

AIR FORCE



HUMAN RESOURCES

ADA018152

REMOTELY PILOTED VEHICLES DESIGN
OPTION DECISION TREES

By

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Duncan L. Dieterly, Major, USAF

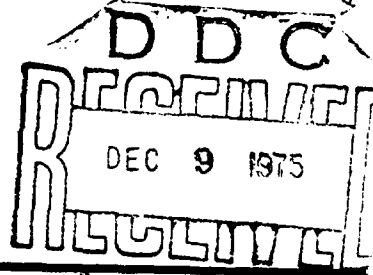
ADVANCED SYSTEMS DIVISION
Wright-Patterson Air Force Base, Ohio 45433

June 1975

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Advanced Systems Division

Approved for publication.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A multiphased study effort was conducted to lead to the development of methods for determining the components and measuring the effects of advances in technology on human resources in Air Force weapon systems. A first phase of the effort involved the conduct of an analysis of the literature to review the status of forecasting and assessing technology and of techniques for predicting the impact of technology on human resource parameters (AFHRL-TR-74-71). The second phase involved the development of Design Option Decision Trees (DODT) for two areas of Air Force systems technology (Digital Avionics Information System and Remotely Piloted Vehicle Systems). The third phase called for the development of unique methods or synthesis of existing techniques to result in a new method for measuring the effects of technology on Air Force human resources. The fourth phase involved		

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application of the method developed under phase three. The fifth and last phase entailed making an evaluation of the usefulness of the method to system designers and planners.

A method integrating the DODT with a modification of the method of summated ratings was developed to arrive at a quantification of human resource effects of technological innovations. This procedure was applied to the Digital Avionics Information System DODT to provide source data for the evaluation of the developed method. The DODTs developed for the RPV system are presented in this volume.



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SUMMARY

PROBLEM

The introduction of a new weapon system has a major impact on the human resource parameters of the Air Force. Depending upon the unique aspects of the weapon system, it may require new types of skills, increased support personnel, revision to training programs and changes in maintenance concepts. These represent only a small sample of the types of changes that may be instigated by introducing a new weapon system into the Air Force inventory.

The objective of this study was the development of methods for defining the components of innovative technology and for measuring the effects of the incoming technology on Air Force human resources. The human resource parameters of concern include manpower (e.g., numbers, job types, skill levels) training considerations, and cost data. Earlier investigations established the feasibility of using human resources data in design trade studies and of determining and graphically depicting the array of trade-off options available before inception of hardware design (Askren and Korkan, 1971; Askren, Korkan, and Watts, 1973). The purpose of the study program reported herein was to identify or to develop a method for quantifying the effects of incoming technology on the Air Force human resources required to maintain or operate a system which incorporates those technological innovations.

APPROACH

A five-step approach was taken to study the problem:

1. Search and critical analysis of the recent literature to review the status of forecasting and assessing technology and of techniques for predicting the impact of technology on human resource parameters.
2. Develop Design Option Decision Trees (DODT) for Remotely Piloted Vehicle Systems and the Digital Avionics Information Systems.
3. Development of unique methods or synthesis of existing techniques to result in a new method for measuring the effects of technology on Air Force human resources.

4. Application of methods developed under the phase three effort.
5. Evaluation of the usefulness of the technique to system designers and planners together with an identification of the various processes by which system designers and planners could make use of the results.

RESULTS AND CONCLUSIONS

A method integrating the Design Option Decision Tree with a modification of the method of summated ratings was developed to permit quantification of specific human resource components at each of the design options represented in the DODT. Using judgmental data collected from an operational unit in the field, the method developed under this study effort was evaluated for utility. It was concluded that quantifying human resource components associated with hardware design options by means of a technique incorporating a DODT and a modification of the method of summated ratings is a feasible approach and will provide one methodological procedure for measuring the effects of advances in technology on human resources in Air Force weapon systems.

The possibility of other, more objectively based, procedures is recognized, but emergence of such a procedure appears likely to come only as a result of additional study and resolution of many current theoretical and methodological problems.

PREFACE

This study was initiated by the Advanced Systems Division, Air Force Human Resources Laboratory, Wright-Patterson Air Force Base, Ohio under Project 7907, "Conditions of Effective Training and Transfer," Dr. Ross Morgan, Project Scientist, and Work-Unit 79070007, "Determining Impact of New Technology on Air Force Human Resources," Duncan L. Dieterly, Major, USAF, Task Scientist. The research was performed by Systems Research Laboratories, Inc., (SRL), Dayton, Ohio, under Contract F33615-74-C-4019 with Dr. Norman R. Polter as Principal Investigator and Kenneth D. Korkan as Associate Principal Investigator.

The authors wish to acknowledge the guidance and support provided by Dr. William B. Askren, Kenneth W. Potempa and Noel Schwartz, Advanced Systems Division, in initial structuring of the research problem.

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Section I

INTRODUCTION

A series of DODT's were generated to reflect the design philosophy of remotely piloted vehicles. This set of DODT's has been derived from the more general Aerospace Vehicle Design DODT's generated on previous efforts for Air Force Human Resource Laboratory (AFHRL). As will be noted, the modifications required to the basic Aerospace Vehicle Design DODT plus the additions to the tailor it to RPV's proved to be extensive enough, resulting in a Remotely Piloted Vehicle Design Tree (SRL Dwg. No. 6810-02-2986). The four-sheet set of Airframe DODT's was also modified extensively to make it appropriate to RPV's (SRL Dwg. No. 6810-02-2500, Sheets 1-4). The Reciprocating Engine Tree was modified considerably, but retained its original drawing (SRL Dwg. No. 6713-10-37-1275, Revision C). Two entirely new trees were also developed, which are unique to RPV technology, which consist of Launch Systems (SRL Dwg. No. 6810-02-2497) and Recovery Systems (SRL Dwg. No. 6810-02-2498).

The following list represents a compilation of the set of eighteen RPV DODT's and their status, i.e., title, drawing number, and whether new/minor modification/no change had been accomplished during the course of the study. A table of definitions (Section IV) of terms as they are used in this series of DODT's is intended as an aid to avoid any semantic ambiguities or misinterpretations.

<u>Title</u>	<u>SRL Dwg. No.</u>	<u>Status</u>
RPV Design	6810-02-2496	New
Launch Systems	6810-02-2497	New
Recovery Systems	6810-02-2498	New
Airframe	6810-02-2500 (Sheets 1-4)	New
Reciprocating Engine	6713-10-37-1275	Minor Modification
Jet Engine	6713-59-1695	No Change
Rocket Engine	6713-10-1277	No Change
Weapons Delivery	6713-53-1693 (Sheets 1-4)	No Change

<u>Title</u>	<u>SRL Dwg. No.</u>	<u>Status</u>
Radar System	6713-64-1945	No Change
Jet Engine-Assembly	6713-53-1691 (Sheets 1-2)	No Change
Jet Engine-Installation	6713-53-1696	No Change
Jet Engine Support System	6713-53-1692	No Change

Corroborative interviews on this series of trees were accomplished with many additional SRL personnel who have been involved in relevant aspects of unmanned flight vehicle design and fabrication. In addition, personnel representing the Aeronautical Systems Division (ASD) RPV Mission Analysis SPO and the Flight Dynamics Laboratory at Wright-Patterson AFB, Ohio, were also briefed to ascertain authenticity of the RPV DODT's.

The following are discussions of the approach and logic used in generating the specified new DODT's or DODT's that required modification. Discussions concerning the remaining DODT's used in this study may be found in previously generated letter reports and will not be included here.

Remotely Piloted Vehicle DODT (SRL Dwg. No. 6810-02-2496)

The Remotely Piloted Vehicle design DODT begins with a consideration of system objectives. For example, what mission the vehicle is intended to perform, how much it is allowed to cost, how long a service life it must have, are considered system objectives which could dictate later decisions and thus must be clearly laid out if available prior to proceeding with the design. Once system objectives are defined, several levels of decisions define the specific mission or missions for which the RPV is being designed. Following mission definition, appropriate steps to choose the basic configuration of the vehicle are defined. Configuration decisions are followed by a set of performance parameter decisions. The last major branch on this decision tree delineates the major hardware classifications which must be simultaneously considered as the RPV design becomes more specific. Many of these hardware classifications are the subject of more detailed trees, as indicated by the drawing numbers which are referenced.

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As a note of interest, the Core Avionics or Information Processing System (SRL Dwg. No. 6810-02-2499), is referred to on the RPV DODT. This is a series of trees that have been developed concurrently as another project task relative to the Digital Avionics Information System (DAIS). It is only one of several possible Core Avionic systems which could be included in an RPV design, and is mentioned here to show the potential interrelation of DAIS with RPV's.

Launch Systems DODT (SRL Dwg. No. 6810-02-2497)

The two areas which had not been previously treated in the DODT format are launch and recovery systems. Each of these was developed into a separate decision tree. Taking launch systems first, the decision as to whether air or ground launch is to be used would frequently be dictated by mission requirements or the operational scenario to be employed. For these reasons, the air/ground launch decision is treated first. As noted, however, a group of considerations must be immediately weighed against requirements of the other vehicle design areas and iterated until a mutually acceptable set of configuration options are arrived at. Although these component locations and performance characteristics are important to many design areas, they are especially crucial to the design of a launch system and are thus included here. Special note should be made of the inclusion of logistics support requirements. These are not considered in other trees and constitute a break in format to the extent that they are not really representative of decisions being made in the design. However, the impact of logistics support on launch systems is considerable, and is included as a reminder that such items cannot be overlooked in the design.

Recovery Systems DODT (SRL Dwg. No. 6810-02-2498)

The recovery system DODT is governed by many of the same constraints as the launch system, as indicated by the similarities on both DODT's. This is especially true of logistics support, which can easily dominate all other factors which might be brought to bear on the recovery system design. Note that the air/ground decision in this case is later in the network. While the

types of launch system are considered early in the design, this is not necessarily true of the recovery system. That is, the mission will obviously not be carried out if the launch is inadequate; thus, the recovery becomes a subordinate decision. However, as a limiting case for the sake of illustration, the RPV is not recovered and becomes expendable.

Airframe DODT (SRL Dwg. No. 6810-02-2500/Sheets 1-4)

The Airframe DODT was modified to reflect those added decisions which are peculiar to an unmanned vehicle and to remove those which are apropos only to manned vehicles. In addition, in some cases the decision network was restructured since the flow of decisions often proceeds in a slightly different manner when an RPV is the objective. Sheets 1 and 2 were almost entirely concerned with the above described sorting out and reorganizing. Sheet 3 (Takeoff and Landing Systems) was modified considerably, which is indicative that such RPV systems encompass a broader spectrum of available options than do the landing gear systems of manned aircraft. Sheet 4 (Airframe/Propulsion Integration) was modified to fit directly into an interface position between the Airframe and Propulsion headings listed at the conclusion of the RPV Design Tree. A major modification was the removal of engine controls, environmental systems, cockpit controls and displays, and some safety decisions which are not required in an RPV.

Section II

SUMMARY

The DODT technique was used to develop a set of trees for an RPV concept. The set of trees developed reflects the insights of both the contractor and other engineers working in the RPV area. The trees provide a starting point for the conceptualization of a new RPV design. The set of drawings establish a linear decision process. In addition to the major purpose of the DODT's for this research project, is a tool for assisting in quantifying human resource requirements of various technologies, they may be used for a series of management actions. The initial set may be used for several types of management processes, for example:

1. As a guide to assist overall program management. The DODT could allow the program management personnel to monitor or track the design activities for the project. The DODT could: (a) show the sequence and priority of the design decisions to be made; (b) show the interrelationships of decisions, which would identify the need for interdisciplinary efforts; (c) provide an indication of the total number of decisions or trade-offs that would be required during the course of the program; (d) provide a basis for allocating design decision making to appropriate levels of the organization, such as program director, chief engineer, detailers, etc.; and (e) provide an historical record of the design trade-off decisions that occurred during development of the system--this could provide a basis for explanation (or defense) of the engineering effort performed.
2. As a method of systematic documentation of alternatives considered and rejected at decision points, together with a cataloging of reasons for accepting or rejecting each.
3. As a teaching/training device for indoctrinating newly assigned personnel on the specifics of the system.
4. As a vehicle for permitting an engineer in any particular system discipline to be cognizant of the impingement of other disciplines on his system inputs and of the specific nature and effect of these interactions.
5. As a means for deriving a measure of the state-of-the-art uniqueness of the final design product. This could be obtained, for example,

by identifying the proportion of the decision point options selected which are traditional design concepts versus the proportion of options selected which are new, state-of-the-art approaches.

6. As a tool for redesign. If a product is judged to be unsatisfactory against certain standards in its present configuration, a reanalysis of the DODT could detect the decision points and options involved. This could lead to a selection of a new set of design options, leading to a new product which better meets the standards.
7. As a dramatic aid to explanation of the system under development to the various levels of presentation required--e.g., Command presentations or Congressional testimonies.
8. As a procedure for assuring that viable alternatives are not ignored due to preexisting biases or failure to be aware of the existence of such options.

Although the RPV set of trees was not selected in this project for much detailed research the impact of human resource parameters could be roughly approximated using the DODTs as the decision base. The preparation of this set of DODTs is the first step in the exploration of the RPV design process and further research would be required to provide more specific results.

Section III

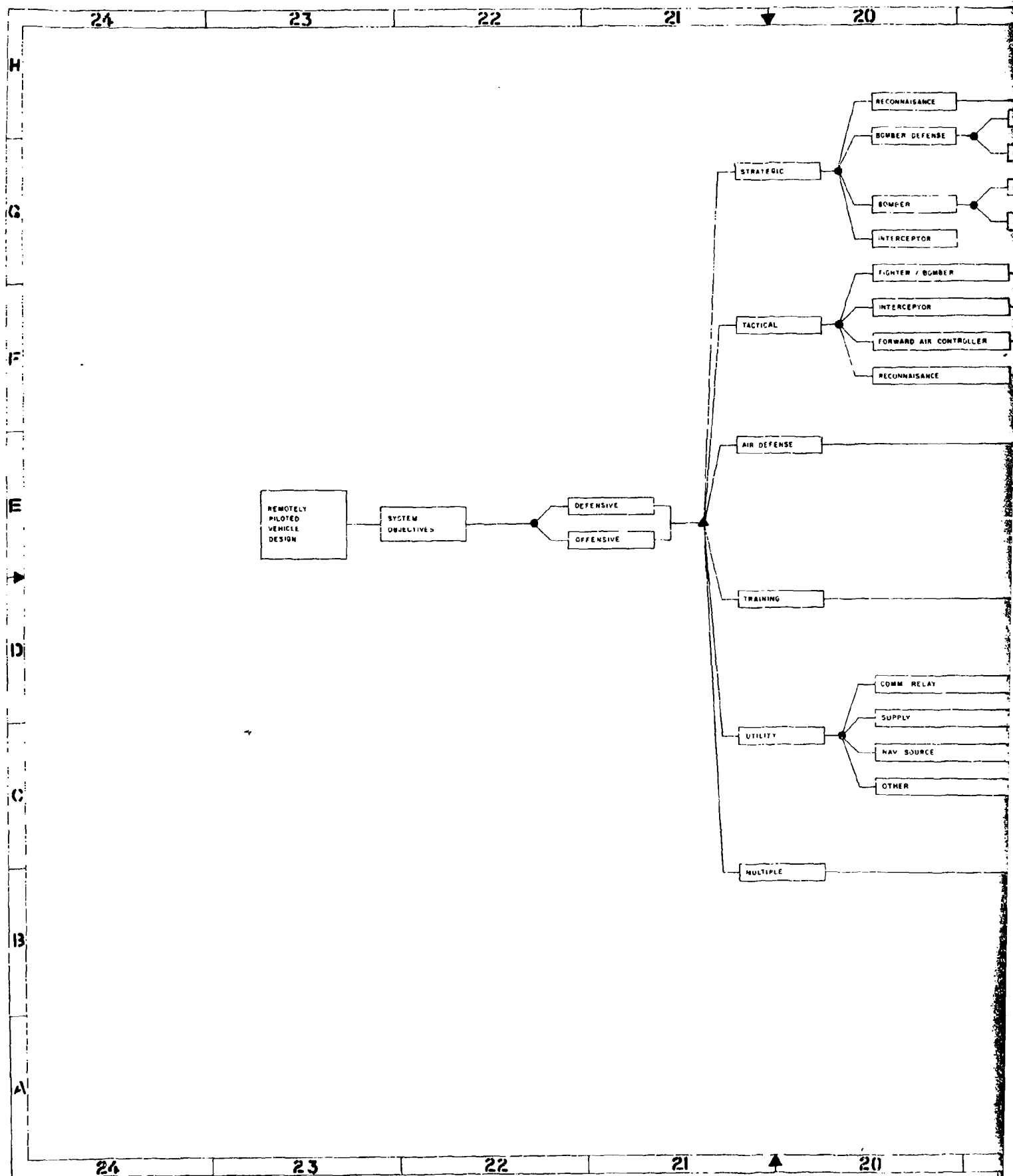
REMOTELY PILOTED VEHICLES DESIGN OPTION DECISION TREES

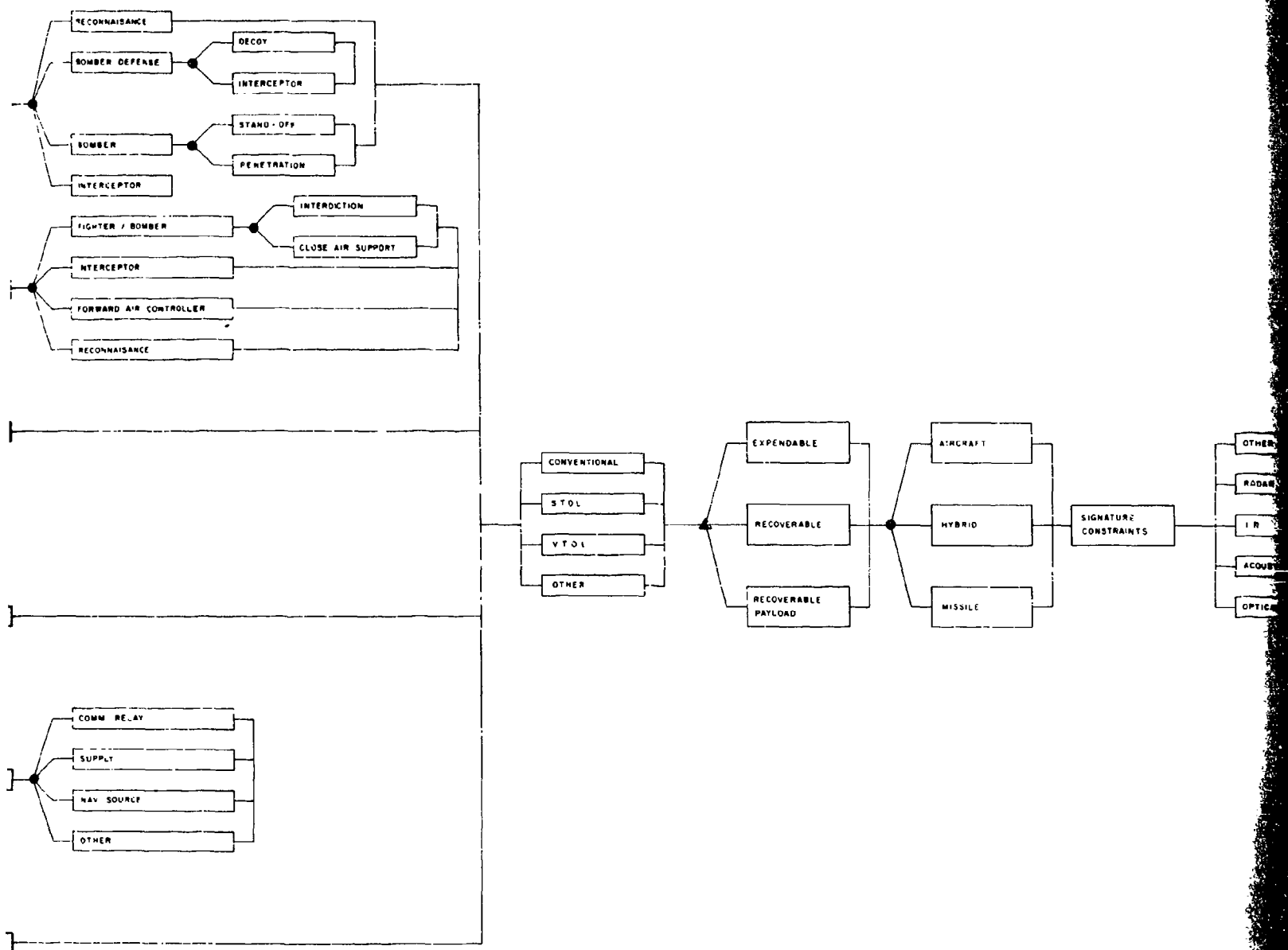
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Launch Systems	6810-02-2497
Recovery Systems	6810-02-2498
Airframe	6810-02-2500 (Sheets 1-4)
Reciprocating Engine	6713-10-37-1275
Jet Engine	6713-59-1695
Rocket Engine	6713-10-1277
Weapons Delivery	6713-53-1693 (Sheets 1-3)
Radar System	6713-64-1945
Jet Engine-Assembly	6713-53-1691 (Sheets 1-2)
Jet Engine-Installation	6713-53-1696
Jet Engine Support System	6713-53-1692

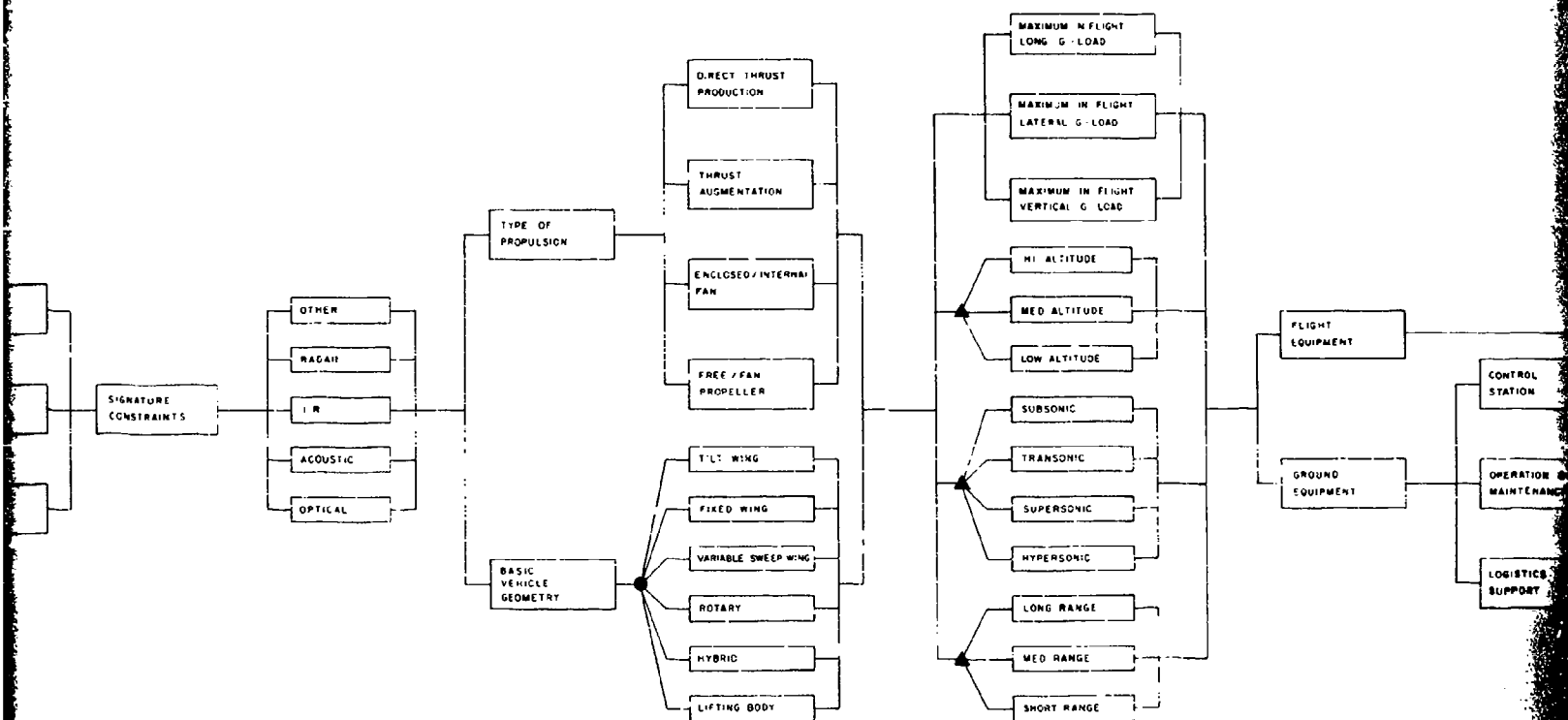
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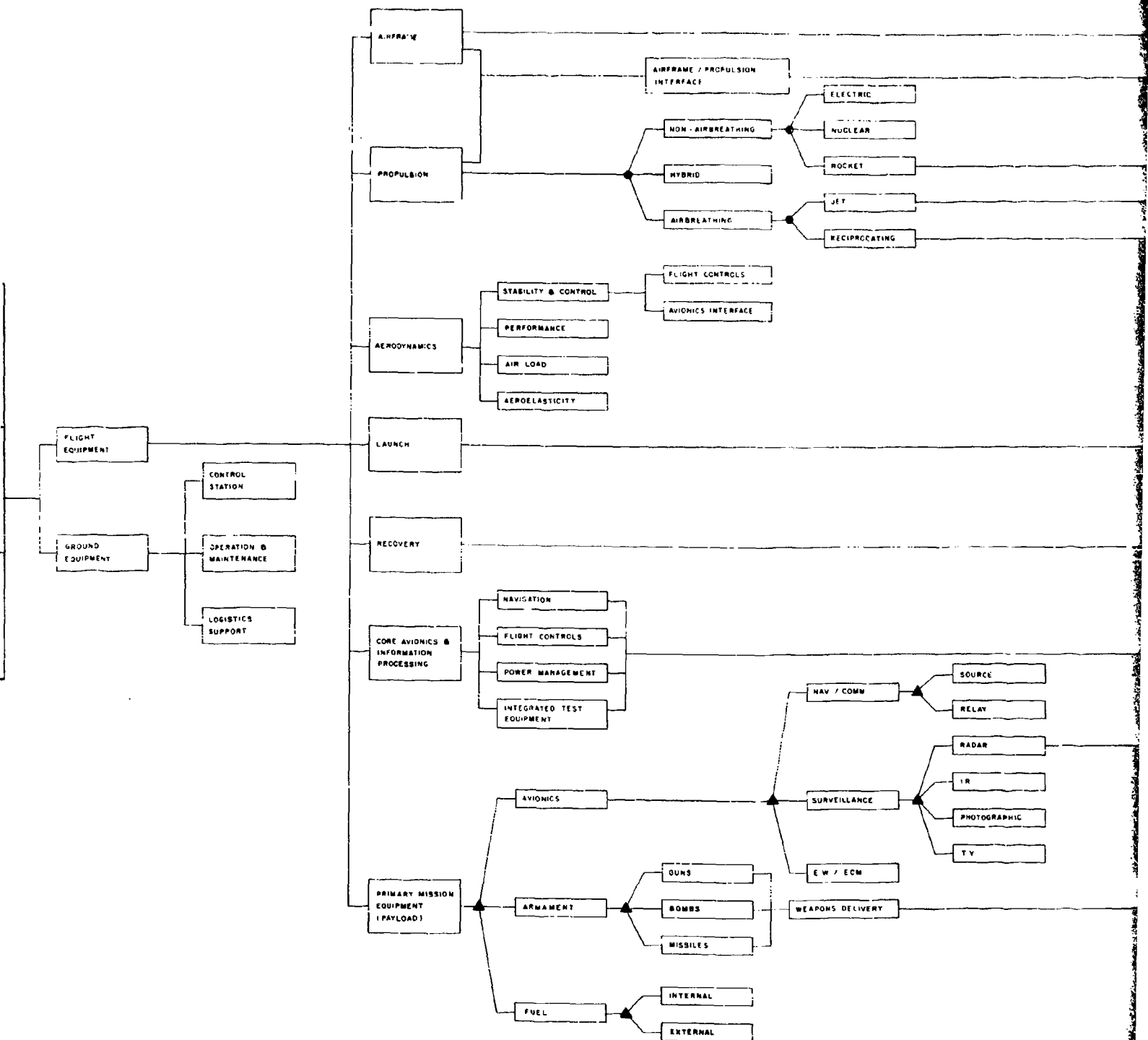
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Launch Systems DODT (Dwg. No. 6810-02-2497)
Recovery Systems DODT (Dwg. No. 6810-02-2498)
Airframe DODT (Dwg. No. 6810-02-2500/Sheets 1-4)





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SEE DWG NO 6810-02-2500
SHEET 1,2,3

