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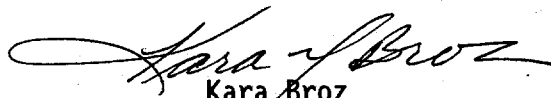
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7. Abstract

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HUMIDITY REQUIREMENTS OF WSCF LABORATORIES

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**MASTER**

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## HUMIDITY REQUIREMENTS IN WSCF LABORATORIES

### 1.0 PURPOSE

The purpose of this paper is to develop and document a position on Relative Humidity (RH) requirements in the WSCF Laboratories. A current survey of equipment vendors for Organic, Inorganic and Radiochemical laboratories indicate that 25% - 80% relative humidity may meet the environmental requirements for safe operation and protection of all the laboratory equipment.

### 2.0 BACKGROUND

The current requirements in the Functional Design Criteria is approximately 50%, which was established on a conservative basis before any laboratory equipment was procured. The HVAC system as configured may not be able to provide the desired RH under certain weather conditions, namely severe cold.

### 3.0 DISCUSSION

This report explores three areas:

- a. The minimum RH requirements according to the equipment manufacturers' recommendations. The laboratories were divided into Organic, Inorganic and Radiochemical (which includes NSL) Laboratories.
- b. The RH available in the various laboratory with the current HVAC system.
- c. Potential corrective options.

Refer to the attachments for additional and related information.

#### 3.1 RELATIVE HUMIDITY REQUIREMENTS IN ORGANIC LABORATORIES

The following pieces of equipment, supplied by Hewlett-Packard (HP) and located in cells N-5, N-7, N-9 & N-11, are particularly sensitive to humidity. Quoting from the operation manuals:

- Model 5890 Gas Chromatograph (RH Requirement: 5% - 95%; optimum 50% - 60%)
- Model 5971 Mass Spectrometers - N/A
- Model 5989 Mass Spectrometers (RH Requirements: 40% - 80%)
- HP-UX (UNIX) Computer Systems - N/A

The HP engineers were contacted by K. L. Kunzweiler and myself at 800-424-9759. It was recommended by the HP engineers that a RH of 25% - 90% (non-condensing) would be a good level for proper operation of these machines. Below this level of RH, there is a potential for:

- Data losses
- Damage to electronic boards
- Intermittent problems with electronics

It is also possible that none of the above may occur, however, there is a good probability. The key is to provide RH in the noted range for proper operation.

### 3.2 RELATIVE HUMIDITY REQUIREMENTS IN THE INORGANIC LABORATORIES

In accordance with the operating manual, the spectrophotometer in cell N-20 (Operating RH: 45% - 85%).

Paul Swaim from the Inorganic Labs contacted Hitachi to consult about the minimum RH requirements. Paul was told that the noted equipment can be safely operated at 25% - 85% relative humidity (non-condensing) and even if the humidity goes below 10% level for couple of days, there is no danger of any significant damage to the equipment. Ideally, the vendor would like to see the equipment operated at the level noted in the manual i.e., 45% - 85%.

### 3.3 RELATIVE HUMIDITY REQUIREMENTS IN RADIOCHEMICAL LAB & THE NSL

The following humidity requirements were found in the operating manuals:

- Micro VAX 3100 (Relative Humidity: 10% - 90%) - CANBERRA- Liquid Scintillation Counter (Relative Humidity: 30% - 85%) - CANBERRA
- X-Terminals (Relative Humidity:10% - 90%) - CANBERRA
- IPC 9025 Detectors (Relative Humidity: 20% - 90%)- PROTEAN
- Octet (Relative Humidity: 8% - 80%) - ORTEC

The most restrictive among the above is Liquid Scintillation Counters by CANBERRA, who was contacted by Marion R. Dowell. The vendor stated that if the RH drops below 10%, there may be an increase in static resulting in background on the instrument.

Asok K. Dasgupta (Radiochemical Labs Manager) contacted all the three vendors noted above and found the following relative humidity requirements:

- Germanium Detectors & electronics (Dave Carter; Tel. 203-238-2351) CANBERRA. Minimum of 10% RH will be no problem.
- Germanium Detectors (Jane Gallop; Tel. 800-251-9750) EG&G ORTEC RH. Requirements: 5% - 80%
- Octet (Alpha Chambers) (Jane Gallop) EG&G ORTEC RH. Requirements: 8% - 80%
- Alpha/Beta Proportional Counters (Joe Bradley; Tel. 615-988-9750) PROTEAN. There was no problem with operating the same detectors at Nevada Test Site at 0% RH.

### 3.4 DATA FROM HUMIDITY AND TEMPERATURE RECORDER IN THE NSL AREA

The data from the RH Recorder in the HVAC room in the basement (not necessarily representative of the NSL) is available from January 21, through June 09, 1994. These weekly charts show temperature, which was maintained at 74 degrees F and a varying RH, which essentially represented the outside environment. The HVAC unit in operation does not provide any humidification to the NSL area in the basement.

The breakdown of RH below 20% is noted below:

2/2/94 - 2/9/94	RH was down to 14% for 48 hours
2/9/94 - 2/16/94	RH was down to 18% for 15 hours and down to 16% for 6 hours
3/2/94 - 3/9/94	RH was down to 16% for 45 hours
3/9/94 - 3/16/94	RH was down to 18% for 18 hours
3/24/94- 3/31/94	RH was down to 16% for 50 hours

For the remaining period the RH stayed between 20% and 30% (mostly staying closer to 20% than 30%) particularly during January through March. During April through June, the RH started inching closer to 30% and even went up to 35% and 40% on a few occasions.

### 3.5 DATA FROM THE WEATHER STATION

Data was requested from PNL Weather Station by Martin C. Prather and provided the following results:

For the five years 1989 through 1994, the number of hourly dew point temperature and barometric pressure measurements corresponding to a humidity ratio below 0.0008 pounds of moisture per pound of dry air is 338. The number of measurements below 0.0018 is 1573.

Assuming the NSL humidity ratio tracks the outside air humidity ratio, this corresponds to approximately 68 hours per year below 5% RH, and 315 hours per year below 10% RH. This is based on outside air temperature being raised sensibly to 74°F. This assumption is conservative, since some moisture may be added due to people and equipment.

On the high side, for the five years, the number of hourly dew point temperature and barometric pressure measurements corresponding to a humidity ratio above 0.0128 pounds of moisture per pound of dry air is 10. The number of measurements above 0.0148 is 0. If the air is taken from outside and conditioned to 74 degrees fahrenheit without adding or removing moisture, this corresponds to an average: 2 hours per year above 71% RH, and 0 hour per year above 82% RH (these high RH readings occurred in August of 1990 and 1991, and June of 1992).

### 3.6 DATA REVIEW WITH LABORATORY MANAGER

The above noted data was reviewed with Kenneth H. Kary (Organic and Inorganic Laboratory's Manager) in some detail and humidity requirements were discussed. Ken believes that NSL is not the problem, however, Organic Laboratory rooms will be affected if RH is allowed to drop below 25%.

### 3.7 CORRECTIVE OPTIONS

The following corrective options and associated cost data was provided by ICF Kaiser Hanford for providing humidification to the NSL and the Northern Laboratory to bring RH up to Functional Design Criteria requirements:

a. NSL Install steam humidification system in the NSL area. The initial estimate was \$240,000. This estimate required some scrubbing and the bottom line is expected to be about \$90,000.

#### b. NORTHERN LABORATORY

Option 1: Install 52 room humidifiers in selected laboratory rooms.  
Cost: \$474,000.

Option 2: Install steam boilers and steam humidifiers in the Air Handling Units. Also, install 52 room humidifiers in selected rooms for supplemental humidification.  
Cost: \$1,009,000.

Option 3: Install evaporative humidifier/cooler units in air handling units #1 and #2. Also, install 52 room humidifiers in selected rooms for supplemental humidification.  
Cost: \$855,000.

Options 4, 5 etc.: Other less costly and potentially more effective options have been suggested but not preliminarily evaluated due to time and funding constraints.

#### 4.0 RECOMMENDED POSITION

The original draft of this position paper and the subsequent comments received from reviewers of the draft provide evidence that:

- a. The humidification requirements for WSCF are not well established.
- b. The present humidification capabilities of WSCF may be insufficient.

This suggests the need for additional study of WSCF requirements for humidification to establish what, if any, additional humidification capability is required; the determination of the most cost effective position for achieving it; and implementing that option.

Based on the above, the recommended position that WSCF should take on this issue is to:

1. For safe operation and protection of the laboratory equipment and instruments, and for maintaining an acceptable environment for the laboratory personnel, it is recommended that an RH level of 25% - 80% should be maintained at all times in the North Laboratory rooms.
2. In the NSL, this RH level must be maintained at 10% - 80% at all times. Recorder in the HVAC Room in the basement of the laboratory should be transferred to the NSL and temperature and RH should be regularly monitored.
3. Grounding mats and grounding straps should be used and clothes that generate high charge of static should be avoided in the laboratories.
4. Most importantly, recorders should be provided in the Organic, Inorganic and Radiochemical Laboratory rooms and the RH should be regularly monitored. It is also recommended that lab personnel i.e., scientists, technicians, chemists etc., who use the equipment and instruments should be alert to level of temperature and RH at all times and should use the necessary caution.
5. The proposals noted in section 3.7 above, to increase humidification capability, should be further studied in light of experience gained from actual WSCF operation and available funding.

#### 5.0 SIGNIFICANT PEER REVIEW COMMENTS

##### 5.1 GENERAL

This position paper did not properly consider the impact of lowering the percentage at the bottom of the humidification range. This impact affects operations at both the NSL and NL laboratories and every room where the humidification is controlled. Asking the vendors more pertinent and specific questions could have avoided this impact. Furthermore, lowering the bottom range from 30% RH to 25% RH aggravates a humidification system that is already inferior.

Humidification is normally supplied to HVAC conditioned buildings for three reasons: for processes, for comfort and health, and for suppressing electrostatic charges. At WSCF the process aspect could be ignored, likewise the lab occupants' comfort and health could also be ignored. The only reason for humidifying is to avoid economic losses. Economic losses associated with humidity in the bottom range is due to static electricity that could cause two types of losses: damage to the hardware and damage or loss of stored data in microprocessors.

Judging from the guide lines provided by the vendors, it appears that do they have confidence in the integrity of their hardware (as evidenced by the wide humidity range) to resist potential damage. But these guide lines may not be safe because in most cases the concerns of electronic data loss were not discussed. Accordingly, if vendors cannot guarantee zero data loss within their specified humidity ranges, then the given guide lines become worthless. Some of the vendor's humidity information declares two ranges, one a wide range and the other narrower and often labeled 'optimum'. A number of questions could be asked about these 'optimum' ranges. Here is a few examples: If avoiding damage to the hardware is the only concern and the equipment cannot be damaged by the wide and less restrictive range, why go through the trouble to even call out the optimum range? Were vendors asked to give RH information just to prevent hardware damage? Could it be that the vendors avoided data loss issues because they are sidestepping warranty consequences?

Economic expenditure from data loss could be as frustrating as hardware damage losses and the cost and schedule impacts could equally be as great. I feel that there are enough reasons to ask the vendors questions regarding data loss related to humidity control. Ask them about guarantees and responsibilities associated with data loss, if humidities are kept within their own specified ranges.

Based on the above reasoning I feel that the proposed 25%-80% RH range will not meet the environmental requirements and it is incorrect. The proposal needs revision to include static electricity effects.

It is a known fact that static electricity is prevalent at 25% relative humidity, the American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE) and a number of other sources confirm this. Examples of static charging are given below.

Two quotes from ASHRAE 1988 Equipment Handbook, Chapter 5 Humidifiers, pp 5.1. "Under some conditions, and with certain materials, maximum electrostatic charging occurs at relative humidities of 25% to 35% or higher. Increasing the humidity from a low value may increase the electrostatic problem unless humidity is carried well beyond the value where charging is a maximum."

"Relative humidities of 45% or more usually reduce or eliminate electrostatic effects with many materials, but wool and some synthetic materials may require still higher humidities."

