Commonwealth Edison Company
Date: July 2, 1984

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket Nos. 50-454 OL
	)	50-455 OL
	)	
(Byron Nuclear Power Station, Units 1 & 2)	)	

SUMMARY OF JOHN M. MCLAUGHLIN'S TESTIMONY
ON CONTENTION 1
(REINSPECTION PROGRAM - WORK QUALITY)

I. John McLaughlin is a partner at Sargent & Lundy, and he manages the S&L structural department.

II. The Byron Reinspection Program was an effort by Edison to establish the qualifications of QC inspectors who were employed by certain construction contractors at the Byron site. The Program results were also used as one basis for judging the quality of the construction work.

III. S&L engineers participated in the Reinspection Program by evaluating the design significance of discrepancies identified during the Reinspection Program.

IV. Mr. McLaughlin's testimony addresses evaluations of discrepant welds covered by the AWS code. Hatfield AWS welding includes conduit supports, cable tray hold-down welds and auxiliary steel for electrical supports. Hunter AWS welding includes pipe supports and pipe restraints.

V. Discrepant Hatfield welds were evaluated on a sampling basis to determine whether the total population of discrepant welds had design significance.

A. In all, 356 discrepant welds produced by Hatfield were evaluated. They were selected as follows: (i) 50 of the discrepant welds were randomly selected; (ii) 50 were selected by a third party inspector as the worst discrepant welds; (iii) 69 discrepant welds were selected as highly stressed; and (iv) an additional 187 highly stressed welds were selected in response to NRC questions.

B. Weld maps for the 356 discrepant welds were reviewed. A detailed engineering evaluation based on the weld maps was conducted to determine the effect of each discrepancy on the strength of the welds. These results were then used to re-examine the load capacity of the various connections.

C. Once the revised capacities of the connections were determined, a re-evaluation of their ability to withstand the expected static and seismic loads was performed.

D. The results of these evaluations demonstrated that none of the discrepancies had design or safety significance.

E. Two types of Hatfield weld discrepancies were judged to be recurring. The first was a gap problem caused by fit up of the horizontal and vertical cable tray members. Strength tests were performed and showed no reduction in the joint capacity. The second recurring discrepancy was the use of a partial penetration weld instead of a fillet weld. To test the significance of this discrepancy, an actual connection was physically removed and sliced open. Test results showed less than a 10% reduction in capacity.

IV. 100% of the discrepant Hunter AWS welds (a total of 60) were evaluated by S&L.

A. These discrepant welds were evaluated in the same way as the Hatfield discrepant welds.

B. The results of these detailed engineering evaluations showed that none of the Hunter AWS weld discrepancies had design or safety significance.

VII. Based on the results of the AWS discrepant weld evaluations, and also based on his review of the testimony of Mr. Donald Leone and Mr. Richard French (where engineering evaluations of discrepant ASME welds and other discrepancies observed in objective attributes are discussed), it is Mr. McLaughlin's professional judgment that the quality of the Hatfield and Hunter work at Byron is adequate.

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TESTIMONY OF JOHN M. MCLAUGHLIN

Q.1. Please state your full name and place of employment for the record.

A.1. John Michael McLaughlin, Sargent & Lundy, 55 East Monroe Street, Chicago, Illinois.

Q.2. Please describe your job responsibilities.

A.2. As a Partner in the firm and Manager of the Structural Department, I am responsible for and coordinate all the architectural, structural and civil engineering and design for nuclear and fossil power plants for Sargent & Lundy. I initiate, review, and authorize all Structural Department standards, procedures, and reports, including those pertaining to technical administration and quality assurance.

Q.3. Please describe your educational background and work experience.

A.3. I graduated from Illinois Institute of Technology in 1958 with a B.S. degree in Civil Engineering. In 1970 I received a M.S. degree in Civil Engineering from IIT. I have 22 years of experience in the field of civil engineering, which includes civil-structural-architectural engineering and design work for fossil and nuclear power plants. My assignments have included 16 units with total capacity in excess of 10,000 M.W. I have also been involved with numerous studies involving nuclear and fossil power plant. Prior to joining Sargent & Lundy in 1964, I practiced civil engineering for a private firm and with the U.S. Air Force.

I am a registered Professional Engineer in 29 states including Illinois. I have, also, a separate Structural Engineering license in the State of Illinois and am licensed in Alberta, Canada, and Israel.

Presently, I am a member of the following organizations:

American Concrete Institute
American Institute of Steel Construction
American Society of Civil Engineers
Building Officials & Code Administrators International, Inc.
Earthquake Engineering Research Institute
Post-Tensioning Institute
Seismological Society of America
Structural Engineers Association of Illinois
Structural Stability Research Council

Q.4. Are you familiar with the Byron Reinspection Program?

A.4. Yes. That program involves an effort by Commonwealth Edison Company to establish the qualification of certain Quality Control Inspectors who were employed at the construction site of the Byron Station. The results were also used to render a judgment on the quality of the construction work. The Reinspection Program is documented in a report which was issued by Edison in February, 1984.

Q.5. Were you involved in the preparation of the report?

A.5. I had only an indirect involvement. Engineers who work for me at Sargent & Lundy participated in the Reinspection Program, principally in the area of evaluating the design significance of various weld discrepancies identified during the reinspection program. However, I had no direct involvement in the preparation of these engineering evaluations.

