MAIN STEAM LINE BREAK CONTAINMENT ANALYSIS
USING A 0.20 INCH DROP SIZE
MAY, 1985

1. INTRODUCTION

In February, 1985, Westinghouse documented the results of two containment temperature transients following a postulated Main Steam Line Break (MSLB) for the Watts Bar plant. The first case documented was an analysis using a revised version of LOTIC-3 (WCAP-8354, Supplement 3), which is described in detail in the Westinghouse submittal to the NRC Containment Systems Branch (CSB), dated September 10, 1984. The second case modified the September 10th model to account for the results of the ice condenser drain tests which were completed at that time. At that time, Westinghouse had test data for the steam generator, reactor coolant pump (RCP), and the cable tray models. Since Westinghouse did not have any data for the free fall drain model, that model remained the same as the September 10th model. The results of both of these cases showed that the peak containment temperature for the Watts Bar plant remained below the original FSAR transient.

Based on a preliminary assessment of the LOTIC-3 drain model by A. Koestel and R.G. Gido, the Containment Systems Branch of the NRC requested that another case be analyzed with a free fall droplet diameter of 0.2 inches. This report documents the results of that analysis. Also in this analysis is a more representative drain configuration breakdown based upon test results and the Watts Bar Unit 1 containment. The containment information was obtained from measurements taken inside the containment building by Westinghouse and TVA personnel. At this time, Westinghouse does not agree with the use of the 0.2 drop diameter, but feels that the model described in the September 10th submittal should be used in the interim until the ice condenser drain tests have been completed. Upon completion of the drain test program, an analysis will be performed using the results of the drain tests.

DISCUSSION

Since the February 1985 submittal, several modifications have been made to the ice condenser drain model. These changes were made to better represent the Watts Bar containment building. These changes include a modification to allow for having the breakdown of drain type as a function of drain flow. This change was neccessary to adequately model what would happen in the plant. For example, at very low flows, the Westinghouse test results show that the drain water from a steam generator type drain will not hit the steam generator. Thus it will actually be a free fall type drain. At intermediate flows, this drain water will hit the steam generator. A fration of the water will splash off of the steam generator and form smaller free fall type droplets, while the rest of the water will run down the steam generator and form droplets at the bottom of the steam generator. The droplets formed at the bottom of the S.G. is accounted for in the steam generator model while a new model had to be developed for the splashed flow. At very high flowrates, nearly all of the flow goes to splash flow.

2.1 SPLASH MODEL

From observing the ice condenser tests it became clear that the original ice condenser drain models described in the September 10th submittal were inadequate to accurately model what was being seen in the tests. A new model had to be developed to account for the splashing off of both large equipment (steam generators and RCPs) and small piping. The steam generator and RCP models were adequate for describing the droplet field generated from flow off the bottom of the equipment but did not consider the droplet field from the water that splashed off of the equipment. From the data obtained from the ice condenser drain tests a curve of droplet diameter versus drain flowrate were made for the splash flow. Figure 1 shows this curve. The dashed line is the equation used in the LOTIC-3 calculation. Splash flow can also occur for the flow considered free fall since this flow will hit small piping and supports.

2.2 BREAKDOWN OF DRAIN CONFIGURATIONS

A review was made of the Watts Bar containment and ice condenser drain configuration to determine the seperation of the drains into the various drain models. A tour of Watts Bar Unit 1 was made to measure various distances and to get a visual image of the containment building. The data recorded at the site went into the determination of the drain configuration. Also, the test data was closely looked at to determine at what flowrates the water would hit a specific piece of equipment. From this study, it was determined that only at intermediate flowrates would a significant amount of the drain flow be in the form of a film on the steam generators or RCPs. Therefore most of the flow will be either free fall or splash flow. Figure 2 shows the number of free fall plus splash drains as a function of drain flowrate. From viewing all of the structures in the Watts Bar containment, it was estimated that nearly 3/4ths of the free fall would splash off of some structure. However, the free fall and splashed drains were split evenly in this analysis. This is conservative since the splash model predicts smaller droplets than the free fall model used in this study.

