CEER-PS-024

[REVISION OF

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PRELIMINARY PROPOSAL

FoR ¢

UPRATING THE AIR CONDITIONING UNIT,

NEW WING, BIO-MEDICAL BUILDING

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH

RIO PIEDRAS, PUERTO RICO

February, 1979

Prepare by:

UNIVERSITY OF PUERTO RICO ~ US, DEPARTMENT OF ENERGY

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH

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CEER ~ P5-24

REVISION OF

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FoR

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1. Purpose and source of Funds

?he purpose of this revised propocal is to describe the requirements to upgrade the Air Conditioning System in the New Wing of the Bio-nedical building, Center for Energy and Environment Research (C.2.£.R.), nfo Piedras, Puerto Rico; to define thy facilities in engineering terms and establish a reasonable budget cost estinate and tine schedule, and to re-

commend an appropriate method of accomplishment.

Three main items will be addressed with this proposal:

1. Provide a reliable air conditioning ysten that will meet the needs of the laboratory and office bullding.

2, Use the thermal vaste heat available from 50,000 £t? Solar Photovoltaic Concentrator Array to be installed at the C.E.£.R, under a nation wide program sponsored by the U. S. Department of Energy.

3, Upgrade the building envelope and building ventilation and aix handling systems to be in accordance with the Present energy conservation regulations now being {m= plemented in Puerto Rico.

As a final result of this proposal a dranatic reduction in operating

cost for the air conditioning system in the New Wing of the C.E.E.R. will be

obtained.

? We propose that the design and construction for this work will be

! charged to General Plant Project FY-1978 under Sub-progran 39-RP.

TL. Justification of Basic Needs

A. .C.BLER. New Ming present air conditioning eysten.

?The air conditioning installation in the new wing of the Center for

Energy end Environment Research (C.#.E.8.) was originally designed in 1968.

---Page Break---

+e. rower Flow Diagram during ths Peak Hour Insolation, including

Solar Cooling

#7, General Information for zcon.aic Analyses

---Page Break---

n

m

a.

?Table of Contents?

?Concentrating photovoltaics for the tropics? and

?Ste relation to the proposed revision.

D. Conceptual design acheaatic.

E. Alternative in case photovoltaic project 1s not

?Analysis of Safety and Pollution Aspects.

considerations given to the use of Existing Facilities

?Proposed Bquizment Specifications

Preliminary Cost Estimate

Comparative Economic Analysis between the previous Proposal.

of April 1977, and the prosent Proposal.

Design and Construction Schedule

Conclusions

Attachments,

C.B.2.R, New Wing Building Cooling toad.

Eetimates

CBLELR. Maw Wing Cooling Load Profiles

?Schematic of the Solar Array piping system in Conjunction vith

the Absorption Chillers

Schematic of the Chilled water and Condensing Water Piping

system

General Plan

---Page Break---

Although sone energy conservation features were included in the original

esign, application of nore advanced know-how, and new technology can reduce the

?energy consumption in the building significantly,

The butlding houses basically laboratory facilities and office areas.

?The actual components of the building envelope are:

windows:

Solar bronse glass (22 percent of wall area).

wauis:

©) combination of insulated glass with concrete

lock back wall.

b) concrete with cement plaster,

?Root Areas

Concrete with 2° rigia insulation.

?Te main component of the actual air conditioning load is the fresh air oad, Im accordance with the original drawings, 20,600 CPM of outaide air is supplied to the building as ventilation. this constitutes 65 percent of the total alr etzoulation.

?The peak design load was 200 TR and 50 percent of this load was out~ side air Load,

A terminal reheat with hot vater vas included in the original design to maintain room conditions.

Te existing air conditioning system consists of two chiller unite, ?euch having two 60-ton reciprocating compressors and two condenser fan units with a total installed capacity of 240 TR, the chiller provides chilled water to the air handling units and circulating system which comprise the renainder of the atx conditioning aysten,

---Page Break---

1B, Btleting eysten operation

The fresh air intake to the main air handling unit vas blocked in order to reduce the outside sir load. Actual building internal conditions, due to this action, are unpleasant, because the necessary fresh air for the Laboratory hoods enters the building across windows, open doors, cracks and return duct openings as infiltration with a resulting high humidity room condition. The terminal reheat systen is out of service completely. The central, chilled water plant is alvays partially or totally out of service. The four existing compressors are Worthington Model EVCS-S2 and are of poor design. They have hed a history of unreliability since first installed, being subject to multiple, internal breakdowns causing complete destruction of their interior mechaniom, This has resulted in partial or complete lose of chilled water for the aysten, for periods of three to four months while parts vere procured and repairs nade.

