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United States Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Braidwood Station, Units 1 and 2
Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket Nos. STN 50-456 and STN 50-457

Byron Station, Units 1 and 2
Facility Operating License Nos. NPF-37 and NPF-66
NRC Docket Nos. STN 50-454 and STN 50-455

Subject: Additional Information Supporting the License Amendment Request to Permit Uprated Power Operations at Byron and Braidwood Stations

References:

(1) Letter from R. M. Krich (Commonwealth Edison Company) to U.S. NRC, "Request for a License Amendment to Permit Uprated Power Operations at Byron and Braidwood Stations," dated July 5, 2000

(2) Letter from, C. L. Caso (Westinghouse) to T. M. Novak (NRC), CLC-NS-309, "Long Term Core Cooling – Boron Considerations," dated April 1, 1975

(3) H. C. Yeh, "Modification of Void Fraction Correlation," Proceedings of the Fourth International Topical Meeting on Nuclear Thermal-Hydraulics, Operations and Safety, Volume 1, Taipei, Taiwan, April 5-9, 1994

In Reference 1, we submitted proposed changes to Facility Operating License Nos. NPF-72, NPF-77, NPF-37 and NPF-66, and Appendix A, Technical Specifications (TS), for Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, respectively. The proposed changes would revise the maximum power level specified in each unit's license and the TS definition of rated thermal power.

During a subsequent telephone conference call among members of the NRC, Exelon Generation Company (EGC), LLC, and Westinghouse Electric Company, EGC's contractor, additional information was discussed regarding the calculation that addresses the maximum allowable time in which operators must direct some Emergency Core Cooling System (ECCS) circulation flow to the Reactor Coolant System (RCS) hot legs (i.e., known as "Hot Leg Switch-Over" (HLSO)) during a Loss of Coolant Accident (LOCA) scenario to prevent boron

A001

precipitation in the reactor core. The focus of the NRC questions was to determine the difference(s) between the current HLSO analysis and the HLSO analysis to support uprated power operations. Four specific issues are addressed in the below discussion.

The current HLSO time is 8.5 hours from event initiation. The following discussion justifies maintaining the HLSO time at 8.5 hours and is not intended to justify an increase in the HLSO time. Note that Reference 2 provides a comprehensive discussion on long term core cooling boron considerations.

Reactor Vessel Mixing Volume Assumptions

For the power uprate HLSO calculation, the reactor vessel mixing volume is the sum of the following regions.

1. Core volume from the top of lower core plate to the top of the upper core plate, which includes the volume from the top of the lower core plate to the bottom of the active fuel.

2. Upper plenum from the top of the upper core plate to the bottom of the cold leg.

3. Core barrel-baffle volumes between former plates where there are baffle holes that allow for communication with the core. Note that the remaining portion of the barrel-baffle volume is not credited.

There is no credit taken for hot leg nozzle gap flow in either the current or power uprate calculation. The lower plenum was also not credited in either the current or power uprate calculation. Although not credited in the Byron and Braidwood Stations HLSO analysis, Westinghouse considers that the lower plenum could be included with the core mixing volume if justified.

The differences between the reactor vessel mixing volumes assumed in the current HLSO calculation and the power uprate HLSO calculation are given below.

1. Inclusion of the barrel-baffle region volume where baffle pressure relief flow holes exist.

2. Inclusion of the plant specific volume from the top of the lower core plate to the bottom of the active fuel.

The core volume used in the HLSO power uprate calculation is 14% larger than the core volume used in the current HLSO calculation.

It is reasonable to assume effective mixing between the core and barrel-baffle volumes based on differences in the local fluid density of these two regions. In the HLSO analysis for the Byron Station and Braidwood Station Power Uprate Program, the barrel-baffle region contributes about 11% of the effective reactor vessel mixing volume that was assumed in the calculation. In Attachment 1, "Reactor Vessel Mixing Volume Figures for Hot Leg Switchover Considerations," Figures 1 through 6 illustrate the barrel-baffle region geometry for the Byron Station and

Braidwood Station reactor vessels, which were designed to have upward flow in the barrel-baffle region during normal operation. As shown in Figure 1, plants of this design have three main flow paths between the core and the barrel-baffle region: (1) near the core inlet, through the gap between the lower core plate and the bottom of the baffle plates; (2) at four axial elevations along the active fuel height, through pressure relief holes in the baffle plates; and, (3) near the core outlet, through the gap between the top of the baffle plates and the upper core plate. Axial flow within the barrel-baffle region passes through holes in the former plates, with a steady-state bypass flow through the barrel-baffle region of about 1,600 gpm for Byron Station and Braidwood Station under uprated power conditions.

