File 20.1

SAND75-0296
Unlimited Distribution

Thermal Test Facility

to support the Central Receiver Solar Thermal Conversion System

A presentation by Sandia Laboratories

May 1975

Sandia Laboratories

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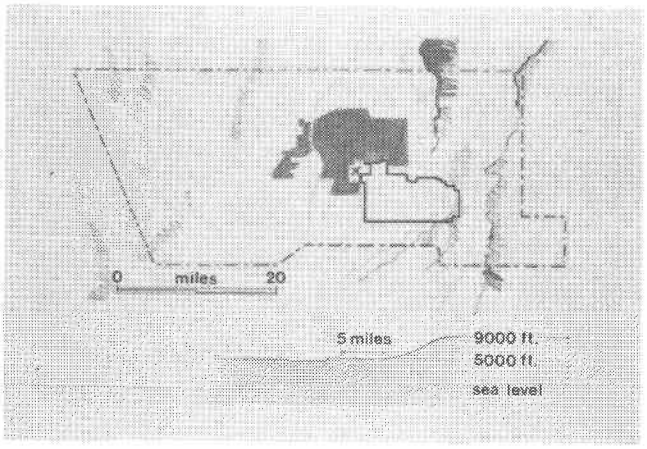
Thank you for this opportunity to present some details about Sandia Laboratories and about the environment of Albuquerque and Livermore. I hope that this information will help you determine where the nation might most advantageously locate a test facility to support the Central Receiver Solar Thermal Conversion System.

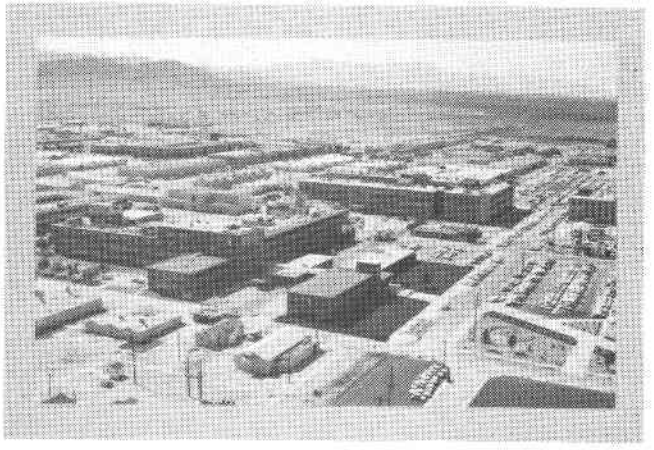
If an orderly well-planned test program is going to proceed in support of the development of the 30 megawatt POCE, then a reliance upon the breadth and depth of an already operational facility seems appropriate. Sandia operates such facilities at both Albuquerque and Livermore. Many factors enter into choice of such a facility, and I shall try to review just some of the most significant. We have reviewed space requirements for the test facility and it is clear that we can accommodate the test facility at either location.

This shows SLL. At the bottom left is open land acquired by ERDA which could marginally accommodate the facility. Shop support, computer and professional staff capability also exist as a support base. However, comparisons of insolation data as presented by Aerospace clearly bias the selection toward Albuquerque or Inyokern. Consequently, no further consideration of the Livermore site is needed.



This view of the Albuquerque area will illustrate how Sandia and the city are situated. The mile-high mesa on which the Laboratories is located is 400 feet above the Rio Grande valley, and the mountain range which is about 5 miles further east and another 4000-5000 feet higher than the mesa does not interfere with the useful insolation.

Let me point out a few dimensions represented on this viewgraph. Albuquerque, Sandia Laboratories and the Kirtland Air Force Base are within Bernalillo County. The county, one of New Mexico's smallest, has 1,163 square miles; that is 105 more than the land area of the entire state of Rhode Island. The area you see blocked off around Sandia, east and south of the airport is about 50,000 acres.



The staff of Sandia at our three locations in Albuquerque, Livermore and Tonopah totals about 6,500. I will discuss experience and assignments later; for the moment, let me say that it is a staff accustomed to working in a project mode while it maintains excellence in functional disciplines-- and that it is oriented toward producing results.

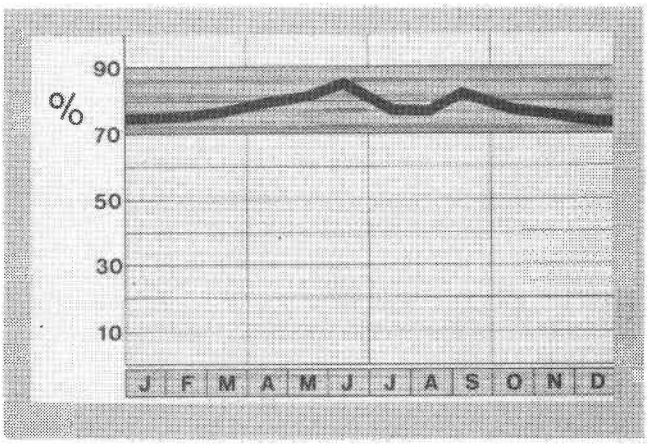
Beyond the practical elements of location, environment, facilities and staff which allow one to become operational efficiently and relatively inexpensively, we also need to consider the value of an approach that will ensure that the proper problems are addressed and the goals of a project can be attained. The design, engineering development and operation of a five megawatt test facility add certain advantages to the over-all program:

1. The momentum of test work can be maintained in the transition from radiant heat (IR) testing of receiver subsystems to solar testing of these receivers.

2. Selective coating can be tested at high temperatures and high flux rates over large surface areas.

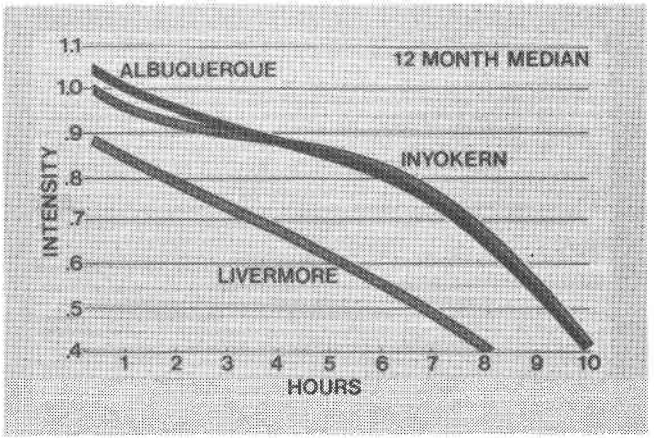
3. Testing of novel receiver design can proceed in an effective manner.

If operation of a test facility of this size can successfully produce or improve components and subsystems, then we can be reasonably optimistic that the full facility can be made productive.

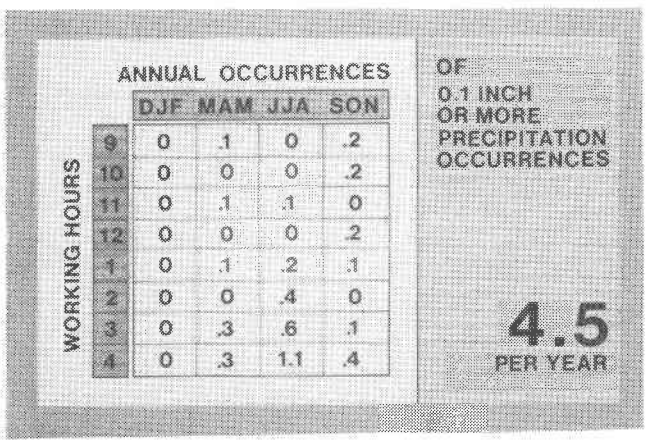


The amount and quality of insolation are obviously basic criteria for locating a central receiver test facility. Albuquerque receives a large amount of insolation — as these data for 35 years show. Because of our altitude, we get more intense sunlight than stations at lower elevations, even though the average amount of insolation may be roughly equal.

