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The Challenges in Development of Automatic CAD for Government and Aerospace Construction Cost Estimating Systems

OR

Challenges Developing CAD/ACE

OR

Challenges Developing Mini-Computer CAD/Estimating for Government Aerospace Construction

By

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JAN 29, 1991

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Challenges in Computer Aided Design/Automatic Cost Estimating for Government and Aerospace Construction

by

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INTRODUCTION

The purpose of this presentation is to summarize the many years of effort in development of Computer Aided Design/Automatic Cost Estimating using a VAX mini computer (CAD/ACE) by explaining the reasons, the purpose, goals, possible productivity improvements, problems, challenges and some solutions; thereby helping those computer professionals in industry and government to learn from our accomplishments and difficulties. This will help the construction industry to understand why and how to use this futuristic cost estimating system. By listing the 24 problems, difficulties and challenges, the next generation of CAD/estimating will be better, faster and cheaper. Computerization of ACE will benefit the Government, aerospace and construction industries, and our society. Our main purpose is to improve estimating accuracy, save time in estimating by making it faster and more automatic, thereby saving money. It will also provide time for more cost engineering and ultimately more cost effective and efficient construction.

The present manual and computer estimating methods require time consuming quantity takeoffs, looking up, pricing out and marking up of cost estimates. A CAD/computer system can do this faster and be more accurate, using the CAD drawing file for quantities extraction. Three of our goals; to keep it simple, easy to use, and do as much as possible automatically; are probably our biggest challenges. An operational analysis and efficiency analysis of manual versus computer estimating will be shown with projection for CAD/ACE, with the impact of customization of CAD estimating software for Government and aerospace. Flow charts, graphics and estimating steps necessary for the CAD Estimating System being tested will be shown along with a sample computer estimate, bids, CAD estimate and menu. By explaining some of these problems and solutions, it is hoped that with many other engineering computer professionals involved in the development of different concepts, productivity improvements may move successfully to overcome problems faster and more effectively.

HISTORY - BACKGROUND
COMPUTERS, CONSTRUCTION COMPUTER ESTIMATION

In the mid-sixties (1963-1967), computers were successfully used in design, planning, scheduling and construction of the Vertical Assembly Building (VAB), the world's largest building at the time of construction. The 57,000 tons of structural steel were computer coded. This 120 million dollar building was successfully completed and was an important milestone for the successful Apollo Lunar Program, with man's first moon landing in July 1969.

Computer Symposium

On November 7-8, 1969, the Florida Section of the American Association of Cost Engineers (AACE) held its first symposium, "Computers Are Working In Construction," at Cape Canaveral, Florida, featuring some creators, developers and pioneers of Computer Estimating, Cost Control, Accounting, and Planning Systems.

<u>Symposium Program</u>

COST ACCOUNTING - Carl Brown of Wellam Lord

(Computerized) PIPING EFFICIENCY PROGRAM - T. G. Papavero of Catalytic Construction Company

COMPUTER PLANNING AND SCHEDULING - Jessie Taylor of Wellam Lord

IBM PRESENTATION - Computer Control of Apollo Using 360 Model 40

TELEPROCESSING - Paul Spindel of McKee, Berger and Mansuetto

COMPUTERIZED ESTIMATING - Bill Orr of Cost Systems Engineers, Inc.

PROVES/COST OF MAJOR EQUIPMENT SCOPE/PDQS - AACE President, Gus Enedy of Diamond Shamrock Corp.

On February 29, 1972, J. A. Brown sent a 5-page memo to KSC management on the potential benefits, etc., of Computer Estimating to KSC aerospace construction. In 1974 a new design engineering support contract was let to PRC, who operated a new Computer Aided Drafting (CAD) System, Applicon, which provided a limited bill of materials and proved that the real value of CAD was in revision; new and

similar projects could be used over again, saving the initial data entry, which took nearly the same time as manual drafting. In 1978-79 Mr. Ed Rich, Navy Cost Engineering, reported on development on computer aided cost engineering with computer cost database. On June 4-8, 1979, Cost System Engineering, Inc., (CSEI) had a training seminar at KSC on Automated Construction Estimating Using the Orr System of Construction Management which resulted in the following:

TRIAL USE OF COMPUTER ESTIMATING SYSTEMS

Problems Encountered June 1979 - August 1980

The following are typical problems an estimating section had with the computer estimating system using a main frame on a time-sharing basis:

1. Frustration with equipment, telephone instruments, interface, terminals, service bureau, computers, etc.

2. Resistance to new ways of doing things.

3. Inability to fully comprehend complex computer system with all it's flexibility.

4. Lack of desire to devote adequate effort to develop and use system.

5. Inadequate manpower capability in Estimating/Cost Engineering.

6. Expected computer system to automatically estimate accurately with little or no extra input or adjustments. Did not use labor and material difficulty factors to adjust estimate to job conditions.

7. Fear of loss of job.

8. Stress - eyes (bifocal glasses), fatigue.

Comments and Recommendations of Cost Engineer Observer, August 1980 - December 1981

1. Computer system <u>must</u> be made simpler and easier to use.

2. If possible, eliminate need to look up cost codes and have data more easily entered in computer.

3. In CAD have quantity survey done by computer eliminating need for costly time-consuming task and cost codes and ready to input into computer estimating system.

4. Develop program for standard format to simplify computer use initially. Later as experience develops, this flexibility can be explored.

5. Get another company (estimating section) that is more receptive to modern technology.

6. When owner/A&E/contractor goes to extensive computer estimating, a computer terminal operator and computer program (software/hardware/data base) manager may be needed for six months to three years to keep system working properly and to develop additional capabilities until owner personnel are ready to take over total system responsibility. (Confirmed by other cost engineers during specialized/R&D work.)

7. An extensive training/incentive program will be required to insure a successful cost-effective computer estimating system.

8. Provisions need to be made for eyeglass users reading CRT's to prevent frustrations; i.e., bifocals, etc. Better CRT's - resolution, adjustability, becoming more available in 1983.

AN IDEAL COMPUTERIZED
COST ESTIMATING SYSTEM

Based on comments of Cost Engineer Observer and ideal computer Estimating System with 16 Features/Requirements/Capabilities were developed, some of which included:

<u>Simplicity</u> - The system should be simple, easy to use, understand, learn and maintain.

<u>Interactivity</u> - Allow quantity inputs, cost codes from computer design drafting system to provide Automatic Computer Cost Estimates thru CAD/ACCE/CADD. This would have five-way interactivity through CAD, design, cost, construction, plan and schedule, and management. Note: July 1989, ACCE changed to ACE by author.

<u>Judgment Factor</u> - Allow for estimator/cost engineer (E/CE) judgment factors.

<u>Maintenance</u> - Ensure the labor and materials prices, data base, etc., are properly maintained to give complete, current, accurate cost information. Have a large, accurate up-to-date and complete data base.

<u>Review and Updating Capability</u> - Have quantities, labor and materials, unit prices, and totals in all detail printouts for easier review and updating.

Have mechanical and electrical labor costs in manhours for easier review and updating.

<u>Detail Breakdown</u> - Provide labor and materials breakdown with total manhours, per task and craft, and crew days for planning and scheduling; for CPM and construction duration; and for procurement and subcontractor information.

Provide Metric-American conversions.

<u>Automatic Adjustment</u> - Have prices automatically adjusted to the local construction environment with minor input.

Computer Quantities - Have the ability to compute quantities. For example: for concrete LxWxHx No. of rows to give cubic yards (CY) of concrete and square foot contact area (SFCA) of form work. Not as necessary if it had CAD capability.

Summaries and Organized Systems - Have the ability to summarize in many different ways -- bid, trades, labor and materials, 16 CSI divisions, buildings, parameters, budget, systems, etc.

Organized for cost engineers, estimators, accounting, cost control, plan, schedule, etc.

All Types of Estimates - Have capability to do budget/conceptual, preliminary, detail labor and materials, bid, etc.

Other Capabilities - These features, with emphasis on CAD/Estimating for Quantities, were the basis for the author advocating the CAD/ACCE simple concept since 1980 and projecting a state of the art Project Integrated Computerization (PIC) concept to integrate design, specifications, cost, construction, plan and schedule, management and occupancy - interactive integrated systems. See Chart (1983-1989), Figure 3. This simple concept was to get the quantities from computer aided design system and use a linkage program to hook it to an CSEI Orr type system which was the most complete and flexible computer estimating system to make cost estimates automatically, especially since the Orr system had been set up with cost codes for budget, preliminary and detail estimating.

Impact of CAD, June 29, 1982 "The Impact of Computer Aided Design on Cost Engineering," by Ed Zamoski and B. E. Seals, at the AACE 1982 Annual Meeting in Houston, TX, reinforces the author's commitment to CAD estimating with excellent technical and slide presentation.

Goddard CAD System Study Frank O. Grady of Goddard Space Flight Center presentation, "Computer Use in Facilities", December 8-10, 1982, Cocoa Beach, FL. Serves as an excellent overview in selection of CAD systems, capabilities and costs and limited CAD/Estimating.

First CAD Estimates - 1983 - 1986

CAD Estimating by Owens Corning Fiberglass, Administrative Engineering Service. Using Computervision and Orr by Robert Shaffer, 1981-1986; had mechanical electrical up and running in 1983. Had total CAD/Estimating, using Computervision/Orr Estimating/Apollo/AutoTrol/Focus on IBM mainframe as of August 1986, with over 800 projects on file. System makes ROM's with plus or minus 25% in $10 to $20 million projects in 80% less time than manual estimating. Master code of accounts for all cost codes cost $2.5 million for development. Estimates by: Standard Process Function, Unit Costs, and Standard Sets.

Other Comments - Using Orr city to city is good. Needs graphics to give engineers better overview and also serves as a good check sheet.

August 29, 1985 - NASA KSC signs contract for $1,350,059 for eight Intergraph work stations, VAX processing and integrating 39 design packages and estimating software ($31,500), etc. Estimate package proposed was using a Means Cost Data Base. Orr system was not proposed as he was not low sub bidder (wanted more because of extensive development time (15 years) and costs and royalty on future licenses.) Also, Orr data base not updated for two years (October 7, 1985, CAD Estimating Memo). Also did not have a deliverable product for VAX/VMS.

Early 1986 - Intergraph selects IBIS-CALC European Estimating Software Package in Lieu of Means. IBIS-CALC had no cost data base but had ability thru correlation table to get more usable construction estimating quantities, such as cubic yards of concrete, form work, rebar, etc.

March 11, 1986 - Manual vs. Computer Estimating vs. CAD/ACCE. The following is an operational and efficiency analysis for manual estimating and computer assisted estimating as shown in "Cost Engineering," Volume 25/A3, June 1983, in an article by Lawrence C. Bacher of Gilbane Building Company, 7 Jackson Walkway, Providence, RI 02940. The original charts have been extended by J. A. Brown, 3/11/86 (indicated by *), to include Projected Computer Aided Drafting and Design/Automatic Computer Cost Estimating CAD/ACCE* and revised 7/20/89, based on experience from developing CAD/ACE prototype project Propellent System Component Lab) PSCL.

Figure 1 Operation Analysis

Activity	Manual	Computer	CADD/ACCE*
Administrative Work	7%	-	-
Quantity Survey Doc. Review	8%	-	20% Improvement
Quantity Survey Measurement	24%	10% Improvement	90% Improvement
Quantity Survey Mathematics	20%	100% Improvement	100% Improvement
Pricing Man-Hour Study	8%	10% Improvement	10% Improvement
Pricing Market Survey	17%	5% Improvement	5% Improvement
Pricing Mathematics	5%	100% Improvement	100% Improvement
Checking Mathematics	7%	100% Improvement	100% Improvement
Summarization Presentation	4%	80% Improvement	80% Improvement
	100%		

Figure 2 Efficiency Analysis

Assuming 500 Man-Hour Estimating Efficiency

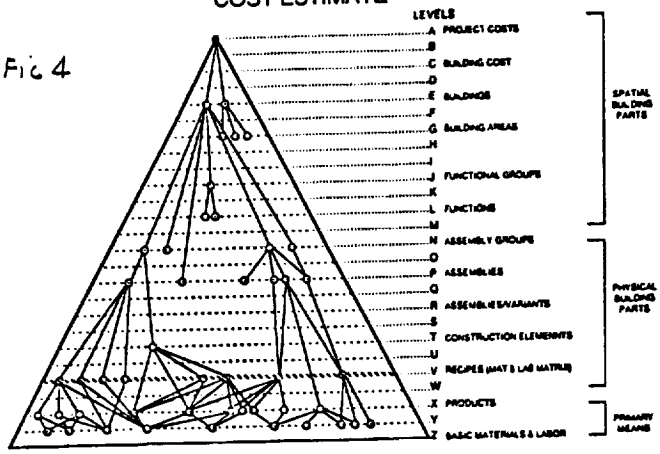
Activity	Normal MH Expended	Computer Aided MH	Est. Imp.	CADD/ACCE* MH Expend.	Improvement	7/24/89 CADD/ACE MH
CADD Intelligence						25**
Administrative Work	35	35	0	35	0%	35
Quan. Surv. Doc. Rev.	40	40	0	32	20%	32
Quan. Surv. Measurement	100	108	10%	12	90%	12
Quan. Surv Mathematics	100	0	100%	0	100%	25**
Pricing Man-Hour Study	40	36	10%	36	10%	36
Pricing Market Survey	85	81	5%	81	5%	81
Pricing Mathematics	25	0	100%	0	100%	0
Checking Mathematics	35	0	100%	0	100%	0
Summary Presentation	20	4	80%	4	80%	4
	500	304	39%	200	60%	250
Cost at $30 per MH	$15,000	$9,120	$5,880	$6,000	$9,000	$7500

** A new item has been added for CAD/ACE which may require 10-20% more time for customizing for CAD projects and for special intelligence input to CAD design to develop correlation tables, etc.

August 15, 1986 - Hank Perkins and J. A. Brown go to Huntsville, AL, for IBIS-CALC demonstration, Pyramid Assembly Program (See Chart, Figure 4), with 26 levels of detail budget to detail labor and material unit prices. IBIS-CALC developed by Integrated Building Information System, developed by Tricht and Brink and European Co. Headquarters in Leidschendam, Holland, making this an International Computer Estimating System.

CONSTRUCTION DOCUMENTS PHASE
COST ESTIMATE

Fig 4

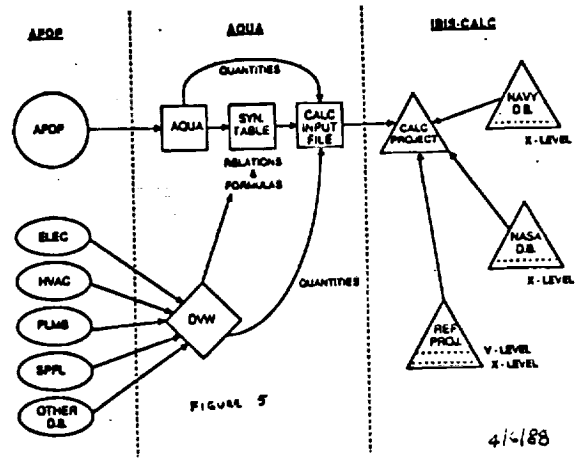


January 12, 1987 - DL-NED/DF-FED LCE contacted Navy Facilities Engineering Command, A. Sadler, II, Head of Cost Engineering Branch, concerning our use of Navy computerized cost data base with IBIS-CALC System Estimating Package because of their current and most complete data base with Alpha numeric Cost Code System linked to SPECSINTACT system with good work description. Formal request by J. Phillips, DE, Director of Engineering Development, March 2, 1987. Formal approval given on April 17, 1987, by Harry M. Zimmerman, Navy Engineering and Design.

January 21, 1988 - EG&G establishes IBIS-CALC Project Preliminary Requirement, by Carlos Ablanedo.

March 2, 1988 - DE support contractor hires an engineer, Pat Tannner, to aid in development of CAD/Estimating.

March 22, 1988 - Memo. April 5-8, 1988, Brinks - Intergraph install Architectural Quantity and demo IBIS-CALC introduction and training given to KSC/DF-FED/EG&G, C. A. Swinkel, D. Mueller. Flow chart with Architectural Production Design Product (APDP) and Data View Development. (See Figure 5)



April 1988 - Management presentation to Jim Towles, Director, Facilities Engineering, by DF Lead Cost Engineer, on CAD Estimating goals, purpose, need for training and projects designed on CAD to make estimating for electrical design projects. T3-T4 power feeder CAD design - go ahead given. Other projects:

Pre- Engineered Metal Building (PEMB) and concrete masonry building (PSCL).

KSC CAD/ESTIMATING MILESTONES

EG&G delivered a draft Intergraph/IBIS-CALC/Navy Data Base Cost Estimate for the pilot project to KSC Lead Cost Engineer on July 7, 1988. After fine tuning the IBIS-CALC/Navy Estimating, the next step is to put the pilot project in Intergraph/CAD-APDP to get class codes for preliminary quantities.

October 11, 12, 1988 - Summary Briefing to Computer Engineering Software Developer (Brinks Group representative)

Goals - To make CAD/Estimates automatically; to save time and money; to improve accuracy of quantity take-off, prices out and mark-up; to allow more time for value engineering, cost engineering, etc.; and to reduce turn-around time on critical projects from weeks to days.

Possible Solutions to Estimating Problems

A. When Design on CAD - Bill of Materials from CAD to AQUA (architectural quantities) to IBIS-CALC (European estimating software package) - pull from Navy cost database to price out and mark-up to reduce estimating time 40-70%.

Allow estimator/cost engineer to:

1. Add line items missing from estimate, such as testing, equipment, cranes, etc.

2. Adjust prices for a particular project by experience, vendor quotes and major cost items, cost analysis of items such as steel, fill barrow, form work, duct work, etc.

3. Make reports and summaries for different situations - cost engineering, cost reduction, plan and schedule, etc.

4. Have minimum cost engineering computer data entry input - 10 line items of commands to get estimate.

See Flow charts - Computer flow chart of software programs/interface: CAD/APDP - Architectural Production Data Package; AQUA - Architectural Quantities; IBIS-CALC; Project File; Databases - Navy, NASA KSC, CACES, Reference Project.

B. When the Design is Not on CAD - The Navy is developing a sonic digitizer system to speed up estimating take-off and make computer aided estimating faster and easier, but not as fast or as accurate as CAD/ACCE.

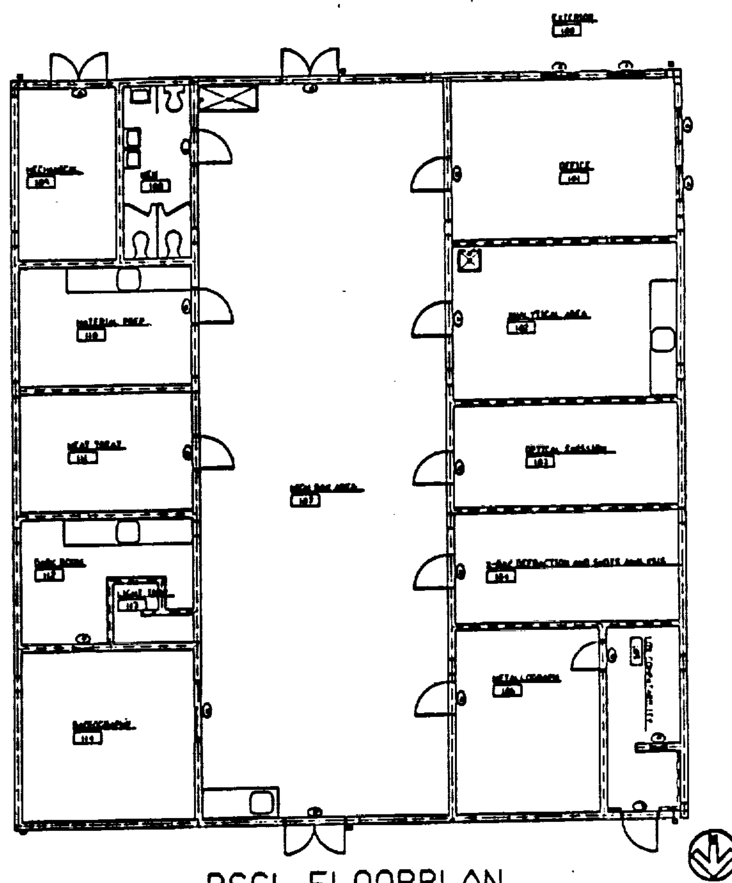
C. Prototype -

1. Electrical Design Project - T3-T4, Figure 6.

2. Concrete, masonry, office, lab, 4100 SF CMU - PSCL, Figure 7

3. Pre-engineered metal building (PEMB)

D. Work to be Done - Correlation Table of Relations and Formulas (link class code to cost code) by Pat Tanner/Joe Brown/System Engineer.



PSCL FLOORPLAN

OCT 1988

REV. MAR 1989

FIGURE 7

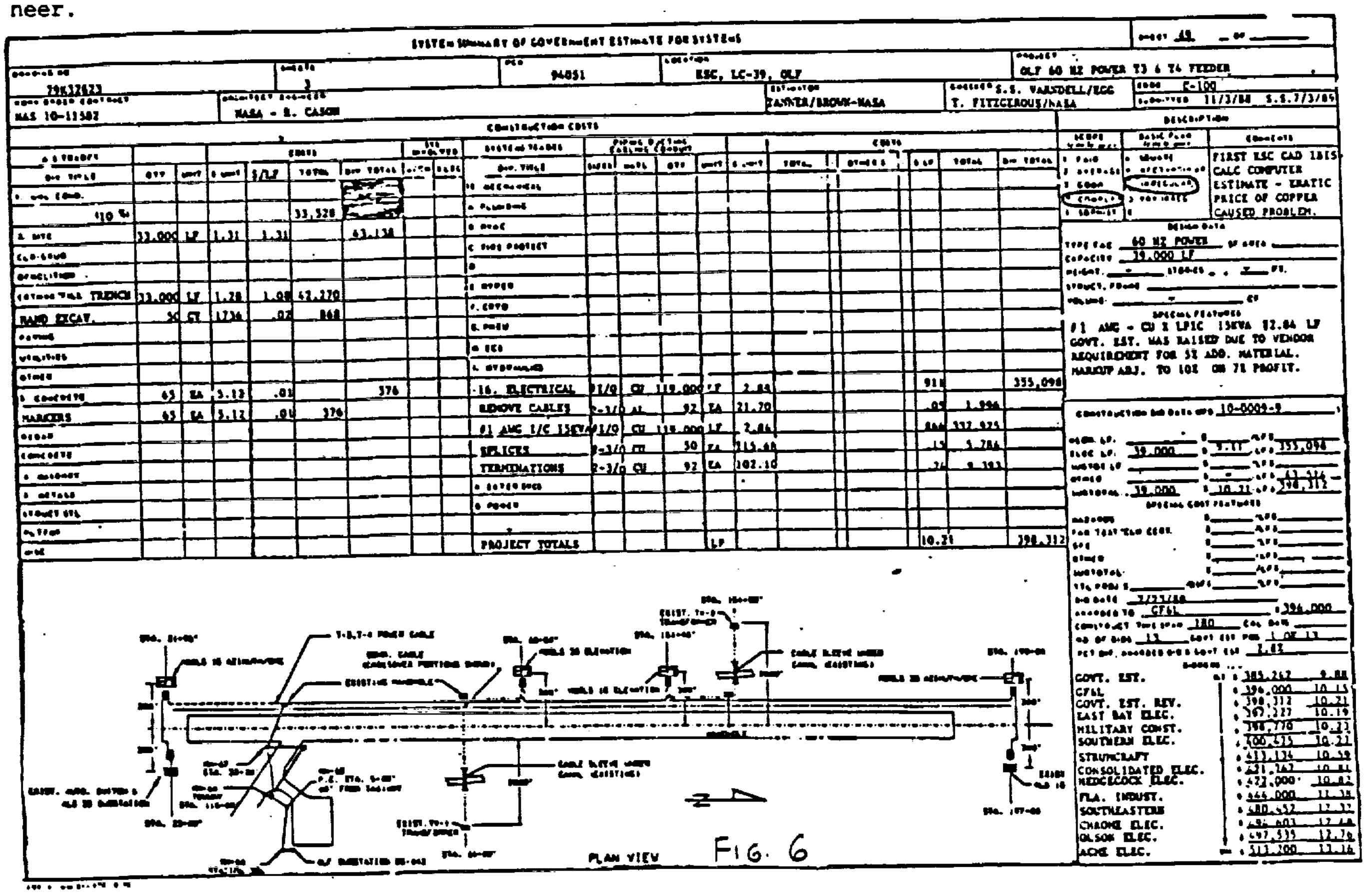


FIG. 6

E. CAD/ACCE Problems, Difficulties and Challenges

1. APDP drawing not complete for PSCL: graphics, concrete and block; dimension; descriptions, finish schedule.

2. IBIS-CALC Format - Summary of labor and material, units quantities and unit prices; separate labor and material mark-ups are not available in Version 2.37 (IBIS-CALC Version 3.0 to solve these problems, Kees said)

3. Present Intergraph CAD, IBIS-CALC Navy System, relationship not complete - civil, mechanical and electrical not integrated. (Some mechanical and electrical fixtures can be incorporated by noting them as components in APDP.)

4. Many quantities missing from APDP/AQUA - foundations, structural, etc.

5. Excessive training time required to understand and use the system. (May require six to eight weeks of training time and hands-on to become proficient; after system up and running - I think 10-24 weeks, for formal classes, supplemental training and practice.)

6. Keeping computerized cost data up to date for local areas.

7. Limited budget to ideally customize CAD/ACCE System.

8. Limited priority, resources.

9. Difficulty making CAD/ACCE faster, simple and easy to use.

10. Difficulty in getting A&E's to use Intergraph CAD, APDP (Auto CAD - Cheaper and easier to learn and use).

11. Intergraph efforts are being concentrated on microstration for auto CAD competition.

12. Low priority allocated to processing causes the slow VAX computer software/cost database loading time of 27 hours. (Kees said individual stand alone work station coming in two years will solve some of this.)

13. Lack of user (cost engineering) input in software program development. (Intergraph may be hiring a cost engineering consultant by early 1989.)

14. Difficulty in putting together off-the-shelf programs (APDP, AQUA, IBIS-CALC) for customized Government application.

15. Negative finishes problem due to corrupt drawing file - October 1988/memo, 3/2/89

16. IBIS-CALC Computer Aided Design/Automatic Cost Estimating using a VAX mini computer Estimating Program cut itself off (built-in timer) 7/1/89

Note: New compact disk CD-ROM disk with October 1988 cost database due January 1, 1989 (which includes Navy CES, NASA, Army and Navy specification system).

Comments, Discussion and Summary

More experienced personnel dedicated to Architectural/Structural APDP are required.

Additional Intergraph APDP projects are needed.

Doing the review of the AQUA report file, it is most important that the designer, computer technician, estimator and LCE, especially, evaluate error messages for intentional errors or mistakes, and check quantities for correctness or reasonableness. (1) Close open spaces to get better quantities, (2) Floor area = finish floor quantities, (3) Wall area = 2 x finish areas; single walls have two sides.

Doing the review of the IBIS-CALC report, which is used to generate the correlation table, the designer, estimator, computer technician and LCE work together to standardize the correlation table for future projects. (It took Brinks 15-20 projects to get most of their (90%) class codes/correlation tables. They are also using their CAD estimates to generate their specification sections.)

After we get the APDP drawing corrected and completed, it may take 1-7 days (?) for a correlation table to get a more complete estimate.

COMPUTER ESTIMATING

The computer 90% design estimate for Orbiter Landing Faciliy (OLF) 60 Hertz (cycles) Power T-3 and T-4 feeder was delivered to J. King, DF-FED-21, by J. Brown on November 3, 1988. This project was designed on Intergraph 2D Generic CAD by Tay Fitzgerald and R. Cason. This is an important milestone in our goal toward CAD/Automatic Computer Cost Estimating (CAD/ACCE). EGG/BOC-139 computer technician, Pat Tanner, inputted Tay's estimate into IBIS-CALC stand-alone estimating program on VAX. The Navy database was used as a reference file for cost and supplemented with vendor quote and KSC unique cost data, Figure 6.

KSC CAD ESTIMATING MILESTONE

A CAD Estimate for the PSCL Building was delivered to DF-FED Lead Cost Engineer on November 17, 1988, by Pat Tanner, based on PSCL drawing for APDP class codes for quantity. See Figure 8, A, B, & C.