Following a large break LOCA, continued decay heat induced boiling in the core would cause the core average void fraction to remain relatively high, throughout the cold leg recirculation phase of the transient. For example, one hour after accident initiation, calculations for a plant similar to Byron Station and Braidwood Station, indicated a core average void fraction on the order of 50%, based on the Modified Yeh Correlation (i.e., Reference 3). Conversely, any boiling in the barrel-baffle region that may occur due to stored metal energy in the core barrel, former plates and baffle plates would be expected to terminate within several minutes following accident initiation; and subcooling in this region would eventually be restored as the downcomer and lower plenum temperatures are reduced. The resulting differences in local fluid density between the core and the barrel-baffle region are fairly substantial and provide a mechanism for circulation between these volumes which would be expected to remain effective and promote sustained mixing during the cold leg recirculation phase of the transient.

Based on the preceding discussion, the barrel-baffle region for Byron Station and Braidwood Station is expected to contribute to the effective reactor vessel mixing volume during the cold leg recirculation phase of a transient. Therefore, the modeling of part of this volume in the HLSO analysis for uprated power conditions is appropriate. For this application, further conservatism is provided by neglecting the barrel-baffle volume in former regions that do not contain pressure relief holes in the baffle plates. The actual calculated HLSO time, given the above assumptions, is 9.6 hours; however, to maintain consistency with the pre-power uprate HLSO time, the post-power uprate HLSO time is conservatively maintained at 8.5 hours for Byron Station and Braidwood Station.

Core Voiding Assumptions

Core voiding was not modeled in either the current or power uprate HLSO calculations. Core voiding was ignored in the reactor vessel mixing volume since it is more than offset by the other reactor vessel volumes, such as the lower plenum which is not included in the mixing volume. This is consistent with the information reported to the NRC in Reference 2.

Boron Solubility Assumptions

A boron solubility limit of 23.53% was used in both the current and power uprate HLSO calculations. This value corresponds to the solubility of boric acid at 212°F and 14.7 psia, and includes a four weight percent reduction specified by the NRC, for conservatism. The solubility of boron in the reactor vessel mixing volume is not modeled as a variable that changes with the fluid temperature for either analysis. The core mass boiloff rate was calculated in the same manner for both the current and power uprate calculations.

Mixing Mechanism for Barrel Baffle Region and Core Volume Below Active Fuel

The reactor vessel mixing volume included only those local regions of the barrel-baffle region between former plates where there are baffle holes that allow for flow communication with the core (i.e., see Attachment 1). The reactor vessel mixing volume included the volume from the top of the lower core plate to the bottom of the active fuel. The inclusion of these volumes is considered acceptable due to mixing of the boron solution driven by flow circulation, fluid agitation from boiling, and diffusion phenomenon in the mixing volume. Flow circulation will be maintained in the mixing volume due to fluid density gradients.

Should you have any questions or concerns regarding this information, please contact Mr. J. A. Bauer at (630) 663-7287.

Respectfully,

RM Krich

R. M. Krich
Director – Licensing
Mid-West Regional Operating Group

cc: Regional Administrator – NRC Region III
NRC Senior Resident Inspector – Braidwood Station
NRC Senior Resident Inspector – Byron Station
Office of Nuclear Safety – Illinois Department of Nuclear Safety

STATE OF ILLINOIS	)	
COUNTY OF DUPAGE	)	
IN THE MATTER OF	)	
EXELON GENERATION COMPANY, LLC	)	**Docket Numbers**
BYRON STATION UNITS 1 AND 2	)	**STN 50-454 AND STN 50-455**
BRAIDWOOD STATION UNITS 1 AND 2	)	**STN 50-456 AND STN 50-457**

SUBJECT: Additional Information Supporting the License Amendment Request to Permit Uprated Power Operations at Byron and Braidwood Stations

AFFIDAVIT

I affirm that the content of this transmittal is true and correct to the best of my knowledge, information and belief.

