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INDUSTRIAL MODERNIZATION INCENTIVES PROGRAM

PHASE I VENDOR PROJECT
CTL AEROSPACE, INC.

FINAL REPORT

PREPARED FOR
AERONAUTICAL SYSTEMS DIVISION
WRIGHT-PATTERSON AFB, OH 45433

Contract Number F33657-86-C-2024

JUNE 1989

Approval

S. Swarup
Manager Productivity

R. Beck, Manager
Industrial Modernization
Incentives Program

TELEDYNE CAE
Turbine Engines
1330 LASKEY ROAD
TOLEDO, OHIO 43612

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This report documents the results of the Phase I Tech Mod program that was conducted at CTL Aerospace, Inc. overseen by Teledyne CAE Contractor Industrial Modernization Incentives Program.

CTL manufactures composite materials for the aerospace industry. By having performed a Phase I study, CTL has identified several areas in the company which can benefit from the introduction of new technology in the company. In addition, CTL has developed a good understanding of its needs to improve product quality, maintain customer delivery, and reduce its product costs. In short, the modernization plan for CTL when implemented fully will help the company to improve its competitive position, and, therefore, provide lower cost systems to the Air Force.

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CTL AEROSPACE, INC.

Phase I
Industrial Modernization
Incentives Program

Final Report

Prepared for:
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P. O. No.: A00264

CTL AEROSPACE, INC.
TELEDYNE CAE SUBCONTRACTOR TECH MOD PROGRAM

PHASE I FINAL REPORT

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FORWARD

This final report covers work performed under Contract F33657-86-C-2024 from May 1988 through January 1989. The contract with Teledyne CAE (TCAE), Toledo, Ohio was performed under the "Industrial Modernization Incentives Program" (IMIP). This program was funded by Aeronautical Systems Division Wright-Patterson Air Force Base (ASD/YZDC) and administered under direction of Captain Sarah Tandy and Major Dale Clary.

IMIP at TCAE was administered by Mr. Robert Beck. Mark Claudio was the Project Engineer directly responsible for the CTL Aerospace Phase I effort.

Factory analysis of the Phase I IMIP program was equally divided between CTL and Price Waterhouse with CTL having the responsibility for the program and Price Waterhouse performing the training, data analysis and providing program management support.

Program management for CTL was performed by Jeff Stoffer with technical support from Shane Swartz and Tom Riley. CTL's steering committee consisted of George Irwin, Carl Scheidenberger, Robin Haviland, J. T. Irwin, and Richard Lewis.

Price Waterhouse provided consultant services. The CTL team included Joe Ness as Partner, Lute Quintrell as Project Manager and Jeff Dean as Technical Specialist.

SECTION I: EXECUTIVE SUMMARY

This report documents the results of the Phase I Industrial Modernization Incentives Program (IMIP) program that was conducted at CTL Aerospace, Inc. (CTL) under the auspices of the Teledyne CAE Sub Contractor IMIP program.

CTL manufactures composite materials for the aerospace industry. By having performed a Phase I study, CTL has identified several areas in the company which can benefit from the introduction of new technology in the company. In addition, CTL has developed a good understanding of its needs to improve product quality, maintain customer delivery, and reduce its product costs. In short, the modernization plan for CTL when implemented fully will help the company to improve its competitive position, and, therefore, achieve CTL's business goals.

The IMIP program began in June, 1988 and concluded in December, 1988. During this period, CTL conducted a total facility analysis of its modernization needs. CTL was assisted in this effort by consultants from Price Waterhouse. Price Waterhouse provided training in the IMIP analysis, cost baseline analysis, and assisted the CTL team in insuring the project was complete and the results of the project met the CTL's business objectives. The CTL project team was responsible for performing each of the tasks of the IMIP project.

The project looked at all business functions of CTL. However, the development of improvement projects was primarily focused on the manufacturing areas of the company. As a result of the program, the CTL project team was able to identify numerous short term, "quick hitter" projects which could be implemented immediately. These projects are currently being implemented, and the company is seeing the benefits. As a result of the project, CTL has identified four projects that will require capital investment which will help to reduce costs significantly and will help to improve product quality. These projects are:

- Integrated Management Information System
- Statistical Process Control
- Polymerization Monitor, and
- Automated Material Preparation Cell.

The Integrated Management Information System (IMIS) will be a MRPII system that will use a PC computer system network to improve the flow data between departments and help to reduce redundant activities. The Statistical Process Control (SPC) project will involve the use of statistical monitoring of operations in order to reduce the amount of time spent in inspection of CTL's products. The Polymerization Monitor project will involve the insertion of transducers in molds that will monitor part thickness during the molding process. This will help to reduce scrap generated from the molding process and reduce the amount of material used in this process. The Automated Material Preparation Cell will involve the user of a laser tool to cut prepreg material to the desired shape. Currently this is done manually and results in a high amount of scrapped material. By using the laser, CTL will be able to reduce the amount of material used in this process, improve operator safety, and reduce the amount of time required to cut prepreg material. The attached report describes these projects in more detail.

The Phase I IMIP program has resulted in complete analysis of the CTL facility. CTL is excited about the benefits that have been identified through this program. The enclosed report describes the methods that were used in conducting the IMIP study, the results of this study, and the conceptual designs of the improvement projects. The report provides information on the investments and savings for each of the projects, as well as an estimate of the time required to conduct the Phase II project.

As a result of the IMIP project, CTL has identified four improvement projects that will help the company meet its business goals. The implementation of these projects will help the company provide a higher quality product at a lower cost to its customers.

SECTION II: FACTORY ANALYSIS

A. INTRODUCTION

This report pertains to the Phase I IMIP factory analysis program of CTL Aerospace, Inc. (CTL), as described in Teledyne Purchase Order #A00264 dated May 24, 1988. The factory analysis phase of the program isolates and defines potential areas for cost improvement, and/or methods to enhance performance in the operation utilizing various methods of inquiry and analysis. The methods used and the results of the analysis are discussed in this report.

Factory analysis of the Phase I IMIP program was equally divided between CTL and Price Waterhouse with CTL having the responsibility for the program and Price Waterhouse performing the training, data analysis and providing program management support.

The information supplied in this Factory Analysis Report details activities from Task 1 - Program Initiation through Task 3 - Evaluation Cost of Operations.

B. PROGRAM DESCRIPTION

The factory analysis portion of the program was divided into three major tasks: Task 1 - Program Initiation; Task 2 - Modeling of Current Procedures; and Task 3 - Evaluate Cost of Operations. The goal of each task, methods utilized and findings are provided in the following paragraphs.

Program Initiation

The program initiation consisted of three major areas: 1) develop a plan for executing the IMIP project; 2) educate the CTL IMIP project team in various analysis techniques and IMIP requirements; and 3) review CTL capital project investment criteria.

Program Management Plan

A program management plan was produced to organize the program prior to initiation, to clearly define the requirements of each task, and to describe the procedures to be used during each task.

Establish Project Team

The Phase I, IMIP management team was comprised of the following individuals:

PROJECT MANAGEMENT	
Program Manager	Jeff Stoffer
Technical Support	Shane Swartz
Technical Support	Tom Riley
TELEDYNE CAE	
IMIP Manager	Bob Beck
Project Engineer	Mark Claudio

Establish Project Team (cont'd)

CTL STEERING COMMITTEE

Executive	George Irwin
Accounting	Carl Scheidenberger
Engineering	Robin Haviland
Production	J T Irwin
Quality	Richard Lewis

CONSULTANT SERVICES - PRICE WATERHOUSE

Partner	Joe Ness
Project Manager	Lute Quintrell
Technical Specialist	Jeff Dean

During program initiation, the CTL project team and Steering Committee were educated about the Tech Mod program and the trend in the IMIP methodology. Lute Quintrell of Price Waterhouse conducted the training portion of the program on June 7 and 8, 1988 at CTL.

Corporate Investment Strategy

Management of CTL defined the capital investment strategy to be used as the basic criteria in evaluation of potential investment opportunities. This included critical success factors, market and technological considerations, and political factors which influence decisions in operating CTL.

Financial Impact

All investment programs must be financially attractive. The investment criteria used is divided into two major areas: short-term and long-term.

SHORT-TERM INVESTMENT STRATEGY: A short-term investment will provide immediate returns and may be sizable enough to allow acquisition of a tool/ machine to reduce direct labor. The direct labor savings from this investment would fund the capital investment. Normally, investments of this nature must have a payback period of three years or less and a return of at least 12%.

LONG-TERM INVESTMENT STRATEGY: Long-term investments in the Company may span several programs and are amortized over many years. An investment of this size is expected to yield a minimum of 30% return with a payback period of three to five years. Equipment is depreciated using straight line depreciation with a five-or ten-year useful life depending upon the type of equipment.

Economic / Technological Trends

CTL is in a dynamic market where new materials and technologies are constantly changing. This condition dictates monitoring the change in the market and investing in new technology as it emerges in order for the Company to remain competitive.

Modeling of Current Operations

Modeling of CTL was performed to obtain a "snapshot" of CTL and its current operation. The model describes current factory functions, and establishes the criteria to determine performance and cost baselines using a "top-down" functional approach. This modeling was based on the CTL organization as of June 20, 1988.

Modeling

Modeling of CTL used the IDEF modeling technique. Modeling consisted of gathering information, consolidating the information into a meaningful context, and determining performance of the system. The basic methods used are described below.

Develop Questionnaire

Modeling of CTL is based on interviews with key personnel. Each person interviewed was asked to define the basic functions they regularly perform. In addition, they were asked to supply the data base or reports used, the data base or reports generated, and information related to how the individuals function. Finally, the questionnaire requested information which would support Task 5 - Identify Modernization Opportunities. A "wish list" of investment opportunities was requested from all participants of the study.

Conduct Interviews

Key individuals within the organization were interviewed using the questionnaire. Personal interviews were conducted to minimize the amount of reporting error.

Develop Top-Down Functional Model

The information gathered from the interviews was then entered into a computer file to compare individual responses and standardize function titles. This was performed to eliminate redundant functions within the Company. Top-Down relationships of the functions were then established in Node Tree form using IDEF syntax rules. The highest level of Node Tree is represented by five major areas which include: Marketing, Administration, Product Development, Production Control and Manufacturing.

The Node Tree was decomposed to the lowest required level of detail to adequately describe functions and their cost drivers. The Node Tree was then computerized using Acad on a personal computer. This was performed to insure complete data storage and as a master reference file for utilization later in the program. The Node Tree can be found in Appendix I.

Define Functional Groups

Major functional groups were then established from all low level functions described in the Node Tree. The function group is defined as a group of inter-related functions which have a synergistic relationship and which may be affected by an improvement program. The major functional groups for CTL are:

Executive: Activities which relate to the direct functioning of the organization. These activities include: policy control and implementation and direct interaction in the market.

Planning and Control: Activities which coordinate the use of materials and labor in the manufacturing process.

Define Functional Groups (cont'd)

Engineering: Engineering is a service group to all other departments within CTL. Engineering coordinates the development of new products with marketing. Activities also interface with production control in the development of process procedures, material requirements and tooling for programs being initiated into the production process.

Production: Activities which produce the hardware. This includes direct labor and materials which go into the product.

Quality Control: Quality Control is responsible for verifying that material, process and products meet all contractual requirements as stipulated in the program contract. This activity includes both direct and indirect labor.

Sub-groups within functions group are identified as follows:

Executive

General Administration
Financial Accounting
Cost Accounting
Purchasing
Human Resources
Marketing

Engineering

Product Development
Process Engineering
Tooling Design

Planning & Control

Production Planning
Inventory Control
Program Management
Tooling Management
External Manufacture
Maintenance
Housekeeping
Shop Floor Control
Assembly / Bond / Finish

Quality Control

Inspection
Documentation Control
Quality Planning
Testing

Production

Compression Molding
Material Layup
Cure
Trim & Rout
Machine Shop

Information flows were also generated which briefly describe the corporate structure, contract administration, estimating and production functions. This information was used to study inter-relationships between functional groups.

Performance Baseline

Development of the performance baseline required a thorough knowledge of the Company and resources. Most of this data was not readily available and required an in-depth search. Sources of information included past job files, scrap tickets for

Performance Baseline (cont'd)

years 1987 through 1988, head counts and other sources. Major tasks involved in generation of the performance baseline included: development of performance criteria, development of statistics and summary of results.

Development of Performance Criteria

In order for CTL to achieve its business goals, critical success factors have been defined. These include: manufacture of products of the highest quality; on-time delivery; and competitive product costs. The combination of these factors can influence CTL's market position.

When selecting performance criteria, CTL looked for quantitative characteristics. If these were not available, a qualitative measure was used based on the judgment of expert personnel. All function groups were analyzed for the following:

1. How was the function group related to cost?
2. How did the function group impact delivery?
3. How did the function group affect quality?

Each function group has been weighted as to the relative importance of the critical success factors. The following weights were assigned to the function group based on assessment of the importance of the function group in terms of Company goals:

FUNCTION GROUP	COST	DELIVERY	QUALITY
1. Executive	30%	20%	50%
2. Production Control	30%	60%	10%
3. Engineering	20%	30%	50%
4. Production	35%	35%	30%
5. Quality Control	10%	40%	50%

The basis of evaluation for each function group is provided in Appendix III of this report.

Development of Statistics

Statistics were compiled from many sources including: past job files, scrap tickets, shipping and receiving records, and interviews with key personnel. This information comprised the "as is" performance baseline.

The "To Be" performance baseline was generated based on interviews with key personnel. Individuals directly related to the functional activity were questioned to determine a realistic goal for improvement.

Baseline Calculation

These statistics were entered into a Lotus 123 software spreadsheet using a personal computer. The results were tabulated on a rating system between 0 and 100%. The actual results represent the improvement potential of the functional group as weighted by the market driver.

Baseline Calculation (cont'd)

The tabulation for each function group is provided in Appendix III of this report.

Evaluate Cost of Operations

This task was to define the high cost functional areas within CTL using fiscal year January 1 through December 31, 1987 as a baseline. Task 3 consisted of the following areas: determine impactable cost center, allocation of costs to the ACBG model and develop the function group allocation matrix.

Determination of Impactable Cost Centers

The functional cost baseline was created using the Price Waterhouse Automated Cost Baseline Generator (ACBG) computer software in which an "as is" cost baseline was developed by assigning CTL's costs to the functions identified in the IDEF model. This functional cost baseline provided the functional costs for each mode in the Node Tree. The "as is" cost baseline was helpful in identifying additional areas of improvement opportunities, as well as, providing a framework for performing cost / benefit analysis. A description of ACBG software is included in Appendix VI of this report.

The cost information for Fiscal Year 1987 "as is" cost baseline was extracted from CTL's general ledger. 1987 was determined to represent a typical business year for CTL. The data includes impactable costs only. Impactable costs are costs which can be influenced by changing methods, materials, or policy within the organization, that is, cost areas which are controlled by Company officials. Costs represented in this category are provided in Appendix II of this report. In order to provide a realistic baseline, the lease expense was adjusted to reflect the cost CTL incurs for its new facility that was occupied in 1988. The remaining costs, such as, insurance, payroll taxes, interest and material costs were excluded from the calculations. These represent costs over which CTL has minimal control. Of the total operating costs, approximately 80% were determined to be impactable.

Cost centers which represent pools of associated costs were determined to be: Manufacturing, General and Administrative and Marketing. Each of the cost centers were then divided into their basic cost elements.

C. CORPORATE BACKGROUND

This section of the report is provided to familiarize the reader with the internal and external influences on CTL. CTL has grown significantly in the last two years. The IMIP Phase I program has provided insight into the projected market position for the Company in years to come.

Company Goals

If we use the number of employees as a measure of business size, CTL is a small business. Due to recently acquired resources and capital investments, CTL is now positioning itself for significant growth. Sales growth expectations are from $5 million to $15 million during the next five years.

Company Goals (cont'd)

CTL is committed to being a recognized producer of advanced composite materials for the aerospace industry seeking out such manufacturers as Boeing, Douglas, North American, Grumman, etc. At the same time, CTL plans to develop improved services to our current customer base, including General Electric, TRW, General Dynamics and Teledyne. A "job shop" (quick turnaround and repair operations) will be maintained while developing the Company's capabilities to provide large composite aerospace components requiring a large amount of assembly.

History

Organized in 1946 as Cincinnati Testing Laboratories, in the late 1950's CTL began production of composite materials. During this period, the Company's primary thrust was the development and production of missile hardware and reentry vehicle hardware for the Atlas, Mercury and Gemini rocket systems.

Structure

In 1983 CTL was acquired and organized as a sole proprietorship under the direction of Mr. James C. Irwin, President / CEO. Mr. Irwin is responsible for all facets of the organization.

Mr. George P. Irwin, Vice President / General Manager is responsible for the internal operations of the organization with five primary departments reporting directly to him. These departments include: Accounting, Contract Administration, Technical Services, Production Control and Quality Control.

Market

CTL provides technical expertise in the manufacture of custom fiber reinforced composite structures. Marketing effort is directed toward the production of composite structures for the aerospace industry. Composite materials offer advantages in strength and weight over conventional materials. Reducing weight in an aerospace vehicle will increase payload and performance of the overall system. These factors are important in understanding the thrust of CTL's marketing efforts. The composite industry is considered a growth industry as the materials work their way into new aerospace design and applications. Rapid introduction is not expected due to the extensive regulation of the aerospace industry.

Published figures from the SPI Composite Institute, a division of the Society of Plastic Industry located in Washington D.C., indicate that the total amount of aerospace composites produced in 1984 was 39 million pounds. Their projections for the year 1988 have increased to 42 million pounds. This figure encompasses all aerospace composites; thermal sets, thermal plastic and metal matrix. Of this number, CTL's market share represents less than 1% of the total market.

CTL's sales are in the following areas:

CTL AEROSPACE, INC.
SALES BY MARKET CATEGORY
1987 SALES

CATEGORY	GOVERNMENT	PRIVATE	TOTAL
1. Aircraft	8%	16%	24%
2. Space / Missile	7	--	7
3. Propulsion	6	62	68
4. Industrial	--	1	1
TOTALS	21%	79%	100%

PRODUCT MIX
BY PRODUCT SHIPPED

Production Hardware	94%
Development Hardware	1%
Repair Station	5%

The sales trends over the last five years have shown a reduction of government programs from 54% in 1983 to 21% in 1987. However, this figure is misleading. The largest factor influencing this percentage is the dramatic increase of sales in the private propulsion sector. Over a period of five years, government programs have stayed constant. In addition, one company currently makes up over 50% of sales. If this is eliminated from the equation, government programs would make up for 77% of all sales dollars.

Economic Climate

CTL sales are influenced by the economy; however, the shift tends to be opposite of an average manufacturing facility. In a strong economy, the commercial aircraft industry does well. If the economy is doing poorly, added governmental spending tends to stimulate CTL's sales. The worst economic condition for CTL is a period of moderate economic prosperity.

Competition

CTL has nine competitors in the aerospace composite industry. Major competitors and their relative size are:

DESCRIPTION	ASSETS
Brunswick	50
Hitco	50
Reynolds & Taylor	10
Swedlow	10
Norton	5
Aeronca	1
Auto Air	1
Quantum Composites	1
Composite Horizons	.5

*NOTE: Figures represent millions of dollars.

Competition (cont'd)

This information is compiled from figures provided in the 1986 Thomas Register.

Trends in the market indicate the major material suppliers such as Hexcel, Cyanamid, Ciba-Geigy, Ferro, Fiberite, US Polymeric and Narmco are beginning to increase sales by heightening their product mix to include manufacture of composite materials. As a result, the composite materials market will be even more competitive.

Product Description

CTL Aerospace provides a broad range of products and services. Products are divided into seven major categories:

1. Isostatic Molding
2. Compression / Transfer Molding
3. Adhesive Bonding
4. Research / Process Development
5. Honeycomb Bonding
6. Repair Station
7. Assembly

A list of major products and customers is provided in Appendix VI of this report.

Personnel

CTL's primary assets are the individuals who team together to develop and produce the products. The technical staff has a combined total of 157 years experience in the manufacture of composite materials. The average fabrication technician has accumulated twelve years of experience. Eighteen employees hold secret security clearances.

Facilities

In March, 1988, CTL moved to a new location; the manufacturing facility is now located at 5616 Spellmire Drive, Cincinnati, Ohio 45246. The new facility is a modern 96,000 square foot building.

Production facilities are divided between material processing and post processing areas. Isostatic molding of broadgoods and bonding operations are performed in one of three cleanrooms. Compression and transfer molding operations have been consolidated into one processing area. Post process, routing and machining operations have been isolated into separate areas to contain the contamination associated with these operations. CTL has recently introduced a security area available for contracts requiring secret clearance.

Quality assurance is a major priority at CTL. Inspection points occur throughout the manufacturing process. CTL has been fully qualified by government agencies and various aerospace prime contractors to MIL-I-45208, MIL-Q-9858, and NASA NGB-5300-4 (IC). The Company also holds FAA Air Agency Certificate #105-4 for flight hardware items.

D. SUMMARY AND CONCLUSIONS

The intent of this section is to discuss the findings of the Factory Analysis portion of the study provided.

Investment Opportunity Matrix

Information from the performance baseline and the cost baseline from the ACBG model were plotted to generate the investment opportunity matrix. This exercise was performed on a personal computer using Lotus 123 software to generate the information. Supporting figures are provided in Appendix IV of this report. The matrix identified the following functional groups for development of conceptual designs during Tasks 4 through 7 of the Tech Mod program:

SUMMARY
COST ALLOCATION / PERFORMANCE MATRIX

FUNCTION GROUP	AREA	AREA COST
Manufacturing	Layup	$ 847,835
Manufacturing	Compression Molding	273,674
Manufacturing	Machining	385,766
Production Planning	Shop Floor	239,625
Quality	Inspection	167,904
Executive	Accounting	151,999
Production Planning	Inventory	128,346
Total Improvement Potential		**$ 2,195,149**

These figures indicate potential cost savings for specific function groups and represent a significant portion of the overall operating cost of CTL. This data suggests the greatest cost savings will be in Manufacturing, Production Planning and Control, Quality and Executive function groups.

It is helpful at this point to understand what the highest cost drivers are in each of these areas. This information is provided in the following pages.

Improvement Potential

The greatest improvement potential in the Cost Allocation / Performance Matrix is in the following areas: Manufacturing, Production Planning and Control, Quality and Executive function groups. A glossary of terms is provided in Appendix V of this report to support information provided.

Manufacturing - Layup

The layup area has the greatest opportunity for improvement from both cost reduction and improvement potential.

Layup is labor intensive and subject to the highest amount of scrap. A major portion of the cost savings is the elimination of scrap which includes manufacturing allowance and production scrap. Manufacturing allowance is the amount of material removed from around the layup while the material is worked against the mold.

Manufacturing - Layup (cont'd)

Production scrap occurs when the part is damaged or incorrect due to operator error. Production scrap not only results in a loss of the direct material but also in the loss of labor. Materials are generally thermalset composite and regrind or reprocessing is not available.

An additional factor which influences the cost of layup is controlling the ply orientations. This is also called "balancing" or "programming" the layup. Composite materials are not homogeneous or uniform in cross section. The characteristics of the material will require a balanced layup to eliminate warp from the final molded structure. This is performed by recording the direction of the "warp" of a fabric prior to beginning the layup. Normally, ply orientation is controlled by cutting prepreg material from the roll in a uniform and consistent manner, ply to ply, and securing the material to the mold with the ply orientation controlled using a template or other means.

A third factor influencing the cost of layup is the material itself. The material normally is a "B-staged" resin on fabric. It has a characteristic called "tack" which influences the ability to handle the material. "Tack" can vary depending on the amount of polymerization which has occurred. Material "tack" is controlled by the specification governing the material in a contract. Environment can influence the material handling characteristics. The "tack" of a material can directly influence the labor in a layup.

Compaction or debulk of the plies during a layup sequence is an area which can be improved. Prepreg materials are produced with a controlled amount of resin impregnated onto a given fabric weight. Debulk is the compaction and the removal of excess resin from the layup via isostatic pressure and / or temperature. A complicated layup will normally require four to five debulk cycles per layup cycle. Indirect materials such as release film breather and bagging film will normally cost $1.00 per square foot. Indirect materials begin to be a factor if the tool is of sufficient size. The majority of the cost involves labor and idle time during the debulk procedure.

Finally, layup is expensive in cutting materials in preparation for layup. Many layups are programmed requiring specific fiber orientations. The material has tack, causing cutting utensils to become gummy and inoperative after repeated use. Currently, only one to two plies can be cut at any given time, limiting the amount of automation available in cutting prepreg materials.

Another area of cost improvement is in compression molding. Compression molding experiences material variation batch to batch, and variation in molding cycles part to part.

Variations in batches of raw material result in 20-30% of all compression molding parts being scrapped. Material is normally supplied to CTL by an outside supplier controlled by a military or commercial specification. The specification normally dictates the mechanical properties the final product must meet to be certified. The specification normally does not define the degree of polymerization of the product; therefore, material molding characteristics may vary batch to batch and still meet specification. In addition, materials polymerize with age. Normally, a material will have a shelf life of six months, with requalification possible after six months. The amount of polymerization dictates process cycle parameters required to mold a successful part.

Manufacturing - Layup (cont'd)

Another reason for isolating compression molding is the cost of maintenance of the production equipment. On the average, the age of the production presses at CTL range between twenty and forty years. The equipment has been rebuilt and maintained; however, it is beginning to show excessive wear.

Post Process, Machining

Isolated as a high cost area during the study was machining. Most products are machined to close dimensional tolerances during a post process operations. Machining is normally milling, turning or waterjet trimming of components to close tolerances, generally within a window of + / - .005 inches. Tolerances closer than this generally cannot be held due to material warpage or distortion after the fiber is cut during the actual machining operation.

Machining is currently performed on manually controlled machines, with numerical controlled readout assist. The machines are calibrated yearly. In limited production situations, the current setup works well, with a scrap rate as low as 3%. If the workload is increased and additional machining capacity is required, the system requires manual operators, introducing variations in product, from batch to batch.

Production Planning and Control

Production planning and control is the one mechanism which monitors the production flow within the facility. Two areas of improvement have been identified in the Tech Mod program.

Inventory Control

Raw material and work-in-process inventory control have been isolated as an area for improvement. CTL's material control system currently requires three full-time employees to accept raw materials, maintain inventory status, and distribute the materials to the shop floor. Work-in-process has no formal mechanism for tracking products in flow other than physical count which occurs weekly.

Shop Floor Control

Control of production is currently performed monthly. A production schedule projects program due dates. The actual material and production flow is then extracted off the required due date on an individual program basis. This system has worked satisfactorily for the last five years. With additional growth, the system may require modification to incorporate an overall view of production flow on the shop floor.

A significant amount of time and effort go into expediting materials through the production process. This is a function of insufficient planning in the early stages of the production process, and insufficient data on production order status.

The cost model shows product development as a large portion of shop floor control costs. This relates to development costs for first articles of production runs which fall outside the context of engineering and process development. Program managers control the labor force of a program. The program managers may modify a process in the procedure. Development of a first article may require reiteration of the process

Shop Floor Control (cont'd)

to obtain a product which meets the contract requirements. These are scrap costs which include raw material and direct labor.

Quality Control

A major objective of CTL is to maintain the highest level of quality. All products currently are 100% dimensionally inspected, data is recorded manually and no product statistics are generated. Maintenance of this quality level is expensive and time consuming. A major portion of this effort is the direct mechanical inspection of CTL product.

A second area which currently has not been pursued is statistical process control which can eliminate inspection of specific characteristics if it can be demonstrated statistically through sampling. This can lead to a great reduction of inspection costs by eliminating the need for specific inspections.

Finally, inspection gaging of products on the floor, reducing handling and inspection throughput time, is just beginning to be introduced into the production process. Generally, all inspections are performed in a designated area, under direct control of the Quality Control Manager. In large production contracts, inspection of the characteristics is justified at the work station.

Accounting

Accounting can impact the overall effectiveness of CTL Aerospace. The current accounting system provides standard financial reports; however, it does not adequately cover cost accounting on an individual program basis. The system does not have the ability to record the actual status of a program in production. The information generated is not useful for measuring program results or product line statistics. Finally, the system does not isolate a process within a program which is operating above the program budget.

Without this basic information, system inefficiencies cannot be isolated and addressed, adequate costing statistics for pricing are not available, and improvement of the overall system is limited.

Conclusion

The areas identified above are high cost areas in the composites industry. The analysis did provide additional insight into CTL and where the Company can improve its operations. The study also indicates some areas which seem to be inconsistent with Company goals. For example, marketing and engineering costs appear to be disproportionally low; the amount of overall scrap, representing 24% of operating costs, exceeded expectations.

In most functional areas of the Company it was shown that significant improvements can be made in accuracy and availability of data used by CTL personnel to make decisions. By improving the distribution of Company performance information, CTL will move toward meeting its business objectives in a cost effective manner. As a final note, it was pleasing to learn through our study that, overall, CTL is an aggressive company with growth potential. CTL is very competitive with a quotation acceptance ratio of 47%; CTL delivers 91% of all products on time; and ships only the highest quality product with less than 1% of material hours rejected by the customer.

SECTION III: CONCEPTUAL DESIGN

As a result of the factory analysis previously discussed (Section II), project conceptual designs have been developed which will strengthen CTL by reducing product cost, improving delivery and/or enhancing quality. These include:

A. Integrated Management Information System
B. Automated Material Preparation Cell
C. Polymerization Monitors
D. Statistical Process Controls

The conceptual designs for these projects are discussed in the following pages.

SECTION III: CONCEPTUAL DESIGN

Integrated Management Information System

1.0 INTRODUCTION

The Phase I "As-Is" Factory Analysis section of this report identified performance improvement and cost reduction opportunity areas at CTL through a comprehensive "top-down" needs analysis. As part of this review, employees were asked during interviews to specify investment areas which would result in the greatest improvement in performing assigned functions. In this regard, across all functional areas, an integrated management information system (IMIS) was identified as exhibiting high potential for performance improvement and cost reduction.

This report will incorporate discussion of:

- the existing CTL information systems,
- conclusions as a result of the analysis,
- project scope and objectives,
- the "to-be" project description,
- project benefits,
- project financial impact,
- impact on quality control,
- risk assessment, and
- application for technology transfer.

2.0 EXISTING MANAGEMENT INFORMATION SYSTEMS

At present, management information systems at CTL are manual in nature with the exception of two stand-alone automated systems.

CTL utilized an IBM System 23 based LIBRA accounting software to process accounts payable, accounts receivable, payroll and job costing. Approximately seven years old, this system is generally considered too slow (run time of several hours per module) to respond to business requirements. As a consequence, numerous manual procedures (manual checks, matching, etc.) have been instituted outside the system to make it more responsive. Moreover, the present job cost module provided by the system, is generally not utilized by management. Because the informational value of job cost reporting is considered limited by management and data provided through the system is viewed as untimely and of questionable accuracy, manual job cost reporting has been developed outside the system.

In addition, a personal computer workstation that includes ACAD automated design software is utilized by the engineering department. This software, though not presently integrated to production equipment, is considered adequate by management.

Five personal computers (PCs) are in place at CTL. Three PCs reside in engineering, one in scheduling, and one in the systems area. Primary PC applications include LOTUS 123 electronic spreadsheet (backlog analysis, etc.) and word processing functions in addition to the previously mentioned ACAD design software. All other systems are manual in nature.

3.0 EXISTING SYSTEM CONCLUSIONS

Existing information systems are inadequate to support CTL business requirements. Moreover, as the business grows, these systems will become increasingly strained.

Information requirements are not being satisfied by the present management information systems at CTL. Because systems are largely manual and not fully integrated, (Exhibit 3.1) data must be re-entered to support multiple system information requirements. This is inefficient and increases the likelihood of error. In addition, the present automated accounting system is considered inadequate (slow, inaccurate and not providing necessary management information) by CTL management. Further, because effective systems have not been implemented, shop floor management information (inventory levels, schedule changes, job status and performance measures, etc.) necessary to manage the business is not available on an accurate or timely basis. This has resulted in higher product costs and increased difficulty in maintaining schedule adherence and product quality. An integrated management information system should be implemented to satisfy information requirements.

4.0 PROJECT SCOPE AND OBJECTIVES

The objective of this project is to identify and implement a microcomputer-based integrated management information system (IMIS). The scope of the project will include:

- development and documentation of detailed information requirement specifications;
- software package evaluation;
- implementation planning;
- system implementation;
- development of system user procedures and documentation;
- system testing; and
- system training and education.

The proposed Phase II IMIP will consist of system requirements definition analysis, software package evaluation and detailed implementation planning. Actual system implementation, procedure development, testing and training will be encompassed under Phase III IMIP. Price Waterhouse, with extensive system implementation experience, will be utilized extensively throughout both project phases in an effort to achieve system implementation in the most efficient and cost-effective manner.

5.0 PROPOSED PROJECT DESCRIPTION

The proposed integrated management information system will reside on a microcomputer-based local area network. This architecture (Exhibit 3.2) will permit incorporation of the five microcomputers already in place at CTL and faciliate an additional 4 - 5 acquired computers at strategic locations throughout the facility. Although considered, a minicomputer (AS/400, VAX, etc.) application was determined to be a less attractive solution to CTL information system requirements, than would be a microcomputer based system. In this regard, a microcomputer based local area network was selected because it affords lower cost; provides comparable processing speeds; is expandable, and represents a technology with which personnel are already familiar. Mainframe applications were deemed unsuitable and not considered.

5.0 PROPOSED PROJECT DESCRIPTION (cont'd.)

Based on our preliminary review, no information requirements were identified which would not be satisfied by available package software. Implementation of package software utilizing a local area network should provide the necessary data to satisfy shop floor and accounting information requirements in the most cost effective manner. In this regard, a detailed information requirement specification should be conducted to ensure that package features satisfy CTL business requirements.

6.0 PROJECT BENEFITS

Implementation of an integrated management information system which provides accurate data in timely manner can significantly improve CTL product quality, delivery and cost. Moreover, improved data availability as a result of the system can provide a "springboard" for statistical process controls (SPC) and other operations analysis tools. Implementation of the IMIS will ultimately result in greater control of the business and its operation. A Phase II/Phase III implementation plan is detailed on Exhibit 3.3.

7.0 FINANCIAL IMPACT

Introduction of an integrated management information system will enhance financial performance at CTL Aerospace. The development and implementation of the IMIS improvement program is designed to result in cost savings to CTL through the elimination of certain manual activities and by improved management control as a result of available business information. In addition, other anticipated benefits include:

- reduced product scrap as a result of automated inventory control, job tracking and vendor analysis;
- reduced job costs through reduced scrap levels, improved job cost tracking and more timely management reporting;
- improved delivery provided through better scheduling and requirements planning;
- enhanced customer service as a result of improved order entry, shipping, receiving and shop floor control; and
- higher product quality levels achieved through shop floor control and scheduling improvements.

Based on our preliminary analysis, CTL can expect to realize total project cost savings of $1.3 million dollars during the IMIS five-year project life (Exhibit D). Total system Phase II and Phase III capitalized costs are estimated at $125,000 inclusive of $60,000 implementation assistance by Price Waterhouse. Projected discounted cash flows are $435,000 (positive) and the project has a payback of eight months.

8.0 IMPACT ON MIS AND QUALITY CONTROL

Implementation of the proposed integrated management information svstem significantly impacts CTL Aerospace. Existing information systems are not providing CTL management with adequate or timely data necessary to support business decisions. Introduction of an integrated microcomputer-based local area network will provide information necessary to satisfy present and future business information requirements. Utilization of existing microcomputers most cost effectively leverages system hardware requirements. Selection of package software, based upon predefined functional requirements, will ensure that functional

8.0 IMPACT ON MIS AND QUALITY CONTROL (cont'd.)

information requirements are addressed. Further, present CTL personnel have openly discussed and appear capable of supporting the project configuration once implemented.

The Integrated Management Information System will also impact Quality Control. Although shipped project quality is excellent, (as is demonstrated in the cost baseline), material scrap costs are high. Improved vendor data, inventory control, job cost monitoring, ship scheduling and scrap analysis information provided through the integrated system to Manufacturing Management will reduce scrap by some measure. Further, inspection at Quality Control is presently a production "bottle neck". On-line entry and release of purchase order data, and implementation of statistical process control afforded through the system will alleviate this problem.

9.0 RISK ASSESSMENT

As is the case with any systems implementation, there is risk associated with this project. In this regard, uncertainty and potential problems may exist related to:

- the ability to fully integrate package software to SPC and other quality control systems;
- software ability to satisfy Government contract cost segregation and reporting requirements; and
- rapidly accelerating microchip processing capacity and microcomputer technology.

Risk, however, will be minimized by the following:

- utilization of existing PC technology, with which CTL personnel are presently familiar;
- installation of proven integrated package and vendor supported software;
- in-house familiarity with LAN technology; and
- utilization of vendor and consultant support throughout implementation.

Moreover, based on the level of information presently available through existing systems, there appears to be some measure of business risk as a result of reliance on the inaccurate and untimely management information provided through existing information systems.

10.0 TECHNOLOGY TRANSFER

CTL Aerospace agrees to transfer integrated management information system technology identified through the IMIP to other government contractors.

Exhibit 3.1

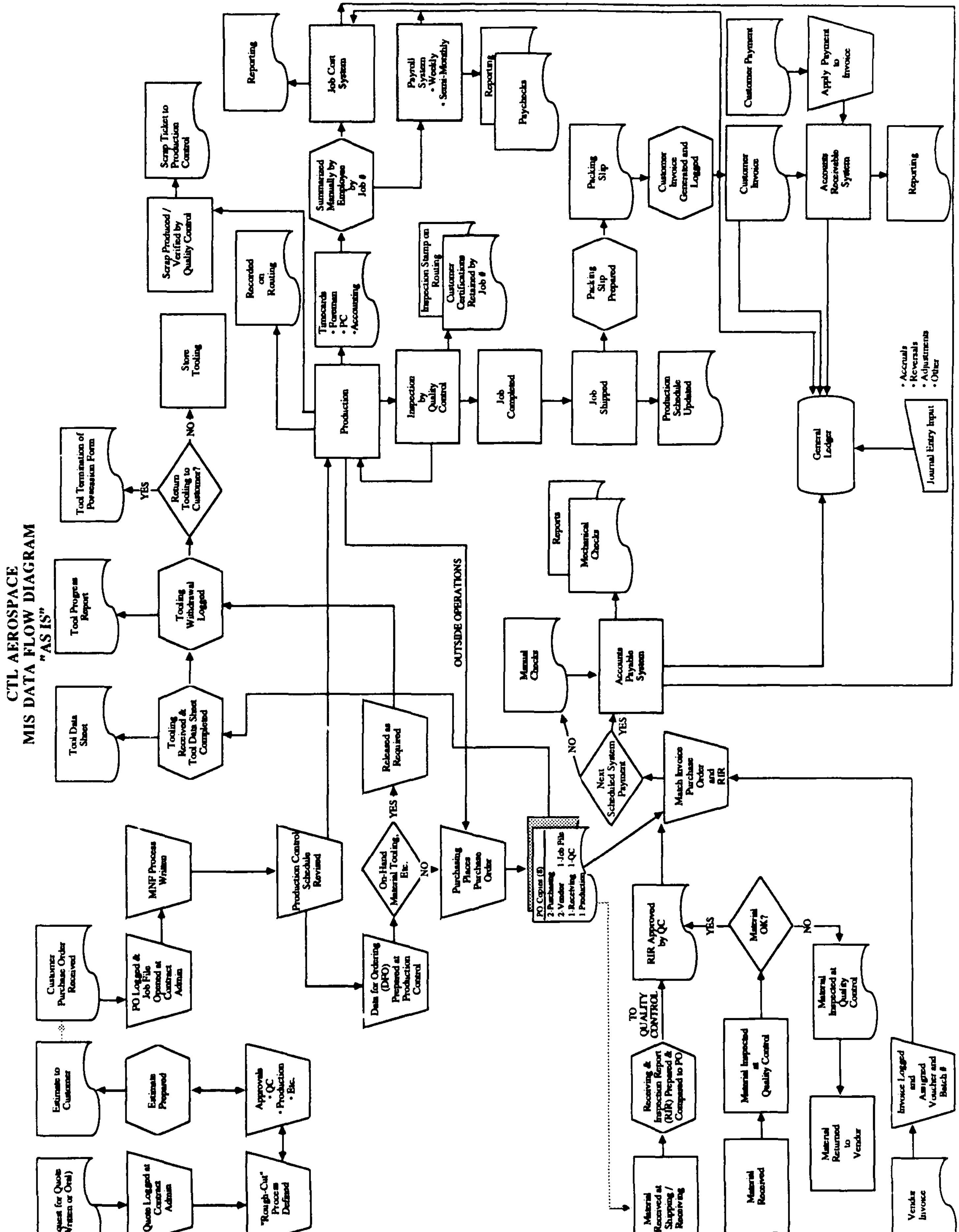
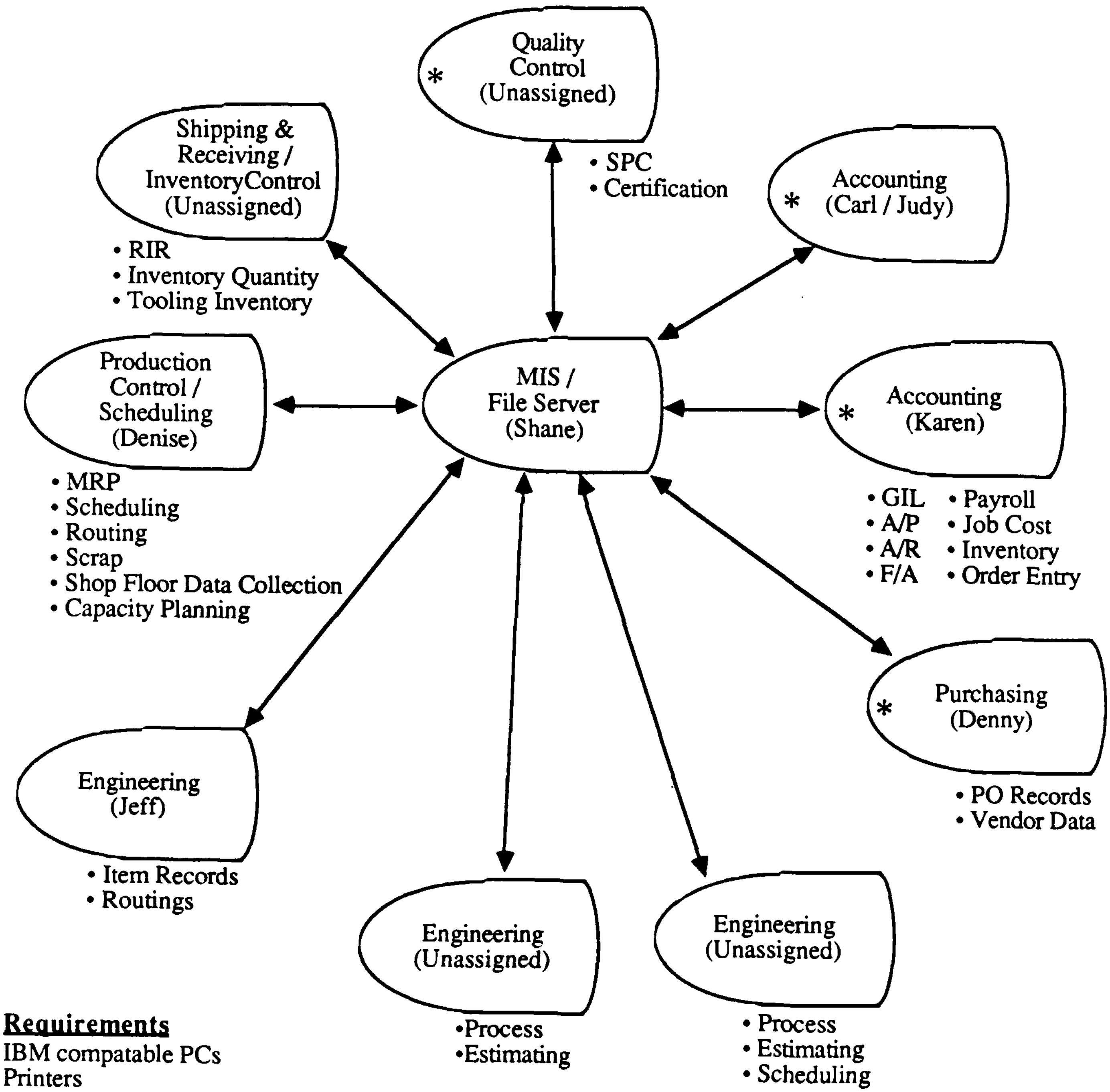

CTL AEROSPACE
MIS DATA FLOW DIAGRAM
"AS IS"
Request for Quote (Written or Oral)
Quote Logged at Contract Admin
"Rough-Cut" Process Defined
Approvals
• QC
• Production
• Etc.
Estimate Prepared
Estimate to Customer
Customer Purchase Order Received
PO Logged & Job File Opened at Contract Admin
MNF Process Written
Production Control Schedule Revised
Data for Ordering (DFO) Prepared at Production Control
On-Hand Material Tooling, Etc.
YES
NO
Released as Required
Purchasing Places Purchase Order
PO Copies (8)
2-Purchasing
2-Vendor
1-Receiving
1-Production
1-Job File
1-QC
Tooling Received & Tool Data Sheet Completed
Tool Data Sheet
Tooling Withdrawal Logged
Tool Progress Report
Return Tooling to Customer?
Tool Termination of Possession Form
Store Tooling
Scrap Produced / Verified by Quality Control
Scrap Ticket to Production Control
Recorded on Routing
Production
Timecards
• Foreman
• PC
• Accounting
Summarized Manually by Employee by Job #
Job Cost System
Reporting
Payroll System
• Weekly
• Semi-Monthly
Reporting
Paychecks
Inspection by Quality Control
Inspection Stamp on Routing
Customer Certifications Retained by Job #
Job Completed
Job Shipped
Production Schedule Updated
Packing Slip Prepared
Packing Slip
Customer Invoice Generated and Logged
Customer Invoice
Customer Payment
Apply Payment to Invoice
Accounts Receivable System
Reporting
General Ledger
Journal Entry Input
• Accruals
• Reversals
• Adjustments
• Other
OUTSIDE OPERATIONS
Material Received at Shipping / Receiving
Receiving & Inspection Report (RIR) Prepared & Compared to PO
TO QUALITY CONTROL
RIR Approved by QC
Material Received
Material Inspected at Quality Control
Material OK?
Material Inspected at Quality Control
Material Returned to Vendor
Vendor Invoice
Invoice Logged and Assigned Voucher and Batch #
Match Invoice Purchase Order and RIR
Next Scheduled System Payment
Manual Checks
Accounts Payable System
Reports
Mechanical Checks

Exhibit 3.2

CTL AEROSPACE INC.
MIS DATAFLOW DIAGRAM
"TO BE"



Requirements
- 5 IBM compatable PCs
- 2 Printers
- Cableing
- Software:
  - Novelle Communication
  - Micropackage
  - Word Processing
  - Lotus 1-2-3

* Location of new machines

Exhbit 3.3

CTL AEROSPACE, INC.
PHASE II - IMIP
IMIS PROJECT WORKPLAN
PRELIMINARY

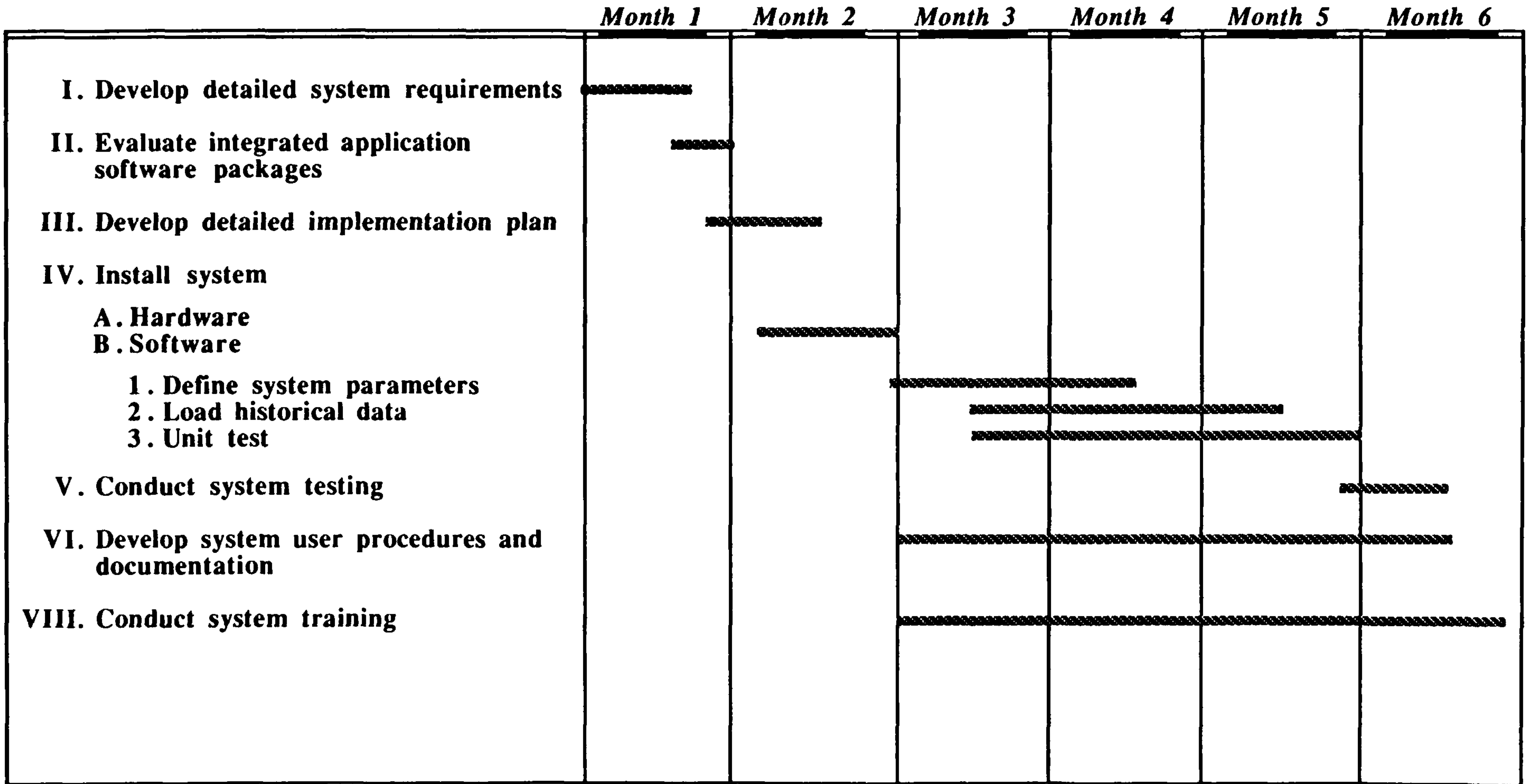


Exhibit 3.4

CTL AEROSPACE, INC.
PHASE I - IMIP

IMIS PROJECT - FINANCIAL ANALYSIS
(Dollars in Thousands)

Est Project Cost:	-1-	-2-	-3-	-4-	-5-	Total
Hardware	25	0	0	0	0	25
Software	35	0	0	0	0	35
Implement	60	0	0	0	0	60
Training	5	0	0	0	0	5
	125	0	0	0	0	125
Project Benefits:						
Labor-Dir	52	52	52	52	52	260
Labor-Ind	32	32	32	32	32	160
Benefits	2	2	2	2	2	10
Scrap	121	121	121	121	121	605
Supplies	5	5	5	5	5	25
Inv Costs	10	10	10	10	10	50
OV Operat	66	66	66	66	66	330
Depreciat	-25	-25	-25	-25	-25	-125
Total	263	263	263	263	263	1315
Projected Cash Flows:						
Savings	263	263	263	263	263	1315
Less: Tax	-87	-87	-87	-87	-87	-434
Net	176	176	176	176	176	176
Add: Depreciation	8	8	8	8	8	41
Cashflow	184	184	184	184	184	922
Discount Factor	0.769	0.592	0.455	0.350	0.269	----
Discount Cashflow	142	109	84	65	50	449

NPV: 324
Discount Payback: 11 months

IRR CALCULATION

Irr: 145%

$$\sum_{T=1}^{N} \frac{\text{Project Benefits}}{(1 + \text{Rate of Return})^{T}} - \text{Cost} = 0$$

% DOD Business:	21%	20%	20%	19%	18%

SECTION III: CONCEPTUAL DESIGN

Automated Material Preparation Cell

1.0 INTRODUCTION

CTL presently uses resin pre-impregnated fibers as a source of the resin/fiber buildup in all hand layups and many compression molded parts produced. This resin pre-impregnated fiber or "prepreg" is purchased from various suppliers. "Prepreg", as used herein, is defined as a resin-coated fiber, either woven fabric or unconnected parallel filaments, in a tape form. This fiber is saturated and/or coated with an activated resinous material that later, through thermal and/or chemical action, completely "wets out" the fiber and fills all of the interfiber interstices with a continuous resinous matrix.

This resinous matrix may be either a thermoplastic, reformable by heat application, or a thermoset, cross linked molecularly and rigid. In excess of 92% of CTL's products are currently being produced as thermal set composites. Typically, this thermoset resin prepreg is slightly to extremely tacky. The complexity of fibers used, such as glass, carbon or aramid, further complicates the cutting of the material. Fiber orientation during cutting within each ply of a multi-ply buildup must be established and controlled to provide a desired physical strength or configuration control.

2.0 EXISTING LAYUP OPERATIONS

Presently, cutting prepreg is a manual operation performed in a clean room with a hand-held utility knife and template. Occasionally, if a large number of similar pieces are required, they may be cut with a steel rule (clicker) die. Whichever method is used, the cutting media quickly becomes extremely gummy with transferred resin, and the cutting edge is rapidly dulled from the abrasive effects of the fiber. This necessitates cleaning the cutting media as well as sharpening or replacing the utility knife blades.

Because the cutting media becomes gummy and the prepreg is very difficult to cut, parts are cut "full" rather than to the precise dimensions required. Therefore, a narrow band of material is left around the product cut and a 10% manufacturing allowance is quoted. Material cutting and handling is further complicated by the material being stored at $0^{o}F$ to $40^{o}F$ to extend the shelf life of the prepreg. This cold storage results in considerable wasted time while the roll of prepreg warms to room temperature prior to being unbagged. (However, this warming removes the possibility of moisture condensation on the cold surface of the prepreg which causes attendant process problems). Each time the prepreg is warmed, the resin in the prepreg is also slowly reacting chemically. This advances the cure condition of the prepreg, shortens the available shelf life, and makes a substantial difference in the handling and curing characteristics of the prepreg from the beginning to the end of the roll. Due to the difficulty and problems with manual cutting, only that material needed immediately is cut from the roll prior to returning the roll to the low temperature storage. This does not permit the development of the most economical cutting pattern for the prepreg and can substantially increase scrap.

The layup operation is labor intensive and results in high costs for supplies and cutting templates. Key cost drivers result in a yearly expenditure:

Direct Labor:	$251,958
Scrap:	290,589
Supplies:	130,083
Inventory Carrying Cost:	27,956
Total Imputable Cost:	$700,586

3.0 "AS IS" CONCLUSIONS

The present manual layup process is costly and inefficient. Layup operations presently generate scrap as a result of the missalignment of the cutting template, and progressive cure advancement ("aging") in the material from cold storage transfer.

4.0 PROJECT SCOPE AND OBJECTIVES

The objective and scope of the Automated Material Preparation Cell (AMPC) includes configuring and implementing CM laser technology to the layup area which will:

- reduce direct labor in prepreg layout and cutting;
- eliminate set-up time associated with prepreg layout;
- improve trimming precision and edge quality;
- reduce manufacturing scrap, both manufacturing allowance and production scrap;
- reduce area throughput time;
- reduce work-in-process inventory; and
- integrate the AMPC with CTL's IMIS (another IMIP project).

Another use area for laser technology at CTL would be cutting non-metallic honeycomb or foam for sandwich panels. This unit would permit precise cutting to size and eliminate any hand finishing of the panels to obtain plane dimensions. Further, many bevel cuts could be performed by the laser, eliminating the hand formation of this type of edge with a router or grinder. This will reduce operations direct labor and also serve to reduce damage resulting from this procedure.

5.0 "TO BE" PROJECT DESCRIPTION

The actual laser cutter would be similar to a commercial metal cutting unit with the addition of a multiroll unwind stand, two sets of pneumatically actuated clamp positions or nips and a powered rewinder for the scrap "ladder." The "ladder" being what is left of the prepreg web after all of the required pieces have been removed.

The commercial unit tested has dual movable tables which would be replaced with a prepreg web handling equipment addition and a small belt conveyor to bring the cut pieces out of the laser cutting area so they can be bagged in kits.

