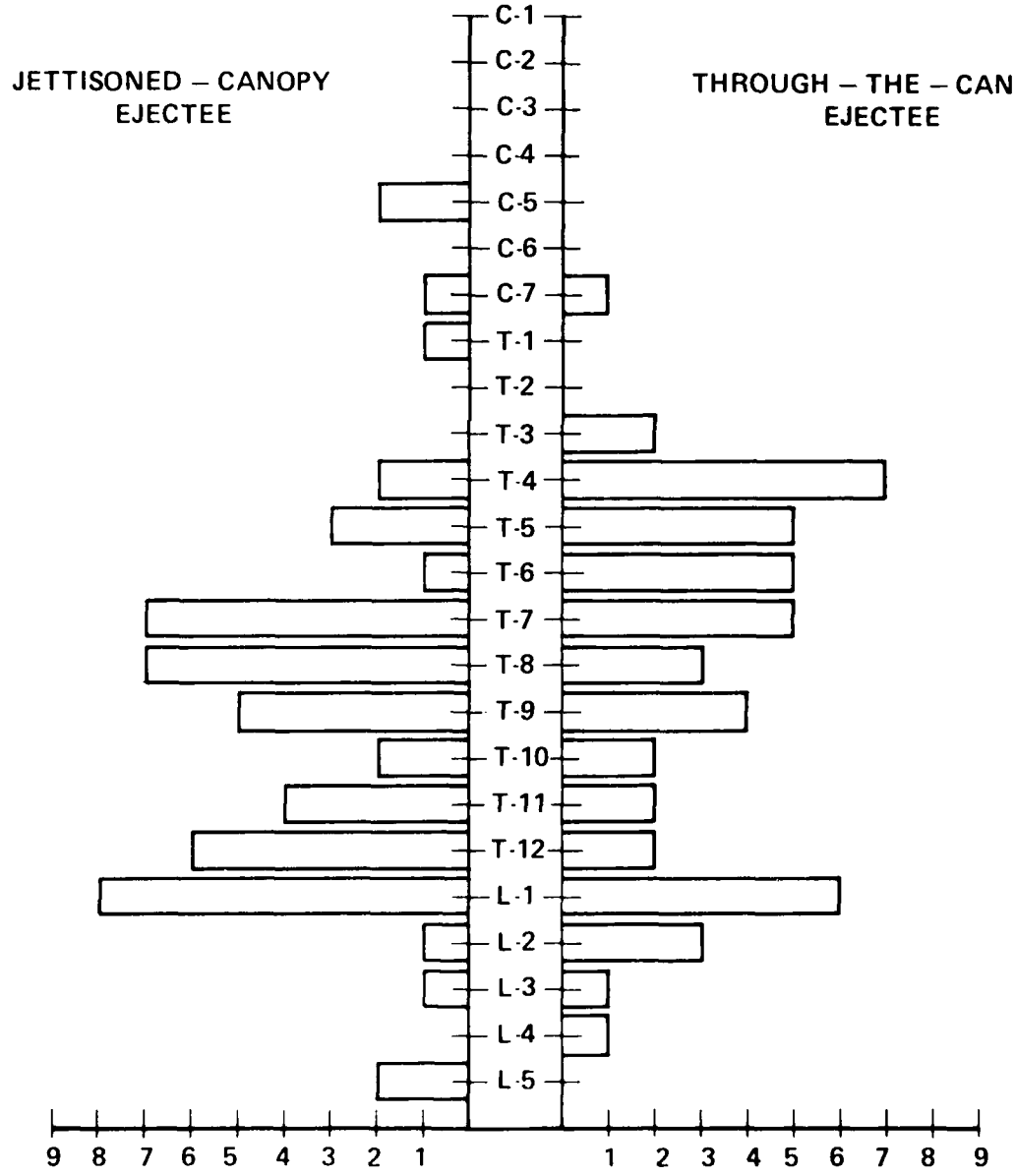
UNGUIDED POWERED FLIGHT PHASE



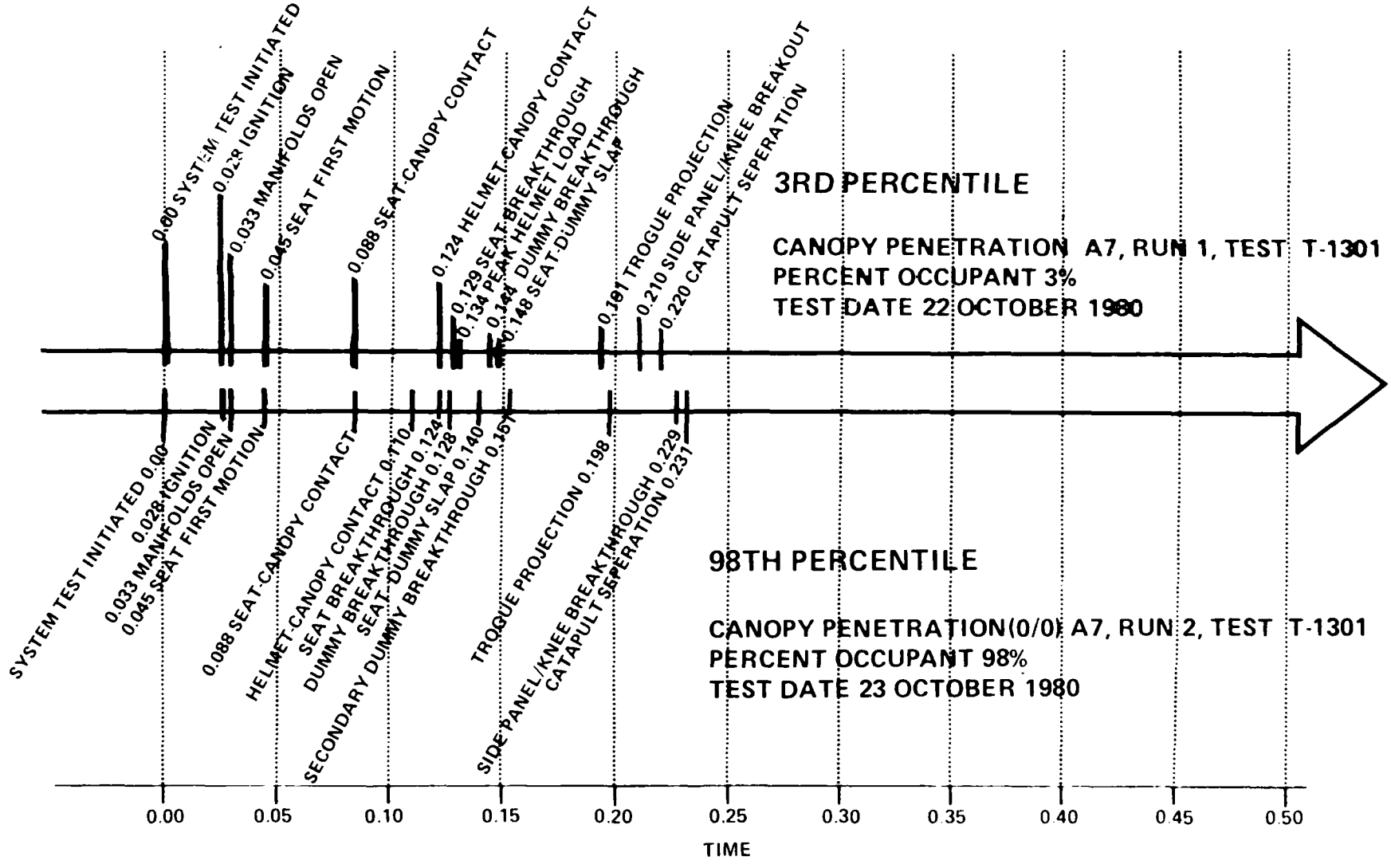


NUMBERS OF COMPRESSIONS FRACTURES REPORTED

COMPARISON OF COMPRESSION FRACTURE FREQUENCY AMONG VERTEBRAE FOR JETTISONED–CANOPY AND THROUGH–THE–CANOPY USN EJECTEES FOR PERIOD 1/1/69 THROUGH 12/1/79

