DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150698

PRELIMINARY DESIGN PACKAGE FOR NONCORROSIVE FLUID SUBSYSTEM, SOLAR HEATING AND COOLING

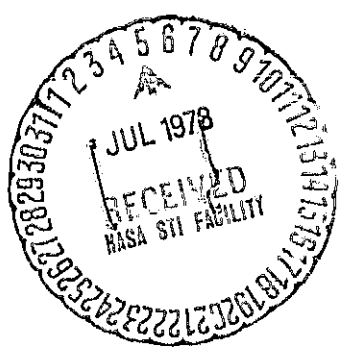
Prepared by

Houston Chemical Company
1 Gateway Center
Pittsburgh, Pennsylvania 15222

Under Contract NAS8-32255 with

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy



U.S. Department of Energy

Solar Energy

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
DOE/NASA CR-150698		

4. TITLE AND SUBTITLE	5. REPORT DATE
Preliminary Design Package for Noncorrosive Fluid Subsystem, Solar Heating and Cooling	May 1978
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT #
9. PERFORMING ORGANIZATION NAME AND ADDRESS Houston Chemical Company 1 Gateway Center Pittsburgh, Pennsylvania 15222	10. WORK UNIT NO.
	11. CONTRACT OR GRANT NO. NAS8-32255
12. SPONSORING AGENCY NAME AND ADDRESS National Aeronautics and Space Administration Washington, D. C. 20546	13. TYPE OF REPORT & PERIOD COVERED Contractor Report
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

This work was done under the technical management of Mr. John C. Caudle, George C. Marshall Space Flight Center, Alabama.

16. ABSTRACT

This report contains the information necessary to evaluate the preliminary design for noncorrosive fluids for use in solar heating and cooling systems. Included are drawings for subsystem definition, rationale for special handling, installation and maintenance tools, and an outline for hazard analysis, along with development and testing plans.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
	Unclassified-Unlimited William A. Brooksbank, Jr. WILLIAM A. BROOKSBANK, JR. Mgr, Solar Heating and Cooling Project Office

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
Unclassified	Unclassified	21	NTIS

TABLE OF CONTENTS

INTRODUCTION

Houston Chemical, under NASA/MSFC Contract NAS8-32255, is tasked with the development of noncorrosive transport fluids. The fluids shall be compatible with closed looped solar heating, combined heating or hot water systems, compatible with both metallic and non-metallic plumbing systems, and any combination of them.

Some renumbering of pages and slight modifications have been done in the interest of clarity only.

SECTION 1

PRELIMINARY DESIGN REVIEW DATA

PRELIMINARY DESIGN REVIEW DATA

The following documentation is being submitted to the Marshall Space Flight Center two weeks prior to the review in compliance of NASA Contract NAS 8-32255 Appendix B, "Management System," under paragraph 4.1 "Preliminary Design Review."

4.1.3 a. Drawing list required for subsystem definition.

Since the contract covers the evaluation of solar heat transport fluids there are no drawings of the subsystem. However, following is a list of reports which will be prepared and submitted:

"Selection of Solar Heat Transport Fluids Through a Screening Process"

"The Determination of Metals Intrained in Solar Heat Transport Fluids"

"Corrosion Evaluation in Solar Collector Panels"

"Parameters for Solar Heat Transport Fluids"

b. Description and rationale for proposed special handling, installation, and maintenance tools.

Handling - All solutions must be premixed to insure proper solution concentration.

Installation - typical of liquid filled systems.

Maintenance tools - No special maintenance tools are recommended but as program develops tools or instruments may be recommended such as concentration determination, pH, etc.

c. Hazards analysis (505-18, Appendix A)

The subsystems hazard analyses shall identify any extreme conditions or potential hazard sources such as voltage, pressure, flammability, toxicity, etc. in the subsystems. It shall include the following:

1. Identification of all hazards to personnel, equipment and structures and action taken to eliminate or control these. Identify the source of the hazard and level (major or minor).

2. Residual hazards and rationale for acceptance.

3. Hardware failure modes at the component level that contribute to occurrence of the hazard.

Minimal hazards are associated with the heat transport fluids used in these tests.

Flash points of the H.T.F. in their concentrated form are above 250°F. Flash points of the solutions are not measurable. Vapor pressures are less than 0.1 mm Hg at 20°C.

Should any of the solutions burn through exposure to open flame or electrical sparks, standard fire extinguishing methods with water, CO_2, or dry chemicals are applicable.

The oral toxicity of the concentrated solutions, when performed on rabbits range from 15.38 g/Kg to 34.6 g/Kg. It should be noted that for ethylene glycol-based materials a single dose oral toxicity is greater to humans than animals. Serious injury or death may result from ingestion of somewhat over two fluid ounces of concentrated ethylene glycol-based materials.

Skin penetration—LD_{50} dose of the concentrated materials when tested on rabbits is greater than 20 ml/Kg. None of the heat transfer materials are active skin irritants.

Standard industrial safety procedures have been proven to be sufficient in the use and handling of these materials.

d. List of data which the contractor recommends to be used to accomplish the design review.

1) Data which pertains to how the evaluation was conducted:

Flow - To be measured in each system

Temperature - To be measured at the following points:

Collector inlet
Collector outlet
Heat exchanger inlet
Heat exchanger outlet

2) Data which pertains to the solar heat transport fluid:

Wet Chemistry
Appearance
Ash content
Foaming
pH
Reserve Alkalinity
Viscosity

3) Data which pertains to corrosion of the solar system:

Determining if metals are in solution in the solar heat transport fluid by instrumental analysis

Surface inspection by appearance

Weight - possibly measuring sections before and after test

Photography - to record corrosion

e. Proposed government furnished instrumentation delivery dates.

No government instrumentation is being used.

f. All Type 1 and 2 documents to be approved at the review

* Type 1 and 2 documents do not apply to this contract.

* This statement is incorrect and was resolved at the Design Review.

SECTION 2

DEVELOPMENT PLAN

DEVELOPMENT PLAN
HOUSTON CHEMICAL COMPANY

1. Test Stand

We propose to construct a test stand platform in accordance with standard building practices, to accommodate sufficient collector panels to further the project.

We propose sixty-four (64) panels, arranged to test the sub-system. This would provide separate systems for running tests coincidentally. We feel this would be an adequate minimum.

Details of the Test Stand

One-inch asphalt slab

Services to enter the building below grade

South elevation, 2' above grade

North elevation, 15' above grade

Roof, 30' x 74' at +25° above horizontal (to nearly match the site's latitude)

2. Coincidental to the construction of the test stand would be activities toward setting up tests, candidate formulae, methods of data recovery, recording, evaluating, scheduling, reporting techniques, etc. for use when the plant starts generating useful and meaningful data. These are routines we have long followed, but we recognize that some variations and modifications and new aspects will come from NASA's requirements to monitor the program and progress effectively.

3. The test stand will be inspected daily for proper operation of the system and the instrumentation, and for maintaining liquid tight integrity.

4. Weekly, from automatic records significant to test needs, temperature data will be recovered.

5. Each test candidate fluid will be sampled periodically and evaluated for deterioration and general performance.

5.1 Monthly sampling of the fluids - wet chemistry

5.2 Bi-monthly instrumental analysis via atomic absorption method

Tests will include:

Wet Chemistry	Instrumental Analysis
Appearance*	Atomic Absorption
Ash Content**	Spectrophotometric
Foaming**	X-ray, if necessary
pH*	
Reserve Alkalinity*	
Viscosity**	

* Monthly tests
** Used if panel fails or at end of test, whichever occurs first.

6. Open collector panel internal passages for examination and evaluation, and schedule it only when we experience failure or complete a panel test. This technique will also be followed when a high pick-up of metal (collector composition) has been noted by instrumental analysis data.

As the test proceeds and as we build up test stand running time, we will correlate data from all points of recovery.

It should be noted that once the tests have been run, and the test stand is still viable, further work, if indicated or required, could be extended with a new contract and without the initial start-up and construction costs.

7. Complete records of data, work, etc. as required by NASA will be diligently handled.

8. Reports NASA will require will be handled expeditiously and will reflect the demands imposed on contractors to best manage the program for the government.

