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AUBURN UNIVERSITY PROJECT THEMIS
TECHNICAL REPORT NUMBER AU-T-11

A COMPUTER ASSISTED MULTI-FLOOR OFFICE BUILDING LAYOUT

PREPARED BY
THE INDUSTRIAL ENGINEERING DEPARTMENT
GEORGE H. BROOKS, PROFESSOR AND HEAD
AUBURN UNIVERSITY, AUBURN, ALABAMA
APRIL, 1970

CONTRACT DAAH01-68-C-0296
ARMY MISSILE COMMAND
HUNTSVILLE, ALABAMA

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ABSTRACT

An application of the Automated Design Layout Program (ALDEP) is presented whereby departmental areas were allocated within a proposed seven story facility for the Birmingham Social Security Payment Center. The criterion used for assignment of departmental facilities to areas was material or folder flow between departments. The final layout proposed was hand adjusted to produce a more aesthetic and practical design.

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I. INTRODUCTION

A proposal has been made to construct a seven story office facility to house the entire Social Security Birmingham Payment Center, due to the limited space now available. At the present time the center is located in five separate buildings: (1) The Social Security Building, (2) The Athens Building, (3) The Eastwood Mall Building, (4) The Citizens Federal Savings and Loan Building, and (5) The 713 Building.

These separate locations make communications and transportation a major problem. Currently the payment center is divided into several broad departments. The extreme size of some of the departments, i.e., Post Entitlement, Awards Processing, and Claims Authorization, creates the difficulty of allocating space in determining flow. The word flow is used here to connotate folder flow within the payment center, which has over 3,000,000 folders on file and over 100,000 folders in operation daily.

At present the payment center's work is partially conducted manually, but the majority is done by the RCA Spectra 70 Model computer. The IBM-360-30 Model computer is used presently for case control so that the location of any given folder can be found at any time.

II. ALDEP - THE APPROACH FOLLOWED

Since the problem of laying out a seven story building is quite complicated a computer program was chosen to aid

in the layout. The computer is not only unbiased, but it can consider a great number of different layouts in a relatively short period of time.

ALDEP (Automated Layout Design Program) was chosen due to the fact that it was a "multi-story" program, although it is limited to three stories at a time. Prior to comparative studies, ALDEP was originally developed using the random selection technique by Jerrold M. Seehof and Wayne O. Evans, both of IBM. ALDEP applies a programming method of decision rule making to create block layouts. Many block layouts are created and the better layouts are selected. The output is in the form of a matrix printout representing the better layouts. Layouts are scored on the basis of interorganizational preference and the score is the summation of the preference values which are explained later in the report.

As was mentioned ALDEP can handle up to three floors at a time and does not require an initial layout. Any number of departments can be fixed either as to a specific area on a floor or just to the specific floor. A fixed department may be an actual department or such things as aisles, stairwells, restrooms, etc., which are called dummy departments. ALDEP, therefore, eliminates the task of hand constructing numerous block layouts, and any number of desired layouts will be produced from the thousands of possibilities the program considers. It is important to note that the program is only a tool and that the layouts produced are based on the problem definition and the input given by the planner.

III. NECESSARY INPUT DATA

The ALDEP input data can be grouped into four major tables:

(1) Layout Control Table
(2) Department Area Table
(3) Preference Table
(4) Preassign Table

The Layout Control Table is used to give the area available for the departments and the size of the floors of the building. The data needed are:

(a) The square feet available for department placement on the floors; This area excludes dummy departments.
(b) The width of the floors,
(c) The depth of floors,
(d) The number of layouts to be tried.

The Department Area Table contains:

(a) The department number,
(b) The department size.

The Preference Table is the most important table used by the layout program. Each department's preference is given for each of the other departments.

A preference of:

A has an assigned preference numerical value of 64. This letter means it is absolutely essential to be located near a department.

E has an assigned preference numerical value of 16. This letter means it is essential to be located near a department.

I has an assigned preference numerical value of 4. This letter means it is important to be located near a

department.

O has an assigned preference numerical value of 1. This letter means it is of optional importance to be located near a department.

U has an assigned preference numerical value of 0. This letter means it is unimportant to be located near a department.

X has an assigned preference numerical value of -1024. This letter means it is undesirable to be located near a department.

S has no assigned preference numerical value. This letter means same department no preference. This value is a type of identity value as in an identity matrix.

The Preassign Table tells the program:

(a) If the department should be assigned to a specific floor or not.
(b) If the department should be assigned to a specific area on a specific floor or not.
(c) If stairwells, aisles, elevator shafts, restrooms, etc., will be preassigned as a dummy department.

IV. ALDEP METHOD OF PROCESSING DATA

With an understanding of the tables, an understanding of ALDEP processing is important. The program reads into the computer the Layout Control Table which creates the layout of the floors, and assigns positions of the dummy departments from the Preassign Table. With the Department Area Table values in the computer memory, a modified random selection technique is used to process departments. Initially any available department is randomly selected. This department

is placed on a floor randomly or to a specific location if it is preassigned. After the selected department is assigned, the Preference Table for that department is searched to find any department with a demand preference, that is the preference of highest priority such as A, E, or O. If an available department is found with a demand preference, this department is processed next. If no available department is found with a demand preference a department is selected randomly. This process is repeated until all departments are processed.

How can one tell if this layout is any better than the other layouts created? The criterion for evaluation is the layout score which is the summation of the numerical preference values of the adjacent departments. For each module (square) of the building the preference numerical values of the eight surrounding modules is added to the layout score, which is a running sum of all the values. The layout score which has the highest value is the best score since in the Preference Table an A=64, E=16, I=4, etc.

A special routine is included to score departments across an aisle.

Better block layouts are obtained by using the program in stages. The planner analyzes the first block layouts, assigns particular departments to a specific floor or to an actual area on a floor. The computer run with these additional preassignments is submitted for more random block layouts. This process can be repeated until the complete building is assigned.

V. DATA FORMULATION IN ALDEP FORMAT

The Layout Control Table was determined from proposed plans of the seven story facility. Ten foot squares were chosen as the most compatible area size for the ALDEP format.(A-1)

Initially the payment center was divided into six major departments - receiving and files, awards processing, post entitlement, claims authorization, reconsideration, and PRP. The extreme size of the departments, however, would create difficulty in allocating space requirements. Therefore, in establishing the department area table, it became obvious that the various branches should be subdivided into smaller units in order to fully utilize the ALDEP approach. By doing this, not only will major branches be layed out, but also the subdepartments within each branch will be layed out according to their preferences.

Current areas of each of these departments were then determined using given data. Total present area occupied by the payment center was divided into the total available area of the new building to give a correction factor of 1.492. Areas in the new facility were obtained by multiplying the present areas of each department by this factor. (A-2)

To establish the preference table a criterion had to be found for determining interorganizational preferences. This might be considered the most important step, since the results of the entire problem depend upon the chosen criterion.

The criterion must not be so general so as to make it inapplicable to each department, but must be a measurable quantity.

The initial step taken to establish the criterion was a complete technical tour of the entire payment center. This tour gave an overall picture of the operations and organizations for the payment center. From this tour, two alternatives for criterion were chosen: (1) personnel flow and (2) folder or material flow. From this point in the report, folder flow will refer to all material flow, since all incoming mail is immediately associated with a folder and moves throughout the center in the folder.

After further reflection on the proposed situation, personnel flow was dropped from consideration. Since the new building will house the entire payment center, personnel flow between separate buildings, which now occurs, will be eliminated. Also, a vertical conveyor system will be installed in the new building, thus eliminating the need for the majority of personnel flow between floors.

As was previously mentioned, there are over 100,000 folders in operation daily moving between departments. Presently folders are not transported between departments individually, but are accumulated into large batches and carried in a cart. This movement occurs only a few times daily between specified departments. Since all work in a department is centered around the folder and time involved in moving folders between departments could affect production rates, a minimization of folder flow will increase the overall

efficiency of the payment center. Therefore, folder flow was chosen as the criterion for determining interdepartmental preferences.

Once the criterion was chosen, appropriate data was collected. Interviews with chiefs of the various branches were collected. From these interviews the folder flow of each department to and from all other departments was determined.

A flowchart of the entire payment center was constructed to give an overall view of folder movement. (A-3) It is important to note that in this diagram, the values given represent total flow in and out of the departments.

From the total interdepartmental folder flow, interorganizational preferences were determined for each department (A-4). A-5 shows a sample calculation in determining one of these preferences. It should be noted that the larger of the two percentages, i.e., 53.7%, was chosen. In every case the larger percentage was chosen as it was deemed to be more important because it represented the maximum flow between the departments.