Also see "Fire Protection Handbook," Chapter 2/31, Control of Electrostatic Ignition Sources, pp 2-287, Dissipation of Static

Electricity, Humidification, "... At the opposite extreme, with relative humidities of 30 percent or less, these same materials may dry out, become good insulators, and static manifestations become noticeable."

The above are only two of many examples that demonstrates static electricity charges is a problem and needs further investigation. Static electricity questions left unanswered are - how much energy could be expended by a typical static charge from common materials at WSCF? What minimum energy expended by an electrostatic charge is needed to cause a loss of data? Answers to questions such as these will need further research and you all also need all the help that the vendors can give. In the meantime it would be safe to use a relative humidity range of 40% to 60%.

## 5.2 GENERAL

Check if any piece of equipment has microprocessors, then ask the vendor about possibility of loss of electronic data.

## 5.3 REF. SECTION 2.0

An equally important decision should be made regarding room dry bulb temperatures. If the North Lab dry bulb temperature could be raised to 75°F, then higher RH's could perhaps be achieved with less drastic changes to the existing HVAC equipment. To do this will require accurate HVAC load calculations based on the actual lab working conditions of connected equipment loads.

## 5.4 REF. SECTION 3.1

I do not agree with either the 25% RH level or the statement "It is possible that none of this may occur." There is too much risk involved and too many unanswered questions; therefore, ask the vendor the question what static charge energy levels could the equipment tolerate and then check it against the common materials used in the lab.

## 5.5 REF. SECTION 3.5

The key word in humidification is dew point temperature. It is also a value that could readily be measured. Make a suggestion to Mr. Prather to substitute dew point temperatures for humidity ratios. This is less confusing for a lay person i.e., trying to unravel RH and humidity ratio. It is also more easily visualized in terms of HVAC. Another suggestion is ask him to go into past weather data as far back as possible and consider the implications, especially the duration of cold snaps. It is worthwhile keeping in mind when working with the weather statistics that if it happened in the past then it could happen again.



**5.6 REF. SECTION 3.7B (OPTION 1)**

This is an ineffective humidification distribution that requires more than one or two humidifiers per lab room proposed in the details of this option. To improve this system will surely increase the present estimated cost of \$474,000 to a much higher expenditure.

**5.7 REF. SECTION 3.7B (OPTION 2)**

Not all 52 humidifiers will be needed with a base steam humidification system. This will reduce present estimated cost.

**5.8 REF. SECTION 3.7B (OPTION 3)**

Not all 52 humidifiers will be needed with a base evaporative humidifier/cooler. This will reduce present estimated cost.

**5.9 REF. SECTION 3.7B**

Consider an Option 4: What would be the cost of rearranging the air handling units to accommodate a humidifier upstream of the cooling coils and downstream of the heat recovery system and the electrical heaters?

**5.10 REF. SECTION 4.0**

At 25% RH there is a distinct risk static that electricity could cause a loss of electronic data. The 80% RH never occurs during winter and in the summer when cooling is called. The reduction in temperature on the cooling coils coincides with a corresponding reduction in RH. This as the result of condensation on the surfaces of the cooling coil. For these reasons high side RH does present a problem.

**5.11 REF. SECTION 4.0**

At 10% RH there remains an extreme risk that static electricity could disrupt electronic data.

**5.12 REF. SECTION 1.0**

The 25-80% range for the RH in at least the organic labs may be a problem. We had serious problems in the 325 Building organic GC/MC lab when the RH was less than 40% (the RH in that lab was usually in the range of 35-45%). Static discharges of up to 2 cm occurred (thousands of volts), which damaged solid state devices in both the Mass Specs and computers. The damage could be evident instantly or weeks later.

The problem was partially resolved by installation of grounding mats, but not entirely resolved until we moved into renovated labs with a grounded computer floor. Problems still occurred at a diminishing frequency until all damaged components were replaced.

At the time of all our problems, the HP service group informed us that the RH should be >40-45%. Our problems were with HP RTE computer systems and the model 5970 MS's. If >40% RH is recommended for the 5989 MS, I heartily recommend that as a minimum.

I do not understand the N/A requirement for the model 5971 MS and the UNIX computers. I am surprised that the HP engineers contacted recommended the 25-80% RH range.

I do not recommend the use of grounding mats. They did not entirely prevent static discharges, they are tripping hazards, and they are certainly not pleasant to view.

It should be added that it cost HP over \$200,000 during nine months of down-up down instrument/computer time to locate and repair the damage to components. A component can be zapped by static electricity and not show problem until much later. The sporadic nature of the failures makes identification of the component circuit board difficult.

### 5.13 GENERAL

I believe that the data presented fails to support your conclusions. It appears that the Organic Lab rooms in which the model 5989 Mass Specs are located need to have at least 25% RH. The others need to have RH high enough to prevent static electrical charge.

Room N-20 needs 25% RH but could operate satisfactorily at about 20% (based on statement about operation for several days at 10% RH).

The Radiochemical Laboratory rooms in the Analytical Laboratory, as well as the NSL seem to have no need for humidification beyond that available in the outside air. On the basis of this, I would recommend that we stop efforts to add a humidifier to the NSL.

### 5.14 GENERAL

It is apparent once again, after another review of the humidity problem, that the facility should be capable of delivering a minimum of 23-25% RH to satisfy the general health and operational requirements of the facility occupants.

If the facility cannot provide the minimum requirements, the facility occupant end user will be left with the responsibility to address the associated risks by other means, which most often translates to operating efficiency and reliability.

## 6.0 PROPOSED PLAN OF ACTION

### 6.1 PURPOSE

Monitor the six NL laboratories and the NSL to determine the temperature and humidity characteristics from October 1994 through March of 1995. Determine what modifications are warranted and install the upgrades.

### 6.2 BACKGROUND

The present HVAC system, as configured, may not be able to provide desired RH levels in the WSCF laboratories, as discussed above.

### 6.3 SCOPE

Install temperature and humidity monitoring and recording instrumentation in the six NL laboratories considered to be the most sensitive to low levels of relative humidity. Similarly instrument the NSL. Collect data for the six month period. Operate the laboratories without humidification until an operating problem being experienced can be traced to a low humidity condition. Then operate the humidification system and monitor the new set of conditions.

Evaluate the data and determine if any additional humidity is required in the WSCF laboratories for continuous and reliable operations.

If humidity upgrades are found to be necessary, provide the change engineering package as well as cost estimate for implementation no later than third quarter of 1995.

### 6.4 DELIVERABLES

The deliverables shall include, but not be limited to, the following:

- Test Report
- Engineering Change Notice(s), as required
- Cost Estimate for any upgrades
- Monthly Status Reports

### 6.5 SCHEDULE

START: First quarter of FY 1995.

COMPLETION: Approved ECN(s) must be completed by April 30, 1995, to facilitate any necessary construction or facility upgrades by the end of the fourth quarter of FY 1995.

## 6.6 BUDGET

The budget set aside for this plan is:

- \$85K expense for the study
- \$300K capital for corrective measures

## 6.7 FOLLOW UP

A follow up study to measure the effectiveness of the implementation can be done the following year.

**APPENDIX A**

**NORTH LABORATORIES**

Sketch from Comment and  
Cost Estimates

UP TO MECH. CHASE.  
SEE KH-M5,2  
FOR CONTINUATION

EXIST.  
INV. 732.67

4" CHWS & R.

FAN

12" C UNDER

B  
M8,1

1st FLOOR ONLY  
1 1/2" DEWS  
2" VTR  
2 1/2" PV  
1-1/2" PA

4" CHWR  
4" CHWS  
1 1/2" DEWS  
2" VTR  
1-1/2" VE  
3" VAS

48" X 32"

43" NEW-30% PERM

RELOCATE EXISTG  
FLUORESCENT LIGHT  
TO THIS POSITION

KH-M8,1  
C

NEW WALL OF  
PLENUM

6' X 10" PIPE CHASE  
UP TO 2 ND. LEVEL

25,210 CFM  
32" X 38"  
UP TO  
CORRIDOR

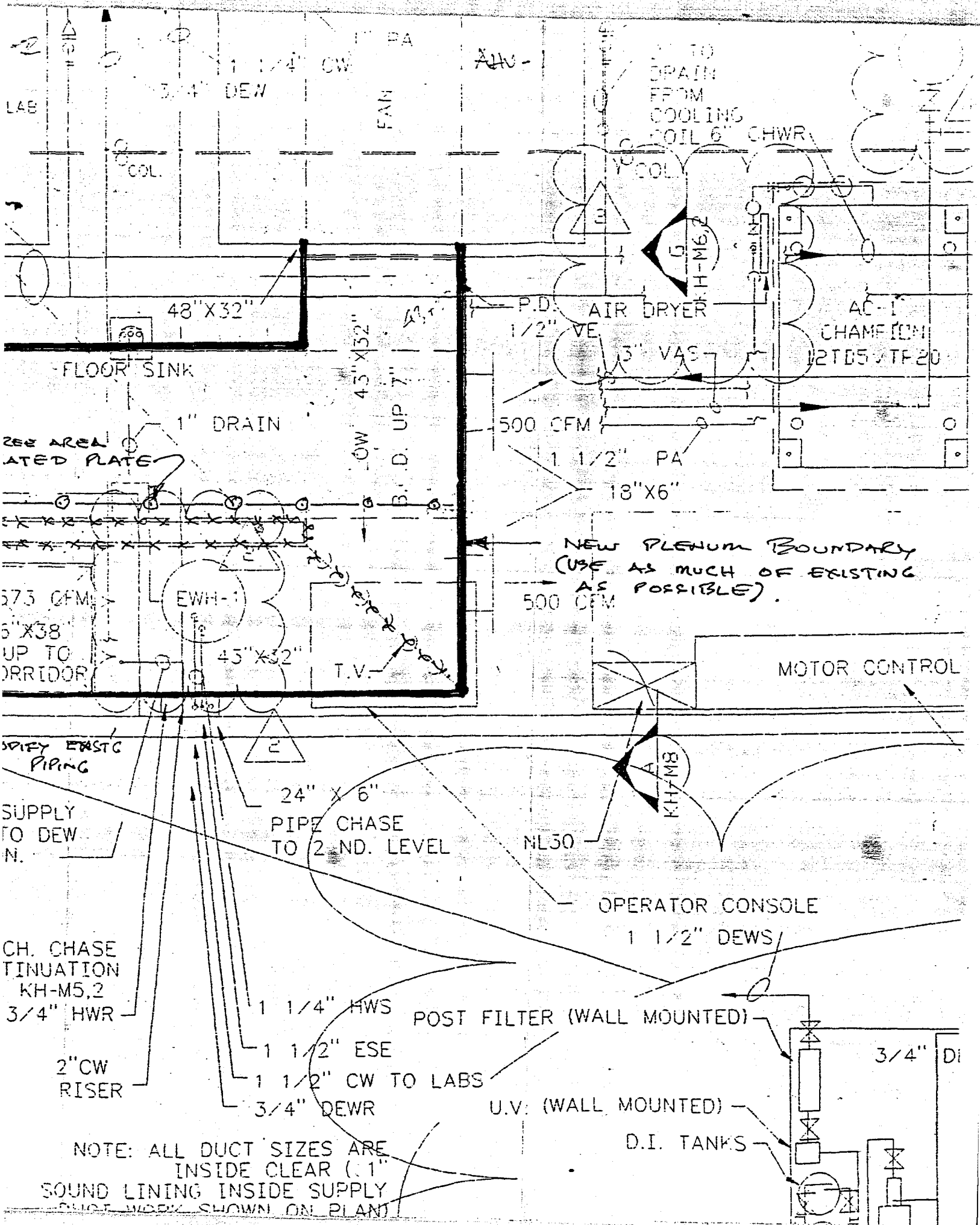
T.V.

1-1/2" DEWS FROM  
DEW WATER  
STATION.

B.O.D. 6'-3" ABV FLOOR  
REMOVE DUCT WALLS  
AND TURNING  
VANES SHOWN  
BY CROSSES

NOTE: ACOUSTICAL INSUL.  
REF. KH-M1,1 SECTION J.

