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CONCEPTUAL DESIGN REPORT

ATOMIC RESOLUTION MICROSCOPE LABORATORY

LAWRENCE BERKELEY LABORATORY

AUGUST 1978

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Section 1

SUMMARY OF CONCEPTUAL DESIGN PLAN

A. INTRODUCTION

Atomic Resolution Microscopy is a new project which responds directly to a national need in the field of materials research. This need stems from the present inability of U.S. scientists to characterize local structure or localized deviations in structure at sufficiently high levels of detail. Particularly for the complex materials currently utilized in advanced energy systems, it is necessary to determine the manner in which individual atoms are arranged in the vicinity of even the smallest lattice defects in order to completely understand, predict and improve material properties.

The technology necessary for this level of characterization already exists in the field of electron microscopy; the prototype atomic resolution microscope (ARM) at the University of Kyoto in Japan has been producing photographs of atoms in a variety of materials since 1974. Moreover, intensive programs are currently under way in England, France and Germany to develop atomic resolution instruments, but there has been no such effort in the U.S. The project described in this conceptual design plan represents the first atomic resolution microscopy laboratory in this country.

The components of the proposed project include: (1) an ARM, in this case a commercially produced instrument which will be maintained and developed to state-of-the-art performance by an on-site engineering staff; (2) support instrumentation, including feeder microscopes, specimen preparation equipment and image analysis systems, and (3) a new building to house the centralized laboratory. The proposed location of the building is based upon the magnetic and mechanical stability of the site, and its proximity to both the high voltage electron microscope laboratory (Building 72) and the Materials and Molecular Research Division's Building 62, where close collaborative research programs will be carried out.

The planned research topics for this project include: (1) imaging of the atomic structure of internal interfaces and determining its relationship to segregation, to the atomic roughness of crystalline/amorphous and intercrystalline boundaries, and to its effect on transformation behavior; (2) assessing the distinctions between internal and surface sites with respect to the role of solute atoms in altering interfacial properties and the poisoning mechanisms affecting the performance of catalysis: (3) establishing the atomic mechanism responsible for phase transformation phenomena, including the role of point defects in both heterogeneous, homogeneous and catalytic reactions, the nucleation event associated with martensitic reactions, the role of dislocations, solute atmospheres,

core structures and the propagation of surface defects into the bulk, and the atomic details of surface structure which influence erosion and corrosion.

Solutions to these problems require unprecendented levels of resolution which will be made available only with the ARM. The project, therefore, provides a unique opportunity for research in the new energy technologies encompassing the fields of materials science, physics and chemistry, and will offer the instrumentation and expertise necessary for wide-ranging interdisciplinary cooperation in basic science, engineering and education.

B. METHOD OF PRODUCING THE CONCEPTUAL DESIGN REPORT

1. Lawrence Berkeley Laboratory

The requirements for the Atomic Resolution Laboratory were compiled by the LBL Plant Engineering Department in collaboration with the Materials and Molecular Research Division. This criteria is reflected in the drawings and project technical evaluation prepared by Ratcliff-Slama-Cadwalader, Architects, Oakland.

LBL Safety Services Department contributed the pollution and environmental assessments. The Conceptual Design Report was prepared by the LBL Plant Engineering Department with editing and production by the LBL Technical Information Department.

2. Consultants

Consultants to the project in addition to Ratcliff-Slama-Cadwalader, Architects, include Butzbach, Bar-Din, and Dagan, Structural Engineers; Charles and Braun, Mechanical Engineers (Energy Conservation Report); Mazzetti and Parish, Electrical Engineers; Interactive Resources, Inc., (Solar Energy Analysis); Harding-Lawson Associates, Engineers and Geologists (Site Geology Report and foundation design recommendation); and Consulting Cost Estimators, Inc. (quantity survey and cost estimate).

Section 2

PROJECT DESCRIPTION AND DESIGN CRITERIA

A. PROJECT DESCRIPTION

The proposed laboratory building will be sited at the south end of existing Building 72 and connected through a lobby/corridor. It will contain 17,000 gross square feet of floor area consisting of three major floors and a partial basement containing the Atomic Resolution Microscope's vibration isolated foundation.

The planning of the laboratory involves two elements - the first containing the 500 KV Atomic Resolution Microscope and its ancilliary equipment in a high bay - the second element containing all supporting laboratories and offices for the ARM operation including the smaller "feeder" electron microscopes with other ancilliary equipment as listed in Schedule I of Form 44.

The completed laboratory complex will include the High Voltage Electron Microscope (currently in Title I Engineering phase), and its supporting facilities at Building 72.

The exterior appearance of the ARM laboratory will be similar to the HVEM Building (Insulated Metal Siding), and where windows occur, the spandrels will consist of textured cement plaster finish. The building will contain a level-in entry for the handicapped and also an elevator serving major floors.

Site utilities will consist of required water, sanitary sewer, natural gas, and electrical power. All utilities are available at the site. The immediate site environs will be landscaped for both erosion control and appearance. The use of the building on a net square footage basis is given in Table 2 - 1 "Schedule of Net Areas, Functions, and Occupancy".

B. DESIGN CRITERIA

1. Architectural

Uniform Building Code criteria for the new addition are as indicated below.

Site Designation:	Fire Zone 3
Estimated number of occupants:	35
Occupancy classification:	B-2
Type of construction:	Type II, F.R.

The space allocations for various uses are set forth in Table 2-1, Schedule of Net Areas, Functions, and Occupancy.

2. Structural

The structural system is composed of a structural steel frame with braced frames designed for lateral loads. The floor frame system consists of metal decking with concrete slab supported by steel beams and girders. The roof frame system consists of metal decking with thermal insulation. Construction of this type provides flexibility for the installation of additional utilities if future need occurs.

All floors have been designed for 125 pounds per square foot live load capacity. The roof has been designed for a live load of 50 pounds per square foot and can accommodate roofmounted solar energy equipment.

The structural design is based upon LBL lateral force criteria, which is more stringent than the latent Uniform Building Code, 1976 Edition.

Foundation design utilizes spread footings and drilled-in-place reinforced concrete caissons continuously tied together at grade with reinforced concrete grade beams.

3. Mechanical

The current High Voltage Electron Microscope Building project at existing Building 72 has been used as a guide for selection of the utilities required in the new Atomic Resolution Microscope Laboratory. These utilities include hot and cold domestic water, natural gas, compressed air, sanitary drainage, acid waste, cooling water, and a wet fire sprinkler system. Equipment requiring vacuum will have a self-contained vacuum system. Demineralized water will be supplied in bottles.

Air conditioning will be provided for all laboratories and the ARM high bay only. Officed will be heated and ventilated. An economizer cycle will be provided for all air conditioning systems. Heating and ventilating units will have 100 percent outside air capability for optimum energy conservation using economizer cycle to meet required room conditions. Laboratory hood, toilet, and mechanical room exhaust systems will be provided. Heat will be provided by a dual fuel gas-oil hot water boiler. Piping will be sized for a future full capacity solar heating system, but only that portion of the solar panels justified by current DOE economic guidelines has been included in the scope and cost of the mechanical system. Cooling will be provided by air-to-water heat pumps or by a chilled water system.

The design criteria and calculations for control of space temperatures will be based on the latest editions of DOE (ERDA) Facilities General Design Criteria Handbook, Appendix 6301 and the ASHRAE Fundamentals Guide.

Energy Conservation and utilization of Solar Energy are included in this report in Sections VII and VIII.

Cost premium has been included in the cost estimate for energy conservation measures required by new DOE directive for life cycle analysis.

New site services include city water and gas lines, including relocation of existing services to Building 72. The building sanitary drain will connect to the existing 4 inch sanitary sewer located west of the HVEM building. The rainwater drainage system at the ARM Laboratory site will be relocated as required.

4. Electrical

A new pad mounted 500 KVA underground distribution transformer with internally mounted switching and protection will be installed outside existing Building 72. Power is available at 12 KV from the existing 10MVA regulated feeder at manhole 98. This work will be completed prior to site work as a portion of the existing feeder to Building 72 will be removed during grading.

Telephone, fire alarm, and communication rights of way will be extended from Building 72.

TABLE 2-1. Schedule of Net Areas, Functions, and Occupancy

Atomic Resolution Microscope Laboratory	Net Area ft^2 Labs	Offices	Other	Staff
ARM Spectrometer Level	—	—	1,350	—
ARM Console Level:				
Console Room	1,350	331	—	3
EM Laboratories	684	247	—	6
HREM Laboratories	684	247	—	6
Instrument Development	345	—	—	1
Supply, Storage, and Misc. Rms.	—	—	153	—
Console Level Subtotal	3,063	825	153	16
ARM Mezzanine	—	—	492	—
Main Entrance Level:				
Computer Laboratory	289	—	—	1
Densitometer/Diffractometer	462	165	—	2
Developing	—	—	108	1
Printing	—	—	106	—
EM Laboratory Offices	—	330	—	(See Labs)
HREM Laboratory Offices	—	330	—	(See Labs)
General Office (clerical)	—	347	—	3
Lobby/Reception	—	—	345	1
Supply, Storage, and Misc. Rms.	—	—	92	—
Main Entrance Level Subtotal	751	1,172	651	8
Top Floor Level:				
Preparation Laboratory	403	248	—	3
Dark Room	—	—	98	1
Viewing	—	—	132	—
Dry Mounting	—	—	385	—
Student Offices (GSRA'S)	—	577	—	7
Conference Room	—	—	315	—
Supply, Storage, and Misc. Rms.	—	—	92	—
Top Floor Level Subtotal	403	825	1,022	11
Subtotal all floor nets	4,217	2,822	3,668	35
Total net functional floor area:	10,707 ft^2			
Total number of occupants:	35 people			

Section III

COST ESTIMATES

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Section 3

COST ESTIMATES

COMPARISON OF CONCEPTUAL DESIGN ESTIMATE WITH SCHEDULE 44 SUBMITTAL

At the time the Schedule 44 was submitted, the Conceptual Design was not complete. Costs were then extrapolated from experience with our current High Voltage Electron Microscope Project. Since then the Conceptual Design has been completed and a detailed construction cost estimate has been compiled by Consulting Cost Estimators, Inc. (CCE).

Although the costs shown in the breakdown differ somewhat from those shown in the original Schedule 44 Cost Estimate, total project cost remains the same. ED & I, and contingencies also remain the same. The cost estimate which results from the final conceptual design confirms the Schedule 44 submittal.

Consulting Cost Estimators, Inc. estimate, which is included in Section X of the CDR, has been modified in format to match Schedule 44 format and adjusted in scope to add energy-conservation-related features as required by DOE. The explanation that follows is a reconciliation of the estimate by CCE, Inc., to correlate with the Schedule 44 Cost Estimate submittal.

The CCE estimate, (today's prices) shown in summary, was recast in the Schedule 44 format as follows:

STEP 1

CCE ESTIMATE	X	ESTIMATORS CONTIGENCY, ETC.			SOLAR COST	SUB TOTAL
Improvements to Land	53,154	x 1.11189	=	59,064		59,064
Building	1,180,926	x 1.11189	=	1,312,232	28,720	1,340,952
Utilities	48,384	x 1.11189	=	53,764		53,764
Total				*1,425,060		1,453,780

*Matches CCE Total; Solar was identified as an Additive Alternate

STEP 2

	ESTIMATE x ESCALATION			SUB TOTAL
Improvements to Land	59,064 x 1.268*	=	74,893	75
Building @ 1,340,952 +Energy Conservation Premium @ 120,000	1,460,952 x 1.268*	=	1,852,487	1,850
Special Facilities	190,000 x 1.268*	=	240,920	240
Utilities	53,764 x 1.268*	=	68,173	70
			Total K	2,235

*Escalation factor, 9% per Annum over 2.75 years to the mid-point of construction

STEP 3

Engineering	350
Construction	2,235
Standard Equipment	3,775
Contingency	840
TOTAL	7,200 K

DEPARTMENT OF ENERGY

Schedule 44

APPROPRIATION ENERGY

FY 1980 BUDGET REQUEST

(Tabular dollars in thousands. Narrative material in whole dollars.)

CONSTRUCTION PROJECT DATA SHEETS

UNIVERSITY OF CALIFORNIA
LAWRENCE BERKELEY LABORATORY

Mission ENERGY SUPPLY-RESEARCH AND TECHNOLOGY DEVELOPMENT

Resource BASIC ENERGY SCIENCES

Activity MATERIALS SCIENCES

1. Title and location of Project: Atomic Resolution Microscope Laboratory-Berkeley

2. Project No. LBL-80

3. Date A-E Work Initiated: 1st Qtr. FY 1980

5. Previous Cost Estimate: $2,200
Date: April

3a. Date Physical Construction Starts: 3rd Qtr. FY 1980

6. Current Cost Estimate:
Less Amount for CR&D -0-
Net cost Estimate: $7,200
Date: June, 1978

4. Date Construction Ends: 4th Qtr. FY 1981

7. Financial Schedule: (Revised)

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1980			$5,200	$1,700
1981			2,000	4,500
1982				1,000

DEPARTMENT OF ENERGY

APPROPRIATION ENERGY

FY 1980 BUDGET REQUEST

CONSTRUCTION PROJECT DATA SHEETS

Schedule 44
(Continued)

UNIVERSITY OF CALIFORNIA
LAWRENCE BERKELEY LABORATORY

1. Title and Location of Project: Atomic Resolution Microscope Laboratory-Berkeley 2. Project No.: LBL-80

10. Details of Cost Estimate (Revised)

A.	Engineering, Design & Inspection at about 15% of Construction Cost		$ 335
	SAN Operations Technical Support .2% of Project Costs		15
B.	Construction Costs		2,225
	1. Improvements to Land	$ 50	
	2. Building 17,000 Sq. Ft. gross at about $111/Sq. Ft.	1,885	
	3. Special Facilities	230	
	4. Utilities	60	
C.	Standard Equipment		3,775
	1. ARM	3,000	
	2. Other	775	
	Sub-Total		6,350
D.	Contingencies at about 13.5 (of which $285,000 is for building contingency)		850
	*Total Project Cost		7,200

Notes:
1. Construction costs have been escalated 9 percent per annum for a period of 2.75 years to the midpoint of construction for a total of 26.8 percent.
2. ARM cost has been escalated 14 percent per annum for a period of 2.5 years to the midpoint of procurement for a total of 39 percent.
3. Other standard equipment has not been escalated.
4. Construction costs and ED & I carry a contingency of 15 percent or $385k.
5. Standard equipment carries a contingency of 12.4 percent or $470k.

Consulting Cost Estimators, Inc.

ATOMIC RESOLUTION MICROSCOPIC LABORATORY
UNIVERSITY OF CALIFORNIA - LAWRENCE RADIATION LABORATORY
BERKELEY, CALIFORNIA

SUMMARY OF ESTIMATED COSTS 1 JULY 1978

1.00 IMPROVEMENTS TO LAND (SITEWORK)

		INDEX		
Demolition	$ 6,520	2.10 Pg 5		
Earthwork	16,833	2.20 " "		
Paving-AC & Concrete	10,315	2.60,.90 Page 7		
Landscaping & Irrigation	9,100	2.80 " "		
Sub Total			$ 42,768	
Gen'l Conditions Pro Rata			6,147	
Bond @ .00625			302	
General Contractor's Fee 8%			3,937	
Estimated Cost as of 1 July 1978				$ 53,154

2.00 BUILDING

Alter Existing Building	$ 2,520	2.40 Pg 6		
Drilled Piers	10,237	2.30 " "		
Foundations	8,852	3.10 " "		
Struct/Arch Concrete	119,222	3.20 Pg 8		
Slab on grade	11,025	3.30 " "		
Structural Steel	93,774	5.10 Pg 9		
Misc.& Ornamental Metal	101,071	5.20,.30 Pg 9		
Carpentry, Rough & Finish	15,180	6.00 Pg 9		
Moisture,Sound/thermal Pro.	30,555	7.00 Pg 10		
Building Closures, Fin Hdw.	46,367	8.00 Pg 11		
Finishes	129,350	9.00 Pg 11 & 12		
Specialties	7,220	10.00 Pg 12		
Furnishings	NIC			
Equipment (Crane)	10,800	11.00 Pg 12		
Elevator	35,000	14.00 Pg 12		
Mechanical				
Plumbing	35,600	15.10 Pg 13		
HV&AC	120,000	15.20 " "		
Fire sprinklers	29,531	15.30 " "		
Electrical	143,420	16.00 " "		
Sub Total			$1,180,926	
Gen'l Conditions Pro Rata			136,934	
Bond @ .00625			6,792	
General Contracor's Fee 8%			87,476	
Estimated Cost as of 1 july 1978				1,180, 926

ATOMIC RESOLUTION LABORATORY - SUMMARY OF COSTS - Continued

3.00	SPECIAL FACILITIES			
	Solar Water Heating System (Add Alternate #1)			$ 28,720
4.00	UTILITIES			
	Electrical	$ 9,000	16.00 Pg 13	
	Mechanical	28,800	2.50 b,c,d,e Pg 6	
	Sub Total		$ 37,800	
	Gen'l Conditions Pro Rata		6,722	
	Bond @ .00625		278	
	Gen'l Contractor's Fee 8%		3,584	
				$ 48,384
CONTINGENCY INCLUDING ALL APPLICABLE PER CENTAGES (10% plus0.11189 - Application Factor 1.111189)				$ 142,596

Consulting Cost Estimators, Inc.
BUILDING & ENGINEERING COSTS
PROJECT MANAGEMENT
CONSTRUCTION COST CONTROLS
415 935-3545
2156 N. Main Street
Walnut Creek
CA 94596

Prepared by: J.W.COOK Checked by: M.F.ESTES	SUMMARY OF ESTIMATED CONSTRUCTION COSTS LAWRENCE BERKELEY LABORATORY ATOMIC RESOLUTION MICROSCOPIC LABORATORY	File CCE#27-6-29 Phase: Adv.Sch. Date: 6/30/78 Revision #

SPEC. SECT.	CLASSIFICATION	AMOUNT
1.0	GENERAL REQUIREMENTS	149,803
2.0	SITE DEVELOPMENT	84,325
3.0	CONCRETE	139,099
4.0	MASONRY	none
5.0	METALS	194,845
6.0	CARPENTRY	15,180
7.0	THERMAL, SOUND AND MOISTURE PROTECTION	30,555
8.0	DOORS, WINDOWS AND GLAZING	46,367
9.0	FINISHES	129,350
10.0	SPECIALTIES	7,220
11.0	EQUIPMENT	10,800
12.0	FURNISHINGS	none
13.0	SPECIAL CONSTRUCTION	none
14.0	CONVEYING SYSTEMS	35,000
15.0	MECHANICAL WORK	185,131
16.0	ELECTRICAL WORK	152,420
17.0	Lab. Spec.	12,000

Consulting Cost Estimators, Inc.
BUILDING & ENGINEERING COSTS
PROJECT MANAGEMENT
CONSTRUCTION COST CONTROLS
415 935-3545
2156 N. Main Street
Walnut Creek
CA 94596

Prepared by: J.W.COOK Checked by: M.F.ESTES	SUMMARY OF ESTIMATED CONSTRUCTION COSTS LAWRENCE BERKELEY LABORATORY ATOMIC RESOLUTION MICROSCOPIC LAB.	File CCE#827629 Phase: Adv.Schem Date: 6/30/78 Revision #

SPEC SECT.	CLASSIFICATION	AMOUNT
	SUB TOTAL (Direct Cost)	1,192,095
	* CONTINGENCY 10 %	119,210
	SUB TOTAL	1,311,305
	Contractor's Mark Up 8%	104,904
	BONDS .00625	8,851
	TOTAL	1,425,060
	≠ ESCALATION FACTOR	

ADDITIVE ALTERNATE #1
Solar heating System.....$28,720

* Schematic & Preliminary Only

≠ Factor to be applied per cal month from current to contract mid point.

BASIS OF ESTIMATE SUMMARY

A. GENERAL

The preceding Estimate Summary is from the detailed cost estimate included in Section X. The July 1978 costs were escalated 9% per year compounded (26.8%) as noted on the Schedule 44 Construction Project Data Sheet (Financial Schedule) of this Section, in accordance with DOE guidance.

Special facilities and standard equipment costs are shown under Construction Costs in Section X, item B, and are summarized and escalated (in accordance with above noted escalation) from the current 1978 prices of the facilities and equipment contained in Schedule 44 lists of Section X.

The breakdown of Engineering, Design, and Inspection costs during FY 1980, 1981, and 1982 is as follows:

Title I	$ 84,000
Title II	140,000
Title III	126,000
	$350,000

B. SPECIAL FACILITIES

The Special Facilities listed in Schedule I are the systems and special equipment required to support experimental programs and work spaces planned for the new Laboratory. Program investigators have analyzed the physical requirements of their activities and translated these analyses into the Special Facilities described. Costs have been estimated on the basis of cost inquiries for known items of equipment, and in the case of the ARM vibration isolated base, the cost estimate is modeled on the vibration isolated base for the similar, current High Voltage Electron Microscope project.

C. STANDARD EQUIPMENT

The Atomic Resolution Microscope (ARM) described in this project exists as a prototype model at the University of Kyoto in Japan. It was manufactured by JEOL, Inc. and to this date no other instrument manufacturers have produced microscopes of this type. When consulted for a current cost estimate of this machine, JEOL responded with the attached letter, placing the cost within the 2.5 to 3 million dollar range for the next year or two. The estimate for procurement and installation of the ARM is consequently placed at 3 million dollars at the mid point of the procurement period.

The uncertainties regarding this cost estimate are due largely to the yen/dollar exchange rate, as explained in the following letter from Jeol, Inc. Furthermore, the figure may be reduced by a competitive bidding process, since Kratos-AEI Scientific Instruments, Inc. has already expressed interest in the design and construction of their own ARM. Nevertheless, since Kratos has had no experience in the atomic resolution field, the quoted cost figure for the ARM conservatively reflects that of its only present manufacturer.

After an analysis of an appropriate escalation factor for use with the remaining items of Standard Equipment, it was determined that the factor would be zero. This conclusion was arrived at through consideration given to the effect of the continuing advances made in the component technology for these items as they are related to competitive market pricing.

D. CONTINGENCIES

The contingency allowance is to provide relief from various uncertainties that may affect costs. These uncertainties may take several forms:

1. Unknown factors or discrepancies encountered during construction. One such item could be a variance in the amount of site work to be done depending upon geologic conditions or exact siting of the building.

2. Currently unknown changes in codes or environmental requirements that could increase costs.

3. Specifics in the Special Facilities or Standard Equipment may change by the time construction or procurement starts.

4. Escalation predictions follow the previously described guidelines and actual costs may be significantly different in future years.

JEOL

USA, INC. • 477 RIVERSIDE AVENUE • MEDFORD, MASSACHUSETTS 02155
(617) 391-7240 • TELEX NO. 949422

June 16, 1978

Dr. R. Gronsky
Lawrence Berkeley Laboratory
University of California
Materials & Molecular Research Div.
Building 8 - Room 111
Berkeley, CA 94720

Dear Dr. Gronsky:

Thank you for your letter of May 3, 1978 and for your interest in JEOL. I am very pleased to be informed that the possibility of the atomic resolution microscopy facility may become a reality in the near future. JEOL is very much interested in the opportunity of building a Kyoto-type 500kV atomic resolution machine. During the first two weeks in July, I will be in Japan at the factory to discuss this, among other subjects. As some time has passed since the development and construction of the Kyoto 500kV instrument, JEOL must, at this point, undergo a complete re-evaluation and up-dating of the design and cost estimation relative to that type of instrument.

Therefore, at this time, I am not able to send you a firm quotation. When I return from Japan, I expect to be able to give you either a preliminary quotation or an estimated preliminary proposal date. As you know, the cost of these kinds of instruments has increased greatly in the last five years; moreover, the yen/dollar exchange rate has further increased the cost in the United States of this type of instrument, which is manufactured in Japan. Very generally speaking, I anticipate, without the benefit of detailed specifications, that the cost of this kind of instrument within the next year or two will be in the 2.5 to 3 million dollar range. Please consider this as only a very rough estimate, as we are anxious to take this opportunity to consider the situation more carefully before giving you a preliminary quotation.

REGIONAL OFFICES: • E. BRUNSWICK, N.J 201/254-5600 • EULESS, (DALLAS) TX. 817/267-6011 • IRWIN, PA 412/864-5809 • LOS ANGELES, CA 213/870-8852
SAN FRANCISCO, CA. 415/697-9220 • MONTREAL, QUEBEC 514/482-6427 • CINCINNATI, OH. 513/232-7350 • CATONSVILLE, MD. 301/953-2959 • DES PLAINES, IL 312/825-7164

Again, thank you for your interest in JEOL and I will be looking forward to contacting you in the near future.

Sincerely,

JEOL U.S.A., INC.

Gary Cogswell (by Kim)

Gary Cogswell
Vice President
Technical Sales & Service

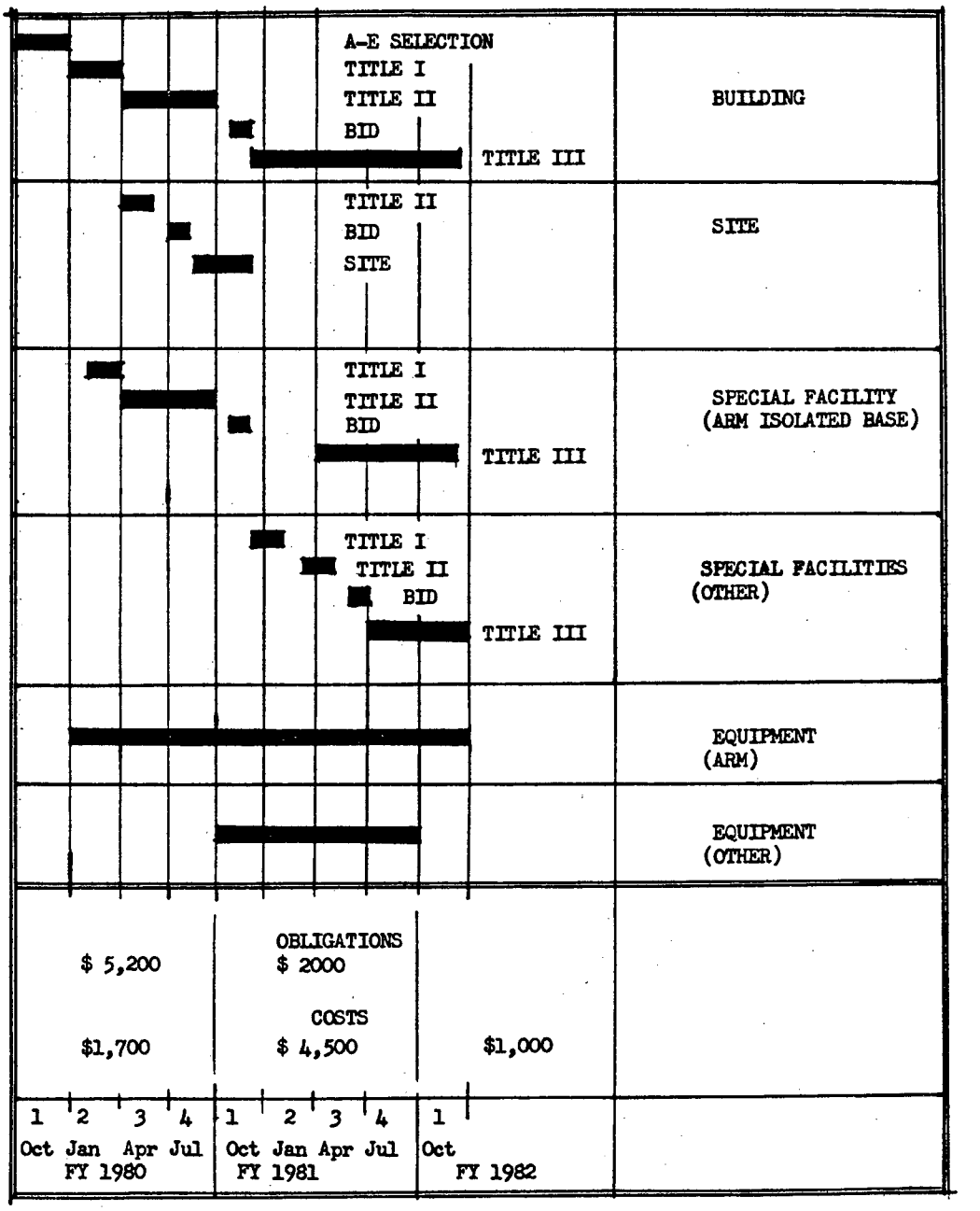
GC/kim

cc: H. Endo, Director
Technical Sales & Service

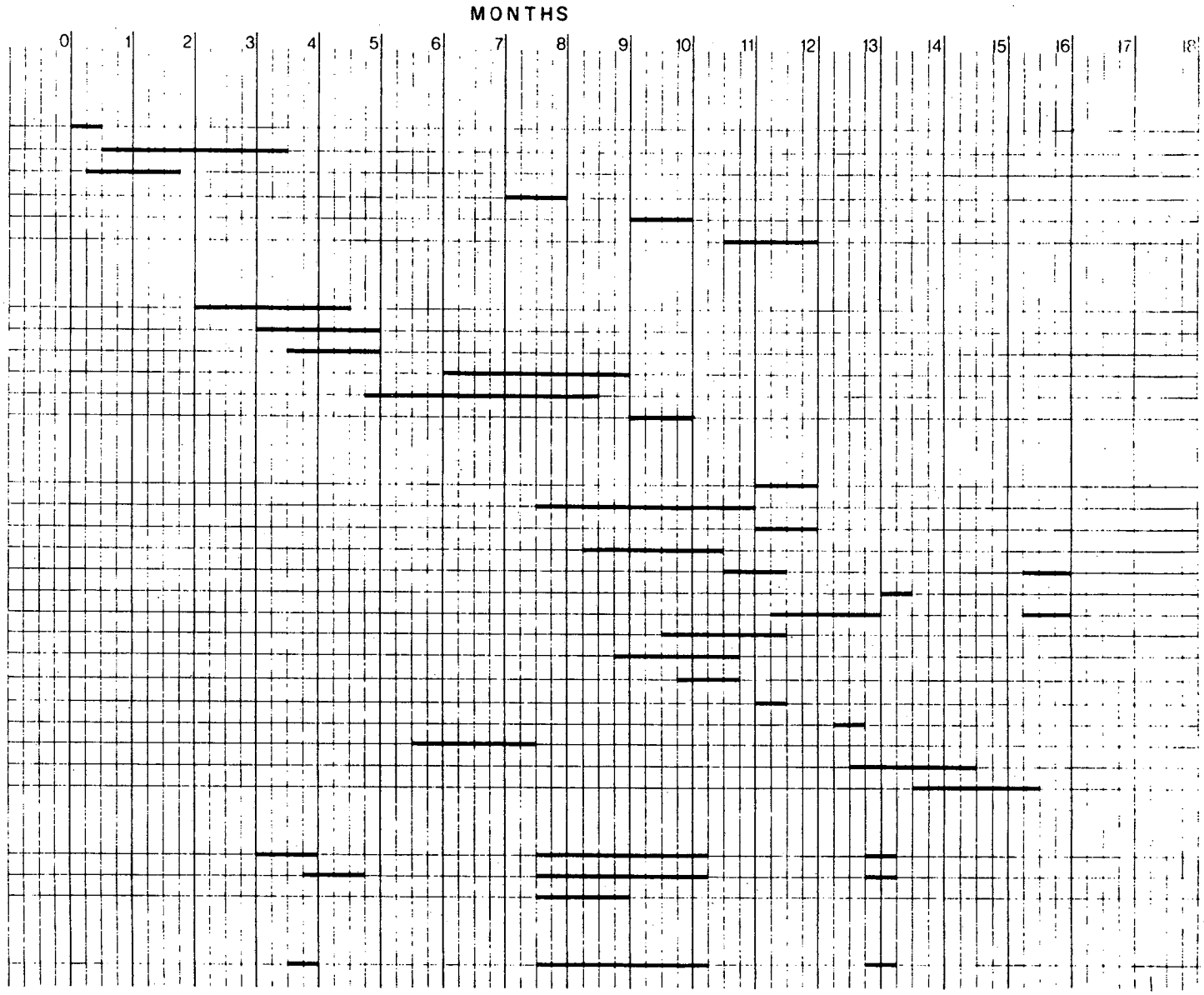
Section IV

PROJECT TIME SCHEDULE, CONSTRUCTION SCHEDULE, AND METHODS OF PERFORMANCE

ATOMIC RESOLUTION MICROSCOPE LABORATORY - PROJECT TIME SCHEDULE



CONSTRUCTION SCHEDULE
ATOMIC RESOLUTION MICROSCOPE LABORATORY
BUILDING 72
LAWRENCE BERKELEY LABORATORY
BERKELEY CALIFORNIA



Section IV

PROJECT TIME SCHEDULE, CONSTRUCTION SCHEDULE, AND METHODS OF PERFORMANCE

METHODS OF PERFORMANCE

1. Design

   a. A Design Program will be produced by the LBL Plant Engineering Department to direct the Architect-Engineer. This program will include design criteria for the architectural, structural, mechanical and electrical aspects of the building as well as site work, utilities, special facilities, and equipment to be included in the construction subcontract documents.

   b. A competent Architect-Engineer firm experienced in this type and scale project will be selected by the University and a lump-sum subcontract will be negotiated and awarded by the University.

   c. LBL construction inspectors will perform inspection of construction (Title III).

2. Construction

   a. Major construction services will be performed under lump-sum subcontracts awarded after competitive bidding.

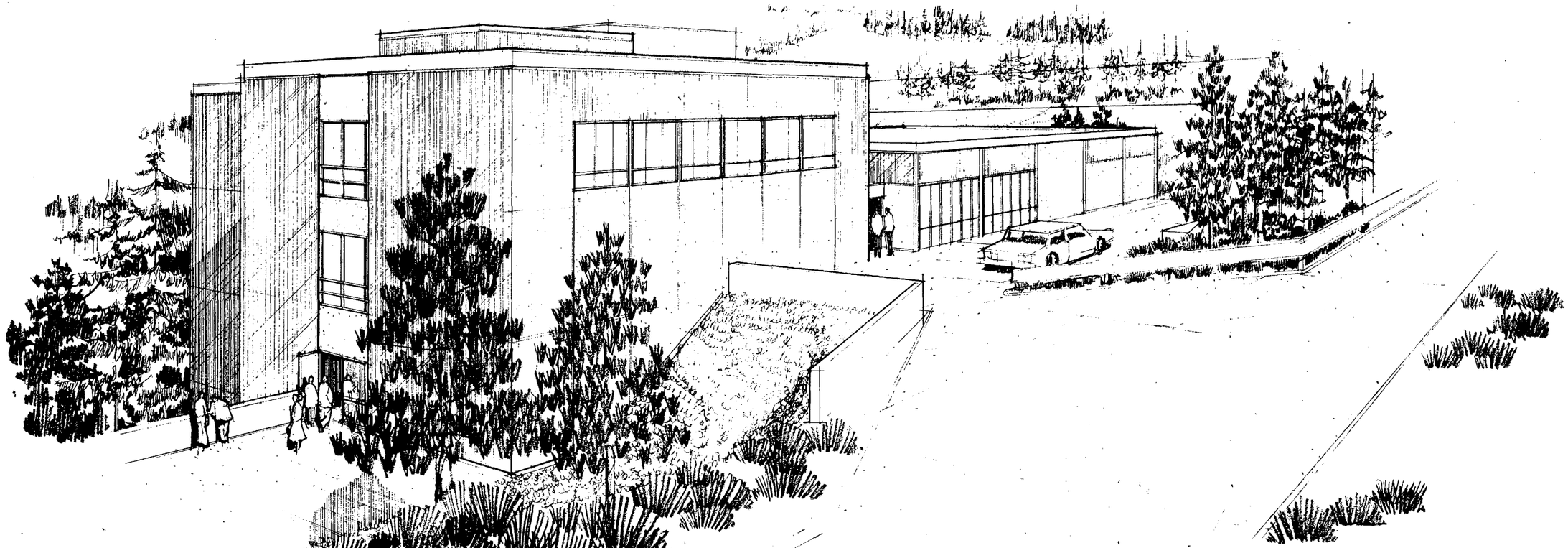
   b. Some construction, alterations, modifications and equipment installation will be done by LBL crafts.

3. Procurement

   Wherever feasible, LBL will procure standard equipment and some special facilities through competitive bidding.

Section V

ARCHITECTURAL/MECHANICAL/ELECTRICAL DRAWINGS



ATOMIC RESOLUTION MICROSCOPE LABORATORY

LAWRENCE BERKELEY LABORATORY BERKELEY, CALIFORNIA

ARCHITECTS/ RATCLIFF, SLAMA & CADWALADER
STRUCTURAL ENGINEERS/ BUTZBACH, BAR-DIN & DAGAN
MECHANICAL ENGINEERS/ CHARLES & BRAUN
ELECTRICAL ENGINEERS/ MAZZETTI & ASSOCIATES
SOLAR CONSULTANTS/ INTERACTIVE RESOURCES, INC.

LIST OF DRAWINGS

A-1 SITE PLAN
A-2 SPECTROMETER LEVEL FLOOR PLAN
A-3 A.R.M. CONSOLE LEVEL FLOOR PLAN
A-4 MAIN ENTRANCE LEVEL FLOOR PLAN
A-5 TOP FLOOR PLAN
A-6 ROOF PLAN
A-7 EAST ELEVATION
A-8 WEST ELEVATION
A-9 SOUTH ELEVATION & SECTION
ME-1 MECHANICAL & ELECTRICAL SITE PLAN
M-1 MECHANICAL: SPECTROMETER LEVEL PLAN & SCHEDULE
M-2 MECHANICAL: A.R.M. CONSOLE LEVEL PLAN
M-3 MECHANICAL: MAIN ENTRANCE LEVEL PLAN
M-4 MECHANICAL: TOP LEVEL PLAN
M-5 MECHANICAL: ROOF PLAN
E-1 ELECTRICAL: SPECTROMETER LEVEL PLAN
E-2 ELECTRICAL: A.R.M. CONSOLE LEVEL PLAN
E-3 ELECTRICAL: MAIN ENTRANCE LEVEL PLAN
E-4 ELECTRICAL: TOP LEVEL PLAN

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

ATOMIC RESOLUTION MICROSCOPE LABORATORY

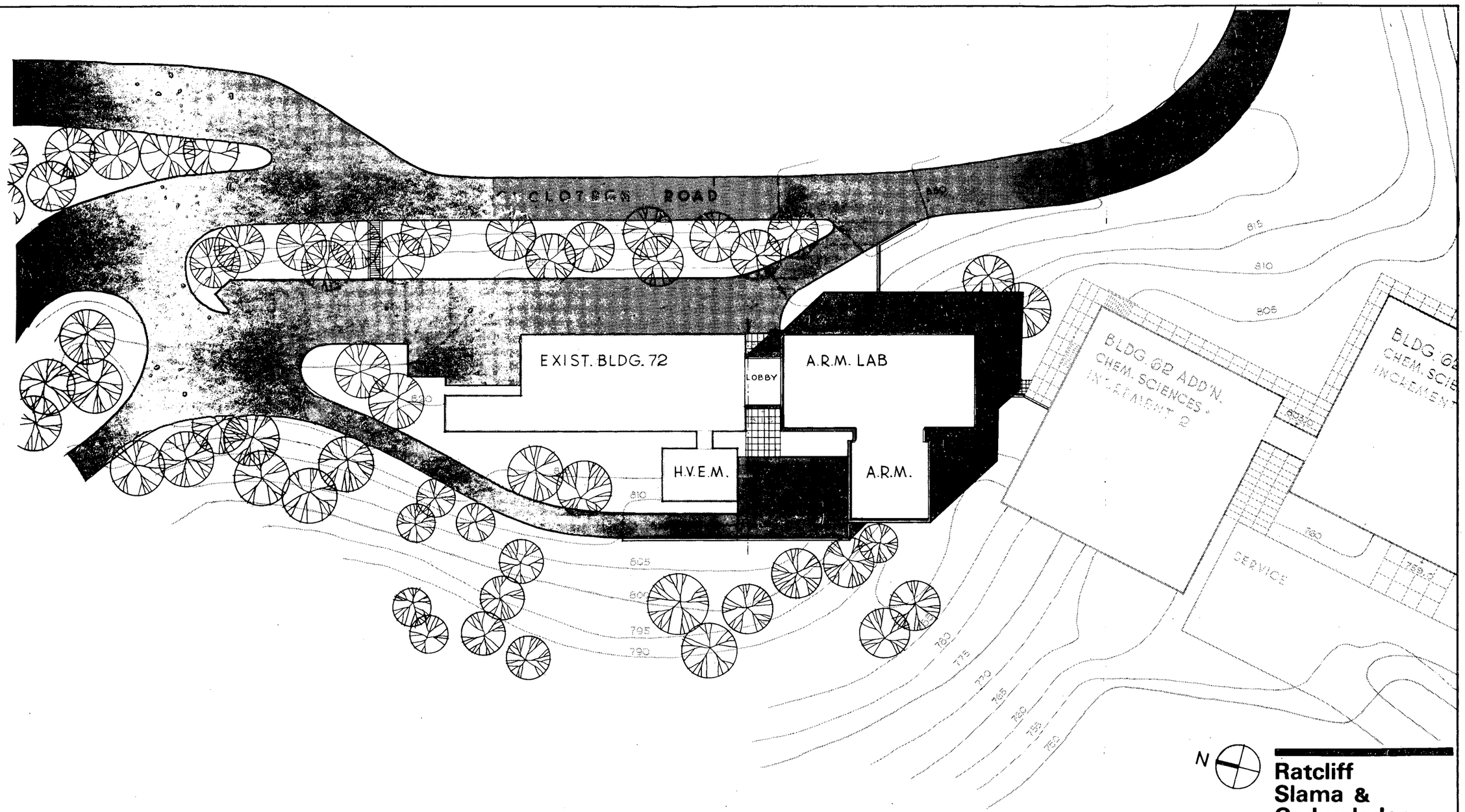
DRAWN BY	DATE	APPR. BY	DATE	SHEET NO.
	JUL 1974	CKD BY	DATE	SCA.
				ACCT NO.

UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY
PLANT ENGINEERING

SITE DRAWING NUMBER

GPO 691-602 — 1976

RL-1046 — SIZE 4



Ratcliff
Slama &
Cadwalader
ARCHITECTS & PLANNERS

SITE PLAN

75 FT.

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

ATOMIC RESOLUTION
MICROSCOPE LABORATORY

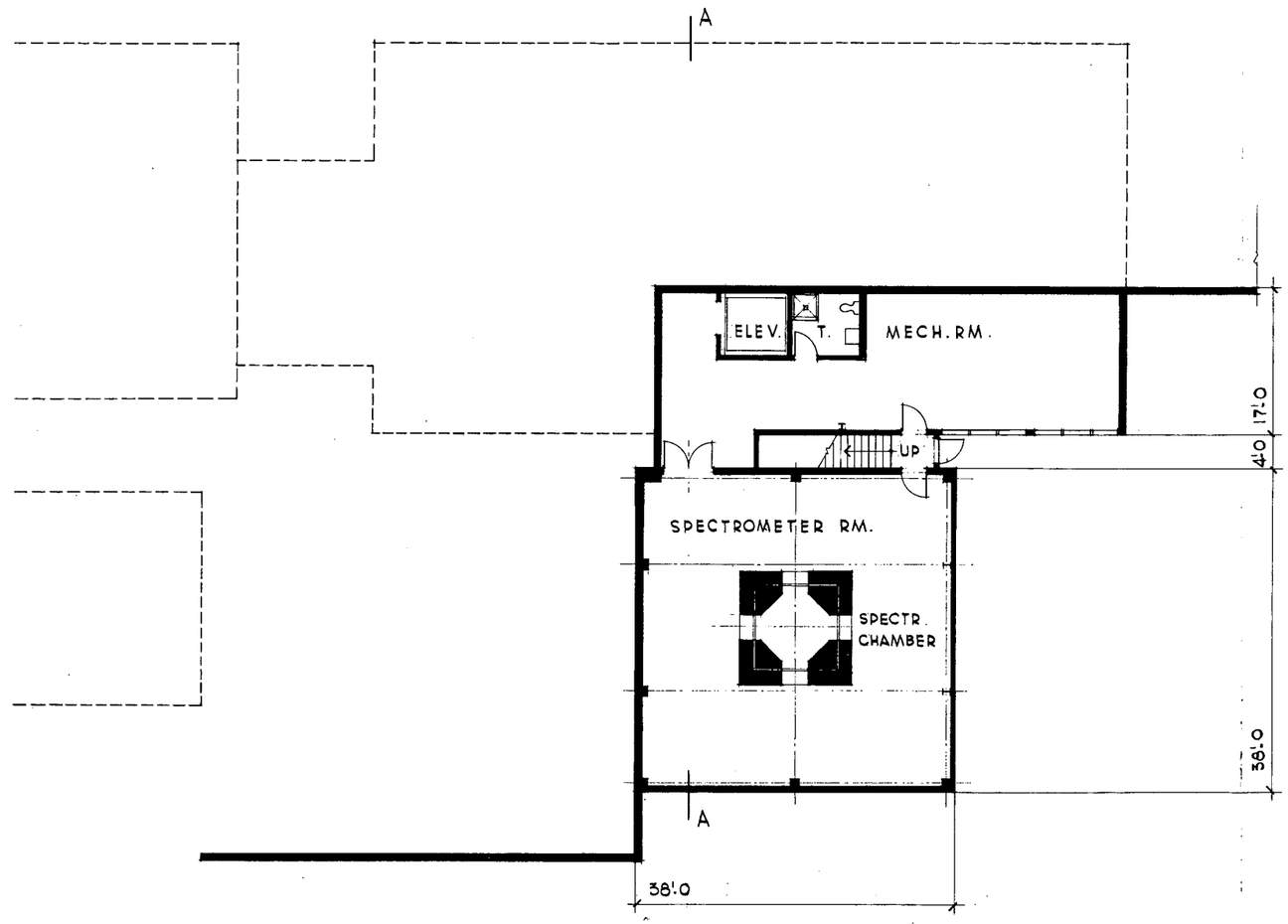
DRAWN BY	DATE	APPR. BY	DATE
	JUL 10 1978	CKD BY	DATE

UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY
PLANT ENGINEERING

SHEET NO. A1
SCALE 1" = 20'
ACCT NO.
SITE DRAWING NUMBER 4B72B027

GPO 891-402 — 1978

RL-1046 — SIZE 4



SPECTROMETER LEVEL

EL. 799.5

24'

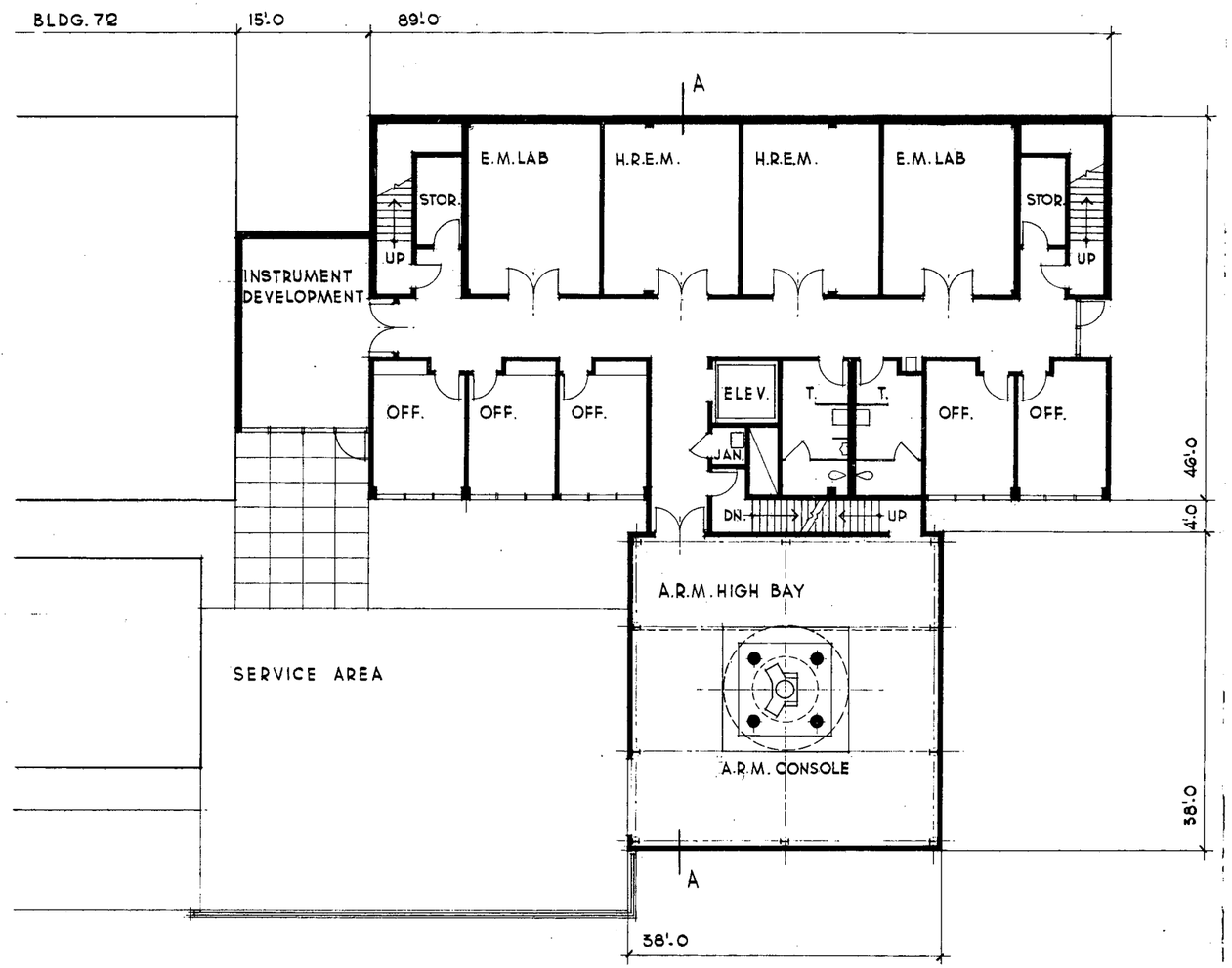
N

ATOMIC RESOLUTION MICROSCOPE LABORATORY				SHEET NO.	A2
DRAWN BY	DATE	APPR. BY	DATE	SCALE 1" = 8'	
	JUL 10 1978	CKD BY	DATE	ACC'T NO.	
UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY				SITE	DRAWING NUMBER
PLANT ENGINEERING					4B72B028

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

☆GPO 891-402 — 1976

RL-1048 — SIZE 4



A.R.M. CONSOLE LEVEL

EL. 811.5

24'

N

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

ATOMIC RESOLUTION MICROSCOPE LABORATORY

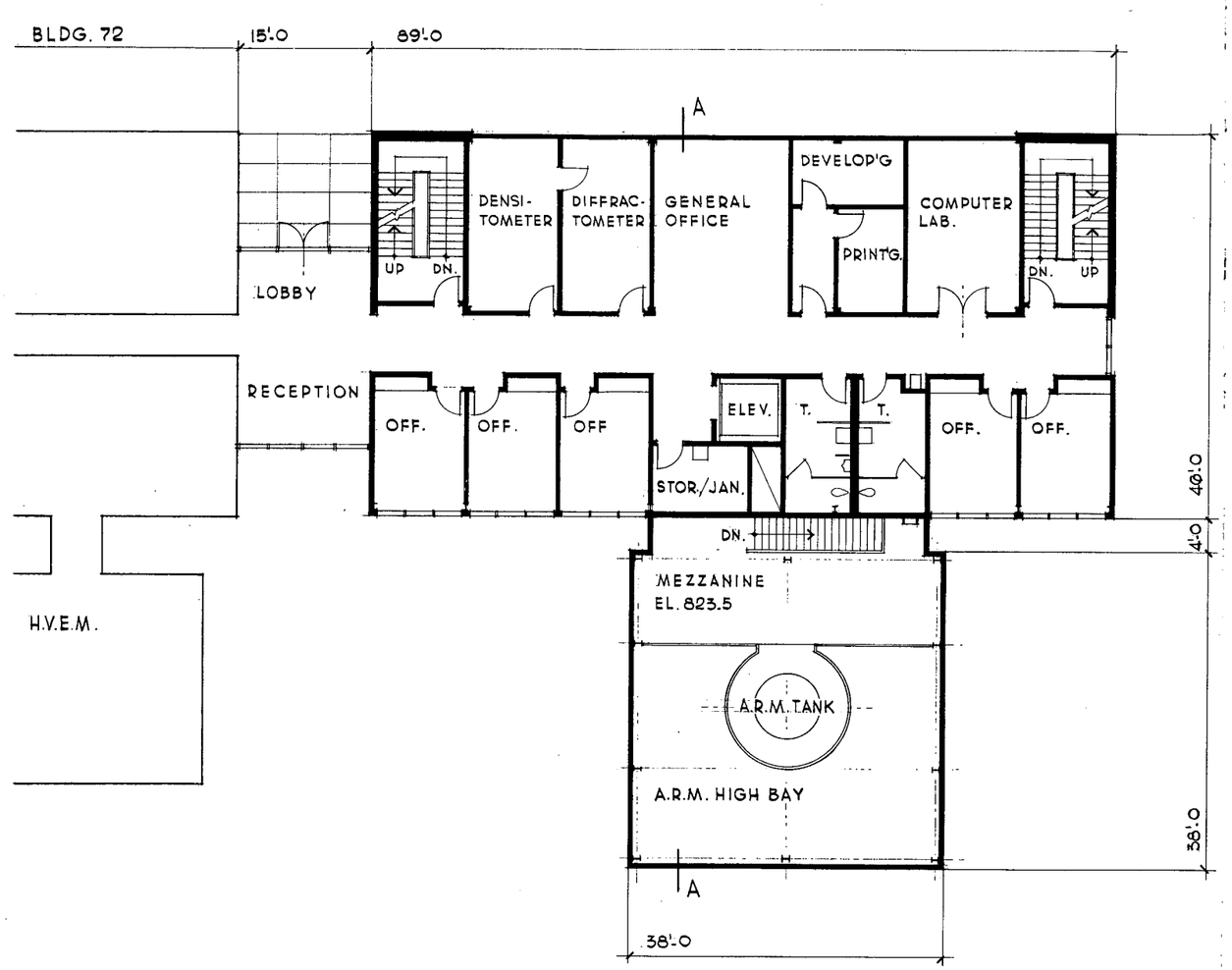
DRAWN BY	DATE	APPR. BY	DATE	SHEET NO. A3
	JUL 10 1978	CKD BY	DATE	SCALE 1" = 8'
				ACC'T NO.

UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY
PLANT ENGINEERING

SIZE DRAWING NUMBER 4B72B029

☆GPO 681-605 — 1974

RL-1046 — SIZE 4



MAIN ENTRANCE LEVEL

EL. 825.5

24'

N

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

ATOMIC RESOLUTION MICROSCOPE LABORATORY

SHEET NO. **A4**

DRAWN BY	DATE	APPR. BY	DATE	SCALE 1" = 8'
	JUL 10 1978	CKD BY	DATE	ACC'T NO.

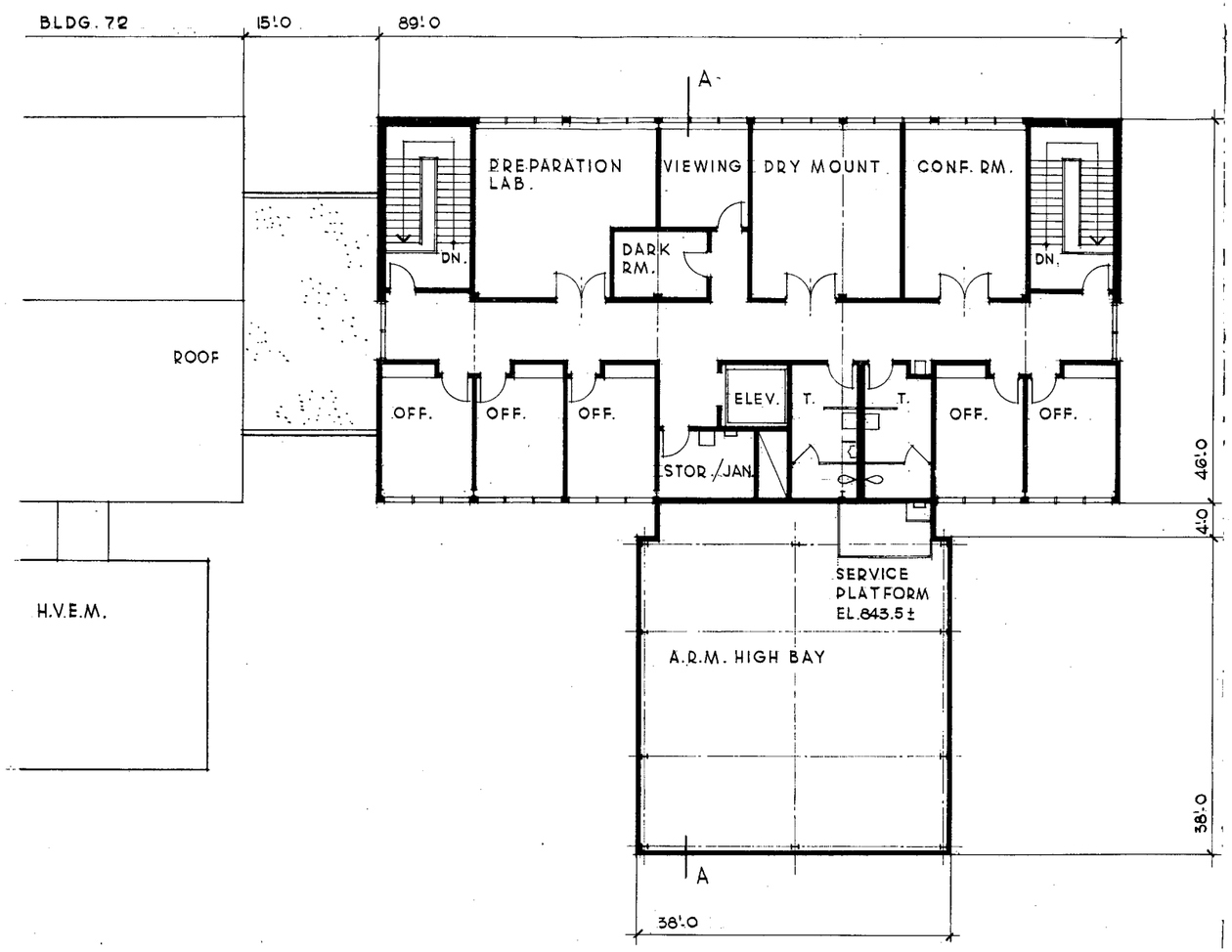
UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY

PLANT ENGINEERING

SITE | DRAWING NUMBER: 4B72B030

GGPO 681-402 — 1976

RL-1048 — SIZE 4



TOP FLOOR
EL. 839.5

24'

N

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

ATOMIC RESOLUTION MICROSCOPE LABORATORY

SHEET NO. **A5**

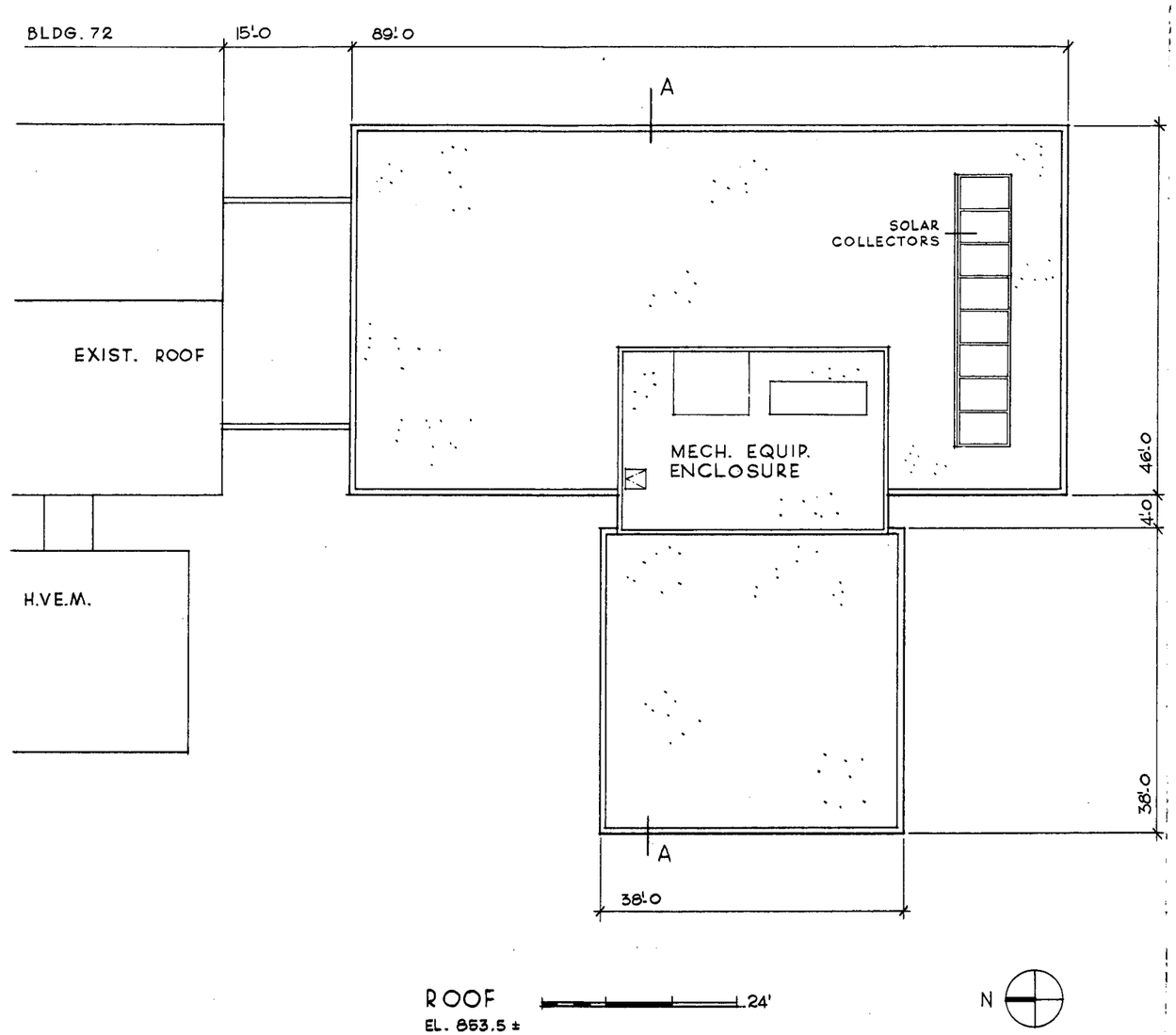
DRAWN BY	DATE	APPR. BY	DATE	SCALE 1" = 8'
	JUL 10 1978	CKD BY	DATE	ACCT NO.

UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY
PLANT ENGINEERING

SITE 4B DRAWING NUMBER 72 BO 31

GGPO 881-402 — 1976

RL-1048 — SIZE 4



CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

ATOMIC RESOLUTION MICROSCOPE LABORATORY

SHEET NO. **A6**

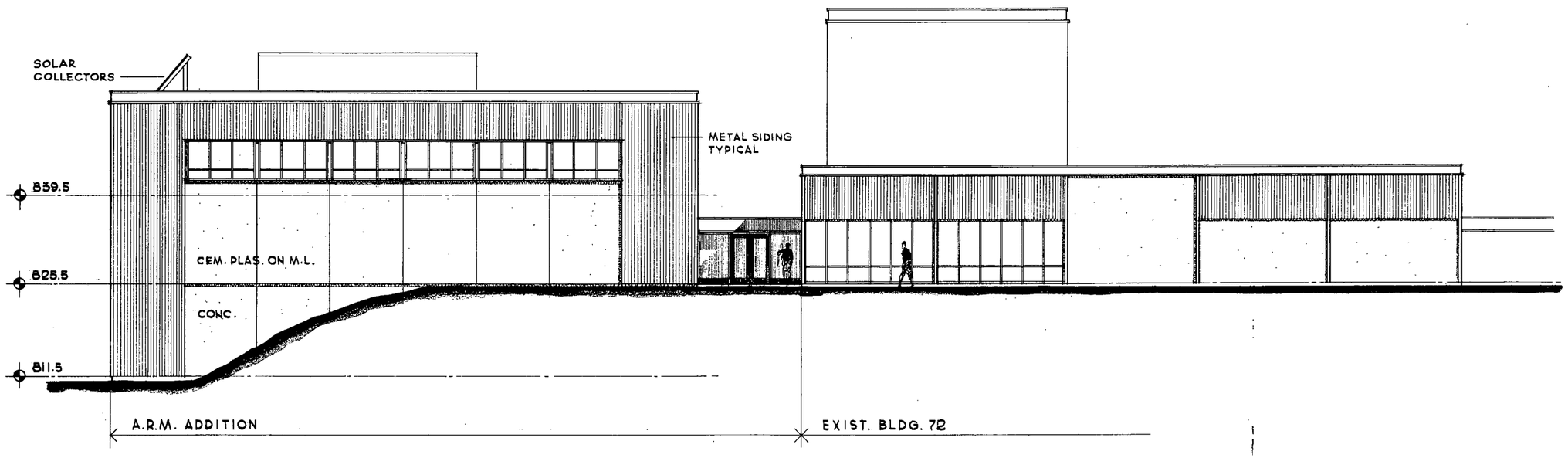
DRAWN BY	DATE	APPR. BY	DATE	SCALE 1" = 8"
	JUL 10 1978	CKD BY	DATE	ACCT NO.

UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY
PLANT ENGINEERING

SITE | DRAWING NUMBER
4B 72 B032

GPO 881-402 — 1976

RL-1048 — SIZE 4



EAST ELEVATION 24'

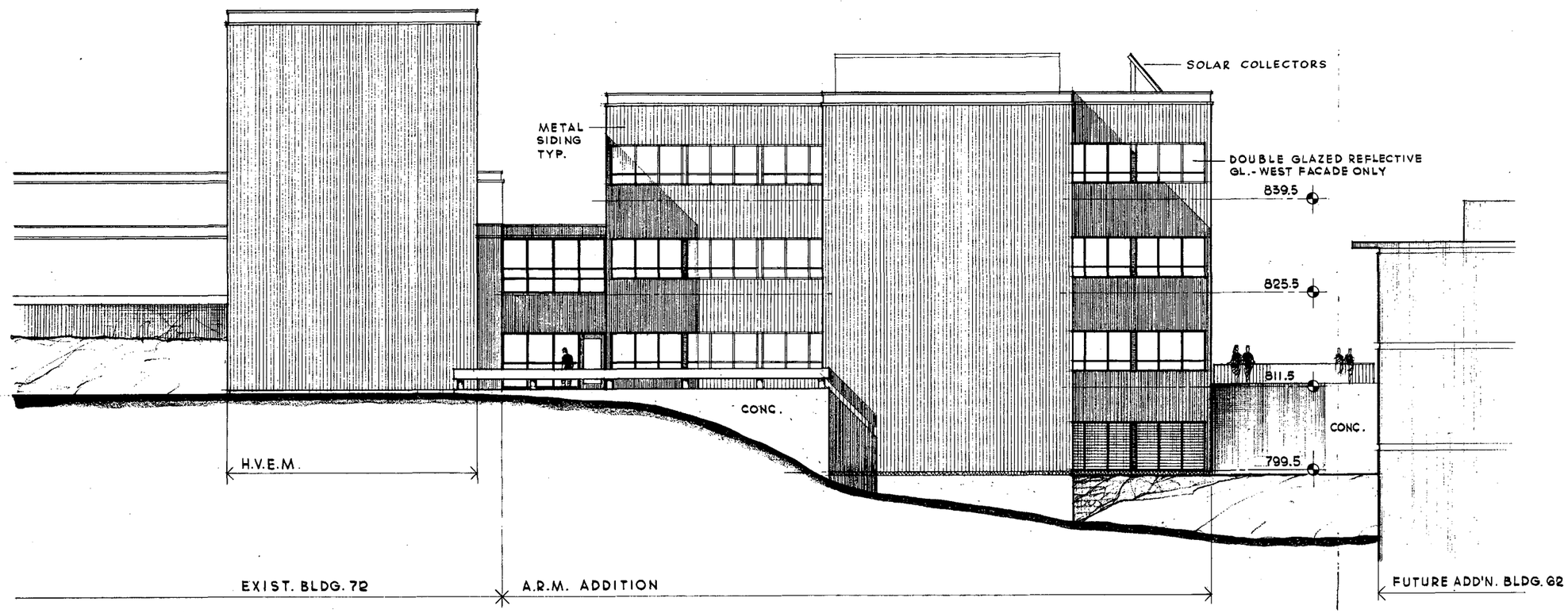
CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

ATOMIC RESOLUTION MICROSCOPE LABORATORY

DRAWN BY	DATE	APPR. BY	DATE
	JUL 10 1978	CKD BY	DATE

UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY
PLANT ENGINEERING

SHEET NO. A7
SCALE 1" = 8'
ACCT NO.
SITE DRAWING NUMBER 4B72B033



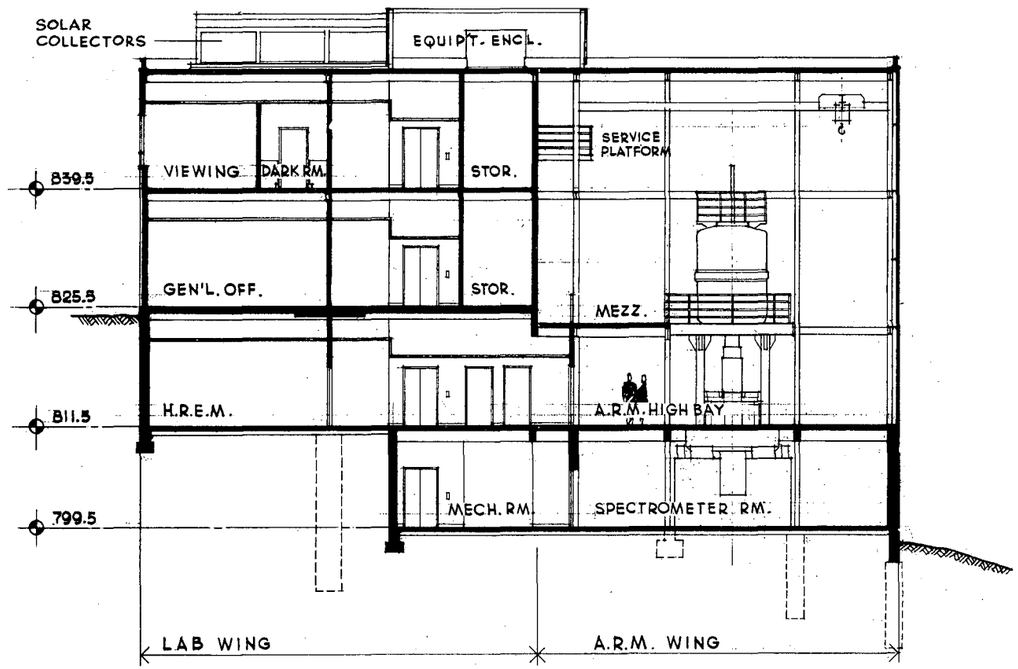
WEST ELEVATION 24'

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

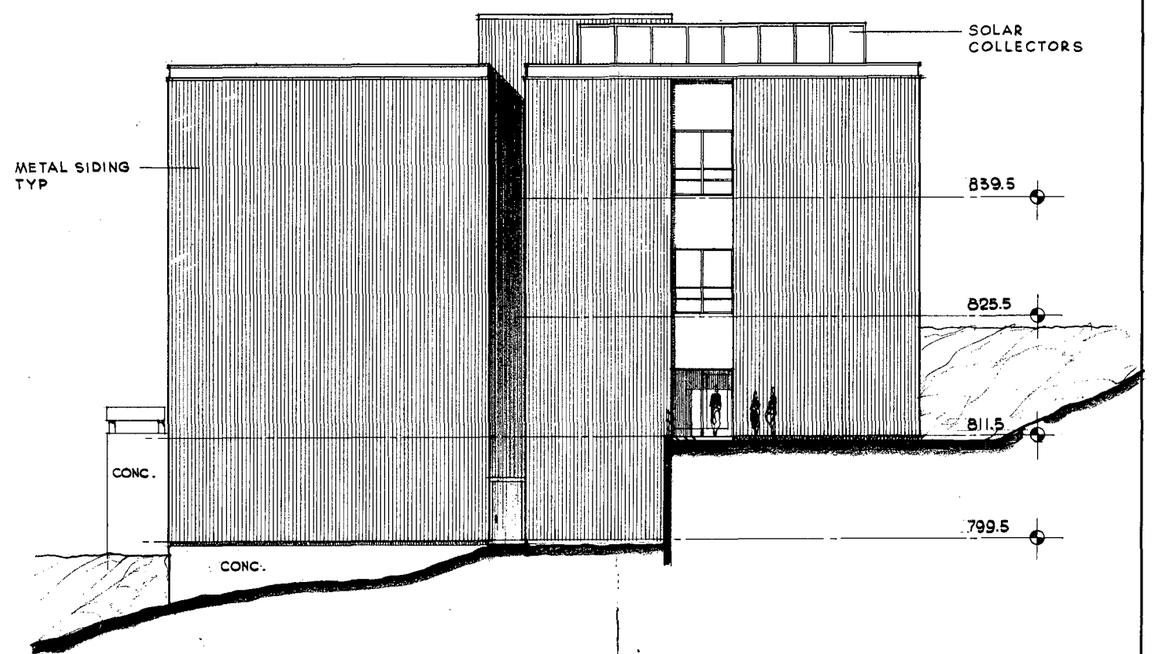
ATOMIC RESOLUTION MICROSCOPE LABORATORY			SHEET NO. A8
DRAWN BY	DATE	APPR. BY / DATE	SCALE 1" = 8'
	JUL 10 1978	CKD BY / DATE	ACC'Y NO.
UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY			SIZE / DRAWING NUMBER
PLANT ENGINEERING			4B72B034

RL-1046 — SIZE 4

GPO 681-402 — 1976



SECTION A-A 24'



SOUTH ELEVATION

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

ATOMIC RESOLUTION MICROSCOPE LABORATORY

SHEET NO. A9

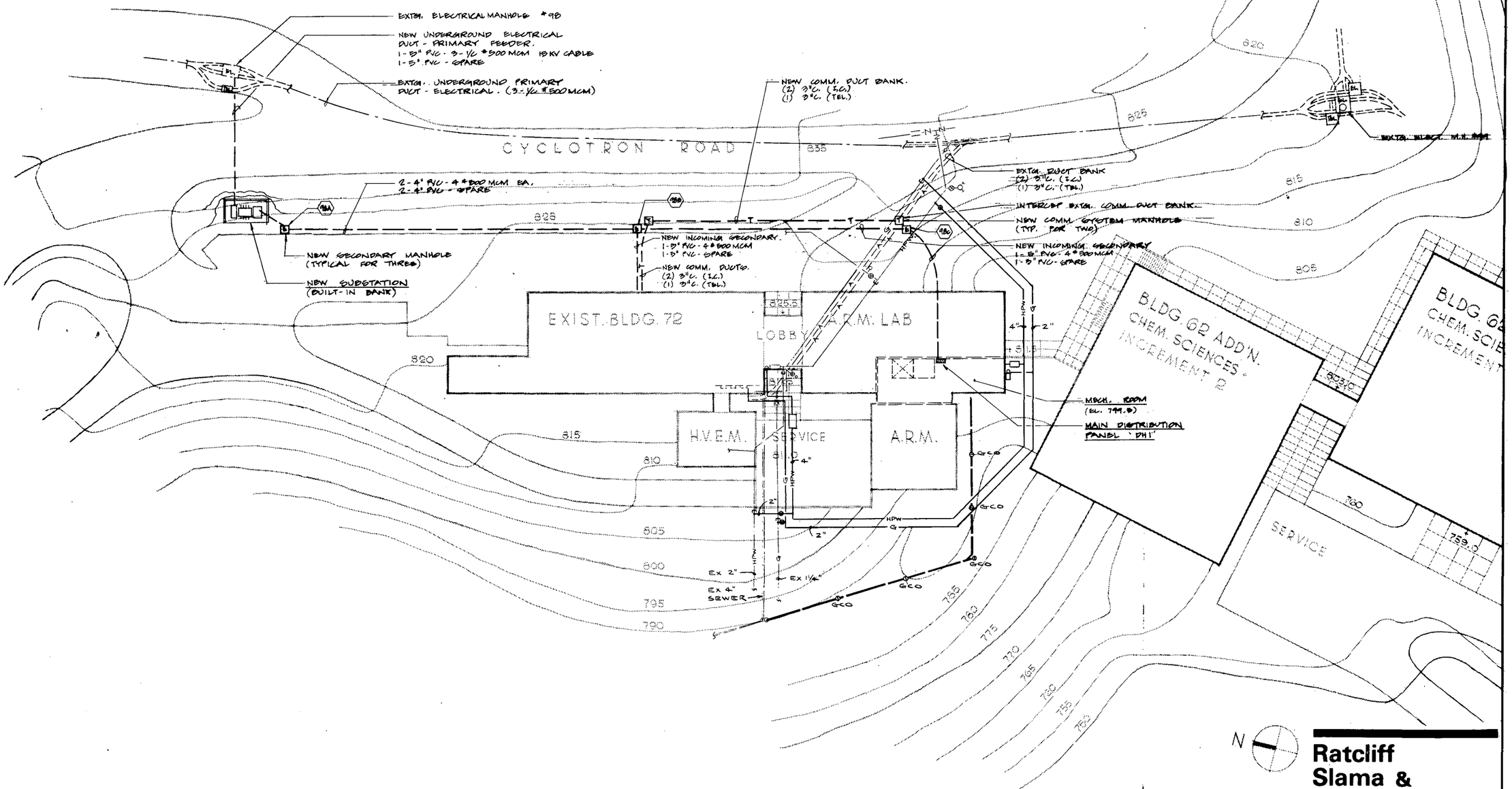
DRAWN BY	DATE	APPR. BY	DATE	SCALE 1" = 8'
	JUL 10 1978	CKD BY	DATE	ACC'T NO.

UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY
PLANT ENGINEERING

SITE | DRAWING NUMBER 4B72B035

RL-1046 — SIZE 4

GPO 681-402 — 1976



ATOMIC RESOLUTION MICROSCOPE LABORATORY			SHEET NO. ME1
DRAWN BY	DATE JUL 10 1978	APPR. BY / CKD BY	DATE / SCALE 1" = 20' / ACC'T NO.
UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY PLANT ENGINEERING			SITE / DRAWING NUMBER 4872B036

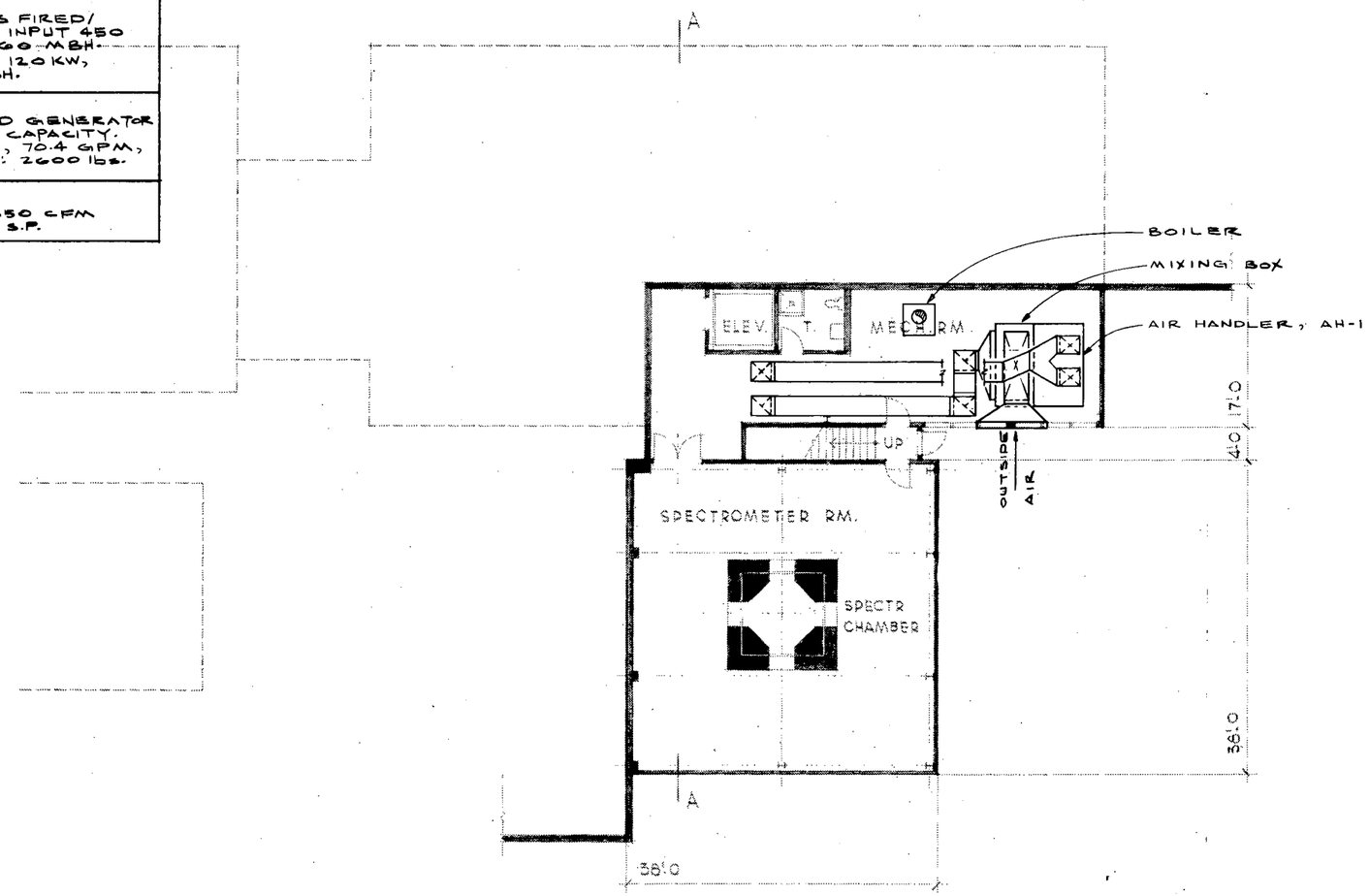
CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

GPO 891-402 — 1976

RL-1068 — SIZE 4

MECHANICAL EQUIPMENT SCHEDULE

MARK	MFG'R & MODEL	DESCRIPTION
AH-1	TRANE TORRIVENT #50	AIR HANDLER: 23,500 CFM @ ESTIMATED S.P. 2.5", 1.5 H.P. MOTOR
B-1	BRYAN D/F/E - 450	BOILER: DUAL FUEL, GAS FIRED/ ELECTRIC. GAS INPUT 450 MBH, OUTUT 360 MBH. ELECTRIC INPUT 120 KW, OUTPUT 400 MBH.
C-1	TRANE CGAA-030M	CHILLER: AIR COOLED COLD GENERATOR 30 TON NOMINAL CAPACITY. 40° LWT, 29.4 TON, 70.4 GPM, 33.4 KW. WIEGHT: 2600 lbs.
EF-1	ACME CENTRI-MASTER MODEL P27K	EXHAUST FAN: BELT DRIVE, 2,350 CFM @ ESTIMATED 3/4" S.P.



SPECTROMETER LEVEL
EL. 799.5

24'

N

Ratcliff Slama & Cadwalader
ARCHITECTS & PLANNERS

ATOMIC RESOLUTION MICROSCOPE LABORATORY

SHEET NO. **M1**

DRAWN BY | DATE | APPR. BY | DATE | SCALE 1" = 8'
JUL 10 1978 | CHD BY | DATE | ACCT NO.

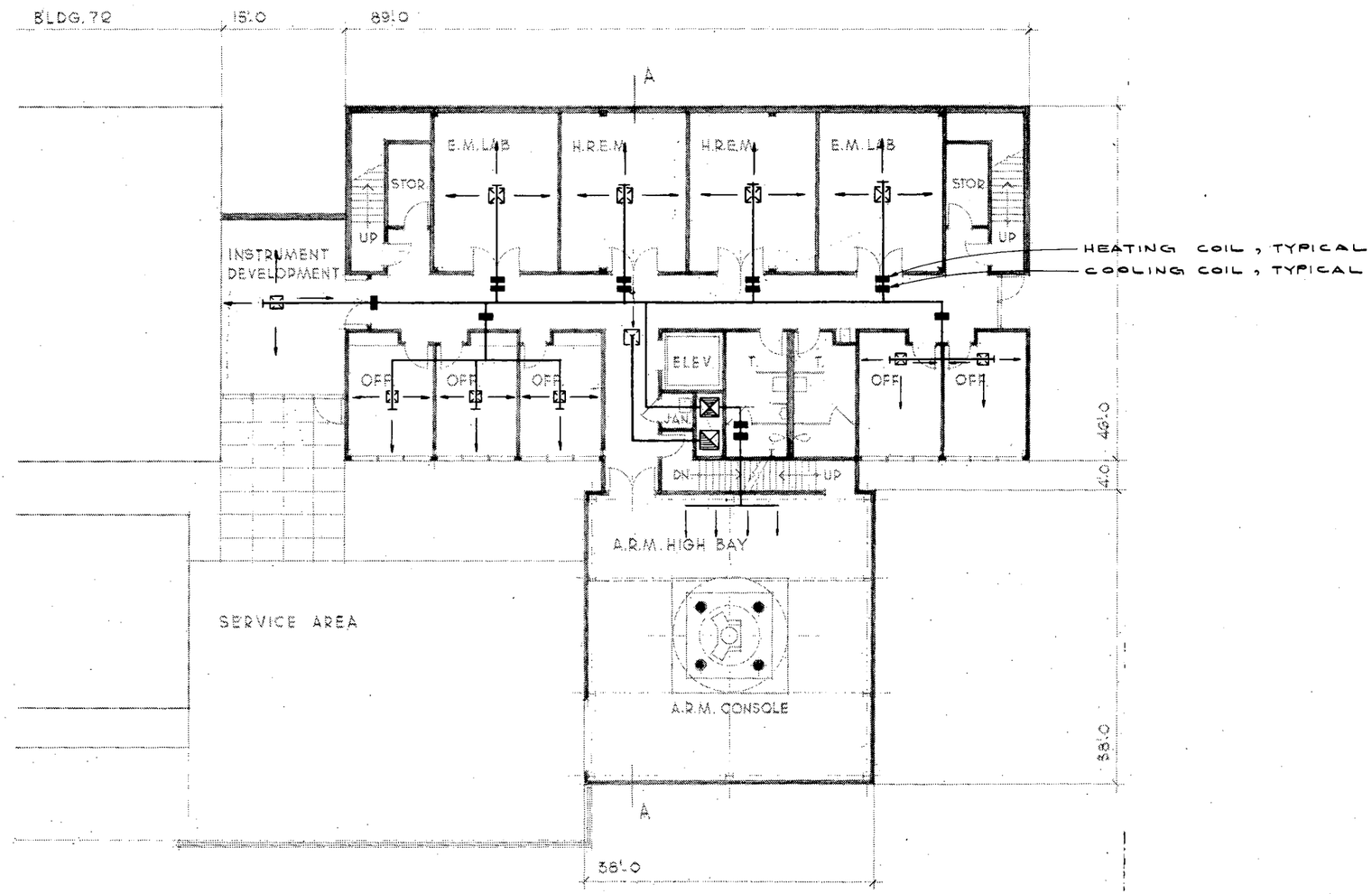
UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY
PLANT ENGINEERING

SIZE | DRAWING NUMBER
4B72B037

CHANGE LETTER | DRAWN BY | CHECK BY | DATE | REVISIONS

GGPO 691-402 — 1978

RL-1048 — SIZE 4



A.R.M. CONSOLE LEVEL
EL. 811.5

24'

N

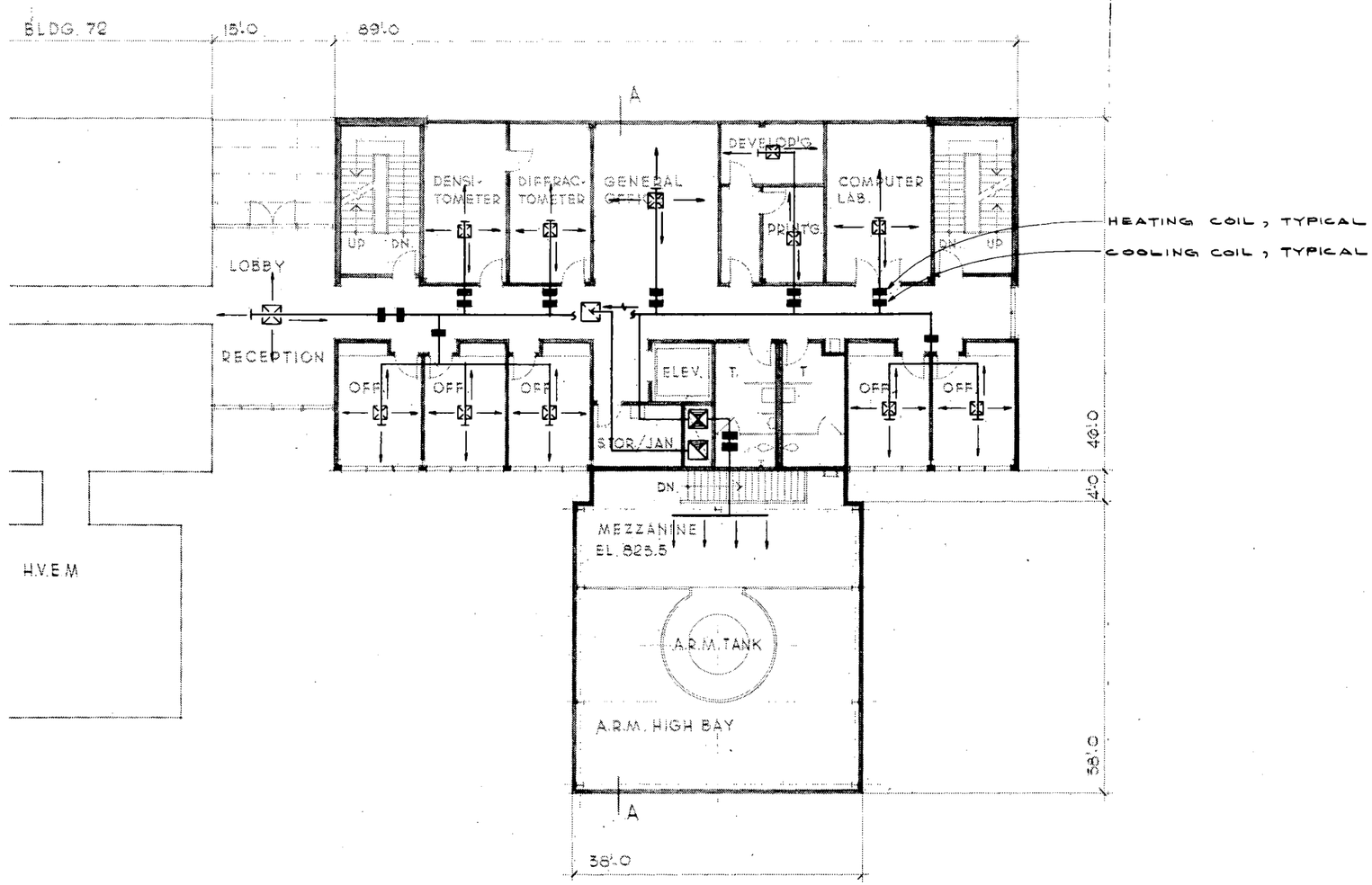
Ratcliff Slama & Cadwalader
ARCHITECTS & PLANNERS

ATOMIC RESOLUTION MICROSCOPE LABORATORY	SHEET NO. **M2**
DRAWN BY / DATE: JUL 10 1978	APPR. BY / DATE; CKD BY / DATE	SCALE 1" = 8' ; ACCT NO.
UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY PLANT ENGINEERING	SITE / DRAWING NUMBER 4B72B038

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

COPO 681-402 — 1978

RL-1048 — SIZE 4



MAIN ENTRANCE LEVEL

EL. 825.5

24'

N

Ratcliff Slama & Cadwalader

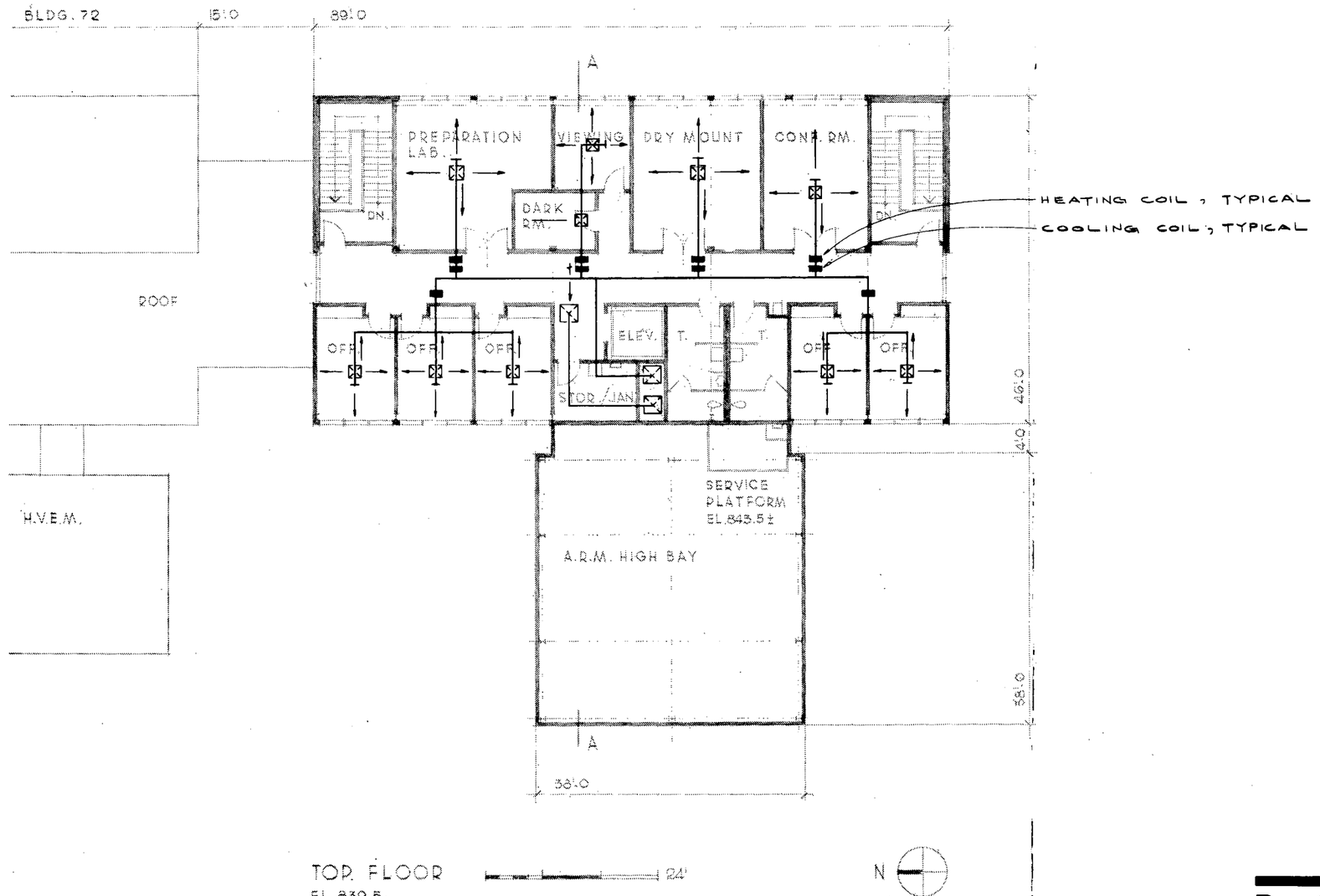
ARCHITECTS & PLANNERS

ATOMIC RESOLUTION MICROSCOPE LABORATORY			SHEET NO. **M3**
DRAWN BY	DATE	APPR. BY / DATE	SCALE 1" = 8'
	JUL 10 1978	CHD BY / DATE	ACCT NO.
UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY			SITE / DRAWING NUMBER
PLANT ENGINEERING			4B72B039

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

OGPO 691-402 — 1976

RL-1068 — SIZE 4



Ratcliff Slama & Cadwalader

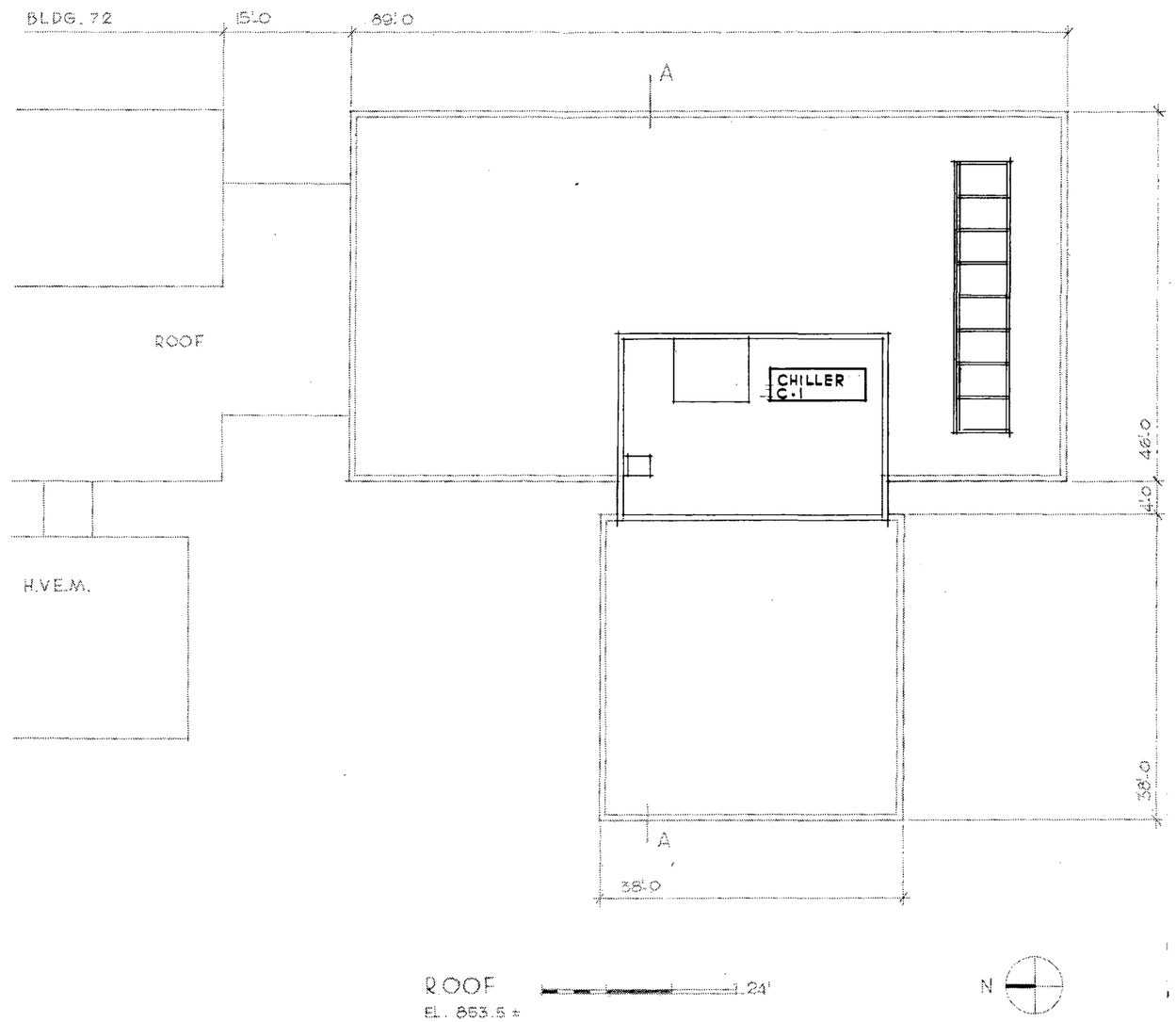
ARCHITECTS & PLANNERS

ATOMIC RESOLUTION MICROSCOPE LABORATORY			SHEET NO. **M4**
DRAWN BY	DATE JUL 10 1978	APPR. BY / CHD BY	DATE / DATE	SCALE 1" = 8' / ACCT NO.
UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY PLANT ENGINEERING			SITE 4B 72 B040 (DRAWING NUMBER)

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

OGPO 681-402 — 1976

RL-1088 — SIZE 4



Ratcliff Slama & Cadwalader

ARCHITECTS & PLANNERS

ATOMIC RESOLUTION MICROSCOPE LABORATORY			SHEET NO. M5
DRAWN BY	DATE	APPR. BY	DATE	SCALE 1" = 8'
JUL 10 1978		CHD BY	DATE	ACCT NO.
UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY				SITE / DRAWING NUMBER
PLANT ENGINEERING				4B728041

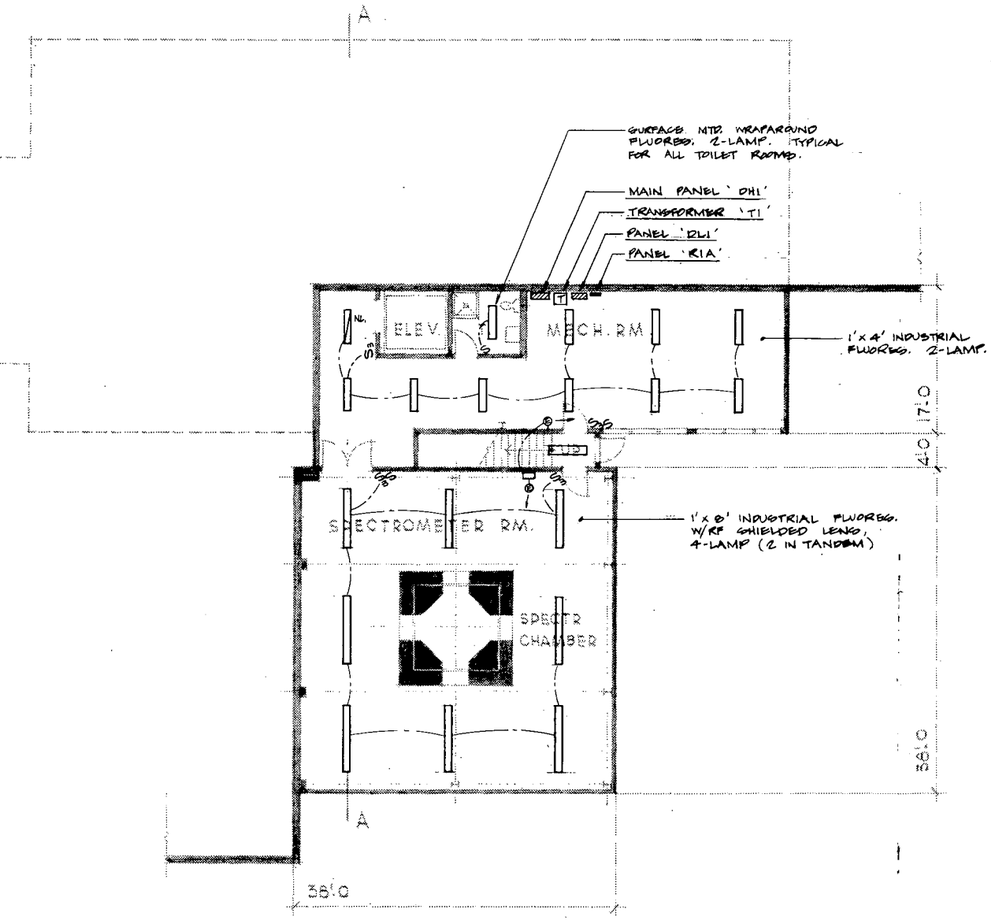
CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

GPO 891-402 — 1976

RL-1048 — SIZE 4

SYMBOL LIST

- CEILING OUTLET AND FIXTURE.
- BRACKET OUTLET AND FIXTURE.
- FLUORESCENT FIXTURE.
- NL — FLUORESCENT FIXTURE, CONNECT TO NIGHT LIGHT CIRCUIT
- EMERGENCY BATTERY LIGHT UNIT WITH ONE HEAD. ARROW DENOTES AIMING DIRECTION.
- REMOTE EMERGENCY LIGHTING HEAD.
- S — SINGLE-POLE LIGHT SWITCH.
- S3 — THREE-WAY LIGHT SWITCH.
- DIMMER CONTROL SWITCH.
- LIGHTING AND RECEPTACLE PANELBOARDS.
- DISTRIBUTION PANELBOARDS.
- T — STEP-DOWN TRANSFORMER.
- CABINET AS NOTED.
- DENOTES CONDUIT RUN FOR FIXTURES CONTROLLED BY ROOM SWITCH.



SPECTROMETER LEVEL

EL. 799.5

24'

N

Ratcliff Slama & Cadwalader

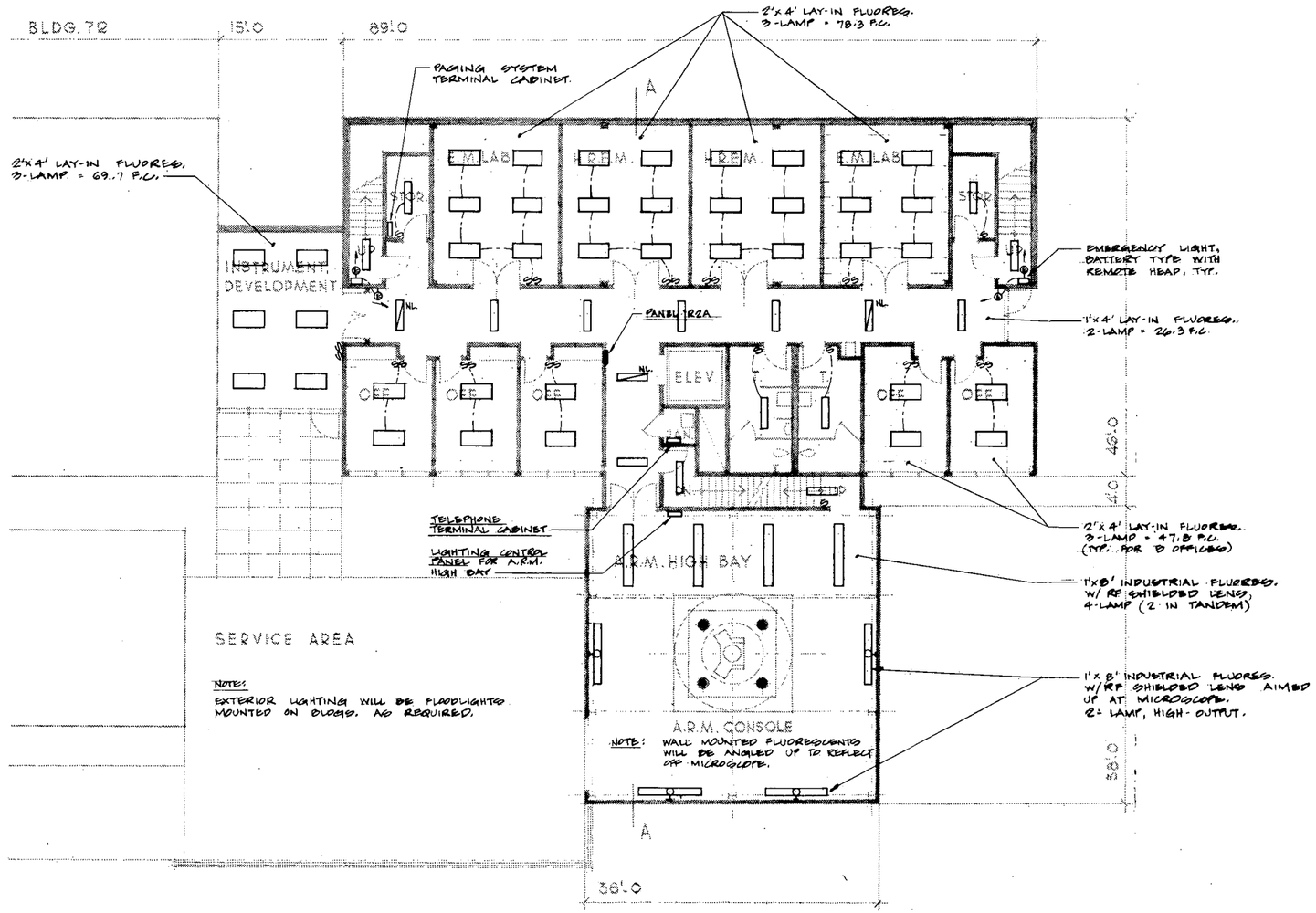
ARCHITECTS & PLANNERS

ATOMIC RESOLUTION MICROSCOPE LABORATORY			SHEET NO. E1
DRAWN BY	DATE	APPR. BY	DATE	SCALE 1/8" = 1'
	JUL 10 1978	CKD BY	DATE	ACCT NO.
UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY			SIZE	DRAWING NUMBER
PLANT ENGINEERING			4B72B042	

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

GPO 691-402 — 1976

RL-1068 — SIZE 4



A.R.M. CONSOLE LEVEL

EL. 811.5

24'

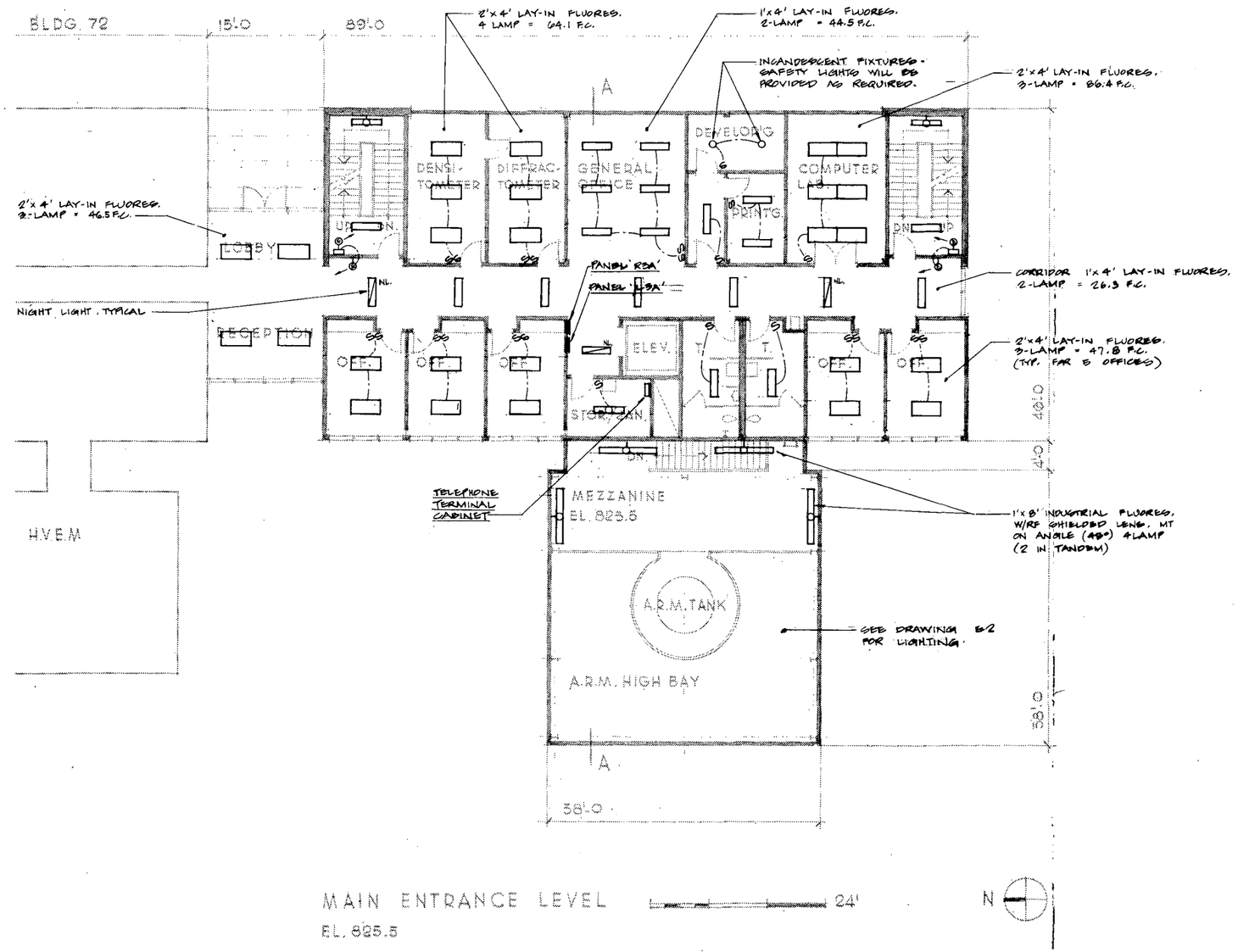
N

Ratcliff Slama & Cadwalader

ARCHITECTS & PLANNERS

ATOMIC RESOLUTION MICROSCOPE LABORATORY			SHEET NO. E2
DRAWN BY	DATE JUL 10 1978	APPR. BY / CKD BY	DATE / DATE	SCALE 1" = 8' / ACCT NO.
UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY			SITE / DRAWING NUMBER
PLANT ENGINEERING			4B72B043

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS



Ratcliff Slama & Cadwalader

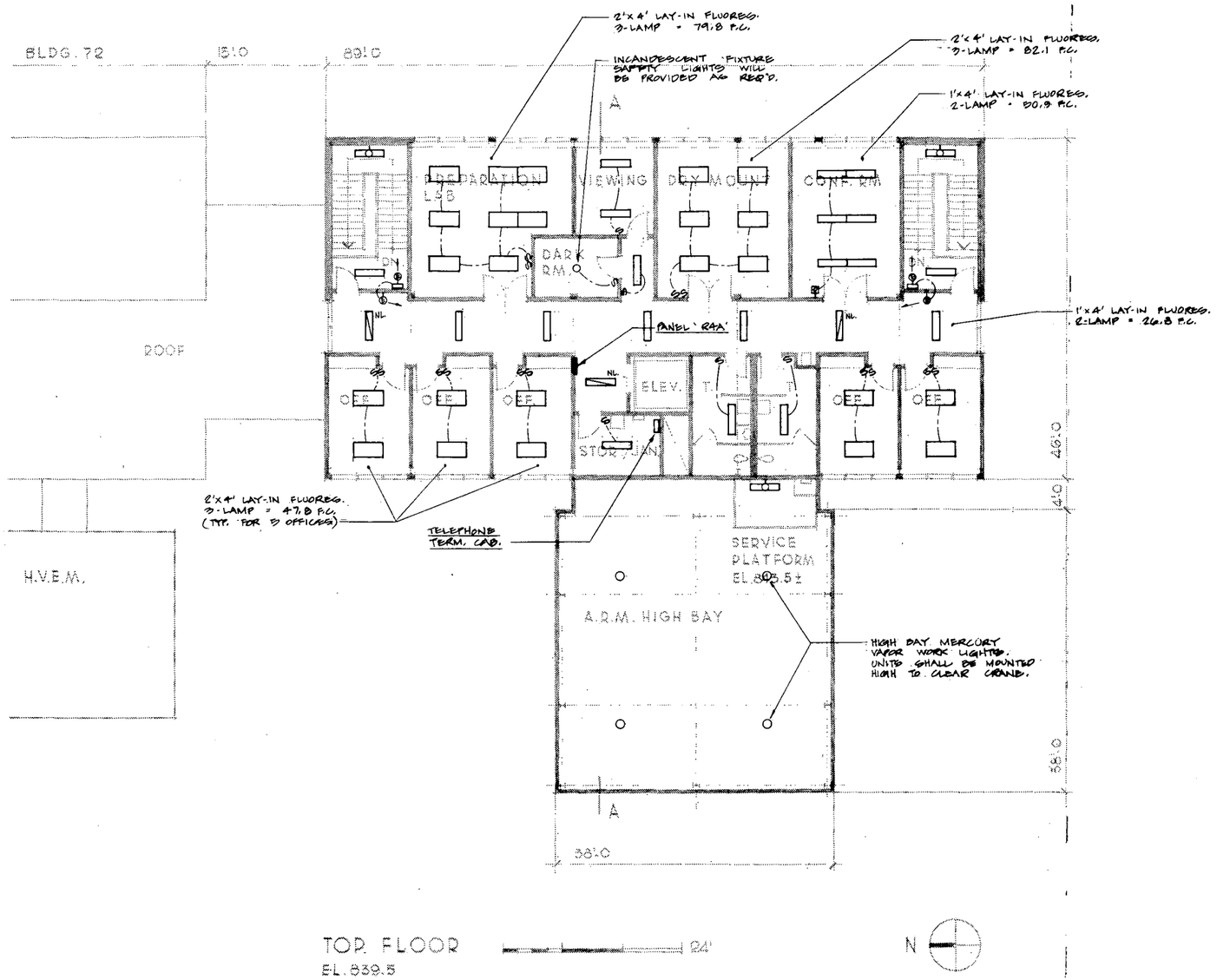
ARCHITECTS & PLANNERS

ATOMIC RESOLUTION MICROSCOPE LABORATORY	SHEET NO. E3
DRAWN BY / DATE: JUL 10 1978 / APPR. BY / DATE / CKD BY / DATE	SCALE 1/8" = 8' / ACC'T NO.
UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY — PLANT ENGINEERING	SITE / DRAWING NUMBER 4B72B044

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

GOPO 691-402 — 1976

RL-1048 — SIZE 4



TOP FLOOR
EL. 839.5

24'

N

Ratcliff Slama & Cadwalader
ARCHITECTS & PLANNERS

ATOMIC RESOLUTION MICROSCOPE LABORATORY			SHEET NO. E4
DRAWN BY	DATE	APPR. BY	DATE	SCALE 1/8" = 8'
	APR 10 1978	CHD BY	DATE	ACC'T NO.
UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LABORATORY PLANT ENGINEERING			SITE 4B	DRAWING NUMBER 72B045

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	REVISIONS

GGPO 691-403 — 1976

RL-1048 — SIZE 4

Section VI

OUTLINE SPECIFICATIONS

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Section VI

OUTLINE SPECIFICATIONS

DIVISION 1 - GENERAL REQUIREMENTS

SECTION 1A - SUMMARY OF WORK

A. Scope

This project entails the following major categories of work.

1. Site development, including earthwork, excavation, finished grading and landscaping.

2. New building construction consists of a new A.R.M. Laboratory addition to Building 72 and connecting lobby.

3. Alteration work will be required at the exterior of the existing facility to accommodate the above mentioned addition.

B. Materials and Systems

New construction will consist of steel framing, reinforced concrete, insulated metal siding, interior wood stud partitions, resilient flooring, acoustical ceilings. New Laboratory Building will be partially air conditioned.