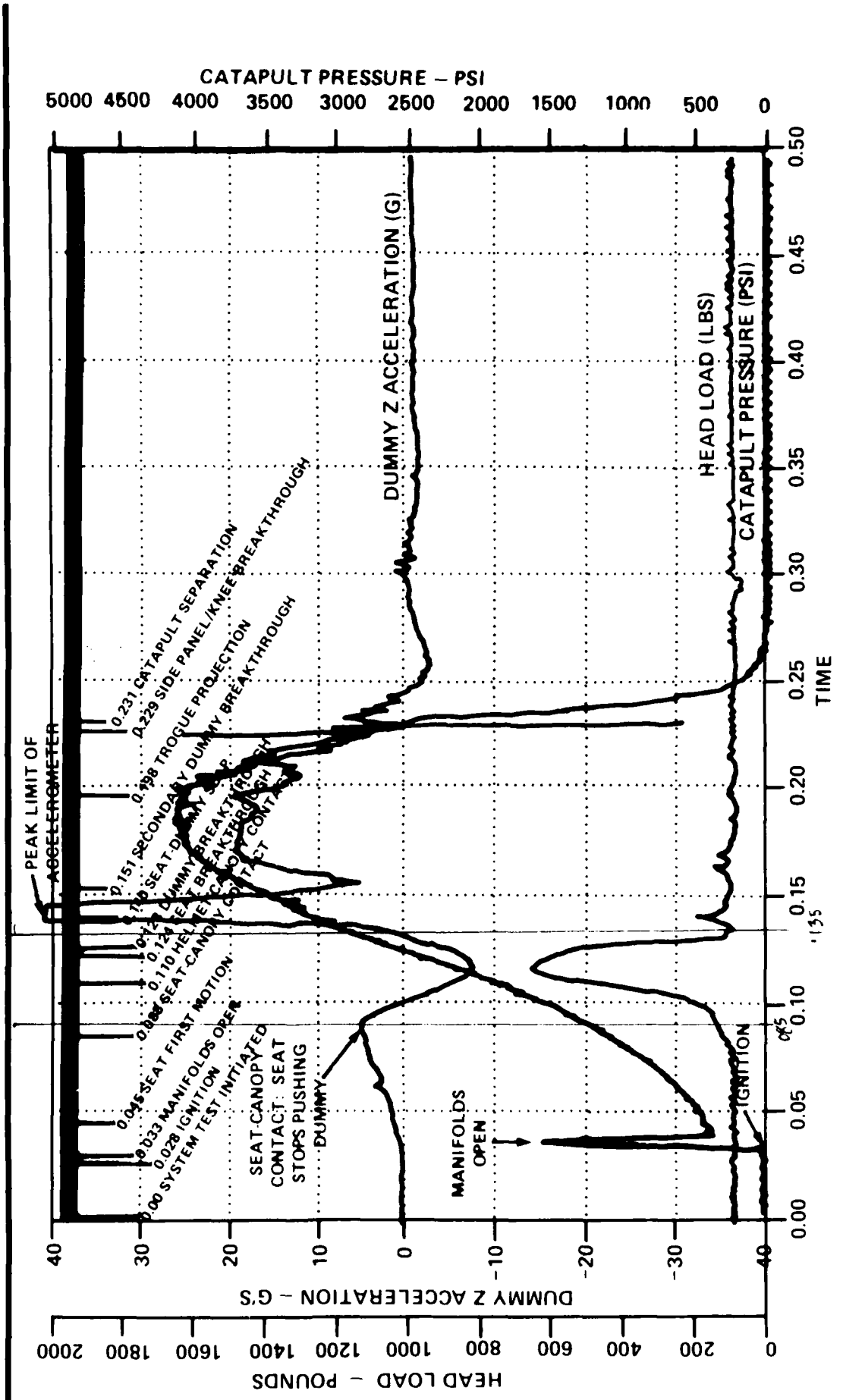


COMPARATIVE EVENT TIME LINES
3RD PERCENTILE VS. 98TH PERCENTILE
A A–7/SIIIS–3ER



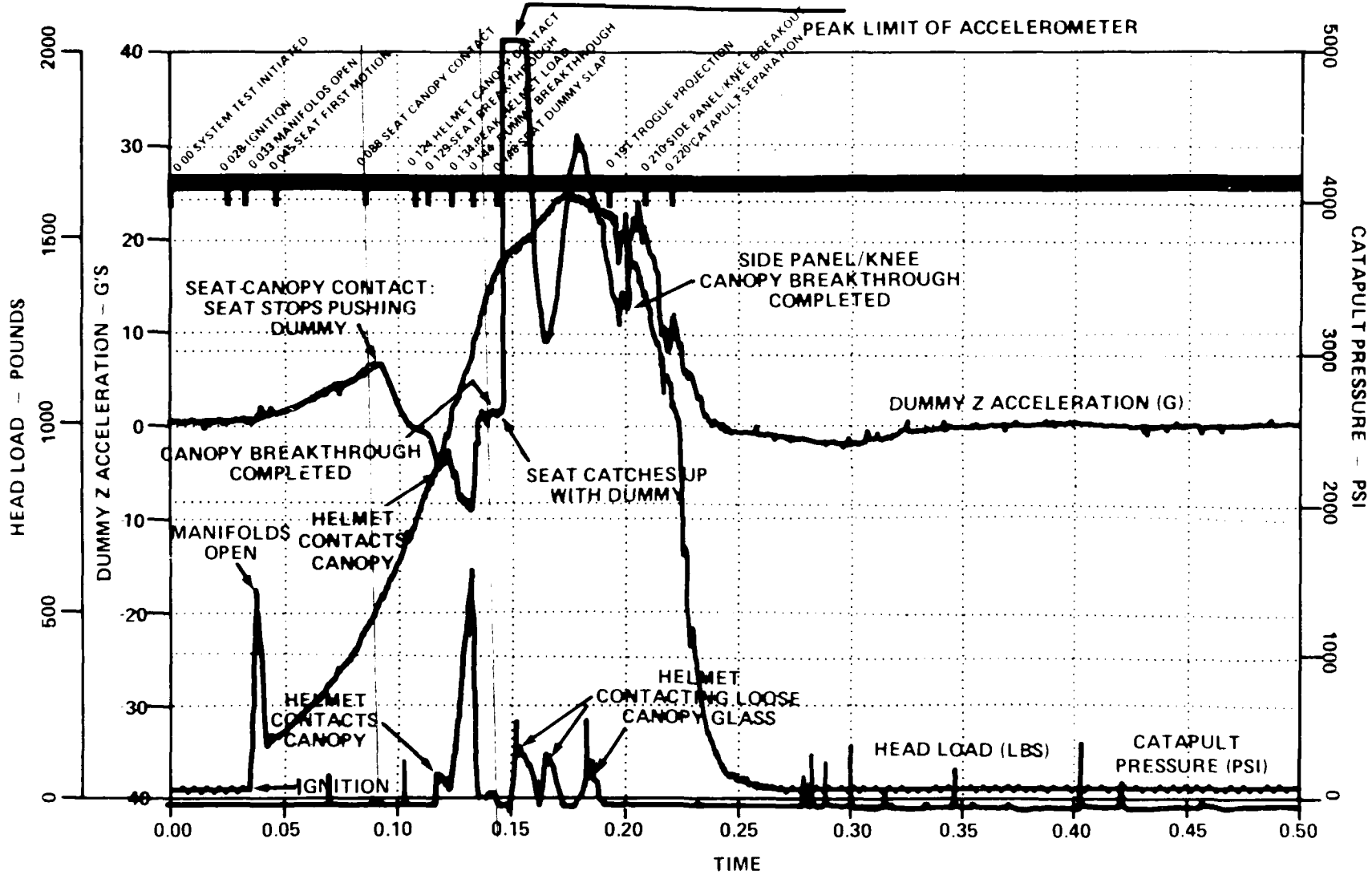
98TH PERCENTILE EVENT TIME LINE

CANOPY PENETRATION(O/O)
A7, RUN 2, TEST T-1301
TEST DATE 23 OCTOBER 1980



3RD PERCENTILE EVENT TIME LINE

CANOPY PENETRATION
A7, RUN 1, TEST T-1301
TEST DATE 22 OCTOBER 1980



VERTEBRAL COMPRESSION FRACTURE MECHANISMS

PERSONAL EQUIPMENT INFLUENCES

- TYPES OF INFLUENCES

  - DISTRIBUTION OF WEIGHT

    - INCREASE LOAD SUPPORTED BY VERTEBRAL COLUMN

    - MOVE EFFECTIVE C.G. FORWARD – INCREASING TENDENCY FOR VERTEBRAL MISALIGNMENT

  - PLACEMENT OF STRAPS, ATTACHMENTS, PHYSICAL BULK

    - PRODUCE LOCALIZED, VARIABLE FROM PERSON-TO-PERSON VERTEBRAL MISALIGNMENT

VERTEBRAL COMPRESSION FRACTURE MECHANISMS

NON–STABLE EJECTION PLATFORM

- CAUSES BUTTOCK AND LOWER TORSO MOVEMENT UNDER CATAPULT BOOST ACCELERATION FORCES RESULTING IN VERTEBRAL MISALIGNMENT.