   The contractor will consider amending or modifying whatever within this contract is too far afield from standard format.

9. During the first quarter, approximately three months after contract award, a detailed schedule for the remaining work will be determined and a no-cost contract change will be made recognizing the schedule. Work will be completed not later than 26 months after contract award.

10. If necessary, future changes in this development plan, by written agreement between the NSFC technical manager and Houston Chemical project manager can be executed.

PRELIMINARY SCHEDULE

Test Stand

1. Build and equip test stand to readiness.
2. Charge banks with base line fluids.
3. Charge banks with candidate fluids.
4. Recover samples.
5. Remove panels only if a panel fails and at end of test, whichever occurs first.

Analysis and Evaulation

1. Devise new test methods; attempt to correlate with current methods, repeatability, etc.
2. Develop analytical data for base-line fluids.
3. Screen for candidate fluids.
4. Analyze, correlate, evaluate and record data. Modify program to utilize pertinent data gained.
5. Disassemble collector, open it, visually inspect and instrument-ally evaluate action of fluid on panel where it interfaces fluid.

NOTE: Much of the initial work, and part of the continuing activity, will be empirical. Only after the pilot plan begins to turn out meaningful and useful data, can a definitive schedule come forth. This should not present any problems in the time frame

or general progress of the project. When researching into new, if also related fields to our experience, empirical approaches are fairly common to our discipline.

PANEL UTILIZATION

To develop base-line data of fluid performance and its effects on solar collectors.

Bank	Collector Metal*	Fluid on Test
1. (1)	Copper	100% Deionized water
2. (1)	Aluminum	100% Deionized water
3. (1)	Steel	100% Deionized water
4. (1)	Copper	100% Hard water
5. (1)	Aluminum	100% Hard water
6. (1)	Steel	100% Hard water
7. (2)	Copper	50/50% MEG/deionized water
8. (2)	Aluminum	50/50% MEG/deionized water
9. (2)	Steel	50/50% MEG/deionized water
10. (2)	Copper	50/50% PG/deionized water
11. (2)	Aluminum	50/50% PG/deionized water
12. (2)	Steel	50/50% PG/deionized water
13. (1)	Copper	60/40% Glycerine/deionized water
14. (1)	Aluminum	60/40% Glycerine/deionized water
15. (1)	Steel	60/40% Glycerine/deionized water
16. (2)	Copper	MEG (M1)
17. (2)	Aluminum	MEG (M1)
18. (2)	Steel	MEG (M1)
19. (2)	Copper	MEG (M2)
20. (2)	Aluminum	MEG (M2)
21. (2)	Steel	MEG (M2)
22. (2)	Copper	MEG (M3)
23. (2)	Aluminum	MEG (M3)
24. (2)	Steel	MEG (M3)
25. (2)	Copper	MEG (M4)
26. (2)	Aluminum	MEG (M4)
27. (2)	Steel	MEG (M4)
28. (2)	Copper	PG (P1)
29. (2)	Aluminum	PG (P1)
30. (2)	Steel	PG (P1)

* See page that follows.

31. (2)	Copper	PG (P2)
32. (2)	Aluminum	PG (P2)
33. (2)	Steel	PG (P2)
34. (2)	Copper	TEG (T1)
35. (2)	Aluminum	TEG (T1)
36. (2)	Steel	TEG (T1)
37 (1)	Unassigned**	To be determined later

Numbers in parenthesis (), are collector panels/bank.

MEG = Monoethylene glycol

TEG = Triethylene glycol

PG = Propylene glycol

* All plumbing is copper with 50/50 solder, sweated joints

** Open bank for testing non-metallic collectors if mutually agreed.

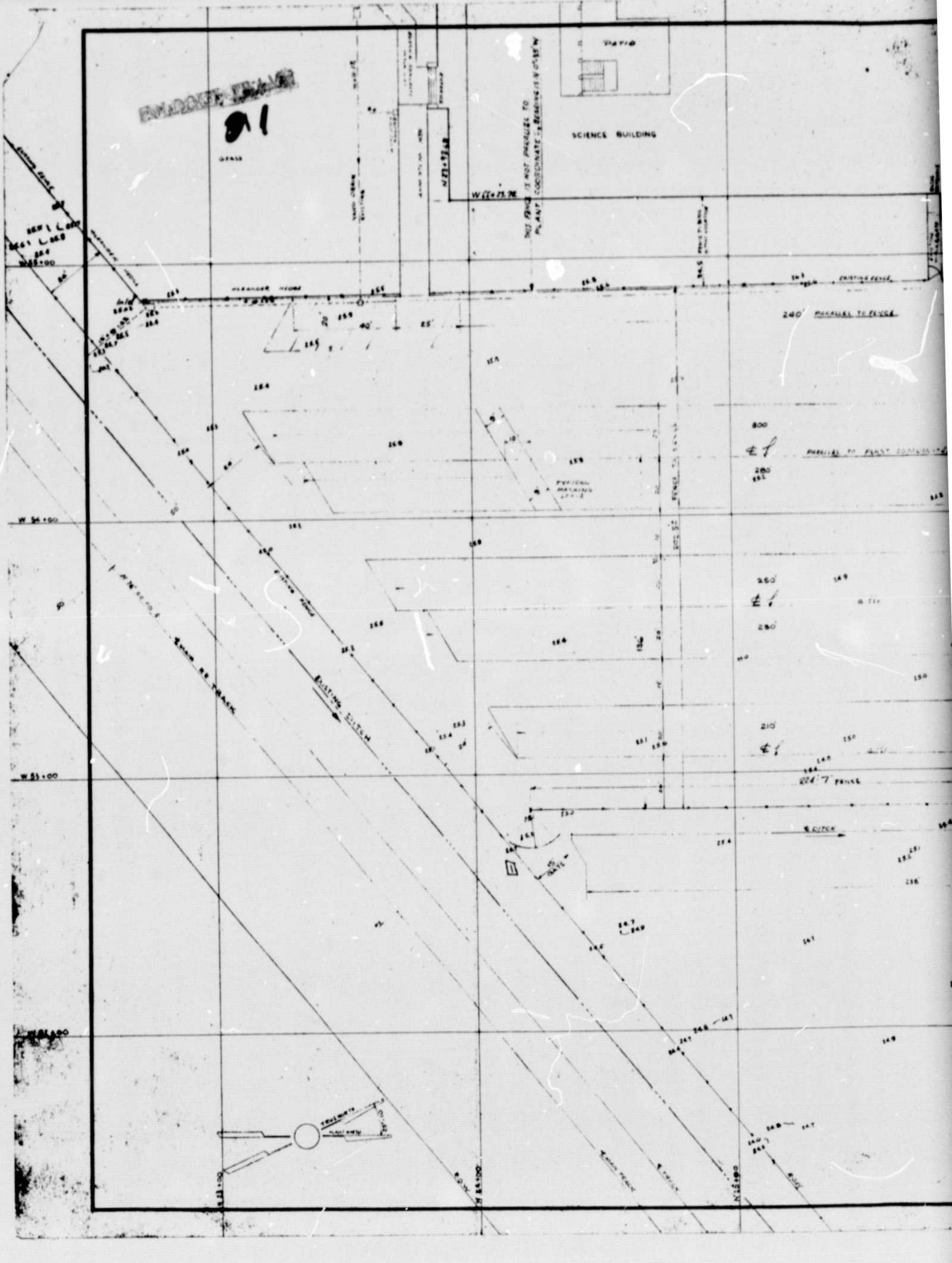
NOTE: As any bank develops sufficient significant data with correlation possibilities to balance of test program, that bank will be aborted and terminated. This will provide, after refurbishing terminated banks, new banks for further testing of candidates indicated from feedback data.