SEE DWG NO 6810-02-2500
SHEET 4

SEE DWG NO 6715-10-37-1277

SEE DWG NO 6715-03-1695
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SEE DWG NO 6715-10-37-1276

SEE DWG NO 6810-02-2497

SEE DWG NO 6810-02-2498

SEE DWG NO 6810-02-2409

SEE DWG NO 6715-04-1945

SEE DWG NO 6715-03-1693
SHEET 1,2,3

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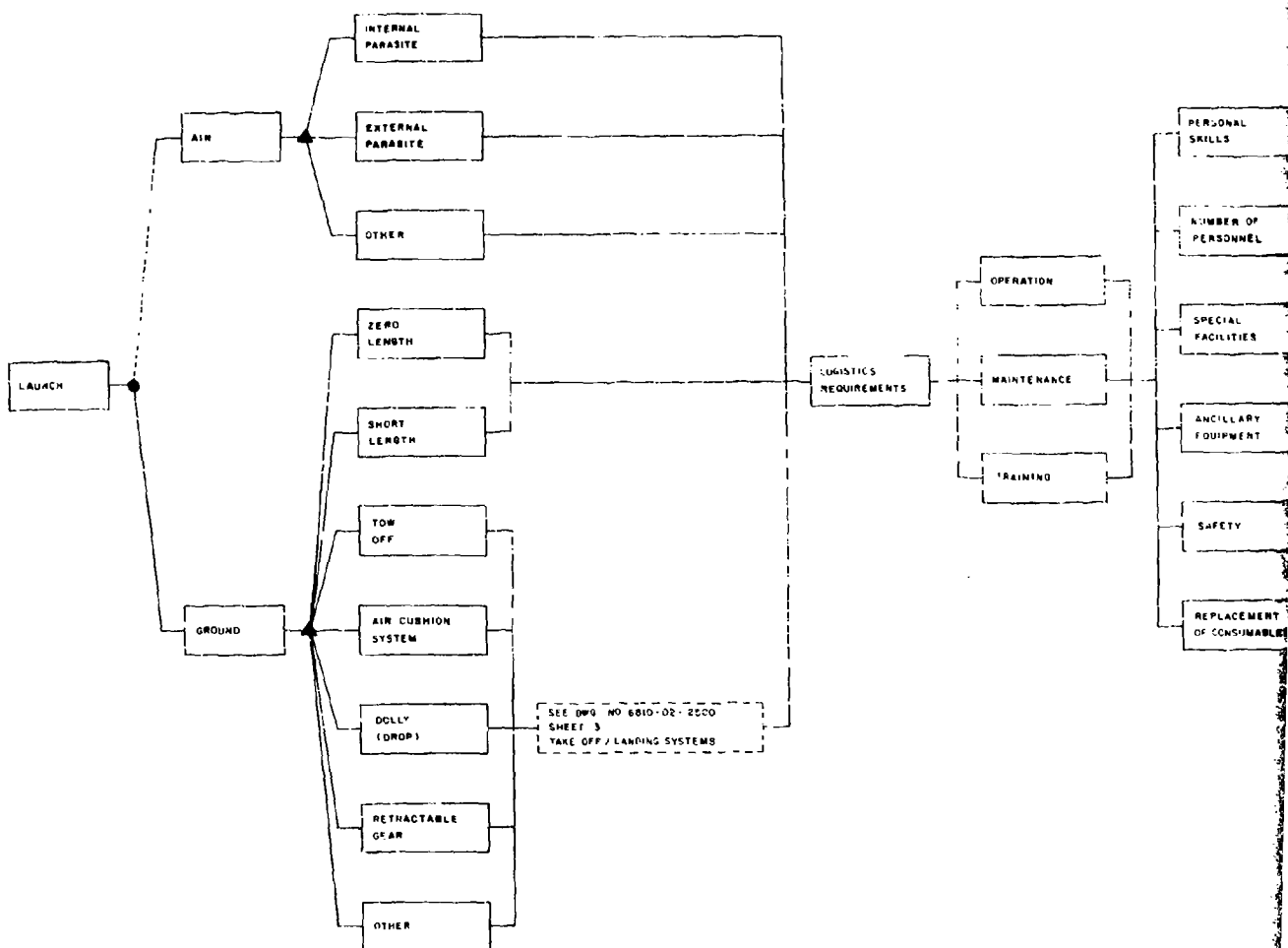
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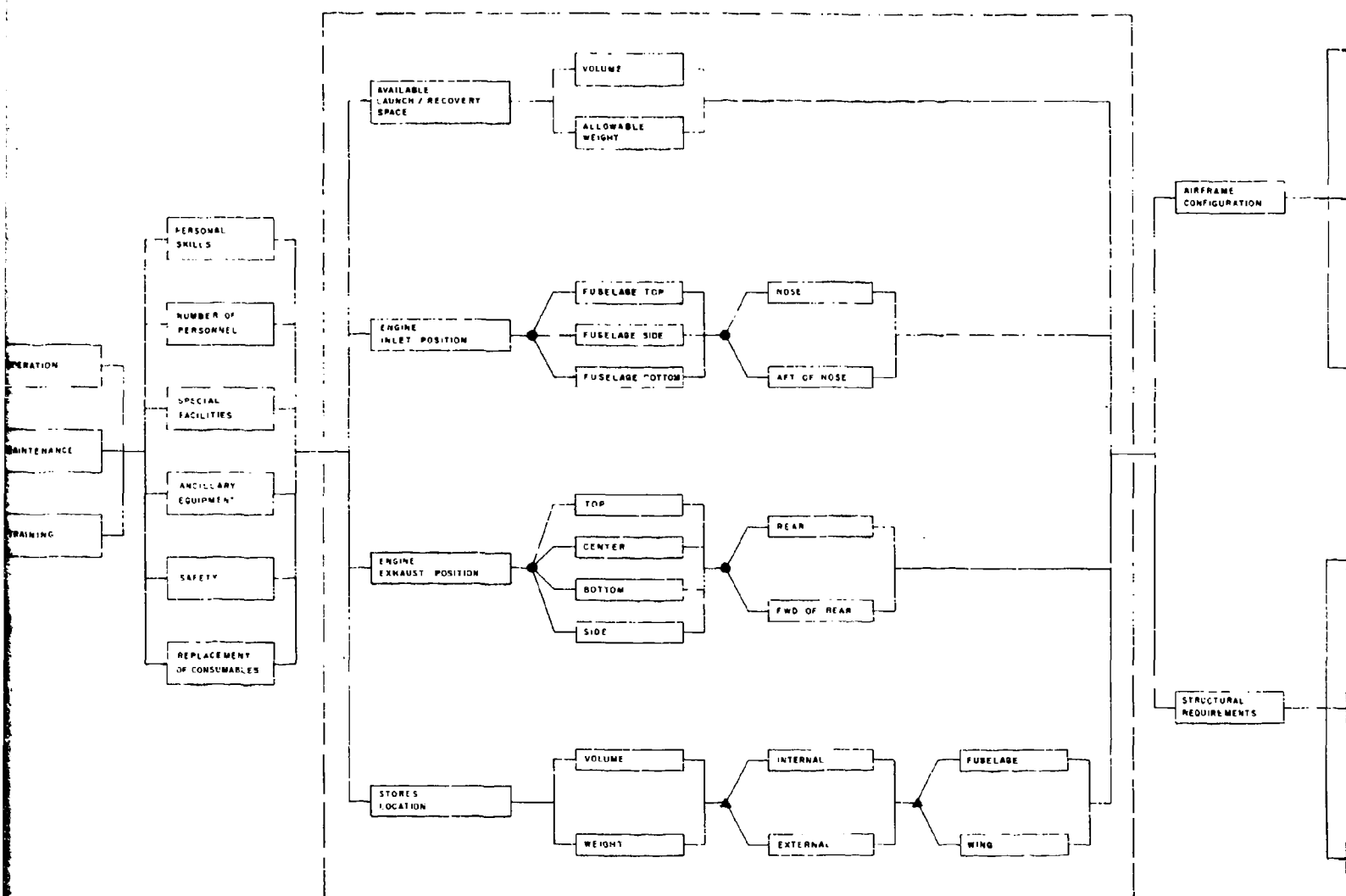
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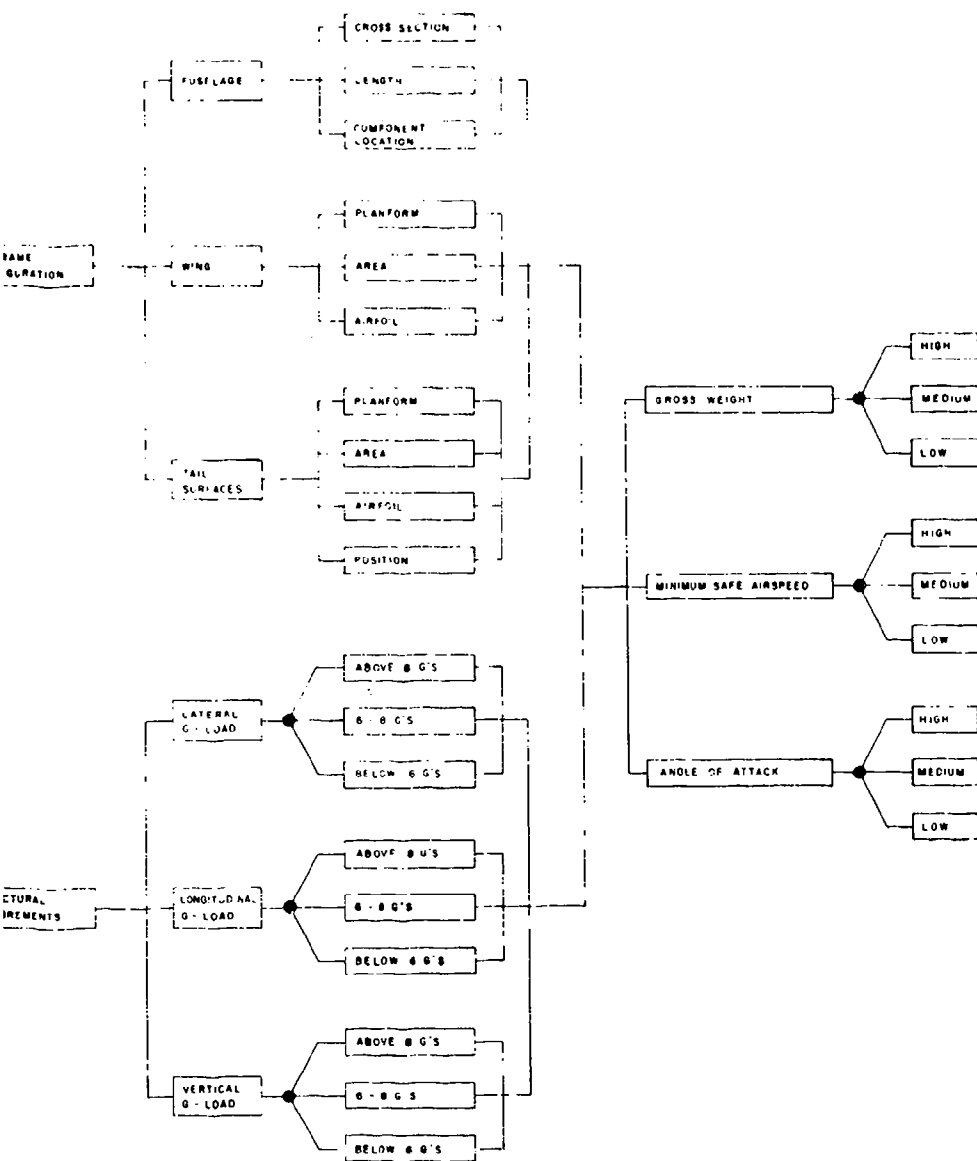
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DECISION TREE
REMOTELY PILOTED
VEHICLE - LAUNCH

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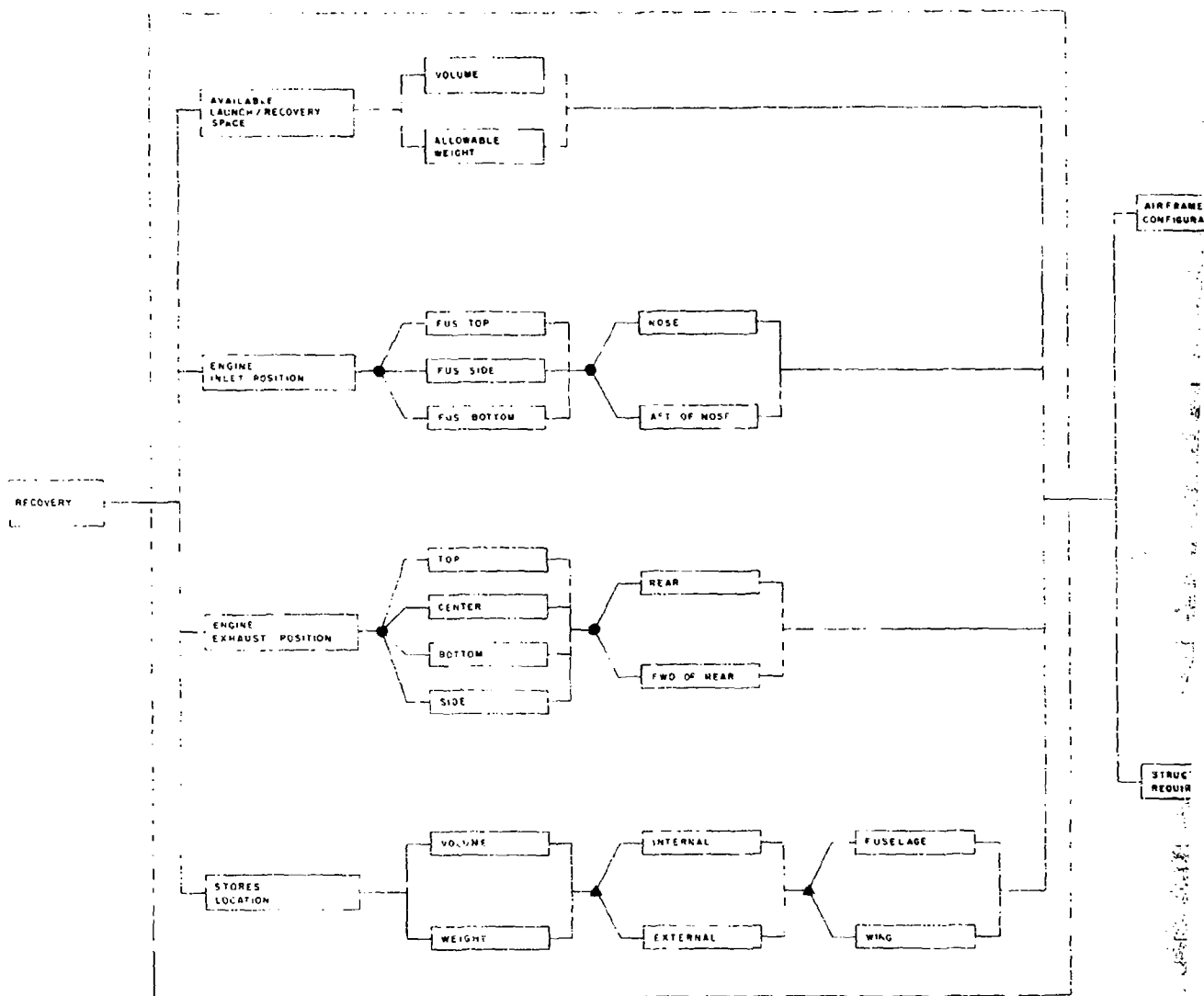
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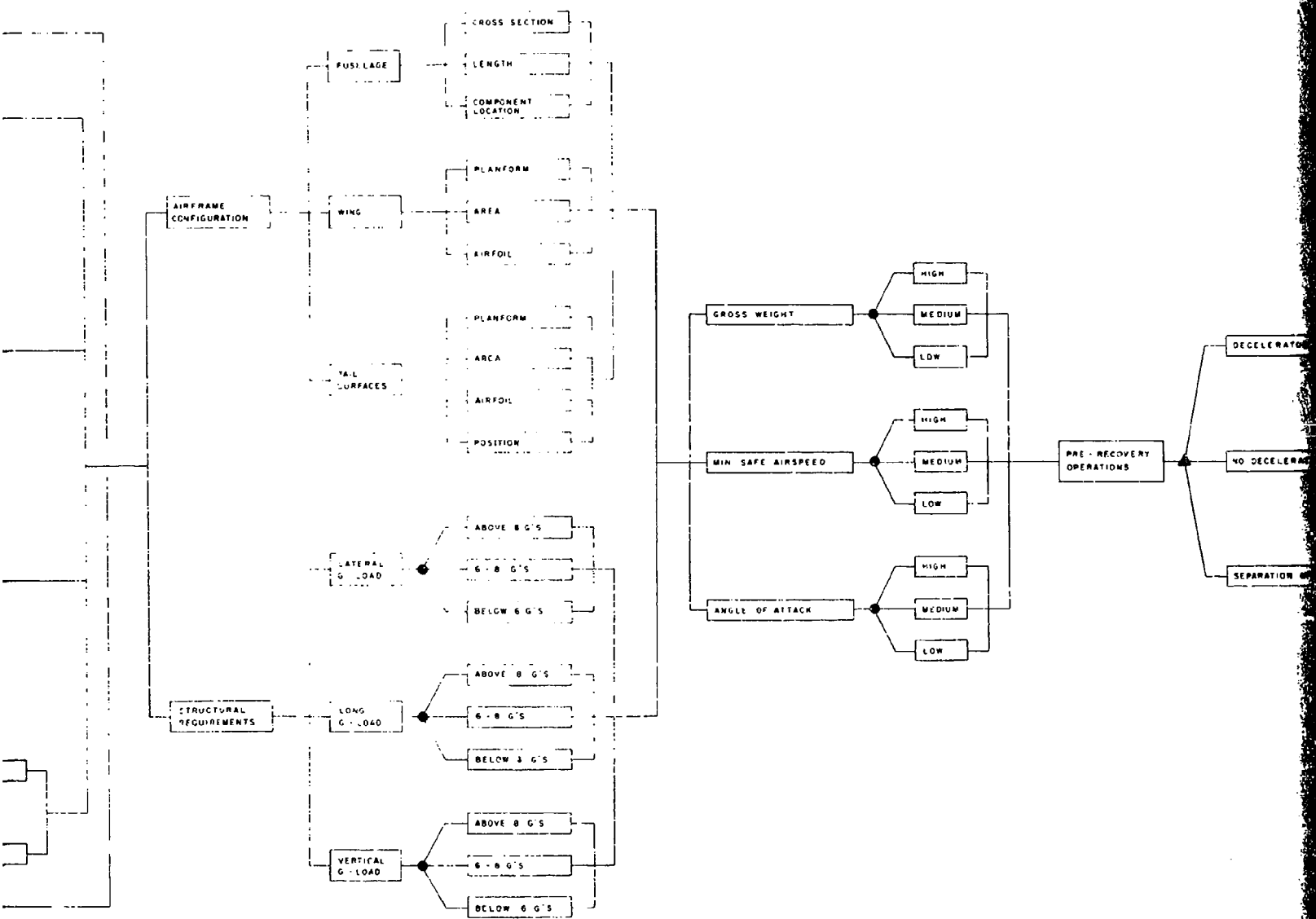
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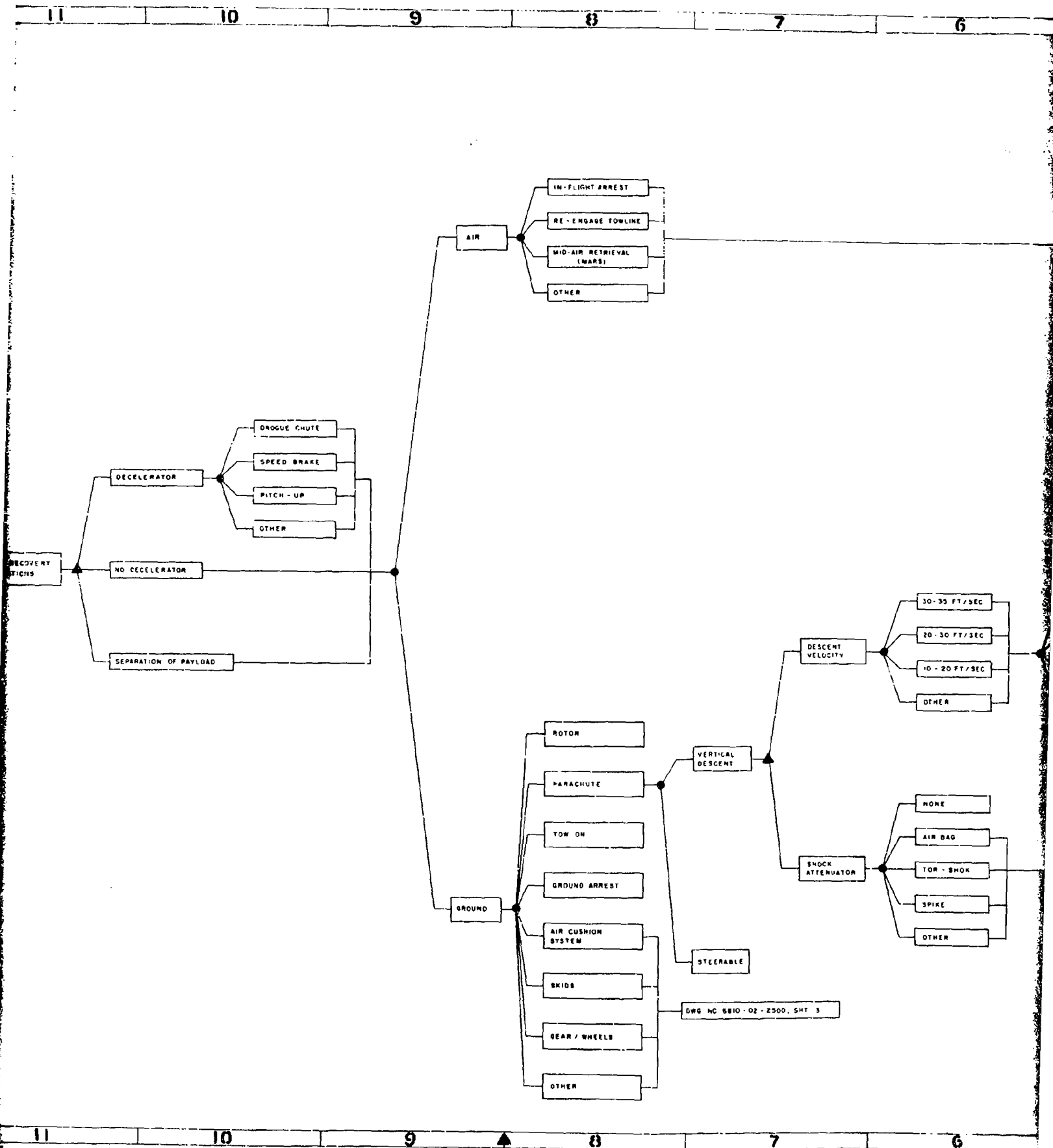
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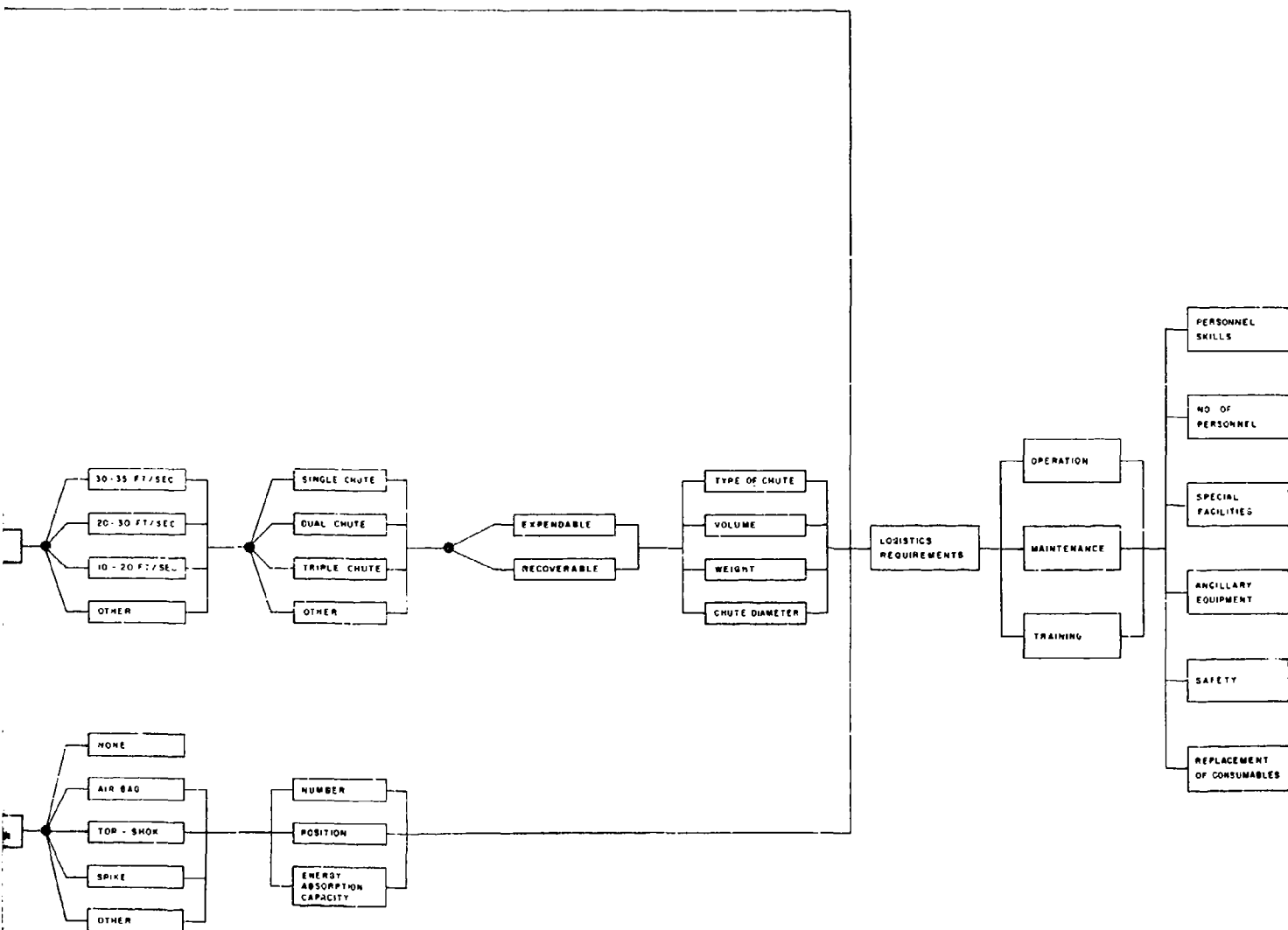
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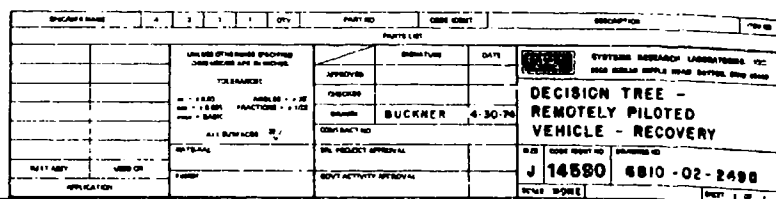