VERTEBRAL COMPRESSION FRACTURE MECHANISMS

INADEQUATE THIGH SUPPORT

- ACCELERATION FORCE OF LOWER LEG PULLS THIGH DOWN AGAINST FORWARD EDGE OF THIGH SUPPORT STRUCTURE
  - ROTATES PELVIS
    - INDUCING VERTEBRAL MISALIGNMENT
  - CAUSES "SUBMARINING" OF LOWER TORSO UNDER LOWER RESTRAINTS (LAPBELT)
    - INDUCING VERTEBRAL MISALIGNMENT

VERTEBRAL COMPRESSION FRACTURE MECHANISMS

POOR TORSO RESTRAINT

- BODY SLUMP DURING CATAPULT BOOST PHASE ACCOMPANIED BY FORWARD MOTION OF TORSO WITHIN RESTRAINTS
  - INDUCING VERTEBRAL MISALIGNMENT
  - MAY BE EXACERBATED BY FIRING CONTROL REACH/ ACTUATION PROBLEMS INDUCING EJECTEE TO MOVE UPPER TORSO FORWARD AND DOWN.
  - ALSO MAY BE EXACERBATED BY DIVERGENCY BETWEEN CATAPULT/RAIL BOOST ANGLE AND SEAT BACK ANGLE.
- BODY "SUBMARINES" UNDER LOWER RESTRAINTS (LAPBELT)
  - INDUCING VERTEBRAL MISALIGNMENT

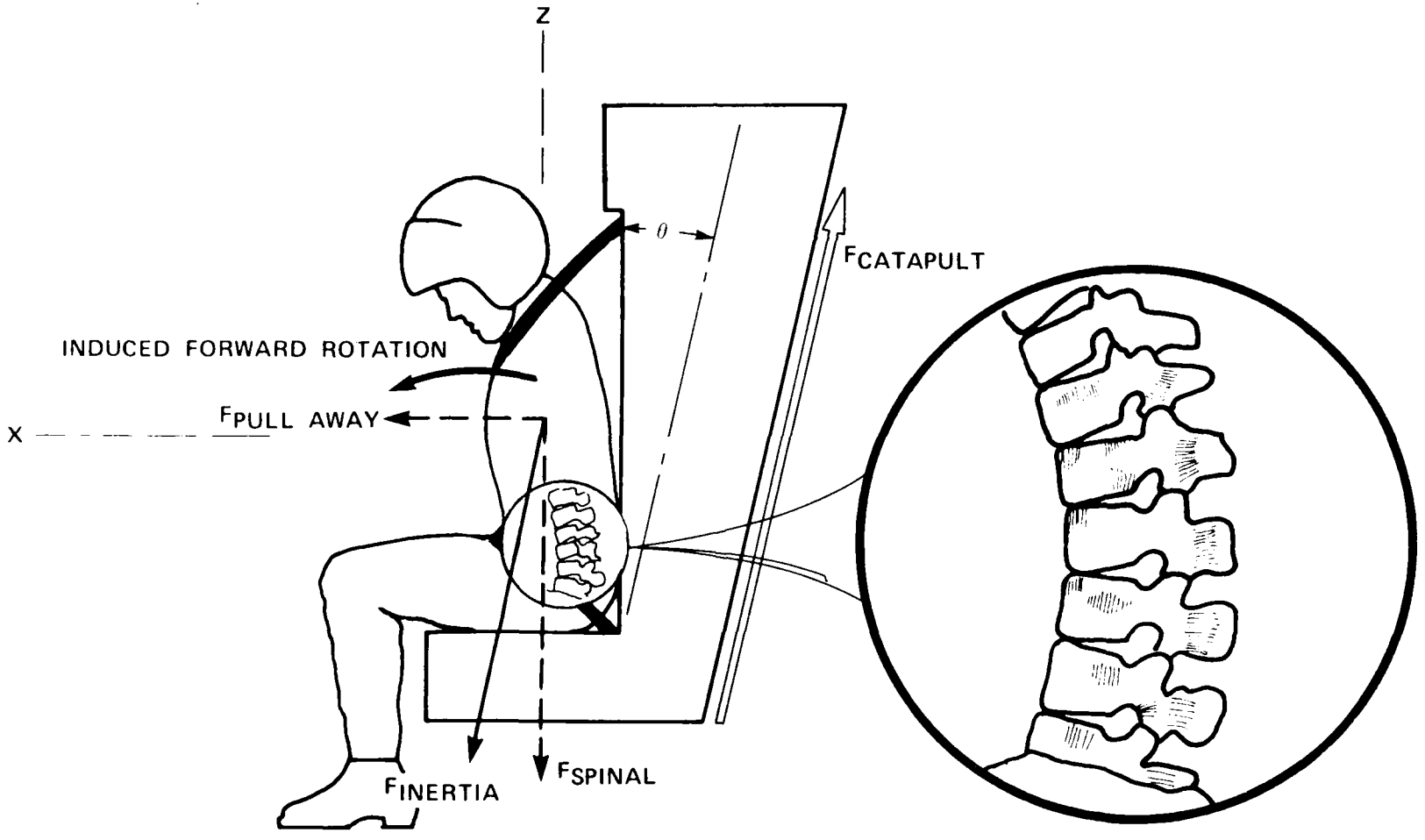
VERTEBRAL COMPRESSION FRACTURE MECHANISMS

CATAPULT BOOST ACCELERATION VECTOR
INDUCED FORWARD TORSO ROTATION

- DIVERGENCY BETWEEN CATAPULT/RAIL BOOST ANGLE AND SEAT BACK ANGLE CAUSES SEAT TO PULL AWAY FROM EJECTEE'S BACK
  - EJECTEE TORSO ROTATES ABOUT LOWER RESTRAINTS (LAPBELT) INTO SHOULDER HARNESS
    - INDUCING VERTEBRAL MISALIGNMENT
  - LOWER TORSO "SUBMARINES" UNDER LOWER RESTRAINTS (LAPBELT)
    - INDUCING VERTEBRAL MISALIGNMENT

VERTEBRAL COMPRESSION FRACTURE MECHANISMS

CATAPULT BOOST ACCELERATION VECTOR
INDUCED FORWARD TORSO ROTATION



VERTEBRAL COMPRESSION FRACTURES MECHANISMS

POOR SEAT BACK SUPPORT

- PRODUCES AREAS OF NON-SUPPORT CAUSING VERTEBRAL MISALIGNMENT DURING CATAPULT BOOST ACCELERATION.