February 23, 1989

The apparent low bidder for replacement of power feeders at the Shuttle Landing Facility is GF&L Construction of Columbia, SC. This project was bid February 23, 1989, as shown:

Project : PLOT4 PILOT WITH PLOT DRAWING
Indexdate: 03-17-89
Estimate : J-A1.1 .1
Printdate 03-20-89
Printtime 12 49 18
Page 2

Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
03	DIVISION III									
03 10										
03 10 0										
X-1EBBRC	FORM COL PLYWD 3-USE	1023 74	SF	2.15	2201 05	2201 05				
X-1EBFRA	FORM ELEVATED SLAB PLYWD	98 21	SF	1.61	158 11	158 11				
X-1EBKRA	FORM BEAMS UNSUPPORTED	1615 28	SF	3.21	5185.05	5185 05				
X-1EBYRA	FORM WALLS TO 16' PLYWD	1528 53	SF	2.58	3943 60	3943 60				
X-1ECFPH.D	EDGE FORMS SLAB ON GRADE	1016 99	LF	1.09	1108 52	1108 52				
X-2EBBRC	FORM COL PLYWD 3-USE	1023.74	SF	0.81			829 23			
X-2EBFRA	FORM ELEVATED SLAB PLYWD	98 21	SF	1.98			194 45			
X-2EBKRA	FORM BEAMS UNSUPPORTED	1615 28	SF	2 26			3650 93			
X-2EBYRA	FORM WALLS TO 16' PLYWD	1528 53	SF	1.52			2323 36			
X-2ECFPH.D	EDGE FORMS SLAB ON GRADE	1016.99	LF	0.28			284 76			
X-3EBBRC	FORM COL PLYWD 3-USE	1023.74	SF	0.09				92.14		
X-3EBFRA	FORM ELEVATED SLAB PLYWD	98 21	SF	0 05				4.91		
X-3EBKRA	FORM BEAMS UNSUPPORTED	1615.28	SF	0.09				145.38		
X-3EBYRA	FORM WALLS TO 16' PLYWD	1528.53	SF	0.08				122.28		
X-3ECFPH.D	EDGE FORMS SLAB ON GRADE	1016.99	LF	0.05				50 85		
03.10.0		total			*******	12996 33	7282 34	415 55		20294 22
03.10		total			*******	12996 33	8852 62	415.55		21864 51
03 20										
03 20 0										
X-1EFAA	REBARS AVG PLACE & SIZE	3 78	TN	330 87	1250 03	1250 03				
X-1ECFU	PLACE WIRE MESH SLABS	45.36	SQ	10 73	486 72	486 72				
X-2EFAA	REBARS AVG PLACE & SIZE	3.78	TN	559.52			2113 87			
X-2ECFU	PLACE WIRE MESH SLABS	45 36	SQ	16.32			740 29			
03 20 0		total			*******	1736 75	1736 75	2854 16		4590 91
03 20		total			*******	1736 75	1736 75	11706 78		13443 53
03 30										
03 30 1										
X-1EKBMG	PLACE CONC 2500 OR 3000#	1.08	CY	13 03	14 10	14 10				
X-1EKBMN	PLACE CONC 2500 OR 3000#	13.27	CY	11.18	148 40	148 40				
X-1EKINN	PLACE CONC 2500 OR 3000#	22 31	CY	6.71	149 71	149 71				
X-1EKAMG	PLACE CONC 2500 OR 3000#	20 94	CY	13 03	272.82	272 82				
X-1EKSMN	PLACE CONC 2500 OR 3000#	89 87	CY	4.79	430.49	430 49				
X-1EKYMN	PLACE CONC 2500 OR 3000#	29 72	CY	9 87	293 35	293 35				
X-1EPKS	FINISHING CONC SLAB	4100 32	SF	0 17	697.05	697 05				
X-1ERIJ	CURING CONC SLAB SPRAYED	4100 32	SF	0.02	82.01	82 01				
X-2EKBMG	PLACE CONC 2500 OR 3000#	1.08	CY	52.73			57 05			
X-2EKBMN	PLACE CONC 2500 OR 3000#	13.27	CY	52.73			699 94			
X-2EKINN	PLACE CONC 2500 OR 3000#	22 31	CY	52.73			1176 51			

FIGURE 8A

FIGURE 8B

Project : PLOT4 PILOT WITH PLOT DRAWING
Indexdate: 03-17-89
Estimate : J-A1.1 .1
Printdate 03-20-89
Printtime 12 49 18
Page 13

Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
16	DIVISION XVI									
16.51										
16.51 0										
X-1ZA12D	2'X4' STL. SIDED SUR.	12.00	EA	13.98	167.76	167.76				
X-1ZA12E	2'X4' STL. SIDED SUR.	30.00	EA	13.98	419.40	419 40				
X-1ZA40A	INCAN. STEP LIGHT W/POLY	18.00	EA	13.98	251.64	251 64				
X-2ZA12D	2'X4' STL. SIDED SUR.	12.00	EA	71.21			854 52			
X-2ZA12E	2'X4' STL. SIDED SUR.	30 00	EA	56.77			1703.10			
X-2ZA40A	INCAN. STEP LIGHT W/POLY	18 00	EA	82.16			1478 88			
X-2ZA91C	LAMP 40W MED. BIPIN BASE	29.00	EA	4.54			131.66			
16.51.0		total			*******	838.80	838 80	4168 16		5006 96
16 51		total			*******	838.80	838 80	80080 44		80919.24
16	DIVISION XVI	total			*******	838.80	838 80	4168 16		5006 96
	TOTAL OF CHAPTERS				*******	54228.09	80080 44	5103 87		139412 40

FIGURE 8C

Project : PLOT4 PILOT WITH PLOT DRAWING
Indexdate: 03-17-89
Estimate : J-A1.1 .1
Printdate 03-20-89
Printtime 12 49 18
Page 15

Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
	LABOR & MATERIAL COST		$							139412 40
	TAXES & INSURANCE	20.00	%							27882.48
	SUB TOTAL L&M T&I COST		$							167294 88
	OVERHEAD	15.00	%							25094 23
	SUB TOTAL		$							192389 12
	PROFIT	10.00	%							19238 91
	SUB TOTAL		$							
	BOND	1.00	%							1923 89
	ESTIMATED CONSTRUCT. BID COST		$							213551 92
	ESCALATION & SPECIAL COND.	10.00	%							21355 19
	SUB TOTAL		$							234907 11
	S & A	10.00	%							23490.71
	CONTIGENCY	10.00	%							23490 71
	C.C.E.		$							281888 33

1.	Government Estimate	$385,282	
2.	GF&L	$396,000	+2.8%
3.	East Bay Elect.	$397,227	+3.1%
4.	Military Const Inc.	$398,770	+3.5%
13.	High Bidder	$513,220	

See Figure 6

Due to the erratic price of copper, etc., cable suppliers may be requiring contractors to buy an extra 5% of cable length. This would add $13,000 to the Government Estimate. This project was designed on Intergraph CAD and estimating, using Intergraph/IBIS-CALC/Navy Database Computer Estimating System. The Navy Database was used as a reference file for cost and supplemented with vendor quotes and KSC unique cost data. This was the first CAD design computer estimated project for KSC. This computer estimating system also allowed worse case scenario, as well as updated government estimates, quickly, as the price of copper kept changing during design and bidding. May 23, 1989 KSC LCE gives CAD ACE briefing for Development of Microstation CAD Estimating.

June 1989 - Where are We?

PRESENT AND FUTURE TYPES OF ESTIMATES

Manual estimating has been used by Government and general contractors' estimators for over 75 years and will continue to be used by both the Government and contractors' estimators for those many applications where computer estimating is not practical or cost effective, such as unique, one-of-a-kind, and complex projects with too many variables to justify extra training and customized computerization, etc. A recent survey of manual vs. computer estimating of 113 shows 71% making manual estimates and only 29% making computer estimates. This is after 20 years of computer estimating. However, 70% of those surveyed <u>want to make and use computer estimating successfully</u>. The trend toward more computer estimating should continue as computer estimating becomes faster, cheaper, more accurate, and easier to use; especially with digitized estimating, voice recognition, artificial intelligence and CAD/ACCE (Automatic Computer Cost Estimating). Computer estimating can be justified on repetitive type projects or when two or more estimates are required. Therefore, the following four types/methods of estimating for the Government and contractors.

<u>Present and Future Types of Estimates</u>

1. Manual estimate, KSC Spec G-0002, TR 5-800

2. Computer estimates, CES/CACES/DOE

3. Digitized estimating, being developed by the Navy.

4. CAD/ACCE being developed and tested by NASA/Intergraph/IBIS-CALC

<u>Accomplishments</u> The PSCL estimates were delivered on 11/17/88 and 3/89 and proved that:

1. A project can be estimated from CAD quantities to get a fair and reasonable cost estimate.

2. The architectural assemblies, elements, wall, floor, ceiling (see type element chart) and components can be used instead of a detail database management system requiring cost/item for each and every item in a building, thus saving 10-50% of date line items in CAD drawings quantities.

3. This accomplishment is now forcing the developing of the next generation workstation concept with integrated civil, structural, architectural, mechanical and electrical design packages to get a totally integrated cost estimating system more automatically. There is still a need for a simpler, faster and more automatic computer estimating system that is also IBM PC compatible.

THE 39 STEPS FOR DEVELOPING CAD ESTIMATES

<u>APDP</u>

1. Create (or copy) project (see figure 15)
2. Create (or copy) DDL (Data Definition Language)
3. Add "AQUA" attributes
4. Add Code list #4 - finishes
5. Create (or copy) class code table
6. "Plan" which drawings are on which floors
7. Create (or copy) drawings
8. Place/manipulate graphics
9. "Trace" room perimeters
10. Compile database - can be done anytime after Step 4
11. Load design file
12. Insert floor to drawing relations. See Figure 9, Class Code Guide

<u>AQUA</u>

13. Manipulate finishes using the Tutorial
14. Establish relations
15. Label elements and graphic groups
16. Run AQUA report option
17. Review quantities and cross check

<u>IBIS</u>

18. Generate correlation table. See Figure 10, Sample Correlation Table.
19. Edit correlation table
20. Create IBIS-CALC input file
21. Edit IBIS-CALC input file
22. Create the new project
23. Process input file into project
24. Activate reference project (Navy database or KSC unique historical database)
25. From top level of project, save triangle to get prices and substructures
26. Calculate and print estimate by spec code
27. Add civil, mechanical, electrical codes and quantities

COST ENGINEERING

28. Add new prices for missing priced items, adjust prices for each unique project (quantities and height)
29. Review cost estimates for accurate quantities and prices
30. Add missing cost line items not an drawing, in specs, etc., such as testing, scaffolding, construction, cranes, hoists, trusses, etc.
31. Do cost analysis of all major cost items, vendor quotes, etc.
32. Summarize mark-up; do other summaries, etc.
33. Review overall estimate
34. Apply bid/market strategy - special conditions, joint occupancy, down time costs, etc.
35. Final mark-up (percentages)
36. Adjust for late vendor quotes, amendments
37. Final check
38. Approve bid estimate and get signatures
39. Get bid in on time

SUMMARY LIST OF PROBLEMS, DIFFICULTIES AND CHALLENGES

1. The need for industry standardization, architectural, structural,. mechanical and electrical CAD input data so pricing can be more accurate. An answer may be that CAD/Industry is now moving in this direction. (ENR 8/10/89, Corps seeks unity through CADD.)

2. The need for cost engineering standards of cost codes (spec description). We used Navy cost codes database but some are changing again in 1989. (Good hope for the future with MOU; Army, Navy and Air Force, October 1988, Tri-Service Automated Cost Engineering System.)

3. The Bill of Materials from CAD programs are not necessarily the construction estimating quantities needed to make a Detail Construction cost estimate. The AQUA/IBIS-CALC Estimating Program helped solve this problem with a correlation table which also allowed adding additional estimate quantities such as, formwork, rebar, finishing, waste factor, etc.

4. The excessive training time required to understand and used the system (10-24 weeks). It is hoped that with the workstation concept and evolution of CAD estimating, this may be reduced to 1-2 weeks.

5. The CAD drawings must be complete (with intelligent information) to obtain accurate quantities. A special estimation/cost engineering review step will be required.

6. The government estimating system requires a detail description, quantity, unit labor, total labor, unit material, total material and total line item cost column for each line item, for review and evaluation. This is not yet possible with the IBIS-CALC product. This is also necessary for proper markups for labor, payroll, taxes, insurance and material and equipment taxes. This government format may be coming on the next IBIS-CALC version, via the workstation with CES.

7. It is most important that these estimating programs can update the cost database easily for local areas, etc. This is another enhancement needed. We plan on working on this with the Navy (CES).

8. The difficulties in getting A&E's and design engineers to use the CAD, with intelligent drawing concept. It is still more expensive initially; but with workstation CAD and industry standardization; a more cost effective hardware and software; simpler systems; and education; this problem will be gradually solved as the benefits outweigh initial cost and extra learning etc.

9. The hardware/software program developer failure to have adequate end user (cost engineer) input, requirements and responsibilities in total system development is a common problem in computer program development. By emphasizing this problem here and now, it is hoped that the next generation will be wiser, resulting in a faster, cheaper, easier to use and more cost effective product.

10. The excessive amount of customization for each user is an expensive hidden cost consideration. With industry standardization, workstation CAD, linked to generic computer cost estimating systems such as CES, MC^2, Bautec/Access, and Timberline, this problem should be reduced to an acceptable level; keeping in mind that each user will have unique requirements, most of which should be solved with a more flexible CAD/ACE.

11. The need for a totally integrated design and estimating program is necessary so a complete cost estimate can be derived more automatically. This is now being planned for the workstation being developed for release in July 1990. The new system is planned to have integrated architectural, structural, civil, space planning, HVAC, electric wiring, plumbing and piping. The quantities captured from unintelligent (dumb) drawings (see Figure 12) will be a new feature.

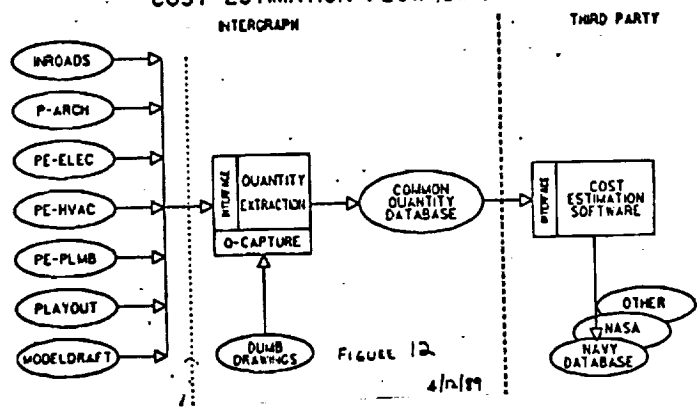
12. The problem of keeping CAD/ACE simple is probably one of the most difficult and yet the most necessary for acceptance by A&E's, owners, government management, and primarily the estimators/cost engineers. If it is to be readily accepted and implemented as soon as possible for more cost effective construction,

it is hoped the simplistic workstation concept as compared to the mini computer system will be a major step to make CAD/ACE more simple. We will continue working on this with future enhancements. See Figure 11. Note 21 steps for manual estimating vs. 39 steps for CAD estimating. CAD/ACE needs to reduce this to 10 steps. This should be accomplished after the 15-20 projects are estimated and many of the user variables can be identified, evaluated and automated.

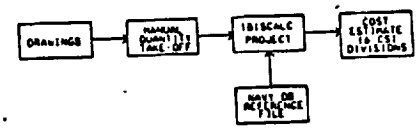
13. Making the CAD/ACE easier to use has been one of the biggest challenges since estimating/cost engineers require years of education and experience, and estimating may vary with each project, each estimator and cost engineer. Our work has been mainly centered on detail labor and material government estimates as required by TM 5-800, KSC Spec G0002, and the Navy CES. Due to limited R&D, funding our efforts have been trying to customize and integrate many different hardware and software programs which required many separate and distinct operations. This can be noted by the 39 steps shown previously to make CAD/ACE linking up (39) separate/different programs to make a complete estimate. The new workstation CAD/ACE should be easier to use since it is being designed and integrated for the workstation with 11 software packages in mind--see sketch 4/12/89, Figure 12. It is being designed for some of the more popular third party computer estimating programs so the estimator can use the program with which he is most familiar and experienced, that also fits his needs best. An example is KSC and Navy using CES which is best suited for government work. The Q-capture with unintelligent drawings also could make it easier to add the unique items not in CAD/ACE. It is hoped that in developing the stand-alone system (See Figure 13), it will be used by A&E/Estimators/ Cost Engineers without access to CAD ACE to start using computer estimating tools. This way, they will be ready when their firms start using intelligent CAD and CAD/ACE.

14. Do as much as possible automatically, try to limit the CAD/ACE to little data entry since most estimators apparently dislike this requirement of present computer estimating system. This requirement will have to be developed as more projects are implemented into this system. It is hoped that many steps can be automated through advanced programing, artificial intelligence, voice recognition, etc. The basic concept is to use CAD for quantities and to use quantity extraction software and correlation tables for cost codes, specifications, description, and other tools such as a data base management system for listing and pricing out, a spread sheet type program for pricing out and marking-up the cost estimate. Also a report writing program for formatting of reports and and to give it the automatic flexibility not thought possible nine years ago when the CAD/ACE concept was first advocated.

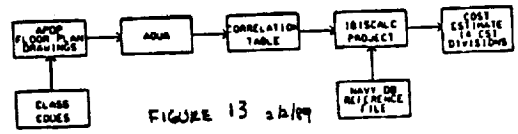
COST ESTIMATION FLOW DIAGRAM



STANDALONE



AUTOMATED - CAD



In summary, we are continuing to develop the mini-computer/CAD/estimating with the stand-along version and requesting more CAD/APDP design projects while advocating and cooperating in the development of the next version of CAD/ACE which we hope and pray will be the futuristic cost estimating system (Figure 14) that will provide time for even more cost engineering and ultimately more cost effective and efficient construction for government and aerospace and ultimately for you, the consumer and taxpayer. Such a cost estimating package would assist in the continuation of our ambitious space program to ensure the United States of continued preeminence in space exploration of development and attaining our new goals for Space Station, to the Moon, and to Mars.

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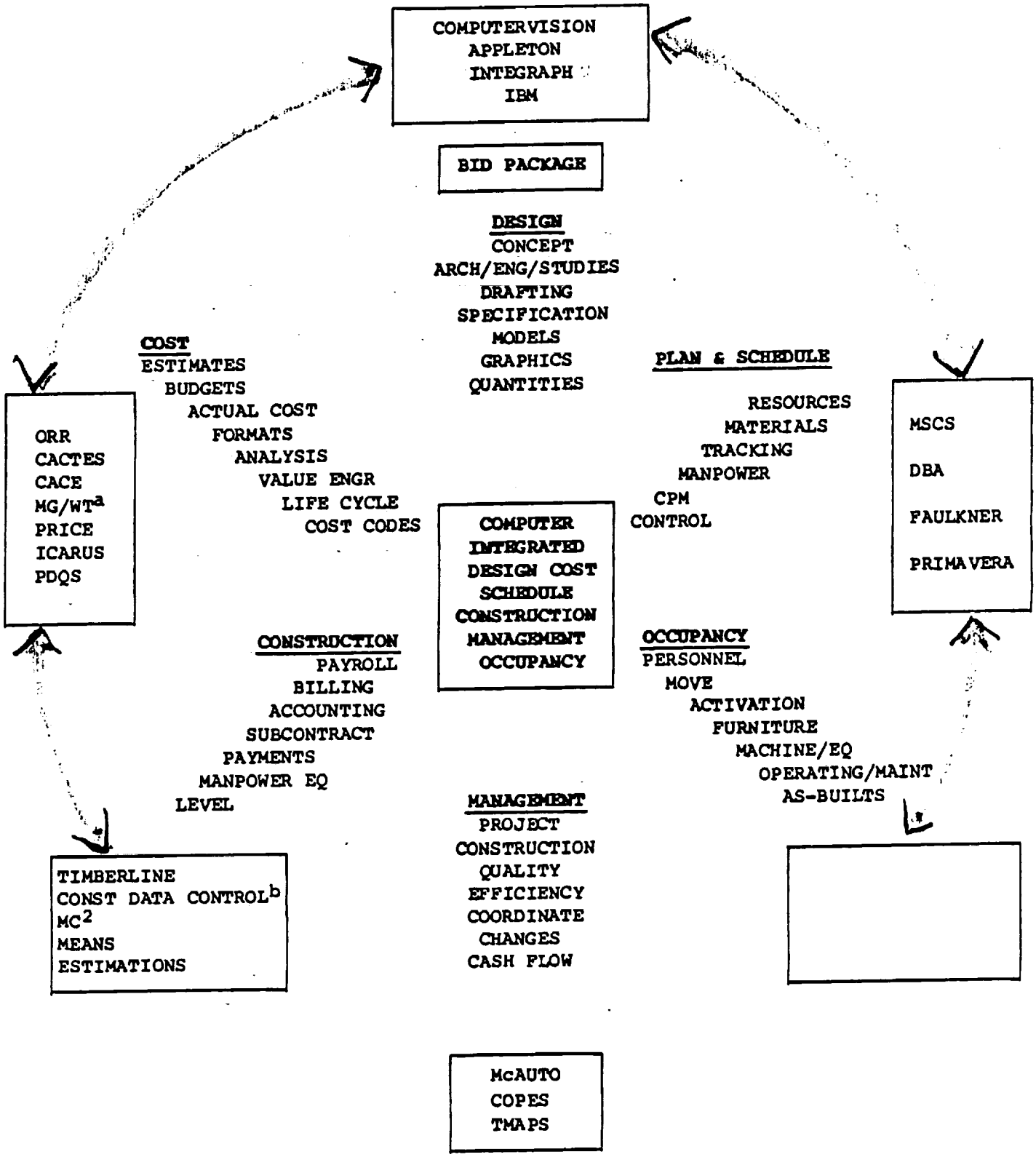
STATE-OF-THE-ART CHART
PROJECT INTEGRATED COMPUTERIZATION (PIC)



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[a]McGraw-Hill/Word Tower
[b]Construction Data Control

FIGURE A

3/4/86

Figure 1 Operation Analysis

Activity	Manual	Computer	CADD/ACCE*
Administrative Work	7%	-	-
Quantity Survey Doc. Review	8%	-	20% Improvement
Quantity Survey Measurement	24%	10% Improvement	90% Improvement
Quantity Survey Mathematics	20%	100% Improvement	100% Improvement
Pricing Man-Hour Study	8%	10% Improvement	10% Improvement
Pricing Market Survey	17%	5% Improvement	5% Improvement
Pricing Mathematics	5%	100% Improvement	100% Improvement
Checking Mathematics	7%	100% Improvement	100% Improvement
Summarization Presentation	4%	80% Improvement	80% Improvement
	100%		

Figure 2 Efficiency Analysis

Assuming 500 Man-Hour Estimating Efficiency

Activity	Normal MH Expended	Computer Aided MH	Est. Imp.	CADD/ACCE* MH Expend.	Improve-ment	7/24/89 CADD/ACE MH
CADD Intelligence						25**
Administrative Work	35	35	0	35	0%	35
Quan. Surv. Doc. Rev.	40	40	0	32	20%	32
Quan. Surv. Measurement	100	108	10%	12	90%	12
Quan. Surv Mathematics	100	0	100%	0	100%	25**
Pricing Man-Hour Study	40	36	10%	36	10%	36
Pricing Market Survey	85	81	5%	81	5%	81
Pricing Mathematics	25	0	100%	0	100%	0
Checking Mathematics	35	0	100%	0	100%	0
Summary Presentation	20	4	80%	4	80%	4
	500	304	39%	200	60%	250
Cost at $30 per MH	$15,000	$9,120	$5,880	$6,000	$9,000	$7500

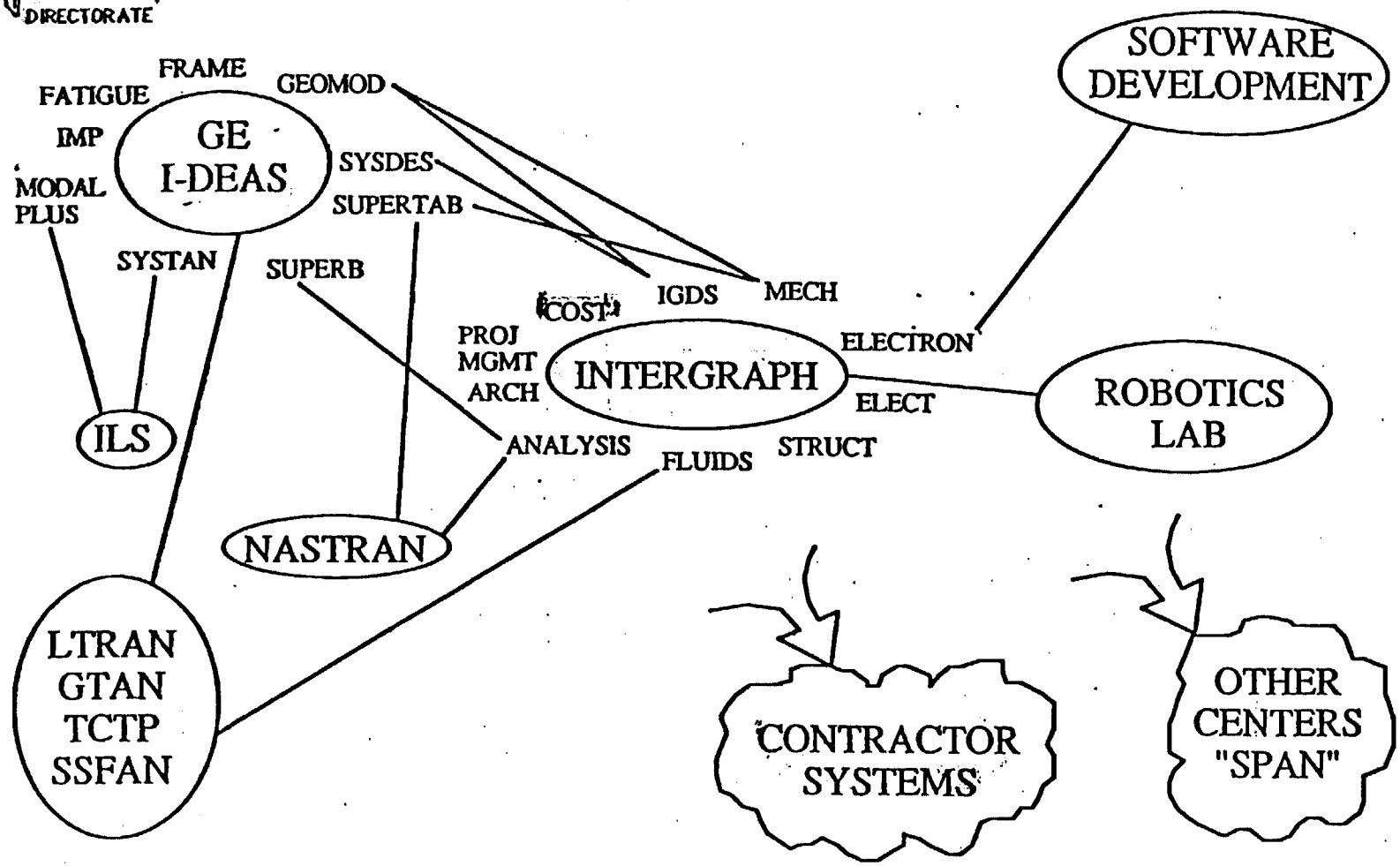
14.

15

KSC

ENGINEERING DEVELOPMENT, DIRECTORATE

COMPUTER SYSTEMS INTEGRATION



EXAMPLE OF SOME POSSIBLY NEEDED NETWORKING

15

16

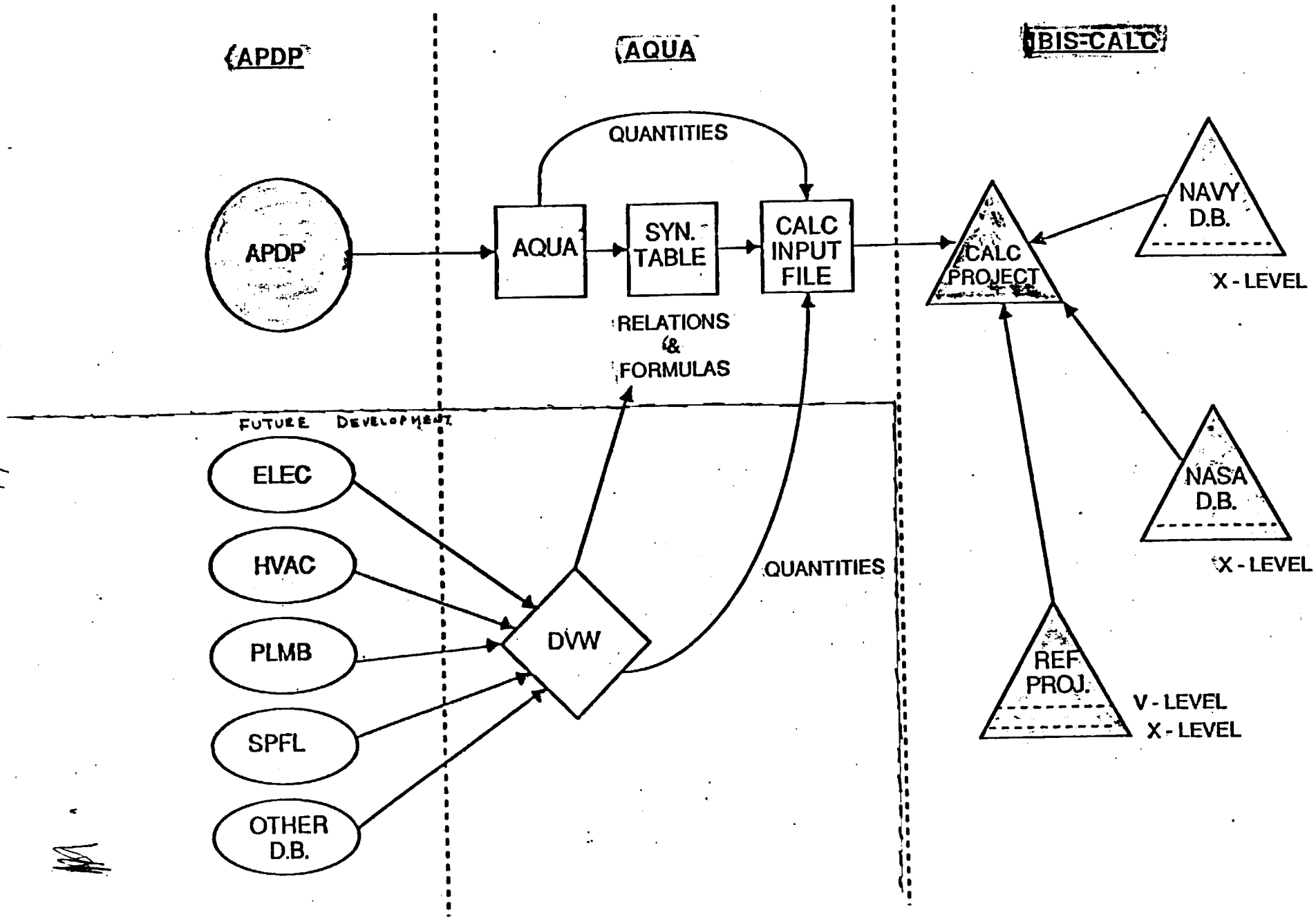
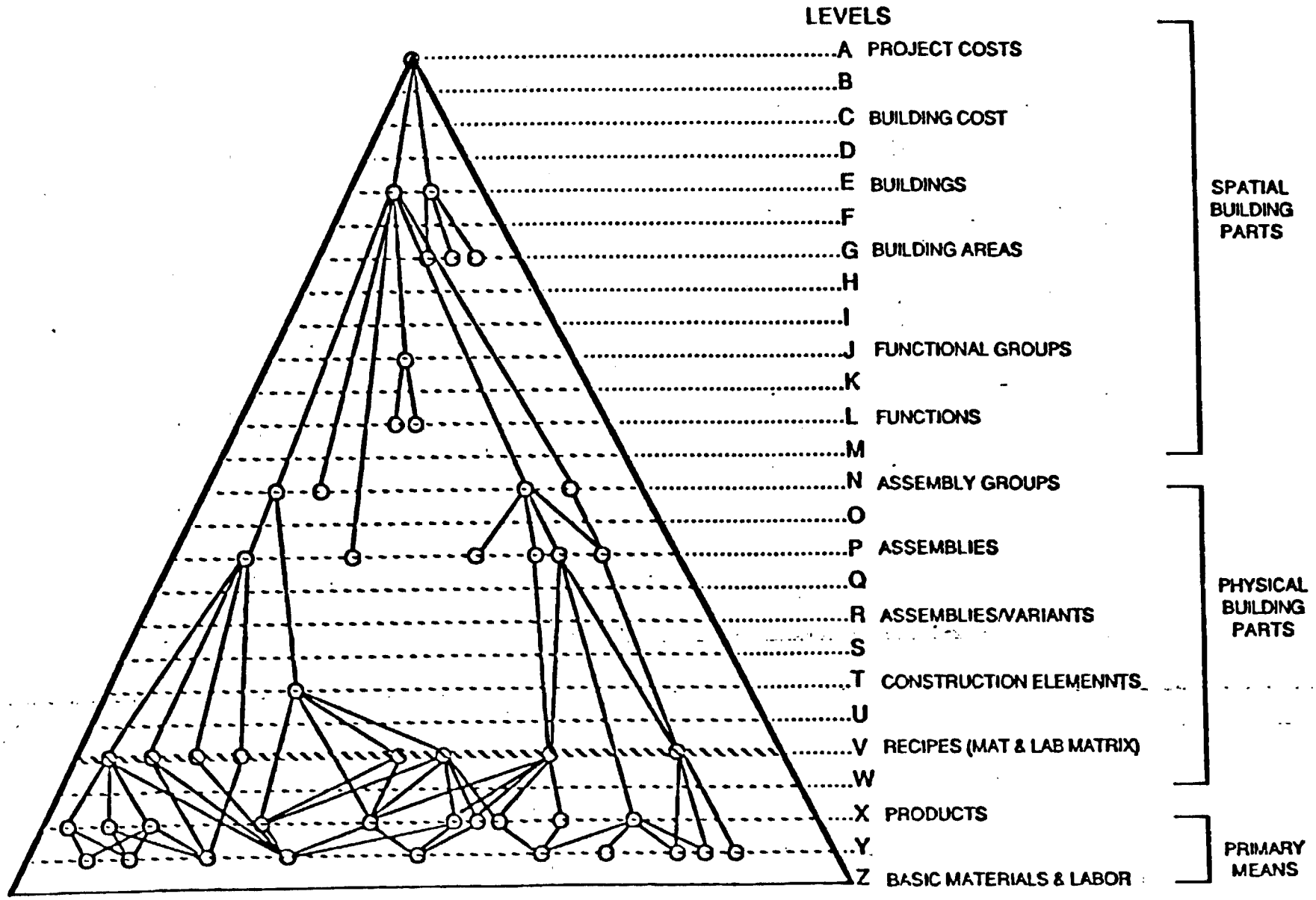

APDP
AQUA
BIS-CALC
QUANTITIES
APDP
AQUA
SYN. TABLE
CALC INPUT FILE
RELATIONS & FORMULAS
CALC PROJECT
NAVY D.B.
X - LEVEL
NASA D.B.
X - LEVEL
REF PROJ.
V - LEVEL
X - LEVEL
FUTURE DEVELOPMENT
ELEC
HVAC
PLMB
SPFL
OTHER D.B.
DVW
QUANTITIES

FIGURE 4

CONSTRUCTION DOCUMENTS PHASE COST ESTIMATE



materials – to give the user access to accurate cost information throughout the design phases. Accurate budgets can be set, and design and material selections can be made according to the owner's budget priorities. The interactive nature of the package enables the estimator to know the cost impact of each design decision immediately at any level of detail.