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DECISION TREE - REMOTELY PILOTED VEHICLE - RECOVER

J 14590 6810-08



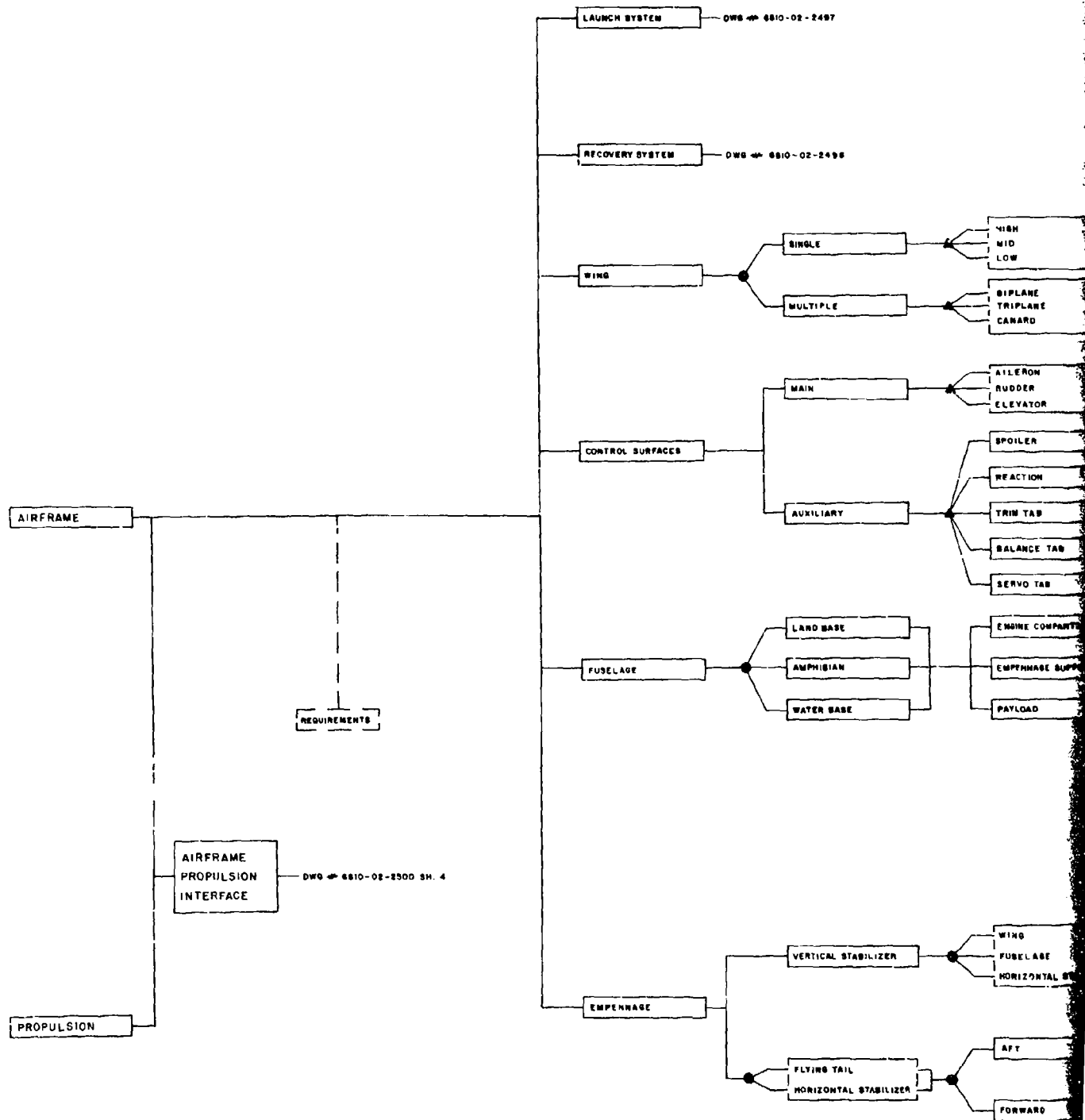
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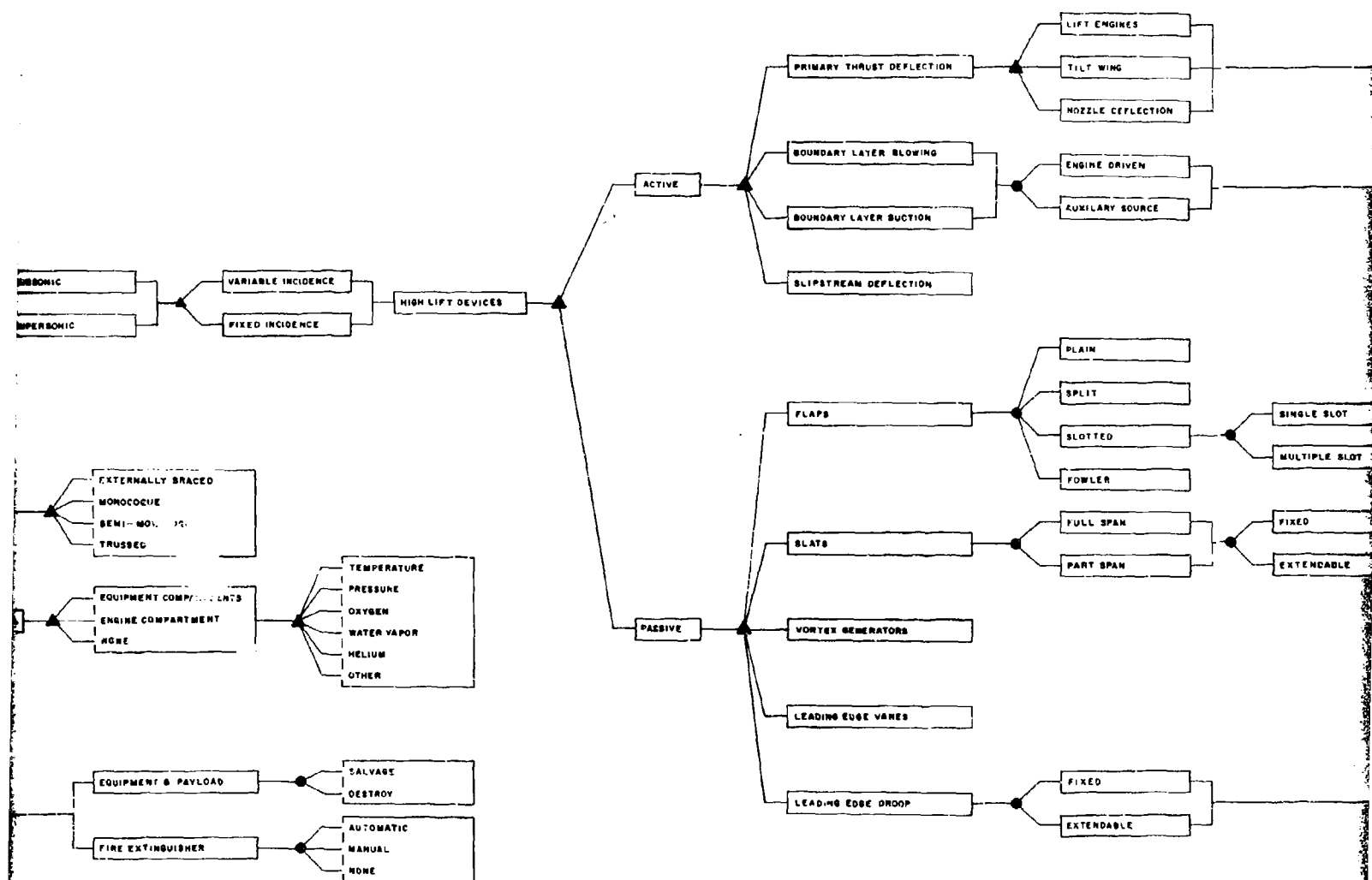
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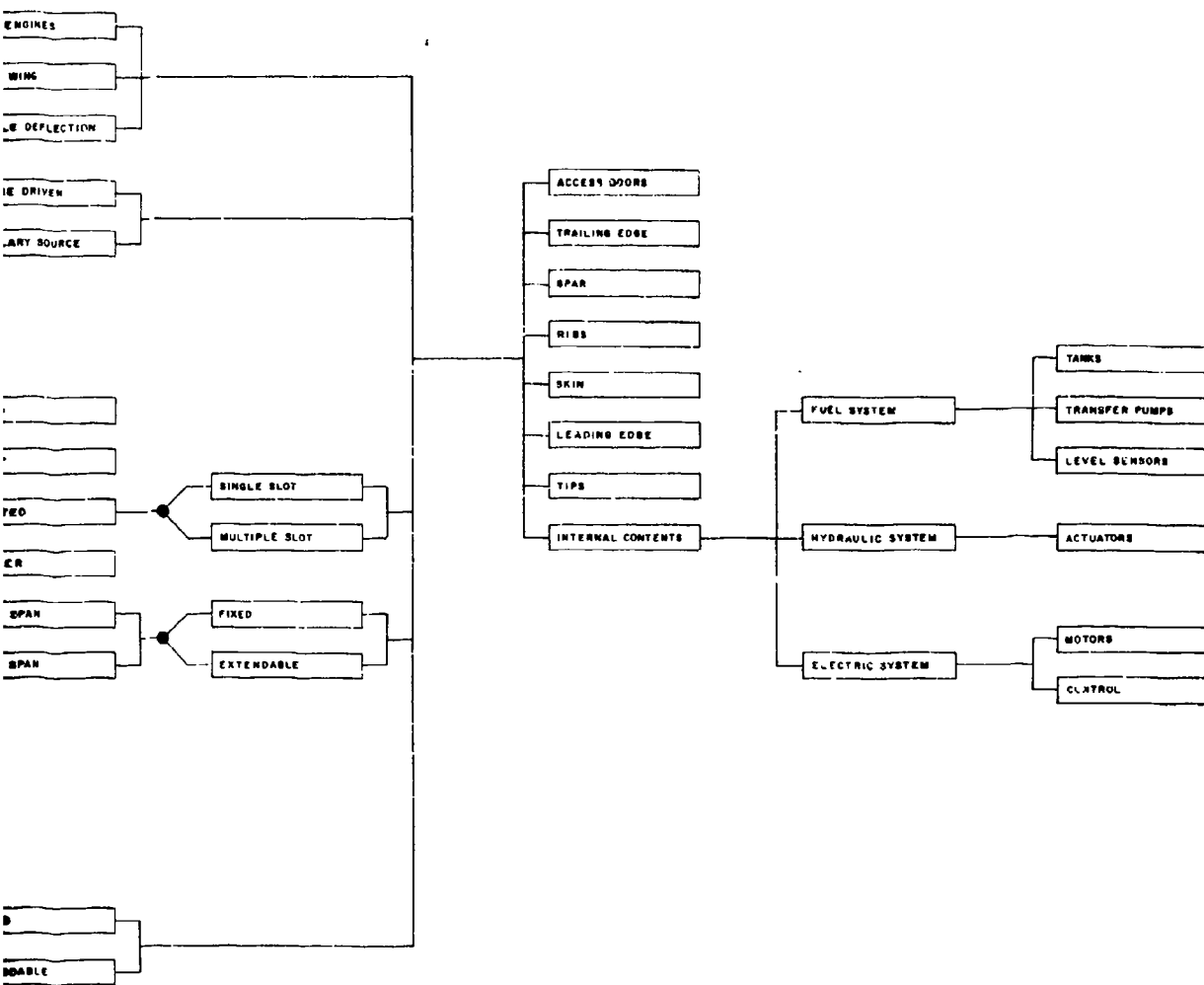
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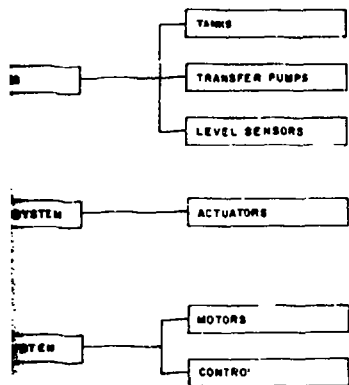
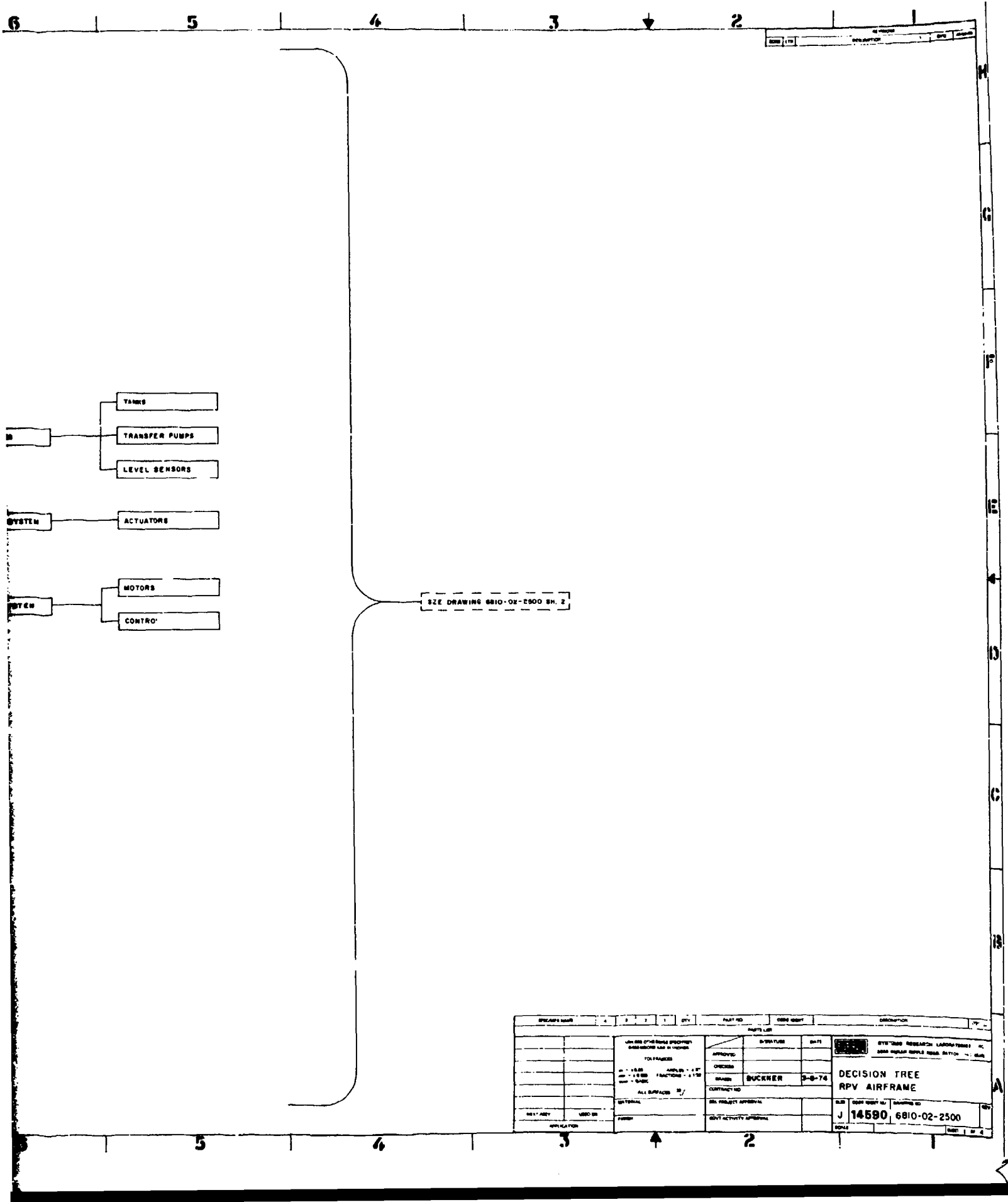
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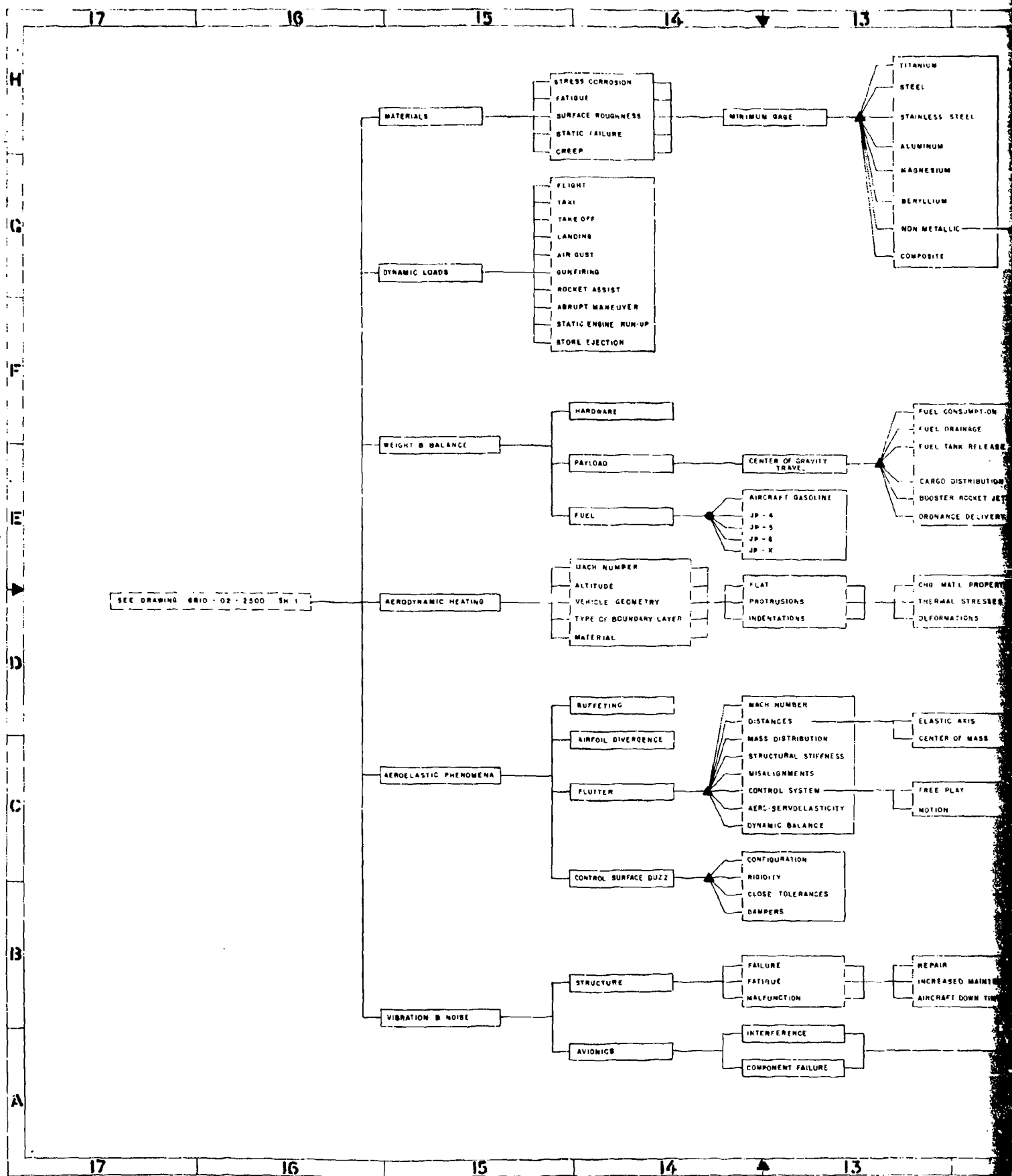






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O - 1.000 INCHES - 1.000 INCHES		APPROVED		DATE		J 14590 6810-02-2500	
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V - 1.000 INCHES - 1.000 INCHES		APPROVED		DATE		J 14590 6810-02-2500	
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X - 1.000 INCHES - 1.000 INCHES		APPROVED		DATE		J 14590 6810-02-2500	
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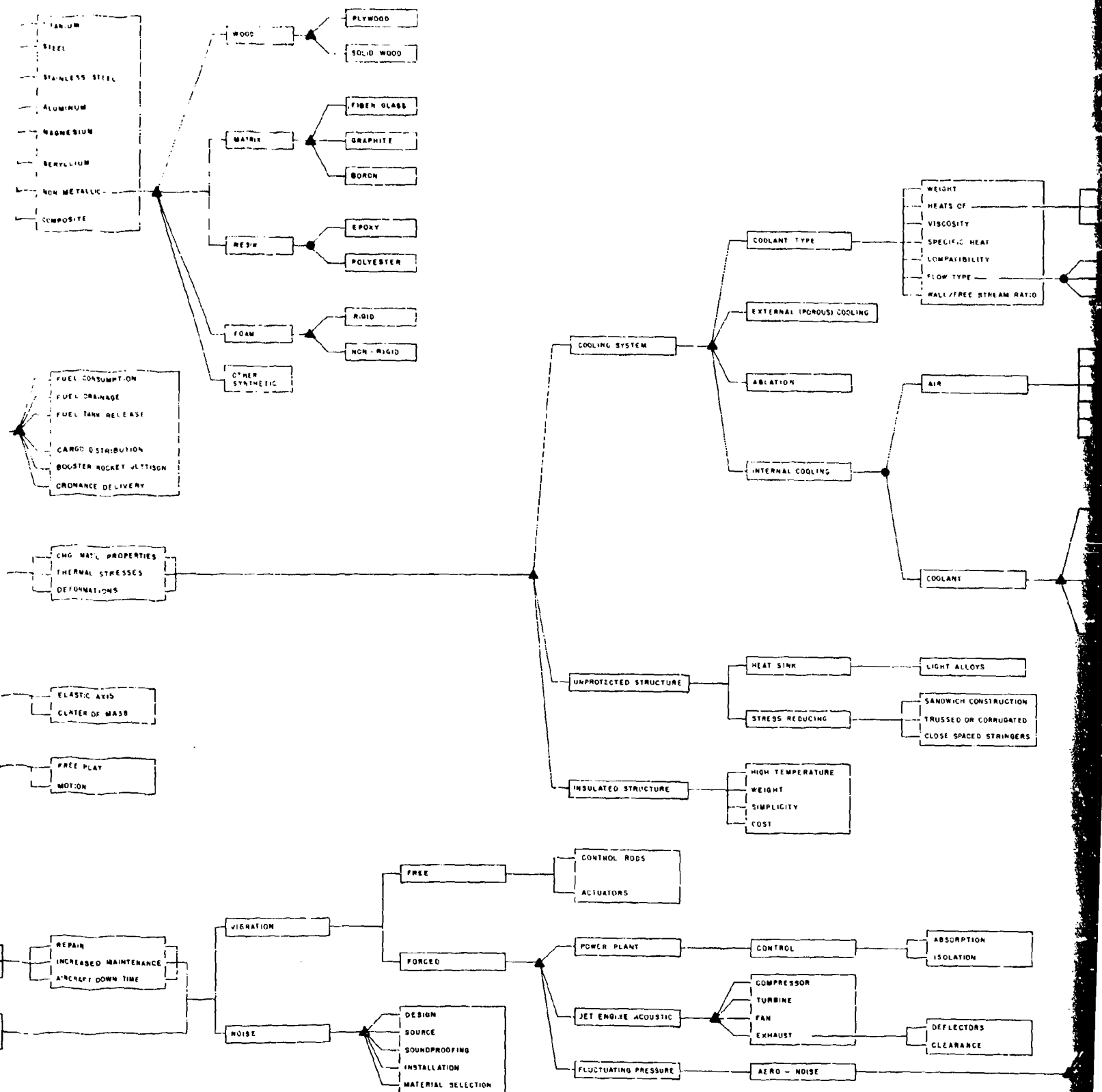
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6810-02-2500

REV 2

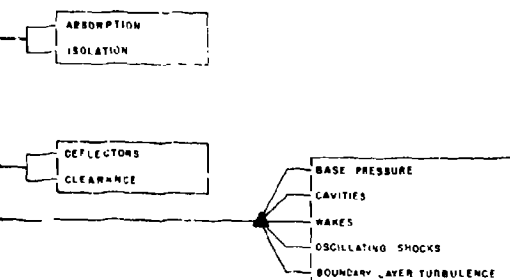
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MISSION

WEIGHT

HEAT SINK

STORAGE

PUMPS

FAN/BLOWER

PRESSURE

LOCATION

CAPACITY

HEAT EXCHANGER

INTERMITTENT

CONTINUOUS

FUEL

AIR

EXPENDABLE

HEAT OF FUSION

VARIABLE DISPLACEMENT

FIXED DISPLACEMENT

CLOSE

RE-OTE

TUBE TYPE

PLATE TYPE

OFFICE NAME	DATE	TIME	PROJECT	CODE	DESCRIPTION	REMARKS
SYSTEMS RESEARCH LABORATORIES, INC.	5/3/74		BUCKNER		DECISION TREE - RPV AIRFRAME	
J 14590	6810-02-2500					

SEE DRAWING 6810 02 - 2500 SHEET 1

AIRFRAME / PROPULSION
INTERFACE

SINGLE ENGINE
MULTI-ENGINE

INTERNAL
COMBUSTION

PROPELLER

TURBOPROP

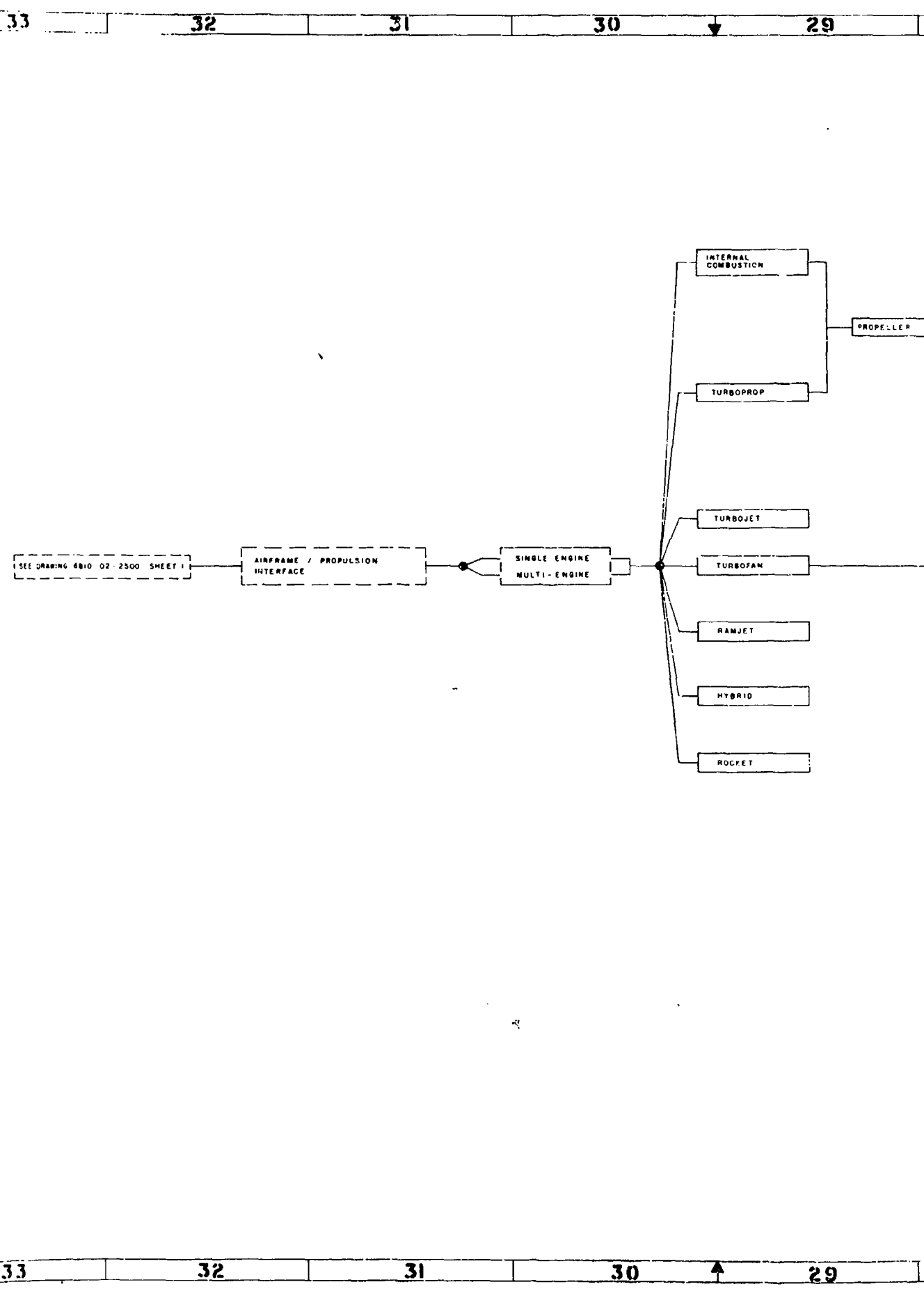
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TURBOFAN

RAMJET

HYBRID

ROCKET



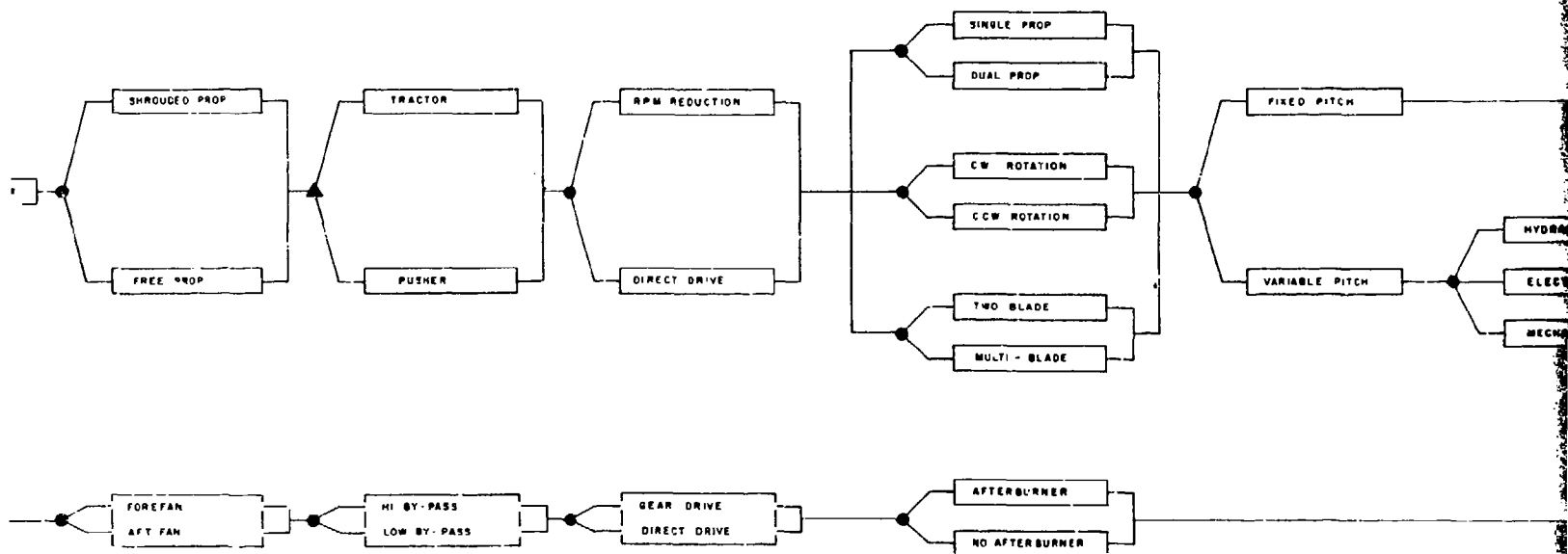
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6810-02-2500