R. M. Krich
Director – Licensing

Subscribed and sworn to before me, a Notary Public in and

for the State above named, this 26th day of

March, 2001.

Notary Public

" OFFICIAL SEAL "
Timothy A. Byam
Notary Public, State of Illinois
My Commission Expires 11/24/2001

ATTACHMENT 1

Reactor Vessel Mixing Volume Figures
for
Hot Leg Switchover Considerations

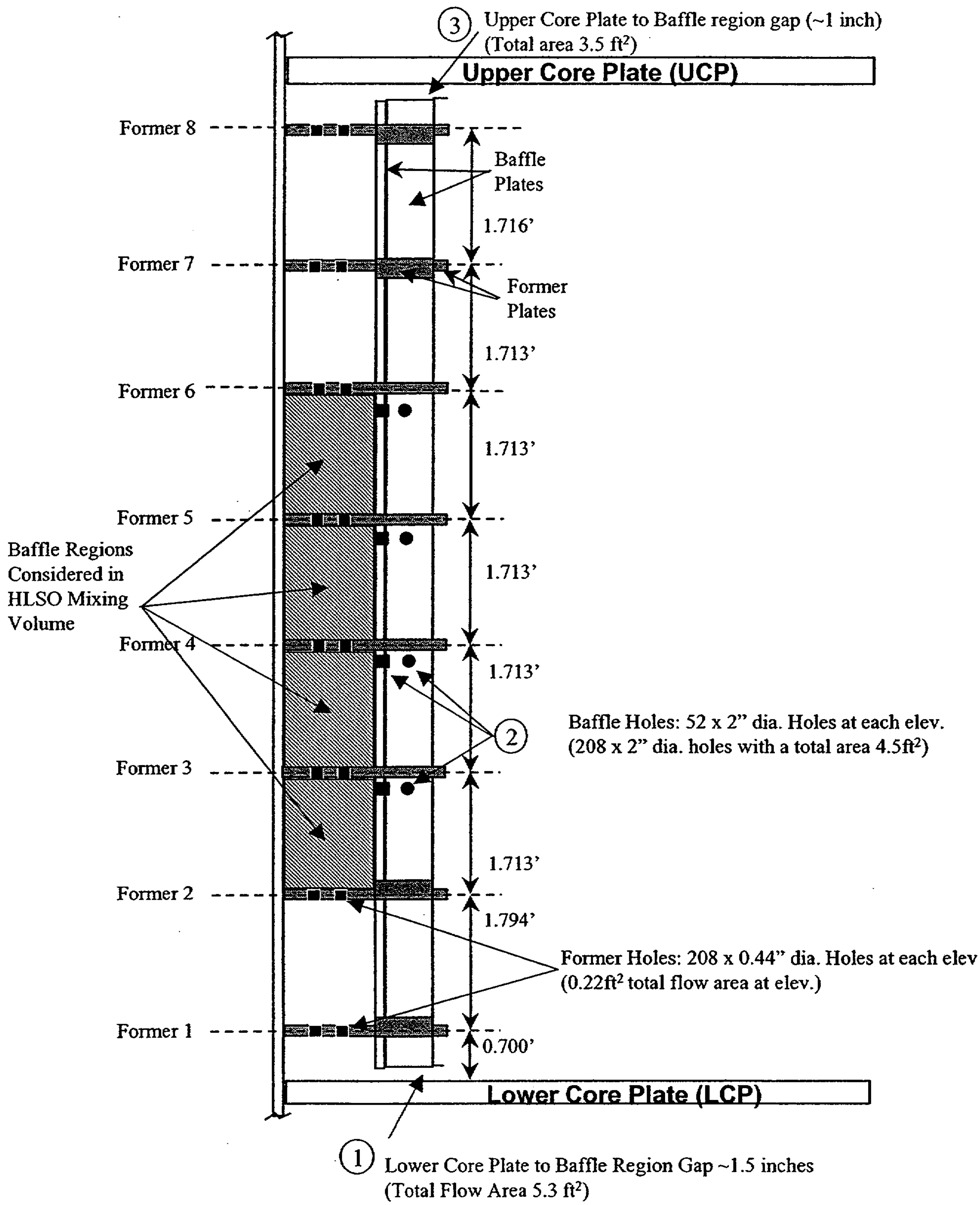