IBIS-CALC features include:

- **Computer-Aided Design (CAD) interface for automatic development of element quantities**
- **The capability to use data from multiple sources**
- **Simultaneous cost updating**
- **The display of project costs or incremental costs**
- **A "recipe" concept**
- **Reporting versatility**
- **The generation of specifications**

IBIS-CALC is highly sophisticated yet easily used, designed for operators with varying levels of experience and training. The menu structure lists available options at all points in the program, making it readily functional for the occasional user. An online help facility is also available from any location within the menu. The frequent user can rapidly move through the menu with single-letter commands.

automatically to
cost estimate.

With automat
extremely accur
available to the
also update the

Data From Mult

The package
information eas
it with other co
project cost esti
commercially av
price informatic

The estimato
information anc
different parts
Several data so
comparison. Th
can be copied i
currencies and
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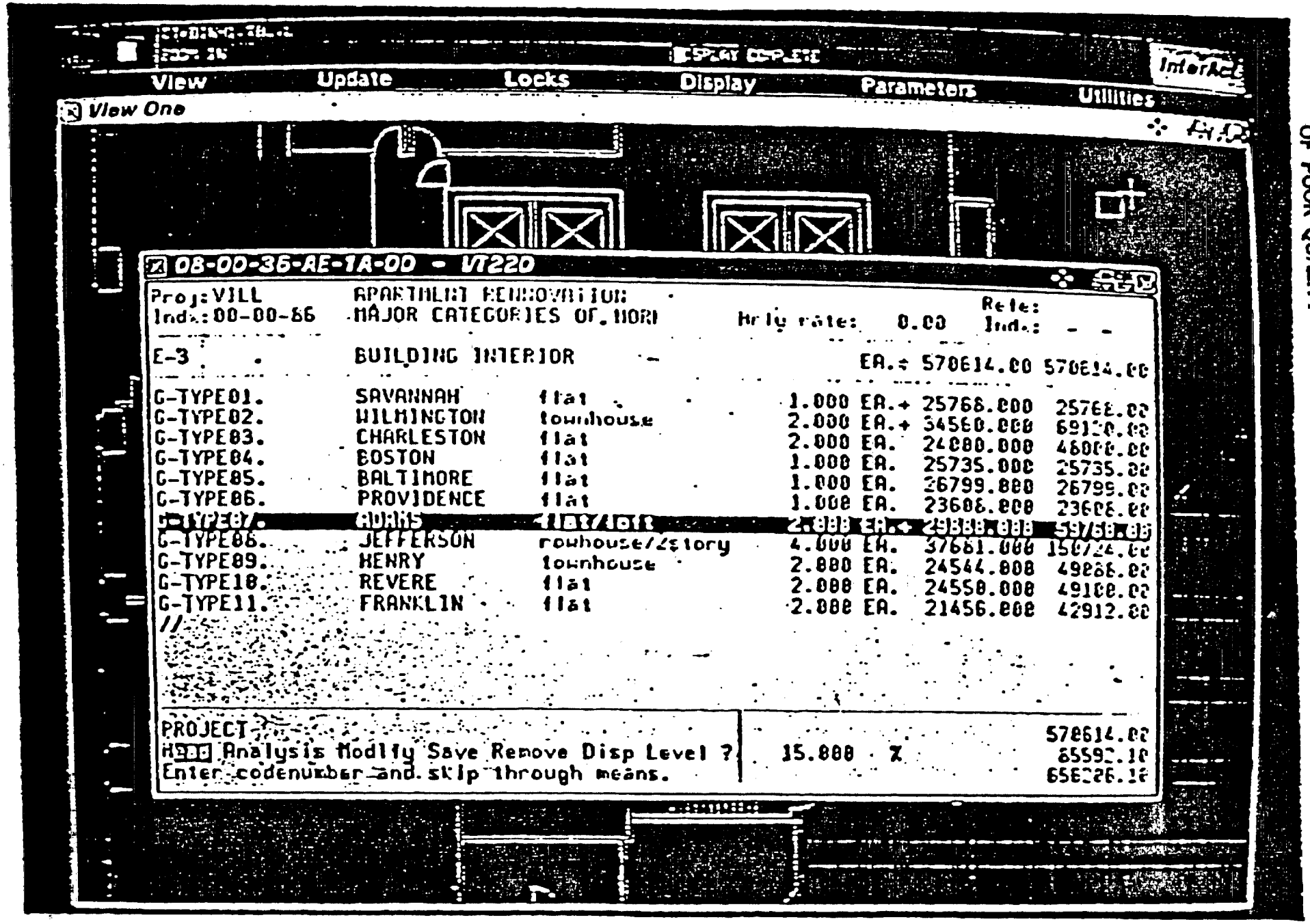

IBIS-CALC can run concurrently with an Intergraph APDP process on an InterPro® 32. This capability allows the user to make decisions in graphics

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SYSTEM SUMMARY OF GOVERNMENT ESTIMATE FOR SYSTEMS

SHEET 49 OF

DRAWING NO 79K32623	SHEETS 3	PCN 94051	LOCATION KSC, LC-39 OLF ORBITER LANDING FAC	PROJECT OLF 60 HZ POWER T3 & T4 FEEDER
PRIME OVER CONTRACT NAS 10-11582	ARCHITECT ENGINEER NASA - R. CASON		ESTIMATOR TANNER/BROWN-NASA	CHECKED S.S. VARNDELL/EGG T. FITZGEROUS/NASA
				CODE C-100 SUBMITTED 11/3/88 S.S.7/3/89

CONSTRUCTION COSTS

A TRADES / DIV TITLE	QTY	UNIT	$ UNIT	$/LF	TOTAL	DIV. TOTAL	SYS INVOLVED	
1. GNL COND.								
(10 %)					33,528			
2 SITE	33,000	LF	1.31	1.31		43,138		
CLR/GRUB								
DEMOLITION								
EXTRA WALL TRENCH	33,000	LF	1.28	1.08	42,270			
HAND EXCAV.	450	CY	1736	.02	868			
PAVING								
UTILITIES								
OTHER								
3 CONCRETE	65	EA	5.12	.01		1376		
MARKERS	65	EA	5.12	.01	376			
REBAR								
CONCRETE								
4 MASONRY								
5 METALS								
STRUCT STL								
PLATFORM								
MISC								

SYSTEMS TRADES / DIV. TITLE	SIZES	MATL	QTY	UNIT	$ UNIT	TOTAL	OTHER $	$ LF	TOTAL	DIV. TOTAL
15 MECHANICAL										
A. PLUMBING										
B. HVAC										
C. FIRE PROTECT										
D										
E. HYDER										
F. COMP										
G. PNEU										
H. BCS										
I. HYDRAULICS										
16. ELECTRICAL	1/0	CU	119,000	LF	2.84			.911		355,098
REMOVE CABLES	2-3/0	AL	92	EA	21.70			.05	1.996	
#1 AWG 1/C 15KVA	1/0	CU	119,000	LF	2.84			.866	337,925	
SPLICES	2-3/0	CU	50	EA	115.68			.15	5.784	
TERMINATIONS	2-3/0	CU	92	EA	102.10			.26	9.393	
A. EXTERIOR										
B. POWER										
PROJECT TOTALS				LF				$10.21		398,312

DESCRIPTION

SCOPE: 1 POOR 2 AVERAGE 3 GOOD 4 COMPLETE 5 SOPHIST

BASIC PLAN: A SOURCE B DETERMINED C INCREASED D VARIABLE E

COMMENTS: FIRST KSC CAD 1815 CALC COMPUTER - $ ESTIMATE - ERATIC PRICE OF COPPER CAUSED PROBLEM.

DESIGN DATA

TYPE FAC: 60 HZ POWER SF AREA

CAPACITY: 39,000 LF

HEIGHT: - STORIES - - FT.

STRUCT. FRAME

VOLUME: - CF

SPECIAL FEATURES

#1/0AWG - CU X LP3C 15KVA $2.84 LF GOVT. EST. WAS RAISED DUE TO VENDOR REQUIREMENT FOR 5% ADD. MATERIAL. MARKUP ADJ. TO 10% OH 7% PROFIT.

CONSTRUCTION BID DATA INFO 10-0009-9

MECH. LF:		$	/LF	
ELEC. LF:	39,000	$ 9.11	/LF	355,098
SUBCOT LF:		$	/LF	
OTHER		$ -	/LF	43,214
SUBTOTAL	39,000	$ 10.21	/LF	398,312

SPECIAL COST FEATURES

HAZARDS		$	/LF
PAD TEST CLM COST		$	/LF
GFE		$	/LF
OTHER		$	/LF
SUBTOTAL		$	/LF
TTL PROJ $		/SFB	/LF

BID DATE 2/23/88

AWARDED TO GF&L $396,000

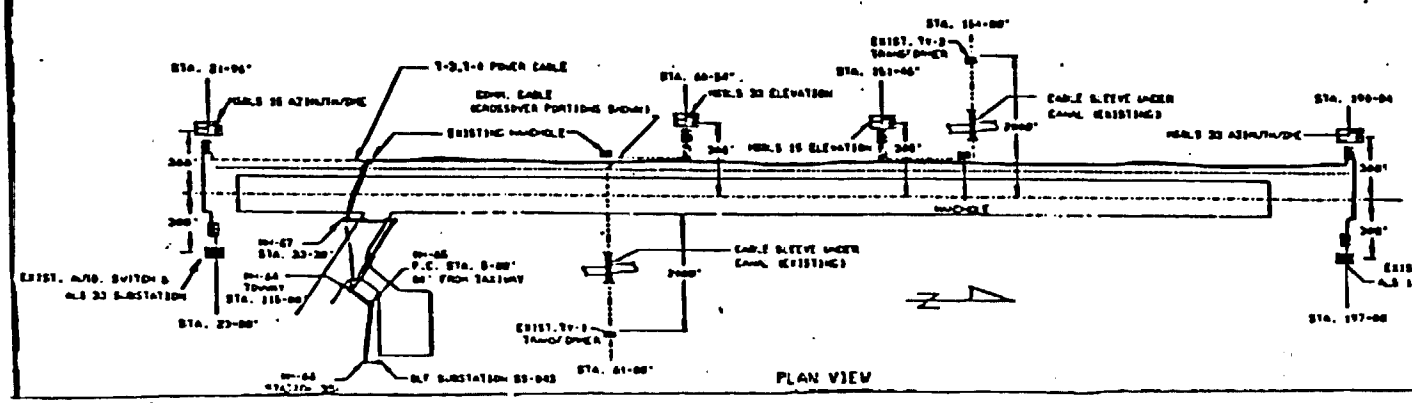
CONSTRUCT TIME SPAN 180 CAL DAYS

NO OF BIDS 13 GOVT EST PCT 1 OF 13

PCT DIF. AWARDED BID GOVT EST 2.82

BIDDERS ....

		$/LF
GOVT. EST.	$ 385,242	9.88
GF&L	$ 396,000	10.15
GOVT. EST. REV.	$ 398,312	10.21
EAST BAY ELEC.	$ 397,227	10.19
MILITARY CONST.	$ 398,770	10.23
SOUTHERN ELEC.	$ 400,425	10.27
STRUMCRAFT	$ 413,136	10.59
CONSOLIDATED ELEC.	$ 421,762	10.81
HEDGECOCK ELEC.	$ 422,000	10.82
FLA. INDUST.	$ 444,000	11.38
SOUTHEASTERN	$ 480,452	12.32
CHROME ELEC.	$ 494,603	12.68
OLSON ELEC.	$ 497,535	12.76
ACME ELEC.	$ 513,200	13.16



COST ESTIMATE COVER SHEET

GOVERNMENT ESTIMATES ARE ADMINISTRATIVELY CONFIDENTIAL
ACCESSIBLE TO AUTHORIZED NASA/KSC PERSONNEL OR REPRESENTATIVES ONLY

Project : REPLACE OF POWER FEEDERS AT THE SPACE SHUTTLE LANDING FACILITY, KSC
OLF 60 HZ POWER T3 & T4 FEEDER
99,000 LF OF 1/0 15KV

Location :

IFB No. : IFB10-0009-9 OF 1/14/89

Bid Date : FEBRUARY 23, 1989

Amendment : 1 OF 02/08/89

Estimate Code: C100

PCN : 94051

Contract No. :

Drawing No. 79k32623 Sht 3:

Model No.:

Lead Designer: R. Carson

KSC Cost Engineer: Joe A. Brown

Project Engineer:

Prepared by: Tay Fitzgerald/Pat Tanner/Joe Brown

Firm/Address: DFFED-21

Location: KSC Hqbld Fla

Submittal Date: 02/17/89

Estimated By: Joe Brown/Pat Tanner

Phone No.: 867-3268/867-3447

Reviewed By:

Approved By:

Phone No.:

Cost Estimating for procurement requires special handling in accordance with DE ID-1142.23, KSC SPEC-G-0002 and KSC SPEC-G-0003 for GSE.

ORIGINAL PAGE IS
OF POOR QUALITY

Project : T3T4ALT4
Indexdate: 03-10-89
Estimate : B-1

ALT END PAGE FOR T3T4 PROJ

LABOR & MATERIAL SUB TOTAL

Printdate: 09-20-89
Printtime: 09:25:38
Page: 1

Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
E-1	LABOR & MATERIAL SUB TOTAL	1.00	EA							
P-15	XV - MECHANICAL	1.00	EA	0.00						
P-16	XVI - ELECTRICAL	1.00	EA							
X-2WKJKC	#1/0 AWG CU XLP 1/C 15KV	119011.00	LF	2.11			251113.20			13601.28
X-WKJKCL	#1/0 AWG CU XLP 1/C 15KV	113344.00		0.12						
X-1ZN82	CABLE SPLICE 0-15KV 1/C	50.00	EA	45.00	2250.00	2250.00				
X-2ZN82	CABLE SPLICE 0-15KV 1/C	50.00	EA	35.00			1750.00			
X-1ZN47C	CABLE TERM. SIZE 2 - 3/0	92.00	EA	26.26	2415.92	2415.92				
X-2ZN47C	CABLE TERM. SIZE 2 - 3/0	92.00	EA	44.28			4073.76			
X-1REMCA.B	REMOVE CABLE	92.00	EA	15.00	1380.00	1380.00				
P-16	XVI - ELECTRICAL	1.00	EA	276584.17	6045.92	6045.92	256936.96			276584.16
P-01	I - GENERAL CONDITIONS	1.00	EA	0.00						
P-02	II - EARTHWORK	1.00	EA							
X-1BIFKE	TRENCHING & BACKFILL IN	33000.00	LF	0.67	*******	22110.00				
X-3BIFKE	TRENCHING & BACKFILL IN	33000.00	LF	0.33				10890.00		
X-1BIGEB.KC	EXCAVATION HANDDIG	50.00	CY	12.00	600.00	600.00				
P-02	II - EARTHWORK	1.00	EA	33600.00	*******	22710.00		10890.00		33600.00
P-03	III - CONCRETE	1.00	EA							
X-1CONCK.C	16" CONCRETE CABLE MARKS	65.00	EA	2.00	130.00	130.00				
X-2CONCK.C	16" CONCRETE CABLE MARKS	65.00	EA	2.00			130.00			
P-03	III - CONCRETE	1.00	EA	260.00	130.00	130.00	130.00			260.00
P-04	IV - MASONRY	1.00	EA	0.00						
P-05	V - STRUCTURAL STEEL	1.00	EA	0.00						
P-06	VI - CARPENTRY	1.00	EA	0.00						
P-07	VII - ROOFING	1.00	EA	0.00						
P-08	VIII - DOORS & WINDOWS	1.00	EA	0.00						
P-09	IX - FINISHES	1.00	EA	0.00						
P-10	X - SPECIALTIES	1.00	EA	0.00						
P-11	XI - EQUIPMENT	1.00	EA	0.00						
P-12	XII - FURNISHINGS	1.00	EA	0.00						
P-13	XIII - SPECIAL CONSTRUCTION	1.00	EA	0.00						
P-14	XIV - CONVEYING SYSTEMS	1.00	EA	0.00						
E-1	LABOR & MATERIAL SUB TOTAL	1.00	EA	310444.17	*******	28885.92	257066.96	10890.00		310444.16
B-1	LABOR & MATERIAL SUB TOTAL	total			*******	28885.92	257066.96	10890.00		310444.16

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Project : T3T4ALT4 ALT END PAGE FOR T3T4 PROJ
Indexdate: 03-10-89
Estimate : B-1 LABOR & MATERIAL SUB TOTAL

Printdate: 09-20-89
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Page: 2

Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
	LABOR & MATERIAL COST		$							310444.16
	TAXES & INSURANCE	8.00	%	MAT. 6% SOLES TAX LABOR 25% P T&I						24835.53
	SUB TOTAL L&M T&I COST		$							335279.70
	OVERHEAD	10.00	%							33527.97
	SUB TOTAL		$							368807.67
	PROFIT	7.00	%							25816.54
	SUB TOTAL		$							
	BOND	1.00	%							3688.08
	ESTIMATED CONSTRUCT. BID COST		$							398312.28

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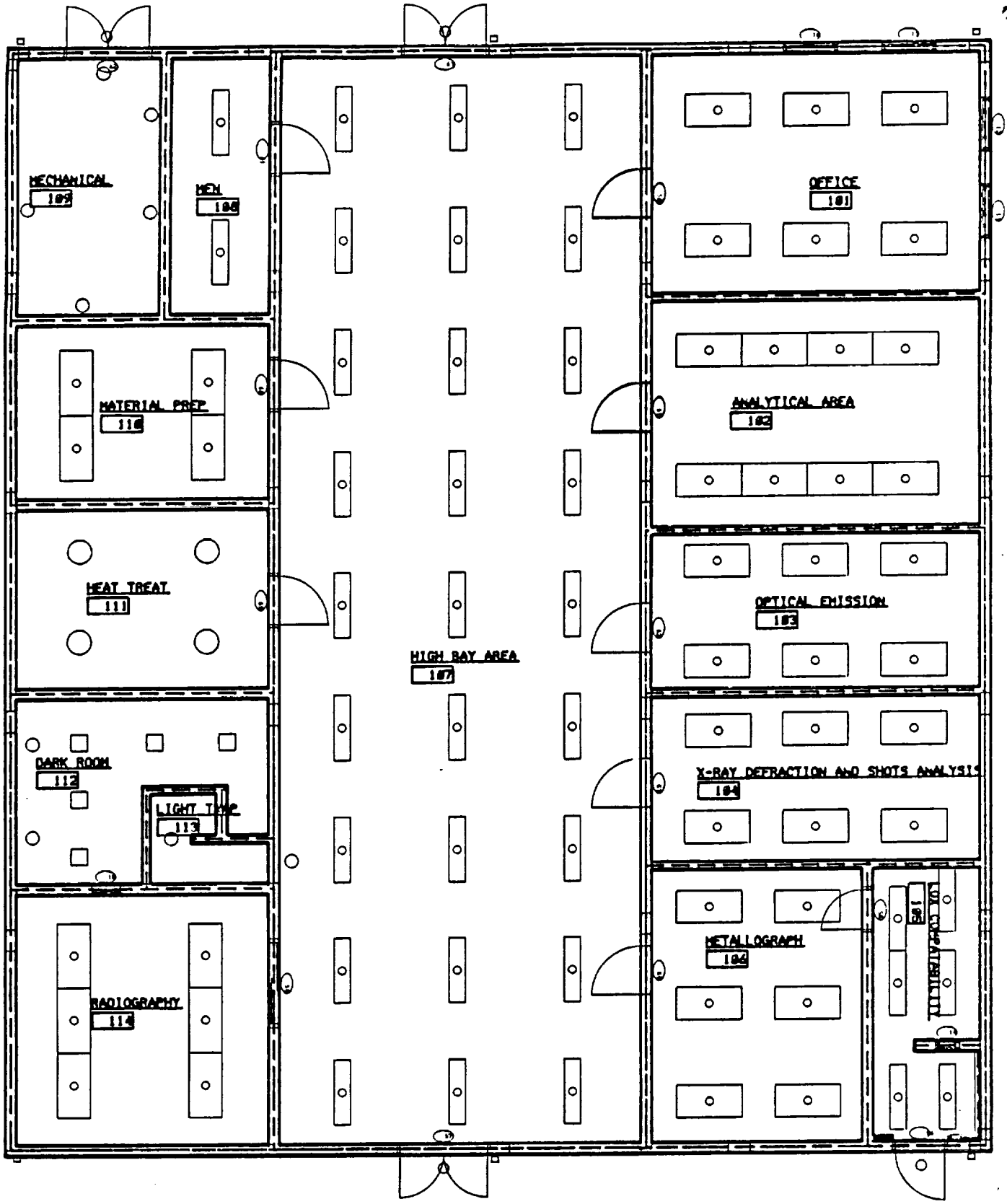
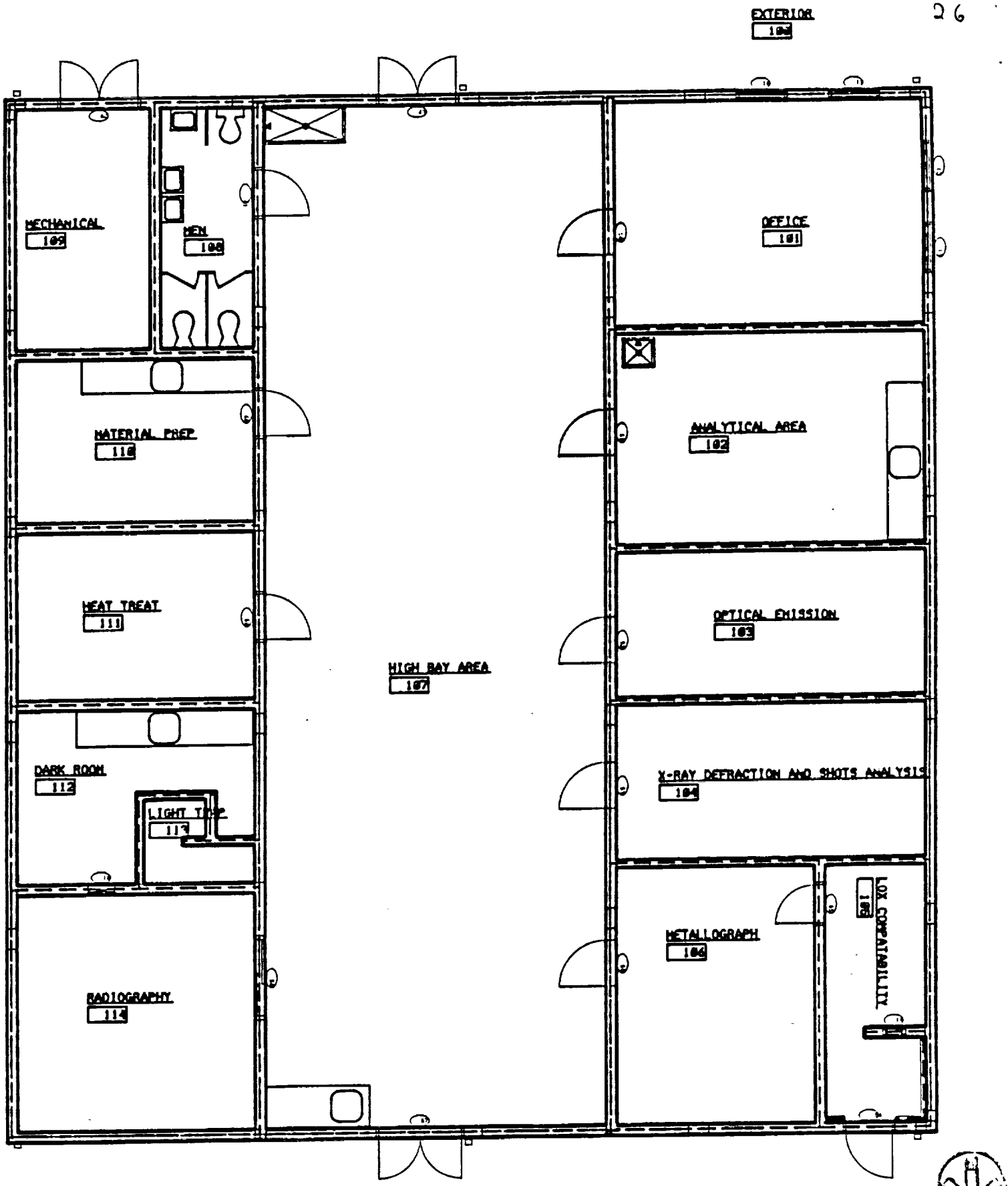


PSCL FLOORPLAN

OCT 1988

REV. MAR 1989

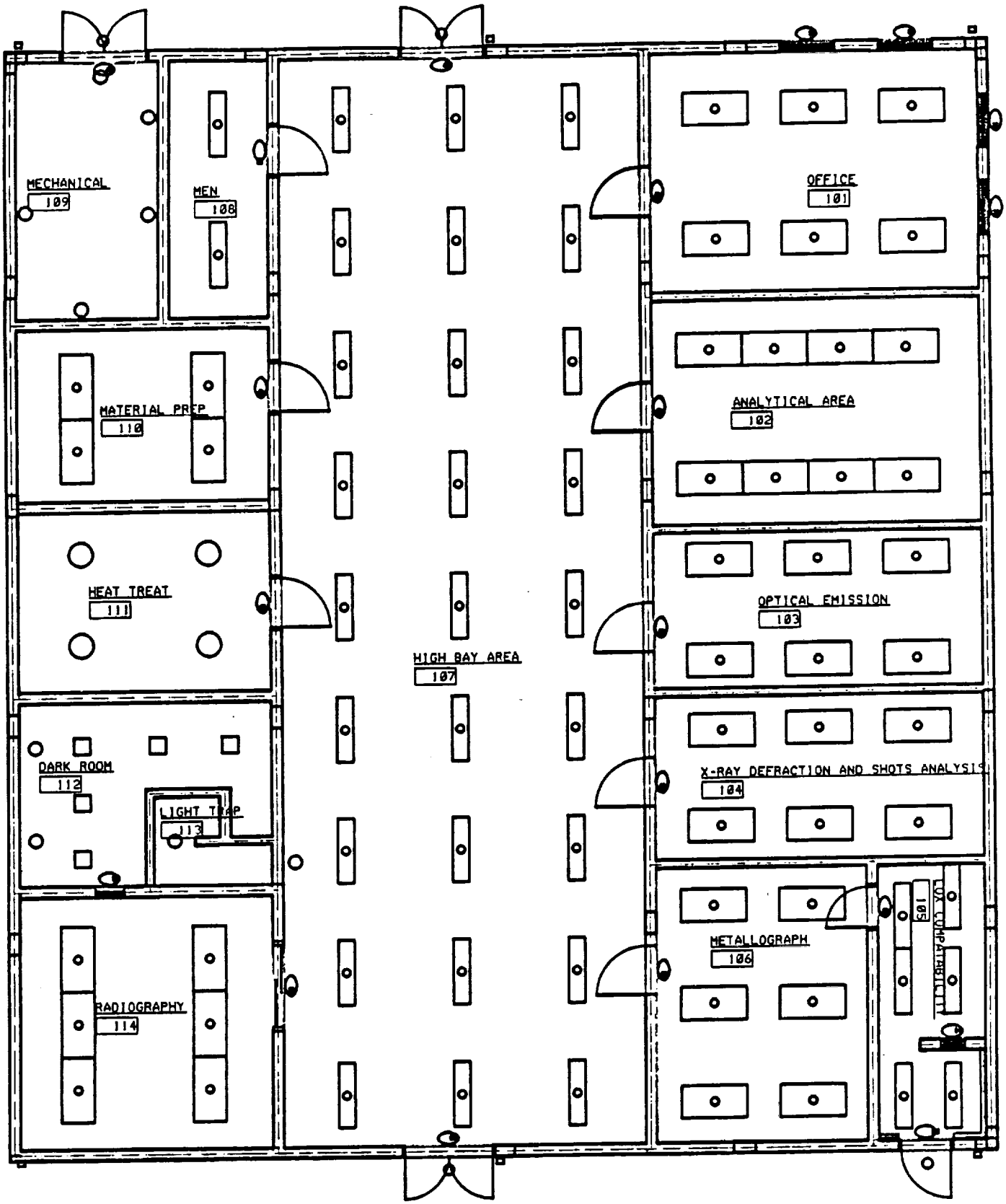


PSCL FLOORPLAN

OCT 1988

REV. MAR 1989

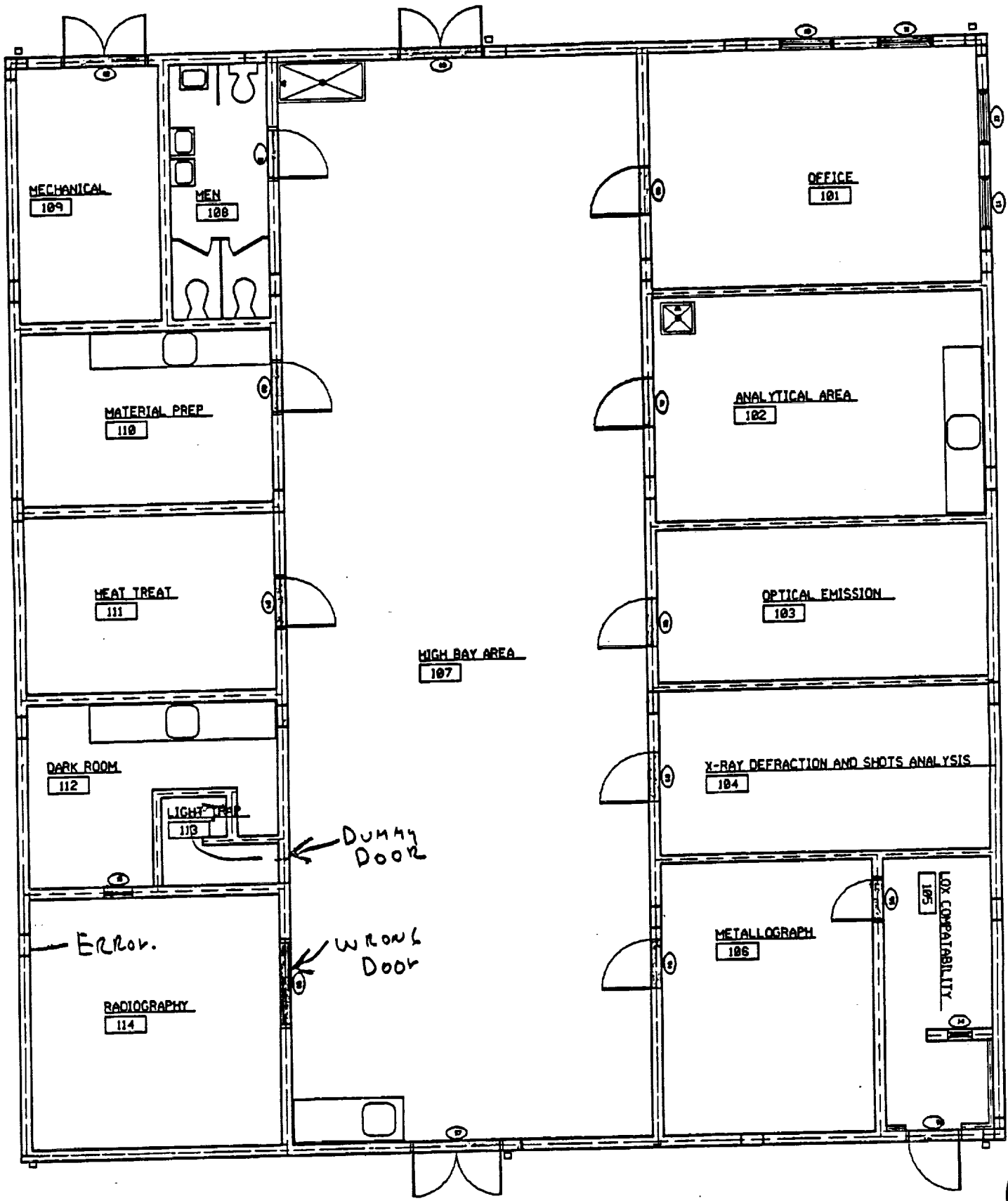
PLUMBING - LAYOUT



ELECTRICAL PSCL FLOORPLAN

LIGHTING LAYOUT OCT 1988

REV. MAR 1989



concrete

MASONRY

DOOR

PSCL FLOORPLAN

OCT 1988

REV. MAR 1989

Project : PLOT4 PILOT WITH PLOT DRAWING Printdate: 03-20-89
Indexdate: 03-17-89 Printtime: 12:49:18
Estimate : J-A1.1 .1 Page: 1-16

Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
02	DIVISION II									
02.20										
02.20.0										
X-1BIGKC.B	FINEGRADING	4100.32	SF	0.10	410.03	410.03				
X-1BIGKC.C	COMPACTION	4100.32	SF	0.10	410.03	410.03				
X-2BIGKC.B	FINEGRADING	4100.32	SF	0.05			205.02			
X-2BIGKC.C	COMPACTION	4100.32	SF	0.06			246.02			
02.20.0		total			820.06	820.06	451.03			1271.10
02.20		total			820.06	820.06	451.03			1271.10
02.21										
02.21.0										
X-1BGAEA.A	CUT, BACKFILL	64.33	CY	1.31	84.28	84.28				
X-3BGAEA.A	CUT, BACKFILL	64.33	CY	2.30				147.97		
02.21.0		total			84.28	84.28		147.97		232.24
02.21.4										
X-1BGCBL	BORROW FILL SAND COMPACT	497.45	CY	1.01	502.42	502.42				
X-2BGCBL	BORROW FILL SAND COMPACT	497.45	CY	2.25			1119.25			
X-3BGCBL	BORROW FILL SAND COMPACT	497.45	CY	2.80				1392.85		
02.21.4		total			502.42	502.42	1119.25	1392.85		3014.52
02.21		total			586.70	586.70	1570.29	1540.81		3697.79
02.22										
02.22.2										
X-1BIGEB	STRUCTURAL EXCAVATION	80.85	CY	6.91	558.65	558.65				
02.22.2		total			558.65	558.65				558.65
02.22		total			558.65	558.65	1570.29			2128.94
02	DIVISION II	total			1965.41	1965.41	1570.29	1540.81		5076.51

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Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
03	DIVISION III									
03.10										
03.10.0										
X-1EBBRC	FORM COL PLYWD 3-USE	1023.74	SF	2.15	2201.05	2201.05				
X-1EBFRA	FORM ELEVATED SLAB PLYWD	98.21	SF	1.61	158.11	158.11				
X-1EBKRA	FORM BEAMS UNSUPPORTED	1615.28	SF	3.21	5185.05	5185.05				
X-1EBYRA	FORM WALLS TO 16' PLYWD	1528.53	SF	2.58	3943.60	3943.60				
X-1ECFPH.D	EDGE FORMS SLAB ON GRADE	1016.99	LF	1.09	1108.52	1108.52				
X-2EBBRC	FORM COL PLYWD 3-USE	1023.74	SF	0.81			829.23			
X-2EBFRA	FORM ELEVATED SLAB PLYWD	98.21	SF	1.98			194.45			
X-2EBKRA	FORM BEAMS UNSUPPORTED	1615.28	SF	2.26			3650.53			
X-2EBYRA	FORM WALLS TO 16' PLYWD	1528.53	SF	1.52			2323.36			
X-2ECFPH.D	EDGE FORMS SLAB ON GRADE	1016.99	LF	0.28			284.76			
X-3EBBRC	FORM COL PLYWD 3-USE	1023.74	SF	0.09				92.14		
X-3EBFRA	FORM ELEVATED SLAB PLYWD	98.21	SF	0.05				4.91		
X-3EBKRA	FORM BEAMS UNSUPPORTED	1615.28	SF	0.09				145.38		
X-3EBYRA	FORM WALLS TO 16' PLYWD	1528.53	SF	0.08				122.28		
X-3ECFPH.D	EDGE FORMS SLAB ON GRADE	1016.99	LF	0.05				50.85		
03.10.0		total			*******	12596.33	7282.34	415.55		20294.22
03.10		total			*******	12596.33	8852.62	415.55		21864.51
03.20										
03.20.0										
X-1EFAA	REBARS AVG PLACE & SIZE	3.78	TN	330.87	1250.03	1250.03				
X-1EGFU	PLACE WIRE MESH SLABS	45.36	SQ	10.73	486.72	486.72				
X-2EFAA	REBARS AVG PLACE & SIZE	3.78	TN	559.52			2113.87			
X-2EGFU	PLACE WIRE MESH SLABS	45.36	SQ	16.32			740.29			
03.20.0		total			1736.75	1736.75	2854.16			4590.91
03.20		total			1736.75	1736.75	11706.78			13443.53
03.30										
03.30.1										
X-1EKBMG	PLACE CONC 2500 OR 3000#	1.08	CY	13.03	14.10	14.10				
X-1EKBMN	PLACE CONC 2500 OR 3000#	13.27	CY	11.18	148.40	148.40				
X-1EKIMN	PLACE CONC 2500 OR 3000#	22.31	CY	6.71	149.71	149.71				
X-1EKKMG	PLACE CONC 2500 OR 3000#	20.94	CY	13.03	272.82	272.82				
X-1EKSMN	PLACE CONC 2500 OR 3000#	89.87	CY	4.79	430.49	430.49				
X-1EKYMN	PLACE CONC 2500 OR 3000#	29.72	CY	9.87	293.35	293.35				
X-1EPKS	FINISHING CONC SLAB	4100.32	SF	0.17	697.05	697.05				
X-1ERIJ	CURING CONC SLAB SPRAYED	4100.32	SF	0.02	82.01	82.01				
X-2EKBMG	PLACE CONC 2500 OR 3000#	1.08	CY	52.73			57.05			
X-2EKBMN	PLACE CONC 2500 OR 3000#	13.27	CY	52.73			699.94			
X-2EKIMN	PLACE CONC 2500 OR 3000#	22.31	CY	52.73			1176.51			

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Project : PLOT4 PILOT WITH PLOT DRAWING Printdate: 03-20-89
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Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
X-2EKKMG	PLACE CONC 2500 OR 3000#	20.94	CY	52.73			1104.06			
X-2EKSMN	PLACE CONC 2500 OR 3000#	89.87	CY	52.73			4739.00			
X-2EKYMN	PLACE CONC 2500 OR 3000#	29.72	CY	52.73			1567.19			
X-2EPKS	FINISHING CONC SLAB	4100.32	SF	0.00						
X-2ERIJ	CURING CONC SLAB SPRAYED	4100.32	SF	0.02			82.01			
X-3EKBMG	PLACE CONC 2500 OR 3000#	1.08	CY	16.44				17.79		
X-3EKBMN	PLACE CONC 2500 OR 3000#	13.27	CY	13.34				177.08		
X-3EKIMN	PLACE CONC 2500 OR 3000#	22.31	CY	8.00				178.50		
X-3EKKMG	PLACE CONC 2500 OR 3000#	20.94	CY	16.44				344.22		
X-3EKSMN	PLACE CONC 2500 OR 3000#	89.87	CY	5.71				513.17		
X-3EKYMN	PLACE CONC 2500 OR 3000#	29.72	CY	11.77				349.82		
X-3EPKS	FINISHING CONC SLAB	4100.32	SF	0.08				328.03		
03.30.1		total			2087.94	2087.94	9425.76	1908.60		13422.29
03.30		total			2087.94	2087.94	21132.54	1908.60		25129.07
03	DIVISION III	total			*******	16421.02	19562.26	2324.15		38307.42

Project : PLOT4 PILOT WITH PLOT DRAWING

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Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
04	DIVISION IV									
04.20										
04.20.0										
X-1FCIC	REINFORCING-LADDER TYPE	2804.98	LF	0.05	140.25	140.25				
X-1FFJH	CMU HOLLOW 6" RGLR WT	1247.67	SF	1.99	2482.86	2482.86				
X-1FFJJ	CMU HOLLOW 8" RGLR WT	5294.32	SF	2.09	*******	11065.14				
X-1FGBM	ACOUSTICAL SLOTTED BLOCK	237.25	SF	2.33	552.80	552.80				
X-2FAP	MORTAR TYPE M	668.40	CF	2.31			1544.01			
X-2FCIC	REINFORCING-LADDER TYPE	2804.98	LF	0.17			476.85			
X-2FFJH	CMU HOLLOW 6" RGLR WT	1247.67	SF	1.01			1260.14			
X-2FFJJ	CMU HOLLOW 8" RGLR WT	5294.32	SF	1.29			6829.68			
X-2FGBM	ACOUSTICAL SLOTTED BLOCK	237.25	SF	3.31			785.31			
X-3FFJH	CMU HOLLOW 6" RGLR WT	1247.67	SF	0.05				62.38		
X-3FFJJ	CMU HOLLOW 8" RGLR WT	5294.32	SF	0.05				264.72		
04.20.0		total			*******	14241.04	10895.99	327.10		25464.13
04.20.3										
X-1EXIH	PRECAST CONC COPING 10"W	13.33	LF	2.51	33.46	33.46				
X-1EXTR	PRECAST CONC LINTELS	79.33	LF	1.26	99.96	99.96				
X-2EXIH	PRECAST CONC COPING 10"W	13.33	LF	3.03			40.40			
X-2EXTR	PRECAST CONC LINTELS	79.33	LF	5.50			436.32			
04.20.3		total			133.42	133.42	476.71			610.13
04.20		total			*******	14374.46	32505.24	327.10		47206.80
04	DIVISION IV	total			*******	14374.46	11372.70	327.10		26074.26

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Project : PLOT4 PILOT WITH PLOT DRAWING
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Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
05	DIVISION V									
05.12										
05.12.0										
X-1GBPC	MISC SHAPES (ANGLES,BARS	488.37	LB	0.23	112.33	112.33				
X-2GBPC	MISC SHAPES (ANGLES,BARS	488.37	LB	0.52			253.95			
05.12.0		total			112.33	112.33	253.95			366.28
05.12		total			112.33	112.33	32759.20			32871.52
05.50										
05.50.0										
X-2GLJLB.D	BOLT HS 3/4"DIA X2" THRU	374.58	EA	2.11			790.36			
05.50.0		total					790.36			790.36
05.50		total					33549.56			33549.56
05	DIVISION V	total			112.33	112.33	1044.31			1156.64

Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
06	DIVISION VI									
06.10										
06.10.0										
X-1HABVG.Z	BLOCKING & NAILERS	495.21	BF	0.64	316.93	316.93				
X-1HFBGI	STRUCTURAL PLYWD EXT	571.30	SF	0.26	148.54	148.54				
X-2HABVG.Z	BLOCKING & NAILERS	495.21	BF	0.41			203.03			
X-2HFBGI	STRUCTURAL PLYWD EXT	571.30	SF	0.87			497.03			
X-3HABVG.Z	BLOCKING & NAILERS	495.21	BF	0.10				49.52		
X-3HFBGI	STRUCTURAL PLYWD EXT	571.30	SF	0.01				5.71		
06.10.0		total			465.47	465.47	700.07	55.23		1220.77
06.10		total			465.47	465.47	34249.63	55.23		34770.33
06.20										
06.20.0										
X-1HPEPN	EXT TRIM CLEAR CASING	119.41	LF	0.50	59.71	59.71				
X-1HQGOW	BASEBOARD FLAT 1X4	71.41	LF	0.51	36.42	36.42				
X-2HPEPN	EXT TRIM CLEAR CASING	119.41	LF	0.84			100.31			
X-2HQGOW	BASEBOARD FLAT 1X4	71.41	LF	0.84			59.99			
X-3HPEPN	EXT TRIM CLEAR CASING	119.41	LF	0.08				9.55		
X-3HQGOW	BASEBOARD FLAT 1X4	71.41	LF	0.08				5.71		
06.20.0		total			96.13	96.13	160.29	15.27		271.69
06.20		total			96.13	96.13	34409.92	15.27		34521.31
06	DIVISION VI	total			561.60	561.60	860.36	70.50		1492.46

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Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
07	DIVISION VII									
07.22										
07.22.0										
X-1IELRD	INSULATION COMPOSITE BD	4100.32	SF	0.17	697.05	697.05				
X-2IELRD	INSULATION COMPOSITE BD	4100.32	SF	0.57			2337.18			
07.22.0		total			697.05	697.05	2337.18			3034.23
07.22		total			697.05	697.05	36747.10			37444.15
07.51										
07.51.1										
X-1IQDIE	BLT-UP ROOFING ASPHALT	41.00	SQ	27.88	1143.16	1143.16				
X-2IQDIE	BLT-UP ROOFING ASPHALT	41.00	SQ	40.85			1674.97			
X-3IQDIE	BLT-UP ROOFING ASPHALT	41.00	SQ	6.00				246.02		
07.51.1		total			1143.16	1143.16	1674.97	246.02		3064.15
07.51.2										
X-1IQDUD	BLT-UP ROOFING ASPH FELT	41.00	SQ	17.43	714.68	714.68				
X-2IQDUD	BLT-UP ROOFING ASPH FELT	41.00	SQ	30.15			1236.24			
X-3IQDUD	BLT-UP ROOFING ASPH FELT	41.00	SQ	3.75				153.76		
07.51.2		total			714.68	714.68	1236.24	153.76		2104.68
07.51		total			1857.85	1857.85	39658.31	399.78		41915.94
07.60										
07.60.0										
X-1IRWAS.J	GRAVEL STOP AL .032" 8IN	256.68	LF	0.98	251.54	251.54				
X-1ISJBS.H	GUTTER BOX AL .032" 5"	118.66	LF	1.02	121.04	121.04				
X-2IRWAS.J	GRAVEL STOP AL .032" 8IN	256.68	LF	4.46			1144.78			
X-2ISJBS.H	GUTTER BOX AL .032" 5"	118.66	LF	1.25			148.33			
07.60.0		total			372.58	372.58	1293.11			1665.69
07.60		total			372.58	372.58	40951.42			41324.00
07	DIVISION VII	total			2927.48	2927.48	6541.50	399.78		9868.76

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Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
08	DIVISION VIII									
08.11										
08.11.0										
X-1JA@CA	INT HM DOOR & FRAME W/	11.00	EA	100.46	1105.06	1105.06				
X-2JA@CA	INT HM DOOR & FRAME W/	11.00	EA	492.49			5417.39			
X-3JA@CA	INT HM DOOR & FRAME W/	11.00	EA	0.53				5.83		
		total			1105.06	1105.06	5417.39	5.83		6528.28
08.11.0		total			1105.06	1105.06	46368.81	5.83		47479.70
08.11										
08.12										
08.12.0										
X-1JKSBE	SWING ENTRANCE 3-0/7-0	1.00	EA	149.44	149.44	149.44				
X-1JKSBK	SWING ENTRANCE 6-0X7-0	3.00	EA	182.88	548.64	548.64				
X-2JKSBE	SWING ENTRANCE 3-0/7-0	1.00	EA	330.00			330.00			
X-2JKSBK	SWING ENTRANCE 6-0X7-0	3.00	EA	574.20			1722.60			
		total			698.08	698.08	2052.60			2750.68
08.12.0		total			698.08	698.08	48421.41			49119.49
08.12										
08.52										
08.52.0										
X-1JLHDI.C	WINDOW D/H AL EXTRUDED	4.00	EA	24.00	96.00	96.00				
X-2JLHDI.C	WINDOW D/H AL EXTRUDED	4.00	EA	102.00			408.00			
		total			96.00	96.00	408.00			504.00
08.52.0		total			96.00	96.00	48829.41			48925.41
08.52										
08.71										
08.71.0										
X-1JPBIQ	LOCKSET SERIES 1000 GR 2	11.00	EA	15.20	167.20	167.20				
X-1JQF-I.K	EXIT DEVICE TYPE 1 626	2.00	EA	16.00	32.00	32.00				
X-2JPBIQ	LOCKSET SERIES 1000 GR 2	11.00	EA	95.00			1045.00			
X-2JQF-I.K	EXIT DEVICE TYPE 1 626	2.00	EA	290.00			580.00			
		total			199.20	199.20	1625.00			1824.20
08.71.0		total			199.20	199.20	50454.41			50653.61
08.71										
08	DIVISION VIII	total			2098.34	2098.34	9502.99	5.83		11607.16

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36

Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
09	DIVISION IX									
09.11										
09.11.0										
X-1KAPWH.E	LATH MET DIAMOND EXPAND	138.88	SY	1.81	251.38	251.38				
X-2KAPWH.E	LATH MET DIAMOND EXPAND	138.88	SY	2.30			319.43			
09.11.0		total			251.38	251.38	319.43			570.81
09.11		total			251.38	251.38	50773.84			51025.22
09.15										
09.15.0										
X-1KBCFC	KEENES CEM PLASTER LIME	138.88	SY	5.73	795.79	795.79				
X-1KBXE	PLASTER SCRATCH COAT FOR	138.88	SY	2.10	291.65	291.65				
X-2KBCFC	KEENES CEM PLASTER LIME	138.88	SY	2.48			344.43			
X-2KBXE	PLASTER SCRATCH COAT FOR	138.88	SY	0.87			120.83			
09.15.0		total			1087.45	1087.45	465.25			1552.70
09.15		total			1087.45	1087.45	51239.10			52326.54
09.31										
09.31.0										
X-1KEMYO	CERAMIC TILE FLOOR	518.93	SF	1.40	726.50	726.50				
X-2KEMYO	CERAMIC TILE FLOOR	518.93	SF	2.01			1043.05			
09.31.0		total			726.50	726.50	1043.05			1769.54
09.31		total			726.50	726.50	52282.14			53008.64
09.50										
09.50.0										
X-1KIJCR.O	ACOUST PANEL FOR EXPOSED	1851.39	SF	0.21	388.79	388.79				
X-1KJEBI.F	SUSP SYS (ACST)CONCEALED	1851.39	SF	0.25	462.85	462.85				
X-2KIJCR.O	ACOUST PANEL FOR EXPOSED	1851.39	SF	0.35			647.99			
X-2KJEBI.F	SUSP SYS (ACST)CONCEALED	1851.39	SF	0.37			685.01			
X-3KIJCR.O	ACOUST PANEL FOR EXPOSED	1851.39	SF	0.04				74.06		
X-3KJEBI.F	SUSP SYS (ACST)CONCEALED	1851.39	SF	0.04				74.06		
09.50.0		total			851.64	851.64	1333.00	148.11		2332.75
09.50		total			851.64	851.64	53615.14	148.11		54614.89
09.65										
09.65.0										

Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
X-1KL1	CLEAN AND WAX FLOORS	1855.59	SF	0.05	92.78	92.78				
X-2KL1	CLEAN AND WAX FLOORS	1855.59	SF	0.10			185.56			
	total				92.78	92.78	185.56			278.34
09.65.0										
	total				92.78	92.78	53800.70			53893.48
09.65										
09.66										
09.66.1										
X-1KLUR	VINYL COMPOSITION TILE	1855.59	SF	0.27	501.01	501.01				
X-2KLUR	VINYL COMPOSITION TILE	1855.59	SF	0.75			1391.69			
	total				501.01	501.01	1391.69			1892.70
09.66.1										
	total				501.01	501.01	55192.39			55693.40
09.66										
09.91										
09.91.0										
X-1KU$BB.0	PAINT CEILING STUCCO SF	2041.39	SF	0.03	61.24	61.24				
X-1KU$BB.1	PAINT WALLS CMU	24355.88	SF	0.28	6819.65	6819.65				
X-1KU$E	PAINT DOORS METAL (1)	238.97	SF	0.26	62.13	62.13				
X-2KU$BB.0	PAINT CEILING STUCCO SF	2041.39	SF	0.12			244.97			
X-2KU$BB.1	PAINT WALLS CMU	24355.88	SF	0.20			4871.17			
X-2KU$E	PAINT DOORS METAL (1)	238.97	SF	0.17			40.63			
X-3KU$BB.1	PAINT WALLS CMU	24355.88	SF	0.01				243.56		
X-3KU$E	PAINT DOORS METAL (1)	238.97	SF	0.01				2.39		
	total				6943.02	6943.02	5156.77	245.95		12345.74
09.91.0										
	total				6943.02	6943.02	60349.16	245.95		67538.13
09.91										
	total				*******	10453.77	9894.75	394.06		20742.58
09	DIVISION IX									

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Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
10	DIVISION X									
10.20										
10.20.1										
X-1LCVIP.J	LOUVERS ALUM. ANODIZED	4.00	SF	4.45	17.80	17.80				
X-1LELII	LOUVERS DOOR FIXED 1" TK	8.00	EA	3.36	26.88	26.88				
X-2LCVIP.J	LOUVERS ALUM. ANODIZED	4.00	SF	19.43			77.72			
X-2LELII	LOUVERS DOOR FIXED 1" TK	8.00	EA	39.33			314.64			
X-3LCVIP.J	LOUVERS ALUM. ANODIZED	4.00	SF	8.25				33.00		
X-3LELII	LOUVERS DOOR FIXED 1" TK	8.00	EA	0.55				4.40		
10.20.1		total			44.68	44.68	392.36	37.40		474.44
10.20		total			44.68	44.68	60741.52	37.40		60823.60
10.40										
10.40.0										
X-1LMZOS	ROOM SIGN 2" HIGH PLAST	1.00	EA	8.48	8.48	8.48				
X-2LMZOS	ROOM SIGN 2" HIGH PLAST	1.00	EA	15.75			15.75			
X-3LMZOS	ROOM SIGN 2" HIGH PLAST	1.00	EA	1.40				1.40		
10.40.0		total			8.48	8.48	15.75	1.40		25.63
10.40		total			8.48	8.48	60757.27	1.40		60767.15
10	DIVISION X	total			53.16	53.16	408.11	38.80		500.07

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Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
12	DIVISION XII									
12.51										
12.51.0										
X-1NFY	VENETIAN BLINDS TYPE I	71.11	SF	0.27	19.20	19.20				
X-2NFY	VENETIAN BLINDS TYPE I	71.11	SF	3.78			268.80			
X-3NFY	VENETIAN BLINDS TYPE I	71.11	SF	0.04				2.84		
12.51.0		total			19.20	19.20	268.80	2.84		290.85
12.51		total			19.20	19.20	61026.07	2.84		61048.12
12	DIVISION XII	total			19.20	19.20	268.80	2.84		290.85

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Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
13	DIVISION XIII									
13.40										
13.40.0										
X-1LXXKC.B	LEAD WALL	691.52	SF	4.00	2766.08	2766.08				
X-1LXXKC.C	LEAD DOOR	1.00	SF	6.00	6.00	6.00				
X-1LXXKC.E	LEAD GLASS 12"X12"	1.00	EA	20.00	20.00	20.00				
X-1LXXKC.F	LEAD LOUVER 24"X24"	1.00	EA	80.00	80.00	80.00				
X-2LXXKC.B	LEAD WALL	691.52	SF	16.00			11064.32			
X-2LXXKC.C	LEAD DOOR	1.00	SF	24.00			24.00			
X-2LXXKC.E	LEAD GLASS 24"X24"	1.00	EA	80.00			80.00			
X-2LXXKC.F	LEAD LOUVER 24"X24"	1.00	EA	100.00			100.00			
		total			2872.08	2872.08	11268.32			14140.40
13.40.0		total			2872.08	2872.08	72294.39			75166.47
13.40		total			2872.08	2872.08	11268.32			14140.40
13	DIVISION XIII									

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Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
15	DIVISION XV									
15.06										
15.06.0										
X-1SJ#AB	ROUGH-IN FOR FLOOR MTD	2.00	EA	120.86	241.72	241.72				
X-1SJ#CA	ROUGH-IN FOR WALL MTD	1.00	EA	127.30	127.30	127.30				
X-1SJ#DA	ROUGH-IN FOR SERVICE	3.00	EA	176.76	530.28	530.28				
X-1SJKRA	URINAL CARRIER,SINGLE WA	1.00	EA	23.24	23.24	23.24				
X-2SJ#AB	ROUGH-IN FOR FLOOR MTD	2.00	EA	126.68			253.36			
X-2SJ#CA	ROUGH-IN FOR WALL MTD	1.00	EA	174.40			174.40			
X-2SJ#DA	ROUGH-IN FOR SERVICE	3.00	EA	151.68			455.04			
X-2SJKRA	URINAL CARRIER,SINGLE WA	1.00	EA	42.48			42.48			
		total			922.54	922.54	925.28			1847.82
15.06.0		total			922.54	922.54	73219.67			74142.21
15.06										
15.44										
15.44.0										
X-1SJB	LAVATORY WALL HUNG 19"	2.00	EA	28.10	56.20	56.20				
X-1SJLK	URINAL, FLUSH VALVE,	1.00	EA	28.10	28.10	28.10				
X-1SJQ	KITCHEN SINK DBL COMP	3.00	EA	21.28	63.84	63.84				
X-1SKWWA	DELVGE SHOWER & EYE WASH	4.00	EA	114.94	459.76	459.76				
X-2SJB	LAVATORY WALL HUNG 19"	2.00	EA	210.72			421.44			
X-2SJLK	URINAL, FLUSH VALVE,	1.00	EA	181.31			181.31			
X-2SJQ	KITCHEN SINK DBL COMP	3.00	EA	176.62			529.86			
X-2SKWWA	DELVGE SHOWER & EYE WASH	4.00	EA	390.00			1560.00			
		total			607.90	607.90	2692.61			3300.51
15.44.0		total			607.90	607.90	75912.28			76520.18
15.44										
15	DIVISION XV	total			1530.44	1530.44	3617.89			5148.33

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odenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
.6	DIVISION XVI									
16.51										
16.51.0										
K-1ZA12D	2'X4' STL. SIDED SUR.	12.00	EA	13.98	167.76	167.76				
K-1ZA12E	2'X4' STL. SIDED SUR.	30.00	EA	13.98	419.40	419.40				
K-1ZA40A	INCAN. STEP LIGHT W/POLY	18.00	EA	13.98	251.64	251.64				
X-2ZA12D	2'X4' STL. SIDED SUR.	12.00	EA	71.21			854.52			
X-2ZA12E	2'X4' STL. SIDED SUR.	30.00	EA	56.77			1703.10			
X-2ZA40A	INCAN. STEP LIGHT W/POLY	18.00	EA	82.16			1478.88			
X-2ZA91C	LAMP 40W MED. BIPIN BASE	29.00	EA	4.54			131.66			
		total			838.80	838.80	4168.16			5006.96
16.51.0		total			838.80	838.80	80080.44			80919.24
16.51		total			838.80	838.80	4168.16			5006.96
16	DIVISION XVI	total			838.80	838.80	4168.16			
	TOTAL OF CHAPTERS				*******	54228.09	80080.44	5103.87		139412.40

Codenumber	Description	Amount Quant.	Unit	Mh/cost per unit	Man-hours	Amounts Labour	Materials	Equipment	Sub-contr.	Totals
	LABOR & MATERIAL COST		$							139412.40
	TAXES & INSURANCE	20.00	%	MUST BE CALCULATED 6% MAT 39% LABOR PT&I						27882.48
	SUB TOTAL L&M T&I COST		$							167294.88
	OVERHEAD	15.00	%							25094.23
	SUB TOTAL		$							192389.12
	PROFIT	10.00	%							19238.91
	SUB TOTAL		$							
	BOND	1.00	%							1923.89
	ESTIMATED CONSTRUCT. BID COST		$							213551.92
	ESCALATION & SPECIAL COND.	10.00	%							21355.19
	SUB TOTAL		$							234907.11
	S & A	10.00	%							23490.71
	CONTIGENCY	10.00	%							23490.71
	C.C.E.		$							281888.53

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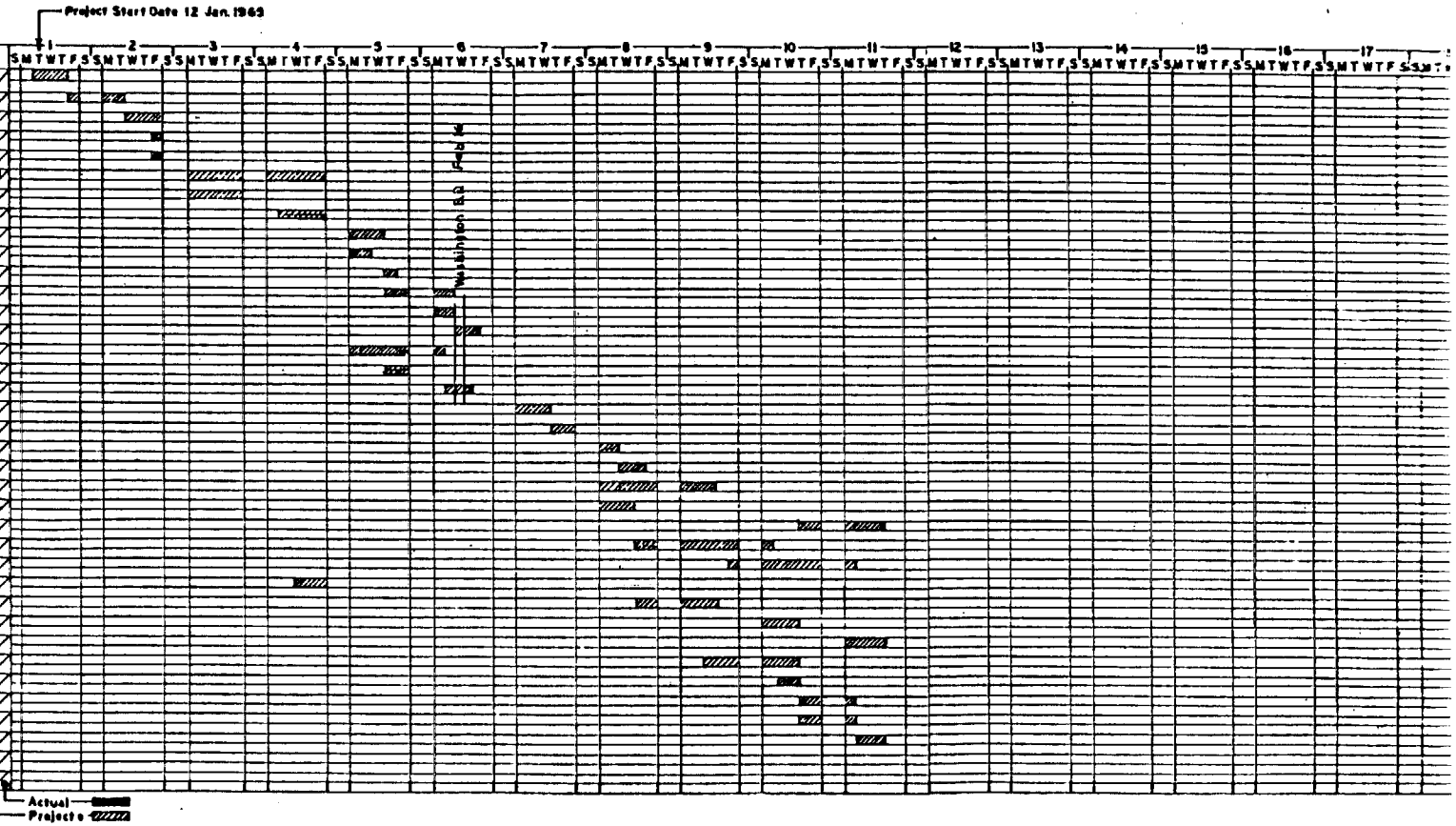
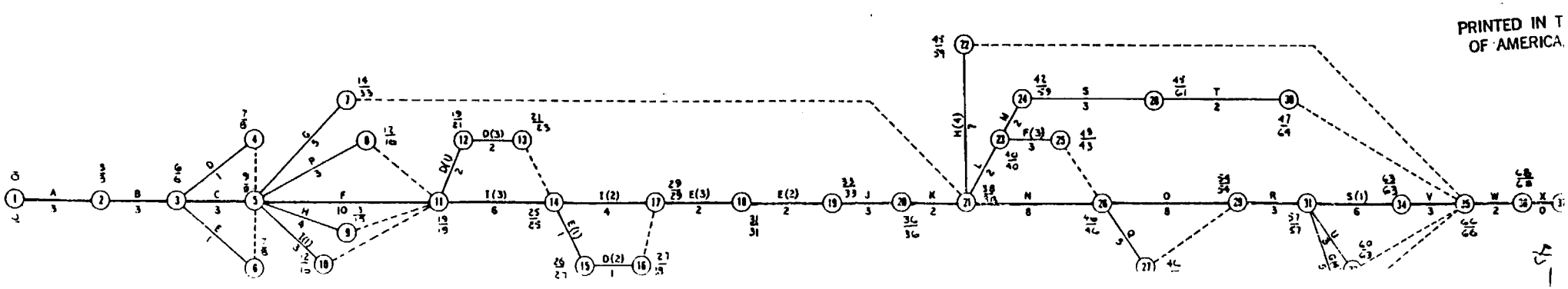
Components' Laboratory
N.A.S.A. Merritt Island Launch Area
Merritt Island, Florida
Project, Number 165