REV 4

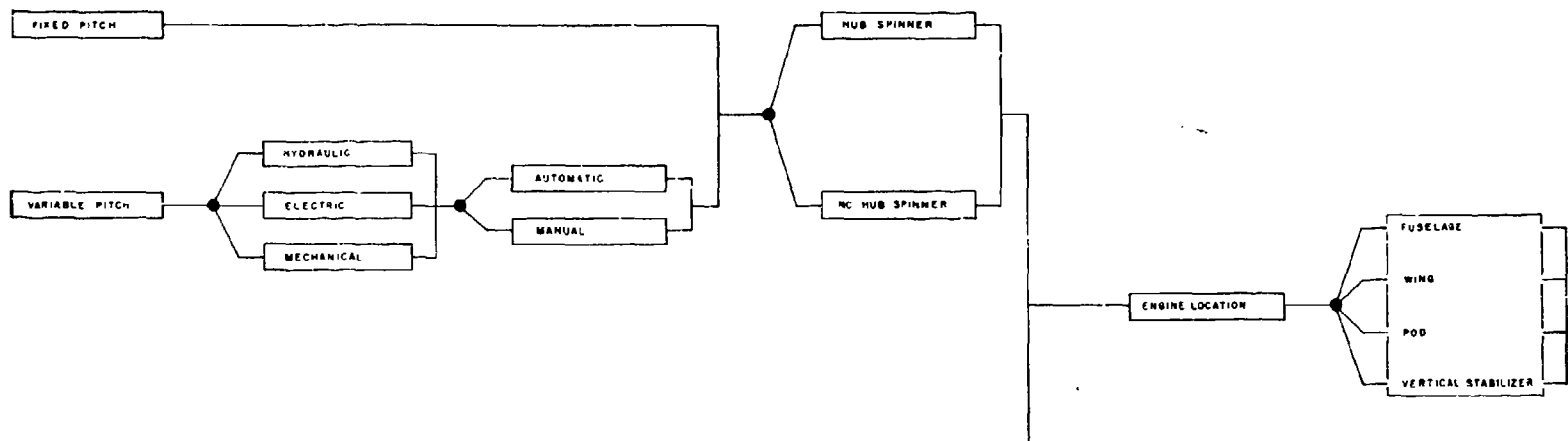
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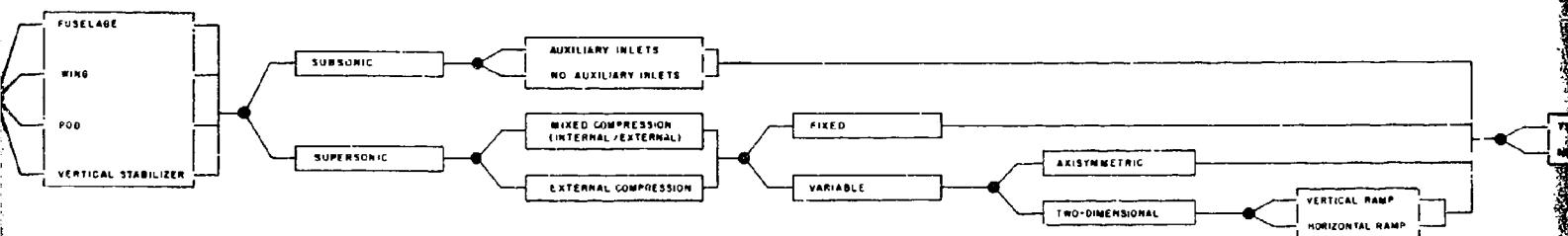
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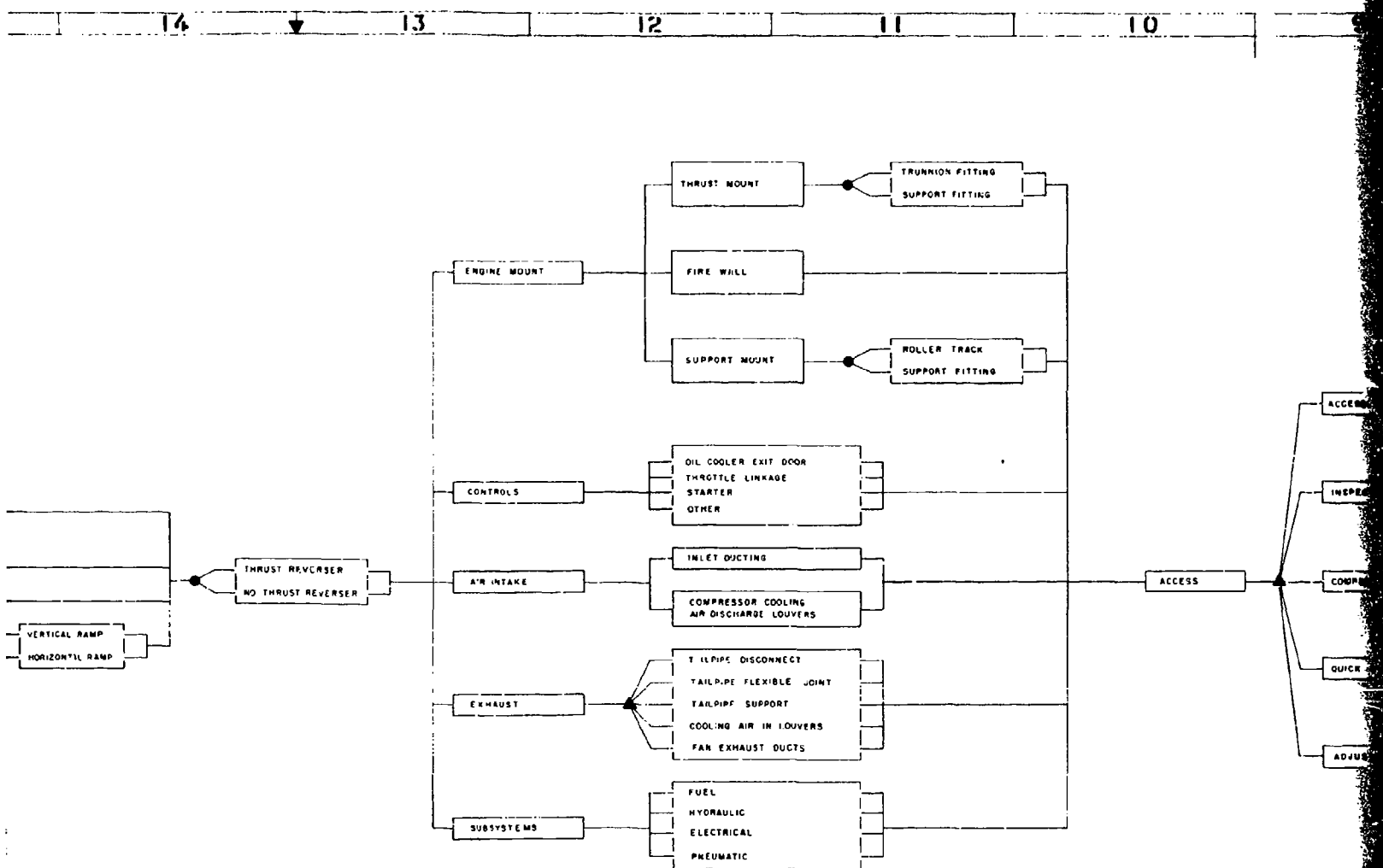
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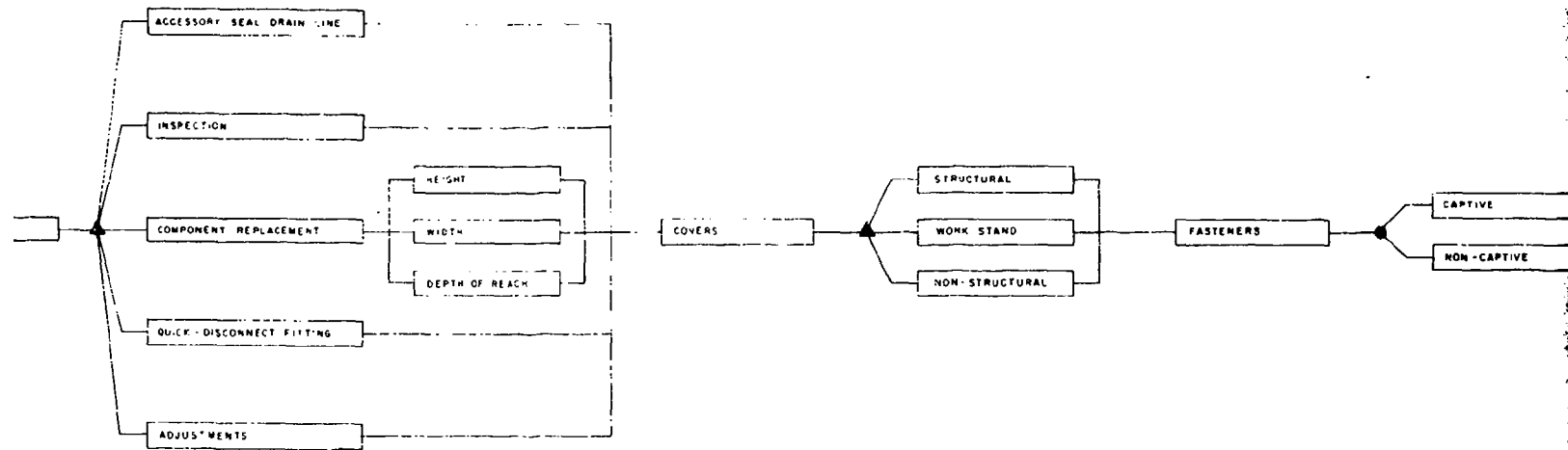
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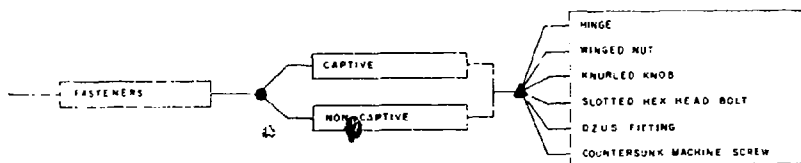




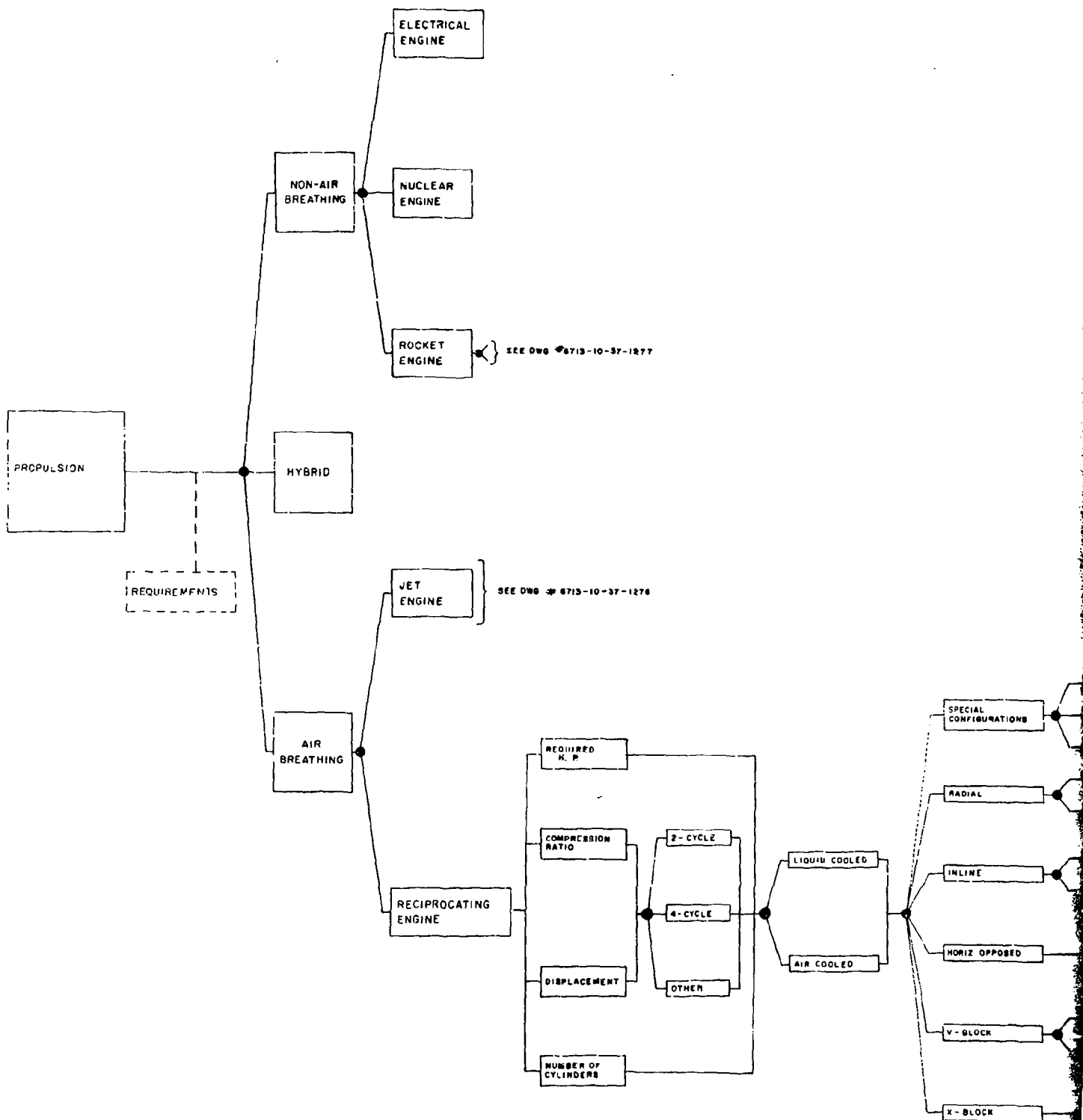


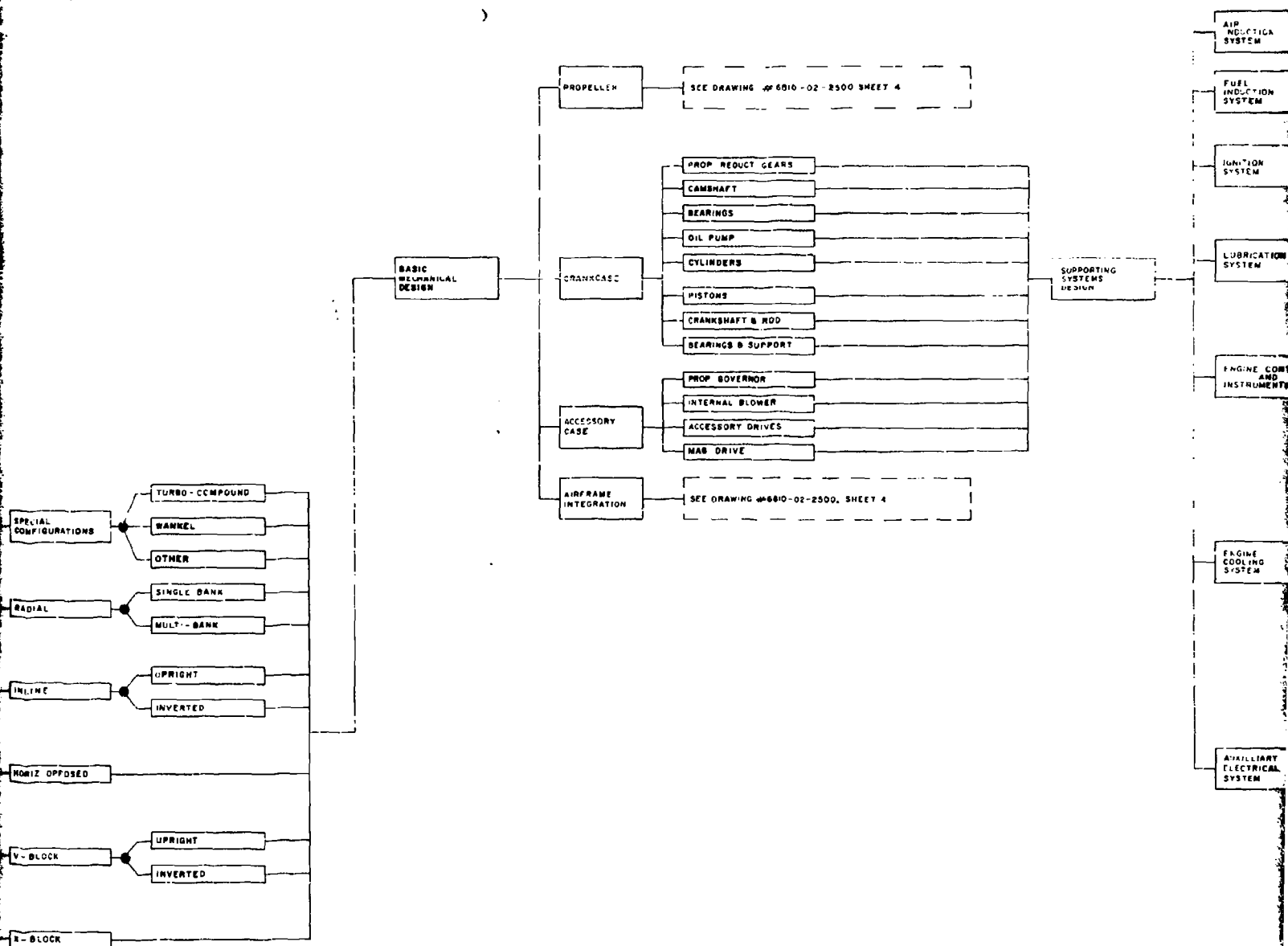


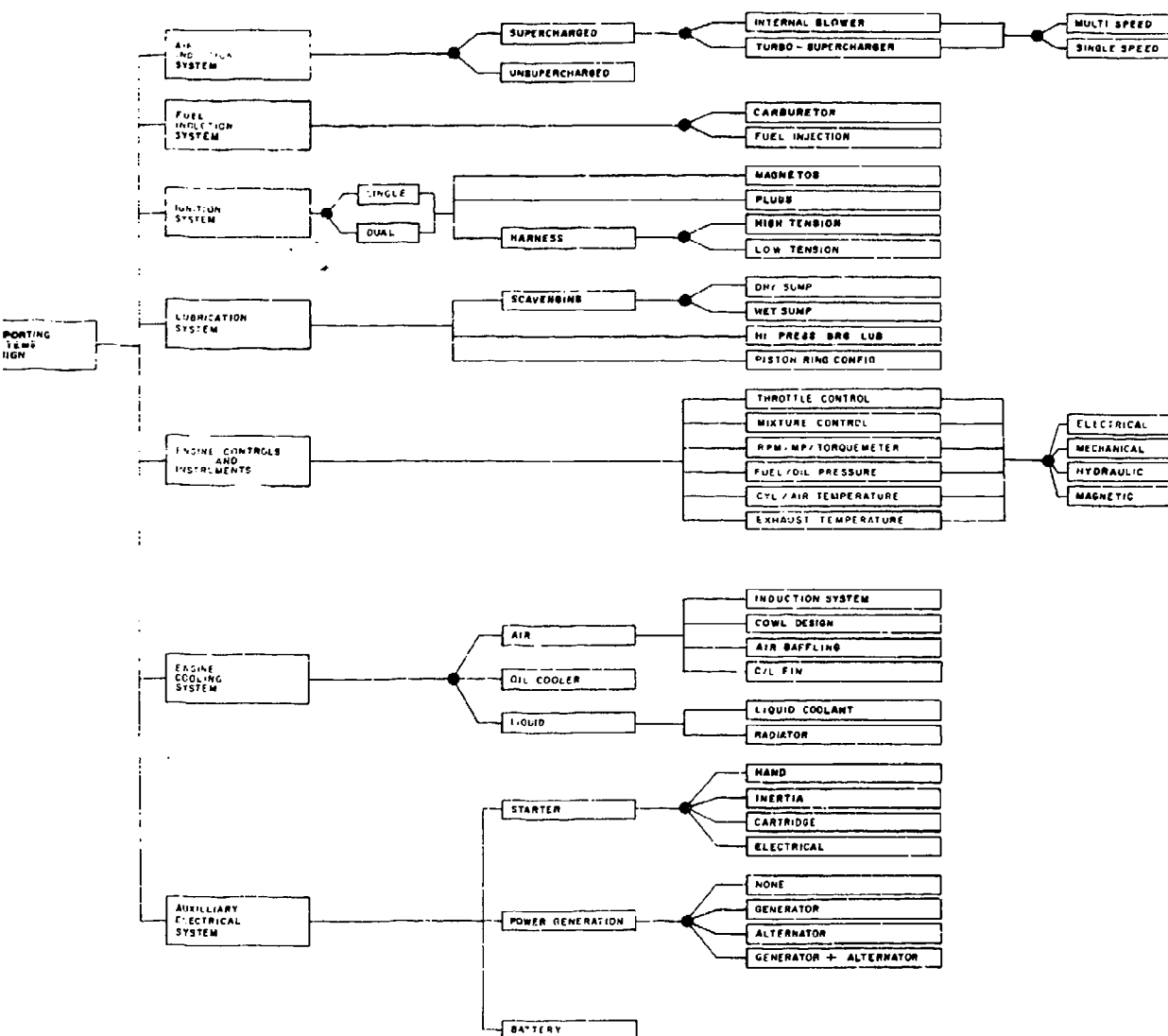
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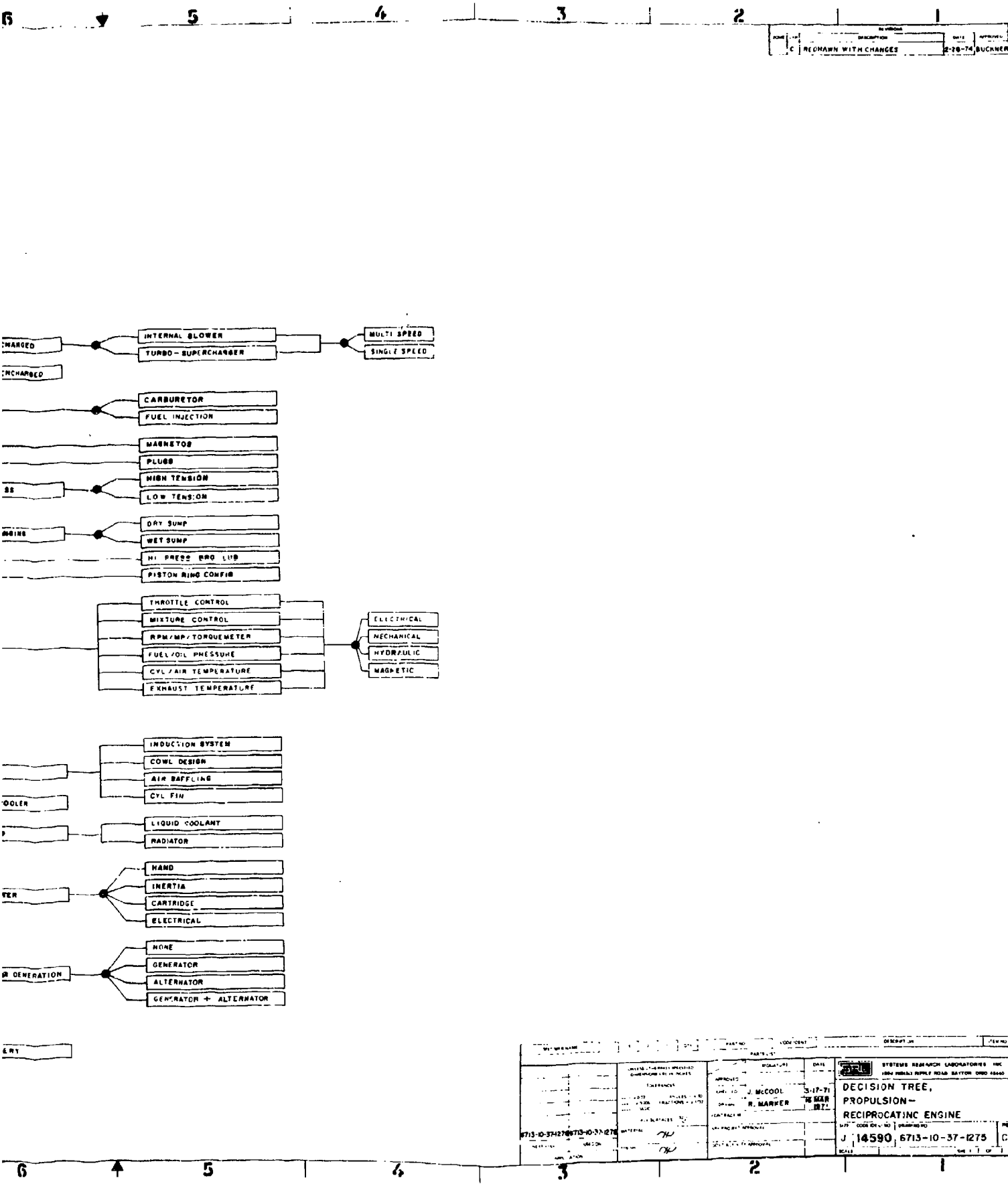
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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		PART LIST		SIGNATURE		DATE		SYSTEMS RESEARCH LABORATORY, INC. 3000 HILLMAN RD. SALT LAKE CITY, UT 84143	
DIMENSIONS		APPROVED		BUCKNER		3-20-74		DECISION TREE RPV AIRFRAME	
ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES		CHECKED		DATE IN		CONTRACT NO.		J 14590 6810-02-2500	
DATE: 1-1-74		BY: PROJECT APPROVAL		DATE: 1-1-74		BY: PROJECT APPROVAL		SCALE: 1/4" = 1"	







SPEC. SHEET NAME		1	3
DATE			
DRAWN BY			
CHECKED BY			
APPROVED BY			
TITLE			
PROJECT			
APPLICATION			



FORM NO.	DESCRIPTION	DATE	APPROVED
C	RECHAWN WITH CHANGES	2-28-74	BUCKNER

SYSTEMS RESEARCH LABORATORIES INC.	1004 WILSON AVENUE, RICHMOND, VIRGINIA 23234
DECISION TREE, PROPULSION-RECIPROCATING ENGINE	J 14590, 6713-10-37-1275
APPROVED: J. MCCOOL	DATE: 3-17-74
DRAWN: R. MARKER	SCALE: 1/2" = 1"
7713-10-37-1275-10-37-1275	7713-10-37-1275-10-37-1275

