PRELIMINARY

Accession No. ______

Contract Program or Project Title: Investigation of Post-CHF Heat Transfer for water-cooled Reactor Application and Development of Two-Phase Flow Instrumentation.

Subject of this Document:

Summary of research effort on contract program from 10/1/77 to 12/31/77

Type of Document:

Quarterly Progress Report for the period 10/1/77 - 12/31/77

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Contract No.: AT(49-24)-0180

Date of Document: 1/3/78

Date Transmitted to NRC: 1/13/78

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U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

PRELIMINARY

7811210246

LU-NUREG-PR774

Investigation of Post-CHF Heat Transfer for Water-Cooled Reactor Application and Development of Two-Phase Flow Instrumentation

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P R O G R E S S   R E P O R T

October 1, 1977 to December 31, 1977

Prepared for the U.S. Nuclear Regulatory Commission
under Contract Number AT(49-24)-0180

Investigation of Post-CHF Heat Transfer for Water-Cooled Reactor Application and Development of Two-Phase Flow Instrumentation

Scope

This program consists of two tasks. Task 1 objective is to improve present state-of-knowledge in the correlation of post-CHF heat transfer, for application in blowdown and reflood calculations in reactor safety analyses. Development of phenomenological models and experimental verification are being undertaken. The objective of Task 2 is to develop a prototype probe for measurement of liquid film thickness and flow rate, for falling films on vertical surfaces. This probe should be suitable for use in safety experiments in PWR upper plenum geometries, under simulated reflood conditions.

Abstract

A two-phase loop has been modified to obtain post-CHF heat transfer data with water at system pressures up to 100 psia. Development of a probe to measure non-equilibrium vapor superheat is in progress. A suitable test section for obtaining post-CHF data which will incorporate measurement of vapor superheat is in the design stage.

A concept for measuring liquid film thicknesses in two phase flow has been developed and tested with reasonable success. Optimization of probe geometry is in progress. A suitable method for measuring film velocities is being sought. Present investigation is directed towards the use of hydrogen bubbles as tracers.

Progress in Report Period

Task 1: Post-CHF Heat Transfer

A boiling, two-phase loop has been modified to obtain low pressure, low flow data in the post-CHF regime. A main objective is to obtain measurements of vapor superheat temperatures at known conditions of system pressure, mass flux, wall temperature, heat flux and equilibrium quality. The data would be useful for testing and upgrading post-CHF correlations proposed by the present, and other investigators.

In this report period, an orifice flow meter has been built and installed to provide an electrical signal which can be directly transmitted to a high speed, 64 channel Data Logger. Also installed was a power measurement system which will provide a millivolt output signal. Thus, all parameters of interest can now be measured and stored by the Data Logger. With this, loop instrumentation is considered complete and the loop is ready for operation as soon as the test section is installed.

A test section is being designed for obtaining post-CHF data. The present concept is to use a 'hot patch' at the entrance [1] and direct Joule heating downstream.

A suitable method for measurement of vapor superheat is in development stage. The basic concept is to use a microthermocouple with a fast response in a configuration that will provide a) shielding of radiation from the wall, b) inertial shielding of droplets, and c) aspiration to maintain vapor flow past the thermocouple.

Results of using one such probe configuration in an air-water environment were reported in the previous report period [2]. It was seen that the temperature-time trace obtained showed quench and recovery periods which could be interpreted to estimate the vapor temperature. In the present report period, a steam rig to provide steam at a superheat of about 100°C was built and various probe configurations were tested in a steam-water environment. Results indicate that the thermocouple does not recover as quickly as in an air-water environment. Further tests are in progress to determine a) the best probe configuration for fast recovery of the thermocouple and b) the operating limits of steam temperature and quality which will yield temperature-time traces from which the steam temperature may be deduced.

Task 2: Two-Phase Flow Instrumentation

The objective of this task is to develop a prototype probe for measurement of liquid film thickness and flow rate, for falling films on vertical surfaces. The operational requirements are:

1) Probes to be suitable for mounting on upper plenum guide tubes or in the core barrel in simulated PWR assemblies.

2) Probes should be operable in a non-radioactive saturated steam-water environment up to a pressure of 115 psia (saturation temperature of 170°C).

1. Film Thickness Measurement

In the last report [2], a probe suitable for measuring either the capacitance or conductance of a thin water film on the probe surface was presented. Figure 1 shows the details of the probe.

a) Capacitance measurement: A commercial capacitance meter employing a bridge circuit was used to measure the capacitance due to the film on the probe surface. With the probe configuration shown, it is possible to measure either the capacitance C_s, between the two half-moon electrodes or the capacitance C, between any half-moon electrode and the brass outer plate. In the last report, variation in C_s with film thickness, δ, was presented for various constant electrical resistivities of the water film. It was seen that 1) the probe was sensitive to change in film thickness up to about 0.05 inches, 2) there was no effect of water resistivity in the resistivity range of 40-600 kΩ-cm, and 3) there was a small and regular effect of water resistivity in the resistivity range of 3-40 kΩ-cm.

In the present report period, the capacitance C, between one of the half-moon electrodes and the outer brass plate was measured for various water film thicknesses at constant electrical resistivity and temperature of the water film. Figure 2 shows the variation of $\Delta C (= C - C_{air})$ with δ at various constant water resistivities. It can be seen that 1) the probe is sensitive up to a film thickness of about 0.1", 2) there is relatively little scatter in the resistivity range of 9-400 kΩ-cm and 3) there is no systematic trend in the scatter.

The higher range of sensitivity in ΔC measurement as compared to ΔC_s measurement is due to the increased distance (d) between the electrodes used. Generally, for electrodes of similar surface area, the capacitance measurement technique seems to be sensitive in the range of $0 < \delta/d < 1.5$. The reduced scatter in these experiments are believed to be due to improved experimental procedure. Conceptually, for a given film thickness, the capacitance is only dependent on the dielectric constant which does not vary much with the electrical resistivity of the water. Hence, there should not be a resistivity effect in the capacitance measurement. This is indicated by the data in Figure 2. Figure 3 shows the variation of ΔC with δ for varying water temperature up to 85°C. Again, there is no systematic deviation and for a measured ΔC, the error in predicting δ is about 10-15 percent.