Project Start Date 12 Jan. 1965

DESCRIPTION	Code	Quantity	% Comp.
Mobilization & Layout	A	48 MH	
Building Fill	B	500 Cy	
Footing Excavation	C	90 Cy	
Footings, Reinf. Steel	D	6 Ton	
Footings Concrete	E	20 Cy	
Walls, CMU-LB	F(3)	8"-5600 Ea.	
Plumbing Rough-In	G	13 Fix	
Electrical Rough-In	H	200 LF	
Forms-Columns	I 1	1100 SFCA	
Reinf. Steel Columns	D(1)	1.1 Ton	
Concrete Columns	E(1)	15 Cy 1	
Forms-Beams	I(2)	1600 SFCA	
Reinf. Steel Beams	D(2)	1 Ton	
Concrete Beams	E(2)	25 Cy 1	
Forms Wall	I(3)	2500 SFCA	
Reinf. Steel Wall	D(3)	1 Ton	
Concrete Wall	E(3)	30 Cy 1	
Structural Steel B.J.	J	4 Ton	
Roof-Deck, Gypsum	K	4100 SF	
Roofing Built-up	L	4100 SF	
Sheet Metal	M	500 LF	
Concrete Floor Slab	N	70 Cy	
Int Partitions, CMU NLB	F(3)	6"-2000 Ea	
Fixtures, Plumbing	G(4)	13 Fix.	
H.V.A.C. EQ & Duct	O	20 Ton	
Elect Lt-Motor-Conduit	H(4)	100 Fix	
Door Frames (LB)	P	20 Ea	
Lathe & Plaster	Q	1400 SF	
Ceramic Tile	R	700 SF	
Painting Exterior	S	5000 SF	
Painting Interior	S(1)	12,000 SF	
Caulking	T	2000 LF	
Acoustical Tile	U	1700 SF	
V.A.T. (Floor Tile)	V	1800 SF	
Clean up & Inspection	W	24 MH	
Completion	X		



PLANNING & SCHEDULING CHART PROJECT-165



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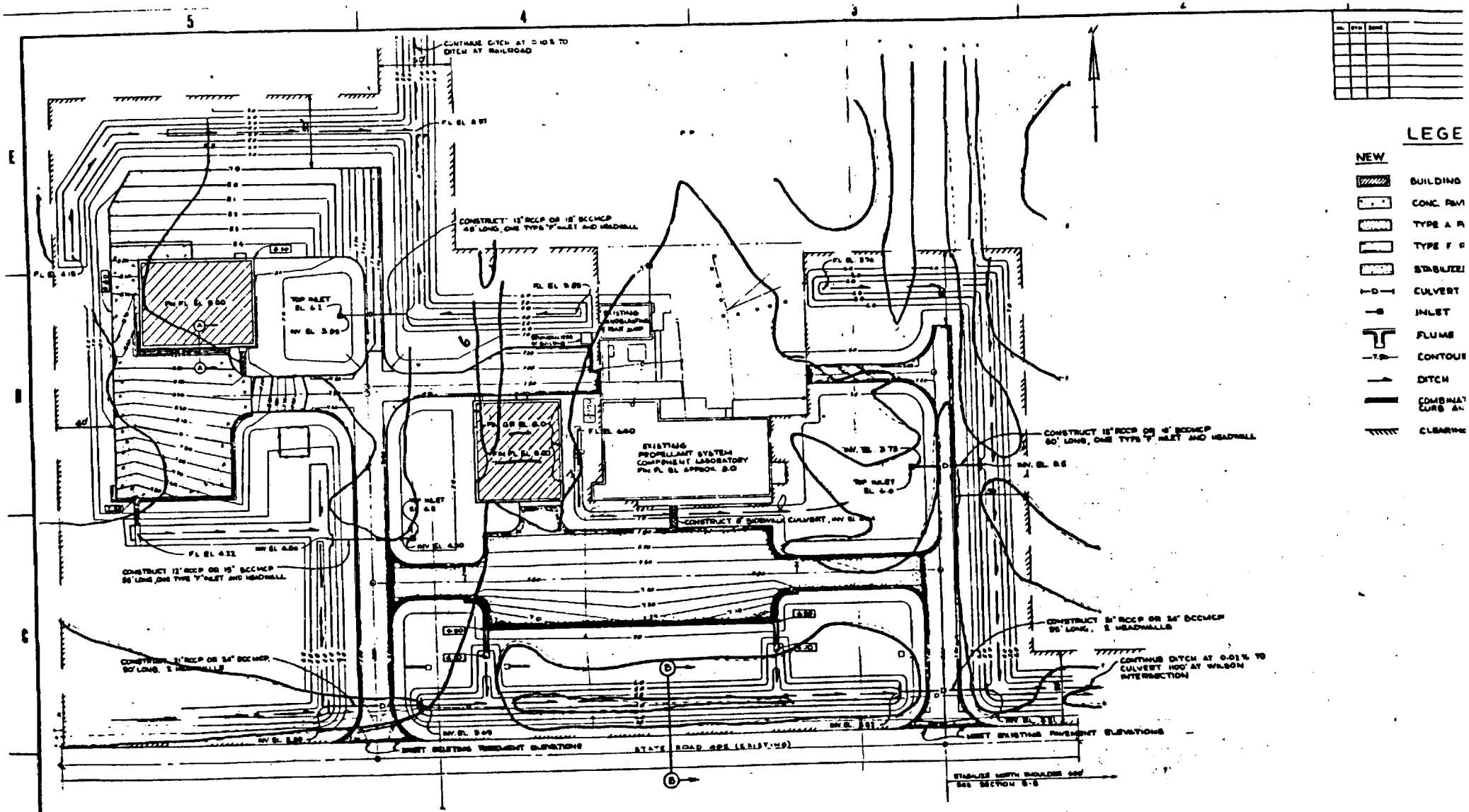
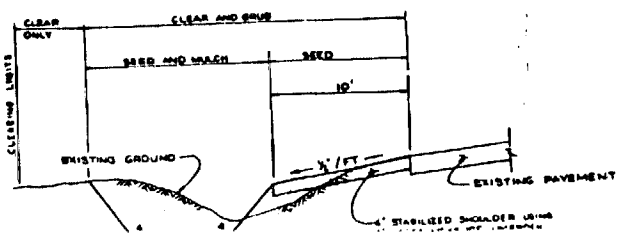
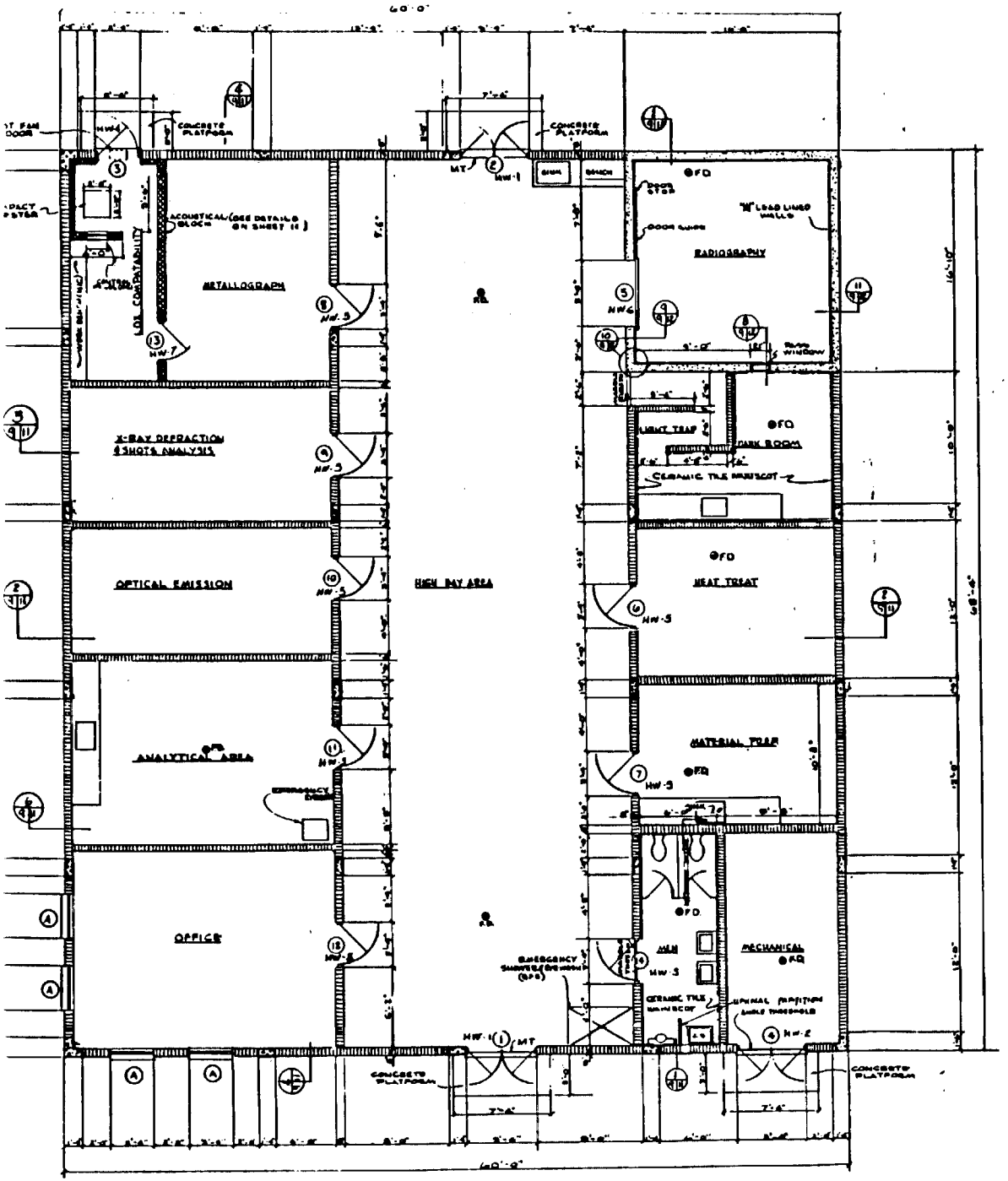


PAVING & GRADING

SCALE 1"=50'





FLOOR PLAN
SCALE 1/4"=1'-0"

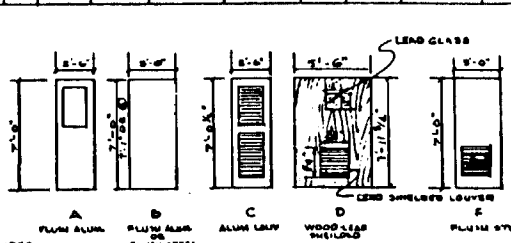
ROOM FINISH SCHEDULE

ROOM	FLOOR: CONC. SEALED W/HARDENER	FLOOR: VINYL ASBESTOS TILE	FLOOR: CERAMIC TILE	BASE: WOOD	BASE: VINYL OR RUBBER	BASE: CERAMIC TILE	BASE: NONE	WAINSCOT: CERAMIC TILE 5'-0"	WALLS: LEAD SHIELDING	WALLS: EXTEND 6" SOUND BASE ABOVE CEILING	WALLS: CONCRETE MASONRY UNIT	WALLS: PORTLAND CEMENT PLASTER	CEILINGS: SUPER ACOUSTICAL TILE	CEILINGS: SUPER PORTLAND CEMENT PLASTER	CEILINGS: LINOFESTOS-OF-BOARD DECK	HEIGHT	REMARKS: EXTEND WALLS TO U.S. OF SOUND DECK	REMARKS: EXTENSIONS TO ...
OFFICE		O			O						O		O			9'-6"		
ANALYTICAL AREA		O					O				O		O			9'-6"		
OPTICAL EMISSION		O					O				O		O			9'-6"		
X-RAY DEF. & SHOTS ANAL.		O					O				O		O			9'-6"		
LOK COMPATABILITY		O					O			O	O		O			9'-6"		SEE SPECIAL FOR ACOUSTICAL TREATMENT
METALLOGRAPH		O					O			O	O		O			9'-6"		
HIGH BAY AREA	O						O				O				O	30'-0"	O	
RADIOGRAPHY		O		O					O				O			12'-0"	O	SEE SHIELDING DETAILS
LIGHT TRAP			O			O		O	O		O	O	O			9'-0"		CERAMIC TILE ...
DARK ROOM			O			O		O	O			O	O			9'-0"		
HEAT TREAT		O					O				O				O		O	
MATERIAL PREP.		O					O				O		O			9'-0"		
MEN			O			O		O	O			O			O	9'-0"		
MECHANICAL	O						O				O				O			

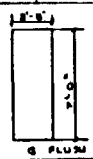
NOTE: SEE SHEET 13 FOR DOOR DETAILS

DOOR SCHEDULE

DOOR NO.	DOOR SIZE: WIDTH	DOOR SIZE: HEIGHT	DOOR SIZE: THICKNESS	MATERIAL: DOOR	MATERIAL: FRAME	FRAME DETAIL TYPES: HEAD	FRAME DETAIL TYPES: JAMB	FRAME DETAIL TYPES: SILL	DOOR TYPES	THRESHOLD	GLAZING
1, 2-PR.	2'-6"	7'-0"	1 3/8"	ALUM.	ALUM.	1	1	1	A	INTERLOCKING	1/8"-3/8"
3	3'-0"	7'-1"	1 3/8"	ALUM.	ALUM.	1	3	3	B	MIDDLE TYPE	NONE
4-PR.	2'-6"	7'-0 5/8"	1 3/8"	ALUM.	ALUM.	1	1	4	C	ANGLE	NONE
5	3'-0"	7'-10 5/8"	2 3/8"	WOOD (LEAD SHIELDED)	WOOD (LEAD SHIELDED)	SEE DETAILS		SHT. 12	D	SPECIAL SHT. 12	1/8"-3/8" LEAD
6	3'-0"	7'-0"	1 3/4"	STEEL	STEEL	2	2	2	E	NONE	NONE
7 THRU 12	3'-0"	7'-0"	1 3/4"	STEEL	STEEL	2	2	2	F	NONE	NONE
13	2'-6"	7'-0"	1 3/4"	STEEL	STEEL	2	6	6	G	NONE	NONE
14	3'-0"	7'-0"	1 3/8"	STEEL	STEEL	2	2A	2A	F	MARBLE	NONE



DOOR TYPES
SCALE 1/4"=1'-0"



DETAIL NUMBER OR ABBT. IDENTIFICATION
NO. OF SHT ON WHICH DET. OR SECT. IS TAKEN
NO. OF SHT ON WHICH DET. OR SECT. IS DRAWN

GROSS AREA - 4,120 SQ FT

GRAPHIC SCALE

NATIONAL AER... AND SPACE ADM... JOHN F. KENNEDY ...

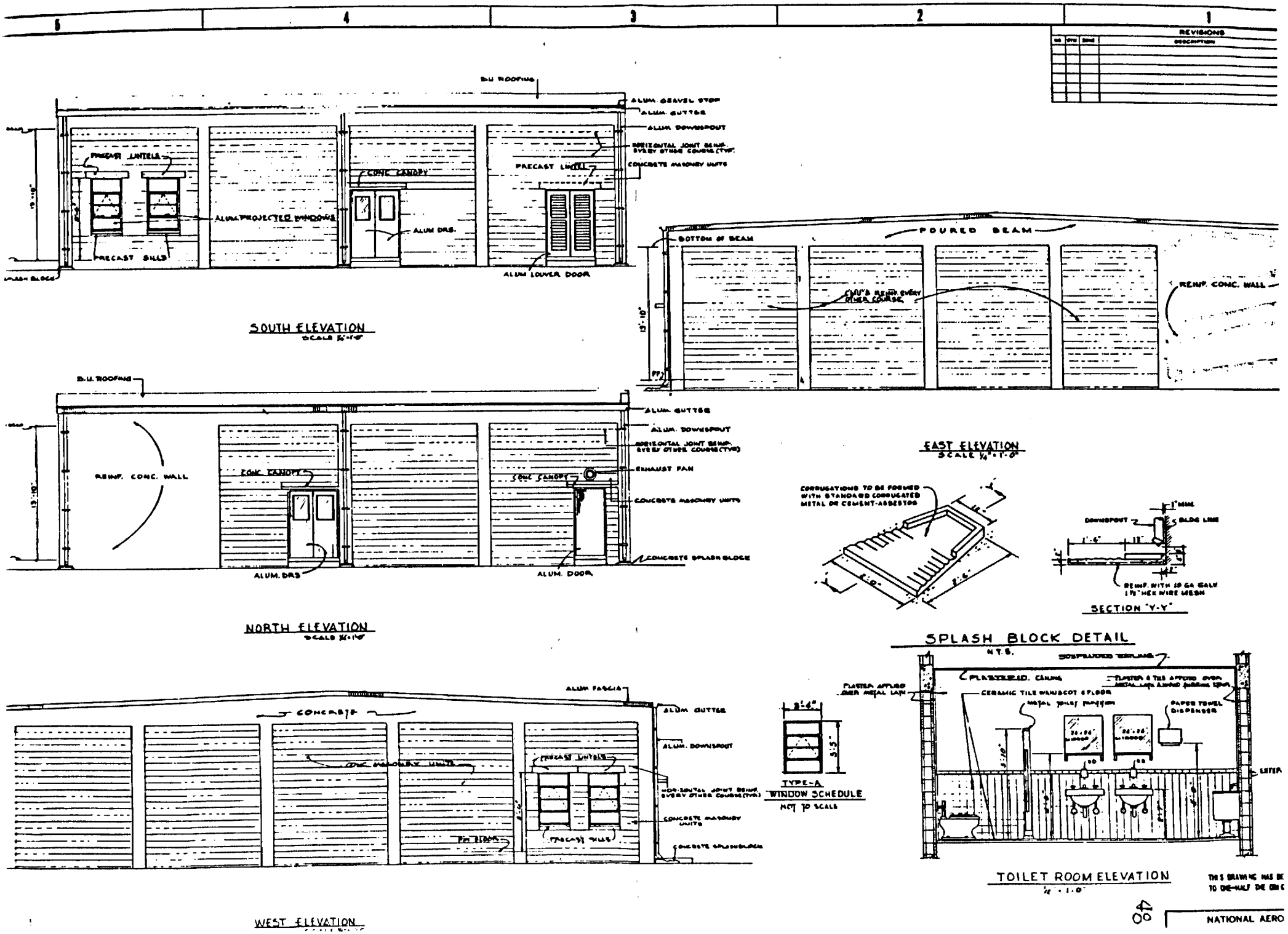
U. S. ARMY ENGINEER DI... CORPS OF E... MERRITT ISLAN...

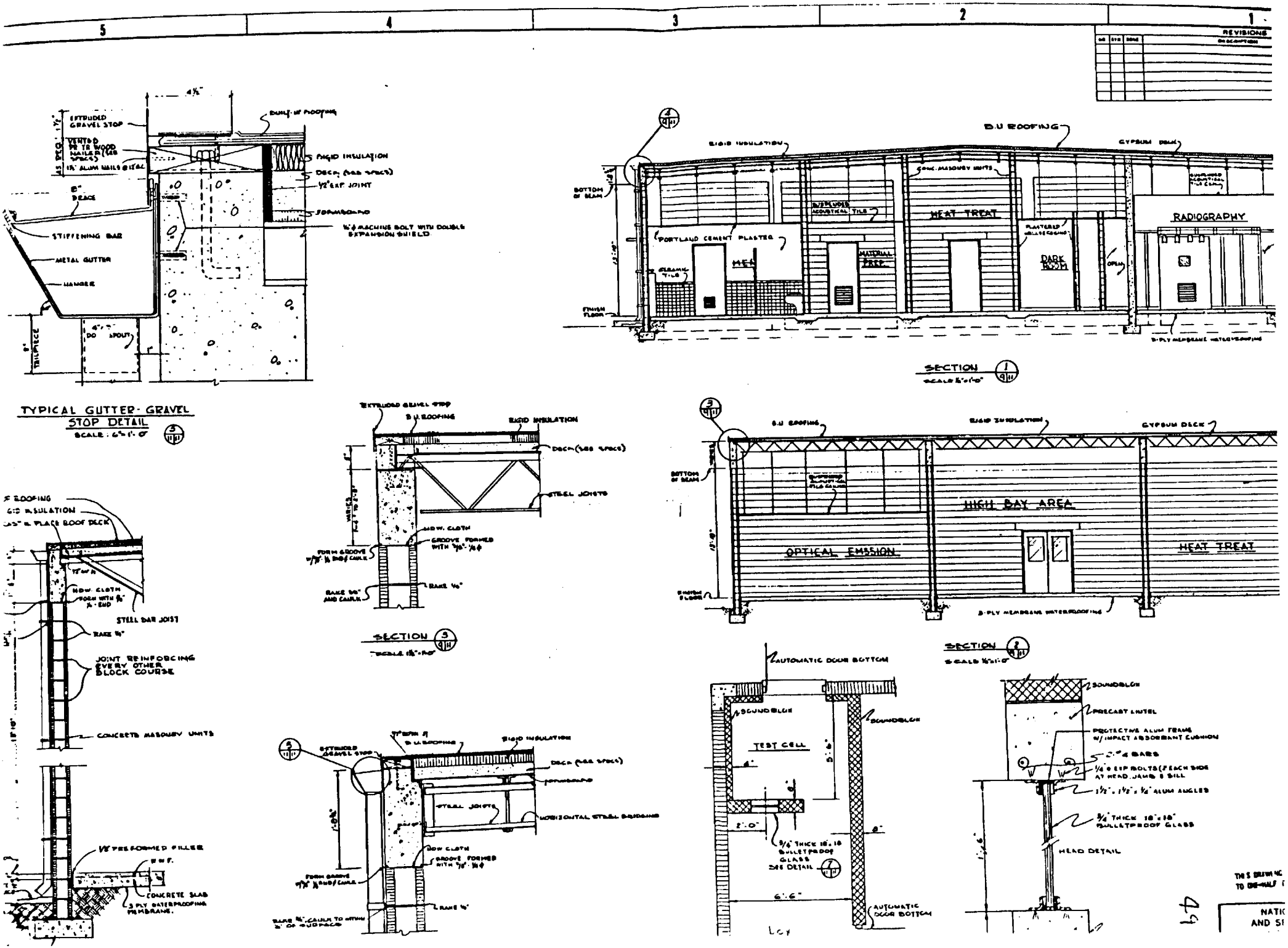
NASA MERRITT ISLAN... MERRITT ISLAN...

ADDITION TO PROPEL... COMPONENTS ...
FLOOR PLAN-FINISH SCHE...
ARCHITECT

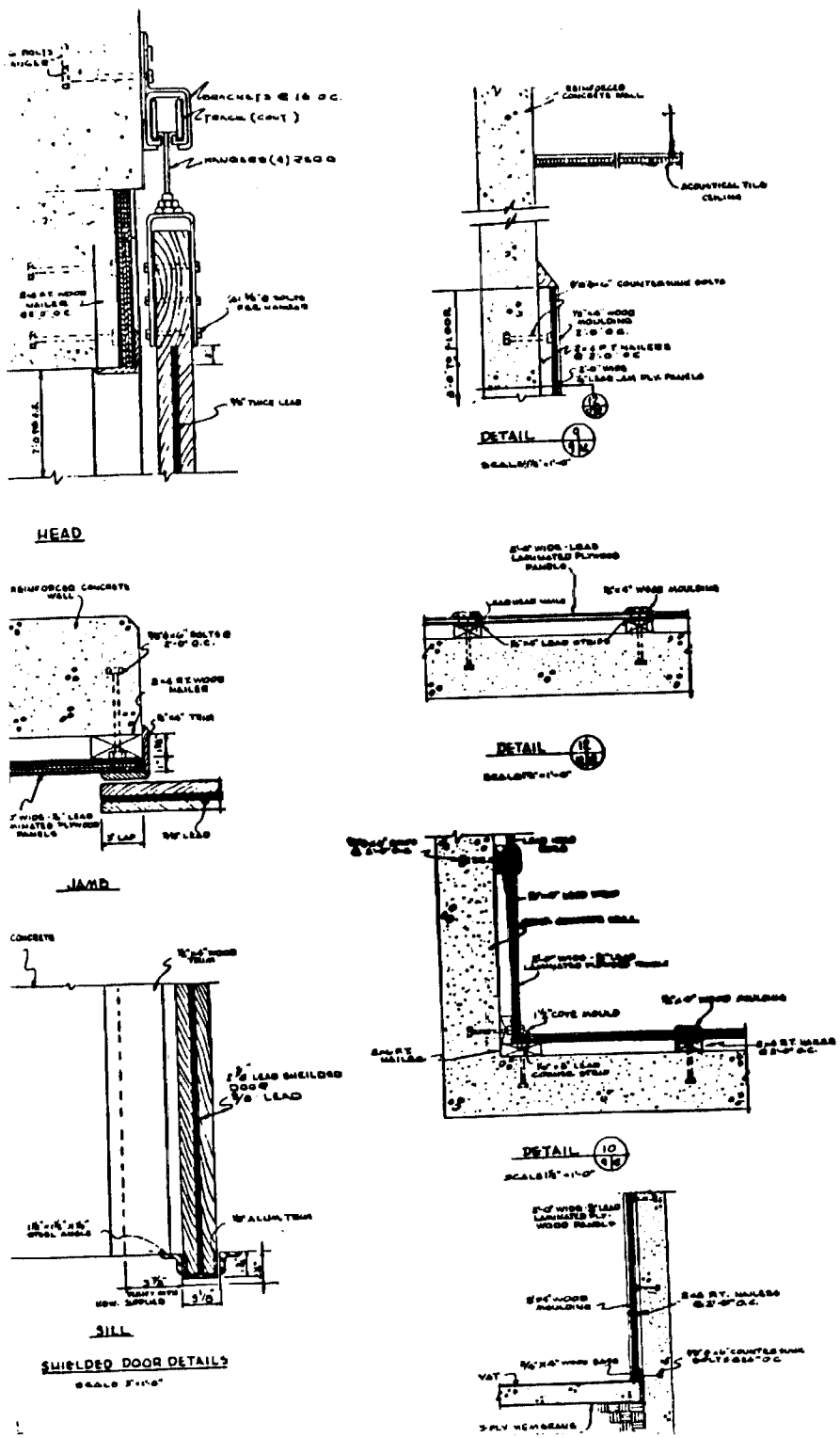
A-1

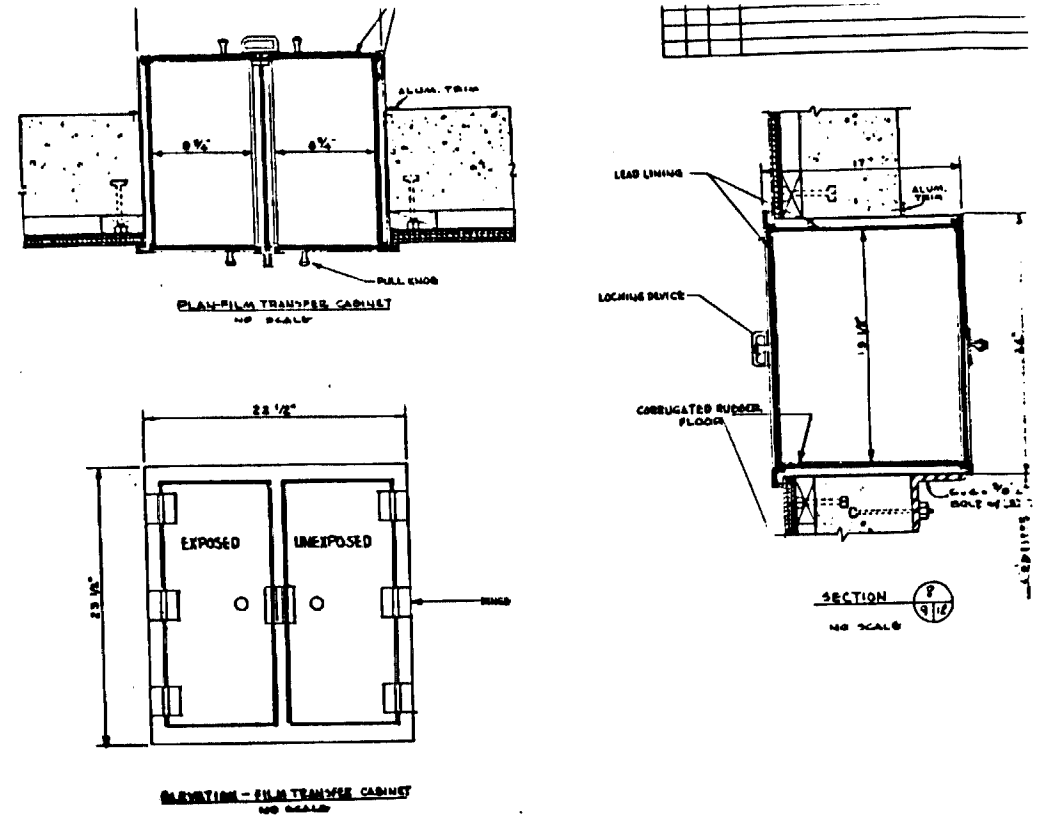
47

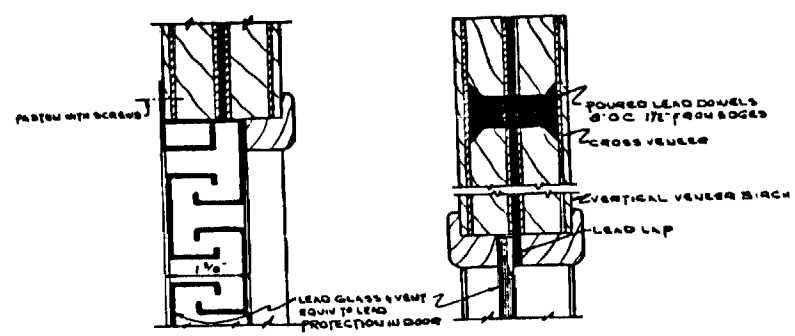

5
4
3
2
1
REVISIONS
DESCRIPTION
B.U. ROOFING
ALUM. GRAVEL STOP
ALUM. GUTTER
ALUM. DOWNSPOUT
HORIZONTAL JOINT REINF. EVERY OTHER COURSE (TYP.)
CONCRETE MASONRY UNITS
PRECAST LINTELS
CONC. CANOPY
PRECAST LINTEL
ALUM. PROJECTED WINDOWS
ALUM. DRS.
PRECAST SILLS
ALUM. LOUVER DOOR
SPLASH BLOCK
SOUTH ELEVATION
SCALE 1/4"=1'-0"
POURED BEAM
BOTTOM OF BEAM
CMU'S REINF. EVERY OTHER COURSE
REINF. CONC. WALL
13'-10"
EAST ELEVATION
SCALE 1/4"=1'-0"
B.U. ROOFING
ALUM. GUTTER
ALUM. DOWNSPOUT
HORIZONTAL JOINT REINF. EVERY OTHER COURSE (TYP.)
EXHAUST FAN
REINF. CONC. WALL
CONC. CANOPY
CONC. CANOPY
CONCRETE MASONRY UNITS
CONCRETE SPLASH BLOCK
ALUM. DRS
ALUM. DOOR
NORTH ELEVATION
SCALE 1/4"=1'-0"
CORRUGATIONS TO BE FORMED WITH STANDARD CORRUGATED METAL OR CEMENT-ASBESTOS
DOWNSPOUT
BLDG LINE
REINF. WITH 10 GA GALV. 1 1/2" HEX WIRE MESH
SECTION "Y-Y"
SPLASH BLOCK DETAIL
N.T.S.
ALUM. FASCIA
CONCRETE
ALUM. GUTTER
ALUM. DOWNSPOUT
CONC. MASONRY UNITS
PRECAST LINTELS
HORIZONTAL JOINT REINF. EVERY OTHER COURSE (TYP.)
CONCRETE MASONRY UNITS
PRECAST SILLS
CONCRETE SPLASHBLOCK
WEST ELEVATION
TYPE-A
WINDOW SCHEDULE
NOT TO SCALE
PLASTERED CEILING
PLASTER APPLIED OVER METAL LATH
CERAMIC TILE WAINSCOT & FLOOR
METAL TOILET PARTITION
PAPER TOWEL DISPENSER
ENTER
TOILET ROOM ELEVATION
1/2"=1'-0"
THIS DRAWING HAS BE
TO ONE-HALF THE ORIG
NATIONAL AERO