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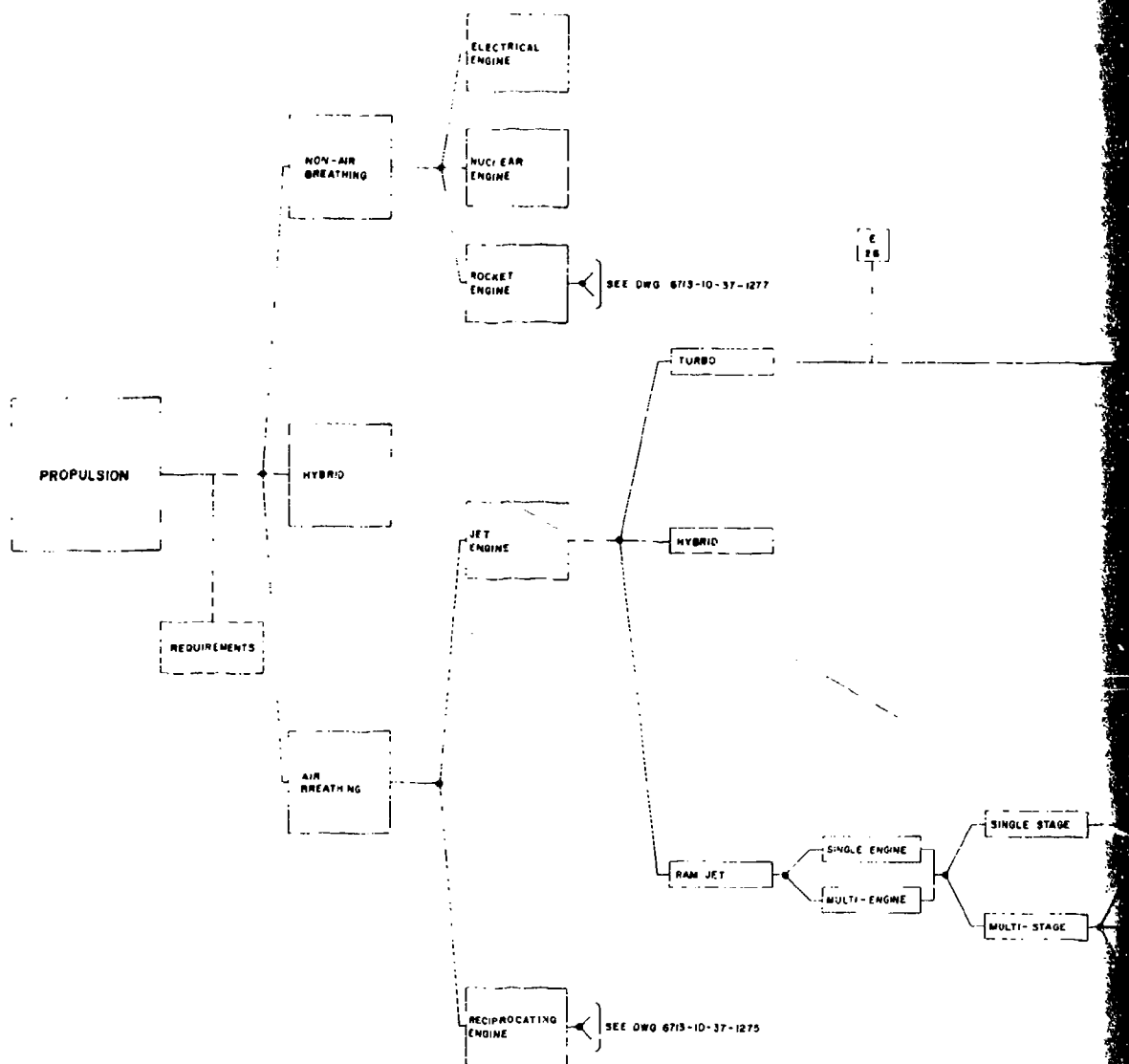
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4

AEROSPACE
GROUND
EQUIPMENTBASIC
MECHANICAL
DESIGNENGINE
ASSEMBLYSEE DWG.
6713-56-1481ENGINE
INSTALLATIONSEE DWG.
6713-55-1698SUPPORTING
SYSTEM
DESIGNSEE DWG.
6713-55-1692POWER
EXTRACTIONAUXILIARY
INLETSNO POWER
EXTRACTIONNO AUXILIARY
INLETSSUPPORTING
SYSTEM
DESIGN

FUEL CONTROL

INSTRUMENTATION

IGNITION

ENGINE CONTROL

DATA RECORDERS

STRESSES AND
VIBRATIONSOPERATING
SEQUENCES

FORCES

PRESSURE

TEMPERATURE

PRESSURIZED
TANKS

TURBO PUMP

POSITIVE
DISPLACEMENT

CENTRIFUGAL

DIRECT GAS

FLEXIBLE BAG

PISTON

STORED
INERT GASCHEMICALLY
GENERATED GAS

ELECTRICAL

MECHANICAL

HYDRAULIC

MAGNETIC

SPARK PLUG

POWDER CHARGE
(PYROTECHNIC)PRECOMBUSTION
CHAMBER

CATALYST

THRUST

RESTART

DIRECTIONAL

TERMINATION

NONE

VARIABLE

FIXED

VARIABLE

IMBALLED
MOTORS

JET DEFLECTION

VANES

THRUST
VECTORS

8

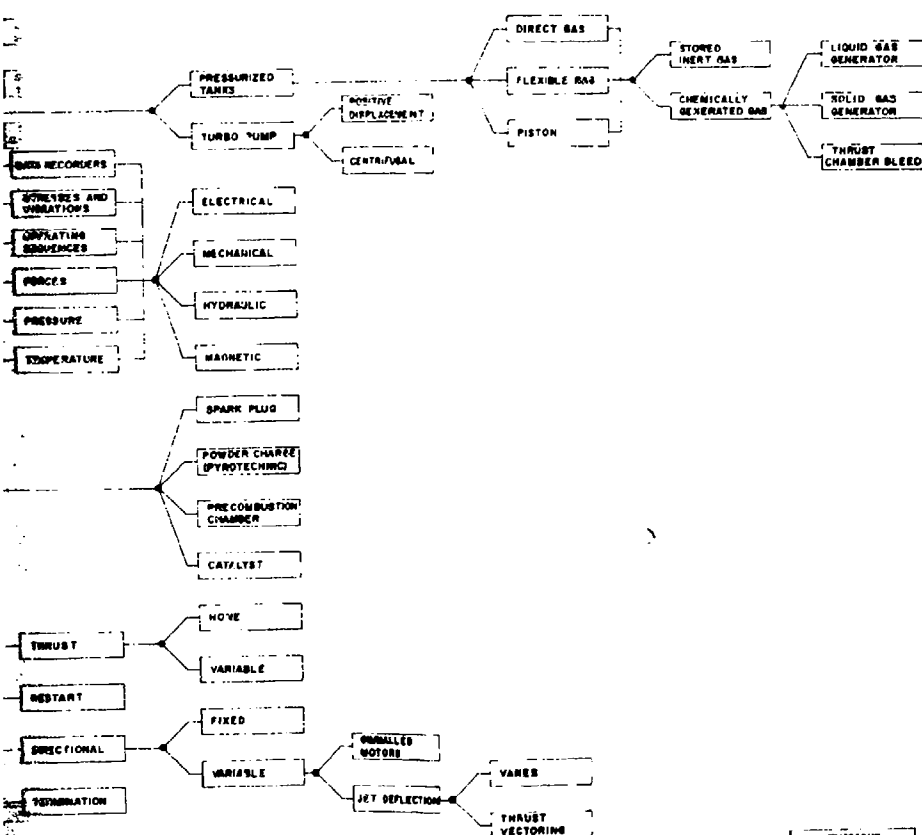
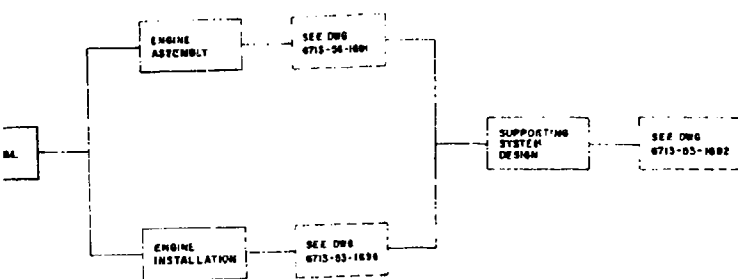
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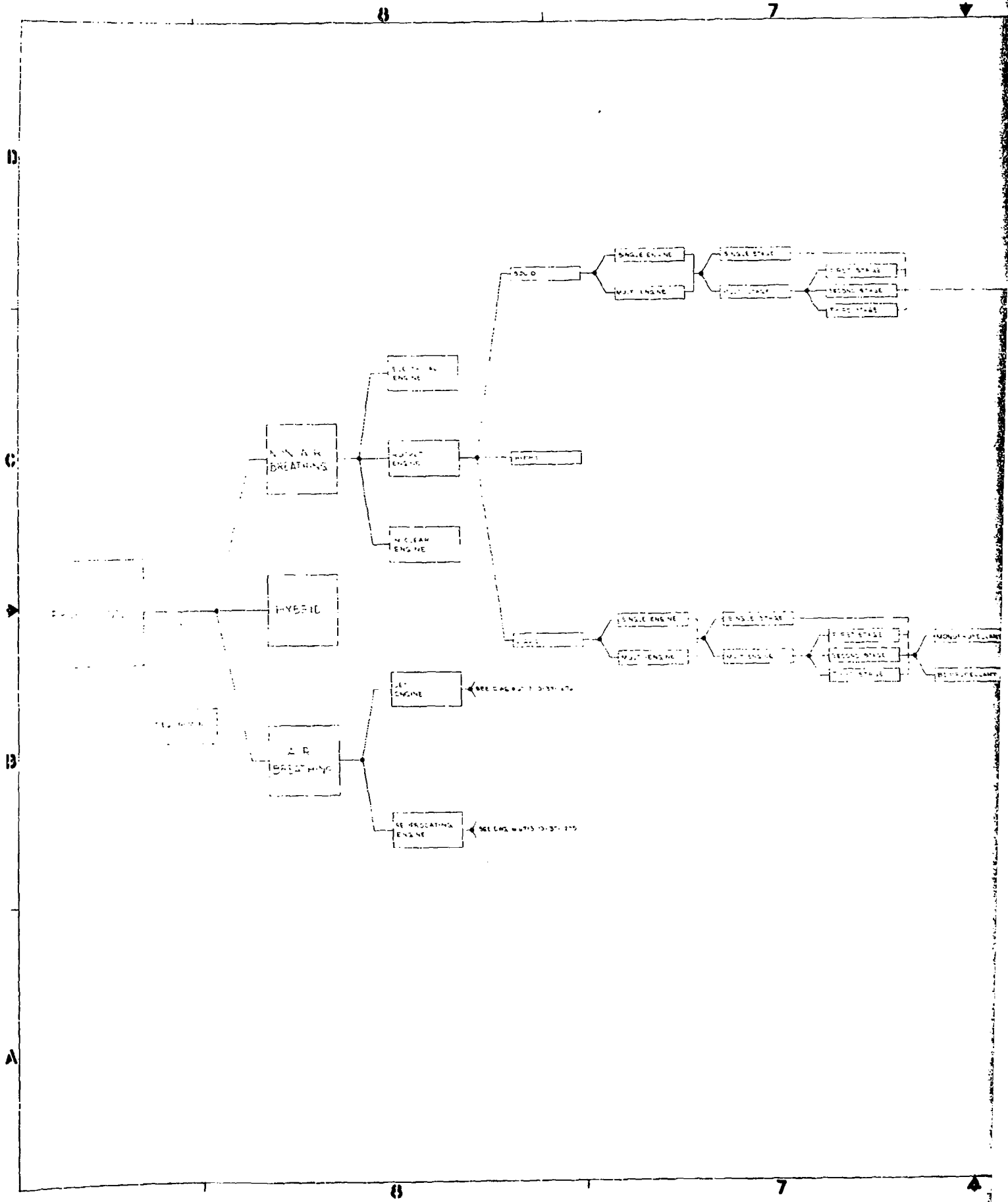


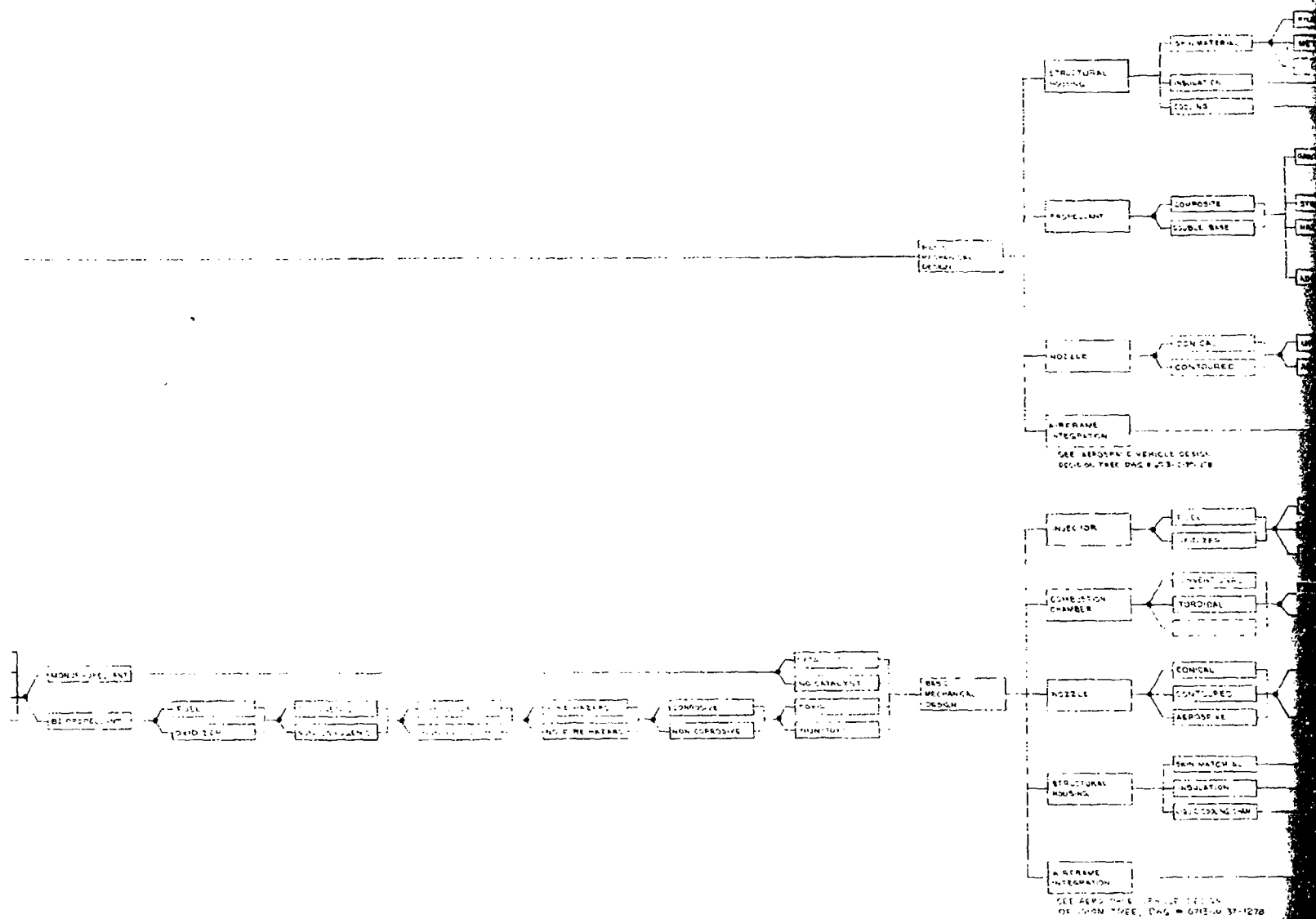
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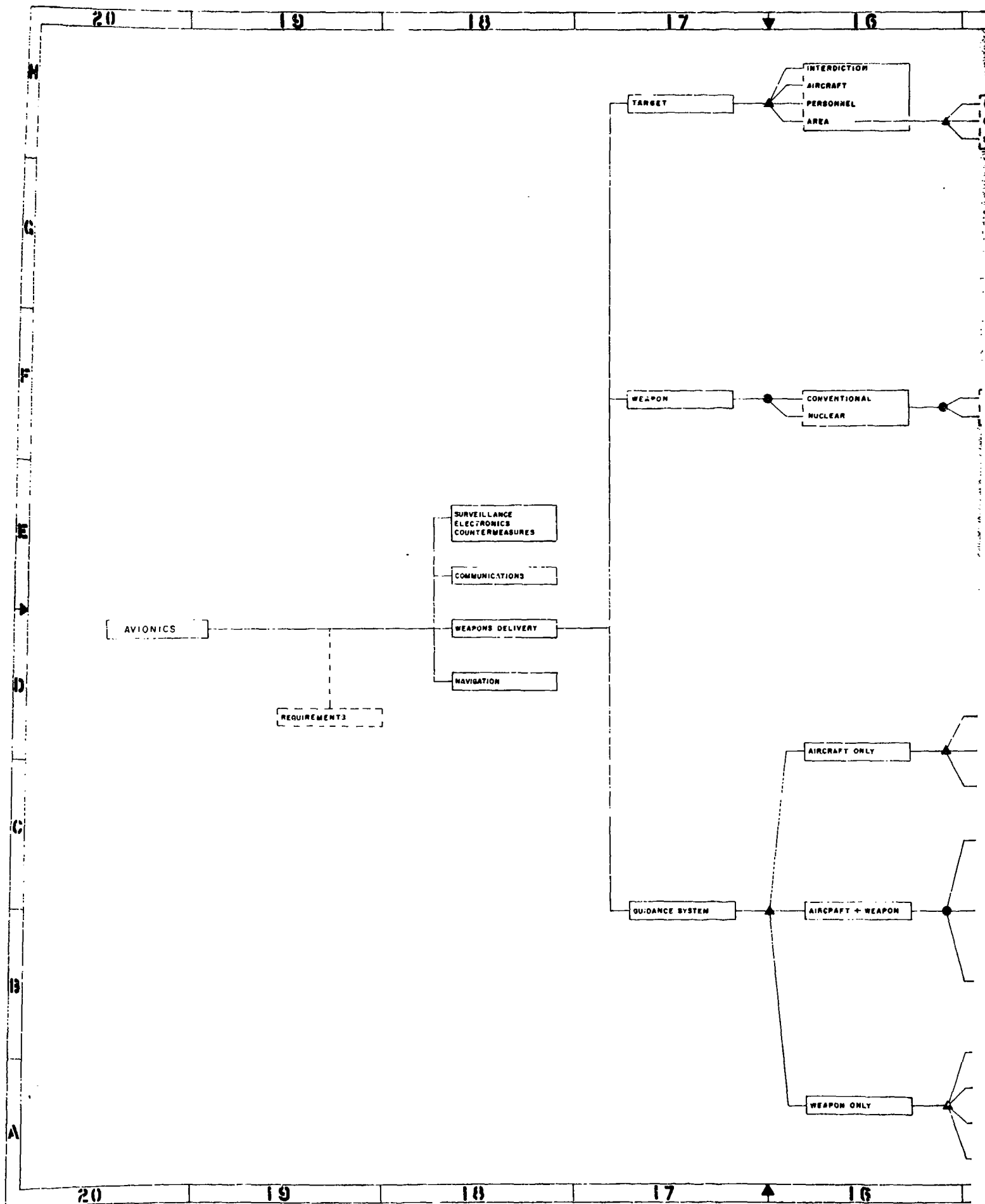
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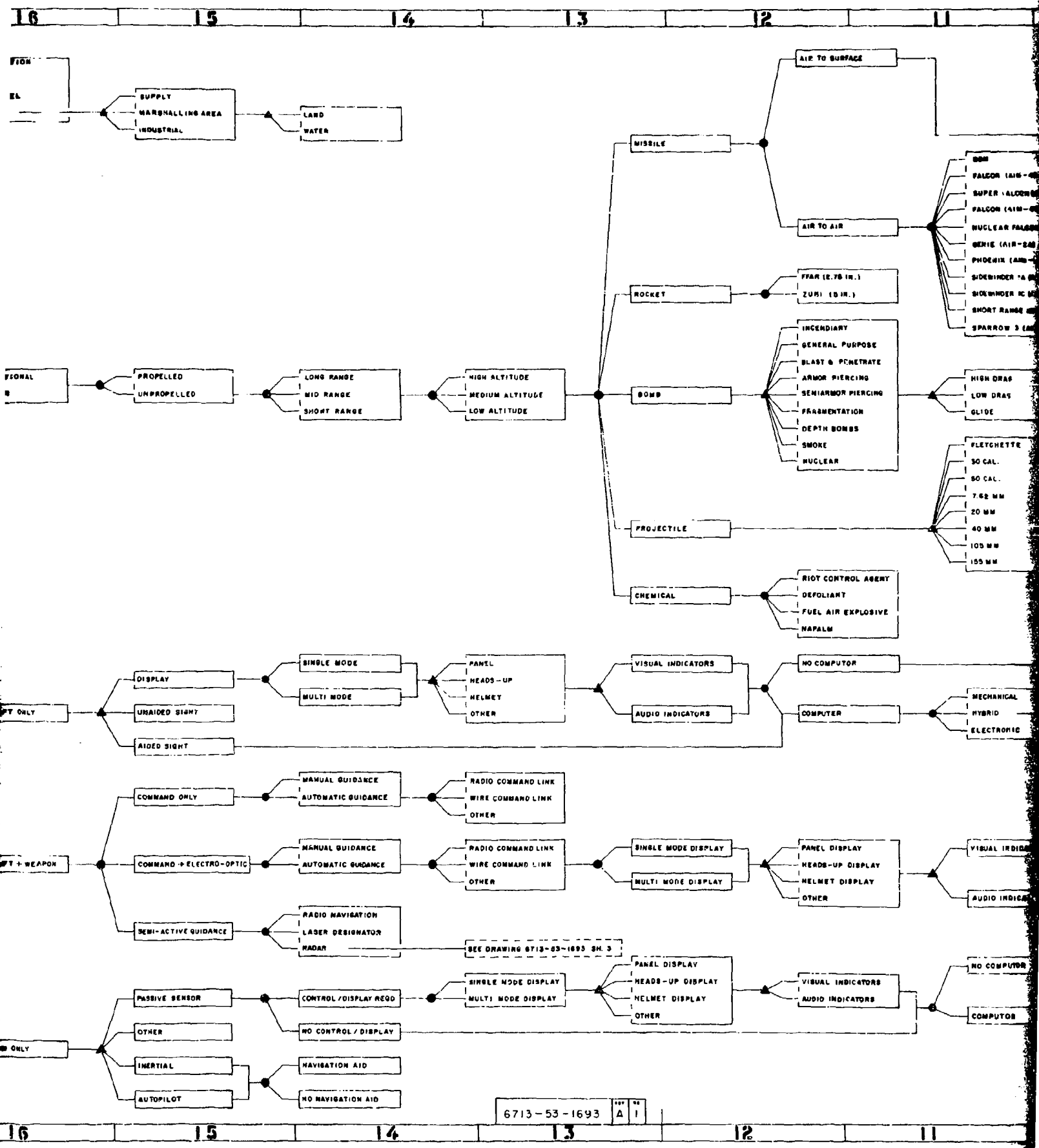
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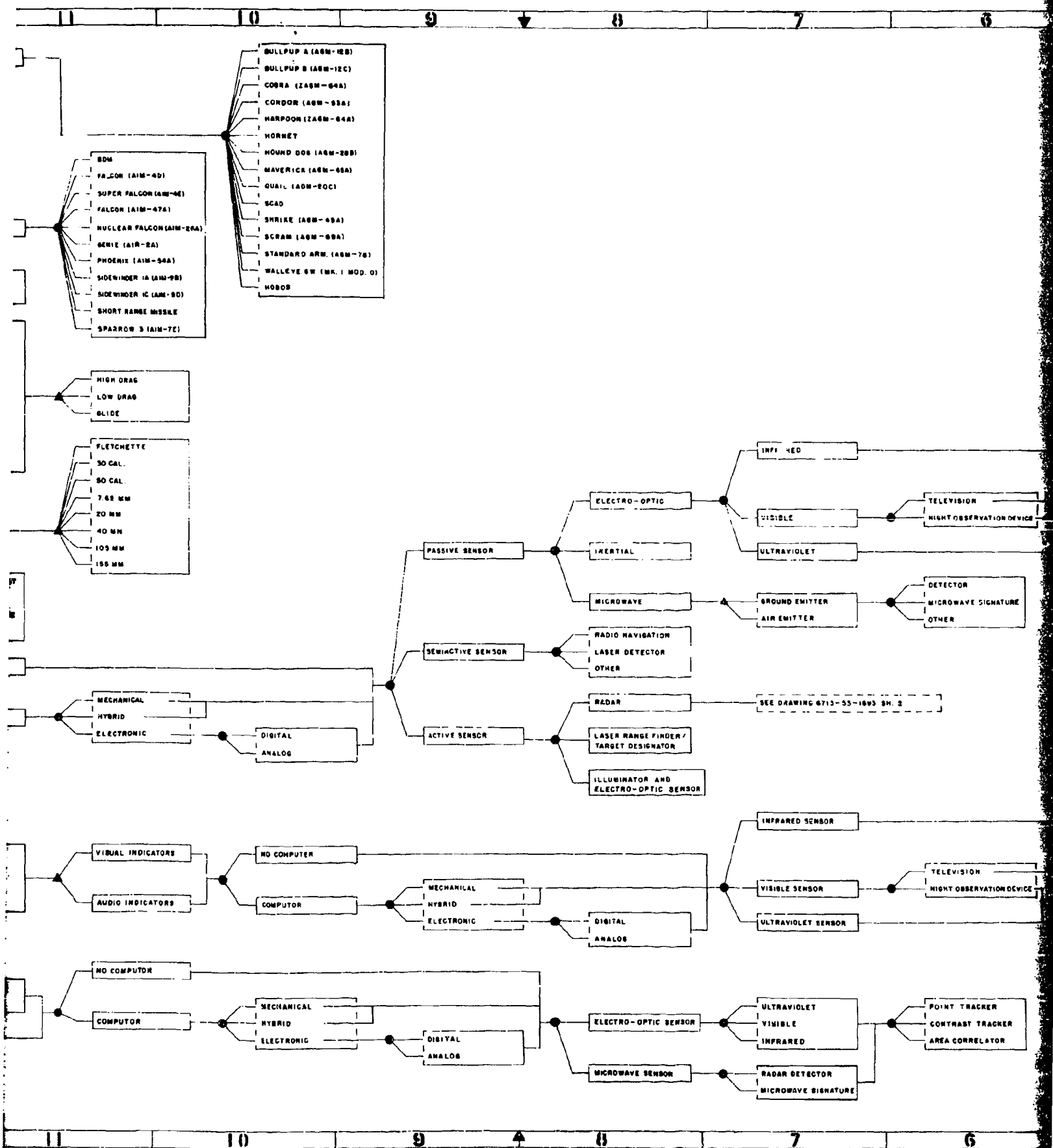
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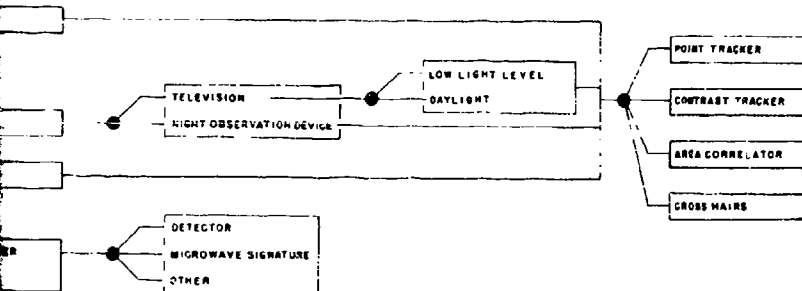




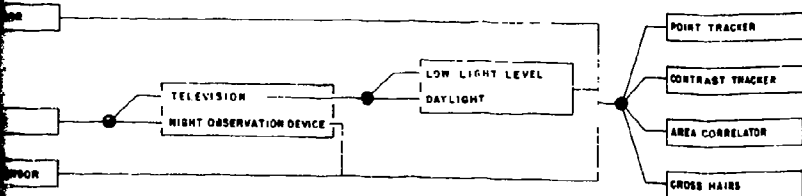




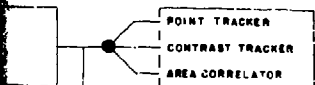




6713-53-1693 SH. 2



NOTES
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 2. THIS STUDY DID NOT INCLUDE ANY ANALYSIS OF GROUND CONTROL.

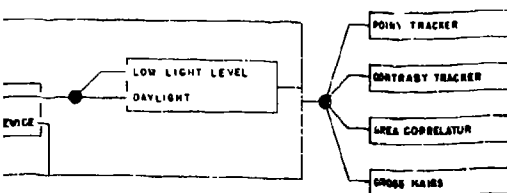


6713-53-1693

REV A

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<p>6713-53-1693</p> <p>REVT: [Signature] USED ON: [Signature]</p> <p>APPROVED: [Signature] DATE: [Signature]</p>									

DECISION TREE
 WEAPONS DEL.