Within this framework, then, I want to discuss three areas in some detail to illustrate how environmental factors, technical capabilities and siting features of Sandia and Albuquerque could contribute to the proposed project.

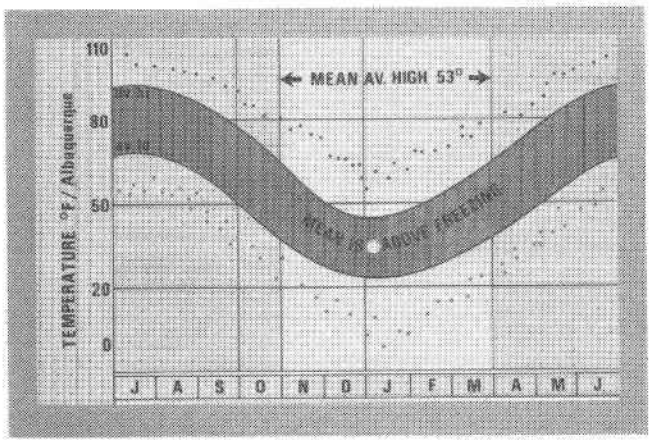


This viewgraph illustrates the point. Notice that although there is little difference between the two locations in question at middle levels of insolation intensity, there is a difference at higher levels that could prove useful for testing. Just the difference between 2000 and 5000 feet alone means a seven percent increase in intensity.



When rain comes with its accompanying clouds, it falls usually between the hours of 3:30 in the afternoon and midnight. What I am showing here are patterns that emerge from collection of field data over a ten-year period. These are total occurrences of precipitation in excess of a tenth of an inch. Note the cluster of late afternoon occurrences in Summer and Fall, and the low ten-year totals for the eight hours between 8 AM and 4 PM. As a result, our daylight hours are quite cloud-free. In a desert country, when rain does fall, it is not a general rain, but a spotty series of quickly moving local showers, interspersed with bright sunlight and rapid run-off and evaporation.

Precipitation in the form of snow over the last ten years has averaged only 7.5 days annually in which one inch or more of snow was on the ground at 5 AM.



Now, if we combine that information with these facts about maximum average temperatures for November through March (you can see they are about in the mid forties) we believe that this snow cover usually melts by noon on more than half the occasions.

What about other conditions such as fog or blowing dust or haze from industry? During the last ten years, when one of these conditions other than cloud cover has occurred, there have been only seven occasions when Albuquerque lost more than three daylight hours.

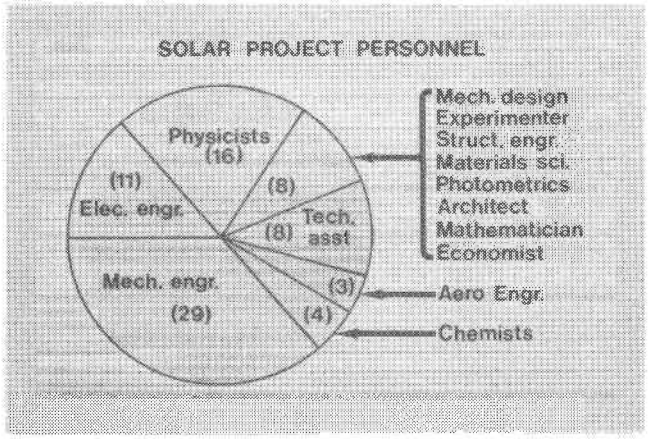
The average annual wind speed is 7.5 knots per hour. Gusts occur at the following frequencies: a 90-mile-an-hour wind gust for more than 1 to 5 seconds has a probability of occurring once every 60 years. A 60-mile-an-hour wind gust lasting for one minute on the average, has a probability of occurring once every two years--and Albuquerque has never had a tornado. These further facts about wind are significant: wind speed during 5 working hours is less than the average of 7.5 knots.

You probably remember from an earlier viewgraph that the east-west runway of the Albuquerque International Airport is located fairly close to Sandia Laboratories. For years, Sandia has had an operating agreement with the FAA that all aircraft will maintain a minimum 300-foot ceiling above the 50,000 acres of Laboratories and Air Force Base air space. An existing 300-foot drop tower has required that our test area appear on all navigational charts as a restricted area for aircraft. If the initial central tower of the test facility will be 140 feet high, no problems are presented. Scale-up to 300 feet is within already established parameters. The end of the east-west airport runway is about 4.5 miles northwest of the nearest part of Area III.

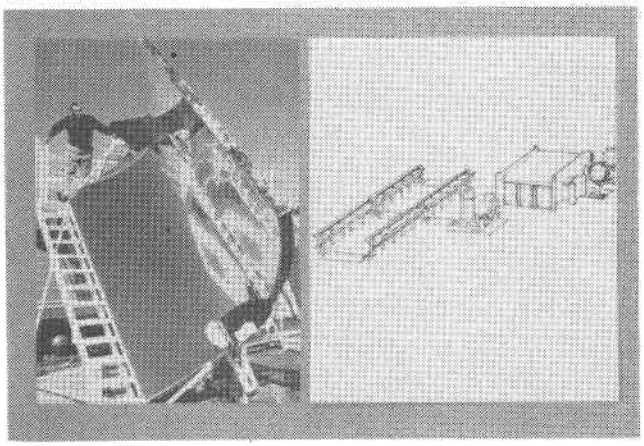
To summarize environmental factors, then, we receive sufficient total solar insolation essentially uninterrupted by cloud cover in any month of the year, have trifling amounts of dust and haze, a total annual precipitation of only 8.5 inches of rain and snow combined, and moderate winds with few gusts of consequence to structures.

It is entirely possible that one could find other locations in this country which have good climatic conditions. But other factors assume importance. I want now to address technical capabilities at Sandia, both from the point of view of staffing and of physical plant.

Several projects at the Laboratories are concerned with various aspects of both nuclear and nonnuclear energy, but let me just discuss briefly solar and solar-related projects that have been funded by various agencies.

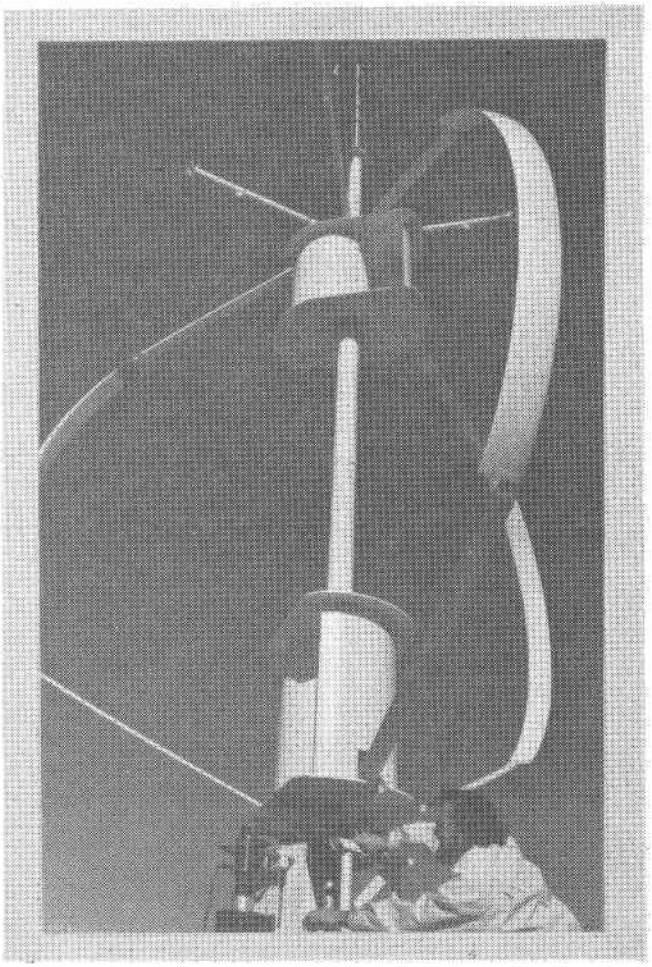


Here are the numbers and types of personnel involved both full and part time.