5
4
3
2
1
REVISIONS
EXTRUDED GRAVEL STOP
BUILT-UP ROOFING
RIGID INSULATION
DECK (SEE SPECS)
1/2" EXP. JOINT
FORMBOARD
STIFFENING BAR
METAL GUTTER
HANGER
TRIPLE PIECE
TYPICAL GUTTER-GRAVEL STOP DETAIL
SCALE: 6"=1'-0"
B.U. ROOFING
RIGID INSULATION
GYPSUM DECK
CONC. MASONRY UNITS
BOTTOM OF BEAM
SUSPENDED ACOUSTICAL TILE
HEAT TREAT
RADIOGRAPHY
PORTLAND CEMENT PLASTER
MATERIAL PREP.
DARK ROOM
OPEN
FINISH FLOOR
3-PLY MEMBRANE WATERPROOFING
SECTION 1
SCALE 1/8"=1'-0"
EXTRUDED GRAVEL STOP
B.U. ROOFING
RIGID INSULATION
DECK (SEE SPECS)
STEEL JOISTS
HDW. CLOTH
GROOVE FORMED WITH 3/8"-1/4 ϕ
FORM GROOVE
RAKE 1/4"
SECTION 3
SCALE 1 1/2"=1'-0"
B.U. ROOFING
RIGID INSULATION
GYPSUM DECK
BOTTOM OF BEAM
HIGH BAY AREA
OPTICAL EMISSION
HEAT TREAT
FINISH FLOOR
3-PLY MEMBRANE WATERPROOFING
SECTION 2
SCALE 1/8"=1'-0"
STEEL BAR JOIST
RAKE 1/4"
JOINT REINFORCING EVERY OTHER BLOCK COURSE
CONCRETE MASONRY UNITS
1/8" PREFORMED FILLER
CONCRETE SLAB
3 PLY WATERPROOFING MEMBRANE.
EXTRUDED GRAVEL STOP
B.U. ROOFING
RIGID INSULATION
DECK (SEE SPECS)
FORMBOARD
STEEL JOISTS
HORIZONTAL STEEL BRIDGING
HDW. CLOTH
GROOVE FORMED WITH 3/8"-1/4 ϕ
FORM GROOVE
RAKE 1/4"
AUTOMATIC DOOR BOTTOM
SOUNDBLOX
TEST CELL
2'-0"
6'-6"
3/4" THICK 18"x18" BULLETPROOF GLASS SEE DETAIL
AUTOMATIC DOOR BOTTOM
SOUNDBLOX
PRECAST LINTEL
PROTECTIVE ALUM FRAME W/ IMPACT ABSORBANT CUSHION
1/4" ϕ EXP BOLTS (2 EACH SIDE AT HEAD, JAMB & SILL
1 1/2" x 1 1/2" x 1/4" ALUM ANGLES
3/4" THICK 18"x18" BULLETPROOF GLASS
HEAD DETAIL
49
NATIO
AND SI







LEAD SHIELDED DOOR DETAILS

FULL SCALE

THIS DRAWING HAS BEEN
TO ONE-HALF THE ORIGIN

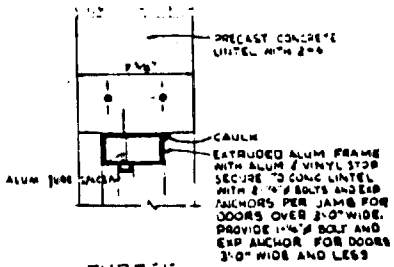
NATIONAL A
AND SPACE A
JOHN F. KENNED

U. S. ARMY ENGINEER
CORPS OF
NEWPORT IN

NASA MERRITT IS
MERRITT IS

ADDITION TO PRO
COMPONENTS

50



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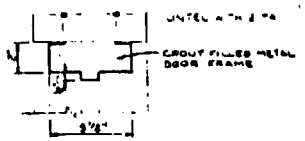

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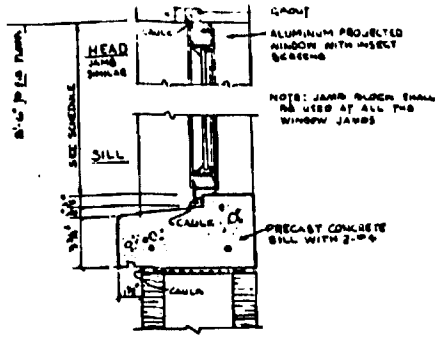
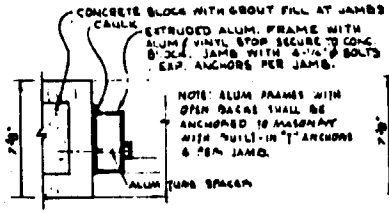


PROJECTED WINDOW DETAIL



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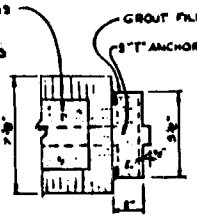

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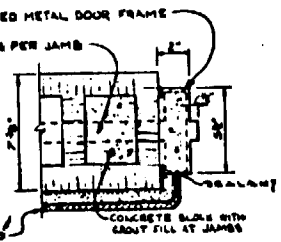

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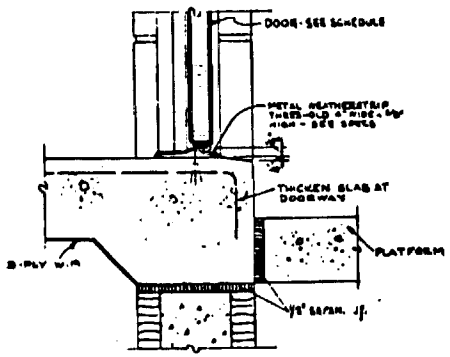

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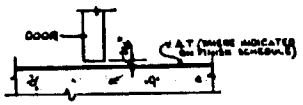

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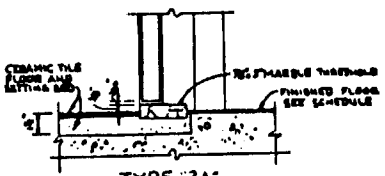

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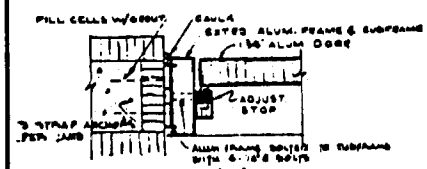
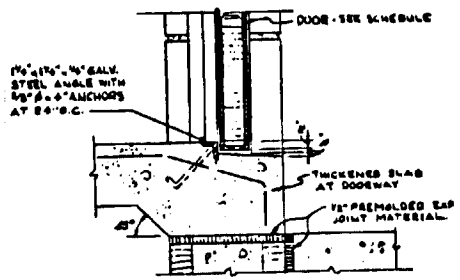
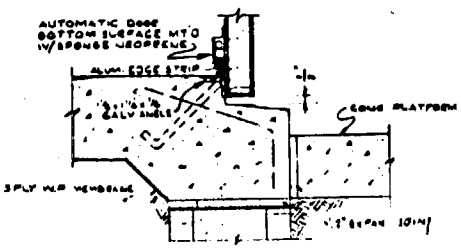


JAMB - TYPE "5"

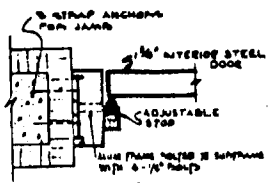


TYPE "4"

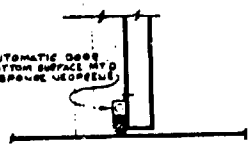


SILL - TYPE "5"

DOOR DETAILS

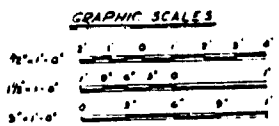


JAMB - TYPE "6"

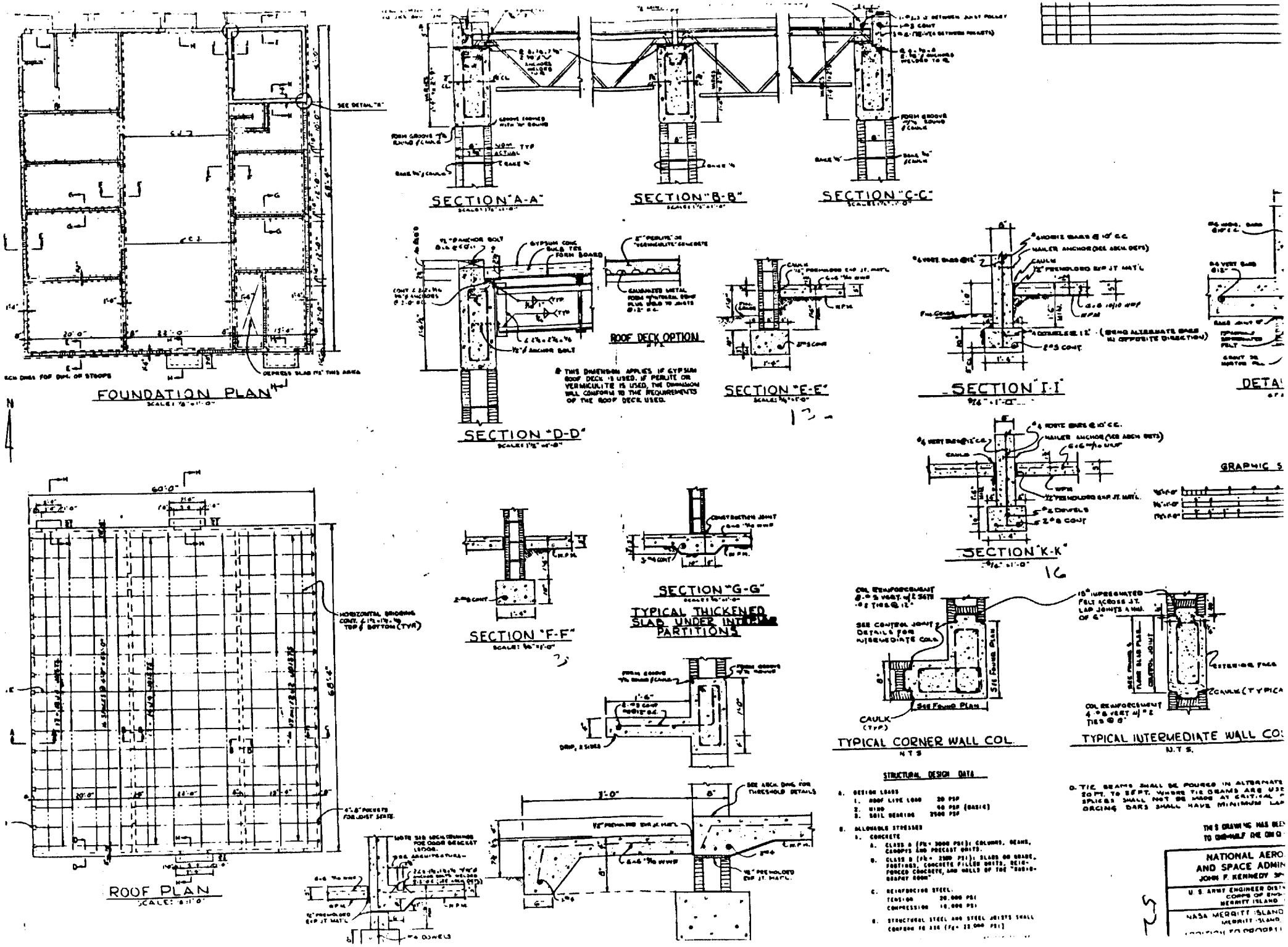


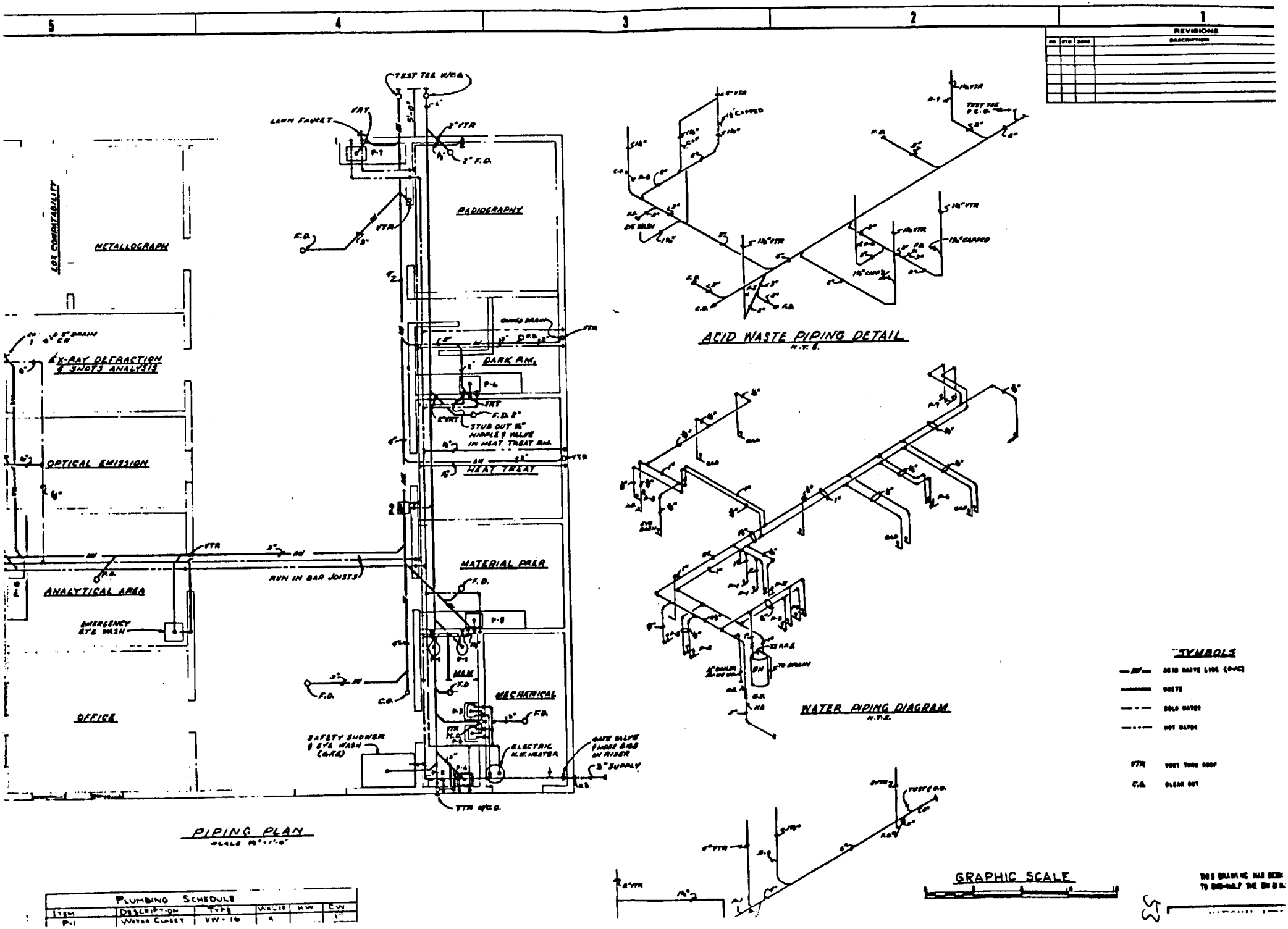
SILL - TYPE "6"

GRAPHIC SCALES

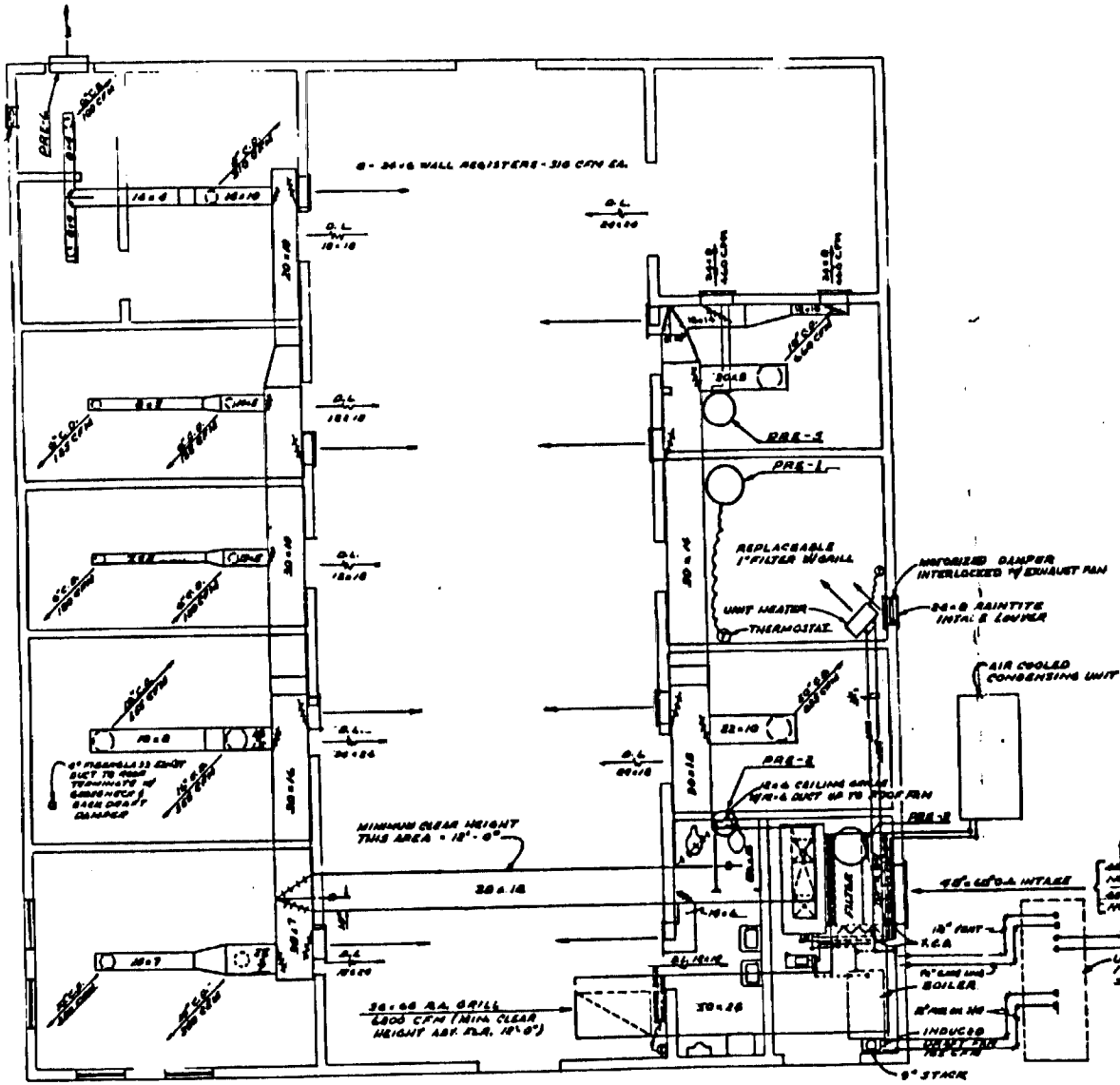


A-5


FOUNDATION PLAN
SECTION "A-A"
SECTION "B-B"
SECTION "C-C"
SECTION "D-D"
ROOF DECK OPTION
SECTION "E-E"
SECTION "I-I"
SECTION "K-K"
SECTION "F-F"
SECTION "G-G"
TYPICAL THICKENED SLAB UNDER INTERIOR PARTITIONS
TYPICAL CORNER WALL COL.
N.T.S.
TYPICAL INTERMEDIATE WALL CO
N.T.S.
ROOF PLAN
STRUCTURAL DESIGN DATA
NATIONAL AERO
AND SPACE ADMIN
JOHN F. KENNEDY
U.S. ARMY ENGINEER DIST
CORPS OF ENG
MERRITT ISLAND
NASA MERRITT ISLAND
MERRITT ISLAND



5
4
3
2
1
REVISIONS
TEST TEE W/C.O.
LAWN FAUCET
VRT
2" VTR
2" F.D.
RADIOGRAPHY
METALLOGRAPH
LOX COMPATABILITY
X-RAY DEFRACTION & SHOTS ANALYSIS
DARK RM.
STUB OUT 1½" NIPPLE & VALVE IN HEAT TREAT RM.
HEAT TREAT
OPTICAL EMISSION
MATERIAL PREP
RUN IN BAR JOISTS
ANALYTICAL AREA
EMERGENCY EYE WASH
MECHANICAL
OFFICE
SAFETY SHOWER & EYE WASH (G.F.E.)
ELECTRIC H.W. HEATER
GATE VALVE & HOSE BIBB IN RISER
3" SUPPLY
VTR W/C.O.
PIPING PLAN
ACID WASTE PIPING DETAIL
N.T.S.
WATER PIPING DIAGRAM
N.T.S.
SYMBOLS
ACID WASTE LINE (PVC)
WASTE
COLD WATER
HOT WATER
VTR VENT THRU ROOF
C.O. CLEAN OUT
GRAPHIC SCALE
PLUMBING SCHEDULE
ITEM
DESCRIPTION
TYPE
WASTE
HW
CW
P-1
WATER CLOSET
VW-16
4
1"



AIR CONDITIONING PLAN
SCALE 1/4" = 1'-0"

AIR CONDITIONING DESIGN SCHEDULE		
OUTSIDE DESIGN CONDITIONS (SUMMER):	88 °F D.B. 680 88 °F W.B.	
OUTSIDE DESIGN CONDITIONS (WINTER):	20 °F D.B.	
INSIDE DESIGN CONDITIONS (SUMMER)	78 °F D.B. 50% 65% R.H.	
INSIDE DESIGN CONDITIONS (WINTER)	70 °F D.B.	
ROOM SENSIBLE COOLING LOAD BTU/HR		150,000
ROOM LATENT COOLING LOAD BTU/HR		8,250
OUTSIDE AIR COOLING LOAD BTU/HR		80,750
TOTAL COOLING LOAD BTU/HR		239,000

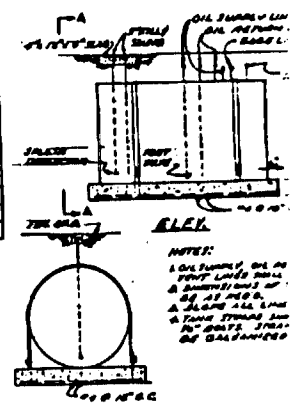
REFRIGERATION SYSTEM (CONDENSING UNIT)	
COMPRESSOR DATA	
CAPACITY TR	10.0
MOTOR HORSEPOWER (APPROX)	20
SATURATED SUCTION TEMP °F (MINIMUM)	40
SATURATED DISCHARGE TEMP °F (MAXIMUM)	100°F 0.1/1/1/1°F 0-30
CONDENSER DATA (AIR COOLED)	
AIR ON CONDENSER TEMP °F	95
CONDENSER FAN HORSEPOWER (APPROX)	5
CONDENSER CAPACITY (BTUH) DET	120,000
CAPACITY REDUCTION - 100%, 66 2/3%, 33 1/3%, OFF	

AIR HANDLING UNIT SCHEDULE	
TYPE UNIT VERTICAL DUAL THERMOSTAT	
OUTSIDE AIR CFM	800
RETURN AIR CFM	6,800
TOTAL AIR CFM	7,700
TOTAL STATIC PRESSURE, IN H_2O	1.00
FAN OUTLET VELOCITY FPM (MAXIMUM)	1,000
FAN MOTOR HP (APPROXIMATELY)	5
FILTER FACE VELOCITY (MAXIMUM)	500
AIR PRESSURE DROP - IN H_2O (DESIGN)	1.00
COOLING COIL DATA (DIRECT EXPANSION)	
COOLING COIL CAPACITY BTU/HR	120,000
AIR QUANTITY CFM	7,700
ENTERING AIR °F D.B. 80 °F W.B.	78/66
LEAVING AIR °F D.B. 50 °F W.B.	58/56.5
COIL FACE VELOCITY (MAXIMUM)	500
EVAPORATOR TEMPERATURE (MINIMUM) °F	50
AIR PRESSURE DROP - H_2O (DESIGN)	0.50
HEATING COIL DATA (HOT WATER)	
HEATING COIL CAPACITY	150,000
AIR QUANTITY CFM	7,700
ENTERING AIR TEMPERATURE °F	70.0
LEAVING AIR TEMPERATURE °F	88.5
COIL FACE AREA SQ. FT. (AS REQUIRED)	
HOT WATER GPM	15.0
HOT WATER ENTERING TEMP °F.	200
WATER PRESSURE DROP, FT. WATER (DESIGN)	5
AIR PRESSURE DROP IN H_2O (DESIGN)	0.51

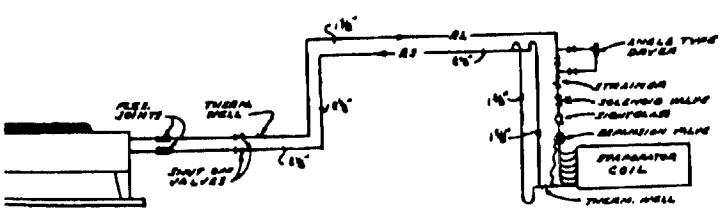
HEAT SA
OUTSIDE DESIGN TEMP.
INSIDE DESIGN TEMP.
TOTAL HEAT LOAD
BOILER RATING
EXPANSION TANK CAPACITY
FUEL OIL TANK CAPACITY
FUEL OIL CONSUMPTION
INDUCED DRAFT FAN CAPACITY
INDUCED DRAFT FAN H.P.
HOT WATER CIRCULATOR - 1.5 GPM
HOT WATER CIRCULATOR MOTOR

UNIT
LOCATION
CAPA
CFM
H.P.
ADM

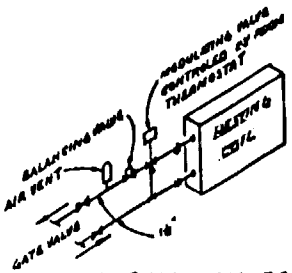
FORCED EXHAUST FAN SCHEDULE				
SYMBOL	LOCATION	CFM	S.P.	
PRE-1	HEAT TREAT	800	1/8	
PRE-2	MED'G ROOM	100	1/8	
PRE-3	MECHANICAL	500	1/8	
PRE-6	DARK ROOM	200	1/8	
PRE-8	LOW COMPATABILITY	100	1/8	



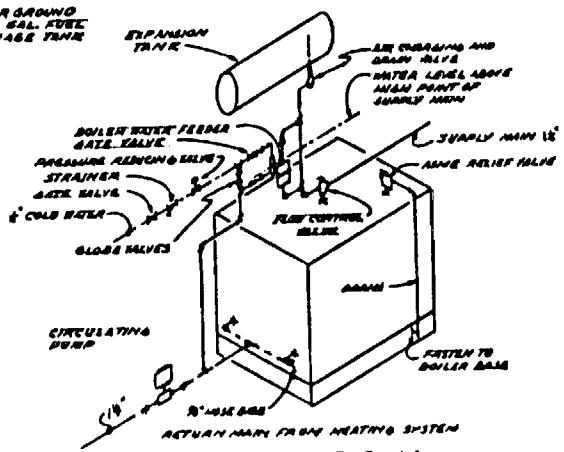
FUEL OIL TANK DETAIL
NO SCALE



REFRIGERANT PIPING SCHEMATIC
N.T.S.