?The maintenance history of this plant shows that on an average two compressors have been down continuously, avaiting spare parte and repair over the past five yeare. Major plant breakdowns occurred in 1972 and in 1976 when all compressors vere down for a period of four mathe each due to compre=

cor failure, At that time 4¢ was necessary to augaent the systen with window

type air conditioners in Laboratories vhere temperature-humidity sensitive

equipeent was being used.

?The coupressors have required the constant service of an air com

ditioning mechanic and the expenditure of Large euna of money for maintenance

and replacenent parts to keep the systen operational over the past six years.

Maintenance probleas have been conpounded by the fact thet the coupressors

fare no longer manufactured, making spare parts difficult to find.

---Page Break---

The following is a breakdown of expenditures made by the C.E.E.

?from operating funds to keep the chiller unit operational:

Fiscal Year Materials 6 supplies Air cond. mech.

as72 $ 9,100

1973 9,200

1974 9,100

1975 9,200

1976 9,100

197 4,500

?total $39,600 $50,000

Grand Total $69,600

?The annual cost of maintenance of this unit has taken such a large Portion of the maintenance budget for the Bio-Wedical bullding that it has been necessary to cut back on essential maintenance of the physical plant in order to have sufficient funds to keep the chiller unit operational. te is Rot considered econoaical or feasible to keep expending large amounts of money to repair a chiller systen which is of inherently poor design end in-capable of reliable operation.

?The real loss is to the laboratory and treatuent areas for the Muclear Medicine Programs which require a continuous and reliable source of ?air conditioning in order to promote scientific research and patient confort.

©. Electric energy consumption of the existing central chilled ater plant.

An estinate of more than 40,000 1 H par month is actually used to

?operate just the central chilled water plant in the New Wing of the C.E.E.

This electric energy with a total cost of more than $2,800.00 per month is

---Page Break---

jused to operate a non-reliable systen with the result of an uncomfortable en~

vironmental condition inside the butlaing.

TIT, General Description of the Proposed Revision

A. Building upgrade for energy conservation.

In order to reduce the air conditioning load the following

?energy conservation measures seem to be imperative and are strongly recom

mended:

1) Provide a11 glass areas with schochtint

solar control f1im to minimize radiation load.

2) Provide inside venetian blinds for ail windows.

3) Provide additional ingulation at roof level with

three inch fiberglass matt above the hung

?ceiling at second floor.

4) Reduce the ventilation to the building. mis

can be accomplished by several vays as follows:

4:2) Rebalance ali supply and exhaust systens

to the laboratory hoods to reduce the

total air each system exhaust: to the ex-

terior.

4.2) Reducing the ventilation air to other areas

£0 the minimum reccemended per the ASHRAE

90-75 and 62-72 standards.

4.3) Provide an automatic control of the fresh

air intake with static pressure sensors.

5) Make a total sir rebalance and upgrading of the

?air side and controle,

---Page Break---

6) Make a peychronctric study and provide controls

4s necessary in order to eliminate the reheat and

maintain room conditions.

Teena Wo. 1 and Wo, 2 above aro already completed under an in-?house conservation program.

Additional engineering is necessary to define the work of up~?rading the building and the air conditioning system to provide a reduction to the refrigeration load.

3. Cooling load estinates for the ?Mew Wing

Using as a base the original set of construction drawings and ?considering the energy conservation features outlined in Section 11%, coo}ing toad calculations for each month were performed. Load profiles were also Prepared. The maximum hourly load vas 113 4R at 4:00 p.m. for the average ay An August. These calculations vere prepared using the Automatic Procedures for mgineering Consultants, Inc, (APEC) program HCC-II. Attachment #1 and Attachment #2 include the computer print-out and the cooling load profiles , Respectively. As indicated in the load profile chart for septesber 1978, a total of 917 TR x H/day are required to maintain building comfort conditions.