First, our Solar Total Energy Project which employs about 30 FTE people is directed toward establishing feasibility of a largely energy self-sufficient community, military or industrial complex. Elements include a collector field, high temperature storage (580 F) a turbine-generator system, low temperature storage (200 F) and an air conditioning/air-water heating system.

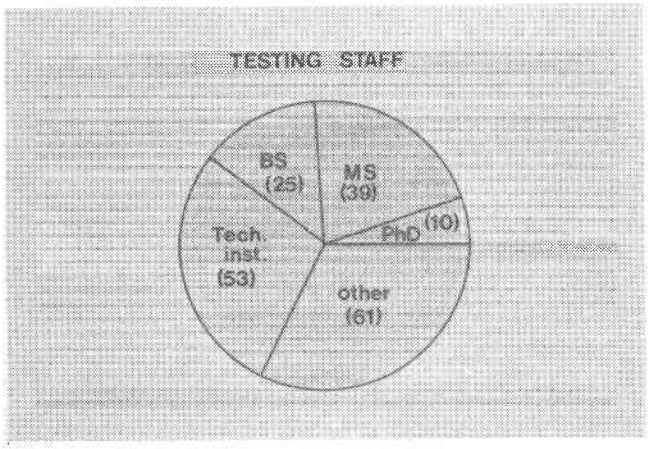
Our Photovoltaics Research Program, employing about 2-5 FTE's, focuses upon studies of silicon and compound-material thin films to convert light energy into electrical energy.



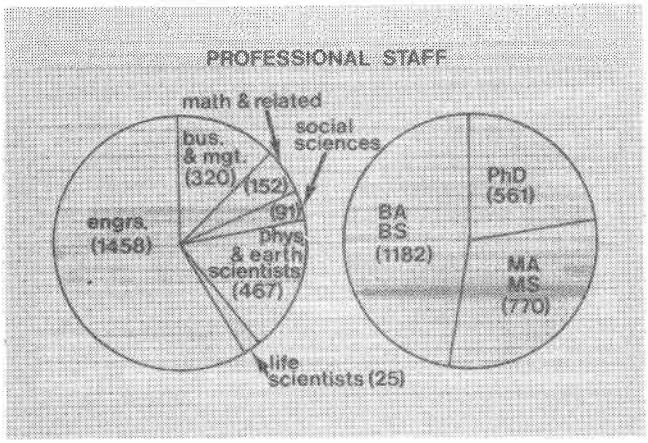
The Vertical Axis Wind Turbine Project has 6-10 FTE's engaged in making improvements on the Darrieus wind turbine and the Savonius vertical axis rotor, and investigating wind turbine integration into electric distribution grids.

The Central Tower Project is currently employing 5 FTE's in support of ERDA for central electrical power generation and chemical processing, and is scheduled for 10 FTE's in FY 76.

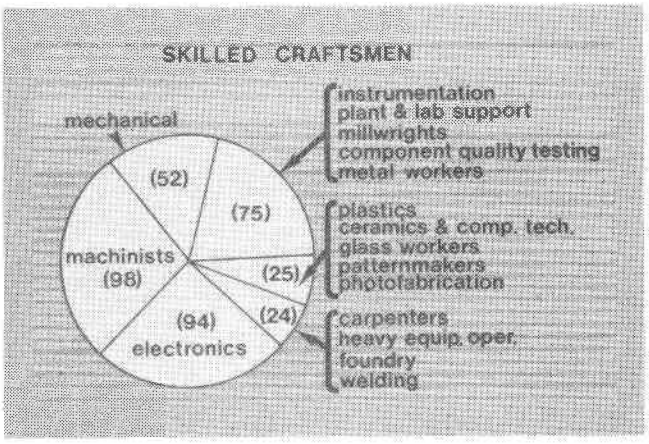
And the Storage Study Project has 1-2 FTE's engaged in a study of technological alternatives for storage of thermal energy.



Above and beyond the personnel involved in those solar projects, we have the following people who specialize in various aspects of testing. Combining solar and test personnel, we find that we have these levels of education represented.



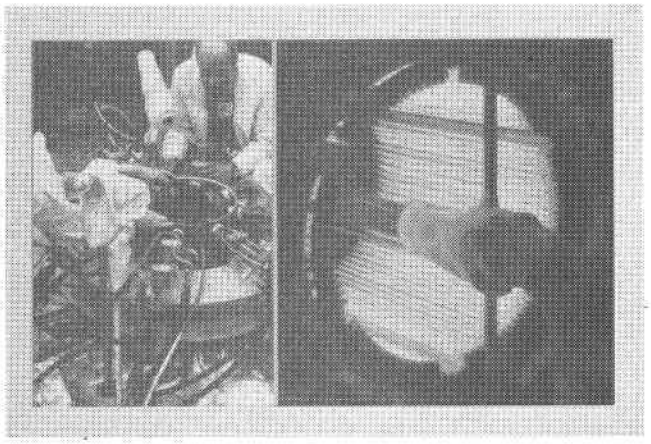
If we take a broader look at the over-all professional staff at Sandia, here is a synopsis of their educational background by discipline. Note the engineering cluster here, and the basic sciences totals here. Skilled personnel are represented by these numbers and crafts.



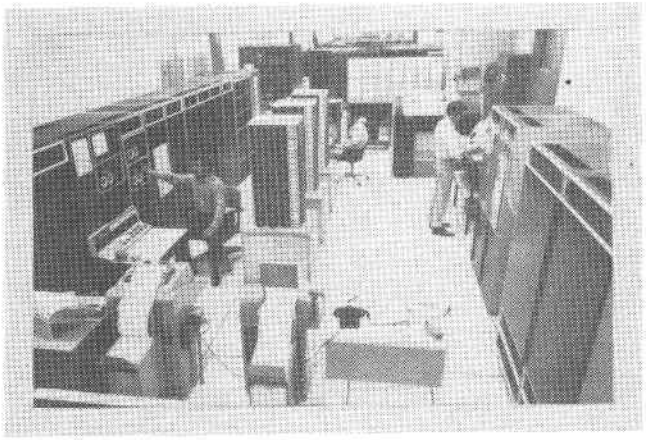
Technical staff aides total 1,302, other than drafting; of those with college or technical institute degrees, about 60% have degrees in electronics, 8% in mechanics.

We have developed an extensive array of facilities to support these personnel. At our three locations, we have a total investment in plant and equipment approaching $320 million (70% in equipment). We maintain 370 structures of one kind or another, providing two and a half million square feet of office, laboratory, test and storage space. Let's survey five principal groupings of facilities which we have developed over the past thirty years. I can only give you highlights and a few illustrations.

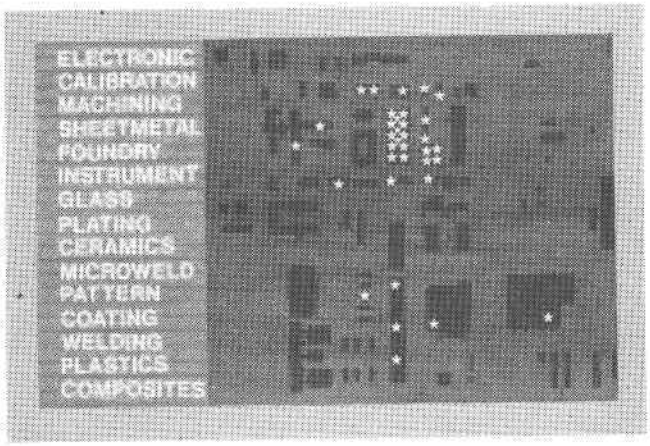
In testing, our investment is $106 million. We can perform environmental and radiation simulations.