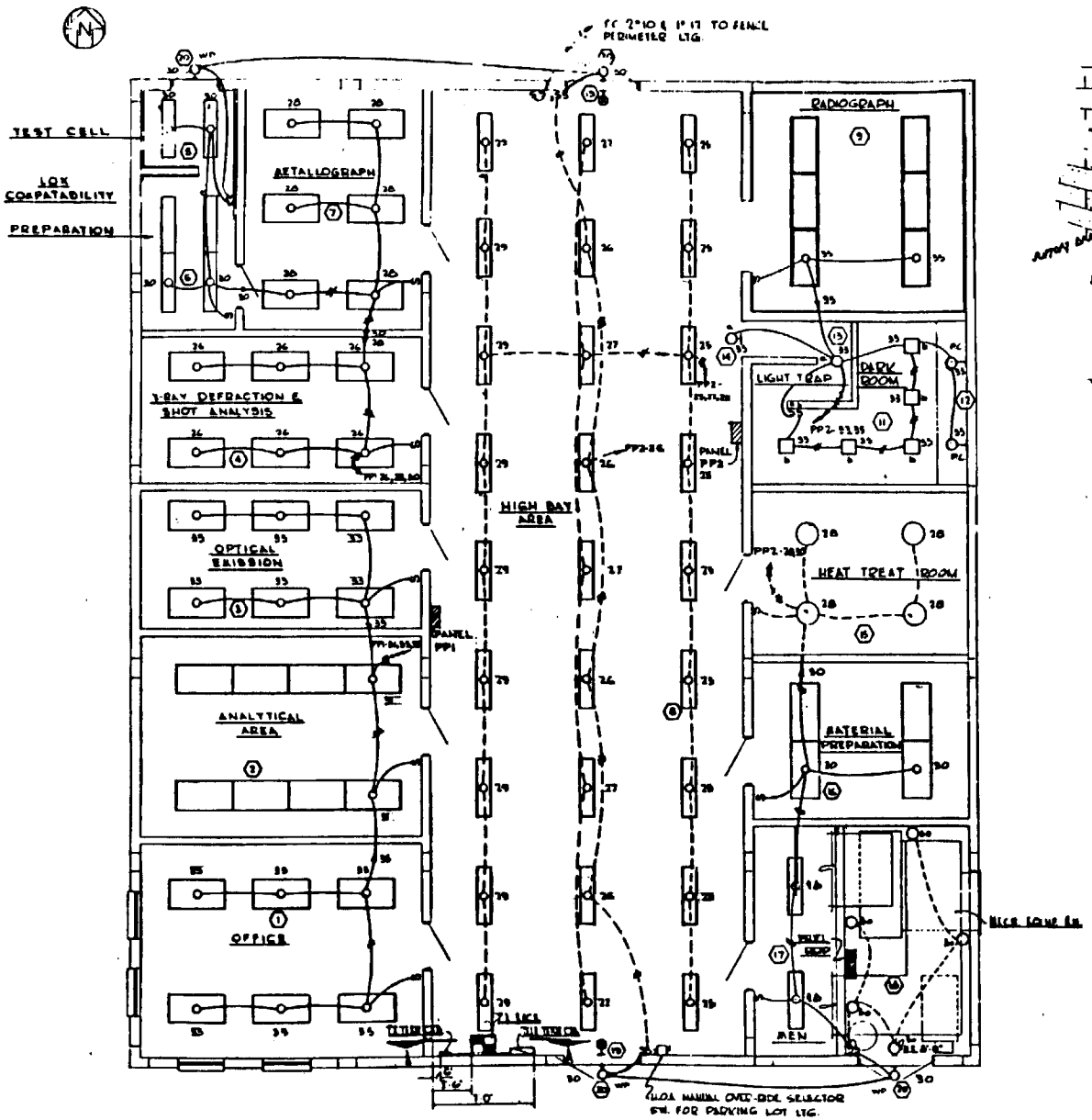
HEATING COIL DETAIL
N.T.S.



BOILER PIPING
N.T.S.

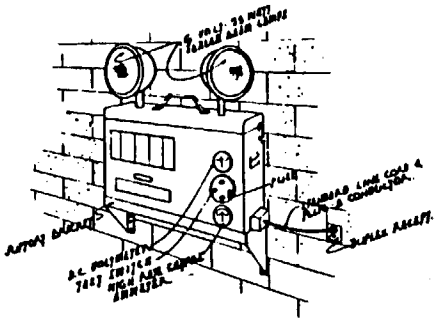
M-4

NATIONAL A
AND SPACE A
JOHN F. KENNED
U. S. ARMY ENGINEER
CORPS OF
MERRITT IS
NASA MERRITT IS
MERRITT
ADDITION TO PRO
COMPONENTS
AIR CONDITIONI



COMPONENT LAB ADDITION - LIGHTING PLAN

SCALE: 1/4" = 1'-0"

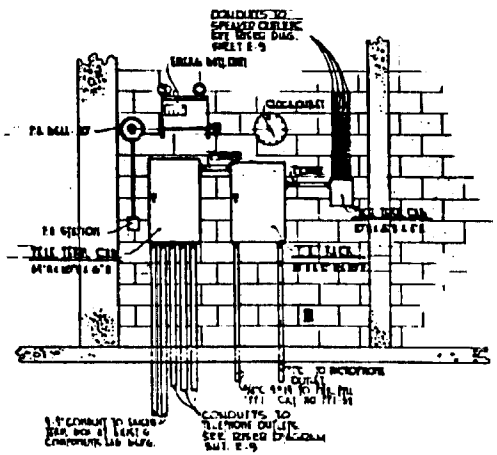


DETAIL - PORTABLE BATTERY OPERATED EMERGENCY LIGHT

NOT TO SCALE

ITEM NO	LOCATION	ROOM NO	TYPE FIXTURE	LAMPS & WATTAGE	MOUNTING
	COMPONENT LAB				
1	OFFICE		FA 440	4-40W	CEILING-FLUSH
2	ANALYTICAL AREA		FA-440	4-40W	CEILING-FLUSH
3	OPTICAL EMISSION		FA-340	3-40W	CEILING-FLUSH
4	X-RAY DEF & SHOT AN		FA 340	3-40W	CEILING-FLUSH
5	LOX COMP. T. CELL		F-20-2	2-40W	CEILING-FLUSH
6	LOX COMP. PREP		F-20-2	2-40W	CEILING-FLUSH
7	METALLOGRAPH		FA 440	4-40W	CEILING FLUSH
8	HIGH BAY AREA		F-9	4-40W	PENDANT-12' A.F.F.
9	RADIOGRAPHY		FA-440	4-40W	CEILING-FLUSH
10	CONTROL RM		F-20-2	2-40W	CEILING-FLUSH
11	DARK ROOM		FL-18	150W	CEILING-FLUSH
12	DARK ROOM		DR-1	1-25W	WALL BRACKET 7' A.F.F.
13	LIGHT TRAP		LR	1-60W	CEILING
14	DARK RM INTERLOCK		LR	1-25W	WALL 8' A.F.F.
15	HEAT TREAT RM		V-8	1-300W	SURFACE
16	MATERIAL PREP		FA-440	4-40W	CEILING-FLUSH
17	MENS ROOM		F-9	2-40W	SURFACE
18	MECHANICAL RM		VG-1	1-150W	BRACKET - 7'-0" A.F.F.
19	EXITS		X-105	2-25W	SURFACE - WALL
20	ENTRANCES		VG-3	1-100W	WALL BRACKET
	TRAILER CLEAN				
21	OFFICE		FA-440	4-40W	CEILING-FLUSH
22	TOILETS		F-9	2-40W	SURFACE
23	STORAGE RM		F-14	2-40W	SURFACE
24	WORK AREA		F-9	4-40W	PENDANT-16' A.F.F.

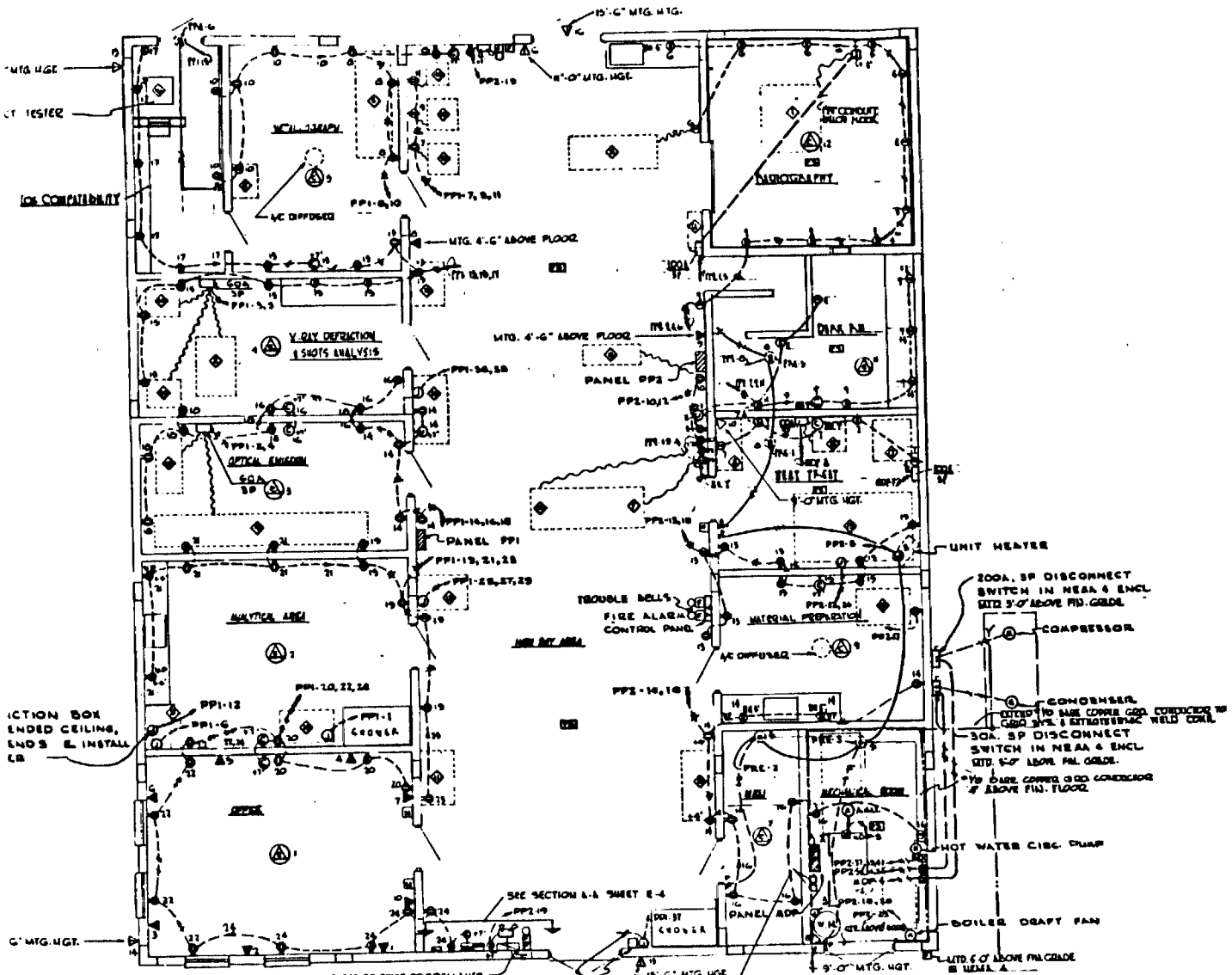
* NOTE:
MOUNTING HT. SHOWN SHALL BE TYPICAL UNLESS OTHERWISE NO



SECTION "A-A"

NOT TO SCALE

SCHE

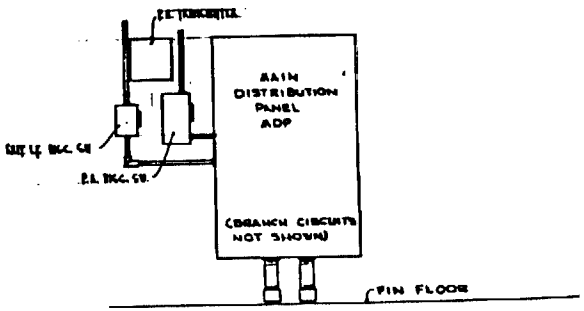


COMPONENT LAB ADDITION - POWER PLAN

SCALE: 1/8" = 1'-0"

G.F.E. SCHEDULE

ITEM	VOLTAGE	PHASE	DESCRIPTION
	208	1	X-RAY
	208	1	X-RAY POWER UNITS
	208	1	X-RAY DIFFRACTION & FLUORESCENCE
	208	1	X-RAY DIFFRACTION & FLUORESCENCE POWER UNITS
	120	1	METALLOGRAPH
	120	1	CUTOFF
	120	1	SANDER
	120	1	GRINDER
	120	1	POLISHER
	120	1	HARDNESS TESTER
	120	1	IMPACT TESTER
	120	1	TENSILE TESTER
	120	1	MICROSCOPES
	120	1	HOOD
	120	1	LEAK DETECTOR
	120	1	ULTRASONIC FLAW DETECTOR
	208	1	OPTICAL EMISSION SPECTOGRAPH
	208	1	OPTICAL EMISSION SPECTOGRAPH
	120	1	CARBON & SULFUR DETERMINATION
	208	3	HOT-COLD CHAMBER
	120	1	LOX COMPATABILITY TESTING
	208	3	HEAT TREAT FURNACE
	208	3	HEAT TREAT FURNACE
	208	1	SALT SPRAY CABINET
	208	1	MAGNETIC PARTICLE INSPECTION
	120	1	FLUORESCENT DYE PENETRANT INSPECTION
	120	1	STRAIN GAGE



ELEVATION A-A

SCALE: NONE

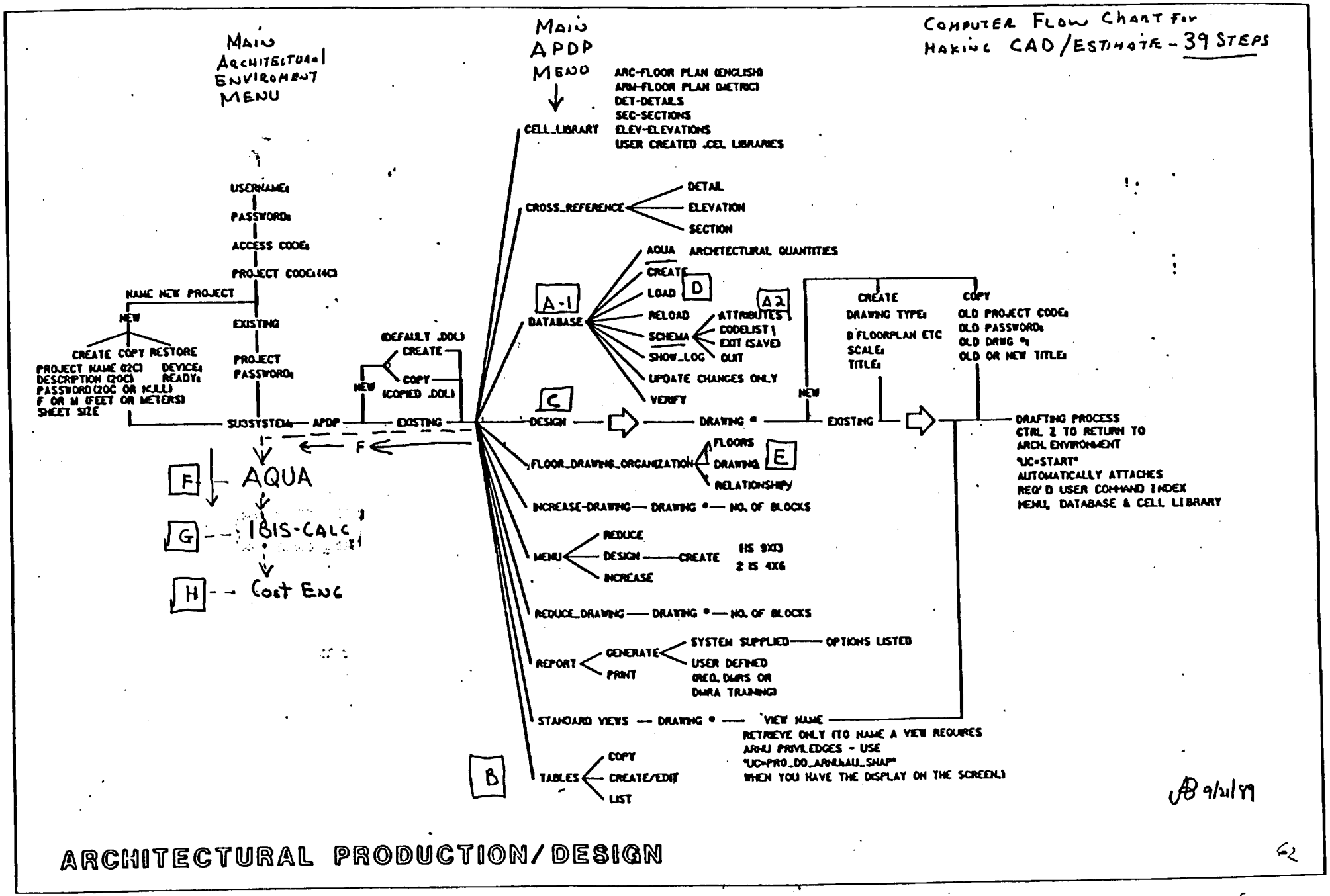
SCHEDULE "B"

NATIONAL AERONA AND SPACE ADMINIS JOHN F. KENNEDY SPACE

NASA MERRITT ISLAND LA MERRITT ISLAND, F

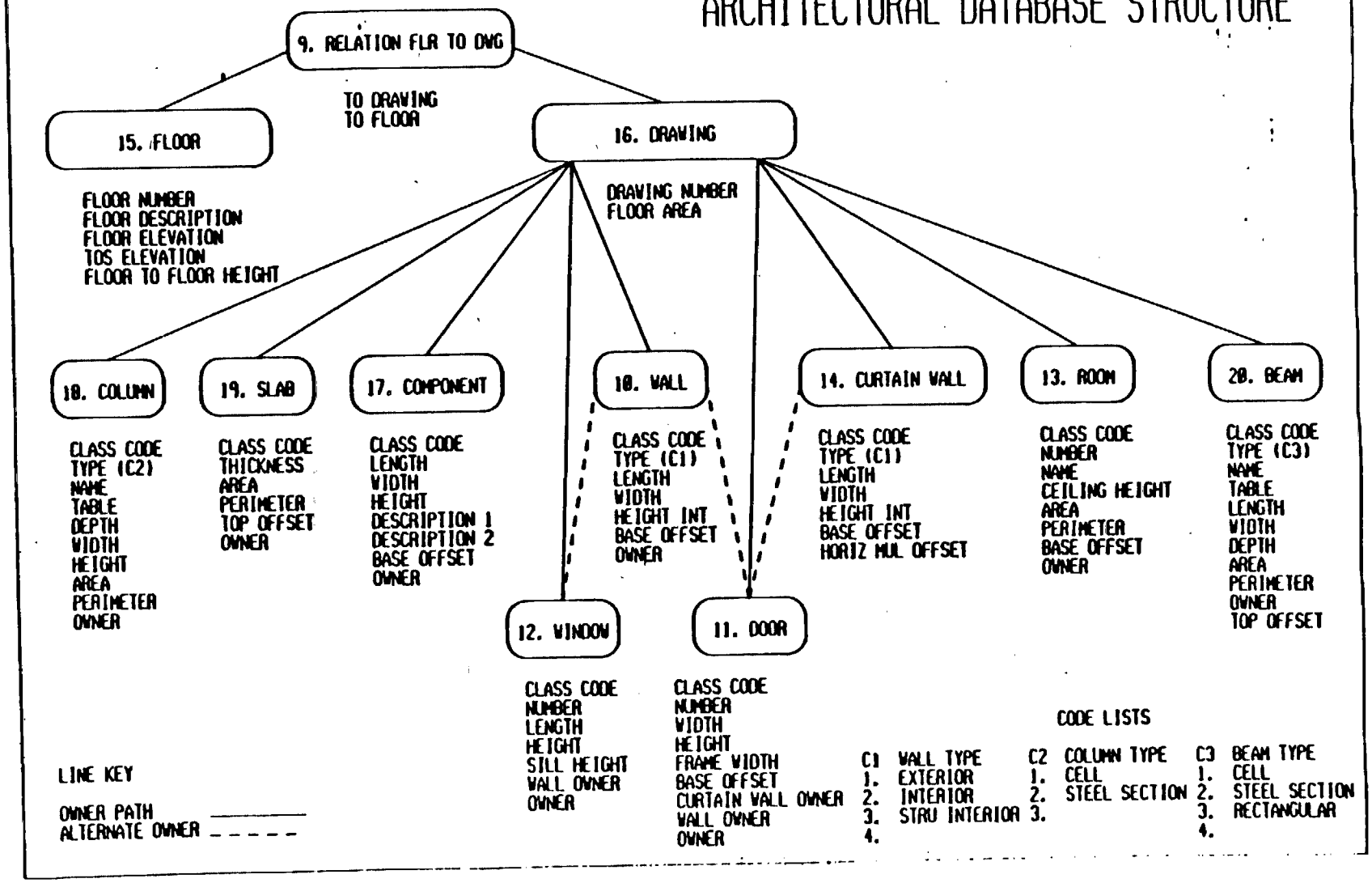
PROP SYS COMPON COMPONENTS LAB POWER PL

E-3


COMPUTER FLOW CHART FOR MAKING CAD/ESTIMATE - 39 STEPS
MAIN ARCHITECTURAL ENVIROMENT MENU
MAIN APDP MENU
USERNAME:
PASSWORD:
ACCESS CODE:
PROJECT CODE:(4C)
NAME NEW PROJECT
NEW
EXISTING
CREATE COPY RESTORE
PROJECT NAME (2C)
DESCRIPTION (20C)
PASSWORD (20C OR NULL)
F OR M (FEET OR METERS)
SHEET SIZE
DEVICE:
READY:
PROJECT PASSWORD:
SUBSYSTEM: APDP
(DEFAULT .DOL)
CREATE
COPY
(COPIED .DOL)
NEW
EXISTING
F
AQUA
IBIS-CALC
Cost Enc
CELL_LIBRARY
ARC-FLOOR PLAN (ENGLISH)
ARM-FLOOR PLAN (METRIC)
DET-DETAILS
SEC-SECTIONS
ELEV-ELEVATIONS
USER CREATED .CEL LIBRARIES
CROSS_REFERENCE
DETAIL
ELEVATION
SECTION
A-1
DATABASE
AQUA ARCHITECTURAL QUANTITIES
CREATE
LOAD
D
RELOAD
SCHEMA
A2
ATTRIBUTES
CODELIST
EXIT (SAVE)
SHOW_LOG
QUIT
UPDATE CHANGES ONLY
VERIFY
C
DESIGN
DRAWING *
NEW
EXISTING
CREATE
DRAWING TYPE:
D FLOORPLAN ETC
SCALE:
TITLE:
COPY
OLD PROJECT CODE:
OLD PASSWORD:
OLD DRWG #:
OLD OR NEW TITLE:
DRAFTING PROCESS
CTRL Z TO RETURN TO
ARCH. ENVIRONMENT
%C=START*
AUTOMATICALLY ATTACHES
REQ'D USER COMMAND INDEX
MENU, DATABASE & CELL LIBRARY
FLOOR_DRAWING_ORGANIZATION
FLOORS
DRAWING
E
RELATIONSHIPS
INCREASE-DRAWING — DRAWING * — NO. OF BLOCKS
MENU
REDUCE
DESIGN — CREATE
INCREASE
1 IS 9X13
2 IS 4X6
REDUCE_DRAWING — DRAWING * — NO. OF BLOCKS
REPORT
GENERATE
PRINT
SYSTEM SUPPLIED — OPTIONS LISTED
USER DEFINED
(REQ. DWRS OR
DWRA TRAINING)
STANDARD VIEWS — DRAWING * — VIEW NAME
RETRIEVE ONLY (TO NAME A VIEW REQUIRES
ARMU PRIVILEDGES - USE
%C=PRO_DO_ARMUAU_SNAP*
WHEN YOU HAVE THE DISPLAY ON THE SCREEN.)
B
TABLES
COPY
CREATE/EDIT
LIST
JB 9/21/89
ARCHITECTURAL PRODUCTION/DESIGN
62

57

ARCHITECTURAL DATABASE STRUCTURE



AQUA REFERENCE GUIDE FOR CLASS CODES/CORRELATION TABLE

TYPE	ELEMENT	Q - A	Q - B	Q - C	Q - D	Q - E
A	WALL	GROSS AREA	LENGTH	WIDTH	HEIGHT	---
M	CURTAIN WALL	GROSS AREA	LENGTH	WIDTH	HEIGHT	---
B	COLUMN	VOLUME	LENGTH	WIDTH	HEIGHT	PERIMETER
C	BEAM	VOLUME	LENGTH	WIDTH	HEIGHT	PERIMETER
D	SLAB	GROSS AREA	THICKN	PERIM	---	---
K	SLAB OPENING	--- AREA	THICKN	PERIM	---	---
E/F	DOOR F WINDOW	1	AREA	WIDTH	HEIGHT	SILL HGT
L	COMPONENT	1	LENGTH	WIDTH	AREA	---
G	FLOOR FINISHING	AREA	PERIM	HEIGHT	---	---
H	CEILING FINISH	AREA	PERIM	HEIGHT	---	---
J	WALL FINISHING	GROSS AREA	LENGTH	WIDTH	---	---
N	WALL FIN OPENING	--- AREA	LENGTH	HEIGHT	SILL HGT	TOTAL HGT

ARCHITECTURAL QUANTITIES REPORT FROM AQUA TO PSCL

LENGTH, WIDTH HEIGHT, AREAS, PERIMETER, EACH.

VARIES WITH EACH CLASS CODE

```
$
$ INTERGRAPH Architectural Quantities report on project :   PLOT
$ Created on : 21-MAR-89 at : 12:45:08 hrs
$
1|4|          |   |1          |   |A1.1  1     |   |          |   |
$|LOC_1 FLOOR_|LOC_2 FLOOR_|NR___|CLASSCODE___|_|AS_NR|AS_CLASSCODE|QUANTITY_A|QUAN_B__|QUAN_C__|QUAN_D__|QUAN_E__|USER_ FLOOR_|
$
$ WALL reporting
$ WALL   372 : invalid quantity A
A|          |          |  84|CONC8"      | | |          |  202.669|  16.000|   0.667|  12.667|          |          |
A|          |          |  84|CONC8"      | | |          |   -3.208|   1.750|   0.667|  -1.833|          |          |
A|          |          | 388|CONC8"      | | |          |  202.628|  15.997|   0.667|  12.667|          |          |
A|          |          | 392|CONC8"      | | |          |  202.667|  16.000|   0.667|  12.667|          |          |
$ WALL   398 : invalid quantity A
A|          |          |  89|MASON8EXT   | | |          |  642.778|  43.333|   0.667|  14.833|          |          |
A|          |          |  89|MASON8EXT   | | |          |  -24.167|   3.333|   0.667|  -7.250|          |          |
A|          |          |  89|MASON8EXT   | | |          |  -40.611|   5.667|   0.667|  -7.167|          |          |
A|          |          |  88|MASON8EXT   | | |          | 1003.722|  67.667|   0.667|  14.833|          |          |
A|          |          |  88|MASON8EXT   | | |          |  -17.778|   3.333|   0.667|  -5.333|          |          |
A|          |          |  88|MASON8EXT   | | |          |  -17.778|   3.333|   0.667|  -5.333|          |          |
A|          |          |  91|MASON8EXT   | | |          |  880.111|  59.333|   0.667|  14.833|          |          |
A|          |          |  91|MASON8EXT   | | |          |  -38.444|   5.333|   0.667|  -7.208|          |          |
A|          |          |  91|MASON8EXT   | | |          |  -38.222|   5.333|   0.667|  -7.167|          |          |
A|          |          |  91|MASON8EXT   | | |          |  -17.778|   3.333|   0.667|  -5.333|          |          |
A|          |          |  91|MASON8EXT   | | |          |  -17.778|   3.333|   0.667|  -5.333|          |          |
A|          |          | 124|MASON8EXT   | | |          |  766.389|  51.667|   0.667|  14.833|          |          |
A|          |          |  58|8"MAS/FOOT  | | |          |  653.625|  48.417|   0.667|  13.500|          |          |
A|          |          |  58|8"MAS/FOOT  | | |          |  -23.889|   3.333|   0.667|  -7.167|          |          |
A|          |          |  58|8"MAS/FOOT  | | |          |  -23.889|   3.333|   0.667|  -7.167|          |          |
A|          |          |  58|8"MAS/FOOT  | | |          |  -23.889|   3.333|   0.667|  -7.167|          |          |
A|          |          | 167|MASON6"     | | |          |  261.775|  20.666|   0.500|  12.667|          |          |
A|          |          | 165|MASON6"     | | |          |  261.775|  20.666|   0.500|  12.667|          |          |
A|          |          | 160|MASON6"     | | |          |  261.775|  20.666|   0.500|  12.667|          |          |
A|          |          | 156|MASON6"     | | |          |  259.664|  20.500|   0.500|  12.667|          |          |
A|          |          | 205|MASON6"     | | |          |   63.336|   5.000|   0.500|  12.667|          |          |
A|          |          | 214|MASON6"     | | |          |   62.275|   4.916|   0.500|  12.667|          |          |
A|          |          | 211|MASON6"     | | |          |   77.066|   6.084|   0.500|  12.667|          |          |
A|          |          | 219|MASON8"     | | |          |   50.667|   4.000|   0.667|  12.667|          |          |
A|          |          | 219|MASON8"     | | |          |   -2.250|   1.500|   0.667|  -1.500|          |          |
A|          |          |  40|MASON8"     | | |          |  202.669|  16.000|   0.667|  12.667|          |          |
A|          |          |  53|MASON8"     | | |          |  202.669|  16.000|   0.667|  12.667|          |          |
A|          |          |  54|MASON8"     | | |          |  202.669|  16.000|   0.667|  12.667|          |          |
A|          |          | 153|MASON8"     | | |          |  208.998|  16.500|   0.667|  12.667|          |          |
A|          |          | 170|8SOUNDBLOX  | | |          |  174.167|  17.417|   0.667|  10.000|          |          |
A|          |          | 170|8SOUNDBLOX  | | |          |  -20.306|   2.833|   0.667|  -7.167|          |          |
A|          |          | 184|SOUNDBLOX   | | |          |   53.393|   5.339|   0.333|  10.000|          |          |
A|          |          | 186|SOUNDBLOX   | | |          |   18.333|   1.833|   0.333|  10.000|          |          |
A|          |          | 402|8"MAS/FOOT  | | |          |  913.500|  67.667|   0.667|  13.500|          |          |
A|          |          | 402|8"MAS/FOOT  | | |          |  -21.000|   3.000|   0.667|  -7.000|          |          |
A|          |          | 402|8"MAS/FOOT  | | |          |  -21.000|   3.000|   0.667|  -7.000|          |          |
A|          |          | 402|8"MAS/FOOT  | | |          |  -21.000|   3.000|   0.667|  -7.000|          |          |
A|          |          | 402|8"MAS/FOOT  | | |          |  -21.000|   3.000|   0.667|  -7.000|          |          |
A|          |          | 402|8"MAS/FOOT  | | |          |  -21.000|   3.000|   0.667|  -7.000|          |          |
A|          |          | 402|8"MAS/FOOT  | | |          |  -21.000|   3.000|   0.667|  -7.000|          |          |
A|          |          | 402|8"MAS/FOOT  | | |          |  -21.000|   3.000|   0.667|  -7.000|          |          |
A|          |          | 201|SOUNDBLOX   | | |          |   11.667|   1.167|   0.333|  10.000|          |          |
A|          |          |  85|CONC8"      | | |          |  204.768|  16.166|   0.667|  12.667|          |          |
A|          |          |  85|CONC8"      | | |          |  -45.260|   5.500|   0.667|  -8.229|          |          |
$
$ CURTAIN WALL reporting
$ CURTAIN WALL            : not located
$
```