FROM  
FOR C  
SEE D



LAB  
 1 1/4" CW  
 3/4" DEN  
 FAN  
 PA  
 AHW-

TO DRAIN FROM COOLING COIL 6" CHWR

48" X 32"  
 FLOOR SINK

P.D. 1/2" VE  
 AIR DRYER

AC-1 CHAMPION  
 12T05/TF-20

1" DRAIN  
 SEE AREA  
 ATED PLATE

45" X 32"  
 OW  
 B. D. UP 7"

500 CFM  
 1 1/2" PA  
 18" X 6"

NEW PLENUM BOUNDARY  
 (USE AS MUCH OF EXISTING AS POSSIBLE)

573 CFM  
 5" X 38"  
 UP TO  
 CORRIDOR

EWH-1

T.V.

MOTOR CONTROL

VERIFY EXISTG PIPING

24" X 6"  
 PIPE CHASE  
 TO 2 ND. LEVEL

NL30

OPERATOR CONSOLE  
 1 1/2" DEWS

CH. CHASE  
 TINUATION  
 KH-M5.2  
 3/4" HWR

1 1/4" HWS  
 1 1/2" ESE  
 1 1/2" CW TO LABS  
 3/4" DEWR

POST FILTER (WALL MOUNTED)

2" CW  
 RISER

U.V. (WALL MOUNTED)

D.I. TANKS

3/4" Di

NOTE: ALL DUCT SIZES ARE  
 INSIDE CLEAR (.1")  
 SOUND LINING INSIDE SUPPLY  
 DUCT WORK SHOWN ON PLAN

Date June 15, 1994	WHC-SD-W011H-ES-002, REV. 0	Page 1 of 1
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To <i>Sobonw</i> D. P. Hughes	From G. C. Lengas
----------------------------------	----------------------

Project/Work Order Number W-011H/CR1218

Project/Work Order Title Waste Sampling & Characterization Facility

Subject Cost Estimates for Humidification Systems

No. of Copies	Company and Distribution	Mailing Address
1	J. M. Frank	S2-55
1*	G. C. Lengas	E6-42
1	Engineering Document Control	E6-44

\* = Original

Attached Are	Purpose	Comments	Please
<input type="checkbox"/> Prints	<input checked="" type="checkbox"/> Information	<input checked="" type="checkbox"/> Preliminary	<input checked="" type="checkbox"/> Comment
<input type="checkbox"/> Specifications	<input checked="" type="checkbox"/> Action	<input type="checkbox"/> Unchecked	<input type="checkbox"/> Approve
<input type="checkbox"/> Travelers	<input type="checkbox"/> Signature	<input type="checkbox"/> Checked	<input type="checkbox"/> Destroy Previous Issue
<input type="checkbox"/> Appr. Data	<input type="checkbox"/> Update	<input type="checkbox"/> Final	<input type="checkbox"/> Return Previous Issue
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<input checked="" type="checkbox"/> Other: Cost Estimate	<input type="checkbox"/>	<input type="checkbox"/> Other:	<input type="checkbox"/>

Document Numbers, Titles, and/or Comments

Three Project Cost Summaries dated 6/13/94 File Numbers: 1) W011SAB3; 2) W011SAD1; 3) W011SAE1.

Transmitted herewith are three cost estimates for three options for upgrading the humidification system for the N. laboratories of the WSCF.

Option # 1: This option will install 52 room humidifiers in selected laboratories of the WSCF.

Cost: \$474,000

Option # 2: This option will install steam boilers and steam humidifiers in the AHUs. It will also install 52 room humidifiers in selected rooms for supplemental humidification.

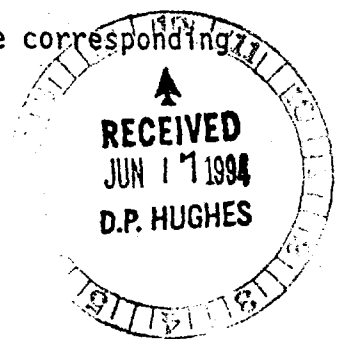
Cost: \$1,009,000

Option # 3: This option will install evaporative humidifier/cooler units in AHUs # 1 and # 2. It will also install 52 room humidifiers in selected rooms for supplemental humidification.

Cost: \$855,000.

Please notify us which option you wish to pursue. On receipt of the corresponding funding we will submit to you a schedule for preparing the work.

GCL:lab





AISR ENGINEERS HANFORD  
 ESTINGHOUSE HANFORD COMPANY  
 OB NO. W-011H / ER4633  
 ILE NO. W011SAB3

\*\* IEST - INTERACTIVE ESTIMATING \*\*  
 WSCF HUMIDIFICATION SYSTEM UPGRADE  
 ROUGH ORDER OF MAGNITUDE ESTIMATE - OPTION 1  
 DOE\_R01 - PROJECT COST SUMMARY

PAGE 1 OF 7  
 DATE 06/13/94 08:11:03  
 BY GDR / DHS

COST CODE	DESCRIPTION	ESCALATED TOTAL COST	CONTINGENCY %	TOTAL	TOTAL DOLLARS
000	ENGINEERING	88,000	30	26,000	114,000
501	BUILDINGS	277,000	30	83,000	360,000
PROJECT TOTAL		365,000	30	109,000	474,000

CHECK

WHC-SD-W011H-ES-002, REV. 0

A-4

TYPE OF ESTIMATE: ROUGH ORDER OF MAGNITUDE (ROM), JUNE 13, 1994

ARCHITECT ENGINEER *[Signature]*

OPERATING CONTRACTOR

REMARKS:

1. THIS ROM ESTIMATE IS FOR WSCF HUMIDIFICATION SYSTEM UPGRADE, OPTION 1.
2. SEE PAGE 3 OF 7 FOR ESTIMATE BASIS.
3. SEE PAGE 6 OF 7 FOR CONTINGENCY ANALYSIS.

(ROUNDED/ADJUSTED TO THE NEAREST " 1,000 " - PERCENTAGES NOT RECALCULATED TO REFLECT ROUNDING)

HAUSER ENGINEERS HANFORD  
 WESTINGHOUSE HANFORD COMPANY  
 JOB NO. W-011H / ER4633  
 FILE NO. W011SAB3

\*\* TEST - INTERACTIVE ESTIMATING \*\*  
 WSCF HUMIDIFICATION SYSTEM UPGRADE  
 ROUGH ORDER OF MAGNITUDE ESTIMATE - OPTION 1  
 DOE\_R02 - WORK BREAKDOWN STRUCTURE SUMMARY

PAGE 2 OF 7  
 DATE 06/13/94 08:11:12  
 BY GDR / DHS

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	ONSITE INDIRECTS	SUB TOTAL	ESCALATION % TOTAL	SUB TOTAL	CONTINGENCY % TOTAL	TOTAL DOLLARS
110001	LABORATORY HUMIDIFIERS	63000	0	63000	0.00	0	30	81900
	SUBTOTAL 11 DEFINITIVE DESIGN	63000	0	63000	0.00	0	30	81900
20001	LABORATORY HUMIDIFIERS	25000	0	25000	0.00	0	30	32500
	SUBTOTAL 12 ENGINEERING/INSPECTION	25000	0	25000	0.00	0	30	32500
	SUBTOTAL 1 ENGINEERING	88000	0	88000	0.00	0	30	114400
20001	LABORATORY HUMIDIFIERS	252202	25219	277421	0.00	0	30	360649
	SUBTOTAL 32 CONSTRUCTION-FIXED PRICE	252202	25219	277421	0.00	0	30	360649
	SUBTOTAL 3 CONSTRUCTION	252202	25219	277421	0.00	0	30	360649
PROJECT TOTAL		340,202	25,219	365,421	0.00	0	30	475,049

A-5

WFC-SD-W011H-ES-002, REV. 0

1. DOCUMENTS AND DRAWINGS

=====

DOCUMENTS: INFORMATION PROVIDED BY ICF KH HVAC ENGINEER.

DRAWINGS: N/A

2. MATERIAL PRICES

=====

UNIT COSTS REPRESENT CURRENT PRICES FOR SPECIFIED MATERIAL.

3. LABOR RATES

=====

CURRENT KEH BASE CRAFT RATES, AS ISSUED BY KEH FINANCE (EFFECTIVE 10-01-93), INCLUDE FRINGE BENEFITS, LABOR INSURANCE, TAXES AND TRAVEL WHERE APPLICABLE, PER HANFORD SITE STABILIZATION AGREEMENT, APPENDIX A (EFFECTIVE 09-06-93). NON CRAFT HOURLY RATES ARE BASED ON THE 1994 FISCAL YEAR BUDGET LIQUIDATION RATES AS ISSUED BY KEH FINANCE (EFFECTIVE 10-01-93)..

4. GENERAL REQUIREMENTS/TECHNICAL SERVICES/OVERHEADS

=====

A.) ONSITE CONTRACT ADMINISTRATION AND CONSTRUCTION MANAGEMENT COSTS, ASSOCIATED WITH THE OVERALL MANAGEMENT OF THE FIXED PRICE CONTRACTS, ARE INCLUDED AS A COMPOSITE PERCENTAGE AND LUMP SUM ALLOWANCE (FOR BID PACKAGE PREP) BASED ON THE ESTIMATING FACTOR/BILLING SCHEDULE. THE TOTAL COMPOSITE PERCENTAGE AND LUMP SUM ALLOWANCE ARE APPLIED AGAINST THE TOTAL FIXED PRICE CONTRACT AMOUNT WHICH IS REFLECTED ON THE KEH SUMMARY REPORT DOER07, INCLUDED WITH THIS ESTIMATE. (FINAL ESTIMATES MAY BE PARTIALLY MANLOADED AND INCLUDED WITHIN THE ESTIMATE DETAIL)

B.) FIXED PRICE CONTRACTOR OVERHEAD, PROFIT, BOND AND INSURANCE COSTS HAVE BEEN APPLIED AT THE FOLLOWING PERCENTAGES AND ARE REFLECTED IN THE "OH&P/B&I" COLUMN OF THE ESTIMATE DETAIL:

LABOR - 26.5% MATERIAL - 26.5% EQUIPMENT USAGE - 10% EQUIPMENT - 10% SUBCONTRACTS - 10%

5. ESCALATION

=====

NO ESCALATION APPLIED TO ESTIMATE.

6. ROUNDING

=====

ESTIMATE ROUNDED TO NEAREST \$1,000.

7. REMARKS

=====

- A. THIS ROM ESTIMATE IS FOR WSCF LABORATORY HUMIDIFICATION SYSTEM UPGRADE, OPTION 1, AND INCLUDES THE INSTALLATION OF FIFTY TWO (52) ROOM HUMIDIFIERS IN SELECTED LABORATORIES.
- B. ESTIMATE IS FOR ENGINEERING DESIGN & INSPECTION AND CONSTRUCTION ONLY, AND DOES NOT INCLUDE OPERATING CONTRACTOR PROJ MGMT.
- C. ESTIMATE ASSUMES CONSTRUCTION WORK WILL BE PERFORMED BY AN OFFSITE CONTRACTOR UNDER A CHANGE ORDER CONTRACT.
- D. DEFINITIVE DESIGN AND ENGINEERING/INSPECTION ESTIMATES HAVE BEEN INCLUDED AS A PERCENTAGE OF CONSTRUCTION, 25% AND 10% RESPECTIVELY.
- E. ESTIMATE ASSUMES THAT WATER FOR HUMIDIFIERS CAN BE TAPPED FROM EXISTING WATER LINES, WITH LATERAL FEED TO EACH LAB, AND THE DRAINS OFF THE HUMIDIFIERS CAN BE MANIFOLDED AND RUN TO FOUR LOCATIONS OF EXISTING SANITARY DRAINS.