Candidates, Inhibitors

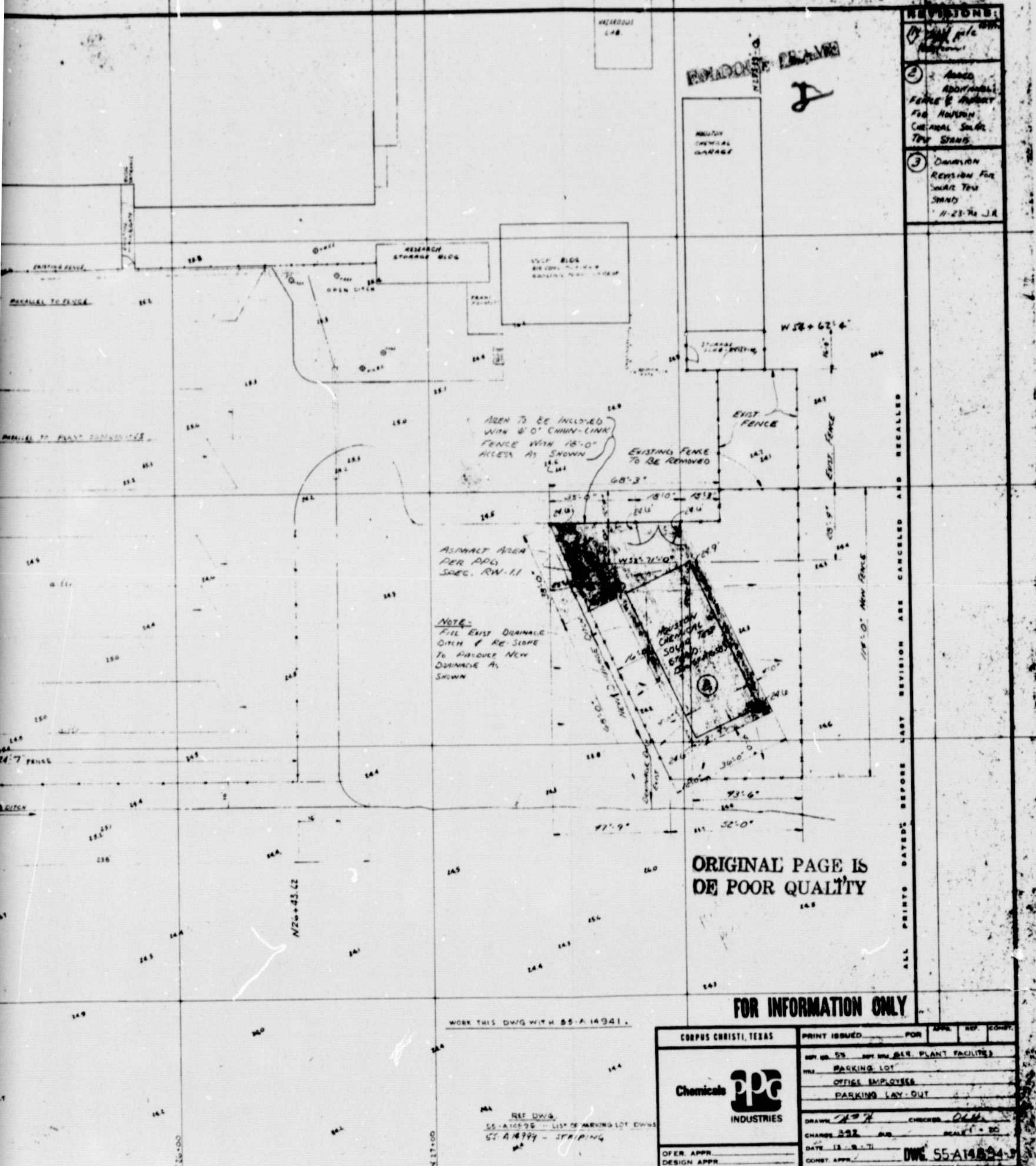
Candidates in Bank 16 through 36 will contain inhibitors. A number of these inhibitors will be those as used in top flight coolants. Other inhibitors will be selected based on the requirement of the system in the bank being evaluated. They will be selected from a wide spectrum and basically proved by our in-house experience and recorded knowledge, and by whatever testing, e.g., wet chemistry, etc. to qualify them as likely candidates for test in the panel bank(s).