b) Conductance measurement: The probe shown in Figure 1 can also be used for measuring the conductance of a water film on the probe surface. The technique adopted was to measure the conductance ratio G/G_s between the two sets of electrode pairs on the probe surface. It was hoped that the ratio measurement would cancel out any changes in the electrical resistivity of the water. In the previous period, it was reported that there was a significant effect of the electrical resistivity on the conductance ratio for a given film thickness. In this report period, this discrepency has been resolved. The electrical circuit employed consisted of an operational amplifier in a simple feedback loop. It was discovered that the amplifier chosen did not have a high enough gain. Mainly, the water resistance at the probe surface, R_s, was about 1 MΩ at a resistivity of 20 kΩ-cm. Using calibrated resistors, it was found that the circuit operated correctly only for $R_s < 300$ kΩ. This is shown in Figure 4. Hence, a new circuit was designed with a high gain amplifier and also incorporating shield followers to eliminate stray capacitance due to cables carrying the probe signal. This circuit was checked with calibrated resistors up to 5 MΩ and found to be adequate (Figure 5). The results of using this circuit are shown in Figure 6 and 7. Figure 6 shows the variation of G/G_s with film thickness for various water resistivities. It can be seen that there is no appreciable effect of resistivity for $\rho < 140$ kΩ-cm, especially in the range of interest ($\delta < 0.1$). It can also be seen that at $\rho > 140$ kΩ-cm, there is significant differences in the data. This corresponds to a resistance R_s at the probes of about 7 MΩ, at which the usefulness of the circuit is questionable. Figure 7 shows the variation in G/G_s with film thickness for various temperatures up to 85°C. Since the only effect of temperature seems to be a decrease in water resistivity, no trend was expected and none is seen in the figure. The figure shows some scatter, but relatively little in the region of interest and for a given G/G_s, the error in predicting δ is about 10 percent. Another way of using these data is shown in Figure 8 where the G/G_s values have been normalized between their zero and asymptotic values. It can be seen that the data fall in a relatively narrow band for all water resistivities tested (3-500 kΩ-cm). This implies that the probe can be calibrated for any given water resistivity simply by measuring the asymptotic G/G_s value at that resistivity.

c) Conclusions: 1) Based on experiments conducted so far, it seems that a probe can be designed to operate in either a capacitive or conductive mode, 2) Capacitance and conductive measurements yield two independent means for measuring thin film thicknesses, thus providing a cross-check, 3) If, for some reason, the water becomes very conductive, the capacitance method may not be useful, but the conductance method would still be viable. On the other hand, if the water becomes extremely resistive, the conductance method may fail, but the capacitance technique would be available, 4) The conductance technique can be improved further by modifying the probe geometry such that the resistances at the probe surface are reduced. This can be done by suitably altering the surface areas of the electrodes and the gaps between them. Several such probes have been designed and, thanks to Oak Ridge National Labs, have been built and are now being tested. It is hoped that this optimization procedure will yield a probe suitable for conductance measurement for a wide range of water resistivities.

2. Film Velocity Measurement

The basic concept being considered presently for film velocity measurement is a time-of-flight measurement using a tracer. The tracer being investigated now is hydrogen bubbles. These bubbles will be generated by electrolysis of the water and made to flow over two probes to give the required time-of-flight measurement.

A rig has been built to test this concept and experiments are in progress. A thin platinum wire (0.005" dia.) is being used to generate hydrogen bubbles and two capacitance probes downstream are being employed to detect the passage of the bubbles. It is not clear at this time whether enough bubbles of reasonable size can be generated and channelled over the probe surfaces to yield a measurable signal. This is being investigated further. Other signal pick-up methods are also being considered. An ultra-sonic technique is also being investigated.

References

1. Groeneveld, D. C. Presentation at the Fiftn Annual Reactor Safety Information Meeting, Washington, D.C., November 7-10, 1977.

2. Progress Report LU-NUREG-773, Report Period, 7/1/77-9/30/77, Prepared for the U.S. Nuclear Regulatory Commission under Contract Number AT(49-24)-0180.

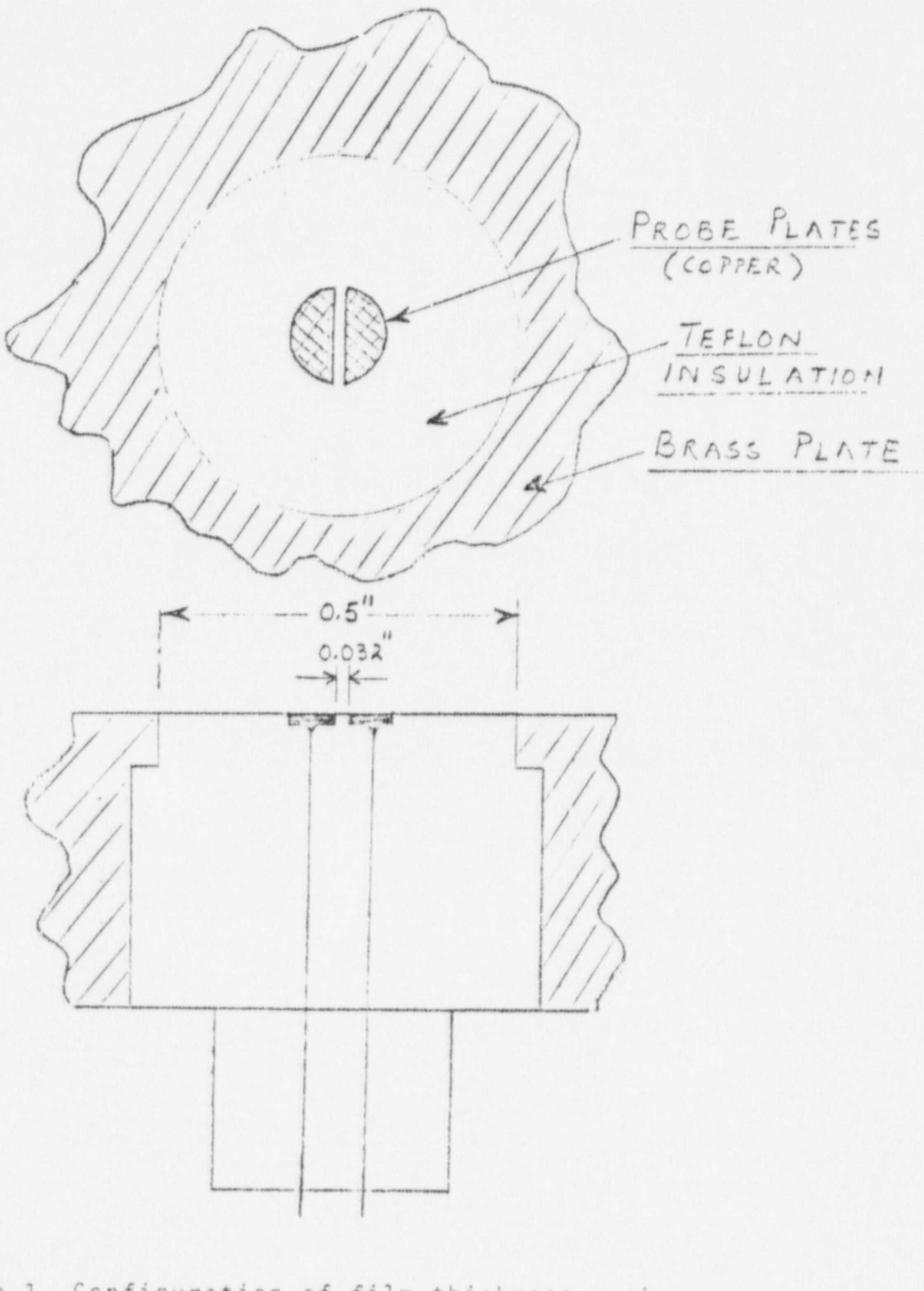
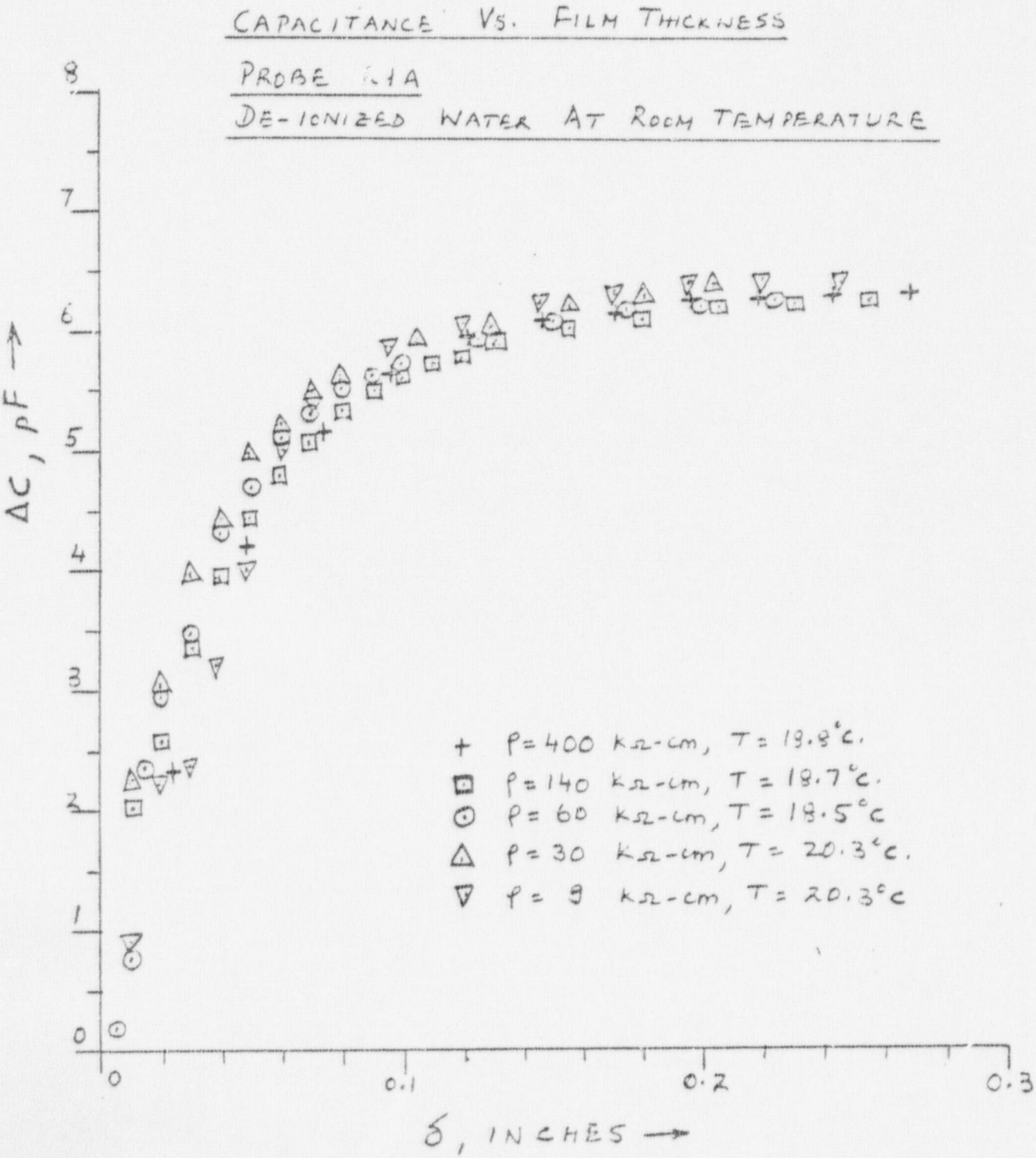