KAISER ENGINEERS HANFORD  
WESTINGHOUSE HANFORD COMPANY  
JOB NO. W-011H / ER4633  
FILE NO. W011SAB3

\*\* IEST - INTERACTIVE ESTIMATING \*\*  
WSCF HUMIDIFICATION SYSTEM UPGRADE  
ROUGH ORDER OF MAGNITUDE ESTIMATE - OPTION 1  
DOE\_R06 - CONTINGENCY ANALYSIS BASIS SHEET

PAGE 6 OF 7  
DATE 06/13/94  
BY GDR / DHS

REFERENCE: ESTIMATE BASIS SHEET PAGE 3 OF 7  
COST CODE ACCOUNT SUMMARY PAGE 4 OF 7

THE U.S. DEPARTMENT OF ENERGY - RICHLAND ORDER 5700.3 "COST ESTIMATING, ANALYSIS AND STANDARDIZATION"  
DATED 3-27-85, PROVIDES GUIDELINES FOR ESTIMATE CONTINGENCIES. THE GUIDELINE FOR A STUDY ESTIMATE  
SHOULD HAVE AN OVERALL RANGE OF 20 TO 30%.

ENGINEERING A 30% CONTINGENCY HAS BEEN APPLIED TO ENGINEERING TO COINCIDE WITH CONSTRUCTION CONTINGENCY.

A-7

CONSTRUCTION A 30% CONTINGENCY HAS BEEN APPLIED TO CONSTRUCTION DUE TO THE PRELIMINARY NATURE OF THE  
INFORMATION FROM WHICH THE ESTIMATE WAS PREPARED.

AVERAGE PROJECT CONTINGENCY 30%

WHC-SD-W011H-ES-002, REV. 0

KAISER ENGINEERS HANFORD  
 WESTINGHOUSE HANFORD COMPANY  
 JOB NO. W-011H / ER4633  
 FILE NO. W011SAD1

\*\* TEST - INTERACTIVE ESTIMATING \*\*  
 WSCF HUMIDIFICATION SYSTEM UPGRADE  
 ROUGH ORDER OF MAGNITUDE - OPTION 2  
 DOE\_R01 - PROJECT COST SUMMARY

PAGE 1 OF 7  
 DATE 06/13/94 08:17:06  
 BY JPM / DHS

COST CODE	DESCRIPTION	ESCALATED TOTAL COST	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
000	ENGINEERING	193,000	14	26,000	219,000
501	BUILDINGS	608,000	30	182,000	790,000
PROJECT TOTAL		801,000	26	208,000	1,009,000

A-8

CHECK

WHC-SD-W011H-ES-002, REV. 0

TYPE OF ESTIMATE	ROUGH ORDER OF MAGNITUDE (ROM), JUNE 13, 1994	REMARKS:
ARCHITECT ENGINEER	<i>all</i>	1. THIS ROM ESTIMATE IS FOR WSCF HUMIDIFICATION SYSTEM UPGRADE, OPTION 2.
OPERATING CONTRACTOR		2. SEE PAGE 3 OF 7 FOR ESTIMATE BASIS.
		3. SEE PAGE 6 OF 7 FOR CONTINGENCY ANALYSIS.

(ROUNDED/ADJUSTED TO THE NEAREST " 1,000 " - PERCENTAGES NOT RECALCULATED TO REFLECT ROUNDING)

AISER ENGINEERS HANFORD  
 ESTINGHOUSE HANFORD COMPANY  
 OB NO. W-011H / ER4633  
 FILE NO. W011SAD1

\*\* IEST - INTERACTIVE ESTIMATING \*\*  
 WSCF HUMIDIFICATION SYSTEM UPGRADE  
 ROUGH ORDER OF MAGNITUDE - OPTION 2  
 DOE\_R02 - WORK BREAKDOWN STRUCTURE SUMMARY

PAGE 2 OF 7  
 DATE 06/13/94 08:17:15  
 BY JPM / DHS

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	ONSITE INDIRECTS	SUB TOTAL	ESCALATION % TOTAL	SUB TOTAL	CONTINGENCY % TOTAL	TOTAL DOLLARS
10001	LABORATORY HUMIDIFIERS	75000	0	75000	0.00	0	0	75000
10002	LABORATORY HUMIDIFIERS	63000	0	63000	0.00	0	30	81900
SUBTOTAL 11 DEFINITIVE DESIGN		138000	0	138000	0.00	0	14	156900
20001	LABORATORY HUMIDIFIERS	30000	0	30000	0.00	0	0	30000
20002	LABORATORY HUMIDIFIERS	25000	0	25000	0.00	0	30	32500
SUBTOTAL 12 ENGINEERING/INSPECTION		55000	0	55000	0.00	0	14	62500
SUBTOTAL 1 ENGINEERING		193000	0	193000	0.00	0	14	219400
20001	LABORATORY HUMIDIFIERS	300247	30024	330271	0.00	0	30	429353
20002	LABORATORY HUMIDIFIERS	252202	25219	277421	0.00	0	30	360649
SUBTOTAL 32 CONSTRUCTION-FIXED PRICE		552449	55243	607692	0.00	0	30	790002
SUBTOTAL 3 CONSTRUCTION		552449	55243	607692	0.00	0	30	790002
PROJECT TOTAL		745,449	55,243	800,692	0.00	0	26	1,009,402

WHC-SD-W011H-ES-002, REV. 0

1. DOCUMENTS AND DRAWINGS

=====  
DOCUMENTS: INFORMATION PROVIDED BY ICF KH HVAC ENGINEER.

DRAWINGS: N/A

2. MATERIAL PRICES

=====  
UNIT COSTS REPRESENT CURRENT PRICES FOR SPECIFIED MATERIAL.

3. LABOR RATES

=====  
CURRENT KEH BASE CRAFT RATES, AS ISSUED BY KEH FINANCE (EFFECTIVE 10-01-93), INCLUDE FRINGE BENEFITS, LABOR INSURANCE, TAXES AND TRAVEL WHERE APPLICABLE, PER HANFORD SITE STABILIZATION AGREEMENT, APPENDIX A (EFFECTIVE 09-06-93). NON CRAFT HOURLY RATES ARE BASED ON THE 1994 FISCAL YEAR BUDGET LIQUIDATION RATES AS ISSUED BY KEH FINANCE (EFFECTIVE 10-01-93).

4. GENERAL REQUIREMENTS/TECHNICAL SERVICES/OVERHEADS

=====  
A.) ONSITE CONTRACT ADMINISTRATION AND CONSTRUCTION MANAGEMENT COSTS, ASSOCIATED WITH THE OVERALL MANAGEMENT OF THE FIXED PRICE CONTRACTS, ARE INCLUDED AS A COMPOSITE PERCENTAGE AND LUMP SUM ALLOWANCE (FOR BID PACKAGE PREP) BASED ON THE ESTIMATING FACTOR/BILLING SCHEDULE. THE TOTAL COMPOSITE PERCENTAGE AND LUMP SUM ALLOWANCE ARE APPLIED AGAINST THE TOTAL FIXED PRICE CONTRACT AMOUNT WHICH IS REFLECTED ON THE KEH SUMMARY REPORT DOERO7, INCLUDED WITH THIS ESTIMATE. (FINAL ESTIMATES MAY BE PARTIALLY MANLOADED AND INCLUDED WITHIN THE ESTIMATE DETAIL)  
B.) FIXED PRICE CONTRACTOR OVERHEAD, PROFIT, BOND AND INSURANCE COSTS HAVE BEEN APPLIED AT THE FOLLOWING PERCENTAGES AND ARE REFLECTED IN THE "OH&P/B&I" COLUMN OF THE ESTIMATE DETAIL:  
LABOR - 26.5% MATERIAL - 26.5% EQUIPMENT USAGE - 10% EQUIPMENT - 10% SUBCONTRACTS - 10%

5. ESCALATION

=====  
NO ESCALATION APPLIED TO ESTIMATE.

6. ROUNDING

=====  
ESTIMATE ROUNDED TO NEAREST \$1,000.

7. REMARKS

=====  
A. THIS ROM ESTIMATE IS FOR WSCF LABORATORY HUMIDIFICATION UPGRADE, OPTION 2, AND INCLUDES INSTALLATION OF STEAM BOILERS AND STEAM HUMIDIFIER GRIDS IN THE AHUS, AS WELL AS THE INSTALLATION OF FIFTY TWO (52) ROOM HUMIDIFIERS IN SELECTED LABS.  
B. ESTIMATE IS FOR ENGINEERING DESIGN & INSPECTION AND CONSTRUCTION ONLY, AND DOES NOT INCLUDE OPERATING CONTRACTOR PROJ MGMT.  
C. ESTIMATE ASSUMES CONSTRUCTION WORK WILL BE PERFORMED BY AN OFFSITE CONTRACTOR UNDER A CHANGE ORDER CONTRACT.  
D. DEFINITIVE DESIGN AND ENGINEERING/INSPECTION ESTIMATES HAVE BEEN INCLUDE AS A PERCENTAGE OF CONSTRUCTION, 25% AND 10% RESPECTIVELY.

KAISER ENGINEERS HANFORD  
WESTINGHOUSE HANFORD COMPANY  
JOB NO. W-011H / ER4633  
FILE NO. W011SAD1

\*\* TEST - INTERACTIVE ESTIMATING \*\*  
WSCF HUMIDIFICATION SYSTEM UPGRADE  
ROUGH ORDER OF MAGNITUDE - OPTION 2  
DOE\_R06 - CONTINGENCY ANALYSIS BASIS SHEET

PAGE 6 OF 7  
DATE 06/13/94  
BY JPM / DHS

REFERENCE: ESTIMATE BASIS SHEET PAGE 3 OF 7  
COST CODE ACCOUNT SUMMARY PAGE 4 OF 7

THE U.S. DEPARTMENT OF ENERGY - RICHLAND ORDER 5700.3 "COST ESTIMATING, ANALYSIS AND STANDARDIZATION" DATED 3-27-85, PROVIDES GUIDELINES FOR ESTIMATE CONTINGENCIES. THE GUIDELINE FOR A STUDY ESTIMATE SHOULD HAVE AN OVERALL RANGE OF 20 TO 30%.

ENGINEERING A 30% CONTINGENCY HAS BEEN APPLIED TO ENGINEERING TO COINCIDE WITH CONSTRUCTION CONTINGENCY.

CONSTRUCTION A 30% CONTINGENCY HAS BEEN APPLIED TO CONSTRUCTION DUE TO THE PRELIMINARY NATURE OF THE INFORMATION FROM WHICH THE ESTIMATE WAS PREPARED.

AVERAGE PROJECT CONTINGENCY 30%

A-11

WMC-SD-W011H-ES-002, REV. 0



AISER ENGINEERS HANFORD  
 ESTINGHOUSE HANFORD COMPANY  
 OB NO. W011H / ER4633  
 FILE NO. W011SAE1

\*\* TEST - INTERACTIVE ESTIMATING \*\*  
 WSCF HUMIDIFICATION SYSTEM UPGRADE  
 ROUGH ORDER OF MAGNITUDE ESTIMATE - OPTION 3  
 DOE\_R01 - PROJECT COST SUMMARY

PAGE 1 OF 7  
 DATE 06/13/94 09:21:11  
 BY DHS / LGH / GDR

COST CODE =====	DESCRIPTION =====	ESCALATED TOTAL COST =====	CONTINGENCY % =====	TOTAL TOTAL =====	TOTAL DOLLARS =====
000	ENGINEERING	159,000	30	48,000	207,000
501	BUILDINGS	477,000	30	143,000	620,000
810	DEMOLITION	22,000	30	6,000	28,000
=====					
PROJECT TOTAL		658,000	30	197,000	855,000

CHECK

MHC-SD-W011H-ES-002, REV. 0

A-12

TYPE OF ESTIMATE    ROUGH ORDER OF MAGNITUDE (ROM), JUNE 13, 1994	REMARKS: 1. THIS ROM ESTIMATE IS FOR WSCF HUMIDIFICATION SYSTEM UPGRADE, OPTION 3. 2. SEE PAGE 3 OF 7 FOR ESTIMATE BASIS. 3. SEE PAGE 6 OF 7 FOR CONTINGENCY ANALYSIS.
ARCHITECT ENGINEER <i>WJH</i>	
OPERATING CONTRACTOR	

(ROUNDED/ADJUSTED TO THE NEAREST " 1,000 " - PERCENTAGES NOT RECALCULATED TO REFLECT ROUNDING)