Figure 1. Illustration of Baffle-Former Regions Considered in HLSO Calculation Mixing Volume

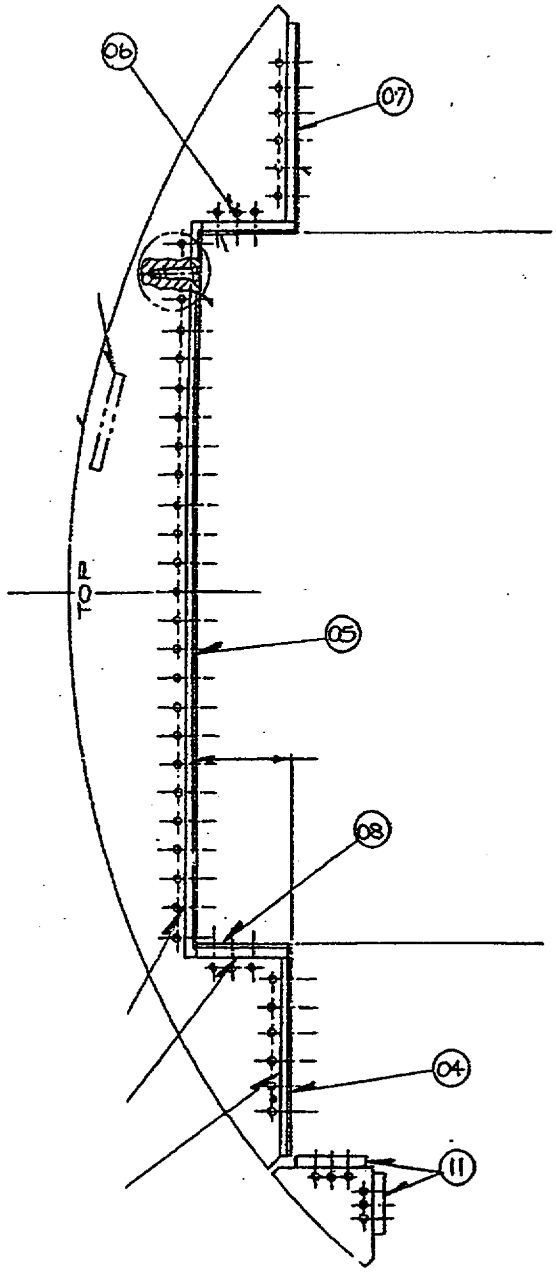

Figure 2 – Baffle Former Region Top View of ¼ Core Region:
Widest Baffle Plate Identified as "05",
Narrowest Baffle Plates Identified as "06" and "08",
Intermediate Size Baffle Plates Identified as "04" and "07",
Plates marked "11" do not contain holes.

