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INSTRUMENT CORROSION DURING STERILIZATION AT UNITED
STATES AIR FORCE HOSPITAL, DYESS AIR FORCE BASE, TEXAS

Edward E. LeFebvre, et al

Environmental Health Laboratory
Kelly Air Force Base, Texas

May 1975

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Report

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INSTRUMENT CORROSION DURING STERILIZATION

AT USAF HOSPITAL, DYESS AFB TX

EHL(K) 75-5

MAY 1975

USAF ENVIRONMENTAL

HEALTH LABORATORY

KELLY AFB, TEXAS

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Pitting and corrosion of surgical instruments during autoclave sterilization has been a problem for the past few years at USAF Hospital, Dyess AFB TX. In mid - 1974, the severity of the problem became so great that surgical procedures had to be discontinued. The USAF Environmental Health Laboratory Kelly responded to an urgent request for analytical service in January 1975 to determine possible causes in the steam and boiler system. Field analysis indicates the problem was most likely		

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ITEM 20 (cont'd).

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USAF ENVIRONMENTAL HEALTH LABORATORY (AFLC)

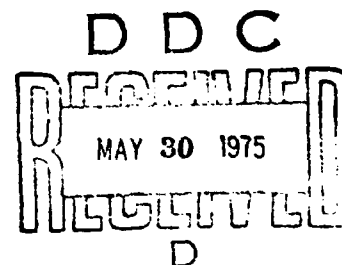
UNITED STATES AIR FORCE

KELLY AFB, TEXAS 78241

Instrument Corrosion During Sterilization at
USAF Hospital, Dyess AFB, TX

EHL(K) 75-5

May 1975



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Commander

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I. SUMMARY

Pitting and corrosion of surgical instruments during autoclave sterilization has been a problem for the past few years at USAF Hospital Dyess AFB, TX. In mid - 1974, the severity of the problem became so great that surgical procedures had to be discontinued. The USAF Environmental Health Laboratory Kelly responded to an urgent request for analytical service in January 1975 to determine possible causes in the steam and boiler system. Field analysis indicates the problem was most likely to be free carbon dioxide in the steam lines from thermal decomposition of carbonates and bicarbonates found in the boiler feed water. The water softener and dealkalizer were put into operation and a new automatic chemical feed system ordered. A second visit to perform on-site analysis was requested and accomplished in April 1975. The autoclave was found, at that time, to be connected to a 40 psi steam line rather than the recommended 50-80 psi line. Occasional inadequate rinsing of linens during laundering has also contributed to instrument "spotting". Corrective action in all of these areas is being taken.

II. INTRODUCTION

The USAF Hospital, Dyess AFB, TX, has been experiencing corrosion and pitting of surgical instruments during sterilization procedures in the autoclave. While the problem has existed for over three years, it has become quite severe in the past several months causing the instruments to be unsatisfactory for surgery. Consequently, the surgical department has suspended all surgery except acute, life-saving emergency procedures pending resolution of the problem. To assist in problem resolution, the USAF Environmental Health Laboratory, Kelly AFB, TX, provided on-site analytical chemistry services to attempt to isolate causes in the boiler plant operation. This report describes the analytical services rendered and an evaluation of the problem based on the analysis and two site visits to Dyess AFB.

III. DISCUSSION

A. Field Analysis

1. Deaerator Water

a. Removal of dissolved gases (oxygen and carbon dioxide) is accomplished by water passing over a series of heated plates by gravity and driving the gases out by solution. These gases rise and pass to the atmosphere through a $\frac{1}{4}$ " vent. The degasified water passes to a storage tank from which needed boiler water is taken. Water to the deaerator is from the condensate return and from a line to the city of Abilene water supply which provides make-up water to the system.

b. Results of on-site analysis of samples of water from the deaerator storage tank are shown in Table 1. Analysis indicates that the deaerator was functioning properly at the time of the sample collection on 29 Jan 75.

TABLE 1. Field Analysis of Water From Deaerator Storage Tank

PARAMETER	CONCENTRATION
Dissolved Oxygen	0.03 mg/l
Total Alkalinity	<20 mg/l
Hardness (Ca-EDTA)	<10 mg/l as CaCO ₃
Hardness (Total - EDTA)	<20 mg/l as CaCO ₃
Chlorides	<15 mg/l
Conductivity	70 umhos
Total Solids	35-40 mg/l
pH	8.3 units

2. Boiler Water

The water in the boilers is tested by the plant operators once each day for pH, tannin and solids to determine if additional chemicals are needed. In addition, pH was determined by EHL/K personnel to be 10.4 - 11.1 during the site visit. At the same time, the solids concentration was 2750 mg/l as determined by conductivity.