?ho working Gay was considered from 8:00 a

to 5:00 pam,

Tf we asmme 250 working days per year and estimate the refri-

?eration work for the average day by the Septenber data (1.0. 971 TR x H/day)

the total yearly refrigeration vork will be 197,750 TR x Hi/year of 697,941 mat.

---Page Break---

© Concentrating Photovoltaic for the ?and-its

jon to the 104 revision

This project consists of a Solar Photovoltaic Concentrator Application forthe Commonwealth

Of Puerto Rico, The application is unique in several aspects, Fits, it reresonts» total energy

{gystem designed to provide the electrical, cooling and thermal energy requirements of the

Ker for Energy and Environment Research (CER) and hot water requirements of the.

?adjacent Oncological and University

in San Juan. Second, the application

The proiect team consists of the Energy Office of the Commonwealth of Puerto Rico,

Santer for Energy and Environment Research of the University of Puerto Rico, TEAM, inc.

BHMG/Engineers, the AA Corporation and Solarex Corporation,

?The broposed system consists of 8 20/1 concentrating first stage and a compouid parabolic

form of hot water at 190°F.

Jha total elecric peak power demand of CEER is about 425 KW. The major part of the toed i the airconditioning (~85%). The electric and thermal energy generated by the grote, ?Wottaie aay wil be utilized to run a 70 ton electric direct expansion split system ena news 120 ton absorption chiles respectively to meet the airconditioning demand of the CEER end ?0 supply the hospitals with 110°F hot water.

sone nexovoltain eray wil be interfaced in parallel with the utility (PRWRA) power grid erat «low commutated inverter to supply electrical power when thee is not ough volar radiation. Exces power generated on holidays or otherwise willbe fed back into the oreo, {id and credited to CEER. This mode of operation eliminates the large investment and the ?prinumnance cost esociated with conventional battaies and represents very useful sod practi

Freon oats while atthe same time resolving the technical, environmental and socal lene {involved in fortering widespread adoption of photovoltaic power syateens,

---Page Break---

D. Genceptual design schematic

Im the solar collector piping diagram (Attachment #3) all

elements indicated by single Lines are parts of the photovoltaic project.

these are:

cs

scr

acre

Photovoltaic collector array

Hot water storage tank

Solar collector water recirculation

pnp

Solar collector supply Lines

Solar collector return Lines

Aix cooled fiuta cooler

Steam heating coll

?Surge tank and hot water services to hospitals.

ALL elenents indicated by double lines in the same Giagram ag voll

?as all elenents included in the chilled water and condensing water piping dia-

gram (Attachment #4) are parts of

nota

ne-2

Poa

P22

?this revision, These are:

absorption chitier #1

Resorption chiller #2

Mot water supply Pump

Not water supply pump

Not water supply Lines

Not water return Line

Cooling tover

condensing water pump

Condensing water pump

cndied water supply Lines

---Page Break---

Gm = cited water return tines

= Condensing water supply Lines

CR = condensing water return Lines

neRcH - Aix cooled reciprocating chiller

7% provide a reliable systen two (2) backup units are inclufed

a8 follows:

2, A steam heating cof) (Su) will be included as part of the Photovoltaic project inside the hot water storage tank (HH) to provide hot water services to the hospitals in caue of any fatlure in the solar azray hot water system, This steam heating coil will also provide the back-up for the absorption atx conditioning syste vhen necessary.

(one single air cooled reciprocating chiller (ACRCH) ?vill be ?ncluded as part of this project to provide the back-up based?oh electric sneray 4n case of a failure in any of the absorption chillers or in the steam

?supply to the area, :

F. Mtematives in case the Photovoltaic Project is not funded

3m the case CHER does not receive the funding for the solar pro-

Jeet the absorption chiller will be operated via a direct connection to the

?steam Lines of the Medical Center. me existing atean distribution Lines of

?she Central Steam Plant provide a simple connection port close to the location

(Of the proposed absorption chillers. In this case a small modification of

?the generator will be necessary to operate the sbvorption chillers with steam,

?he une Of absorption chillers energized by a atean supply from a large central

steam plant 49 standard in the mainland U.S. A, the existing central stean

Plant at the Puerto Rico Medical Centar ie one of the largest in the Carib-

ean and has plenty excess capacity available.

---Page Break---

210.

