JSM

GULF STATES UTILITIES COMPANY
POST OFFICE BOX 2951 • BEAUMONT, TEXAS 77704
AREA CODE 409 838-6631

Date 7-1-86

American Nuclear

Ref:
P.O. No. NONE
Invoice No. 043693

DEAR SIR:

THE ATTACHED IS RETURNED FOR THE FOLLOWING REASON(S):

|__| Invoiced quantity does not agree with quantity received.

|__| Invoiced unit price does not agree with purchase order price.

|✓| ~~Gulf~~ States purchase order number not referenced.
No P.O.# received

|__| Incorrect Gulf States purchase order number referenced.

|__| Incorrect purchase order release number referenced.

REC'D JUL 10 1986

|__| No purchase order release number referenced.

|__| Purchase order freight terms are Prepaid. Invoice contains freight charges.

|__| Purchase order freight terms of Prepay & Add require a copy of the freight bill attached to the invoice.

|__| Purchase order freight terms are Collect. Materials invoice contains freight charge.

|__| Expired purchase order.

|__| Incorrect sales taxes invoiced.

|__| Other

Please direct any questions concerning the Purchase Order or Invoice to: person receiving material, and return invoice
~~(Purchasing Agent)~~

to: Invoice Processing.
P. O. Box 4048
Beaumont, TX 77704

Lisa
Invoice Processing Clerk

SUMMARY [illegible]

CONTRIBUTED/STIMULATED PAPER ☒ INVITED PAPER ☐ 459

ORIGINAL AND [...] COPIES REQUIRED

INSTRUMENT SENSING LINE PROBLEMS IN BWR'S

J. S. MILLER — ANS Member: Yes ☒ No ☐

Gulf States Utilities Company — Phone 504-[...]-6094

PO Box 220, St. Francisville, LA 707[...] — [...] 2813

J. E. ELLIOTT — ANS Member: Yes ☐ No ☒

General Electric Company — Phone 504-[...]-6094

PO Box 220, St. Francisville, LA [...] — [...]

[illegible] — No ☐

List additional authors on a separate sheet. Complete [illegible]

#070112-01

BILLING INFORMATION

(Check one)

☐ PO attached to original summary

PO Number:

Bill [...] page charge to:

Name: J. S. MILLER

Company: (Same as above)

Address:

[illegible] 900.)

[...] lines of [...] 450

3 figures [...] 450

tables [...]

lines of [...]

TOTAL (Must not be more than 900) 900

CONTRIBUTED SUMMARY

Subject category number for your summary (from page [...]): 13.1

Alternative subject category number: 12.5

INVITED SUMMARY

ANS Division/Technical Group [...]

Chairman that invited you:

Subject category number (from page [...]):

PUBLICATION INFORMATION

	Yes	No
[...] of this summary [...]	☐	☒
[illegible]		
[...] been submitted [...]	☐	☒
[illegible]		GE
[illegible]	☐	☒

[redacted] K 3/17

[...] ATTACHED [...] [...]IPS.

AMERICAN NUCLEAR SOCIETY

555 North Kensington Ave. LaGrange Park, Illinois 60525 USA
(312) 352-6611 TELEX 25-4635

INVOICE NO.	INVOICE DATE
043693	6/20/86

CL# 1325

CUSTOMER # 070117-01

SOLD TO
GULF STATES UTILITIES CO
ATTN - ACCOUNTS PAYABLE
P O BOX 2951
BEAUMONT TX
77704-0000

SHIP TO
GULF STATES UTILITIES CO
RIVER BEND ENERGY CENTER
P O BOX 220
ST FRANCISVILLE LA
70775-0000

PURCHASE ORDER #

PURCHASE ORDER # J S MILLER

QUANTITY	DESCRIPTION	AMOUNT
	043693 6/20/86	
	PAGE CHARGE FOR PAPER PUBLISHED IN 03415 TRANSACTIONS VOL. 52 - JUNE 1986 INSTRUMENT SENSING LINE ANOMALIES IN BWRS J S MILLER, J C ELLIOTT SG	538.35
	SUB-TOTAL AMOUNT	538.35
	INVOICE AMOUNT	538.35
	AMOUNT TO BE PAID IN U.S. FUNDS	538.35
	**** NET PAYABLE UPON RECEIPT ****	

REC'D R&S

GSU ACCTG

PLEASE REFER TO 043693 INV# IN ALL CORRESPONDENCE
PLEASE REMIT TO. AMERICAN NUCLEAR SOCIETY
PO BOX 4957
CHICAGO, IL 60680

(A$3115-REV.03)

AMERICAN NUCLEAR SOCIETY
555 North Kensington Avenue, LaGrange Park, Illinois 60525 USA
Telephone: (312) 352-6611 • Telecopier: (312) 352-0499 • Telex: 254635

June 1986

The attached invoice represents the publication charge made by the American Nuclear Society for the summary(ies) of the technical paper(s) presented by you or by member(s) of your organization and published in Volume 52 of 1986 TRANSACTIONS of the American Nuclear Society. A copy of each relevant summary is also attached.