3. Boiler Plant Steam Header Condensate

a. The three boilers in the plant are connected through a header to the main steam line to the hospital. There is a sampling point above each boiler at the point where steam enters the header system. Samples were collected at the point above the middle boiler.

b. Steam samples were collected by passing the steam through a 50-foot copper tube immersed in ice in a 30-gallon trash can. The condensate passed into the BOD bottle which was allowed to overflow into a large container so that the sample was collected under water. A minimum of 15 minutes of overflow under water was allowed before accepting the samples. For dissolved oxygen analysis, reagents were added under water and the bottle capped before removing from the water bath. For other analyses, the bottle was also capped under water before removal. This procedure is a modification of that described by Powell(2).

c. Samples were collected between 0930-1100 hours on 31 Jan 75. The pH on five samples ranged from 4.9-5.7 with an average of 5.3. The dissolved oxygen was <0.02 mg/l. Determination of free carbon dioxide was made titrimetrically according to Standard Methods⁽³⁾. The presence of amines can contribute to positive error and there was less than 10 mg/l of amines present. The amount of CO₂ ranged from 4.9-6.6 mg/l in four samples with an average 6.1 mg/l. Extent of the amine contribution is unknown but considered small due to the low pH.

4. Surgery Autoclave Steam Line Condensate

a. Steam samples were collected at the surgery autoclave on the afternoon of 30 Jan 75 in the manner described above. The dissolved oxygen was found to be 0.02-0.03 mg/l and the pH was consistently 4.2. The CO₂ was 9.0 mg/l. Chloride, hardness and total solids were not measurable. Amines were also present in these samples. However, the presence of amines in the condensate does not mean that there will be no carbon dioxide in the steam phase. The presence of amines merely insures the removal of free CO₂ to prevent corrosion of condensate return lines but will not remove free CO₂ in the steam phase.

b. Sample collection was concentrated in this area on the second visit in April 1975. During this visit, this steam line was found to carry a pressure of 40 psi whereas the manufacturer's manual for the autoclave recommended 50-80 psi. The higher pressure would, of course, produce a dryer steam. The manual specified 97% vapor quality, dry steam. Collections were made at 40 psi and with a temporary pressure boost to 56 psi.

c. Steam quality parameters measured on-site were similar to January findings. Chloride, hardness and total solids were not measurable. The pH was improved at 6.3 to 6.6. The CO₂ also improved by dropping to 4.0 to 7.0 mg/l. Dissolved oxygen was up slightly to 0.08 mg/l. Surgical instruments autoclaved at the higher pressures were spotless and satisfactory for surgery. Autoclaving at the lower pressure showed water spots on unwrapped instruments and extensive spotting on some wrapped instruments.

d. Steam condensate was analyzed at EHL Kelly for phosphate to determine whether or not there was any indication of carryover. On at least one previous occasion, there had been foaming and carry over due to an excess of phosphate

added to the boiler water. The water level in the boiler is being more closely monitored now and the analysis indicates no detectable silica, iron or chromium in the condensate or the boiler feed water.

B. Laboratory Analysis

1. Water and Steam

a. Samples of water and steam condensate were collected and returned to EHL Kelly for more extensive analysis. These results are shown in Table 2. These analyses indicated no apparent causal factors.

b. Table 3 is the water analysis results of the water supply to Dyess AFB furnished by the city of Abilene. Various parameters were spot-checked in the field and indicated that this analysis is indicative of the water quality at the time of the site visit. These field results are included in the table for comparison. The relationship of phenolphthalein to total alkalinity indicates the presence of both carbonates and bicarbonates.

2. Used Steam Traps

During the January visit, many of the steam traps in the hospital were being replaced. Two of these were returned to the laboratory for analysis to see if they would provide information pertinent to the problem. Residue in the traps, as expected, was primarily iron oxide. Trace quantities of magnesium, silicon, aluminum, calcium, zinc and sodium were found and considered insignificant.