The cutting program with the proper ply layout and parts positioned for the most economical utilization of the "prepreg" web would be on a "floppy disc" generated with the use of a CAD drafting system. This would permit inspection of all the proposed cuts and orientation prior to any actual cutting of prepreg. This "floppy" would also be available for future use in the event of a reorder of the same part.

The actual equipment operation would start with the roll/rolls of prepreg being hung in the unwind stand. The prepreg web would then be fed through the first opened hip, through the laser operating area and through the second opened hip. The second hip is closed on the web, securing it in position. The first hip then closes and rotates lightly, pulling the web taut. The laser then performs its cuts, directed by the software, with the cut pieces falling onto the stationary conveyor belt. After the kit of material is cut, the hips open, first then second, and the ladder is pulled through and attached to the rewinder roll. After the initial web and ladder hookup, this stepping operation of the prepreg web on a conveyor will be under the control of the laser equipment, the same way the tables were previously controlled.

There is no labor required during the cutting phase of this operation. Everything is being done under the laser control. The initial "stringing of the prepreg" web through the unit requires manning as does the bagging of the kits, although this latter operation could also be automated.

The AMPC project will be implemented over a 16-month period. During this time the AMPC system will be installed at CTL and tests will be run on various materials and part configurations to determine the capability of the equipment to operate at CTL. The attached workplan, Exhibit 3.7, demonstrates how this will be accomplished during a Phase II project.

6.0 PROJECT BENEFITS

The use of a CNC laser as a cutter of the prepreg would eliminate most of the material cutting and handling described previously. The laser cutter never contacts the prepreg; therefore, contamination cannot occur. The cutting edge is a concentrated beam of energy and never dulls or needs to be replaced while always cutting the material with the same speed and efficiency. In addition, the part "template" is a series of signals stored within the laser control system, the expense of making, maintaining and storing the physical templates is eliminated. Further, manufacturing scrap should be reduced through computerized prepreg layout which optomized material yield. In this regard, the laser control system will determine the "best" fit of the parts to the ply with the required fiber orientation. Precise cutting would eliminate the need to "full cut" parts.

The actual cutting speed of parts is 10-25 times faster than manual. This would enable the laser cutting of all of the required pieces from a roll or cutting the entire roll into pieces with just one outing from the cold storage. The cut material could then be grouped into assembly kits and bagged together prior to being returned to cold storage. These bagged "kits" could then be withdrawn from cold storage as usage and/or need demanded and no additional time would be lost while the roll was warmed to room temperature. There would be less resin "aging" because the roll would be at room temperature a much shorter time.

7.0 FINANCIAL IMPACT

The anticipated costs of the laser cutting system has an initial capital expense of $370,000 installed. Operational costs include $6/hour for consumable gases and $7.50/operating hour for the 150 KVA of electricity used. Costs for housing the unit will vary depending on location of its approximately 840 square foot need. Due to the speed of the laser operation, installation in a conditioned area may not be required. Operator attendance is also not required.

As demonstrated in the "As Is" Cost Baseline Summary, the layup group represents direct labor cost of $251,598. From observed operator performance, prepreg cutting time represents 6-10% of the layup labor. Using an average of 8%, this would translate to $20,127.84 reduction in direct labor and $7,842.08 reduction in salaried costs. This direct labor reduction encompasses the labor savings incurred in

7.0 FINANCIAL IMPACT (continued)

initial cutting of the prepreg as well as trimming the "full" overcut from many of the layed up parts prior to curing.

Present scrap costs of $290,589 would also be reduced by the 10% "full" cut and the estimated 1% finished scrap as a result of improved ply orientation. This would provide a scrap cost reduction of at least 7% or $20,341.23. It is estimated that the cutting steps (initial and trim) contributes 1% ($1,300.83) of the costs of supplies.

Benefits would likewise be reduced from $30,113 by 8% or $2,409.04. Additional savings could be realized through a reduction in monthly Workman's Compensation claims for employee cutting injuries directly related to this cutting operation. The total would provide a cost savings of at least $52,000.

8.0 IMPACT ON MANAGEMENT INFORMATION SYSTEM and QUALITY CONTROL

The acquisition of the capital equipment for this project should have minimal effect on the management information system. Quality control should be significantly improved as a result of improvement in cut precision and uniformity of material characteristics through this technology.

9.0 RISK MANAGEMENT

Although laser cutting technology has been previously applied to cured composite hardware, based on our research this project represents the initial attempt to apply laser cut technology to a prepreg material. Accordingly, there is risk associated with the application of this technology. Primary risks include:

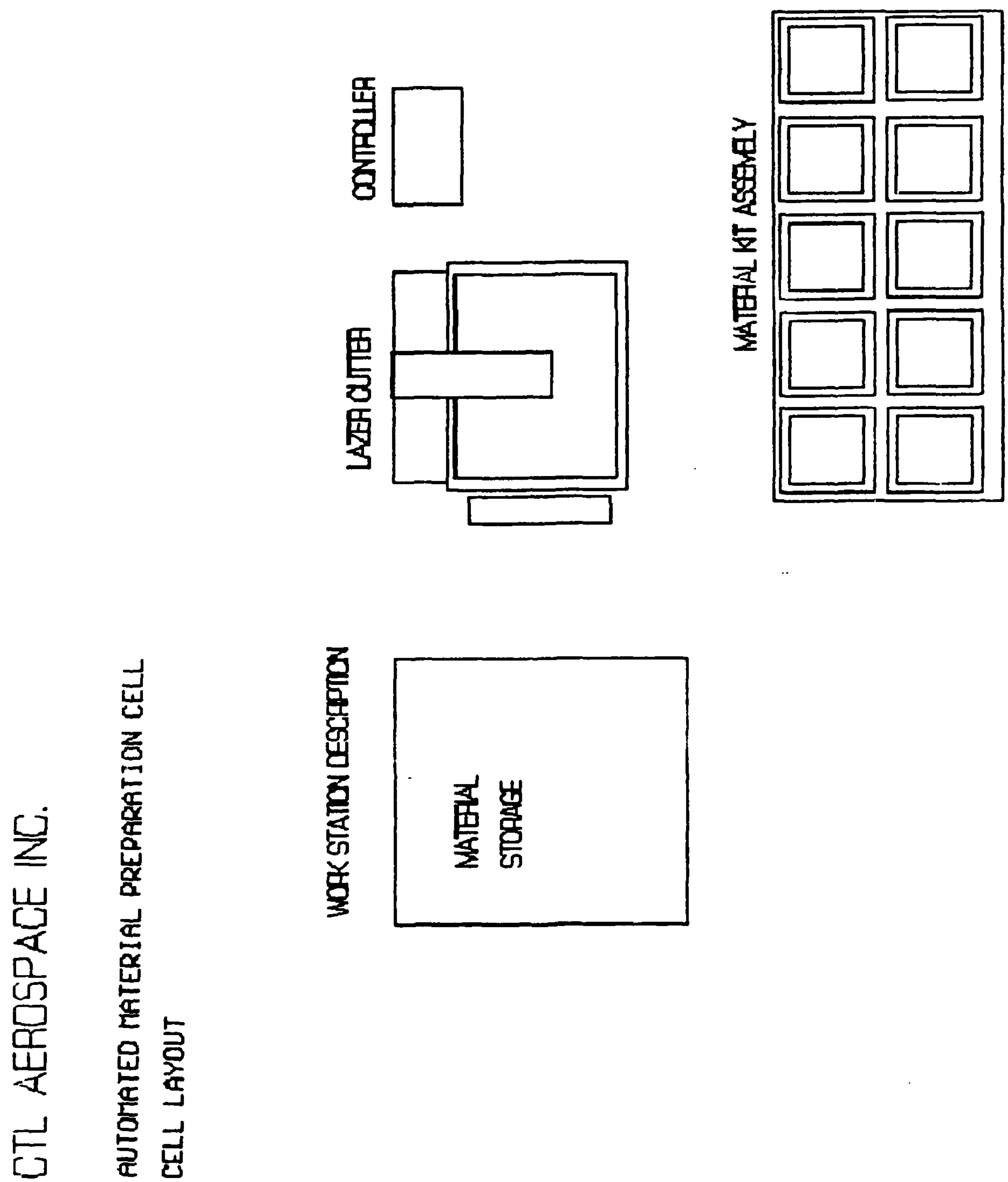
- the prepreg material laser cut technology application is developmental;
- identification of all potential problems is difficult until technology validation is complete.

Risks are alleviated to some degree by the manufacturers willingness to assist in insuring the viability of this new product application.

10.0 TECHNOLOGY TRANSFER

As discusssed previously, laser cut of prepreg material is a new application for laser technology. Moreover this project represents the initial application of laser technology to prepreg material. Although the full implications and benefits to the industry are not fully understood at this time, CTL agrees to transfer technology identified through the IMIP to other government contractors.

Exhibit 3.5



CTL AEROSPACE INC.
AUTOMATED MATERIAL PREPARATION CELL
CELL LAYOUT
WORK STATION DESCRIPTION
MATERIAL
STORAGE
LAZER CUTTER
CONTROLLER
MATERIAL KIT ASSEMBLY

Exhibit 3.6

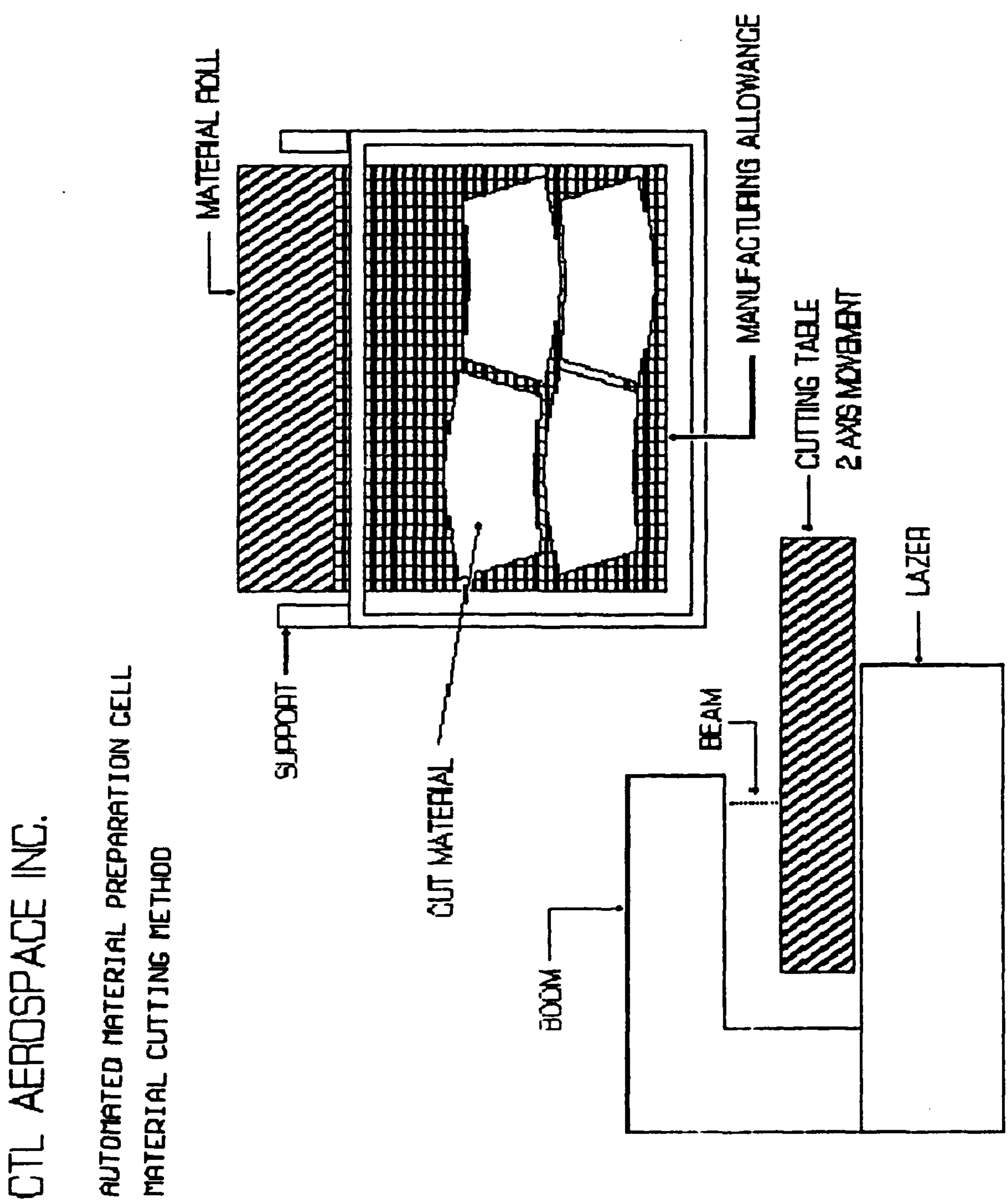

CTL AEROSPACE INC.
AUTOMATED MATERIAL PREPARATION CELL
MATERIAL CUTTING METHOD
MATERIAL ROLL
MANUFACTURING ALLOWANCE
CUTTING TABLE
2 AXIS MOVEMENT
SUPPORT
CUT MATERIAL
BEAM
LAZER
BOOM

Exhibit 3.7

CTL AEROSPACE
PHASE II - IMIP

AMPC PRELIMINARY PROJECT WORKPLAN

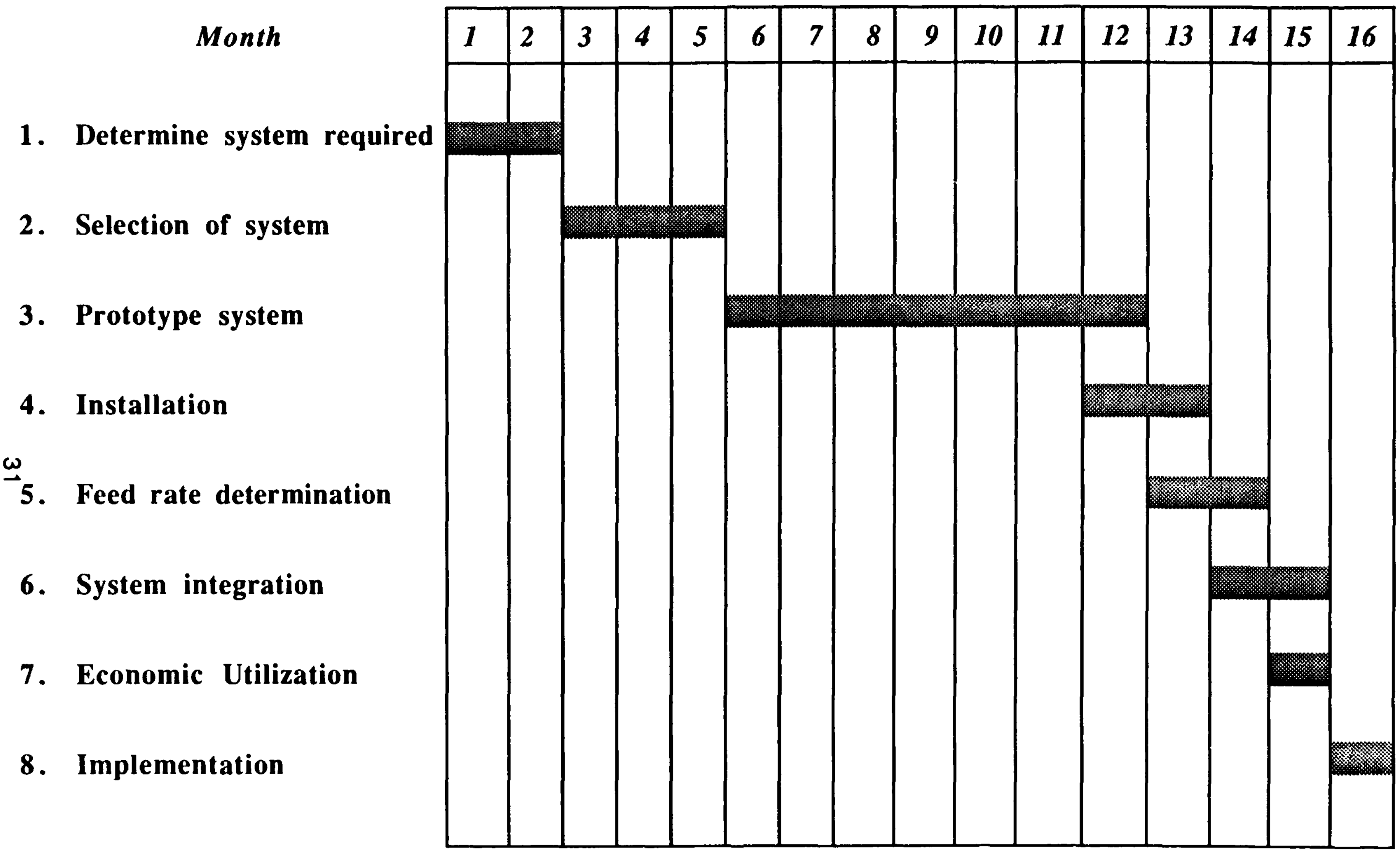


Exhibit 3.8

CTL AEROSPACE, INC.
PHASE I - IMIP

AUTOMATED MATERIAL PREPARATION CELL - FINANCIAL ANALYSIS
(Dollars in Thousands)

Est Project Cost:	-1-	-2-	-3-	-4-	-5-	-6-
Equipment	245	0	0	0	0	6
Rearrange	15	0	0	0	0	3
Training	25	0	0	0	0	3
Tech Asst	25	0	0	0	0	0
Test Material	45	0	0	0	0	2
	355	0	0	0	0	14
Project Benefits:						
Labor-Dir	35	35	35	35	35	35
Labor-Ind	3	3	3	3	3	3
Benefits	8	8	8	8	8	8
Scrap	198	198	198	198	198	198
Supplies	33	33	33	33	33	33
Inv Costs	2	2	2	2	2	2
Utilities	-15	-15	-15	-15	-15	-15
Depreciat	-36	-36	-36	-36	-36	-36
Total	228	228	228	228	228	228
Projected Cash Flows:						
Savings	228	228	228	228	228	228
Less: Tax	-75	-75	-75	-75	-75	-75
Net	153	153	153	153	153	153
Add: Depreciation	12	12	12	12	12	12
Cashflow	165	165	165	165	165	165
Discount Factor	0.769	0.592	0.455	0.350	0.269	0.207
Discount Cashflow	127	97	75	58	44	34
NPV:	46					
Discount Payback:	48 months					
Irr:	45%					
% DOD Business:	21%	20%	20%	19%	18%	N/A

IRR CALCULATION

$$\sum_{T=1}^{N} \frac{\text{Project Benefits}}{(1 + \text{Rate of Return})^{T}} - \text{Cost} = 0$$

CTL AEROSPACE, INC.
PHASE I - IMIP

AUTOMATED MATERIAL PREPARATION CELL - FINANCIAL ANALYSIS (continued)
(Dollars in Thousands)

Est Project Cost:	-7-	-8-	-9-	-10-	TOTAL	
Equipment	0	0	0	0	0	
Rearrange	0	0	0	0	0	
Training	0	0	0	0	0	
Tech Asst	0	0	0	0	0	
Test Material	0	0	0	0	0	
	0	0	0	0	0	
Project Benefits:						
Labor-Dir	35	35	35	35	350	
Labor-Ind	3	3	3	3	30	
Benefits	8	8	8	8	80	
Scrap		198	198	198	198	1980
Supplies	33	33	33	33	330	
Inv Costs	2	2	2	2	20	
Utilities	-15	-15	-15	-15	-150	
Depreciat	-36	-36	-36	-36	-360	
Total	228	228	228	228	2280	
Projected Cash Flows:						
Savings	228	228	228	228	2280	
Less: Tax	-75	-75	-75	-75	-752	
Net	153	153	153	153	1528	
Add: Depreciation	12	12	12	12	119	
Cashflow	165	165	165	165	1646	
Discount Factor	0.159	0.123	0.094	0.073	---	
Discount Cashflow	26	20	16	12	401	
	===	===	===	===	===	
	N/A	N/A	N/A	N/A	N/A	

SECTION III: CONCEPTUAL DESIGN

Polymerization Monitor

1.0 INTRODUCTION

Factory analysis identified significant costs associated with prepreg material aging and volatility. Scrap costs for isostatic and compression molding represent 61.2% ($500,000) of the total CTL scrap costs and 14.7% of total CTL costs. This project involves the monitoring and recording time the degree of resin polymerization and compaction to ensure product uniformity and reduce product on scrap.

2.0 CURRENT STATE

At present, outside of prepreg shelf life and resin monitoring provided through existing manual inventory control systems, operator judgment is the basis for determining the relative aging or "dryness" of prepreg material. Prepreg aging, especially toward the end of the prepreg material shelf life, results in a dry material with a lack of flow in the resinous matrix. When this occurs, it results in interply voids in the composite which impacts the composite mechanical strength and quality.

3.0 CURRENT STATE CONCLUSIONS

Operator subjectivity should be eliminated as a basis for determining the required prepreg consolidation time. Under the current system, under- or over-consolidation of prepreg generates excessive product scrap not identified until later operations. In addition, operator and equipment time is presently wasted while consolidation time beyond that actually required is incurred.

4.0 PROJECT SCOPE AND OBJECTIVES

The objective of this project is to implement a composite consolidation monitor program which would incorporate ultrasonic transducers into mold design resulting in the elimination of excess operator consolidation time and scrap reduction. The scope of this project will include:

- development of detailed production and quality requirements;
- ultrasonic transducer research and equipment selection;
- ultrasonic transducer program implementation planning;
- training and education;
- development of ultrasonic transducer procedures and documentation; and
- testing.

5.0 PROPOSED PROJECT DESCRIPTION

The polymerization monitor project requires a portable reader and multiple ultrasonic transducers. Transducers would be attached to molds in the layup area and consolidation monitored by measuring the thickness of void-free material between the mold and part surface at that time. Based on material measurements, systematic consolidation time requirements would be developed by material to achieve uniformity of part thickness. The program will provide a characteristic process parameter which could be used as a determination point for subsequent time cycles.

5.0 PROPOSED PROJECT DESCRIPTION (continued)

The polymerization monitor will be implemented over a six-month period. The key portion of this work will be the prototyping of the monitors on molding presses to demonstrate their feasibility in production.

6.0 PROJECT BENEFITS

Benefits associated with the implementation of the Polymerization Monitor include: primarily the elimination of excess operator time spent during the mold process and reduction of scrap through the immediate identification of undersized parts prior to successive value added operations.

7.0 FINANCIAL IMPACT

Total three-year program costs associated with the implementation and use of Polymerization Monitor is approximately $15,000. Transducer life expectancy in a mold installation is six months and replacement costs are considered.

Based on preliminary analysis, CTL can expect to achieve an estimated project NPV of $21,000.

8.0 IMPACT ON MANAGEMENT INFORMATION SYSTEM and QUALITY CONTROL

No significant impact is anticipated through MIS as a result of this stand-alone system. Quality will be directly affected through project introduction. Product quality will improve through introduction of this program by achievement of uniform product mold thickness. In addition, quality personnel are expected to participate in this program by way of attending initial training and in supporting the program on an ongoing basis.

9.0 RISK MANAGEMENT

Risk associated with this program primarily includes attainment of less than anticipated scrap savings as a result of consolidation monitoring.

10.0 TECHNOLOGY TRANSFER

CTL does not anticipate DOD participation in this program.

Exhibit 3.9

CTL AEROSPACE INC.

MATERIAL POLYMERIZATION MONITOR – THE SYSTEM WILL ALLOW THE DIRECT MONITOR OF THE DEGREE OF COMPACTION AND DEGREE OF POLYMERIZATION WITHIN A LAMINATE OR COMPRESSION MOLDING.

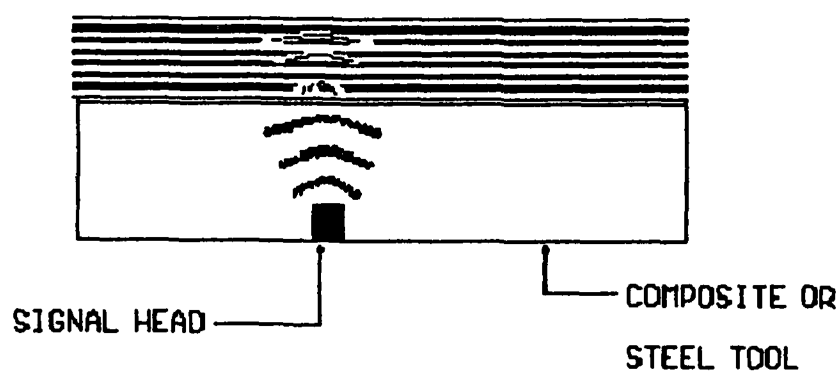


Exhibit 3.10

CTL AEROSPACE
PHASE II - IMIP

POLYMERIZATION MONITOR PROJECT WORKPLAN

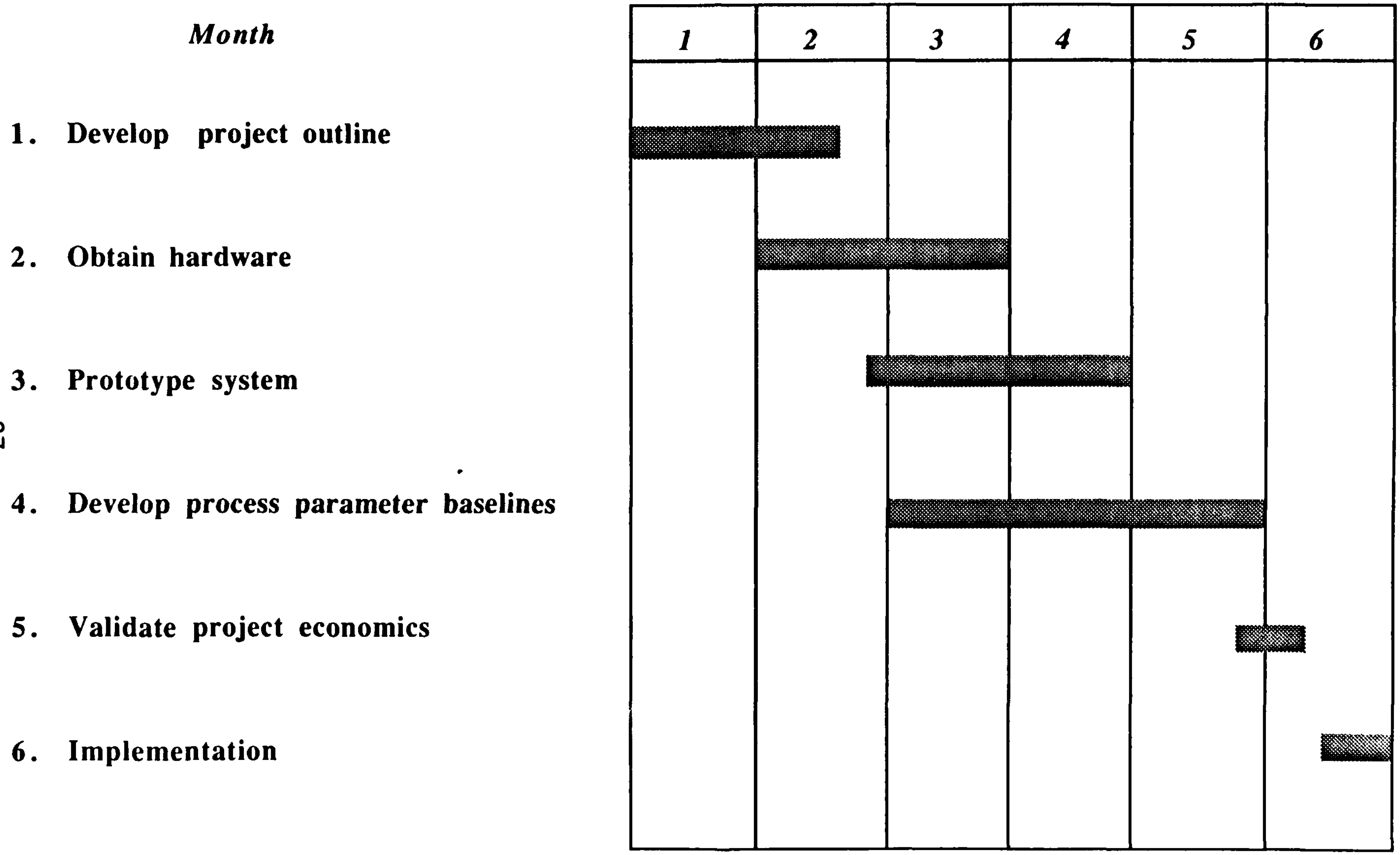


Exhibit 3.11

CTL AEROSPACE, INC.
PHASE I - IMIP

POLYMERIZATION MONITOR - FINANCIAL ANALYSIS
(Dollars in Thousands)

Est Project Cost:	-1-	-2-	-3-	Total
Hardware	9	1	1	11
Training	4	0	0	4
	13	1	1	15
Project Benefits:				
Labor-Dir	11	11	11	33
Benefits	2	2	2	6
Scrap	17	17	17	51
Inv Costs	1	1	1	3
Depreciation	-3	-3	-3	-9
Total	28	28	28	84
Projected Cash Flows:				
Savings	28	28	28	84
Less: Tax	-9	-9	-9	-27
Net	19	19	19	57
Add: Depreciation	1	1	1	3
Cashflow	20	20	20	60
Discount Factor	0.893	0.797	0.712	---
Discount Cashflow	18	16	14	48

NPV: 33
Discount Payback: 7 months

IRR CALCULATION

Irr: 120%

$$\sum_{T=1}^{N} \frac{\text{Project Benefits}_T}{(1 + \text{Rate of Return})} - \text{Cost} = 0$$

% DOD Business:	21%	20%	20%

SECTION III: CONCEPTUAL DESIGN

Statistical Process Control

1.0 INTRODUCTION

Statistical Process Control has been identified by the Phase I "As-Is" factory analysis as a tool that can be used to improve CTL's overall financial production efficiency. The performance baseline calculations indicated that CTL currently has extremely high scrap rates and this is an area with high improvement potential.

This report includes a discussion of the following:

- The current state of CTL's Production, Quality Control and Statistical Process Control (SPC) system.
- Conclusions from current position analysis
- Objectives and scope of the project.
- A "to be" project description
- The SPC project benefits.
- The project's economics.
- SPC's impact on MIS.
- A risk assessment.
- Application of technology transfer

2.0 EXISTING SPC AND CURRENT STATE OF QUALITY CONTROL AND PRODUCTION

Existing Statistical Process Control (SPC) is negligible in the fact that manual SPC is performed on selected products determined by Quality Control management. A fully implemented SPC system currently does not exist.

Quality Control uses 100% inspection of parts which has led to excellent quality products and a high quality rating. However, 100% inspection is time-consuming and this inspection method has been identified as a "bottleneck" in production.

CTL's production does not statistically evaluate "on line", in-process measurements for the quality of the parts being produced. Analysis and control of process variability is not currently being performed.

3.0 CONCLUSIONS FROM CURRENT POSITION ANALYSIS

Present production processes have shown high scrap rates and have a great potential for improvement. Statistical Process Control is the tool that can minimize this problem and bring the production processes under control.

There are many labor hours involved in performing 100% inspection which has, as a result, created a bottleneck. Although 100% inspection is costly, CTL has been given an excellent Quality rating and has achieved high customer satisfaction.

With the continuous growth of CTL, the control and improvement of production processes, through the use of SPC, will reduce product costs and improve and company's overall competitive position.

4.0 PROJECT SCOPE AND OBJECTIVES

The objective of this project is to implement an effective Statistical Process Control system. The scope of this project will include:

- development of system requirements on an overall strategic plan;
- management involvement sessions;
- development of a trial implementation;
- trial system implementation;
- development of procedures and user documentation;
- system testing;
- system training;'
- system evaluation;
- system updating; and
- on-going system expansion and improvement.

5.0 "TO-BE" PROJECT DESCRIPTION

The initial SPC system will be implemented on a single product line. Statistical analysis of the production process will be performed and corrective actions on the production process will be deemed necessary. Computer support will be achieved by accessing the computer associated with the Cordax coordinate measuring machine. A statistical Process Control software package will provide the capability to analyze the production process and to perform the SPC. Training sessions will be held to instruct CTL personnel involved with the project how to use SPC and why it works. Quality Control personnel will administer the implementation process. As time progresses, the SPC system will expand into many other areas of the plane (i.e. other product lines, etc.).

6.0 PROJECT BENEFITS

Statistical Process Control will benefit CTL in many aspects of the business. Probably the most noticeable benefit is the decreased amount of scrap and rework and the correlating cost decline. SPC analysis of the production process will expose problems such as scrap and correction of the problem will improve the process and eliminate excess costs.

Once the SPC system is implemented, a change from 100% inspection to sampling inspection will occur. As a result, labor hours required for inspection will be decreased and the bottleneck will be minimized and product throughput will be increased.

7.0 FINANCIAL IMPACT

A Statistical Process Control System, once functional, will have a positive financial impact on various areas of CTL. Savings will be realized in Production, Purchasing and Quality Control. Production will realize a decrease in scrap and rework thus minimizing wasted labor on scrap and excess labor hours required to correct rework problems. Purchasing will have the opportunity to buy in smaller quantities due to the decrease in scrapping of materials. Quality Control will notice a decrease in labor hours required to perform inspection on parts in-process.

Other less quantifiable benefits anticipated are as follows:

- Higher customer satisfaction due to the implementation of the functional SPC system (i.e. the use of new technology).
- Higher quality levels due to improvement of process consistency and capability.

7.0 FINANCIAL IMPACT (continued)

- Reduced job costs due to scrap and rework reduction.
- An increase of throughput resulting from the improvement of a bottleneck.
- Quicker reaction to and correction of production problems.

8.0 IMPACT ON MANAGEMENT INFORMATION SYSTEM AND QUALITY CONTROL

The MIS system will allow SPC personnel to identify high cost areas to be improved through job cost analysis. Scrap analyses will also be made effectively through the help of the MIS system. The MIS system will allow a smooth flow of information concerning the SPC system.

Quality Control will realize:

- A decrease in labor hours required for inspection.
- A decrease in scrap and rework required.
- An increase in productivity.
- An increase in quality of the products.

9.0 RISK MANAGEMENT

Due to the nature of the proposed SPC system, initial implementation will begin on a single product line. The remainder of the system will be gradually implemented over a period of years. Initial investment will include a SPC software package, a minimal amount of inspection equipment, and the creation of a staff position. This situation presented provides a minimum amount of risk for an area with high improvement potential.

10.0 TECHNOLOGY TRANSFER

The proposed Statistical Process Control system technology is readily transferable to similar firms in the industry. As part of this project, CTL will seek to visit similar companies that have successfully implemented this program.

Exhibit 3.12

CTL AEROSPACE, INC.
PHASE I - IMIP

STATISTICAL PROCESS CONTROL PROJECT - FINANCIAL ANALYSIS
(Dollars in Thousands)

Est Project Cost:	-1-	-2-	-3-	-4-	-5-	Total
Hardware	6	0	0	0	0	6
Software	3	0	0	0	0	3
Implement	3	0	0	0	0	3
Training	2	0	0	0	0	2
	14	0	0	0	0	14
Project Benefits:						
Labor-Dir	14	18	13	6	6	57
Benefits	3	3	3	3	3	15
Scrap	94	87	72	65	43	361
Depreciation	-3	-3	-3	-3	-3	-15
Salaries	-15	-15	-15	-15	-15	-75
Benefits	-3	-3	-3	-3	-3	-15
Total	90	87	67	53	31	328
Projected Cash Flows:						
Savings	90	87	67	53	31	328
Less: Tax	-30	-29	-22	-17	-10	-108
Net	60	58	45	36	21	220
Add: Depreciation	1	1	1	1	1	5
Cashflow	61	59	46	37	22	225
Discount Factor	0.769	0.592	0.455	0.350	0.269	----
Discount Cashflow	47	35	21	13	6	122

NPV: 108

Discount Payback: 4 months

IRR CALCULATION

Irr: 400%

$$\sum_{T=1}^{N} \frac{\text{Project Benefits}}{(1 + \text{Rate of Return})^{T}} - \text{Cost} = 0$$

% DOD Business:	21%	20%	20%	19%	18%

SECTION IV: PROJECT MANAGEMENT PLAN

In order to provide project continuity, personnel involved with Phase I program will participate in the Phase II program. In order to ensure personnel availability and to involve and educate personnel, individuals have been assigned primary responsibility as project leader for individual projects. All projects will be coordinated by Jeff Stoffer.

Phase II Project Management:

Project		Project Manager
• IMIS	-	Shayne Swartz
• AMPC	-	Jeff Stoffer
• Polymerization Monitors	-	Ken Meyers
• SPC	-	Tom Riley

CTL IMIP Steering Committee:

• Jim Irvin	-	President
• Judy Stopkotte	-	CFO
• J.T. Irwin	-	Manufacturing
• Richard Lewis	-	Quality
• Jeff Stoffer	-	Engineering

Consultant Services - Price Waterhouse:

• Joe Ness	-	Partner
• Lute Quintrell	-	Project Manager

The CTL IMIP Steering Committee will meet on a monthly basis to review the progress of individual projects, resolve operating or policy issues, and will be responsible for insuring the overall program meets the objectives of CTL. It is anticipated that the Steering Committee will meet on a monthly basis, at a minimum.

Each project manager will be responsible for insuring that their project meets its design and economic objectives. Assigned to each project will be selected CTL personnel who will be responsible for completing the assigned tasks for the Phase II project.

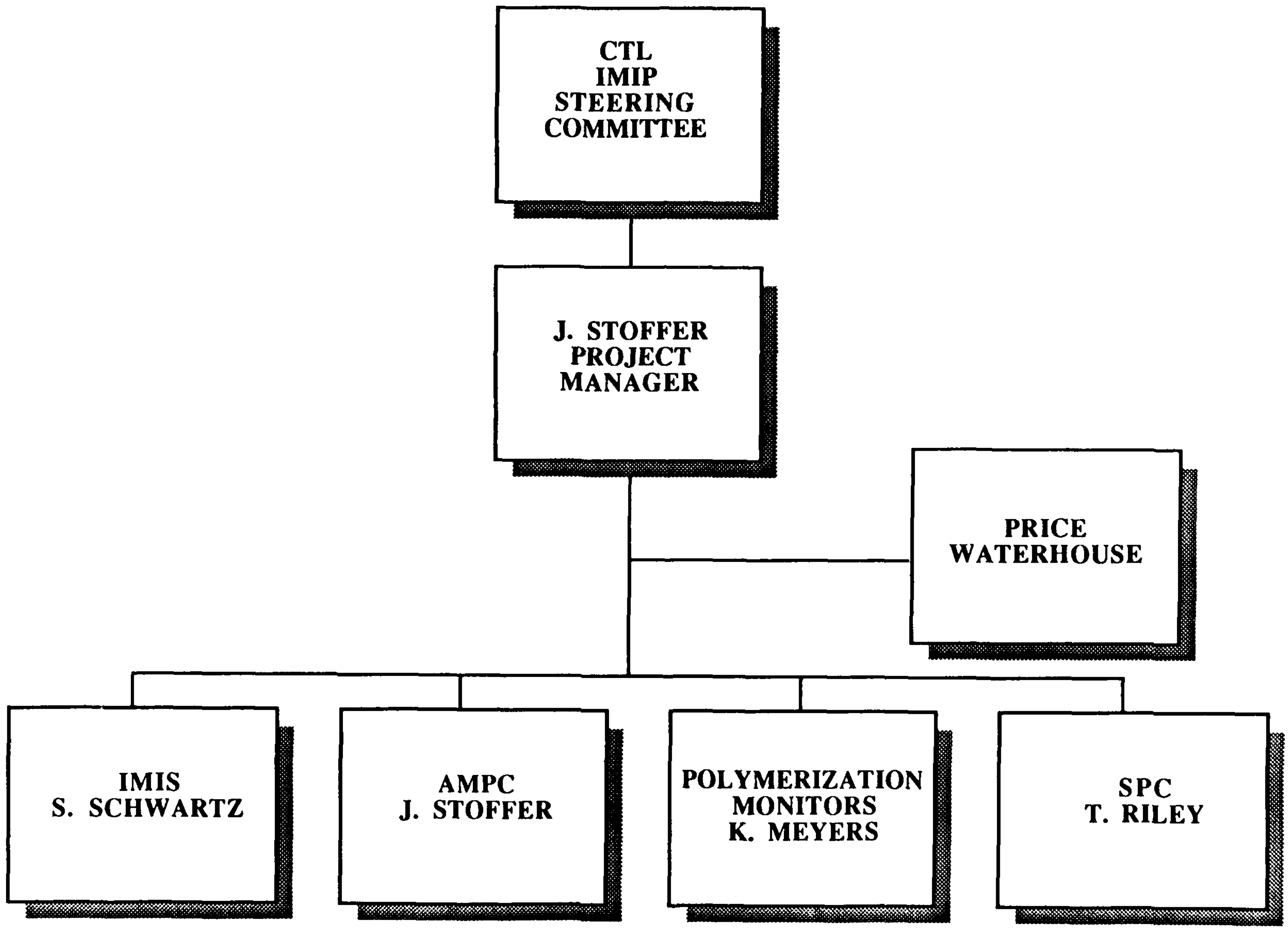
The CTL Phase II activities will be coordinated by Jeff Stoffer. Jeff was the Phase I IMIP Project Manager. He will be responsible for coordinating the day-to-day tasks of the project.

Assisting CTL in the Phase II project will be Price Waterhouse. They will provide technical assistance to the IMIP project, project management guidance, and will assist CTL in validating and quantifying the economic portion of the Phase II projects. Price Waterhouse assisted CTL in conducting the Phase I project.

Exhibit 3.13

CTL AEROSPACE
PHASE II

PROJECT MANAGEMENT



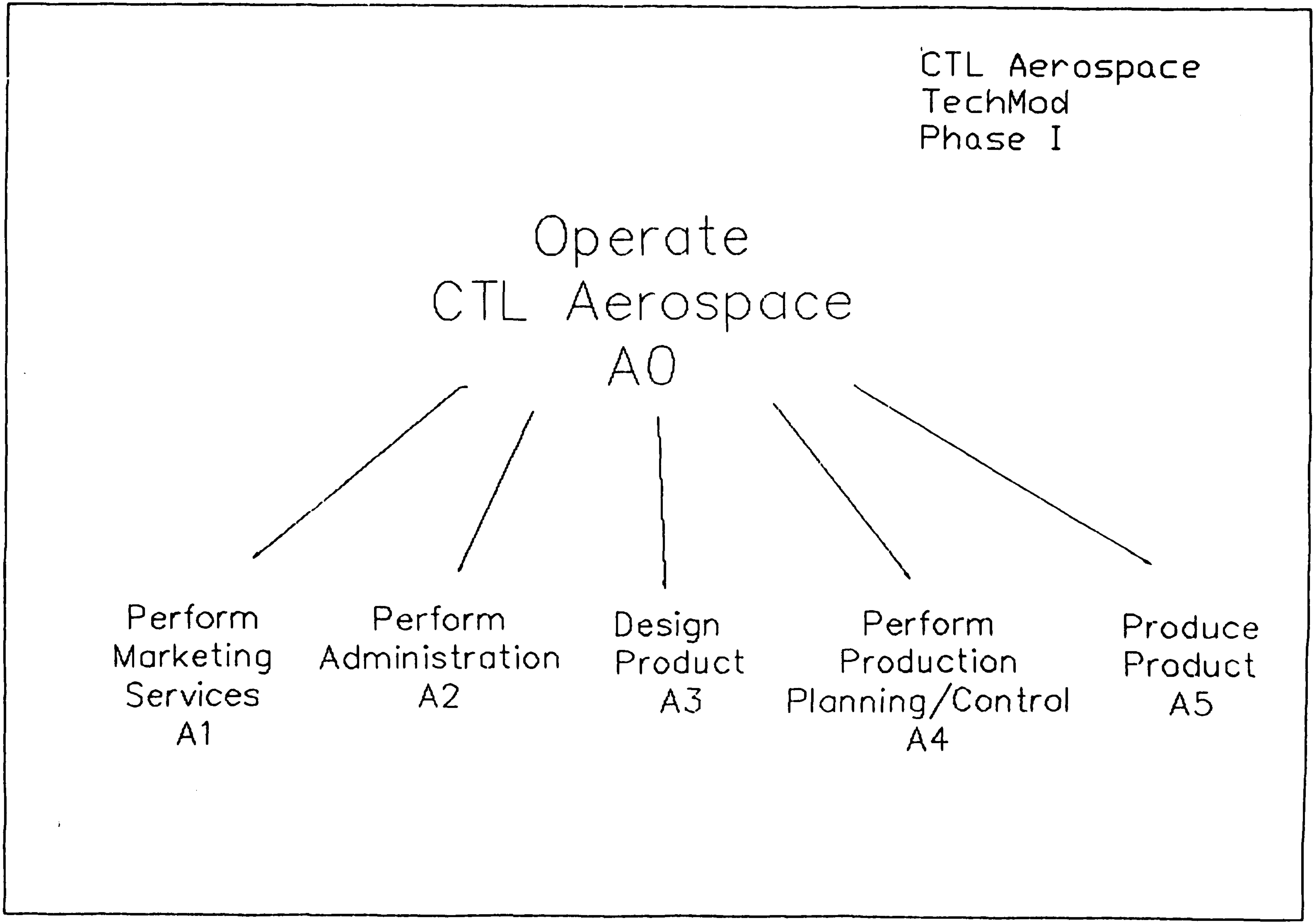
SECTION V: PHASE II BENEFITS TRACKING

The key to successfully completing the Phase II project will be to develop a system that can track associated costs with the IMIP program and provide a means to quantify and evaluate the actual savings against the expected savings. This will be accomplished by developing a tracking system that will allow for the identification of all costs incurred in the project as well as time charged to the project for all CTL employees. This information will be used to validate expected savings of the projects. As part of each project, a system will be created to insure that savings from this project are identified and can be compared to the expected savings.