A percentage range was assigned to each of the preference values. The previously chosen percentage of 53.7 was then compared to these ranges to determine into which one it fell. Since it fell into the 40%-60% range, a corresponding value of I was assigned to the relationship of claims control to files maintenance. In this manner the entire preference table

was constructed. (A-4)

The areas to be frozen throughout the building were then specified for the Preassign Table. (A-6). These areas constituted aisles, the core of the building, the restrooms and stairwells not included in the core and conference rooms. The computer room was also frozen to a specific area on the third floor as dictated by the building requirements.

Once all the tables were completed the actual ALDEP computer runs were made. The problem of determining which department to put in which set of three floors was simplified by the restrictions within the payment center: for example, the Computer Room and subsequently other closely related departments had to be placed on the third floor; Files Maintenance required a whole floor; and many management oriented departments were restricted to the seventh floor.

After the initial runs a minimum acceptable layout score was inserted into the program to determine the final layouts. This minimum score was the maximum score of the initial runs.

The best final ALDEP runs are given in (A-7 to A-10). However, to produce a more aesthetic and practical design, some alterations in the layouts were made. The final hand adjusted layout of each floor can be found in (A-11 to A-18).

VI. CONCLUSIONS

It was concluded that the final ALDEP computer runs produced a configuration as close to optimal as possible with the constraints imposed by the input data.

ALDEP is indeed a useful tool to use as an aid in the layout of multi-story facilities. Many more configurations were considered than would have been possible by hand, and, therefore, a better design probably resulted. ALDEP is only a tool, however, since the final computer runs had to be hand adjusted for practical considerations.

The use of folder flow as a criterion for determining interdepartmental preferences was a logical choice for this office facility, since all paperwork was linked to the folders concerned. It should be kept in mind, however, that since the layout is based on folder flow, it may not be best for other criteria.

VII. RECOMMENDATIONS

It is recommended that the final layouts shown in Appendices 11-18 be implemented in the proposed building.

If in the future an enlargement of the building is decided upon or the original plans are altered in any way, it is further recommended that a similar approach be used to aid in laying out the facilities, i.e., a computer assisted facility location.

VIII. SELECTED BIBLIOGRAPHY

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5. "The Planning of Single Story Layouts," B. Whitehead, and M. Z. Eldars, Building Science, Vol. 1, 1965.
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A-1

LAYOUT CONTROL TABLE

Floors [1]	2	3	4	5	6	7
Number of square feet per square	100	100	100	100	100	100
Number of squares available for department placement	162	564	564	564	564	425
Width of floors in squares (less than 50)	27	32	32	32	32	32
Depth of floors in squares (must be less than 50)	6	23	23	23	23	23

[1]The first floor was not considered because it had been decided to use that area for a restaurant which would be open to the public. The second floor was restricted to an area 54' x 269' - the remainder being preassigned to the treasury department. The basement was not considered in the computer algorithm, but was analyzed and drawn by conventional layout techniques.

A-2

DEPARTMENT AREA TABLE

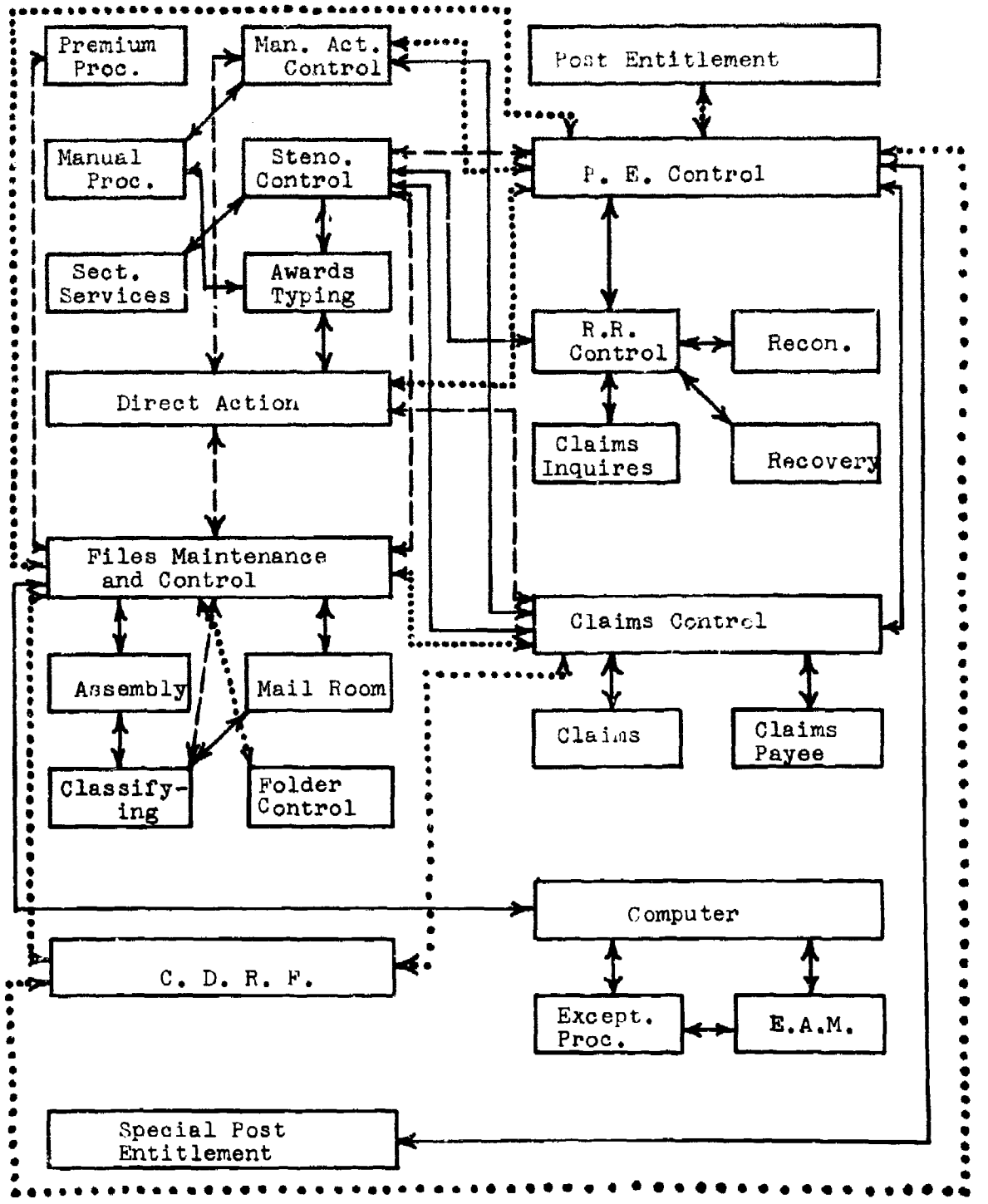
(In Square Feet)

Dept. No.	Department Name	Old Area	New Area
231	Mail Room	1,683	900
232	Assembly	2,556	3,811
233	Classifying	1,598	2,384
234	Files Maintenance	33,179	49,503
235	Folder Cont.	5,346	7,976
236	Claims Cont.	3,965	5,916
237	Claims-Payee	3,080	4,595
238	Claims Sections	16,863	25,160
239	PE- Exam & Cont.	10,309	15,381
240	PE Sections	18,329	27,347
241	Reconsideration	2,778	4,144
242	Recovery	2,592	3,867
243	Recon. Cont.	510	761
244	AP Control	2,524	3,766
245	Direct Action	7,646	11,408
246	Prem. Coll.	5,346	7,976
247	Manual Action	7,487	11,171
248	Sec. Serv.	2,000	2,986
249	Awards Typ.	6,000	8,952
250	Steno. Cont.	1,000	1,492
251	Computer	3,407	5,400
252	E A M	5,517	8,070
253	Excep. Prog.	4,686	6,834
254	Claims Inq.	2,592	3,867
255	S. P. E.	4,750	7,087
256	Expediting	940	1,402
257	Qual. Appr.	1,490	2,223
258	Recruiting	1,200	1,790
259	Office Serv.	13,500	16,308
260	Personnel	2,200	3,282
261	Empl. Devel.	2,760	1,149
262	Fiscal Audit	2,258	3,369
263	Manag. Anal.	2,760	4,118
264	C.D.R.F.	3,620	5,401
265	Oper. Anal.	320	477