GENERATION OF HEAD LOADS DURING THROUGH–THE–CANOPY EJECTION

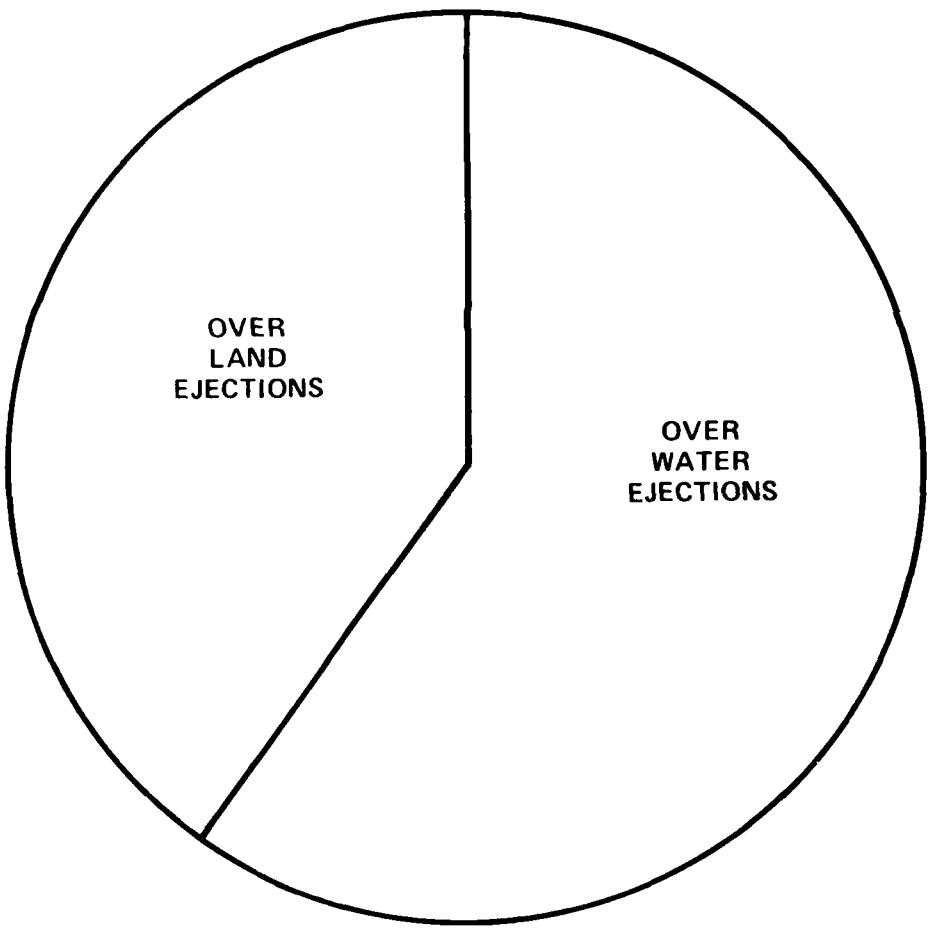
- REQUIRES HELMET CONTACT WITH CANOPY SEGMENT RESISTING PENETRATION
  - HELMET STRIKES CANOPY BEFORE SEAT DOES
  - HELMET STRIKES CANOPY WHEN SEAT DOES
  - SEAT STRIKES CANOPY AND STOPS. BODY INERTIAL FORCES AND RESTRAINT SUBSYSTEM SLACK PERMIT BODY TO RISE UNTIL HELMET STRIKES CANOPY
  - HELMET STRIKES CANOPY AFTER SEAT PENETRATES CANOPY

DEFICIENCIES IN HEAD LOAD DATA MEASUREMENTS

- NONREPRESENTATIVE COMPRESSION OF DUMMY UNDER ACCELERATION
- NONREPRESENTATIVE RESTRAINT SYSTEM CONSTRAINT OF DUMMY UNDER DECELERATION
- GEOMETRIC MISALIGNMENTS BETWEEN HELMET-CANOPY FORCE AND TRANSDUCER:
  - CONTACT FORCE VECTOR VS TRANSDUCER AXIS
  - CONTACT POINT OFFSET FROM TRANSDUCER
  - HELMET SHIFT DURING CANOPY CONTACT