Charges for publications in TRANSACTIONS have been authorized by the Board of Directors of the ANS. The charges on each invoice are calculated in the following manner: $170.00 per page (18 inches); $85.00 for 9 inches; $9.45 for each inch (or fraction greater than ½ inch) remaining. There is a minimum charge of $85.00.

Reprints of the summaries published in TRANSACTIONS are not available; consequently, upon payment of the publication charge, you are authorized to reproduce up to 25 copies of the summary(ies) covered in the invoice.

Publication charges are used by a large number of professional societies as a means of expediting the dissemination of scientific and technical material. These charges, which are authorized under government sponsored research contracts, are infinitesimal when compared with the cost of the research and paper presentation.

Your continued support of the scientific-publications efforts of the American Nuclear Society is greatly appreciated.

Sincerely,

W. Michael Diekman

W. Michael Diekman
Manager of Publications

WMD:mm

Enclosure - Publication Charge Invoice
Copy of Summary

fuel assembly and support grid structure. The TMI-2 defueling operations are made difficult because, unlike most other underwater experiences, the required activities in the reactor vessel cannot be reduced to a set of precisely defined problems. The unknown conditions beneath the upper core layer at TMI-2 during the tooling design phase imposed a basic requirement to provide a set of tools with maximum versatility and usefulness for a wide range of conditions that could not be precisely defined.

UNDERWATER TOOLING DESIGN

The basic tool kit designed for early core removal activities includes long-handled tools that are either manually or hydraulically operated for the purposes of picking up and placing into fuel canisters fuel rods or pieces of control rods and fuel assembly upper end fittings that lay on the rubble bed after they were dislodged from the upper plenum grid structure. A special underwater vacuum system is also designed to clear the loose rubble that lay under the end fittings.

Once the upper layers are cleared of loose debris, the major problems associated with breaking up and removing the anticipated hard-crusted material of liquefied fuel and cladding will have to be resolved with more elaborate tooling. Unknown conditions in the lower core region, which was assumed to include partial fuel assemblies possibly fused with once-molten core material, will also require special tooling. A summary of the tooling that is designed for this unique core removal operation is discussed below.

A manual tool positioner provides a strongback capable of positioning various defueling tools in all areas of the reactor vessel. It provides four degrees of freedom for the defueling tools: vertical travel, lateral positioning, rotation around the main axis, and rotation around the lateral positioner axis. A hydraulically operated remote manipulator arm with six additional degrees of freedom can be installed on the tool positioner and used to operate cutting equipment, to help guide long-handled tools or underwater video cameras, and to pick and place core debris.

Abrasive/waterjet cutting equipment will be used to break up the hard crust layer of the core, to cut fuel debris and fuel assemblies into pieces small enough to fit into fuel canisters, and to cut access holes, if required, in lower vessel components (e.g., lower grid, flow distributor plate, etc.). A hydraulically operated abrasive saw will also be used to cut the anticipated hard crust layer of the core, and to cut fuel debris and fuel assemblies into pieces small enough to fit into fuel canisters. A hydraulically operated impact chisel will be used to break up the hard crust layer of the core. A cutting station will be used to clamp and cut ductile pieces that are too large to be loaded into fuel canisters, but could be more easily sectioned in a stationary position than on the core surface. Cutting will be accomplished with a hydraulically operated wire saw.

SUMMARY OF TMI-2 DEFUELING EXPERIENCE

Defueling of the TMI-2 reactor core commenced on October 30, 1985. Initial efforts included knocking down a few partially intact fuel assemblies that were restricting full use of the defueling system from the rotating work platform. Many of the upper fuel assembly end fittings were distorted or fused together and had fuel rod stubs and control rod spider components attached. These pieces were too large to be directly placed into fuel canisters and had to be supported in the debris cutting station and properly sized using cutting shears and other tools. The first few canisters were then loaded with these partial fuel assemblies and upper end fittings along with miscellaneous control rod spiders and fuel rods.