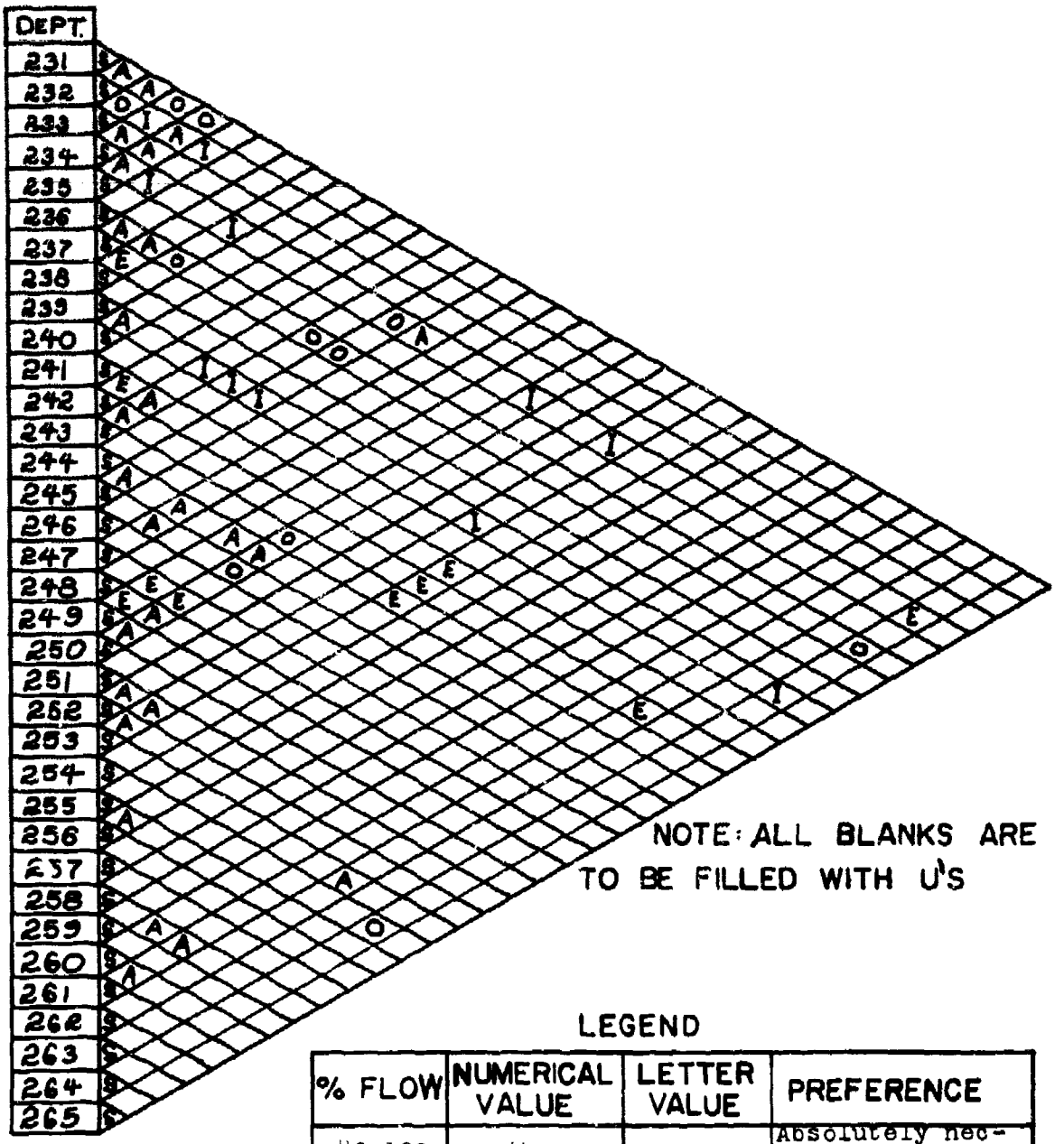
FLOW DIAGRAM

FOLDERS PER MONTH

0 - 5000 ——— 5000 - 25000 ----- Over 25000 •••••



PREFERENCE TABLE



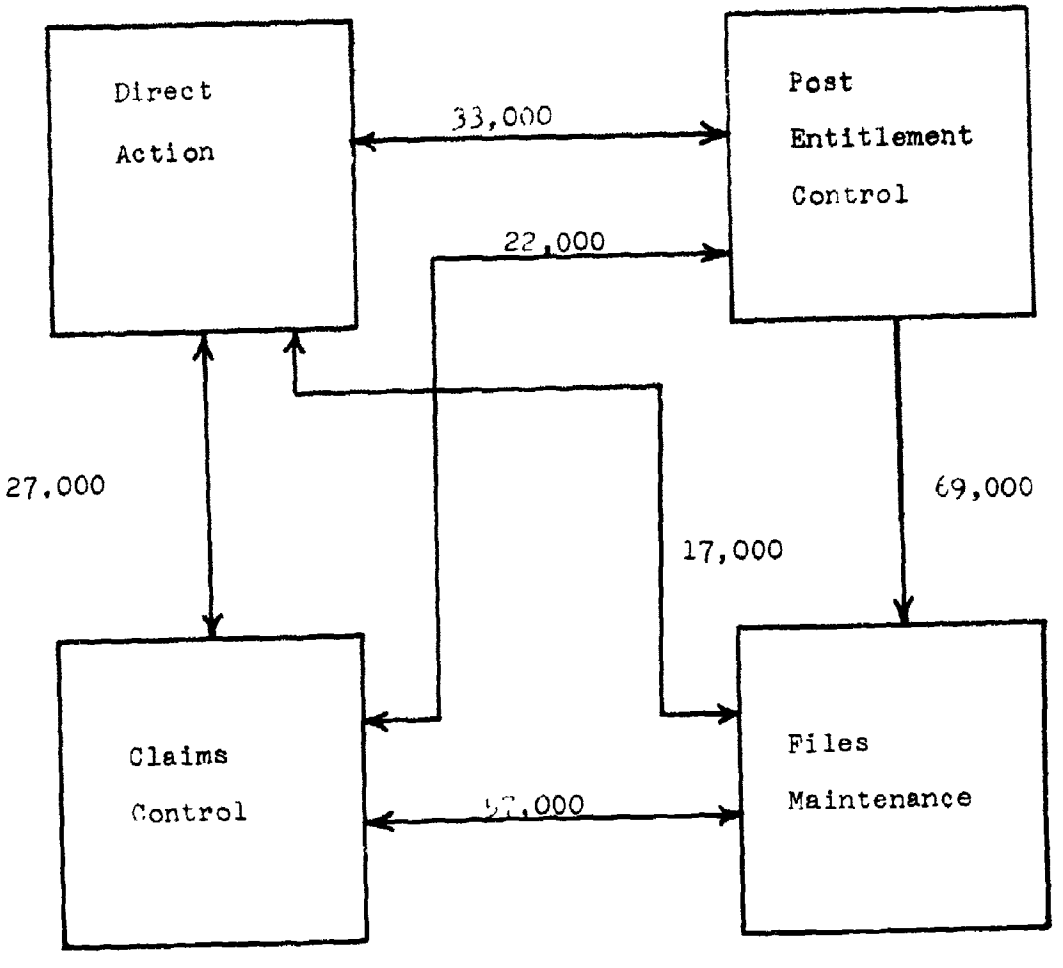
NOTE: ALL BLANKS ARE TO BE FILLED WITH U'S

LEGEND

% FLOW	NUMERICAL VALUE	LETTER VALUE	PREFERENCE
80-100	64	A	Absolutely necessary
60-80	16	E	Especially important
40-60	4	I	Important
20-40	1	O	Ordinarily Close
0-20	0	U	Unimportant
----	-1024	X	Undesirable
----	----	S	Same Dept.

PREFERENCE TABLE

SAMPLE CALCULATION



Claims Control to Files Maintenance

% of Claims Control = $\frac{57,000}{106,000}$ x 100 = 53.7%

% of Files Maintenance = $\frac{57,000}{143,000}$ x 100 = 39.9%

Choose 53.7%

A-6

PREASSIGN TABLE

An"F" in the table represents an assignment to a specific floor.