Q.6. What is the purpose of your testimony?

A.6. My testimony addresses a portion of the engineering evaluations performed by Sargent & Lundy engineers with respect to certain weld discrepancies that were identified during the Reinspection Program. The welds of interest are those covered by the applicable provi-

sions of the American Welding Society (AWS) standard and produced by welders employed by Hatfield Electric Company and Hunter Corporation. Also, I state an opinion with respect to the quality of the work performed by Hatfield and Hunter.

Q.7. Since your involvement in the Reinspection Program was minimal, how is it you are able to testify with respect to this matter?

A.7. I am a qualified structural engineer with many years of experience in, among other things, the structural integrity of welded structures and components. In this instance, I have read the Reinspection Program report, I have been thoroughly briefed with respect to the engineering evaluations of the AWS welds performed by my people, and I have studied the underlying calculations and data for the Hatfield and Hunter evaluations. I understand and adopt that work. It represents highly competent work. It serves as the basis for my testimony.

Q.8. Does your testimony address all of the engineering evaluations of discrepant welds produced by Hatfield and Hunter?

A.8. No, only those evaluations of discrepant welds covered by the AWS code. Evaluations involving the ASME code will be discussed by Mr. Leone in his testimony.

Q.9. What is the difference between the two codes?

A.9. There are basically two codes that govern welding on nuclear power plants. The ASME code governs welding for piping and pressure vessels and the AWS code governs all other welding. All of Hatfield's welds captured in the Reinspection Program are covered by the AWS code. Twenty-seven percent of the Hunter welds are covered by the AWS code.

Q.10. What was the nature of the welding work performed by Hatfield and Hunter?

A.10. The Hatfield AWS welding covered by the reinspection program included conduit supports, junction box supports, cable tray supports, cable tray hold-down welds and auxiliary steel for electrical supports. Figure 1 depicts a typical cable tray support system. The circles on the Figure 1 are around areas that are welded connections. The vertical members are connected at the top by welding to either a plate embedded in concrete or a structural member (connection 1). The connection of the horizontal to vertical members is

also a welded connection (connection 2). Figure 2 is a detail of the connection of the horizontal to vertical connection. Figure 1 also shows the hold-down welds for the connection of the cable tray to the horizontal member (connection 3). Connection 1 in Figure 3 is the attachment of a vertical conduit support to a plate embedded in concrete or a structural steel member.

The Hunter AWS welding covered by the reinspection program included pipe supports and pipe restraints. Figure 4 is an example of the Hunter AWS connection for pipe support auxiliary steel. Figure 5 shows a pipe whip restraint and Figure 6 is a detail of the end connection of this restraint which is an example of the Hunter welding for this program.

Q.11. How were the discrepant AWS welds produced by Hatfield and Hunter evaluated in the Reinspection Program?

A.11. A program was established to evaluate the discrepant welds using either a sampling plan, as in the case of Hatfield, or a 100% evaluation plan, as in the case of Hunter. A sample of all of the discrepant welds for Hatfield was evaluated to determine whether the total population of discrepant welds had design signifi-

cance. For Hunter, all discrepant welds were evaluated to make this determination.

Q.12. What was the nature of the sampling plan used in the Reinspection Program to evaluate the Hatfield discrepant welds?

A.12. Of the 27,538 Hatfield welds which were subjected to reinspection during the original program, 1986 welds were identified with various discrepant conditions. A sample of 100 welds was taken from this group. The number of discrepant welds in the sample was later expanded by 69, for a total of 169, as a result of follow-up inspections which were conducted to answer NRC questions. An additional 187 discrepant welds were included as a part of the sample when, again in response to NRC questions, additional inspections were made of welds not initially covered by the Reinspection Program. Thus, the total sample for Hatfield comprised 356 discrepant welds.

Q.13. How was the sample of 356 discrepant welds selected?

A.13. The 356 discrepant welds were broken down into four categories. Fifty of the discrepant welds were randomly selected. An additional 50 were selected by a third party inspector and were identified as the worst

discrepant welds. This category included two welds with cracks. An additional 69 welds were selected on the basis of being highly stressed. Finally, 187 highly stressed welds were included in the sample as a result of the inspections conducted in response to NRC questions. One weld was cracked in this group.

Q.14. What does the term "highly stressed" mean as used in your previous answer?

A.14. "Highly stressed" means that there is a minimum design margin in the connection. The highly stressed welds that were evaluated as a part of the Hatfield sample were those welds where the difference or margin between the design load and the actual load was minimal. Thus, the sample included 256 welds, or over two-thirds of the total, that were located at connections where the greatest question existed concerning potentially significant design deficiencies.

Q.15. What does "margin" mean?

A.15. The concept of margin is one that in inherent in the engineering discipline. Engineers design a structure such that it is sufficiently strong to withstand the expected forces and stresses with spare or extra strength to account for uncertainties and contingencies. This extra strength is called margin.

Design margin is that margin imposed by engineers during the design process. For example, connections are designed in groups rather than individually. As a consequence, the force or load bearing capability for each connection is established on the basis of the most highly stressed connection. The actual stresses for most connections will be less than those established by the design process. The difference between the two is an example of design margin.