SECTION VI

Appendices

Node Tree



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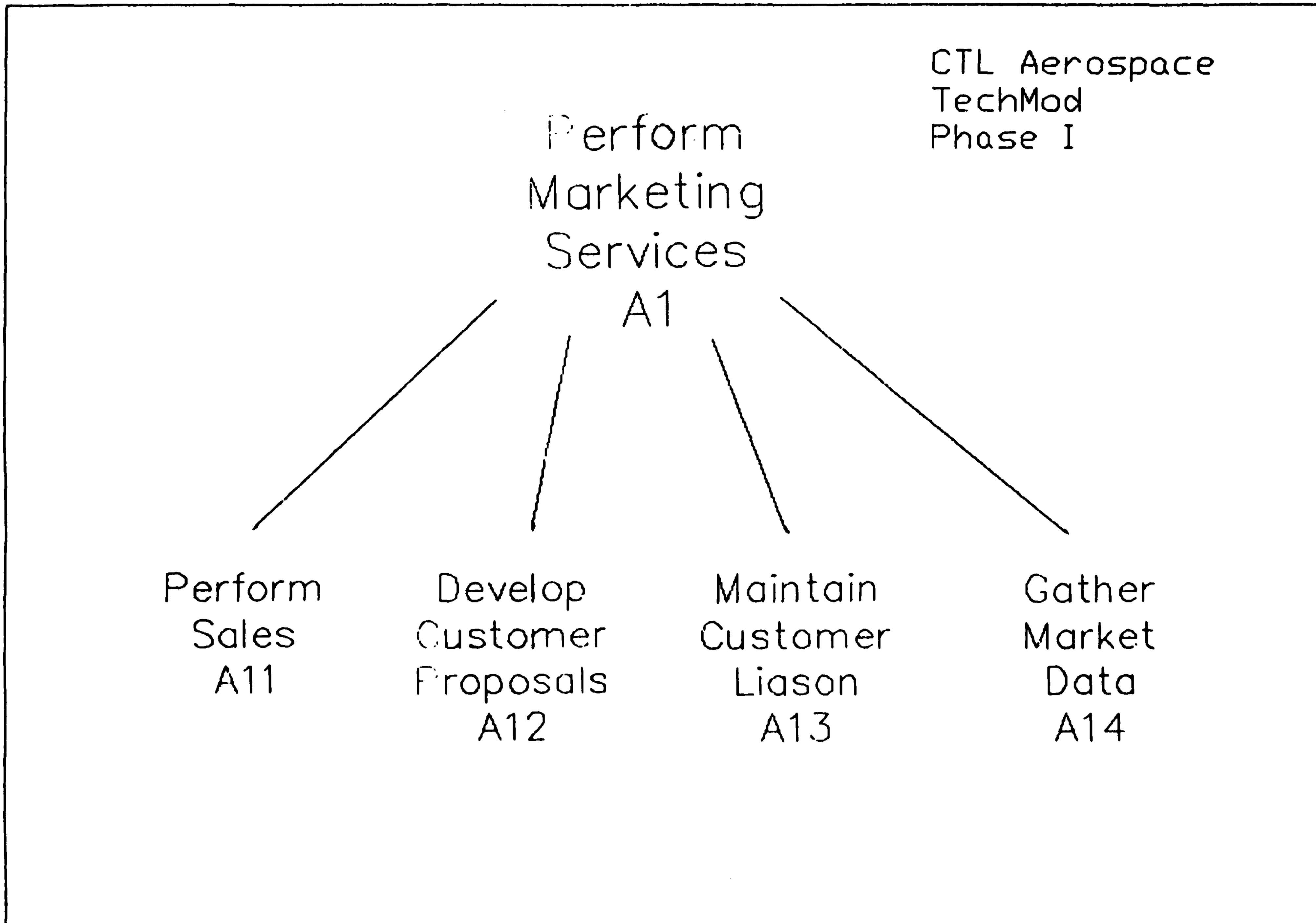
TechMod
Phase I
Operate
CTL Aerospace
A0
Perform
Marketing
Services
A1
Perform
Administration
A2
Design
Product
A3
Perform
Production
Planning/Control
A4
Produce
Product
A5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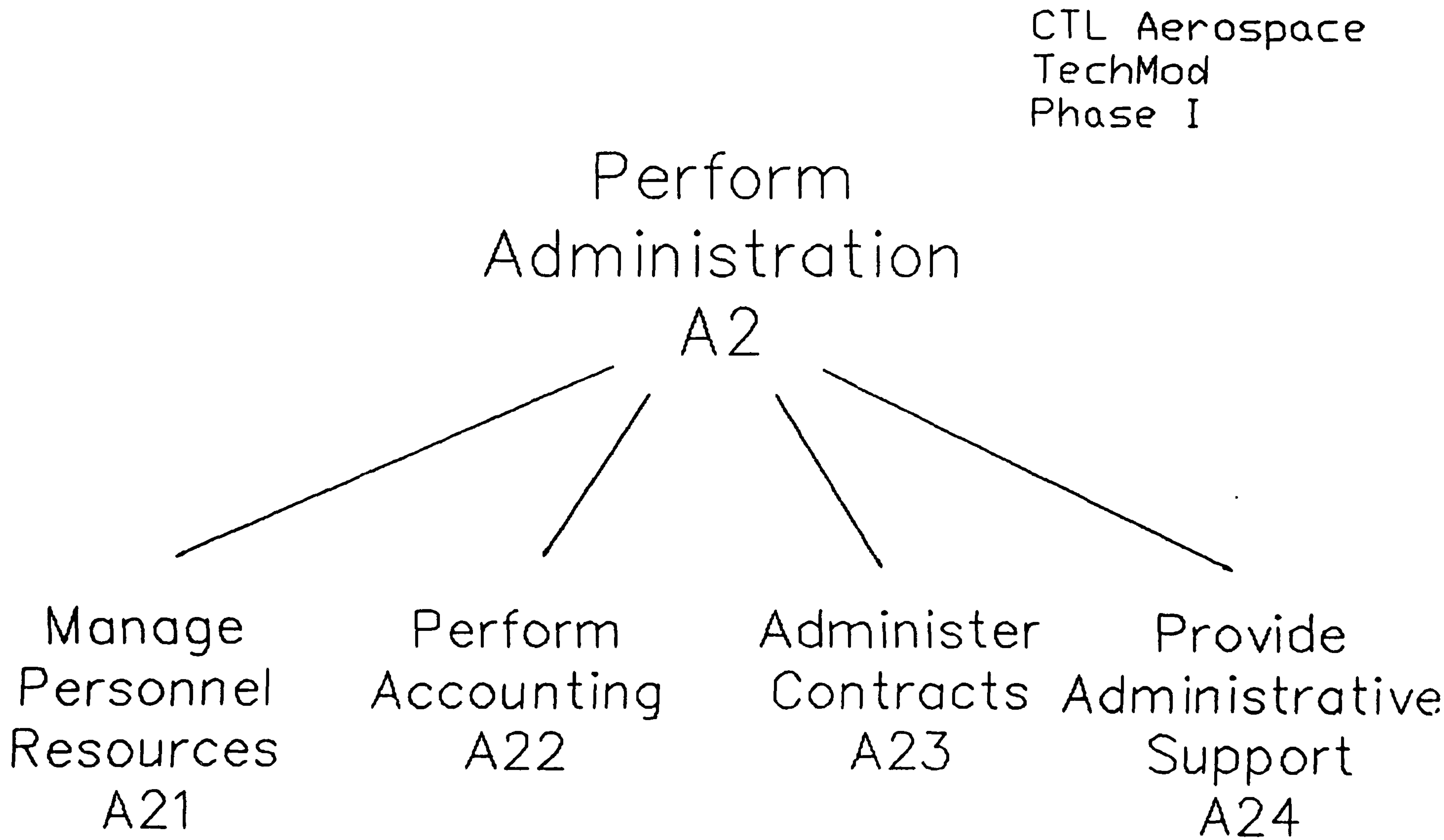
TechMod
Phase I
Perform
Marketing
Services
A1
Perform
Sales
A11
Develop
Customer
Proposals
A12
Maintain
Customer
Liason
A13
Gather
Market
Data
A14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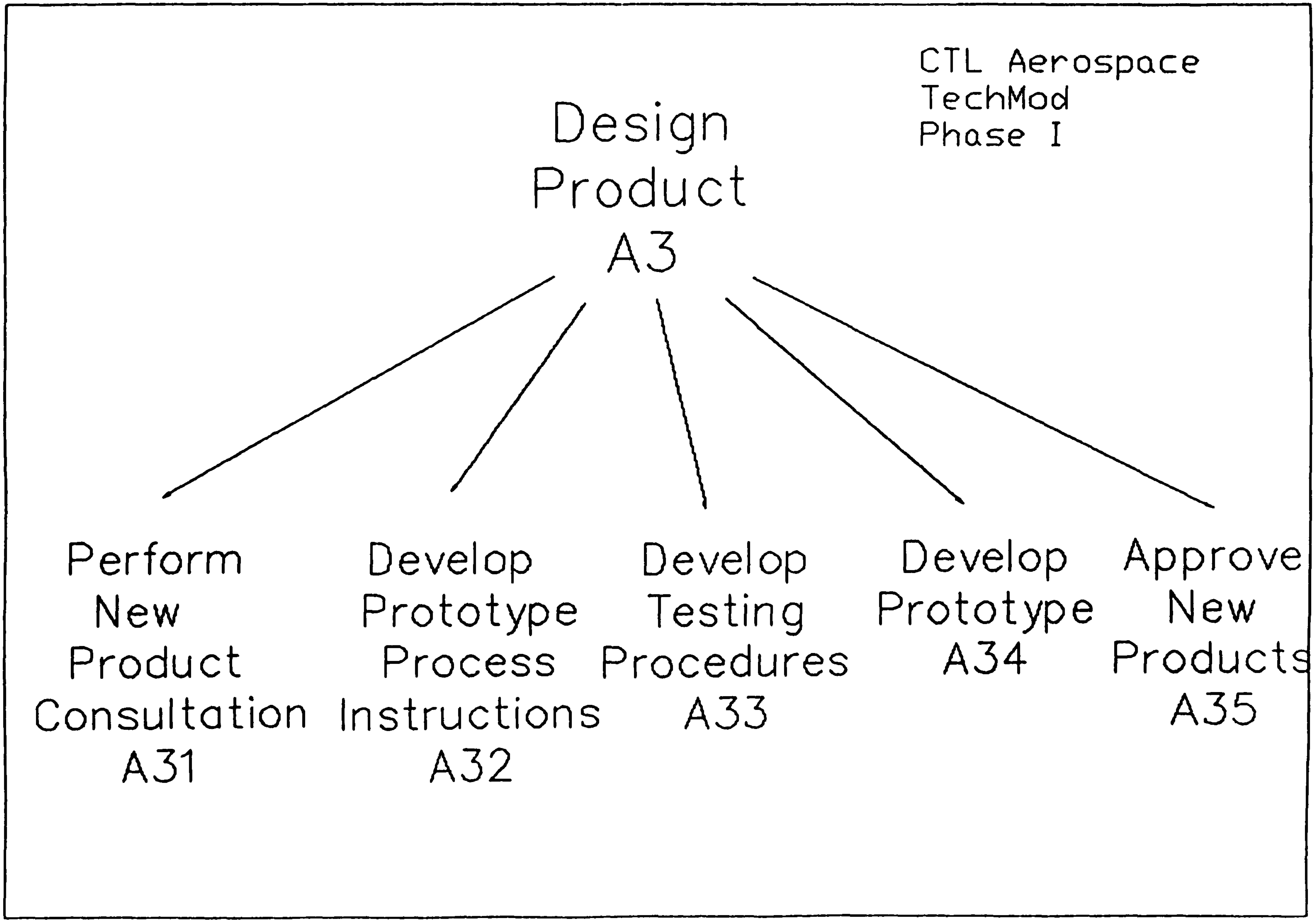
Phase I
Perform
Administration
A2
Manage
Personnel
Resources
A21
Perform
Accounting
A22
Administer
Contracts
A23
Provide
Administrative
Support
A24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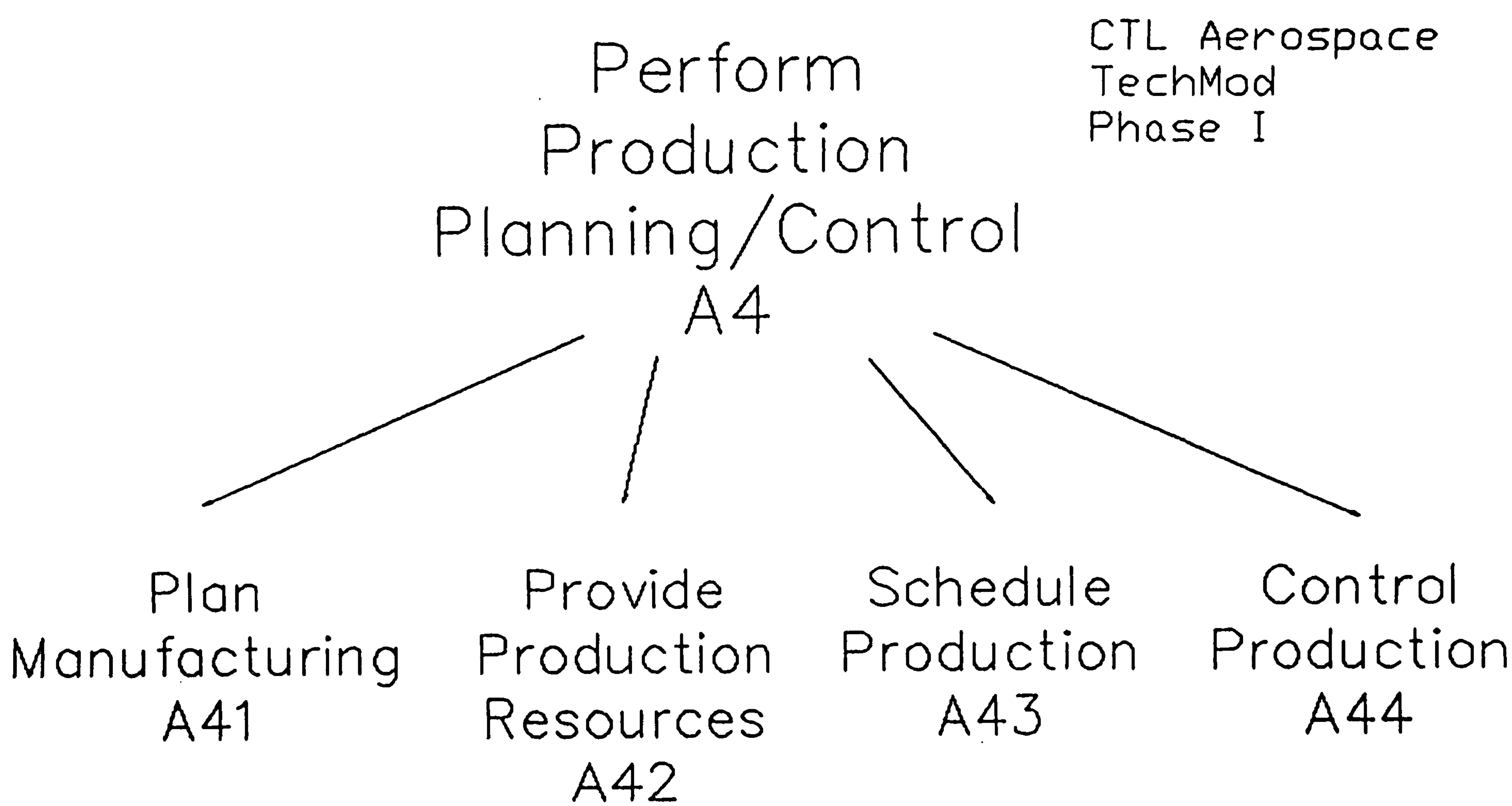
TechMod
Phase I
Design
Product
A3
Perform
New
Product
Consultation
A31
Develop
Prototype
Process
Instructions
A32
Develop
Testing
Procedures
A33
Develop
Prototype
A34
Approve
New
Products
A35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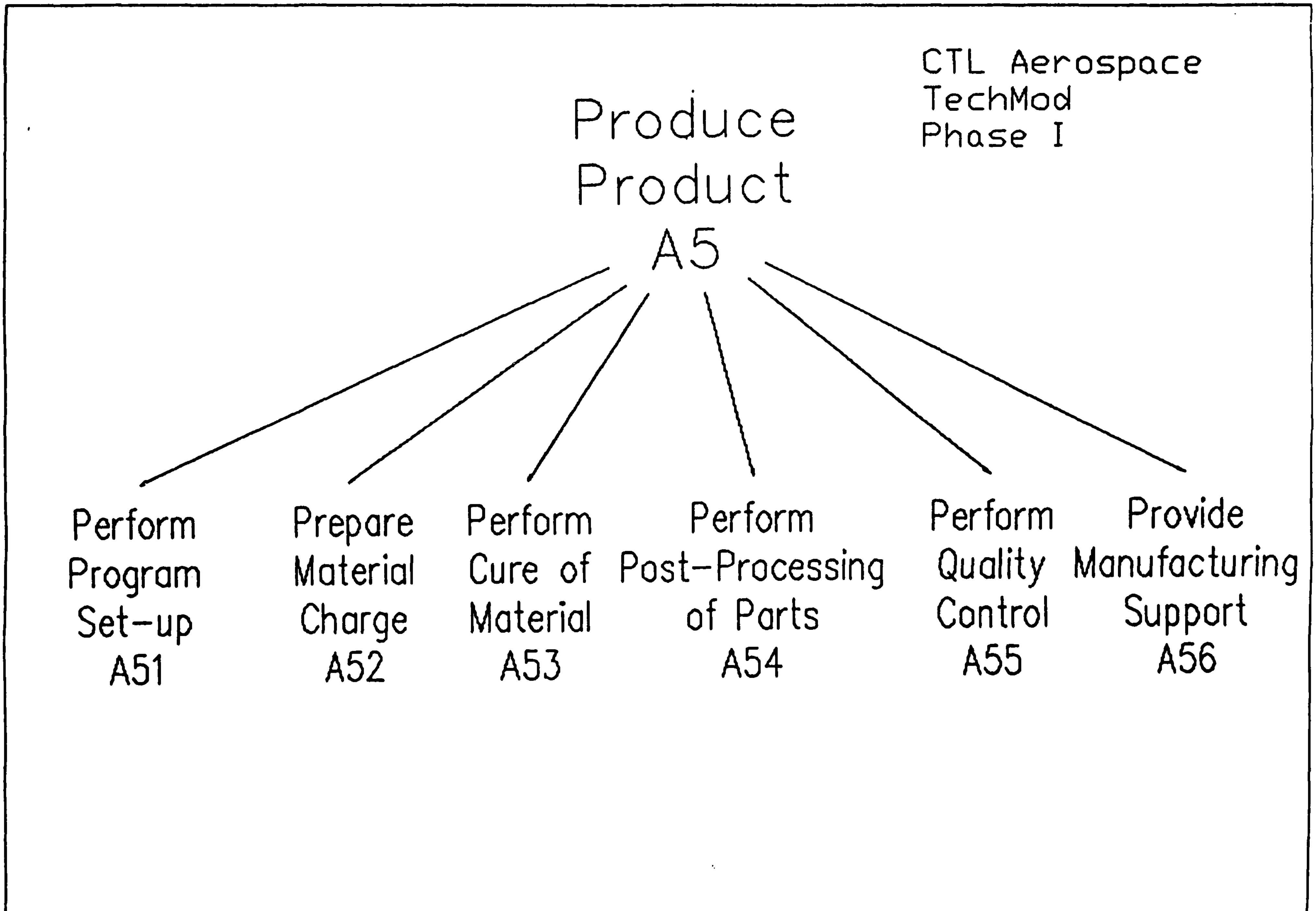
Phase I
Perform
Production
Planning/Control
A4
Plan
Manufacturing
A41
Provide
Production
Resources
A42
Schedule
Production
A43
Control
Production
A44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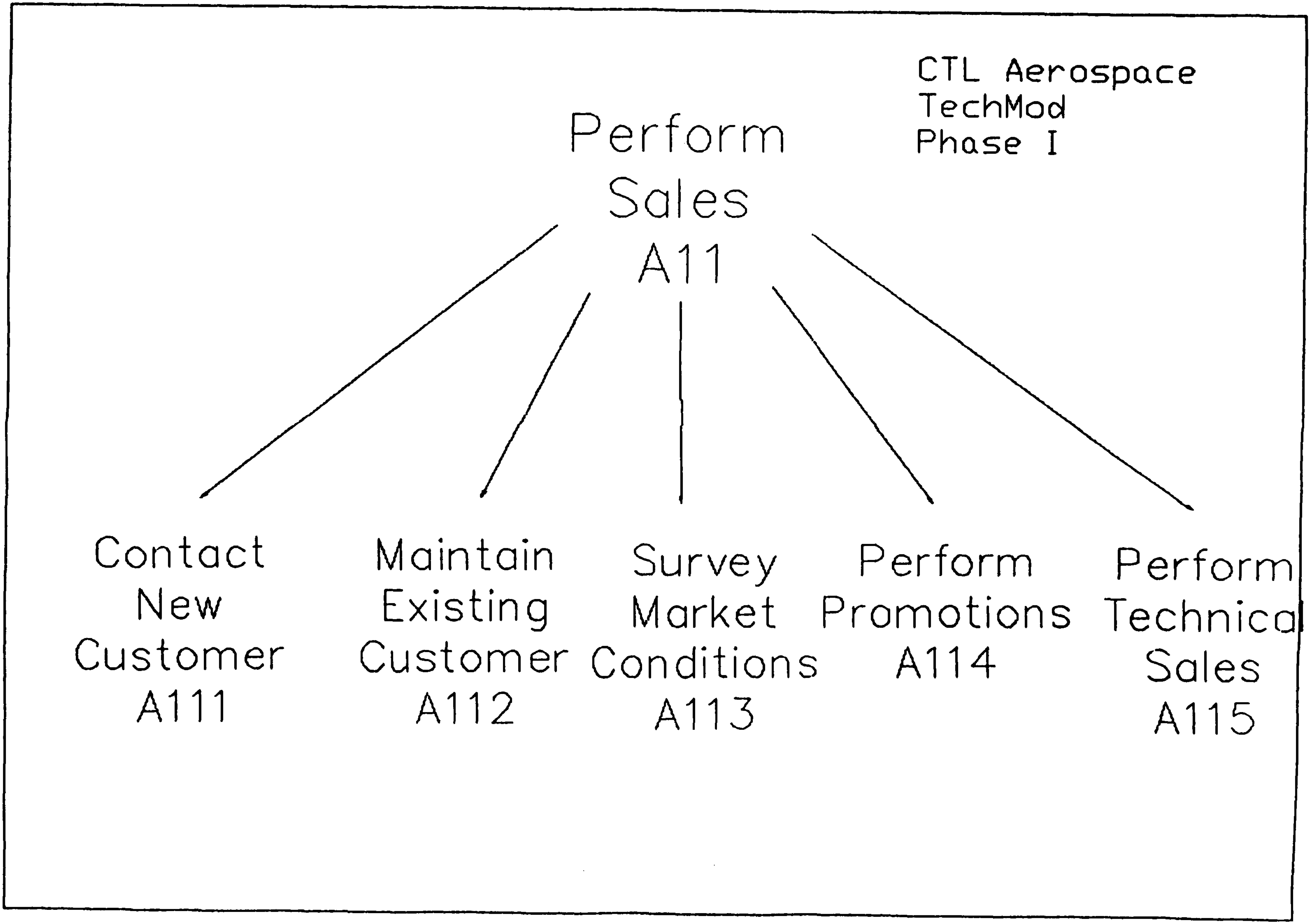
TechMod
Phase I
Produce
Product
A5
Perform
Program
Set-up
A51
Prepare
Material
Charge
A52
Perform
Cure of
Material
A53
Perform
Post-Processing
of Parts
A54
Perform
Quality
Control
A55
Provide
Manufacturing
Support
A56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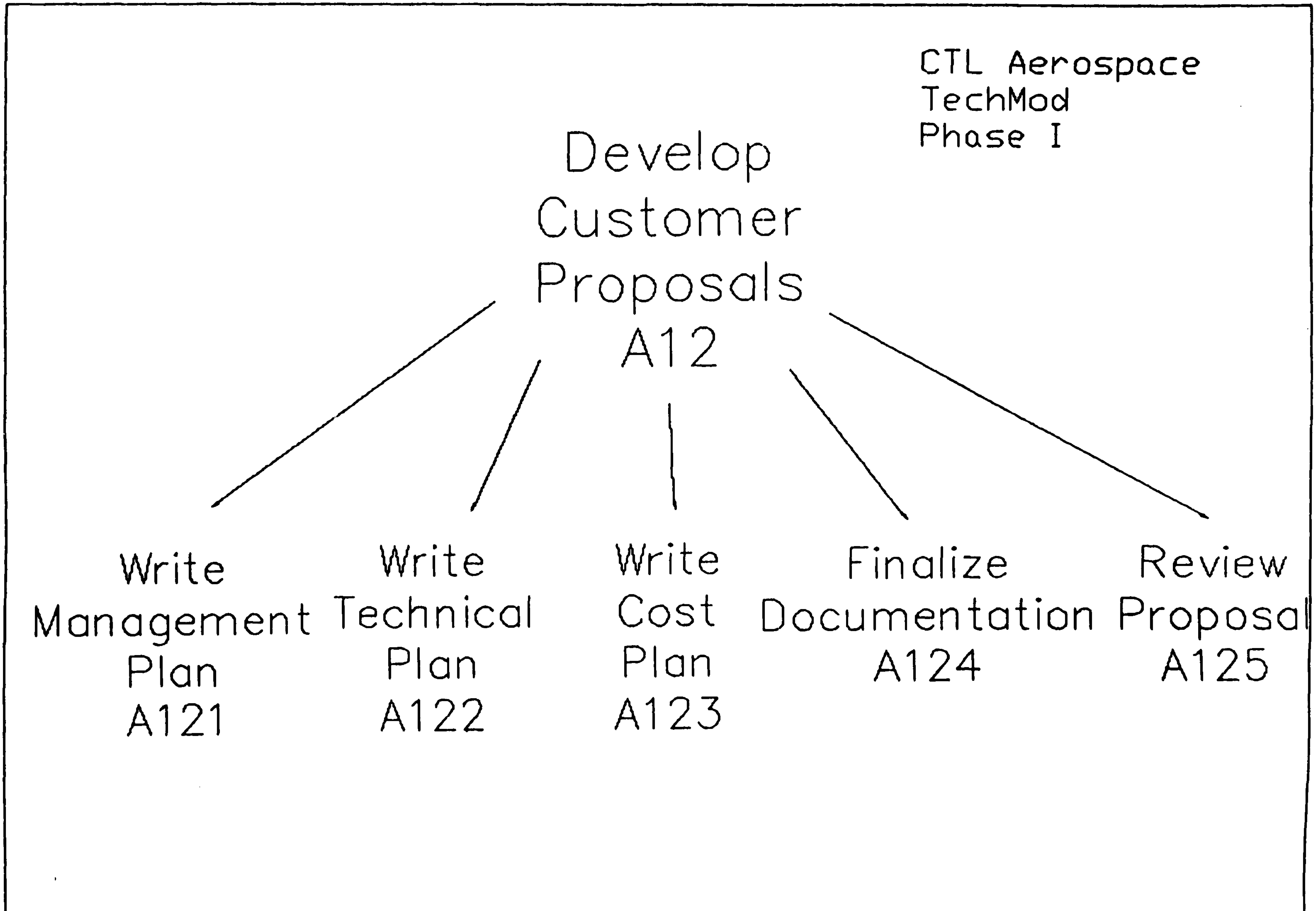
TechMod
Phase I
Perform Sales A11
Contact New Customer A111
Maintain Existing Customer A112
Survey Market Conditions A113
Perform Promotions A114
Perform Technical Sales A115



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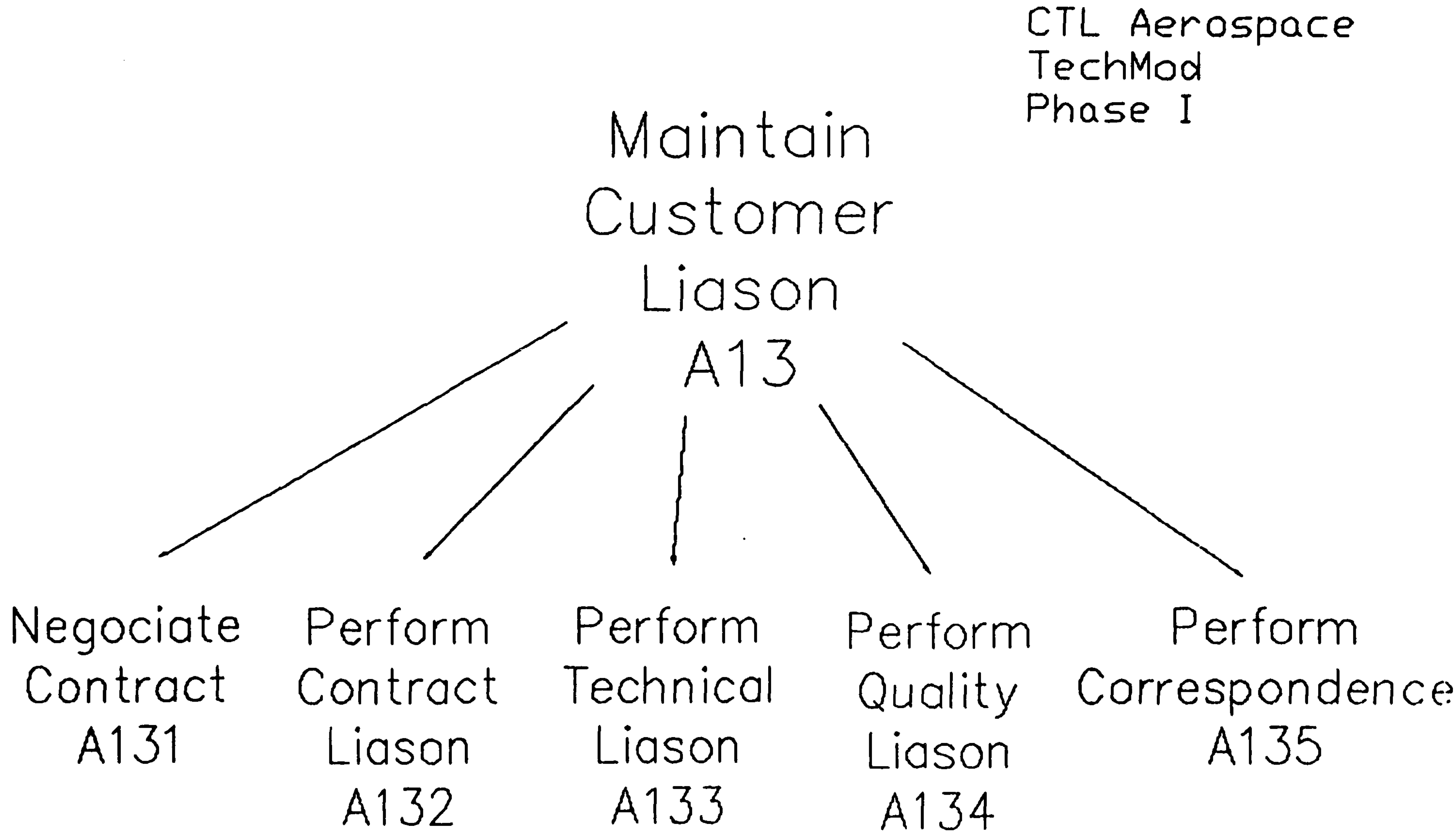
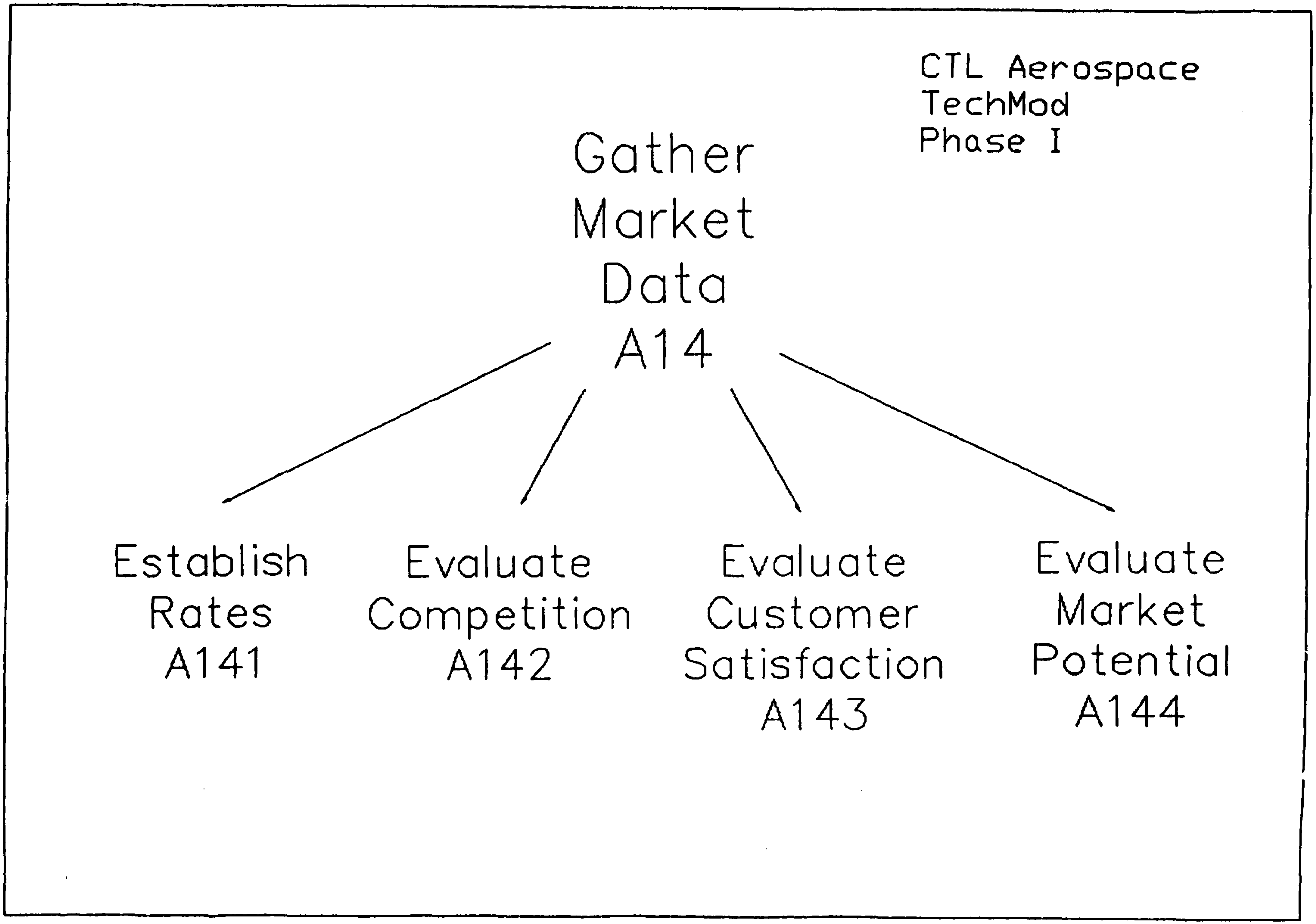
TechMod
Phase I
Develop Customer Proposals A12
Write Management Plan A121
Write Technical Plan A122
Write Cost Plan A123
Finalize Documentation A124
Review Proposal A125



CTL Aerospace
TechMod
Phase I
Maintain Customer Liason
A13
Negociate Contract
A131
Perform Contract Liason
A132
Perform Technical Liason
A133
Perform Quality Liason
A134
Perform Correspondence
A135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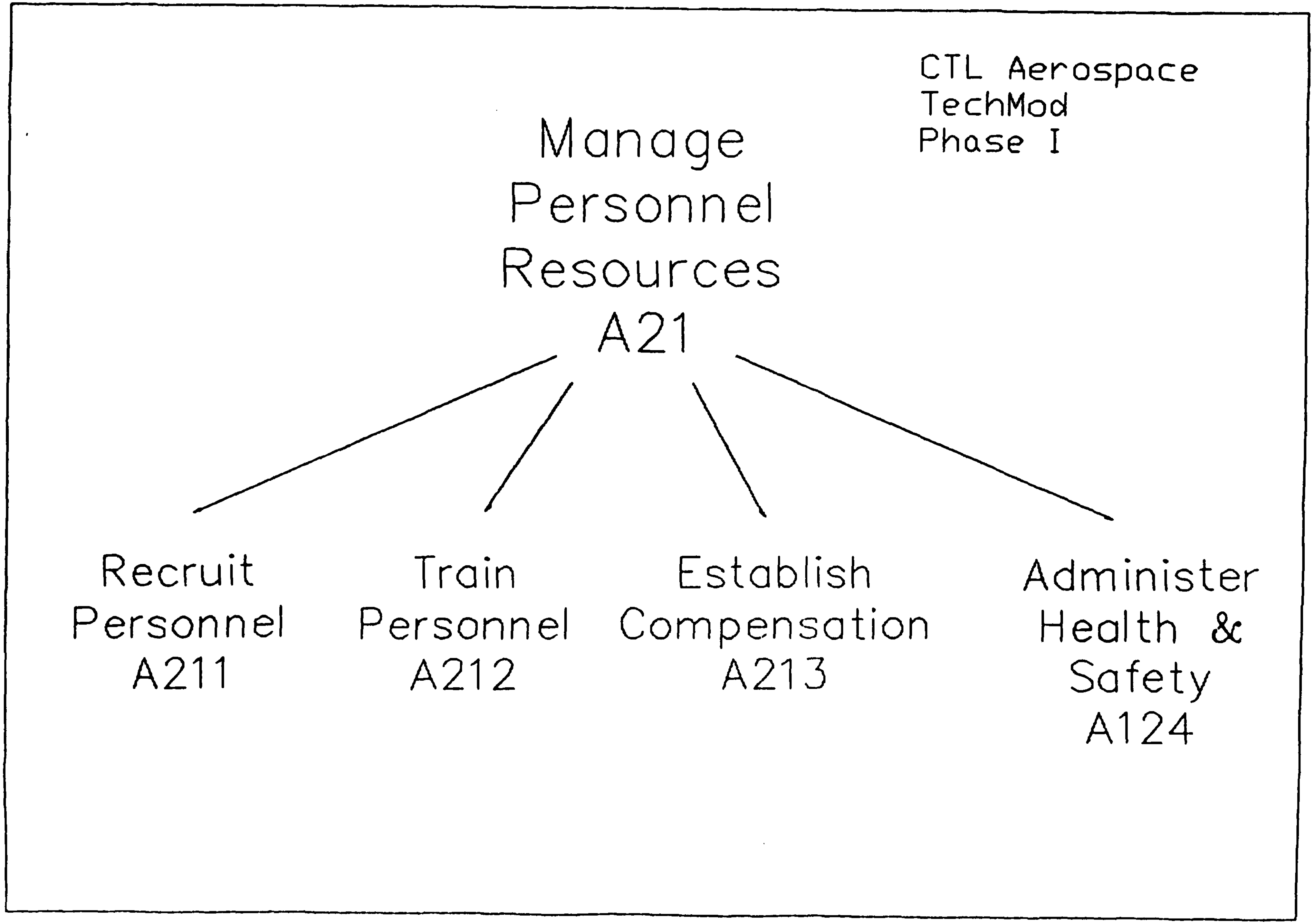
TechMod
Phase I
Gather
Market
Data
A14
Establish
Rates
A141
Evaluate
Competition
A142
Evaluate
Customer
Satisfaction
A143
Evaluate
Market
Potential
A144


CTL Aerospace
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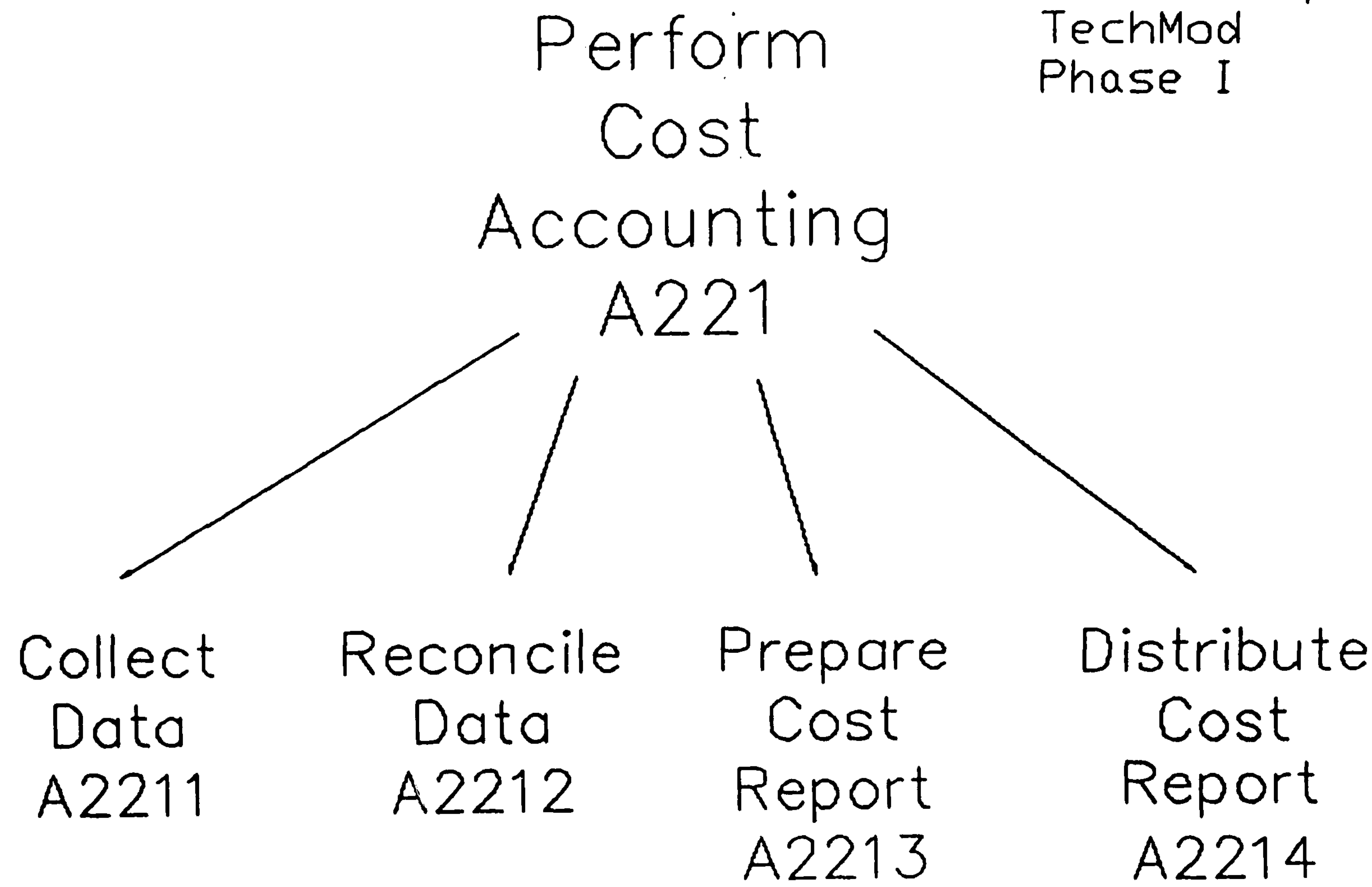
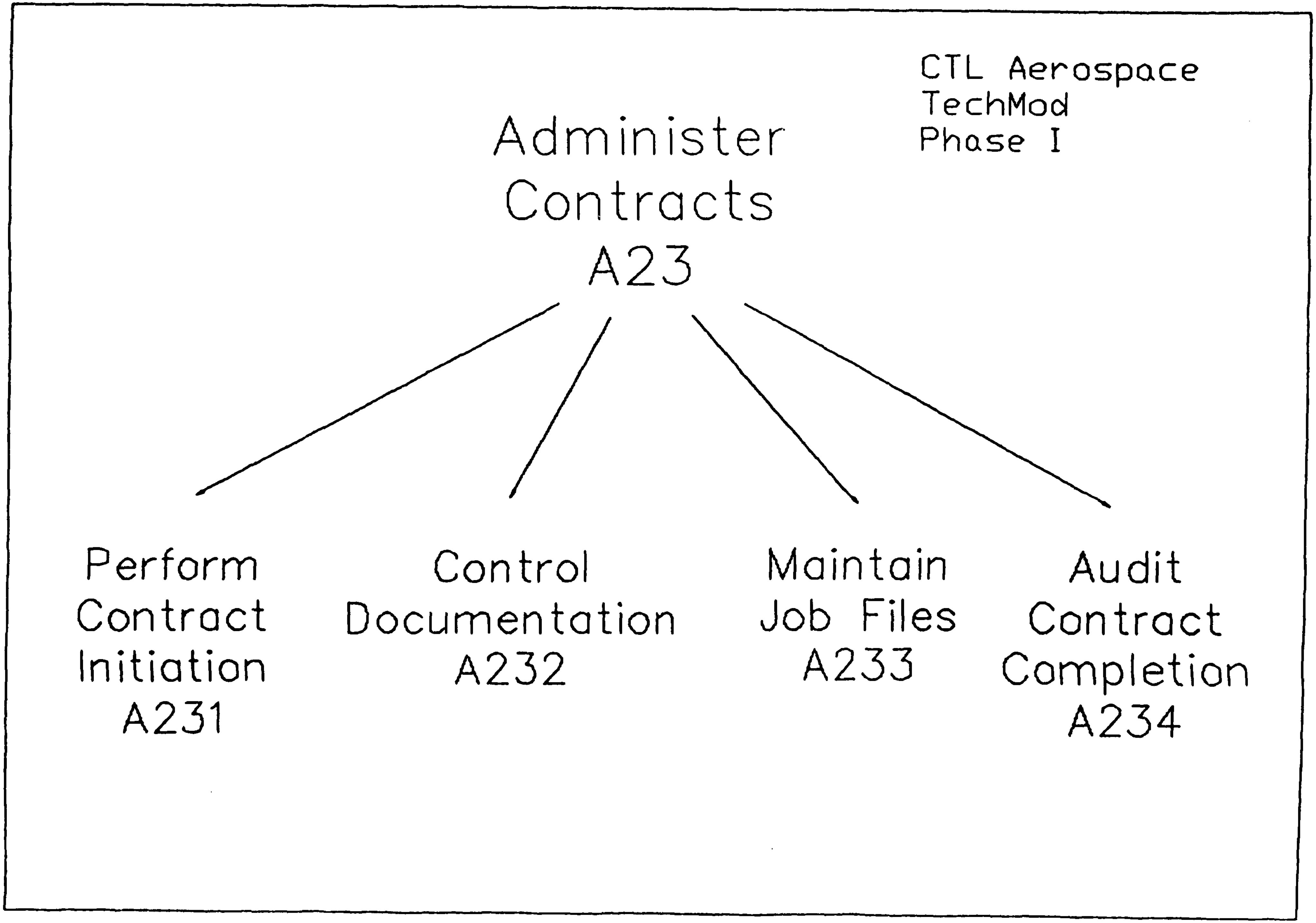
Phase I
Manage Personnel Resources A21
Recruit Personnel A211
Train Personnel A212
Establish Compensation A213
Administer Health & Safety A124

CTL Aerospace
TechMod
Phase I

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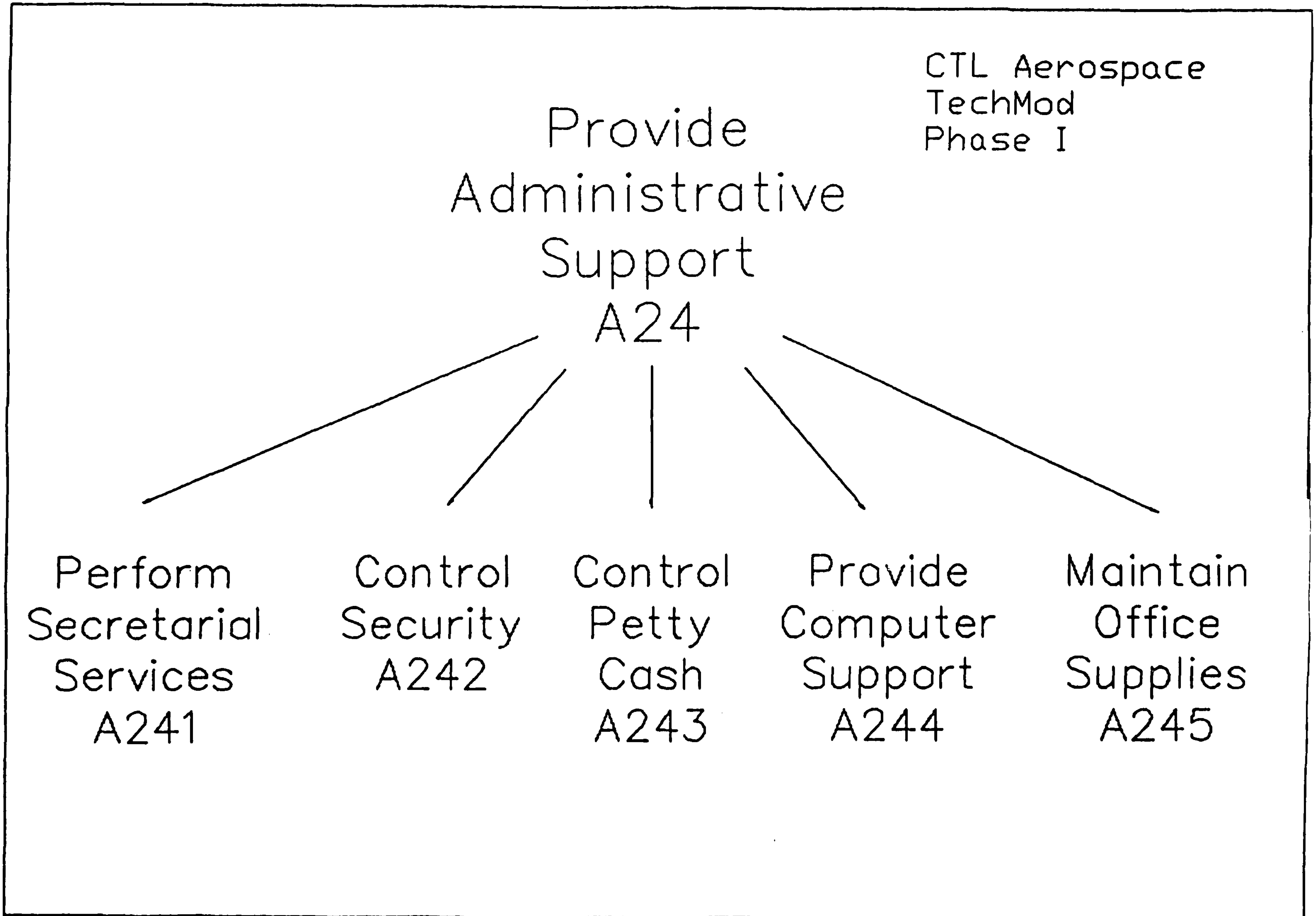
TechMod
Phase I
Administer Contracts A23
Perform Contract Initiation A231
Control Documentation A232
Maintain Job Files A233
Audit Contract Completion A234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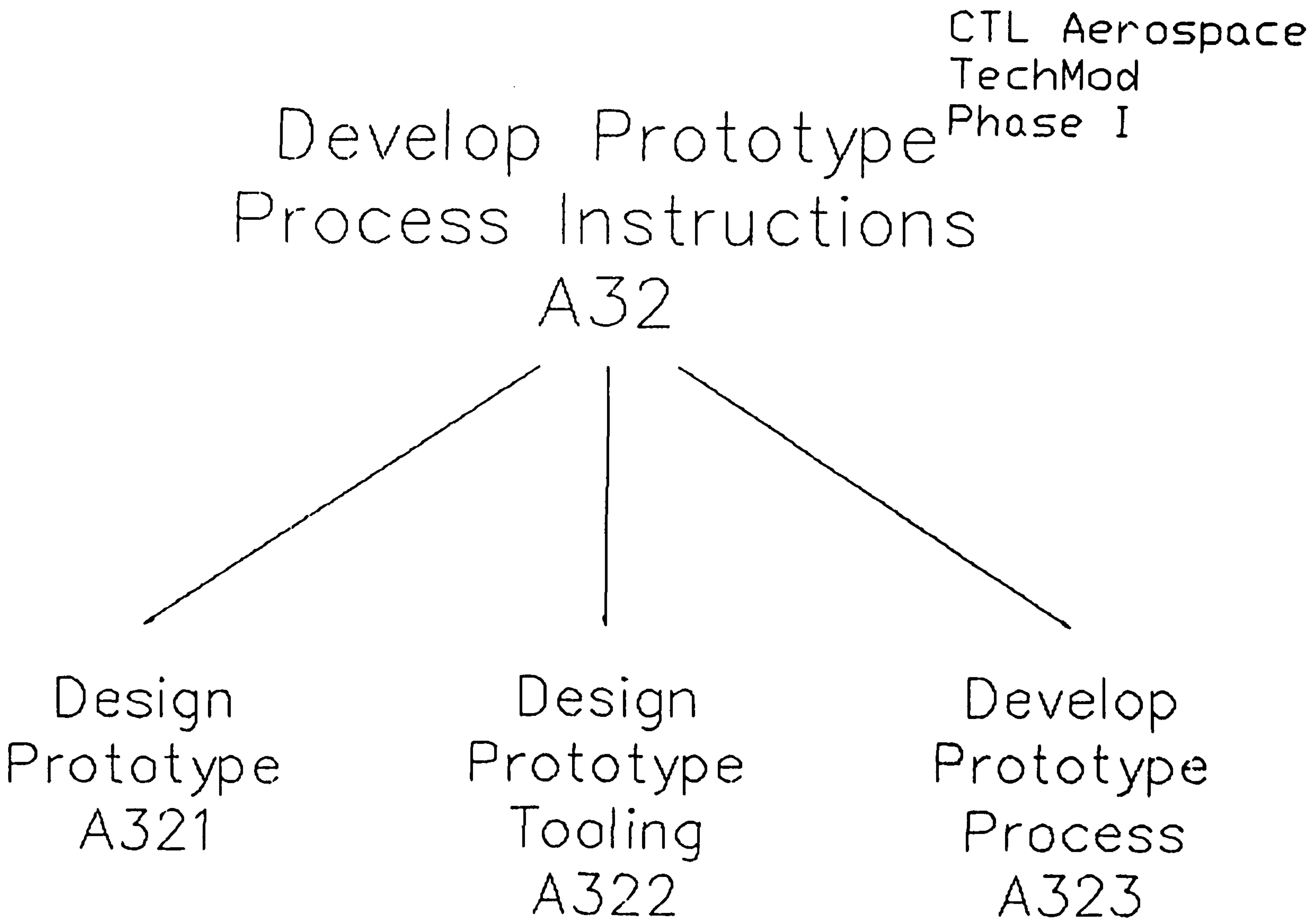
TechMod
Phase I
Provide Administrative Support
A24
Perform Secretarial Services
A241
Control Security
A242
Control Petty Cash
A243
Provide Computer Support
A244
Maintain Office Supplies
A245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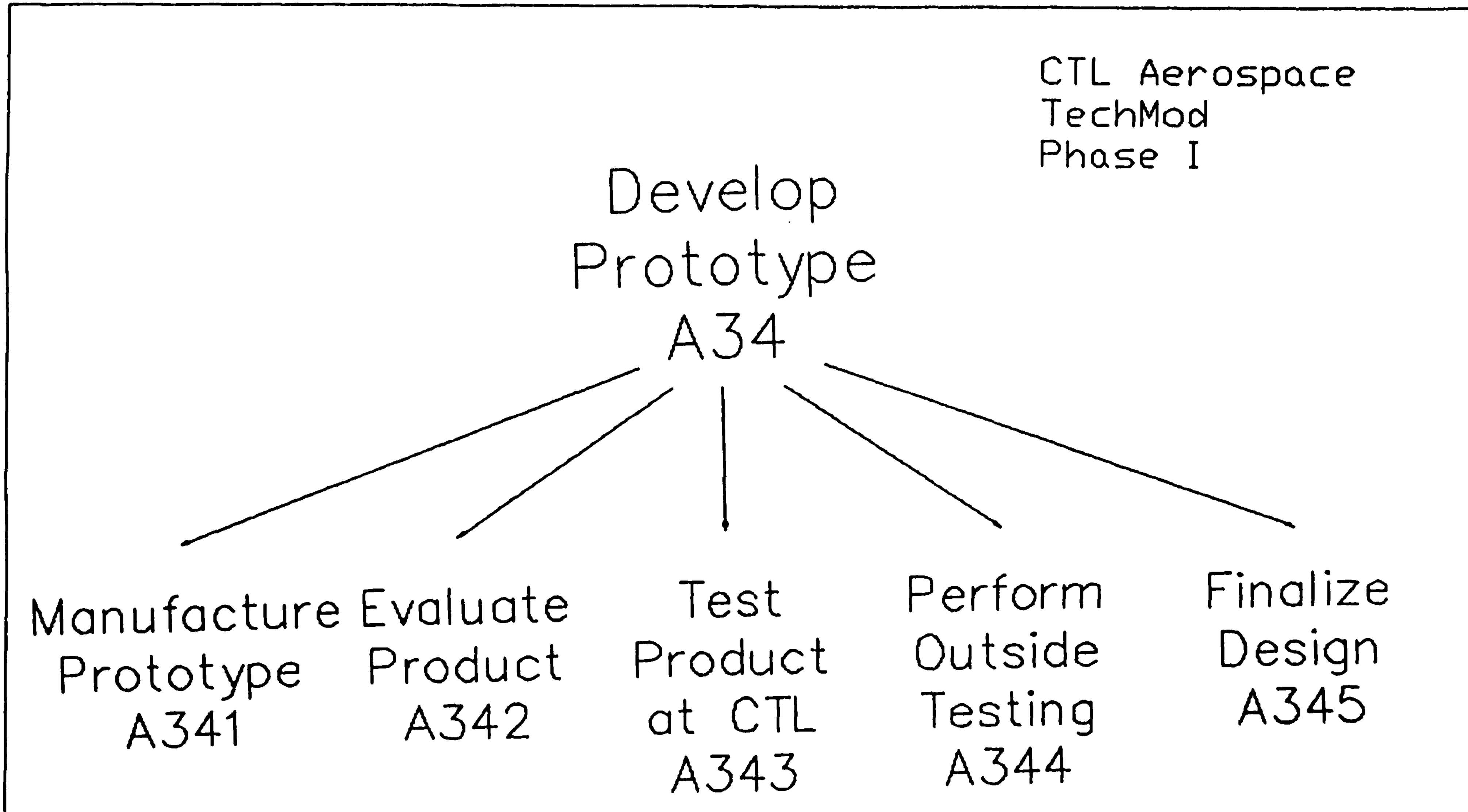
TechMod
Phase I
Develop Prototype
Process Instructions
A32
Design
Prototype
A321
Design
Prototype
Tooling
A322
Develop
Prototype
Process
A323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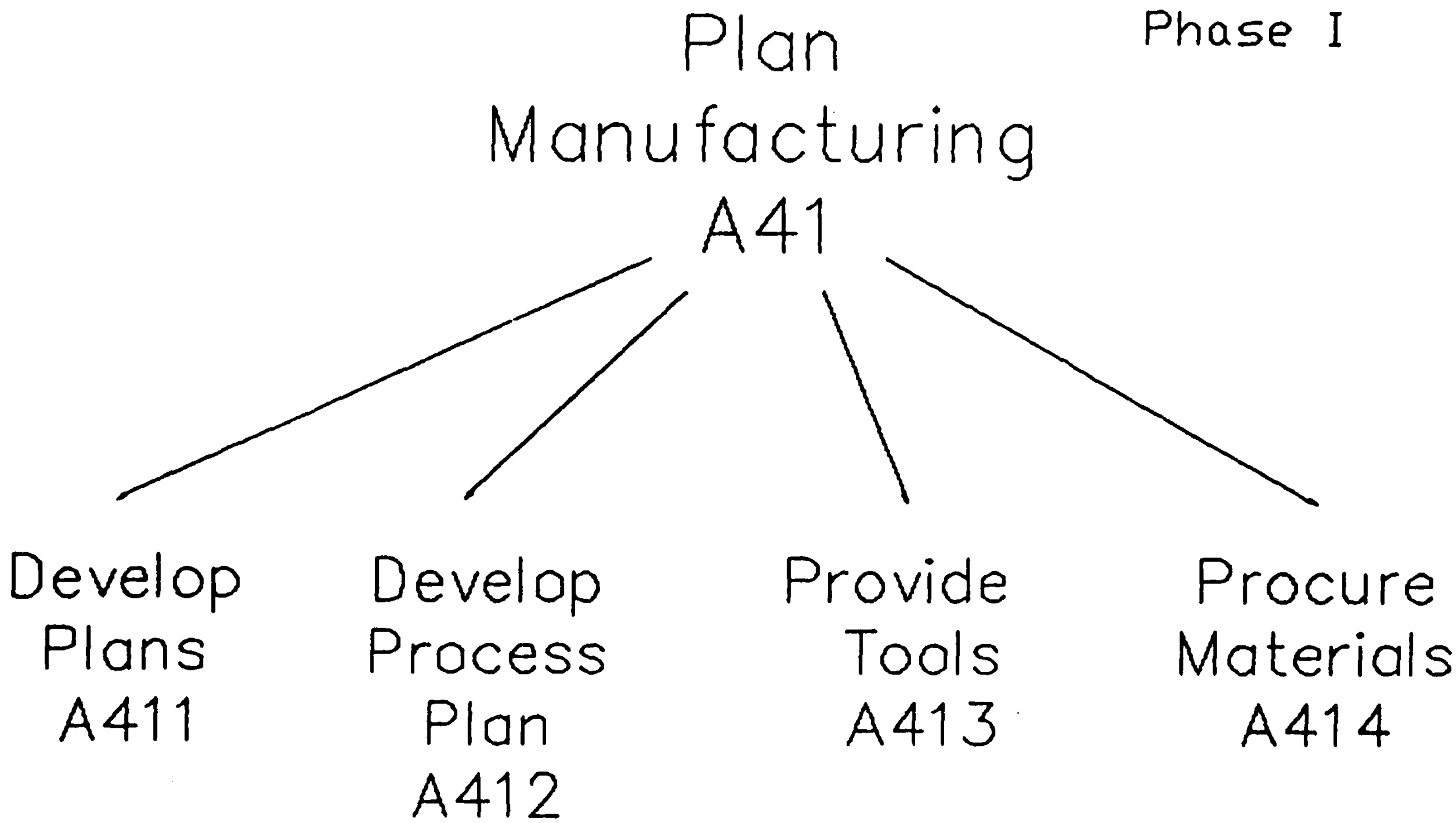
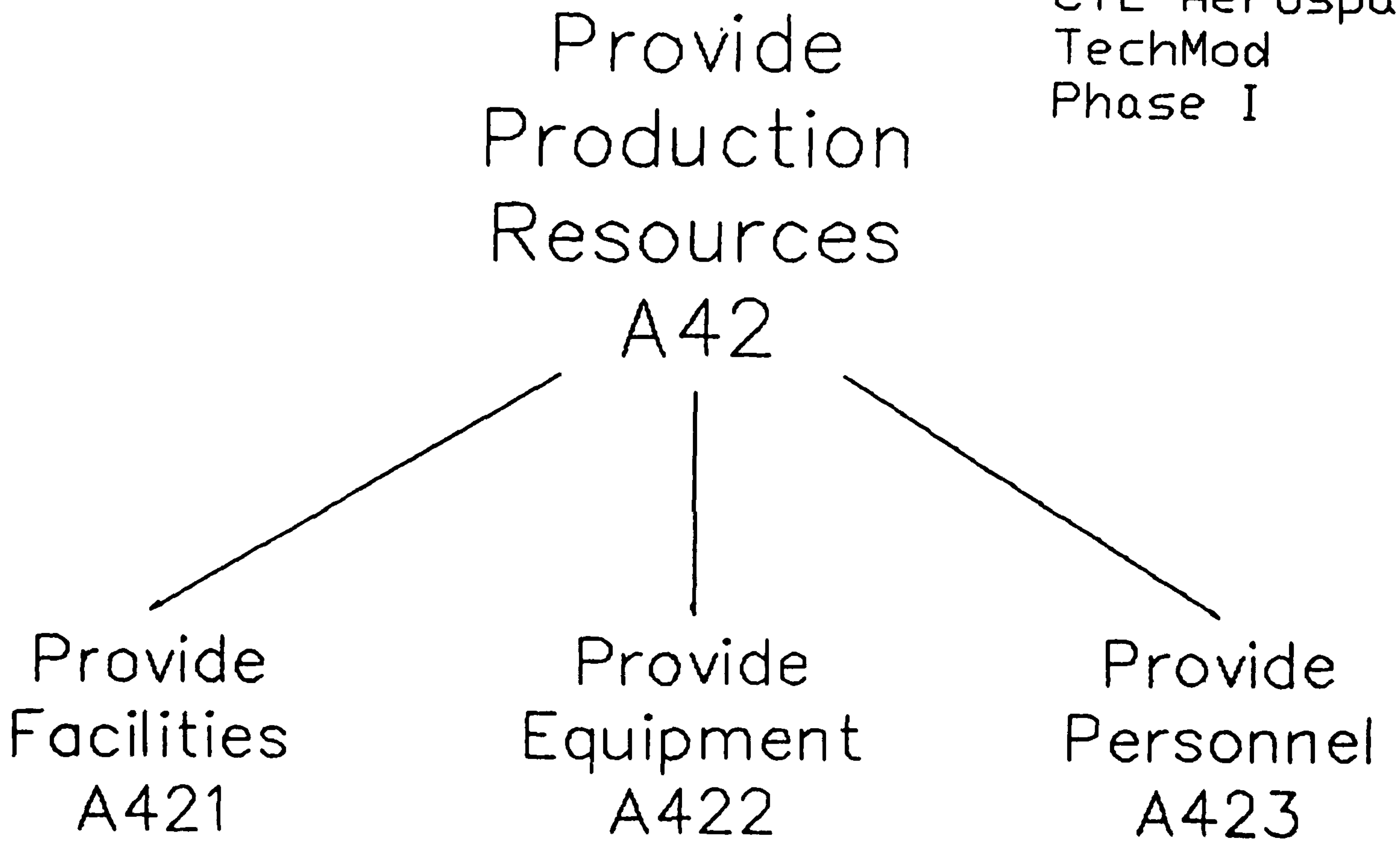
TechMod
Phase I
Develop Prototype A34
Manufacture Prototype A341
Evaluate Product A342
Test Product at CTL A343
Perform Outside Testing A344
Finalize Design A345