Early efforts to pick-and-place material into the fuel canisters were not very efficient because of the maze of partial-length fuel assemblies and other rod-like structures in the upper core region and the relative bulkiness of the special tooling, which was being manipulated from 8 m above the target debris pieces. Most of the tools require direct vertical access for greatest effectiveness, and any overlying material would inhibit tooling maneuverability. Using the large cutting shears, most of the upper interfering pieces of the damaged core were cut away and improved access was gained to the underlying material. These pieces were then also loaded into defueling canisters.

Defueling of the upper core region will continue with vacuuming of the loose, pellet sized and smaller debris and removal of as many loose partial fuel assemblies as possible. A U.S. Department of Energy-sponsored core stratification survey will be made by taking several core bore samples of the underlying mass, to assess its strength and composition. Various configurations of special tooling described above will be used to then break up and remove the material in the lower regions, which is scheduled to occur through the middle of 1986.

SUMMARY

By the middle of 1986, it is expected that the experience gained from these TMI-2 underwater operations will advance the knowledge of performing complex operations in support of defueling and maintenance in nuclear plant reactor vessel and storage pools.

4. Instrument Sensing Line Anomalies in BWRs, *J. S. Miller (Gulf States Util, St. Francisville), J. C. Elliott (GE, St. Francisville)*

This paper describes the instrument sensing line anomalies found at the River Bend Station (RBS), approaches that were used to identify solutions, and modifications that were used to bring the instrument sensing lines within design specifications. Also, instrument sensing lines at other reactor facilities that exhibit the same symptoms as those experienced at RBS will be discussed.

DISCUSSION

When the RBS reactor was first pressurized, it was observed that several leak detection instruments that measure steam flow in the reactor core isolation cooling (RCIC) steam line indicated erratically. One of the four flow measurement instruments (all on the same steam line) indicated a substantial steam flow when the RCIC turbine was not running. Another instrument indicated a slightly negative reading when there was no flow, then drifted strongly negative when steam flow was established, and then slowly returned to initial indication after steam flow stopped.

The purpose of these instruments is to detect excessive steam flow indicative of a steam leak or line break, and to initiate an automatic closure of isolation valves. Since these instruments are safety-related, they must satisfy technical specifications established by the U.S. Nuclear Regulatory Commission. These specifications require that the instrumentation satisfy accuracy and operability requirements, or that the affected isolation valves be closed. Since closure of the valves disables the RCIC system, other sections of the tech specs limit the length of time that the plant can be operated. Consequently, it was necessary to quickly diagnose and correct the situation.

Figure 1 illustrates the flow measuring instrumentation used. Each flow measuring instrument consists of the following elements:

1. *Flow elbow:* This is an ordinary 90-deg pipe elbow with taps at 45 deg, one on the outside and one on the inside of the elbow. The elbow may be mounted in the horizontal or