Here is a view of the radiant heat facility's cylindrical quartz lamp heater array. I will be describing this facility later. We can do full scale performance testing in any environment.

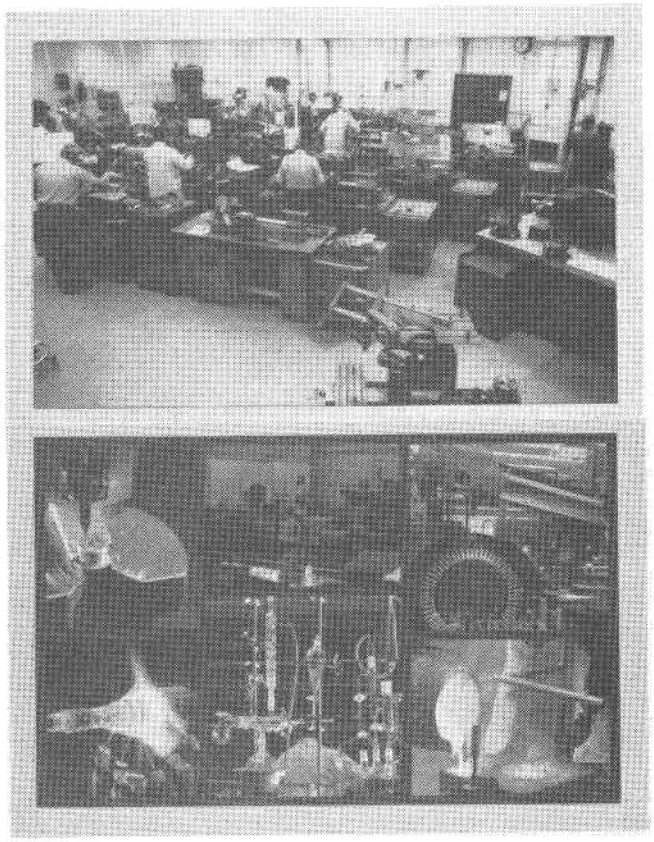


Computation facilities exemplified by this view represent an investment of $32 million. We have five CDC 6600 computers and are scheduled to put a 7600 into operation shortly. We use two UNIVAC 1108's and several smaller computers for dedicated data handling, both digital and analog, and for experiment controls.



This viewgraph will give you some idea of the variety of our 12 million-dollars worth of fabrication facilities which are located at several strategic locations throughout the working areas and in special sole-purpose buildings.

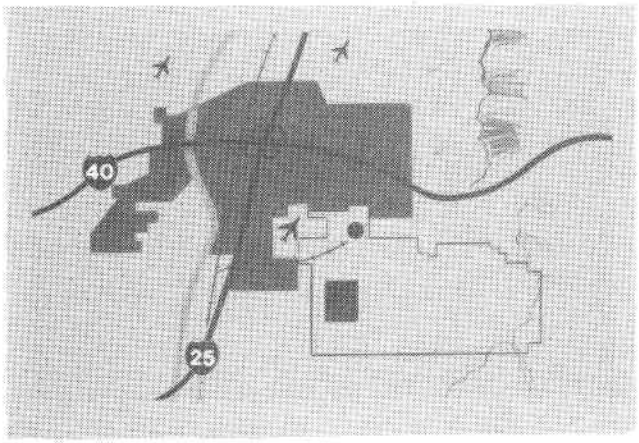
Here is a composite of some fabrication technologies.

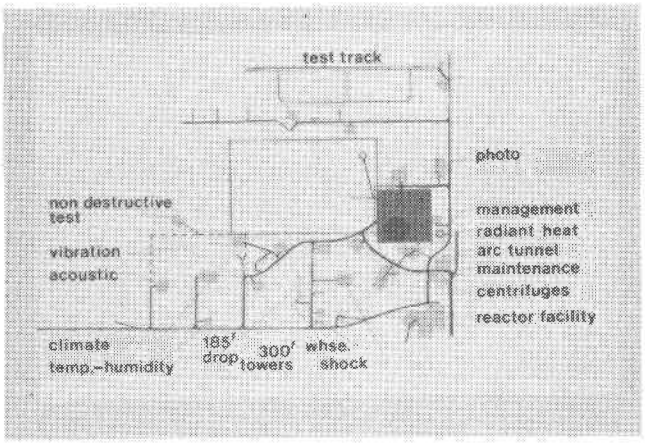


In addition, we maintain laboratories for development of hybrid microcircuitry, semiconductor and vacuum tube technologies.

In our ERDA primary standards laboratory we maintain measurement standards in AC and DC current, microwave, electrical pulse, radiation, mechanical and environmental areas.

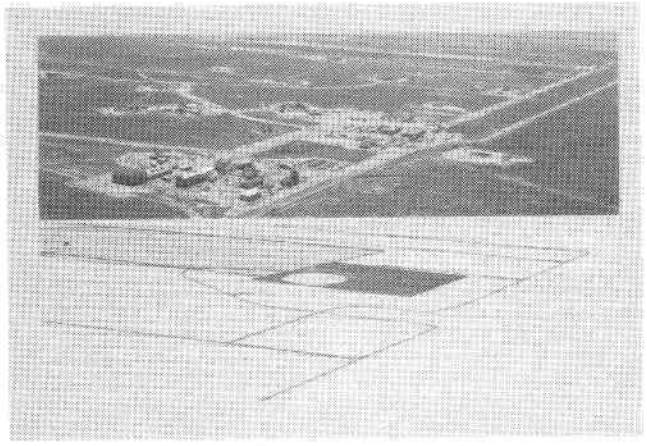
We will be leaving with you several copies of some recent volumes which provide details of all of these, and more, technical capabilities of the Laboratories.

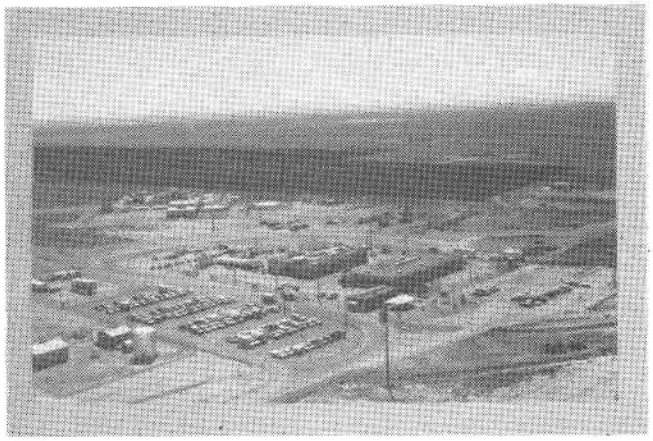




Other aspects of the location are important besides climate. Let me review again the location of Albuquerque and point out some features which require consideration. We are at a north-south, east-west crossroads – U. S. 25 and 40 intersect in the middle of the city. Seventeen motor truck companies provide freight service. The Santa Fe Railroad links Albuquerque with the Midwest and the West Coast. Four major airlines provide passenger and freight service to the Albuquerque International Airport for transcontinental traffic.

A wide range of facilities is arrayed throughout this area. At this location we propose the initial 40-acre site; immediately to the south there is another 130 acres available for any needed expansion. There is a railroad spur with cranes and ramps that permit off-loading of the largest units that can be shipped by railcar.