AISER ENGINEERS HANFORD  
 ESTINGHOUSE HANFORD COMPANY  
 OB NO. W011H / ER4633  
 ILE NO. W011SAE1

\*\* IEST - INTERACTIVE ESTIMATING \*\*  
 WSCF HUMIDIFICATION SYSTEM UPGRADE  
 ROUGH ORDER OF MAGNITUDE ESTIMATE - OPTION 3  
 DOE\_R02 - WORK BREAKDOWN STRUCTURE SUMMARY

PAGE 2 OF 7  
 DATE 06/13/94 09:21:22  
 BY DHS / LGH / GDR

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	ONSITE INDIRECTS	SUB TOTAL	ESCALATION % TOTAL	SUB TOTAL	CONTINGENCY % TOTAL	TOTAL DOLLARS
10001	AIR INTAKE PLENUM	14100	0	14100	0.00	0	14100 30	18330
10002	AHU MODIFICATIONS	36200	0	36200	0.00	0	36200 30	47060
10003	LABORATORY HUMIDIFIERS	63000	0	63000	0.00	0	63000 30	81900
SUBTOTAL 11 DEFINITIVE DESIGN		113300	0	113300	0.00	0	113300 30	147290
20001	AIR INTAKE PLENUM	6000	0	6000	0.00	0	6000 30	7800
20002	AHU MODIFICATIONS	15000	0	15000	0.00	0	15000 30	19500
20003	LABORATORY HUMIDIFIERS	25000	0	25000	0.00	0	25000 30	32500
SUBTOTAL 12 ENGINEERING/INSPECTION		46000	0	46000	0.00	0	46000 30	59800
SUBTOTAL 1 ENGINEERING		159300	0	159300	0.00	0	159300 30	207090
20001	AIR INTAKE PLENUM	56537	5654	62191	0.00	0	62191 30	80848
20002	AHU MODIFICATIONS	144706	14471	159177	0.00	0	159177 30	206930
20003	LABORATORY HUMIDIFIERS	252202	25219	277421	0.00	0	277421 30	360649
SUBTOTAL 32 CONSTRUCTION - FIXED PRICE		453445	45344	498789	0.00	0	498789 30	648427
SUBTOTAL 3 CONSTRUCTION		453445	45344	498789	0.00	0	498789 30	648427
PROJECT TOTAL		612,745	45,344	658,089	0.00	0	658,089 30	855,517

WHC-SD-W011H-ES-002, REV. 0

USER ENGINEERS HANFORD  
STINGHOUSE HANFORD COMPANY  
JOB NO. W011H / ER4633  
FILE NO. W011SAE1

\*\* TEST - INTERACTIVE ESTIMATING \*\*  
WSCF HUMIDIFICATION SYSTEM UPGRADE  
ROUGH ORDER OF MAGNITUDE ESTIMATE - OPTION 3  
DOE\_R03 - ESTIMATE BASIS SHEET

PAGE 3 OF 7  
DATE 06/13/94  
BY DHS / LGH / GDR

DOCUMENTS AND DRAWINGS

=====  
DOCUMENTS: INFORMATION PROVIDED BY ICFKH HVAC ENGINEER.

DRAWINGS: N/A

MATERIAL PRICES

=====  
UNIT COSTS REPRESENT CURRENT PRICES FOR SPECIFIED MATERIAL.

LABOR RATES

=====  
CURRENT KEH BASE CRAFT RATES, AS ISSUED BY KEH FINANCE (EFFECTIVE 10-01-93), INCLUDE FRINGE BENEFITS, LABOR INSURANCE, TAXES AND TRAVEL WHERE APPLICABLE, PER HANFORD SITE STABILIZATION AGREEMENT, APPENDIX A (EFFECTIVE 09-06-93). NON CRAFT HOURLY RATES ARE BASED ON THE 1994 FISCAL YEAR BUDGET LIQUIDATION RATES AS ISSUED BY KEH FINANCE (EFFECTIVE 10-01-93).

GENERAL REQUIREMENTS/TECHNICAL SERVICES/OVERHEADS

- =====  
A.) ONSITE CONTRACT ADMINISTRATION AND CONSTRUCTION MANAGEMENT COSTS, ASSOCIATED WITH THE OVERALL MANAGEMENT OF THE FIXED PRICE CONTRACTS, ARE INCLUDED AS A COMPOSITE PERCENTAGE AND LUMP SUM ALLOWANCE (FOR BID PACKAGE PREP) BASED ON THE ESTIMATING FACTOR/BILLING SCHEDULE. THE TOTAL COMPOSITE PERCENTAGE AND LUMP SUM ALLOWANCE ARE APPLIED AGAINST THE TOTAL FIXED PRICE CONTRACT AMOUNT WHICH IS REFLECTED ON THE KEH SUMMARY REPORT DOER07, INCLUDED WITH THIS ESTIMATE. (FINAL ESTIMATES MAY BE PARTIALLY MANLOADED AND INCLUDED WITHIN THE ESTIMATE DETAIL)  
B.) FIXED PRICE CONTRACTOR OVERHEAD, PROFIT, BOND AND INSURANCE COSTS HAVE BEEN APPLIED AT THE FOLLOWING PERCENTAGES AND ARE REFLECTED IN THE "OH&P/B&I" COLUMN OF THE ESTIMATE DETAIL:  
LABOR - 26.5% MATERIAL - 26.5% EQUIPMENT USAGE - 10% EQUIPMENT - 10% SUBCONTRACTS - 10%

ESCALATION

=====  
NO ESCALATION APPLIED TO ESTIMATE.

ROUNDING

=====  
ESTIMATE ROUNDED TO NEAREST \$1,000.

REMARKS

- =====  
A. THIS ROM ESTIMATE IS FOR WSCF LABORATORY HUMIDIFICATION UPGRADES, OPTION 3, AND INCLUDES THE INSTALLATION OF EVAPORATIVE HUMIDIFIER/COOLER UNITS IN AHUS 1 AND 2, AS WELL AS THE INSTALLATION OF FIFTY TWO (52) ROOM HUMIDIFIERS IN SELECTED LABS.  
B. ESTIMATE IS FOR ENGINEERING DESIGN & INSPECTION AND CONSTRUCTION ONLY, AND DOES NOT INCLUDE OPERATING CONTRACTOR PROJ MGMT.  
C. ESTIMATE ASSUMES CONSTRUCTION WORK WILL BE PERFORMED BY AN OFFSITE CONTRACTOR UNDER A CHANGE ORDER CONTRACT.  
D. DEFINITIVE DESIGN AND ENGINEERING/INSPECTION ESTIMATES HAVE BEEN INCLUDED AS A PERCENTAGE OF CONSTRUCTION, 25% AND 10% RESPECTIVELY.  
E. ESTIMATE ASSUMES THAT AHUS CAN BE EASILY SEPARATED FOR INSTALLATION OF EVAPORATIVE COOLER/HUMIDIFIER, AND THAT UNITS WILL FIT INTO SPACE AVAILABLE.

WHC-SD-W011H-ES-002, REV. 0

USER ENGINEERS HANFORD  
STINGHOUSE HANFORD COMPANY  
JOB NO. W011H / ER4633  
FILE NO. W011SAE1

\*\* TEST - INTERACTIVE ESTIMATING \*\*  
WSCF HUMIDIFICATION SYSTEM UPGRADE  
ROUGH ORDER OF MAGNITUDE ESTIMATE - OPTION 3  
DOE\_R06 - CONTINGENCY ANALYSIS BASIS SHEET

PAGE 6 OF 7  
DATE 06/13/94  
BY DHS / LGH / GDR

REFERENCE: ESTIMATE BASIS SHEET PAGE 3 OF 7  
COST CODE ACCOUNT SUMMARY PAGE 4 OF 7

THE U.S. DEPARTMENT OF ENERGY - RICHLAND ORDER 5700.3 "COST ESTIMATING, ANALYSIS AND STANDARDIZATION" DATED 3-27-85, PROVIDES GUIDELINES FOR ESTIMATE CONTINGENCIES. THE GUIDELINE FOR A STUDY ESTIMATE SHOULD HAVE AN OVERALL RANGE OF 20 TO 30% .

ENGINEERING A 30% CONTINGENCY HAS BEEN APPLIED TO ENGINEERING TO COINCIDE WITH CONSTRUCTION CONTINGENCY.

CONSTRUCTION A 30% CONTINGENCY HAS BEEN APPLIED TO CONSTRUCTION DUE TO THE PRELIMINARY NATURE OF THE INFORMATION FROM WHICH THE ESTIMATE WAS PREPARED.

AVERAGE PROJECT CONTINGENCY 30%

A-15

MHC-SD-W011H-ES-002, REV. 0

**APPENDIX B**

**NUCLEAR SPECTROSCOPY LABORATORIES**

Engineering Change Notices and  
Cost Estimates

WHC-SD-W011H-ES-002, REV. 0  
**ENGINEERING CHANGE NOTICE**

Page 1 of 3

1. ECN No. ~~176178~~

Proj. ECN **W011H-280**

2. ECN Category (mark one)

- Supplemental
- Direct Revision
- Change ECN
- Temporary
- Supersedure
- Discovery
- Cancel/Void

3. Originator's Name, Organization, MSIN, and Telephone No.

**T.T. TAKAOKA, EG-26-ICF KH, 376-3928**

4. Date

**06-02-94**

5. Project Title/No./Work Order No.

**WASTE SAMPLING & CHARACTERIZATION FACILITY/W011H**

6. Bldg./Sys./Fac. No.

**6266**

7. Impact Level

**/SC-3**

8. Document Number Affected (include rev. and sheet no.)

**H.6-1733 SH1, & 2 REV. 2**

9. Related ECN No(s).

**N.A.**

10. Related PO No.

**N.A.**

11a. Modification Work

- Yes (fill out Blk. 11b)
- No (NA Blks. 11b, 11c, 11d)

11b. Work Package

Doc. No.  
**N.A.**

11c. Complete Installation Work

**N.A.**

Cog. Engineer Signature & Date

11d. Complete Restoration (Temp. ECN only)

**N.A.**

Cog. Engineer Signature & Date

12. Description of Change

**SEE PAGE 3**

**SC-3**



**EXPIRES 3/13/ 96**

13a. Justification (mark one)

- Criteria Change
- Design Improvement
- Environmental
- As-Found
- Facilitate Const.
- Const. Error/Omission
- Design Error/Omission

13b. Justification Details

**ADDING A HUMIDIFICATION SYSTEM PER WHC TASK ORDER REQUISITION/DESCRIPTION TOD 017 FOR THE NUCLEAR SPECTROSCOPY LABORATORY (WHC INTERNAL MEMO No. 94-W011H-17, DATED 4-11-94.**

14. Distribution (include name, MSIN, and no. of copies)

RELEASE STAMP

12. DESCRIPTION OF CHANGE (CONT'D)

PROVIDE AND INSTALL A COMPLETE, AUTOMATIC STEAM HUMIDIFICATION SYSTEM AS SHOWN IN THIS ECN.

EQUIPMENT SPECIFICATION

Humidification Equipment:

MFR DRI Steam Humidifier Co.  
MFR' Rep K. J. Barnett Co  
17619 N E 67 th Court  
Redmond, WA. 98052  
Phone (206) 881-1128  
FAX (206) 883-6522  
Att: Mr. Kenth Martin

Humidifier Tag No. NSL-HDF-1:

NSL-HDF-1 shall be Model VPC-16-16 (Two 1.6 KW, 480V, 3 PH, 60 HZ Heating Elements) Vaporstream Electric Humidifiers. Single point Electric connection, Capacity 90.9 Lbs/Hr. Factory installed Insulation for Steam Generation Tank and 24 inches high Tank Support Legs.

Steam Dispersion Tube Humidifier Panel:

Model LH Ultra-Sorb Steam Dispersion Tube Humidifier Panel, 48" Length by 42" height face dimension. Unit includes steam supply header/separator, assembled package of tubes and headers contained in galvanized metal casing, two floats/thermostatic steam traps.

12. DESCRIPTION OF CHANGE (CONT'D).

HUMIDIFIER CONTROL PANEL TAG NO. NSL-HCP-1

Model SCR Modulation/Sequencer Control suitable for Laboratories and Clean Rooms humidification control. A single heater shall be SCR modulated and the second element shall be 'ON/OFF'.