?The absorption chillers capacity will go up to 14@ TR each when operated by direct stem, with this alternative one single absorption chiller will Be able to handle the air conditioning load of the New Wing and the second unit will be ready for Back-up purpos

Im addition, the reciprocating chiller (AcRGH) will provide a second back-up in case of a failure in the steam supply to the area.

Based on the actual cost Medical Center charges CEER for the steam,

the use of electrical cooling systers {2 in general more cost effective

?than using steam systems. However, for large uses of steas a new contract can be negotiated with the Medical center to obtain a lover cost for the ?steam purchased.

¥, System main components and their location

The main components of the photovoltaic project and of this project ?are shown in the plan of Attachment #5, The absorption chillers (Acii-1 and ?AGH2), the hot water supply pumps (P2-1 and P22), all the controls for the chilled water systen and the condensing water systen will be located inside ?the existing mashine shop building in an area to be prepared for this purpose.

The cooling tover (CT), the condensing water pumps (P3-1 and P32), and the

air cooled reciprocating chillér will be located inside the existing chiller

©. Thermal meray available fron the photovoltaic array to

operate the absorption ?chillers.

1. Peak Hour Conaiderations:

?As indicated in the Energy Flow diagran of Attactment

"6, the thermal power available fron the collector array at the peak averege

hour 4s 1021 Kw. (3.47 x 108 pru/n). If the proposed solar cooling system

is utilized, 594 xw of this thermal power can be used to operate the absorption

---Page Break---

of 0.70.

?Tas is 1120 of the peak hourly air conditioning load indicated in section

mre (23 t.R.).

2. Daily and Yearly average Considerations:

Considering an average total direct radiation of 1300

Brv/sa. £t- per day, and a collector arca of 2179.8 m2 operating at 44s ef-

#ictency the available thermal energy per day is

Typ = 5754 .H/aay

During the weekdays the hot water demand for the onco-

logic and Pedriatric Wospitals can be estimated as

uD = 2324 wW.H/aay

?Thus the available thermal energy to operate the absorp

?tion chillers during a weekday is

> = 7

> 7 Tp ~%y

iD

Typ 7 3430 RO.W/Aay

For an eatinated 250 working days per year the total avalable thermal energy

to operate the air conditioning of the new Wing is:

Tay, 7 857,500 HH per year

?Adaitional energy will be avadlable from the hot vater

storage tank (20,000 galtons) on monday mornings. During the veckend the Protoveltaic array will operate without the thermal load of the solar cooling system and will maintain an average tank temperature close to 190°. ?this a Sinicm of 63 Mit will be available per weekend. For the 52 weekends of the

year the energy available fron the storage tank will be:

---Page Break---

a2.

Tyg 7 33-124 we

?And the total for the year

Tx ?Tan + Taye

Thy ~ 690.626 Kw per year

De estimated to be 897,000 r¥.4/year. hus the themmad waste enersy from the

?cordance with above figures. towever, sone Feduction in the solar contribu

kisn fe te ais conitionty eyston hat tobe conidered because the sin on

voltaic array are not identical. in 854 solar ?contribution to the air con-

1¥. Analysis of Safety and Pollution aspects

She method of shutting down the equipment and in the use of fire extinguishers

for electrical fires. tn addition, thero are telephones available in the ad=

Jncent offices for calling the Fire Department, if needed,

---Page Break---

23.

Personnel injuries will be controlled by providing eafety shields

nd guards around moving parts of the eguigment. Personnel will be thorooghly

instructed in the operation of the equipment, safety procedures and firet aid.

?The potential pollutants in this area would consist of Liquid i4ehiom

?bronide solution used as the absorbent in the absorption chiller unit and oft

?and grease used to service the pump and notore,

The Lithium bromide 49 4 non-toric salt at standard atmospheric pres foure and temperature. the refrigerant in the absorption cycle ta distiliea water. ?e charging of this systen with Lithium bromide would be done by ?rained personnel using proper equipment. should an inadvertent spl happen, AE wit be quickly tspersed with a wash-down with soap and vater and die-posed of through the floor drain to the sewage systan.