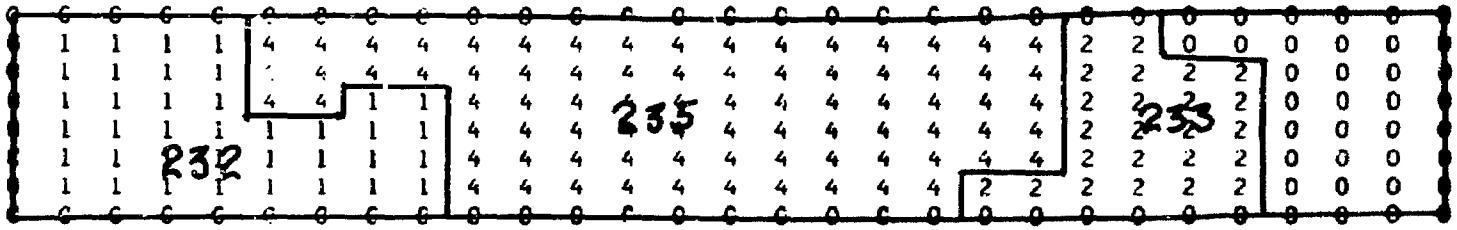
An "A" in the table represents an assignment to an actual area on a floor.

Dept. No.	Name	Floors 2	3	4	5	6	7
251	Computer Room		A				
1	Stairwells and Restrooms		A	A	A	A	A
2	Conference Rooms		A	A	A	A	
3	Core		A	A	A	A	A
4	Offices						A
5	Auditorium						A
255	Special P. E.						F
256	Expediting						F
257	Quality Appraisal						F
258	Placement Recruiting						F
260	Personnel						F
261	Employee Development						F
263	Management Analysis						A
264	CDRF						F
265	Operations Analysis						F