Figure 1 Configuration of film thickness probe



CAPACITANCE VS. FILM THICKNESS
PROBE 1A
DE-IONIZED WATER AT ROOM TEMPERATURE
ΔC, pF →
0
1
2
3
4
5
6
7
8
0
0.1
0.2
0.3
δ, INCHES →
+ ρ = 400 kΩ-cm, T = 18.8°C.
⊡ ρ = 140 kΩ-cm, T = 18.7°C.
⊙ ρ = 60 kΩ-cm, T = 18.5°C
△ ρ = 30 kΩ-cm, T = 20.3°C.
▽ ρ = 9 kΩ-cm, T = 20.3°C

Figure 2

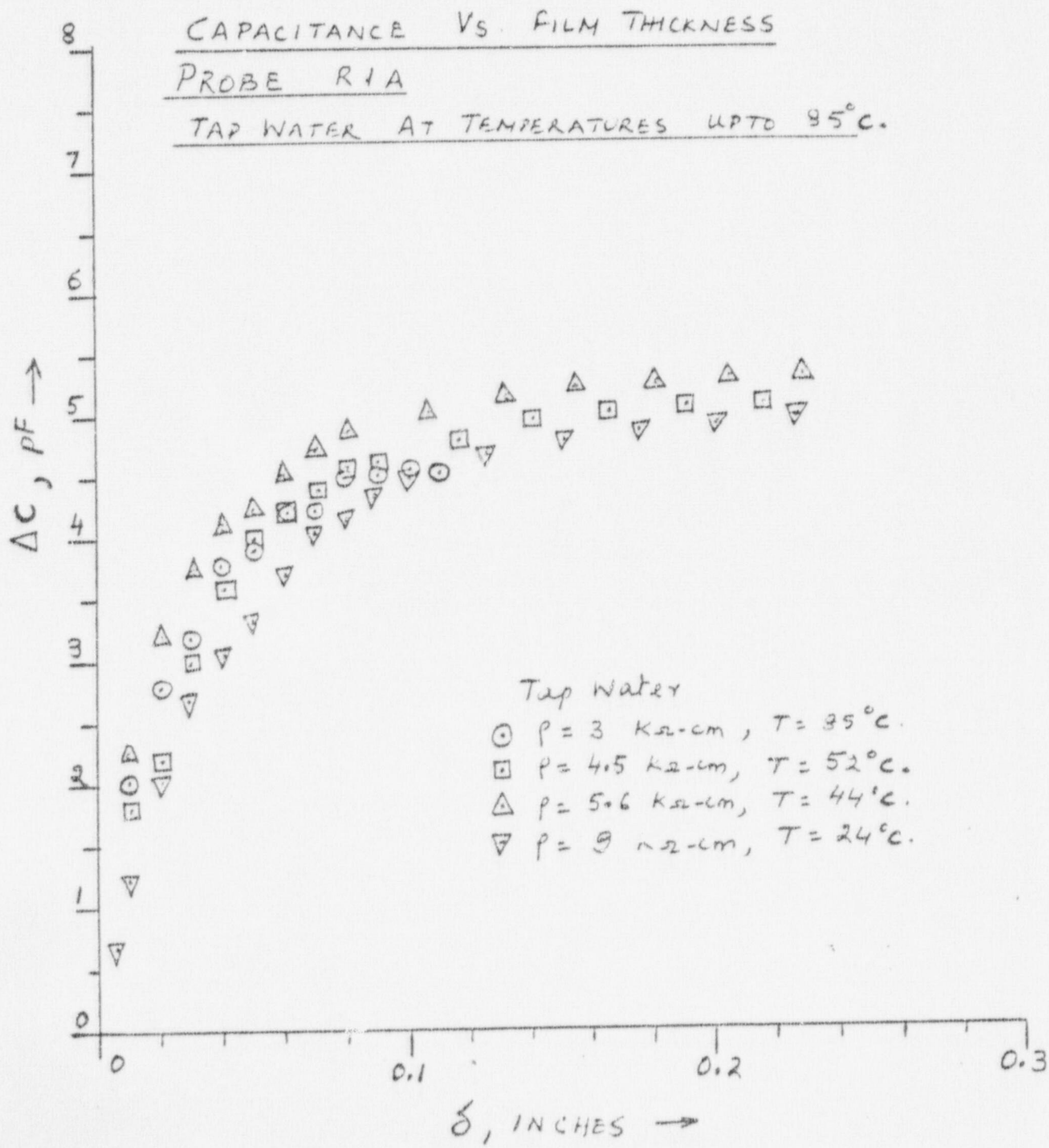
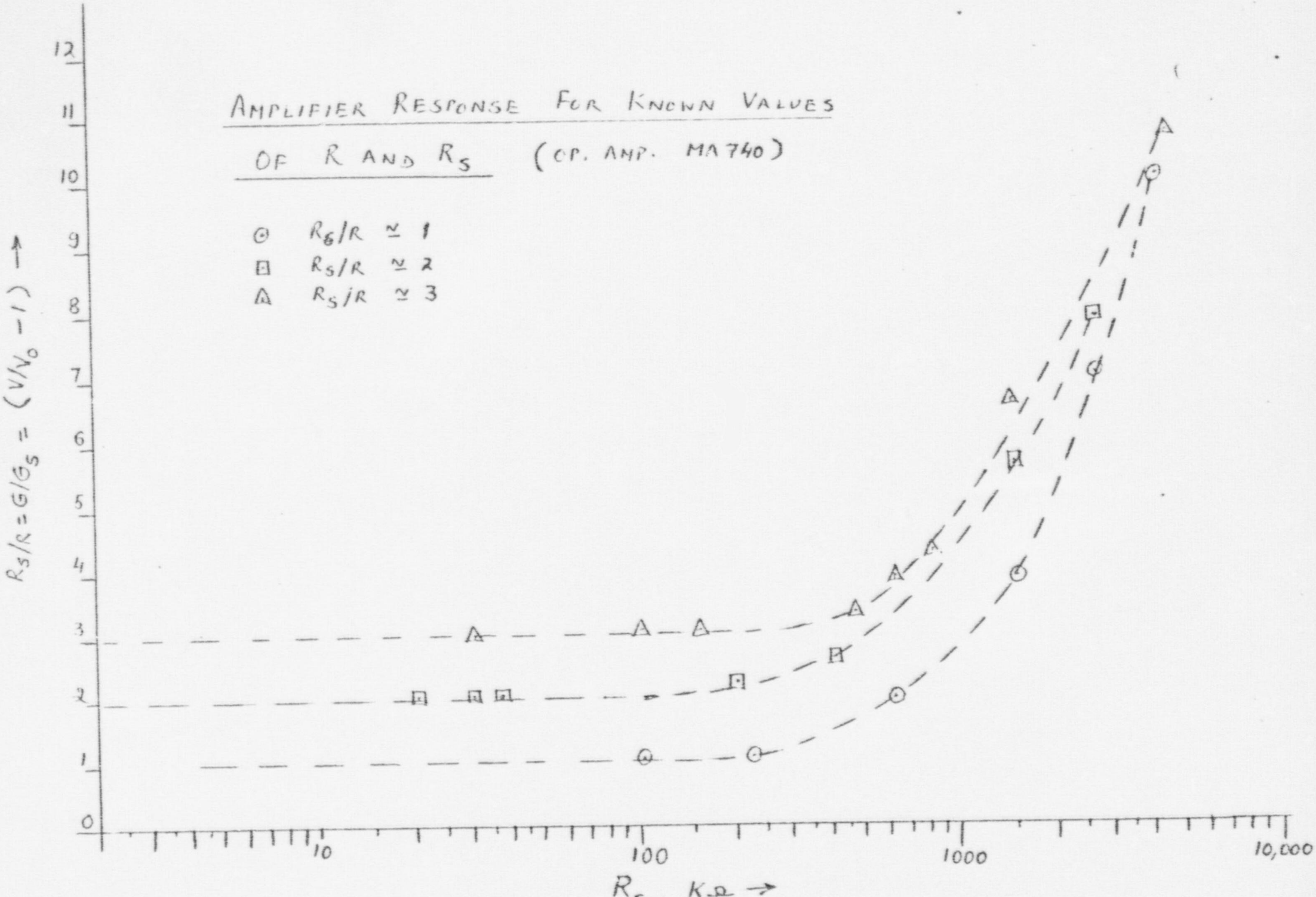
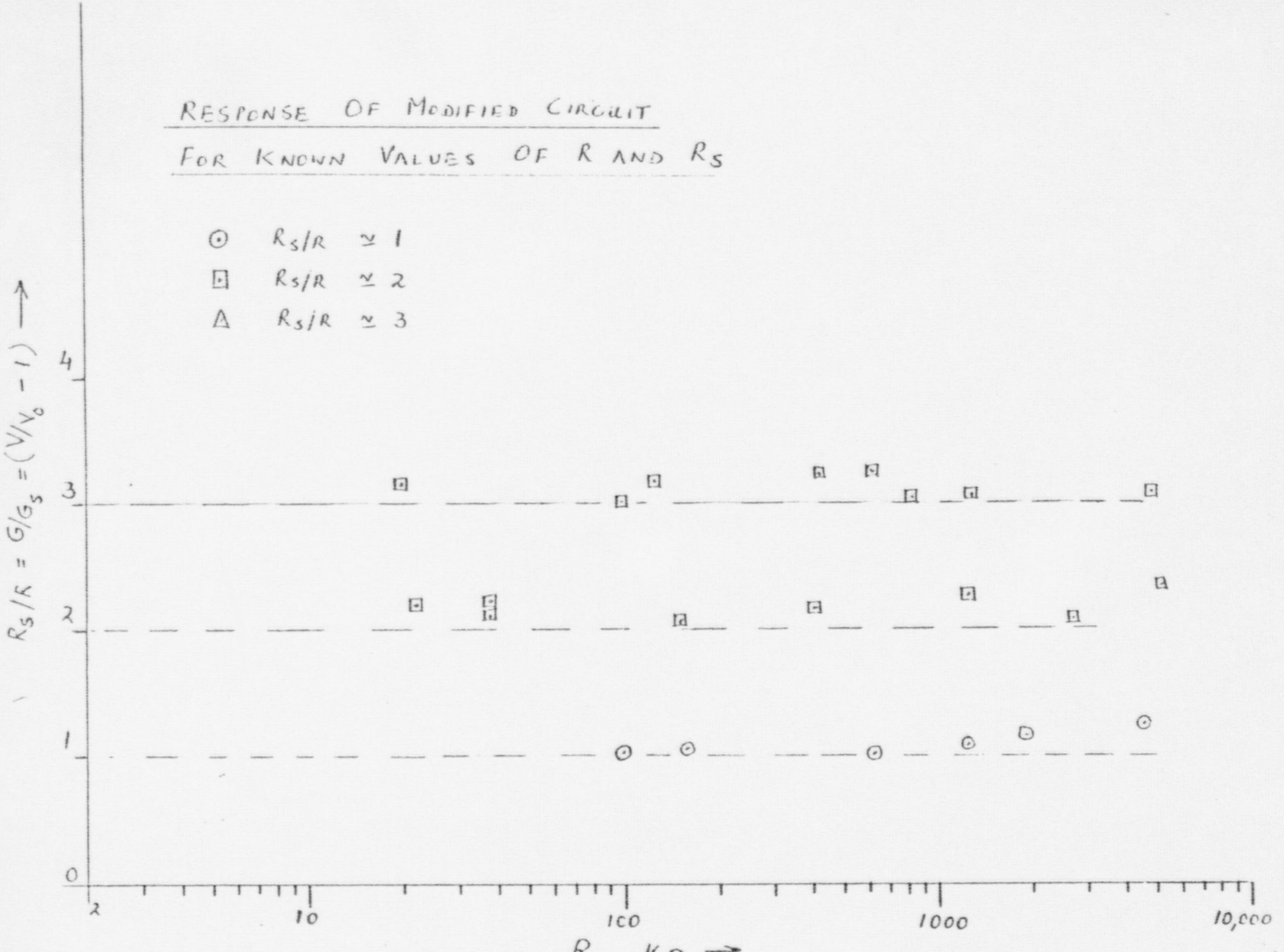