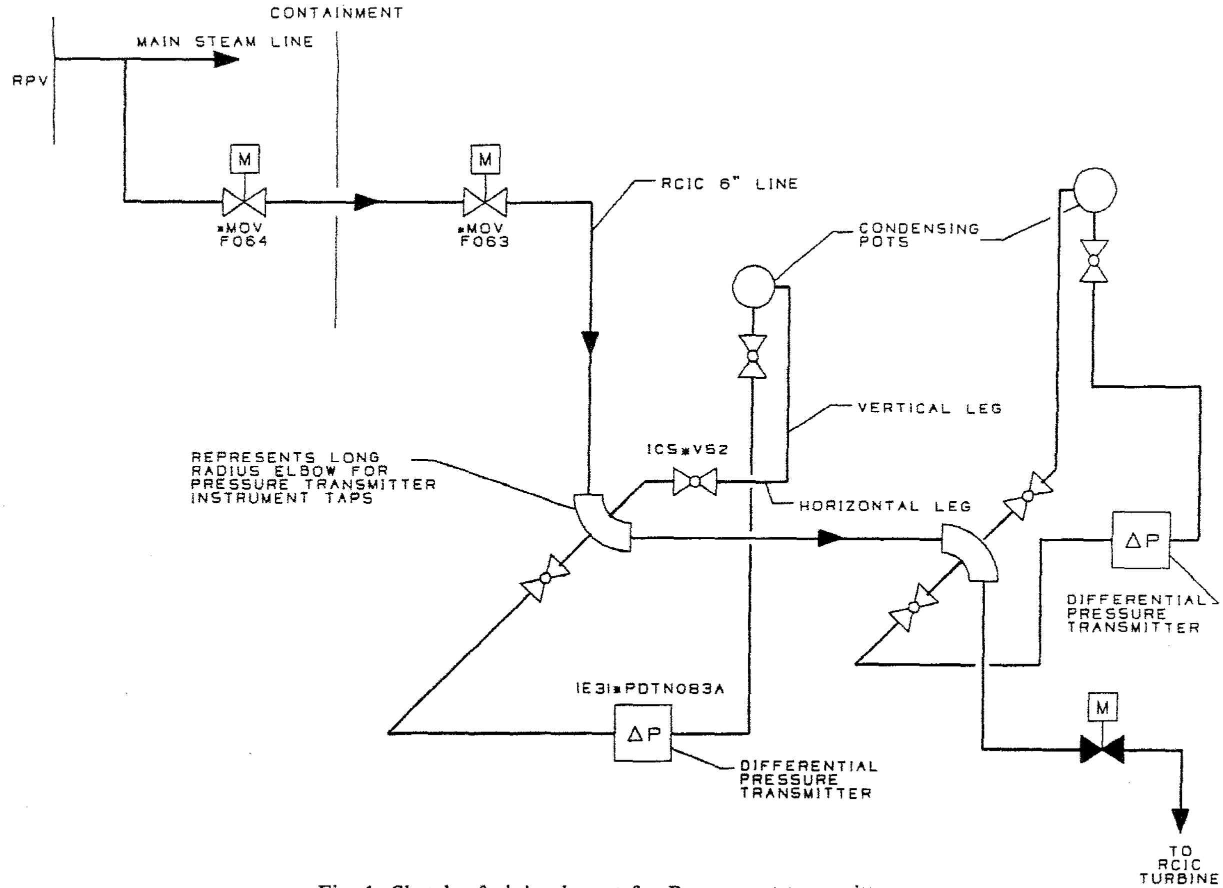

Fig. 1. Sketch of piping layout for Rosemount transmitters.

vertical plane. Steam flow through the elbow in either direction causes a differential pressure that is a function of flow.

2. *Condensing pot:* These are generally used for the top tap of a vertically mounted elbow or for both taps of a horizontally mounted element to ensure the instrument line is maintained full of water. In one case at RBS, condensing pots were used to gain enough elevation to permit proper sloping of the instrument line to the differential pressure transmitter.

3. *Differential pressure transmitter:* Converts the differential pressure to an electrical signal.

4. *Sensing lines:* This is small-diameter piping connecting the flow elbow, the condensing pot, and differential pressure transmitter. The piping from the elbow must be sloped upward to the condensing pot and permit a countercurrent flow of steam and condensate (i.e., flow of steam to the condensing pot and flow of condensate back into the steam line). The line from the condensing pot (or elbow if no pot is used) should be sloped continuously down to the transmitter so that no air pockets will form that may cause an erroneous reading.

The possible causes of the observed instrument line anomalies are as follows:

1. air in the sensing lines causing water legs, which biases the indication
2. incorrect calibration of the transmitter, including the wrong elevation of the condensing pot or elbow
3. faulty transmitter
4. the line between the flow elbow and the condensing pot partially or completely filling with condensate.

After a thorough investigation, items 1 through 3 above were ruled out, and item 4 was determined to be the cause. The reason that the line fills with water is that, at some point in the line, water accumulates and blocks steam flow to the condensing pot. When this happens, steam above the blockage gradually condenses and draws condensate up into the piping leading to the condensing pot. Factors that cause blockage are:

1. *Inadequate line slope:* The line slope should be a minimum of 0.5 in. per foot in 0.75-in. piping to ensure proper draining. It is important to realize that line slope may change as the plant heats up to rated conditions so line slope should also be checked after heat up.

2. *Valves:* Globe valves in nearly horizontal lines may cause blockage (see Fig. 2) due to the internal construction of the globe valve. Valves should be eliminated or located in vertical runs of piping.

3. *Obstructions:* Foreign objects inadvertently left in the piping during construction could cause a blockage.

4. *Fitting geometry:* The geometry of the fittings welded to the flow elbow (particularly the lower tap on the vertically mounted flow elbow) may result in blockage (see Fig. 3).