There is a second margin in the structural design of connections. This is the margin that the code writers put into the design process in the form of allowable stresses. The code writers typically attempt to obtain a margin of approximately two when they write the code. This means that a structure designed to a code could carry approximately twice the design load and not fail. It should be pointed out that in our detailed engineering evaluation we did not encroach on the code margin.

Q.16. How were the 356 discrepant welds evaluated?

A.16. The first step in the engineering evaluation was to acquire and review weld maps for the 356 discrepant welds. A weld map is similar to a blown up photograph

of a weld. It provides a detailed discription and location of the discrepancy in the weld.

The review of the 356 weld maps indicated that 5 of the discrepant welds consisted of arc strikes, spatter and convexity. Arc strikes and spatter are cosmetic discrepancies and they would only create a strength problem if there were a large amount in a given weld. The weld maps indicated that the weld spatter and arc strikes were minimal. Convexity is only a proglem if the weld is subjected to fatigue loading, for example, cars passing over a bridge. Twenty thousand on and off loadings are required before a weld is considered subjected to fatigue loading. The welds on the structures under consideration are not subject to fatigue loading. These 5 weld discrepancies do not reduce the load carrying capacity of the weld, and therefore, they have no structural impact.

A detailed engineering evaluation based on the weld maps was conducted with respect to the remaining 351 discrepant welds to determine the effect of the discrepancy on the strength of the weld. It was determined that 162 welds had strength reductions of less than 10% and 186 discrepant welds had strength reductions equal to or greater than 10%. Three welds had

cracks. These results were used to re-examine the load capacity of the various connections.

Since the discrepant portion of the weld must be disregarded for evaluation purposes, it is necessary to recalculate the capacities of the connections. For example, if the weld map indicated that there was 1-1/2" of porosity in a 10" weld, we would recalculate the capacity of the connection on the basis of only 8-1/2" of weld. This is conservative in that there is probably no reduction at all in the capacity of the connection for this 1-1/2" of porosity. In the case of welds with cracks, no credit is given in the evaluation for the presence of the weld.

Once the revised capacities of the connections are determined, a further evaluation of their ability to withstand the expected loads or forces is performed. The forces on the connections are made up of two major loadings. The first is the dead weight or static load of the cables and the tray. The second is the seismic load on the connection.

With respect to the static load, we reviewed the cable loadings to confirm that the loads of the cables were less than that assumed in the original design. Because maximum or bounding loads were used in the

original design of the cable tray and conduit system, the actual loads are expected to be less than design loads. In each case where we calculated the actual load, we found it was less than the original design load.

We re-examined the seismic loading and did a more detailed seismic analysis to determine the amount of design margin in the original design. The seismic loading used in the original design of the cable tray and conduit system is based on a response spectra design method, a very conservative design assumption used in the nuclear industry. The re-evaluation of the seismic loading on the connections was based on a time history seismic analysis which is a more accurate determination of the seismic loading.

The detailed evaluations described above were conducted on all 356 discrepant welds. The results of these evaluations demonstrated that none of the discrepancies exceeded design margin and, accordingly, none had design or safety significance.

Q.17. Were any of the weld discrepancies of a recurring nature?

A.17. During our evaluation of the 356 discrepant welds, we found two examples of discrepancies that appeared to

be repetitive. The first was a gap problem caused by fitup of the horizontal and vertical cable tray members. Figure 7 is a sketch of a typical cable tray support. The gap occurred at the connection of the horizontal and vertical support members which is noted as connection 1 in Figure 7. Figure 8 is a detail of connection 1 in Figure 7 showing the gap. In some cases, the gap exceeded the AWS code allowable.

The second apparent recurring deficiency was the use of a partial penetration weld instead of a fillet weld, as called for in the design. Figure 9 is a sketch of a cable tray support with a diagonal member. The use of the partial penetration weld instead of the fillet weld occurred at connection 1 which is the connection between the diagonal and the vertical member. Figure 10 is a blowup of connection 1. Detail 1 in Figure 10 shows the weld called for in the original design. This shows that a fillet weld should have been used between the two members. Detail 2 is the connection that was actually provided in the field. This detail shows that a partial penetration weld was provided instead of a fillet weld.

Q.18. Please explain the test program that was developed to determine the significance of these two types of discrepancies.

A.18. In the case of the fitup gap between the horizontal and vertical member, ten test specimens which would resemble Figure 8 were prepared. Strength tests were performed where loads were applied to these joints. These tests showed that even though the AWS code required that the strength of this connection be reduced, there was no reduction in the joint capacity.

In the case of the partial penetration weld instead of the fillet weld, an actual connection was removed from the Byron Site. This connection was taken to a testing laboratory where the connection was sliced open with a saw. This process allowed a determination of the depth of penetration for the partial penetration weld. Based on the result of this testing, it was determined that the as-built partial penetration weld had less than a 10% reduction in capacity when compared to the original design.

Q.19. In your earlier testimony, you stated that 100% of the Hunter discrepant AWS welds were evaluated. Is that correct?

A.19. Yes, a total of 60 AWS welds produced by Hunter were evaluated.

Q.20. How were these welds evaluated?

A.20. These welds were evaluated by exactly the same procedure I previously described for the Hatfield discrepant welds.

Q.21. What were the results of the engineering evaluation of the 60 Hunter discrepant AWS welds?