Humidifier shall be electrically hard wired interlocking with NSL-AHU-1 and shall be de-energized when NSL-AHU-1 is not in operation.

Humidifier shall be complete with humidifier transmitter and duct mounted high limit humidistat.

Piping:

Drain Piping: DWV Copper

Condensate & Cold Water Piping: Type L Copper

Steam Piping: Type K Copper

Insulation for Steam and Condensate Piping:

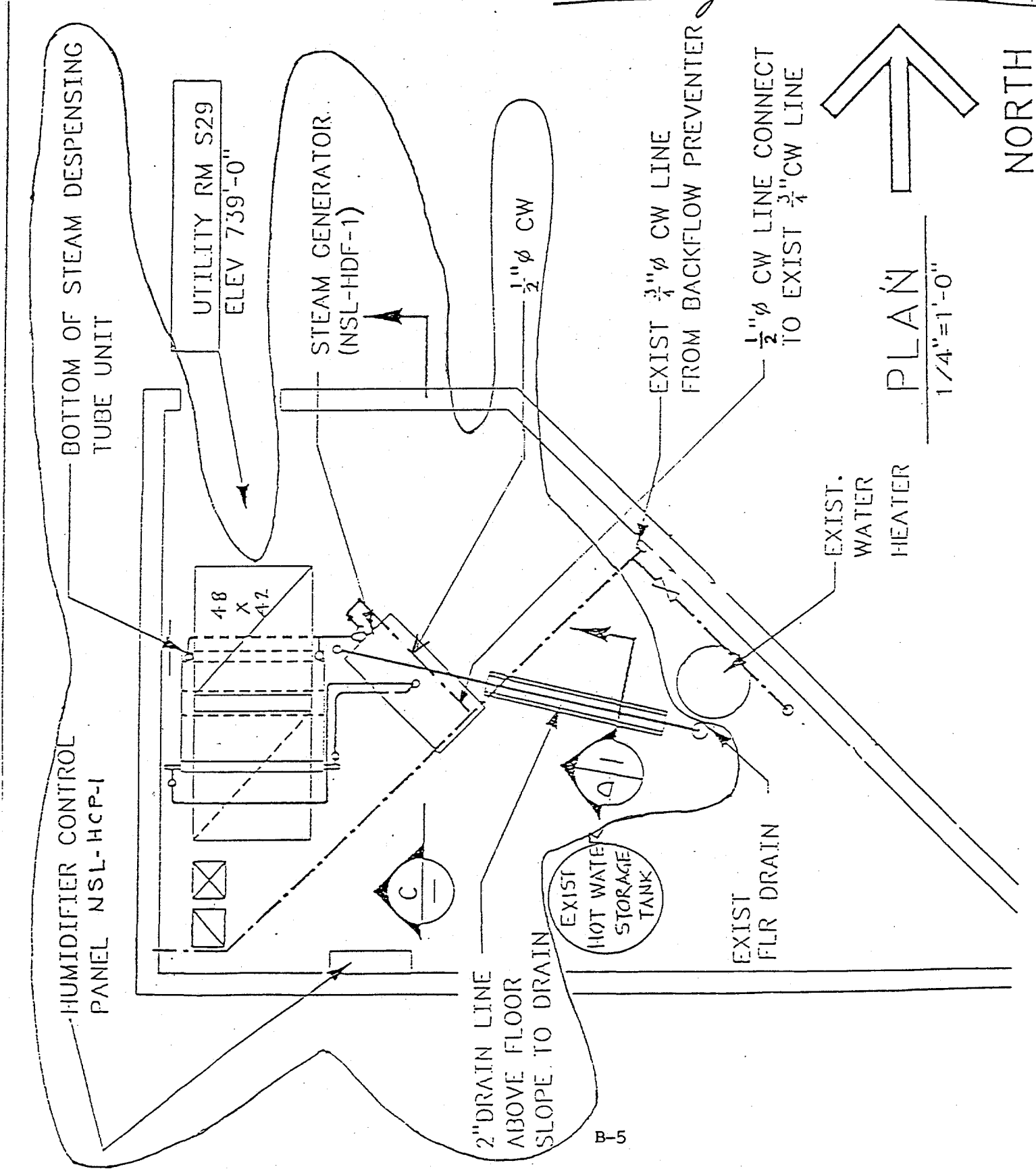
Owens Corning Fiberglass SSL-II pipe insulation with DOUBLESERE closure system or equal. Thickness shall be 1" for Condensate lines and 1 1/2" for Steam line.

OWNER'S MANUALS SHALL BE PROVIDED FOR THE HUMIDIFICATION SYSTEM AND SHALL INCLUDE:

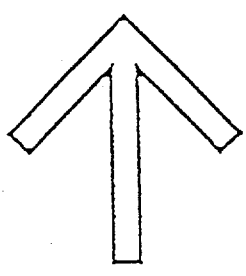
- Illustrative Cuts
- Dimensional Drawings
- Equipment Weights
- Specification
- Certified Test Data
- Data sheets and performance curves/Wiring diagrams
- Spare Parts Lists
- Instructions for Installation, Operation, and Maintenance



Ref. Dwg. H-6-1733	Sh. 2 of 3	Rev. 2	Prepared By <i>[Signature]</i>	Checked By <i>[Signature]</i>	ECN No. W-011H-280	Page 5
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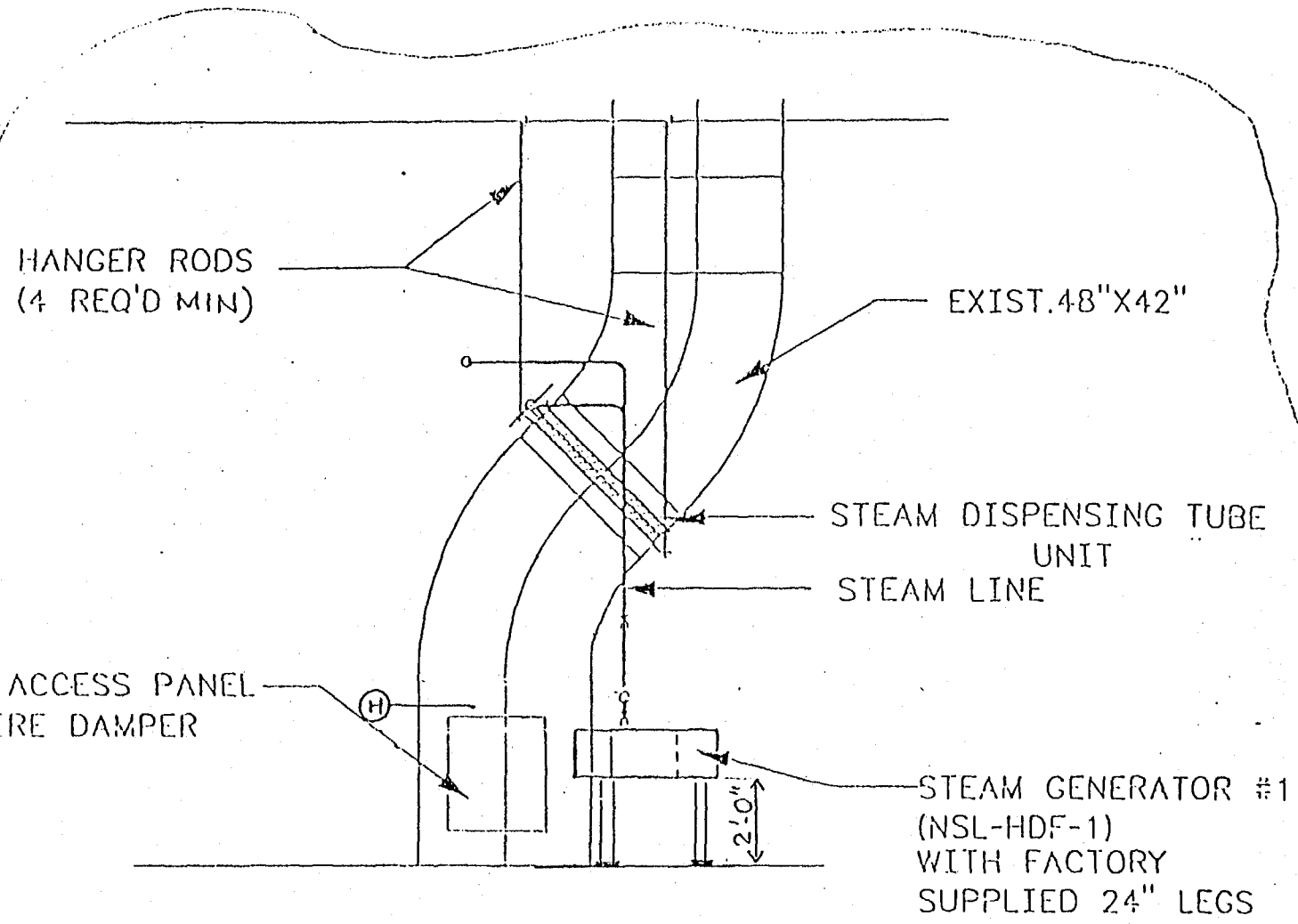
PLAN  
1/4" = 1'-0"



NORTH

B-5

Proj. DWG. H-6-1733	Sh. 2	Rev. 2	Prepared By <i>[Signature]</i>	Checked By <i>[Signature]</i>	ECN No. W-Φ 11H-280	Page 6
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(A) SECTION  
1/4" = 1'-0"

B-6

KEH-0159 (2/10/80)

Ref. Dwg.

H-6-1733

Sh.

2  
of 3

Rev.

2

Prepared By

*J. Schreiber*

Checked By

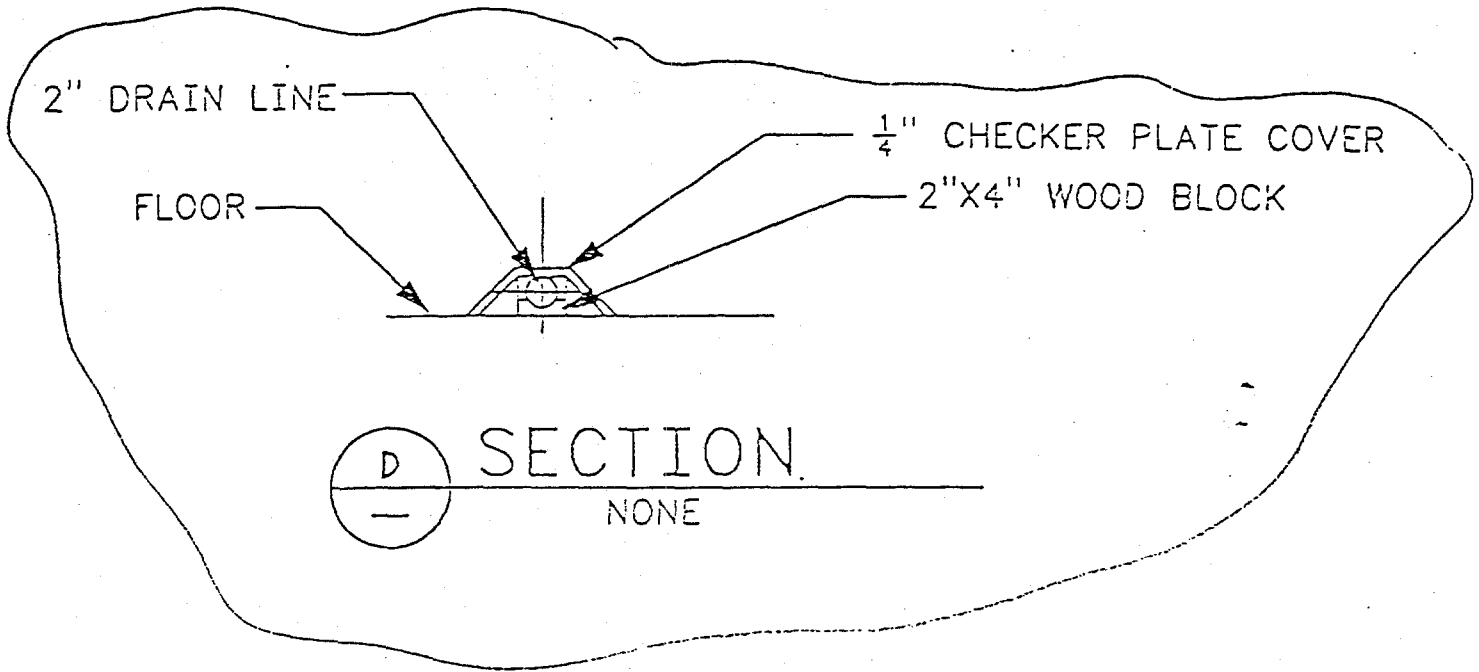
*S. & Doney*

ECN No.