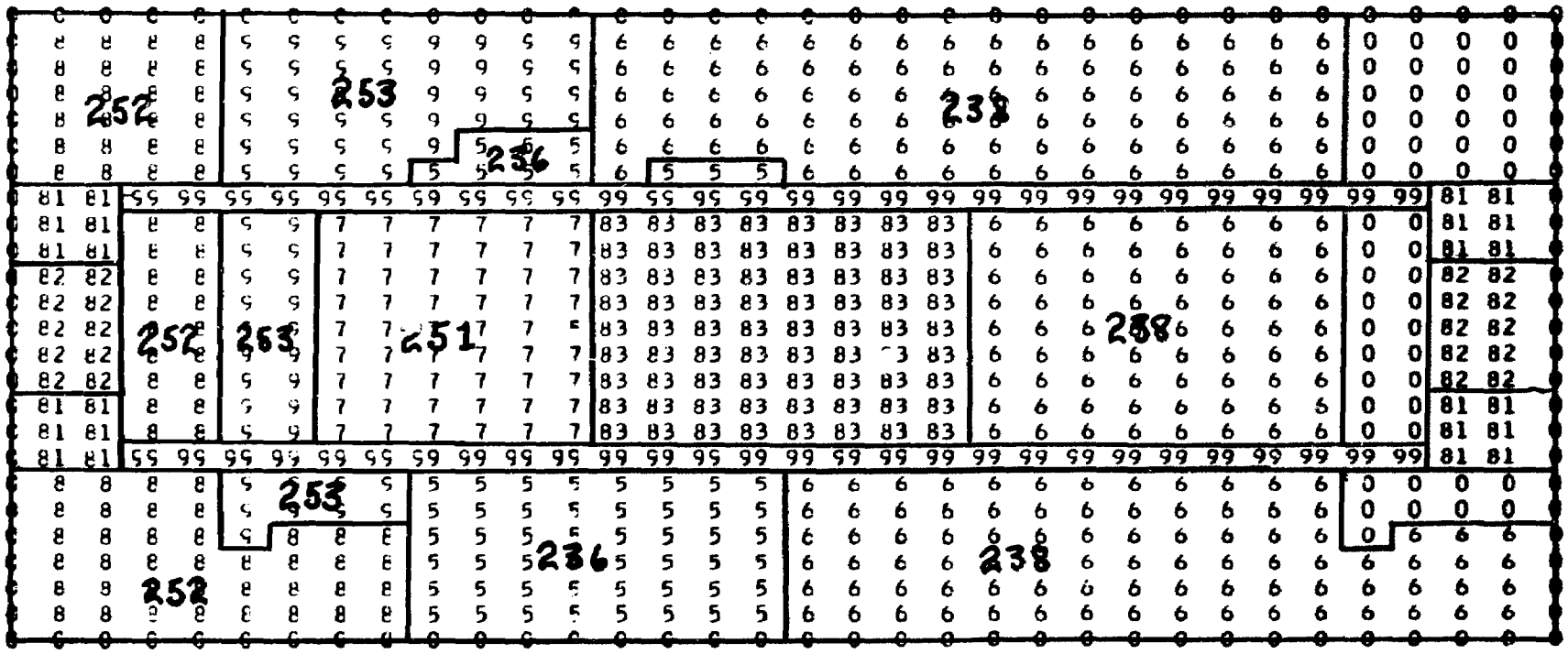
A-7 TO A-10

ALDEP COMPUTER OUTPUT LAYOUTS

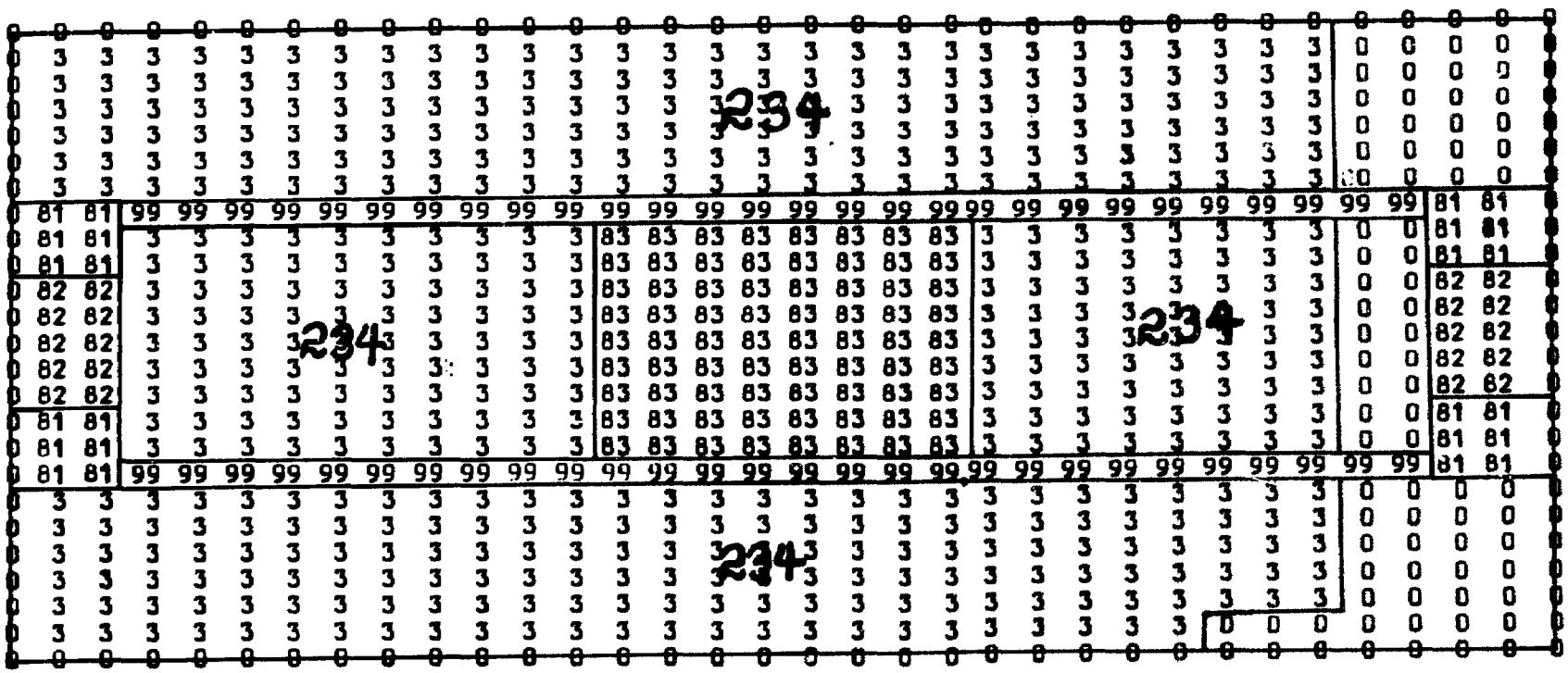
TRIAL LAYOUT 38 SCORE = 640



TOP FLOOR = 1

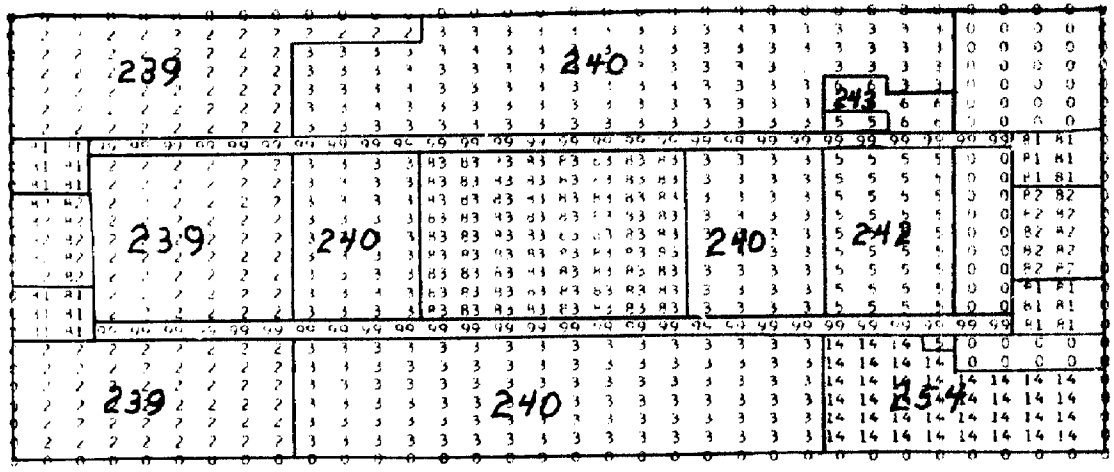


GROUND FLOOR = 3

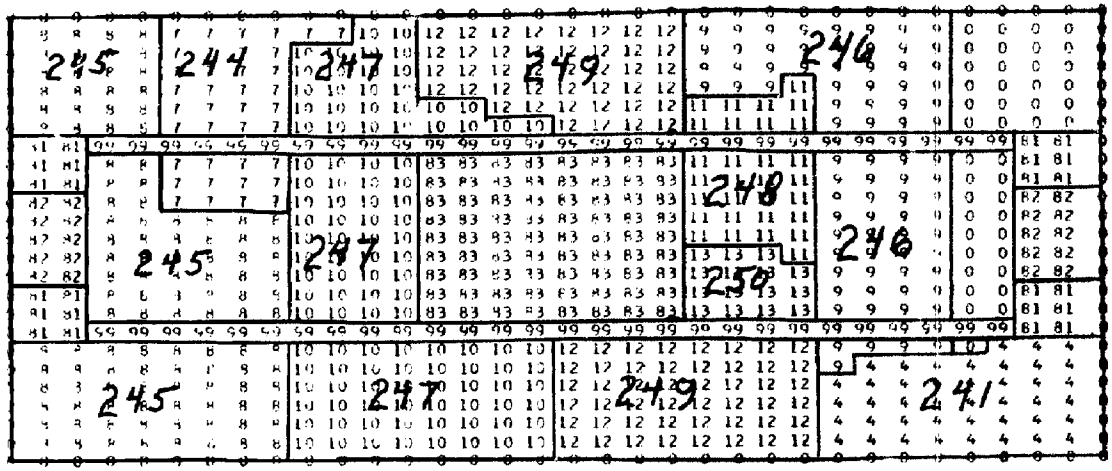


TERRACE LEVEL = 4

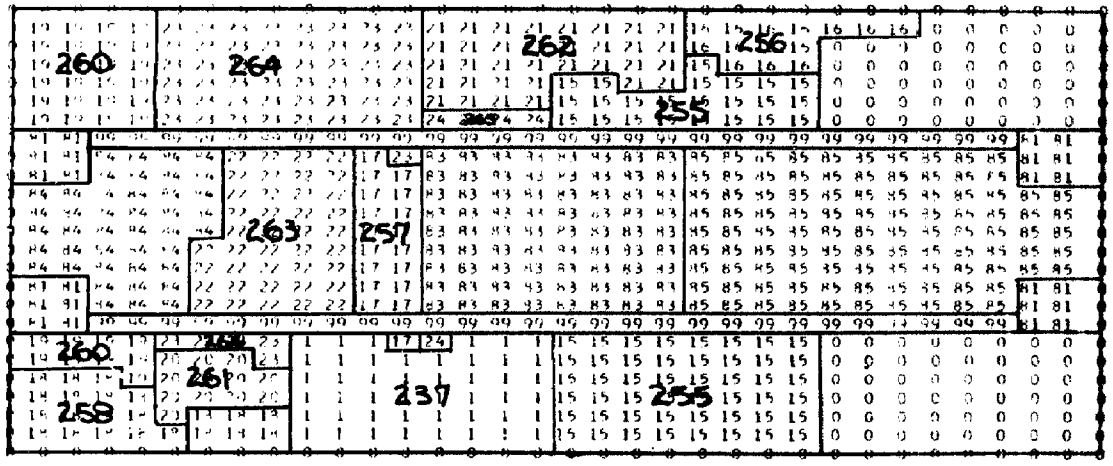