The proposed air cooled reciprocating chiller 1s a factory chazged ?unit, and no freon leakage As expected from this one.

fle and grease are kept in approved metal containers and stored in ?metal locker when not being used, O11 spi2le will be cleaned with dagresser ?and washed down the floor drain with soap and water,

?The proposed absorption chiller operation will reduce substantially the electric energy consumption of the ey

energy, 4

Asland of Puerto Rico Will be a reduction in pollution.

Gonsideration Given to the Use of Existing Factiitie

?Te existing chiller units will be eliminated. the rest of the exis-

fem by the use of & non-polluting

solar energy, The overall effect on the environment of the ing air conditioning installation will be maintained in service with small

modifications to upgrade the operation.

---Page Break---

4.

Proposed equipment specifications

ACH-1, AcH-2 aBsonDtroN crE:

. 4%) Wominal capacity: 148 7

B) Actual capacity for low temperature application: 63.4 7

. ©) Generator:

. Passes: 2

. Flow: 320 cpu

Inlet Temperature: 190¢7

Outlet Teaperatuxe: 162.5°R

P) condensing water:

Flow: 353 cen

Inlet Temperature: 85°F

Outlet Temperature: 95¢F

2) chiltea water:

Flow: 160 eM

Inlet Temperature: 55°F

Outlet Temperature: 45¢

P) Power input: (4.2 30)

?Frane model ABSC-O18 or simi iar

© coonma rower

4) Capacity to cool 353 GPM of water from 95:

to 85°F at 80°F wet bulb

. outside temperature.

3) Power input 7-1/2 HP (6.6 kw)

Baltimore Air Coil (BAC) ceT 2413 or similar

ATROH AIR CooLeD mEcrPReCNTING cuinitE::

9) capacity 69.9 TR with 90°7 entering alr at condenser and 45°F leaving

chi1268 water temperature,

---Page Break---

B) Total power input 63.1 KW.

a8.

©) Trane OG AA 7506 E or similar.

Vit. Preliminary Cost Estinate

Project C.E.E.R. New Wing Aix Conditioning Upgrading

J mechanical Equipment

1 Absorption chitiers ee. 238,000. 76,000.00

2 Air cooled chitler ea 221,000. 22,000.00

3 Cooling Tower ea. 9,000.~ 19,000.00

4 Hot water supply powers ea. 2 1,500.~ 3,000.00

4 condensing water supply

Pimpe eo. 2 2,000.~ 4,000.00

Mechanical Equipment Total '$ 113,000.00

Ti+ Mechanical-Blectetea) contract

Yo. Description unit Quantity ont Tote

Price

1 Bgutpment ingtalle~

?elon 1s 1 5,000.00, ,000.00

2 5% chilted water

Lines with 1" methane

Ansulation we 200 25.00 5,000.00

35% Condensing ater

Lines w 200 39.00" 3,800.00

? water

Lines we 300 30.00 3,000.00

s "Hot water Lines

with 2° methane

insulation w 120 20.00 2,400.00

?

Lines 1s 2,000.00

---Page Break---

216.

TI Mechantcal-Blectrical contract

Description unit Quantity unit ?Total

Price

7 Cooling tower and

c.? Pumps connec

tion 1s 11,000.00

8 Absorption chillers

aie conditioning

ingtallation is 110,000.00

10 Modifications in

shop Building ry 5,000.00

22 ngulation addition

to roof level. 3"

Fiber glass se 10,000 1,00 10,000.00

12 Safety avitch and

?conn. for absorption

units EN 2 500.00 10,000.00

13 Safety switch and

power electrical conn.

for reciprocating

chiller a 1 $1,000.00 $1,000.00

14 Combination magnetic

electrical com. for

?hot water pumps = 2 700.00 1,400.00

15 Combination mag-

netic starters and

?conn. for cooling

towur and cond.

water pumps = 3 1,000.00 3,000.00

16 Ade handling unit

?and duct work up

grading 1s 2 5,000.00

---Page Break---

a7.

mr Weal-Blectrtcal contract

wo. Description onie Quantity unit ?total

Price

17 Hot water and

chilled water

?system upgrading 1s 2 5,000.00

18 systens balance

and test is 4,000.00

19 Air conditioning

?system control

upgrading 5 1 8,000.00

20 Control chiiied

water plant con-

trols 1s a 2,000.00

$ 78,600.00

23,500.00

$102,280.00

---Page Break---

SUMARY OF PRELIMINARY ?COST RSTDOTE

Description vate Quantity mit

Price

218,

?Total

a

Mechanical Equipment

Mechanical Electrical

Contract

108 contingencies on

Mechanical Equipment

208 contingencies on

Mechanical Electrical

Contract

Sub-total

Engineering and Project

management at 128 of

tena #16 #2

?The initial investment for this

$113,000.00

11,300.00

20,436.00

seseee $246,926.00

25,614.00

++ $272,730.00

is between the Previous 2 of April, 1977

revised proposal.