3. Surgical Linens

a. Because wrapped instruments were showing the most deposit after autoclaving, linen samples from both Dyess AFB and Hendricks Memorial Hospital in Abilene were submitted to the Laboratory. Linens were soaked in one liter of deionized water which was subsequently analyzed. There was approximately twice as much Dyess linen as Hendricks so that quantities of constituents would be expected to be double in the Dyess linen. However, the Dyess linen contained five times as much dissolved solids and ten times as much methylene blue active substances (usually surfactants). The pH of the Hendricks water extract was 5.9 while that of the Dyess sample was 3.1. These factors all indicate that the rinsing of this Dyess linen was not as thorough as the Hendricks linen. Sub-

TABLE 2. Analysis of Water and Steam Samples
USAF Hospital Dyess AFB, Texas

PARAMETER	All Results in mg/l				
	Boiler Feed Water	Deaeration Unit Storage Tank	Boiler Water	Boiler Steam Condensate	Steam Line Return
Dissolved Solids	324	91	1673	32	32
Suspended Solids	3	8	174	2	2
Volatile Suspended Solids	2	5	21	0	0
Surfactants	<0.1	<0.1	0.2	<0.1	0.2
Chloride	76	20	320	12	8
Fluorides	1.6	0.5	2.2	0.3	<0.1
Nitrates	<1	<1	Not Run	<1	<1
Phosphates (total)	0.2	<0.2	.50	<0.2	<0.2
Sulfates	46	9	400	<1	10
Chromium (Hex)	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium (total)	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	<0.10	0.19	1.06	<0.10	<0.10
Sulfides	<0.05	<0.05	<0.05	<0.05	<0.05
Hardness	120	32	30	12	12
Nitrite-N	<0.02	<0.02	<0.02	<0.02	<0.02
Ammonia-N	<0.2	<0.2	<0.2	<0.2	<0.2
Phosphates (other)	<0.2	<0.2	41.8	<0.2	<0.2
Fixed Suspended Solids	1	3	153	2	2

TABLE 3. Analysis of Water Supply to Dyess AFB from Abilene, Texas

PARAMETER	Results in mg/l unless noted	
	City Water Plant Analysis	EHLK Field Analysis
pH (Units)	9.9	
Phenolphthalein Alkalinity	17	20
Total Alkalinity	46	60
Hardness	98	100
Ammonia	0	
Nitrite	0.09	
Nitrate	2.32	
Sulfate	25	
Chloride	64	75
Calcium	14	20
Iron	<0.02	
Sodium	38	
Magnesium	15	
Potassium	6	
Phosphate	<0.2	
Total Solids	260	250
Total Coliform	0	
Algae Count	0	

sequent samples of the linens showed the opposite result, i.e. another sampling of Hendricks linen showed greater depositing on instruments than another sampling of Dyess linen. The variation from batch to batch in each of the linens does not appear to be limited to only one laundry's output.

C. Causes of Corrosion and Pitting

1. Oxygen and carbon dioxide in the steam system are generally responsible for corrosion and pitting. While oxygen may have been a contributing factor in the past, this is no longer a problem with the proper functioning of the deaerator so it will not be discussed further here.

2. Carbon dioxide arises chiefly from the bicarbonate and carbonate alkalinity of the makeup water to the boilers. When subjected to boiler temperature, they undergo thermal decomposition and liberate carbon dioxide which becomes entrained with the steam⁽¹⁾. Dealkalization of the make-up water by the use of hydrogen zeolite, chloride anion exchange or any other suitable process should eliminate this problem.

3. Metallic ions, especially calcium and magnesium, may also contribute to corrosion problems in the boiler system causing poor operation. These "hardness" ions are easily removed with a conventional water softening system such as that available in the boiler plant.

4. Deposits may appear on surgical instruments from two other sources. The first is from carry over of boiler chemicals such as phosphates from addition of a large excess. This is being corrected by the installation of automatic chemical feeders. The second source is from inadequate rinsing of linens coupled with moist steam. The wet steam serves to provide enough moisture to wash the residue on to the instrument. Better laundry quality control and increased steam pressure is expected to eliminate this as a problem source.

IV. CONCLUSIONS

A. Pitting and corrosion of surgical instruments during sterilization procedures has been caused by dissolved oxygen and carbon dioxide in the steam line from the boiler plant.

B. Dissolved oxygen has been eliminated as a problem with the placing of the deaerator into proper operation in mid-January 1975.

C. Bicarbonate and carbonate alkalinity in the makeup water supply provided a source for carbon dioxide in the steam line. Dealkalization of the makeup water will remove this problem.

D. Operation of the water softener should enhance boiler operation.

E. Better laundry quality control is necessary to reduce residue left in linens.

F. Proper steam pressure to the autoclave is needed to produce dryer steam.

V. RECOMMENDATIONS

A. Maintain the present operation of the deaerator, and insure proper operation of the water softener.

B. Monitor the contract laundry to insure adequate rinsing of linens.

C. Bring the steam line to pressures to meet autoclave manufacturers specifications and provide a steam that is adequately dry.