[illegible] SCORE = 1504



TOP FLOOR = 5



GROUND FLOOR = 6



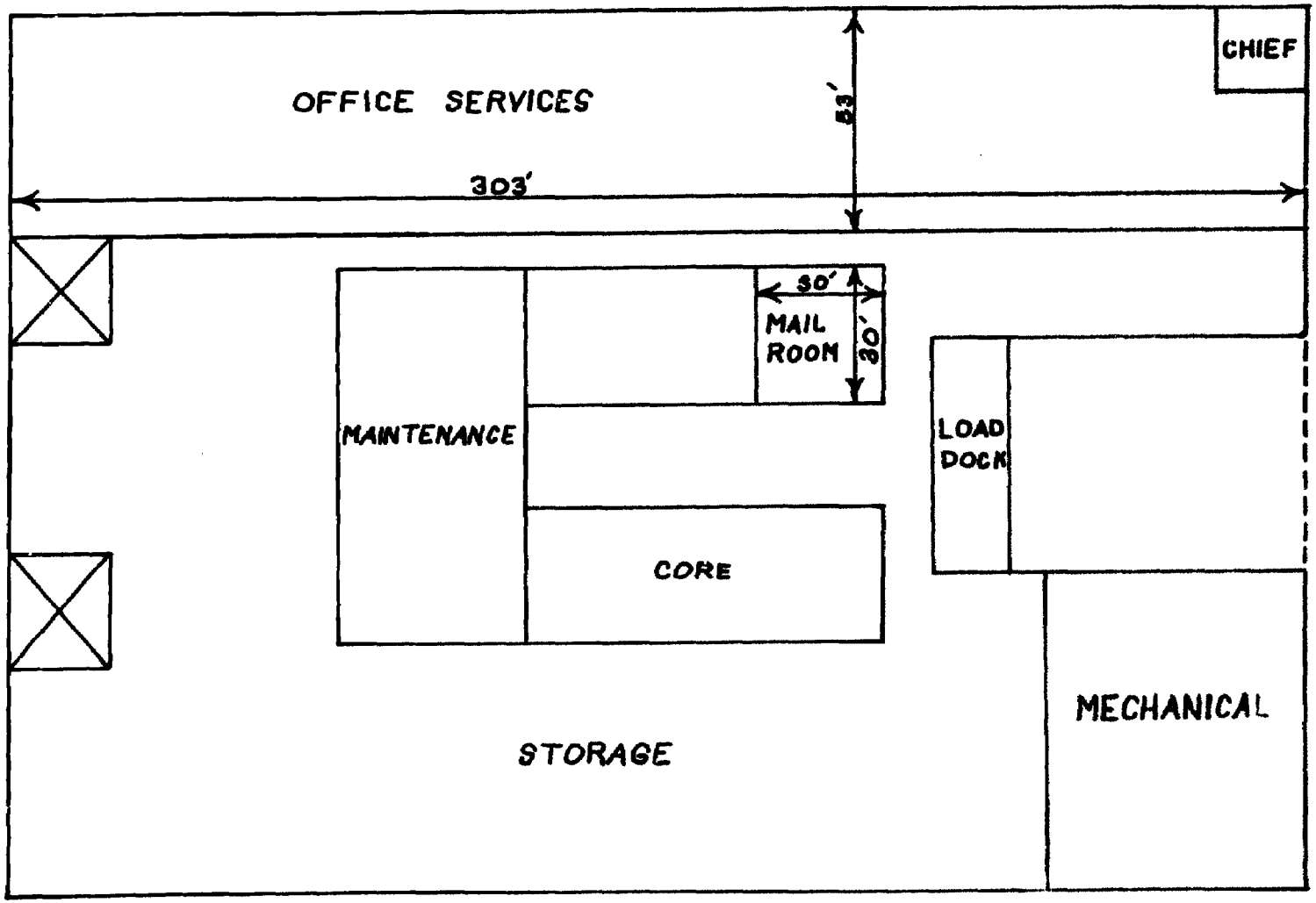
TERRACE LEVEL = 7

UNDER THE FREE-FORM EVALUATION, THIS LAYOUT DOES NOT SATISFY THE FOLLOWING NECESSARY CLOSE RELATIONSHIPS

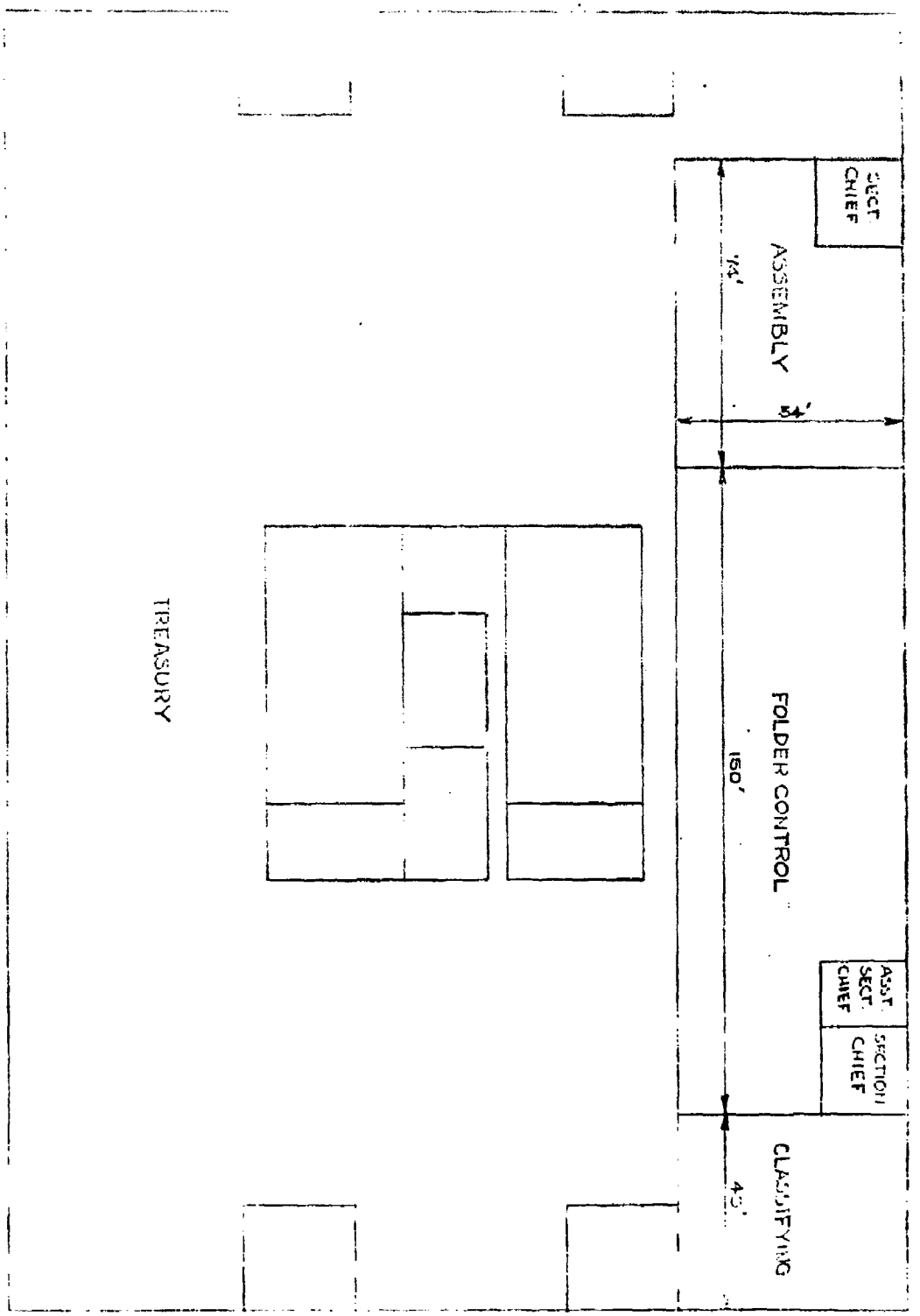
241	243
243	241
244	241
244	251
249	244
250	244