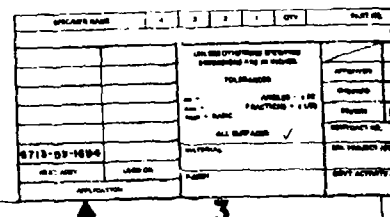


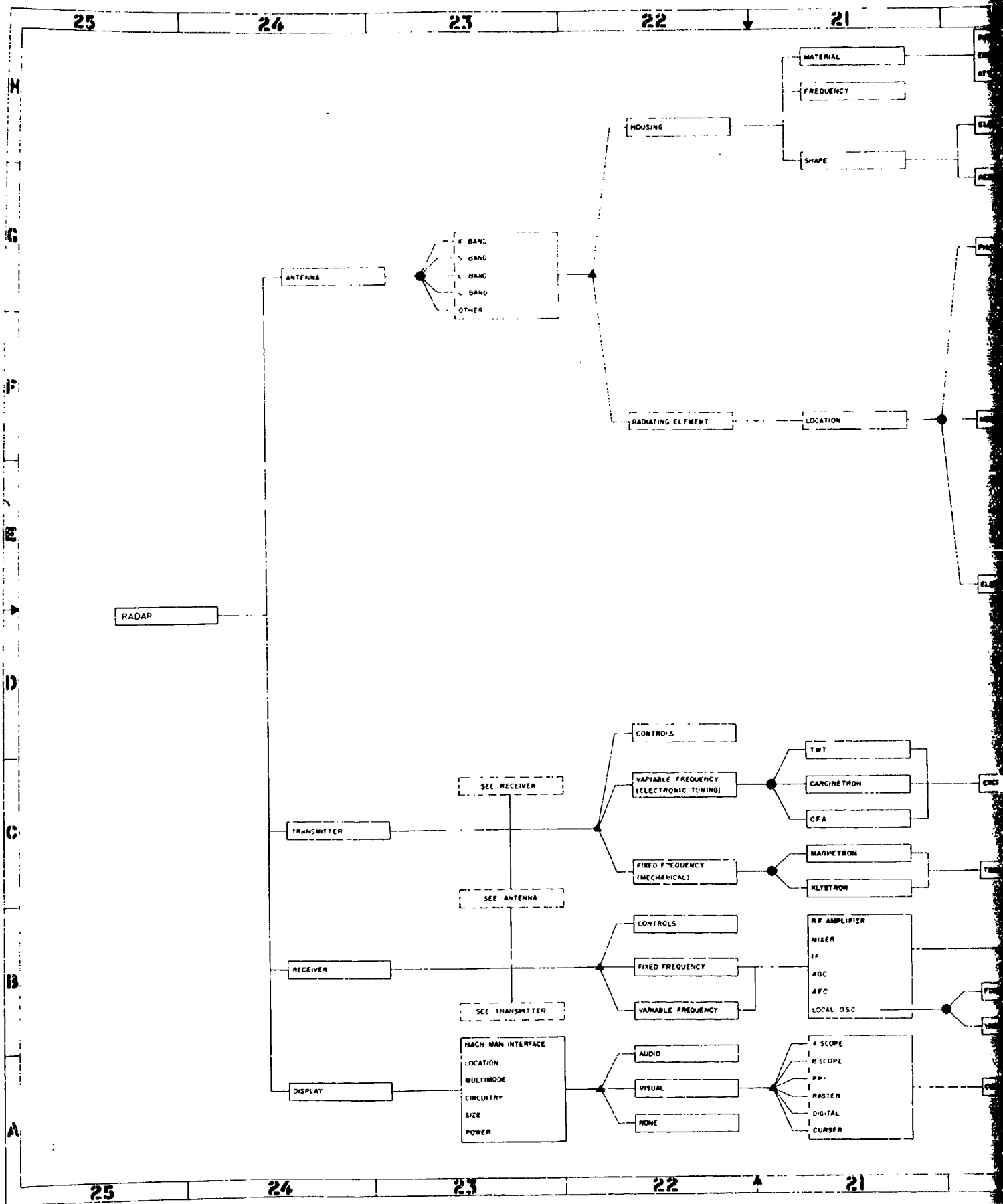
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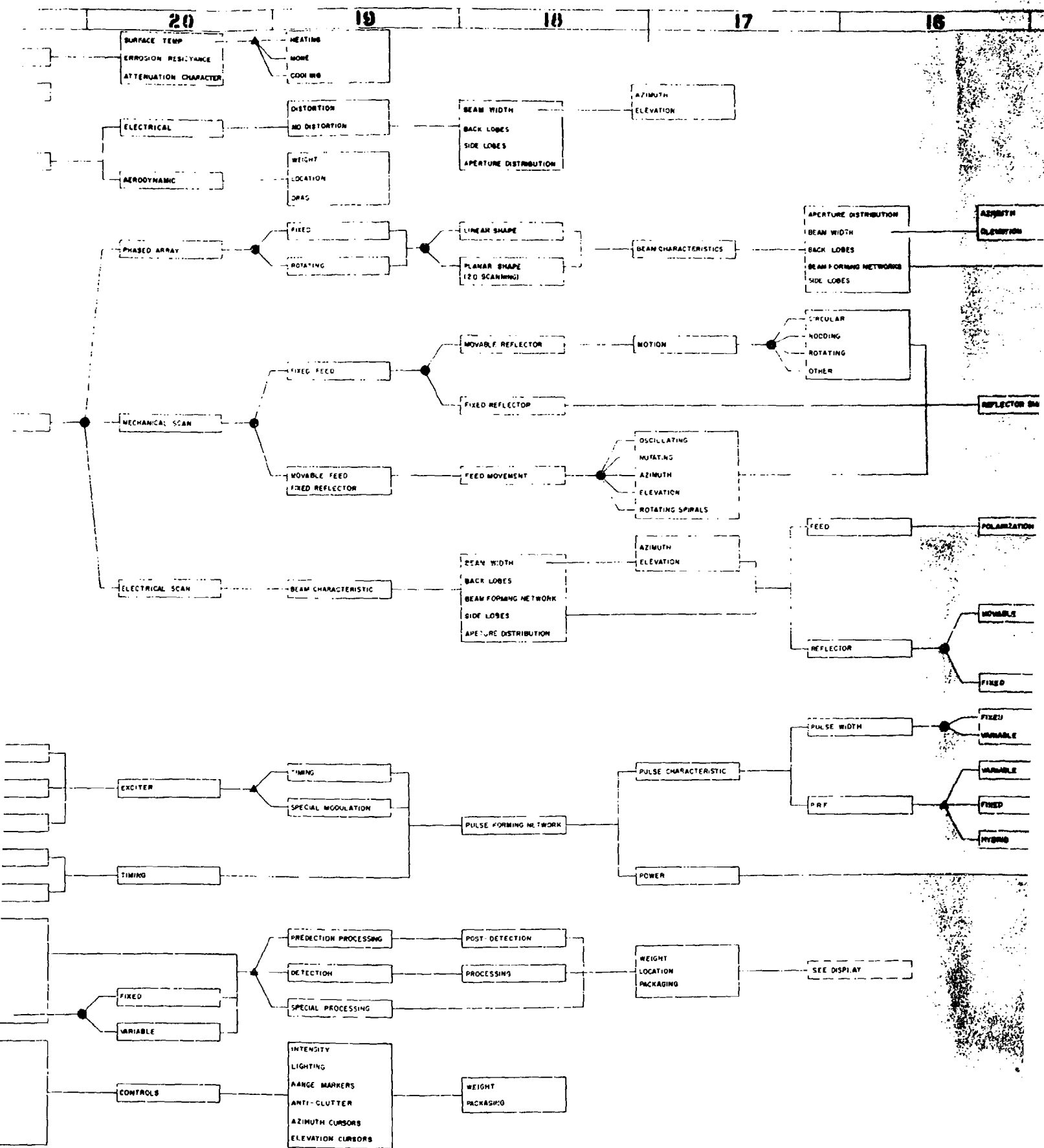
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2. THIS STUDY DID NOT INCLUDE ANY ANALYSIS OF GROUND CONTROL OF WEAPONS

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6713 - 53 - 1693







6713-64-1945

REV A

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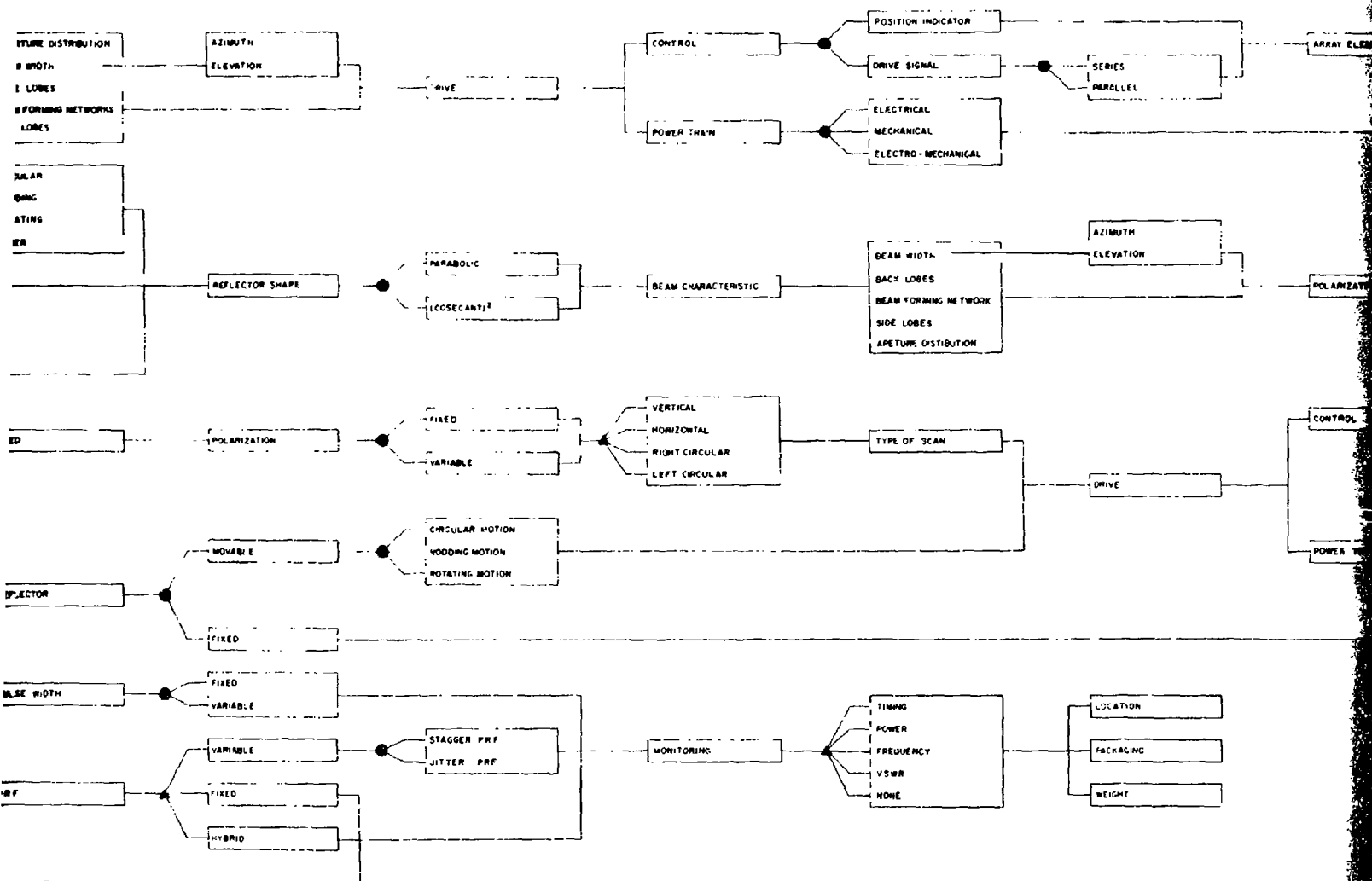
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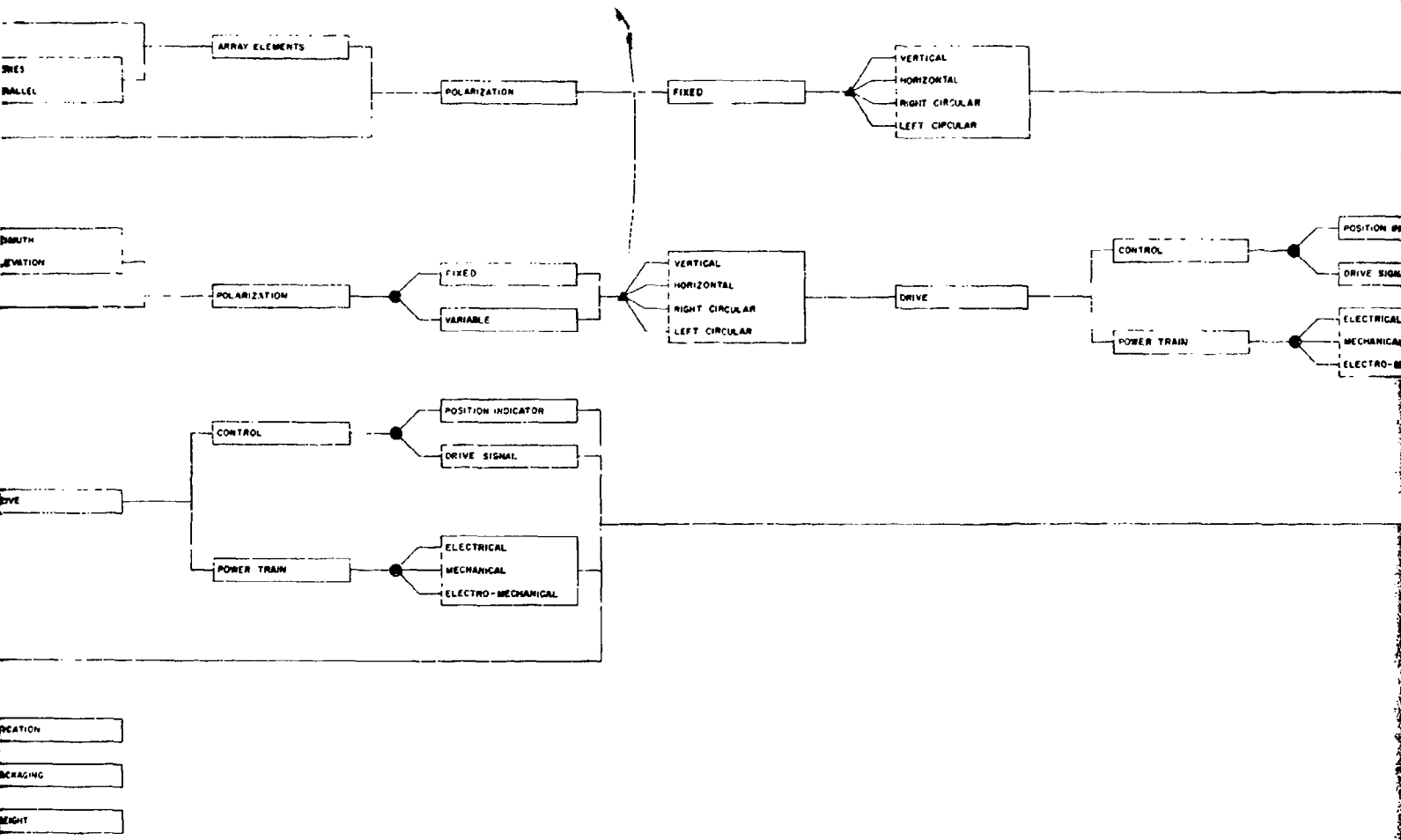
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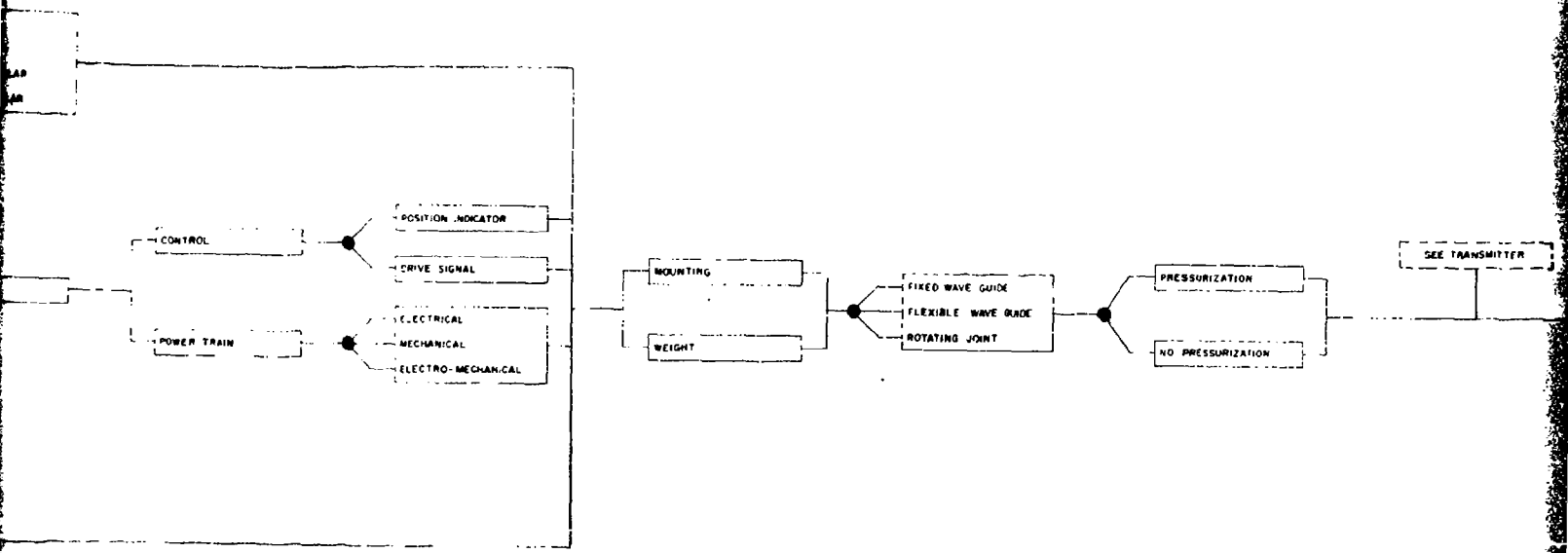
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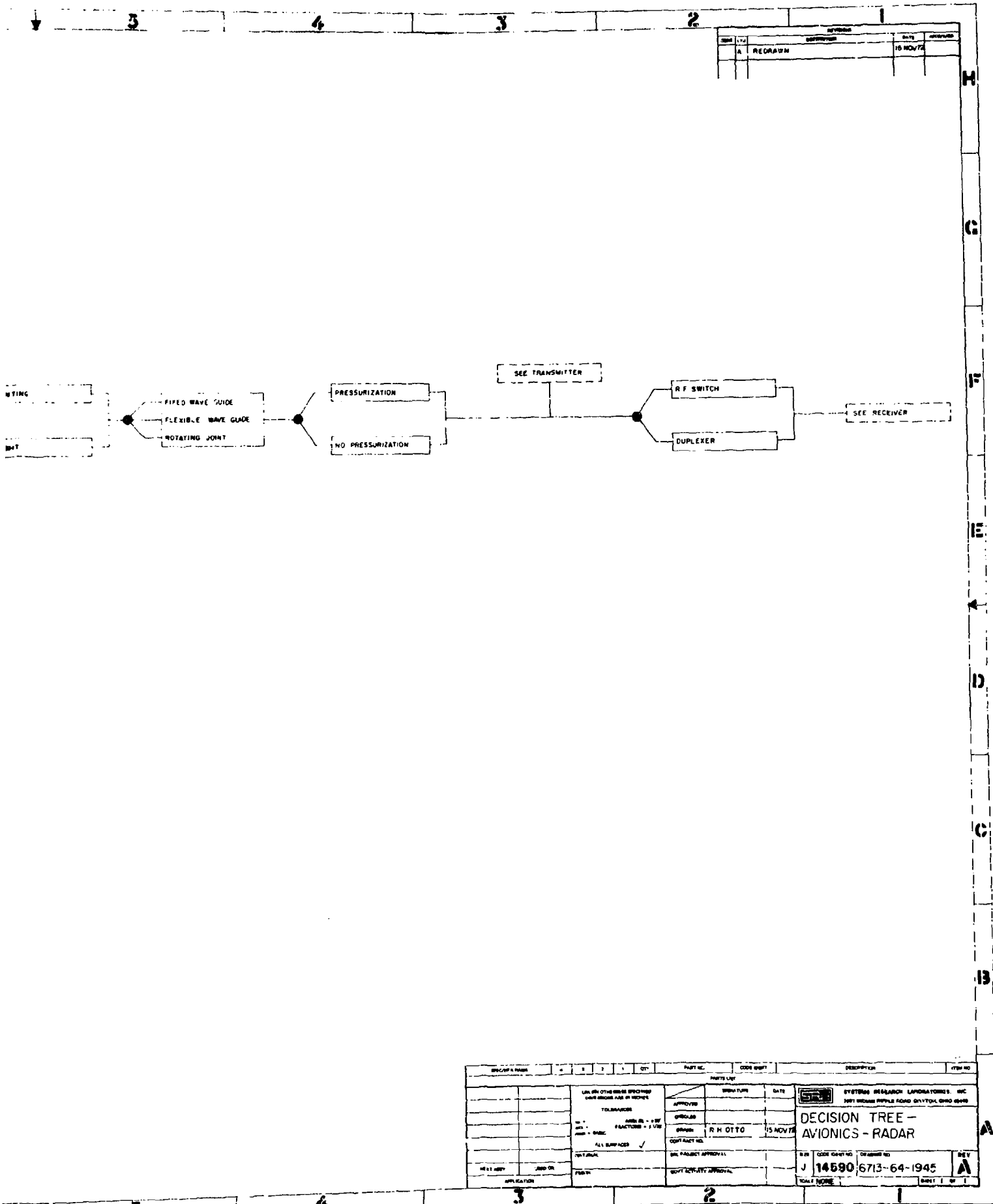
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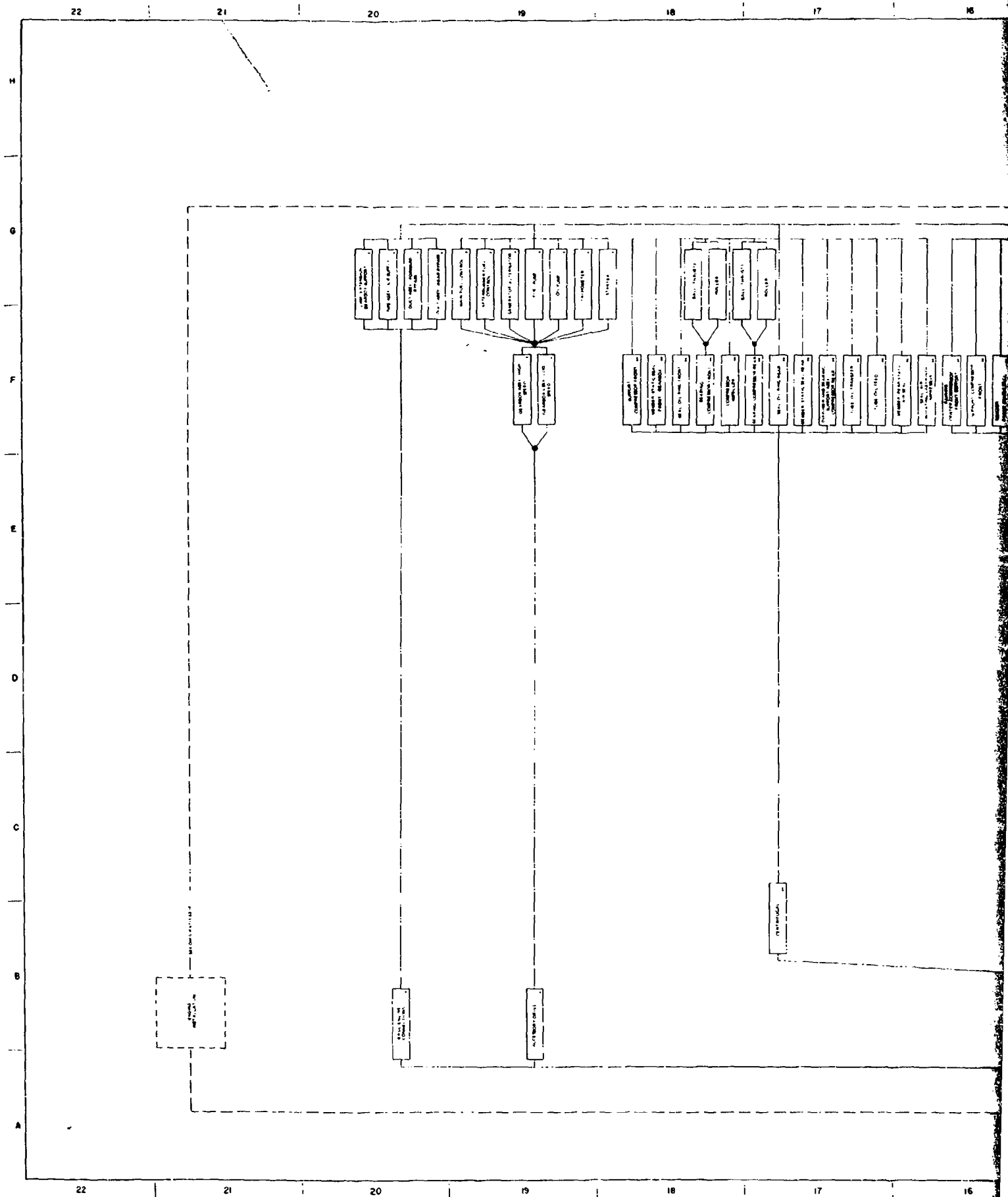


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GENERAL INFORMATION	NAME			
	DATE			
	BY			
	FOR			
NEXT STEP	APPROVAL			
	DATE			