C. Execution

All work will conform to highest standards of construction practices, and will conform to special Lawrence Berkeley Laboratory design standards. Applicable provisions of the following codes are hereby referred to and made a part of this work. All work performed shall be in accordance with such laws, regulations, and the latest edition of all applicable codes including, but not limited to:

1. 29 CFR Part 1926, Safety and Health Regulations for Construction, Department of Labor.

2. 29 CFR Part 1910, Occupational Safety and Health Standards, Department of Labor.

3. General Safety Requirements, EM 385-1-1, U.S. Corps of Engineers (Department of Army).

4. National Fire Codes.

5. National Electrical Safety Code.

6. Lists of Inspected Appliances, Equipment and Materials (U.L.).

7. Approved Equipment Listing (FM).

8. Handbook of Rigging (Rossnagel).

9. Safety Code for Building Construction, ANSI A10.2.

10. California Administrative Code, Title 8, General Industry Safety Orders, Construction Safety Orders.

11. California Administrative Code, Title 19, Chapter 1, Title 24; Part 2, and Title 24, Part 6, Division T-19.

12. Uniform Building Code.

13. National Plumbing Code, ANSI A.40.8.

14. National Bureau of Standards "Design and Evaluation Criteria for Energy Conservation in New Buildings", No. NBSIR 74-452, latest edition.

Where codes or standard specifications other than those listed in this paragraph are referred to in the different Divisions of these specifications, it is understood that they apply as fully as if cited here.

Where differences exist between codes affecting this work, the code affording the greatest protection shall govern.

DIVISION 2 - SITE WORK

SECTION 2A - CLEARING

A. Scope

Accomplish all clearing and grubbing of existing topography as required to accommodate the new construction.

B. Materials

Clearing will be accomplished by power operated equipment for appropriate type for the task required and by hand equipment for close work.

SECTION 2B - DEMOLITION

A. Scope

Cut new opening in the existing building wall to accommodate new circulation tie-in.

SECTION 2C - EARTHWORK

A. Scope

1. Work includes all excavation, fill, and backfill, as well as site preparation. Work also encompasses slope grading and stabilization, drilling for reinforced concrete piles, trenching, neat excavations for footings and retaining walls, preparation for paving, backfilling of trenches, foundations and retaining walls, and the placing of base materials for slabs on grade, and paved areas.

2. ASTM Standards will be applied for the testing and control of earthwork.

3. Testing will be done by an independent laboratory selected by the Lawrence Berkeley Laboratory.

4. Shoring and lagging will be the responsiblity of the Subcontractor.

B. Materials

1. All backfill will be a non-expansive material. On-site excavated materials meeting these requirements may be used.

2. Base under slabs on grade and roadways will be Class 2 aggregate base.

SECTION 2D - SITE DRAINAGE

A. Scope

Work includes interceptor trench drains, installation of perforated pipe subsurface drains, culvert, erosion control channels and ditches, storm water inlets and junction boxes, and storm water conduits.

B. Materials

1. Perforated pipe will be corrugated galvanized pipe that has been protected with a bituminous coating.

2. Manholes, catch basins, and junction boxes will be precast heavy duty type; lids and grating will sustain highway loading wheel loads.

3. Shallow culverts will be galvanized corrugated steel pipe with a bituminous coating.

4. Storm water piping at depths greater than 4 ft will be reinforced concrete pipe.

SECTION 2E - SITE MECHANICAL WORK

A. Scope

1. Sanitary Sewer - Connect to existing site sewer as required.

2. Storm - Remove existing catch basin and pipe under proposed new building. Provide new catch basins and storm drain piping as required for new grading.

3. High Pressure Water Lines - Remove existing piping under proposed new building, reroute piping and provide service connections to new building and re-connect to existing building 72.

4. High Pressure Gas Line - Remove existing piping under proposed new building, rerouting piping and provide gas meter for new building and re-connect to existing gas meter serving Building 72.

B. Materials and Equipment

1. Sanitary Sewer - Hubless cast iron soil pipe.

2. High Pressure Gas Line - Sch. 40 black carbon steel pipe with welded joints, coated and wrapped.

3. Water Lines

(a) 2 inch line Type K copper tubing with wrought solder joint fittings.

(b) 4 inch line-250 pound class cast iron mechanical joint water pipe with 250 pound fittings.

4. Storm Sewer - Reinforced concrete or Asbestos cememt pipe.

SECTION 2F - SITE ELECTRICAL WORK

A. Scope

1. The new primary service shall be obtained by cable splicing the existing 12KV radial feeder in manhole #98 and extending to primary switch at new substation.

2. New substation, consisting of 12KV fused primary switch, step-down oil transformer and secondary distribution section, shall be installed on concrete pad, built-in the existing bank as shown on Drawing ME-1.

3. Secondary feeders shall be installed in new manholes and duct bank to serve the existing Building 72 and the new A.R.M. Laboratory Building.

4. New secondary service shall be installed complete to existing Building 72 before existing service conductors (served from Building 62) can be disconnected and removed, clearing the new building site for excavation.

5. The existing communications duct bank, serving existing building #72, shall be intercepted, and rerouted to clear new building site for excavation. The communications shall serve both the existing building #72 and the new A.R.M. Laboratory Building.

SECTION 2G - ASPHALT PAVING

A. Scope

1. Work includes all new paving and patch paving for new access drive and paved area.

2. Materials and paving methods will conform to the Standard Specifications of the State of California, Division of Highways.

B. Materials

1. Asphalt concrete surface will consist of a two(2) inch minimum layer of Type B aggregate, 85 - 100 percent penetration, steam refined asphalt.

2. Penetration prime coat, asphalt paint binder, and seal coat will conform to the Standard Specifications.

SECTION 2H - LANDSCAPING

A. Scope

Provide new landscapiing to provide erosion control:

1. Trees
2. Ground Cover
3. Accent Planting

Automatic irrigation system will be provided where required.

B. Materials

All landscaping materials will be native to the area, and/or such that will adapt well to the locale. Materials, in general, will be evergreen, except for certain flowering varieties that are seasonal. All materials will be selected for low maintenance after initial establishment.

DIVISION 3 - CONCRETE

SECTION 3A - CONCRETE WORK

A. Scope

1. Includes supply and placement of concrete for cast-in-place caissons, foundations, footings, slabs on grade, walls, suspended beams and slabs, and miscellaneous concrete structures, including membraned and concrete-topped roof at the new Laboratory Building.

2. Preparation of mix designs.

3. All concrete work and materials will conform to applicable ASTM and ACI Specifications.

B. Materials

1. Concrete will have the following minimum 28 day compressive strengths:

Foundations and Footings	3,000 psi
Slabs on Crade	3,500 psi
Beams and Girders	4,000 psi
Suspended Slabs	4,000 psi
Walls & Columns	4,000 psi
Fill Over Floor Deck	3,000 psi light-weight (110 pcf)

2. Reinforcing steel will be intermediate grade deformed bars.

DIVISION 4 - MASONRY

NONE

DIVISION 5 - METALS

SECTION 5A - STRUCTURAL AND MISCELLANEOUS STEEL

A. Scope

1. Includes all structural and miscellaneous steel such as columns, beams, purlins, girts, structual studs framing for equipment and supports, and metals cast in concrete.

2. Shop drawings will be submitted for all fabricated steel.

B. Materials

1. All steel will conform at ASTM A-36.

2. Field connections will be made with ASTM A-325 high strength bolts.

3. Welds will be made by certified welders and will conform to AWS Standards.

SECTION 5B - METAL DECKING

A. Scope

1. Includes all metal roof and floor decking.

B. Materials

1. Roof decking: 1 1/2" x 18 gauge

2. Floor decking: 3" x 20 gauge

SECTION 5C - MISCELLANEOUS METAL

A. Scope

1. Includes metal stair system, railings, handrails, grilles, expansion joints and miscellaneous clips, anchors, angles, connectors and fasteners.

B. Materials

1. Refer to Section 5A for structural requirements.

2. Welded metal pan steel stair system with concrete fill.

3. Handrails and railings: steel or aluminum.

DIVISION 6 - WOOD AND PLASTICS

SECTION 6A - ROUGH AND FINISH CARPENTRY

A. Scope

This section includes all rough and finish carpentry work for interior nonbearing wood stud partitions, related fasteners and all other miscellaneous carpentry and mill work items.

B. Materials

Wood studs and miscellaneous wood framing will bear Underwriters Laboratories, Inc. FR-S Label indicating compliance with applicable regulations pertaining to use of noncombustible wood in building construction.

Cabinet work exclusive of Laboratory furniture will conform to WIC Standards for "Custom Grade" construction.

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

SECTION 7A - ROOFING AND ROOF INSULATION

A. Scope

Furnish and install roofing and roof insulation at all roof areas.

B. Materials

1. Roofing insulation will be rigid board insulation over metal deck meeting prescribed "U" value for the roof construction in accordance with applicable regulations.

2. Roofing shall be 4-ply asphalt, 20-year bondable type with aggregate surface. Color of aggregate to match existing.

3. Roofing shall include additional cap sheet within screened mechanical area.

SECTION 7B - FLASHING AND SHEET METAL

A. Scope

Flashing and sheet metal work will include all metal flashing, reglets, wall louvers, collars, and other miscellaneous items.

B. Materials

All flashing and sheet metal work will be fabricated from "Armco Zincgrip-Paintgrip" copper-bearing sheet steel, or approved equal. Reglets will be plastic, precaulked.

SECTION 7C - CAULKING AND SEALANTS

A. Scope

All joints at exterior surfaces subject to water penetration will be sealed.

B. Materials

Sealants will be either polysulfide, butyl, or silicone, as appropriate. Oil base compounds will not be permitted.

SECTION 7D - PREFORMED METAL SIDING

A. Scope

Furnish and install exterior preformed metal siding and all accessories.

B. Materials

1. Performed insulated metal siding. Exterior surface prefinished. Interior surface prime coated.

2. Fabricated from 22 gauge steel.

3. Concealed fasteners.

4. Perimeter trim.

SECTION 7E - WATERPROOFING

A. Scope

Furnish and install waterproof membrane at walls of rooms below grade and between structural slab and topping at slab on grade.

1. Below grade wall and under slab waterproofing membrane will be hot applied bituminous system with glass fiber mat reinforcing.

2. Protection course: 1/2" fiberboard.

DIVISION 8 - DOORS AND WINDOWS

SECTION 8A - HOLLOW METAL DOORS AND HOLLOW METAL FRAMES

A. Scope

Furnish and install hollow metal door frames at all door openings and hollow metal doors at all exterior exit, Spectrometer Level, in the A.R.M. High Bay, and at rated interior openings, such as at stair enclosures and mechanical spaces.

B. Materials

1. Door frames will be fully welded construction, 16 gauge steel.

2. Hollow metal doors will be flush seamless construction with incombustible core, 18 gauge steel.

3. Hollow metal window trim will be 18 gauge steel.

4. All hollow metal work will be job-delivered with a baked-on shop primer.

SECTION 8B - WOOD DOORS

A. Scope

Wood doors will be provided at all interior openings except at certain locations where metal doors are required at fire rated openings.

B. Materials

All interior wood doors will be flush face solid core, select white birch, conforming to Commercial Standard CS-171, Grade 1.

SECTION 8C - ALUMINUM WINDOWS, DOORS AND ENTRANCES

A. Scope

Furnish and install aluminum windows, storefront construction, and new aluminum entrances.

B. Materials

1. Windows will be aluminum projected sash.

2. New storefront construction will be fabricated from stock aluminum rectangular extrusions, flush glazed.

3. New aluminum entrances will be fabricated from aluminum extrusions, narrow line design.

SECTION 8D - GLAZING

A. Scope

Furnish and install glass at all new windows, store front construction, and aluminum entrances. Furnish and install glass at door lights.

B. Materials

1. Glass at exterior windows will be "B" quality, 7/32-inch thick. Double glazed - reflective glass at west facade.

2. Lights, less than 9 square feet at interior doors, entrance doors, and view windows will be 1/4-inch thick, type 1 safety glazing.

3. Lights at hollow metal doors will be 1/4-inch thick, polished wire glass with welded diamond mesh.

4. Glass at store front doors and store front panels will be 1/4-inch type II safety glazing.

SECTION 8E - SPECIAL DOORS

A. Scope

Metal roll-up door will be provided A.R.M. High Bay at Service Area.

B. Materials

Doors will be electrically operated with safety toe piece, flat faced slats. Door assembly will be factory shop primed.

SECTION 8F - HARDWARE

A. Scope

Finish hardware will be provided at all new door openings.

B. Materials

1. Locksets and latches: Schlage Type C, Saturn design, dull chrome (US 26D) finish.

2. Great grand master key all cylinders to existing system.

3. Closers, kickplates, butts, stops, and all other miscellaneous hardware will match existing design and quality.

DIVISION 9 - FINISHES

SECTION 9A - GYPSUM DRYWALL

A. Scope

1. Provide gypsum drywall finish surfaces at all interior nonbearing partitions, and exterior wall furring.

2. Provide suspended gypsum board ceilings in toilets and other designated areas.

B. Materials

1. Wall and ceiling gypsum board will be 5/8 inch thick.

2. Furring channels, 25 gauge, galvanized.

3. Suspended ceiling system will be comprised of wire hangers, runner channels and furring channels with seismic bracing system per applicable standards.

SECTION 9B - RESILIENT FLOORING

A. Scope

Furnish and install resilient flooring and top-set resilient base at all room spaces except toilets and mechanical areas.

B. Materials

1. Resilient flooring will be 12 inch by 12 inch vinyl asbestos, 1/8 inch thick.

2. Base will be vinyl or rubber, 4 inch high, coved, with preformed exterior corners.

SECTION 9C - CERAMIC TILE

A. Scope

Ceramic tile floors and wainscots will be provided in all toilet rooms. Mortar thin-set method at floor tile,and inorganic adhesive setting method at wall tile.

B. Materials

Wall tile will be matt glazed. Floor tile will be unglazed vitreous porcelain mosaic.

SECTION 9D - ACOUSTIC TREATMENT

A. Scope

Furnish and install suspended acoustical ceiling system in all laboratory and office spaces. Provide acoustical sound attenuation blanket in partition cavities of all toilet room partitions, office to laboratory separating partitions, mechanical and compressor room partitions, and other locations where sound attenuation is required.

Gypsum wall board will be installed on resilient sound attenuating channels over metal ceiling suspension system at mechanical equipment and compressor rooms, with a vinyl-faced sound attenuation blanket attached thereto.

B. Materials

1. Suspended acoustical ceiling system will consist of 2 foot by 4 foot lay-in washable face acoustical board in an inverted, factory finished metal tee-grid. Space above ceiling will be completely accessible. Seismic bracing system will be provided per applicable standards.

2. Acoustical sound deadening material will be 3 inches thick at walls, 2-inches thick at mechanical room setting.

SECTION 9E - PAINTING

A. Scope

Provide finish painting at all exposed nonfactory finished surfaces, interior and exterior, as follows:

1. Woodwork
2. Metals
3. Sheet Metal
4. Concrete Surfaces (Sealer at Exterior Concrete)
5. Gypsum Board
6. Exposed Piping and Duct Work

B. Materials

All paint materials will be of one manufacturer, with the exception of certain specialty items that may be required. Paints will be delivered to the site in manufacturer's unopened containers, and no thinning will be allowed unless specifically authorized by the manufacturer.

C. Execution

All paint work shall be three-coat except a four-coat stain and lacquer system will be used at wood doors, and exterior concrete sealer will be a two-coat system.

SECTION 9F - FIREPROOFING

A. Scope

Furnish all materials, labor, equipment and supervision to install steel spray fireproofing.

B. Materials

Steel spray fireproofing materials will be a mill mix, cementitious-only compound, bearing proper U.L. Inc. label.

C. Application

Application shall be to structural steel which is not encased in concrete, and the underside of steel floor and roof decking:

Thicknesses for a minimum rating of 2 hour fire resistance shall be provided in accordance with applicable codes and regulations. Material shall be sprayed to surfaces which are clean of dust, grease, and oil base paint. Ducts, piping, conduit and other equipment which could cause interference with uniform application are to be positioned after fireproofing spray application.

SECTION 9G - LATHING AND PLASTERING

A. Scope

Furnish and install metal plaster studding, ceiling suspension system, metal lath, and cement plaster at soffits and walls where indicated.

B. Materials

1. Walls:

   a. 18 gauge metal studs with paper backed metal lath.

   b. Scratch, brown and finish coat of cement plaster, with finish coat "Marblecrete," color of aggregate to match existing building. Total thickness, 1 inch.

2. Cement plaster soffits:

   a. Metal furring suspension system with expanded metal lath.

   b. Scratch, brown and finish coats of cement plaster. Total thickness, 1 inch.

DIVISION 10 - SPECIALTIES

SECTION 10A - METAL TOILET COMPARTMENTS

A. Scope

Furnish and install metal toilet compartments, urinal screens and sight screens as indicated on the drawings.

B. Materials

Toilet compartments will be overhead braced, baked enamel finish. Urinal and sight screens will be wall hung type, finish and construction to match the toilet compartments.

SECTION 10B - TOILET ROOM ACCESSORIES

A. Scope

In each toilet room provide mirror and shelf units, toilet paper dispensers, seat cover dispensers, and combination paper towel dispenser/disposal units.

B. Materials

All accessories will be stainless steel. Paper towel dispenser/ disposal unit will be wall-mounted, and semi-recessed type.

SECTION 10C - FIRE EXTINGUISHER CABINETS

A. Scope

Furnish and install wall-mounted fire extinguisher cabinets in locations as required by Code and Lawrence Berkeley Laboratory.

B. Materials

Cabinets will be of size and type as required by Lawrence Berkeley Laboratory.

DIVISION 11 - EQUIPMENT

SECTION 11A - LABORATORY FURNITURE

A. Scope

Manufacture, deliver, assemble and install all Laboratory furniture, including work tops and reagents shelves, base cabinets, work benches, storage cabinets and fume hoods.

B. Materials

Laboratory furniture will be modular, plastic laminate clad as manufactured by Hamilton Manufacturing Company, Laboratory Furniture Company, Permalab Equipment Corporation or other approved fabricator. Stainless steel stops will be provided where required.

DIVISION 12 - FURNISHINGS

NONE

DIVISION 13 - SPECIAL CONSTRUCTION

NONE

DIVISION 14 - CONVEYING SYSTEMS

SECTION 14A - ELEVATOR

A. Scope

Furnish and install combination freight and passenger elevator with single automatic push button operation.

B. Materials

1. Car platform will be 7 ft wide and 8 ft 4-inch deep, resulting in an effective usable area of 6 ft 8-inches wide by 7 ft 7-inches deep.

2. Maximum capacity will be 5,000 pounds and minimum "up" speed shall be 80 feet per minute.

3. Car entrance will be 4 ft 6-inches by 7 ft clear with two-speed horizontal sliding doors.

4. Car ceiling panels will be readily removable to accommodate transport of excessively long test specimens.

5. Elevator operation will be hydraulic.

DIVISION 15 - MECHANICAL

SECTION 15A - PLUMBING

A. Scope

The plumbing system for the building consists in general of:

1. Furnishing and installing plumbing fixtures.

2. Soil, waste, and vent piping.

3. Natural gas and fuel oil piping.

4. Hot and cold water piping, including domestic water heater.

5. Roof drains and rainwater leaders.

6. Rough-in and connect to mechanical equipment.

7. Laboratory piping systems.

B. Materials

1. Plumbing fixtures are to be commercial grade vitreous china.
   Water closets and urinals - wall hung flush valve type.
   Lavatories - 20" x 18" wall hung.
   Mop basins - 24" x 24" pre-cast tera 330.
   Electric Water Cooler: Dual purpose for handicapped.

2. Piping
   Water - Type L copper 95/5 solder. Soil, waste, vent, and rainwater - Hubless cast iron soil pipe.
   Gas and fuel oil - Black steel with wrought iron screwed fittings.

3. Water Heater: Gas fired task type, 50 gallon storage.

4. Fuel oil tank.

SECTION 15B - HEATING, VENTILATION AND AIR CONDITIONING

A. Scope

The entire building shall be furnished with a central force air system. Heating and cooling or heating only are provided to designated zones. Cooling coils are supplied with chilled water from an air-cooled chiller on roof. Heating coils will use hot water supplied by one dual fuel (fuel oil/gas) boiler located at the mechanical room. Room temperature shall be maintained within the limits called for herein. Humidity control will not be required, however, supply air temperatures must not be low enough to cause formation of dew on the atomic resolution microscope. An economizer shall be required to permit cooling by outside air when possible.

SECTION 15C - AUTOMATIC FIRE SPRINKLERS

A. Scope

1. Sprinkler System - A wet sprinkler system for ordinary hazard rating will be provided. The supply will be made from the new 4-inch water supply serving the Building. The piping will be concealed where possible and both pendant and upright

heads will be utilized. A fire department siamese inlet connection with check valve shall be provided.

2. Wet Standpipe System - Hose racks having 1 1/2 inch hose with nozzels shall be installed.

3. Water Flow Alarm Service - Provision shall be made to indicate the flow of water in the sprinkler system and wet standpipe system, except movement of water due to waste, surges or variable pressure, by an alarm signal operating at waterflows of ten or more gallons per minute. Control valves shall be supervised to indicate required conditions for proper operation of the system. The foregoing will connect to the detection and alarm system in 16.C.3.C.

B. Material and Equipment

1. Piping - Sch. 40 Black Carbon steel with 150 pound malleable iron screwed fittings.

2. Fire Hose Racks - U.L. listed rack with approved 1-1/2 linen hose and fog type nozzles.

3. Sprinkler Alarm Switches - Autocall-Howe Type WF4 - Model 4156-4.

4. Post Indicator Valve Switch; Potter Electric Signal Co. Model P1VS-U (-C is acceptable).

SECTION 15D - SOLAR HEATING

A. Scope

1. Furnish and install solar space heating and building service hot water system.

2. Back up systems to be provided in plumbing and HVAC sections.

B. Materials

1. Solar collectors: Flat plate, single glazed, selective surface type.

2. Water storage tanks.

3. Heat exchangers.

4. Circulating pumps.

5. Piping and controls.

DIVISION 16 - ELECTRICAL

SECTION 16A - INTERIOR ELECTRICAL WORK

A. Scope

Furnish and install a complete electrical system for this facility, including, but not limited to the following:

1. A new secondary service from new exterior substation complete with main distribution panel, transformer, panelboards, conduits and feeder conductors.

2. Extend telephone system from adjacent building #72 (existing) complete with terminals, raceways, and outlets. Cables will be provided by phone company.

3. Extend fire alarm system from adjacent building #72 (existing) complete with terminals, raceways, outlets, wiring and devices as required.

4. Extend paging system from adjacent building #72 (existing) complete with terminals, raceways, speaker outlets and cabling.

5. System and equipment grounding complete.

6. Branch circuits for 120, 208 and 480 volt power outlets complete as required for laboratory and general use.

7. Lighting system complete with all fixtures, multiple switching and necessary auxiliary apparatus.

8. Branch circuits for all mechanical equipment motors complete with disconnect switches, starters, control devices and all final connections.

9. Power feeders and disconnect switches for elevator equipment and overhead crane.

10. Power feeders and disconnect switch for atomic resolution microscope (provided by L.B.L.).

11. Smoke detection system as required by DOE publication W.A.S.H. 1245-1.

B. Materials

1. Conduits: Conduits shall be rigid galvanized steel, intermediate grade steel, polyvinyl chloride or electrical metallic tubing, as required.

2. Conductors: All conductors shall be copper as follows:

   a. Conductors No. 10 AWG and smaller shall be solid; No. 8 AWG and larger will be stranded, except otherwise noted.

   b. Conductors No. 6 AWG and smaller shall be Type THWN or THHN; No. 4 AWG and larger will be Type THW or THWN.

   c. Control conductors shall be Type THWN/THHN stranded copper.

3. Receptacles: Receptacles at 120 volt, single phase and 208 volt, three phase shall be provided as required for building services, research equipment and for convenience outlets.

   a. Duplex receptacles shall be rated 20 ampere, 125 volt, three wire Hubbell No. 5362, or approved equal.

   b. Single-phase receptacles shall be rate 30 ampere, 125 volt, three wire Hubbell No. 2610, or approved equal.

   c. Three phase receptacles shall be rate 20 amperes, 120/208 volt, three phase wye, four pole, five wire, Hubbell Twistlock No. 2510, or approved equal.

   d. Three phase receptacles shall be rated 30 ampere, 120/208 volt, three phase, four pole, five wire, Hubbell Twistlock No. 2810, or approved equal.

4. Light Fixtures:

   a. Offices: 2 x 4 ft. lay-in fluorescent troffers, with acrylic prismatic lenses.

   b. Laboratories: 2 x 4 ft. lay-in fluorescent troffers with acrylic prismatic lenses and RF shielding.

   c. Conference Room: Same type as offices equipped with dimming controls.

   d. Corridors: 1 x 4 ft., lay-in fluorescent troffers, with acrylic prismatic lenses.

e. Microscope Laboratory: Industrial two lamp fluorescent fixtures, wall mounted on angular brackets with acrylic lenses, RF shielding and finished baked enamel finish.

5. Main Distribution and Panelboards: Panelboards shall be installed where required and shall be flush or surface mounted as required by building construction. Trim shall be of the door-in-door type. Panels shall be equipped with equipment grounding blocks.

   a. Main distribution panel for 277/480 volt, three phase, four wire shall be Westinghouse Type CDP, or approve equal. Circuit breakers shall have a minimum interrupting rating of 22,000 amperes RMS.

   b. Lighting panelboards shall be 277/480 volt, three phase, four wire, Westinghouse Type WEHB, or equal. Circuit breakers shall have a minimum interrupting rating of 14,000 amperes RMS. Main breakers shall be current limiting type Westinghouse Tri-Pak, or equal.

   c. The 208Y/120 volt, three phase, four wire panelboards for receptacles and miscellaneous laboratory equipment shall be Westinghouse Type WEB, or approved equal.

6. Transformers:

   a. Transformers shall be dry with 220°C insulation system, rated 150°C maximum temperature rise in 40°C ambient. Unit shall be Westinghouse type DT-3, or approved equal.

   b. Transformers shall be rated 480 volt to 120/208 volt, 3-phase, 4-wire wye with two 2-1/2% taps above and four 2-1/2% taps below normal primary voltage.

7. Motor Control Panelboards: Motor control panelboards shall be installed where required for building mechanical equipment. Control voltage shall be 120 volts with control transformer in each unit. A ground bus, full length of the motor control panelboard, shall be provided. The motor control panelboards shall be General Electric type CLB or approved equal. Panelboards shall be rated 480 volt, 3-phase, three-wire.

8. Starters: Starters shall be 480V, 3-phase, magnetic type with 120 volt coil and ambient compensated overload relays, rated at 115% of full load nameplates amperes. Starter shall be equipped with one n.o. and one n.c. auxiliary contacts. Starters shall be Westinghouse or approved equal.

C. Execution

1. Conduit Installation:

   a. Conduits shall be installed concealed where possible. Outlet boxes in laboratories, offices, corridors and other finished areas shall be installed flush. In service areas, shops, equipment rooms, etc., boxes may be surface mounted.

   b. All wiring shall be installed in conduit. Electrical metallic tubing, 2 inches and smaller, shall be used in all concealed work. Complete runs of exposed conduit, 2 inches and smaller, in protected areas, more than 5 feet above the floor may be electrical metallic tubing.

   c. Rigid steel conduit or PVC conduit, concrete encased shall be used for exterior secondary power duct. Minimum depth of burial shall be 36" below finished grade.

2. Grounding:

   a. Main ground shall be 1/2-inch galvanized strand, minimum 25-feet long, within 2 inches of bottom of building foundations. This conductor shall be center-tapped and brought out of foundation to connect to the building and service grounding system.

   b. System and equipment grounding:

      (1) Connections shall be made to the above grounding system for grounding the various 208Y/120 volt transformer.

      (2) The equipment ground block in each panel shall be connected to the ground system.

      (3) Each feeder and branch circuit shall have a bare copper equipment grounding conductor in the same raceway as the circuit power conductors. The grounding conductor shall be electrically and mechanically connected to the panelboard equipment grounding block.

      (4) Equipment ground conductor shall be provided for microscope equipment. Terminate as directed.

3. Fire Alarm System:

   a. The building will be protected by a sprinkler system. Flow switches will be provided under the Mechanical Division. These switches shall be connected into the

LBL fire alarm system with transmitters to properly indicate location.

b. Manual fire alarm stations, as required, shall be provided.

c. New fire alarm circuits shall be extended from existing terminal cabinets in building #72. Terminate wiring as directed.

d. Bell as required will be provided.

4. Telephone System:

a. Telephone terminal cabinet shall be provided on each level in the janitor closets. Cabinets shall be tied together with one 1-1/2" conduit as well as conduit extended to main telephone terminal in building #72.

b. Conduits sized to suit shall be run from terminals to outlets in the office, laboratories and elsewhere as required.

c. Telephone outlets shall consist of a flush 4-11/16 inch square box with double device plaster ring and double device plate with cable opening.

5. Paging System:

a. Paging system terminal cabinet shall be provided in north storage room on A.R.M. console level. Conduit and cable, sized as required, shall be extended to main terminal in builing #72 and terminated.

b. Conduit and cable shall run from terminal cabinet to all outlets in corridors, offices, laboratories and elsewhere as required on each level.

c. Paging system outlets shall consist of a flush speaker enclosure, speaker with transformer and baffle.

6. Emergency Lighting: Emergency lighting shall consist of battery operated 12 volt lamps in stairs, corridors, microscope laboratory, etc. for egress, which will transfer automatically upon power failure. Exit sign shall be self-contained emergency type. All units shall be connected to 120 volt AC source.

7. Mechanical Equipment Connections: Necessary power and control wiring, starters, contactors, relays, push buttons and switches shall be installed and connected for the mechanical equipment furnished under Mechanical Section.

8. Equipment Identification: Each panelboard, motor control switch, starter, wiring device, etc., will be identified by circuit number with an engraved nameplate. Transformers shall be identified by number, KVA, voltage ratings and primary circuit number.

D. Quality Assurance

The installation will comply with the requirements of the State of California Administrative Code, Title 8, Subchapter 5, Electrical Safety Orders, California Occupational Safety Health Act, applicable City and County rules and regulations, and the National Electrical Code, latest edition.

Section VII

ENERGY CONSERVATION REPORT

SCOPE OF REPORT

This report is an Energy Conservation Analysis of various heating, ventilating and air conditioning (HVAC) systems which could be used for the new Atomic Resolution Microscope Building. The four architectural and HVAC systems listed below were modeled on the Trane Company TRACE computer code, comparing energy usage and owning and operating costs based on available fuels. The entire building was modeled by dividing the space according to occupancy and exposures.

CRITERIA

The Facilities General Criteria Handbook, DOE(ERDA) Appendix 6301, has been used as the governing criteria supplemented by Life Cycle Costing Emphasizing Energy Conservation DOE(ERDA) 76/130, Interim Management Directive Fuels and Energy Use Policy for DOE facilities, and ASHRAE Standards 90-75 and 62-73. California Title 24 has been used as a guide.

Due to the limitations of the Fuels Policy, the use of natural gas and resistance heat have been excluded from modeling as they would only be used as backup. Analytical models in TRACE do not have capability for analyzing coal, therefore, the energy sources analyzed in addition to the solar reported in Section VIII, have been fuel oil and electric driven heat pumps.

The Atomic Resolution Microscope and other support laboratories require the use of a temperature controlled environment, the control points being 72°F heating and 76°F cooling. Humidity control has not been identified as a requirement of the process at this time. Other areas such as offices, conference rooms, photo laboratories and viewing rooms will be heated-and-ventilated-only; the control point will be 72°F. Toilets will use heated air from other spaces but heat will not be added to meet the 65°F limit. The ASHRAE 99% value of dry bulb will be used for heated - only space. Summer design conditions will be the 1% ASHRAE values for air conditioned laboratories. Since required heat transfer coefficients for walls and roof are so close, common values were assumed for each. Both single and double window glazing architectural systems were considered.

Several building mechanical systems were considered to select the two for further computer study. A central, constant-volume variable temperature system, with terminal heating and cooling coils for air conditioned spaces, and heating coils only for heated-and-ventilated spaces, can meet the temperature control requirements.

Also, an air-to-water terminal heat pump system, with a terminal heat pump for each controlled zone and with the cooling locked out

for heated-and-ventilated-spaces-only, can meet the temperature control requirements.

The need to avoid cooling the heated-only spaces dictates the use of separate air systems for heated-only areas, and for heated-and-cooled areas. Use of energy recovery makes a common exhaust advantageous as most recovery occurs on the heating side of the cycle. Because of the climate, the use of an economizer cycle, with an all air system is an energy conserving measure in general use throughout the San Francisco Bay Area, and is included here. Effective use of these systems requires that ducts be able to carry the load with a small temperature difference between supply and return air temperature. Use of increased air quantity when economizer cycle is active is nonstandard to air-to-water heat pump system but should conserve energy.

The need for cooling in some areas, while heating in others, makes air-to-water heat pump system attractive because of its ability to remove heat from one area and deliver it to another. Heat pumps also lend themselves to solar assistance. An oil-fired boiler or a heat pump energy source may be used on either system. Extreme variations in load and requirement for close control under simultaneous heating and cooling in adjacent areas preclude the consideration of a variable volume system. A double duct system requires high pressure ductwork and high pressure and high horsepower fans for the required extra duct in scarce space. Terminal reheat has been excluded because of thermal losses of that system.

As a result of the above, the building system chosen for computer modeling are as follows:

SYSTEM 1 - CONSTANT VOLUME TERMINAL HEATING AND COOLING

This is a centralized system consisting of a water chiller, boiler (fuel oil, water tube) and constant volume air handlers. Zone control is accomplished by the use of a 4 pipe system with cooling and heating coils for the air conditioned zones and heating coil only for heated and ventilated zones. Each zone has one thermostat to modulate the flow of water and operate bypass dampers to maintain the design conditions. The air handlers have outdoor air and mixed air sensors to control automatic dampers to provide 100% outside air cooling. A hydronic heat recovery system is used.

SYSTEM 2 - TERMINAL HYDRONIC HEAT PUMP

This is a central system consisting of a close circuit cooling tower, boiler (fuel oil, water tube) or heat pump and constant volume air handlers. Each zone has one or more heat pumps connected hydronically with a two-pipe system. Cooling is accomplished by each unit in conventional manner. The total heat rejected is either used to heat the other zones or is removed by a cooling tower. In the heating only zones, cooling capability is locked out. When net heating is required, a boiler, a heat pump, or solar heat will supply the net heat required.

A duct system is included to accomodate economizer cycle and heat pump energy recovery system.

THERMAL MODELING

The above systems were modeled on the TRACE computer code. The TRACE computer code is a proprietary code of the Trane Company. Use of the program requires input of pre-programmed weather data. The model provides for heat transfer to the exterior from the space via roof, wall and floor. Energy transfer between areas modeled is assumed to be negligible. Standard pre-programmed systems, with pre-programmed response to load, are used. Provisions account for energy mass transport by liquid and air systems. A pre-programmed economic model is also employed.

An analytical model was formulated that approximates the new Atomic Resolution Microscope Building. The building was divided into seven areas based on common usage. The dominant exposure, and whether heated-only or heated-and-cooled, were the prime considerations in choosing areas. The properties of the common areas throughout the building were tabulated to determine the thermal properties of the modeled volume. The model consists of the following:

Floor area	14,353 ft^2
Wall area (includes 10% glass)	15,914 ft^2
Roof	5,933 ft^2
People	36
Minimum outside air	5 ft^3/min. person
Light (except corridor @ 1 watt/ft^2)	2 watts/ft^2

The internal generation from laboratory equipment is tabulated and distributed to the appropriate areas except that some process heat of the Atomic Resolution Microscope is assumed to be dissipated in ventilated only equipment rooms and in the cooling water circulated for laboratory equipment.

The system models available to the TRACE program are standard systems. These are used to model the proposed energy conserving systems proposed for the new Atomic Resolution Microscope Building. The four alternates were compared to study the two mechanical systems and the two architectural systems. The terminal heating and cooling system was modeled using a chiller; boiler; fans for supply, exhaust and return air; and pumps for heating hot water and cooling chilled water. Hydronic heat recovery was modeled. The terminal hydronic heat pump

system with storage was modeled using an oil fired boiler, cooling tower and supply and return fans. Heat pump energy recovery was modeled. The absence of an air-to-water heat pump system in the standard TRACE systems model caused the selection of an air-to-air heat pump to model the heat pump energy source. This was done using return air fans in place of the terminal hydronic heat pump. Heat pump energy recovery was modeled. This later system was used to model the effect of double glazing.

The economic parameters used in the standard pre-programmed TRACE economic model are based on DOE Guidelines. Escalation of the economy is taken to be accounted for in the 10% discount rate used, hence the only inflation modeled is the differential of 8% for oil from a base of $\$2.75/10^6$ BTU and the electricity is escalated at a differential of 7.3% from a base of $.038/kw hr. incremental cost. The economic life was taken at 25 years with equity funding and no tax effect. The system first-cost and operating-cost per square foot were established.

Results of the TRACE run are as follows:

Alternate	Envelope BTU/sq.ft. Year	Present Worth $
Terminal heat & cooling; double glazed	58,704	378,657
Terminal heat pump system using boiler; double glazed	54,656	310,334
Terminal heat pump system using air-to-air heat pump; double glazed	50,607	293,779
Terminal heat pump system using air-to-air heat pump; single glazed	54,873	307,542

Because of computer software problems experienced in the TRACE computer code, certain months gave apparently erroneous values for the first two alternates. Five months through the year were in the range expected, and were several orders of magnitude different from the other months. The above results were obtained by ratioing the results of Alternate 3 to the good months of Alternates 1 & 2. The systematic order of the alternate each month gives improved confidence in the above results.

The net programmatic energy use for the equipment and lighting is 31,286 BTU/ft^2 year. The total net energy consumption for programmatic use and for the building envelope is predicted to be 81,893 BTU/ft^2 year.

RECOMMENDATIONS

The results of the analysis indicate that fuel economy, as well as the difference in the present worth of Alternates 3 & 4, justify the use of the double glazing. The results also indicate that Alternate 2, the terminal heat pump system, appears to have a lower energy usage and lower present worth than Alternate 1, the terminal heating and cooling system. To model hydronic heat recovery a sensible heat recovery efficiency of 50% was input to the TRACE program for Alternate 1. To model heat pump heat recovery a sensible heat recovery efficiency of 65% was input to the TRACE program for the other alternates. These estimated figures are to be modeled in detail at final design. Alternate 1 is included with a heat recovery option in the reciprocating chiller. Influence of a higher condensing temperature and higher horsepower is to be modeled in detail at final design.

In considering the present worth figure, it should be noted that the first cost difference between alternates 1 & 2 represents $52,000, whereas the owning and operating costs difference represents approximately $17,000. Since, at this early stage of the project, the first costs are general in nature (based on cost/sq.ft.), it can be seen that further refinement of the first costs of both alternates may change the results.

The better coefficient of performance of the central heat pump as opposed to the terminal heat pump is projected to cause some of the difference between the terminal heat pump and air-to-air heat pump system. The difference between the prediction for the terminal heating and cooling results (Alternate 1) and the air-to-air heat pump (Alternate 3) is taken to indicate that an incremental capital cost of $32,000 for small heat pump capacity required is more than justified. The small amount of heating required is due to the good insulation and high internal heat generation.

Work done indicates the ability of heat pump to compete with oil as an energy source. The work has shown that an energy conserving system will need to have nonstandard features. Indications are that from an energy use standpoint, it is advisable to also consider the possibilities of a direct-expansion, 2-pipe, single-coil heat pump system. The non-standard nature of such a system requires detail design, costing and modeling before committing to such a system. Efforts should also focus on the optimization of the solar energy interface. It should also consider the possibility of integrating the solar assisted heat pump into the system. The cost of these nonstandard features is included in the inputs to the cost estimate.

Title I detail design will have available firmer information on internal generation rates and limits on the critical temperature and humidity control once the vendor of the Atomic Resolution Microscope has been selected. Final selection of a system should be deferred until firmer information is available.