VI. REFERENCES

1. Betz Handbook of Industrial Water Conditioning, 6th Ed. (1962)
Betz Laboratories Inc., Trevese, PA L9047.
2. Powell, S.T. (1954). Water Conditioning for Industry. McGraw -
Hill Book Co., New York.
3. Standard Methods for the Examination of Water and Wastewater,
13th Ed. (1971). American Public Health Association, New York.

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INFO RUVKAAA/USAF EHL KELLY AFB TX/CC
RUYTDGA/USAF HOSP DYESS AFB TX/SG
ZEN/CINCSAC OFFUTT AFB NE/DEMU

BT 16
UNCLAS

SUBJ: EMERGENCY REQUEST FOR LABORATORY SERVICES
1. ENVIRONMENTAL HEALTH LABORATORY ASSISTANCE IS REQUESTED TO RESOLVE CRITICAL PROBLEM WITH STEAM OPERATED STERILIZER AT USAF HOSP DYESS, DYESS AFB TX. SURGICAL INSTRUMENTS ARE BEING RUINED BY DEPOSITS AND CORROSION DURING STEAM STERILIZING PROCESS. PRELIMINARY EVALUATION BY USAF EHL (K) HAS SUGGESTED THE PROBLEM MAY BE CAUSED BY EXCESSIVE DISSOLVED GASSES IN THE SYSTEM. INEFFECTIVENESS OF DEAIRATOR IS SUSPECTED TO BE THE SOURCE OF THE PROBLEM.
2. CINCSAC/DE PERSONNEL HAVE DEvised A FIX WHICH IS BEING IMPLEMENTED LOCALLY. EHL SUPPORT IS REQUIRED TO DETERMINE THE EFFICIENCY OF DEAIRATOR AFTER REPAIRS HAVE BEEN ACCOMPLISHED.

PAGE 2 RUVTEKASG47 UNCLAS

LT COL A. M. ELLIOTT, EHL (K), HAS INDICATED, VIA TELECON, THAT LABORATORY SUPPORT COULD BE PROVIDED BY 27 JANUARY 1975.
3. THE SURGICAL SUITE AT USAF HOSP DYESS IS CURRENTLY CLOSED, RESULTING IN A MAJOR IMPACT ON MEDICAL SUPPORT PROVIDED AND PROHIBITIVE COSTS FOR REFERRALS TO LOCAL MEDICAL FACILITIES.
4. THIS MESSAGE CONFIRMS TELECONS BETWEEN LT COL ELLIOTT, EHL (K), MAJOR SHEAD, AFLC/SGP, AND MAJOR DOUGHERTY, CINCSAC/SGPAB, ON 23 JAN 75.

BT
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*Cy D. Melvin
Lt Col Elliott
File*

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PRIORITY

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PTTUZYUW SUVA AAAA 29 0242000-UUUU--PQYKAAA.

ZNR UUUUU

0242000Z JAN 75

FM AFLO WPAFB OH/SSB

TO: RUVAAA/USAF/HL KELLY AFB TX/CC

INFO: RUVTEKA/CINCSAC OFFUTT AFB NE/SSP

BT BS

UNCLAS/SSB

SUBJECT: EMERGENCY REQUEST FOR LABORATORY SERVICES (CINCSAC/SSP MESSAGE 0232055Z JAN 75).

REQUEST YOU RESPOND TO EMERGENCY ASSISTANCE REQUIREMENT CITED IN SUBJECT MESSAGE. THIS CONFIRMS TELECON BETWEEN LT COL ELLIOTT AND MAJOR SHEAD ON 23 JAN 75.

BT

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TOP-02-2087Z

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EHL/KELLY AFB TX/CC
DYESS AFB TX/DE

AS.
IS INTERIM REPORT-DYESS SURGERY CLOSURE
FIELD ANALYSIS AT DYESS AFB HOSPITAL ON STEAM TO SURGICAL
ISOLATE HAS BEEN COMPLETED. DEAERATOR AT BOILER PLANT APPEARS
TO BE FUNCTIONING PROPERLY AND ELIMINATING DISSOLVED OXYGEN
AND CARBON DIOXIDE. HOWEVER, SEVERE CORROSION STILL APPEARS
ON SURGICAL INSTRUMENTS. SURGERY REMAINS CLOSED.
SAMPLES OF WATER, CONDENSATE AND STEAM TRAPS ARE BEING
RETURNED TO EHL/KELLY FOR MORE DETAILED ANALYSIS. PENDING
LABORATORY ANALYSIS OF THESE SAMPLES RECOMMEND THAT (A) ACTION
BE TAKEN TO PLACE BOILER PLANT DEMINERALIZER INTO OPERATION
AT EARLIEST OPPORTUNITY AND (B) CONSULTANT WITH EXPERTISE IN
BOILER PLANT OPERATION BE OBTAINED TO REVIEW CURRENT