OVERWATER SURVIVABILITY

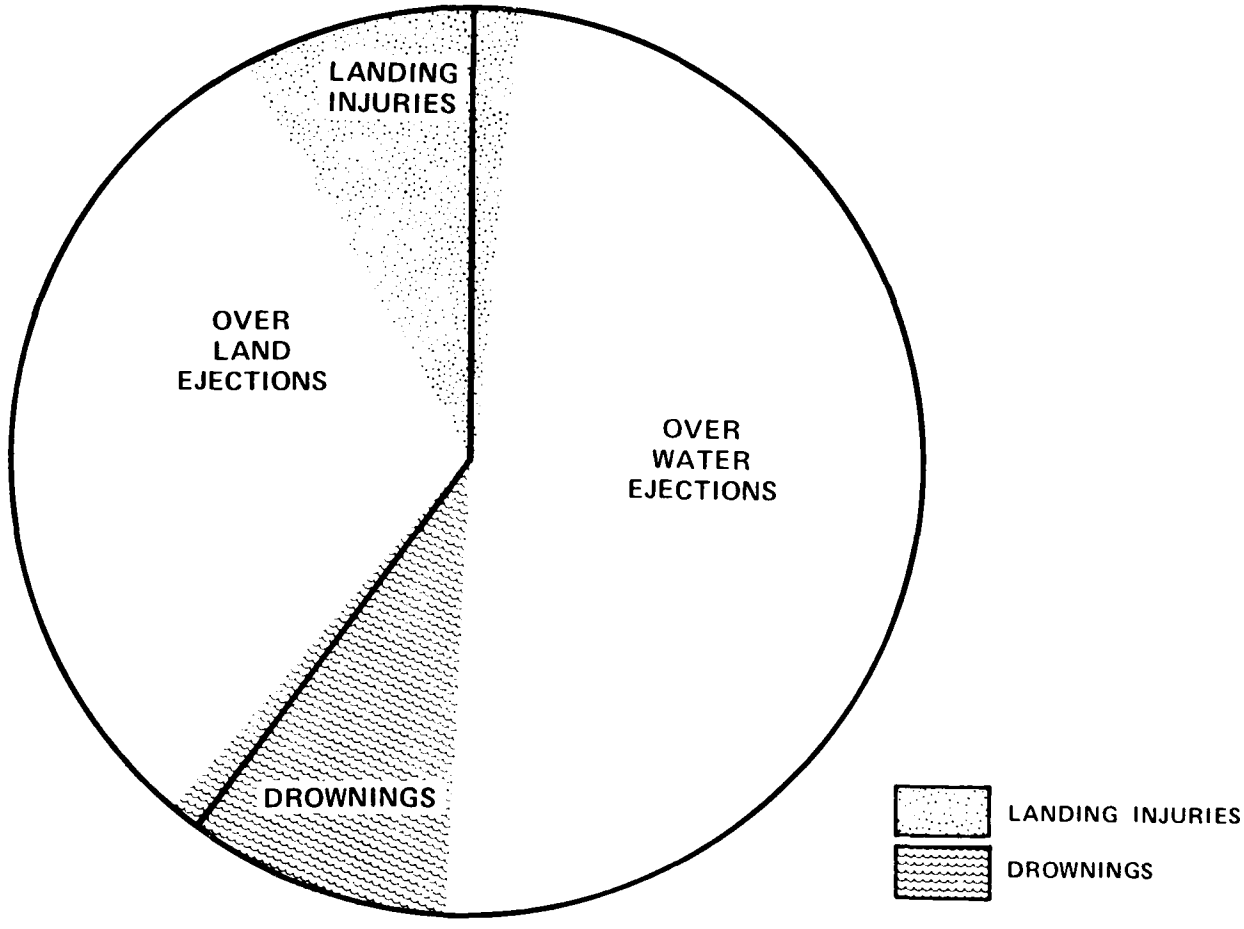
EFFECTS OF LANDING TERRAIN UPON TYPES AND FREQUENCY OF INJURIES



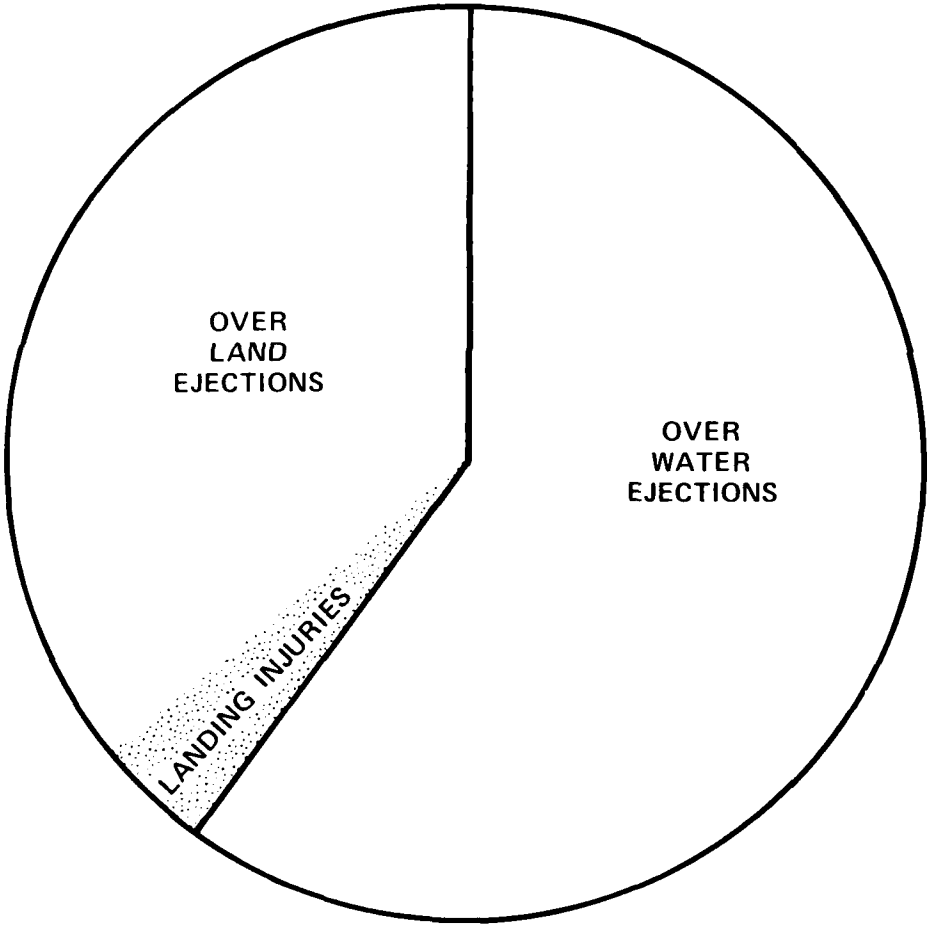
TYPES OF TERRAIN

HYPOTHETICAL POPULATION	
OVER LAND	40
OVER WATER	60
TOTAL	100

EFFECTS OF LANDING TERRAIN UPON TYPES AND FREQUENCY OF INJURIES



EFFECTS OF LANDING TERRAIN UPON FREQUENCY OF LANDING INJURIES



HYPOTHETICAL POPULATION

OVER LAND	40
OVER WATER	60
TOTAL	100
LANDING INJURIES (ALL OVER LAND)	4

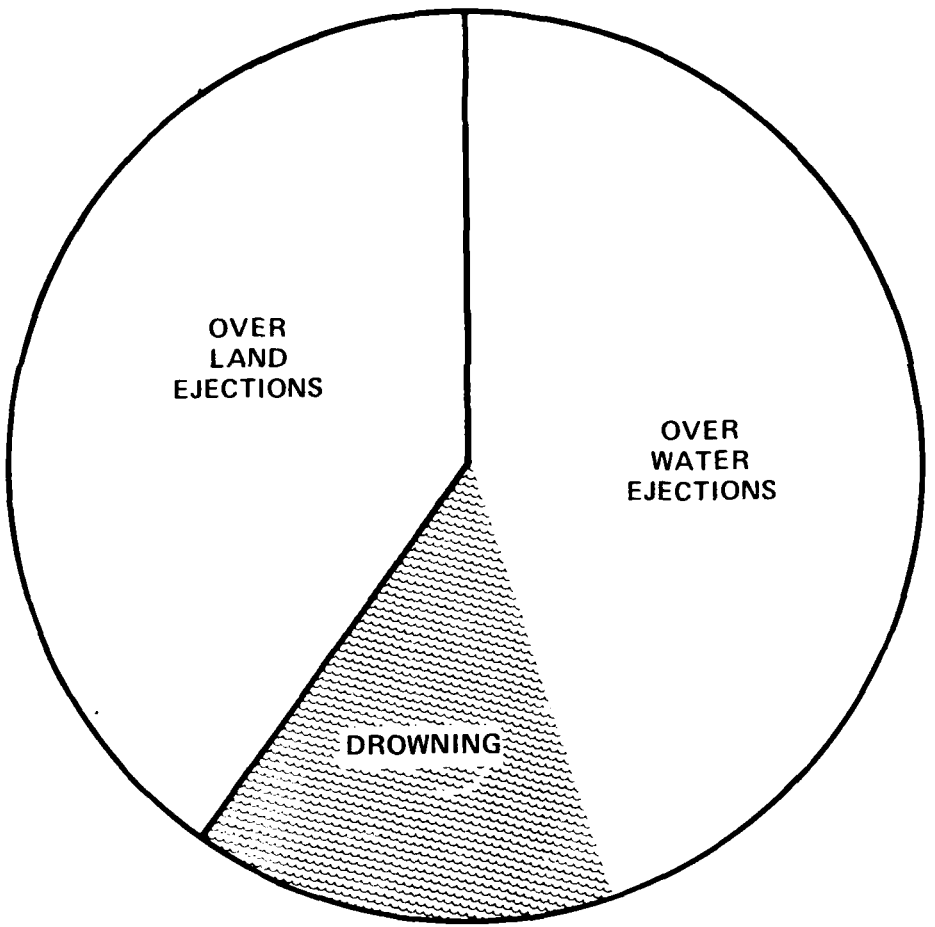
LANDING INJURY RATES:

- $\frac{\text{LAND. INJ.}}{\text{TOTAL}} = 4\%$
- $\frac{\text{LAND. INJ.}}{\text{OVER LAND}} = 10\%$

LANDING INJURIES

NOTE: VERY FEW LANDING INJURIES ARE ASSOCIATED WITH WATER LANDINGS. THUS LANDING INJURY RATE AS PERCENTAGE OF TOTAL EJECTIONS MASKS CRITICAL RATE BY INCLUDING LOW RISK OF LANDING INJURY OVER WATER POPULATION. SHOULD PERCENTAGE EJECTING OVER LAND CHANGE, A CORRESPONDING INCREASE OR DECREASE IN THE TOTAL EJECTEE PERCENTAGE WOULD OCCUR UNLESS THE HIGH RISK OVER LAND INJURY RATE WERE TO CHANGE.

EFFECTS OF LANDING TERRAIN UPON FREQUENCY OF DROWNING



HYPOTHETICAL POPULATION

OVER LAND	40
OVER WATER	60
TOTAL	100
DROWNINGS (ALL OVER WATER)	15

DROWNING RATES:

- $\frac{\text{DROWNING}}{\text{TOTAL}} = 15\%$
- $\frac{\text{DROWNING}}{\text{OVER WATER}} = 25\%$

DROWNINGS

NOTE: VERY FEW DROWNINGS, ALTHOUGH A FEW, OCCUR OVER LAND. THUS THE LOW RISK OF DROWNING POPULATION EJECTING OVER LAND CAN OBSCURE A CRITICAL RATE PREVENTING RECOGNITION OF A PROBLEM. IF PERCENT EJECTING OVER WATER WERE TO CHANGE THEN, WITHOUT A CHANGE IN DROWNINGS AMONG OVER WATER EJECTEE RATE, THE RATE AMONG TOTAL EJECTEES WOULD CLIMB.

1/1/69 - 12/31/78

ESCAPAC DROWNINGS AMONG ALL EJECTIONS

A-4	IA-1 0 0% DATES: 69-78	IC-3 1 1% DATES: 69-77	IF-3 1 5% DATES: 72-77	IG-3 2 6% DATES: 74-78
A-7		IC-2 3 2% DATES: 69-76		IG-2 3 9% DATES: 75-78
S-3				IE-1 0 0% DATES: 73-78

1/1/69 - 12/31/78

ESCAPAC OVER LAND EJECTIONS

A-4	**IA-1** 53 60% DATES: 69-78	**IC-3** 93 72% DATES: 69-77	**IF-3** 8 40% DATES: 72-77	**IG-3** 25 71% DATES: 74-78
A-7		**IC-2** 73 46% DATES: 69-76		**IG-2** 14 41% DATES: 75-78
S-3				**IE-1** 3 60% DATES: 73-78

1/1/69 - 12/31/78

ESCAPAC OVER WATER EJECTIONS

A-4	IA-1 35 40% DATES: 69-78	IC-3 36 28% DATES: 69-77	IF-3 12 60% DATES: 72-77	IG-3 10 29% DATES: 74-78
A-7		IC-2 86 54% DATES: 69-76		IG-2 20 59% DATES: 75-78
S-3				IE-1 2 40% DATES: 73-78

1/1/69 - 12/31/78

ESCAPAC DROWNINGS OVER WATER

A-4	IA-1 0 0% DATES: 69-78	IC-3 1 3% DATES: 69-77	IF-3 1 8% DATES: 72-77	IG-3 2 20% DATES: 74-78
A-7		IC-2 3 3% DATES: 69-76		IG-2 3 15% DATES: 75-78
S-3				IE-1 0 0% DATES: 73-78