Section VIII

SOLAR ENERGY ANALYSIS

The feasibility of using solar energy for building service hot water, space heating, and space cooling in the new Atomic Resolution Microscope Building was modeled using FCHART 2.0 computer code and the recommendations and economic parameters of the Facilities Solar Design Handbook DOE (ERDA) 77-65, Life Cycle Costing Emphasizing Energy Conservation DOE (ERDA) 76/130, and Facilities General Design Criteria Handbook DOE (ERDA) Appendix 6301. The tax credits allowed by the State of California were applied to the solar system costs per the April 1978 DOE Guidelines for Evaluating and Implementing Solar Heating and Cooling in DOE Facilities. The difference between the budget costs and the system costs used in the economic studies is attributed to the cost of the DOE stimulation policy.

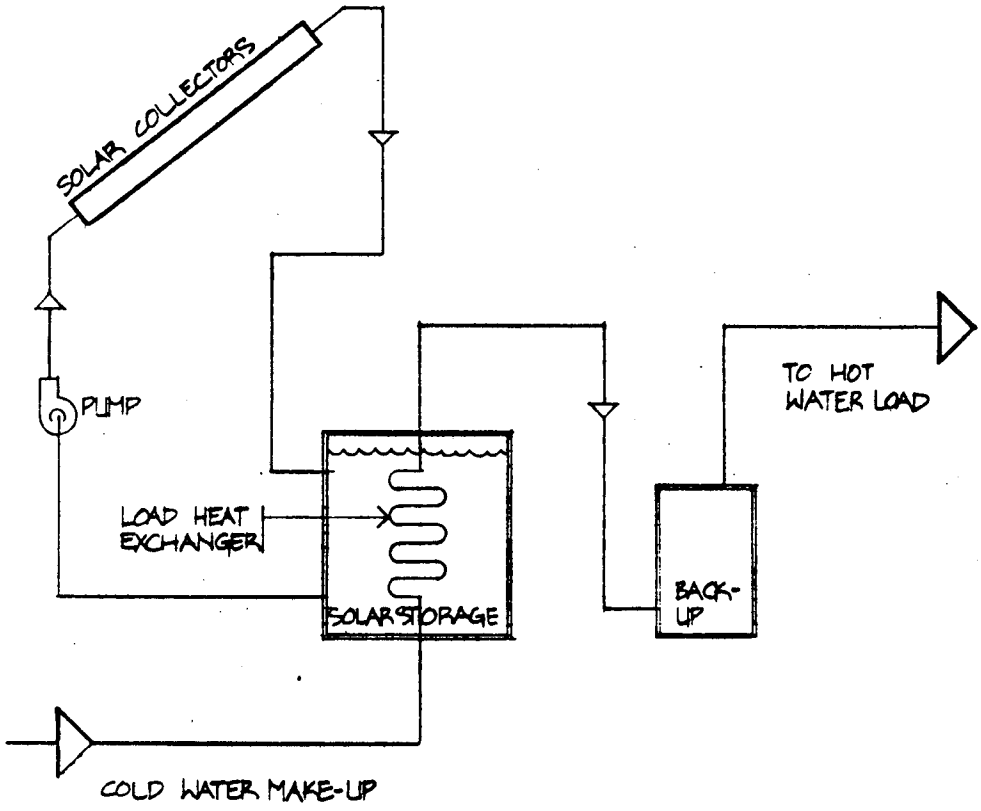
BUILDING SERVICE HOT WATER

Figure 1 is a schematic diagram of the system. A collector-to-storage heat exchanger was not used. This will improve the collection efficiency. Freeze protection will be supplied by draindown. The FCHART 2.0 computer program was used for this analysis for which the principal parameters are listed below:

Collector orientation	Due South
Collector tilt	37° from horizontal
Storage capacity	15 BTU/°F-ft^2
Collector type	Flat plate, single glazed non-selective
	F_r^1 $(\tau\alpha)$ - 0.79
	F_r^1 (UL) - 1.10
Hot water load	108 gal/day
Set temperature	110°F
Main temperature	60°F
Climate data	Oakland, CA
Economic life	25 years
Discount rate	8%/year
Fuel cost including system efficiency	4 \$/10^6 BTU

FIGURE 1

BUILDING SERVICE HOT WATER



Fuel differential inflation above economy	8%/year
Maintenance cost	1%/year of capital cost

The following assumptions were made for this analysis:

1. The collector tilt was chosen to be 37°. This should be close to an optimum tilt, but would be optimized during the building design process.

2. The amount of storage was set at 15 BTU/°F - ft^2. This also would be optimized during building design.

3. Since there is no heat exchanger between the collectors and storage, $F_r^1/F_r = 1$.

4. The hot water load was set at 108 gal/day and the residential use pattern employed by FCHART 2.0 was applied.

5. The tax credit was taken to be the 55% residential tax credit since the system cost needed for the economic analysis was below $6000.

6. The exact design of the system - pressurized or unpressurized solar storage - will be decided during building design.

Figure 2 shows the net savings with solar, i.e., the difference in cumulative present value of owning and operating costs with and without solar, vs. collector area. Absence of a collector-to-storage heat exchanger and the potential placement of the solar tanks near the collectors cause this system to be judged as a relatively low cost system. Therefore, the lower price range indicated in the DOE solar design manual was used for the size specification. DOE is assuming that this price range is what would be typical for a well-established solar industry. The difference between this cost and the budget requirement can be attributed to the cost of DOE's policy for solar industry stimulation. These assumptions result in an optimum collector size of 60 square feet which will provide 78% of the energy for service hot water.

SPACE HEATING AND BUILDING SERVICE HOT WATER

Figure 3 is a schematic diagram of the system. A collector-to-storage heat exchanger was not used. This will improve the collection efficiency. Freeze protection will be provided by draindown. Connection of the solar storage tank to the space heating load and the building service hot water load is through heat exchangers. The FCHART 2.0 computer program was used for this analysis. The principal parameters used in the analysis are listed below.

FIGURE 2

BUILDING SERVICE HOT WATER

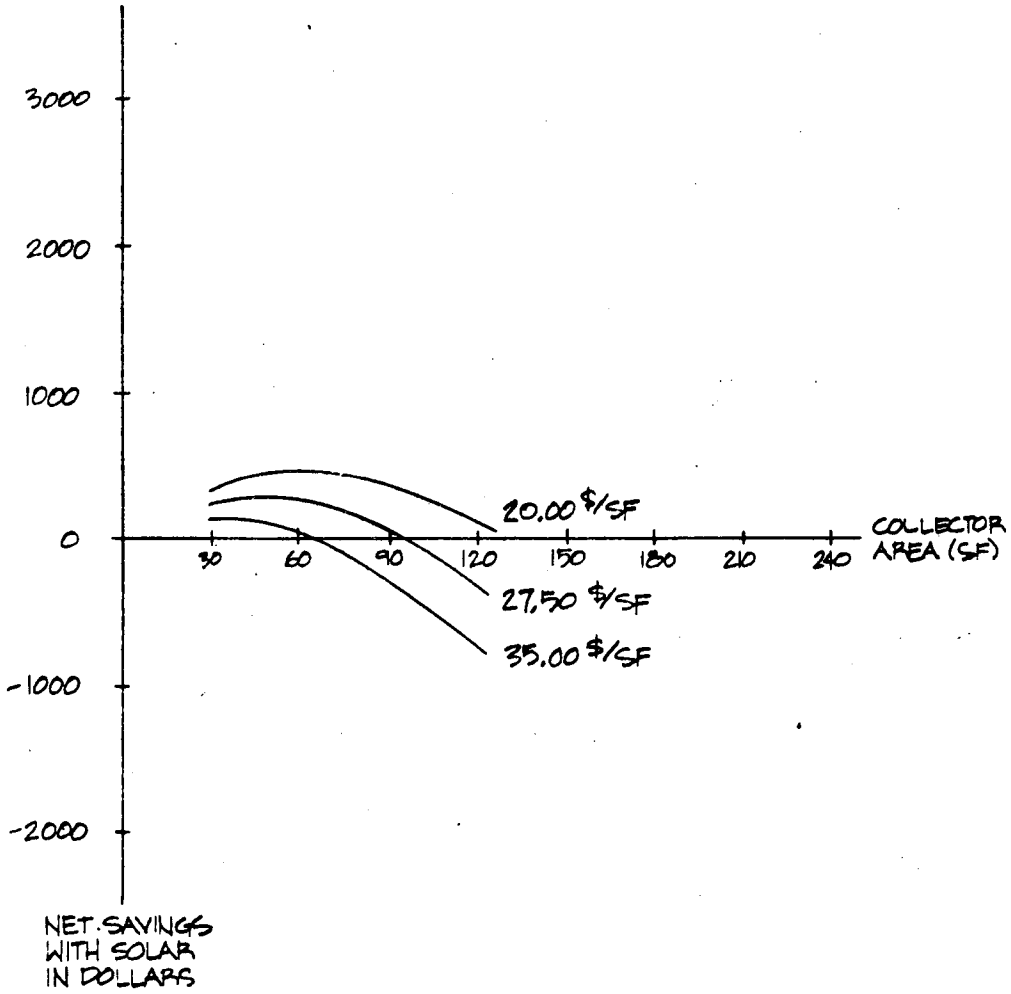
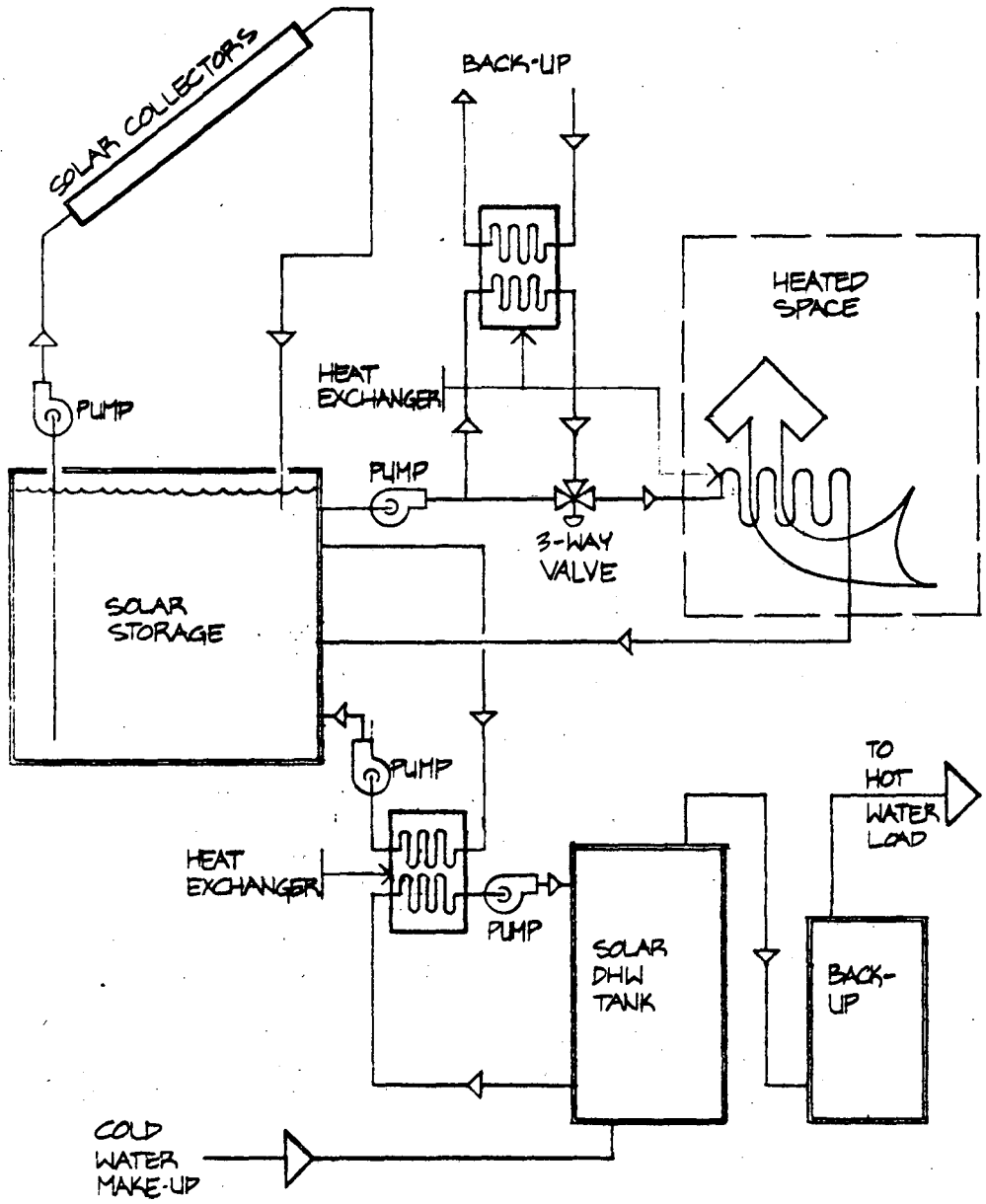


FIGURE 3

SPACE HEATING AND
BUILDING SERVICE HOT WATER



Collector orientation	Due South
Collector tilt	50° from horizontal
Storage capacity	15 BTU/°F - ft^2
Collector type	Flat plate, single glazed, selective surface
	F_r^1 $(\tau\alpha)$ - 0.79
	F_r^1 (UL) - 0.81
Effective UA of load	4615 BTU/hr°F
Hot water load	108 gal/day
Set temperature	110°F
Main temperature	60°F
Climate data	Oakland, CA
Economic life	25 years
Discount rate	8%/year
Fuel cost including system efficiency	4 $\$10^6$ BTU
Fuel differential inflation above economy	8%/year
Maintenance	1%/year of capital cost

The following assumptions were made for this analysis:

1. The collector tilt was chosen to be 50°. This should be close to an optimum tilt, but would be optimized during the building design process.

2. The amount of solar storage was set at 15 BTU/°F - ft^2. This also would be optimized during building design.

3. Since there is no heat exchanger between the collectors and storage, $F_r^1/Fr = 1$.

4. Internal heat generation was ignored. Detailed information on the load and internal heat generation rate and schedules has been approximated by a UA value chosen to provide a heating energy use pattern typical for the degree days listed for Oakland.

5. The system costs used in the economic analysis were adjusted by the California tax credit which was taken to be the 55% residential tax credit for systems costing less than $6000.

   For systems costing $6000 and more the non-residential tax credit was used which provides for $3000 or 25% of systems costing over $6000, whichever is greater.

Figure 4 shows the net savings with solar, i.e., the difference in cumulative present value of owning and operating costs with and without solar vs. collector area. The analysis indicates that the highest cost systems are not economic (per DOE guidelines). Medium and lower cost systems, on the other hand, are shown to be economical. The use of medium performance collectors, an unpressurized storage tank, and no collector-to-storage heat exchanger in the proposed system tends to lower the system cost. Therefore, the lower price range indicated in the DOE Solar Design Manual was used for the size specification.

DOE is assuming that this price range is what would be typical for a well-established solar industry. The difference between this cost and the budget requirement can be attributed to the cost of DOE's policy for solar industry stimulation. These assumptions result in an optimum system collector size of 200 square feet which would provide 18% of the heating and service hot water energy needs.

AIR PRE-HEAT SYSTEM

Figure 5 shows a schematic diagram of the system. This system is meant to pre-heat the outside air supplied to the building. Storage is provided by a rock bed in order to provide the early morning energy needs. The FCHART 2.0 computer program was used for this analysis. The principal parameters used in the analysis are listed below.

Collector orientation	Due South
Collector tilt	50° from horizontal
Storage capacity	15 BTU/^{o}F - ft^{2}
Collector type	Flat Plate, single glazed selective
	F_r^1 $(\tau\alpha)$ - 0.79
	F_r^1 (UL) - 0.81
UA of load	1000 Btu/^{o}F hr.
Climate data	Oakland, CA
Economic life	25 years

FIGURE 4

SPACE HEATING AND
BUILDING SERVICE HOT WATER

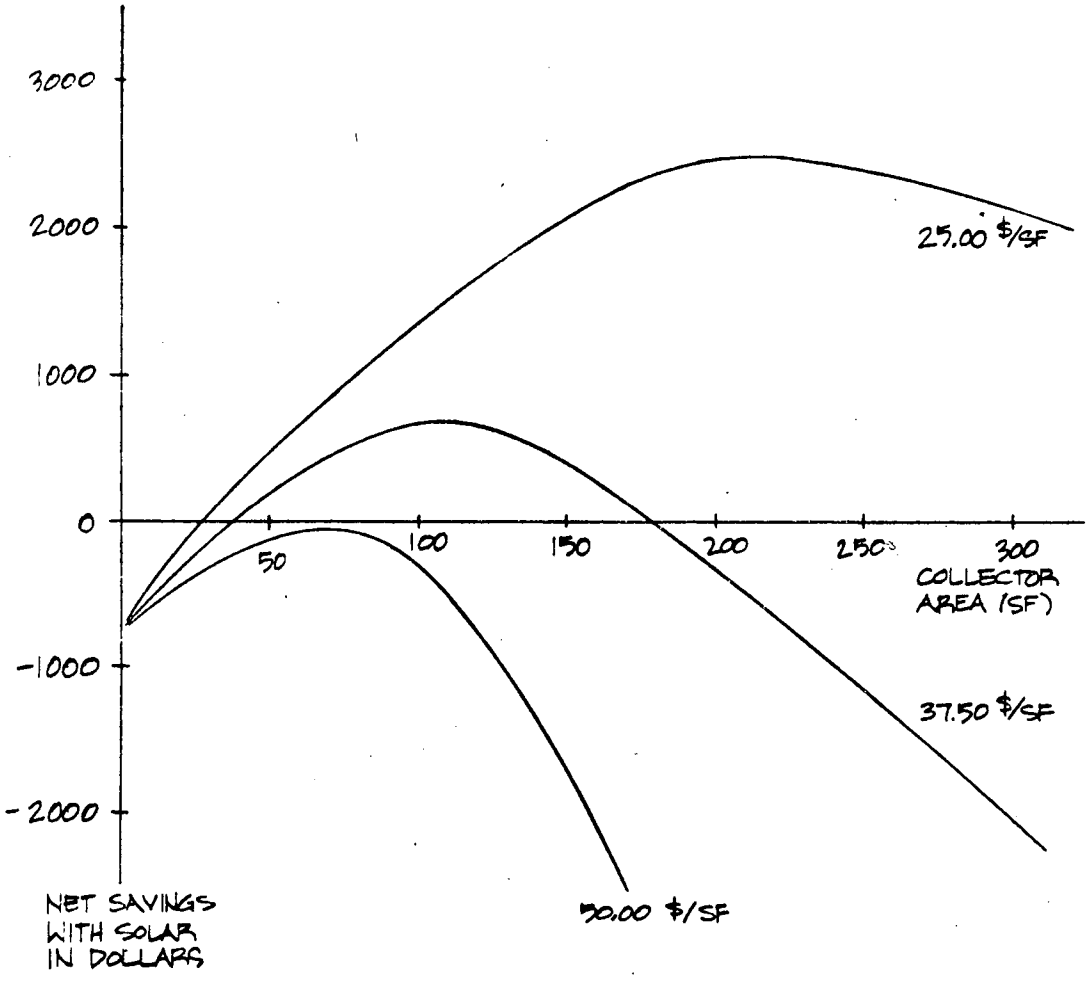
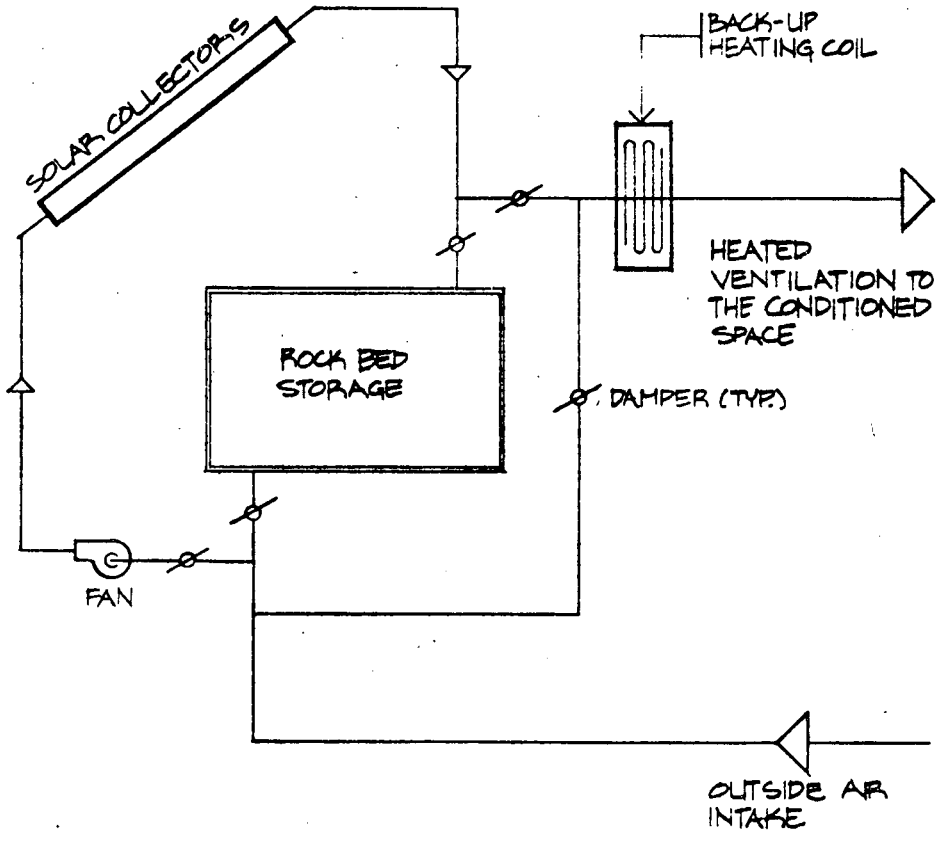


FIGURE 5

OUTSIDE AIR PREHEAT SYSTEM



Discount rate	8%/year
Fuel cost including system efficiency	4 $\$/10^6$ Btu
Fuel differential inflation above the economy	8%/year
Maintenance cost	1%/year of capital cost.

The following assumptions were made for this analysis:

1. The collector tilt was chosen to be 50°. This should be close to an optimum tilt, but would be optimized during the building design process.

2. The amount of storage was set at 15 BTU/°F - ft^2. This also would be optimized during building design.

3. Since there is no heat exchanger between the collectors and storage $F_r^1/F_r = 1$.

4. The energy requirements were estimated to be a function of the degree days for Oakland, with a UA of 1000 BTU/hr°F. This would be optimized during design when the interaction with possible energy recovery opportunities of the mechanical system is studied in detail.

5. The FCHART 2.0 program is designed to model a residential solar system. A pre-heat system could operate at a lower temperature and therefore be more efficient. Thus the results predicted are considered conservative.

Figure 6 shows the net savings with solar, i.e., the difference in cumulative present value of owning and operating costs with and without solar, vs. collector area. The DOE solar design manual addresses liquid systems. The proposed system is projected to have costs at the lower end of the range given for liquid space heating systems in the DOE facilities solar design manual. DOE is assuming that this price range is what would be typical for a well-established solar industry. The difference between this cost and the budget requirement can be attributed to the cost of DOE's policy for solar industry stimulation. At this cost, a collector area of 150 square feet providing 53% solar heating of the outside air is recommended.

SPACE HEATING, SPACE COOLING AND BUILDING SERVICE HOT WATER

Figure 7 shows a schematic diagram of the system. A collector-to-storage heat exchanger was not used. This will improve the collection efficiency. Freeze protection will be provided by draindown. The FCHART 2.0 computer program was used for this analysis. The principle parameters used in the analysis are listed below.

FIGURE 6

OUTSIDE AIR PREHEAT SYSTEM

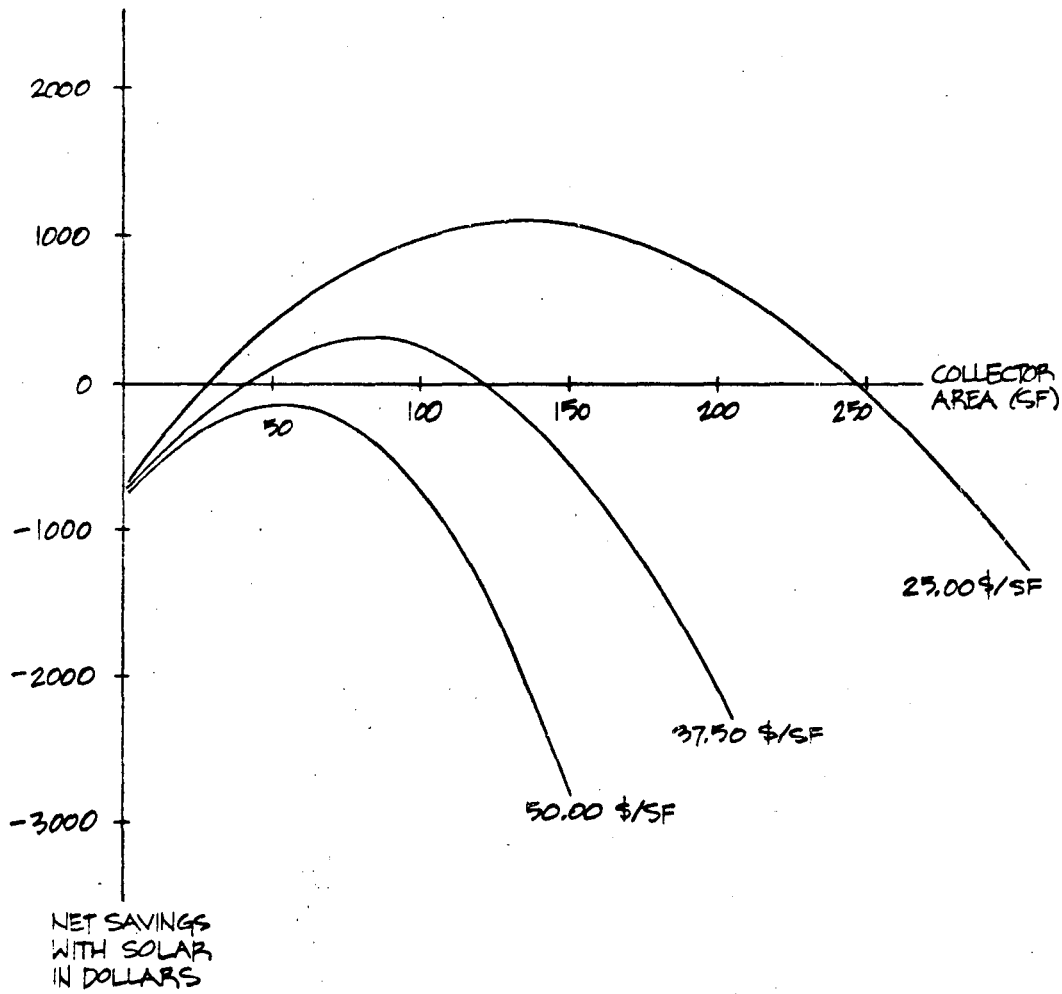
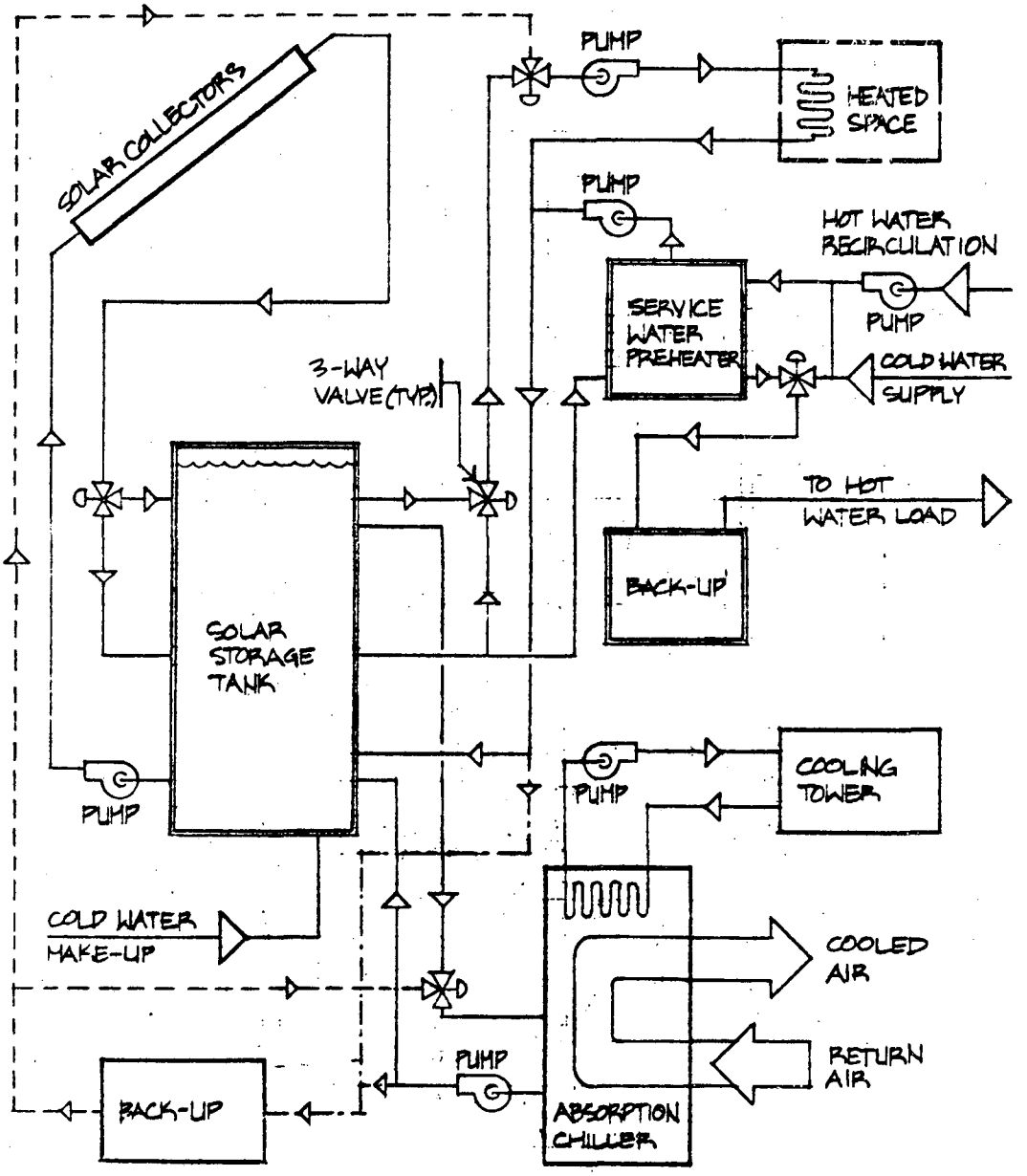


FIGURE 7

SPACE HEATING, SPACE COOLING, AND BUILDING SERVICE HOT WATER



Collector orientation	Due south
Collector tilt	37° from horizontal
Storage capacity	15 BTU/°F - ft^2
Collector type	Evacuated tube
	F_r^1 $(\tau\alpha)$ = 0.55
	F_r^1 (UL) = 0.10
Effective UA of load	4615 BTU/°F - ft^2
Hot water load	108 gal/day
Set temperature	110°F
Main temperature	60°F
Climate data	Oakland, CA
Economic life	25 years
Discount rate	8%/year
Energy cost including system efficiency	$\$4/10^6$ BTU
Fuel differential inflation above economy	8%/year
Maintenance cost	1%/year of capital cost

The following assumptions were made for this analysis:

1. The collector tilt was chosen to be 37°. This should be close to an optimum tilt, but would be optimized during the building design process.

2. The amount of storage was set at 15 BTU/°F - ft^2. This also would be optimized during building design.

3. Since there is no heat exchanger between the collectors and storage, $F_r^1/F_r = 1$.

4. The heating energy use was estimated to be a function of degree days, an assumed UA value of 4615 BUT/hr°F, and an internal heat generation of 546,000 BTU/day. The cooling energy requirement was estimated using the above information and cooling degree days.

5. The amount of energy that solar could supply for cooling was estimated using the FCHART 2.0 domestic hot water code with a set temperature of 190°F and a main temperature of 180°F. A COP of 0.6 was assumed for the absorption refrigeration cooling machine. These assumptions would tend to overestimate the amount of cooling produced by the solar system which would tend to make the economic analysis liberal.

6. The economic analysis was done using the FCHART 2.0 program life-cycle cost analysis. The heating energy supplied by solar was automatically given by the FCHART 2.0 program. The cooling energy supplied by the solar system was estimated by the method described in Assumption 5 and added to the heating energy. This combined energy from solar was then input into the FCHART 2.0 economic analysis to get the cumulative present value for various collector sizes.

7. It was assumed that the FCHART residential profiles for energy use were accurate enough for the purpose of this report.

Figure 8 is a graph of the net cumulative present value, i.e., the difference in cumulative present value of owning and operating costs with and without solar, vs. collector area. The space heating, space cooling and building service hot water system is shown to be economically unfeasible even at the reduced DOE specified system costs.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

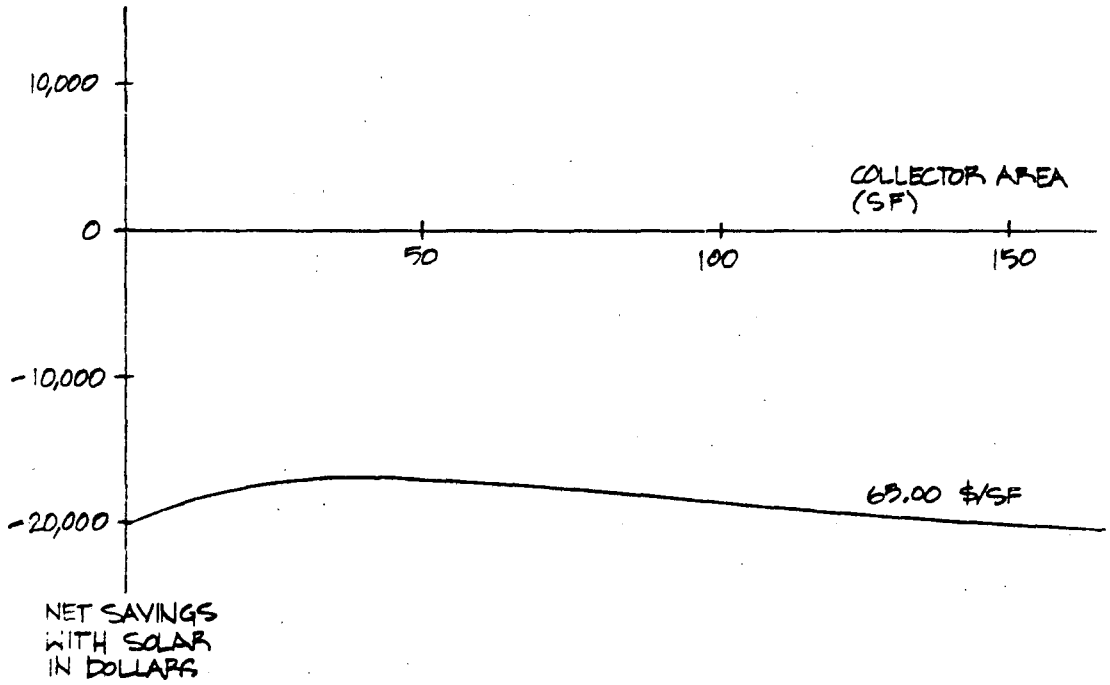
Four active solar systems were investigated for economic viability. The difference between the system costs used in this analysis and the budget requirements can be attributed to the cost of DOE's policy for solar industry stimulation.

The results of the analysis indicate that a building service hot water solar system should be included in the building program if building service hot water is not included in space heating systems. A space heating, space cooling and service hot water solar system does not meet the economic criteria used and, therefore, is not recommended. However, a space heating and service hot water solar system, or an air pre-heat solar system, meets the economic criteria used. Budget costs for either of these last two systems are comparable.

Final selection of the solar system to be used will be done during detailed design when the interaction with detailed building system performance will be studied and system design parameters will be optimized. Further, more detailed studies of passive solar options and other complex systems such as a solar-assisted heat pump require more sophisticated computer analysis and therefore have been deferred until detailed design. These last two options are potentially more cost effective than traditional active solar systems, but require more time and analysis in the design stage.

FIGURE 8

SPACE HEATING, SPACE COOLING, AND BUILDING SERVICE HOT WATER



Section IX

SAFETY, POLLUTION, AND ENVIRONMENTAL ASSESSMENTS

A. ANALYSIS OF PRINICIPAL HAZARDS AND RISKS

1. Potential Injury and Property Damage Accidents

a. Fire and Explosion

The chief source of flammable substances will be the lube oils associated with some of the mechanical pumping systems used for roughing and backup of turbomolecular and other high vacuum pumping systems. Although records exist of explosions in roughing pump exhaust lines, no problems are anticipated with this installation. Filtered exhaust ports will minimize discharge of pumping fluid fumes into the exhaust manifolds. To control moisture and other high vacuum contaminants when it is necessary to return the column and accelerator to atmospheric pressure, high purity nitrogen gas will be used. This procedure will eliminate generation of explosive mixtures generated when systems are brought down to air. As an added safety feature, critical systems will be charged with perfluoropolyethers, characterized as having no flashpoints and extremely low vapor pressures at high pumping temperatures. Small volumes, pints or less, of flammable solvents will be used in the laboratories preparing specimens for insertion in the microscope. These will be used with adequate ventilation to dilute the vapors below flammable limits as well as to protect the users from inhalation hazards. Class A materials will consist of paper generated in the recording of experimental results and computer printouts. Except for construction finishes with flame spreads below 25, no additional combustibles will be incorporated in the structures. All facilities will be sprinklered and alarmed to the LBL Fire Department with a run time of one minute from its on site station.

b. Radiation

Explicit specifications for X-ray generation will be incorporated in the purchase order for the microscope. The radiation level at any position at the external surface of the instrument accessible to operating personnel will not exceed 0.3mR/hr and 0.25mR/hr during operation at 500Kv. In addition, the instrument will be equipped with four radiation monitors: one at the level of condenser 1, one at the level of the specimen chamber, one at the level of the viewing window, and

one at knee-level below camera. These monitors shall be preset to illuminate visible warning lights in the control console area when the radiation level exceeds 0.3mR/hr and to sound an audible alarm, switching off the electron beam in the process when the radiation level exceeds 0.7 mR/hr under normal operating conditions. The machine will be shielded to the extent that non-controlled laboratory personnel exposure will not exceed 500mR/yr, and the X-ray level at LBL boundaries shall not exceed an exposure in excess of 5mR/yr.

c. Structural Failure and Seismic Activity

This building site has been investigated and found satisfactory for seismic stability and construction. The structural design will minimize the possibility of damage due to seismic activity by applying the following criteria.

Maximum potential earthquakes causing ground shaking at the LBL site are a Richter magnitude 8.3 on the San Andreas Fault, which is about 20 miles away, and a magnitude 7.0 on the Hayward Fault about 1/2 mile away. Intensity of ground shaking at the site is estimated to be VIII on the Modified Mercelli Scale. The data on hand will be adequate to incorporate into the building design present criteria for safety from seismic disturbances.

The building proper will be designed to structural criteria which will provide lateral force resistance above that required by the latest Uniform Building Code. Final design will be reviewed independently by structural engineers specializing in seismic design and earthquake damage surveys. These engineers have reviewed the conceptual design.

Special design criteria for tie-downs will be applied to all critical equiment and emergency utility supplies provided for, to ensure that damage to equipment and support systems is minimized. ASME codes for unfired pressure vessels will be applied.

d. Operating Error

The chief risks for serious injury and property damage are those associated with material handling during the construction phase. The tank or tanks housing the high-voltage generator and accelerator will be filled with a dielectric gas at pressure to control coronal discharges. To prevent overpressurizing, the tanks will be equipped with safety relief valves and

pressure gages which can be read from the operating console. The system will be provided with complete protection for operating personnel against electrical shock hazards. When applicable, the design callouts for electrical material shall require conformance to the latest NEMA standards, and construction shall be to NEC standards.