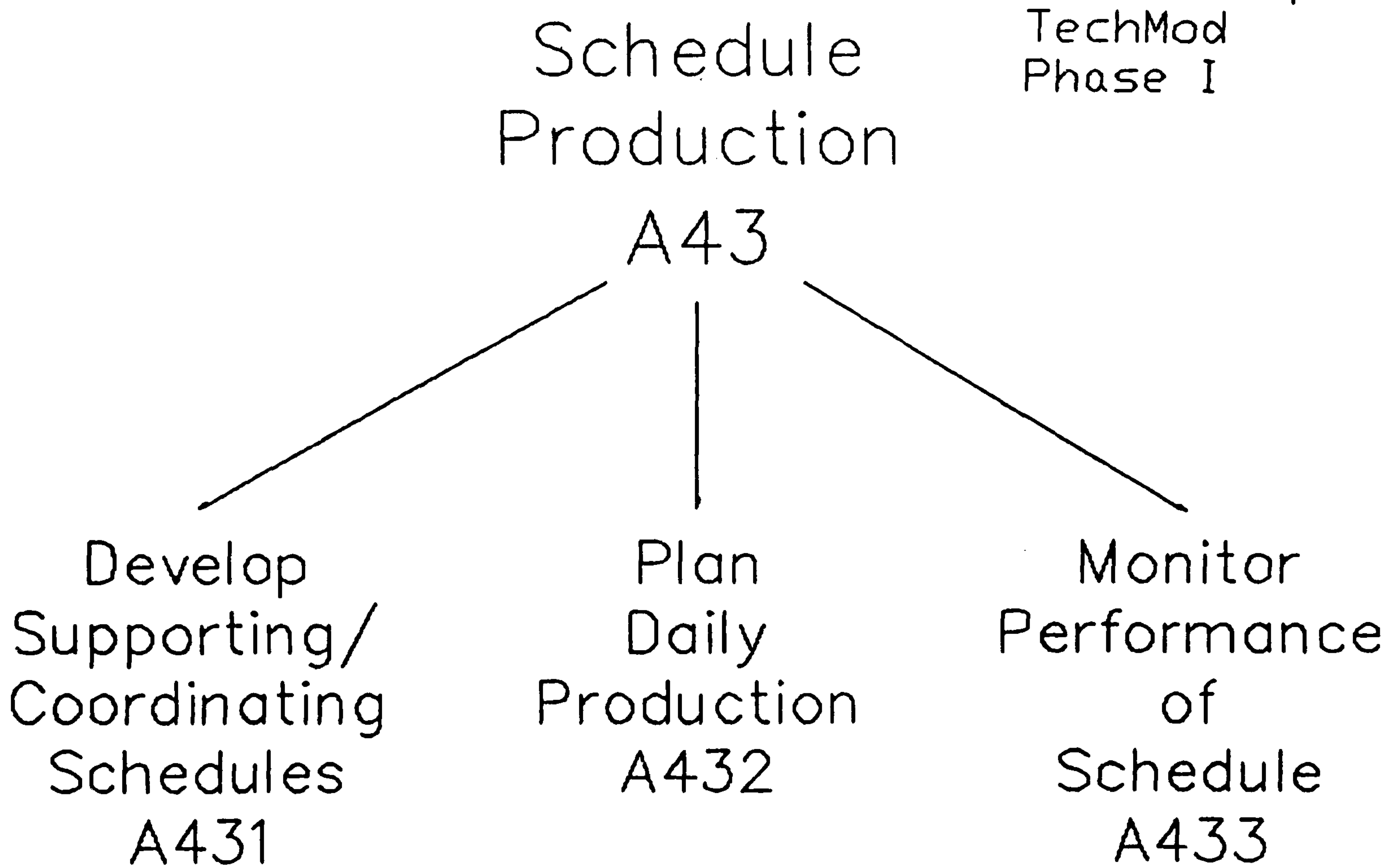
CTL Aerospace
TechMod
Phase I

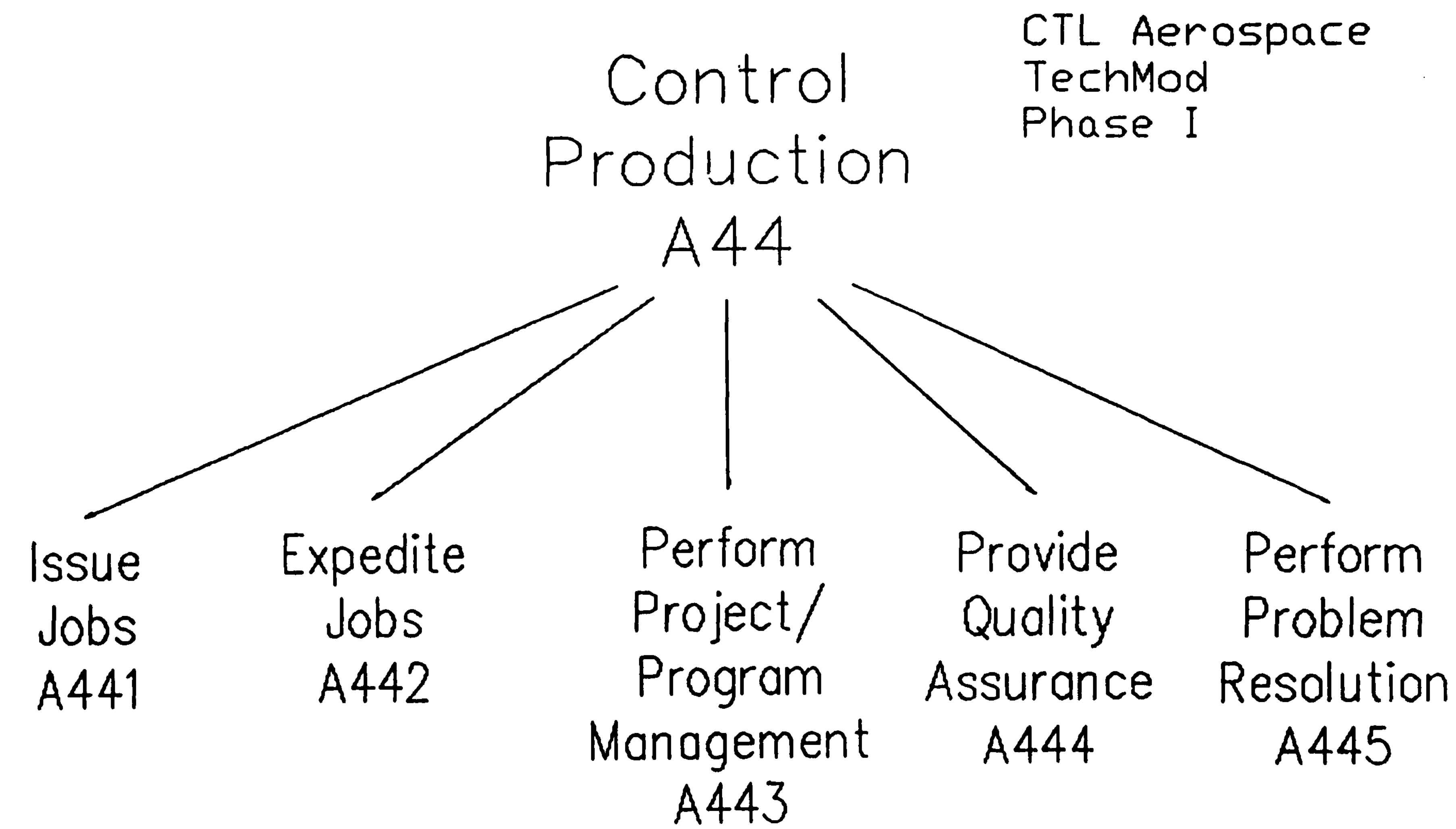


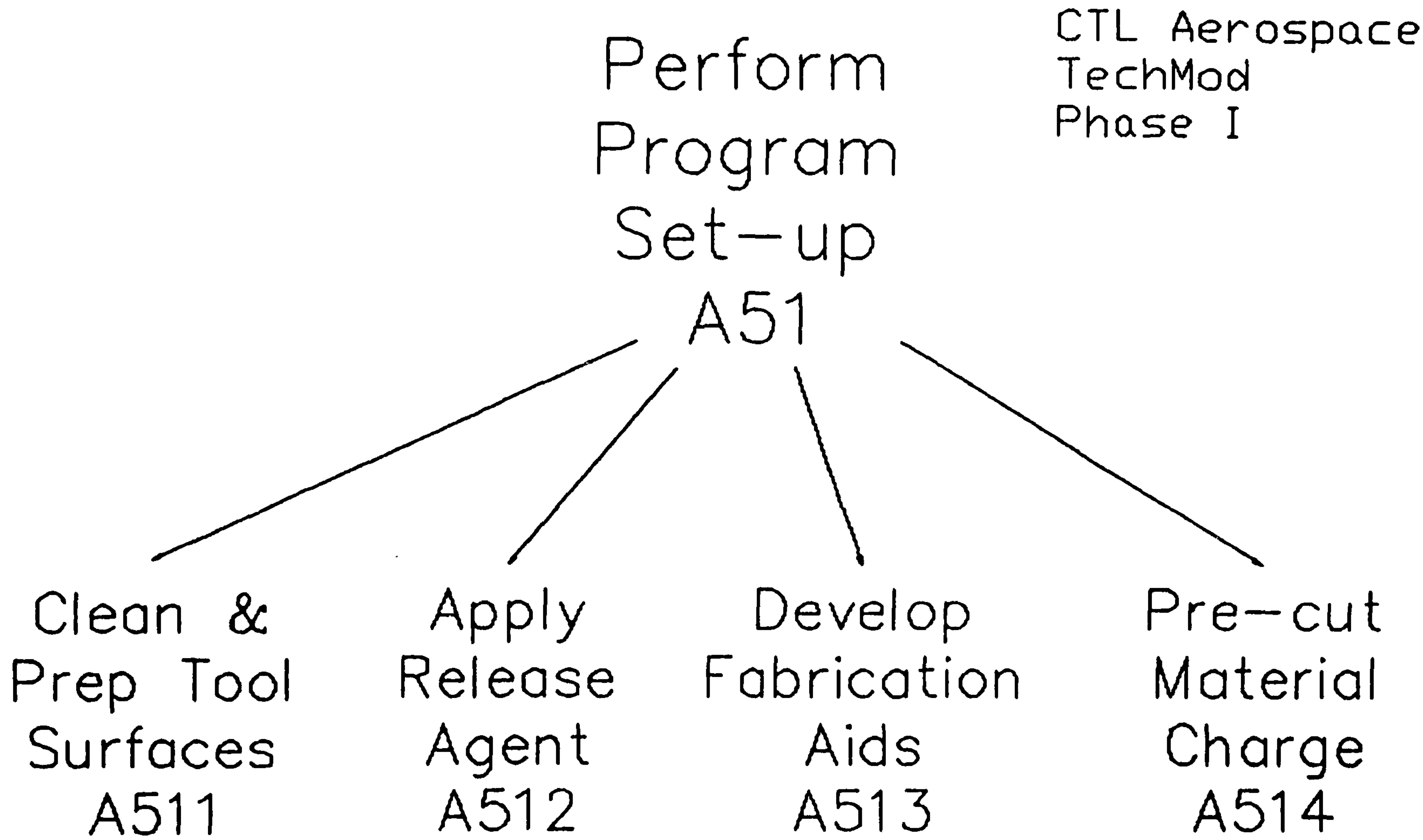
CTL Aerospace
TechMod
Phase I

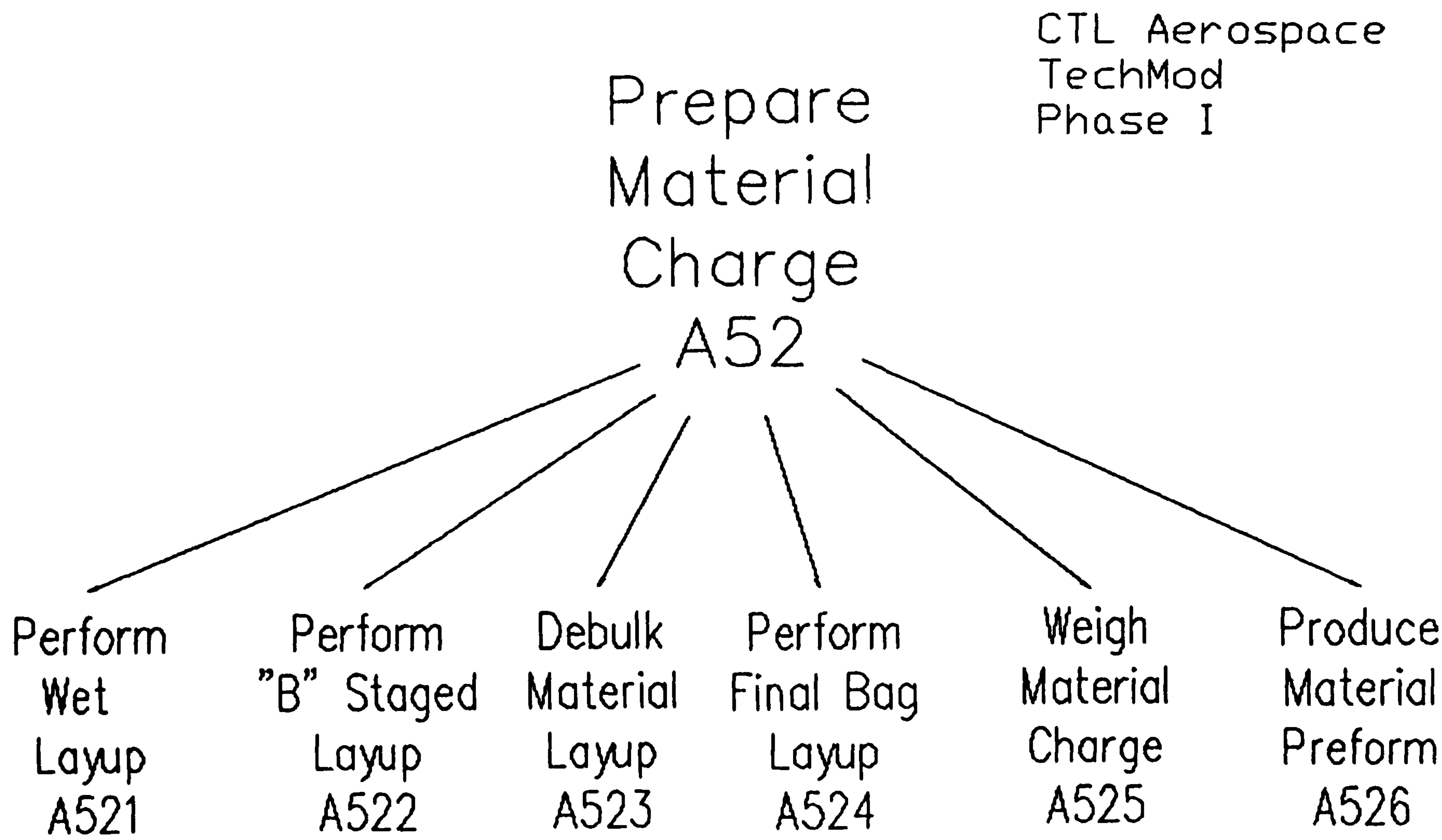


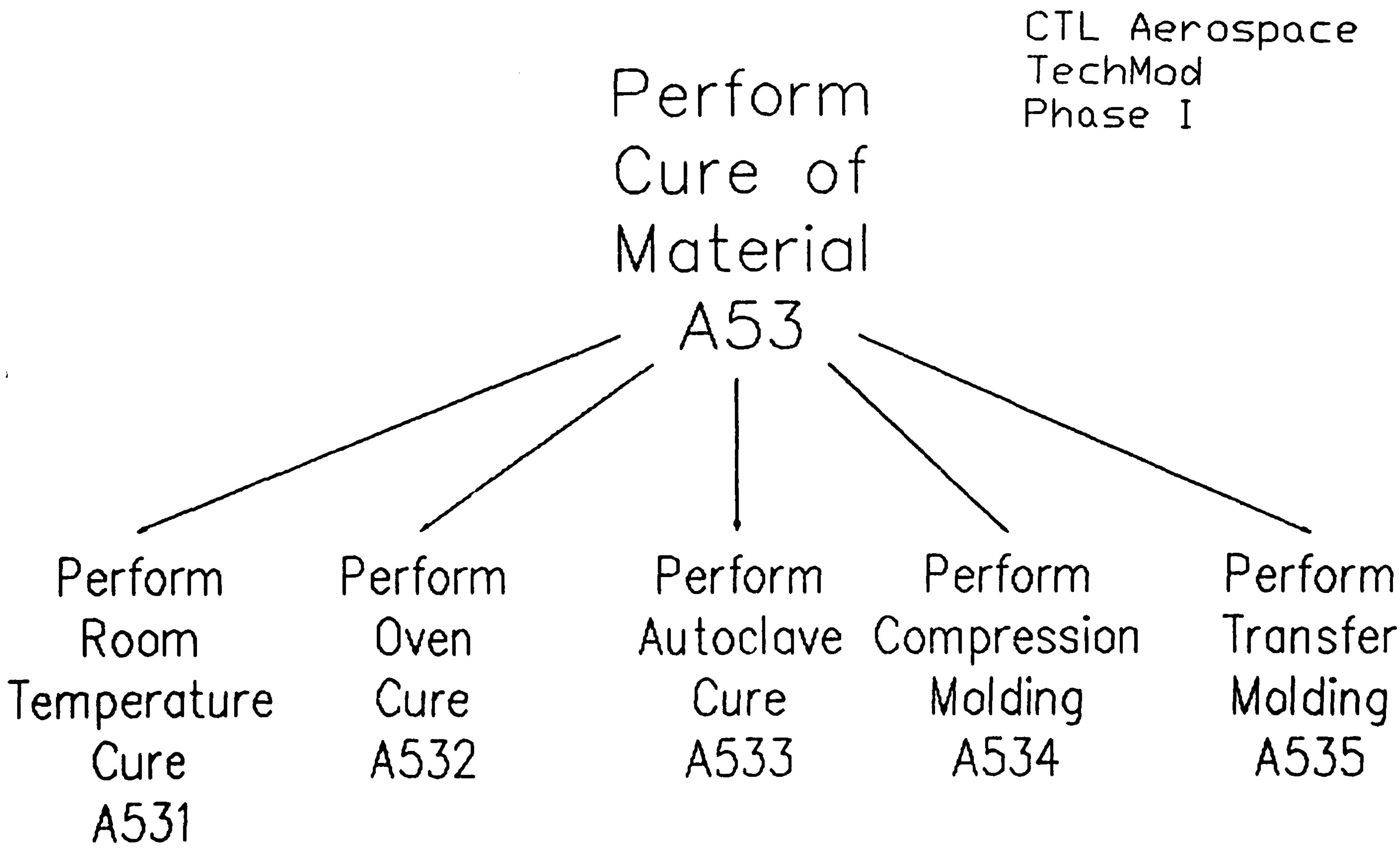
CTL Aerospace
TechMod
Phase I

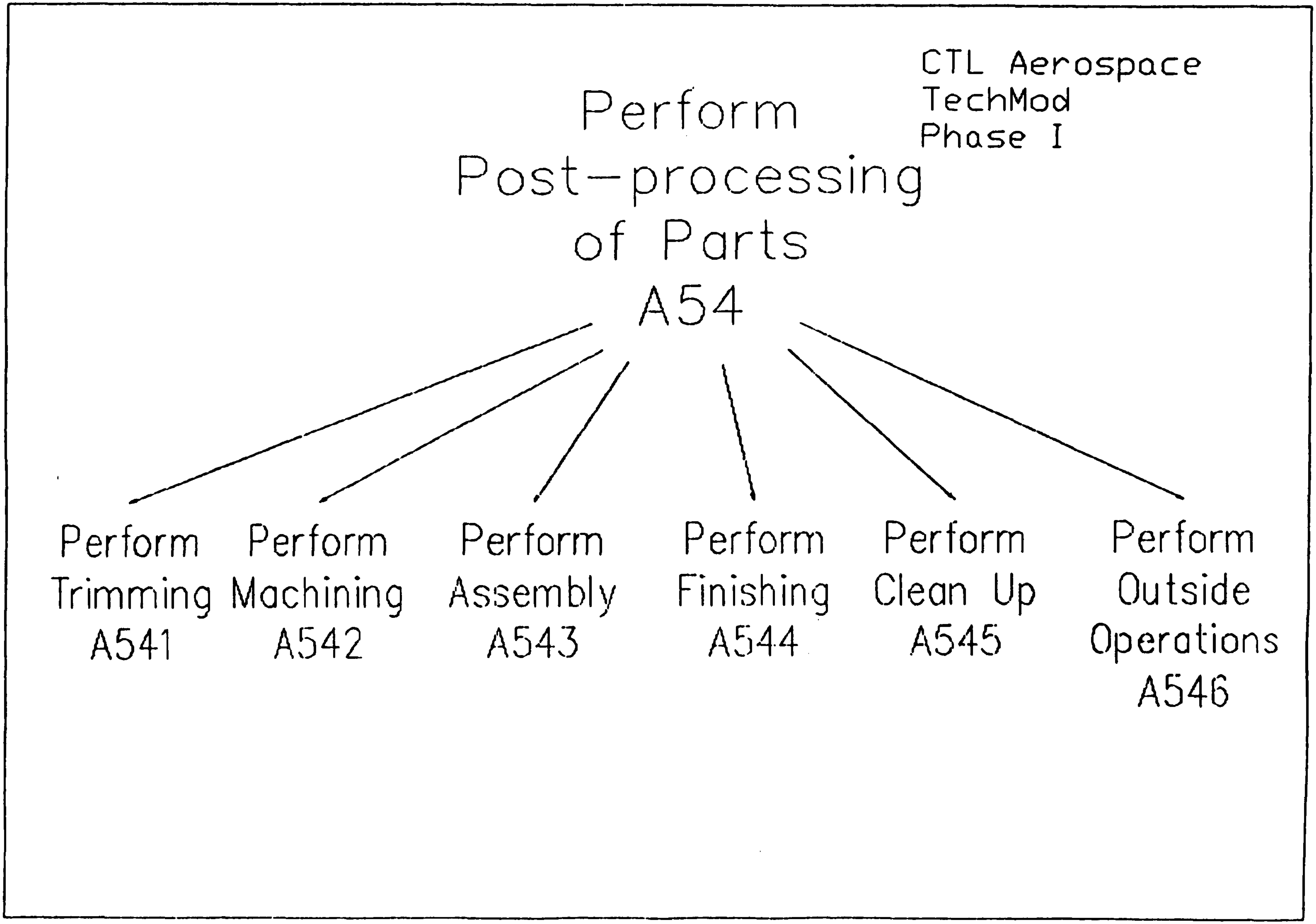


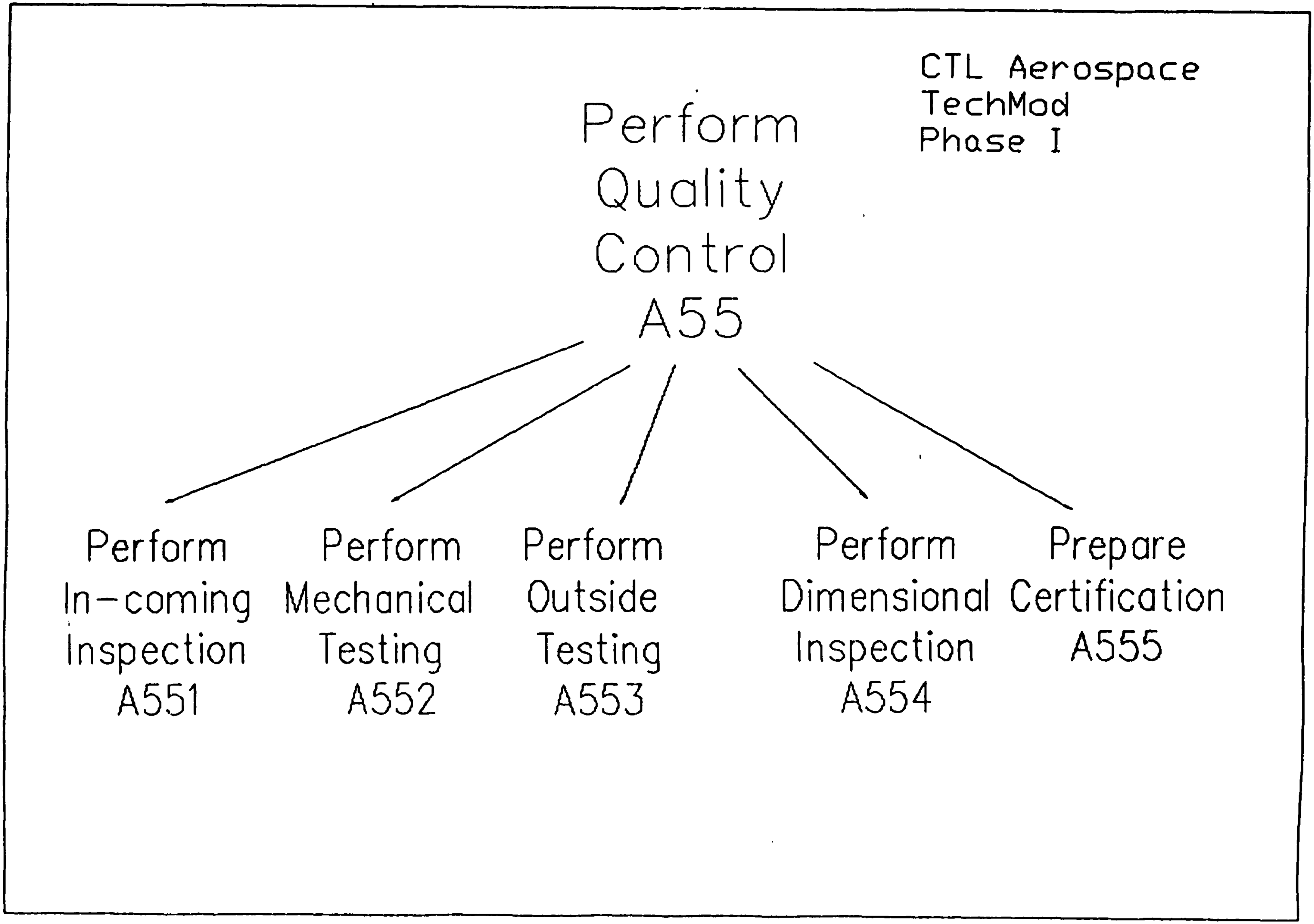

CTL Aerospace
TechMod
Phase I
Control
Production
A44
Issue
Jobs
A441
Expedite
Jobs
A442
Perform
Project/
Program
Management
A443
Provide
Quality
Assurance
A444
Perform
Problem
Resolution
A445


CTL Aerospace
TechMod
Phase I
Perform Program Set-up A51
Clean & Prep Tool Surfaces A511
Apply Release Agent A512
Develop Fabrication Aids A513
Pre-cut Material Charge A514

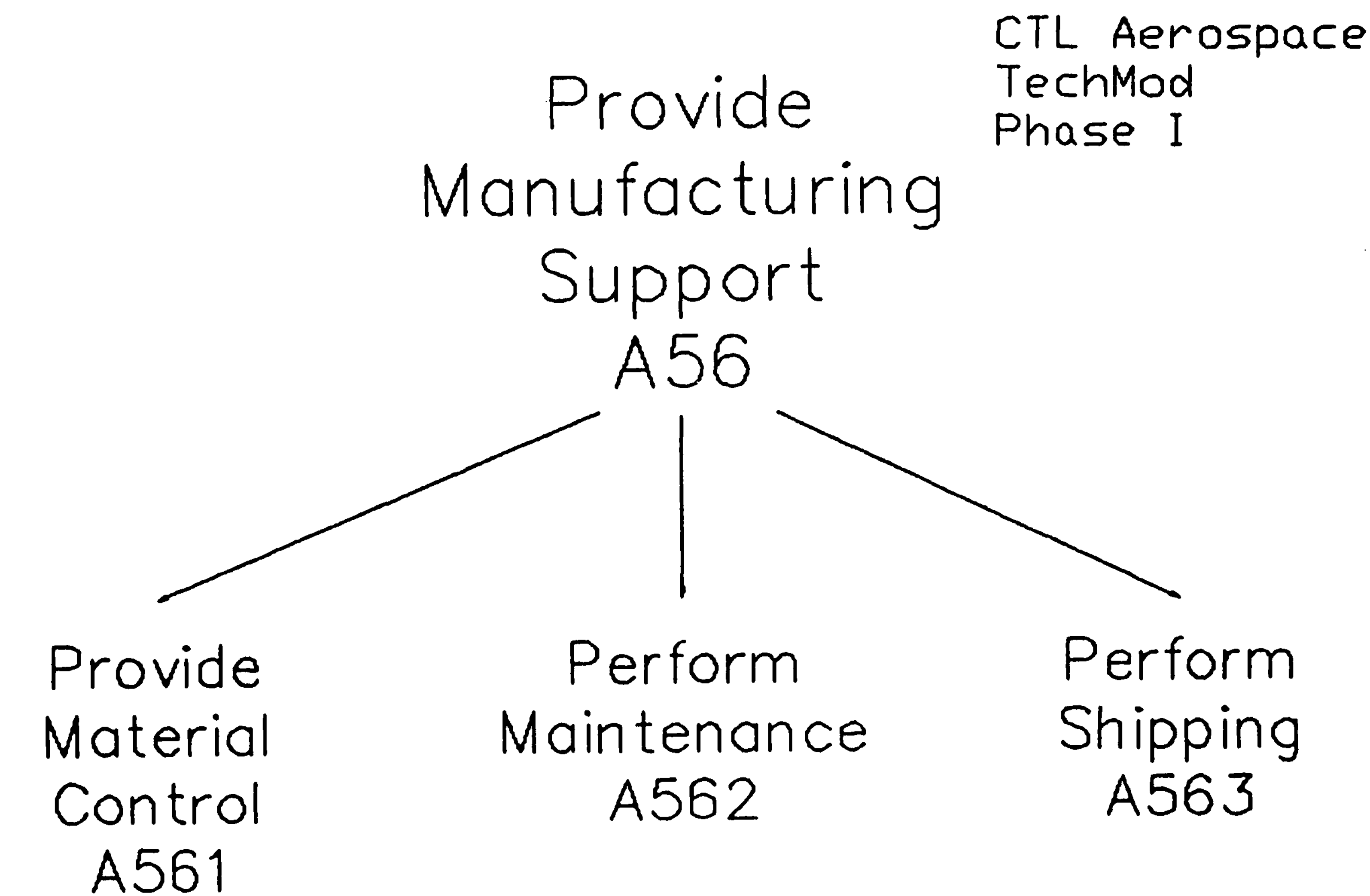

CTL Aerospace
TechMod
Phase I
Prepare
Material
Charge
A52
Perform
Wet
Layup
A521
Perform
"B" Staged
Layup
A522
Debulk
Material
Layup
A523
Perform
Final Bag
Layup
A524
Weigh
Material
Charge
A525
Produce
Material
Preform
A526

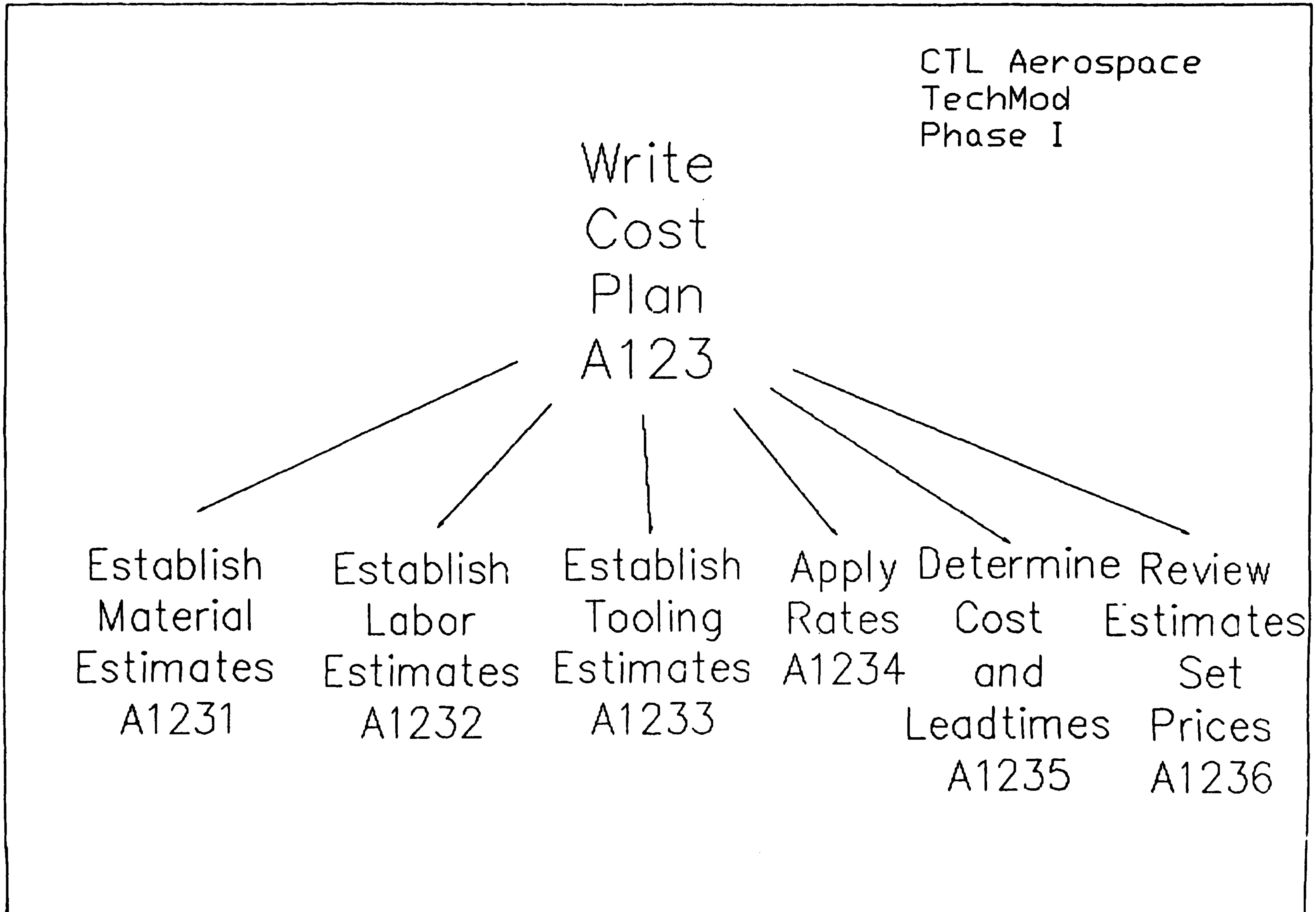

CTL Aerospace
TechMod
Phase I
Perform
Cure of
Material
A53
Perform
Room
Temperature
Cure
A531
Perform
Oven
Cure
A532
Perform
Autoclave
Cure
A533
Perform
Compression
Molding
A534
Perform
Transfer
Molding
A535

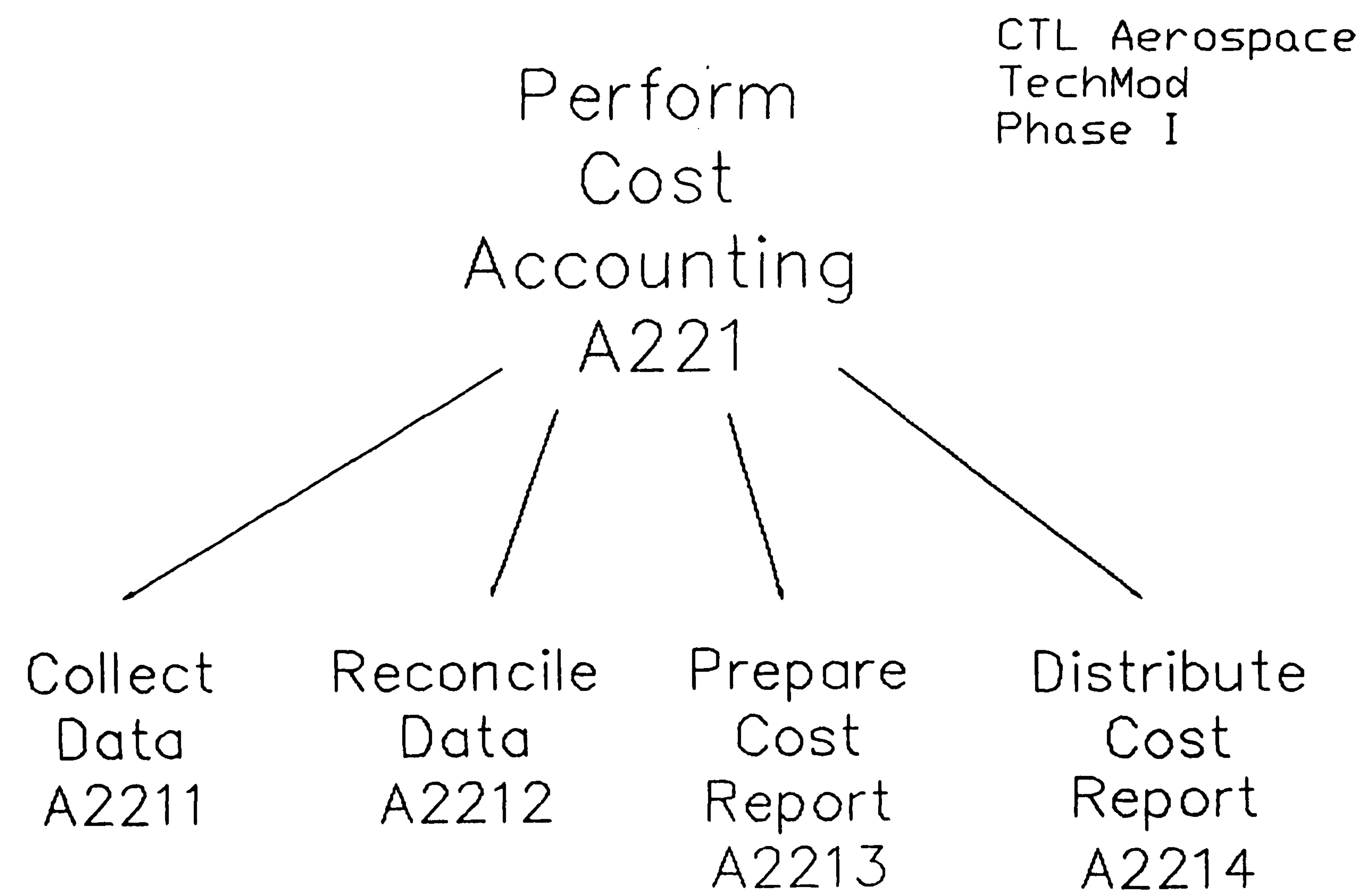

CTL Aerospace
TechMod
Phase I
Perform
Post-processing
of Parts
A54
Perform
Trimming
A541
Perform
Machining
A542
Perform
Assembly
A543
Perform
Finishing
A544
Perform
Clean Up
A545
Perform
Outside
Operations
A546

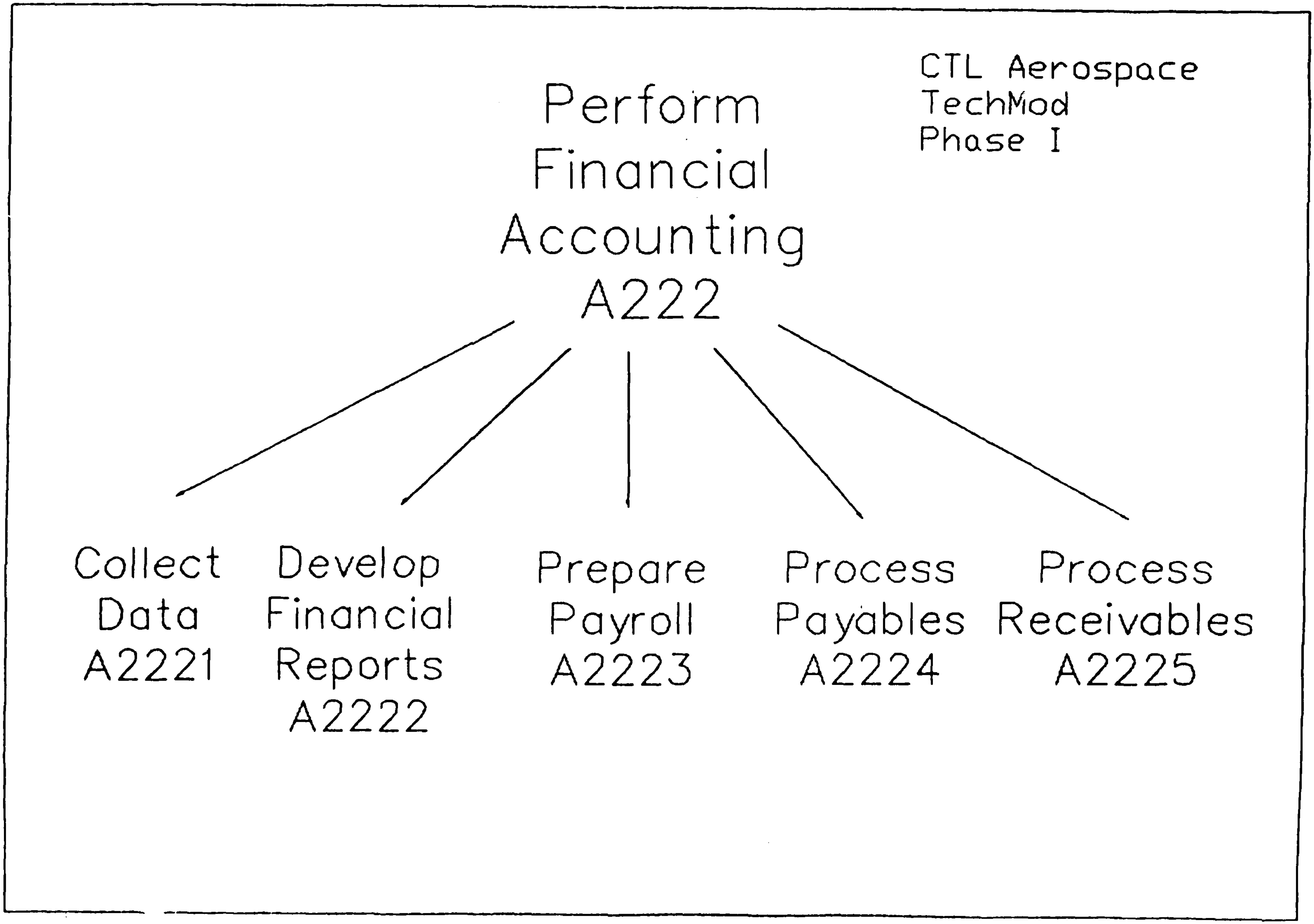


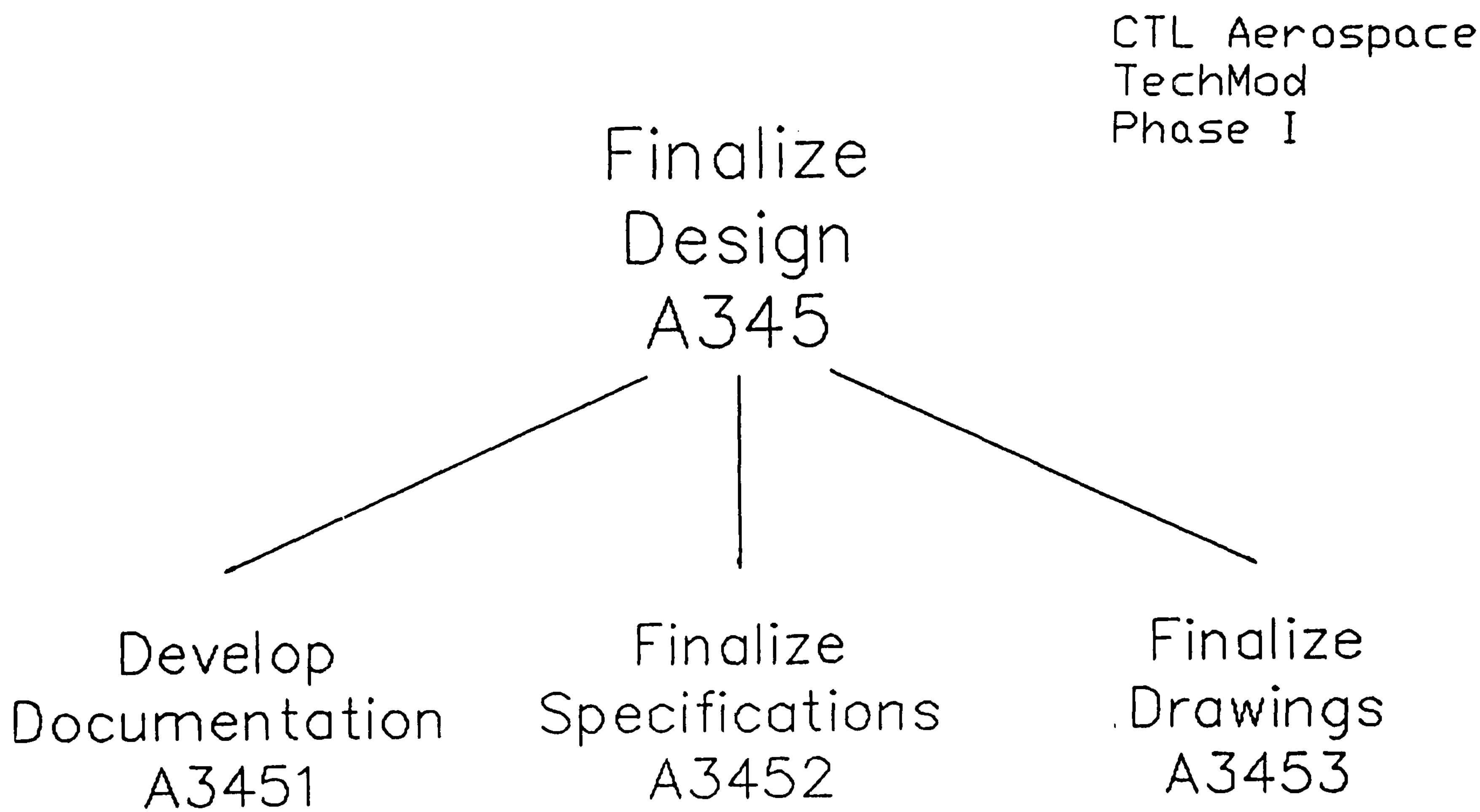
CTL Aerospace
TechMod
Phase I
Perform
Quality
Control
A55
Perform
In-coming
Inspection
A551
Perform
Mechanical
Testing
A552
Perform
Outside
Testing
A553
Perform
Dimensional
Inspection
A554
Prepare
Certification
A555

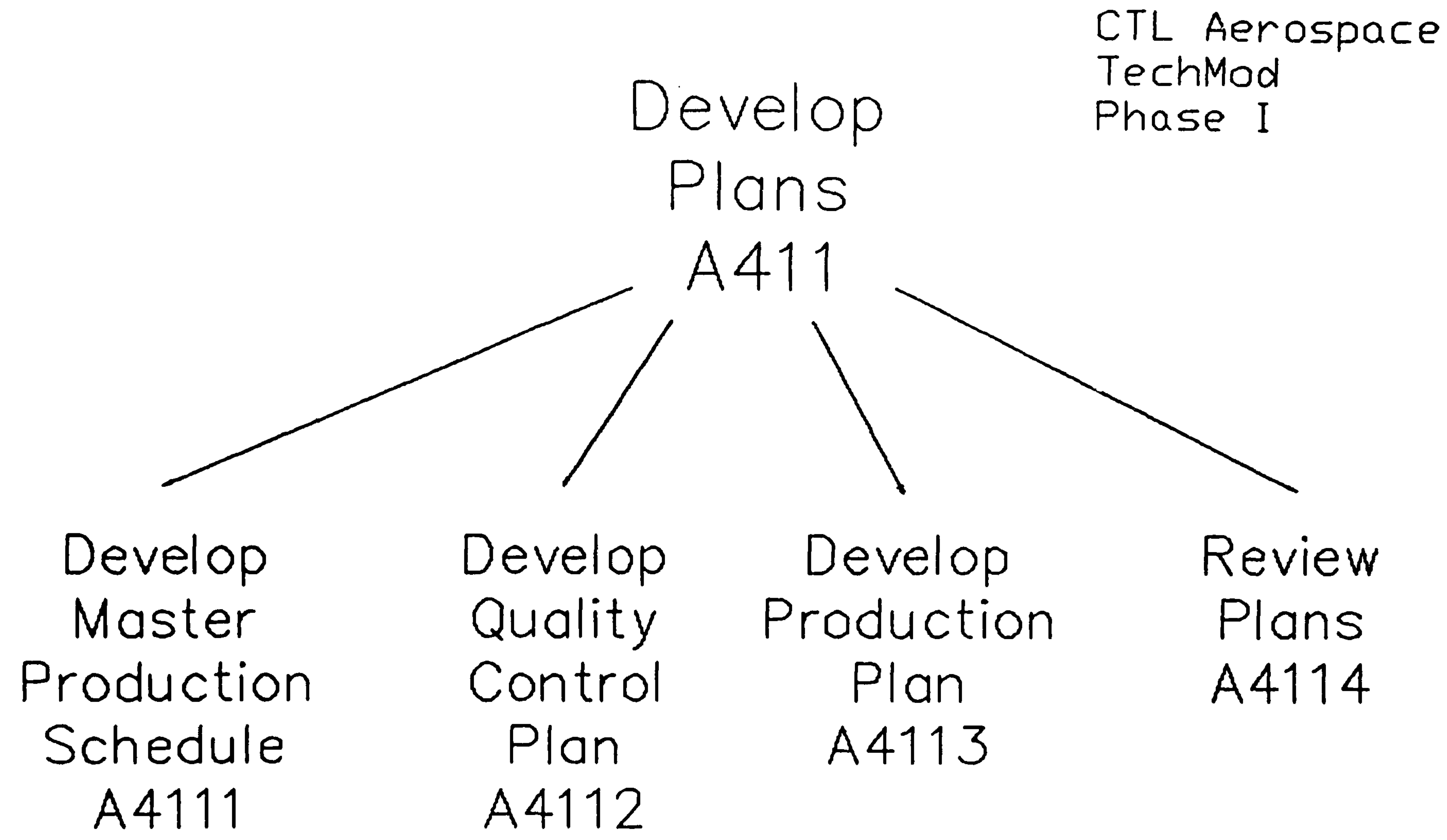

CTL Aerospace
TechMod
Phase I
Provide
Manufacturing
Support
A56
Provide
Material
Control
A561
Perform
Maintenance
A562
Perform
Shipping
A563


CTL Aerospace
TechMod
Phase I
Write Cost Plan A123
Establish Material Estimates A1231
Establish Labor Estimates A1232
Establish Tooling Estimates A1233
Apply Rates A1234
Determine Cost and Leadtimes A1235
Review Estimates Set Prices A1236

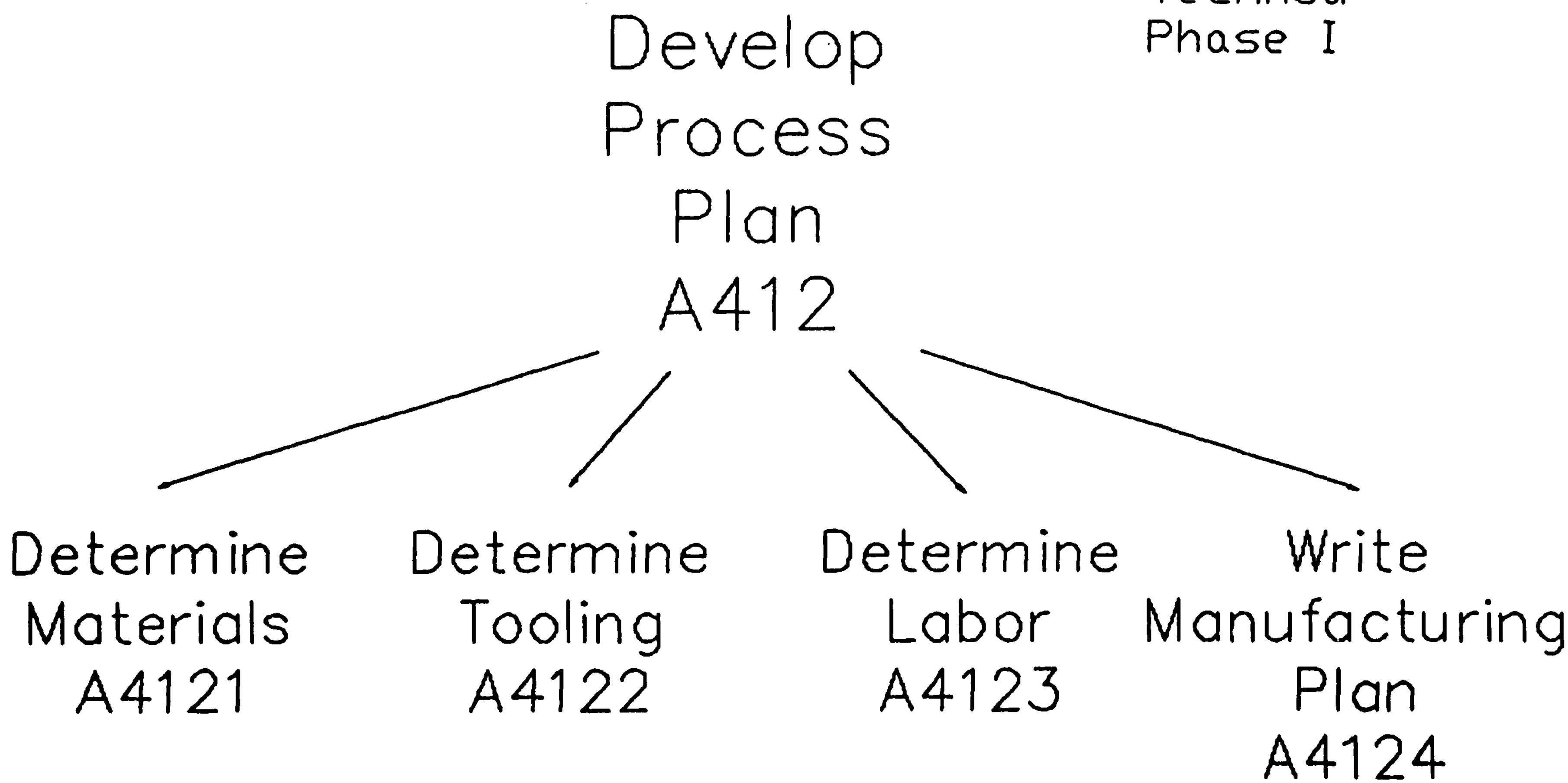

CTL Aerospace
TechMod
Phase I
Perform
Cost
Accounting
A221
Collect
Data
A2211
Reconcile
Data
A2212
Prepare
Cost
Report
A2213
Distribute
Cost
Report
A2214


CTL Aerospace
TechMod
Phase I
Perform Financial Accounting A222
Collect Data A2221
Develop Financial Reports A2222
Prepare Payroll A2223
Process Payables A2224
Process Receivables A2225

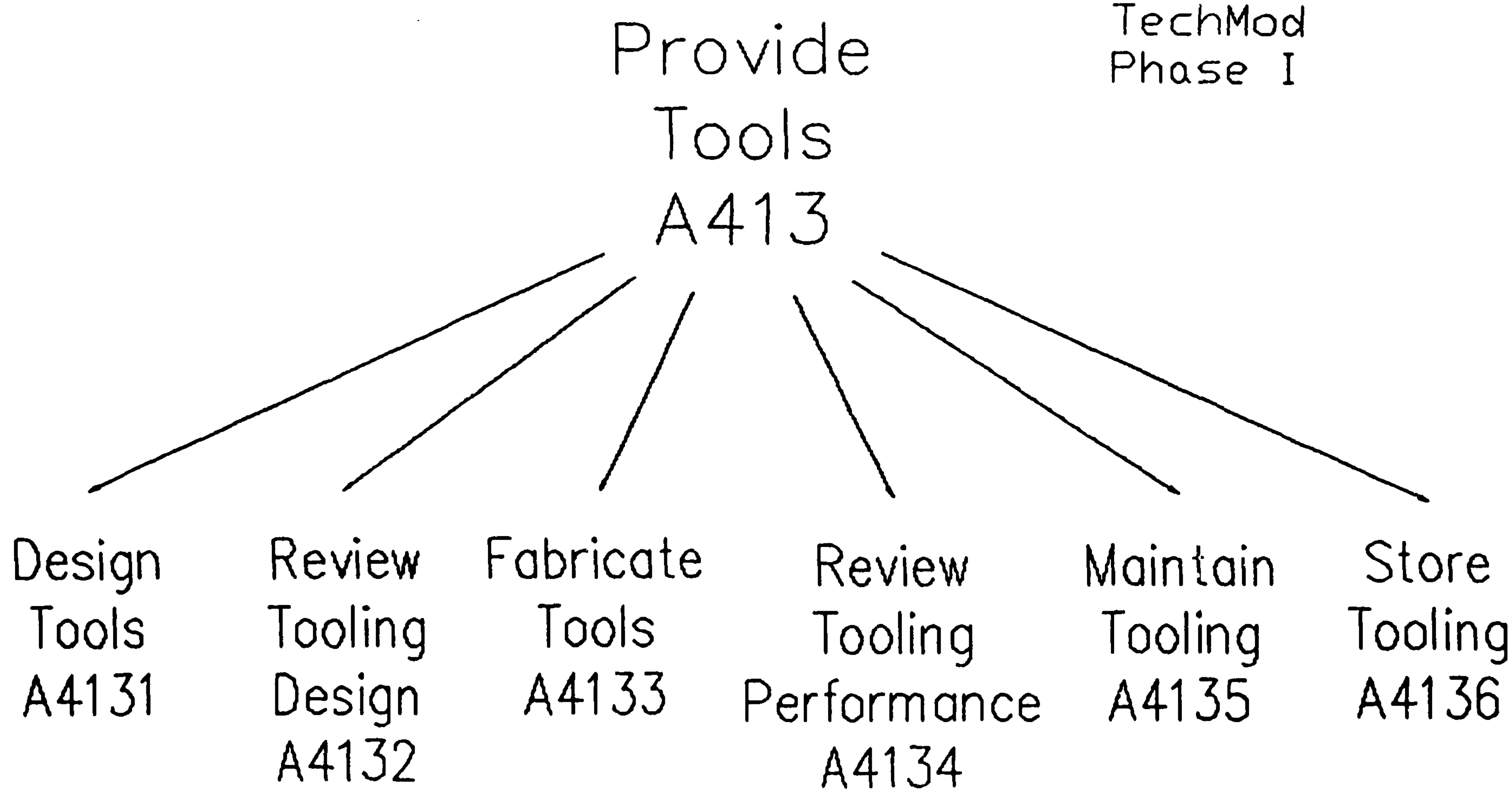

CTL Aerospace
TechMod
Phase I
Finalize
Design
A345
Develop
Documentation
A3451
Finalize
Specifications
A3452
Finalize
Drawings
A3453