A.21. Nineteen of the welds fell into the no structural impact category. As I explained previously, this category covers weld spatter, arc strikes and convexity, which do not reduce the load carrying capacity of the weld. Eighteen welds had a capacity reduction of less than 10%. Twentythree welds had a capacity reduction of 10% or more. The detailed engineering evaluation of the 60 discrepant welds indicated that none of the discrepancies exceeded design margin and, accordingly, none had design or safety significance.

Q.22. Are you familiar with the testimony of Messrs. Leone and French?

A.22. Yes, their testimony explains the results, for Hatfield and Hunter, of the engineering evaluations performed with respect to discrepancies identified in objective attributes and certain welds covered by the ASME Code.

Q.23. Based on the testimony of Messrs. Leone and French and your evaluation as described above, do you have an

opinion as to the quality of the Hunter and Hatfield work?

A.23. Yes. It is my professional judgment that the quality of the Hatfield and Hunter work on the Byron Station is adequate.

Q.24. What is the basis for that opinion?

A.24. My opinion is based on engineering judgment that relies on two significant elements. First, none of the discrepancies identified with respect to the Hatfield and Hunter work had design significance. Second, the existence of the conservative loadings and assumptions used in the design of the Byron Station and the margins inherent in that design, as explained in my prior responses to questions, provides the capacity for the design to compensate for unidentified discrepancies.

I should emphasize the first point by summarizing the results of the engineering evaluations. With respect to Hatfield AWS welding, I have looked at the engineering evaluations of the 356 weld discrepancies. These evaluations demonstrate that none of the deficiencies has design significance. I know that the makeup of the sample of 356 is highly biased to examine the most highly stressed welds in the reinspection

program. As explained previously, 50 of the welds were selected on the basis that they were the worst welds from a weld discrepancy standpoint. Two hundred and fifty-six welds were selected on the basis of being the most highly-stressed welds in the Reinspection Program. My judgment is further reinforced by the testing program that was undertaken to investigate two apparent recurring deficiencies. The test program showed that these deficiencies had only a minor reduction (less than 10% in one case and zero in the other) in the design capacity of the connection. With respect to Hunter AWS welding, I have reviewed the engineering evaluations of all 60 of the weld deficiencies. These evaluations indicated that none of the deficiencies has design significance. Finally, as explained by Messrs. Leone and French, the engineering evaluation of the 2,273 Hatfield and 684 Hunter objective discrep- ancies indicated that none of the discrepancies had design significance.

For these reasons, I am confident that the quality of the Hatfield and Hunter work at the Byron Station is adequate. Moreover, from a statistical standpoint it can further be stated with a 95% confidence level and, in general with a greater than 99% reliability, that all of the Hatfield and Hunter work in the plant meets the original design basis.