The ARM system will be fully interlocked for simplicity of operation, for complete safety of the operator, and for full self-protection of the instrument against damage. Vacuum will be electrically or mechanically interlocked to insure proper sequential operation. Accelerator and electron gun will be interlocked for protection in case of degeneration of vacuum, or failure of the vacuum system. Automatic shutoff will be provided to the recirculating chilled water system for vacuum pump and lens cooling to protect against excessive water temperature or low cooling water flow. The high-voltage generator and accelerator will be interlocked with appropriate sensors and relays for turning off the filament and activating a distinctive alarm in the event that the beam current at the condensor lens assembly is in excess of the critical maximum value. Access panels and doors to the high-voltage cabinets shall be interlocked to cut off power when opened.

B. POLLUTION CONTROL AND TREATMENT MEASURES

1. Air

The measures taken to control air pollution from vacuum pumping systems were discussed under Fire and Explosion. A stack will be provided to the manifolded exhausts which will discharge any residual vapors not captured by the filter systems at a height of greater than the roof level. Radioactive particulates generated in the preparation of specimens will be captured by high efficiency HEPA filters attached to closed systems (gloved boxes). These operations will not be housed in the structure containing the microscope but will be performed in adjacent laboratory rooms. These facilities are routinely monitored to assess the efficiency of the containment systems. Reports of total releases are made to governmental agencies and routinely show average concentrations one tenth or less of the guidelines set by the regulatory authorities. Area heating for LBL buildings is accomplished with hot air or hot water systems augmented with solar systems. Fuel has been natural gas; the sulfur content is limited to the added ppm's of odorant.

2. Water

Water pollution will be controlled at the source. The chief liquid wastes from this facility will be those from photographic processing of the pictures generated from the microscope operation. All wastes with recoverable silver values will be processed to recover those values. The two sewer outfalls at the Blackberry and Strawberry canyons are routinely monitored for materials considered deleterious by the municipal sewage authorities. When concentration trend differences are noted, measures are taken to control the effluents before the concentration reaches the maximum permissible set by the authorities. When radioactive wastes are generated, they are separated out into small containers before they reach the sinks and are sophisticated for perpetual storage at an approved site. Lube oils are recycled.

3. Solid Wastes

Solid wastes are largely materials and replaced parts from maintenance operations as well as paper from office and computer operations. Metals and a large fraction of the paper from computers are recycled. Replacement filters from heating and cooling equipment add to this volume. Radioactive solids and contaminated filters are consigned to steel barrels which are routinely collected by a licensed disposal firm. Non-active solid wastes are collected by a commercial firm for landfill disposal.

C. ENVIRONMENTAL ASSESSMENT

The site selected to house the ARM is adjacent to existing Building 72 and the HVEM facility. The new ARM Laboratory will add approximately 50% more runoff area to that of the combined existing and new HVEM buildings. Situated as it is on the side of a grass covered hill at the southeastern portion of LBL, and draining into Strawberry Creek, no problems will arise from the increased runoff.

Visual impact will be minimal. This portion of LBL is not visible from the campus one mile below. The new structure will be painted an earth color as are all of the LBL buildings.

There will be no displacement of historical, archeological, or esthetic values, and depletion of resources will not be noticed on a national or local basis.

An increase of about 35 scientists and technicians to operate the new facility will not add significantly to the economy of the East Bay communities. A large part of this effort will come from graduate students working on advanced degrees.

Alternative facilities are unavailable either on the campus or from commercial sources owning to the unique operating parameters of this instrument.

Section X

DETAILED SUPPORTING DATA

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LAWRENCE BERKELEY LABORATORY

ATOMIC RESOLUTION MICROSCOPIC LABORATORY

ESTIMATED CONSTRUCTION COSTS

ADVANCED SCHEMATIC

PREPARED BY

CONSULTING COST ESTIMATORS

2156 North Main Street

P.O. Box 5367

Walnut Creek, California 94596

Phone No. 415/935-3545

Current Cost Index

2798.1

FILE CCE# 827-6-29

Consulting Cost Estimators, Inc.
BUILDING & ENGINEERING COSTS
PROJECT MANAGEMENT
CONSTRUCTION COST CONTROLS
415 935-3545
2156 N. Main Street
Walnut Creek
CA 94596

Prepared by: J.W.COOK Checked by: M.F.ESTES	SUMMARY OF ESTIMATED CONSTRUCTION COSTS LAWRENCE BERKELEY LABORATORY ATOMIC RESOLUTION MICROSCOPIC LABORATORY	File CCE#827-6-29 Phase: Adv.Sch. Date: 6/30/78 Revision #

SPEC. SECT.	CLASSIFICATION	AMOUNT
1.0	GENERAL REQUIREMENTS	149,803
2.0	SITE DEVELOPMENT	84,325
3.0	CONCRETE	139,099
4.0	MASONRY	none
5.0	METALS	194,845
6.0	CARPENTRY	15,180
7.0	THERMAL, SOUND AND MOISTURE PROTECTION	30,555
8.0	DOORS, WINDOWS AND GLAZING	46,367
9.0	FINISHES	129,350
10.0	SPECIALTIES	7,220
11.0	EQUIPMENT	10,800
12.0	FURNISHINGS	none
13.0	SPECIAL CONSTRUCTION	none
14.0	CONVEYING SYSTEMS	35,000
15.0	MECHANICAL WORK	185,131
16.0	ELECTRICAL WORK	152,420
17.0	Lab. Spec.	12,000

CONCEPTUAL – SCHEMATIC – PRELIMINARY – FINAL & PROGRESSIVE COST ESTIMATES

Consulting Cost Estimators, Inc.
BUILDING & ENGINEERING COSTS
PROJECT MANAGEMENT
CONSTRUCTION COST CONTROLS
415 935-3545
2156 N. Main Street
Walnut Creek
CA 94596

Prepared by: J.W.COOK Checked by: M.F.ESTES	SUMMARY OF ESTIMATED CONSTRUCTION COSTS LAWRENCE BERKELEY LABORATORY ATOMIC RESOLUTION MICROSCOPIC LAB.	File CCE#827629 Phase: Adv.Schem Date: 6/30/78 Revision #

SPEC SECT.	CLASSIFICATION	AMOUNT
	SUB TOTAL (Direct Cost)	1,192,095
	* CONTINGENCY 10 %	119,210
	SUB TOTAL	1,311,305
	Contractor's Mark Up 8%	104,904
	BONDS .00625	8,851
	TOTAL	1,425,060
	≠ ESCALATION FACTOR	

ADDITIVE ALTERNATE #1
Solar heating System.....$28,720

* Schematic & Preliminary Only

≠ Factor to be applied per cal month from current to contract mid point.

CONCEPTUAL – SCHEMATIC – PRELIMINARY – FINAL & PROGRESSIVE COST ESTIMATES

LAWRENCE BERKELEY LABORATORY
ATOMIC RESOLUTION MICROSCOPIC LABORATORY

6/29/78

SPEC. SECT.	DIVISION	QUANTITY	UNIT	UNIT COST	TOTAL COST
1.00	GENERAL CONDITIONS				
	Non Distributable Labor				
	Superintendent	18	MO	3400.	61,200
	Engineering and Layout	JOB	LOT	LS	5,500
	Temp. Utilities				
	Power, Lighting	18	MO	300.	5,400
	Sewerage	18	MO	45.	810
	Heat	3	MO	400.	1,200
	Telephone	18	MO	125.	2,250
	Water	18	MO	90.	1,620
	Temporary Structures				
	Trailer - Office	2	EA	150 Max.	5,400
	Storage Buildings - Temporary	3	EA	275.	825
	Material Handling				
	Cranes	3	MO	4500.	13,500
	Other General Conditions				
	Barricades and Temp. Fencing	JOB	LOT	LS	900
	Scaffolding	JOB	LOT	LS	3,900
	Debris Removal	18	MO	150.	2,700
	Cleanup, Maintenance	18	MO	250.	4,500
	Cleanup, Final	16,000	SF	.025	400
	Sm. Tools and Consumable Supplies	LOT		LS	1,250
	Trucks and Autos	18	MO	300.	5,400
	Photos and Signs	-	-	-	N.I.C.
	Manual Labor Distributables				
	Prt. Ins. Fringes	54% Line 1			33,048
	TOTAL - ITEM #1.00 GENERAL CONDITIONS				149,803

CONSULTING COST ESTIMATORS

SPEC. SECT.	LAWRENCE BERKELEY LABORATORY ATOMIC RESOLUTION MICROSCOPIC LABORATORY DIVISION	QUANTITY	UNIT	UNIT COST	6/29/78 TOTAL COST
2.00	SITE WORK				
.10	Demolition				
	a. Cut Existing Bldg. 72 South Wall For New Connecting Corridor Max.Width of Existing Wall to Be Removed Computed As 24 LF x 15 VF	360	SF	7.	2,520
	b. Provide Inset Temporary Closure W/ Floor, Wall, Ceiling and Finish Covering	ALLOW	JOB	LS	1,500
	c. Restore Disturbed Surfaces, Clean Fixtures and Finish,etc.	ALLOW	JOB	LS	2,500
	d. No Other Demolition Shown Nor Covered	-	-	-	-
	Sub Total - Item #2.10				6,520
.20	Cut/Fill and Grading				
	a. Strip Site 15,000 SF ≠ x 0.5 & Stock Pile	278	CY	3.75	1,043
	b. Bulk Excavation - Non Rock	417	CY	5.	2,085
	Bulk Excavation - Rock	456	CY	18.	8,208
	c. Engineered Fill Pad 18" Deep x 6618SF Computed as Quarry Unselect W/130% Ratio to Net x 2760#s CY	440	TONS	5.10	2,244
	d. Service Yard Fill From Rock Excav.	115	CY	2.25	259
	e. Backfill @ N.&E. Bldg. Walls Where 5.0 Access Space For Working	419	CY	6.50	2,724
	f. Haul Off - None If Cut Rock Excav.	-	-	-	note
	Can Be Reused As Fill & Stock Piled Strippings Used For Fin.Contouring	-	-	-	note
	g. Rough Grade Site	9,000	SF	.03	270
	Sub Total - Item #2.20				16,833

SPEC. SECT.	LAWRENCE BERKELEY LABORATORY ATOMIC RESOLUTION MICROSCOPIC LABORATORY DIVISION	QUANTITY	UNIT	UNIT COST	6/29/78 TOTAL COST
2.30	Drilled Piers 24"ø-16 Rock 160 VF Fill	118VF 278	VF	11.95	3,322
	" 36"ø 2 Rock 20 VF Fill 11.5 VF	32	VF	17.10	547
	Pier Rebar Allowed 310 VF x 16#	4,960	#	.29	1,438
	Pier Concrete @ 130% Net	41	CY	48.	1,968
	Pier Collar Cap	18	EA	12.	216
	Pier Remove Excess Excav.	41	CY	6.	246
	Move In/Move Out & Set Up	ALLOW	LOT	LS	2,500
	Sub Total - Item #2.30				10,237
.40	Underpin Existing Bldg. 72 @ Lobby Connector	24	LF	105.	2,520
.50	Site Utilities				
	a. Storm Drainage-Surface Run Off	None Shown		-	-
	b. Sanitary Sewage-Not Sized-Allowed				
	6" V.C.	638	LF	11.	7,018
	C.O.T.G.	5	EA	105.	525
	Conn. to Existing Line	1	JOB	LOT	150
					7,693
	c. Domestic Water 4" w/Valve and Fittings	1,200	LF	10.17	12,204
	2" W/" & Fittings	75	LF	6.40	480
	Conn. to Existing	2	UNIT	JOB	525
					13,209
	d. Gas 2" SW/T&C	1,275	LF	5.70	7,268
	Road Conn.to Existing	1	EA	LS	630
					7,898
	e. Steam Lines	Not Shown		-	-
	Specialty Water	Not Shown		-	-
	Fire Main	Not Shown		-	-
	Electrical Distribution	Not Shown-See 16.0 Elect.Sect.			
	Electrical Night Site Lighting	Not Shown- See 16.0 " "			
	Sub Total - Item #2.50				28,800

CCE#827-6-29

SPEC. SECT.	LAWRENCE BERKELEY LABORATORY ATOMIC RESOLUTION MICROSCOPIC LABORATORY DIVISION	QUANTITY	UNIT	UNIT COST	6/29/78 TOTAL COST
2.60	General Site Work				
	a. A.C. Paving - Road Extension 3" on 4" on 6"	1,000	SF	1.20	1,200
	Service Yard 2" on 4"	1,800	SF	.70	1,260
					2,460
	b. Concrete Paving-Entry Walk & North Area Adjacent Bldg. 72	680	SF	1.50	1,020
	c. Curb, Curb and Gutter	None	-	-	-
	d. Masonry	None	-	-	-
.70	Fencing	None	-	-	-
.80	Landscaping and Irrigation	6,500	SF	1.40	9,100
.90	Retaining Walls - Service Yard	55	LF	103.	5,665
	South Walk	30	LF	39.	1,170
					6,835
	ITEM #2.00 SITE WORK COMBINED				84,325
3.00	CONCRETE				
.10	a. Excavation For Fdns. Typ.Footing 1.33 x 1.0 From R/Grade x 480 LF Pads 1.0 Below R/Grade (FF-18")	33	CY	18.	594
	b. Forms For Foundations Exposed Upper Faces 2x480 - 960 SF Exposed Upper Pads 160 SF	1,020	SF	1.85	1,887
	c. Rebar For Foundations - 480 LF x 6.26# Rebar For Foundations #5 Mats	3,419	#	.28	957
	d. Concrete For Foundations 480 LF x 1.56 CF x 1.1 Factor= 2,405 CF Pads 2.0 Thick Factor 540 CF	109	CY	48.	5,232
	e. Backfill - None, Offhaul Excess	33	CY	5.50	182
	Sub Total - Item #3.10				8,852

CONSULTING COST ESTIMATORS

LAWRENCE BERKELEY LABORATORY
ATOMIC RESOLUTION MICROSCOPIC LAB.

6/29/78

SPEC. SECT.	DIVISION	QUANTITY	UNIT	UNIT COST	TOTAL COST
3.20	Architectural/Structural Concrete				
	a. Forming Walls	12,760	SF	2.75	35,090
	b. Rebar- Ext. Walls & Int. Walls	49,090	#	.30	14,727
	c. Concrete - Material in Place	172	CY	55.	9,460
	d. Patch/Plug/Sack	12,760	SF	.15	1,914
	e. Column Forming	1,335	SF	3.40	4,539
	f. Column Concrete	21	CY	68.	1,428
	g. Form Beams	645	SF	2.10	1,355
	h. Beam Concrete (Including Cost to Reshore)	15	CY	60.	900
	i. Suspended Slabs (Arm 7", Lab 9" Lobby 7)	6,607	SF	2.40	15,857
	j. Arm 7", Rebar) Lab 9" Rebar) Lobby 7" Rebar)	56,303	#	.30	16,891
	k. Arm 7" Conc. Mat'l.) Lab 9" Conc. Mat'l.) Lobby 7")	161	CY	58.	9,338
	l. Finish Concrete - Including Cure/Cover	6,607	SF	.32	2,114
	m. Lite Weight Concrete Fill(Over Decking)	4,710	SF	.78	3,674
	n. Column Rebar	6,454	#	.30	1,935
	Sub Total - Item #3.20				119,222
.30	Slab on Grade				
	Fine Grade	6,000	SF	.o3	180
	Capillary Cushion 4" @ 120%	90	CY	10.75	968
	Sand Cushion 2" Net	37	CY	7.25	268
	Membrane See Section 7.0	-	-	-	-
	Rebar #4 @ 16" O.C. 1 layer 0.9#	5,400	#	.27	1,458
	Concrete - Material	112	CY	48.	5,376
	Concrete Finish/Cure/Protect	5,725	SF	.31	1,775
	Allow Exp./Const. Jts. & Misc. Iron Set	JOB	LOT	LS	1,000
	Sub Total - Item #3.30				11,025
	TOTAL - ITEM #3.00 CONCRETE COMBINED				139,099
4.00	MASONRY				None

6/29/78

SPEC. SECT.	LAWRENCE BERKELEY LABORATORY ATOMIC RESOLUTION MICROSCOPIC LAB. DIVISION	QUANTITY	UNIT	UNIT COST	TOTAL COST
5.00	METALS				
.10	Structural Steel	91,455	#	.66	60,360
	Detail Steel	7,300	#	.70	5,110
	X Bracing	38,249	#	.74	28,304
	Sub Total - Item #5.10 Structural Steel				93,774
.20	Misc. Metal				
	Decking 1½"	6,141	SF	1.58	9,703
	Decking 3"	5,000	SF	1.75	8,750
	Railing & Hatch & Equipt.Deck Platform	1	UNIT	LS	1,617
	Steel Stairs with Railing	128	R	LS	14,160
	Railings @ Mezz.,etc.	141	LF	LS	4,001
	Steel Tubes @ Louvers	600	#	.70	420
	Roof Screen Framing	96	LF	45.	4,320
	Wall Openings - Framing	ALLOW	LOT	LS	2,500
	Roof/Hatch/Ladder	1	UNIT	LS	400
	Sub Total - Item #5.20 Misc. Metals				45,871
.30	Metal Insulated Wall Panels	9,200	SF	6.	55,200
	TOTAL - ITEM #5.00 METALS COMBINED				194,845
6.00	CARPENTRY				
.10	Carpentry - Rough (Lab Wing Only - None In High Bay)				
	Interior Partitions 2x4 Framing	20,078	FBM	.70	14,055
	Block All Trades	1,500	FBM	.75	1,125
	Sub Total - Item #6.10 Rough Carpentry Lab Wing Only				15,180

CONSULTING COST ESTIMATORS

6/29/78

SPEC. SECT.	LAWRENCE BERKELEY LABORATORY ATOMIC RESOLUTION MICROSCOPIC LAB DIVISION	QUANTITY	UNIT	UNIT COST	TOTAL COST
6.20	Carpentry Finish - No Finish Woodwork or Trim Shown. Labor For Installing Doors, Frames, Hardware, Accessories is Covered In Those Sections	-	-	-	Note *
	TOTAL - ITEM #6.00 CARPENTRY COMBINED				15,180
7.00	MOISTURE - SOUND & THERMAL PROTECTION				
.10	High Bay - Rigid Roof Insulation	1,600	SF	.78	1,248
	High Bay - Roofing B.U. T&G	16	SQS	78.	1,248
	High Bay - Sheet Metal Flashing - All	921	#	2.70	2,487
	High Bay - Sheet Metal Arch. Louvers	168	SF	9.65	1,621
	High Bay - Misc. Cover & Exp.Joints	LOT		LS	900
	Sub Total - Moisture, Sound & Thermal Protection High Bay				7,504
.20	Lab Wing - Rigid Roof Insulation	4,656	SF	.78	3,632
	Lab Wing Roofing BUTG	47	SQS	78.	3,666
	Lab Wing - Sheet Metal Flashing	2,578	SF	2.70	6,961
	Lab Wing - Flash Wall Opgs.	772	LF	3.10	2,393
	Lab Wing - Flash Roof Opgs. & Equipt.	JOB	LOT	LS	300
	Lab Wing - Bridge Deck Water Proofing	JOB	LOT	LS	300
	Sub Total - Moisture Sound & Thermal Protection Lab Wing				17,252
	Floor Membrane and Wall W/Proof	8,284	SF	.70	5,799
	TOTAL - ITEM #7.00 MOISTURE SOUND & THERMAL PROTECTION COMBINED				30,555
8.00	BUILDING CLOSURES				
	Hollow Metal Doors and Frames in Place High Bay	2	PR	458.	916
	Finish Hardware	2	UNITS	LS	678
	Sub Total - Bldg. Closures High Bay				1,594

CONSULTING COST ESTIMATORS

LAWRENCE BERKELEY LAB.
AUTOMIC RESOLUTION MICROSCOPIC LAB

6/29/78

SPEC. SECT.	DIVISION	QUANTITY	UNIT	UNIT COST	TOTAL COST
8.00	BUILDING CLOSURES, CONT.				
	Lab Wing				
	H.M. Door Frames W/SC Wood Door	39	Single	235.	9,165
	H.M. Door Frames W/SC Wood Door	8	PR	458.	3,664
	D/Glazed Window Wall W/1 Door 3x7	240	SF	16.	3,840
	D/Glazed Anod Sash Glazed	960	SF	11.48	11,021
	Single Glazed Anod Sash Glazed	614	SF	8.70	5,342
	Glazed Entries	2	Single	LS	1,470
	Glazed Entries	2	EA	LS	2,674
	Lab Wing Finish Hardware	47	UNITS	LS	7,597
	Sub Total - Bldg. Closures Lab Wing				44,773
	TOTAL - ITEM #8.00 BLDG.	CLOSURES COMBINED			46,367
9.00	FINISHES (None in High Bay Except Painting)				
	Lab Wing Exterior Metal Studs - 16G 6" C.S. Weld	990	SY	21.	20,790
	Lab Wing Exterior Stucco With Lath	150	SY	16.	2,400
	Lab Wing Int. Gypsum Board-Wall & Ceil.	52,603	SF	.70	36,822 *
	Lab Wing Suspension Grid	13,000	SF	.80	10,400
	Lab Wing Ceramic Tile to 6 VF Wall	2,100	SF	3.	6,300
	Lab Wing Ceramic Tile Floor in Mud	830	SF	3.70	3,071
	Lab Wing Ceramic Tile Base	350	LF	2.75	963
	Lab Wing Acoustical Tile	11,780	SF	1.25	14,725
	Lab Wing Resilient Floor Covering	14,480	SF	.75	10,860
	Lab Wing Resilient Floor Base	3,246	LF	.68	2,207
	Painting				
	Lab Wing Exterior Stucco	1,350	SF	.25	338
	" " Exterior Louvers & Sheet Metal	JO B	LOT	LS	700
	" " Int. Gypsum Board-2 Coat & Sealer	41,000	SF	.30	12,300
	Lab Wing Interior Stairs	JOB!	LOT	LS	420
	Lab Wing Int. Doors and Frames	47	UNITS	22.	1,034
	Lab " Int. Heat,Vent & A.C. Code & Duct	Opgs. JOB	LOT	LS	650
	" " " Electrical Code & Equipt.	JOB	LOT	LS	370
	Lab Wing Interior Painters Graphics	JOB	LOT	LS	500
	Lab Wing Int. Wall Covering-Lobby Offices	ALLOW	LOT	LS	3,500
	Sub Total Finishes - Lab Wing				128,350

* 5/8 Gyp Bd. or Fire Spray Insul. Interchangeable Cost Wise But Acoustic Can Be Adhesive Applied Cheaply to Gyp Bd.

6/29/78

SPEC. SECT.	LAWRENCE BERKELEY LAB AUTOMIC RESOLUTION MICROSCOPIC LAB DIVISION	QUANTITY	UNIT	UNIT COST	TOTAL COST
9.00	FINISHES - cont.				
	Painting Allowance - High Bay	JOB	LOT	LS	1,000
	TOTAL - ITEM #9.00 FINISHES COMBINED				129,350
10.00	SPECIALTIES - Lab Wing Only				
	Toilet Partitions	6	EA	225.	1,350
	Toilet Sight Screen	6	EA	110.	660
	Toilet Sight Urinal Screen	3	EA	70.	210
	Toilet Accessories	LOT	JOB	LOT	1,300
	Misc. Accessories - F/Ext.,etc.	ALLOW	LOT	LS	1,000
	Dark Room - Lite Doors	2	EA	600.	1,200
	Dark Room - Equipment	-	-	-	N.I.C.
	Chalk and Tack Boards	ALLOW	LOT	LS	1,200
	Directory	1	EA	LS	300
	Lockers	-	-	-	N.I.C.
	TOTAL - ITEM #10.00 SPECIALTIES COMBINED				7,220
11.00	EQUIPMENT - High Bay 5 Ton Traveling Hoist	1	EA	LS	10,800
	Lab Wing - All Equipment by Owner			-	N.I.C.
12.00	FURNISHINGS				N.I.C.
13.00	SPECIAL CONSTRUCTION				None
14.00	ELEVATOR - 4 Stop Hydraulic	1	EA	LS	35,000

CCE#827-6-29

6/29/78

LAWRENCE BERKELEY LAB
AUTOMIC RESOLUTION MICROSCOPIC LAB

SPEC. SECT.	DIVISION	QUANTITY	UNIT	UNIT COST	TOTAL COST
15.00	MECHANICAL				
.10	Plumbing				
	High Bay	JOB	LOT	LS	10,900
	Lab Wing	JOB	LOT	LS	24,700
					35,600
.20	Heat, Vent and A.C.				
	High Bay	JOB	LOT	LS	39,000
	Lab Wing	JOB	LOT	LS	81,000
					120,000
.30	Fire Protection System High Bay-Deluge	System	JOB	LOT	12,029
	Lab Wing	JOB	LOT	LS	17,502
					29,531
.40	Site Mechanical - See Section 2.5				
	TOTAL - ITEM #15.00 MECHANICAL COMBINED				185,131
16.00	ELECTRICAL				
	Buildings	17,176	SF	8.35	143,420
	Site	ALLOW	LOT	LS	9,000
	Emergency Gen.	-	-	-	N.I.C.
	TOTAL - ITEM #16.00 ELECTRICAL COMBINED				152,420
17.00	LABORATORY SPECIAL PIPING, AIR, GAS, ETC.,	ALLOW	LOT	LS	12,000

CONSULTING COST ESTIMATORS

SPEC. SECT.	LAWRENCE BERKELEY LAB AUTOMIC RESOLUTION MICROSCOPIC LAB DIVISION	QUANTITY	UNIT	UNIT COST	TOTAL COST
	ADDITIVE ALTERNATE #1				
	Roof mounted solar heating panels with structural supports, piping, insulation, storage facility, pumps and all valving necessary for an integrated system/panel area	240	SF	L/S	28,720

DEPARTMENT OF ENERGY

APPROPRIATION: ENERGY

FY 1980 BUDGET REQUEST

CONSTRUCTION PROJECT DATA SHEETS

UNIVERSITY OF CALIFORNIA
LAWRENCE BERKELEY LABORATORY

1. Title and Location of Project: Atomic Resolution Microscope Laboratory-Berkeley

2. Project No: LBL-80

SCHEDULE I

	FY 1978 Est. Costs
SPECIAL FACILITIES	
1. ARM Vibration Isolated Base	$122
2. HREM Isolation Systems (2)	3
3. Bridge Crane	20
4. Laboratory Furniture (Built-in)	40
5. Products of Combustion Detection System	5
	$190
STANDARD EQUIPMENT	
1. Atomic Resolution Microscope 500 KV	$3000
2. HREM 200 KV + Stem	350
3. Evaporator	10
4. Ion Beam Thinner	25
5. Image Processor	20
6. Optical Diffractometer	20
7. Microdensitometer	115
8. Computer PDP-11 and Interface	235
TOTAL STANDARD EQUIPMENT	$3775

Notes:

1. Special facilities items appear in "Details of Cost Estimate: on an escalated basis, with an estimated 26.8 percent increase to mid-point of construction.

2. Standard Equipment costs indicated are to the midpoint of procurement.

KORFUND DYNAMICS CORPORATION

VIBRATION · SHOCK · NOISE / CONTROL AND MEASUREMENT

CANTIAGUE ROAD · WESTBURY, LONG ISLAND, N.Y. 11590

516 · ED 3-7580

U.C. Lawrence Berkeley Laboratory
Building 930, Purchasing
One Cyclotron Road
Berkeley, CA 94720

DATE July 10, 1978
YOUR REFERENCE RFQ 4903002
YOUR LETTER DATED 6/22/78
OUR REFERENCE NO. 28840

ATTN: Mr. H. T. McGrath

Thank you for your inquiry. We appreciate the opportunity of providing you with the following information and look forward to working with you on this project.

ITEM NO.	DESCRIPTION		
	Re: Vibration Isolation and Seismic Restraint System for 1.5 MeV High Voltage Electron Microscope in accordance with LBL Technical Provisions dated June 21, 1978.		
1.	For the supply of one (1) Vibration Isolation and Seismic Restraint System as outlined in the attached Drawing D-1797 and Technical Proposal ER-780 which form parts of this quotation ----------	$53,100.00 F.O.B. Westbury, NY, with freight allowed to jobsite.	
	Notes: 1. Vibration Isolation and Seismic Restraint System includes (4) Type CFR-200 all-directional constant force seismic restraints (14) type ASG-10-250 pneumatic isolators, (3) GHP automatic height control valves, (1) control panel and (1) set of copper tubings and fittings.		
	2. Price includes the following engineering service: a. Complete construction drawings for the inertia block. b. Complete construction drawings for the foundation. c. Vibration survey at various stages of the project. d. Field inspection as stated in note #3. e. Supervision of installation of all Korfund supplied material and equipment. f. All required documents, drawings, manuals and maintenance instructions.		

Quotation for Vibration Isolation System for High Voltage Electron Microscope. This facility is an FY 1978 project of comparable size and complexity to ARM. This quotation, plus the inertia block and foundation costs, provides a basis for the estimated cost of Item #1 of Special Facilities

Vibration Isolation System 60K
Inertia block & found'n 62K
Total, including Engineering 122K

ALL SALES SHALL BE SUBJECT TO THE TERMS AND CONDITIONS SET FORTH ON THE REVERSE HEREOF.

Bulletin 288

CALIFORNIA
NEVADA
TEXAS
ALASKA
HAWAII
WASHINGTON, D.C.
SAUDI ARABIA
NIGERIA

HARDING-LAWSON ASSOCIATES
55 Mitchell Boulevard, P.O. Box 3030,
San Rafael, California 94902 • (415) 472-1400 • Telex 340523

Engineers, Geologists and Geophysicists

RICHARD S. HARDING
Civil Engineer

ROBERT T. LAWSON
Civil Engineer

DONALD L. SCHREUDER
Civil Engineer

KEITH H. BERGMAN
Civil Engineer

E.C. WINTERHALDER
Engineering Geologist

JEROME S. NELSON
Geophysicist

June 22, 1978

2000,124.01

Lawrence Berkeley Laboratory
Berkeley, California 94720

Attention: Mr. John Klein, Architect

Gentlemen:

Preliminary Geotechnical Investigation
Atomic Resolution Microscope Facility
Lawrence Berkeley Laboratory
Berkeley, California

This letter presents our preliminary geotechnical investigation for the proposed Atomic Resolution Microscope (A.R.M.) Facility. It is to be located about 15 to 20 feet south of Building 72 and will be attached to Building 72 by a lobby. The A.R.M. will be housed in a high bay structure four stories in height. A lab and office facility up to four stories high which will be attached to the A.R.M. will be located immediately east of the A.R.M. structure. The buildings will be of steel-frame construction with metal siding.

The purpose of our work was to provide preliminary recommendations for use in conceptual design phase of the project. Our scope was to provide recommendations for foundation support, lateral pressures for retaining walls and estimates of settlement.

The recommendations presented in this report are based on previous projects in the adjacent areas and experience with the soil and rock conditions at the Lawrence Berkeley Laboratory. Recent projects on which Harding-Lawson Associates (HLA) has been involved are listed below:

1. Investigation of unstable area north of Building 72

2. Recommendations for underpinning of Building 72

3. Soil and geologic investigation for high voltage electron microscope (H.V.E.M.)

4. Investigation and construction inspection of landslide south of Building 72

SURFACE AND SUBSURFACE CONDITIONS

The ground surface across the area of the proposed A.R.M. facility varies from 825* on the east to about 792 on the west. The south end of the proposed lab and office facility is located in a repaired landslide area. This landslide was repaired in 1977 under our engineering inspection.

The soil cover consists of natural soil and fill. The surface soils between the repaired landslide area and Building 72 are weak. Except for this condition, the remainder of the soils are generally moderately strong, moderately expansive to expansive and of low to moderate compressibility. Bedrock is of the Orinda formation and underlies the soil at depths varying from about 1 to 4 feet along the existing road (Borings 1.110, 2.110, 1.109) to as much as 17 feet in Boring 2.109. The depth to bedrock in the area of the H.V.E.M. (Boring 3.110) is about 3 feet.

CONCLUSIONS AND RECOMMENDATIONS

As indicated above, the proposed facility is underlain by bedrock of the Orinda formation. The required excavation for the A.R.M. and a portion of the support facility at Elevation 799.5 and the remainder of the support facility at Elevation 811.5 will expose bedrock throughout about 60 to 70 percent of the excavated area. Approaching the daylight (no cut or fill) line, the material at grade will be a clayey soil. Small amounts of fill will be required on the southwest corner of the facility.

To minimize the tendency for differential settlement and possible downhill creep, all foundations should be bottomed in bedrock or supported on drilled, cast-in-place concrete piles gaining frictional support from bedrock.

If all foundations are to be supported on spread footings, the footing excavation will have to be deepened down to bedrock in areas where the excavation did not encounter bedrock.

As an alternative, the entire building could be supported on drilled, cast-in-place concrete piles gaining frictional support from bedrock. A third alternative would be to support the structures on a combination of spread footings and drilled, cast-in-place concrete piles.

The floor slabs could be supported on ground if corrective measures are applied to the expansive clay and slab support is provided for existing surfaces below slab subgrade. The latter area could be raised to subgrade level with properly compacted fill or a lesser quality fill could be placed to act as a lower form for reinforced floor slab design to span the area where the fill will settle.

The excavation for a portion of the A.R.M. support facility will remove lateral support from the spread foundation supporting the east end of Building 72. These Building 72 foundations should be underpinned by extending the foundation support to below the level of the adjacent excavation.

Recommendations for the design of foundations and retaining walls are presented in subsequent paragraphs.

If spread footings are to be used, they should penetrate a minimum of 18 inches below the surface of the rock. Footings can be designed for dead load bearing pressure of 4000 pounds per square foot (psf) and total design bearing pressures including seismic of 6000 psf. However, the footings should not be less than 12 inches wide. Settlement should be small (1/2 inch or less) and should result primarily from elastic compression of the rock early in the load appplication.

If drilled, cast-in-place concrete piles are used, they can be designed for a skin friction of 1800 psf dead load and 2700 psf total design load in the Orinda bedrock. Soil above the bedrock should not be relied upon for support.

The bearing pressure design criteria provided for continuous spread footings also applies to retaining wall foundations. The retaining walls should be fully backdrained. The basement walls should be designed for an equivalent fluid pressure of 75 pounds per cubic foot (pcf). Free-standing retaining walls with level backfills can be designed for equivalent fluid pressures of 35 pcf.

Prior to final design of the facility, a detailed soil investigation should be performed. This would include drilling of approximately four test borings, performing laboratory tests and engineering analysis to finalize the design recommendations and values given in this report.

Yours very truly,

HARDING-LAWSON ASSOCIATES

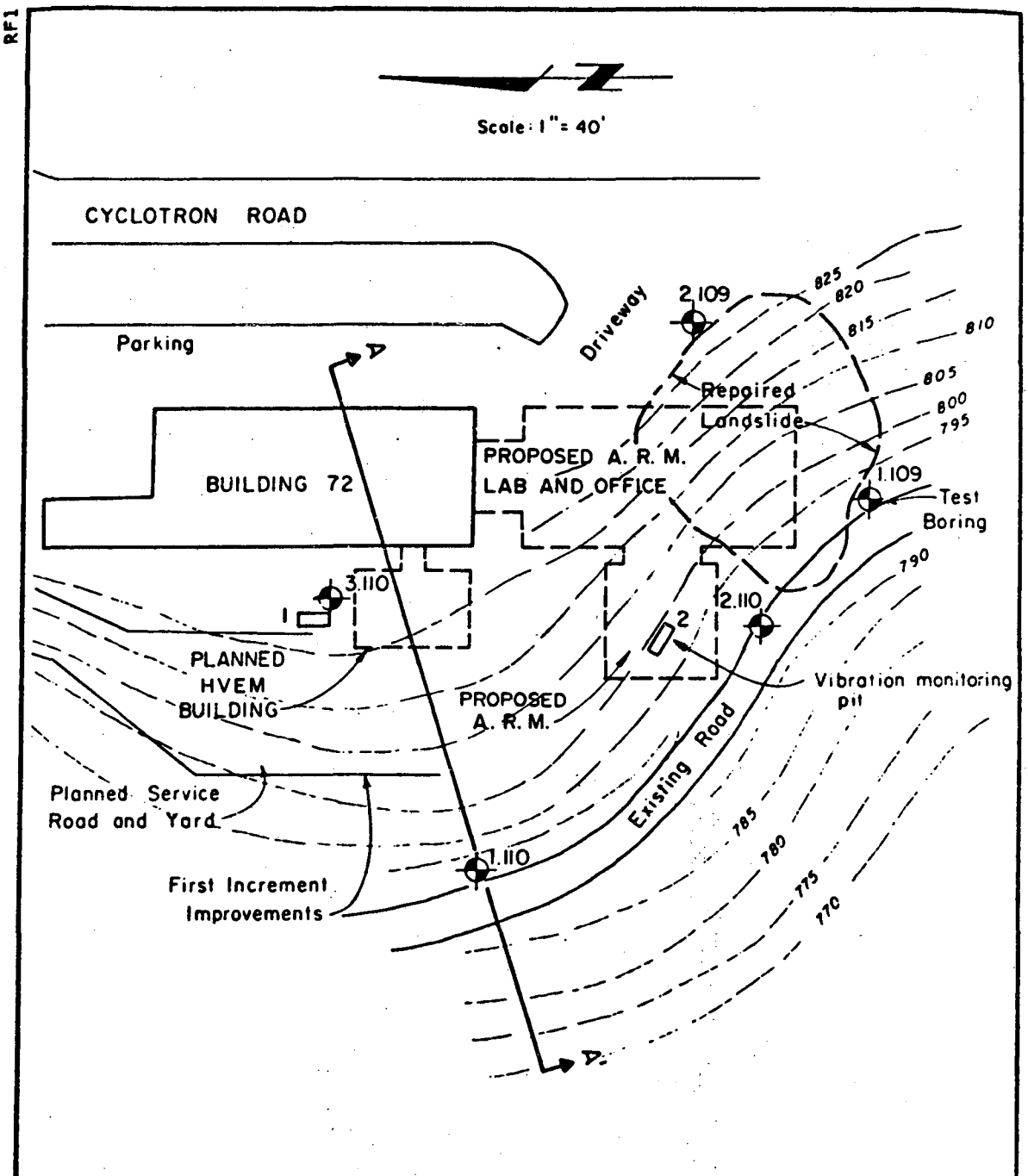
Lyle E. Lewis

Lyle E. Lewis,
Civil Engineer - 16360

LEL/jd
Attachment: Plate A
3 copies submitted

cc: Butzbach, Bar-Din, Dagan
514 Mission Street
San Francisco, California

Attention: Mr. Victor Bar-Din



HARDING-LAWSON ASSOCIATES *Consulting Engineers and Geologists*	BORING LOCATION PLAN VICINITY OF A. R. M. BUILDING LOCATION LAWRENCE BERKELEY LABORATORY	PLATE A
Job No. 2000,112.01 Appr: LEL Date 5/23/77		

8

CONSULTANT RESUMES

1. Ratcliff, Slama & Cadwalader, Architects & Planners

This firm has extensive experience and expertise in buildings and facilities analysis and planning, in functional relationships, and in architectural planning and design. The firm has executed numerous projects encompassing a broad range of facility types, including site development and master planning. They have an impressive record of performing on projects for the University of California, various State Colleges, the General Services Administration, the Department of the Navy, the East Bay Municipal Utility District, various school districts, and many projects in the private sector of businesses.

2. Butzbach, Bar-Din & Dagan, Structural Engineers

This firm has an impressive record for structural engineering services in many diversified field including earthquake engineering and hazard evaluation of the James Lick School in San Francisco. Included among their many projects are over 200 public school buildings, over 30 hospitals, regional shopping centers, state detention facilities, many municipal civic centers, state college and University of California buildings, and work for the General Services Administration and the Department of the Navy.