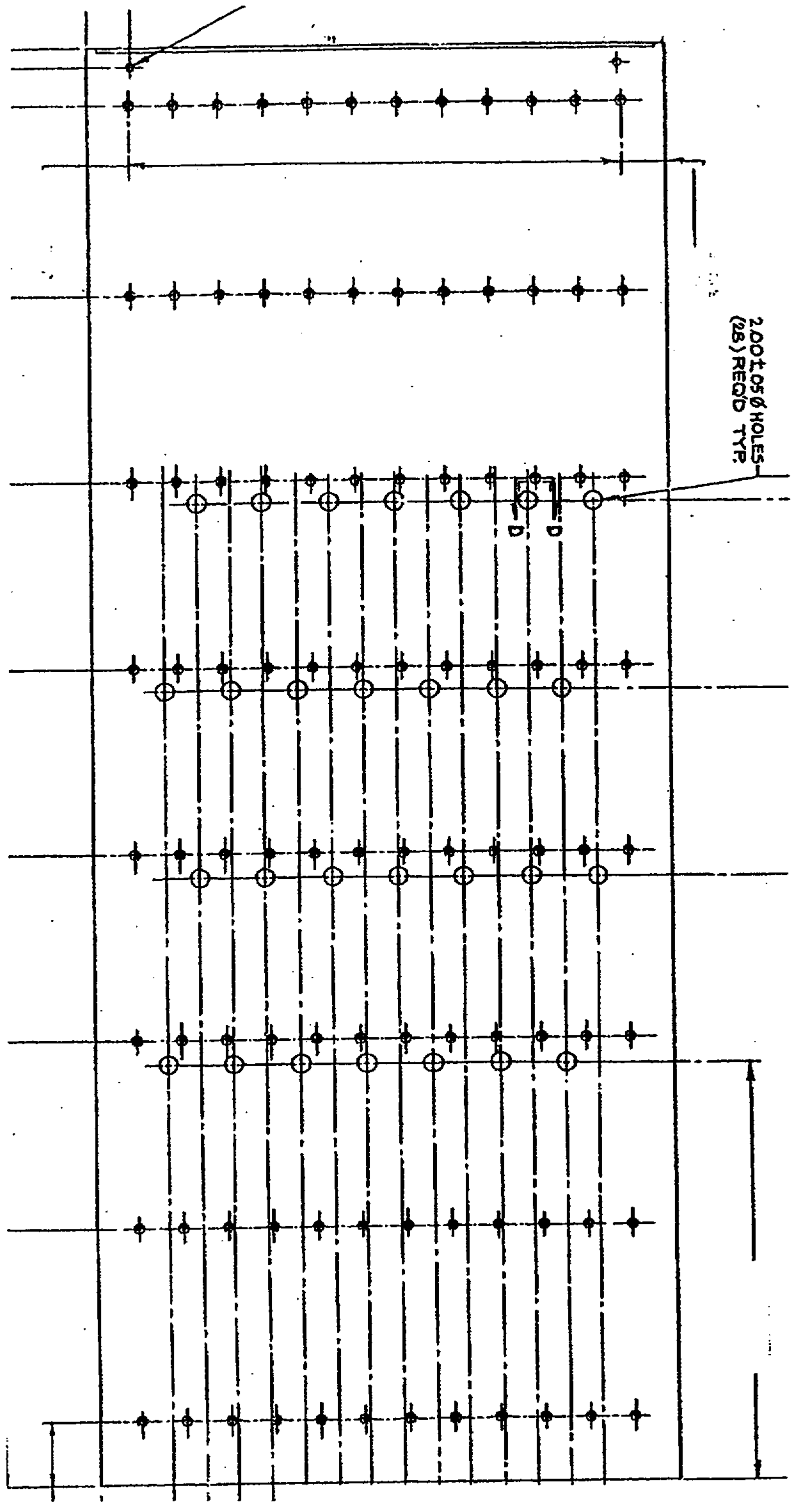

Figure 3 Widest Baffle Plate Showing Pressure Relief Holes

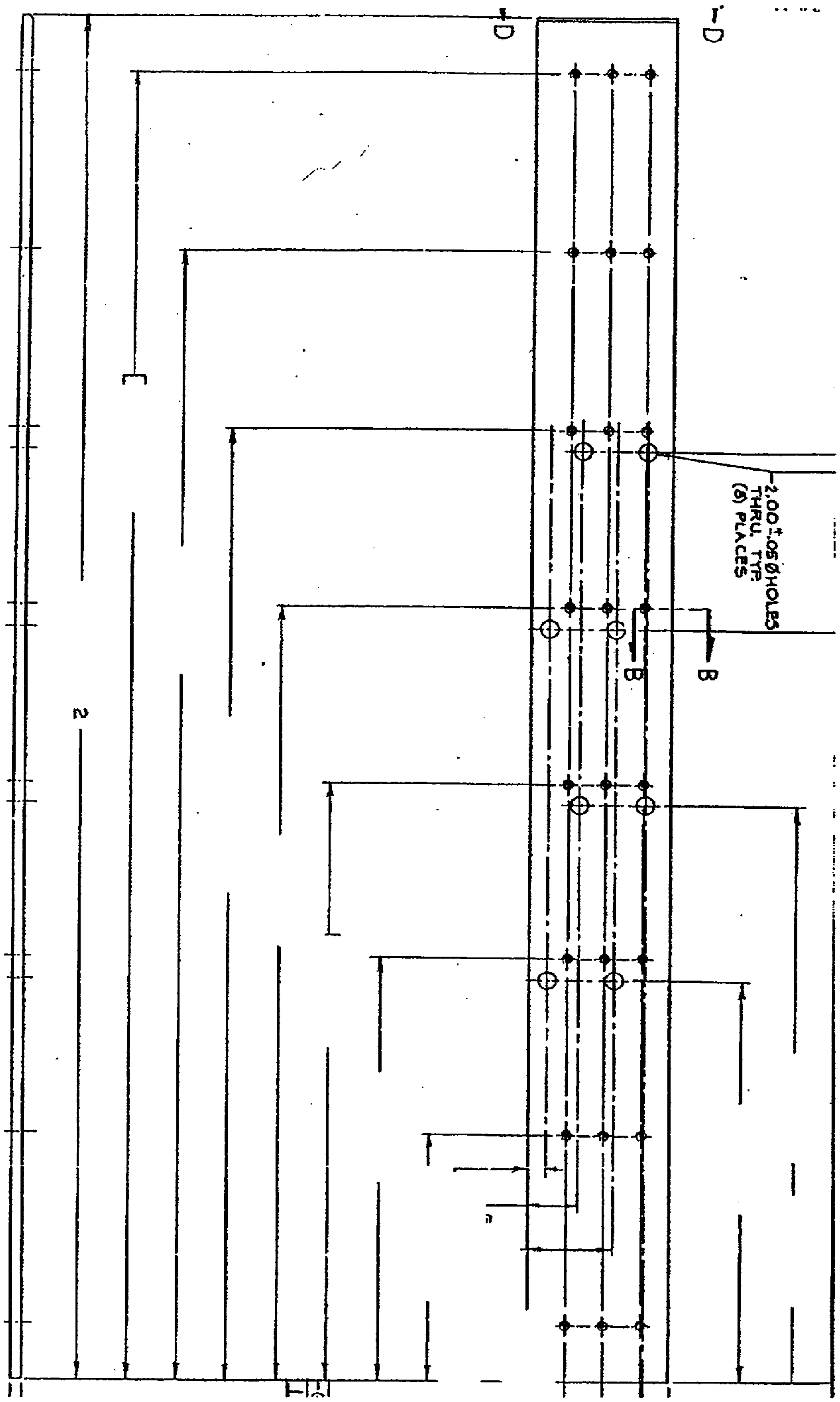