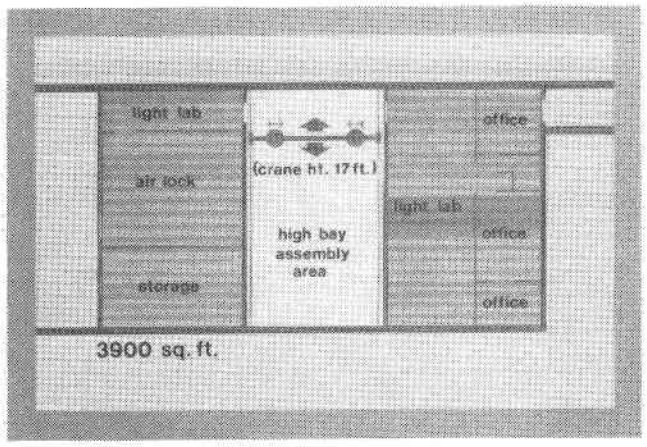


The specific site which we propose is located within what we call Area III, a large area set aside for testing of various kinds that involve some hazard. It is about ten miles from downtown Albuquerque.

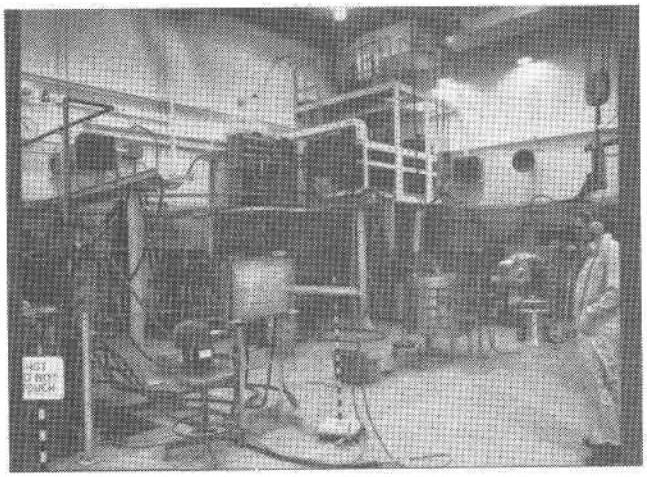
Roads now provide access to nearly any point in the area, and it would be a minor matter to construct one more arc here so that the 40-acre site would be completely encircled with a perimeter road. Access would be available for personnel who would not need to be cleared.

Adjacent to the 40-acre site Sandia has a Radiant Heat Facility which is an ideal adjunct for a Solar Test Facility because it will provide a means of testing the receiver of the central collector at IR and solar flux. In fact, ERDA has funded to design and prepare a plan with Martin Marietta to test their 1 megawatt (thermal) Bench Model Cavity Receiver Steam Generator in this facility either before or after their experiments are conducted in France.

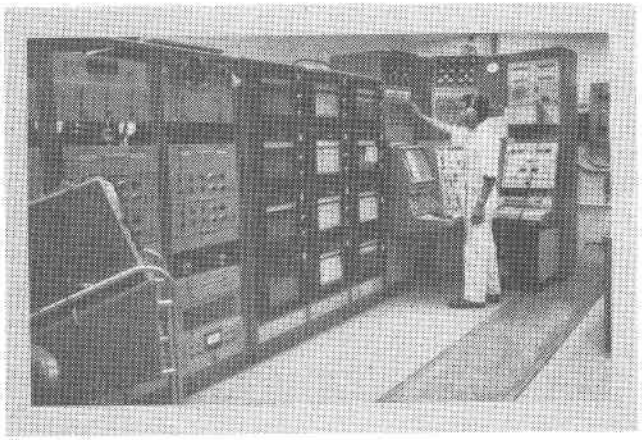
There are some other features of this Radiant Heat Facility which make it attractive. We have two water systems; a boiler for generation of steam at 6.3 kg/s at 1.2 MPa; compressed air and gases; a 1.25 MW cooling tower; a 1370 cubic meter water storage tank; and two sources of electrical power, one of which is a 5 MW (electric) substation which can be used independently of the Area III power grid.



Office and laboratory space comprise 1400 square feet and there are another 1000 square feet of storage and air lock space.



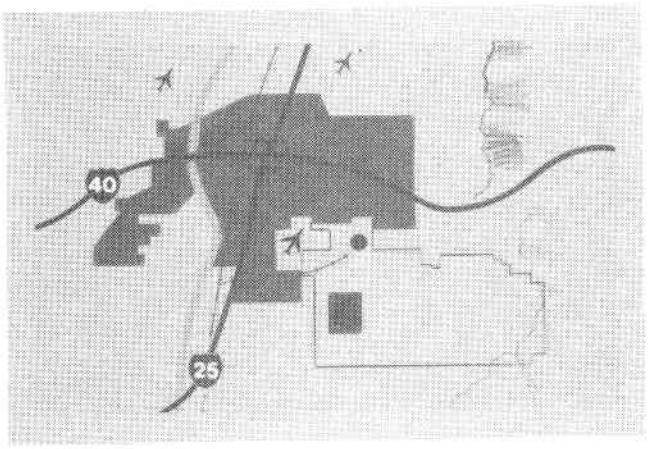
A high bay assembly has 1500 square feet with two bridge cranes.



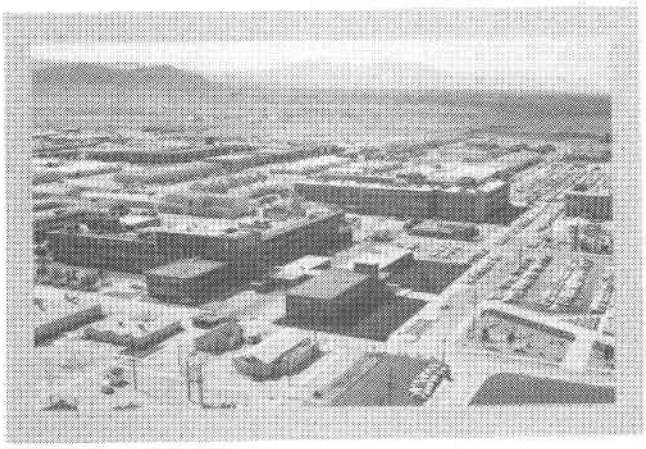
A minicomputer-based data system with an installed capacity of 192 channels of low level data can be expanded to several thousand channels in a very short time. This system provides on-line data reduction and real-time control of data acquisition and recording -- as well as off-line computation, including the reduction and plotting of previously recorded data. There is a closed-circuit TV monitoring system with video tape recording capability. Support personnel provide services from a branch machine shop; there is a maintenance system with plumbers, electricians, welders and millwrights; and there is a complete photometrics group.

As a point for consideration, I can say that representatives of the Los Alamos Scientific Laboratory have expressed an interest in using the 5-megawatt test facility as an energy source for experiments in thermo-chemical production of hydrogen. We have received a letter from the Public Service Company of New Mexico endorsing the concept of a test facility in Albuquerque and noting that solar repowering of existing generating stations could take state wide advantage of existing facilities, public acceptance, existing grids and vacant land, and permit minimum-cost, hybrid operation. The Company has a record of cooperation with Sandia on other solar programs.

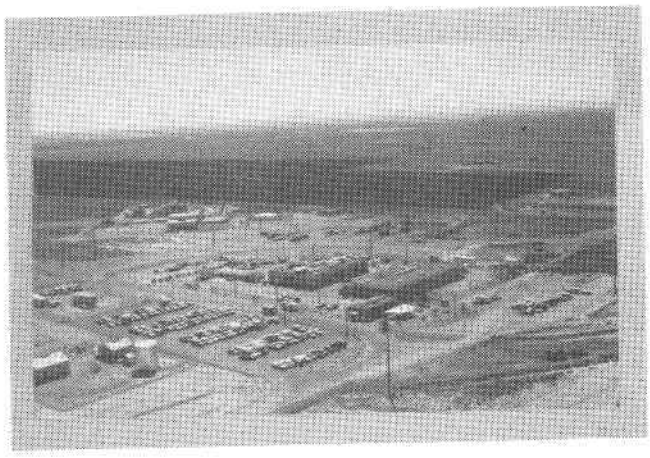
Let me bring all this together so that the high points will be visible from amongst these details.