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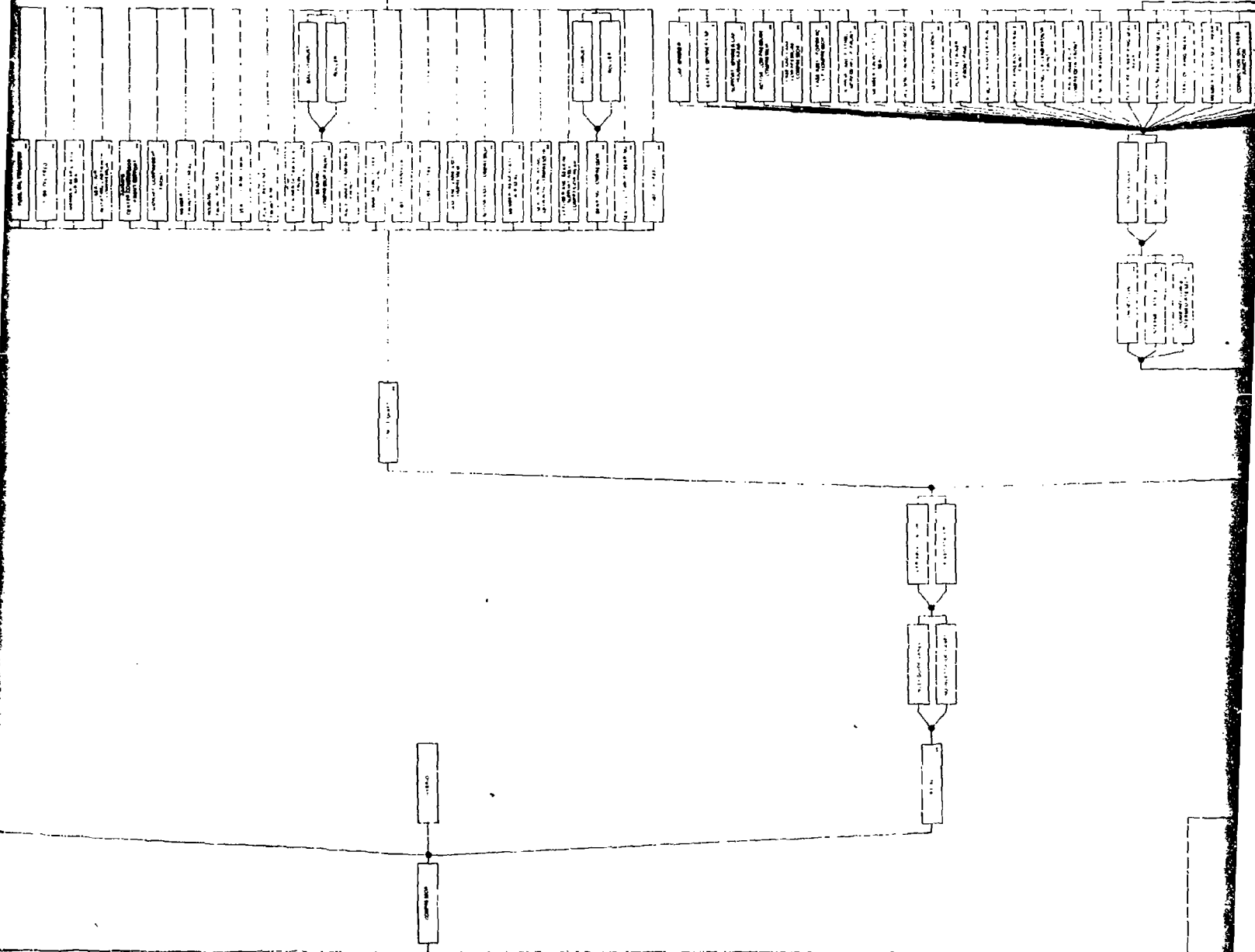
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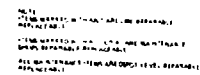
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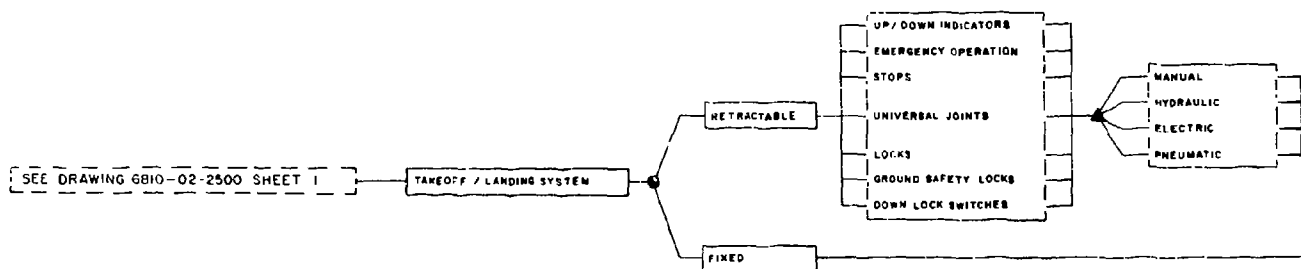
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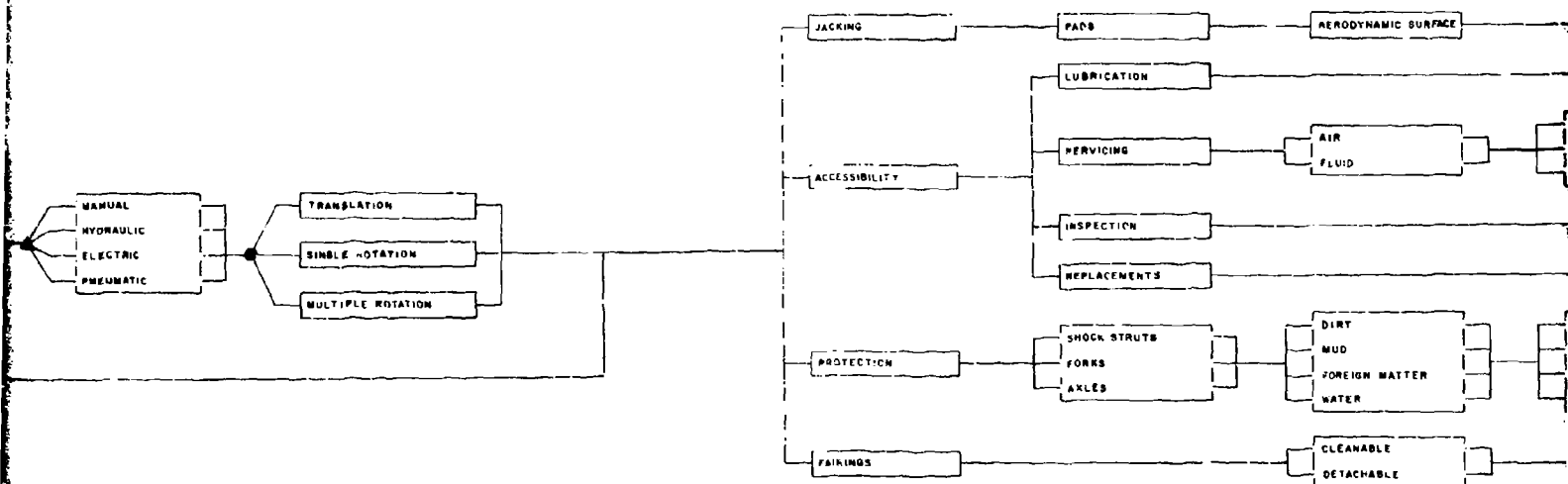
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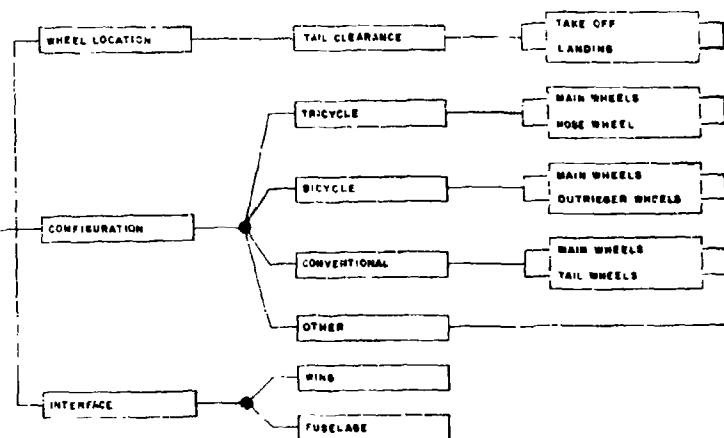
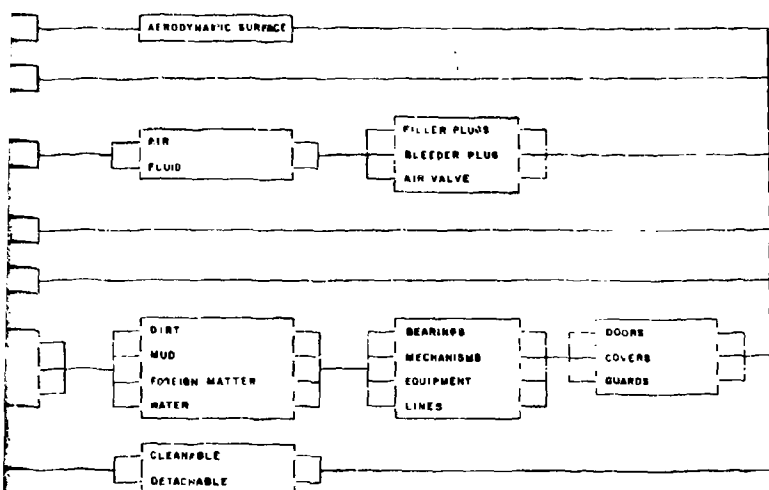
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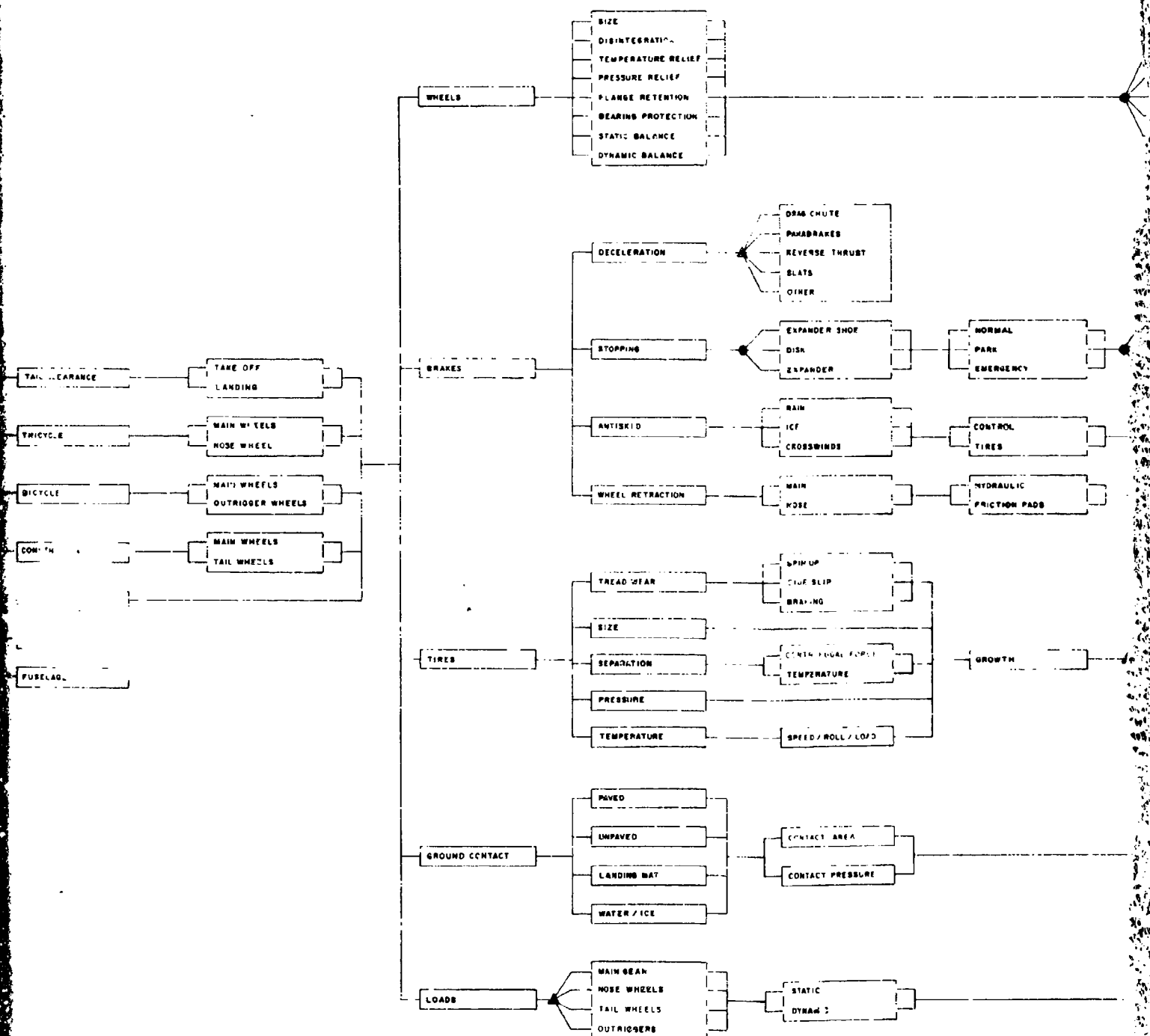
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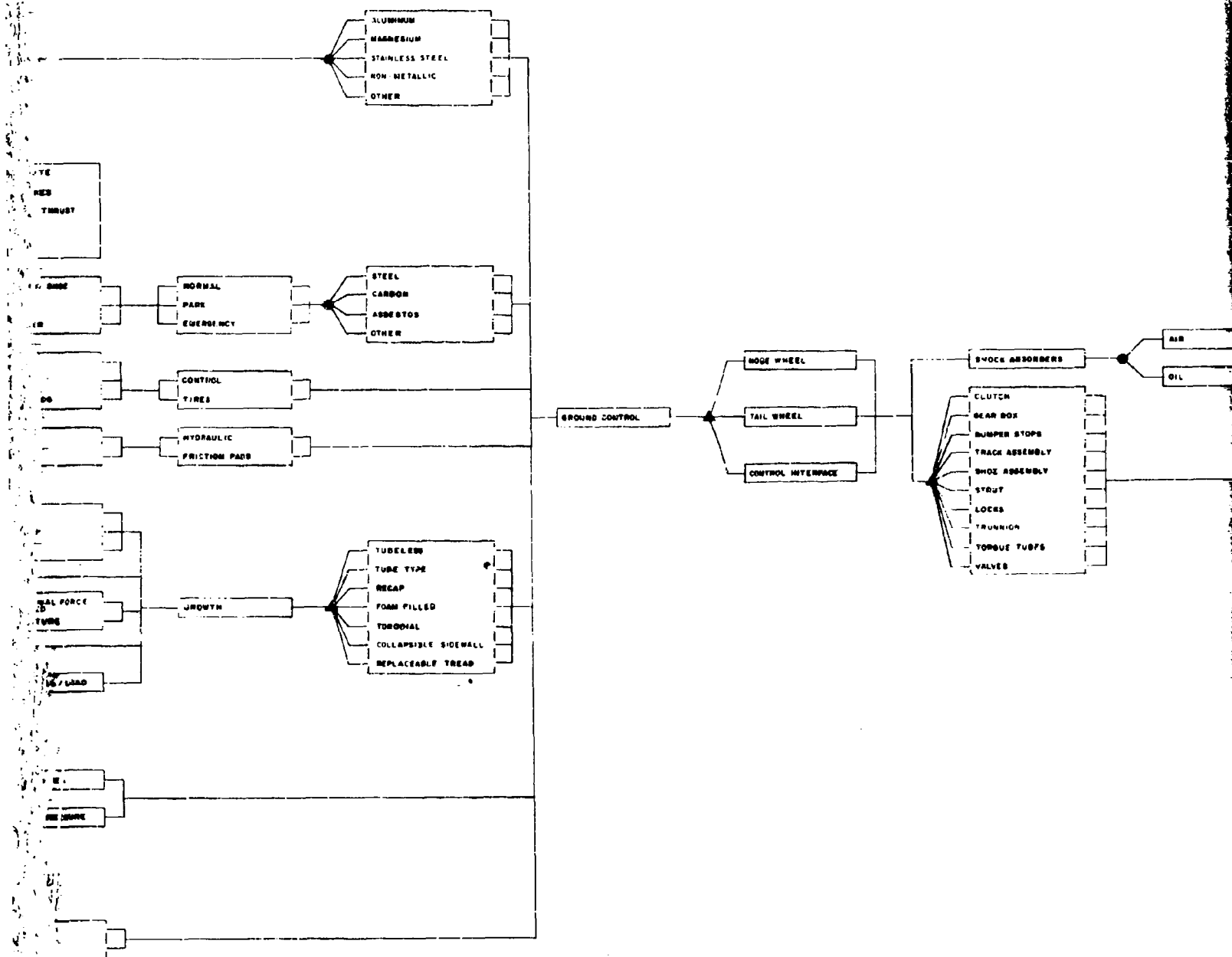
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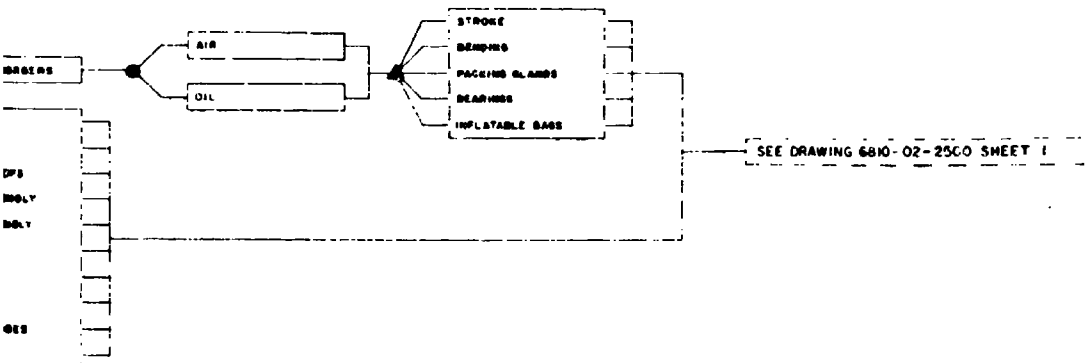
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DRAWING NO.		REV.		DATE		BY	
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TITLE		PROJECT		SHEET		OF	
HYDRAULIC SYSTEM		BUCKNER		7-10-74		1488	
DESIGNED BY		CHECKED BY		APPROVED BY		DATE	
J		J		J		J	
DATE		DATE		DATE		DATE	
7-10-74		7-10-74		7-10-74		7-10-74	

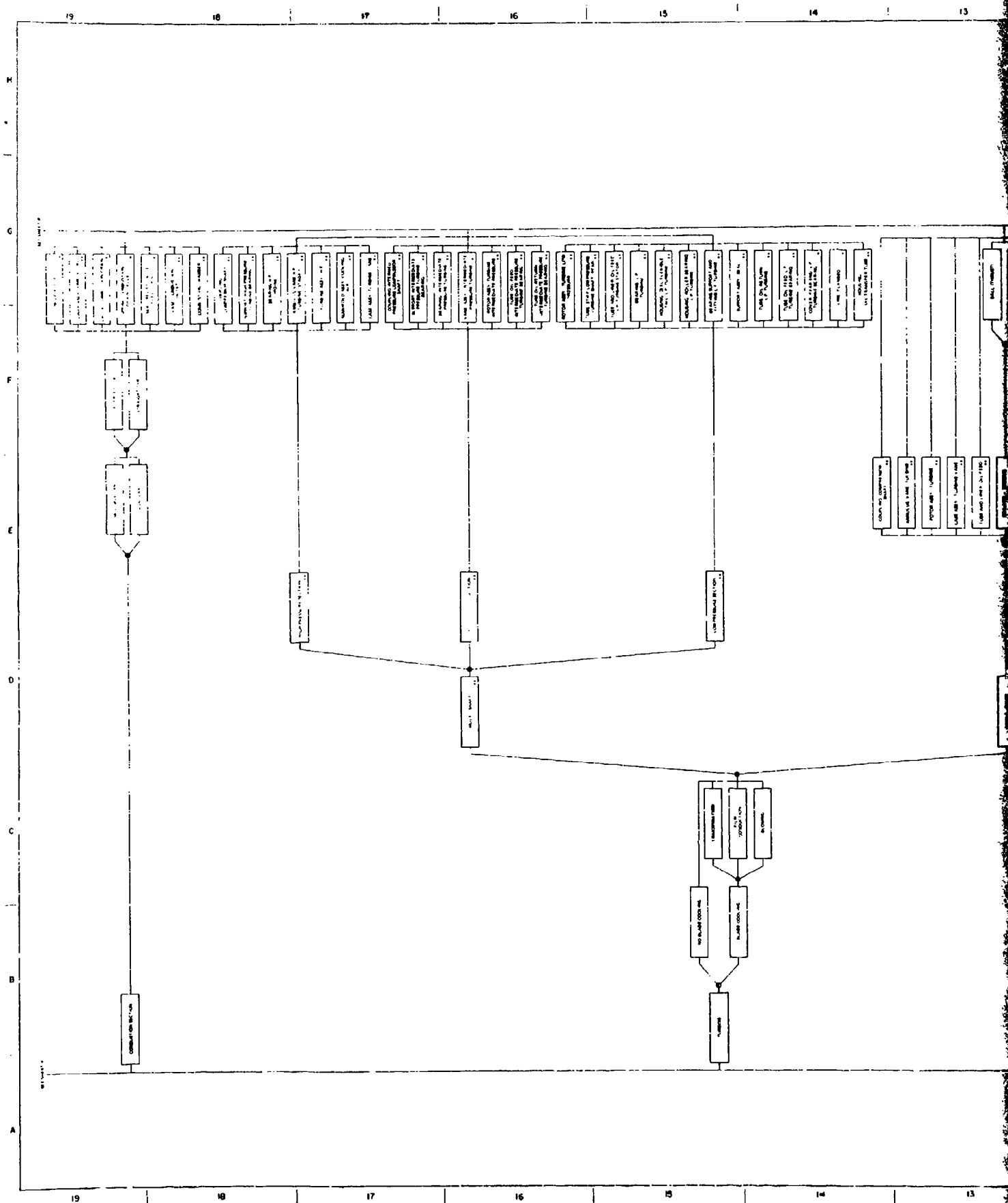
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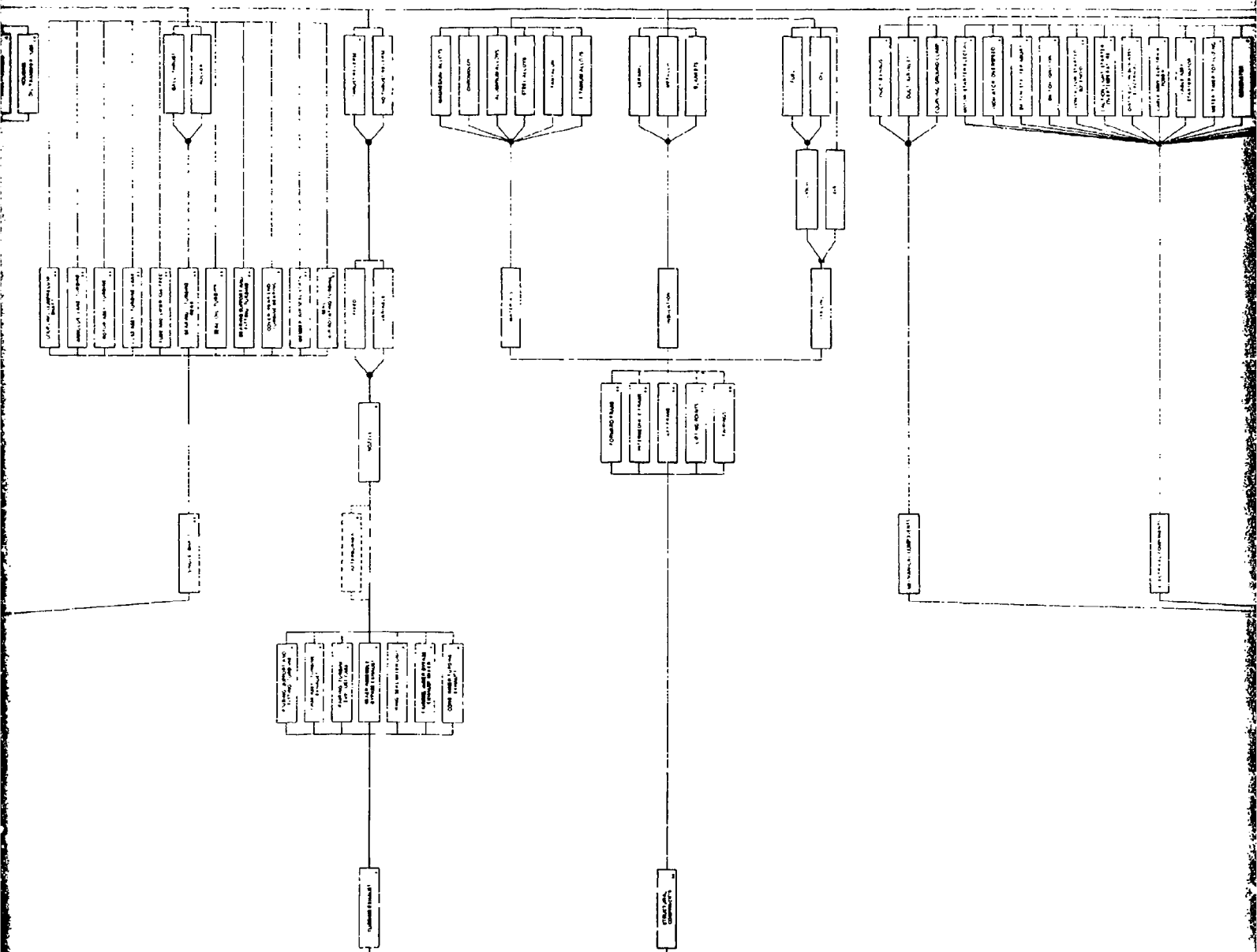
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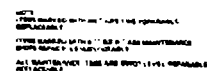
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ENGINE
MOUNTS

CONTROL
SYSTEM

ACCESSORY
SEAL DRAINS

ENGINE
INSTALLATION

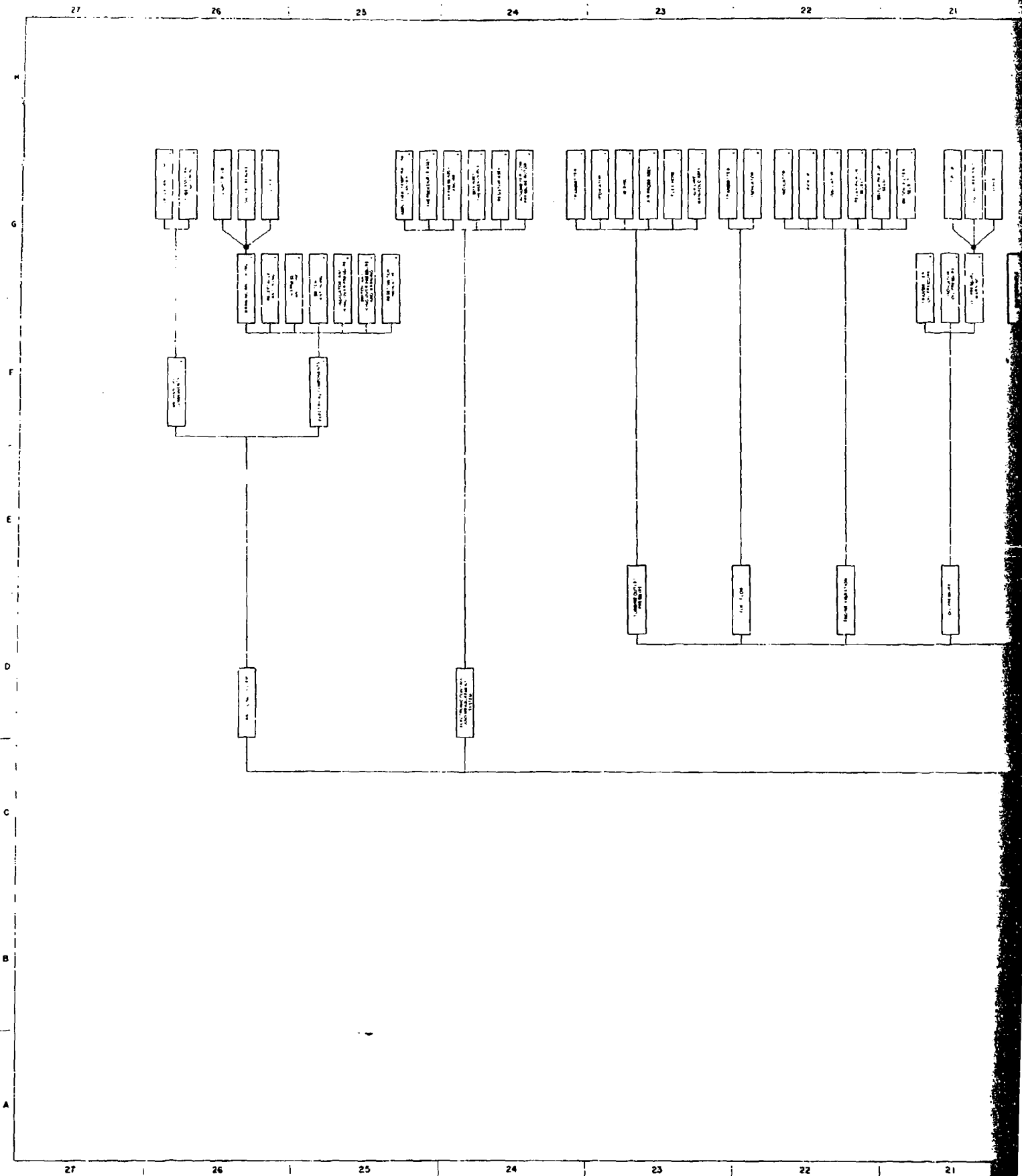
AIRFLOW
SYSTEMS

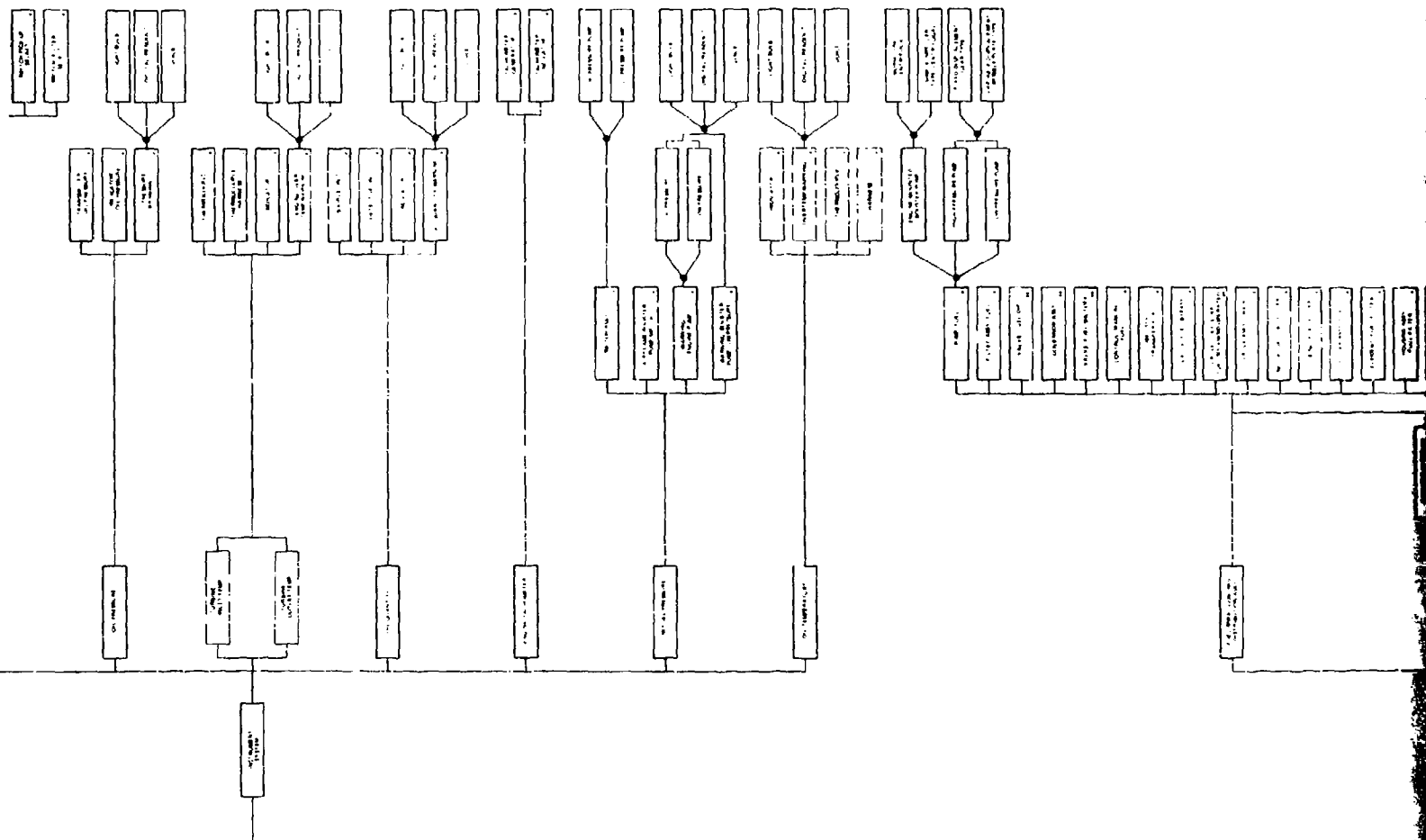
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DESIGN