A-11 TO A-18

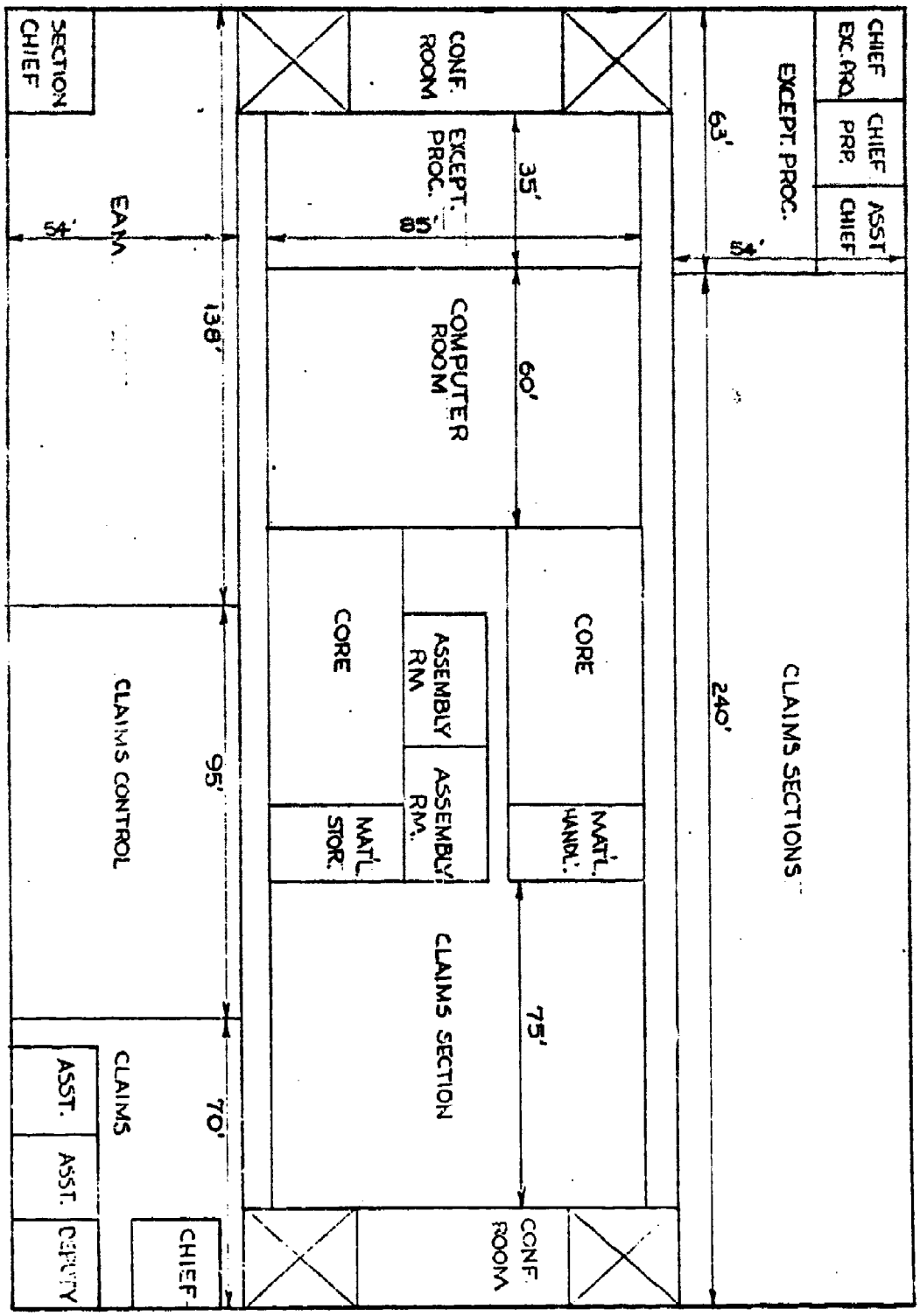
FINAL RECOMMENDED FLOOR ALLOCATIONS


OFFICE SERVICES
CHIEF
53'
303'
30'
MAIL ROOM
30'
MAINTENANCE
LOAD DOCK
CORE
MECHANICAL
STORAGE

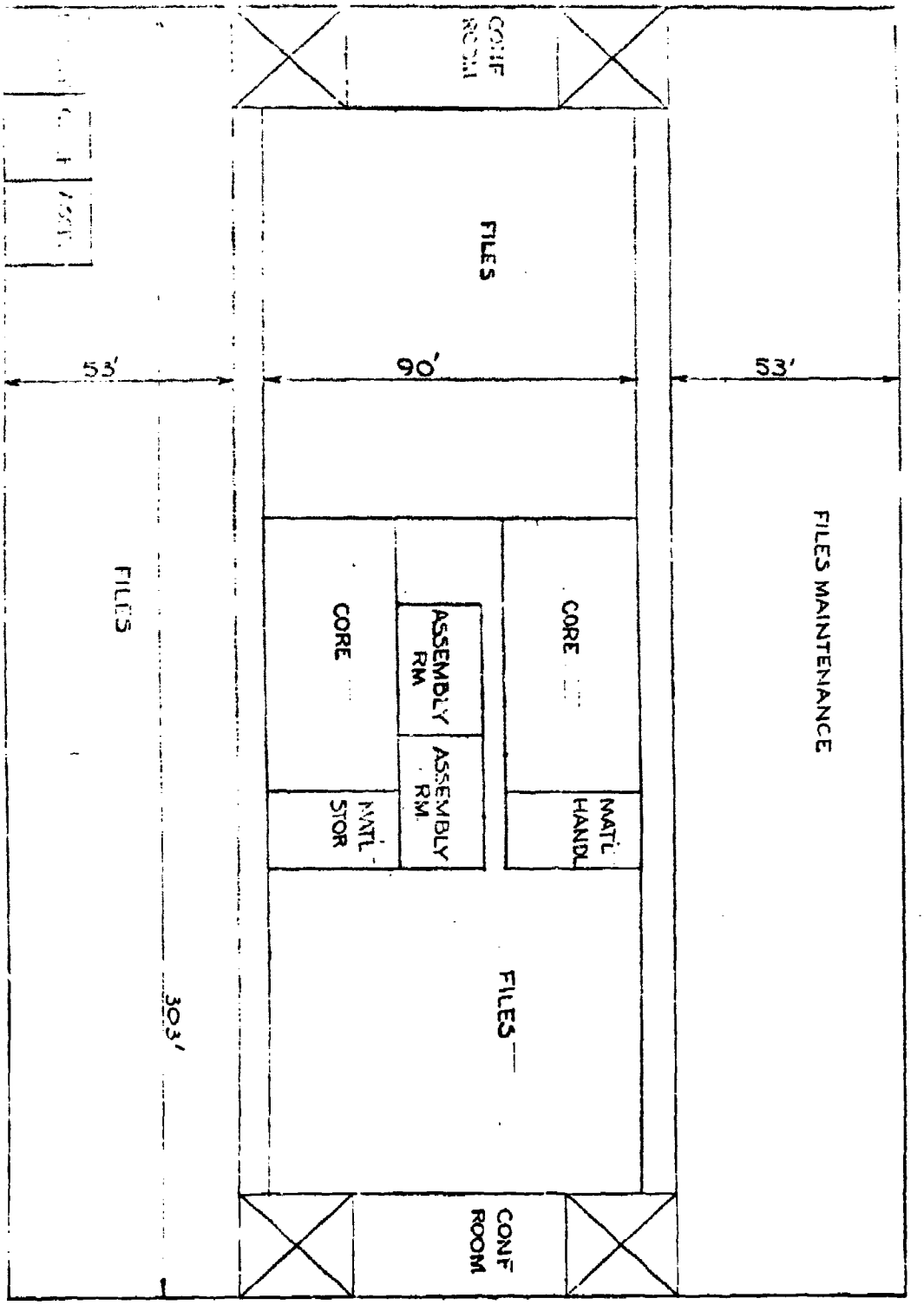
BASEMENT



SECOND FLOOR

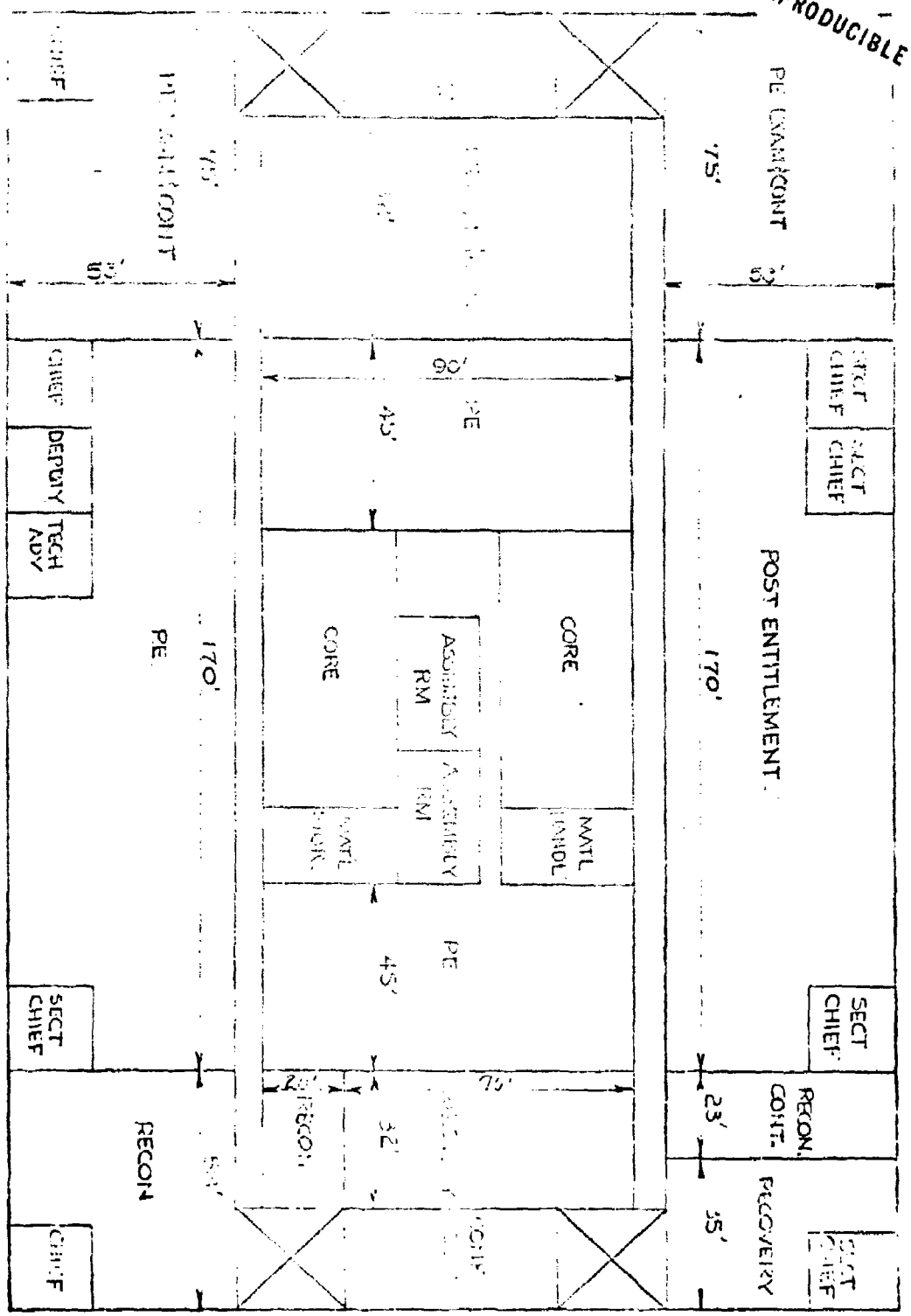

CHIEF EXC. PROC.
CHIEF PRP.
ASST CHIEF
EXCEPT. PROC.
63'
54'
CLAIMS SECTIONS
240'
CONF. ROOM
EXCEPT. PROC.
35'
85'
COMPUTER ROOM
60'
CORE
MAT'L. HANDL.
ASSEMBLY RM.
ASSEMBLY RM.
MAT'L STOR.
CLAIMS SECTION
75'
CONF. ROOM
SECTION CHIEF
EAM
54'
138'
CLAIMS CONTROL
95'
70'
CLAIMS
ASST.
ASST.
DEPUTY
CHIEF