3. Harding-Lawson Associates, Soils Engineering, Geologists and Geophysists

This firm has carried out extensive work in foundation and earthquake engineering for seismic restraint design for numerous large projects throughout the local area, including soil dynamics for major slide repair at LBL.

4. Charles and Braun, Mechanical Engineers

This firms has an extensive background in mechanical engineering for design and construction projects. They possess extensive expertise in energy conservation computer program analysis, planning and programming skills, and have performed well on numerous major projects both public and private.

5. Interactive Resources, Inc.

This firm has provided solar instrumentation and design for ERDA, and DOE demonstration projects as well as solar application to the Steinhart Acquarium and the Stanford University Central Food Services Building. They have also have provided solar applications for the private sector of business.

6. Mazzetti and Parish, Inc., Electrical Engineering

This firm has provided electrical engineering services for various school districts, hospitals, the Golden Gate Bridge District, food processing plants, the San Francisco Redevelopment Agency, as well as for the private business sector.

7. Consulting Cost Estimators, Inc.

This firm has extensive experience in producing schematic, preliminary, and final cost estimates for large scale construction projects, included among which are projects for GSA, Departments of the Army and Navy, University of California, various California school districts, and many for the private sector of business.

PRELIMINARY STRUCTURAL CALCULATIONS

Contents

Design Criteria and Structural Calculations 10-24

Framing Plans 10-29

Framing Calcs & Sizes 10-34

Lateral Calcs & Framing 10-42

Foundations 10-48

DESIGN CRITERIA

UBC 1976 & LBL Lateral Force Design Criteria
Dated May 9, 1978.

Live Loads:

Roof: 50 psf.
Floors: 125 " (inc. 20 psf Partitions.)

Lateral: $V = ZIKCSW \not< 0.2W$.

$Z = 1.0$ $I = 1.0$ $K = 1.33$ $CS = .14$

$\therefore ZIKCS = .19$ $\therefore V = \underline{0.2W}$ ←

STRUCTURAL SYSTEMS:

The project is devided into 2 separate structures: the A.R.M. enclosure & the LAB bldg. with expansion joint between the two.

1) LAB BLDG: a) Vertical

ROOF: 1½" x 18 ga metal deck w/rigid insulation, supported on steel purlins & beams, which are supported by steel columns.

TOP FLOOR: 3" x 20 ga metal deck w/ LW concrete fill supported on steel purlins & beams, which are supported by steel columns.

Main Entrance Level:

concrete slab on concrete walls & columns.

A.R.H. Console Level:

concrete slab-on-grade & suspended concrete slab over Mech. Rm. Area.

Spectrometer Level:

concrete slab-on-Grade.

b) Lateral

above Main-Entrance Level:

Lateral forces resisted by steel X bracings along peripheral walls.

Below Main-Entrance Level:

Lateral forces resisted by horizontal concrete diaphragm & concrete shear walls as seismic loads resisting elements.

2) A.R.M. ENCLOSURE

a) Vertical

Roof: 1½" x 18 ga metal deck w/ rigid insulation, supported on steel purlins & beams, which are supported by steel columns.

Top Floor: non-existent.

Main-Entrance Level: (mezzanine)

3" x 20 ga. metal deck with LW concrete fill, supported on steel beams, which are supported by steel columns.

A.R.M. Console Level: concrete slab on concrete beams & concrete walls.

Spectrometer Level:

Concrete slab-on-Grade.

b) Lateral

above A.R.M. Console Level:

Lateral forces (seismic &/or wind) supported by a system of steel X bracings along peripheral walls.

Below A.R.M. Console Level:

Lateral forces resisted by horizontal concrete diaphragm & concrete shear walls as seismic loads resisting elements.

3 FOUNDATIONS: SEE HARDING-LAWSON'S LETTERS TO LBL DATED JUNE 22, 1978 & SUBSEQUENT MARKED-UP PLATE A.

ALSO SEE SHEETS F-1 etc. of our calcs.

4. MATERIALS

a) STRUCTURAL STEEL - ASTM A 36

HIGH-STRENGTH BOLTS - ASTM A-325

ANCHOR BOLTS - ASTM A-307

b) METAL DECK ON ROOFS: 1½" ROBERTSON UKX 16-16

METAL DECK ON FLOORS: 3" x 20 GA Robertson Q Lock #99 WITH 3/4" L.W. CONCRETE FILL.

c) CONCRETE: L.W. FILL (110#/FT³ MAX WT) $f'_c = 3000$ psi

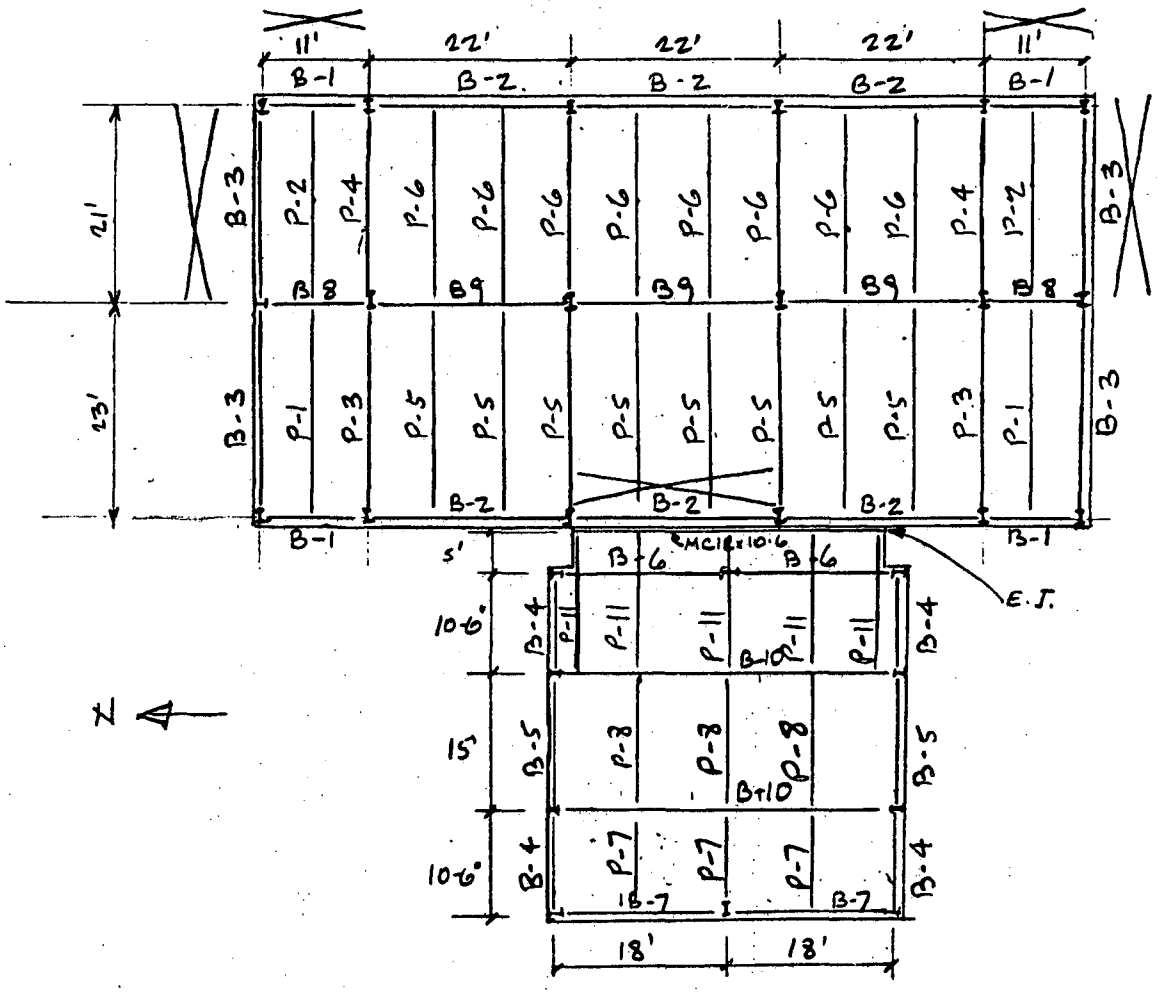
SLABS & BEAMS: REG. WT. $f'_c = 4000$ psi.

walls & COLS: " $f'_c = 4000$ psi.

CAISSONS & GRADE BMS: " $f'_c = 3000$ psi.

CONC. REINFORCING: A-615, GRADE 40 OR 60.

ROOF: ELEV. 853.5'



DECKING:

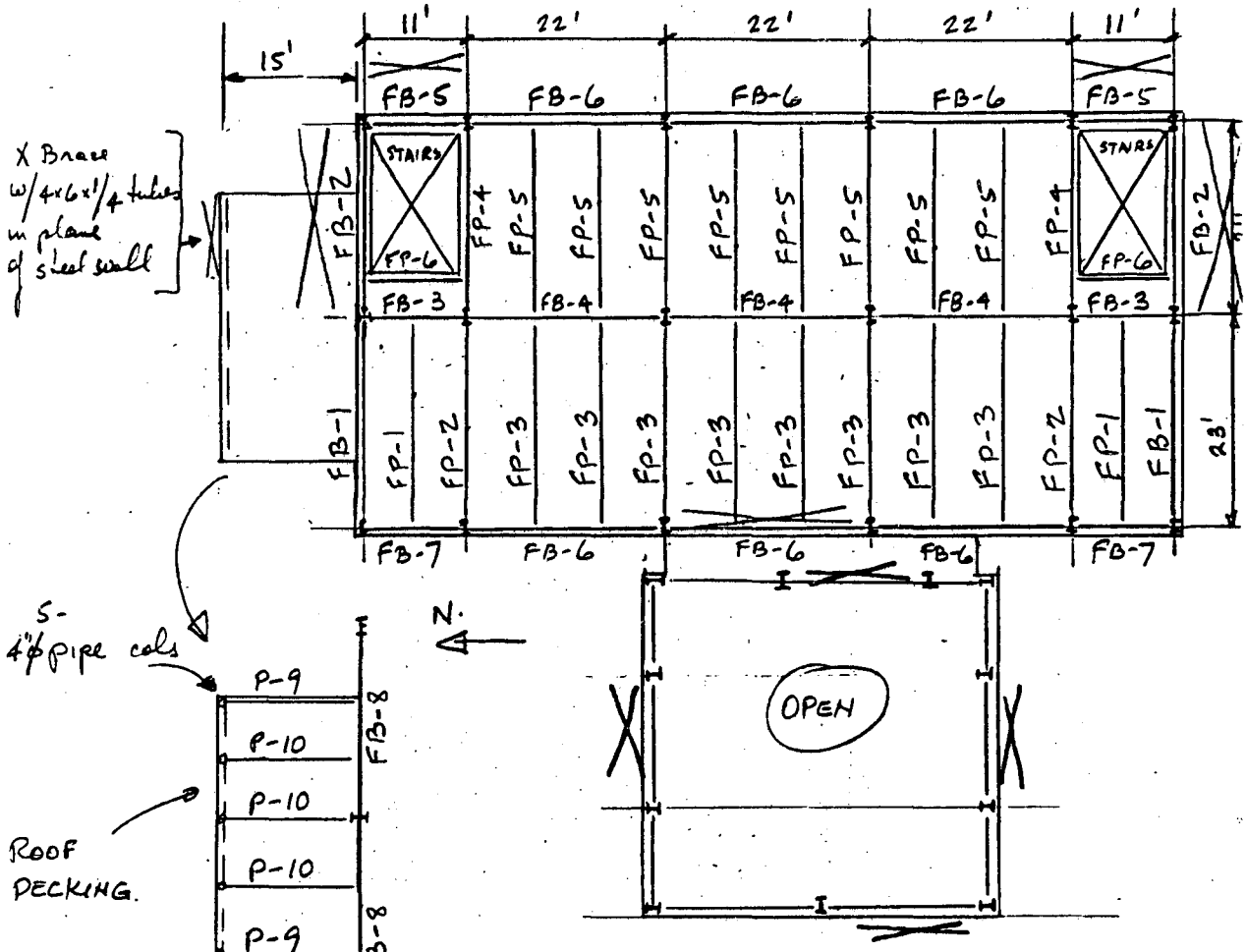
1½" ROBERTSON UKX 16-16
WITH RIGID INSULATION.

INDICATES X BRACING
IN WALL UNDER.
SEE L-2.

(see pp. 11 & 12 for sizes.)

BUTZBACH · BAR-DIN & DAGAN STRUCTURAL ENGINEERS	JOB		
	BY	DATE	SHEET 6

TOP FLOOR: ELEV. 839.5'



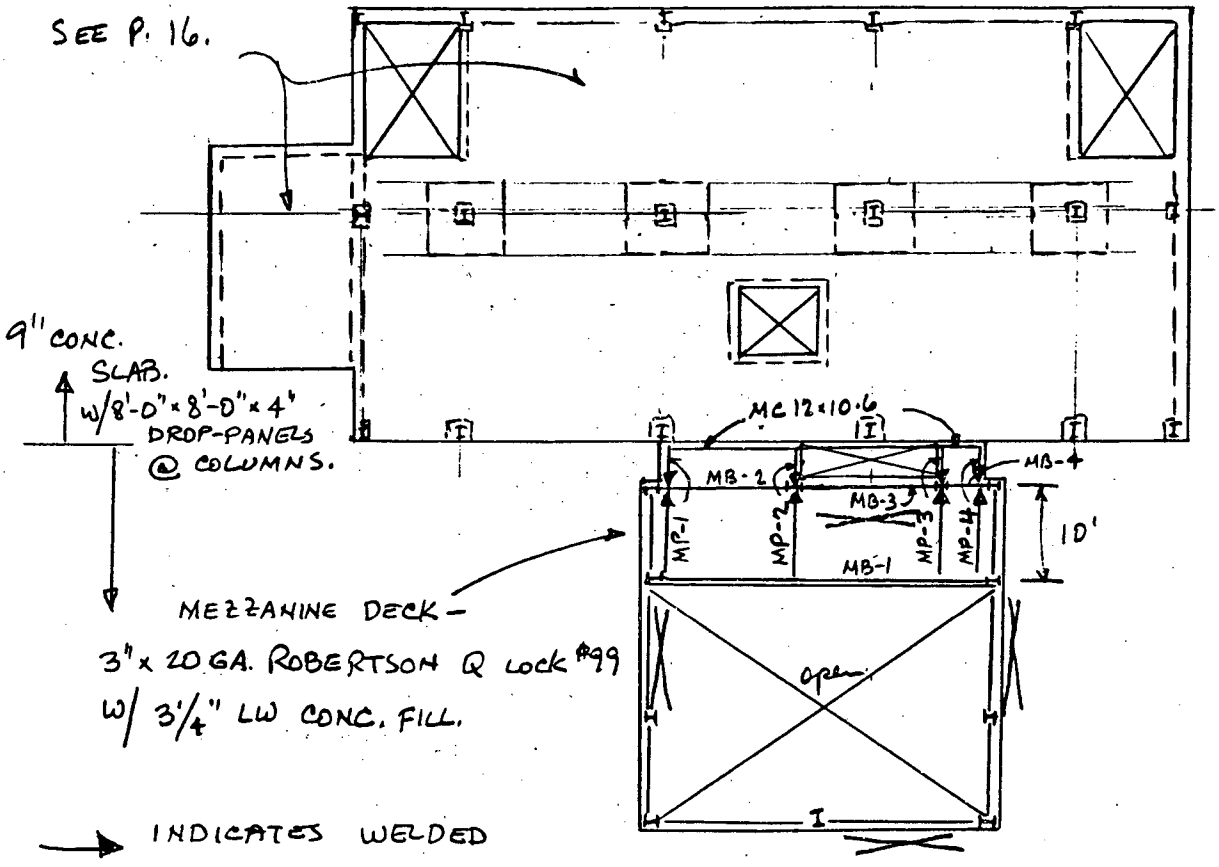
see p. 13 for floor purlins & beams.
see p. 11 " roof purlins
see p. 18 for shear columns.

DECKING: 3" × 20 GA. ROBERTSON Q LOCK #99 w/ 3 1/4" L.W. CONCRETE FILL.] @ FLOOR

X indicates X bracing in wall under - see p. L-2.

BUTZBACH · BAR-DIN & DAGAN STRUCTURAL ENGINEERS	JOB		
	BY	DATE	SHEET 7

MAIN ENTRANCE LEVEL - ELEV. 825.5'



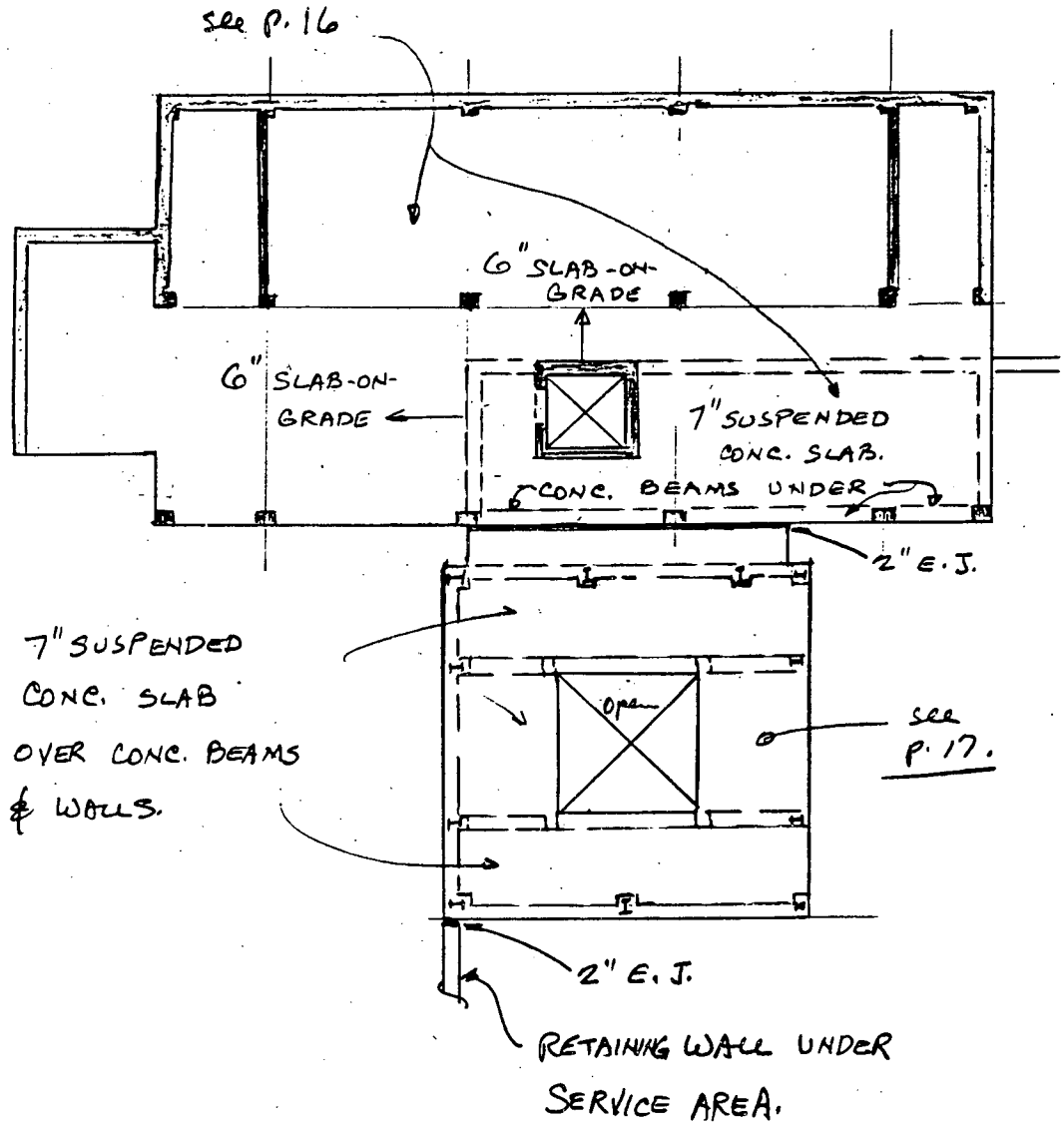
→ INDICATES WELDED MOMENT CONNECTION.

FOR MEZZ PURLINS & BEAMS SEE P. 14

MEZZANINE ELEV. 823.5'.

BUTZBACH · BAR-DIN & DAGAN STRUCTURAL ENGINEERS	JOB		
	BY	DATE	SHEET 8

A.R.M. CONSOLE LEVEL – ELEV. 811.5'

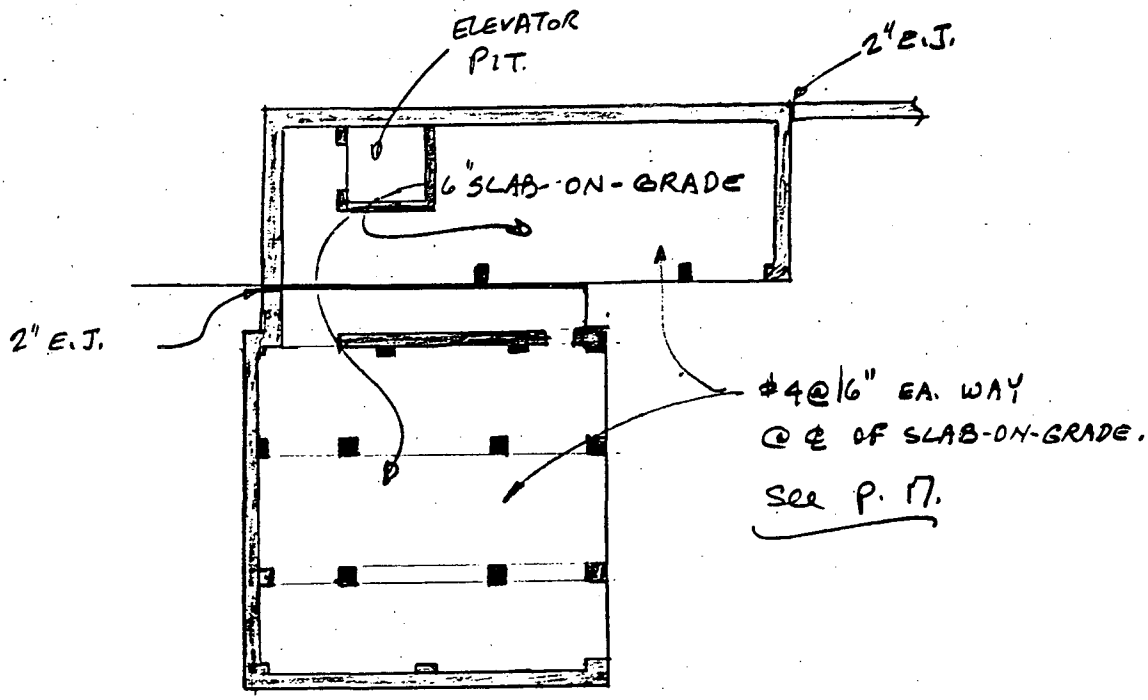


INDICATE CONC. WALS

CONC. COLS.

BUTZBACH · BAR-DIN & DAGAN STRUCTURAL ENGINEERS	JOB		
	BY	DATE	SHEET 9

SPECTROMETER LEVEL – ELEV. 799.5'



SPECT. CHAMBER (NOT SHOWN) – BY OTHERS.

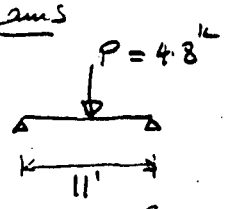
wt. of Roof Deck:

Decking & insulation	10	psf
Roofing	6	"
ceiling	5	"
framing	4	"
DL	25	"
LL	50	"
TL	75	"

Purlin No.	SPAN	w/'	W	use
P-1	23	413 #/'	9.5 k	W12×16.5
P-2	21	413 #/'	8.7 k	W12×14
P-3	23	490 #/'	11.3 k	W14×17.2
P-4	21	490 #/'	10.3 k	W12×16.5
P-5	23	550 #/'	12.7 k	W14×17.2
P-6	21	550 #/'	11.6 k	W12×16.5
P-7	10.5	675 #/'	7.1 k	W12×14
P-8	15	675 #/'	10.1 k	W12×14
P-9	15	280 #/'	4.2 k	W12×14
P-10	15	544 #/'	8.2 k	W12×14
P-11	10.5	675 #/'	10.1	W12×14 ($-M = 8.5^k$ $S_{req} = 5.1$)

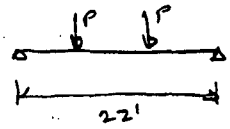
Roof Beams

B-1



$M = 13.2 \quad S = 7.2 \quad$ use $\underline{W12\times14}$

B-2



$P = 6.4 \quad M = 7.33\times6.4 = 47^{k} \quad S = 25.6\ in^3$

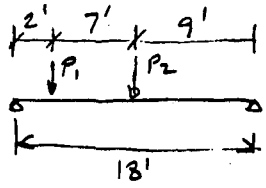
use: $\underline{W14\times22}$

B-3 use $\underline{W12\times14}$

B-4 use $\underline{W12\times14}$

B-5 use $\underline{W12\times14}$

B-6



$P_1 = 75\times4.5\times\overline{15.5}^2\times\frac{1}{2\times10.5} = 3.9^{k}$

$P_2 = 75\times8\times\ \ \text{"} = 6.9^{k}$

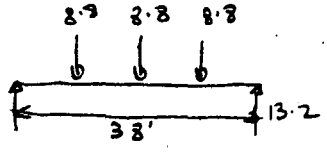
$V_L = 3.45 + 3.9\times\frac{16}{18} = 6.9^{k}$

$V_R = 3.45 + .45 = 3.9^{k}$

$M = 3.9\times9 = 35.1 \quad S = 19.1$

use $\underline{W14\times17.2}$

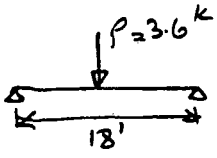
B-10



$M = 13.2\times19 - 8.8\times9.5 = 251 - 83 = 168^{k}$

$S_{req} = 92$ use $\underline{W21\times55}$

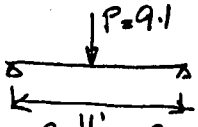
B-7



$M = 16.2 \quad S = 8.8$

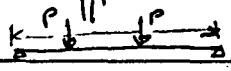
use $\underline{W12\times14}$

B-8



$M = 25 \quad S = 13.7 \quad$ use $\underline{W12\times16.5}$

B-9



$L = 22$
$P = 12.2 \quad M = 90 \quad S = 49 \quad$ use $\underline{W14\times43}$

FLOOR	DECK & CONC	46	psf
	ceiling	4	"
	DL	50	"
	LL	125	"
	TL	175	"

FLOOR PURLINS :

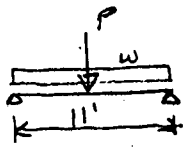
No. of Purlin	SPAN	w	W	use
FP-1	23'	963#/'	22.2^k	W 16 x 26
FP-2	23'	1138#/'	26.2^k	W 16 x 31
FP-3	23'	1283#/'	29.5^k	W 16 x 31
FP-4	21'	700#/'	14.7^k	W 16 x 26
FP-5	21'	1283#/'	27.0^k	W 16 x 31
FP-6	11'	1575#/'	17.4^k	W 12 x 14

FLOOR BEAMS

FB-1 L = 23' W = 14^k use W 12 x 19

FB-2 use W 12 x 3.5 (wind)

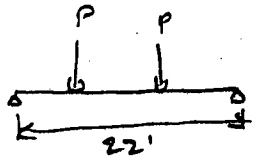
FB-3



P = 11.1^k w = 0.5^k/' $M = 11.1 \times \frac{11}{4} + .5 \times \frac{11^2}{8} =$
$= 30.5 + 7.6 = 38.1^{'k}$

S = 21 in^3 use W 14 x 22

FB-4



P = 28.3^k M = 208$^{'k}$ S = 113 in^3

use W 24 x 61

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JOB		
BY	DATE	SHEET 13

FB-5 use W 10×30 (wind)

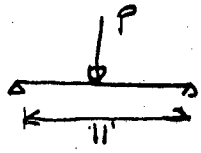
FB-6

$P = 15^k$ $M = 119^{'k}$ $S = 65\ in^3$

$w = 140^{\#}/$

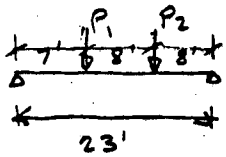
use W 18×45 or W 21×44

FB-7



use W 14×22

FB-8



$P_2 = 7.5 \times .075 \times 8 = 4.5^k$

$P_1 = \text{"} \quad \text{"} \times 4 = 2.3^k$

$R_L = 4.5 \times \frac{8}{23} + 2.3 \times \frac{16}{23} = 1.6 + 1.6 = 3.2^k$

$R_R = 6.8 - 3.2 = 3.6^k$

$M = 3.6 \times 8 = 28.8$ $S = 15.7$ use W 14×22

MEZZANINE DECK PURLINS

$w_{DL} = 50$

$w_{LL} = 125$

$w_{TL} = 175$

MP-1 $W = 7 \times .175 \times 10 = 12.3$

$L = 10'$

$-M = 7 \times .175 \times 5^2 \times \frac{1}{2} = 15.3^{'k}$ $S = 8.35$

use W 12×14

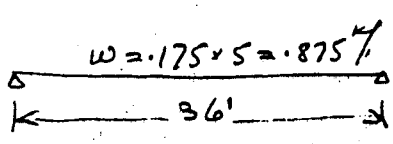
MP-2 $W = 8 \times .175 \times 10 = 14$

$L = 10$ use W 12×14

MP-3
MP-4 } use W12×14

MEZZ. BEAMS

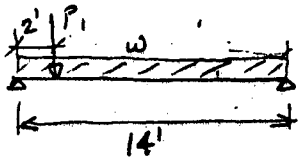
MB-1



$W = 31.5^k$

use W21×44

MB-2



$P_1 = \frac{15}{10} \times .175 \times 2.5 \times 6 = 4^k$

$w = .175 \times 7.5 = 1.32 \, k/'$

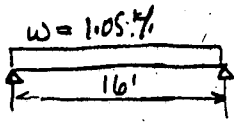
$R_L = 1.32 \times 7 + 4 \times \frac{12}{14} = 9.24 + 3.43 = 12.7^k$

$R_R = 9.24 + .57 = 9.8$

$M_{max} = \frac{9.8^2}{2 \times 1.32} = 37^{'k}$ $S_{req} = 20$

use W12 x 27

MB-3

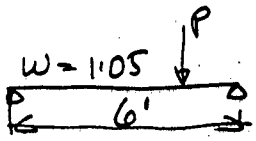


$M = 1.05 \times 16^2 \times 1/8 = 34^{'k}$ $S = 18 \, in^3$

$W = .175 \times 6 = 1.05$

use W12×22

MB-4



use W12×22

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JOB		
BY	DATE	SHEET 15

CONCRETE SLAB @ LAB BLDG @ ELEV. 825.5'

9" conc. ($f'_c = 4000$) w/ 8'×8'×4" DROP PANELS

@ LOBBY - 7" concrete slab.

REINFORCING: 9 lbs/ft²

A.R.M. CONSOLE LEVEL ELEV. 811.5'

1) LAB BLDG: 6" SLAB-ON-GRADE w/ #4@16" EF @ ℄ of SLAB.

7" SUSPENDED SLAB w/ 7.5 lbs/FT² REINF.

[17' span $w = 0.22^k/\phi$ $+M = 17^2 \times .22 \times 1/9 = 7.06^{'k}/'$ $A_s = .89 \text{ in}^2/'$

assume #6 @ 6" Bot. #5@12 TOP

#5@12 T&B trans.

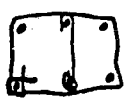
wt. = 1+1+1+3 = 6 #/ϕ ×1.25 = 7.5 #/FT²]

walls: EXTERIOR: 9" CONC. w/ 6 #/ϕ Reinf.

INTERIOR: 8" CONC. w/ 4 #/ϕ Reinf.

COLUMNS 16×16 w/ 6-#9(V) & #3@16" TIES.

$f'_c = 4000$ psi.



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JOB		
BY	DATE	SHEET 16

2) A.R.M. ENCLOSURE BLDG @ ELEV. 811.5'

7" SLAB w/ 7.5 #/ft reinf. f'_c = 4000 psi.

Beams 14" x 24" w/ 15 #/ft reinf. f'_c = 4000 psi.

SPECTROMETER LEVEL - ELEV. 799.5'

1) LAB BLDG: 6" SLAB-ON-GRADE w/ #4@16" EA. WAY @ ℄ SLAB.

℄ A.R.M. ENCLOSURE:

INT. COLUMNS @ A.R.M. ENC.

14x14 w/ 4-#7 (V) & #3@14" TIES.

EXTERIOR WALLS: 9" CONC. w/ 6 #/ft reinf.

INTERIOR WALLS: 8" CONC w/ 4 #/ft reinf.

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JOB		
BY	DATE	SHEET 17

COLUMNS IN LAB BLDG: LOAD PER FT^2: Roof - 75
TOP FLOOR = 175
250 psf.

Interior cols:
max area = $22 \times 22 = 484\ ft^2$ $P = 121^k$ length = 14' use W12x40
& $22 \times 16.5 = 363\ ft^2$ $P = 91^k$ length = 14' use W12x40

EXTERIOR COLS
max area = $11.5 \times 22 = 253\ ft^2$ $P = 63^k + 75 = 138^k$
use W12x40

USE W12x40 for all columns in Lab Bldg from 325.5' to Roof.

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JOB		
BY	DATE	SHEET 18

LATERAL @ LAB BLDG. $V = 0.2\,W$

@ Roof : $W = 89 \times 46 \times 0.025 = 102^k$ V

partitions $0.02 \times \frac{1}{2} \times 89 \times 46 = 41^k$

$W_R = 143^k$ $28.6^k \times 3 = 85.8$

@ TOP FL. (339.5') $W = 89 \times 46 \times .070 = 287^k$

$+ \quad 15 \times 29 \times .025 = 11^k$

298^k $59.6^k \times 2 = 119.2$

@ MAIN ENT. LEVEL (325.5') $W = 89 \times 46 \times .14 = 573^k$

$15 \times 29 \times .10 = 44^k$

617^k $123.4^k \times 1 = 123.4$

211.6 328.4

$V_R = \frac{85.8}{328.4} \times 211.6 = 55.3^k$ Lat. @ Roof $= 55.3^k$

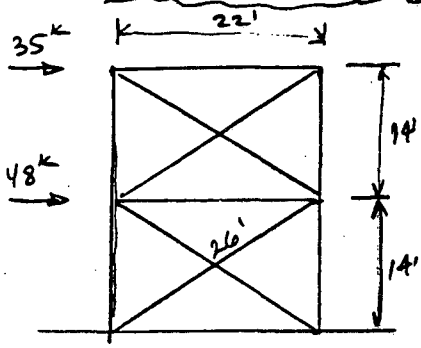
$V_T = \frac{119.2}{328.4} \times 211.6 = 76.8^k$ Lat. @ TOP FLOOR $= 132.1^k$

$V_M = \frac{123.4}{328.4} \times 211.6 = 79.5^k$ Lat. @ MAIN. LEVEL $= 211.6^k$

211.6^k OK.

FORCES TO X BRACES = 1.25 × SHEARS LISTED ABOVE (UBC 2312(J)(G).)

X BRACING @ WEST WALL:



FORCE @ Roof $= 55.3 \times \frac{1}{2} \times 1.25 = 35^k$

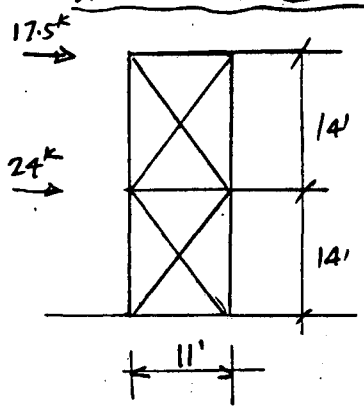
@ TOP FL. $= 76.8 \times \frac{1}{2} \times 1.25 = 48^k$

use tubes $6 \times 6 \times 5/16$ ROOF TO TOP FL.

$6 \times 6 \times 3/8$ TOP FL TO MAIN ENT LEVEL

$V = \frac{35 \times 28 + 48 \times 14}{22} = \underline{75^k}$

X BRACING @ EAST WALL: (2 - ONE @ EA. STAIR WALL - SEE PP. 6 & 7.)

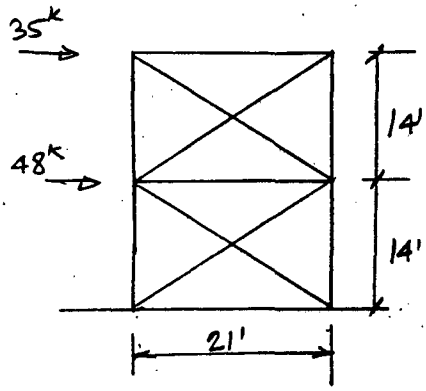


use tubes $6 \times 6 \times 5/16$ ROOF TO TOP FL.

$6 \times 6 \times 3/8$ TOP FL. TO MAIN ENT LEVEL.

$V = \frac{17.5 \times 28 + 24 \times 14}{11} = \underline{75^k}$

X BRACING @ NORTH & @ SOUTH WALLS: (@ STAIRS)



use $6 \times 6 \times 5/16$ TUBES ROOF TO TOP FL.

$6 \times 6 \times 3/8$ TUBES TOP FL TO MAIN ENT. LEVEL.

$V = \frac{35 \times 28 + 48 \times 14}{21} = \underline{79^k}$

(TUBES IN PLANE OF STUDS)

BUTZBACH · BAR-DIN & DAGAN STRUCTURAL ENGINEERS	JOB		
	BY	DATE	SHEET L-2

LATERAL BELOW MAIN LEVEL: 211.6^k

1) N-S $86+15+16 = 117'$ wall.

$$\text{Shear} = \frac{211.6}{117} = 1.8^{k}/_{'}$$ O.K. for conc. shear walls

2) E-W $21+21+21+21+24 = 108'$ wall

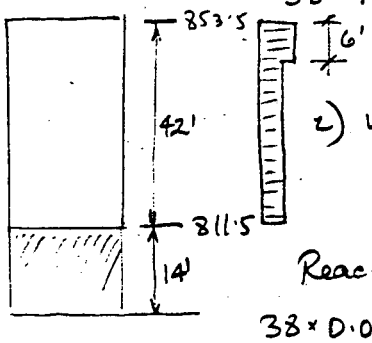
$$\text{shear} = \frac{211.6}{108} = 2^{k}/_{'}$$ O.K.

@ A.R.M. ENCLOSURE.

1) Seismic: $38 \times 38 \times 0.025 = 36.1^k$

$38 \times 4 \times 0.010 \times 21 = 31.9^k$

$68^k \times 0.2 \times 1.25 = 17^k$ seismic.