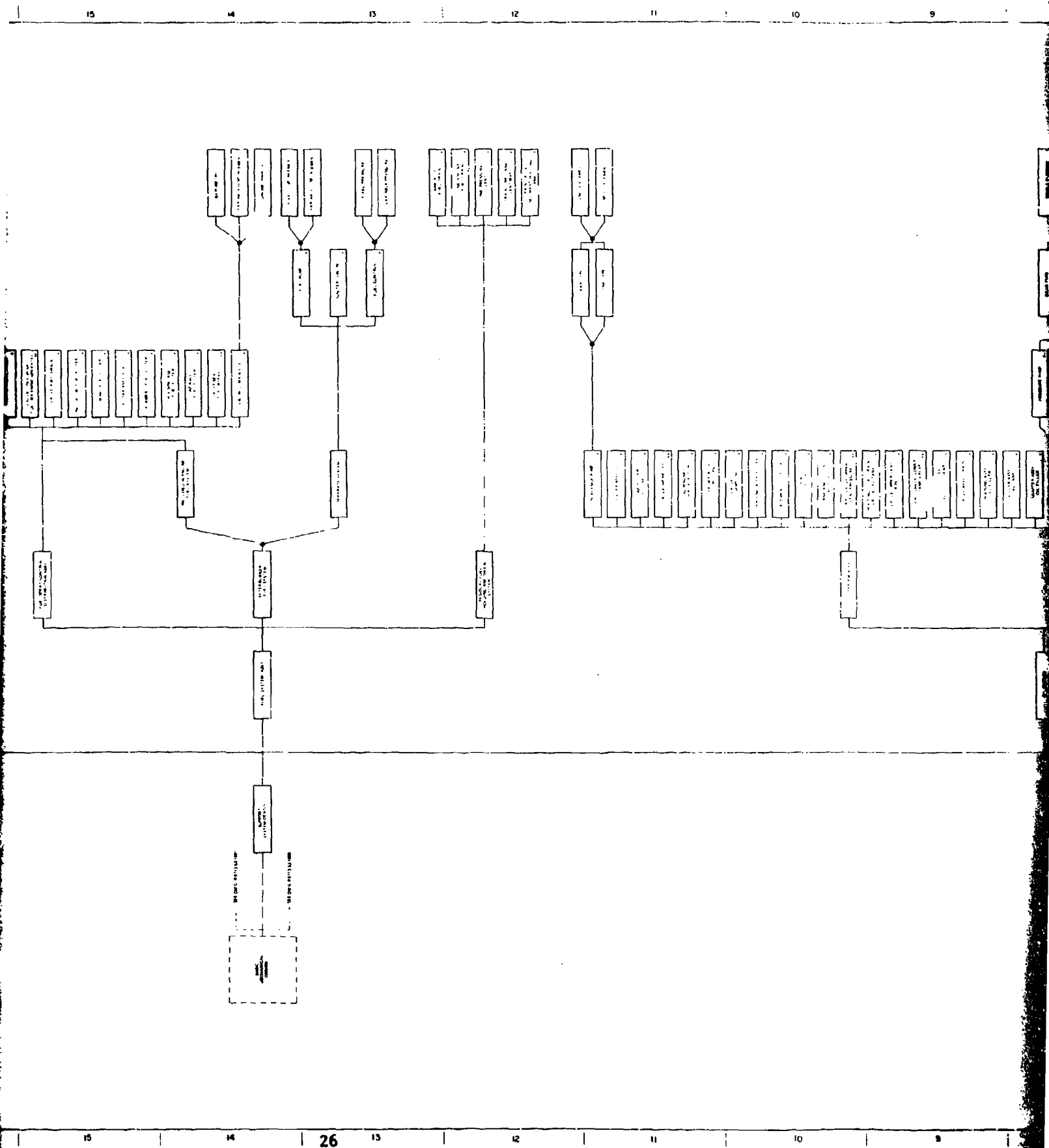
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SYSTEM
ENGINE
BUILDUP

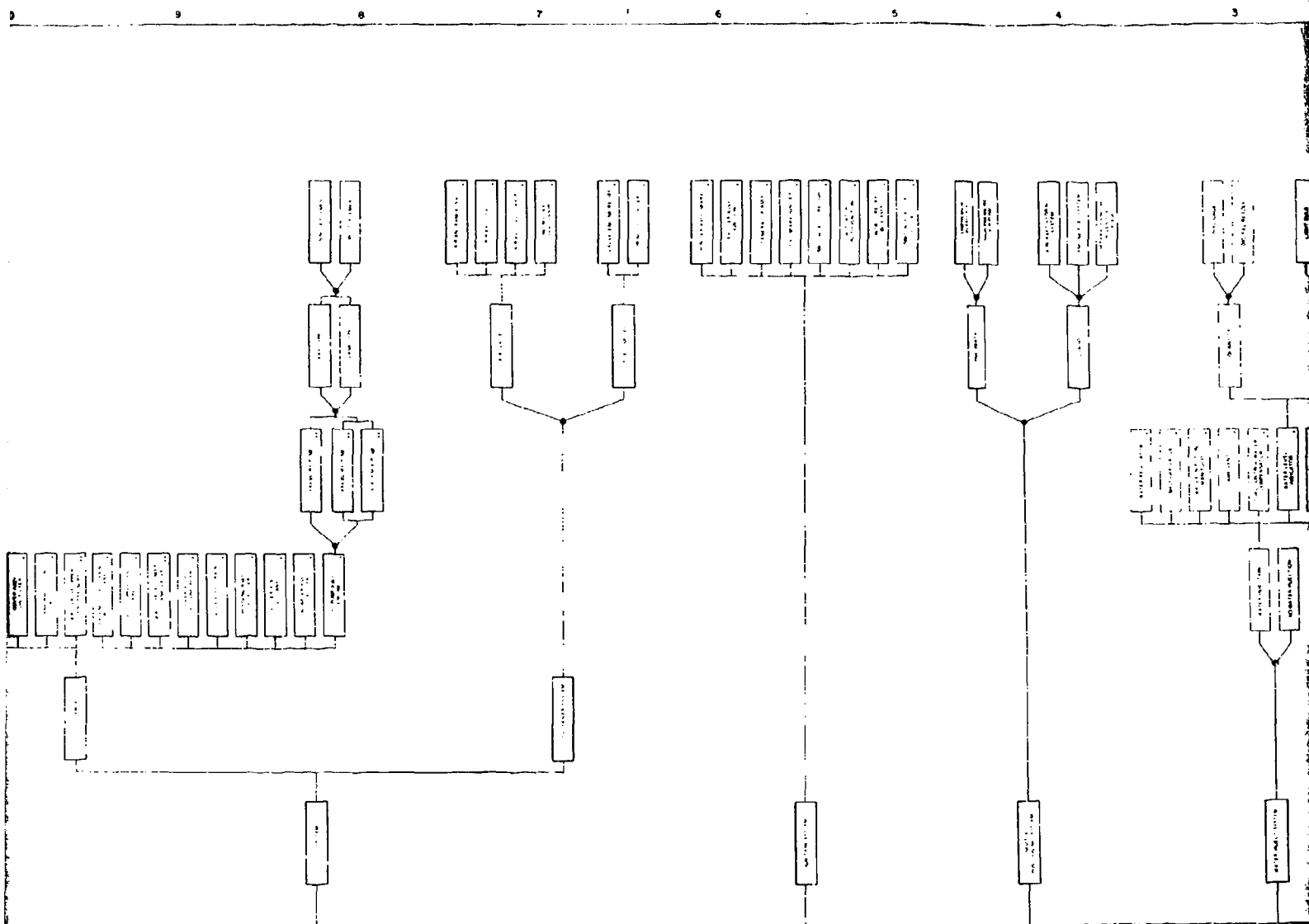
ENGINE
ASSEMBLY

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OFFICIAL'S NAME		1	2	3	4	5	6	7
NAME AND POSITION OF OFFICIAL								
DATE								
TIME								
PLACE								
REMARKS								
INITIALS								
SIGNATURE								
DATE								
TIME								
PLACE								

Section IV
DEFINITIONS

REMOTELY PILOTED VEHICLE DODT

The following is a list of definitions of the terms used in the Remotely Piloted Vehicle DODT.

NOTE: The numbers and letters in parenthesis are drawing coordinates used to denote locations when a word is used more than one time with more than one meaning.

Aerodynamics -- Those forces generated by the movement of air over the surfaces of the vehicle and the resulting motion of the vehicle.

Aeroelasticity -- The deflections and vibrations of the airframe caused by the air loads due to the non-rigid nature of the airframe.

Air Defense -- Operations keyed to prevention of air attack by some adversary.

Air Loads -- The aerodynamic loads imposed upon the airframe structure.

Airbreathing -- Engines which require an inlet utilizing atmospheric air for combustion.

Aircraft -- A vehicle whose primary sustaining force is the dynamic reaction of air against its surfaces.

Airframe -- The structural components which make up the vehicle configuration and support the included vehicle subsystems.

Airframe/Propulsion Interface -- Those items involved in installation and operation of the propulsion system which require integration with airframe structure and aerodynamic configuration.

Altitude -- Height above theoretical sea level based on local air density.

Armament -- Projectiles, powered or unpowered, intended to destroy a target.

Avionics -- Electrical/electronic equipment tailored to a given RPV mission.

Avionics Interface -- The network by which the avionics system actuates the flight controls to provide desired navigation, maneuvers, etc.

Bomber -- A vehicle which carries air-co-ground weapons to a distant target.

Bomber Defense -- A mission involving accompanying a bomber for the purpose of protection.

Close Air Support -- A tactical mission assisting the immediate objectives of ground based forces.

Communications Relay -- A vehicle which serves as a communications link between stations which would otherwise be out of range.

Control Station -- The console from which the RPV is guided and operated while flying.

Conventional -- Using a standard aircraft runway.

Core Avionics and Information Processing -- Avionics equipment, information exchange and processing equipment, and required interfaces which are part of the basic operation of the RPV, exclusive of specific mission payload equipment.

Decoy -- A vehicle which draws attackers away from the bomber.

Defensive -- A mission whose basic purpose involves preventing an attack by some other source.

Direct Thrust Production -- Direct conversion of temperature and pressure into thrust; e.g., a rocket engine.

EW/ECM -- Electronic noise, jamming, illumination, etc., intended to modify the effectiveness of avionics equipment.

Electric -- Engines which run on electrical energy, either generated by the vehicle subsystem or stored in batteries.

Enclosed/Internal Fan -- Fan or compressor enclosed in a shroud or within an engine casing; e.g., a fanjet or ducted propeller.

Expendable -- A vehicle which is not recovered for reuse.

Fighter/Bomber -- A tactical vehicle capable of a mixture of bombing and missile/rocket/gun attacks.

Fixed Wing -- A wing whose position and sweep are not variable.

Flight Controls -- Those aerodynamic surfaces that maneuver the vehicle along with their associated mechanisms and actuators.

Flight Equipment -- Equipment which is part of the flyable RPV.

Forward Air Controller -- A tactical aircraft crew member who directs the delivery of munitions on specified targets.

Free Fan/Propeller -- An unrestrained fan or propeller; e.g., a standard propeller driven by reciprocating or turbine engine.

Ground Equipment -- Any support equipment which is not part of the flyable RPV.

Hybrid -- A combination of wing types. (13/D)

Hybrid -- A vehicle whose configuration is not clearly definable as aircraft or missile. (16/E)

Hybrid -- New technology combinations of airbreathing and non-airbreathing, such as turbo-rocket and ramjet/rocket. (8/G)

Hypersonic -- High supersonic speed, usually taken as above Mach 5.0.

Interceptor -- A strategic interceptor is one which has the capability to intercept attacking forces while they are still safely distant from their target. (20/G)

Interceptor -- A tactical interceptor has the mission of maintaining control of airspace over a field of action to allow other operations to continue in reasonable safety. (20/F)

Interceptor -- A vehicle which destroys those vehicles attacking a bomber. (19/A)

Interdiction -- A tactical mission whose objective is cutting enemy supply lines.

Jet -- Denotes ramjet and all classes of turbine engines.

Launch -- That segment of the RPV mission which involves getting the vehicle off the ground and into a flight condition from which the mission can be initiated.

Lifting Body -- A vehicle without wings but whose shape generates aerodynamic lift.

Logistics Support -- Management and maintenance of parts supplies, personnel training, repair facilities, etc., outside of operational organization.

Maximum In-Flight G-Loads -- Maneuver loads imposed during performance of the mission excluding launch and recovery.

Missile -- A vehicle whose primary sustaining force is its propulsion system.

Multiple -- An indication of the possibility that an RPV may be designed to fulfill more than one of the previous classes of missions.

NAV/COM -- That equipment involved in determining and controlling the position and velocity of the vehicle and in transmitting information to and from the vehicle.

Navigation -- That equipment involved in determining the position and velocity of the vehicle. (9/D)

Navigation Source -- A vehicle which provides a beacon of known position from which other positions can be determined.

Non-airbreathing -- Those propulsion systems which do not require an intake for combustion air.

Nuclear -- Engines using a nuclear reactor as an energy source.

Offensive -- A mission whose basic purpose involves an attack initiative.

Operation and Maintenance -- Personnel, facilities, and equipment required to maintain the RPV system in an operational status and to conduct operations.

Other -- General utility missions not previously included. (20/C)

Penetration -- A bomber intended to make its way through an adversary's defense system without being detected.

Performance -- The characteristic speed, altitude, maneuverability, and other parameters which describe the ability of the vehicle to perform a given flight profile.

Primary Mission Equipment (Payload) -- On-board equipment whose specific function is to carry out the particular RPV mission.

Propulsion -- The thrust producing system which propels the vehicle.

Range -- Distance vehicle can cover and still accomplish its mission.

Reciprocating -- Internal combustion engines using reciprocating motion of pistons for power transfer.

Reconnaissance -- A mission whose primary purpose is collecting information. (20/H)

Reconnaissance -- A tactical reconnaissance involves gathering of information on specific objectives required to allow effective use of other tactical operations. (20/F)

Recoverable -- A vehicle which is recovered for refurbishment and/or replenishment and reuse.

Recoverable Payload -- Some part of a vehicle which is recovered while other parts are not recovered.

Recovery -- The terminal segment of the mission which involves those steps necessary to return all or part of the vehicle to a base for reuse.

Remotely Piloted Vehicle -- An aerospace vehicle which is flown by an operator in real time physically isolated from the vehicle.

Rocket -- Engines carrying self-contained fuel and oxidizer to produce thrust from a nozzle.

Rotary Wing -- A wing whose position can or must rotate, e.g., a helicopter rotor.

Stability and Control -- The ability of a vehicle in flight to maintain an equilibrium condition and the ability of the controller to change the equilibrium condition.

Stand-off -- A bomber which can attack a ground target while staying reasonably distant from the target.

STOL -- Using a short runway, i.e., typically 1500 feet or less.

Strategic -- Operations covering a wide geographical scale or having widespread and long term effects.

Subsonic -- Speed below Mach 1.0.

Supersonic -- Speed above Mach 1.0.

Supply -- Delivery of equipment and various materials to sites for use and/or further distribution.

Surveillance -- That equipment used for monitoring activities and information; typically photographic, television, radar, infrared, acoustic, and radio.

System Objectives -- Goals the RPV system is intended to fulfill. May be mission requirements, design-to-cost, minimization of operation and maintenance costs, incorporation of a specific subsystem, or any other similar guiding considerations.

Tactical -- Operations intended to accomplish specific missions of more limited scope.

Thrust Augmentation -- Entrainment of air by turbulent shear forces on the boundaries of the primary thrust producer resulting in increased total thrust; e.g., an ejector system.

Tilt Wing -- A wing with variable incidence.

Training -- Familiarization of operators with the proper utilization of available equipment.

Transonic -- Transition speed range, usually taken as between Mach 0.8 and Mach 1.3.

Type of Propulsion -- The general class of thrust producing device to be employed.

Utility -- A grouping of those missions which do not clearly fit under the previous mission groupings.

Variable Sweep Wing -- A wing whose sweep angle can be varried in flight.

VTOL -- Requiring no ground roll for takeoff or landing.

Weapon Delivery -- Equipment involved in the selection, activation, and delivery of a weapon on the desired target.

LAUNCH SYSTEMS DODT
(Dwg. No. 6810-02-2497)

The following is a list of definitions of the terms used in the Launch Systems DODT.

Aft of Nose -- Refers to inlet aft of forward extremity of fuselage.

Air -- Launch methods which entail releasing the vehicle from a flying launch platform.

Air Cushion System -- An inflated skirt or bag which serves as ground effect flotation to replace standard type landing gear.

Airfoil -- The cross-section of the wing or tail surface in a plane cut parallel to the fuselage centerline.

Airframe Configuration -- The distribution of shape and size of airframe components.

Allowable Weight -- Weight of equipment which can be installed in each available space.

Ancillary Equipment -- AGE, test and checkout equipment, and maintenance equipment.

Angle of Attack -- The angular orientation of the wing with respect to the on-coming air required to maintain a specified flight condition.

Area -- The area of the wing or tail surface planform shape.

Available Launch/Recovery Space -- Space within the vehicle which can be occupied by Launch equipment.

Bottom -- Exhaust at bottom centerline of fuselage.

Center -- Exhaust centered or nearly centered on fuselage centerline.

Component Location -- Spaces occupied by components and/or systems other than launch.

Cross Section -- The size and shape of the fuselage envelope at various lengthwise locations.

Dolly -- A wheeled cart on which the RPV executes a runway take-off, but separates from the vehicle and remains on the ground.

Engine Exhaust Position -- Location of exhaust for combustion products and cooling air for the propulsion system.

Engine Inlet Position -- Location of inlets for combustion air and cooling air for the propulsion system.

External -- Stores attached in such a manner as to remain outside the contours of the airframe, e.g., pylons or racks.

External Parasite -- Refers to an RPV which is carried outside the contours of the launch vehicle prior to launch such as mounted on a wing pylon.

Forward of Rear -- Exhaust plane forward of aft extremity of fuselage.

Fuselage -- The central pod or enclosure to which wings and tail surfaces are attached.

Fuselage -- Stores attached to or within the fuselage.

Fuselage Bottom -- Inlet location on bottom centerline of fuselage.

Fuselage Side -- Inlets on sides of fuselage including inlets at wing-fuselage junction.

Fuselage Top -- Inlet location on top centerline of fuselage.

Gross Weight -- The total weight of the vehicle including all fuel and removable loads.

Ground -- Launch methods which entail starting the launch sequence with the RPV on the ground.

Internal -- Stores contained within the contours of the airframe.

Internal Parasite -- Refers to an RPV which is carried inside the launch vehicle prior to launch.

Lateral G-Load -- The aerodynamic and inertial forces on the airframe in a side-to-side orientation normalized by vehicle weight.

Launch -- That segment of the RPV mission which involves getting the vehicle into a flight condition from which the mission can be initiated.

Length -- Nose to tail dimension of the fuselage.

Logistics Requirements -- Personnel, equipment, and facilities needed to keep a system in operational status.

Longitudinal G-Load -- The aerodynamic and inertial forces on the airframe in a front-to-back orientation.

Maintenance -- Personnel, equipment, etc., required to keep the RPV system in an operational readiness status.

Minimum Safe Airspeed -- The minimum airspeed at which the vehicle will remain airborne with an appropriate safety factor above the stall speed.

Nose -- Refers to inlet at forward extremity of fuselage.

Number of Personnel -- Size of required O&M group.

Operation -- Personnel, equipment, etc., directly involved in checkout and performance of the RPV mission.

Personnel Skills -- The types of skills and levels of competence required to perform Operations and Maintenance (O&M) tasks.

Planform -- The shape of the wing or horizontal tail surface as projected vertically from above or below. Also the shape of the vertical tail surface as projected perpendicular to the side.

Position -- The location of both horizontal and vertical tail surfaces on the fuselage or wings.

Rear -- Exhaust located at aft extremity of fuselage.

Replacement of Consumables -- Replacement of any items or equipment not intended for re-use.

Retractable Gear -- Standard wheel type landing gear which retracts into the vehicle after takeoff.

Safety -- Special tests, equipment, and personnel required to insure safety of O&M group and nearby uninvolved personnel.

Short Length -- Launch system which has a requirement for a ground run but not a length typical of a runway, e.g., a catapult.

Side -- Exhaust on side of fuselage.

Special Facilities -- Those facilities unique to an RPV system which would not be presently available at the proposed RPV base of operation.

Stores Location -- Location of any/all equipment, munitions, and fuel pertinent to the mission without destroying the basic aerodynamic and/or structural integrity of the vehicle.

Structural Requirements -- The strength of the airframe structure required by a potential launch system and the associated dynamic environment.

Tail Surfaces -- The airfoil surfaces which provide lateral and longitudinal stability and control.

Top -- Exhaust at top centerline of fuselage, including location at base of vertical fin.

Tow-Off -- Launch system which involves using another vehicle to tow the RPV off from a runway.

Training -- Development of skills required of operation and maintenance personnel.

Vertical G-Load -- The aerodynamic and inertial forces on the airframe in a top-to-bottom orientation.

Volume -- Volume available for stores at each available location.

Volume -- Volume of each compartment available for launch equipment.

Weight -- Allowable weight which can be installed at each location.

Wing -- Main lift producing surface of the vehicle.

Wing -- Stores attached to or within the wing.

Zero Length -- Launch system which takes no ground run leading up to takeoff point.

RECOVERY SYSTEMS DODT
(Dwg. No. 6810-02-2498)

The following is a list of definitions of the terms used in the Recovery Systems DODT.

Aft of Nose -- Refers to inlet aft of forward extremity of fuselage.

Air -- Recovery techniques resulting in bringing vehicle under physical control while it is still airborne.

Air Bag -- An inflated device to absorb landing shock.

Air Cushion System -- An inflated skirt or bag which serves as ground effect flotation to replace standard type landing gear.

Airfoil -- The cross-section of the wing or tail surface in a plane cut parallel to the fuselage centerline.

Airframe Configuration -- The distribution of shape and size of airframe components.

Ancillary Equipment -- AGE, test and checkout equipment, and maintenance equipment.

Angle of Attack -- The angular orientation of the wing with respect to the on-coming air required to maintain a specified flight condition.

Area -- The area of the wing or tail surface planform shape.

Available Launch/Recovery Space -- Space within the vehicle which can be occupied by recovery equipment.

Bottom -- Exhaust at bottom centerline of fuselage.

Center -- Exhaust centered or nearly centered on fuselage centerline

Component Location -- Spaces occupied by components and/or systems other than recovery.

Cross Section -- The size and shape of the fuselage envelope at various lengthwise locations.

Decelerator -- A device or operation used to reduce the speed of the vehicle.

Descent Velocity -- The velocity at which the vehicle contacts the ground when suspended from a parachute system and is dependent upon size, number, and type of parachutes employed.

Droque Chute -- A small parachute deployable at fairly high speed providing sufficient drag to slow the vehicle.

Engine Exhaust Position -- Location of exhaust for combustion products and cooling air for the propulsion system.

Engine Inlet Position -- Location of inlets for combustion air and cooling air for the propulsion system.

Expendable -- Refers to a type of parachute which is used only once.

External -- Stores attached in such a manner as to remain outside the contours of the airframe, e.g., pylons or racks.

Forward of Rear -- Exhaust plane forward of aft extremity of fuselage.

Fuselage -- The central pod or enclosure to which wings and tail surfaces are attached.

Fuselage -- Stores attached to or within the fuselage.

Fuselage Bottom -- Inlet location on bottom centerline of fuselage.

Fuselage Side -- Inlets on sides of fuselage including inlets at wing-fuselage junction.

Fuselage Top -- Inlet location on top centerline of fuselage.

Gear/Wheels -- Standard wheel landing gear.

Gross Weight -- The total weight of the vehicle including all fuel and removable loads.

Ground -- Recovery technique which results in the vehicle reaching the ground without physical control.

Ground Arrest -- Arrest of a very low flying vehicle by a ground cable, e.g., similar to a carrier landing arresting gear.

In-Flight Arrest -- Capture of the RPV in flight by a parent aircraft.

Internal -- Stores contained within the contours of the airframe.

Lateral G-Load -- The aerodynamic and inertial forces on the airframe in a side-to-side orientation normalized by vehicle weight.

Length -- Nose to tail dimension of the fuselage.

Longitudinal G-Load -- The aerodynamic and inertial forces on the airframe in a front-to-back orientation.

Logistics Requirements -- Personnel, equipment, and facilities needed to keep a system in operational status.

Maintenance -- Personnel, equipment, etc., required to keep the RPV system in an operational readiness status.

Mid-Air Retrieval System -- Capture of a suspending cable on the RPV by a helicopter while the RPV is descending on a special parachute system.

Minimum Safe Airspeed -- The minimum airspeed at which the vehicle will remain airborne with an appropriate safety factor above the stall speed.

Nose -- Refers to inlet at forward extremity of fuselage.

Number of Personnel -- Size of required O&M group.

Operation -- Personnel, equipment, etc., directly involved in checkout and performance of the RPV mission.

Parachute -- A canopy inflated by ram air at low velocity which lowers the vehicle to the ground at relatively safe velocities.

Personnel Skills -- The types of skills and levels of competence required to perform Operations and Maintenance (O&M) tasks.

Pitch-Up -- Manipulation of control surfaces to raise the nose of the vehicle producing decelerating drag due to increased angle of attack.

Planform -- The shape of the wing or horizontal tail surface as projected vertically from above or below. Also the shape of the vertical tail surface as projected perpendicular to the side.

Position -- The location of both horizontal and vertical tail surfaces on the fuselage or wings.

Pre-Recovery Operations -- Any functions performed to render the RPV ready to initiate recovery.

Rear -- Exhaust located at aft extremity of fuselage.

Recoverable -- Refers to a parachute which can be repacked and reused.

Recovery -- The terminal segment of the mission which involves those steps necessary to return all or part of the vehicle to a base for reuse.

Re-Engage Towline -- Engagement of a towing point on the vehicle by a parent aircraft with a towline which tows the RPV to a landing site.

Replacement of Consumables -- Replacement of any items or equipment not intended for re-use.

Rotor -- A rotary wing system based on the principle of an autorotating helicopter.

Safety -- Special tests, equipment, and personnel required to insure safety of O&M group and nearby uninvolved personnel.

Separation of Payload -- Mechanism by which payload is separated from RPV if entire RPV is not to be recovered.

Shock Attenuator -- A device which absorbs landing impact energy thereby reducing or preventing vehicle damage.

Side -- Exhaust on side of fuselage.

Skids -- Fixed or retractable devices on the underside of the vehicle on which it can slide after contacting the ground.

Special Facilities -- Those facilities unique to an RPV system which would not be presently available at the proposed RPV base of operation.

Speed Brake -- An extendable surface on the vehicle which produces decelerating drag.

Spike -- A pointed extension which absorbs energy as it penetrates landing surface.

Steerable -- A parachute or parawing device which exhibits the characteristics of a marginal airfoil and has moderate guidance capability.

Stores Location -- Location of any/all equipment, munitions, and fuel pertinent to the mission without destroying the basic aerodynamic and/or structural integrity of the vehicle.

Structural Requirements -- The strength of the airframe structure required by a potential recovery system and the associated dynamic environment.

Tail Surfaces -- The airfoil surfaces which provide lateral and longitudinal stability and control.

Top -- Exhaust at top centerline of fuselage, including location at base of vertical fin.

Tor-Shok -- A mechanical shock absorber device similar to a shock strut.

Tow-On -- Landing of a towed vehicle by flying it very near or onto the ground before releasing the towline by the parent aircraft.

Training -- Development of skills required of operation and maintenance personnel.

Vertical Descent -- A parachute system which lowers the vehicle to the ground nearly vertically without guidance.

Vertical G-Load -- The aerodynamic and inertial forces on the airframe in a top-to-bottom orientation.

Volume -- Volume of each compartment available for recovery equipment.

Volume -- Volume available for stores at each available location.

Weight -- Allowable weight which can be installed at each location.

Wing -- Main lift producing surface of the vehicle.

Wing -- Stores attached to or within the wing.

AIRFRAME DODT
(Dwg. No. 6810-02-2500/Sheets 1-4)

Composite -- Any combination of one or more individual material types.

Launch -- That phase of the RPV mission which involves getting the vehicle into a flight condition.

Recovery -- The terminal phase of the RPV mission which involves bringing the vehicle back to the ground at the desired location.

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