THIRD FLOOR



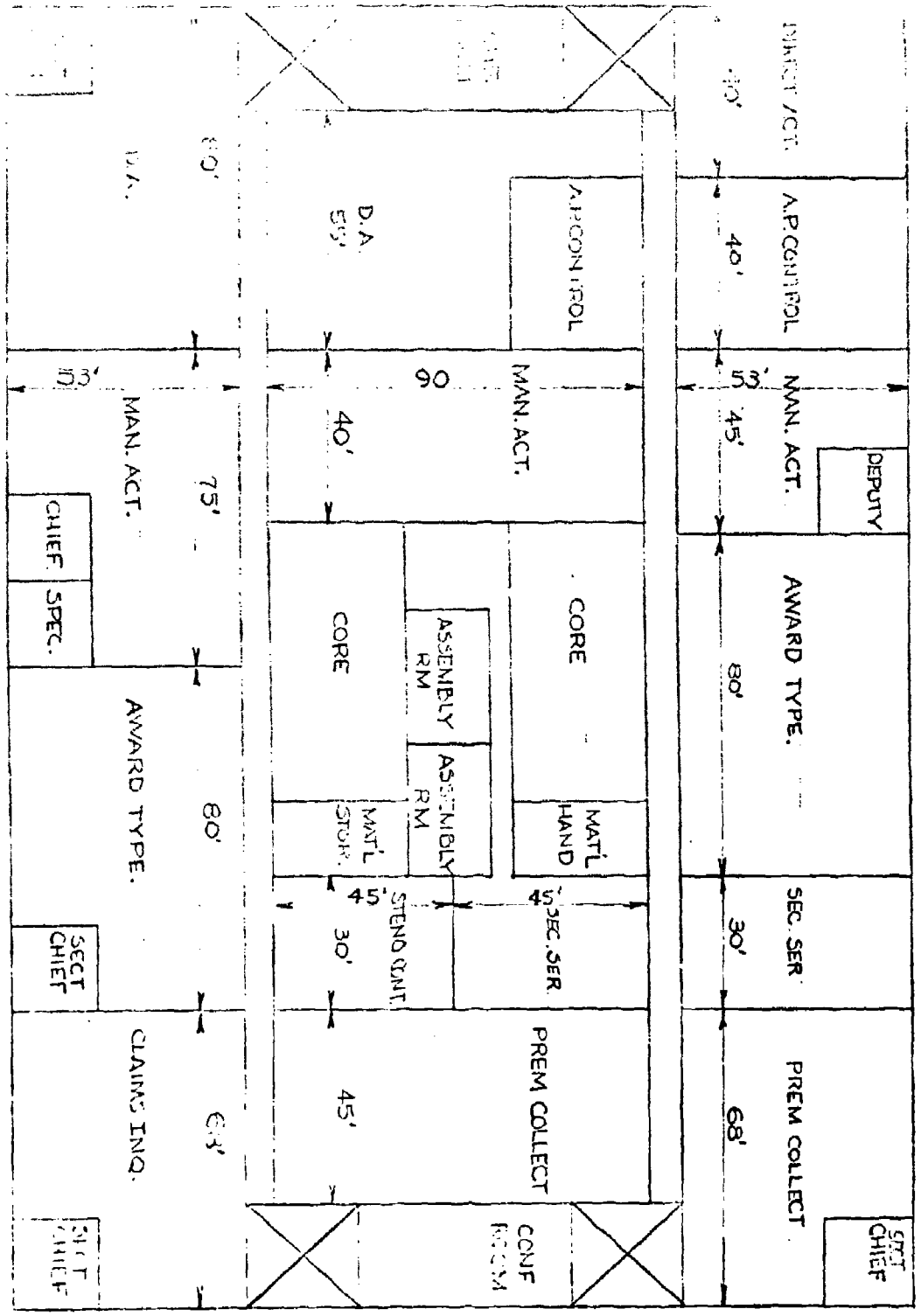
FOURTH FLOOR

NOT REPRODUCIBLE



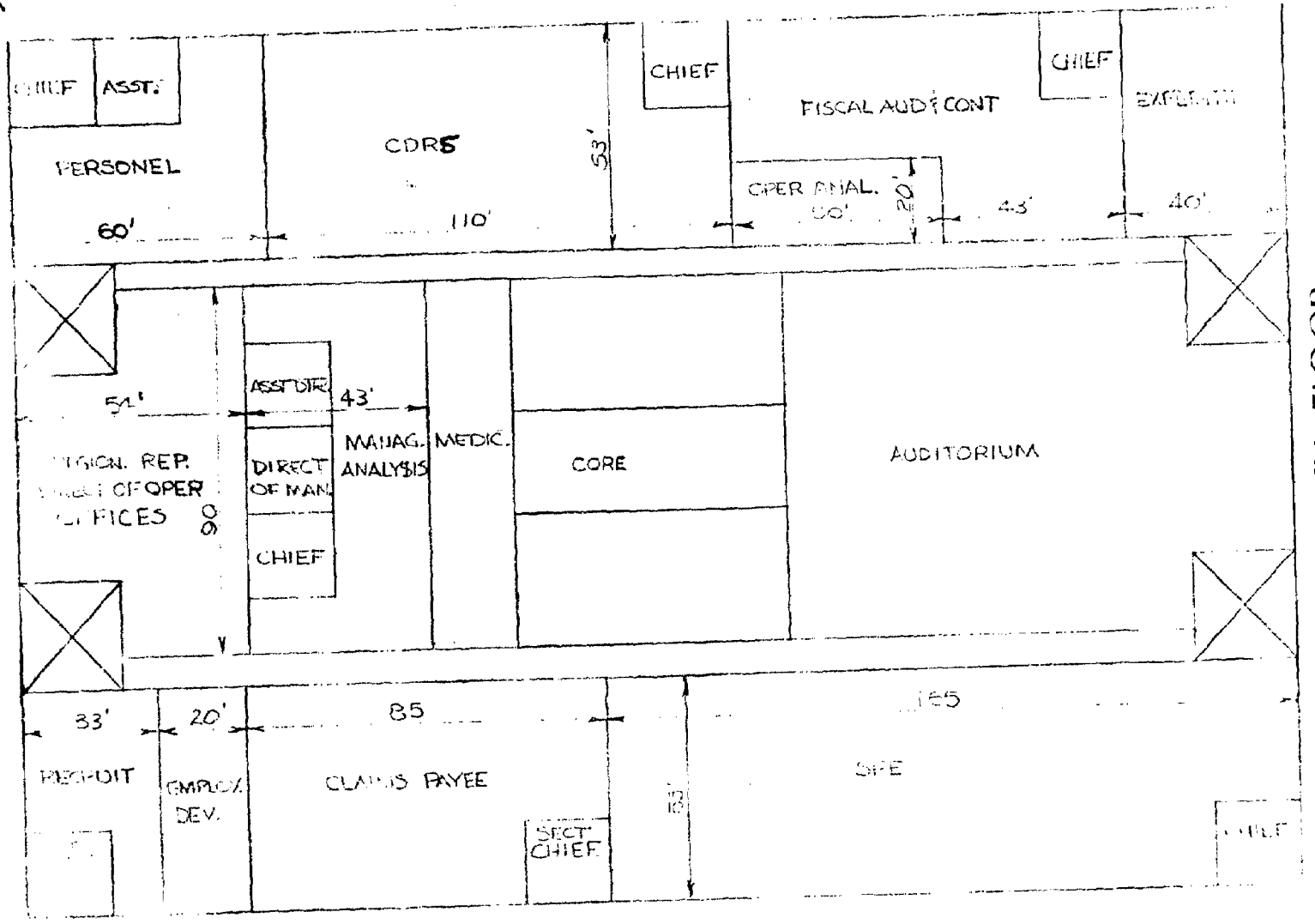
FIFTH FLOOR

NOT REPRODUCIBLE



SIXTH FLOOR

NOT REPRODUCIBLE



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13. ABSTRACT

An application of the Automated Design Layout Program (ALDEP) is presented whereby departmental areas were allocated within a proposed seven story facility for the Birmingham Social Security Payment Center. The criterion used for assignment of departmental facilities to areas was material or folder flow between departments. The final layout proposed was hand adjusted to produce a more aesthetic and practical design.

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14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
ALDEP						
Facilities Design						
Layout						
Computer Aided Design						
Material Flow						

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