CAPACITANCE Vs FILM THICKNESS
PROBE R1A
TAP WATER AT TEMPERATURES UPTO 85°C.
ΔC, pF →
δ, INCHES →
0
0.1
0.2
0.3
1
2
3
4
5
6
7
8
Tap water
ρ = 3 KΩ-cm, T = 85°C
ρ = 4.5 KΩ-cm, T = 52°C.
ρ = 5.6 KΩ-cm, T = 44°C.
ρ = 9 KΩ-cm, T = 24°C.

Figure 3



AMPLIFIER RESPONSE FOR KNOWN VALUES OF R AND R_S (OP. AMP. MA740)
$R_S/R \simeq 1$
$R_S/R \simeq 2$
$R_S/R \simeq 3$
$R_S/R = G/G_S = (V/V_0 - 1) \rightarrow$
0
1
2
3
4
5
6
7
8
9
10
11
12
10
100
1000
10,000
R_S, KΩ →

Figure 4


RESPONSE OF MODIFIED CIRCUIT
FOR KNOWN VALUES OF R AND R_S
⊙ $R_S/R \simeq 1$
⊡ $R_S/R \simeq 2$
△ $R_S/R \simeq 3$
$R_S/R = G/G_S = (V/V_0 - 1)$ →
0
1
2
3
4
2
10
100
1000
10,000
R_S, $K\Omega$ →
Figure 5