The Albuquerque environment and location, as a mountain-dominated, mile-high desert, provide effective insolation in throughout-the-year daily periods of interest for testing. Cloud cover, haze and dust are minimal. Rain- and snow-fall do not significantly interrupt day-time insolation. Transportation of several kinds is readily available.



Sandia Laboratories, as ERDA's largest engineering development facility has a staff with experience and training not only in basic engineering testing and scientific disciplines, but specifically in on-going nuclear and nonnuclear energy projects that have been funded by several agencies. Certain facilities are in many cases unique in the nation, but it is the mix of broad capabilities and sophisticated facilities which permit Sandia to design, manage and complete projects requiring systems emphasis and long-term commitment



A specific site within an existing testing area offers land capable of being extended, that is road and rail accessible to handling of large components and to uncleared personnel, and that is furnished with basic utilities. An existing radiant heat facility offers complete basic and special utilities; expandable data handling equipment; and office, laboratory and testing space. Support services are available on site for mechanical and electrical maintenance and for photometric needs.

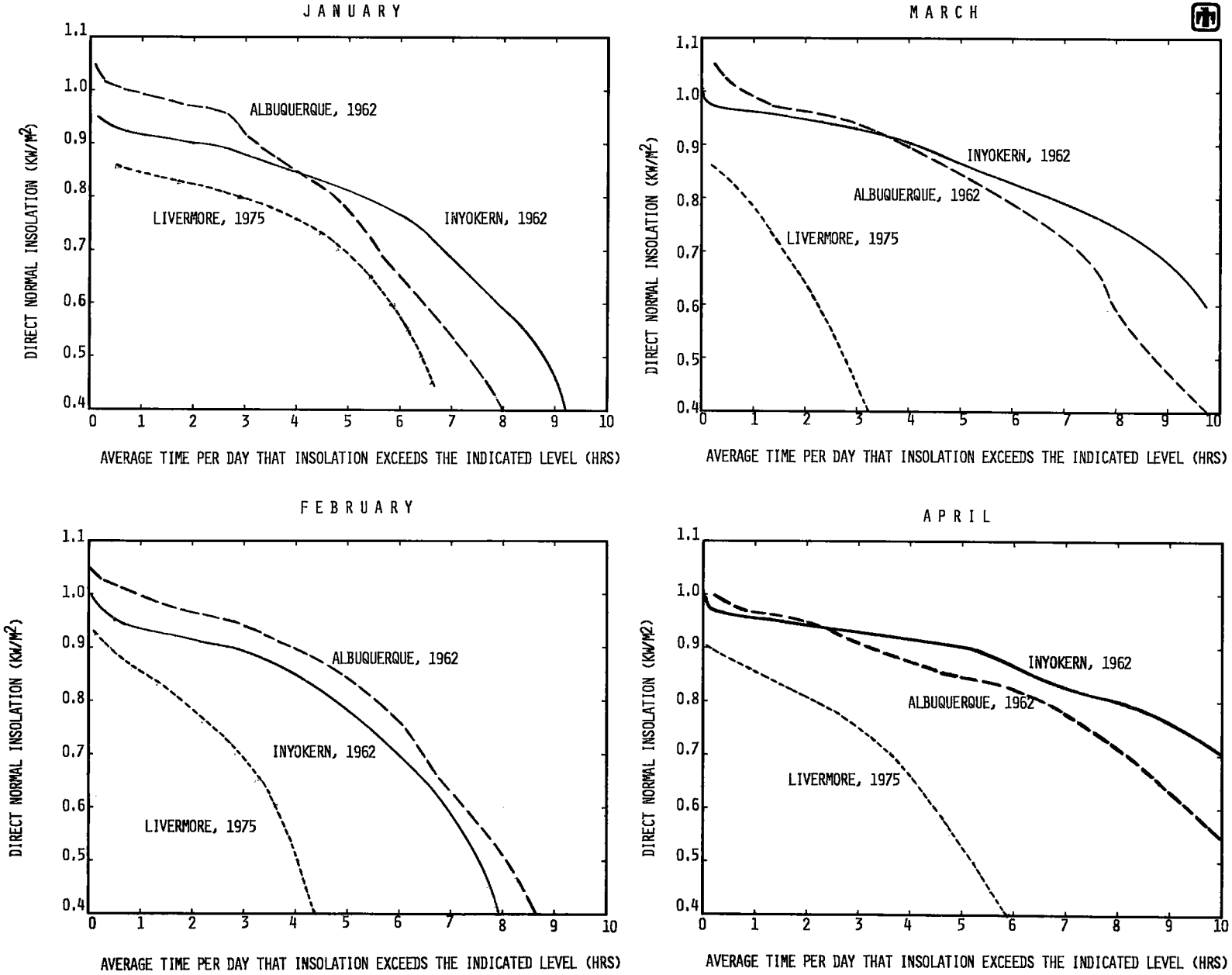
We invite you to visit the Sandia Laboratories to make an on-site evaluation of our facilities and to discuss further details with management and technical staff. Copies of this presentation are here for your review, as are other supporting documents. Can any of us answer questions at this time?

TOTAL OCCURRENCES OF PRECIPITATION
AMOUNTS IN EXCESS OF .0.1 INCHES, BY HOUR

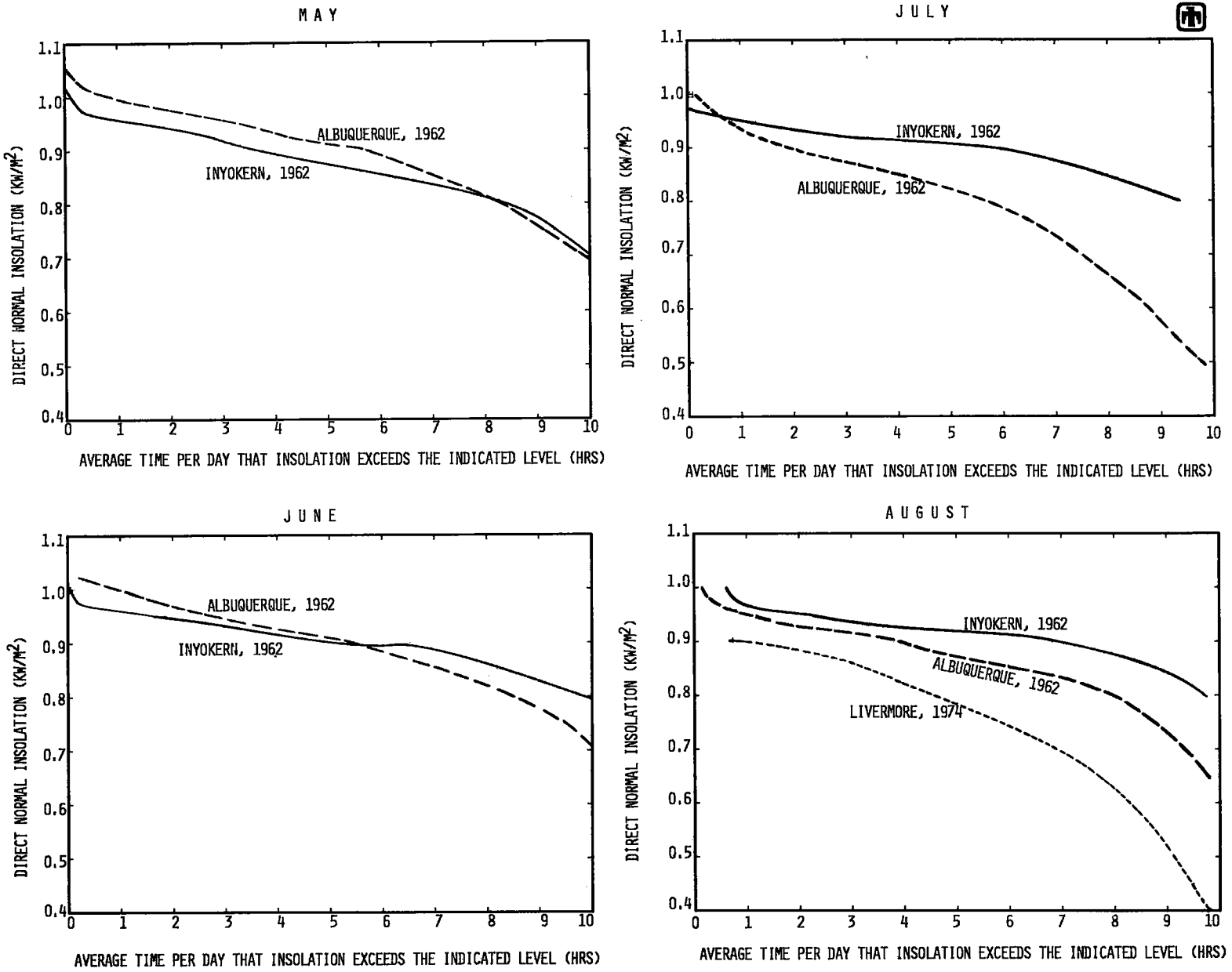
(Data Period, 1951-1960)