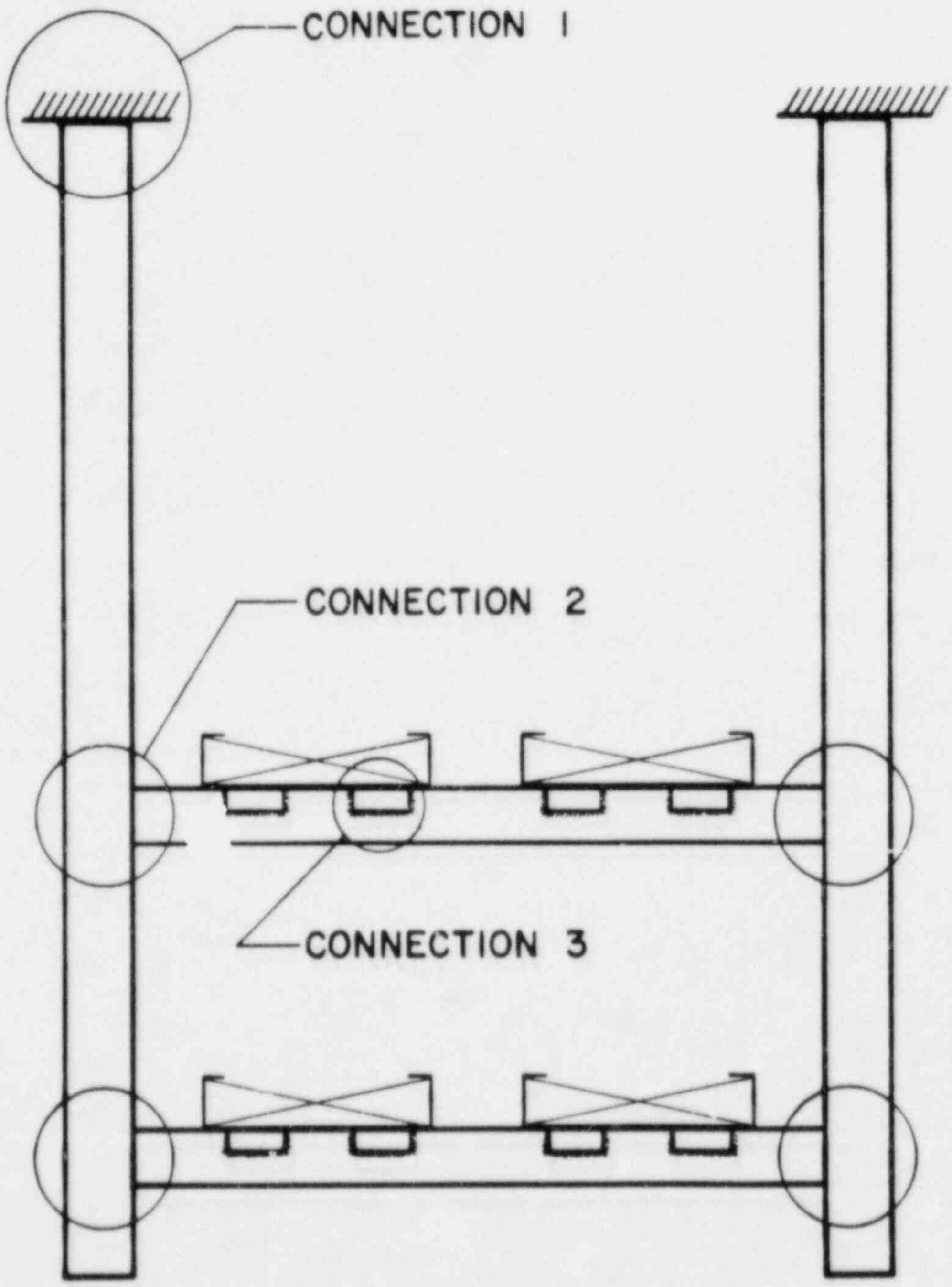

FIGURE 1

HATFIELD AWS
WELDING FOR CABLE TRAYS

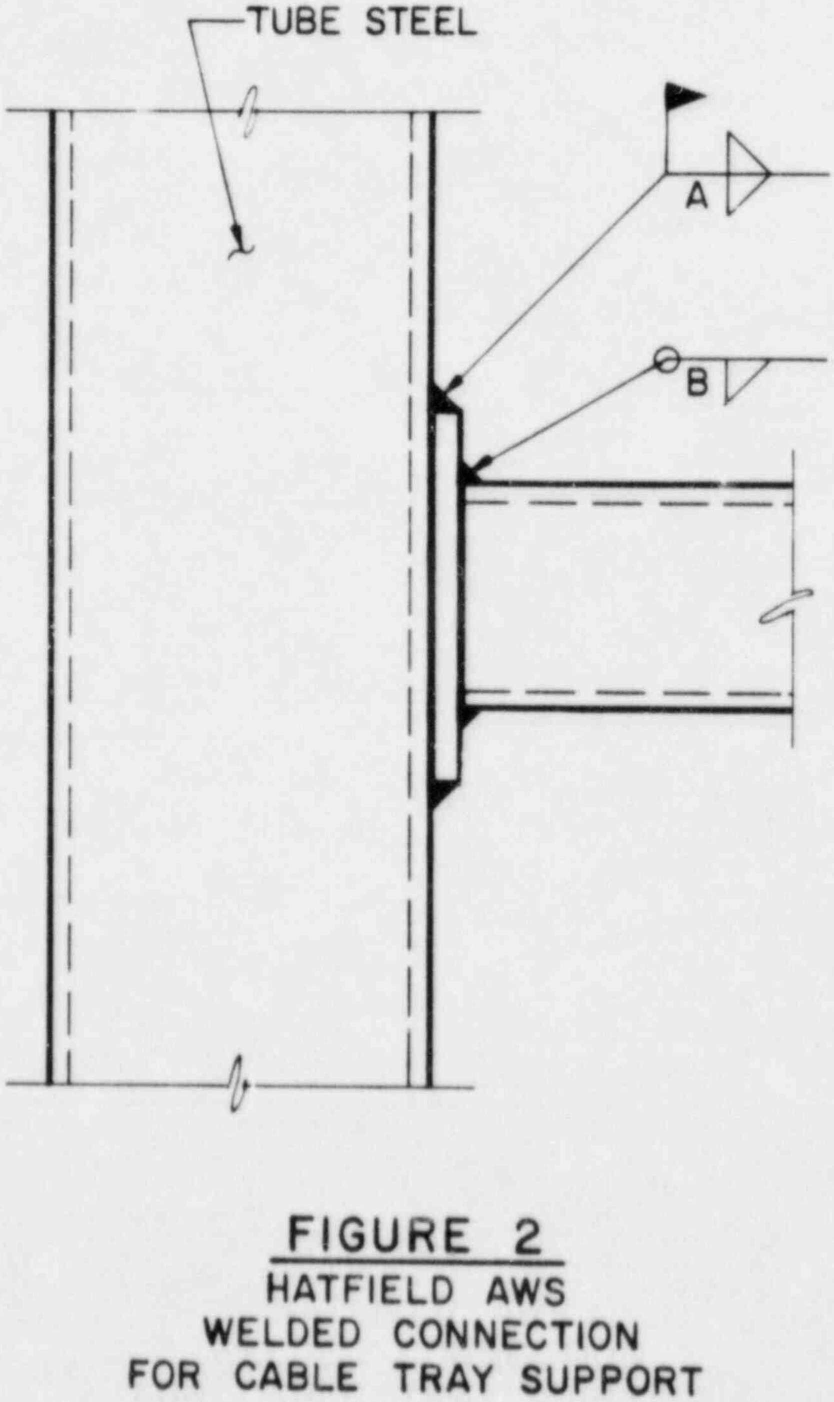

FIGURE 2
HATFIELD AWS