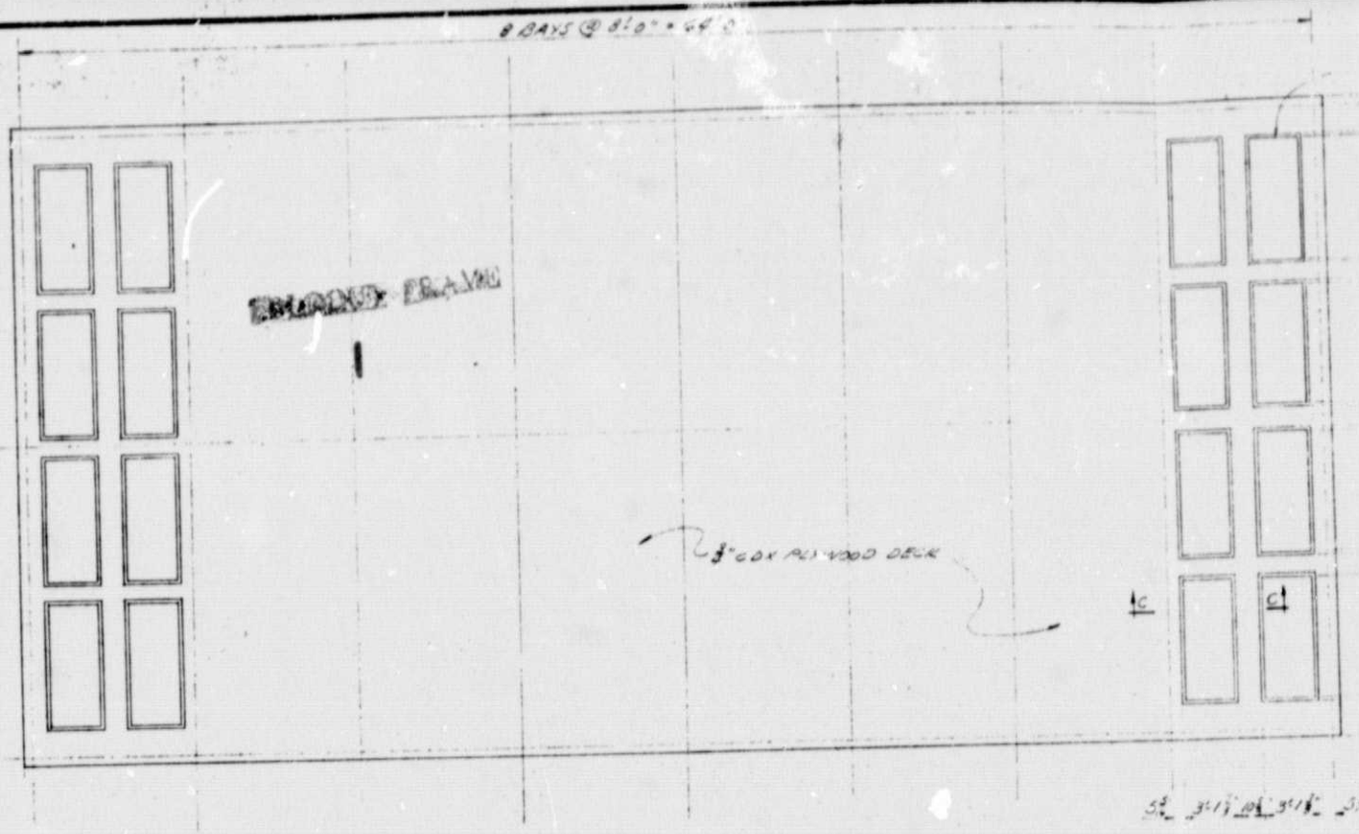
SECTION 3

DRAWINGS

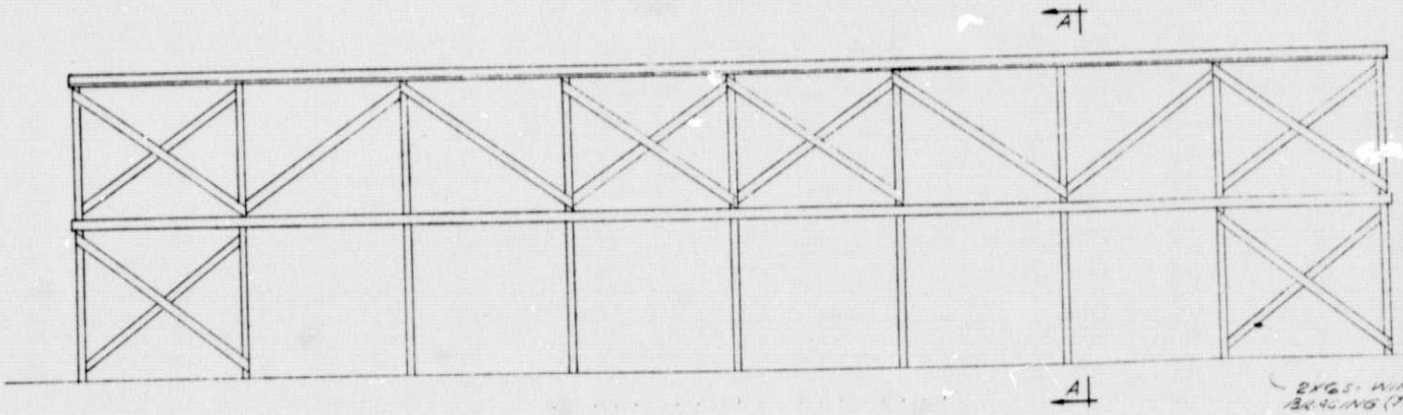


PATIO
SCIENCE BUILDING
GRASS
EXISTING FENCE
240' PARALLEL TO FENCE
EXISTING DITCH
W 54+00
W 53+00
250'
230'
210'


REVISIONS
2 ADDED ADDITIONAL FENCE & ASPHALT FOR HOUSTON CHEMICAL SOLAR TEST STANDS
3 DRAWING REVISION FOR SOLAR TEST STANDS 11-23-76 J.R.
HOUSTON CHEMICAL GARAGE
RESEARCH STORAGE BLDG
OPEN DITCH
EXISTING FENCE
PARALLEL TO FENCE
W 58+62.4'
AREA TO BE INCLOSED WITH 6'0" CHAIN-LINK FENCE WITH 18'-0" ACCESS AS SHOWN
EXIST. FENCE
EXISTING FENCE TO BE REMOVED
68'-3"
ASPHALT AREA PER PPG SPEC. RW-1.1
NOTE: FILL EXIST DRAINAGE DITCH & RE-SLOPE TO PRODUCE NEW DRAINAGE AS SHOWN
HOUSTON CHEMICAL SOLAR TEST STAND
NEW FENCE
EXIST. FENCE
43'-6"
47'-9"
32'-0"
N20+43.42
ORIGINAL PAGE IS OF POOR QUALITY
ALL PRINTS DATED BEFORE LAST REVISION ARE CANCELED AND RECALLED
FOR INFORMATION ONLY
WORK THIS DWG WITH 55-A14941.
REF DWG
55-A14999 - STRIPING
CORPUS CHRISTI, TEXAS
PPG INDUSTRIES Chemicals
PRINT ISSUED FOR
PARKING LOT
OFFICE EMPLOYEES
PARKING LAY-OUT
OPER. APPR.
DESIGN APPR.
DWG. 55-A14934



ROOF PLAN



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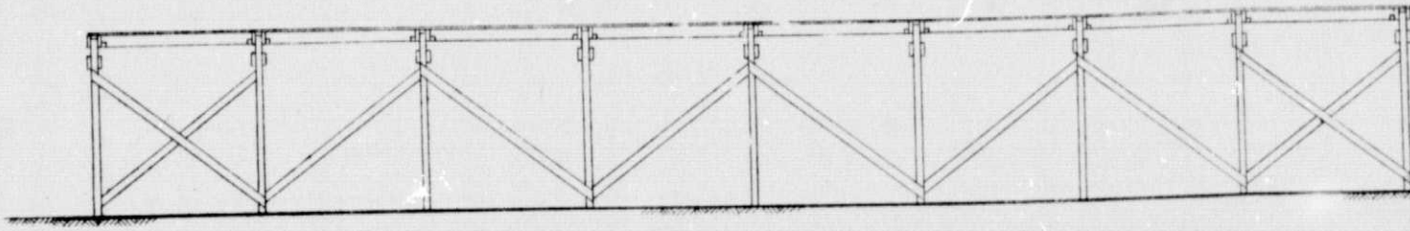
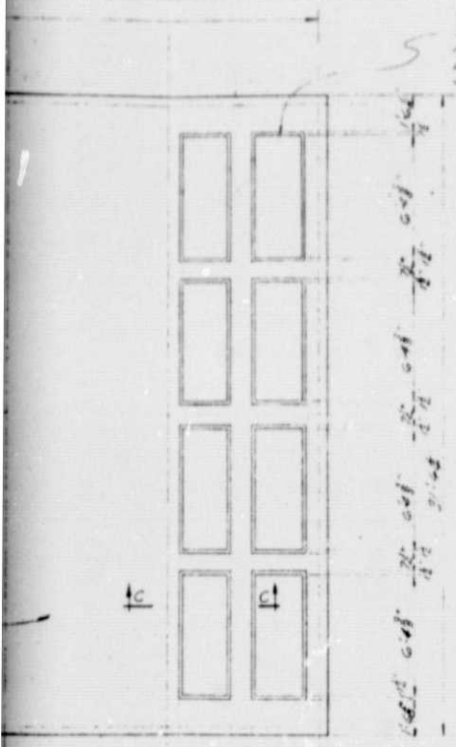
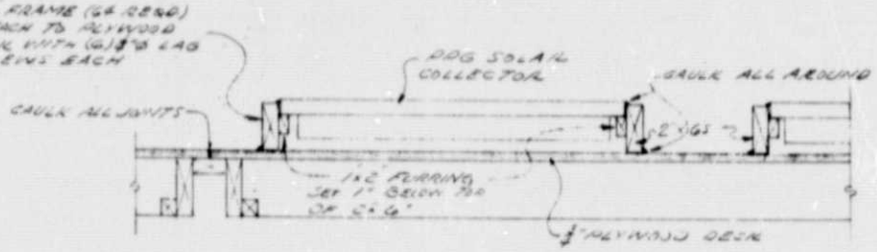


ELEVATION AT SECTION B-B

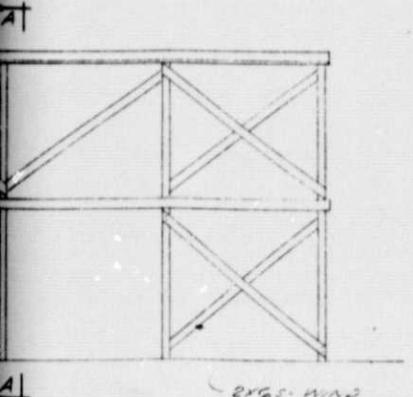




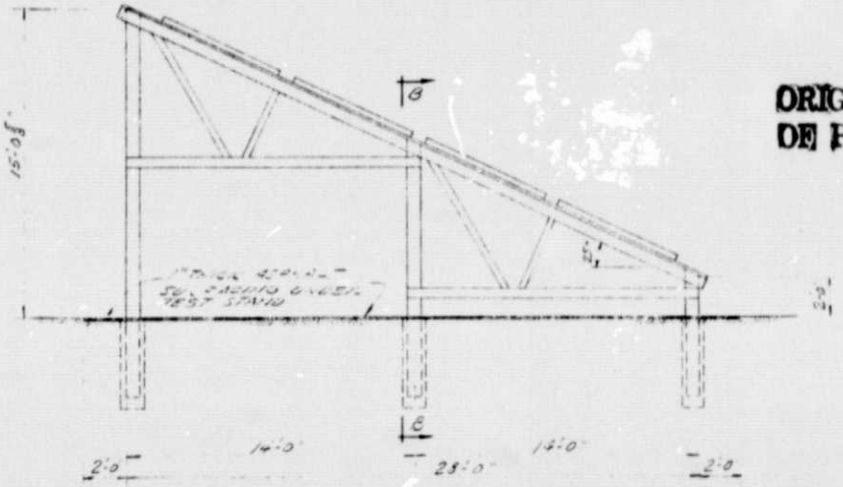
SECTION C-C

REVISED PLANS
2

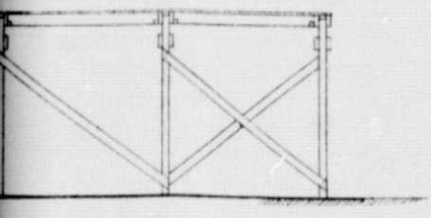
(E) NOTE -
FINISH STRUCTURE A: PER PPG SPEC 89-08-0030
PAINT WITH PPG EPOXY FLOOR SHIELD -
PPG COMPONENT "A" UC-40X15 & "B" UC-40X06
(NON-SKID SURFACE - LIGHT GRAY) AS FOLLOWS:
A. APPLY FIRST COAT
B. AFTER ONE HOUR SPRINKLE ON SAND (DECK AREA ONLY)
C. REMOVE LOOSE SAND AFTER PAINT IS DRY
D. APPLY FINAL COAT