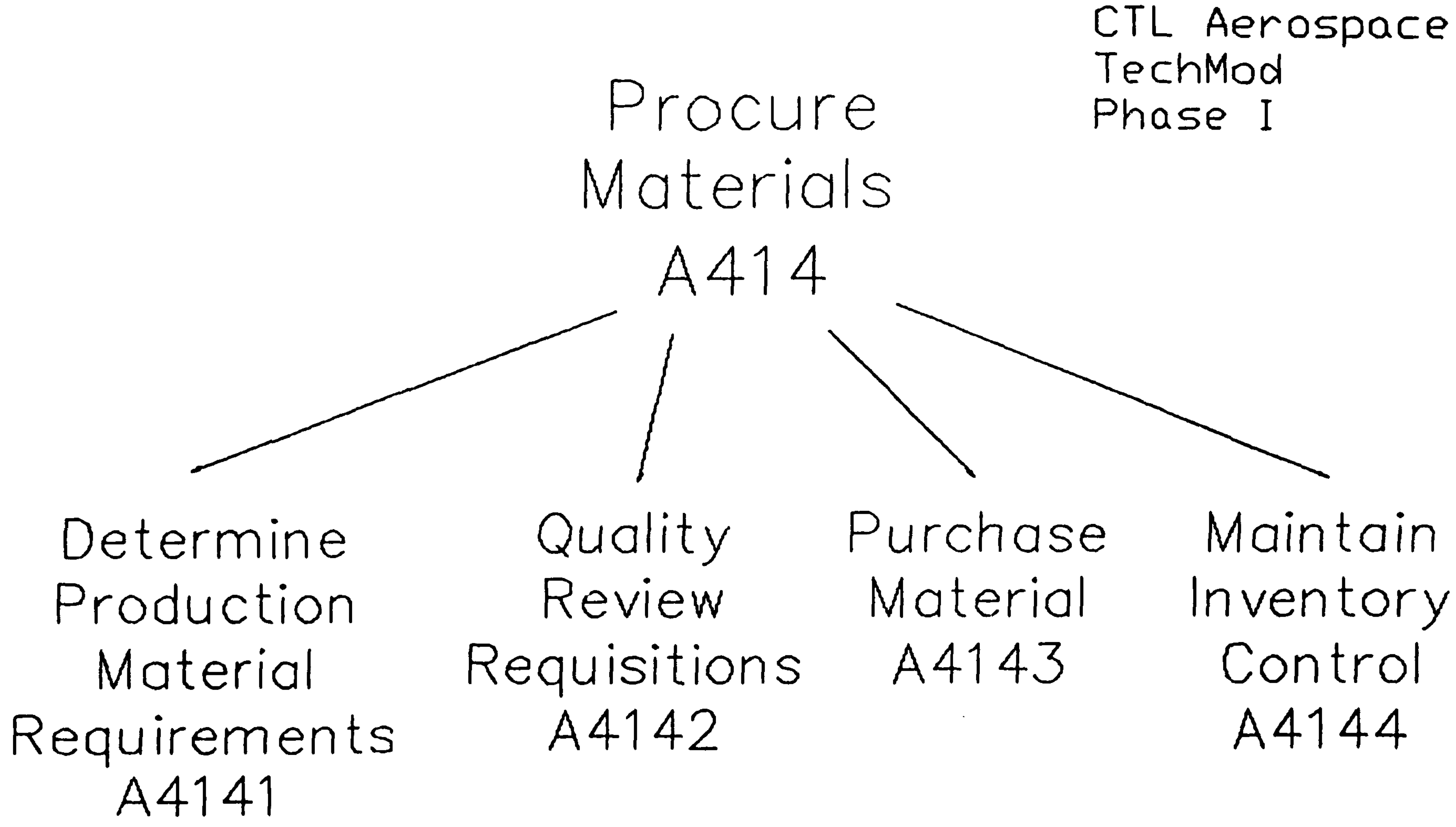

CTL Aerospace
TechMod
Phase I
Develop
Plans
A411
Develop
Master
Production
Schedule
A4111
Develop
Quality
Control
Plan
A4112
Develop
Production
Plan
A4113
Review
Plans
A4114

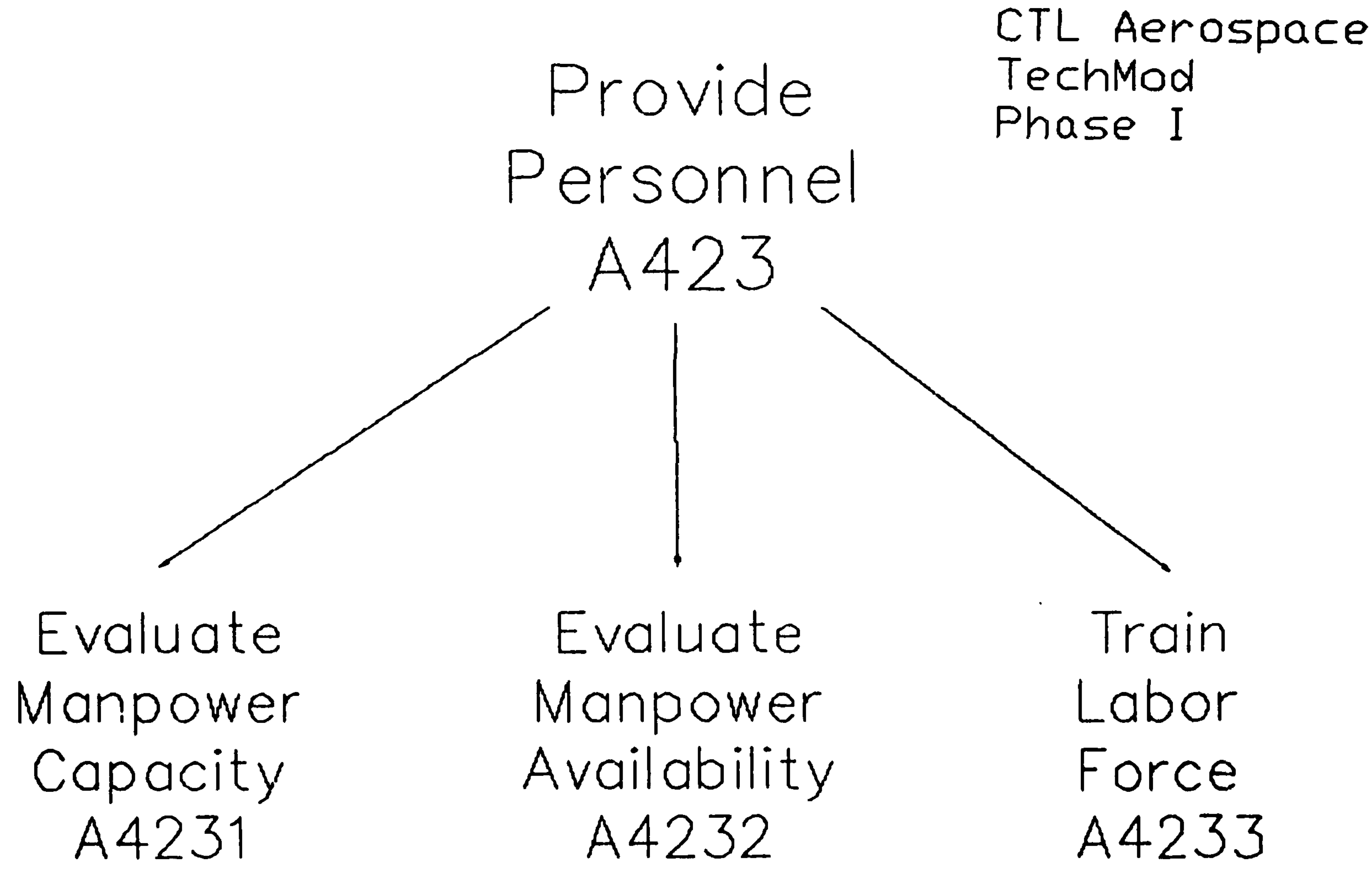
CTL Aerospace
TechMod
Phase I



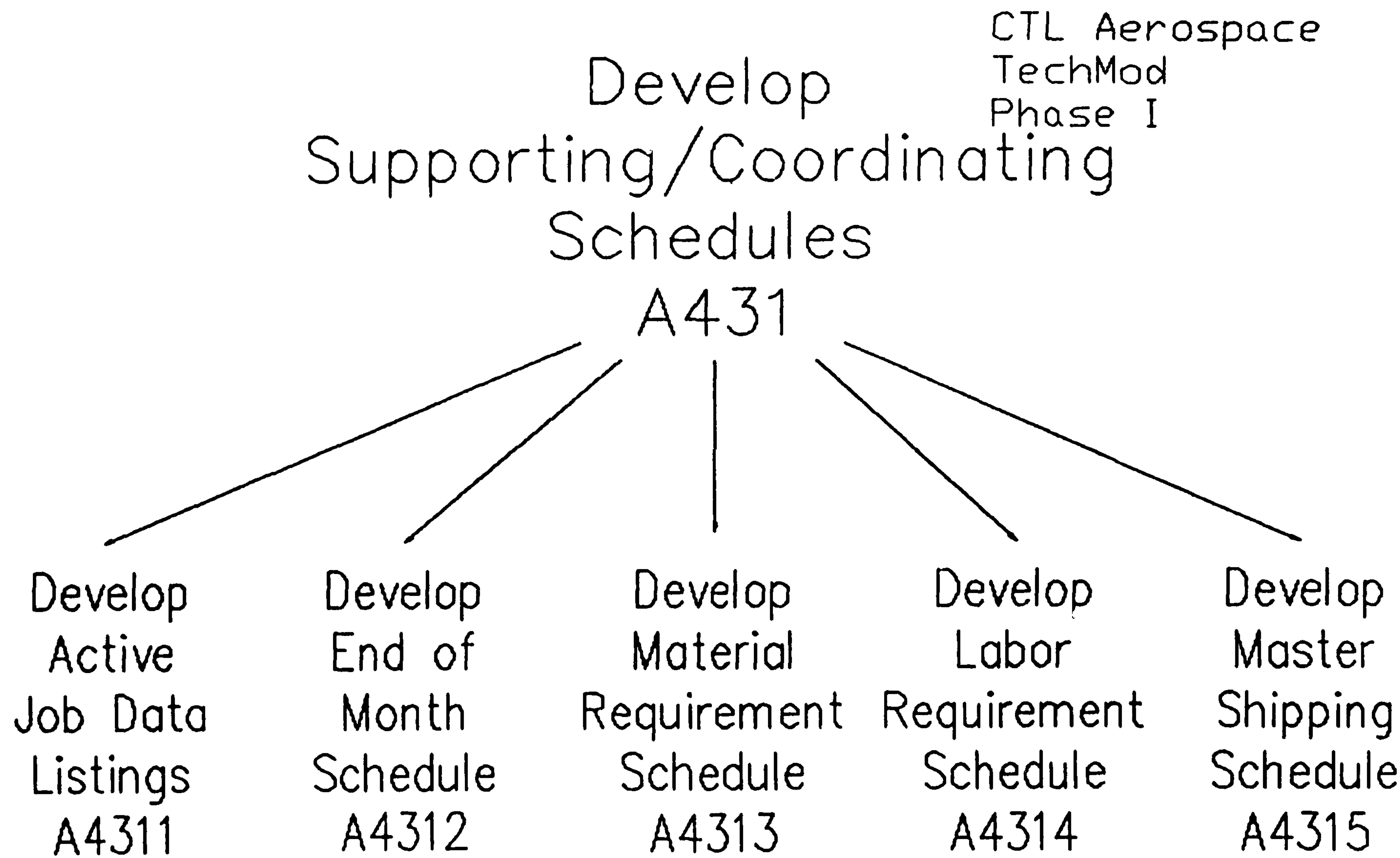
CTL Aerospace
TechMod
Phase I



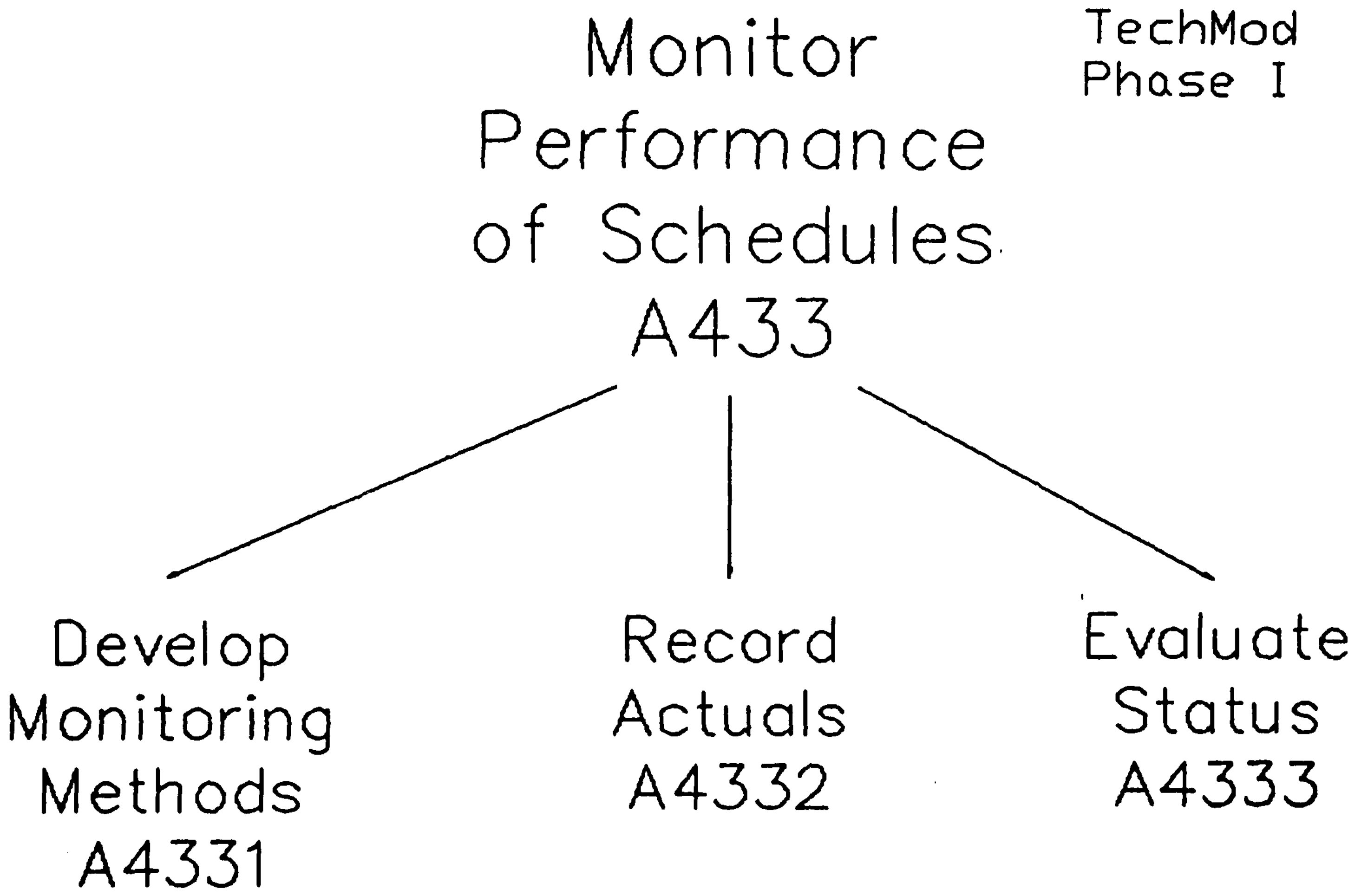

CTL Aerospace
TechMod
Phase I
Procure
Materials
A414
Determine
Production
Material
Requirements
A4141
Quality
Review
Requisitions
A4142
Purchase
Material
A4143
Maintain
Inventory
Control
A4144



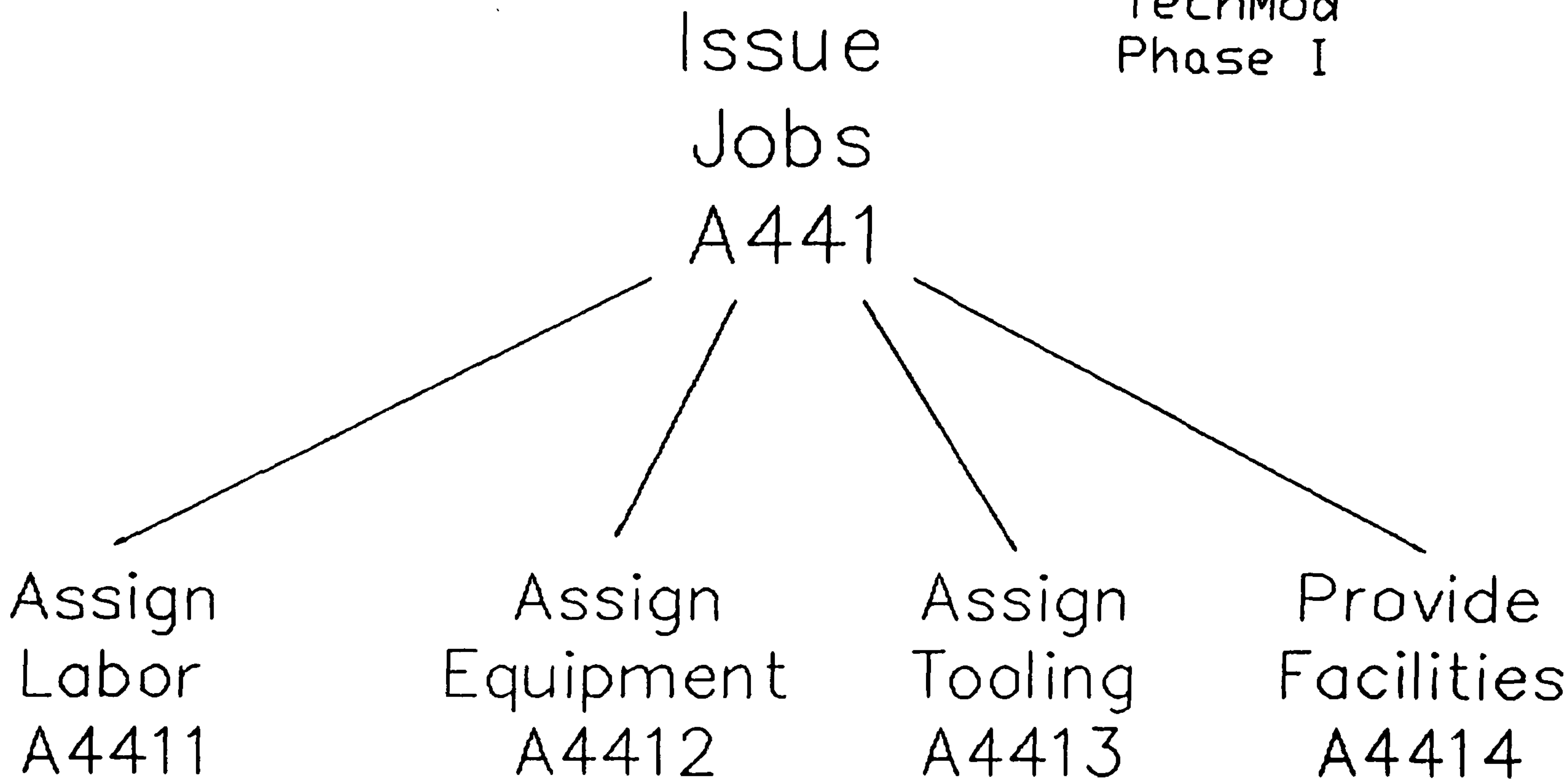
CTL Aerospace
TechMod
Phase I
Provide Personnel A423
Evaluate Manpower Capacity A4231
Evaluate Manpower Availability A4232
Train Labor Force A4233

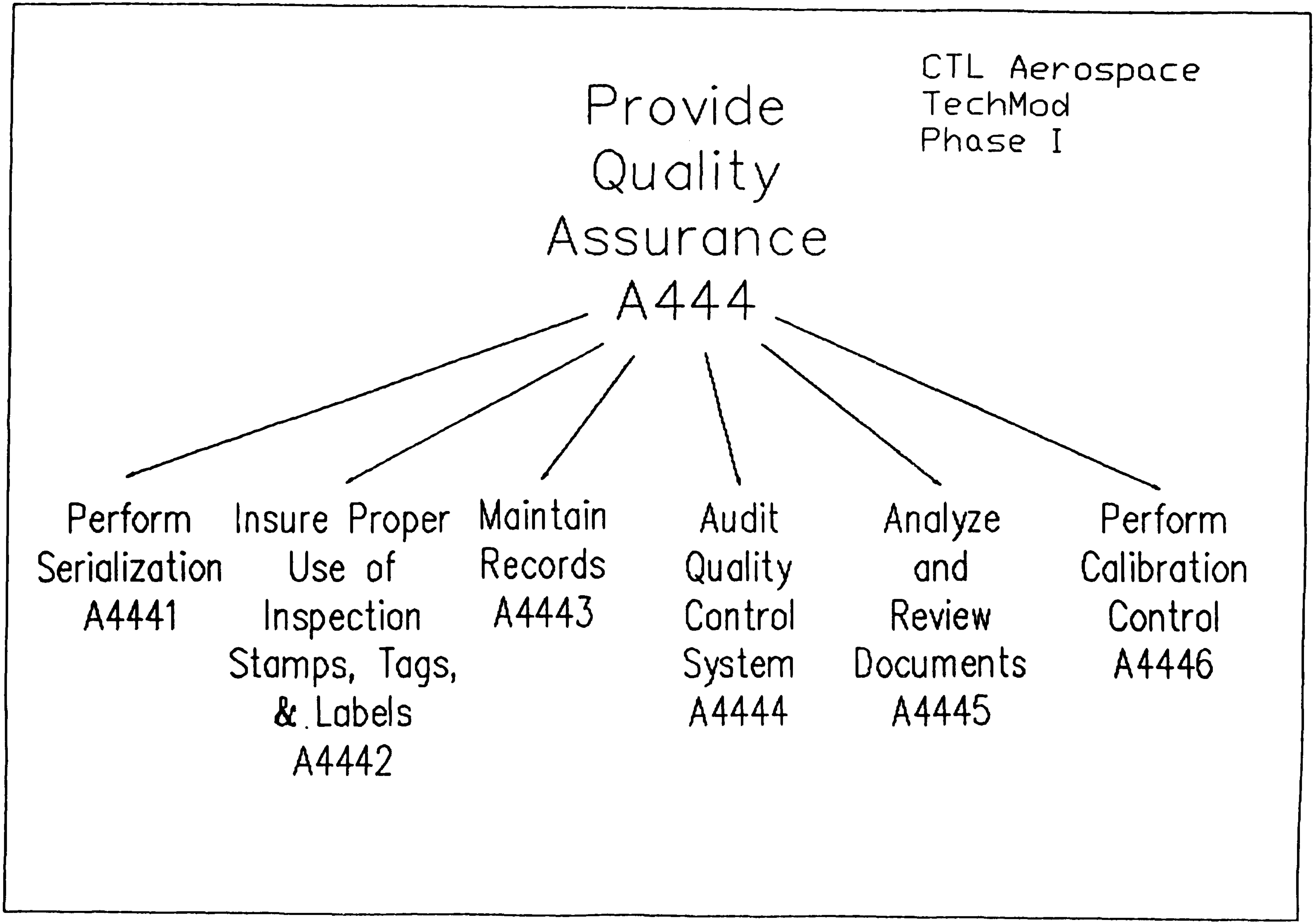

CTL Aerospace
TechMod
Phase I
Develop
Supporting/Coordinating
Schedules
A431
Develop
Active
Job Data
Listings
A4311
Develop
End of
Month
Schedule
A4312
Develop
Material
Requirement
Schedule
A4313
Develop
Labor
Requirement
Schedule
A4314
Develop
Master
Shipping
Schedule
A4315

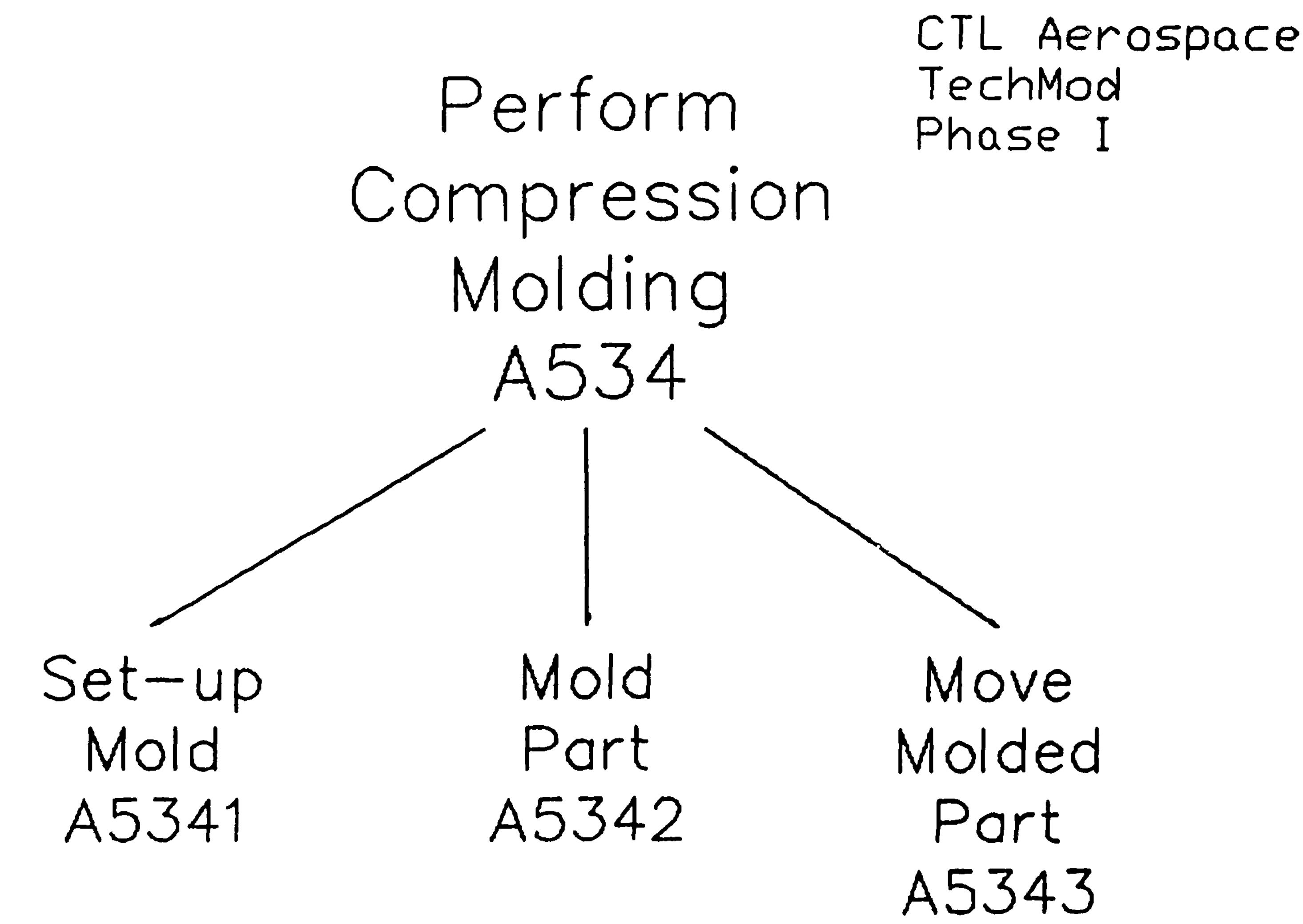
CTL Aerospace
TechMod
Phase I

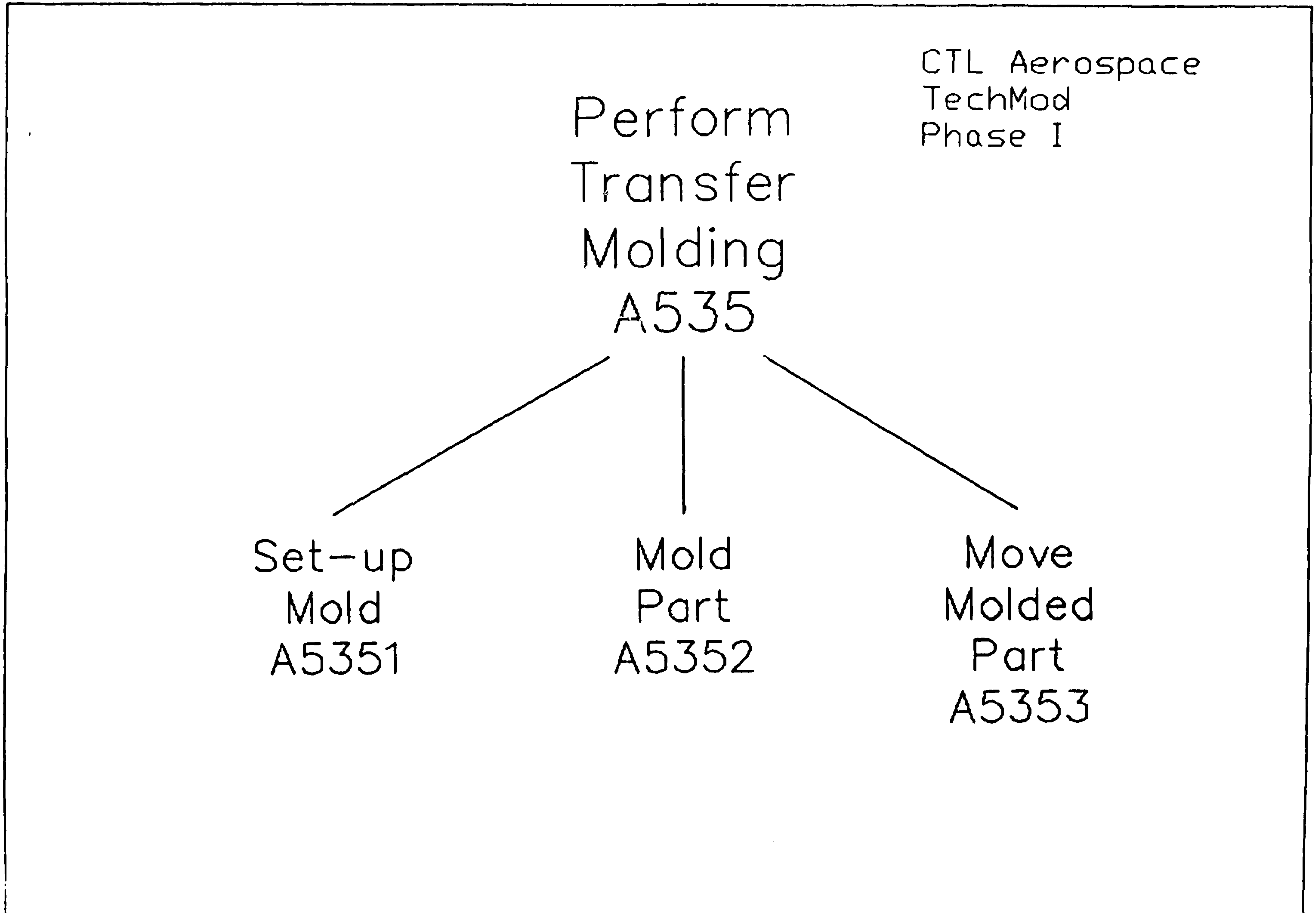


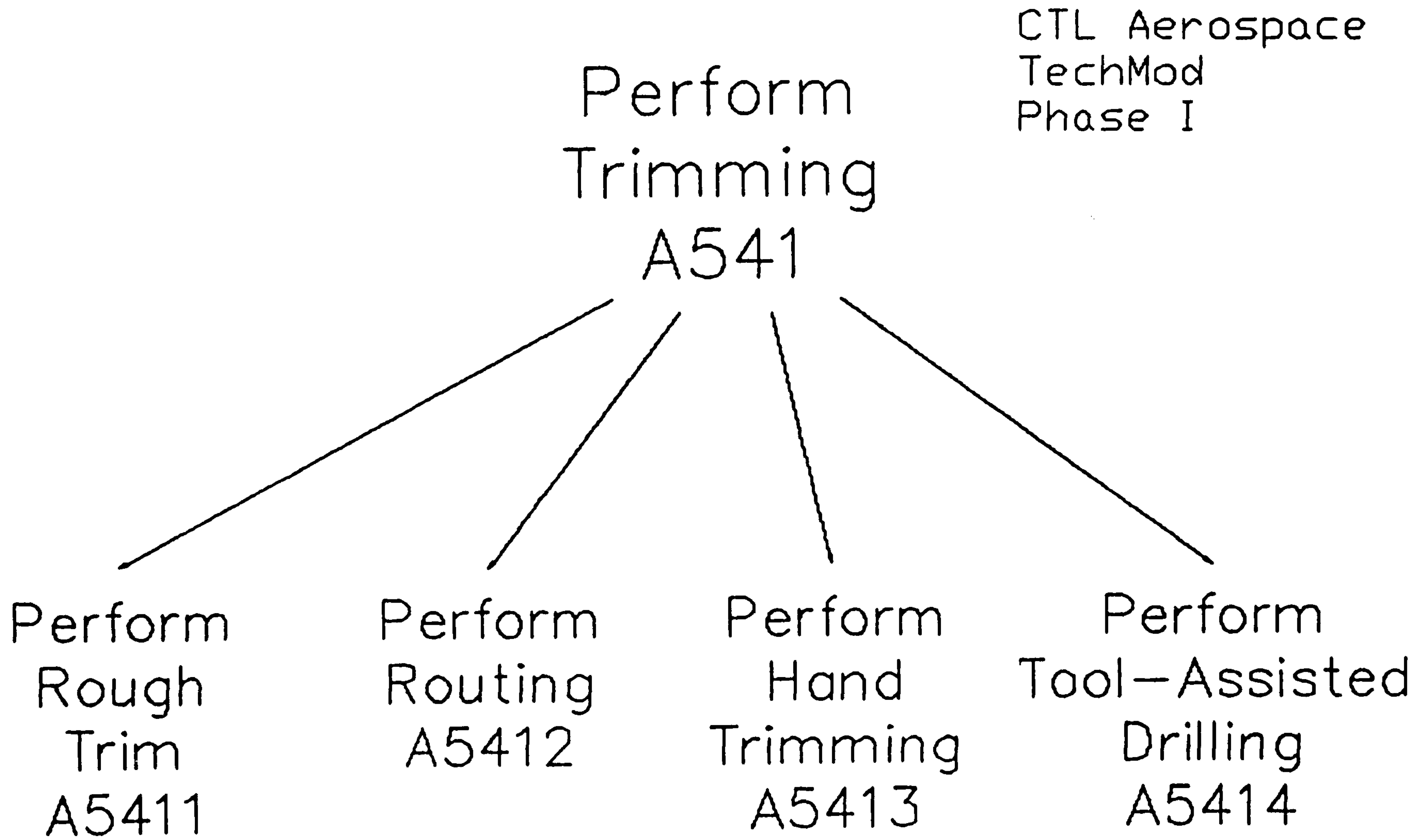
CTL Aerospace
TechMod
Phase I



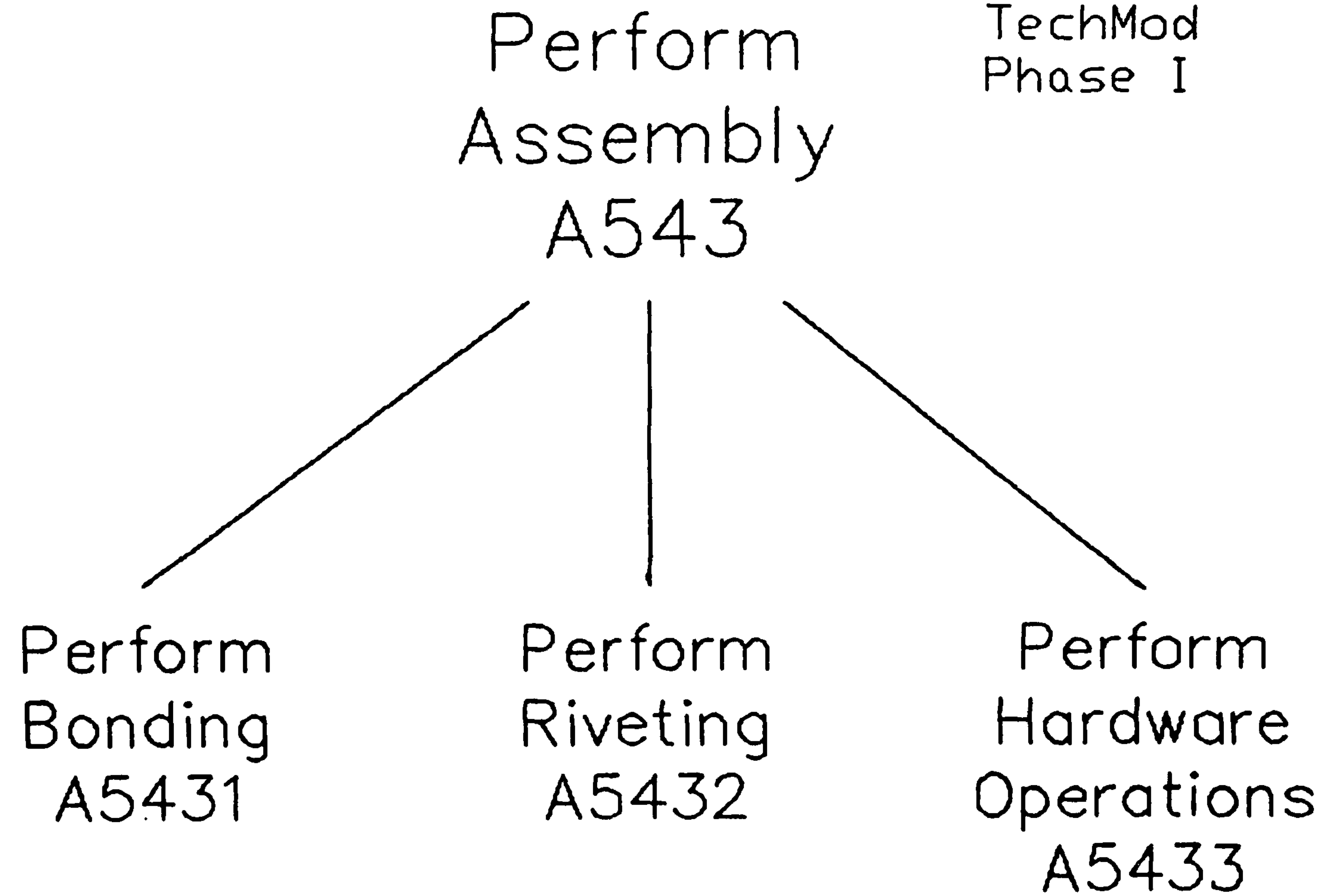

CTL Aerospace
TechMod
Phase I
Provide Quality Assurance A444
Perform Serialization A4441
Insure Proper Use of Inspection Stamps, Tags, & Labels A4442
Maintain Records A4443
Audit Quality Control System A4444
Analyze and Review Documents A4445
Perform Calibration Control A4446

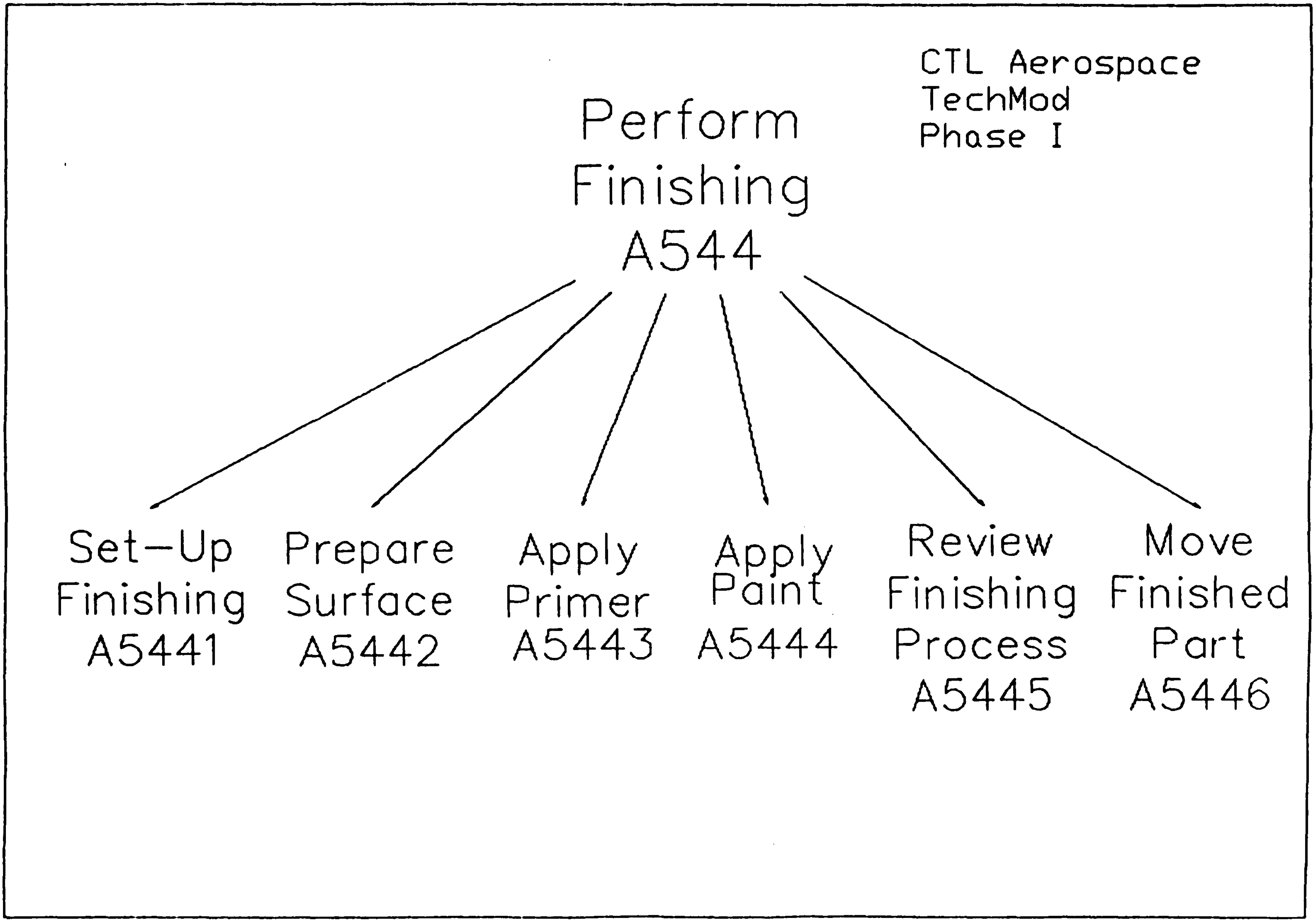

CTL Aerospace
TechMod
Phase I
Perform Compression Molding A534
Set-up Mold A5341
Mold Part A5342
Move Molded Part A5343

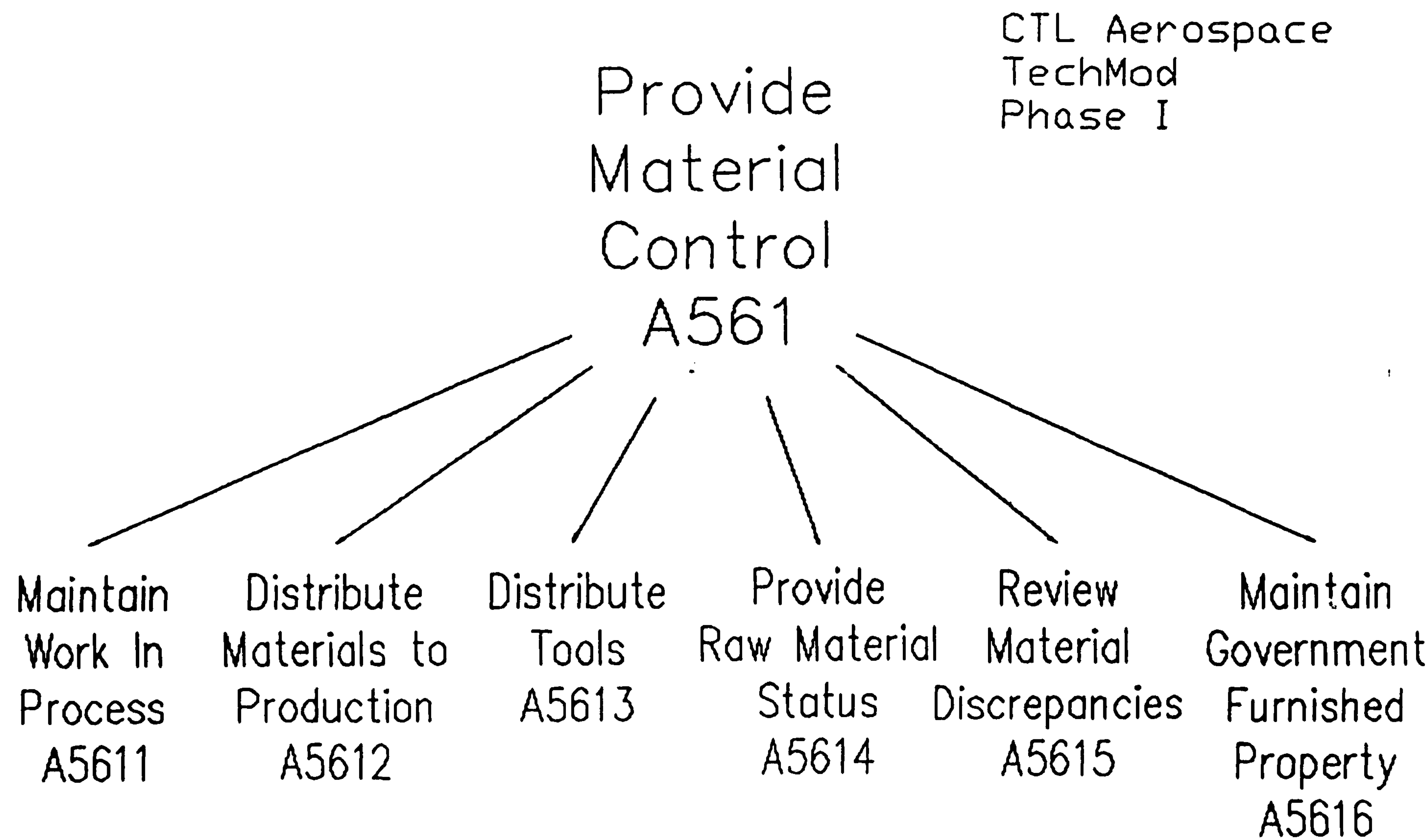

CTL Aerospace
TechMod
Phase I
Perform
Transfer
Molding
A535
Set-up
Mold
A5351
Mold
Part
A5352
Move
Molded
Part
A5353

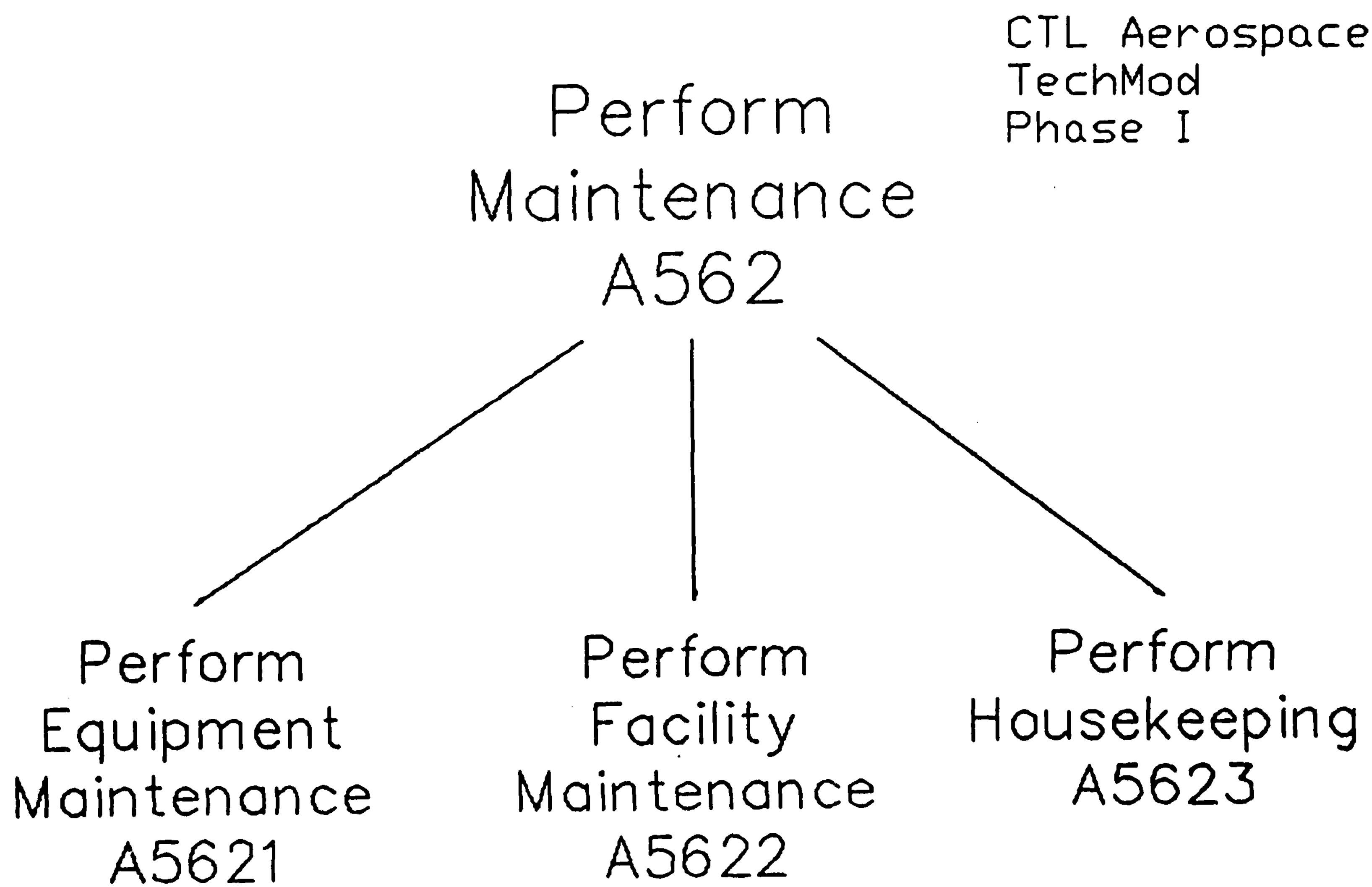

CTL Aerospace
TechMod
Phase I
Perform
Trimming
A541
Perform
Rough
Trim
A5411
Perform
Routing
A5412
Perform
Hand
Trimming
A5413
Perform
Tool-Assisted
Drilling
A5414

CTL Aerospace
TechMod
Phase I

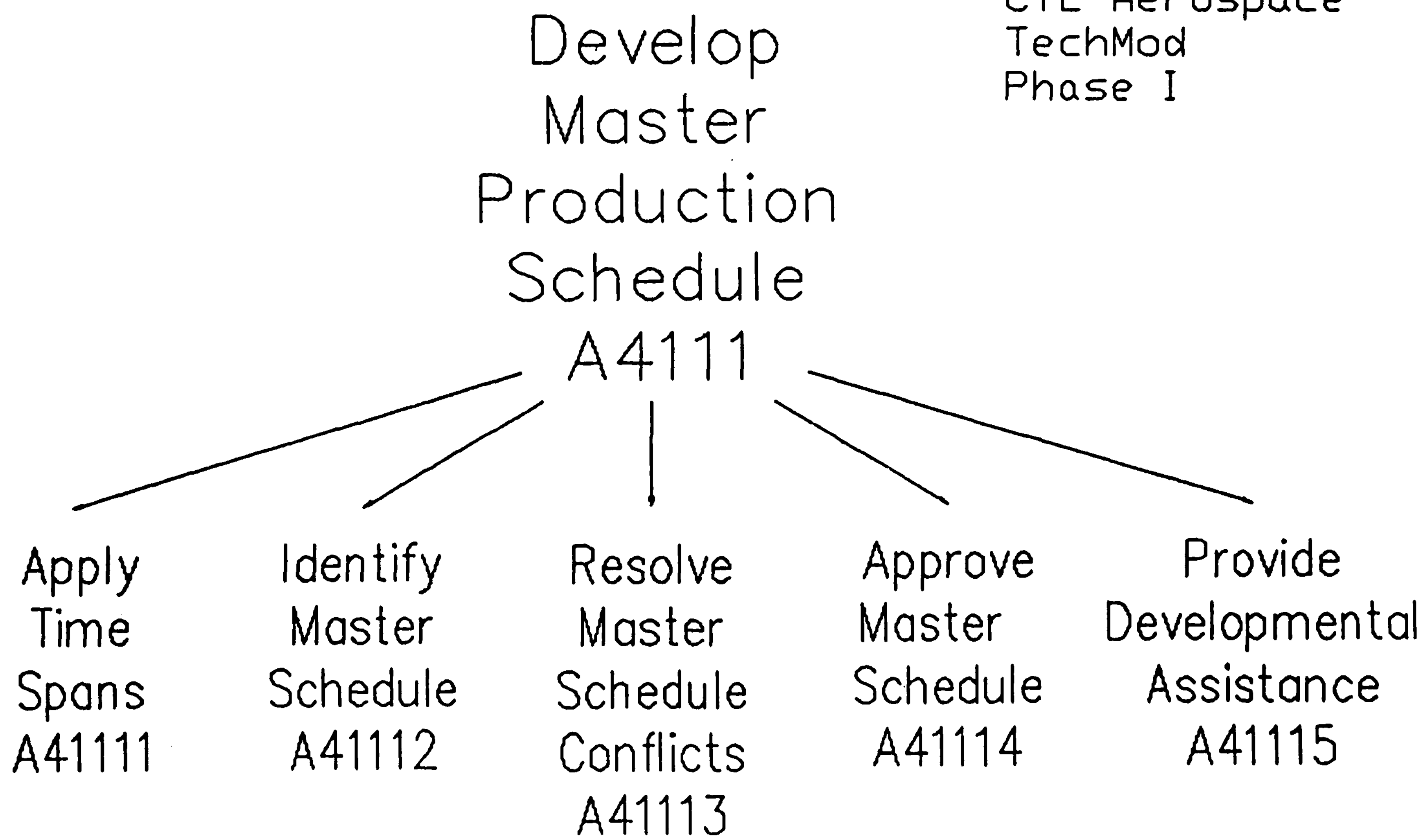



CTL Aerospace
TechMod
Phase I
Perform Finishing A544
Set-Up Finishing A5441
Prepare Surface A5442
Apply Primer A5443
Apply Paint A5444
Review Finishing Process A5445
Move Finished Part A5446