LOCAL STANDARD HOUR ENDING AT	DEC JAN FEB	MAR APR MAY	JUN JUL AUG	SEP OCT NOV	TOTALS
1 AM	1	1	5	3	10
2	1	1	3	1	6
3	1	0	2	0	3
4	0	1	2	0	3
5	1	0	3	3	7
6	0	2	0	2	4
7	0	1	1	0	2
8	0	1	1	0	2
9	0	1	0	2	3
10	0	0	0	2	2
11	0	1	1	0	2
12	0	0	0	2	2
1 PM	0	1	2	0	4
2	0	0	4	0	4
3	0	3	6	1	10
4	0	3	11	4	18
5	0	3	8	8	19
6	1	3	11	3	18
7	2	3	5	3	13
8	1	1	9	4	15
9	2	0	7	1	10
10	1	0	8	2	11
11	0	0	4	4	8
12	2	1	3	1	7

COMPARISON OF DIRECT INSOLATION

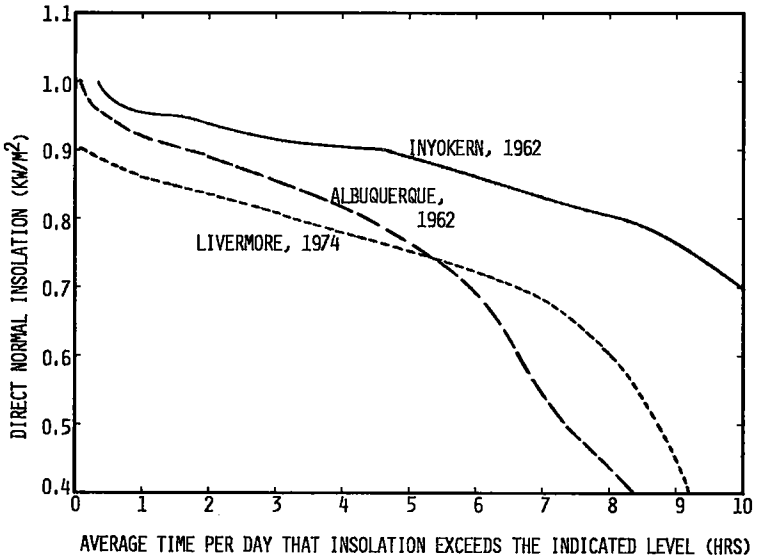


COMPARISON OF DIRECT INSOLATION

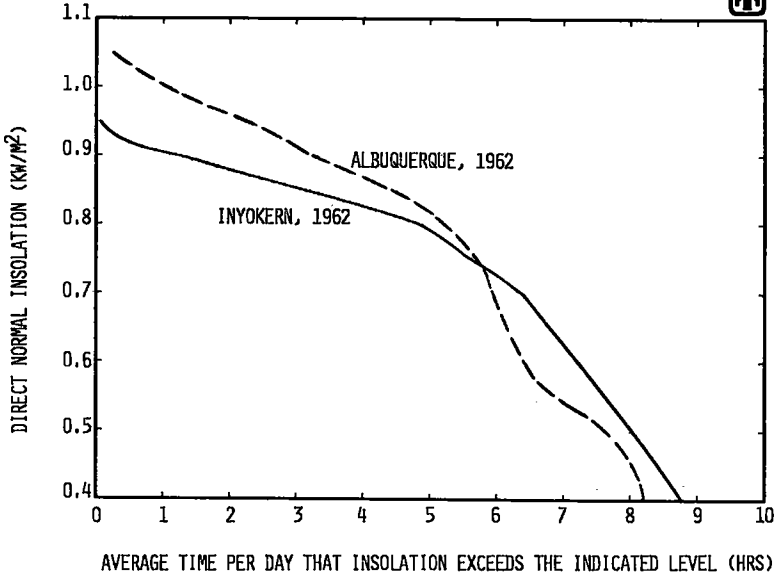


COMPARISON OF DIRECT INSOLATION

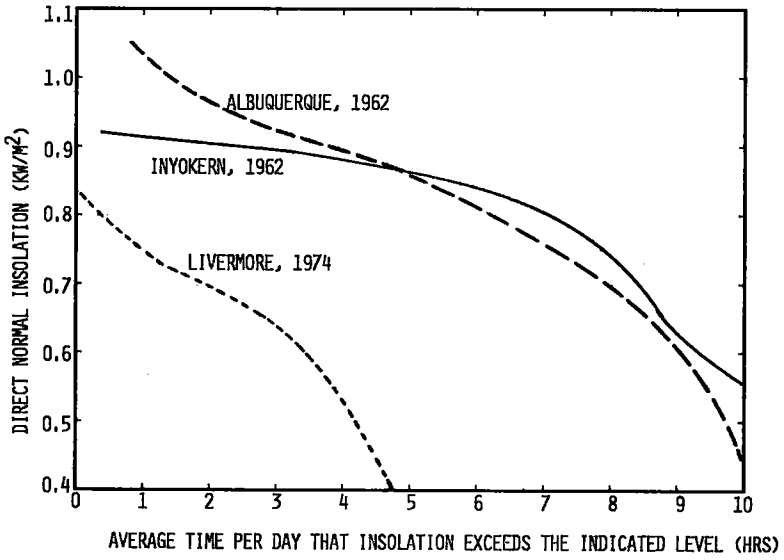
SEPTEMBER



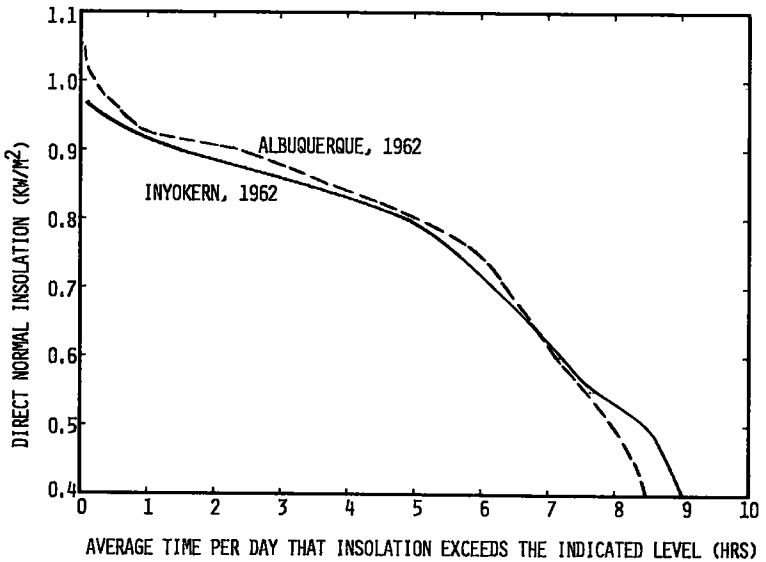
NOVEMBER

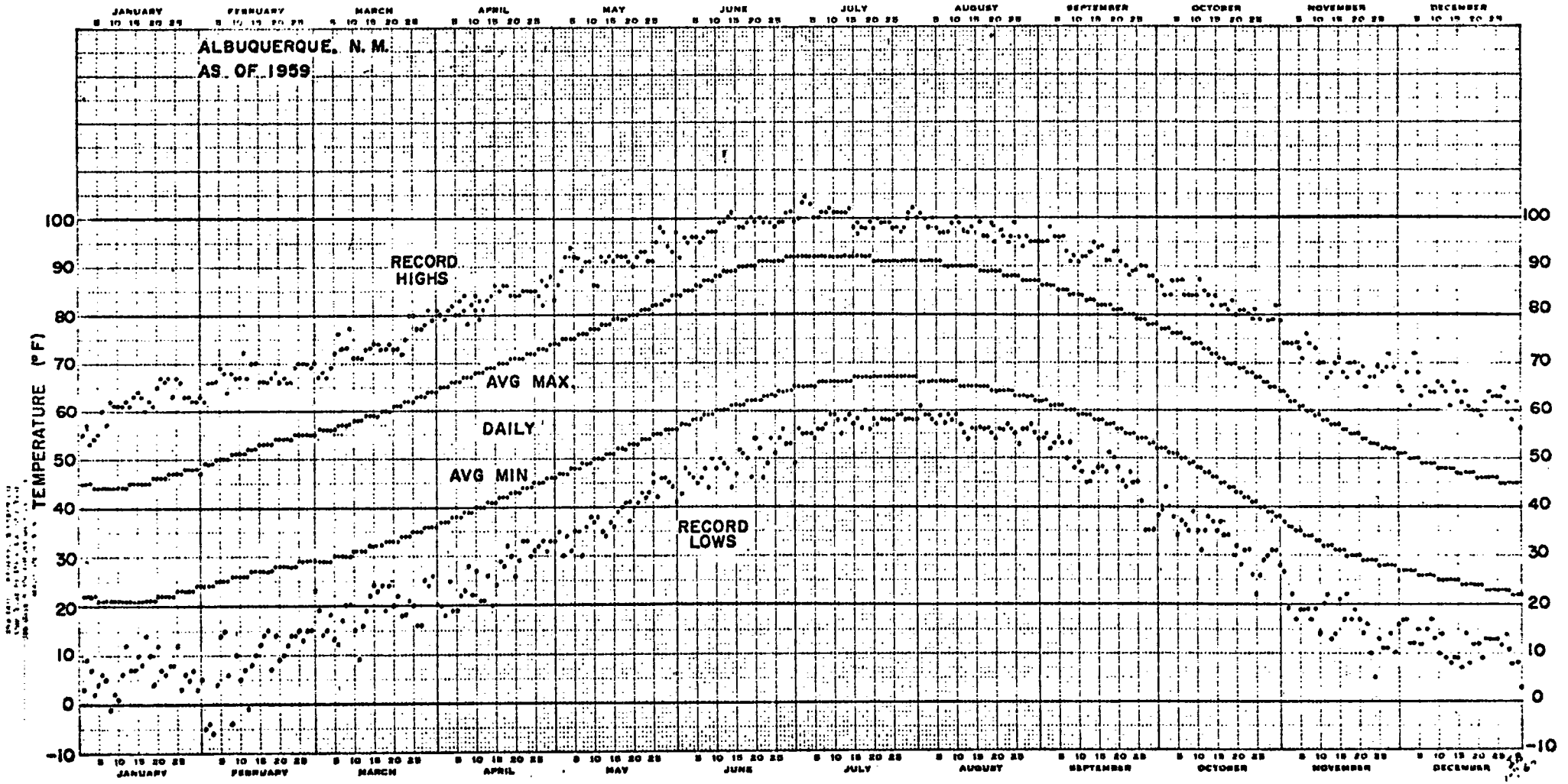


OCTOBER



DECEMBER




ALBUQUERQUE, N. M.
AS OF 1959
RECORD HIGHS
AVG MAX.
DAILY
AVG MIN
RECORD LOWS
TEMPERATURE (°F)
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
100
90
80
70
60
50
40
30
20
10
0
-10

TEST STAFF

AREA III AND COYOTE TEST FIELD SHOCK, VIBRATION, HIGH VELOCITY

3 PhD		26 MTS
19 MS		1 TSA
5 BS	OR	23 ESA
28 TI		16 SAT
12 Other		1 Manget Aide

AREA I SHOCK, VIBRATION, etc.

2 MS		6 MLS
4 BS		1 TSA
3 TI	OR	5 ESA
12 Other		9 SAT

AREA I CLIMATIC SIMULATION TESTING

2 BS		1 MLS
1 TI		1 MTS
1 Other	OR	1 ESA
		1 SAT

AREA III CENTRIFUGE

2 Other	OR	1 ESA
		1 SAT

AREA I CENTRIFUGE & STATIC TESTS

1 MS		2 MTS
1 BS		1 TSA
2 TI	OR	4 ESA