2XG'S- WIND BRACING (TYPICAL)



END ELEVATION



REVISIONS:
1. ADDED PAINTING SPECS 11-22-76
2. REVISED PAINT SPEC TO INCLUDE NON-SKID SURFACE 11-23-76
3. REVISED SECTION C-C TO SHOW 2'-6" FRAME WITH 1x6" FURRING - REVISED DIMS TO SUIT 12-17-76

ALL PRINTS DATED BEFORE LAST REVISION ARE CANCELLED AND RECALLED

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FOR INFORMATION ONLY

CORPUS CHRISTI, TEXAS

Chemicals PPG INDUSTRIES

PRINT ISSUED ____ FOR ____ APPR. ____ REF. ____ CONST. ____

DEPT. NO. G4 DEPT. TITLE HOUSTON CHEMICAL

TITLE HOUSTON CHEMICAL SOLAR TEST STAND - GENERAL ARRANGEMENT & DETAILS

DRAWN LINDSEY CHECKED ____

CHARGE ____ BUD ____ SCALE 1/4"-1'-0"

DATE 7-13-76

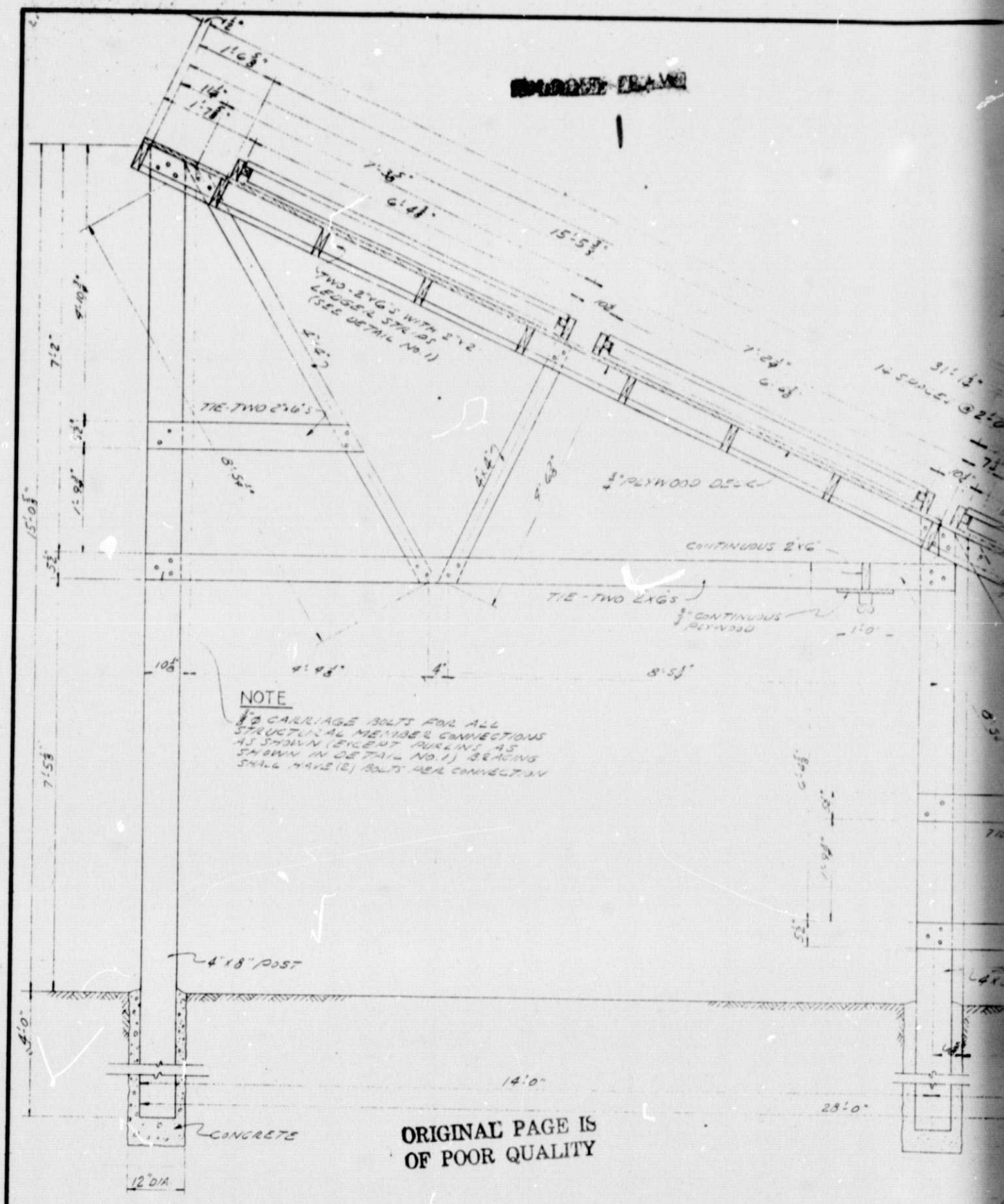
CONST. APPR. ____

OPER. APPR. ____

DESIGN APPR. ____

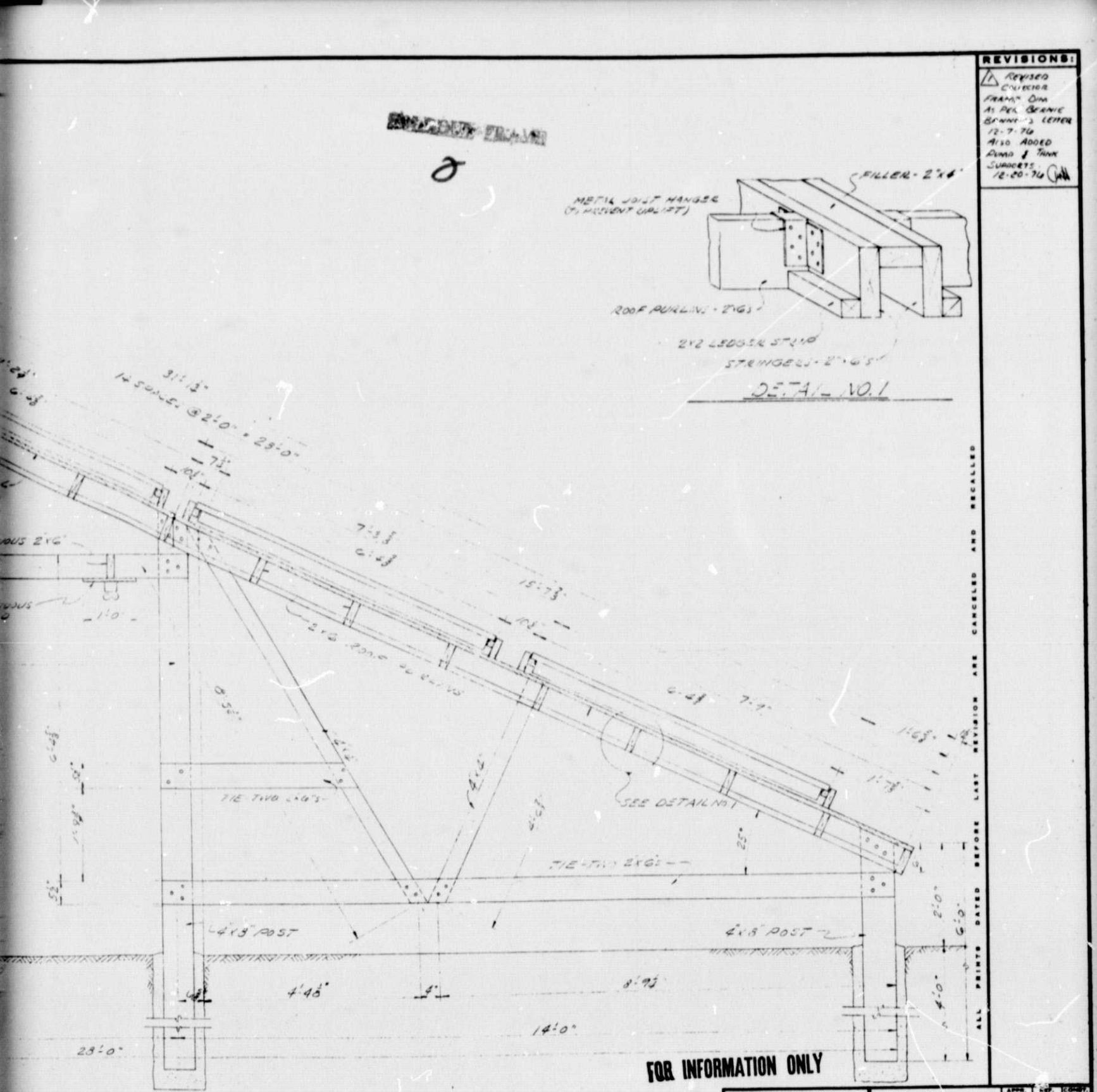
DWG. 64-A16583-3

REF DWGS
64-A16594 - HOUSTON CHEM TEST STAND - DETAILS
55-A14394 - LOCATION & LAYOUT



ELEVATION AT SECT

(SEE PLAN - DWG



ELEVATION AT SECTION A-4

(SEE PLAN - DWG 64-A16589)

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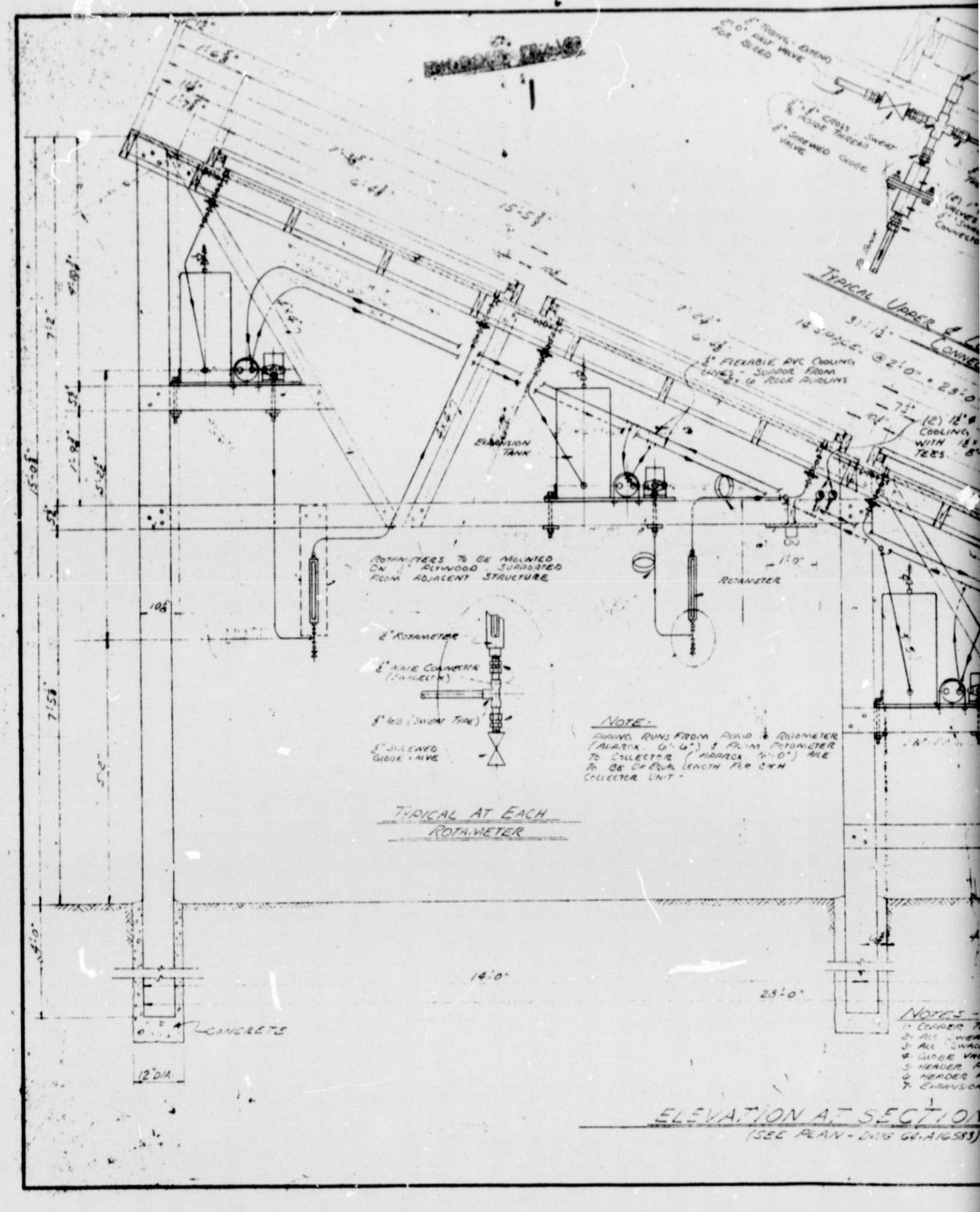
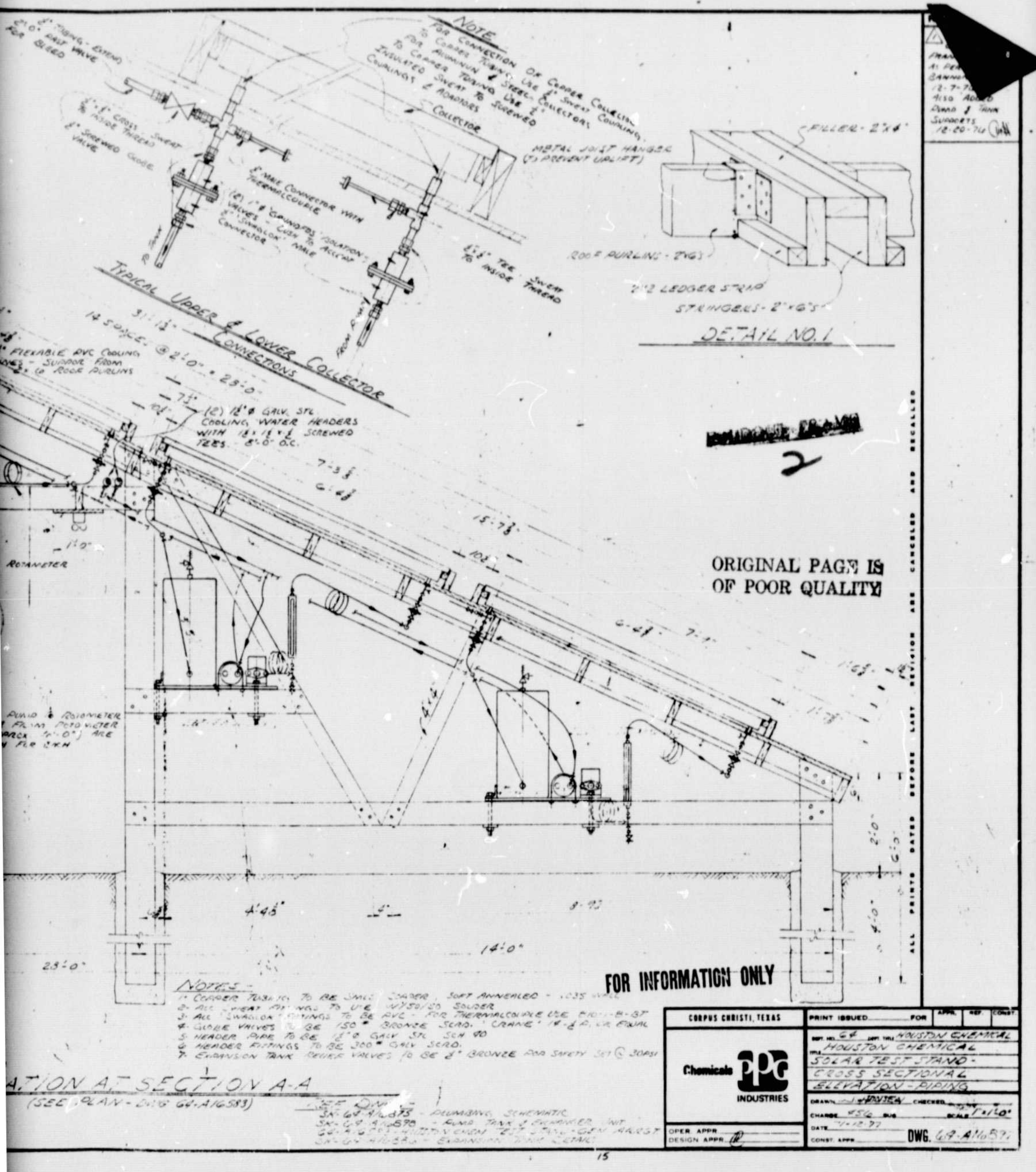
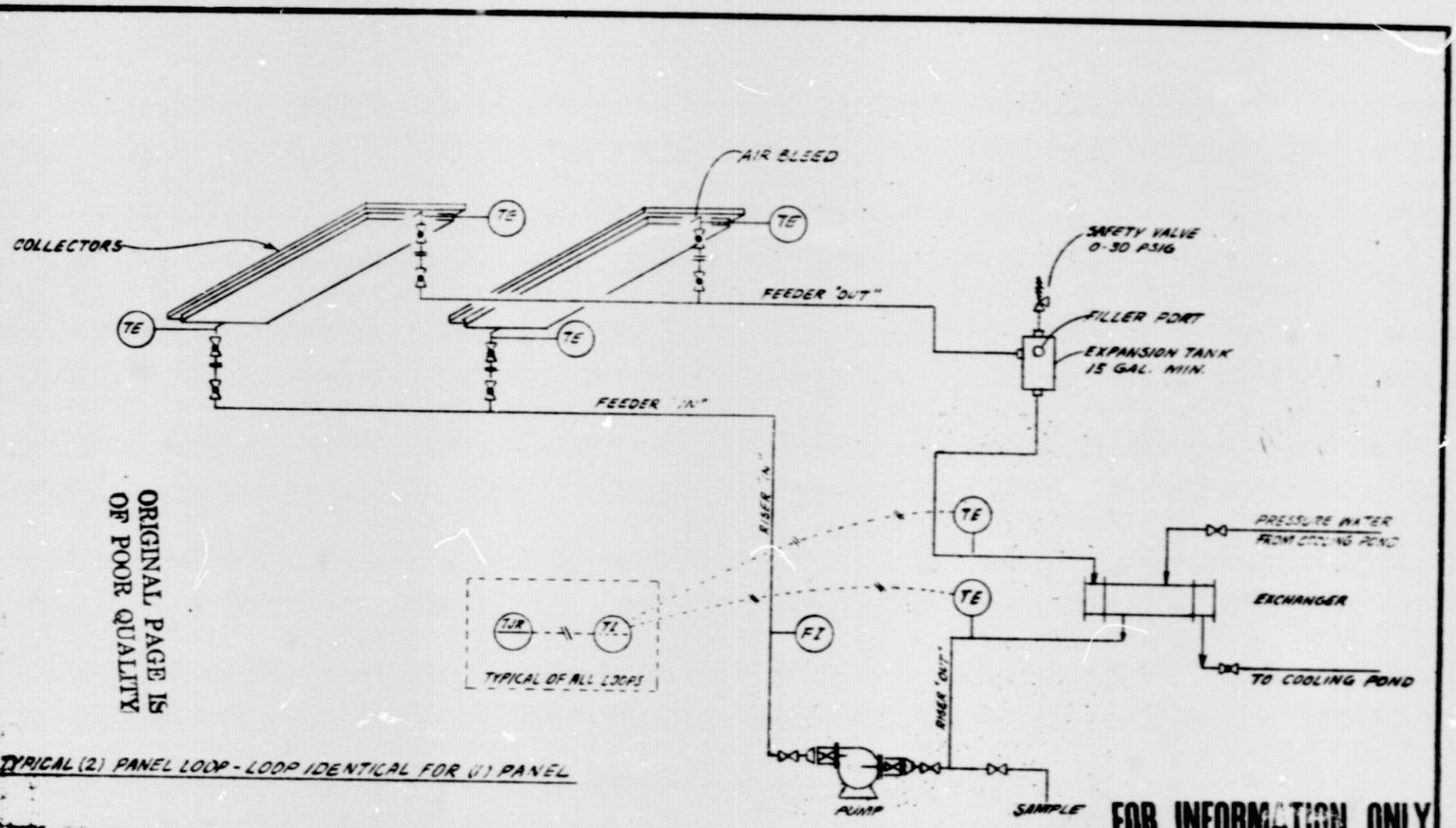
64-A16593 - HOUSTON CHEM TEST STAND - GEN ARRGT