Yostment for the previous proposal. Nowaver, "Uniform Annuel Cost?

lower due to the use of the waste thermal energy from the Photovelt

analysis is included in order to underline the coat effect-

project is higher than the estimated in-

is substantially

aic array,

Basic Data for the Preliminary Proposal of April 1977 (Alternative A)

New oilecooled cantrifugel chiller (270 TR) with stean terminal:

reheat.

Eetinated design and inspection cost:

Estimated project cost (Savestment) :

Escalation two years at S¥ per year:

$17,629.00

164,000.00

16,450.00

---Page Break---

19.

Upgrading of alr distribution system, reheat

system and controle: $ 12,500.00

Retimated Steam Cost, 526,000 Ib/year at

17/1000 1b: 3,682.00

Batinated yearly refrigeration: 3.5 x 105 Rut

Estimated electric energy to operate

the air cooled centrifugal chiller

to provide this refrigeration set

1.3 2M per TR: 4.55 x 105 soa

Batimated first year cost at

3.07 per XH: $31,850.00

Estimated first year cost for

maintenance, spare parts, etc.+ $4,000.00

calculated uniform annual cost

without terminal value over 20 year

Life time. For nore detail see couputer

print out "alternative A" $140,292.40

Data for the Revised Proposal, February 1979 (Alternative,

Solar energized absorption chillers each

148 TR

Estimated design and project

munagenent cost: $25,814.00

Eotinated project cost (investment) + $246,916.00

Upgrading of dir distribution system

and controls:

Eotinated steam cost, 263,000 1b/year

?at $7/1000 br $1,842.00

Batinated electrical energy to operate

?the absorption chillers auxiliary equip-

?ment and the air cooled refrigeration

chiller to provide 15% of the cooled: 3.06 105 rant

Eatimated first year cost at $.07 per KW $7,420.00

Eatinated first year cost for maintenance,

spare parts, etc.: $4,000.00

Calculated Uniform annual cost without

terminal value over 20 yoare life tine.

For more detail see computer print out

for "Alternative B*: $63,408.61

---Page Break---

Computations on both alternatives (A and B) show clearly the sig-

tgicant economical advantage of the solar cooling. the uniform annual cost

Aiefarence As about $76,004. over a Life tine of twenty years without ?the

terminal value the relative savings will be §1,536.000 in 1978 dollars.

: Im terms of relative pay back" the solar system will pay back in

- ess than 3 yeara.

"we define relative pay back as follow

?The time during which the summation of the &ifference in recurring costs

equals the difference in non-recurring cost of the. firet year.

---Page Break---

|

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Loith mit 4502 IWOAy ne04!

Bi ihomtta 1893 qwinvy seat

salsa siting

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40VA wwitaesk mutn 1899 TWH sacatN |

ana "Wwateslinonita 1803 wesw seostNn ~

4509 W104 cautnorsi9 43%

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fe a Sasavewy stauvoag Spo

soteeeee Ia.

stoattonrias: .

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23.

1X, Design and construction schedu

?The U. 5, DOE will announce the vinners of the Second Phase of

?the Concentrating Photovoltaic Projects around the first of May, 1979. rt

is imperative for the c.

Ridge Operations Offices on the revision at least one month prior to that

I+ to receive the final decision by the Oak

date, i.e. by april 1, 1979.

?The proposed design and construction schedule for the uprating

Of the New Wing air conditioning systen follows:

april 2 - april 16 - choose an Engineering/Architect fim to

Perform the design and project managenent.

?eril 16 = april 23 - complete final equipment selection. ne

quest equipment quotations.

april 23 - april 30 = Select equipment supplier and prepare

purchase orders,

peri. 16 = may 7 ~ Prepare final constryction drawings and

Prepare bidding documents.