DROWNINGS AND LOST(WATER) AMONG OVERWATER, WITHIN ENVELOPE TYPE 1 AND 5 EJECTEES (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT EJECTIONS)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979

SEAT TYPE	WITHIN ENVELOPE, OVERWATER EJECTION DATA		
	TOTAL EJECTIONS	COMBINED LOST (WATER) AND DROWNING	COMBINED RATE LOST (WATER) AND DROWNING
TYPE H-9	1	0	0%
MK A5	1	0	0%
MK F5	4	1	25.0%
MK GRU5	39	1	2.6%
MK H5	4	1	25.0%
MK5 SERIES	48	3	6.3%
MK A7	1	0	0%
MK F7	41	0	0%
MK GRUEA 7	13	1	7.7%
MK GRU 7	15	3	20.0%
MK GRU 7A	44	2	4.5%
MK H7	204	13	6.4%
MK7 SERIES	318	19	6.0%
ESCAPAC I	2	0	0%
ESCAPAC IA-1	30	1	3.3%
ESCAPAC IC-2	78	4	5.1%
ESCAPAC IC-3	32	3	9.4%
ESCAPAC I, IA-1, IC-2, IC-3	142	8	5.6%
ESCAPAC IF-3	11	1	9.1%
ESCAPAC IG-2	22	4	18.2%
ESCAPAC IG-3	6	1	16.7%
ESCAPAC IF-3, IG-2, IG-3	39	6	15.4%
LS-I/LS-IA	9	0	0%
HS-I	8	0	0%
HS-IA	8	0	0%
LW-3B	4	1	25.0%

DROWNINGS AMONG TYPE 1 AND 5 OVERWATER EJECTEES (ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT EJECTIONS)

1 JANUARY 1969 THROUGH 31 DECEMBER 1979

	IN ENVELOPE	OUT OF ENVELOPE
MK GRU5	0	2
MK H7	3	0
MK GRU7	1	0
MK GRU7A	1	1
LW-3B	1	0
ESCAPAC 1C-2	2	1
ESCAPAC 1C-3	1	0
ESCAPAC 1F-3	1	0
ESCAPAC 1G-2	3	0
ESCAPAC 1G-3	0	1

DISTRIBUTION OF TYPE 1 AND 5 EJECTIO
EJE

(ACCOMPLISHED CLEAR OF A

1 JANUARY

TYPE EJECTION SEAT	TOTAL EJECTIONS	TOTAL DROWNINGS	TOTAL LOST-WATER	WITHIN ENVELOPE				L
				OVERWATER EJECTIONS	DROWNINGS	DROWNINGS %	LOST-WATER	
TYPE H-9	8			1		0%	0	
MK A5	19		1	1		0%	0	
MK F5	17		2	4		0%	1	
MK GRUEA5	5			0			0	
MK GRU5	84	2	3	39	0	0%	1	
MK H5	14		1	4		0%	1	
MK L5	6			0				
MK Z5	7			0				
MK A7	8			1		0%	0	
MK F7	88		2	41		0%	0	
MK GRUEA7	17		2	13		0%	1	
MK GRU7	38	1	5	15	1	6.7%	2	
MKGRU7A	67	2	2	44	1	2.3%	1	
MK H7	348	3	22	204	3	1.5%	10	
ESCAPAC I	7			2		0%	0	
ESCAPAC IA-1	89		1	30		0%	1	
ESCAPAC IC-2	158	3	5	78	2	2.6%	2	
ESCAPAC IC-3	124	1	4	32	1	3.1%	2	
ESCAPAC IE-1	8		2	2			0	
ESCAPAC IF-3	19	1		11	1	9.1%	0	
ESCAPAC IG-2	41	3	3	22	3	13.6%	1	
ESCAPAC IG-3	43	1	1	6	0	0%	1	
LS-1/LS-1A	57		1	9		0%	0	
HS-1	25		3	8		0%	0	
HS-1A	9			8		0%	0	
LW-3B	21	1		4	1	25.0%	0	
SIIIS-3AV8	7			2		0%	0	
NAMC-II CATAPULT	1			0				
F-5E	1			0				
ESCAPAC IG-4	1			0				

N OF TYPE 1 AND 5 EJECTIONS, DROWNINGS AND LOST WATER BY SEAT TYPE AND EJECTION ENVELOPE

ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT EJECTIONS)

1 JANUARY 1969 – 31 DECEMBER 1979

WITHIN ENVELOPE				OUT OF ENVELOPE					
S	DROWNINGS %	LOST-WATER	LOST-WATER %	OVERWATER EJECTIONS	DROWNINGS	DROWNINGS %	LOST-WATER	LOST-WATER %	OVERWATER EJECTIONS
	0%	0	0%	0			0		0
	0%	0	0%	1			1	100%	0
	0%	1	25%	1			1	100%	0
		0		0			0		0
	0%	1	2.6%	7	2	28.6%	2	28.6%	1
	0%	1	25%	0			0		0
				0			0		0
				0			0		0
	0%	0	0%	0			0		0
	0%	0	0%	2			2	100%	1
	0%	1	7.7%	1			1	100%	0
	6.7%	2	13.3%	3	0		3	100%	0
	2.3%	1	2.3%	2	1	50%	1	50%	0
	1.5%	10	4.9%	8	0		6	75%	6
	0%	0	0%	0			0		0
	0%	1	3.3%	4		0%	0	0%	0
	2.6%	2	2.6%	5	1	20%	3	60%	1
	3.1%	2	6.3%	2	0		2	100%	0
		0	0%	0			2	100%	0
	9.1%	0	0%	0	0	0	0		0
	13.6%	1	4.5%	1	0	0	1	100%	1
	0%	1	16.7%	2	1	100%	0	0%	0
	0%	0	0%	1			1	100%	0
	0%	0	0%	3			3	100%	0
	0%	0	0%	1		0%	0	0%	0
	25.0%	0	0%	1	0	0	0	0%	0
	0%	0	0%	0					0
				0					0
				0					0
				0					0

'E AND

		POSSIBLY OUT OF ENVELOPE			
ATER	LOST-WATER %	OVERWATER EJECTIONS	DROWNINGS %	LOST-WATER	LOST-WATER %
		0		0	
	100%	0		0	
	100%	0		0	
		0		0	
	28 6%	1	0%	0	0%
		0		0	
		0		0	
		0		0	
		0		0	
	100%	1	0%	0	0%
	100%	0		0	
	100%	0		0	
	50%	0		0	
	75%	6		6	100%
		0		0	
	0%	0		0	
	60%	1	0%	0	0%
	100%	0		0	
	100%	0		0	
		0		0	
	100%	1		1	100%
	0%	0		0	
	100%	0		0	
	100%	0		0	
	0%	0		0	
	0%	0		0	
		0		0	
		0			
		0			
		0			

OVERWATER EJECTIONS ACCOMPLISHED CLEAR OF AIRCRAFT (INCLUDING INADVERTENT) -DROWNINGS AND LOST AT SEA FATALITIES-

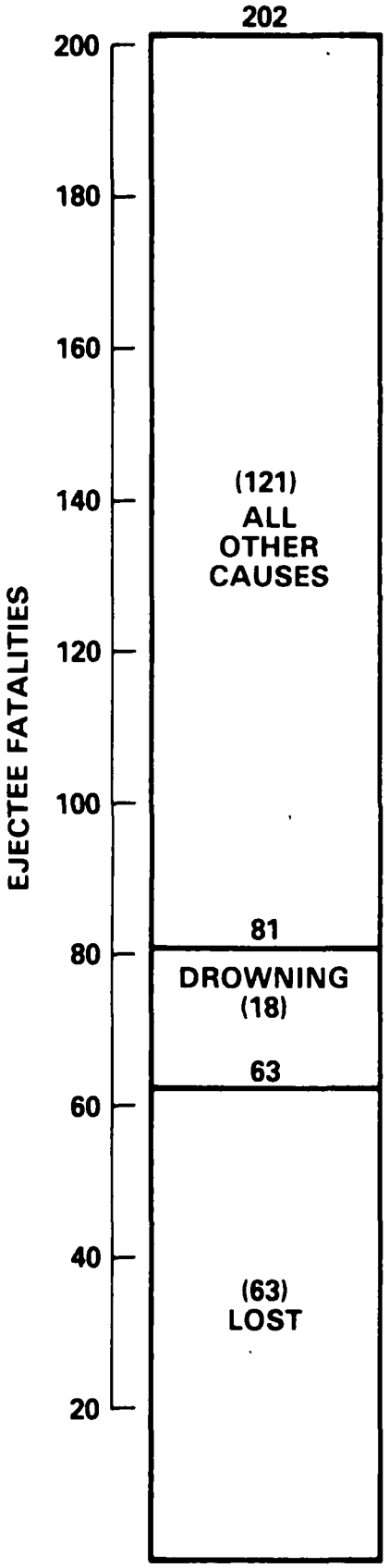
(1 JANUARY 1969 THROUGH 31 DECEMBER 1979)