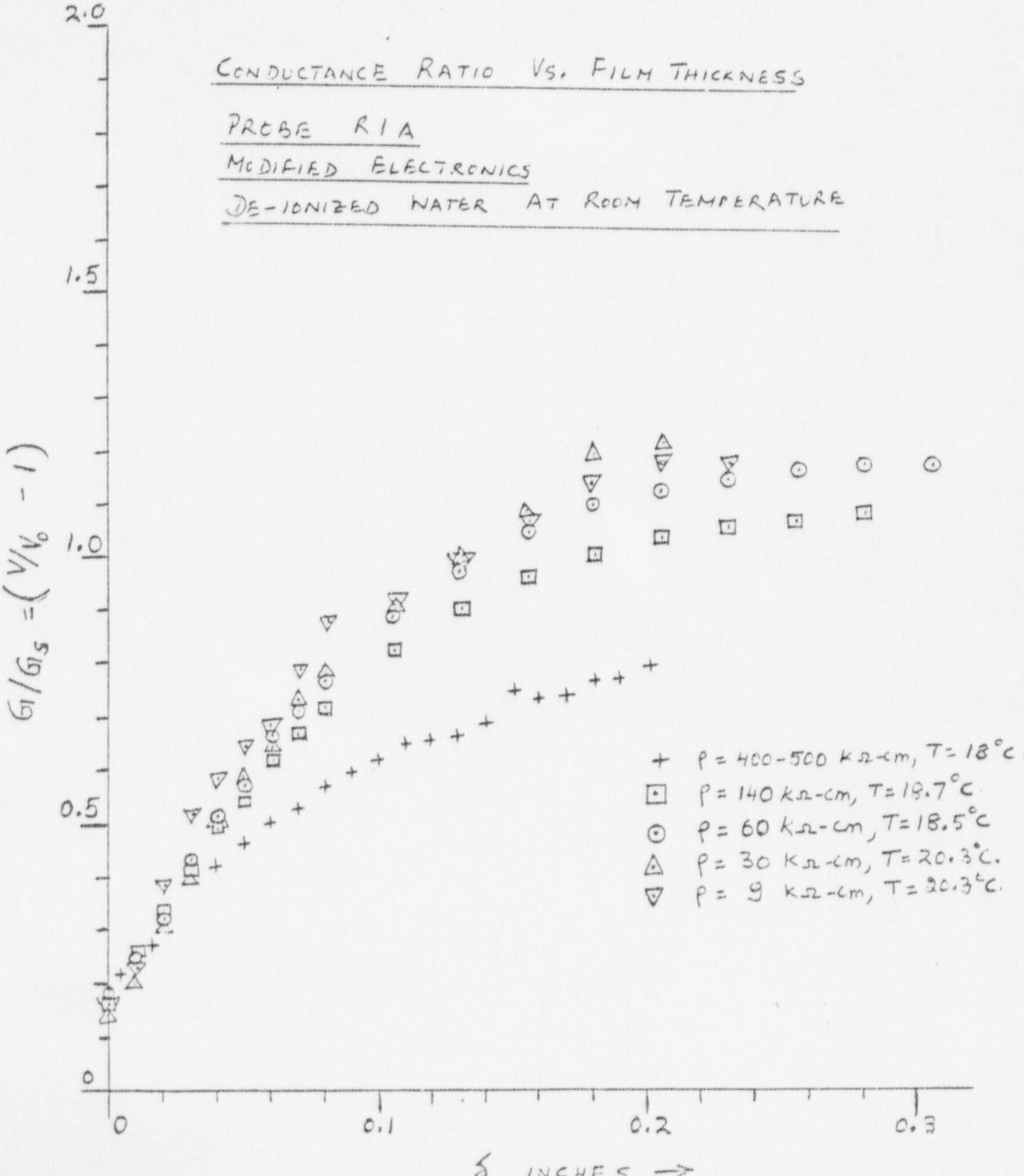
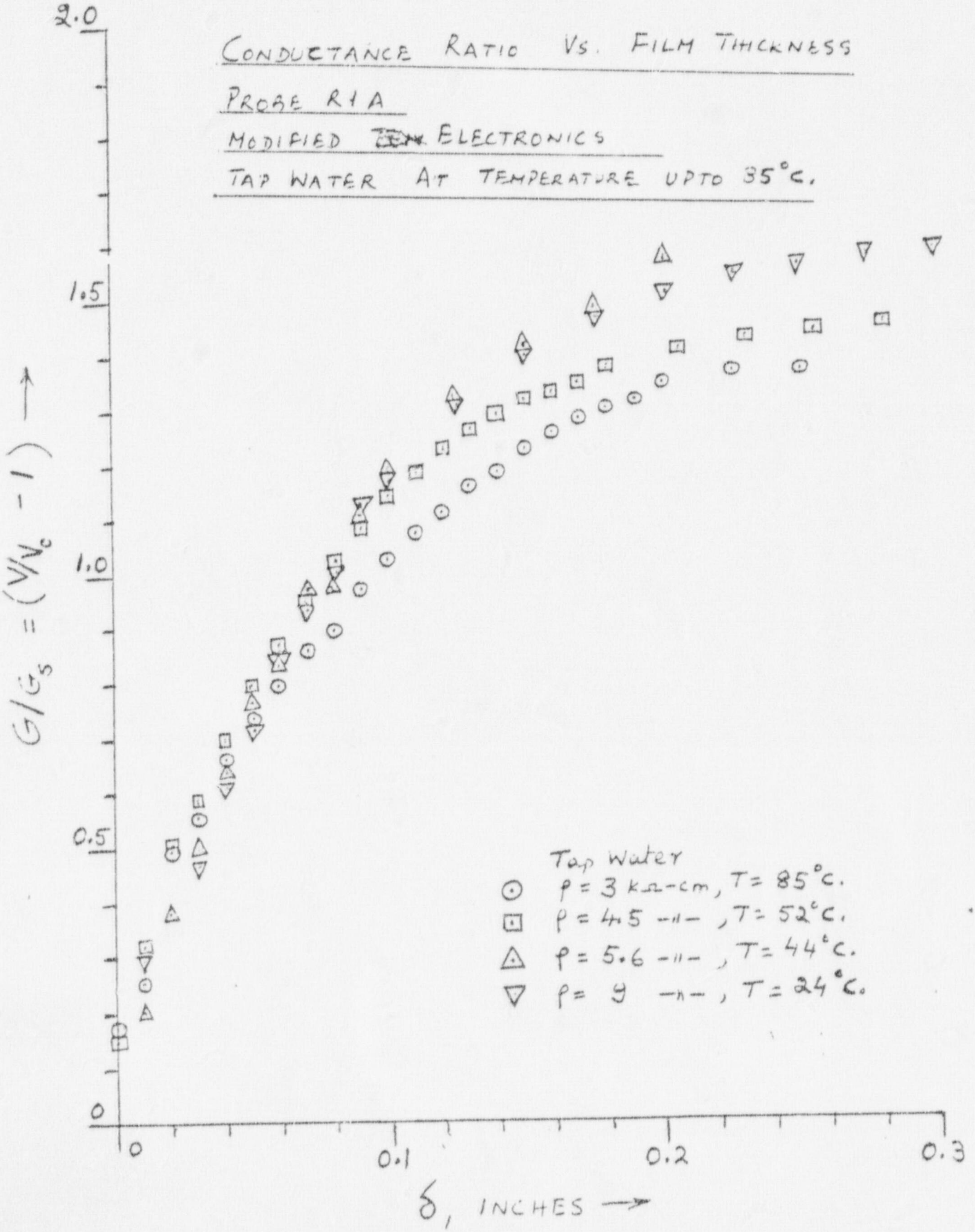
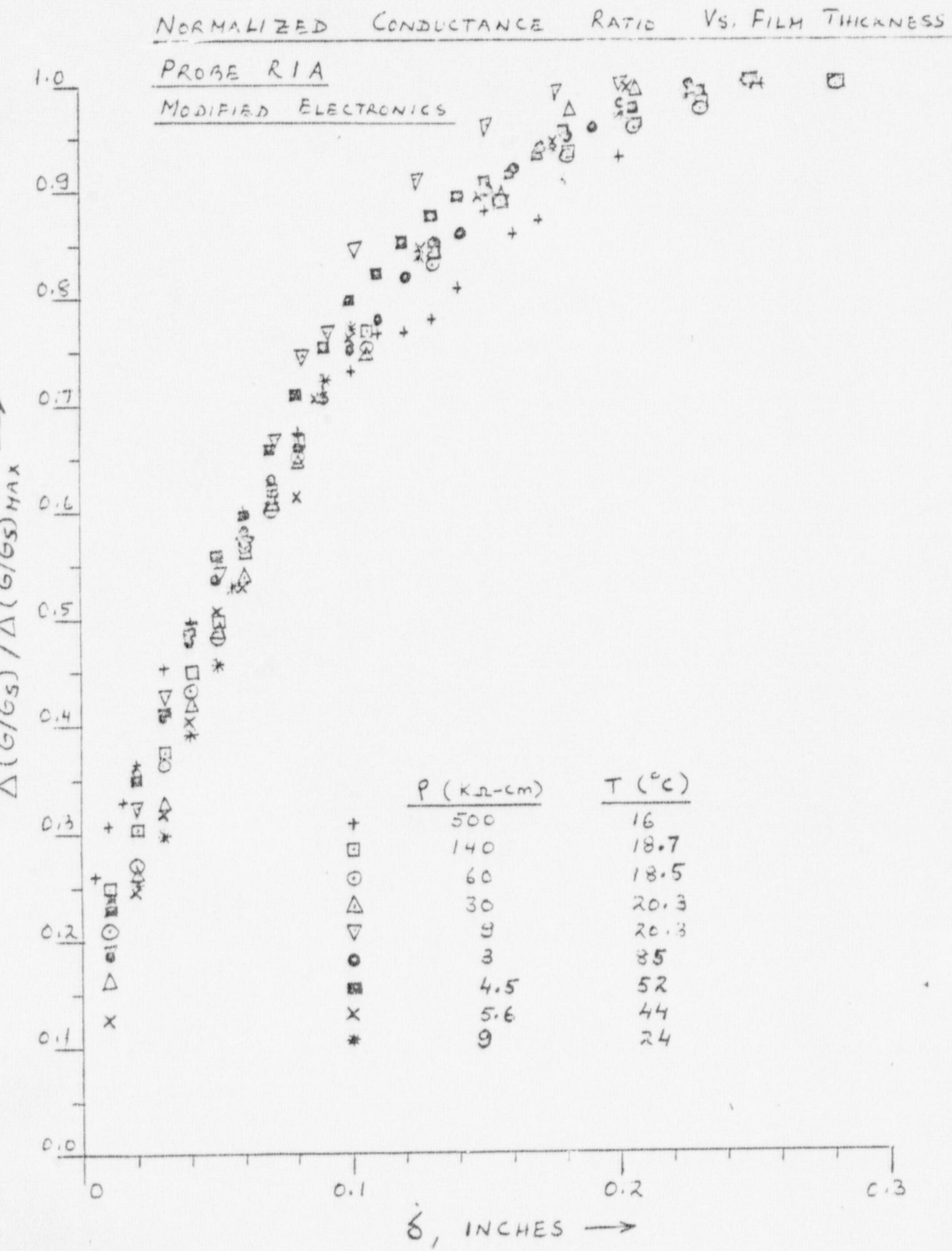

CONDUCTANCE RATIO VS. FILM THICKNESS
PROBE R1A
MODIFIED ELECTRONICS
DE-IONIZED WATER AT ROOM TEMPERATURE
2.0
1.5
1.0
0.5
0
$G_T/G_S = (V/V_0 - 1)$
0
0.1
0.2
0.3
δ, INCHES →
+ ρ = 400-500 kΩ-cm, T = 18°C.
⊡ ρ = 140 kΩ-cm, T = 18.7°C
⊙ ρ = 60 kΩ-cm, T = 18.5°C
△ ρ = 30 kΩ-cm, T = 20.3°C.
▽ ρ = 9 kΩ-cm, T = 20.3°C.