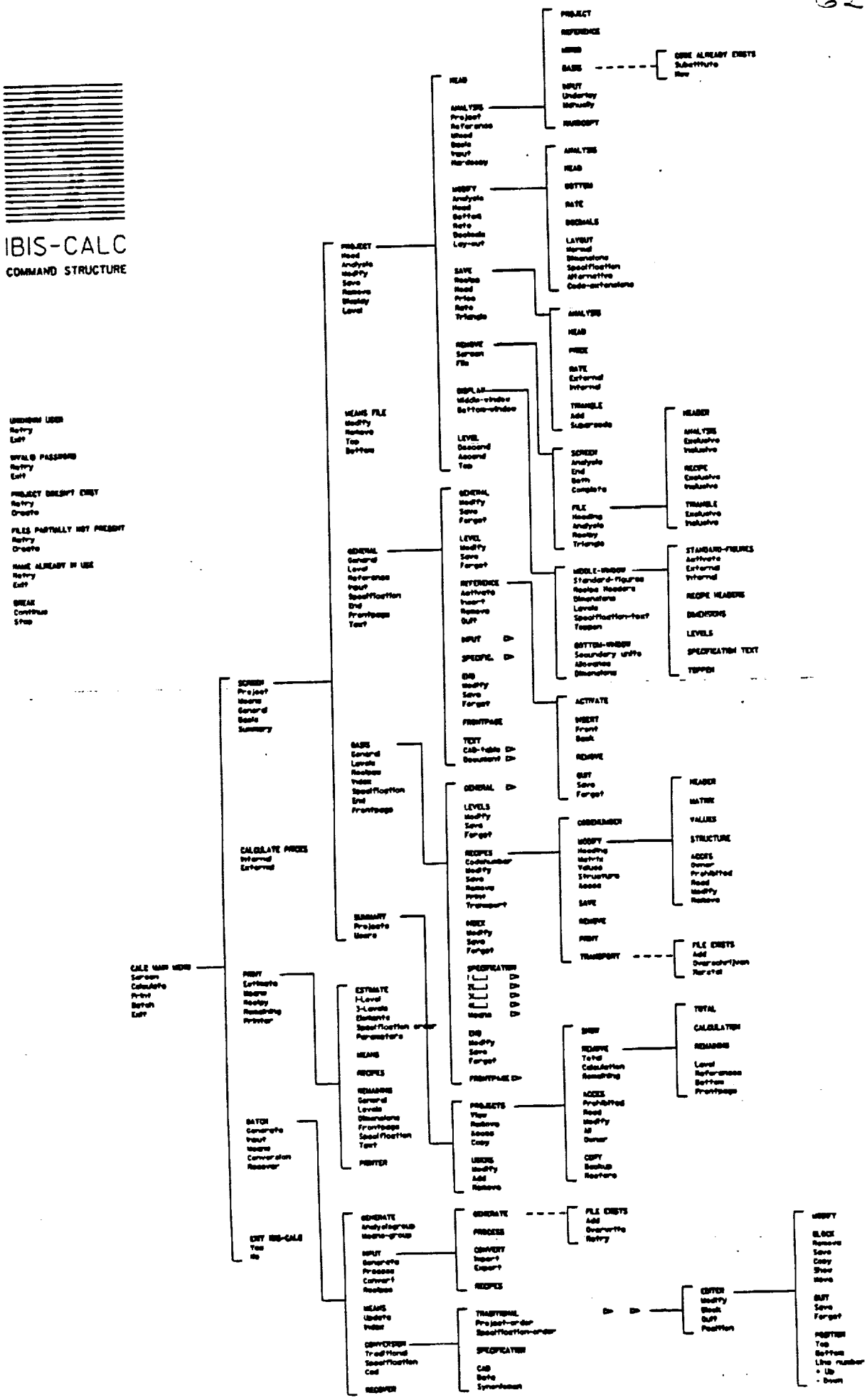
* TIMES
/ DEVIDE
\- MINUS
\+ ADD

CORRELATION TABLE

Class Code		IBISCALC Code*		Quantity Calculation
A8"MAS/FOOT		1	V-FFJJ .	A ' '8" MASONARY WALLS
A8"MAS/FOOT		7	V-BIGEB .	B*2.33*2.33/27' EXCAVATION
A8"MAS/FOOT		8	V-BGCBL .	B*1.33*.833/27*-1'BUILDING
A8"MAS/FOOT		9	V-BGCBL .	' FILL REDUCTION FOR FOOTINGS
ACONC8"		1	V-EKYMN .	A/27*1.05 '8" CONCRETE WALL
ACONC8"		2	V-EBYRA .	A*2 'FORMWORK WALL
ACONC8"		3	V-EFAA .	(A+B)*.688*1.1/2000'#4REB-V
BA		1	V-EKBMN .	A/27*1.05' CONCRETE COLUMNS
BA		2	V-EBBRC .	B*2*D 'FORMWORK COLUMNS
BA		3	V-EFAA .	4*D*1.1*1.04/2000'#5REBAR
C12J2		1	V-GFS .	B*4.5/2000' BAR JOIST
CA		1	V-EKKMG .	A*1.05/27'CONCRETE BEAM PLACE
CA		2	V-EBKRA .	B*D*2 ' BEAM FORMWORK
CA		3	V-EFAA .	B*4*1.04*1.1/2000'#5 REBAR
DSLAB		0	V-IQDIE .	A/100 'ROOFING
E3X7-1		0	V-JKSBE .	A 'AL DOOR SINGLE
E5-6X7-11	KSC-Spec	0	V-LXXKCC.	A ' LEAD DOOR
E5-6X7-11	" "	1	V-LXXKCF.	A ' LEAD LOUVER
E5-6X7-11	" "	2	V-LXXKCE.	A ' LEAD GLASS
EPR2-6X7		1	V-JKSBK .	A' ALUM DOOR-PAIR
FWIN		1	V-JLHDIC.	A 'WINDOW
GVINYL		1	V-KLUR .	A 'VINYL COMPOSTION FINISH
HACOUST TILE		1	V-KJEBIF.	A 'ACOUSTICAL CEILING GRID
HACOUST TILE		2	V-KIJCRO.	A 'ACOUSTICAL TILE
HPLASTER		1	V-KBCFC .	A/9 'PLASTER
JLEAD		1	V-LXXKCB.	A 'LEAD WALL LINING
JMASONARY		1	V-KU#BB1.	A*2'PAINT WALL-2COATS
LF9		1	V-ZA91C .	A '40 W LAMP
LFA340		1	V-ZA12D .	A 'FLOURESCENT 3 LAMP
LSHOWER		1	V-SKWWA .	A 'SHOWER
LTOILET		1	V-SJB .	A 'TOILET
LURINAL		1	V-SJLK .	A 'URINAL
NLEAD		1	V-LXXKCB.	A 'LEAD WALL LINING
NPLASTER		1	V-KU#BB1.	A*2'PAINT PLASTER -2COATS

* A navy database code converted into IBISCALC.

IBIS-CALC
COMMAND STRUCTURE



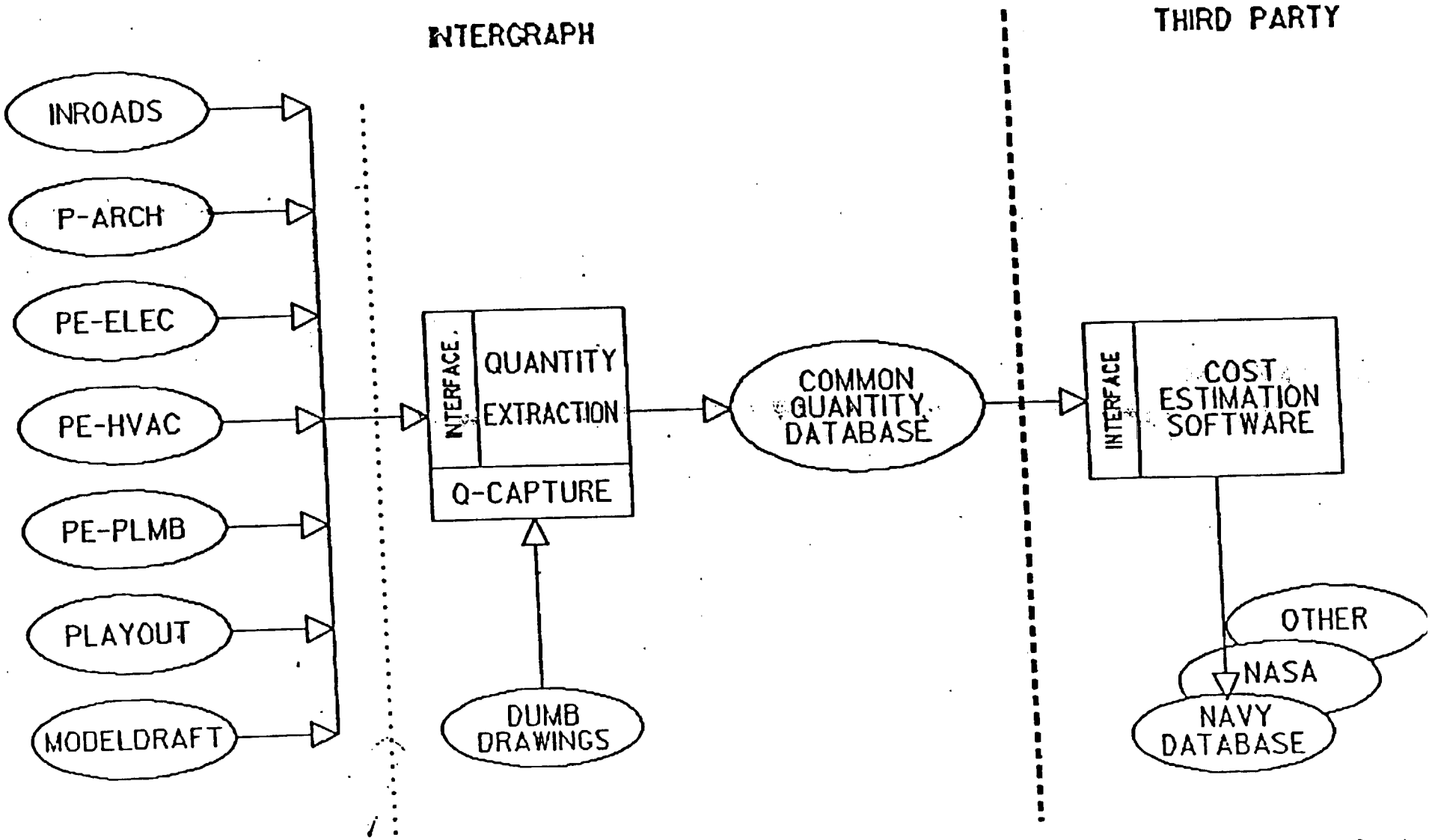
SAMPLE NAVY DATA BASE

NAVY Cost/SPEC CODE	UNIT	SPEC CODE	SUB-SPEC CODE	Cost DATE	MATERIAL PRICE	LABOR UNIT PRICE	EQUIPMENT UNIT PRICE	DESCRIPTION		
EK@MA	SF	03300	03300	12/28/88	1.2993	0.49		FLOOR SLAB 4" COMPLETE	INCL FORMS WWM CURING	FINISHING PO
EK@MB	SF	03300	03300	12/28/88	1.4681	0.50		FLOOR SLAB 5" COMPLETE	INCL FORMS WWM CURING	FINISHING PO
EK@MC	SF	03300	03300	12/28/88	1.6228	0.52		FLOOR SLAB 6" COMPLETE	INCL FORMS WWM CURING	FINISHING PO
EKB		03300		/ /	0.0000	0.00	0.00	PLACING CONCRETE AND	MASONRY GROUT	
EKB-		03300		/ /	0.0000	0.00	0.00	PLACE CONC 2500 OR 3000#	COLS. ELEV. SLAB. FTG.	PILE CAP. GI
EKBMG	CY	03300	03301	12/28/88	52.7300	0.15	0.15	PLACE CONC 2500 OR 3000#	COLUMNS BY CRANE	
EKBMN	CY	03300	03301	12/28/88	52.7300	0.13	0.13	PLACE CONC 2500 OR 3000#	COLUMNS BY PUMP	
EKFMG	CY	03300	03301	12/28/88	52.7300	0.08	0.08	PLACE CONC 2500 OR 3000#	ELEVATED SLAB BY CRANE	
EKFMN	CY	03300	03301	12/28/88	52.7300	0.07	0.07	PLACE CONC 2500 OR 3000#	ELEVATED SLAB BY PUMP	
EKIMD	CY	03300	03301	12/28/88	52.7300	0.07	0.07	PLACE CONC 2500 OR 3000#	FTG OR PILE CAP BY CHUTE	
EKIMN	CY	03300	03301	12/28/88	52.7300	0.08	0.08	PLACE CONC 2500 OR 3000#	FTG OR PILE CAP BY PUMP	
EKIMP	CY	03300	03301	12/28/88	52.7300	0.08	0.08	PLACE CONC 2500 OR 3000#	FTG OR PILE CAP BY HAND	BUGGY
EKKMG	CY	03300	03301	12/28/88	52.7300	0.15	0.15	PLACE CONC 2500 OR 3000#	GIRDERS & BEAMS BY CRANE	
EKKMN	CY	03300	03301	12/28/88	52.7300	0.16	0.16	PLACE CONC 2500 OR 3000#	GIRDERS & BEAMS BY PUMP	
EKN		03300		/ /	0.0000	0.00	0.00	PLACE CONC 2500 OR 3000#	SLAB ON GRADE. STAIRS.	TOPPING
EKNM	CY	03300	03301	12/28/88	52.7300	0.00	0.00	CONCRETE 2500 OR 3000#	MATERIAL ONLY	
EKNN	CY	03300	03301	12/29/88	5.0903	0.00	0.00	CONCRETE 2500 OR 3000#	MATERIAL ONLY ADD FOR	HIGH EARLY S
EKNU	BAG	03300	03301	12/28/88	4.6700	0.00	0.00	CEMENT TYPE II MATERIAL	ONLY (TRUCKLOAD LOTS)	
EKSMD	CY	03300	03301	12/28/88	52.7300	0.06	0.06	PLACE CONC 2500 OR 3000#	SLAB ON GRADE BY CHUTE	
EKSMG	CY	03300	03301	12/28/88	52.7300	0.06	0.06	PLACE CONC 2500 OR 3000#	SLAB ON GRADE BY CRANE	
EKSMN	CY	03300	03301	12/28/88	52.7300	0.06	0.06	PLACE CONC 2500 OR 3000#	SLAB ON GRADE BY PUMP	
EKSMP	CY	03300	03301	12/28/88	52.7300	0.07	0.07	PLACE CONC 2500 OR 3000#	SLAB ON GRADE BY HAND	BUGGY
EKUMD	CY	03300	03301	12/28/88	52.7300	0.09	0.09	PLACE CONC 2500 OR 3000#	STAIRS BY CHUTE	
EKUMG	CY	03300	03301	12/28/88	52.7300	0.09	0.09	PLACE CONC 2500 OR 3000#	STAIRS BY CRANE	
EKUMN	CY	03300	03301	12/28/88	52.7300	0.08	0.08	PLACE CONC 2500 OR 3000#	STAIRS BY PUMP	
EKUMP	CY	03300	03301	12/28/88	52.7300	0.10	0.00	PLACE CONC 2500 OR 3000#	STAIRS BY HAND BUGGY	
EKVMG	CY	03300	03301	12/28/88	52.7300	0.08	0.08	PLACE CONC 2500 OR 3000#	TOPPING BY CRANE	
EKVMN	CY	03300	03301	12/28/88	52.7300	0.07	0.07	PLACE CONC 2500 OR 3000#	TOPPING BY PUMP	
EKW		03300		/ /	0.0000	0.00	0.00	PLACE CONC 2500 OR 3000#	WALLS	
EKWMD	CY	03300	03301	12/28/88	52.7300	0.05	0.05	PLACE CONC 2500 OR 3000#	WALLS & GRADE BEAMS	TO 4' BY CHU
EKWMN	CY	03300	03301	12/28/88	52.7300	0.06	0.06	PLACE CONC 2500 OR 3000#	WALLS & GRADE BEAMS	TO 4' BY PUM
EKWMP	CY	03300	03301	12/28/88	52.7300	0.07	0.07	PLACE CONC 2500 OR 3000#	WALLS & GRADE BEAMS	TO 4' BY HAN
EKXMG	CY	03300	03301	12/28/88	52.7300	0.10	0.10	PLACE CONC 2500 OR 3000#	WALLS TO 8' BY CRANE	
EKXMN	CY	03300	03301	12/28/88	52.7300	0.09	0.09	PLACE CONC 2500 OR 3000#	WALLS TO 8' BY PUMP	
EKYMG	CY	03300	03301	12/28/88	52.7300	0.13	0.13	PLACE CONC 2500 OR 3000#	WALLS TO 16' BY CRANE	
EKYMN	CY	03300	03301	12/28/88	52.7300	0.12	0.12	PLACE CONC 2500 OR 3000#	WALLS TO 16' BY PUMP	
EKZMG	CY	03300	03301	12/28/88	52.7300	0.14	0.14	PLACE CONC 2500 OR 3000#	WALLS OVER 16' BY CRANE	
EKZMN	CY	03300	03301	12/28/88	52.7300	0.13	0.13	PLACE CONC 2500 OR 3000#	WALLS OVER 16' BY PUMP	

WORKSTATION PRODUCTS

PRODUCT	DESCRIPTION	APPLICATION AVAILABLE	QUANTITY EXTRACTION AVAILABLE
P ARCH	FLOOR PLANS - 2D DATABASE	NOW	NONE
	FLOOR PLANS - 3D DATABASE	4Q 89	1Q 90
	REFLECTED CEILING - 2D DATABASE	NOW	NONE
	REFLECTED CEILING - 3D DATABASE	4Q 89	1Q 90
	SECTIONS/ELEVATIONS - 3D DATABASE	4Q 89	1Q 90
IN-ROADS	CIVIL SITE - 3D DATABASE	NOW	1Q 90
P-LAYOUT	SPACE PLANNING - 2D DATABASE	NOW	NONE
	SPACE PLANNING - 3D DATABASE	4Q 89	1Q 90
MODEL DRAFT	STRUCTURAL MODELING - 3D DATABASE	NOW	1Q 90
PE HVAC	HVAC - 3D DATABASE	4Q 89	2Q 90
PE ELEC	ELECTRICAL WIRING - 3D DATABASE	4Q 89	2Q 90
PE PLUMB	PLUMBING/PIPING - 3D DATABASE	1Q 90	2Q 90
Q CAPTURE	QUANTITY CAPTURE FROM DUMB DRAWING	2Q 90	2Q 90

COST ESTIMATION FLOW DIAGRAM



21 STEPS FOR MAKING BID ESTIMATES

GOVERNMENT	GENERAL CONTRACTOR
1. Get the bid package from owner/A&E/government	Same
2. *Read plans	Same
3. *Read specs	Same
4. *Make check list from specs and plans	Same
5. *Tell civil, mechanical, electrical engineers you need estimates on their portions- ASAP	Different
6. *Make site visit	Same
7. *Make take-off on your portion	Same
8. *Do math extensions	Same
9. *Price out labor and materials	Similar
10. *Get quotes on own items	Similar
11. *Mark-up own - tax, insurance, O.H., profit, bonds	Similar
12. *Check estimate	Same
13. *Add in civil, mechanical and electrical estimates, etc.	Similar
14. *Summarize mark-up. Do other summaries, etc.	Similar
15. **Review overall estimate	Similar
16. **Apply bid/market strategy - special conditions, joint occupancy, down time	Different
17. **Final mark-up	Similar
18. **Adjust for late vendor quotes and amendments	Similar
19. **Final check	Different (get bid bond)
20. Approve bid estimate and get signatures	Same
21. Get bid in on time	Same

*Most government estimates are prepared during the preliminary design phase and finalized during the bid period; sometimes by A&E (architectural and engineering firm), sometimes by consultants or support contractors.

**Sometimes also by A&E firms for government agency.

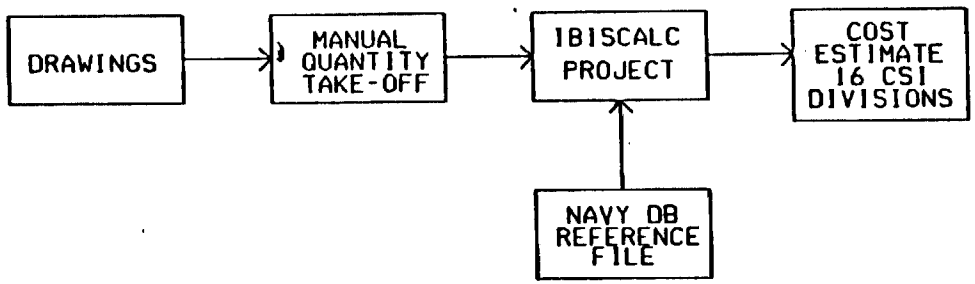
COST ESTIMATION SYSTEM

CREATE/MODIFY KSC COST ITEMS

Item Code	EKBMG
Unit of Measure	CY
Spec Code	3300
Sub Spec Code	3301
Date Revised	01/07/89
Material Costs	57.5000
Labor Costs	12.9793
Equipment Costs	21.4442
Description	PLACE CONC 2500 OR 3000# COLUMNS BY CRANE

BASED ON NAVY DATA BASEN

STANDALONE



AUTOMATED - CAD

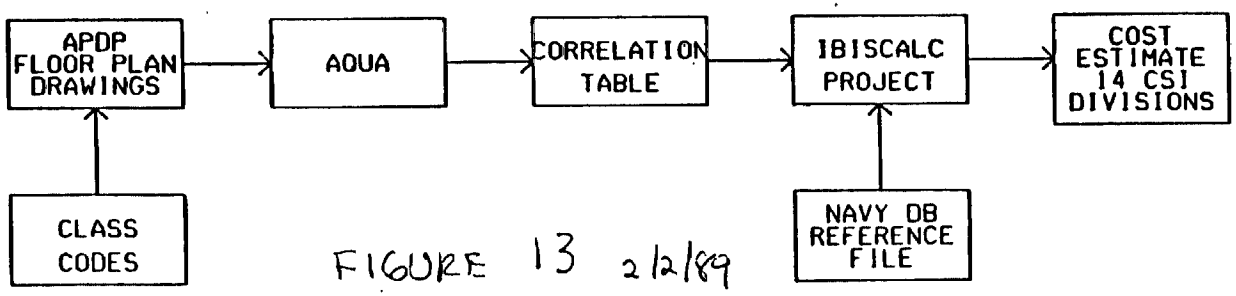


FIGURE 13 2/2/89

<u>ACCOMPLISHMENTS</u> - THE ESTIMATES WERE DELIVERED ON 11/17/88 AND 3/89 AND PROVED THAT:

1. A PROJECT CAN BE ESTIMATED FROM CAD QUANTITIES TO GET A FAIR AND REASONABLE COST ESTIMATE.

2. THE ARCHITECTURAL ASSEMBLIES, ELEMENTS, WALL, FLOOR, CEILING AND COMPONENTS CAN BE USED INSTEAD OF A DETAIL DATABASE MANAGEMENT SYSTEM REQUIRING COST/ITEM FOR EACH AND EVERY ITEM IN A BUILDING, THUS SAVING 10-50% OF DATA LINE ITEMS IN CAD DRAWINGS QUANTITIES.

ACCOMPLISHMENTS (CONTINUED)

3. THIS EFFORT IS FORCING THE DEVELOPMENT OF THE NEXT GENERATION WORKSTATION CONCEPT WITH INTEGRATED CIVIL, STRUCT, ARCHITECT, MECH AND ELECT DESIGN PACKAGES TO GET A TOTALLY INTEGRATED COST ESTIMATING SYSTEM MORE AUTOMATICALLY.

4. THIS EFFORT HAS ACCELERATED CAD ESTIMATING DEVELOPMENT (FOR MINI-COMPUTERS, WORK STATIONS, AND MAIN FRAMES).

5. A MULTI-PLATFORM/SOFTWARE CAD ESTIMATING SYSTEM HAS NOW BEEN INTEGRATED ON ONE COMPUTER ESTIMATING SYSTEM.

6. THIS EFFORT SHOWS THAT USEFUL ESTIMATING QUANTITIES CAN BE OBTAINED FROM INTELLIGENT CAD SYSTEMS.

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AUTHOR BIOGRAPHICAL DATA

Name: Joseph A. Brown

Position: Lead Cost Engineer

Company: NASA/KSC, FL

Address: DF-FED
Kennedy Space Center, FL 32899-0001

Paper Title: Government vs. Contractor Estimating

Professional Experience:

Joseph A. Brown, CCE, has prepared and reviewed construction cost estimates amounting to over $7 billion. He is a graduate of the University of Florida with a Bachelor of Building Construction, BBC (1959). He has been a consultant to commercial, industrial and residential complex interests in several states including work for the Walt Disney World Contemporary Resort Hotel. He has received AACE's Fellow Award and the prestigious astronauts "Silver Snoopy" for professional excellence and his contributions to the success of the manned space efforts. He has successfully prepared estimates for the U.S. Army Corps of Engineers and Air Force facilities. Mr. Brown has written an estimating workbook and is writing a text book, "Estimation of Construction Cost and Cost Engineering." He is currently employed by NASA at Kennedy Space Center, where he specializes in construction cost engineering.

Education:
Bachelor of Building Construction
BBC, 1959, University of Florida

Professional Society Affiliations:
AACE Member **Yes** X **No** ____
Other: ~~Same~~ SAME.

Publications, Papers & Patents:
20 Technical Papers on
Cost Engineering, etc.

Honors Received:
AACE "Fellow"
"Silver Snoopy"
DE - Outstanding Performance
Awards, 1987-88

VISUAL AIDS REQUIREMENTS

____ **None**

X **35-mm Projector**

X **Overhead Projector**

X **Other (specify)** Movie Screen, Blackboard or Chart Board, Lapel Mike

NOTE: AACE cannot provide computer equipment and/or data projectors.

Mail with the completed paper and publication agreement to AACE, 308 Monongahela Building, Morgantown, WV 26505 USA no later than December 31 preceding the meeting at which the paper is to be presented.

What is AACE?

The American Association of Cost Engineers is a non-profit organization of 6000 members worldwide who are concerned with cost estimating, cost control, profitability analysis, planning & scheduling and project management.

It is the one technical association concerned with all aspects of project costs, from the original conceptual appraisal, to completion of construction, to operating costs, to eventual abandonment.

We invite you to explore what AACE has to offer. Membership applications will be available at the registration desk.

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– SYMPOSIUM COMMITTEE–

Bob Burgett - Chairman
Larry Groves - Technical Program
Barry Barnes - Program Arrangements
Joe Brown, CCE - Seminars

This symposium has been approved by the University of Florida for continuing education credit, and by AACE for recertification credit.

22nd Annual Cost Engineering Symposium

Saturday, March 2nd, 1991
8 a.m. til 6 p.m.

CADD-CAE Systems (Computer Aided Design & Drawing - Computer Aided Estimating) combine CADD systems with estimating software to produce a complete design/estimating package. Quantities are calculated by computer from the CADD drawings, and a cost estimate is generated from the integrated data base. This symposium will feature some of the nations leading developers of CADD-CAE systems.

• SCHEDULE •

8:00 a.m.	Registration - Coffee & Doughnuts
8:30 a.m.	Peter Haines, CCE Senior Estimator Rust International Corp. - Birmingham, AL *"CAD Estimating for Design Builders"*
9:15 a.m.	Tom Goff President G2 International - Boise, ID
	Christopher Barron Marketing Manager Intergraph Corp. - Huntsville, AL *"CAD Estimating with Intergraph and G2 Estimator"*
10:00 a.m.	Break
10:15 a.m.	Dennis Neeley President ASG (Autodesk) - Sausalito, CA
11:00 a.m.	Benny Ingram Director of Marketing U.S. Cost, Inc. (SUCCESS) - Atlanta, GA
11:45 a.m.	Curtis Peltz Vice-President Timberline Software - Beaverton, OR *"Linking CAD and Estimating - It's Impact on the Construction Project"*
12:30 p.m.	Lunch (Provided) Luncheon Speaker Ed Hamm, PE, CCE AACE President
2:00 p.m.	Joseph A. Brown, CCE Lead Cost Engineer NASA - Kennedy Space Center, FL *"Challenges Developing CAD/ACE"*
2:45 p.m.	Break
3:00 p.m.	Panel Discussion *"CADD Estimating - Past, Present & Future"*
4:00 p.m. to 6:00 p.m.	Software Demonstrations

SEMINAR
BLUEPRINT READING AND INTRODUCTION TO COST ESTIMATING

Friday, March 1st, 1991

This program is designed to teach the participant how to read construction blueprints and to provide an introduction to general construction cost estimating. It will be through the review of standard estimating procedures that participants will learn blueprint reading. You will go from the project layout to the bid summary through reviewing a detailed summary through reviewing a detailed 13 page cost estimate of a general construction project using a set of plans and specifications for a component office laboratory.

PROGRAM SCHEDULE

Morning Session (9:30 a.m. to 11:30 a.m.)
- Introduction
- How to Sharpen Bidding Through Plan Reading and Estimating
- How to Read Blueprints - Symbols, Plans, Elevators, Scales
- Plan Reading - Schedules, Sections, Isometrics
- Drawings - Structural, Mechanical, Electrical, Civil
- Specifications - Important Checklist C.S.I.
- Study Method for Blueprint Reading, 9 keys, p. 65

Lunch (11:30 a.m. to 1:00 p.m.)

Workshop (1:00 p.m. to 3:00 p.m.)
- Blueprint Reading Exercises
- Concrete Masonry Project - Questions
- PSCOL Bid Problem
- Inspector's Field Office Bid

Second Afternoon Session (3:30 p.m. to 5:00 p.m.)
- Review Problems, Answers, Discussion
- Plan Readings, Faster and Better
- Three Speeds of Plan Reading

SEMINAR LEADER

JOSEPH A. BROWN, CCE, AACE Fellow
Consultant Cost Engineer, (407) 452-4909

Joseph A. Brown, CCE, AACE Fellow, has prepared and reviewed construction cost estimates amounting to over $7 billion. His is a graduate of the University of Florida with a Bachelor of Building Construction, BBC (1959). He has been a consultant to commercial, industrial and residential complex interests in several states including work for the Walt Disney World Contemporary Resort Hotel. He has received the prestigious astronauts "Silver Snoopy" for professional excellence and his contributions to the success of the manned space efforts. His has successfully prepared estimates for U.S. Army Corps of Engineers and Air Force facilities. Mr. Brown has written an estimating workbook and is writing Estimation of Construction and Cost Engineering. He is currently employed by NASA at Kennedy Space Center where he specializes in construction cost engineering.

REGISTRATION FORM

NAME _____

ADDRESS _____

_____

CO. NAME/TITLE _____

PHONE _____

REGISTRATION FEES

1991 Symposium:
Before February 11th, 1991 - $65
After February 11th, 1991 - $75
Students - $20

Seminar
Before February 1st, 1991 - $185
After February 1st, 1991 - $215

I will attend:
Symposium $ _____
Seminar $ _____
Amount Enlosed $ _____

Fees do not include hotel accomodations.
All refunds subject to a $25 service fee.
No refunds after February 18th, 1991.

Mail to:
AACE Symposium
c/o PMA Consultants
Attn: Ken VanderJagt, PE
201 S. Orange Ave., Suite 901
Orlando, FL 32801

For further information contact:
Ken VanderJagt, PE – (407) 843-1969

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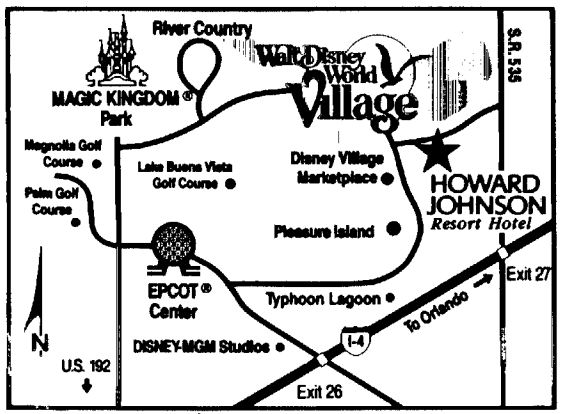
A limited number of rooms are available at a discount rate by mentioning AACE.



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