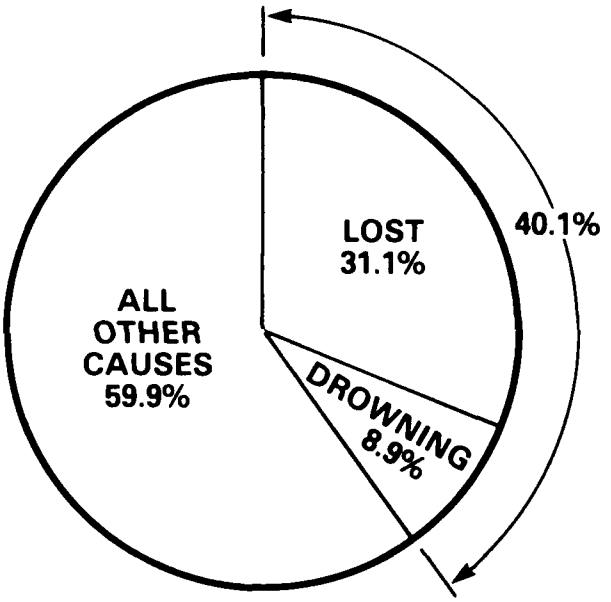
MONTH	OVERWATER		CUM %	DROWNING		CUM %	LOST @ SEA		CUM %	LOST @ SEA & DROWNING		CUM %
	MONTH	CUM	OVERWAT.	MONTH	CUM	DROWN	MONTH	CUM	LOST	MONTH	CUM	LOST & DROWN
OCT	46	46	7.3	1	1	5.6	5	5	7.9	6	6	7.4
NOV	50	96	15.1	3	4	22.2	4	9	14.3	7	13	16.0
DEC	44	140	22.0	4	8	44.4	6	15	23.8	10	23	28.4
JAN	53	193	30.3	0	8	44.4	6	21	33.3	6	29	35.8
FEB	61	254	39.9	3	11	61.1	7	28	44.4	10	39	48.1
MAR	51	305	48.0	1	12	66.7	6	34	54.0	7	46	56.8
APR	45	350	55.0	1	13	72.2	6	40	63.5	7	53	65.4
MAY	69	419	65.9	0	13	72.2	5	45	71.4	5	58	71.6
JUN	57	476	74.8	3	16	88.9	8	53	84.1	11	69	85.2
JUL	54	530	83.3	0	16	88.9	3	56	88.9	3	72	88.9
AUG	53	583	91.7	1	17	94.4	3	59	93.7	4	76	93.8
SEP	53	636	100.0	1	18	100.0	4	63	100.0	5	81	100.0

ROLE OF LOST & DROWNING IN EJECTION FATALITIES AMONG TYPE 1 AND 5 EJECTIONS

(INADVERTENT AND ACCOMPLISHED CLEAR OF AIRCRAFT EJECTIONS)