TYPICAL UPPER & L
CONNE
EXPANSION TANK
ROTAMETERS TO BE MOUNTED ON ¾" PLYWOOD SUPPORTED FROM ADJACENT STRUCTURE
ROTAMETER
2" ROTAMETER
2" MALE CONNECTOR (SWEAT X THREAD)
2" 90° (SWEAT TYP.)
2" SCREWED GLOBE VALVE
NOTE:
RISING RUNS FROM PUMP TO ROTAMETER (APPROX. 6'-6") & FROM ROTAMETER TO COLLECTOR (APPROX. 11'-0") ARE TO BE OF EQUAL LENGTH FOR EACH COLLECTOR UNIT.
TYPICAL AT EACH ROTAMETER
CONCRETE
12" DIA.
14'-0"
28'-0"
ELEVATION AT SECTION
(SEE PLAN - DWG 66-A16589)


NOTE
FOR CONNECTION OF COPPER COLLECTOR TO COPPER TUBING, USE 3/8" SWEAT COUPLING. FOR ALUMINUM & STEEL COLLECTORS TO COPPER TUBING USE 3/8" INSULATED SWEAT TO SCREWED COUPLINGS & ADAPTORS
TYPICAL UPPER & LOWER COLLECTOR CONNECTIONS
METAL JOIST HANGER (TO PREVENT UPLIFT)
FILLER - 2"x4"
ROOF PURLINS - 2x6'S
2x2 LEDGER STRIP
STRINGERS - 2"x6"S
DETAIL NO. 1
ROTAMETER
ORIGINAL PAGE IS OF POOR QUALITY
14'-0"
23'-0"
FOR INFORMATION ONLY
NOTES -
ATION AT SECTION A-A
CORPUS CHRISTI, TEXAS
PRINT ISSUED
HOUSTON CHEMICAL
SOLAR TEST STAND -
CROSS SECTIONAL
ELEVATION - PIPING
Chemicals PPG INDUSTRIES
DWG. 64-A16587