WELDED CONNECTION
FOR CABLE TRAY SUPPORT

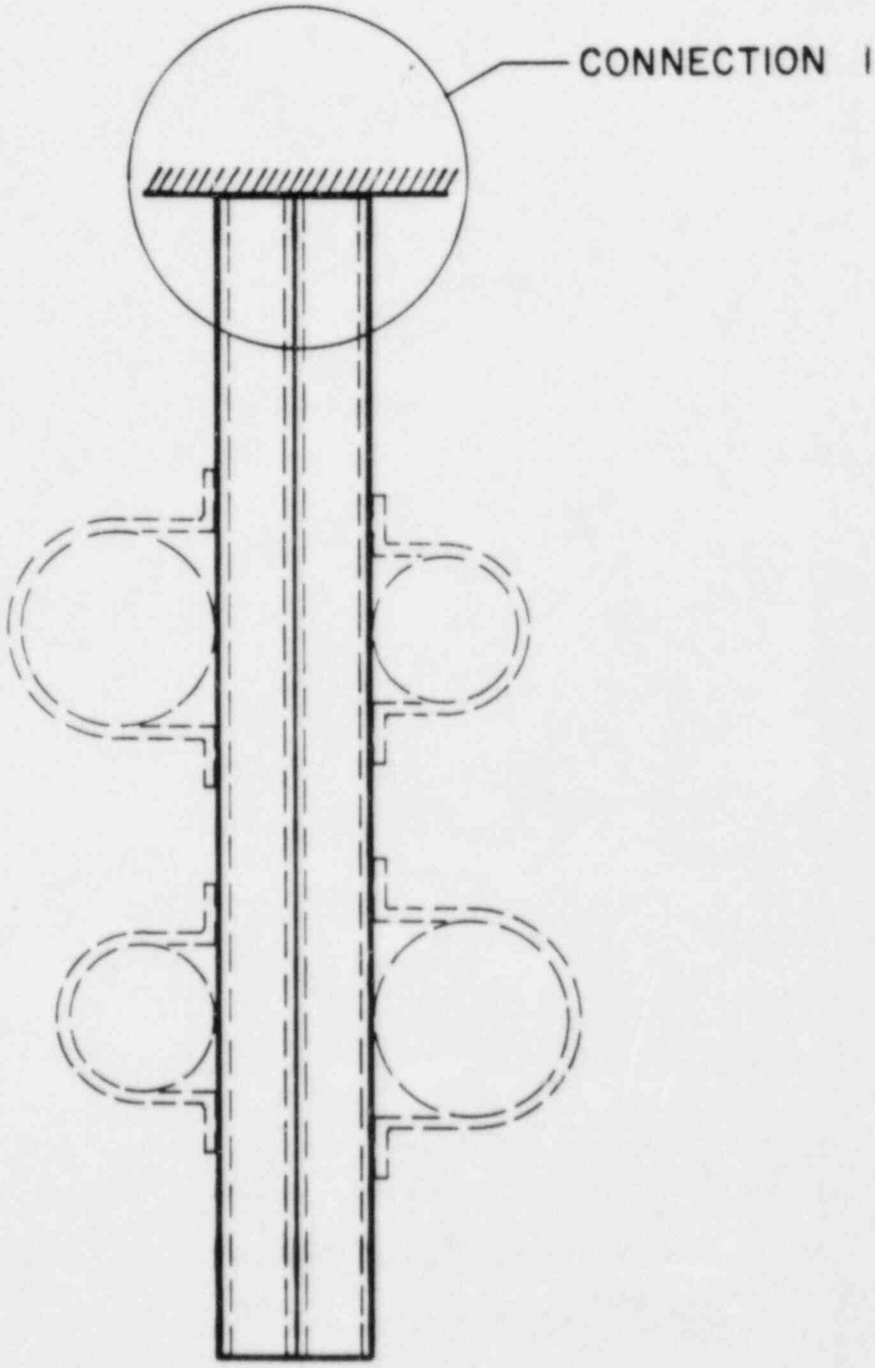

FIGURE 3
HATFIELD AWS
WELDING FOR CONDUIT SUPPORTS

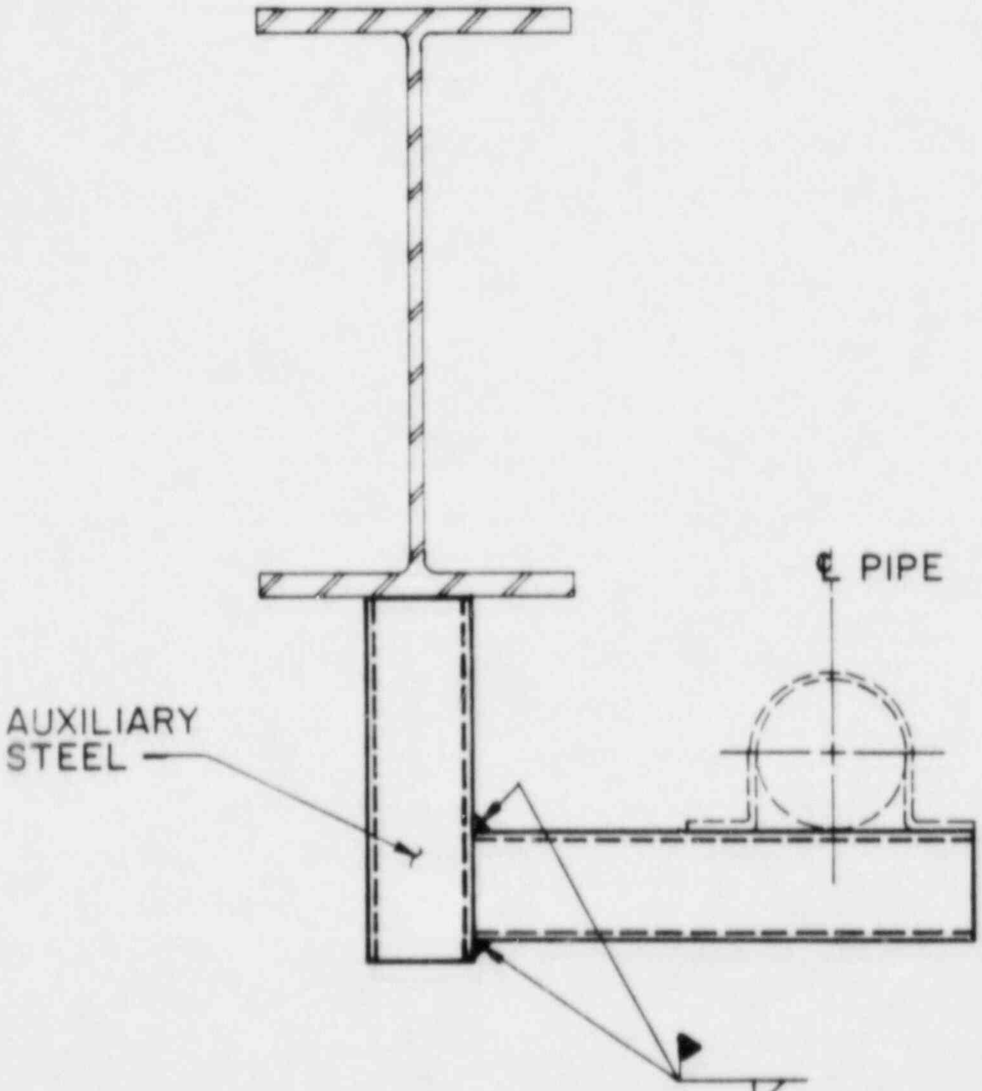