In the first case mentioned where the instrument indicated a substantial flow when no flow was present, it was postulated that the low-side leg was filling with water since this would explain the positive error observed. This leg has a globe valve installed in a nearly horizontal run of piping and was the likely

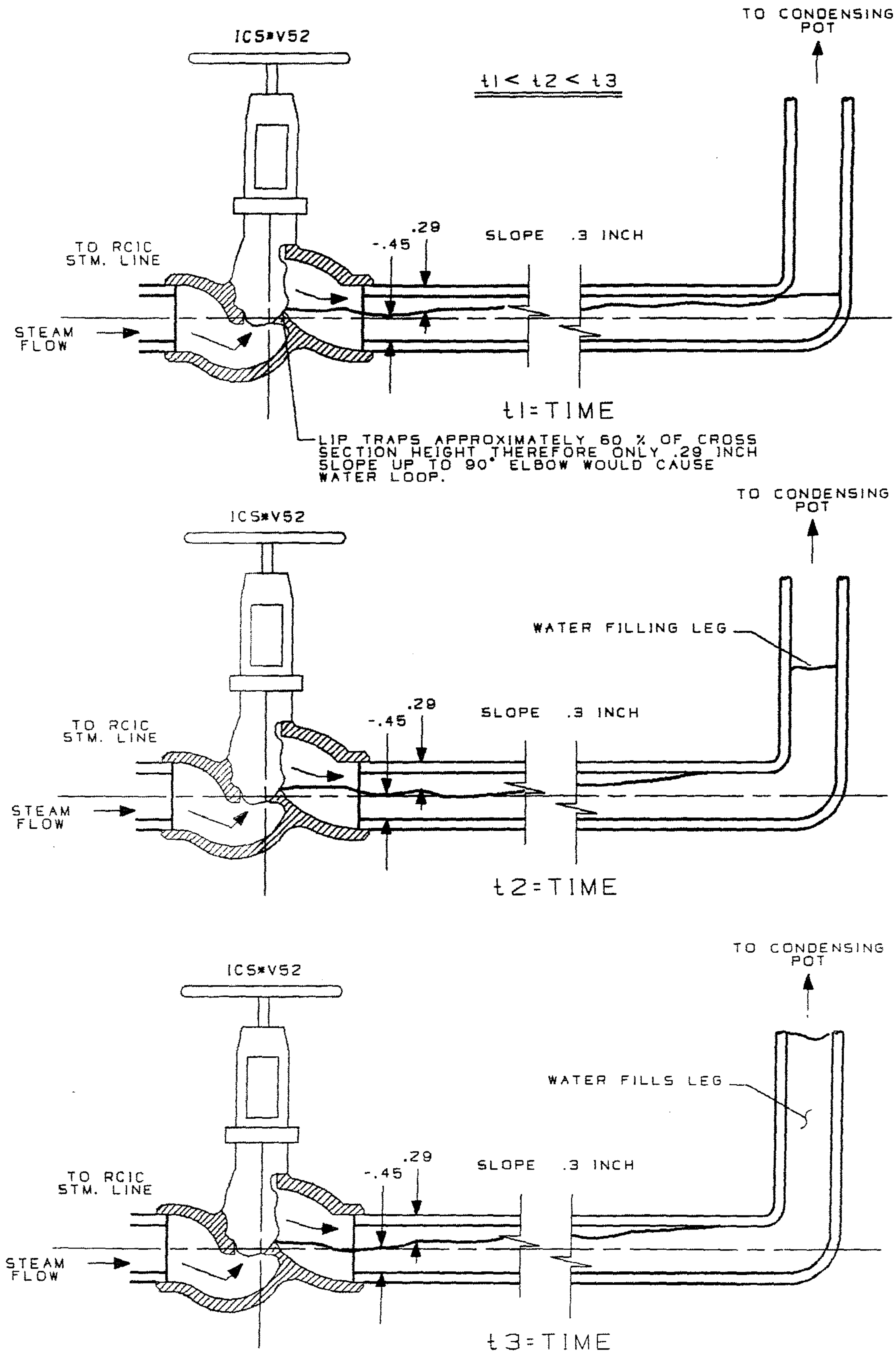

Fig. 2. Filling vertical leg on I-ICS-750-90-2(Z-).