May7 ? -?may 28 Contractor bidding time and contract avard

May 28 = muguat 6 construction tine

august 6 - August 20 - Receive chillers and install

?ogust 20 - September 3 system balance, test and acceptance, Ready

to interface with photovoltaic array.

X. Conctusicns

AL meLtabiaiey

The proposed revision will provide a nore reliable eystem than the Proposal of April 1977. the absorption refrigeration units have practically no moving parts,.one snall heretic pump is the only moving part in these

---Page Break---

ehillers. In contrast to that the proposal of April 1977 involves a large centrifugal chiller with a rotor-impeller assembly moving at 8000 RPM.

?The revised ?proposal as detailed in section I1T-@ vill include ?two different back-up ?systems. the proposal? of April 1977 considered the Feruse of the existing reciprocating unite as back-up. According to the ?same proposal this equipment is of poor design, and has had a history of unreliability since the first day it was installed. ?the compressors for these

?mits are no longer manufactured and to find parts is almost impossible.

B. Cost effectsvene

The conparative ?Economic Nnalysia? included in Section VIII

indjcates that the new proposal is nore cost effective than the previous proposal.

C. ?Energy conservation

2A dramatic reduction in electric energy consumption of C.E.E.R.

will be obtained with the revised proposal.

D. Pollution aspects

?The use of non-polluting solar energy to operate the system will

be a step tovards improving the overall environmental condition on the {sland

of Puerto Rico.

E. Systen completeness

With tie provisions ?included in the proposal of April, 1977 the

attempt of upgrading the C.E.B.R. New Wing air conditioning systes would be

Snoomplete, An improvinent of the existing conditions inside the building should

De a part of the overall effort. this revised proposal includes the iaprove-

wont of the conditions inside the bufldling.

P. mergy savings

Substantial energy savings will be obtained with the revised pro-

Posal. A yearly total of 3.44 x 10° 1 H of electrical energy can be saved

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with the solar air conditioning.

G. otal savings over the 20 years life ¢:

?Total savings over the 20 years life tine of the solar equip-

ment will exceed 1.5 millions in 1978 dollars.

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HOURLY COOLING LOAD ESTIMATES

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ATTACHMENT 42

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Cooling Load Profiles

Summary

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C.B.E-R. New Wing

Building hourly Cooling Load

Profile for January (1)

(typical Day) Lots

Sane for May (5) 2of4

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ATTACHMENT $3

SCHEMATIC OF THE SOLAR ARRAY

PIPING SYSTEM IN CONJUNCTION

WITH THE ABSORPTION CHILLERS

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ADTACHMENT #4

SCHEMATIC OF THE CHILLED WATER

?AND CONDENSING WATER PIPING

?SYSTEM

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ATTACHMENT 45

IERAL PLAN

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APPACHMENT 46

POWER FLOW DIAGRAM DURING

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FLOW DIAGRAM? DURING THE PEAK.

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GENERAL INFORMATION FOR

ECONOMIC ANALYSTS

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GENERAL INFORMATION FOR ECONOMIC ANALYSES

RECURRING cost

Expenses for electric energy, fuel (or steam

Purchased from a central plant),material consumed in

operation, maintenance services? and other items incurred

. in an annual basis.

. DISCOUNT RATE-INTEREST RATE

That rate which is used to transform future investment costs into a value of equivalent worth (see ?Present Value"). It enables one to compare investments which have dissimilar cost streams.

Discourin

The discounted cost of an investment represent the return that would be earned if the money obtained through taxation and spent by the Government were retained by the private sector and allowed to earn a return on its investment opportunities.

PRESENT VALUE

Each year's expected yearly cost multiplied by its discount factor and then summed over all years of the planning period.

Present value of one (1) dollar. Factors are based on continuous compounding of interest at stated effective rate per annum, assuming uniform cash flow

throughout stated one (1) year periods. These factors

are equivalent to an arithmetic average of beginning and

end of the year compound amount factors found in standard

. Present value tables.

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GENERAL INFORMATION FOR ECONOMIC ANALYSIS (cont'd.)

TERMINAL VALUE

?The expected value of assets at the end of their

economic life.

UAIFORM ANNUAL cosT

?The average cost per year for those years in

which benefits accrue. It is obtained by dividing the

total present value cost by the sum of the present value

factors of the years in which benefits accrue.

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