8 Other		5 SAT

AREA I COMPONENT EVALUATION

2 MS		4 MLS
2 BS		3 ESA
1 TI	OR	8 SAT
10 Other		

INSTRUMENT AND FACILITY DEVELOPMENT AREAS I & III

5 MS		7 MTS
2 BS		11 ESA
8 TI	OR	3 SAT
6 Other		

NDT

4 PhD		9 MTS
3 MS		3 ESA
3 BS	OR	5 SAT
4 TI		
3 Other		

EMR/EMP

1 PhD		4 MTS
2 MS		3 ESA
2 BS	OR	1 SAT
3 TI		

EMR-EMP INSTRUMENT DEVELOPMENT

2 MS		3 MTS
1 BS		1 TSA
1 TI	OR	1 ESA
1 Other		

9300 SUMMARY INCLUDING 4 DEP'T MAGRS AND 3 DEPT SECY'S

10 PhD
39 MS
25 BS
53 TI
61 Other

INVENTORY OF EDUCATIONAL ATTAINMENT

INVENTORY OF EDUCATIONAL ATTAINMENT

	BA BS	MA MS	PhD	Tot.
ENGRS.				
Chemical	15	5	14	34
Civil	21	19	11	51
EE	376	258	70	704
Mech.	233	168	87	488
Nuc/Reactor		10	12	22
Metallurg.	4	7	7	18
Petroleum			1	1
Other	80	33	27	140
TOTAL	729	500	229	1458
MATH/RELATED				
Math.	58	43	33	134
Info. Sci.		4	1	5
Syst. Anal.		8	5	13
TOTAL	58	55	39	152
PHYS/EARTH SCI.				
Chemists	53	12	66	131
Geologists/ Geophysicists	6	6	4	16
Physicists	51	47	175	273
Metallurg.	3	5	28	36
Other	6	2	3	11
TOTAL	119	72	276	467
LIFE SCI.				
Biological	7	3	2	12
Medical	2		3	5
Health	1	5	2	8
TOTAL	10	8	7	25

	BA BS	MA MS	PhD	Tot.
BUS. & MGT.				
Admin.	119	67	4	190
Finance	2	1		3
Accounting	53	9		62
Mgt. Sci.	18	24		42
Personnel	3	5		8
Other	8	7		15
TOTAL	203	113	4	320
SOC. SCI.				
Sociology	7	6	3	16
Psychology	7	3	1	11
Economics	15	6	1	22
Other	34	7	1	42
TOTAL	63	22	6	91
TOTALS	1182	770	561	2513