RESULTS

The base Watts Bar containment case was run using the modified version of LOTIC-3. A 0.2 inch free fall drain droplet diameter was used with the additional modification described above to account for the splash flow. The results of the LOTIC run are shown in Figure 3. The peak temperature is 312 F compared with the previosly transmitted result for Watts Bar using the September 10th model of 319 F. This shows that the penalty for having the larger droplet size of 0.2 inches is offset by the benefit in more accurately modelling the ice condenser drains.

When the ice condenser drain tests currently being performed are completed, the drain models used in this analysis will be reviewed and modified to better match the test data on the hydrodynamics of the ice condenser drain flow. The Watts Bar containment case will be rerun with these modified drain models.

K•E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A. 46 1320

Figure 1. Splash Droplet Diameter vs. Flowrate

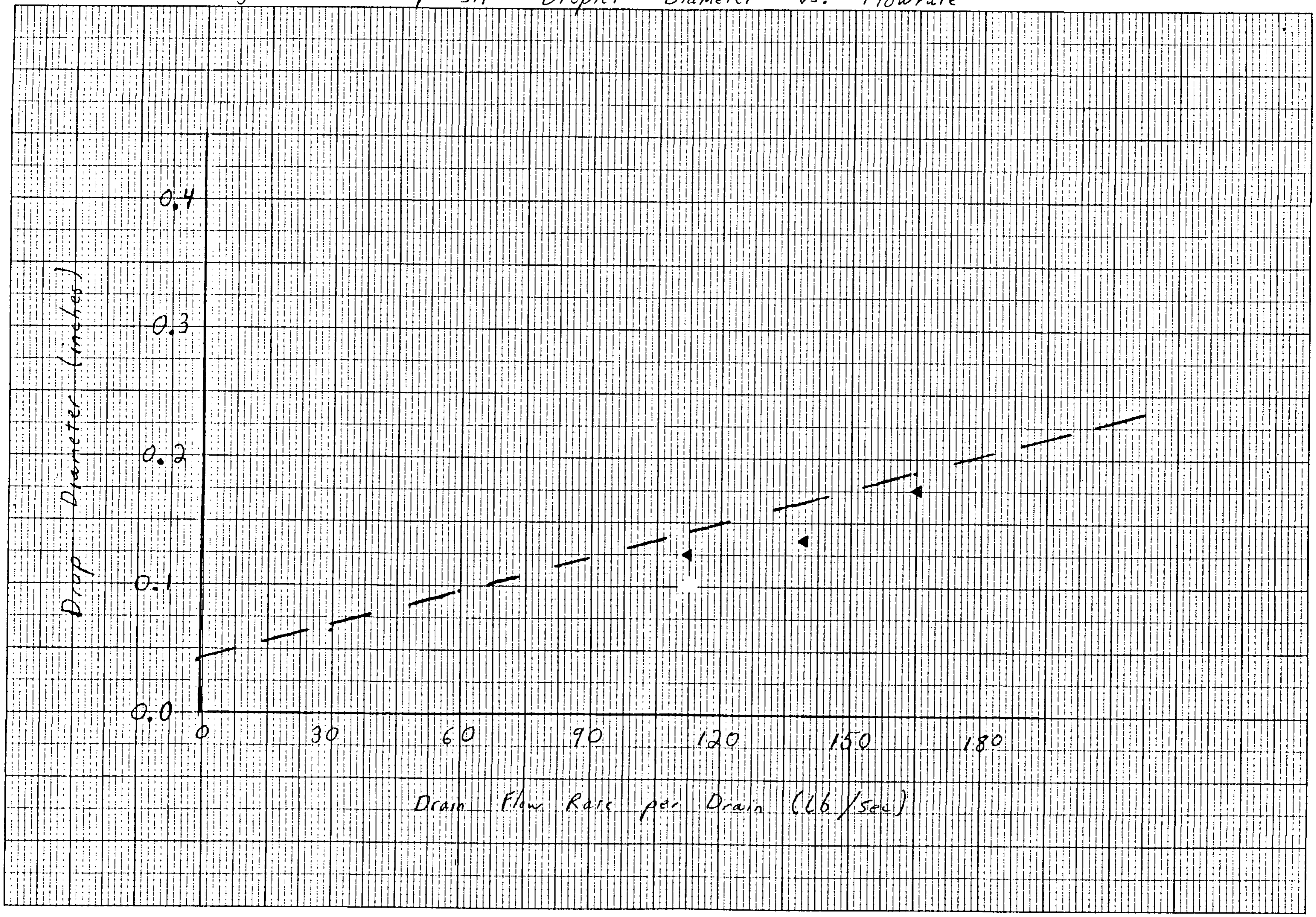

Figure 2. Drain Configuration

As A Function Of Drain Flow

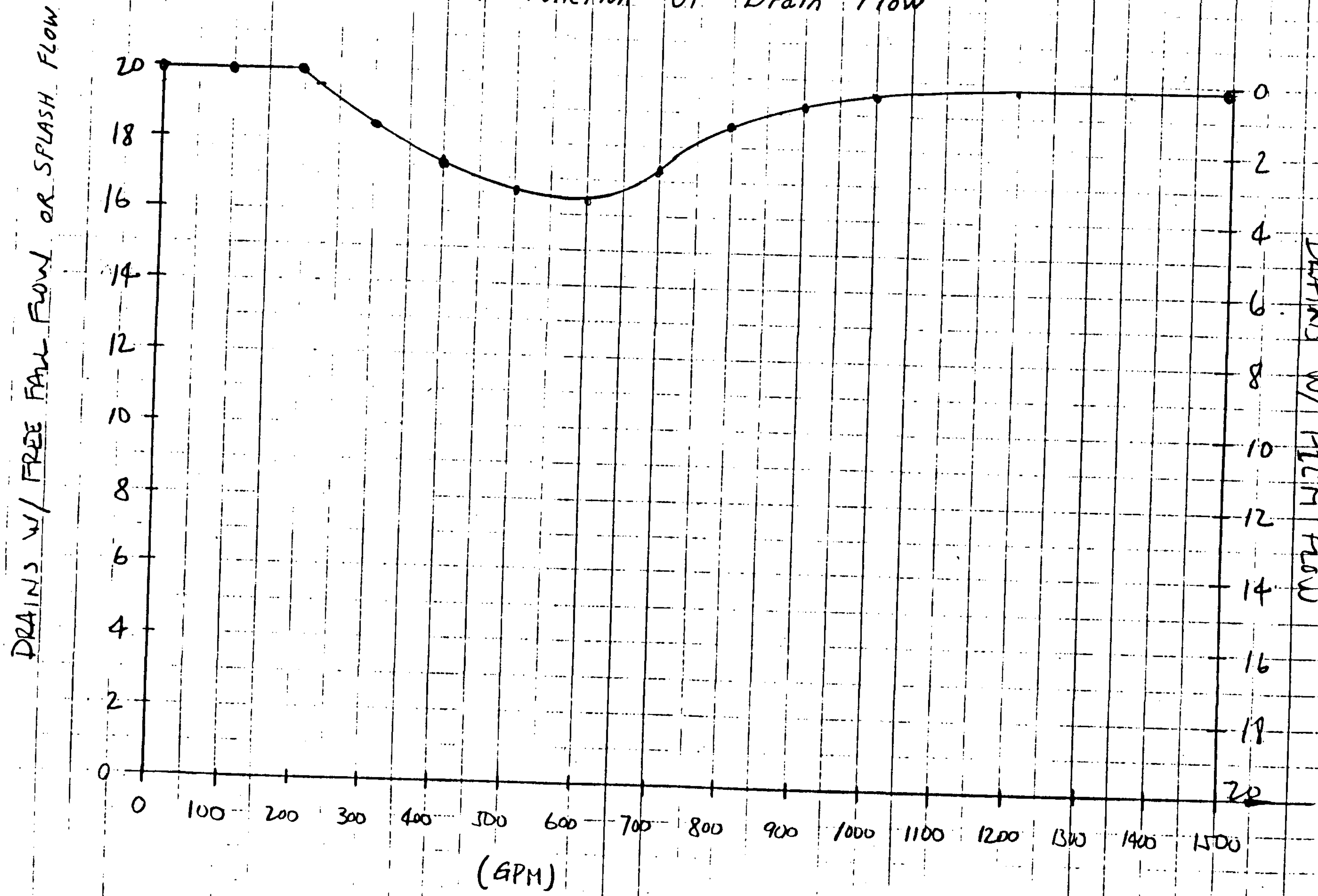

Figure 3. Containment Temperature Profile