Figure 6



CONDUCTANCE RATIO VS. FILM THICKNESS
PROBE R1A
MODIFIED ~~[illegible]~~ ELECTRONICS
TAP WATER AT TEMPERATURE UPTO 35°C.
2.0
1.5
1.0
0.5
0
0
0.1
0.2
0.3
G/Gs = (V/Vo − 1) →
δ, INCHES →
Tap Water
ρ = 3 kΩ-cm, T = 85°C.
ρ = 4.5 -"- , T = 52°C.
ρ = 5.6 -"- , T = 44°C.
ρ = 9 -"- , T = 24°C.

Figure 7



NORMALIZED CONDUCTANCE RATIO VS. FILM THICKNESS
PROBE R1A
MODIFIED ELECTRONICS
$\Delta(G/G_S)/\Delta(G/G_S)_{MAX}$ →
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
0.1
0.2
0.3
δ, INCHES →
ρ (kΩ-cm)
T (°C)
500
16
140
18.7
60
18.5
30
20.3
9
20.3
3
85
4.5
52
5.6
44
9
24

Figure 8

NRC PDR

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

November 1, 1978

Docket No. 50-298

Mr. J. M. Pilant, Director
Licensing and Quality Assurance
Nebraska Public Power District
P. O. Box 499
Columbus, Nebraska 68601

Dear Mr. Pilant:

On October 10 through October 13, 1978 a NRC staff fire protection review team visited the Cooper Nuclear Station. The results of this review were discussed with NPPD personnel during an October 13, 1978 exit meeting. Enclosure 1 lists attendees at this meeting.

Enclosure 2 describes staff positions discussed during the exit meeting for which NPPD verbally agreed either to implement the position or to propose and justify an acceptable alternative solution. We request that you provide written comments and implementation schedules for the items in Enclosure 2 within 30 days of receipt of this letter. Enclosure 3 describes those staff positions discussed during the exit meeting for which NPPD indicated a need for additional time for further consideration. You are requested to address each of these items by: (1) a commitment to implement the position; (2) a proposal of an acceptable alternative resolution with the basis and/or justification for same; or (3) providing a basis by which the present fire protection program addresses the positions without further action. Your response as well as implementation schedule for items in Enclosure 3 is also requested within 30 days of receipt of this letter. The implementation schedules you provide should include design submittal dates for NRC review where appropriate, and should also include completion dates for modifications based on allowing 90 days for NRC review.

We are presently reviewing the administrative controls that you have proposed for your fire protection program. Any concerns and related positions that result from this review will be forwarded to you under separate cover.

Sincerely,

T A Ippolito

Thomas A. Ippolito, Chief
Operating Reactors Branch #3
Division of Operating Reactors

7811220248

Enclosures:
As stated

cc w/enclosures:
See next page

cc
Mr. G. D. Watson, General Counsel
Nebraska Public Power District
P. O. Box 499
Columbus, Nebraska 68601

Mr. Arthur C. Gehr, Attorney
Snell & Wilmer
3100 Valley Center
Phoenix, Arizona 85073

Cooper Nuclear Station
ATTN: Mr. L. Lessor
Station Superintendent
P. O. Box 98
Brownville, Nebraska 68321

Auburn Public Library
118 - 15th Street
Auburn, Nebraska 68305

ENCLOSURE NO. 1

ATTENDEES

COOPER NUCLEAR STATION: OCTOBER 13, 1978

NRC Staff

V. L. Rooney
R. T. Dodds
C. H. Brown
E. A. Kleinsorg
D. L. Kelley
E. H. Johnson

NRC Consultant

M. A. Antonetti

NPPD Staff

R. S. Kamber
R. E. Buntain
L. C. Lessor
J. M. Pilant
J. Weaver
R. Allen

NPPD Consultant

C. Lewis

ENCLOSURE NO. 2

COOPER NUCLEAR STATION

STAFF REVIEW POSITIONS (SRP) AGREED TO BY LICENSEE

SRP-1 Self-Contained Breathing Apparatus

Staff Concern:

Self-Contained breathing apparatus using full face positive pressure masks, approved by NIOSH, should be provided for fire brigade, damage control and control room personnel.

Staff Position:

An onsite six hour supply of reserve air should be provided for ten men. Estimate the working capacity of 30-minute-rated air tanks at 20 minutes each.

SRP-2 Fire Emergency Radio Communication

Staff Concern:

Two way voice communication is vital to safe shutdown and emergency response in the event of fire.

Staff Position:

Three portable radios should be provided for fire emergency situations.

SRP-14 Manual Foam Suppression

Staff Concern:

Capability should be provided to suppress certain fires involving flammable liquids that respond well to foam suppression.

Staff Position:

Manual foam suppression capability should be provided for the oil hazards in various areas of the plant.

SRP-25 Conduit Risers - Battery Room 1B

Staff Concern:

Safety related cables inside pull boxes (includes cables for dedicated shutdown system) should be protected from a fire in the battery room.

Staff Position:

A one hour fire barrier enclosure should be provided for the conduit risers in battery room 1B.

SRP-27 Smoke Ejectors

Staff Concern:

The products of combustion may need to be exhausted manually to permit fire brigade access in fire area where a controlled ventilation system has not been provided.

Staff Position:

Three 5,000 CFM portable explosion-proof, fire service smoke ejectors with suitable ducting should be provided.

SRP-28 Hydrant Fittings

Staff Concern:

A hose house, equipped with hose, combination nozzle and other auxiliary equipment recommended in NFPA 24 "Outside Protection" should be provided as needed but at least every 1,000 feet.

Staff Position:

In addition to equipment already provided in hose houses, provide two hose carts with the following capability: 250 feet of 2-1/2 inch hose, 200 feet of 1-1/2 inch hose, one 2-1/2 inch by 1-1/2 inch by 1-1/2 inch gated Y, one 2-1/2 inch adjustable spray nozzle, two 1-1/2 inch adjustable spray nozzles, forceable entry tool, hose clamp, gaskets (two spare for each size hose), minimum two universal spanner wrenches, two hydro wrenches, one each 2-1/2 inch male to male adaptor and a 1-1/2 inch male to male adaptor, one each 2-1/2 inch female to female adaptor and 1-1/2 inch female to female adaptor.

SRP-30 Responsibilities of Fire Brigade Chief

Staff Concern:

The Fire Brigade Chief should not have any ancillary responsibilities during an emergency fire situation.