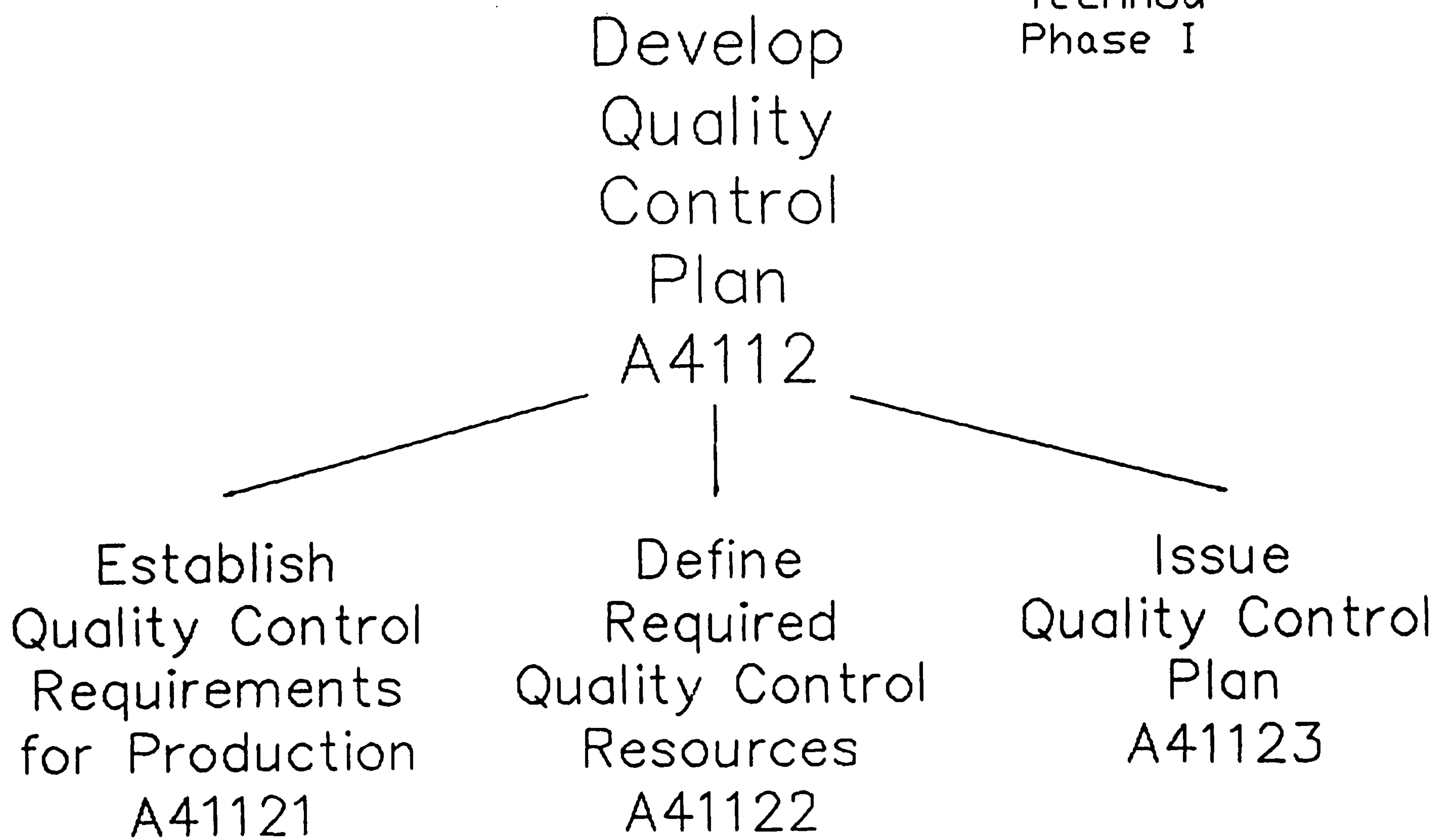

CTL Aerospace
TechMod
Phase I
Provide
Material
Control
A561
Maintain
Work In
Process
A5611
Distribute
Materials to
Production
A5612
Distribute
Tools
A5613
Provide
Raw Material
Status
A5614
Review
Material
Discrepancies
A5615
Maintain
Government
Furnished
Property
A5616

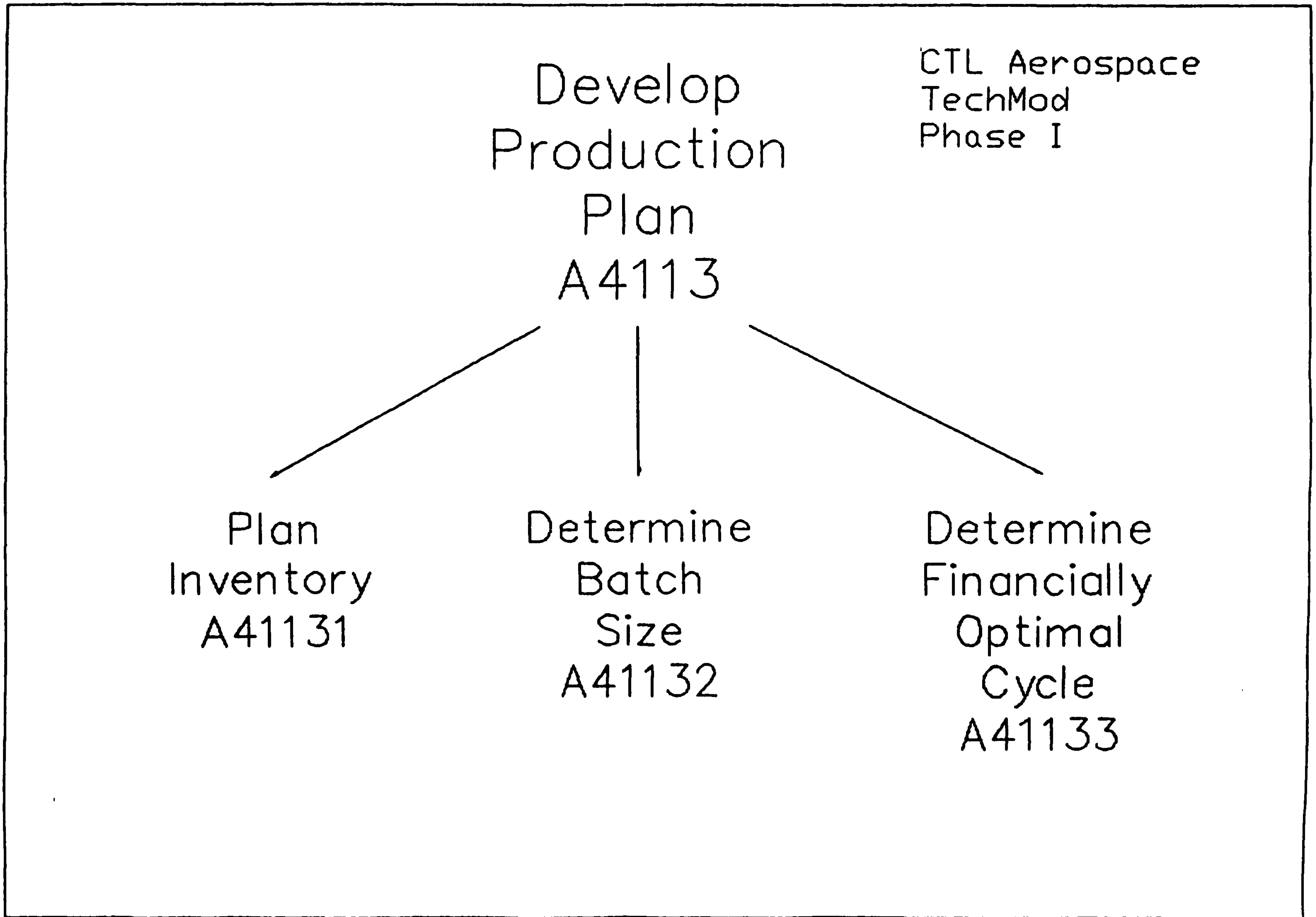

CTL Aerospace
TechMod
Phase I
Perform
Maintenance
A562
Perform
Equipment
Maintenance
A5621
Perform
Facility
Maintenance
A5622
Perform
Housekeeping
A5623

CTL Aerospace
TechMod
Phase I

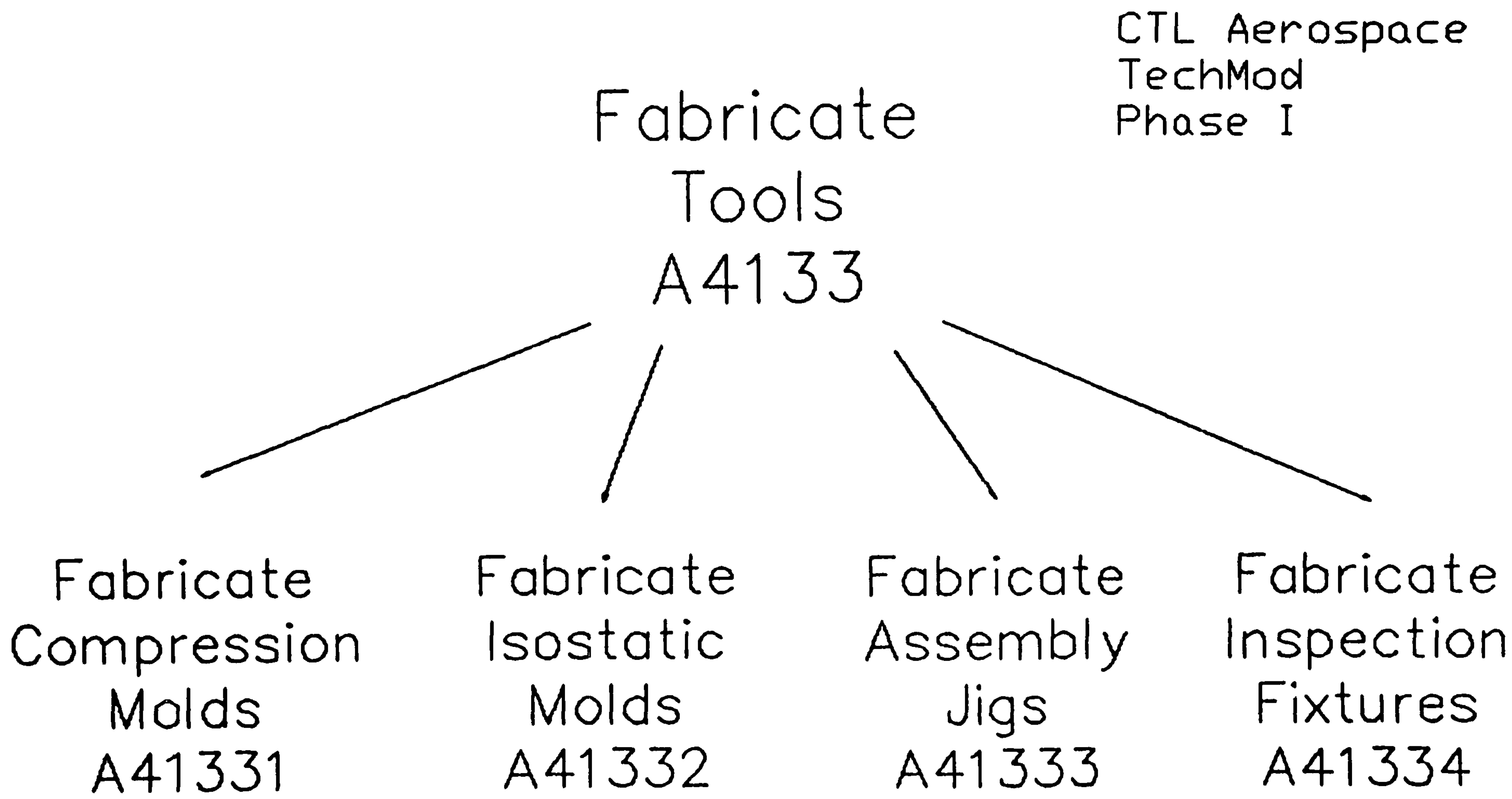


CTL Aerospace
TechMod
Phase I

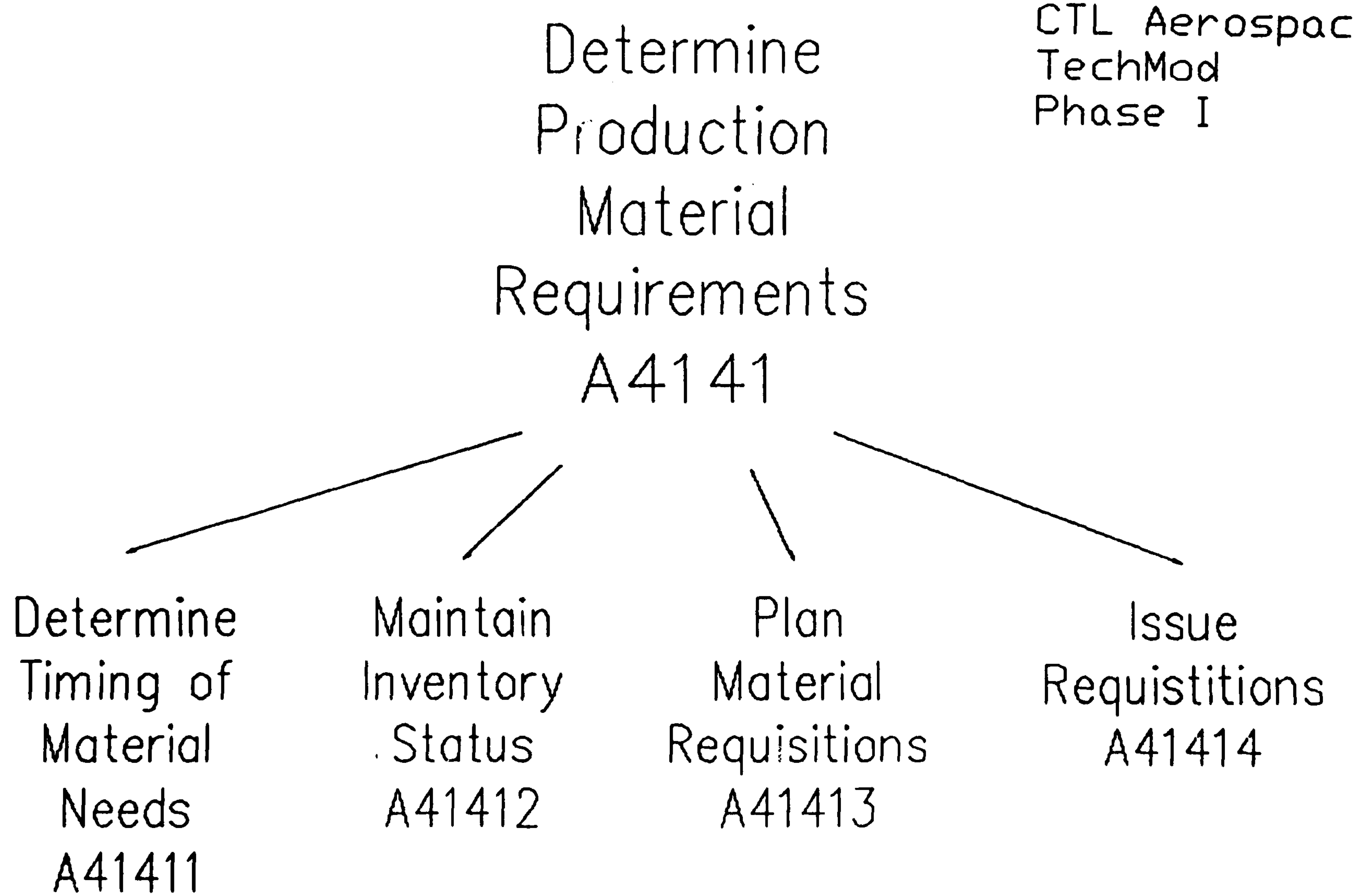


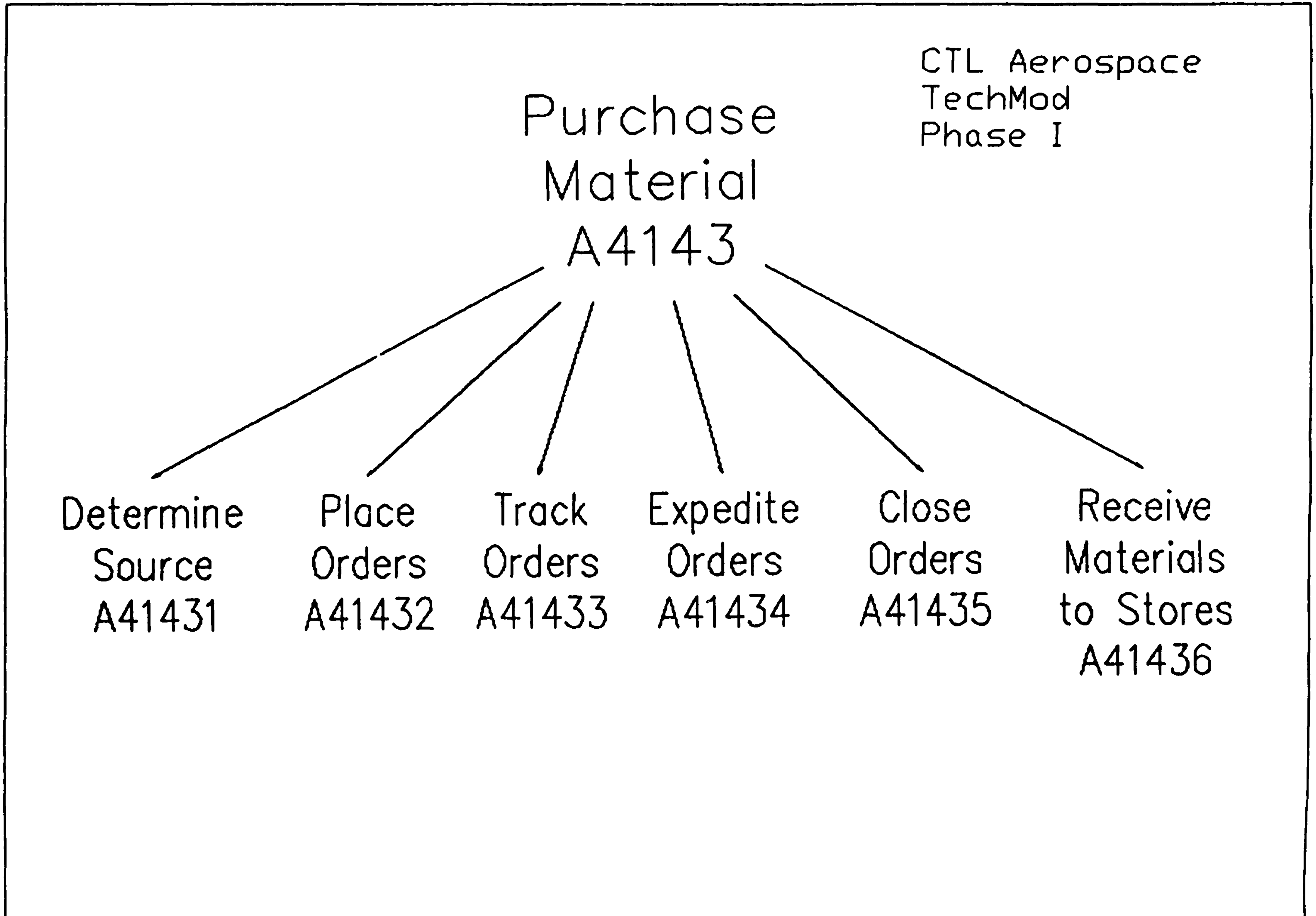


CTL Aerospace
TechMod
Phase I
Develop Production Plan A4113
Plan Inventory A41131
Determine Batch Size A41132
Determine Financially Optimal Cycle A41133

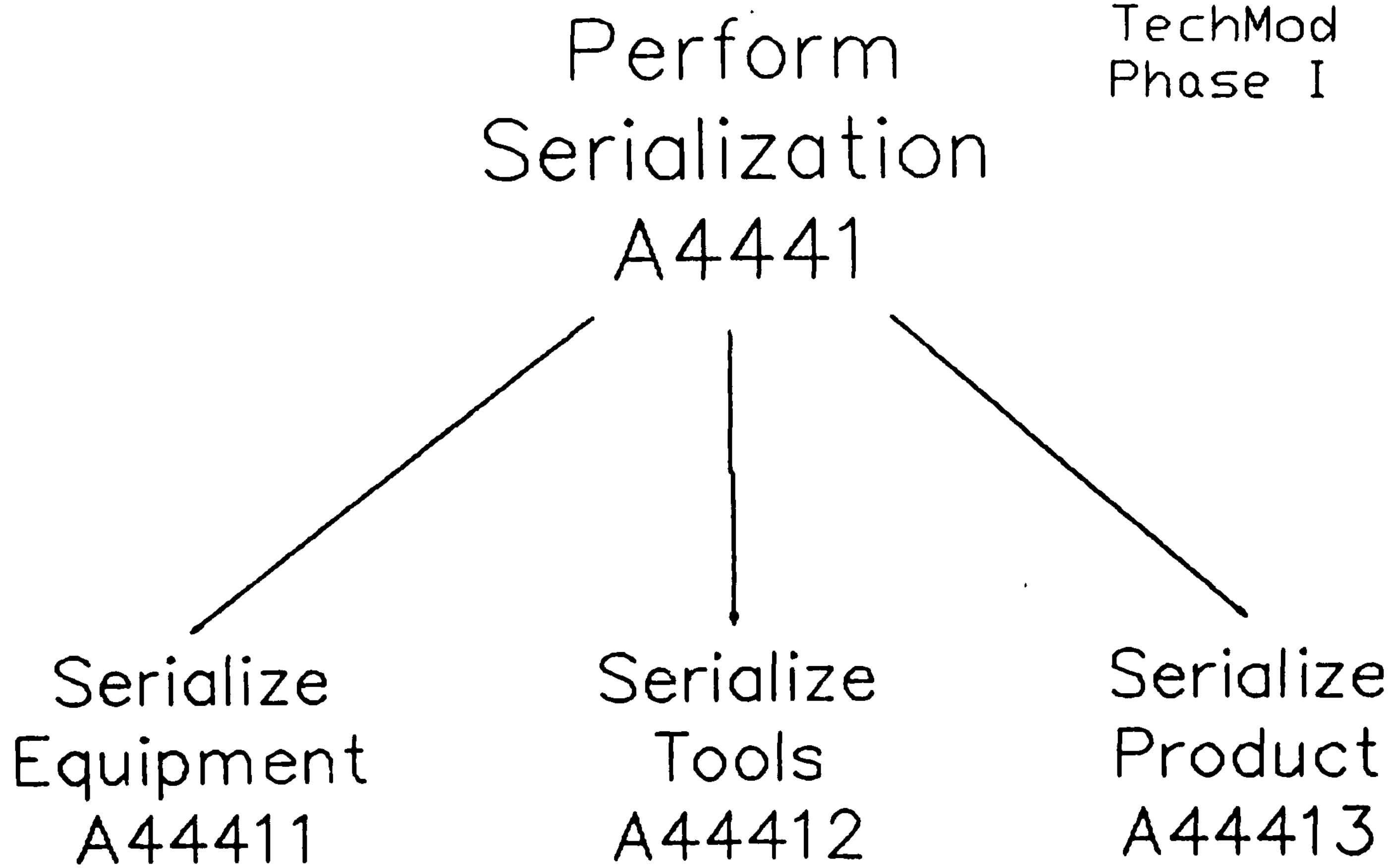

CTL Aerospace
TechMod
Phase I
Fabricate
Tools
A4133
Fabricate
Compression
Molds
A41331
Fabricate
Isostatic
Molds
A41332
Fabricate
Assembly
Jigs
A41333
Fabricate
Inspection
Fixtures
A41334

CTL Aerospace
TechMod
Phase I

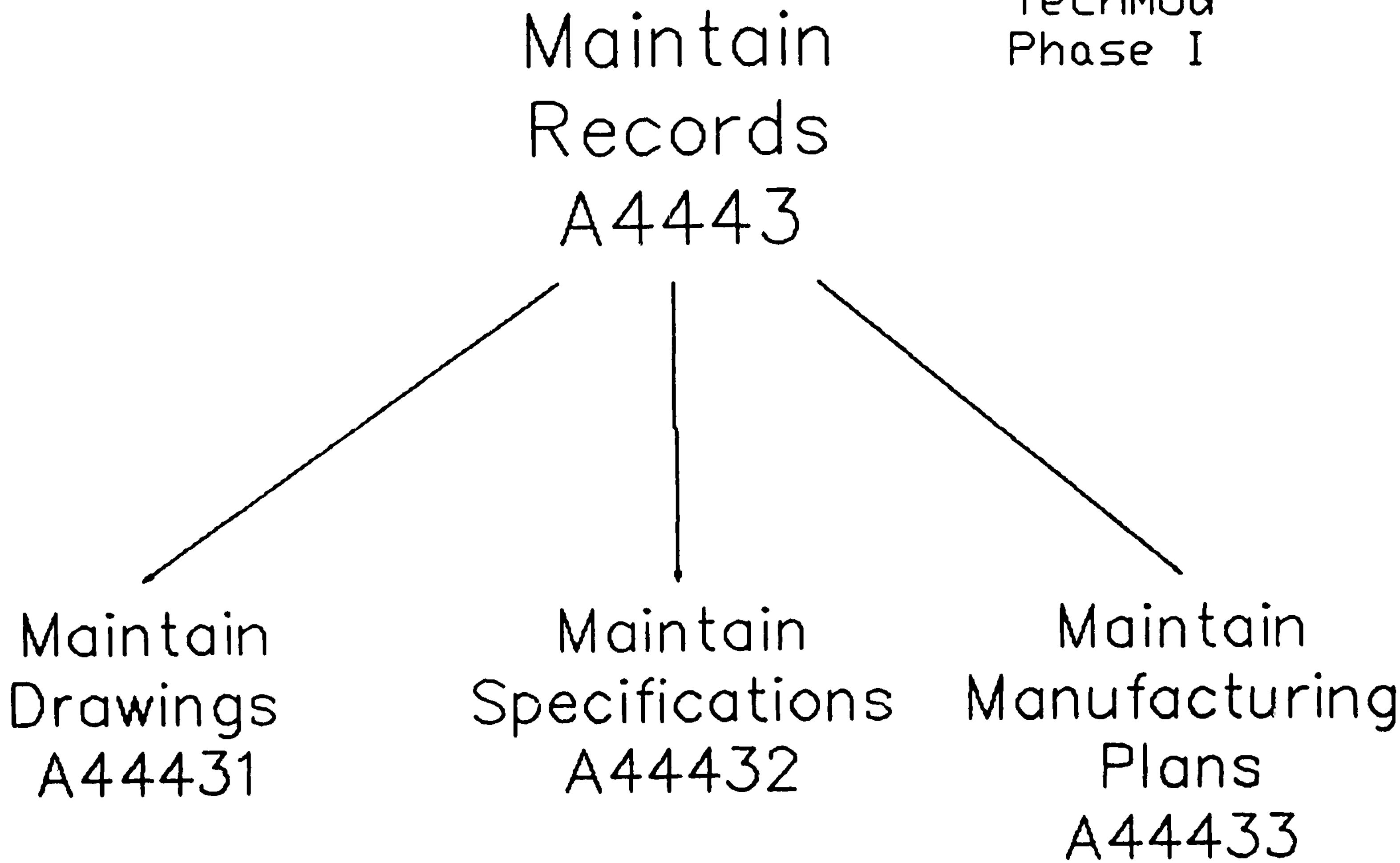



CTL Aerospace
TechMod
Phase I
Purchase Material A4143
Determine Source A41431
Place Orders A41432
Track Orders A41433
Expedite Orders A41434
Close Orders A41435
Receive Materials to Stores A41436

CTL Aerospace
TechMod
Phase I



CTL Aerospace
TechMod
Phase I

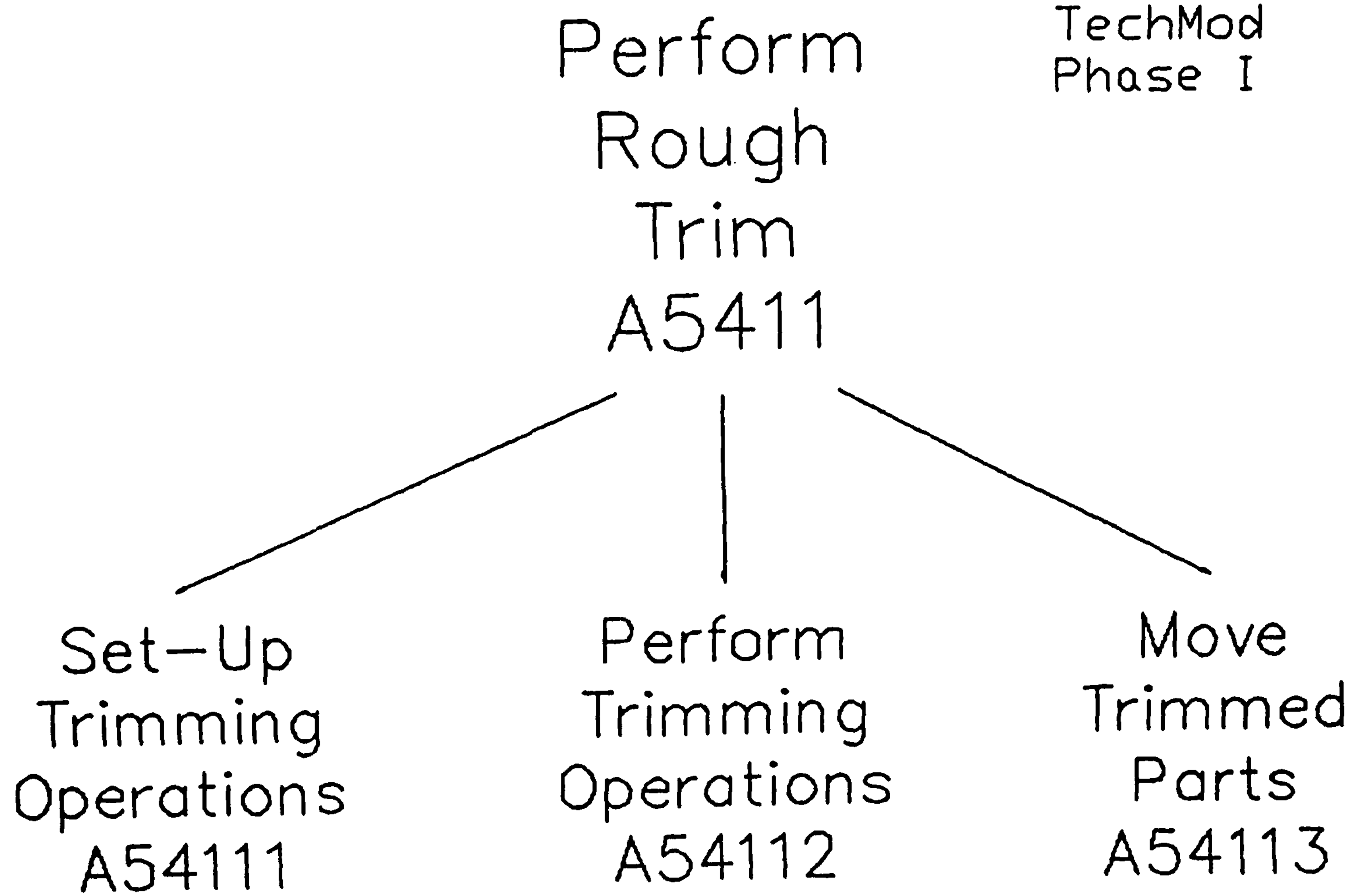


CTL Aerospace
TechMod
Phase I

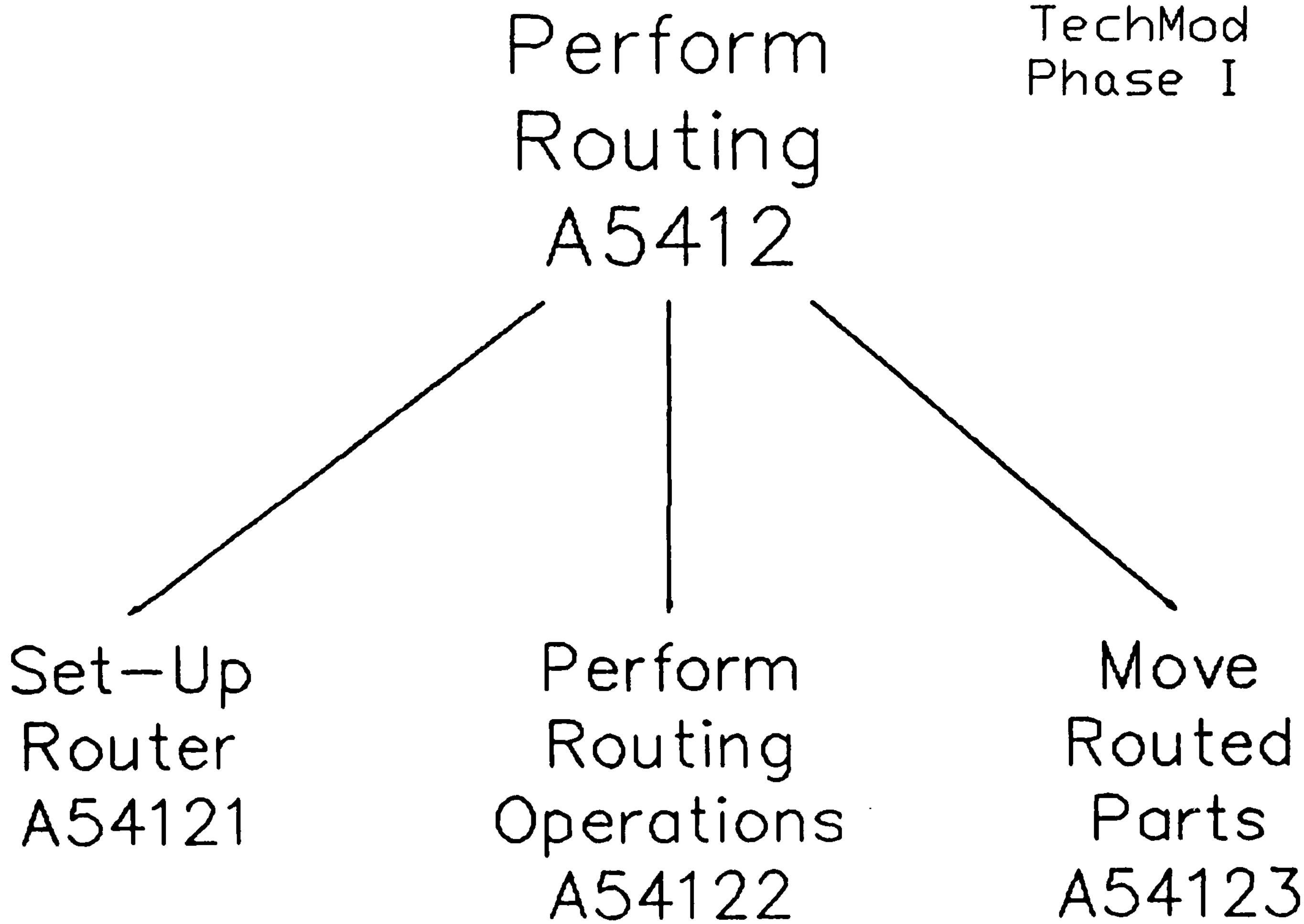
Analyze & Review Production Documents A4445

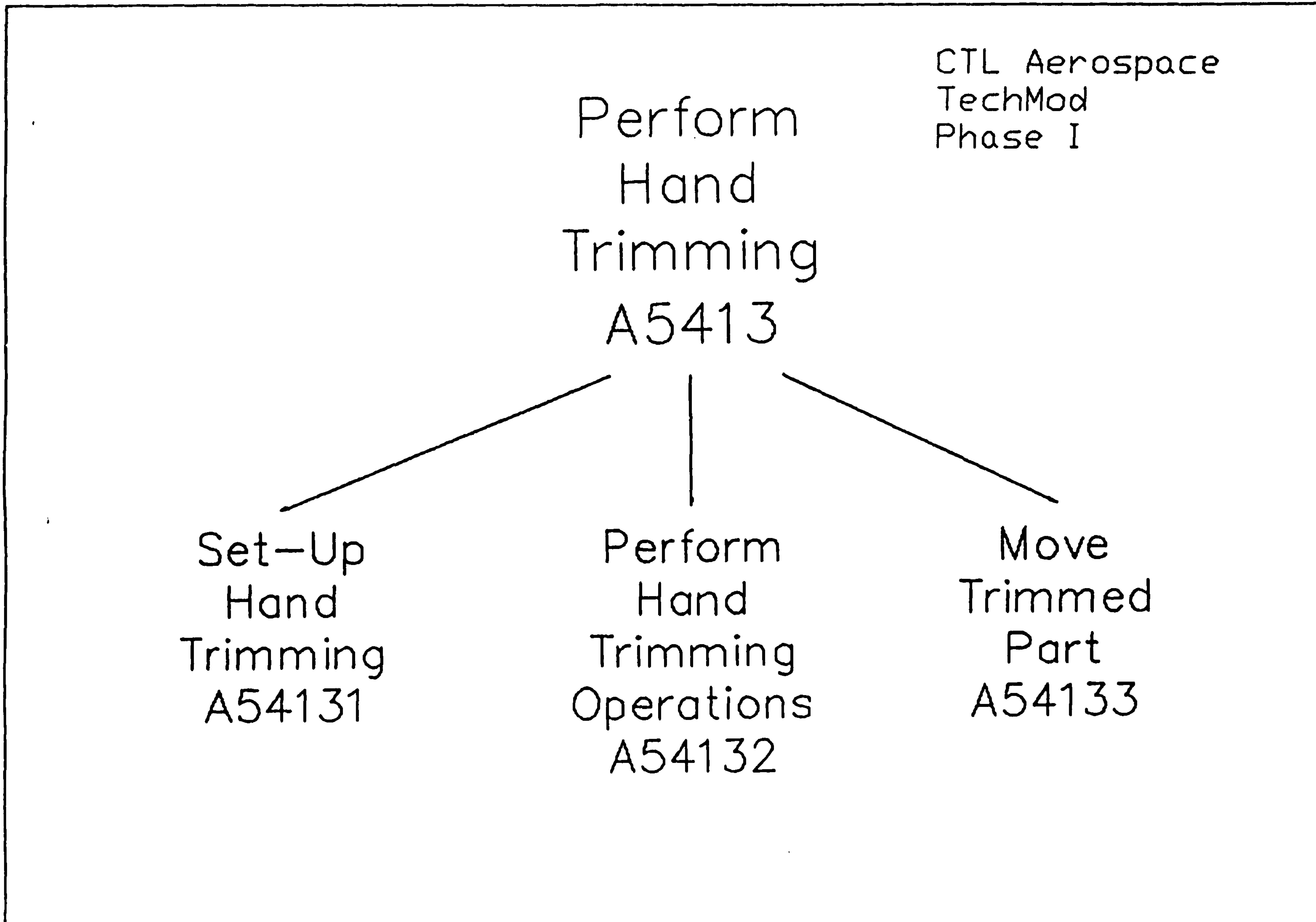
- Analyze/Review CTL Purchase Orders A44451
- Analyze/Review Manufacturing Plans A44452
- Analyze/Review Requests For Quotes A44453
- Evaluate CTL Drawings A44454
- Assure Proper Documentation A44455
- Evaluate CTL Specifications A44456

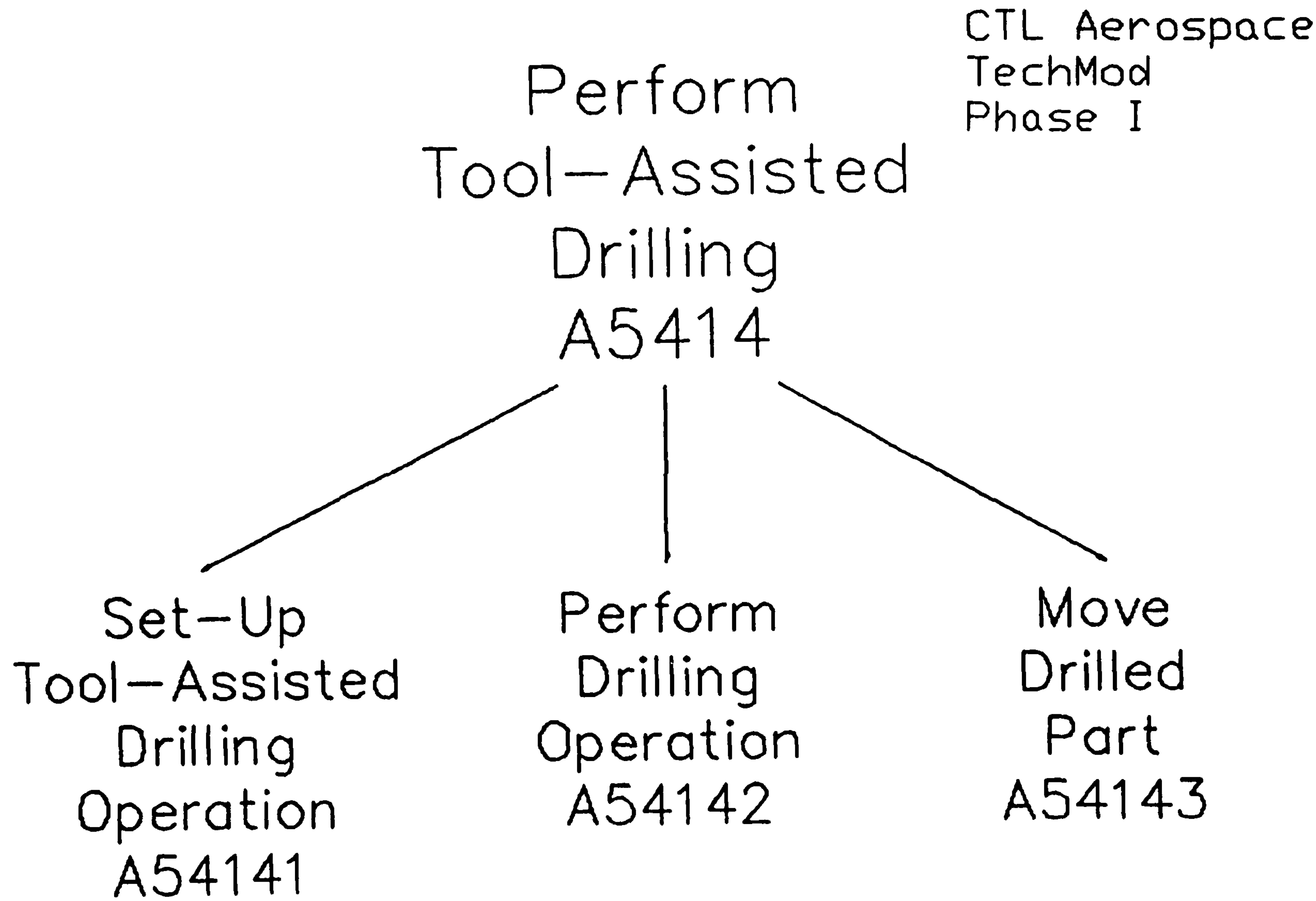
CTL Aerospace
TechMod
Phase I

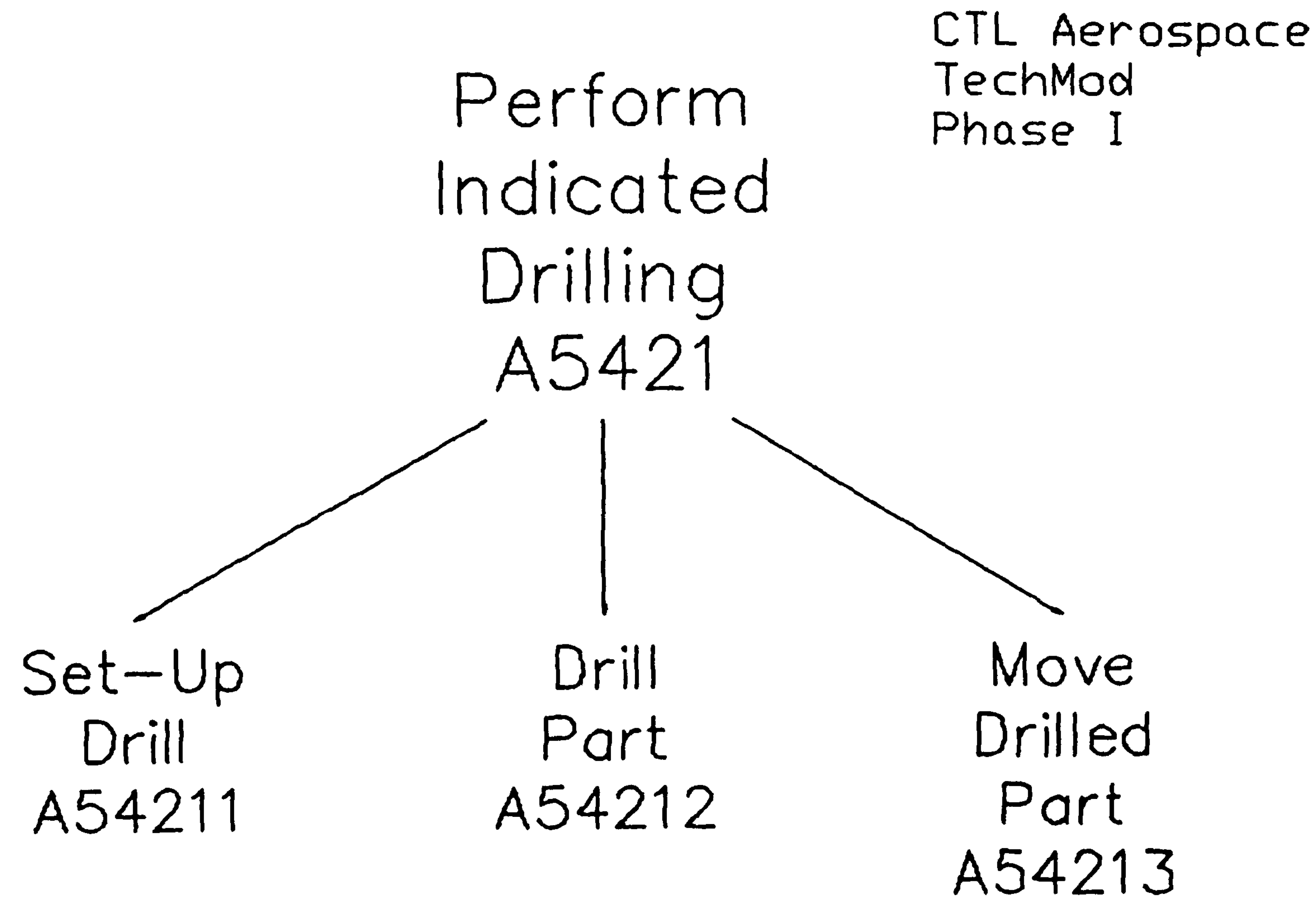


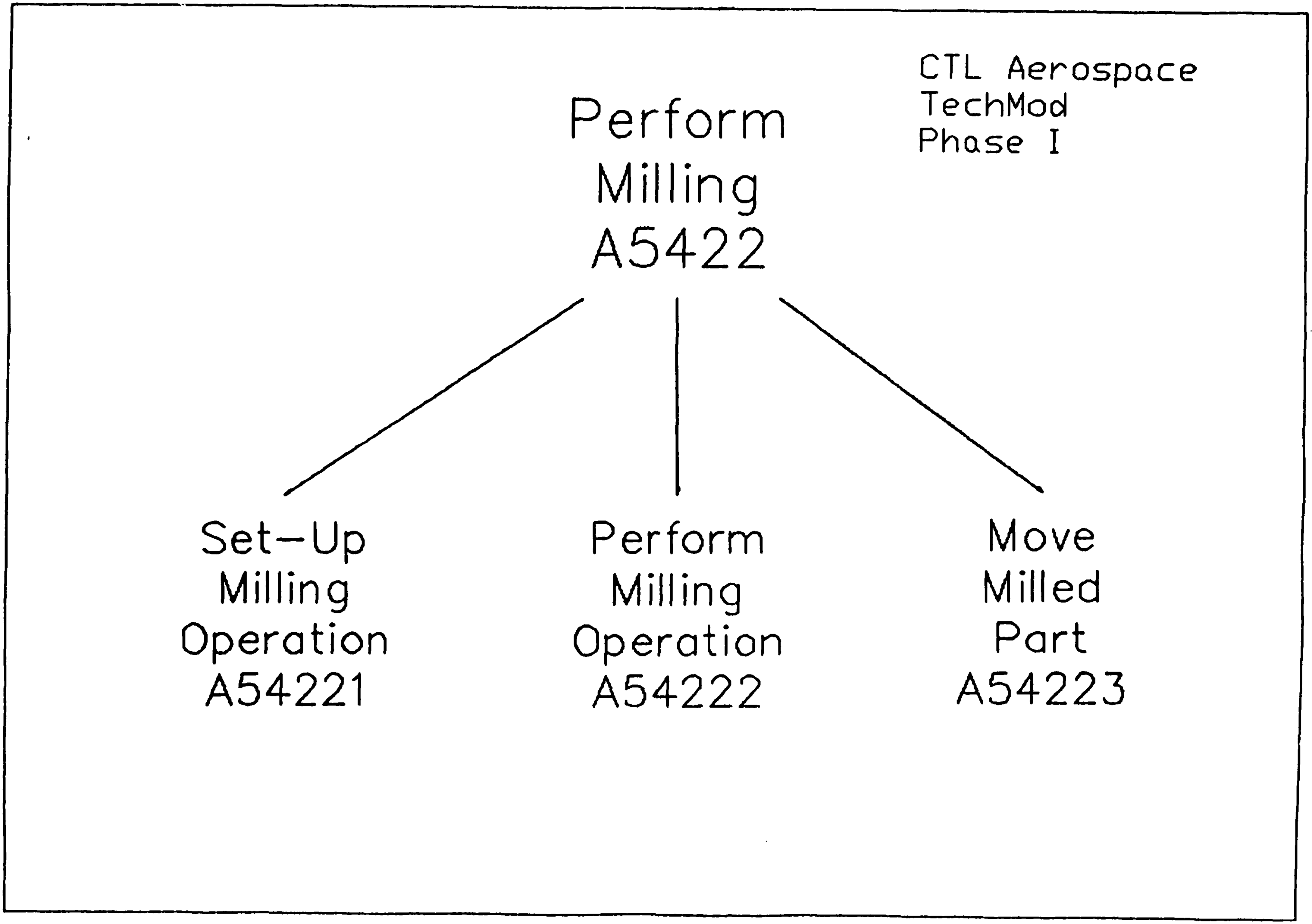
CTL Aerospace
TechMod
Phase I



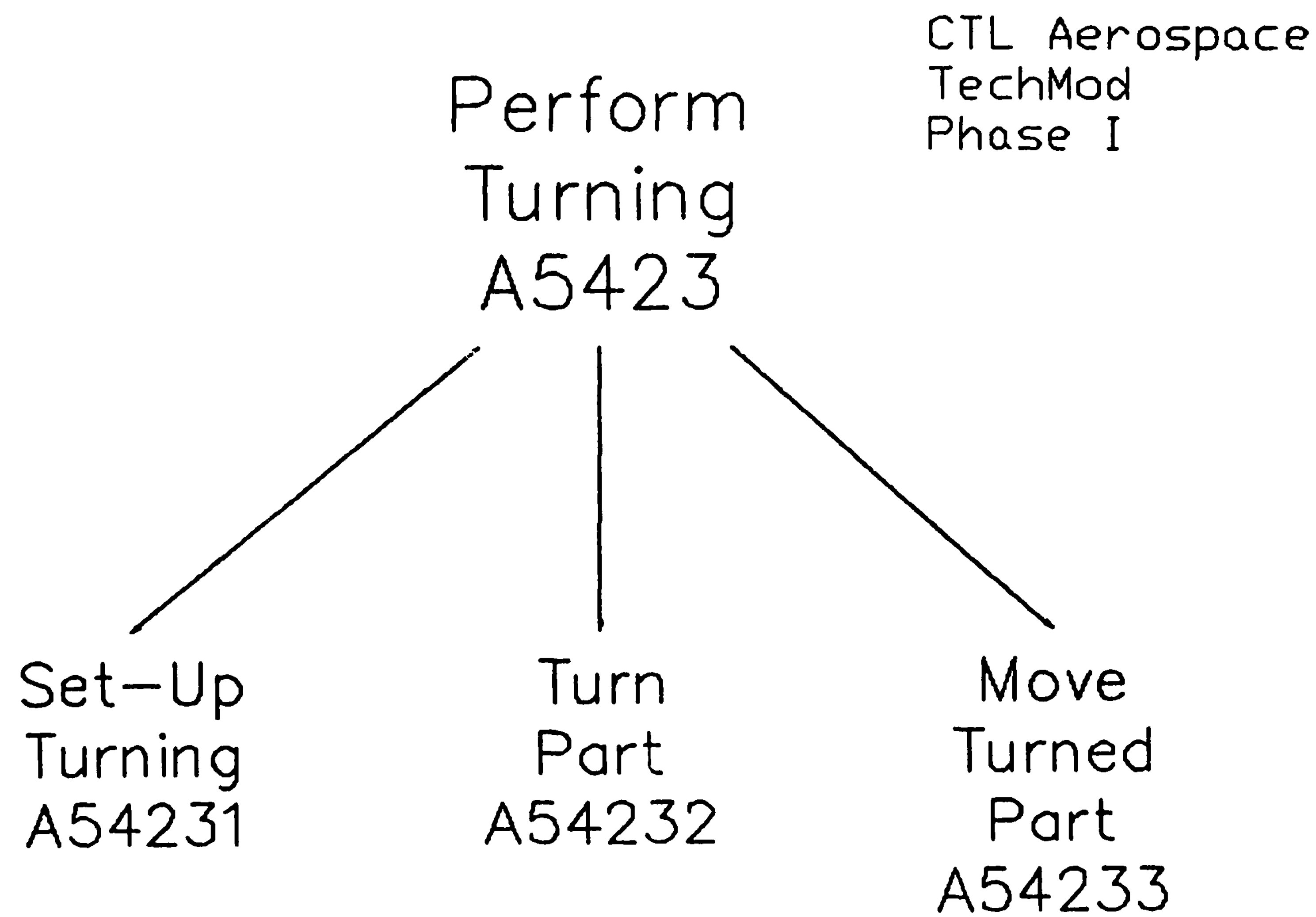

CTL Aerospace
TechMod
Phase I
Perform Hand Trimming A5413
Set-Up Hand Trimming A54131
Perform Hand Trimming Operations A54132
Move Trimmed Part A54133

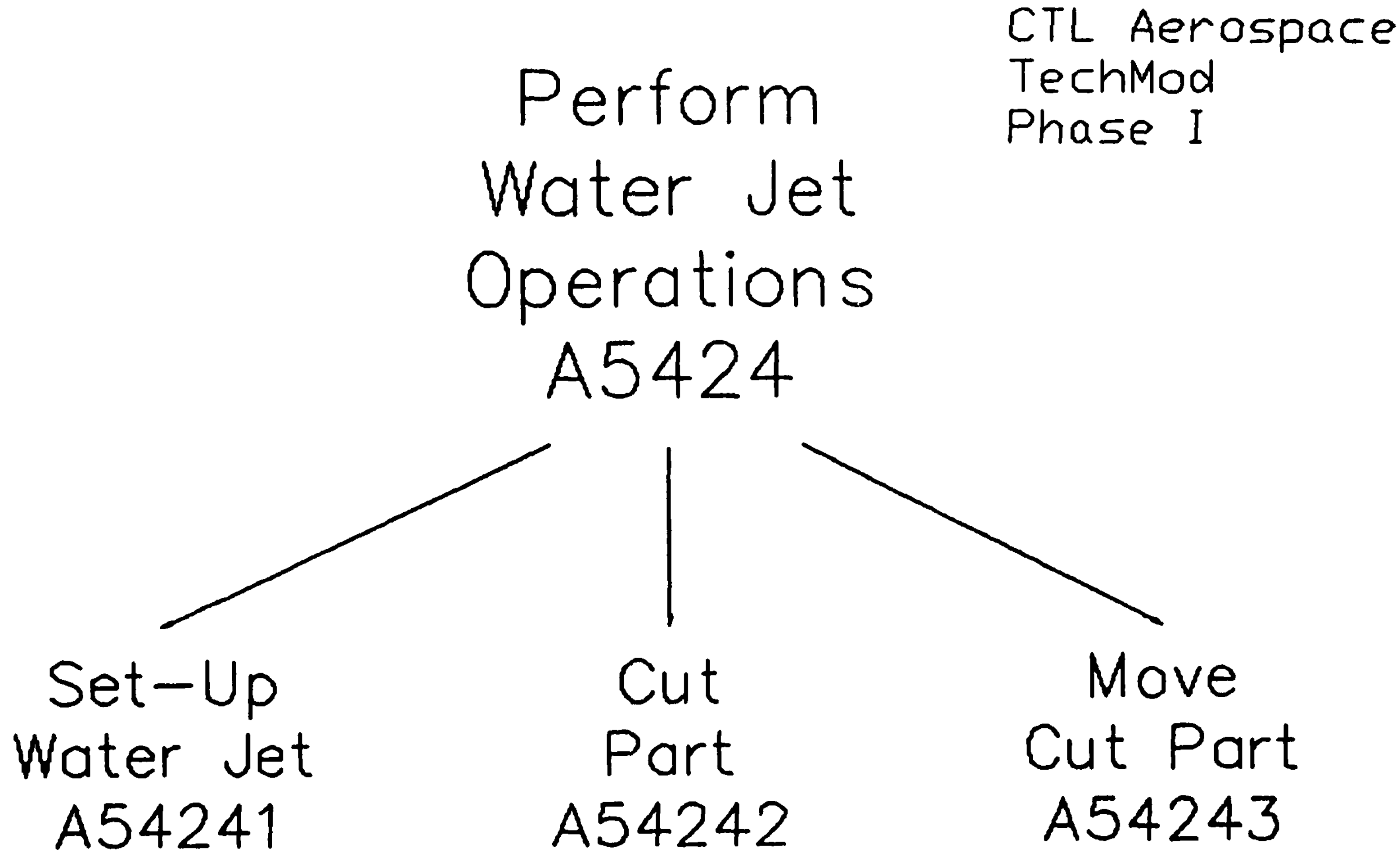

CTL Aerospace
TechMod
Phase I
Perform
Tool-Assisted
Drilling
A5414
Set-Up
Tool-Assisted
Drilling
Operation
A54141
Perform
Drilling
Operation
A54142
Move
Drilled
Part
A54143