FIGURE 4

HUNTER AWS WELDING FOR
PIPE SUPPORT AUXILIARY STEEL

SARGENT & LUNDY
ENGINEERS
CHICAGO

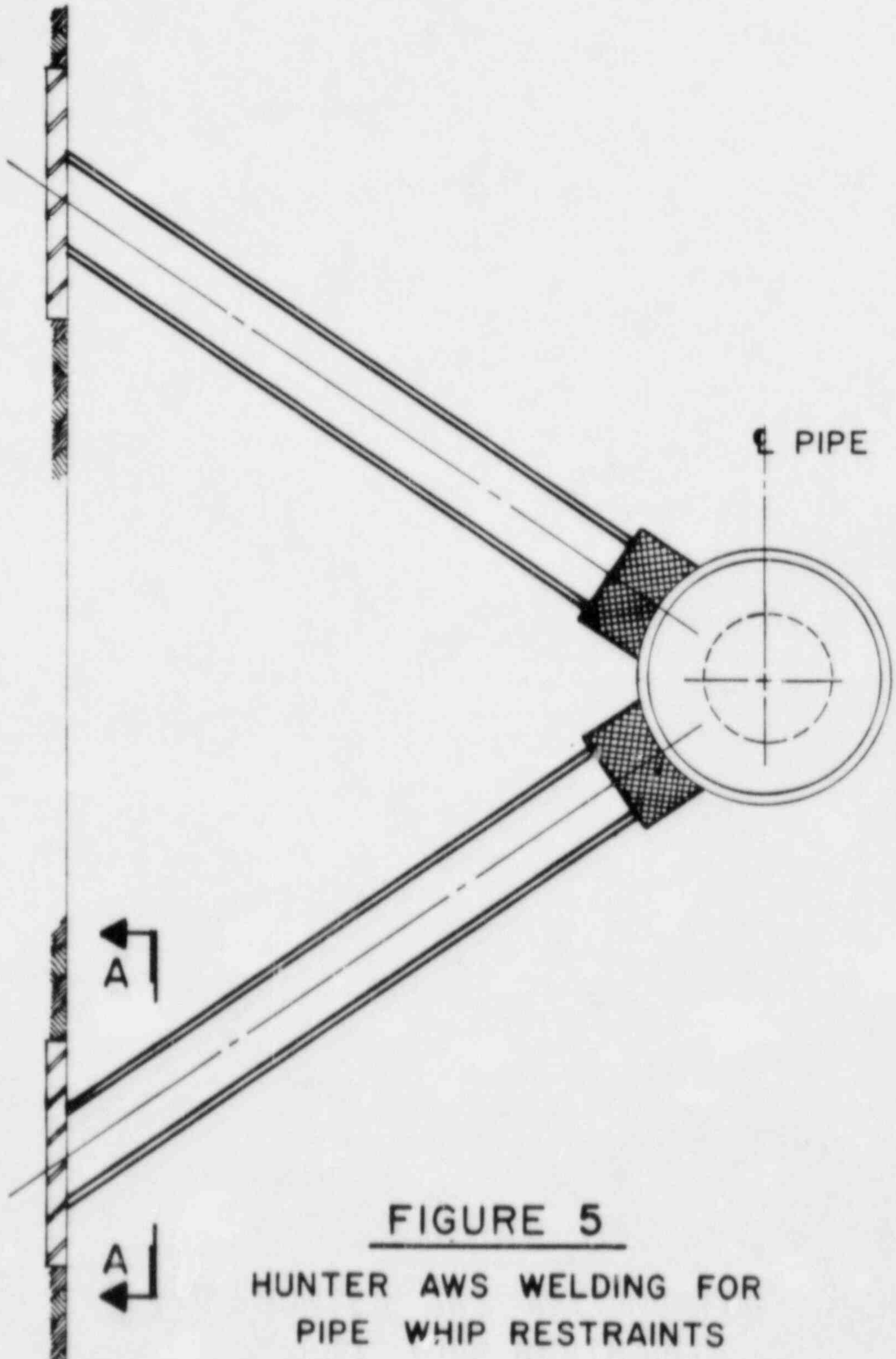

FIGURE 5