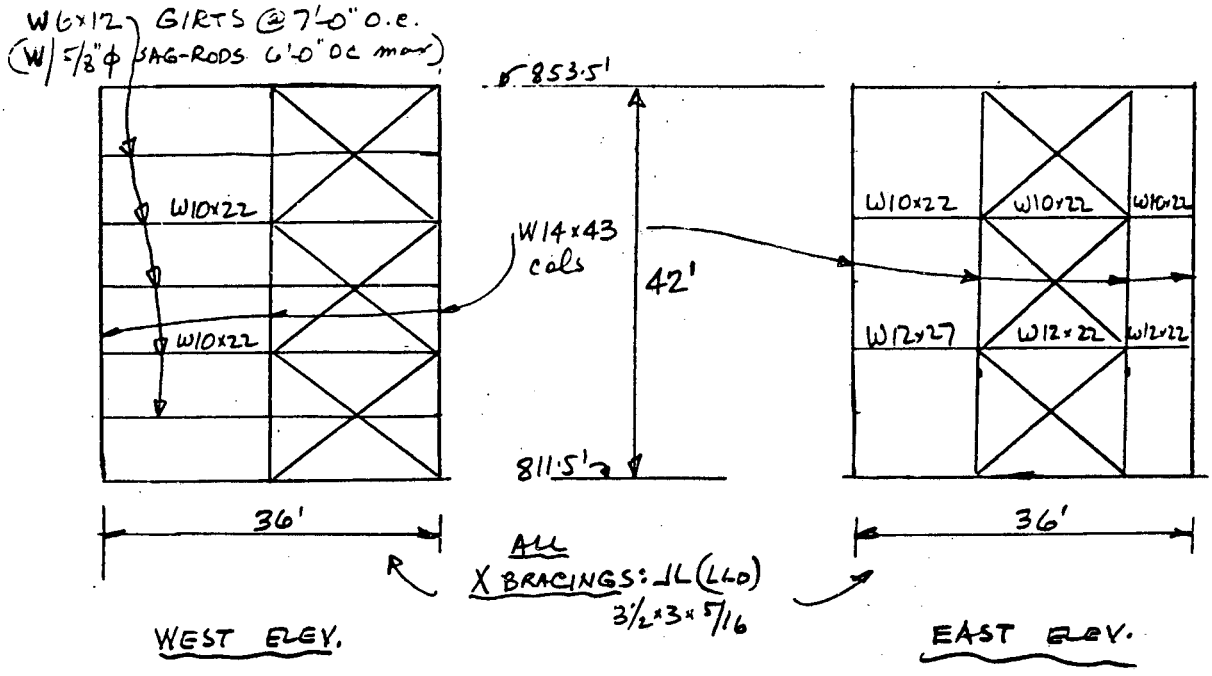
2) Wind @ 20 PSF up to 50'
25 " above 50' (upper 6 ft)

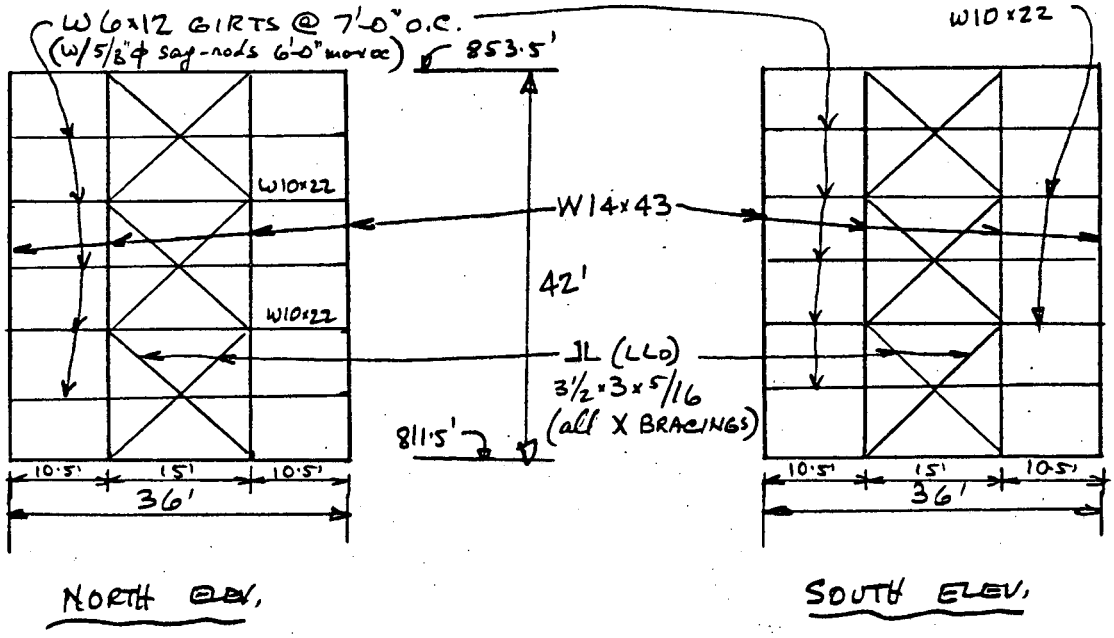
Reaction @ Roof from wind:

$38 \times 0.020 \times 42 \times \frac{1}{2} = 15.96^k$

$+ \; 38 \times 0.005 \times 6 \times \frac{39}{42} = 1.06^k$

17^k — same as wind.





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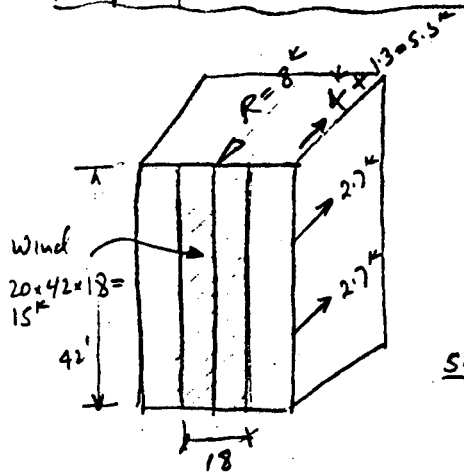
STRUCTURAL ENGINEERS

JOB		
BY	DATE	SHEET L-4

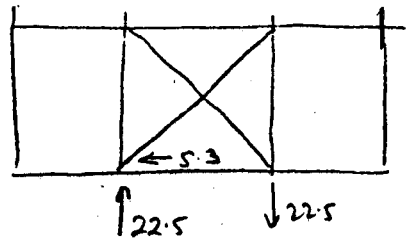
North & South elevations:



$$\begin{aligned} \text{OTM} &= 5.3\times 42 = 223 \\ &+ 2.7\times 28 = 76 \\ &+ 2.7\times 14 = 38 \\ &\quad 337 \div 18 = 18.7^k \end{aligned}$$

$$\frac{337}{15} = 22.5^k$$

$$\frac{5.3+2.7+2.7}{2} = 5.3$$



stress on diag. = $1.414\times 5.3 = 7.5^k$

use $3\frac{1}{2}\times 3\times \frac{5}{16}$ X bracing.

Cols: $h = 42' = 504''$ $\quad w = 260\#/'$ $\quad M = \frac{42^2}{8}\times .26 = 57.3'^k$ $\quad N_w = 22.5^k$

$N_{DL} = 18\times 13\times .025 = 6^k$ $\quad N_T = 28.5^k$

$L/r < 200$ $\quad r_x > 2.5$

$r_y = \frac{168}{200} = .84$

Deflection: $\Delta_{wind} = \frac{l}{240} = \frac{42\times 12}{240} = 2.1'$

$$\Delta = 2.1 = \frac{5wL^4}{384EI} = \frac{w\times 42^4\times 22.5}{29000\,I} \qquad \therefore I_{min} = \frac{.26\times 42^4\times 22.5}{29000\times 2.1} = 300$$

use W14×43 $\quad I = 429 \quad \Delta = 1.5'$ OK.

check col: $S_x = 62.7$ $\quad F_a = 14.3$ $\quad f_a = \frac{28}{12.6} = 2.22$ $\quad \frac{f_a}{F_a} = \frac{2.22}{14.3} = .15$

$A = 12.6$ $\quad \frac{L_x}{r_x} = \frac{42\times 12}{5.82} = 87$ $\quad f_b = \frac{57.3\times 12}{62.7} = 11$ ksi. $\quad \frac{f_b}{F_b} = \frac{11}{22} = .50$

$r_x = 5.82$

$r_y = 1.89$ $\quad \frac{L_y}{r_y} = \frac{14\times 12}{1.89} = 89$ $\quad$ OK. $\quad .65$

BUTZBACH · BAR-DIN & DAGAN STRUCTURAL ENGINEERS	JOB		
	BY	DATE	SHEET 65

Girts 18' span max. @ 7'-0" c.c.

max load $25 \times 7 = 175$ #/'

try W6x12 $\frac{Ld}{A_f} = 5.38 \times 18 \times 12 = 1162$ $F_b = \frac{12000}{1162} \times 1.33 = \underline{13.7 \text{ ksi}}$

$M = \frac{18^2}{8} \times .175 = 7.1^{\text{'k}}$

$f_b = \frac{7100 \times 12}{7.31} = 11.7 < 13.7$ o.k.

$\Delta = \frac{.175 \times 18^4 \times 22.5}{29000 \times 22} = .65 < \frac{\ell}{240}$ o.k.

West elevation use same columns & Girts & X Bracings.

East elevation same columns & Bracings. - No Girts.

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JOB		
BY	DATE	SHEET L6

FOUNDATIONS HARDING-LAWSSON'S LETTER TO LBL DATED 6-22-78 & MARKED PLATE "A" BY MR. LYLE E. LEWIS W/ SUBMITTAL DATED 6-23-78 INDICATED THE FOLLOWING:

1) FOUNDATIONS ARE TO BE SPREAD FOOTINGS FOR THE NORTHERN PORTION & DRILLED PIERS FOR THE SOUTHERN PORTION. APPROX. DIVIDING LINE BETWEEN PIERS & SPREAD FTGS SHOWN ON PLATE (A) & P. F-2.

ALLOW. BEARING PRESSURE FOR SPREAD FOOTINGS:

DEAD LOAD - 4000 PSF.
TOTAL LOAD - 6000 PSF.

ALLOWABLE SKIN FRICTION FOR DRILLED, CAST-IN-PLACE CONCRETE PILES:

DEAD LOAD - 1800 PSF
TOTAL LOAD - 2700 PSF

ALLOWABLE SKIN FRICTION TO START AT BEDROCK LEVEL, BEDROCK APPROX. ELEV. MARKED ON PLATE (A) & SHEET F-2.

SINCE THE ABOVE IS AN APPROXIMATION OF ACTUAL SITE CONDITION & WAS ARRIVED AT BY H-L WITHOUT ACTUAL BORINGS ON THIS SITE (ONLY ON ADJACENT SITES) - IT IS SUGGESTED THAT ALLOWANCES BE MADE FOR DEVIATIONS FROM THE EXTENT OF DRILLED PIERS AREA.

ALSO - UNDERPINNING OF BLDG 72 SHOULD BE BUDGETED AS SUGGESTED IN H-L'S LETTER.

SPREAD FOOTING - BOT. ELEV. 18" INTO ROCK.

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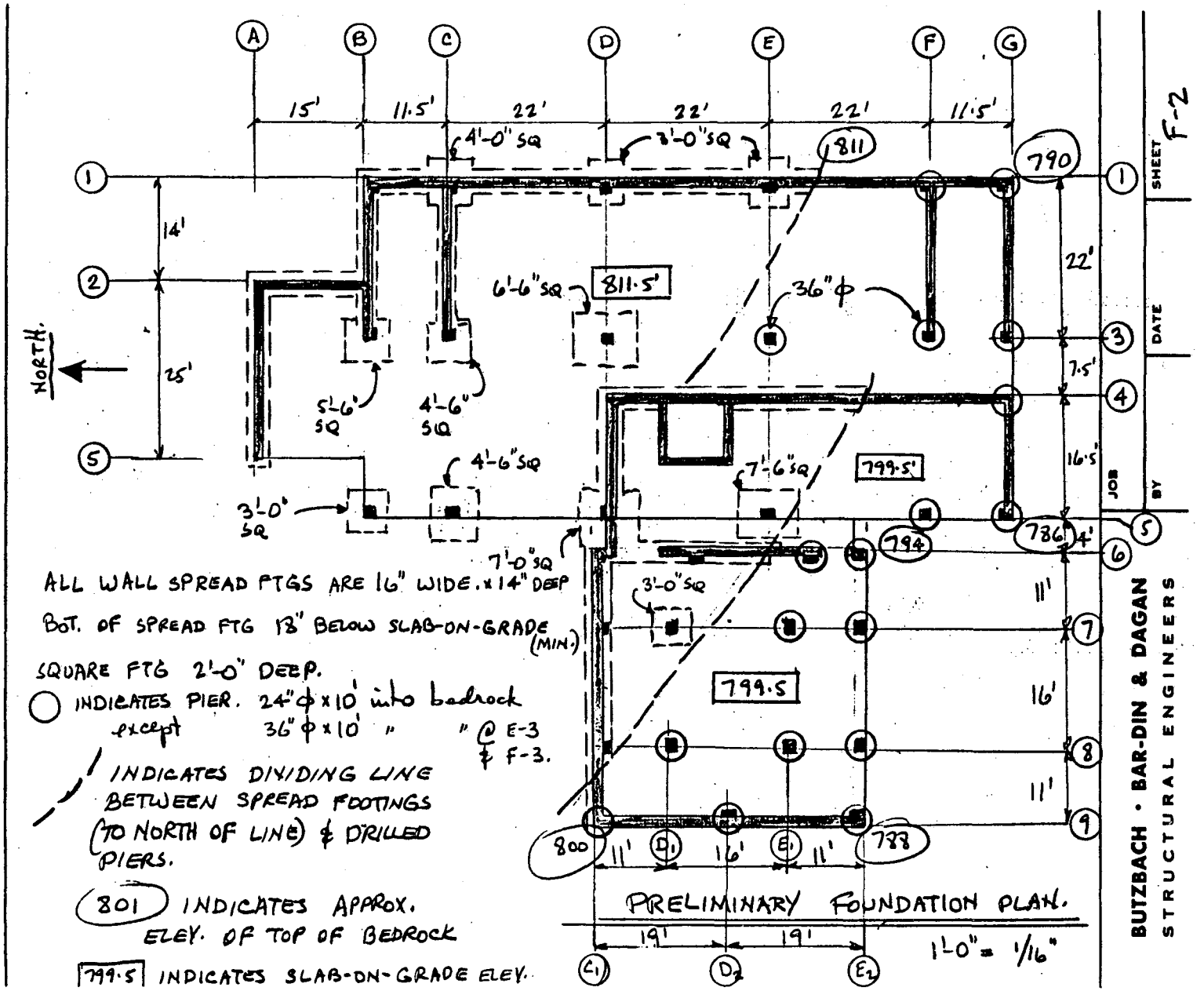
JOB		
BY	DATE	SHEET F-1



ALL WALL SPREAD FTGS ARE 16" WIDE x 14" DEEP

BOT. OF SPREAD FTG 18" BELOW SLAB-ON-GRADE (MIN.)

SQUARE FTG 2'-0" DEEP.

○ INDICATES PIER. 24" ϕ x 10' into bedrock
except 36" ϕ x 10' " " @ E-3 & F-3.

INDICATES DIVIDING LINE BETWEEN SPREAD FOOTINGS (TO NORTH OF LINE) & DRILLED PIERS.

801 INDICATES APPROX. ELEV. OF TOP OF BEDROCK

799.5 INDICATES SLAB-ON-GRADE ELEV.

PRELIMINARY FOUNDATION PLAN.

1'-0" = 1/16"

FOOTINGS @ SPREAD FOOTING ZONE:

min. 16" $\sigma_{all} = 5.33^k/_1$ DL & $8^k/_1$ TL.

wall ①: $.15 \times \frac{9}{12} \times 15.5 = 1.75^k/_1$

slab = $.15 \times \frac{9}{12} \times 10.5 = 1.18^k/_1$

DL = $2.93^k/_1$

LL = $1.31^k/_1$

$4.24^k/_1$ 16" O.K.

use 16" under all walls.

ADDITIONAL SQUARE FTGS:

B-1 - none.

C-1: $10.5 \times 16.5 \times .075 = 13^k$ DL

$\times .250 = 43^k$ D+L 30^k LL.

Lateral = 75^k Lat.

∴ TL = 118^k $A_{req} = 14.75\ ft^2$ use 4'-0" SQ.

D-1 $10.5 \times 22 \times .075 = 17^k$

E-1 $\times .250 = 58^k$ $A_{req} = 7.25\ ft^2$ use 3'-0" SQ.

B-3 LATERAL = 79^k

$5.75 \times 23 \times .075 + 14 \times 7.5 \times .14 = 10 + 15 = 25^k \div 4 =$

$\times .250 + \quad " \quad \times .29 = 33 + 31 = 64^k$

$+ 79$

$143 \div 6 = 24\ ft^2$

use 5'-6" SQ.

D-3 $22 \times 22 \times (.250 + .245) = 242^k$ TL

$A = 40.3$ use 6'-6" SQ.

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JOB

BY DATE SHEET F-3

C-3 $16.5 \times 22 \times 0.25 = 91^k$ $A = 15\ ft^2$ use 4'-6" SQ.

B-5 $12 \times 5.75 \times 0.5 = 35^k$ $A = 6\ ft^2$ use 3'-0" SQ

C-5 $12 \times 16.5 \times 0.5 = 100^k$ $A = 1.7\ ft^2$ use 4'-6" SQ

D-5 $22 \times 16.5 \times 0.5 = 182^k$ $A =$

Lat. = 75^k

257^k $A = 43\ ft^2$ use 7'-0" SQ.

E-5 $257 + 22 \times 8 \times 0.250 = 301^k$ $A = 50\ ft^2$ use 7'-6" SQ

SPREAD FTG @ A.R.M. ENCL. BLDG.

D_1-7 : $13.5 \times 13.5 \times .25 = 46^k$ $A = 7.6\ ft^2$ use 3'-0"

wall @ (D) :

$18 \times .125$	=	2.25	roof
$.01 \times 42$	=	0.42	steel wall
$9 \times \frac{.15}{12}$	=	0.11	conc. wall
$.25 \times 5.5$	=	1.38	conc. floor
		4.16 k/ft.	16" o.k.

Lateral (max) = 22.5^k o.k.

$\frac{22.5 - (8 - 4.16)}{8} = 2.33'$ no add. ftg for lateral.

DRILLED-IN-PLACE-CONCRETE PIERS

24"ϕ: $1.8 \times \pi \times 2 = 11.3^k/_1 \times 10'$ min $= \underline{113^k}$ DL

$2.7 \times \pi \times 2 = 17^k/_1 \times 10'$ " $= \underline{170^k}$ TL

36"ϕ $17^k/_1 = \underline{170^k}$ DL

$25.5^k/_1 = \underline{255^k}$ TL

E-3 $0.5 \times 22 \times 22 = 242^k$ TL use 36"$\phi \times 10'$

F-1 $4.24 \times 16.5 + 1.75 \times 11 + .25 \times 16.5 \times 11 = 70 + 19 + 46 = 135^k$ TL
use 24"$\phi \times 10'$

G-1 use 24"$\phi \times 10'$

F-3 $16.5 \times 22 \times .5 + 1.75 \times 11 = 182 + 20 = 202^k$ use 36"$\phi \times 10'$

G-3 $8.75 \times 22 \times .5 + 1.75 \times 11 = 63 + 20 = 83^k$ use 24"$\phi \times 10'$

G-4 $1.75 \times 20 + 0.25 \times 8 \times 20 = 35 + 40 = 75^k$ use 24"$\phi \times 10'$

F-3 $135 + 0.25 \times 16.5 \times 8 = 135 + 33 = 168^k$ use 24"$\phi \times 10'$

G-3 use 24"$\phi \times 10'$.

D_1-8, E_1-7, E_1-8 $13.5 \times 13.5 \times 0.25 = 46^k$ use 24"$\phi \times 10'$

D_2-9 conc. wall: 19×1.75 + steel wall: $19 \times .01 \times 42$ + conc. slab: $.25 \times 5.5 \times 19$ + roof: $.075 \times 6 \times 19 =$
$= 33 + 8 + 26 + 9 = 76^k + 23$ Lat. $= 99^k$ use 24"$\phi \times 10'$

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JOB		
BY	DATE	SHEET F-5

BASIS OF MECHANICAL DESIGN

A. SCOPE

a. Divisions of Work

(1) Work Included: Site Mechanical Facilities Plumbing, Heating, Ventilating and Air Conditioning, Fire Protection, and Energy Conservation.

(2) Work Not Included: Special cooling water requirements for atomic resolution microscope which are covered under C. Special Design Criteria.

b. Design Standards and Guides

(1) Codes and Design Standards referenced as listed under Division 1 of the Outline Specifications.

(2) Earthquake Restraints shall be in accordance with LBL Seismic Design Criteria.

B. SITE MECHANICAL UTILITIES

a. Scope

(1) Sanitary Sewer - connect to existing site sewer as required.

(2) Storm - remove existing catch basin and pipe under proposed new building. Provide new catch basins and storm drain piping as required for new grading.

(3) High Pressure Water Lines - remove existing piping under proposed new building, reroute piping and provide service connections to new building and re-connect to existing building 72.

(4) High Pressure Gas Line - remove existing piping under proposed new building, reroute piping and provide gas meter for new building an re-connect to existing gas meter serving building 72.

b. Materials and Equipment

(1) Sanitary Sewer - hubless cast iron soil pipe.

(2) High Pressure Gas Line - Sch. 40 black carbon steel pipe with welded joints, coated and wrapped.

(3) Water Lines

(a) 2 inch line Type K copper tubing with wrought solder joint fittings.

(b) 4 inch line-250 pound class cast iron mechanical joint water pipe with 250 pound fittings

(4) Storm Sewer - reinforced concrete or asbestos cement pipe.

C. PLUMBING

a. Scope

The Plumbing system for the building consists in general of:

(1) Furnishing and installing Plumbing fixtures

(2) Soil, waste, and vent piping

(3) Natural gas piping

(4) Hot and cold water piping, including domestic water heater

(5) Roof drains and rainwater leaders

(6) Rough-in and connect to mechanical equipment.

b. Materials

(1) Plumbing fixtures are to be commercial grade vitreous china.

Water closets and Urinals - wall hung flush valve type.

Lavatories - 20" x 18" wall hung

Mop basins - 24" x 24" pre-cast terrazzo

Electric Water Cooler: dual purpose for Handicapped.

(2) Piping:

Water - Type L copper 95/5 solder

Soil, Waste, Vent and Rainwater - hubless cast iron soil pipe

Gas - black steel with wrought iron screwed fittings.

(3) Water Heater - gas fired tank type, 50 gallon storage.

D. HEATING, VENTILATING, AND AIR CONDITIONING

a. Scope

The entire building shall be furnished with a central forced air system. Heating and cooling, or heating only, are provided to designated zones. Cooling coils are supplied with chilled water from an air-cooled chiller on roof. Heating coils will use hot water supplied by one dual fuel (gas/oil) boiler located in the Mechanical Room. Room temperature shall be maintained within the limits called for herein. Humidity control will not be required; however supply air temperatures must not be low enough to cause formation of dew on the atomic resolution microscope. An economizer shall be required to permit cooling by outside air when possible.

Special cooling requirements for the atomic resolution microscope, such as cooling water, are not covered by this section but are specified under Special Design Criteria.

b. Materials and Equipment

(1) Mechanical equipments shall be as scheduled. Complete system shall consist of air handler with mixing box and automatic dampers to provide 100% outside air cooling. Chiller, boiler, cooling coils, heating coils and exhaust system, ductwork, air outlets, filters, and all relocated appurtenances to provide satisfactory operation.

Air filters will be of the standard 2 inch thick throwaway type having a minimum efficiency of 36.5 percent, NBS atmospheric. All ductwork must not transmit vibration to the building or atomic resolution microscope exceeding those limits called for in Special Design Criteria. All mechanical equipment shall be mounted on isolators appropriate for the building structure.

(2) Controls - Controls will be electric. Each zone shall have its zone thermostat. An outdoor thermostat will activate the economizer dampers. Interlocks for fire control will be required.

(3) Ductwork - Ducts will be fabricated of galvanized steel sheet metal in conformance with SMACNA "Low Velocity Duct Construction Standards." Elbows will have airfoil type turning vanes. Direction changers will be provided at all outlet collars. Supply registers will have double direction vanes. Ducts external to the building will have internal thermal insulation in accordance

with the requirements of the appropriate referenced standards. Special consideration must be given in sizing and supporting ducts to prevent any vibration or noise which may exceed the limits specified in Special Design Criteria.

c. Design Criteria

(1) Standards - Design Criteria and calculations for heat loss and gain, outdoor design temperatures, and selection of equipment will be in accordance with the following:

- ASHRAE Guide, latest edition
- ERDA Appendix 6301, "Energy Conservation Design Manual."
- ASHRAE Std.-90-75 - "Energy Conservation in New Building Design."

(2) Design Conditions - (Inside)

	Dry Bulb °F	RH %
Cooling	76	50
Heating	72	50

(3) Ventilation Minimum to offset infiltration, 5 cfm per person.

d. Energy Conservation

An economizer will be installed on the heat pump unit. This will permit up to 100 percent outside air to be used for cooling. A low ambient cooling kit will permit the unit to operate on the heating cycle when the outside temperature is down to as low as 20°F. The heat pump is specified to have at least two separate condensing systems thus permitting only one compressor to operate on partial load.

E. FIRE PROTECTION

a. Scope

(1) Sprinkler System - A wet sprinkler system for ordinary hazard rating will be provided. The supply will be made from the new 4-inch water supply serving the building. The piping will be concealed where possible and both dependent and upright heads will be utilized. A fire department siamese inlet connection with check valve shall be provided.

(2) Wet Standpipe System - Hose racks having 1-1/2 inch hose with nozzles shall be installed.

(3) Water Flow Alarm Service - Provision shall be made to indicate the flow of water in the sprinkler system and wet standpoint system, except movement of water due to waste, surges or variable pressure, by an alarm signal operating at waterflows of ten or more gallons per minute. Control valves shall be supervised to indicate required conditions for proper operation of the system. The foregoing will connect to the detection and alarm system.

b. Materials and Equipment

(1) Piping - Sch. 40 black carbon steel with 150 pound malleable iron screwed fittings.

(2) Fire Hose Racks - U.L. listed rack with approved 1-1/2" linen hose and fog type nozzles.

(3) Sprinkler Alarm Switches - Autocall-Howe Type WF4 - Model 4156-4.

(4) Post Indicator Valve Switch - Potter Electric Signal Co. Model P1VS-U (-C is acceptable).

ELECTRICAL AND LIGHTING CALCULATIONS

MAZZETTI & ASSOCIATES, INC. — ELECTRICAL ENGINEERS — 594 HOWARD STREET — SAN FRANCISCO, CALIFORNIA 94105

BY JAZ DATE 6-30-78 JOB NO. 1131 SHEET NO. 1 OF 2

SUBJECT L.B.L. - A.R.M. LAB. BLDG. - ELECTRIC LOAD ANALYSIS

1. ASSUMPTIONS

A. GROSS AREA TAKEN FROM THE ARCHITECTURAL DRAWINGS
= OFFICE & LAB. BLDG + MICROSCOPE
= 14,200 + 3,500 = 17,700 SQ. FT.

B. THE OCCUPANCY TO BE TREATED AS A SCHOOL, MAINLY CONSISTING OF OFFICES & LABORATORIES.

C. THE MECHANICAL LOAD WAS FURNISHED IN TWO SCHEMES BY THE MECHANICAL GROUP AS FOLLOWS:

1) HVAC SYSTEM I = 56.4 KVA (CHILLER, A.H.)

2) HVAC SYSTEM II = 50.6 KVA (HEAT PUMPS)

D. RESEARCH LABORATORY EQUIPMENT LOADS AS FURNISHED BY L.B.L. (ESTIMATED) = 45.0KVA.

E. ELEVATOR & OVERHEAD CRANE LOADS DERIVED FROM ARCHITECT (ESTIMATED) = 35.4 KVA.

2. REFERENCES

A. I.E.E.E. RECOMMENDED PRACTICE FOR ELECTRIC POWER SYSTEMS IN COMMERCIAL BUILDING STANDARD 241-1974.

B. NATIONAL ELECTRIC CODE - 1978.

C. ESTIMATING TOTAL DEMAND LOADS, USING L.B.L. DATA RECOMMENDATIONS.

MAZZETTI & ASSOCIATES, INC. — ELECTRICAL ENGINEERS — 594 HOWARD STREET — SAN FRANCISCO, CALIFORNIA 94105

BY JAZ DATE 6-30-78 JOB NO. 1131 SHEET NO. 2 OF 2

SUBJECT L.B.L. - A.R.M. LAB. BLDG. - ELECTRIC LOAD ANALYSIS

3. CALCULATIONS FOR NEW BLDG LOADS

TYPE OF LOADS	GROSS SQ. FT.	CONN. LOAD KVA	DEMAND FACTORS	DEMAND LOAD KVA
LIGHTING (2 W/□'-OFF., LAB) (1W/□'-OTHERS)	17,200	28.2	1.0	28.2
RECEPTACLES (1.5 w/□')	17,200	25.8	0.3	7.74
RESEARCH EQUIPMENT (LABS)	—	45.0	0.4	18.0
ELEVATOR	—	29.5	0.6	17.7
O.H. CRANE	—	5.9	0.3	1.8
MECHANICAL HTG. & A.C.	SYST. I SYST II	56.4 (50.6)	0.8	45.1 (40.5)
SUB. TOTAL - NEW BLDG.		190.8 (185.0)		118.5 (113.9)
FUTURE RESERVE CAPACITY @ 30%				35.6
GROSS OVERALL DEMAND				154.1
ESTIMATED DIVERSITY FACTOR				1.3
NET OVERALL DEMAND				118.5
NET DEMAND AMPERES @ 480V 3φ				142.3

MAZZETTI & ASSOCIATES, INC. — ELECTRICAL ENGINEERS — 594 HOWARD STREET — SAN FRANCISCO, CALIFORNIA 94105

BY JAZ DATE 6-30-78 JOB NO. 1131 SHEET NO. 3 OF

SUBJECT

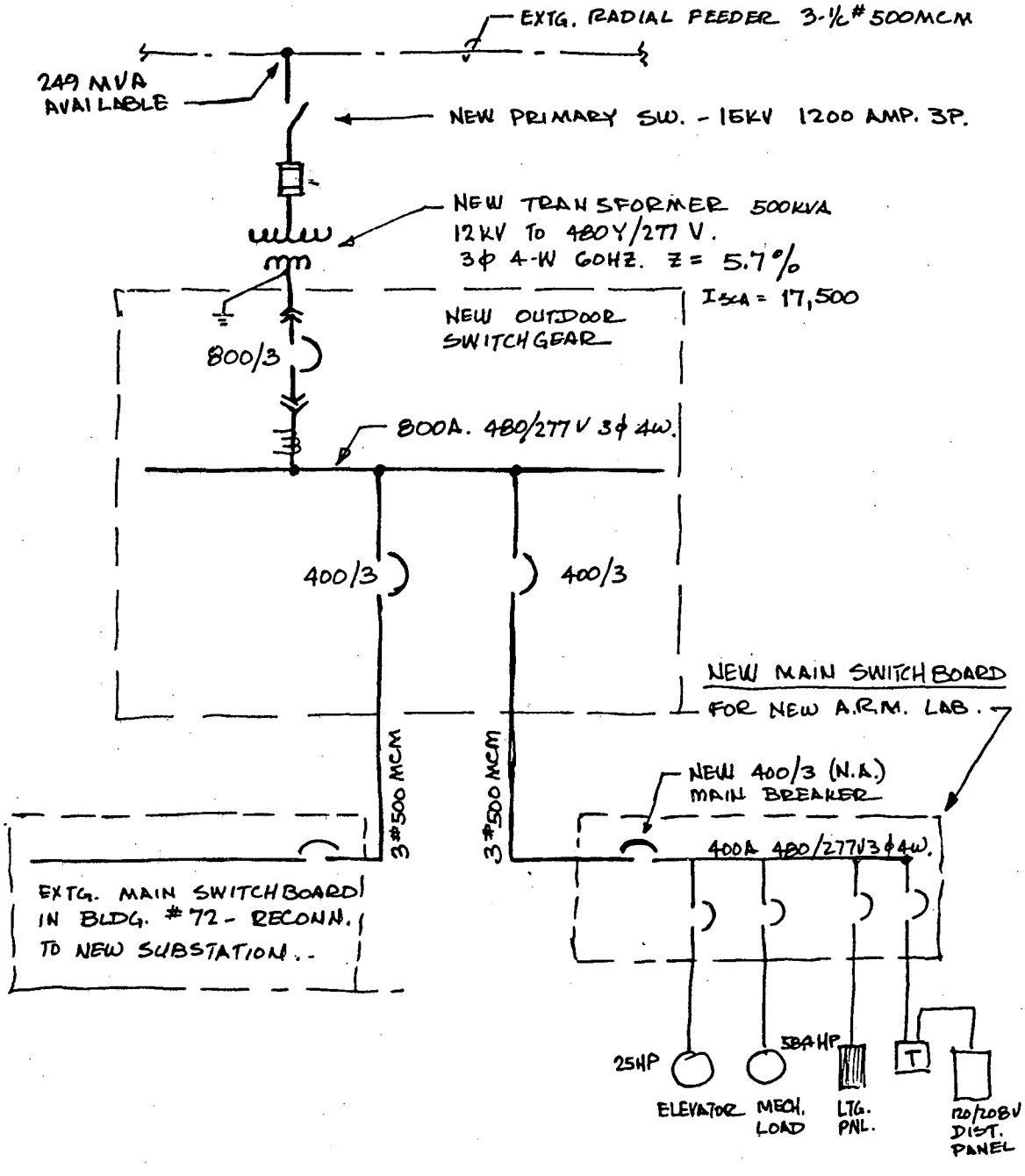
MOTOR LOAD CONTRIBUTION

ELEVATOR	25HP
O.H. CRANE	5HP (ESTIMATED)
BOILER	3 HP
AIR HANDLER	15 HP
EXH. FAN	1.5HP
CHILLER	33.4 KW.
SOLAR PUMP	.5 HP.
MISC. PUMPS	5 HP
TOTAL	88.4 HP.

MAZZETTI & ASSOCIATES, INC. — ELECTRICAL ENGINEERS — 594 HOWARD STREET — SAN FRANCISCO, CALIFORNIA 94105

BY JAZ DATE 6-30-78 JOB NO. 1131 SHEET NO. 4 OF

SUBJECT L.B.L – A.R.M. LAB. BLDG – SHORT CIRCUIT CALCULATION



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BY JZ DATE 6-30-78 JOB NO. 1131 SHEET NO. 1 OF 2

SUBJECT L.B.L. - A.R.M. LAB. BLDG. - ILLUMINATION CALCULATION

RM. NAME	L×W	TOTAL AREA IN □'	TITLE #24 TASK #	FT²/OCC	TASK AREA	TASK WATTS/FT²	WATTS ALLOWED	LAMP, FIXT. & F.C. DETAIL					RM. CAVITY RATIO	
								COEFF. OF UTILIZ.	MAINT. FACTOR	LUMENS/LAMP / WATTS/FIX.	#FIX. / #LPS	F.C. I.E.S. / F.C. DERIVED	5×hRC×(L+W) / L×W	RCR
				#/OCC	GEN. AREA	GEN. WATTS/FT²	WATTS USED	AREA						
TYPICAL OFFICE	15×10	150	240	75	150	2	300	.47	.80	3150 / 144	2 / 3	75	5×7×(23)	5.8
				2			288	150				48	150	
GENERAL OFFICE	22×17	374	240	100	374	2	748	.55	.80	3150 / 92	6 / 2	75	5×7×(39)	3.7
				3.7			552	374				45	374	
E.M. LAB HREM	21×16	336	154 #1	80	336	3	1008	.58	.80	3150 / 144	6 / 3	90	5×7×(37)	3.9
				4.2			864	336				78	336	
COMPUTER LABORATORY	21×14	294	151 #1	80	294	3	882	.56	.80	3150 / 144	6 / 3	90	5×7×(35)	4.2
				3.6			864	294				86	294	
DENSITO. DIFFRACTO.	21×11	231	154 #1	80	231	3	693	.49	.80	3150 / 184	3 / 4	70	5×7×(32)	4.9
				2.9			552	231				64	231	
CONFER. RM.	21×15	315	240	50	315	2	630	.53	.80	3150 / 92	6 / 2	50	5×7×(36)	4.0
				6.3			552	315				51	315	
DRYMOUNT	21×15	315	154 #1	80	315	3	945	.57	.80	3150 / 144	6 / 3	90	5×7×(36	4.0
				3.9			864	315				82	315	
PREPAR. LAB.	22×21	462	154 #1	80	462	3	1386	.47	.80	3150 / 144	8 / 3	90	5×7×(43)	3.3
				5.7			1152	462				80	462	

ILLUMINATION CALCULATIONS

MAZZETTI & ASSOCIATES, INC. — ELECTRICAL ENGINEERS — 594 HOWARD STREET — SAN FRANCISCO, CALIFORNIA 94105

BY JZ DATE 6-30-78 JOB NO. 1131 SHEET NO. 2 OF 2

SUBJECT LBL. - A.R.M. LAB. BLDG. - ILLUMINATION CALCULATIONS, CONT'

RM. NAME	L x W	TOTAL AREA IN □'	TITLE #24 TASK #	FT²/OCC #/OCC	TASK AREA GEN. AREA	TASK WATTS/FT² GEN. WATTS/FT²	WATTS ALLOWED / WATTS USED	LAMP, FIXT. & F.C. DETAIL: COEFF. OF UTILIZ.	MAINT. FACTOR	LUMENS/LAMP / WATTS/FIX.	# FIX. / # LPS	F.C. I.E.S. / F.C. DERIVED	RM. CAVITY RATIO: 5 x hRC x (L+W) / L x W	RCR
INSTR. DEVEL.	24x16	384	154 #1	80	384	3	1152	.59	.80	3150	6	90	5x7x(40)	3.7
				4.8			864	AREA		144	3		384	
LOBBY RECEPT.	24x16	384	240	200			384	.59	.80	3150	4	50	5x7x(40	3.7
				19	384	1	576	384		144	3	47	384	
CORRIDOR	88x7	616	240	—			616	.46	.80	3150	7	20	5x7x(95)	5.4
				—	616	1	644	616		92	2	26	616	

BASIS OF ELECTRICAL DESIGN CALCULATIONS

A. New substation #98 will feed the main distribution panel to the located in the mechanical room, spectrometer level.

B. Lighting will be served from 277/480 volt 3-phase, 4-wire. Lighting panel to be located on main entry level. A main feeder will run from lower level to the main entry level.

C. Step-down transformer will be served from main distribution panel and feed the 120/208 volt distribution panel to be located in mechanical room, spectrometer level. This panel will serve the 120/208 volt 3-phase, 4-wire receptable panels to be located on each floor complete with feeders. Laboratory power panel will be served from the 120/208 volt distribution panel, complete with feeder.

D. Mechanical equipment including all roof mounted fans, will be served from motor control panelboard in the spectrometer level which will be connected to main distribution panel.

E. For load analysis, refer to electrical load calculation.

F. Lighting:

1. Lighting will be based on Title #24 energy standard and IES recommendations. General lighting fixtures in the offices, laboratories, conference room, areas with 2' x 4' modular acoustical ceilings will be 2' x 4' recessed fixtures with acrylic prismatic lenses and three or four rapid-start lamps and in corridors will be 1' x 4' recessed fixtures with acrylic primatic lenses and two rapid-start lamps. These fixtures will give the following intensities:

   (1) Laboratories: 70 - 100 fc. (TASK)

   (2) Offices: 50 - 70 fc. (TASK)

   (3) Conference room: 30 - 50 fc with dimming controls.

   (4) Corridors, lobby, and means of egress, 10 - 20 fc.

2. Fixtures in A.R.M. High Bay will be controlled by dimmers, with all controls mounted in a light control panel.

3. Fixtures in offices and small laboratories will be controlled by multiple switching, providing two levels of lighting for energy conservation.

4. Lighting in rest rooms and toilets will be 15 to 30 fc using surface-mounted fluorescent fixtures with acrylic wrap-around lenses.

5. Lighting in mechanical spaces and other areas without finished ceilings will be 10 to 20 fc using industrial fluorescent fixtures.

6. Incandescent accent lighting will be provided in public areas as required for architectural effect.

7. Outdoor lighting will be provided where required for use and architectural accent.

8. Exit signs, self contained type, will be provided where required by codes.

This report was done with support from the Department of Energy. Any conclusions or opinions expressed in this report represent solely those of the author(s) and not necessarily those of The Regents of the University of California, the Lawrence Berkeley Laboratory or the Department of Energy.

TECHNICAL INFORMATION DEPARTMENT
LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720