2 RHDAARA1848 UNCLAS
ITEM AND RECOMMEND SOLUTION.

8

Ag Dr Melvin
Lt Col Abbott
File
Monroe

009Z

PRIORITY

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HKCC file 923

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ROUTINE

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UNTEKA/CINCSAC OFFUTT AFB NE/DE
EHL KELLY AFB TX/CC
DYESS AFB TX/DE

AS:
RENCE OUR MSG 312125Z JAN 75. REQUEST GUIDANCE IN
CURRING SERVICES OF STEAM PLANT CONSULTANT AS RECOMMENDED
ITED MESSAGE. EFFORTS AT THIS LEVEL HAVE FAILED TO PRODUCE
A SPECIALIST. DYESS HOSPITAL SURGERY DEPARTMENT REMAINS
ED.

7

*Cy D. Melvin
H. Cal Elliott
File
Macee*

TOR-C361732Z

PRIORITY

MLN-004517

PT TUZYUW RUWTEKA 3401 0861700-UUU- -RUVKAAA.

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P R 271435Z MAR 75

FM CINCSAC OFFUTT AFB NE/SGPAB
TO RUVKAAA/USAFEHL KELLY AFB TX
INFO RUVARIA/AFLC WPAFB OH/SGB
RHDAAA/USAFHOSP DYESS AFB TX/SG

BT

UNCLAS

SUBJ: REQUEST FOR CONSULTANT SERVICES

1. REQUEST ADDITIONAL CONSULTANT SERVICES BE PROVIDED TO USAF HOSP DYESS. DYESS AFB TX. TO ASSIST IN RESOLVING PROBLEM OF INSTRUMENT CORROSION IN STERILIZER. SINCE YOUR LAST VISIT, THE SOFTENER HAS BEEN REHABED AND THE DEALKALIZER REPLACED. THE BOILERS HAVE BEEN CLEANED. CONTROLLED TESTING HAS SHOWN OCCASIONAL IMPROVEMENT BUT NO CONSISTENT IMPROVEMENT TREND HAS BEEN NOTED.
2. REQUEST THAT ALL WATER/STEAM CONDENSATE ANALYSIS INCLUDE DISSOLVED OXYGEN, CARBON DIOXIDE, SILICA, ALKALINITY (ALL TYPES) PH, CHLORIDES, TOTAL DISSOLVED SOLIDS, CHROMIUM, IRON SULFIDES, AND HARDNESS (MAGNESIUM AND CALCIUM).
3. CARRYOVER OF WATER WITH THE STEAM MAY BE CONTRIBUTING TO THE PROBLEM. BECAUSE OF THE COMPLEXITY OF THIS SYSTEM AND THE NEED FOR A SYSTEM

AGE 2 RUWTEKA 3401 UNCLAS

APPROACH, IT IS REQUESTED THAT AN ENGINEER ACCOMPANY THE CHEMICAL ANALYSIS TEAM.

. THIS REQUEST HAS BEEN COORDINATED WITH AFLC/SGB.

T

3401

DEPARTMENT OF THE AIR FORCE
USAF ENVIRONMENTAL HEALTH LABORATORY (AFLC)
KELLY AIR FORCE BASE, TEXAS 78241



REPLY TO
ATTN OF: CC

4 February 1975

SUBJECT: Trip Report

TO: Commander, USAF Env Health Lab/CC, Kelly *Wright*
AFLC/SGB
Wright-Patterson AFB OH 45433
IN TURN

1. Place: Dyess AFB TX
2. Inclusive Dates of Travel: 28 Jan - 1 Feb 75
3. Persons Making Trip: Major E. E. Lefebvre
TSgt S. A. Britt
4. Primary Mode of Transportation: Private automobile
5. Purpose of Trip: To perform analysis of boiler waters, steam and condensate at the hospital boiler plant. Surgery is presently closed due to corrosion of instruments during autoclaving.
6. Persons Contacted:

Colonel Woltjen, Hospital Commander
Lt Colonel Braden, Hospital Executive Officer
Major Christensen, O.R. Supervisor
Captain Jasper, O.R. Nurse
MSgt Agee, NCOIC Environmental Health
MSgt Ellis, NCOIC Surgery
MSgt Sims, Civil Engineering
Mr. Swindle, Hospital Plant Supervisor
Mr. Russell, Mechanical Engineer, Civil Engineering
7. Findings or Observations:
 - a. Problem has existed for at least three years but has gotten gradually worse.
 - b. Revisions in operation of the boiler plant deaerator were completed one week prior to EHL site visit.
 - c. Sampling and analysis of steam lines reveals no dissolved oxygen. This should eliminate pitting of instruments.

d. While the deaerator is removing both dissolved oxygen and carbon dioxide, CO₂ appears in the steam line at the boiler header and the hospital autoclave. A probable source for CO₂ is the breakdown of carbonates and bicarbonates from the water supply.

e. Both the dealkalizer and water softener systems are currently inoperative. There is no literature or operating procedures for these items and no record of how or when they may have been fully functional.

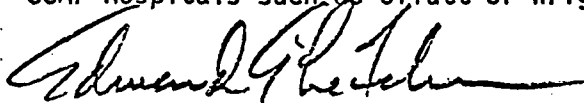
f. USAF Hospital Dyess Surgery is closed pending resolution of the problem.

8. Conclusions and Recommendations:

a. Pitting of instruments should stop due to elimination of dissolved oxygen but corrosion remains a problem sufficient to have the surgery remain closed.

b. The dealkalizer should be put into operation on a high priority basis to eliminate chemicals contributing to corrosion problem.

c. A consultant with expertise in boiler plant operation should be retained to review problem and recommend solutions. An alternate solution for consideration is to consult responsible operating personnel at other USAF Hospitals such as Offutt or Wright-Patterson for possible solutions.



EDWARD E. LEFEBVRE, Major, USAF, BSC
Chief, Laboratory Env Studies Branch

Cy to: EHL/M, McClellan AFB CA
SGPM, Dyess AFB TX
DEMMH, Dyess AFB TX
Hq SAC/SGP, Offutt AFB NE

DEPARTMENT OF THE AIR FORCE
USAF ENVIRONMENTAL HEALTH LABORATORY (AFLC)
KELLY AIR FORCE BASE, TEXAS 78241



REPLY TO
ATTN OF: CC

15 Apr 1975


SUBJECT: Trip Report

10- Commander, USAF Environmental Health Lab/CC, Kelly AFB TX
AFLC/SGB, Wright-Patterson AFB OH 45433
IN TURN

1. Place: Dyess AFB, TX
2. Inclusive Dates of Travel: 8 - 11 Apr 1975
3. Persons Making Trip: Maj E. E. LeFebvre and TSgt S. A. Britt
4. Primary Mode of Transportation: Private automobile
5. Purpose of Trip: To provide on-site analytical service on sterilizer corrosion problem as requested by Hq SAC/SGPAB.
6. Persons Contacted: Colonel Woltjen, Hospital Commander
Colonel Murray, Civil Engineer
Lt Colonel Braden, Hospital Executive Officer
Major Christensen, O. R. Supervisor
Captain Jasper, O. R. Nurse
MSgt Agee, NCOIC Environmental Health
MSgt Ellis, NCOIC Surgery
MSgt Sims, Civil Engineering
Mr. Swindle, Hospital Plant Supervisor
Mr. Ball, Chief Engineer, C. E.
Mr. Russell, Mech Engineer, C. E.
7. Findings and Observations:
 - a. Dealkalizer and water softener have been put into operation since our last visit in January 1975. Steam quality appears improved.
 - b. Instrument pitting has stopped and corrosion is now sporadic.
 - c. Corrosion problem appears to be related partly to occasional inadequate rinsing of linens during laundering.
 - d. The sterilizer is connected to a 40 psi steam line while the manufacturer's manual specifies a 50 - 80 psi steam line.
 - e. A new chemical treatment system with automatic feeders is scheduled to be installed on the boilers in a week.

8. Conclusions and Recommendations: Several factors have contributed to this problem and should be corrected by past and programmed actions including:

- a. Operation of dealkalizer and softener,
- b. Installation of automatic chemical feeding equipment on boilers,
- c. Connection of Sterilizer to correct steam line as recommended by the manufacturer, and
- d. Inspection of new contract laundry facility to insure proper techniques are employed in laundering linens.


EDWARD E. LEFEBVRE, Major, USAF, BSC
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