W-Ø11H-280

Page

7



Ref. Dwg.

1--6-1733

Sh.

2  
of 3

Rev.

2

Prepared By

*A. J. Haberman*

Checked By

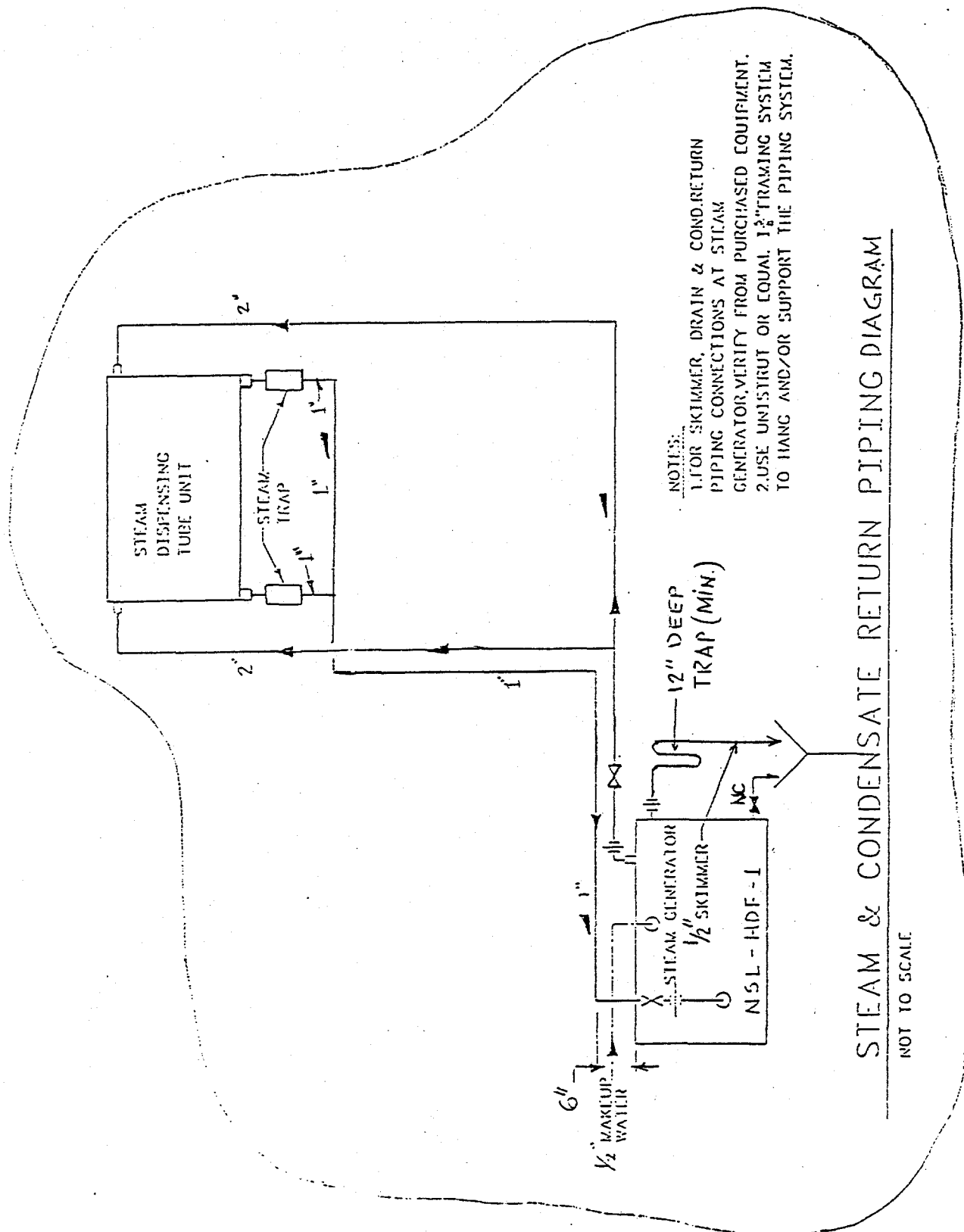
*L. E. Joney*

ECN No.

W-0-11H-280

Page

8



NOTES:

1. FOR SKIMMER, DRAIN & COND. RETURN PIPING CONNECTIONS AT STEAM GENERATOR, VERIFY FROM PURCHASED EQUIPMENT.
2. USE UNISTRUT OR EQUAL, 1 1/2" TRAMING SYSTEM TO HANG AND/OR SUPPORT THE PIPING SYSTEM.

STEAM & CONDENSATE RETURN PIPING DIAGRAM

NOT TO SCALE

ENGINEERING CHANGE NOTICE

Page 1 of \_\_\_\_\_

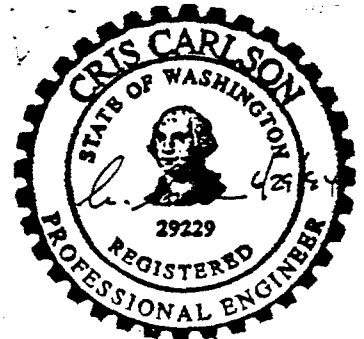
1. ECN ~~041007~~

Proj. ECN W-011H-281

2. ECN Category (mark one) Supplemental <input checked="" type="checkbox"/> Direct Revision <input type="checkbox"/> Change ECN <input type="checkbox"/> Temporary <input type="checkbox"/> Standby <input type="checkbox"/> Supersedure <input type="checkbox"/> Cancel/Void <input type="checkbox"/>	3. Originator's Name, Organization, MSIN, and Telephone No. M. Gorji/ KEH / E6-26 / 376-6842		4. Date 6/8/94
	5. Project Title/No./Work Order No. Waste Sampling & Characterization Facil/ W-011H	6. Bldg./Sys./Fac. No. 6266	7. Impact Level SC3
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) SEE BLOCK 12	9. Related ECN No(s). N/A	10. Related PO No. N/A
11a. Modification Work <input type="checkbox"/> Yes (fill out Blk. 11b) <input type="checkbox"/> No (NA Blks. 11b, 11c, 11d) UNKNOWN	11b. Work Package No. UNKNOWN	11c. Modification Work Complete N/A _____ Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A _____ Cog. Engineer Signature & Date

12. Description of Change  
documents affected:  
 H-6-1737 SH1, REV. 2 AND H-6-1738 SH2, REV. 2.  
 1. Revise per the attached sheets 3 AND 4.

SC3



EXPIRES 06/24/95

13a. Justification (mark one)	Criteria Change <input checked="" type="checkbox"/>	Design Improvement <input type="checkbox"/>	Environmental <input type="checkbox"/>
As-Found <input type="checkbox"/>	Facilitate Const. <input type="checkbox"/>	Const. Error/Omission <input type="checkbox"/>	Design Error/Omission <input type="checkbox"/>

13b. Justification Details  
 The new NSL humidifier (ONE at 32 KW) requires a 50-ampere, 3-phase, 480 volts feeder. A new 100-ampere frame size, with 50-ampere trip rating, circuit breaker is added to 110 HVAC panel to supply 480-volt, 3-phase power to humidifier control panel. The humidifier is interlocked with NSL HVAC system through a new air switch to be furnished by vendor.

14. Distribution (include name, MSIN, and no. of copies)	RELEASE STAMP
--	---------------

Ref. Dwg. H-6-1737 Sh. 1 Rev. 2 Prepared by: M. GORJI

Checked by:

ECN No. W-011H-281

Page 3/4

Z C / 5-6

Panel Schedule 110 HVAC PNLBD 3 Phase 4 Wire Voltage LL: 480 Voltage LG: 277

DC Devices: BREAKERS Device Family: BOLT-ON Mounting: SURFACE Enclosure: NEMA 1  
 Comments: MAIN LUGS ONLY Bus Rating: 400 Available Fault Duty: 28022 A 3 Phase

Ckt No	Description/Location	W Load Type	Criteria Ea	Qty Den	Total VA	Remarks	Device P Amps	P H	Device Remarks	Total VA	W Load Type	Criteria Ea	Qty Den	Description/Location	Ckt No		
1	##NSL-AHU-1	BUS#	1107	10	34166	TMB	175	3	A	25	3	TMB	3866	BUS# 112	9	##P-XFMR T2	2
3	##NSL-AHU-1	BUS#	1107	10	34166	W/CKT#1			B			W/CKT#2	3866	BUS# 112	9	##P-XFMR T2	4
5	##NSL-AHU-1	BUS#	1107	10	34166	W/CKT#1			C			W/CKT#2	3866	BUS# 112	9	##P-XFMR T2	6
7	##ADM-EF-1	BUS#	118	9	484	TMB	20	3	A	40	3	TMB	8873	BUS# 117	9	##ADM-AHU-2	8
9	##ADM-EF-1	BUS#	118	9	484	W/CKT#7			B			W/CKT#8	8873	BUS# 117	9	##ADM-AHU-2	10
11	##ADM-EF-1	BUS#	118	9	484	W/CKT#7			C			W/CKT#8	8873	BUS# 117	9	##ADM-AHU-2	12
13	##NSL-AHU-3	BUS#	1109	9	5569	TMB	20	3	A	60	3	TMB	10323	BUS# 1102	9	##ADM-AHU-1	14
15	##NSL-AHU-3	BUS#	1109	9	5569	W/CKT#13			B			W/CKT#14	10323	BUS# 1102	9	##ADM-AHU-1	16
17	##NSL-AHU-3	BUS#	1109	9	5569	W/CKT#13			C			W/CKT#14	10323	BUS# 1102	9	##ADM-AHU-1	18
19	##STMUMDFR	BUS#	1110	16	13333	TMB	50	3	A	1	1					SPACE	20
21	##STMUMDFR	BUS#	1110	16	13333	W/CKT#19			B							SPACE	22
23	##STMUMDFR	BUS#	1110	16	13333	W/CKT#19			C							SPACE	24
25	SPACE								A							SPACE	26
27	SPACE								B							SPACE	28
29	SPACE								C							SPACE	30

ENDUSE LOADS: PHASE A VA 0, PHASE B VA 0, PHASE C VA 0  
 TOTAL LOADS: CONNECTED KVA 229.9 DEMAND KVA 191.2 DESIGN KVA 217.8  
 CONNECTED FLA 229.9 DEMAND FLA 191.2 DESIGN FLA 262.0

NOTES: 1. PNLDB SIMILAR TO SQUARE 'D' I-LINE TYPE 'HCH' W/TYPE 'KA' BRKRS.  
 2. THE CKT#1 175AT BRKR SHALL BE EQUIPPED W/GROUND FAULT TRIP SIMILAR TO SQUARE 'D' TYPE 'GFH'.