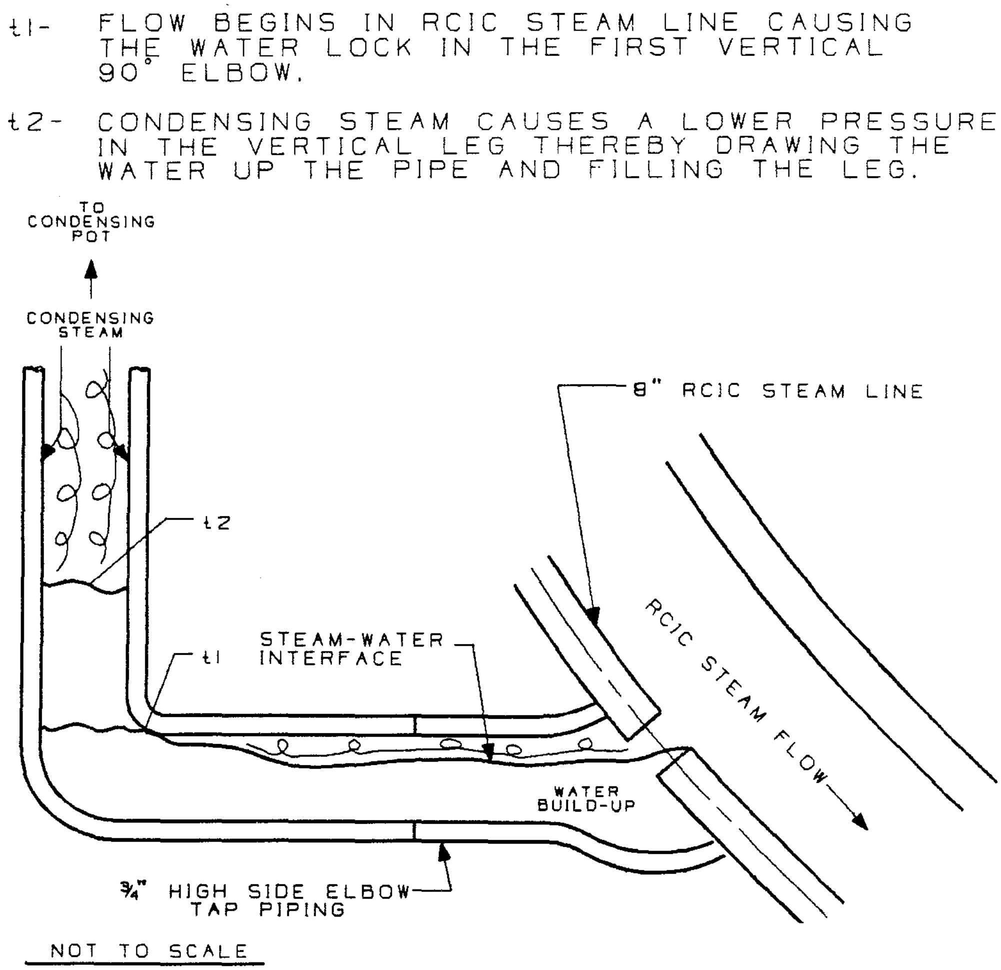

Fig. 3. Water pocket forming in sensing line.

cause. Subsequently, a design modification to this piping configuration (see Fig. 1), which moved globe valve ICS*V52 from the horizontal to the vertical leg, proved to be the solution. This modification prevented water from filling the vertical leg, thereby allowing the differential pressure transmitter to indicate properly.

Similar anomalies with the same instrumentation have been reported or observed at other plants in construction or initial startup. In one case, level instrumentation for the turbine moisture-separator-reheater drain tanks was observed to be installed incorrectly, having a globe valve in a nearly horizontal line, and using small diameter tubing from the tank to the condensing pot. Reference 1 describes a condition at a foreign pressurized water reactor in which accumulation of noncondensable gases in a pressurizer level instrument condensing pot resulted in erroneous indications. Thus, it is concluded that improper installation of condensing pots may be a generic problem that warrants special engineering attention to avoid plant startup delays.

RECOMMENDATIONS

Plant owners should inspect instrumentation that employ condensing pots to ascertain if the following criteria are satisfied by the piping connecting the process and condensing pot:

1. minimum line size of 0.75-in. pipe.
2. minimum slope of 0.5 in. per foot (Double check the thermal expansion calculations of the sensing line to ensure that the slope does not change significantly during pipe line heatup.)
3. no globe valves or, if present, installed in vertical runs
4. line insulated up to condensing pot.

1. OLLE NOCKERT, "Calculations and Measurements of Condensation in Level Pots," Nuclear Network Information, Ringhals Nuclear Power Station (1983).