Figure 4 Intermediate Size Baffle Plate Showing Pressure Relief Holes

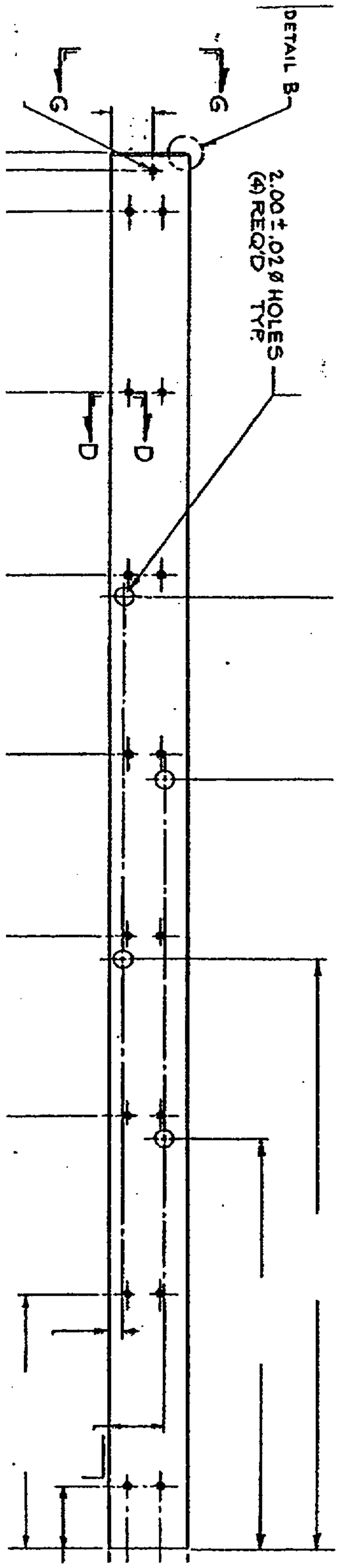

Figure 5 Narrow Baffle Plate