B-10

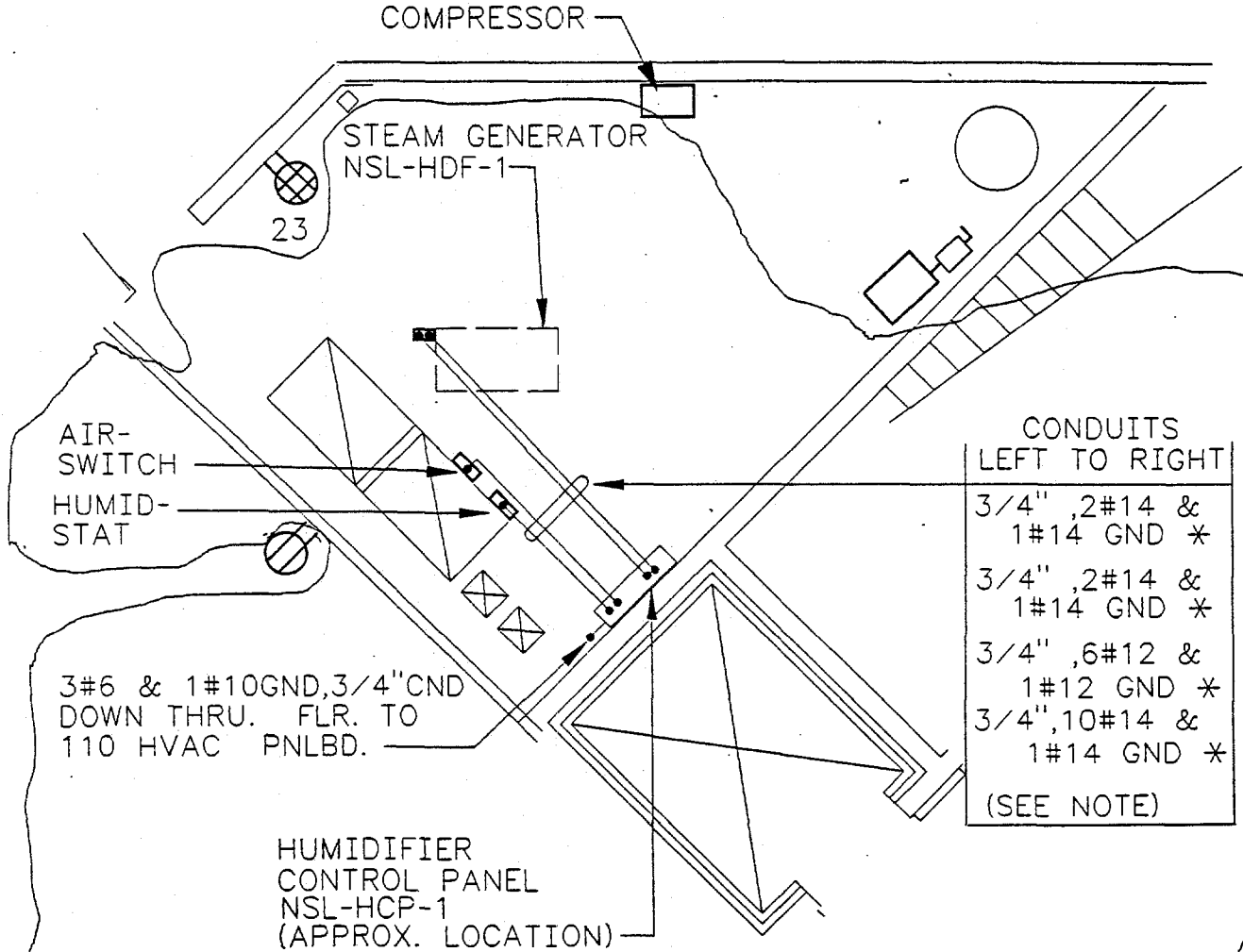
ADD

REVISE

110.DWG

Ref. Dwg. H-6-1738	Sh. 2	Rev. 2	Prepared by: M. GORJI	Checked by: <i>[Signature]</i>	ECN No. W-011H-281	Page 4/4
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Z 6/7E



NOTE:

WIRE RUNS ARE BASED ON "K.J.BARNETT COMPANY" PROPOSAL.  
FOR WIRE CONNECTIONS REFER TO CERTIFIED VENDOR DWGS.

\* USE COPPER CONDUCTORS SUITABLE FOR 105 DEGREES C ENVIRONMENT.

KAISER ENGINEERS HANFORD  
 WESTINGHOUSE HANFORD COMPANY  
 JOB NO. W011-H / ER4633  
 FILE NO. W011SAF1

\*\* TEST - INTERACTIVE ESTIMATING \*\*  
 BUILDING 6266 NSL HUMIDIFICATION  
 ROUGH ORDER OF MAGNITUDE  
 DOE\_R01 - PROJECT COST SUMMARY

PAGE 1 OF 7  
 DATE 06/02/94 08:45:57  
 BY J P M

COST CODE	DESCRIPTION	ESCALATED TOTAL COST	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
000	ENGINEERING	41,000	30	12,000	53,000
	(ADJUSTED TO MEET DOE 5100.4)	-1,000		-2,000	-3,000
501	BUILDINGS	143,000	30	43,000	186,000
	(ADJUSTED TO MEET DOE 5100.4)	7,000		-3,000	4,000
PROJECT TOTAL		190,000	30	50,000	240,000

B-12

WHC-SD-W011H-ES-002, REV. 0

TYPE OF ESTIMATE	ROUGH ORDER OF MAGNITUDE	JUNE 2, 1994	REMARKS:
ARCHITECT ENGINEER	<i>[Signature]</i>		<b>CHECK</b>
OPERATING CONTRACTOR			

(ROUNDED/ADJUSTED TO THE NEAREST " 1,000 / 10,000 " - PERCENTAGES NOT RECALCULATED TO REFLECT ROUNDING)



KAISER ENGINEERS HANFORD  
 WESTINGHOUSE HANFORD COMPANY  
 JOB NO. W011-H / ER4633  
 FILE NO. W011SAF1

\*\* TEST - INTERACTIVE ESTIMATING \*\*  
 BUILDING 6266 NSL HUMIDIFICATION  
 ROUGH ORDER OF MAGNITUDE  
 DOE\_R02 - WORK BREAKDOWN STRUCTURE SUMMARY

PAGE 2 OF 7  
 DATE 06/02/94 08:46:04  
 BY J P M

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	ONSITE INDIRECTS	SUB TOTAL	ESCALATION % TOTAL	SUB TOTAL	CONTINGENCY % TOTAL	TOTAL DOLLARS
111100	DEFINITIVE DESIGN-ONSITE E/C	21000	0	21000	0.00	0	30	27300
121000	ENGINEERING/INSPECTION-ONSITE E/C	10000	0	10000	0.31	31	30	13040
	SUBTOTAL 1 ENGINEERING	31000	0	31000	0.10	31	30	40340
320000	F/P CONSTRUCTION DRY-HUMIDIFICATION	101735	40616	142351	0.72	1025	30	186389
	SUBTOTAL 3 CONSTRUCTION	101735	40616	142351	0.72	1025	30	186389
400000	ONSITE CONTRACTOR PROJ/MGMT	10000	0	10000	0.00	0	30	13000
	SUBTOTAL 4 PROJECT INTEGRATION	10000	0	10000	0.00	0	30	13000
PROJECT TOTAL		142,735	40,616	183,351	0.58	1,056	30	239,722

B-13

MHC-SD-W011H-FS-002, REV. 0

1. DOCUMENTS AND DRAWINGS

=====

DOCUMENTS: NONE

DRAWINGS: SKETCH (NO DOCUMENT NUMBER)

2. MATERIAL PRICES

=====

UNIT COSTS REPRESENT CURRENT PRICES FOR SPECIFIED MATERIAL.

3. LABOR RATES

=====

CURRENT KEH BASE CRAFT RATES, AS ISSUED BY KEH FINANCE (EFFECTIVE 10-01-93), INCLUDE FRINGE BENEFITS, LABOR INSURANCE, TAXES AND TRAVEL WHERE APPLICABLE, PER HANFORD SITE STABILIZATION AGREEMENT, APPENDIX A (EFFECTIVE 09-06-93). NON CRAFT HOURLY RATES ARE BASED ON THE 1994 FISCAL YEAR BUDGET LIQUIDATION RATES AS ISSUED BY KEH FINANCE (EFFECTIVE 10-01-93).

4. GENERAL REQUIREMENTS/TECHNICAL SERVICES/OVERHEADS

=====

A.) ONSITE CONTRACT ADMINISTRATION AND CONSTRUCTION MANAGEMENT COSTS, ASSOCIATED WITH THE OVERALL MANAGEMENT OF THE FIXED PRICE CONTRACTS, ARE INCLUDED AS A COMPOSITE PERCENTAGE AND LUMP SUM ALLOWANCE (FOR BID PACKAGE PREP) BASED ON THE ESTIMATING FACTOR/BILLING SCHEDULE. THE TOTAL COMPOSITE PERCENTAGE AND LUMP SUM ALLOWANCE ARE APPLIED AGAINST THE TOTAL FIXED PRICE CONTRACT AMOUNT WHICH IS REFLECTED ON THE KEH SUMMARY REPORT DOER07, INCLUDED WITH THIS ESTIMATE. (FINAL ESTIMATES MAY BE PARTIALLY MANLOADED AND INCLUDED WITHIN THE ESTIMATE DETAIL)

B.) FIXED PRICE CONTRACTOR OVERHEAD, PROFIT, BOND AND INSURANCE COSTS HAVE BEEN APPLIED AT THE FOLLOWING PERCENTAGES AND ARE REFLECTED IN THE "OH&P/B&I" COLUMN OF THE ESTIMATE DETAIL:  
LABOR -35% MATERIAL -35% EQUIPMENT USAGE -15% EQUIPMENT -15% SUBCONTRACTS -15%

5. ESCALATION

=====

ESCALATION PERCENTAGES WERE CALCULATED BY THE HANFORD MATERIAL & LABOR ESCALATION STUDY, DATED FEBRUARY 1994.

6. ROUNDING

=====

U.S. DEPARTMENT OF ENERGY - DOE ORDER 5100.4 PAGE 1-32 SUBPARAGRAPH (M), REQUIRES ROUNDING OF ALL GENERAL PLANT PROJECTS (GPP'S) AND LINE ITEM (LI) COST ESTIMATES. REFERENCE: DOE 5100.4, FIGURE 1-11, DATED 10-31-84.

7. REMARKS

=====

- A.) ASSUME ALL WORK TO BE BY FIXED PRICE CONTRACTOR
- B.) ASSUME CONSTRUCTION TO BE COMPLETED BY NOV. 1994
- C.) ASSUME ALL WORK TO BE NON QA

KAISER ENGINEERS HANFORD  
WESTINGHOUSE HANFORD COMPANY  
JOB NO. W011-H / ER4633  
FILE NO. W011SAF1

\*\* IEST - INTERACTIVE ESTIMATING \*\*  
BUILDING 6266 NSL HUMIDIFICATION  
ROUGH ORDER OF MAGNITUDE  
DOE\_R06 - CONTINGENCY ANALYSIS BASIS SHEET

PAGE 6 OF 7  
DATE 06/02/94 08:25:12  
BY J P M

REFERENCE: ESTIMATE BASIS SHEET  
COST CODE ACCOUNT SUMMARY

PAGE 3 OF 7  
PAGE 4 OF 7

THE U.S. DEPARTMENT OF ENERGY - RICHLAND ORDER 5700.3 "COST ESTIMATING, ANALYSIS AND STANDARDIZATION" DATED 3-27-85, PROVIDES GUIDELINES FOR ESTIMATE CONTINGENCIES. THE GUIDELINE FOR A R O M ESTIMATE SHOULD HAVE AN OVERALL RANGE OF 30% TO 50% .

CONTINGENCY IS EVALUATED AT THE THIRD COST CODE LEVEL AND SUMMARIZED AT THE PRIMARY AND SECONDARY COST CODE LEVEL OF THE DETAILED COST ESTIMATE.

B-15

ENGINEERING

COST CODE 000

WBS 1.1 - 1.2 - 4.0 EXPENSE FOR ENGINEERING HAS BEEN BY PERCENTAGE METHOD FROM DIRECT CONSTRUCTION ESTIMATED COSTS. CONSEQUENTLY, DUE TO THIS APPLICATION OF ATTAINING COSTS A 30% CONTINGENCY HAS BEEN INCLUDED

AVERAGE ENGINEERING CONTINGENCY 30%

CONSTRUCTION

COST CODE 501

3.2 PLAN AND SPECIFICATION ENGINEERING AT THIS TIME IS INSUFFICIENT. THEREFORE WE HAVE INCORPORATED A 30% CONTINGENCY

AVERAGE CONSTRUCTION CONTINGENCY 30%

AVERAGE PROJECT CONTINGENCY 30%

MHC-SD-W011H-ES-002, REV. 0