CTL Aerospace
TechMod
Phase I
Perform Indicated Drilling A5421
Set-Up Drill A54211
Drill Part A54212
Move Drilled Part A54213

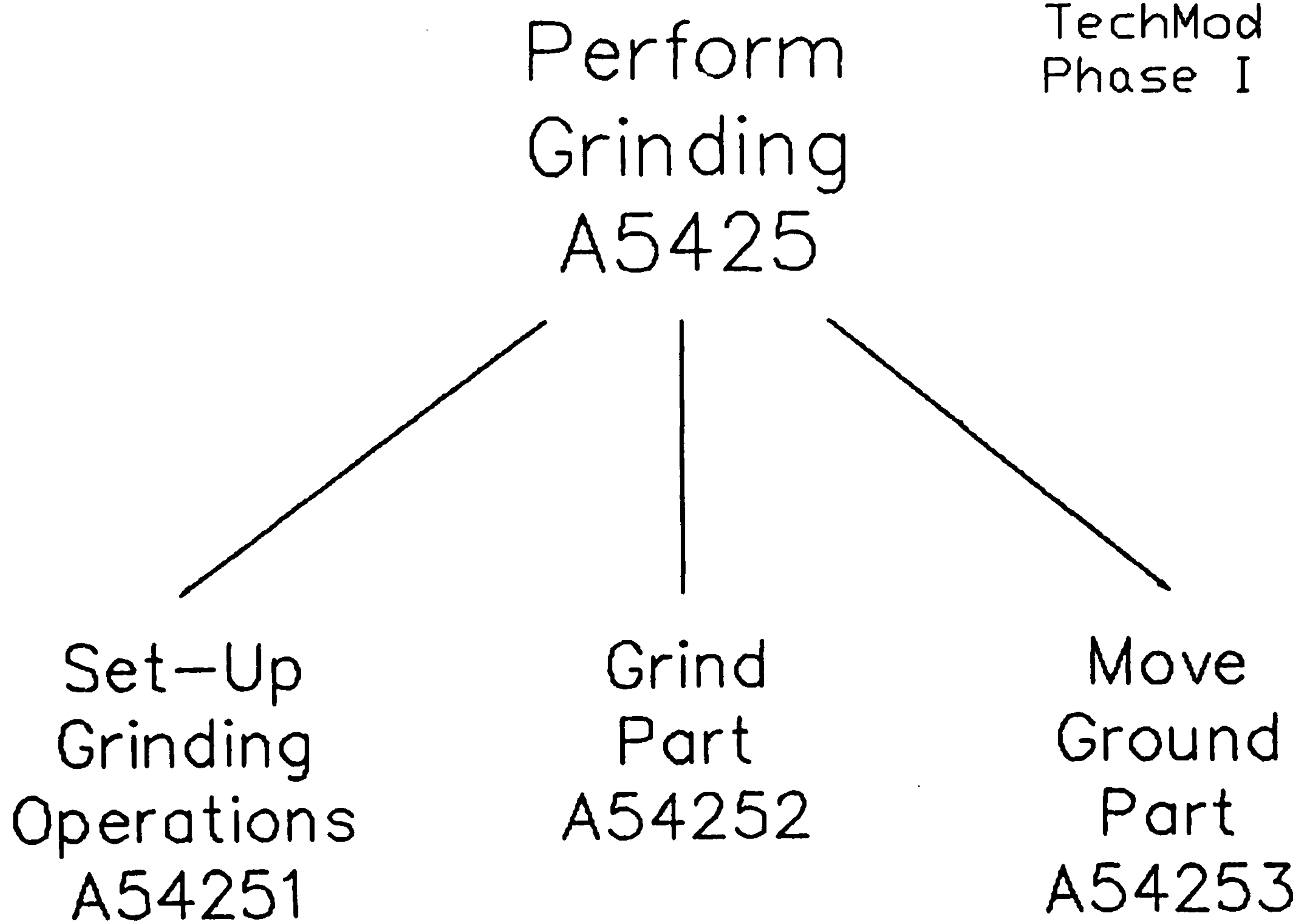


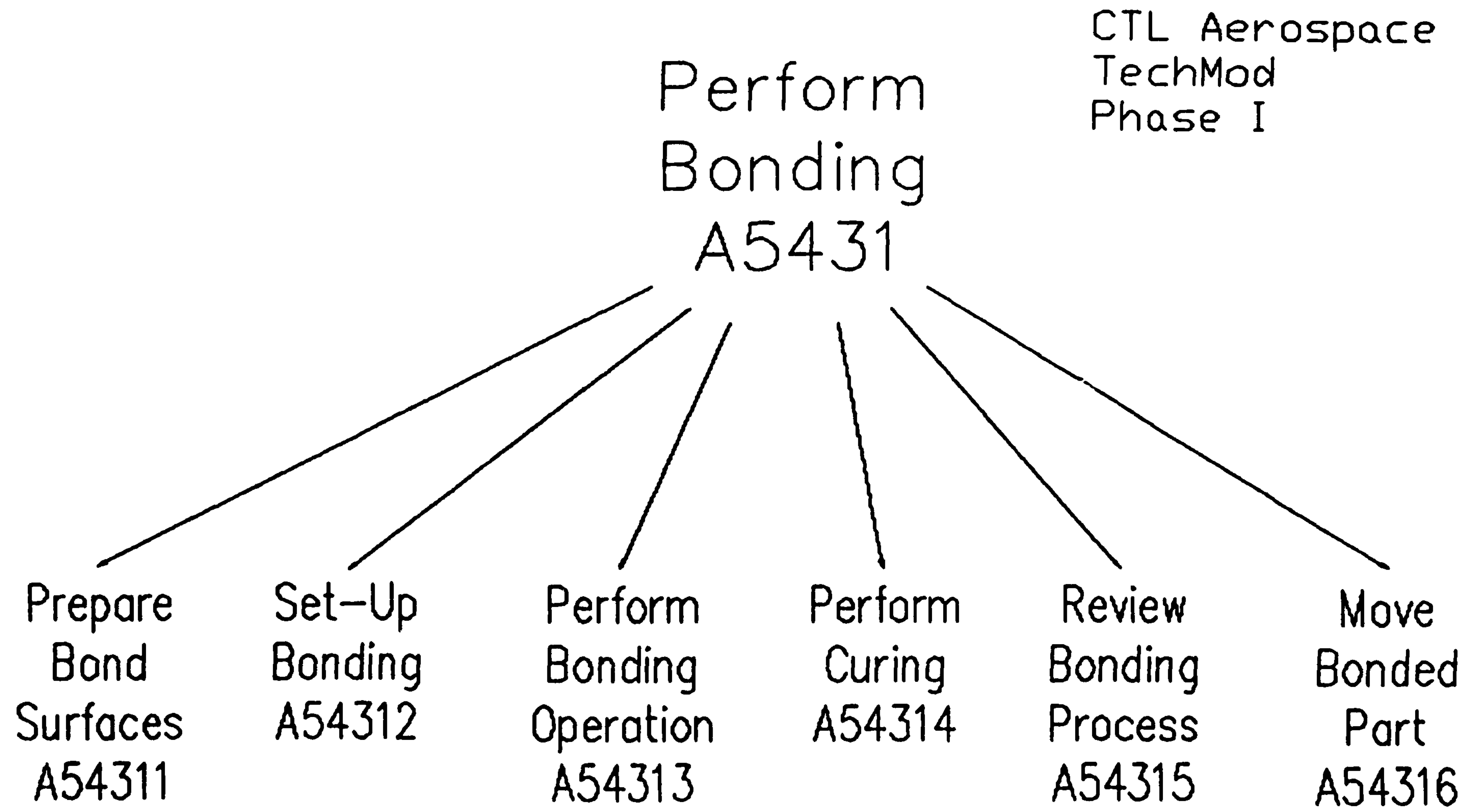
CTL Aerospace
TechMod
Phase I
Perform
Milling
A5422
Set-Up
Milling
Operation
A54221
Perform
Milling
Operation
A54222
Move
Milled
Part
A54223

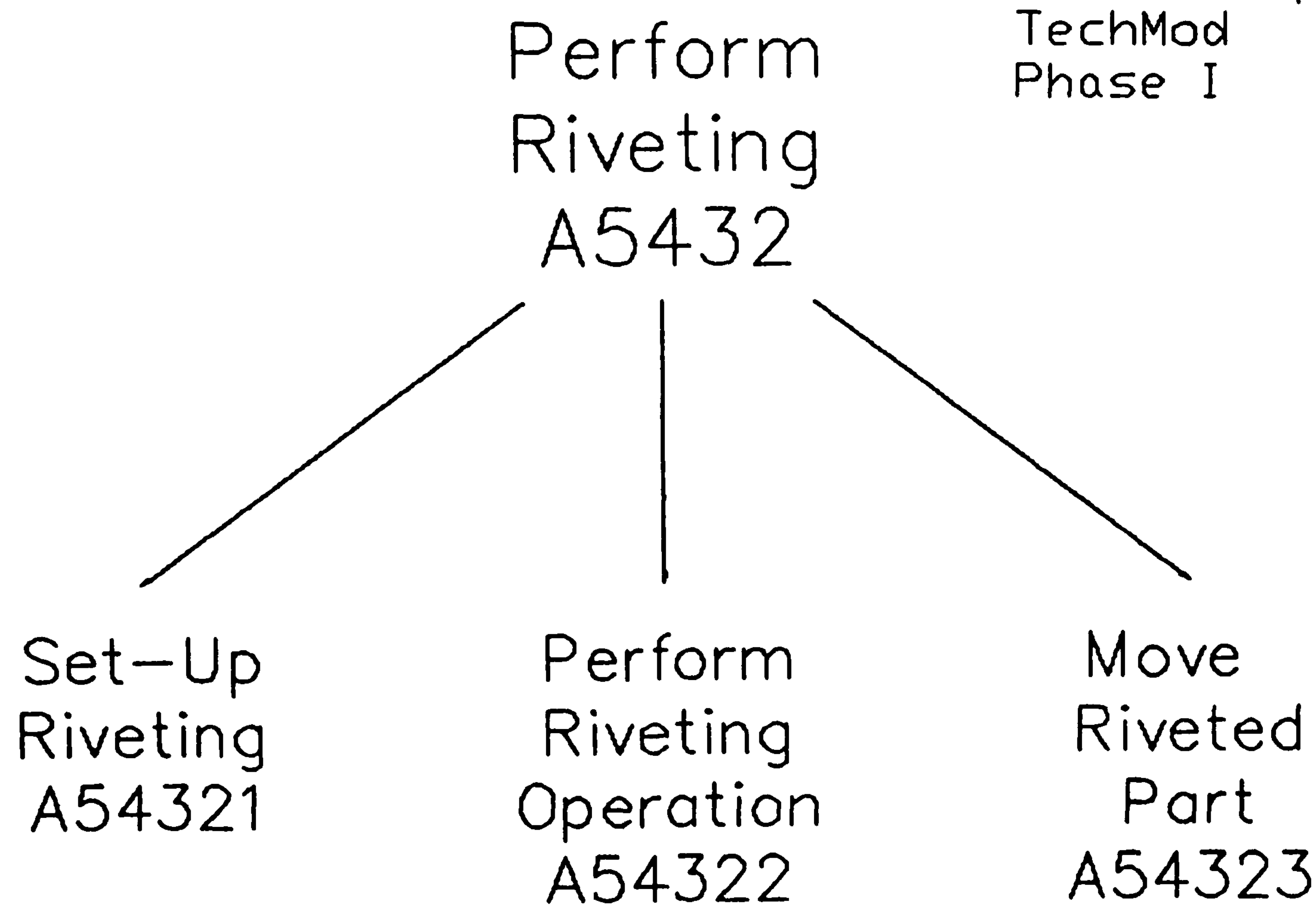

CTL Aerospace
TechMod
Phase I
Perform
Turning
A5423
Set-Up
Turning
A54231
Turn
Part
A54232
Move
Turned
Part
A54233

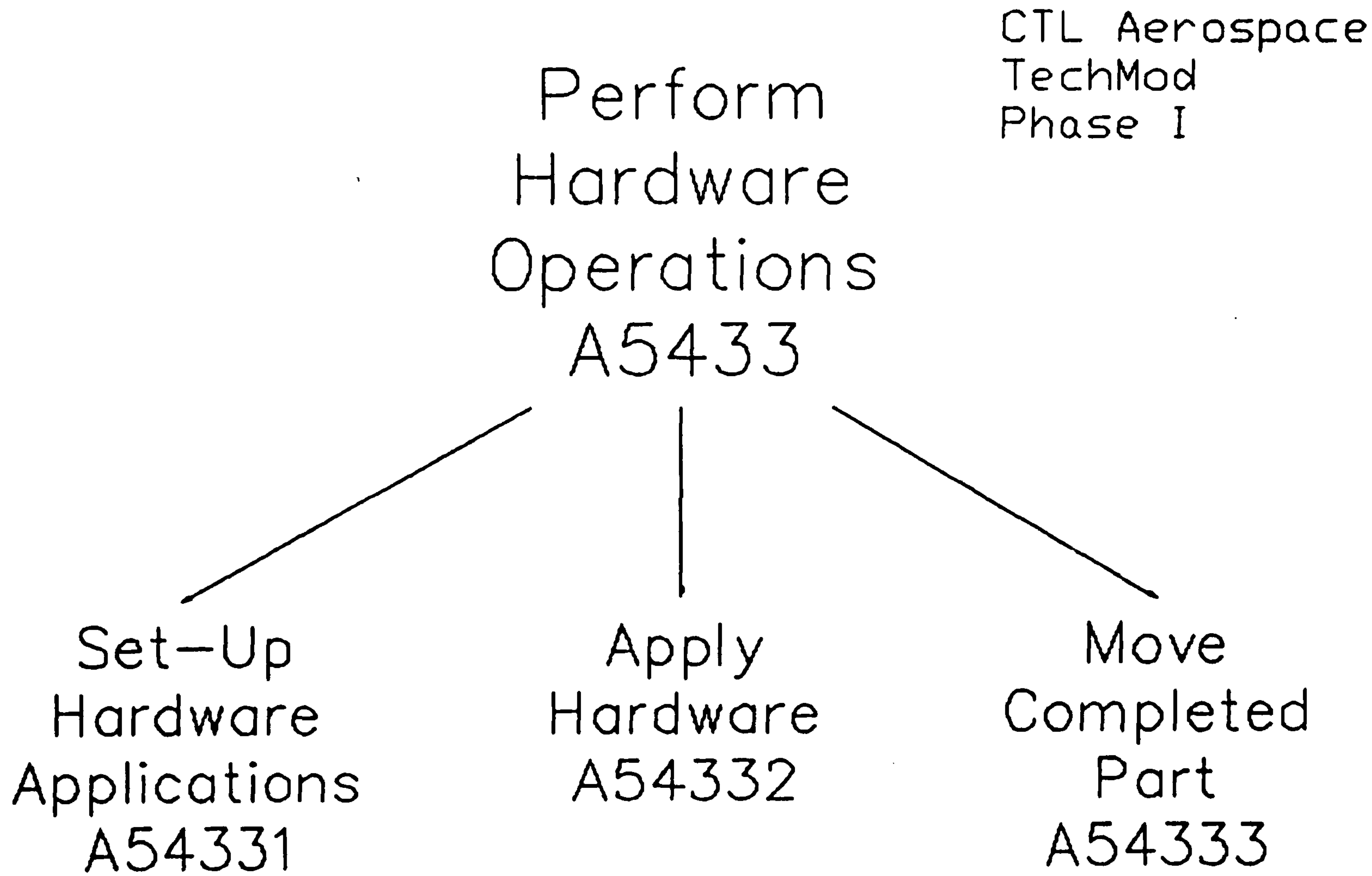

CTL Aerospace
TechMod
Phase I
Perform
Water Jet
Operations
A5424
Set-Up
Water Jet
A54241
Cut
Part
A54242
Move
Cut Part
A54243

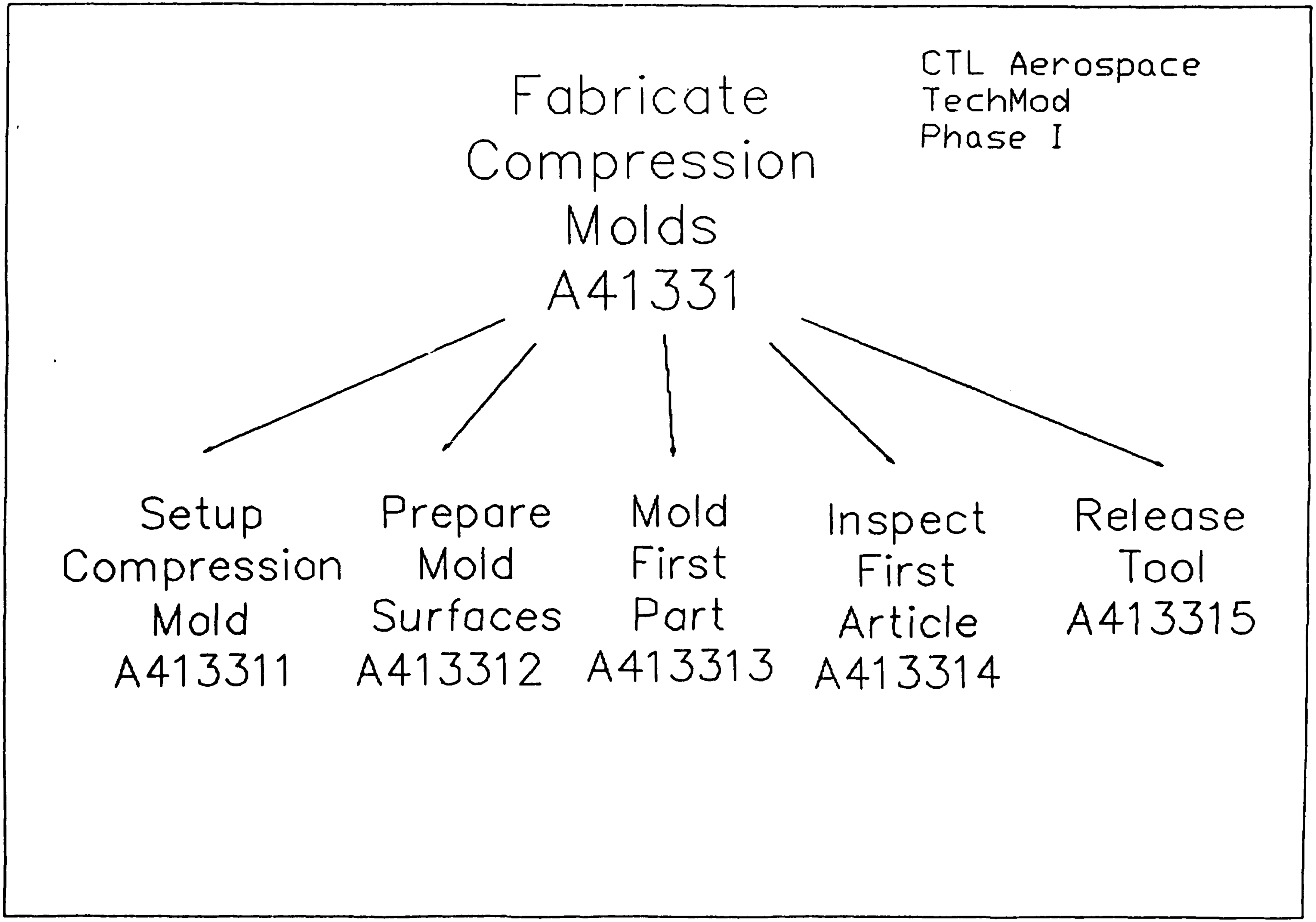
CTL Aerospace
TechMod
Phase I

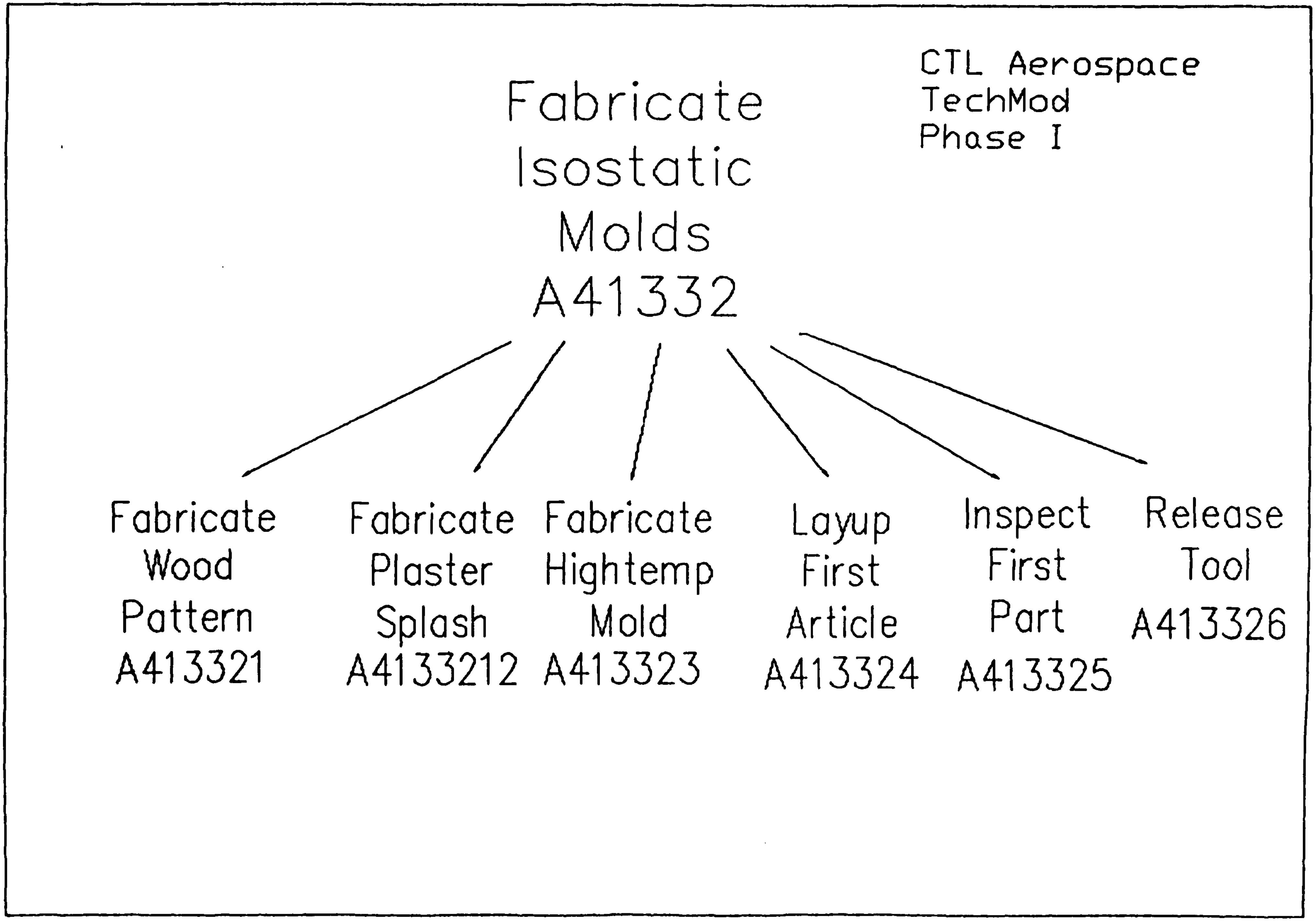


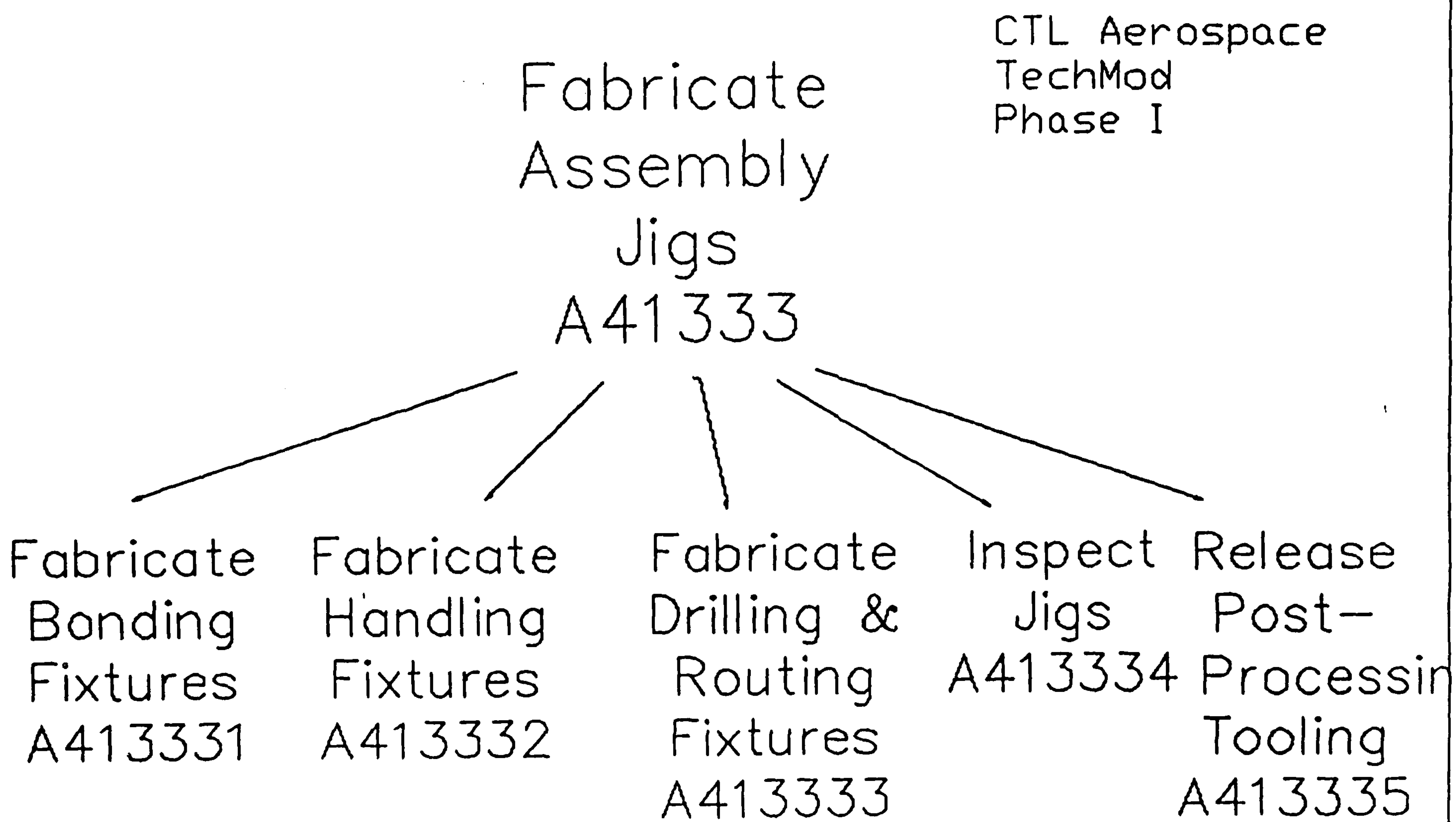

CTL Aerospace
TechMod
Phase I
Perform Bonding A5431
Prepare Bond Surfaces A54311
Set-Up Bonding A54312
Perform Bonding Operation A54313
Perform Curing A54314
Review Bonding Process A54315
Move Bonded Part A54316

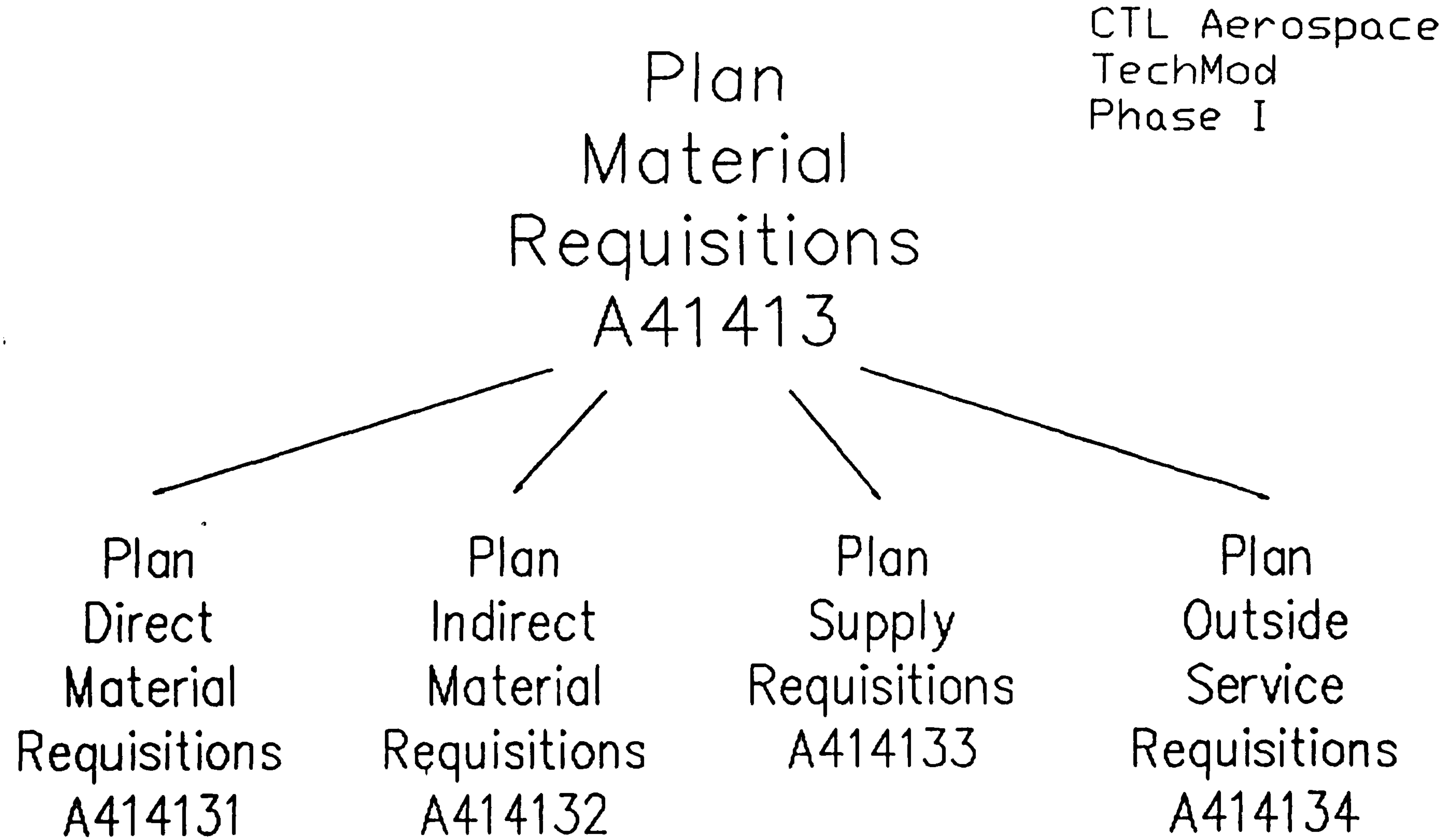

CTL Aerospace
TechMod
Phase I
Perform
Riveting
A5432
Set-Up
Riveting
A54321
Perform
Riveting
Operation
A54322
Move
Riveted
Part
A54323

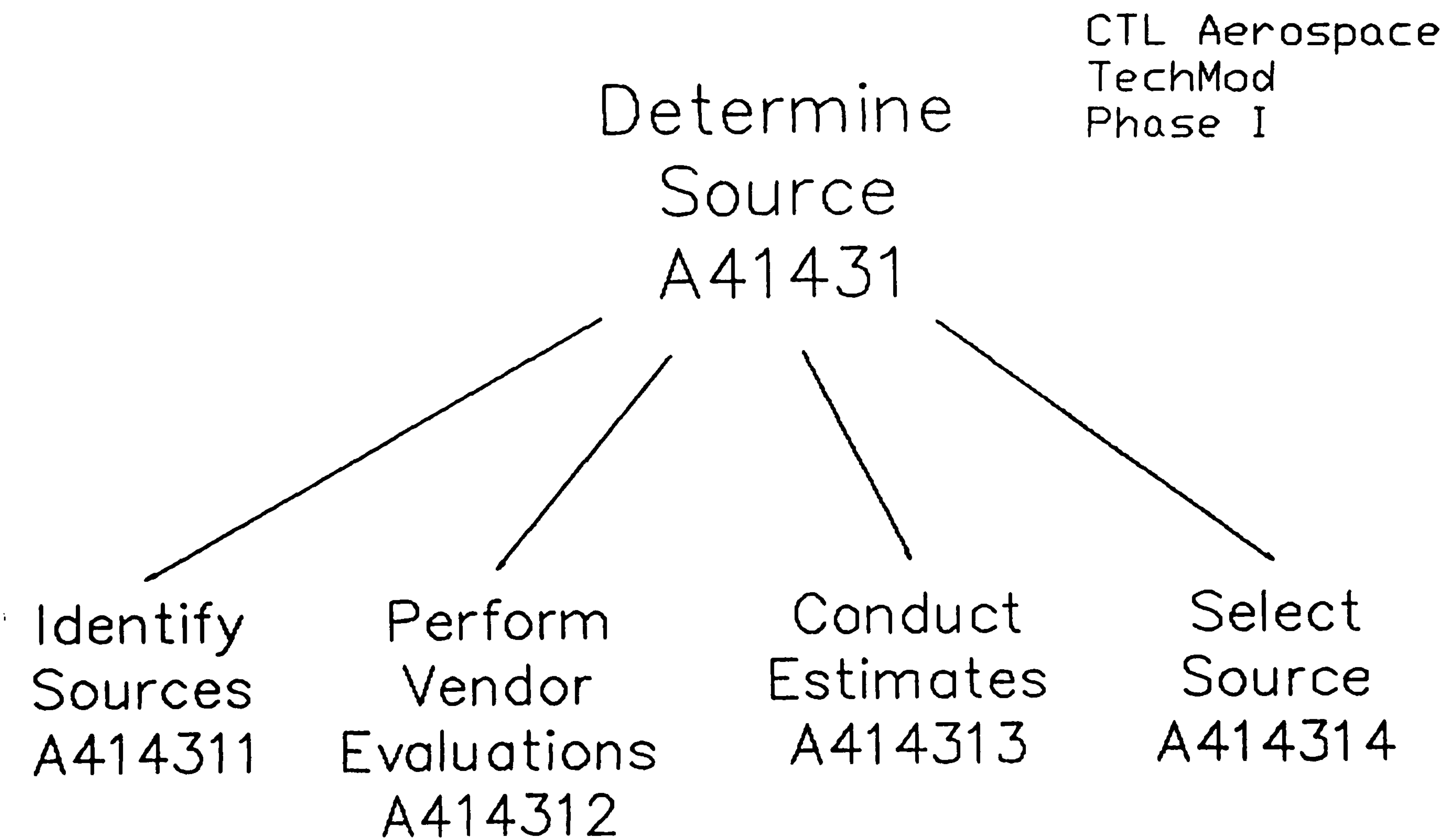

CTL Aerospace
TechMod
Phase I
Perform Hardware Operations A5433
Set-Up Hardware Applications A54331
Apply Hardware A54332
Move Completed Part A54333


CTL Aerospace
TechMod
Phase I
Fabricate Compression Molds A41331
Setup Compression Mold A413311
Prepare Mold Surfaces A413312
Mold First Part A413313
Inspect First Article A413314
Release Tool A413315

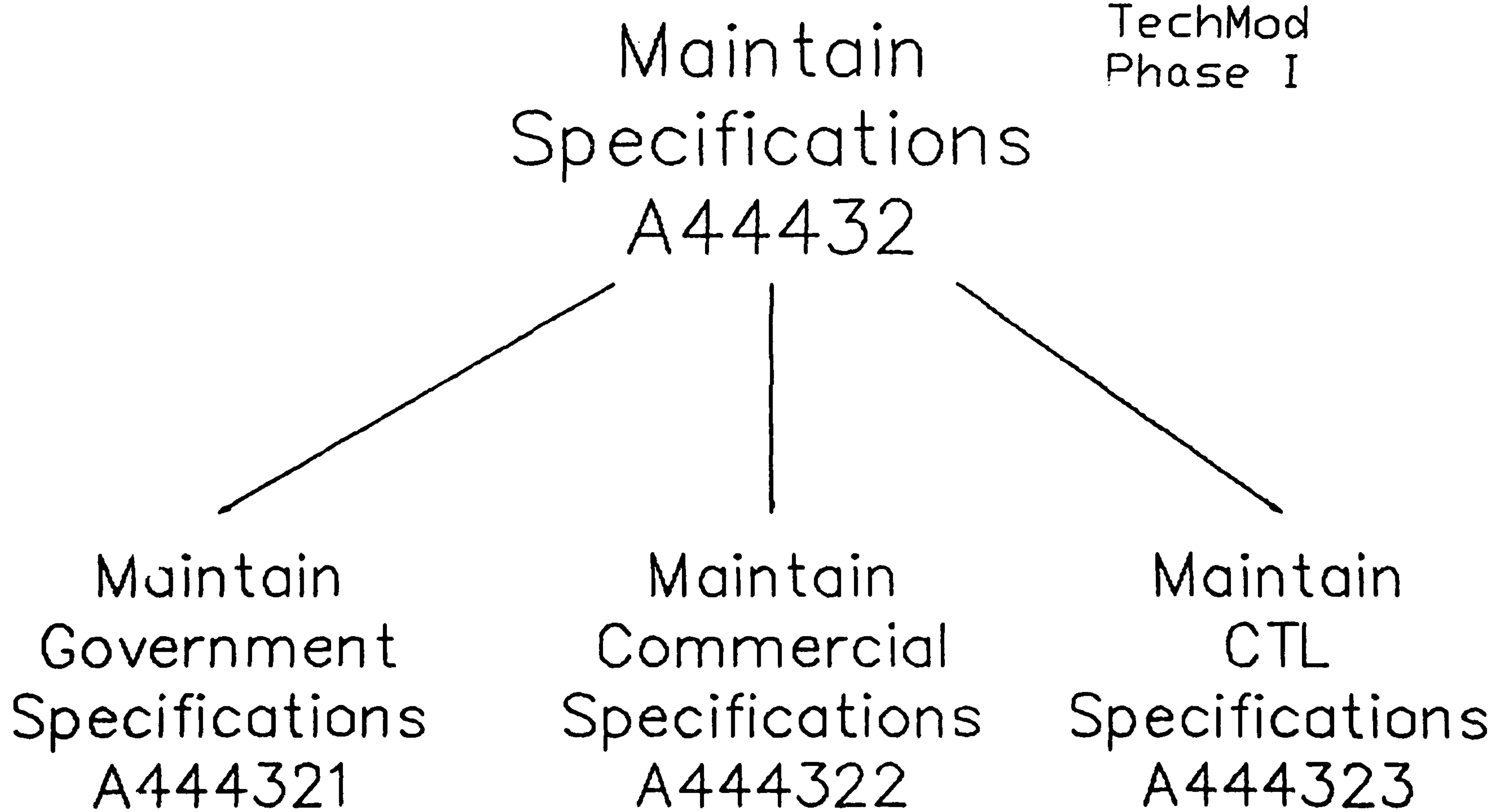

CTL Aerospace
TechMod
Phase I
Fabricate Isostatic Molds A41332
Fabricate Wood Pattern A413321
Fabricate Plaster Splash A4133212
Fabricate Hightemp Mold A413323
Layup First Article A413324
Inspect First Part A413325
Release Tool A413326

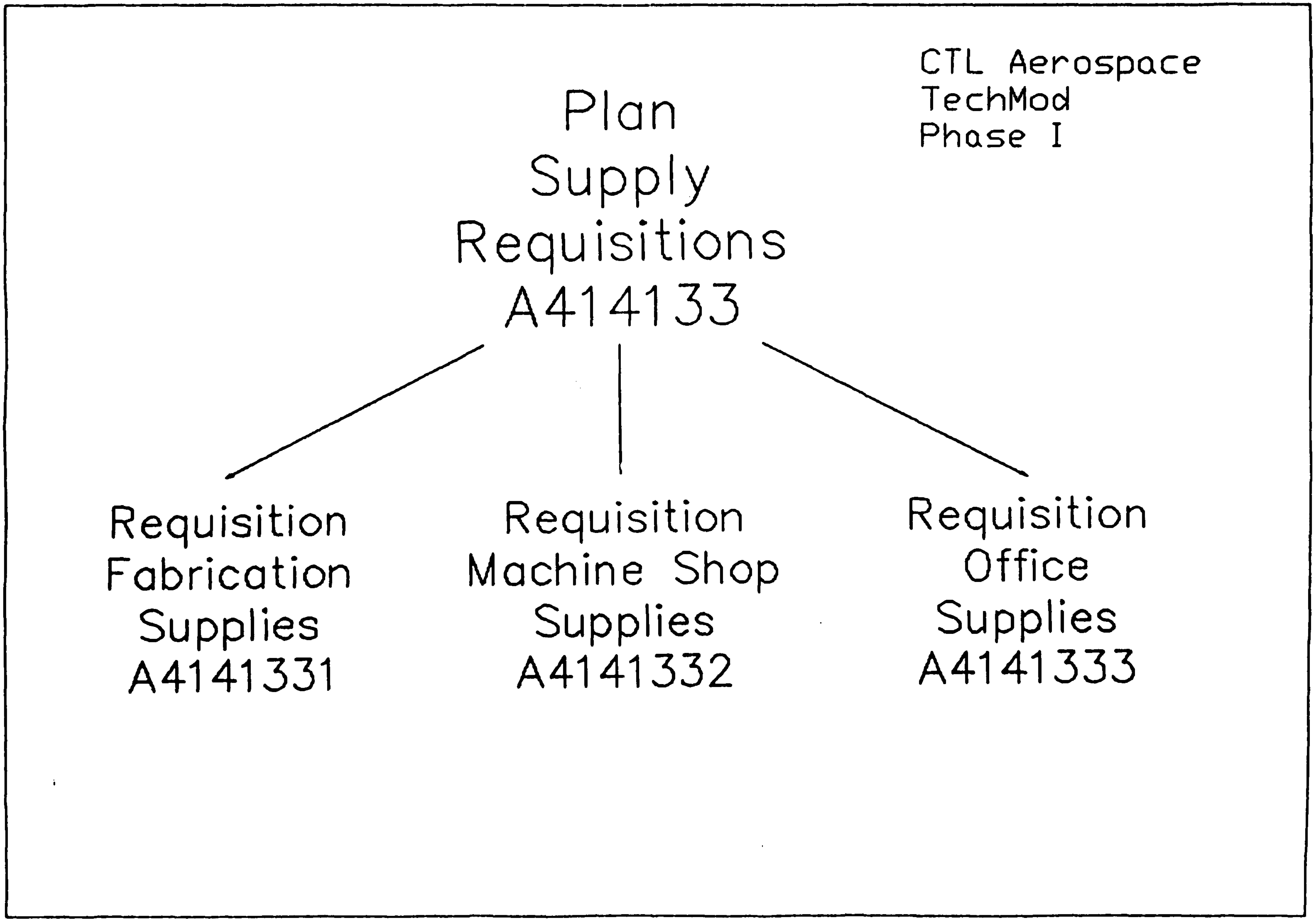

CTL Aerospace
TechMod
Phase I
Fabricate Assembly Jigs A41333
Fabricate Bonding Fixtures A413331
Fabricate Handling Fixtures A413332
Fabricate Drilling & Routing Fixtures A413333
Inspect Jigs A413334
Release Post-Processin Tooling A413335


CTL Aerospace
TechMod
Phase I
Plan
Material
Requisitions
A41413
Plan
Direct
Material
Requisitions
A414131
Plan
Indirect
Material
Requisitions
A414132
Plan
Supply
Requisitions
A414133
Plan
Outside
Service
Requisitions
A414134


CTL Aerospace
TechMod
Phase I
Determine
Source
A41431
Identify
Sources
A414311
Perform
Vendor
Evaluations
A414312
Conduct
Estimates
A414313
Select
Source
A414314

CTL Aerospace
TechMod
Phase I

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Plan
Supply
Requisitions
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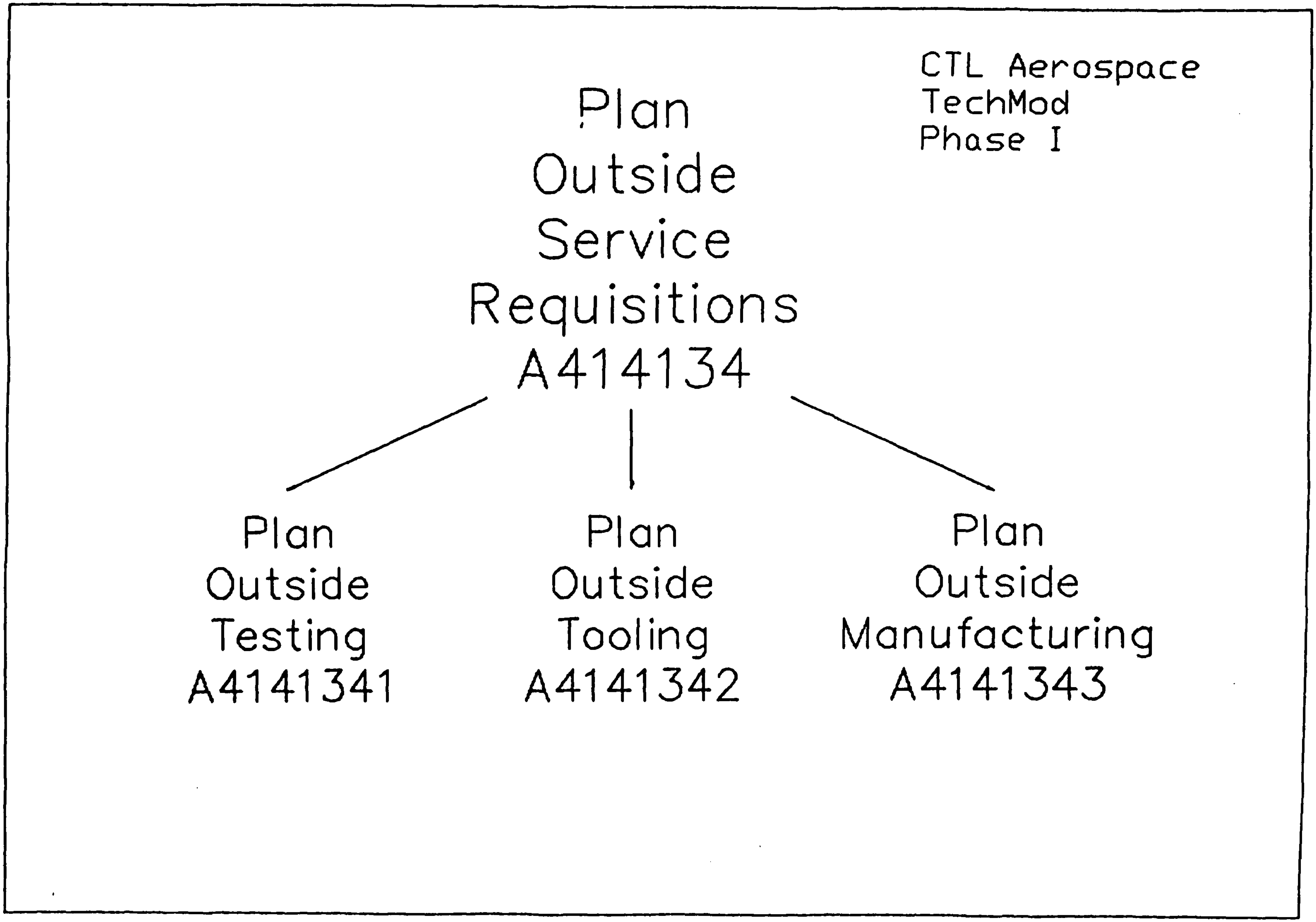
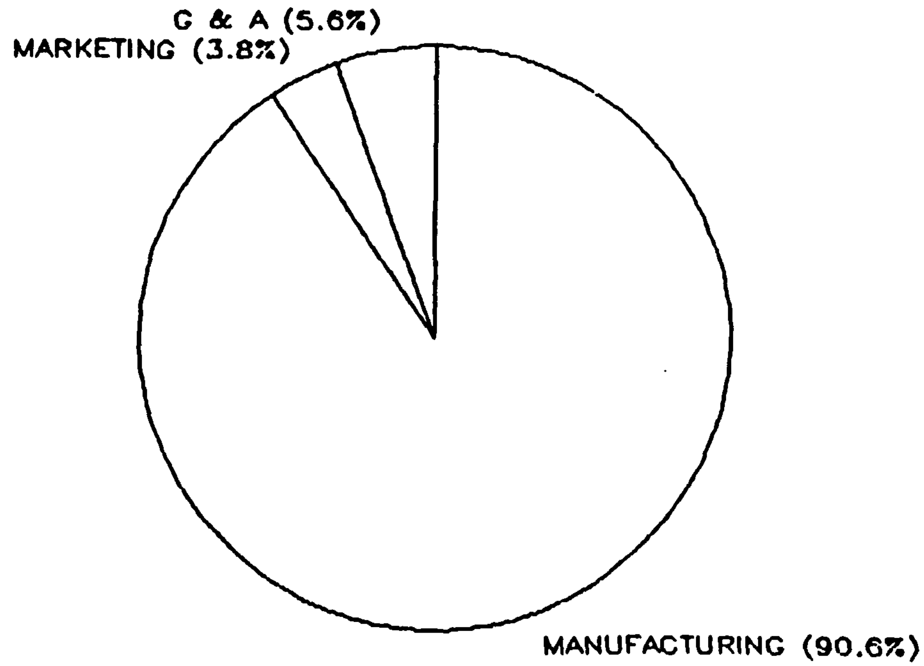
Requisition
Fabrication
Supplies
A4141331
Requisition
Machine Shop
Supplies
A4141332
Requisition
Office
Supplies
A4141333


CTL Aerospace
TechMod
Phase I
Plan Outside Service Requisitions A414134
Plan Outside Testing A4141341
Plan Outside Tooling A4141342
Plan Outside Manufacturing A4141343

CTL Aerospace
TechMod
Phase I

CTL AEROSPACE IMIP COST CENTER CHART

BREAKDOWN BY COST CENTERS



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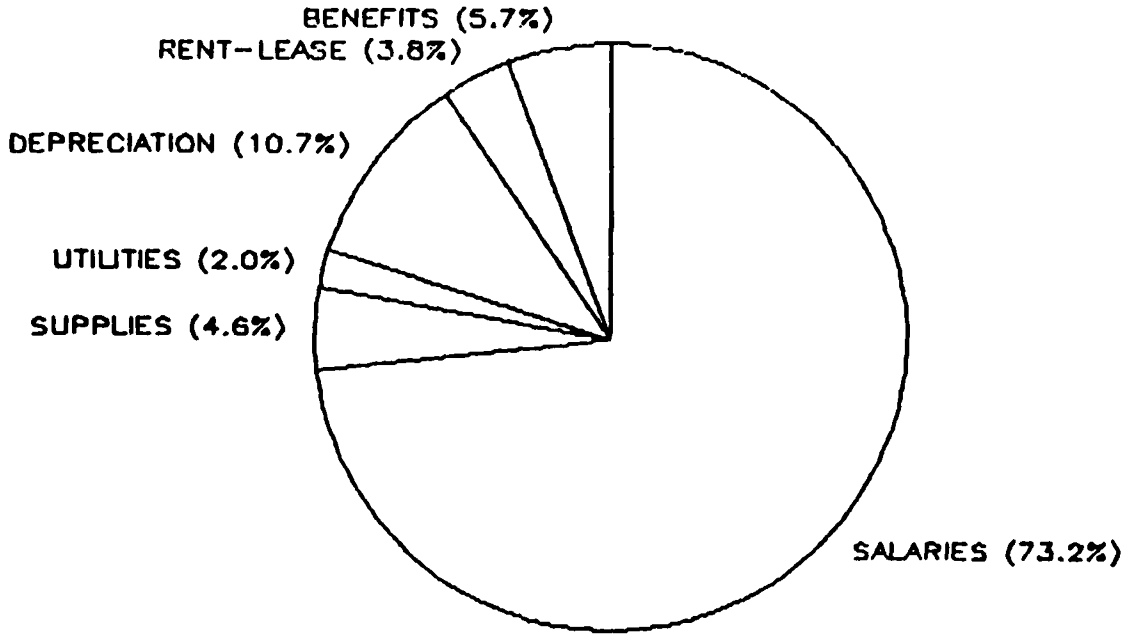
TechMod
Phase I

CTL AEROSPACE IMIP COST CENTER CHART

BREAKDOWN BY ELEMENT FOR: MARKETING



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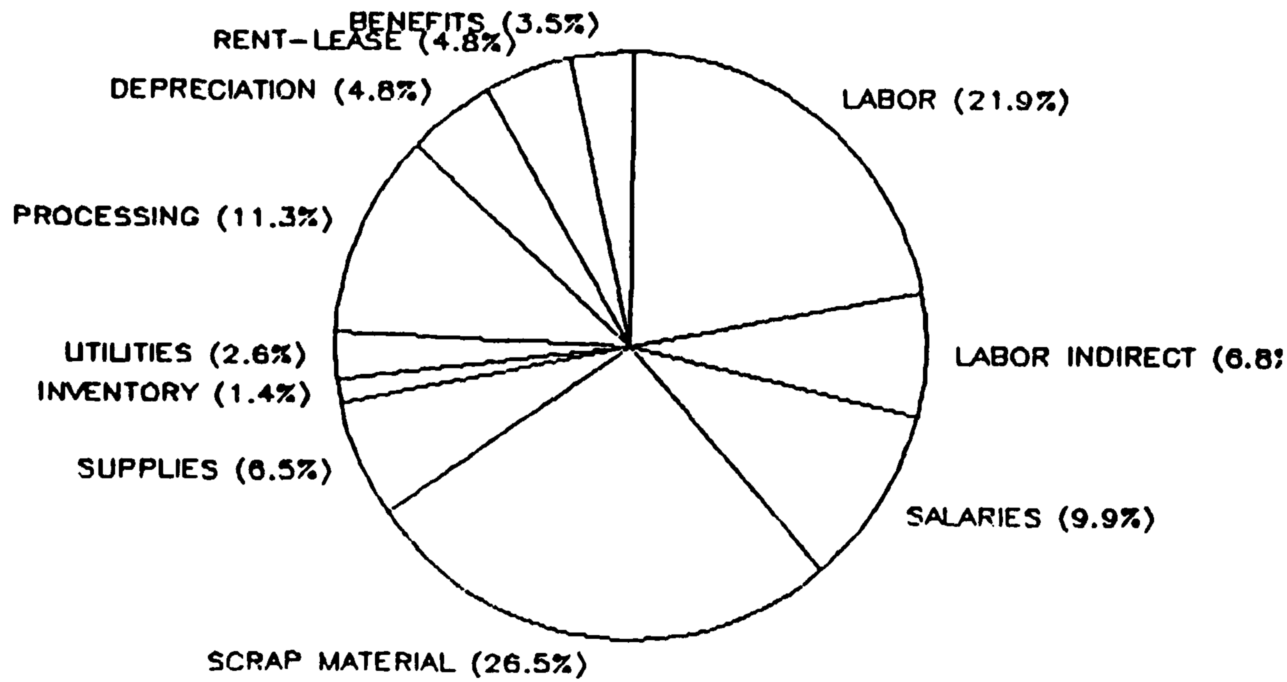
Phase I