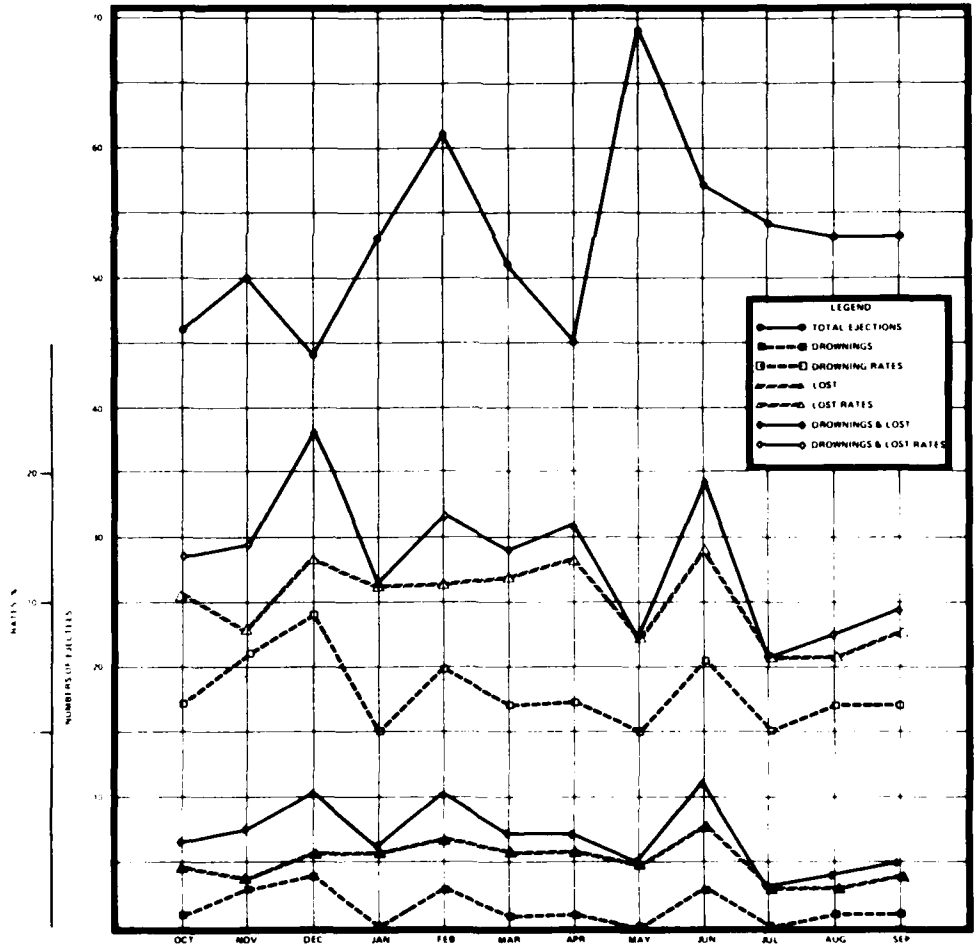
1 JANUARY 1969
THROUGH
31 DECEMBER 1979





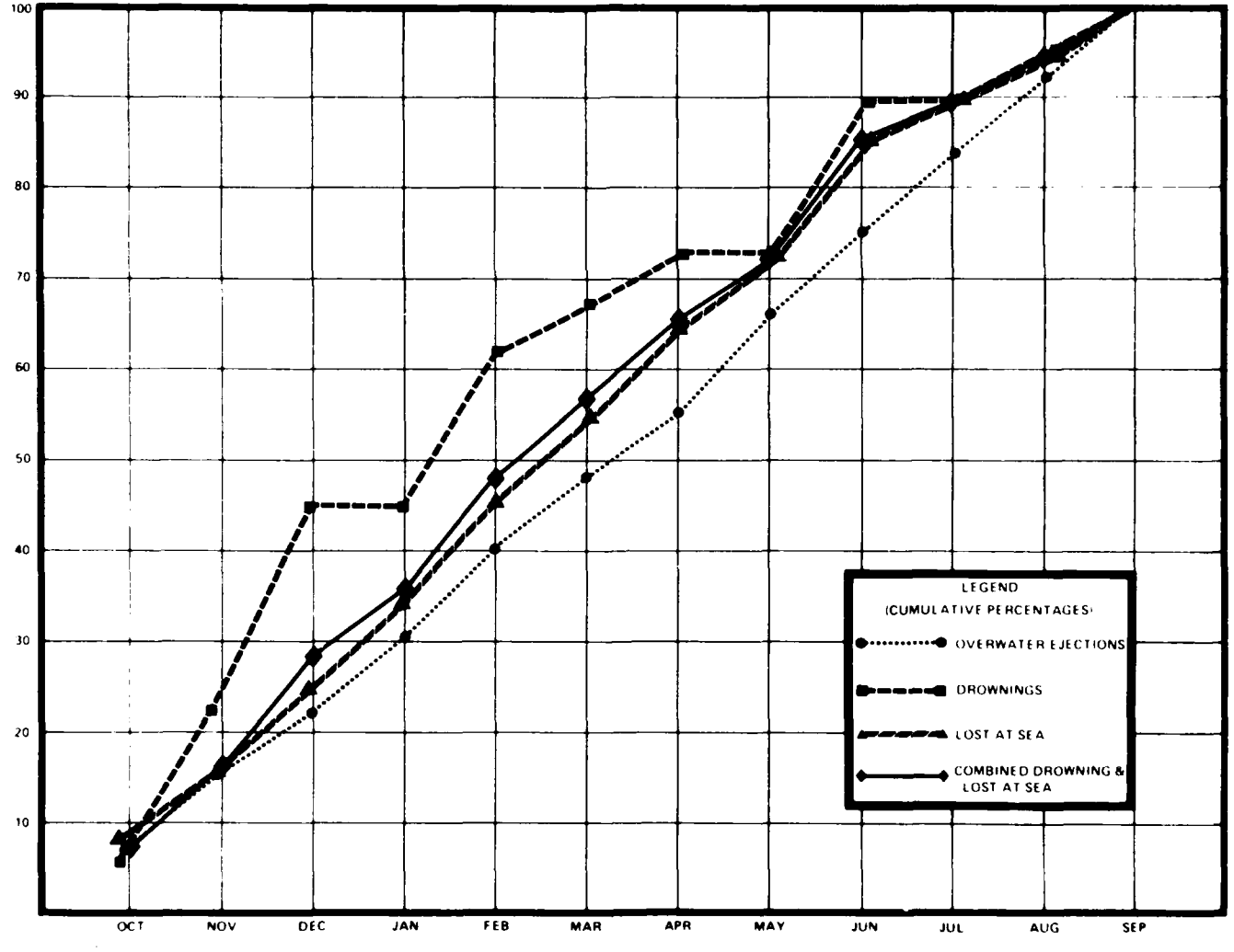
MONTHLY COMPARISONS OF OVERWATER EJECTION, DROWNING, LOST AT SEA, & DROWNING AND LOST AT SEA QUANTITIES AND RATES

1 JANUARY 1969 THROUGH 31 DECEMBER 1979



MONTHLY COMPARISONS OF DROWNINGS, LOST AT SEA, COMBINED DROWNINGS & LOST AT SEA EJECTIONS AGAINST OVERWATER EJECTIONS BY MONTHLY CUMULATIVE PERCENTAGES

(1 JANUARY 1969 THROUGH 31 DECEMBER 1979)



ESCAPAC EJECTIONS

DATA PERIOD BEGINNING 1 JANUARY 1969
ENDING 31 DECEMBER 1979 (EXCEPT AS NOTED)

	IA-1	IC-3	IF-3	IG-3
A-4	88	128	20	63

THROUGH DEC. 1980

	IC-2	IG-2
A-7	159	63

THROUGH AUG. 1981

ESCAPAC FATALITIES

DATA PERIOD BEGINNING 1 JANUARY 1969
ENDING 31 DECEMBER 1979 (EXCEPT AS NOTED)

	IA-1	IC-3	IF-3	IG-3
A-4	14 15.9%	17 13.3%	4 20.0%	13 (7 OVER WATER) 20.6%

THROUGH DEC. 1980

	IC-2	IG-2
A-7	19 11.9%	12 19.0%

THROUGH AUG. 1981

ESCAPAC OVERLAND EJECTIONS

DATA PERIOD BEGINNING 1 JANUARY 1969
ENDING 31 DECEMBER 1979 (EXCEPT AS NOTED)

	IA-1	IC-3	IF-3	IG-3
A-4	53	92	8	50

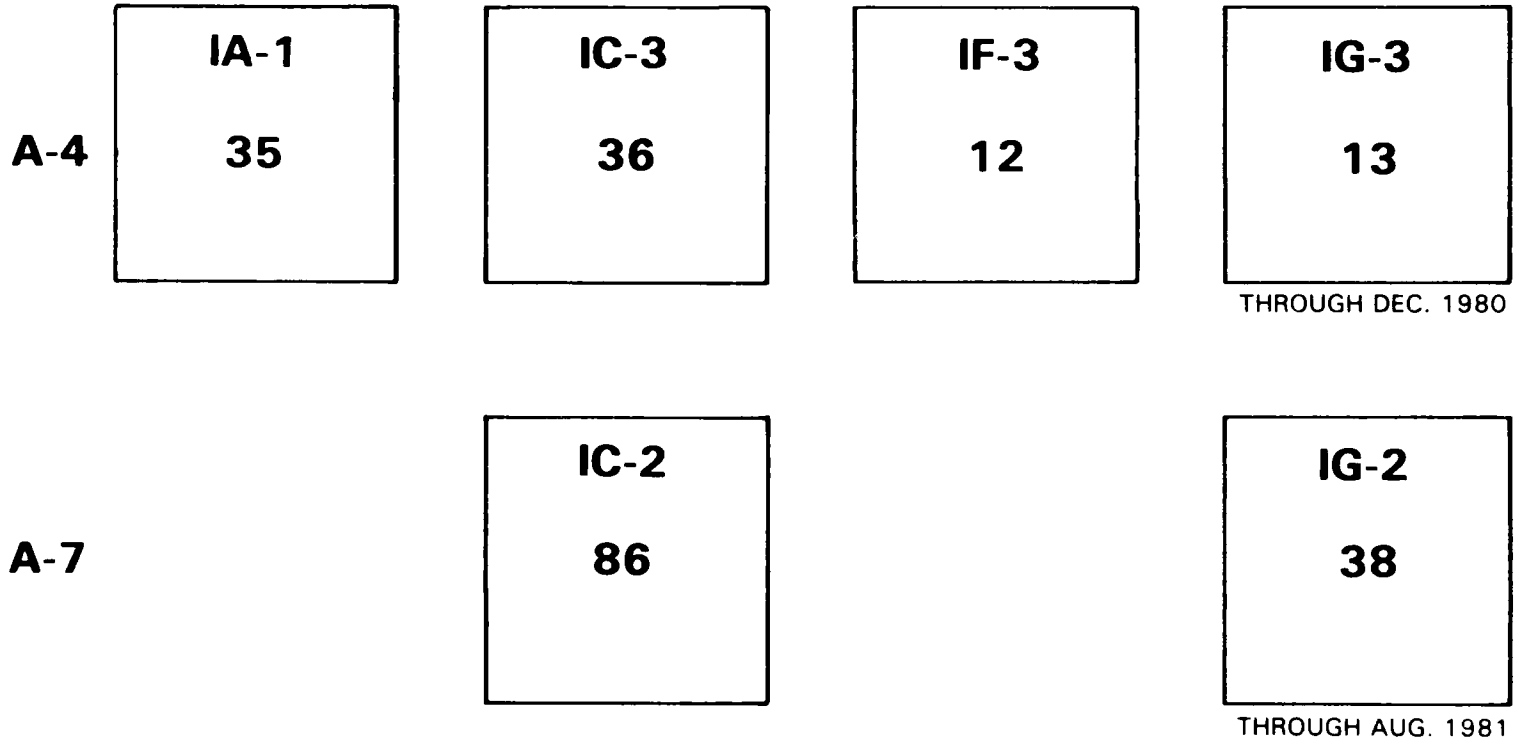
THROUGH DEC. 1980

	IC-2	IG-2
A-7	73	27

THROUGH AUG. 1981

ESCAPAC OVERWATER EJECTIONS

DATA PERIOD BEGINNING 1 JANUARY 1969
ENDING 31 DECEMBER 1979 (EXCEPT AS NOTED)



ESCAPAC EJECTEE DROWNINGS

DATA PERIOD BEGINNING 1 JANUARY 1969
ENDING 31 DECEMBER 1979 (EXCEPT AS NOTED)

	IA-1	IC-3	IF-3	IG-3
A-4	0	1	1	2
	0%	3%	8%	15.4%

THROUGH DEC. 1980

	IC-2	IG-2
A-7	3	4
	3%	10.5%

THROUGH AUG. 1981

END

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