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TYPICAL (2) PANEL LOOP - LOOP IDENTICAL FOR (1) PANEL

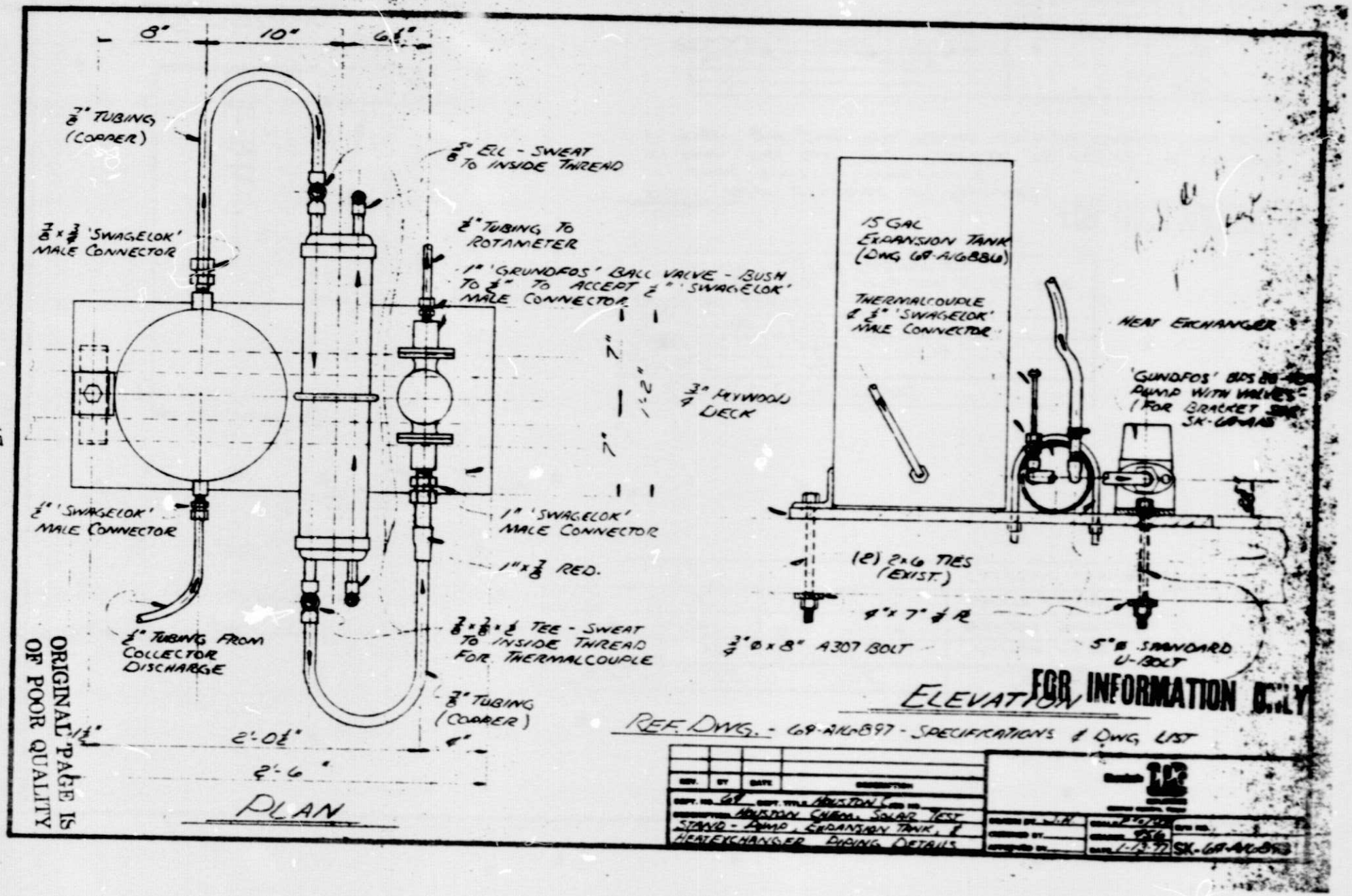
NOTE:
ALL PIPING SHOWN TO BE ½" RIGID COPPER
ALL FITTINGS, EXCEPT TEMPERATURE ELEMENTS, TO BE SWEAT TYPE W/ 50/50 SOLDER.
½" x ½" x ½" TEE FOR TEMPERATURE ELEMENT
SLIDE COPPER TO COPPER SWEAT TO INSIDE THREAD

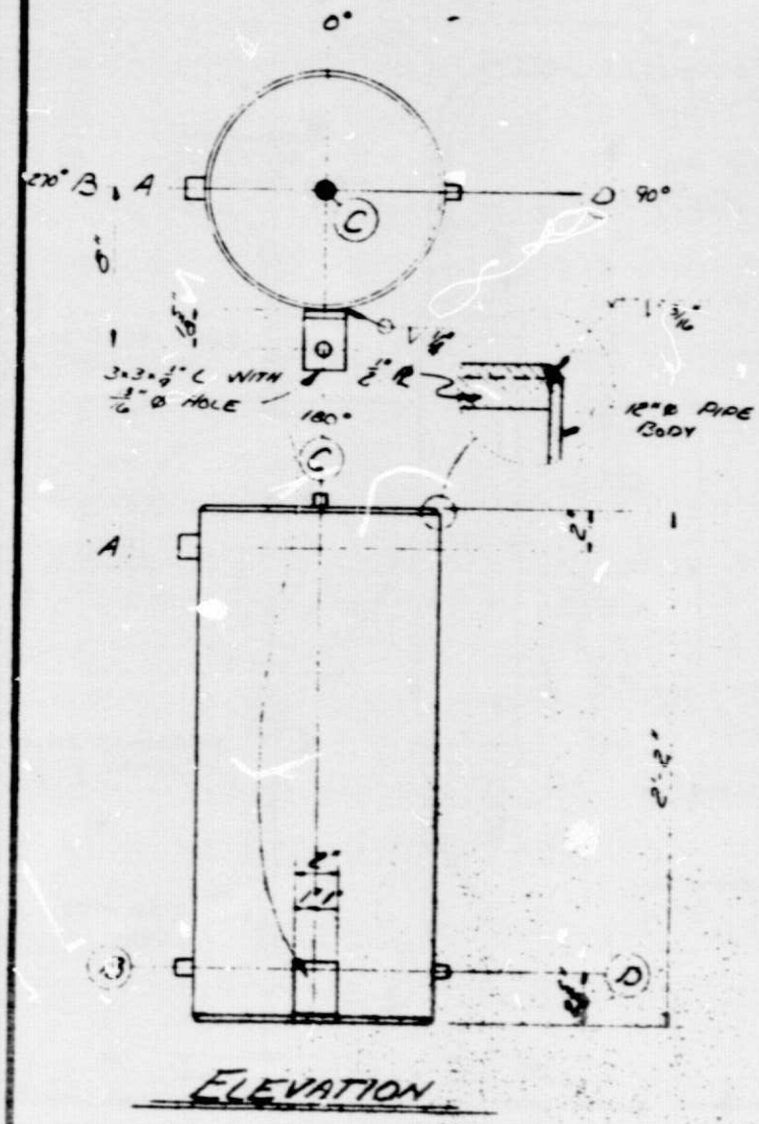
FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION

DEPT. NO. ____ DEPT. TITLE ____ JOB NO. ____
DESCRIPTION: HOUSTON CHEMICAL SOLAR TEST STAND - PLUMBING SCHEMATIC

DESIGNED BY: J.B. SCALE: NTS
CHECKED BY: DRAWN: 11-[illegible]
APPROVED BY: DATE: SK-64-A16875





NOZZLE	SIZE	TYPE	SERVICE
A	1"	3000# F.S. HALF COUPLING	FILLER PORT
B	¾"	" "	HEAT EXC. SUCTION
C	½"	" "	SAFETY VALVE
D	½"	" "	COLLECTOR DISCHARGE

DESIGN CONDITIONS
SERVICE - H_2
PRESSURE - 50 PSI
TEMPETURE - 250 °F
MATERIAL SPECS - VESSEL BODY : 12" ø SCH. 10 STL PIPE HEADS : ½" R CARBON STL.

NOTE -

PAINT TANK EXTERIOR AS FOLLOWES:

1- SAND BLAST TO "NEAR-WHITE"
2- APPLY ONE COAT PPG METALHIDE 100 PRIMER, No. UC-90103
3- APPLY ONE COAT PPG ACRYLIC SILICONE ENAMEL, No. UC-36[illegible]

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION

DEPT. NO. 68 DEPT. TITLE HOUSTON C. 956
DESCRIPTION HOUSTON CHEMICAL SOLAR TEST STAND - EXPANSION TANK DETAILS

DESIGN BY JJR — SCALE NONE — CHECKED BY — APPROVED BY — DATE 1-3-77 — SK-68-[illegible]

☆ U.S. GOVERNMENT PRINTING OFFICE 1978—740-193/434 REGION NO. 4