Showing Pressure Relief Holes

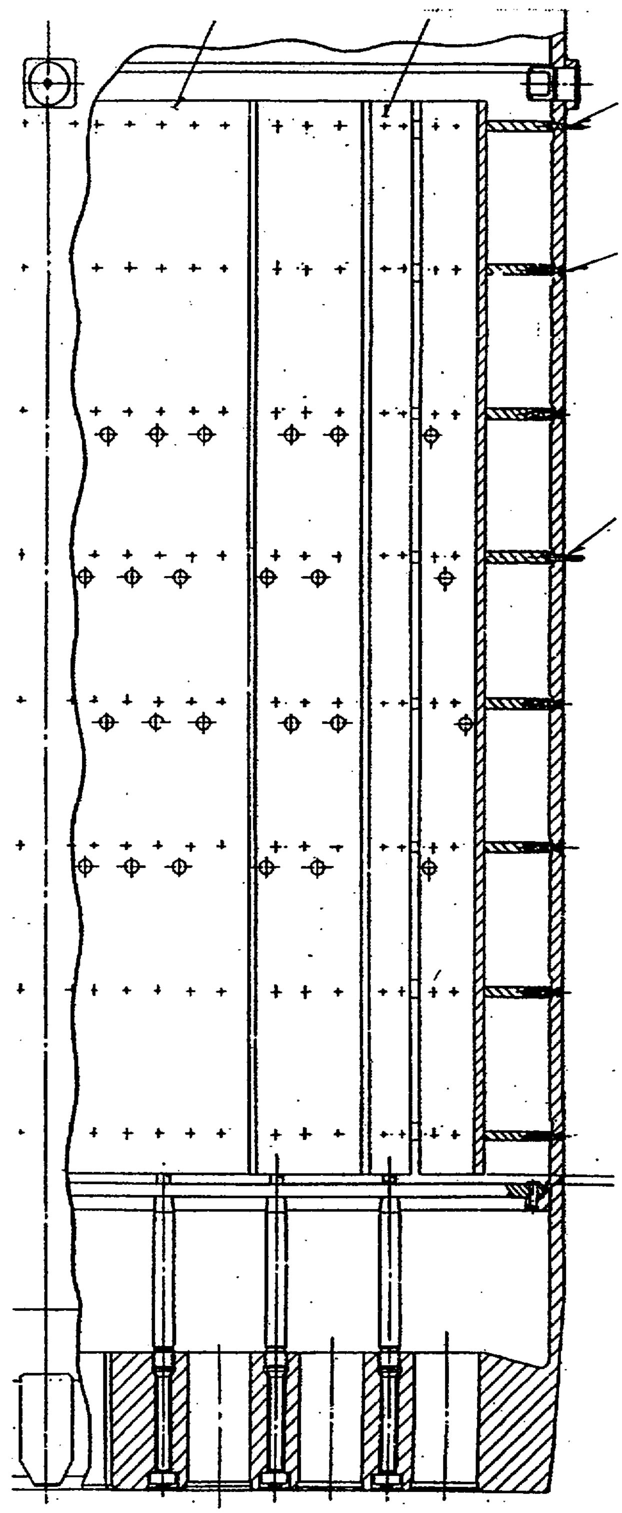

Figure 6 Baffle-Former-Barrel Region Cutaway View Showing Baffle Holes