Staff Position:

Provide Administrative Procedure that defines the responsibility of the Fire Brigade Chief (Shift Supervisor) during a fire emergency situation.

ENCLOSURE NO. 3

FIRE PROTECTION STAFF REVIEW POSITIONS (SRP)
LICENSEE AGREED TO CONSIDER FURTHER

SRP-3 Diesel Fire Pump

Staff Concern:

A diesel fuel oil spill fire could spread and cause damage to the two motor operated fire pumps or the four service water pumps (safe shutdown system).

Staff Position:

Provide Automatic foam suppression for the diesel fire pump. Feed to the foam suppression should be independent of the feed to the sprinkler system.

SRP-4 House Boiler to Diesel Generator Room Oil Isolation

Staff Concern:

A fuel oil spill fire in the house boiler room could spread to emergency diesel generator room 1B.

Staff Position:

Provide a dike or drainage between the diesel generator room 1B and the house boiler room.

SRP-5 Diesel Generator Room to Diesel Generator Room Oil Isolation

Staff Concern:

A fuel oil spill fire in diesel generator room 1A could spread under the door into diesel generator room 1B to the existing dike.

Staff Position:

Provide a dike between diesel generator room (other side of door from existing dike).

SRP-6 Control Room Kitchenette Smoke Detection

Staff Concern:

Fire in the control room kitchenette could go undetected until well developed.

Staff Position:

Provide a smoke detector in the kitchenette in the control room.

SRP-7 MG Set Oil Coolers

Staff Concern:

Reliance on the floor drainage system to remove fire hazard oil spill is not considered adequate. Manual suppression alone is not considered acceptable for potential oil fires that could involve safety related cables.

Staff Position:

An automatic suppression system should be provided over the oil system heat exchanger for the MG set on the 931 foot level in the northwest corner.

SPR-8 Reactor Building Cable Tray - Northeast Corner - EL.903

Staff Concern:

A fire in this area could cause an unacceptable loss of redundant safety-related electrical circuits. Furthermore, due to the height of the cables above the floor, it is not credible that fires in this area could be adequately suppressed with a manual hose stream.

Staff Position:

Provide an automatic Suppression system over the cable trays in the northeast corner of the reactor building - EL.903.

Consider the effect on MCC-K.

SRP-9 Battery Rooms 1A and 1B Detection

Staff Concern:

The single detectors in these rooms may not be adequate.

Staff Position:

Provide an analysis and/or in situ testing that proves the single detector in battery rooms 1A and 1B are sufficient to detect a fire anywhere in the room.

SRP-10 Hydrogen Gas Buildup Battery Rooms 1A and 1B

Staff Concern:

Failure of exhaust ventilation in battery rooms 1A and 1B could lead to a buildup of explosive hydrogen concentrations.

Staff Position:

Provide air flow supervision in exhaust ducts of each battery room.

SRP-11 Turbine Building to Control Building Oil Isolation

Staff Concern:

Oil could enter the control building from an oil spill in the turbine building on the mezzanine level - EL.903.

Staff Position:

Provide a curb or alternate means to control oil at the entrance to the control building from the turbine building on the mezzanine level - EL.903.

SRP-12 Reactor and Control Building Automatic Suppression Water Feed

Staff Concern:

The loss of the present single suppression water supply to the control and reactor buildings will result in a loss of both automatic and manual fire suppression capability.

Staff Position:

Provide an independent feed for automatic suppression systems in the reactor building and control building.

SRP-13 Cable Expansion Room

Staff Concern:

A fire in this room could cause an unacceptable loss of redundant safety-related electrical circuits.

Staff Position:

Provide an automatic suppression system for the cable expansion room.

SRP-15 MG Set Curbing

Staff Concern:

A lubricating oil spill fire in one MG set could result in an oil system failure and resultant oil spill from the adjacent MG set with a potential for effecting safety related cables.

Staff Position:

Provide a curb between MG sets - EL.976.

SRP-16 Control Room Particle Board Wall

Staff Concern:

Flames spread characteristics of this wall are unknown.

Staff Position:

Provide the flame spread rating for the plastic laminate and particle board wall panels in the control room.

SRP-17 Penetration Barriers

Staff Concern:

The cable penetration barriers may not be adequate to prevent a fire from propagating through the barriers.

Staff Position:

Provide the testing documentation that substantiates the adequacy of the penetration barriers.

SRP-18 Fire Alarm System

Staff Concern:

The existing fire alarm system may not meet requirement of NFPA 72D.

Staff Position:

The existing fire alarm system should meet NFPA 72D, and if not, identify any deviations.

SRP-20 Control Building Corridor - EL.903

Staff Concern:

Due to the location of the safety-related equipment and non-contunity of three hour fire barriers in this area, positive methods for elimination of fire paths are essential. A fire in this area could cause an unacceptable loss of redundant

DC safety related circuits.

Staff Position:

Provide a plan to control the combustibles in the corrider of the control building - EL.903.

SRP-21 Laundry Room Area

Staff Concern:

A fire in this area could propagate to the cable expansion room on the floor above and could cause an unacceptable loss of safety related circuits.

Staff Position:

An automatic sprinkler system should be provided throughout the laundry room and in the control access corridor around to the stairs, or a three hour fire barrier should be provided between the cable expansion room and all other areas, including all penetrations into the cable expansion room.

SRP-22 Air Compressors - Automatic Suppression

Staff Concern:

The Libe oil spill fire for the air compressors could damage the 4160 volt power cables to the service water pumps.

Staff Position:

In the compressor room of the control building basement (EL 882) an automatic suppression system should be provided for the air compressors.

SRP-23 Air Compressor Room - Curbing

Staff Concern:

A means of protecting the 4160 volt power cables to the service water pumps should be provided in the event of a failure of the automatic suppression system over the air compressors. Also, these same power cables need to be protected from flamable liquid spills in the manholes through which they pass.

Staff Position:

In the compressor room in the control building basement, curbs should be provided around the conduit risers adjacent to the south wall and in front of the manways adjacent to the east wall.

SRP-24 Instrument Storage Room

Staff Concern:

A fire in this store room (EL.903) could have the same detrimental affect on the redundant safety-related equipment that was referenced in SRP-20.

Staff Position:

An automatic sprinkler system should be provided in the instrument storage room control building (EL.903).

SRP-26 Fire Brigade

Staff Concern:

The present proposal for manning the fire brigade is not considered adequate to successfully combat the types of fires that could be expected to occur.

Staff Position:

A fully trained five man fire brigade should be provided.

SRP-31 Control Room

Staff Concern:

The present suppression systems proposed for the control room may not be adequate for combating fires inside of cabinets or control boards.

Staff Position:

Two 17 pound halon 1211 fire extinguishers should be provided in the control room.

SRP-32 Drip Protection for Certain Vital Switchgear

Staff Concern:

Water from fire fighting efforts may inadvertently cause the loss of some safety-related circuits.

Staff Position:

Provide overhead drip protection for vital switchgear in areas where manual suppression is the prime means of extinguishment or automatic suppression systems have been installed above switchgear.

SRP-33 Fire Pump Discharge Header

Staff Concern:

Single break in the fire pump discharge header will cause complete loss of fire water availability.

Staff Position:

Install isolation valve to permit utilization of redundant pump(s).