CTL AEROSPACE IMIP COST CENTER CHART

BREAKDOWN BY ELEMENT FOR: MANUFACTURING



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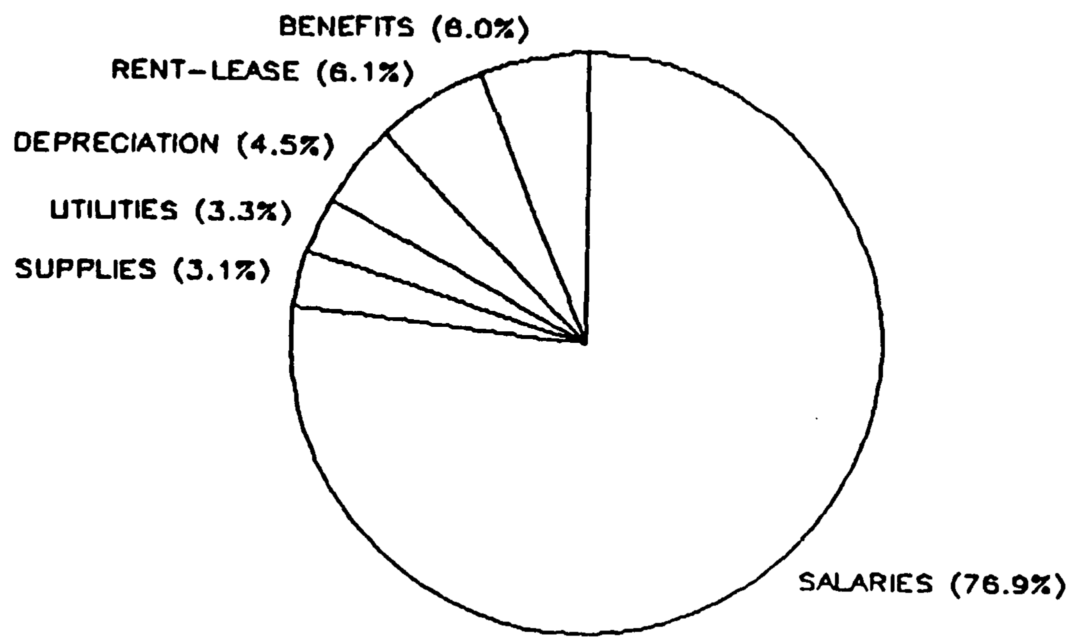
Phase I

CTL AEROSPACE IMIP COST CENTER CHART

BREAKDOWN BY ELEMENT FOR: G & A



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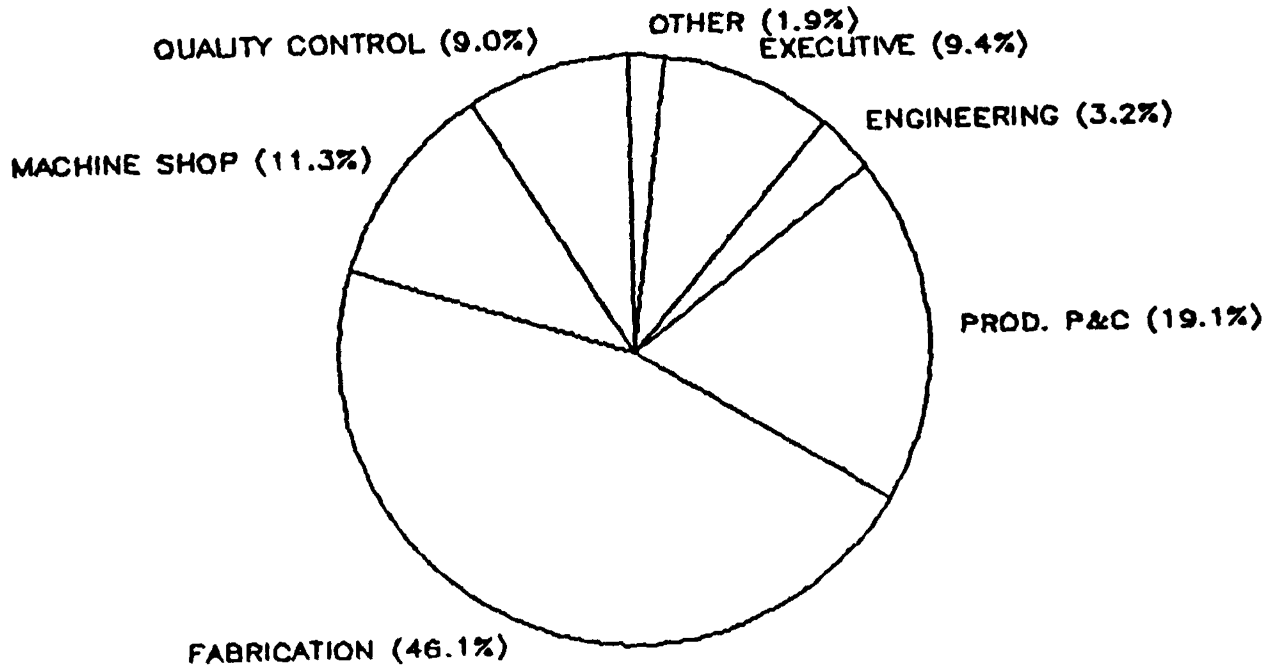
Phase I

CTL AEROSPACE COST FUNCTION GROUP



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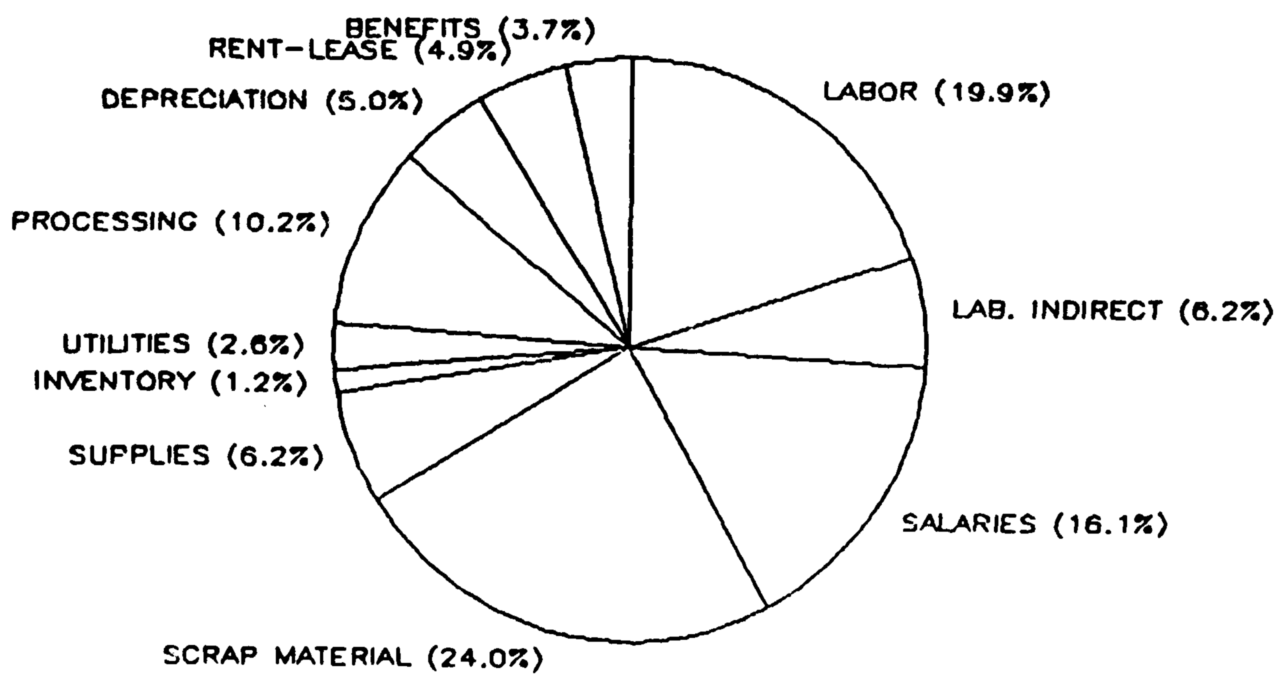
Phase I

CTL AEROSPACE IMIP COST CENTER CHART

BREAKDOWN BY ELEMENT FOR: TOTALS



Performance Baseline

CTL Aerospace TechMod Phase I

Performance Baseline
Tally Sheet

	Function	Node		Cost Measure As Is	Cost Measure To Be	Cost Measure Delta	Cost Measure Weight	Delivery As Is	Delivery To Be	Delivery Delta	Delivery Weight	Quality Measure As Is	Quality Measure To Be	Quality Measure Delta	Quality Measure Weight	Total
11	Exec	Gen Admin	P1/P1/P2	1.3580	1.4000	0.0126	0.3000	0.0000	0.0000	0.0000	0.2000	0.0000	0.0000	0.0000	0.5000	0.0126
12	Exec	Financial Account	P4/P4	51.4000	30.0000	0.1249	0.3000	18.0000	3.0000	0.1667	0.2000	0.0175	0.0100	0.0038	0.5000	0.2953
13	Exec	Cost Accounting	P4/P4	0.1620	0.1000	0.0186	0.3000	0.0000	0.0000	0.0000	0.2000	0.0000	0.0000	0.0000	0.5000	0.0186
14	Exec	Purchasing	P5/P5/P5	0.0422	0.0100	0.0097	0.3000	0.6363	0.9000	0.0527	0.2000	0.9500	1.0000	0.0250	0.5000	0.0874
15	Exec	Human Resources	P4/P4	0.0000	0.0000	0.0000	0.3000	0.9800	1.0000	0.0040	0.2000	0.0000	0.0000	0.0000	0.5000	0.0040
16	Exec	Marketing	P1/P1/P2	0.3480	0.4000	0.0156	0.3000	0.9174	1.0000	0.0165	0.2000	0.9966	1.0000	0.0017	0.5000	0.0338
				53.3102	31.9100	0.1814		20.5337	5.9000	0.2399		1.9641	2.0100	0.0305		0.4517
21	Eng	Product Develop	P5/P4	0.3900	0.4000	0.0020	0.2000	8.0000	5.0000	0.1125	0.3000	0.6000	0.8500	0.1250	0.5000	0.2395
22	Eng	Process Engineer	P5/P4	0.3900	0.4000	0.0020	0.2000	4.0000	2.0000	0.6000	0.3000	0.6000	0.8500	0.1250	0.5000	0.7270
23	Eng	Tooling Design	P3/P3/P3	0.2900	0.3200	0.0060	0.2000	0.5200	1.0000	0.1440	0.3000	0.8000	1.0000	0.1000	0.5000	0.2500
				1.0700	1.1200	0.0100		12.5200	8.0000	0.8565		2.0000	2.7000	0.3500		1.2165
31	P&C	Planning	P1/P1/P2	0.3900	0.4000	0.0030	0.3000	0.9100	1.0000	0.0540	0.6000	0.8400	1.0000	0.0160	0.1000	0.0730
32	P&C	Inventory	P8/P2	0.0087	0.0050	0.0011	0.3000	0.6000	1.0000	0.2400	0.6000	0.8400	1.0000	0.0160	0.1000	0.2571
33	P&C	Tooling Mang	P3/P3/P3	0.2900	0.3200	0.0090	0.3000	0.8000	1.0000	0.1200	0.6000	0.8000	1.0000	0.0200	0.1000	0.1490
34	P&C	Program Mang	P1/P1/	0.3900	0.4000	0.0030	0.3000	0.9100	1.0000	0.0540	0.6000	0.8400	1.0000	0.0160	0.1000	0.0730
35	P&C	Shop Floor	P4/P4/P4	0.9600	1.0000	0.0120	0.3000	0.9100	1.0000	0.0540	0.6000	0.8400	1.0000	0.0160	0.1000	0.0820
36	P&C	External Mfg	P4/P4	1.0000	1.0000	0.0000	0.3000	0.8000	1.0000	0.1200	0.6000	0.9500	1.0000	0.0050	0.1000	0.1250
37	P&C	Maintenance	P8/P4	0.9600	1.0000	0.0120	0.3000	0.8000	1.0000	0.1200	0.6000	0.0000	0.0000	0.0000	0.1000	0.1320
38	P&C	Housekeeping	P4/	0.0000	0.0000	0.0000	0.3000	0.0000	0.0000	0.0000	0.6000	0.9300	1.0000	0.0070	0.1000	0.0070
				3.9987	4.1250	0.0401		5.7300	7.0000	0.7620		6.0400	7.0000	0.0960		0.8981
41	Fab	Layup	P1/P8/P2	0.3900	0.4000	0.0035	0.3500	20.0000	15.0000	0.0875	0.3500	0.5600	1.0000	0.1320	0.3000	0.2230
42	Fab	Compression	P1/P8/P2	0.3900	0.4000	0.0035	0.3500	20.0000	15.0000	0.0875	0.3500	0.7600	1.0000	0.0720	0.3000	0.1630
43	Fab	Cure	P1/P8/P2	0.3900	0.4000	0.0035	0.3500	1.0000	1.0000	0.0000	0.3500	0.9500	1.0000	0.0150	0.3000	0.0185
44	Fab	Trim&Rout	P1/P8/P2	0.3900	0.4000	0.0035	0.3500	1.0000	1.0000	0.0000	0.3500	0.9200	1.0000	0.0240	0.3000	0.0275
45	Fab	Assembly/Finish	P1/P8/P2	0.3900	0.4000	0.0035	0.3500	2.0000	1.0000	0.3500	0.3500	0.9200	1.0000	0.0240	0.3000	0.3775
				1.9500	2.0000	0.0175		44.0000	33.0000	0.5250		4.1100	5.0000	0.2670		0.8095
51	Ms	Milling	P1/P8/P2	0.3900	0.4000	0.0035	0.3500	5.0000	4.0000	0.3500	0.3500	0.9100	1.0000	0.0270	0.3000	0.3805
52	Ms	Turning	P1/P8/P2	0.3900	0.4000	0.0035	0.3500	5.0000	4.0000	0.3500	0.3500	0.9400	1.0000	0.0180	0.3000	0.3715
53	Ms	Waterjet	P1/P8/P2	0.3900	0.4000	0.0035	0.3500	1.0000	1.0000	0.0000	0.3500	0.9700	1.0000	0.0090	0.3000	0.0125
54	MS	Drilling	P1/P8/P2	0.3900	0.4000	0.0035	0.3500	2.0000	1.0000	0.3500	0.3500	0.9700	1.0000	0.0090	0.3000	0.3625
55	Ms	Grinding	P1/P8/P2	0.3900	0.4000	0.0035	0.3500	1.0000	1.0000	0.0000	0.3500	0.9900	1.0000	0.0030	0.3000	0.0065
				1.9500	2.0000	0.0175		14.0000	11.0000	1.0500		4.7800	5.0000	0.0660		1.1335
61	Qc	Inspection	P1/P8/P7	0.3900	0.4000	0.0010	0.1000	5.0000	2.0000	0.2400	0.4000	0.9100	1.0000	0.0450	0.5000	0.2860
62	QC	Documentation	P4/P4	0.0000	0.0000	0.0000	0.1000	0.8000	1.0000	0.0800	0.4000	0.0000	0.0000	0.0000	0.5000	0.0800
63	Qc	Quality Planning	P4/P4	0.0000	0.0000	0.0000	0.1000	0.7500	0.8000	0.0200	0.4000	0.9500	0.9800	0.0150	0.5000	0.0350
64	QC	External Testing	P1/P2	0.3900	0.4000	0.0010	0.1000	0.9100	1.0000	0.0360	0.4000	0.9800	1.0000	0.0100	0.5000	0.0470
				0.7800	0.8000	0.0020		7.4600	4.8000	0.3760		2.8400	2.9800	0.0700		0.4480

NOTE: Delta represents "to be" factor less "as is" factor multiplied by the relative node weight

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TechMod
Phase I

Performance Baseline
Statistic Criteria

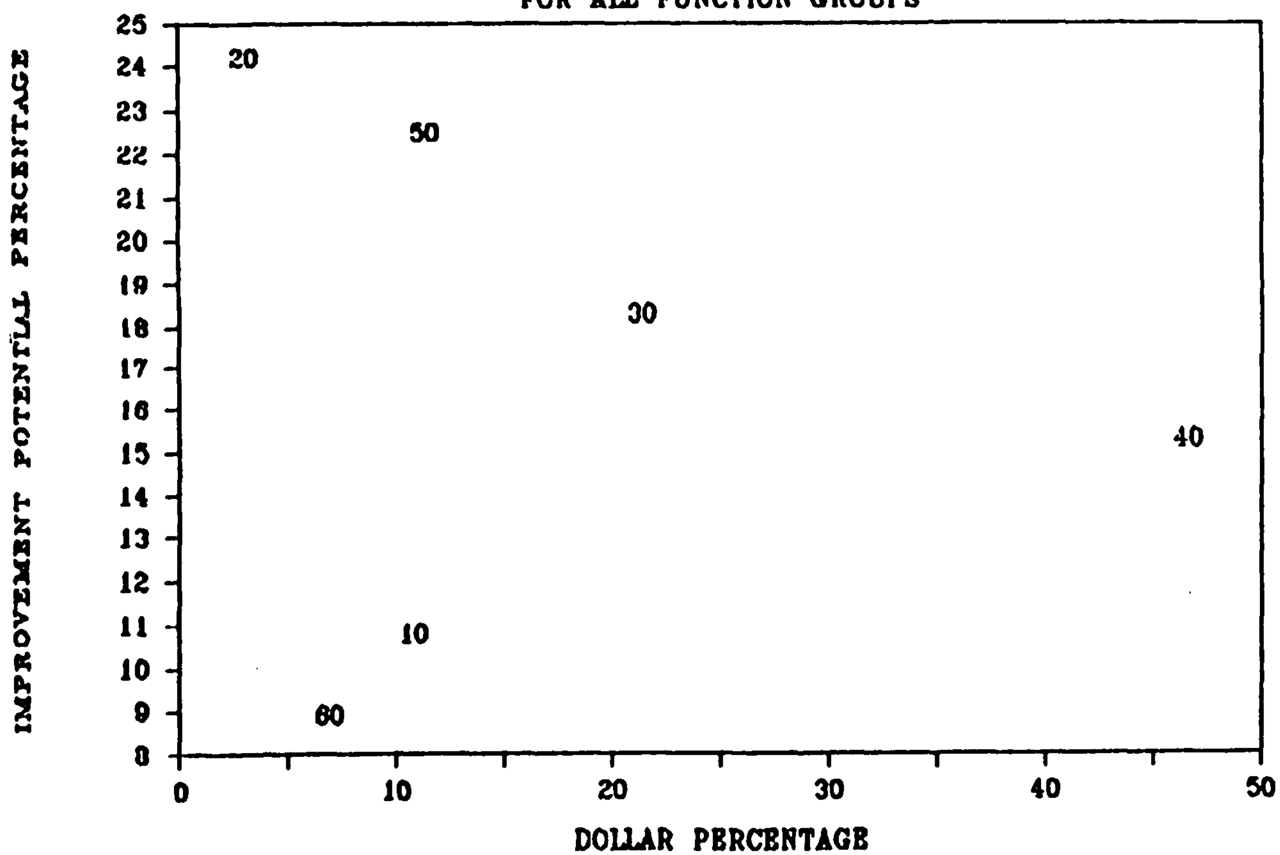
	Function	Node	Support	Cost Measurement	Delivery Measure	Quality Measure
11	Exec	Gen Admin	P1	ROI	N/A	N/A
12	Exec	Financial Account	P1/P1/P1	Days Receivable	Days to Close Books	Borrowing Rate
13	Exec	Cost Accounting	P1	Operating Expense/Sales	N/A	N/A
14	Exec	Purchasing	P1/P2/P2	Raw Matl Inv & Supplies/Sales	PO/Receiver Date	Pieces Rejected/Accepted
15	Exec	Human Resources	P4	N/A	Attendence	N/A
16	Exec	Marketing	P1/P5/P3	Gross Margin %	Late Shipments/Total Shipments	Pieces Rejected/Shipped
21	Eng	Process Engineer	P5/P7/P1	Budget/ Actual Cost	PO Date/Plan Issue	Cycles In Signoff
22	Eng	Product Develop	P5/P7/P5	Budget/ Actual Cost	PO Requirement/Actual	Terminated/Success
23	Eng	Tooling Design	P6/P6/P6	Budget/ Actual Cost	PO Date/Tool Acceptance	Tools Reworked/All Tools
31	P&C	Planning	P5/P5/P9	Prog Budget/Job Cost	PO Requirement/Actual	Scrap/Production
32	P&C	Inventory	P1/P8/P9	Cost of Goods Sold/Avg Inventory	Premium/Total Shipments	Scrap/Production
33	P&C	Tooling Mang	P5/P5/P9	Prog Budget/Job Cost	PO Requirement/Actual	Scrap/Production
34	P&C	Program Mang	P5/P5/P9	Prog Budget/Job Cost	PO Requirement/Actual	Scrap/Production
35	P&C	Shop Floor	P1/P5/P9	Idle & Overtime/Prod Time	PO Requirement/Actual	Scrap/Production
36	P&C	External Mfg	P5/P10/P11	Prog Budget/Job Cost	Quoted/Actual Delivery	PO/Revisions
37	P&C	Maintenance	P1/P1	Maintence $/Equipment Cost	Down Time/Running Time	N/A
38	P&C	Housekeeping	P11	N/A	N/A	Shop Grading System
41	Fab	Layup	P5/P12/P9	Prog Budget/Job Cost	Process Time	% Production Scrap
42	Fab	Compression	P5/P12/P9	Prog Budget/Job Cost	Process Time	% Production Scrap
43	Fab	Cure	P5/P12/P9	Prog Budget/Job Cost	Process Time	% Production Scrap
44	Fab	Trim&Rout	P5/P12/P9	Prog Budget/Job Cost	Process Time	% Production Scrap
45	Fab	Assembly/Finish	P5/P12/P9	Prog Budget/Job Cost	Process Time	% Production Scrap
51	Ms	Milling	P5/P12/P9	Prog Budget/Job Cost	Process Time	% Production Scrap
52	Ms	Turning	P5/P12/P9	Prog Budget/Job Cost	Process Time	% Production Scrap
53	Ms	Waterjet	P5/P12/P9	Prog Budget/Job Cost	Process Time	% Production Scrap
54	MS	Drilling	P5/P12/P9	Prog Budget/Job Cost	Process Time	% Production Scrap
55	Ms	Grinding	P5/P12/P9	Prog Budget/Job Cost	Process Time	% Production Scrap
61	Qc	Inspection	P5/P12/P3	Prog Budget/Job Cost	Process Time	Customer Reject Parts/Actual
62	QC	Documentation	P4	N/A	Attendence	N/A
63	Qc	Quality Planning	P5/P11	N/A	PO Date/Plan Date	Revision/All Planning
64	QC	External Testing	P5/P5/P3	Prog Budget/Job Cost	PO Requirement/Actual	Customer Reject Parts/Actual

Cost Allocation/ Performance Matrix

CTL Aerospace
TechMod
Phase I

COST ALLOCATION/PERFORMANCE MATRIX

FOR ALL FUNCTION GROUPS



10 EXECUTIVE
20 ENGINEERING
30 PRODUCTION CONTROL
40 PRODUCTION/FABRICATION
50 PRODUCTION/MACHINING
60 QUALITY CONTROL

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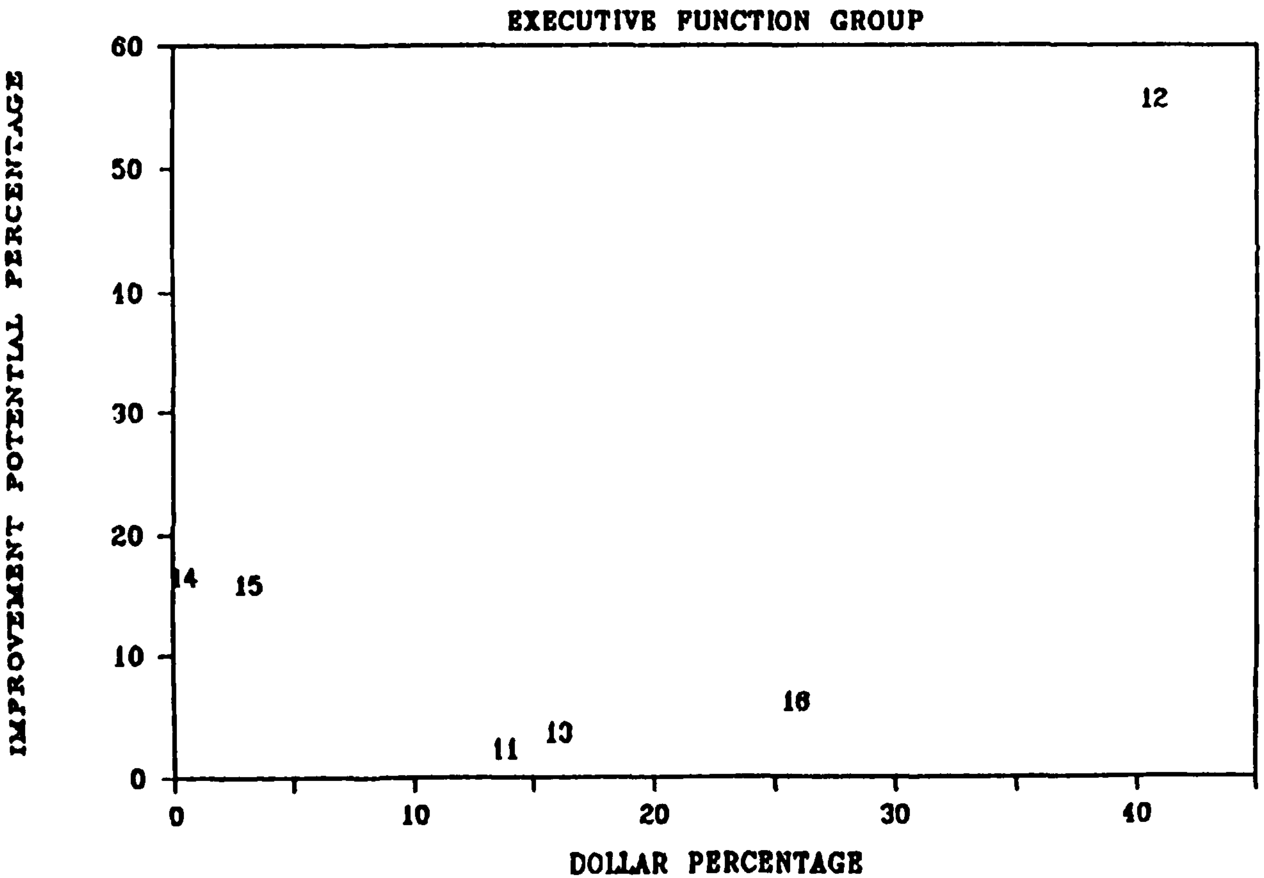
Phase I

COST ALLOCATION/PERFORMANCE MATRIX



11 GENERAL ADMINISTRATION
12 FINANCIAL ACCOUNTING
13 COST ACCOUNTING
14 PURCHASING
15 HUMAN RESOURCES
16 MARKETING

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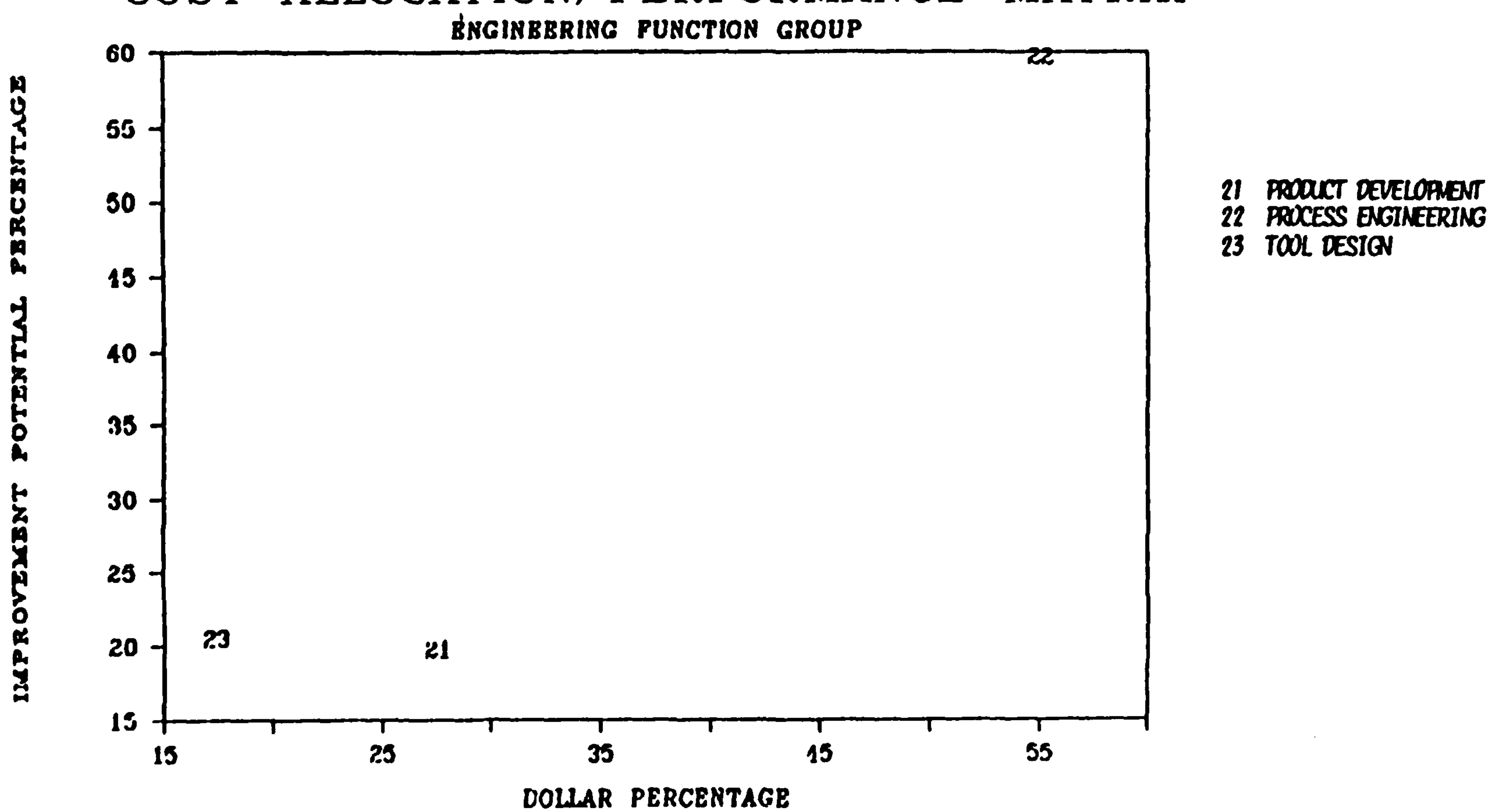
Phase I

COST ALLOCATION/PERFORMANCE MATRIX



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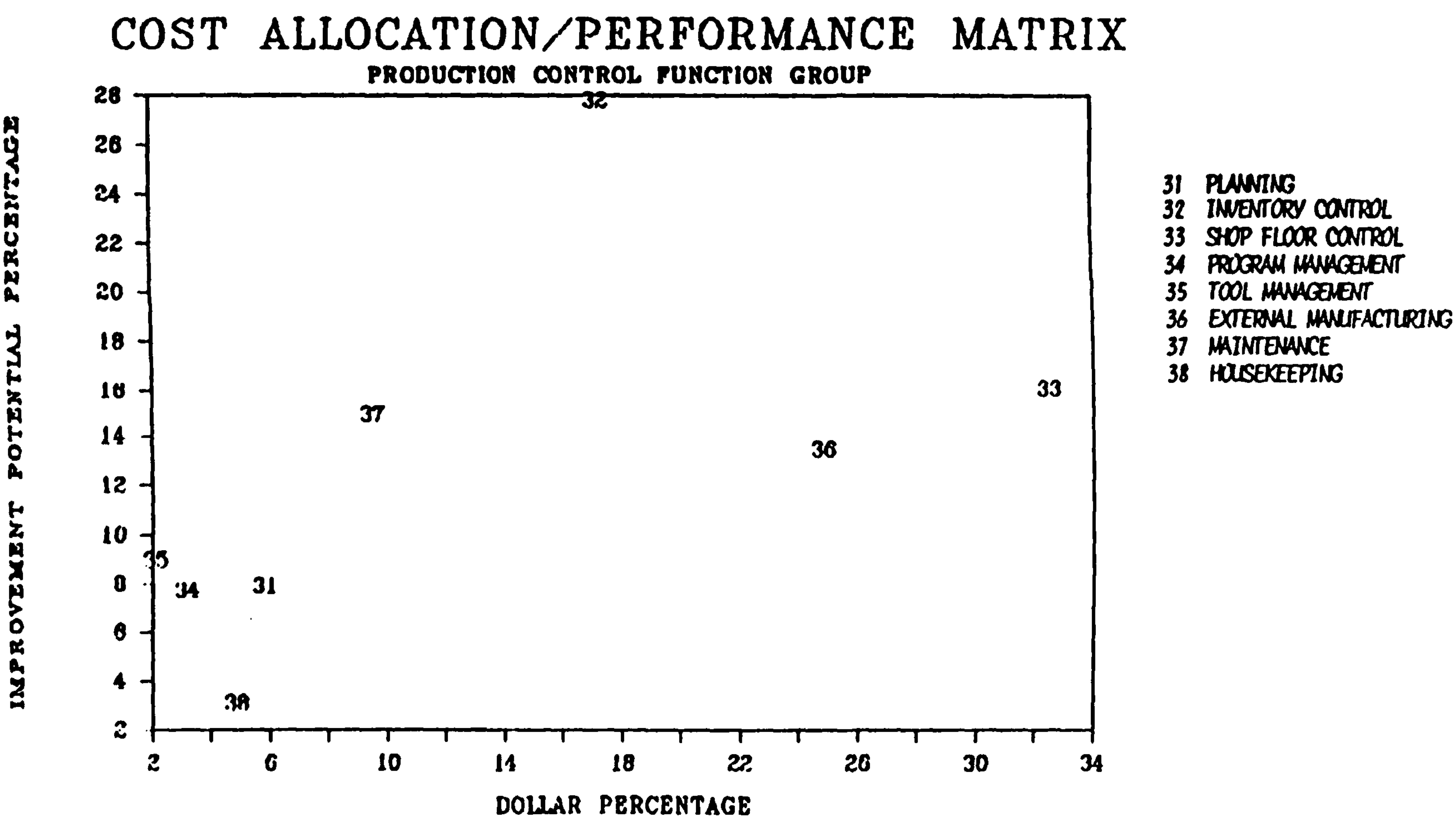
Phase I



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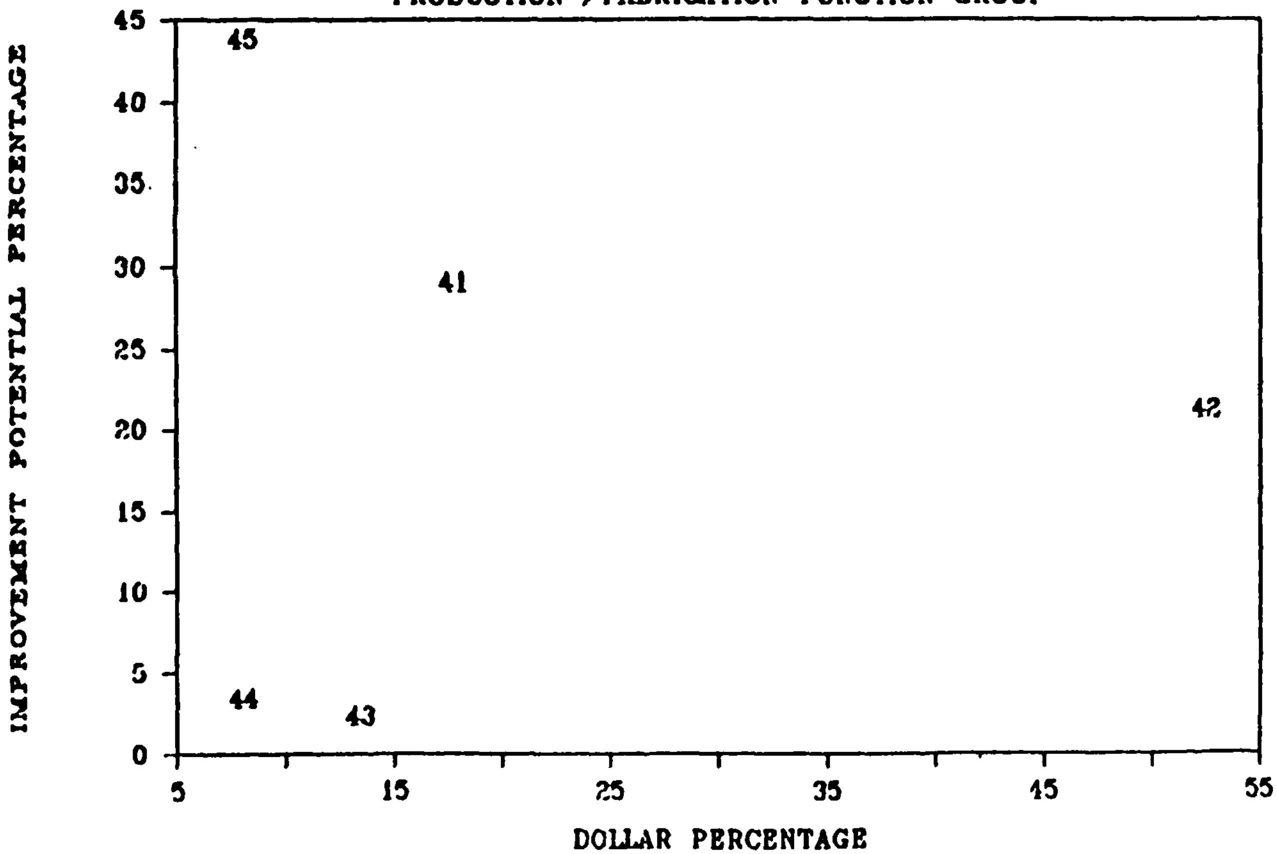
Phase I

COST ALLOCATION/PERFORMANCE MATRIX

PRODUCTION /FABRICATION FUNCTION GROUP



41 COMPRESSION MOLDING
42 LAYUP
43 CURE
44 TRIM AND ROUT
45 BONDING/ASSEMBLY

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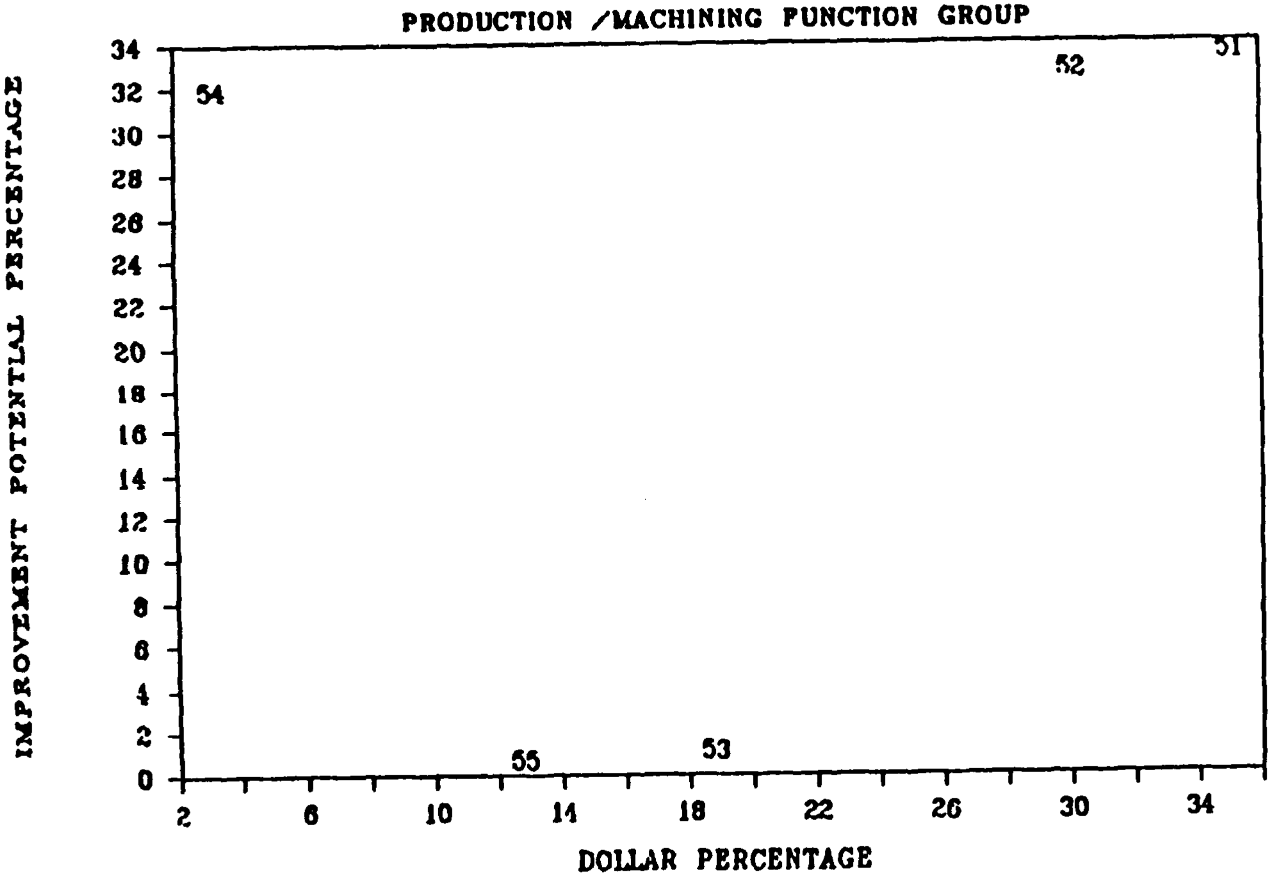
Phase I

COST ALLOCATION/PERFORMANCE MATRIX

PRODUCTION /MACHINING FUNCTION GROUP



51 MILLING
52 TURNING
53 WATERJET
54 GRINDING
55 DRILLING

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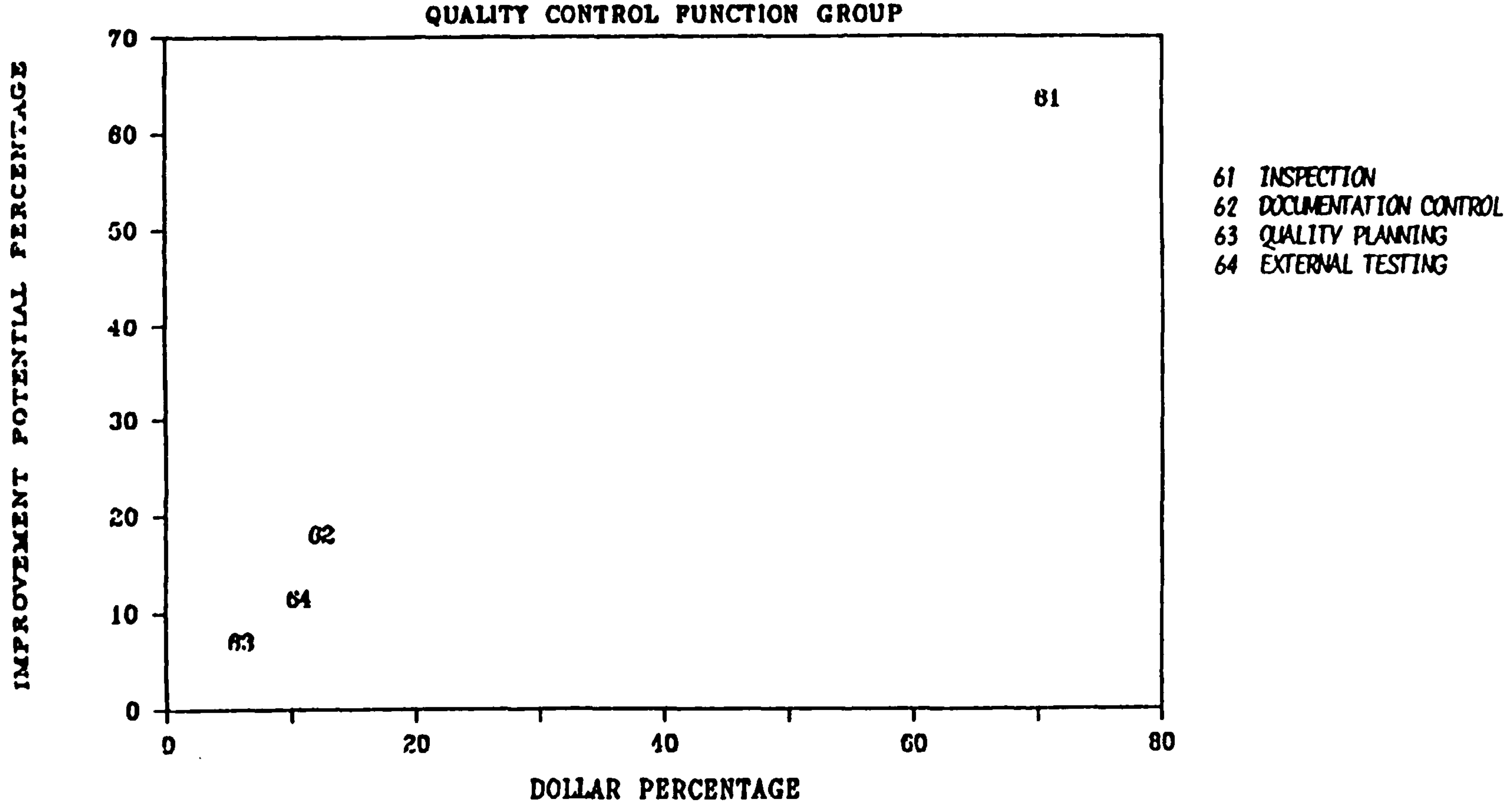
TechMod
Phase I

COST ALLOCATION/PERFORMANCE MATRIX



Glossary of Terms

Tech Mod
5-26-88

Glossary of Terms

1) A-Stage - The condition of a preimpregnated resin where the resin is in very early stages of advancement. The material is still soluble in solvent.

2) Autoclave - A closed vessel or container used to conduct molding cycles, chemical reactions or other processes where heat, pressure, or vacuum may be required.

3) B-Stage - Preimpregnated fabric or toe is infiltrated with resin and advanced to a point of tack, however, with additional heat, the material will remelt and combine with overlaying plies.

4) Bag - A sealed flexible envelope or membrane used to contain material during isostatic molding procedures.

5) Broadgoods - Fabrics, before they are impregnated, which are supplied in long rolls and normally a minimum of thiry inches in width.

6) C-Stage - A laminate which has been fully polyimerized.

7) Calibrate - To check the accuracy and, if necessary, to correct the readings obtained from various instruments such as pressure gauges, micrometers, potentiometers, balances, etc.

8) Charge Weight - The precise measure of material required to completely fill out a mold and yield a part of proper thickness and density.

9) Compression Mold - a two part pattern or form for imparting a desired shape and curing under conditions of heat and pressure. Pressure is normally applied in two opposing directions perpendicular to one plane.

10) Cure - A chemical reaction which is usally accomplished under conditions of heat and pressure to effect the polymerization of a resin, vulcanization of a rubber, or hardening of a adhesive.

11) Isostatic Molding - A method of applying equal pressure to all side of a molding at a given time. Isostatic molding includes; vacuum room temperature, vacuum temperature cure and autoclave molding.

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12) Impregnate - The uniform application of resin to fabrics or molding compounds.

13) Isotropic Layup - Normally a programmed layup which the material laminate exhibits mechanical or physical properties which are uniform or equal in all directions.

14) Job Number - A number prefixed by letters which are assigned to all individual orders or contracts for products or services recieved by a company. The prefix designates the company placing the order and the dumber indicates the sequence in which the order was recieved or quoted.

15) Layup - A term used in reinforced plastics to denote the particular manner in which a material is put on a mold or mandrel. The term denotes the material itself as an object prior to molding.

16) Manufacturing Plan - The complete list of materials, drawings and processes required to fabricate and end product.

17) Mold - A cavity or contour for holding and shaping a material precharge or layup.

18) Orientation - Generally used in referring to the angular displacement of laminations or planes of material in layups or the controlled pattern of fiber in compression moldings.

19) Pattern - A sheet metal template or clicker die for cutting a given shape to a multiple of plies going into a material layup.

20) Programed Layup - A layup which the ply orientation is specified on a drawing, requiring peticular attention to warp or fill orientation.

21) Polymerization - The chemical reaction of a synthetic or natural resin in which the molecules are linked together to form large molecules. When properly completed, the polymerization process results in a fully cured, fully hardened resin or optimum physical properties.

22) Postcure - The additional temperature cure which is often accomplished after molding to effect a more complete cure, thereby enhance physical properties of the part.

23) Prepreg - Broadgoods which have been impregnated to a B-Staged condition.

24) Quality Plan - The detailed description, which with a manufacturing plan for a specific job or project, includes the detailed or referenced requirements necessary for establishing the minimum receiving, storage, process, dimensional, tooling, and component testing to assure the product meets all contractual commitments stated in a customers purchase order.

25) Transfer Molding - A process for producing shaped thermosetting or thermoplastic articles by forcing a preheated charge under high pressure to flow from a charge chamber into a mold cavity . The procedure is simular to injection molding, however is different due to larger spurs and gates in the tool to allow for movement of the reinforcement into the chamber.

Background Information

FACILITIES

Allocation of the plant facilities are as follows:

DESCRIPTION	SQUARE FEET
OFFICE SPACE	
General Offices	4,400
Engineering	4,600
PRODUCTION AREAS	
Processing	
Press Molding Operations	4,800
Laminar Flow Clean Room FED-STD-209, Class 10,000	1,200
Forward Layup Room	1,600
Aft Layup Room	1,600
General	3,200
Post Processing	
Routing	4,800
Machining	5,000
General	5,000
Assembly	48,850
QUALITY CONTROL	
Inspection	3,600
Cold Storage	200
Freezers	350
Storage	2,400
Tool Storage	2,400
MAINTENANCE	2,000
TOTAL	96,000

FACILITIES

The following is a partial list of our company's production and quality control equipment:

PRODUCTION EQUIPMENT

Hydraulic Presses
Eleven presses from 14 tons with 21" x 24" platen and 36" stroke, to 1500 tons with 72" x 72" platen and 82" stroke.

Ovens
Five (5) gas fired, air circulating ovens:

WIDTH	DEPTH	HEIGHT	RANGE	CONTROL
10 ft.	10 ft.	8 ft.	100-150°F	Thermostat
10 ft.	10 ft.	8 ft.	100-450°F	Thermostat
11 ft.	10 ft.	10 ft.	100-350°F	Thermostat
6 ft.	6 ft.	14 ft.	100-1000°F	Programmed
6 ft.	6 ft.	8 ft.	100-5000°F	Programmed

Four (4) electric ovens:

WIDTH	DEPTH	HEIGHT	RANGE	CONTROL
3 ft.	2 ft.	3 ft.	100-500°F	Thermostat
2 ft.	2 ft.	1 ft.	250-1200°F	Thermostat
2 ft.	2 ft.	3 ft.	100-1000°F	Cam Programmable
2 ft.	2 ft.	2 ft.	100-1000°F	Chart Programmable

Pressure Vessels
Autoclave, 100 PSIG @ 400°F, 103 ID by 156 length
Autoclave, 300 PSIG @ 400°F, 60 ID by 108 length

Machine Shop
Vertical milling machines, "T" lathes, lathes, drill presses, surface grinder, radial drills, band saws, cutoff saws, and a 144 inch diameter verticle turning/milling center

Machining Center
Thermwood Cartesian 5, Computer Control, 5 Axis Waterjet/Router System

Miscellaneous
Filament Winder - 35" diameter by 144' length
Filament Winder - 5" diameter by 48" length
Panel Saw - 10' length
Grind Booth - 9' x 8' x 2'
Clicker Press - 2' x 5' Automatic
Clicker Press - 2' x 2'
Centrifugal Drive - 3' diameter, 50 lbs.
Broken Arm Router
Paint Booth - 12' x 12' x 10'

FACILITIES

Quality Control

Cordax 1000 3-axis measuring machine, 24x x 18y x 15z
Surfact Plate - 6' x 9' and 10' x 10'
Rotab - 26" diameter
ID Micrometers to 22 feet
Venier Caliper to 8 feet
Outside Micrometers to 30 inches
Baldwin 6000 lb. Testing Machine
Contour Projector - 14" diameter, 20x
Dead Weight Gage - Tested to 15,000 psi
Torque wrenches to 2000ft. lb.
Analytical Balances
Analog Height Gages - 48"
Pressure Test Chamber
Termal Test

PRODUCTS AND / OR SERVICES LIST

The following is a partial list which describes products and/or services which we have provided:

ITEM	*CUSTOMER*	*PRODUCT DESCRIPTION*
1	Bendix Environmental Process & Inst. Div.	Cast Tops & Bottoms for the Chemical Agent Alarm
2	General Dynamics Tank Plant	Solar Heat Shroud M-70A2 and M1 Tank
3	Rockwell International Collins Defense Communications	Ducting, Panels for Surveillance Aircraft
4	Warner Robins AFB Robins AFB, GA	Antenna Enclosures USAF - ARC-96
5	TRW, Inc. Space Systems Division	Hinge Assemblies
6	General Electric Company Aircraft Engine Group Evendale, Ohio	Aircraft Engine Components
7	General Electric Company Burlington, VT	Scoop Disc
8	Hughes Aircraft Hughes Optical Products	Collimator Housings Maverick Missle
9	Grumman Aerospace Corp. Bethpage, NY	Tip Cap Assemblies E-2C Aircraft
10	General Electric Company Aircraft Engine Group Evendale, Ohio	QCSEE Airframe
11	Goodyear Aerospace Corp. Akron, Ohio	Engineering Mockup GZ-22 Airship
12	Pacific Optical Torrance, CA	Lazer Components
13	Garrett Phoenix, AZ	Ram Jet Components
14	Aeronca, Inc. Fleet Aerospace Middletown, Ohio	747 Flaptrack Tooling
15	General Electric Company Aircraft Engine Group	Seals TF-39 Engine Components

In addition to the aforementioned projects, our company has produced Jupiter Nose Cones, Gemini, Apollo, Attitude Control Engines, Lance Chambers, Minuteman, Polaris Ablative Exit Cones and other engine components.

AUTOMATED COST BASELINE GENERATOR (ACBG)

Price Waterhouse has developed a microcomputer-based modeling system for cost-efficient measurement of the cost benefit of advanced manufacturing technologies. The Automated Cost Baseline Generator (ACBG) was used to develop both the "as is" and "to be" cost baselines for validating the economics of the technology manufacturing projects identified in Phase I of the CTL Tech Mod program.

WHAT ACBG DOES

ACBG facilitates the cost benefit evaluation (including the treatment of indirect costs) of various manufacturing improvement scenarios with only minor user input. By computerizing the generation of factory baselines, the model allows the contractor to verify the impact of a given technology on the factory's total costs. Without this computer assistance, making this evaluation can be a tedious and expensive task, since variations of a given technology (or the synergism of two technologies) may require continuous revalidation of the "to be" cost baseline.

ACBG is a Revelation-based system for cost allocation that can be run on an IBM PC/XT, or Compaq Plus. Paralleling the IDEF Node Tree architecture, the system allocates costs in a top-down manner. Built-in tests ensure that you will have a valid number of subnodes (from three to six), numeric tests, and node numbers, in accordance with the IDEF architecture.

As many as eighteen cost groupings, classified as variable, semi-variable, or fixed can be allocated to individual nodes on a specific, equal, percentage or by up to eight different performance measures. Audit trails are generated for data source as well as allocation method, amount and basis. Environmental assumptions (for example, inflation) can also be considered.

Finally, the baselines generated by the system can also be used to drive tax analysis and product cost reduction reports, based upon forward pricing rate data.

HOW ACBG WORKS

ACBG is based on the US Air Force's IDEF Node Tree "top down" functional architecture. However, and this is most important, ACBG is initiated from a contractor's actual financial reports. It is interrelated with the existing financial reporting structure.

Using ACBG requires three items of input -- all unique to a contractor's manufacturing facility. These are: 1) a table of manufacturing cost groupings (up to eighteen); 2) copies of annual departmental financial reports (or budgets) at the cost center level; and 3) a "top down" Node Tree structure of the manufacturing facility.

The key processing steps are summarized as follows:

- Input of manufacturing cost groupings and performance measures
- Input of cost center financial data extracted from company financial reports

- Input of the "top down" IDEF Node Tree
- Run the reports documenting the data entered into the system
- Allocate the departmental expenses to the nodes of the Node Tree. The system has the flexibility to perform these allocations: on an equal basis; according to performance measures; on a percentage basis; or specifically
- Once sufficient manual allocations have been made to assure reasonable accuracy, ACBG will then complete the remaining allocations through an explosion process. After this process is complete, all of the departmental costs will have been allocated to the individual nodes of the Node Tree.
- Develop "to be" models. Any number of "to be" analyses can be done. These analyses are always done on a facility-wide basis.

Throughout this process, reports are run which provide an audit trail of all information entered. Additionally, reports are available which show manufacturing process costs at various levels of detail, as well as, "as is" and "to be"comparison reports.