HUNTER AWS WELDING FOR PIPE WHIP RESTRAINTS

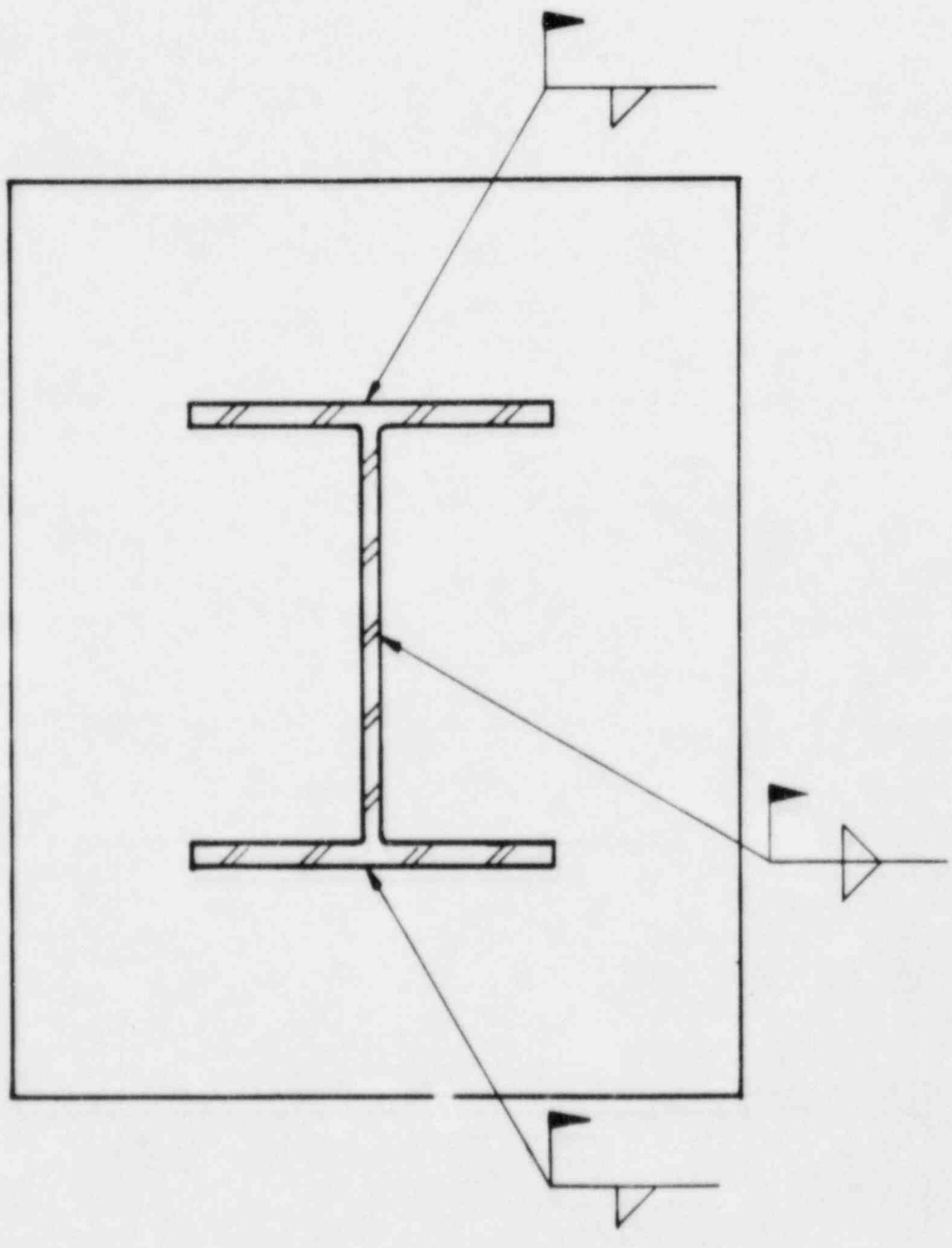

FIGURE 6

SECTION A-A OF FIGURE 8
HUNTER AWS WELDING FOR
PIPE WHIP RESTRAINTS

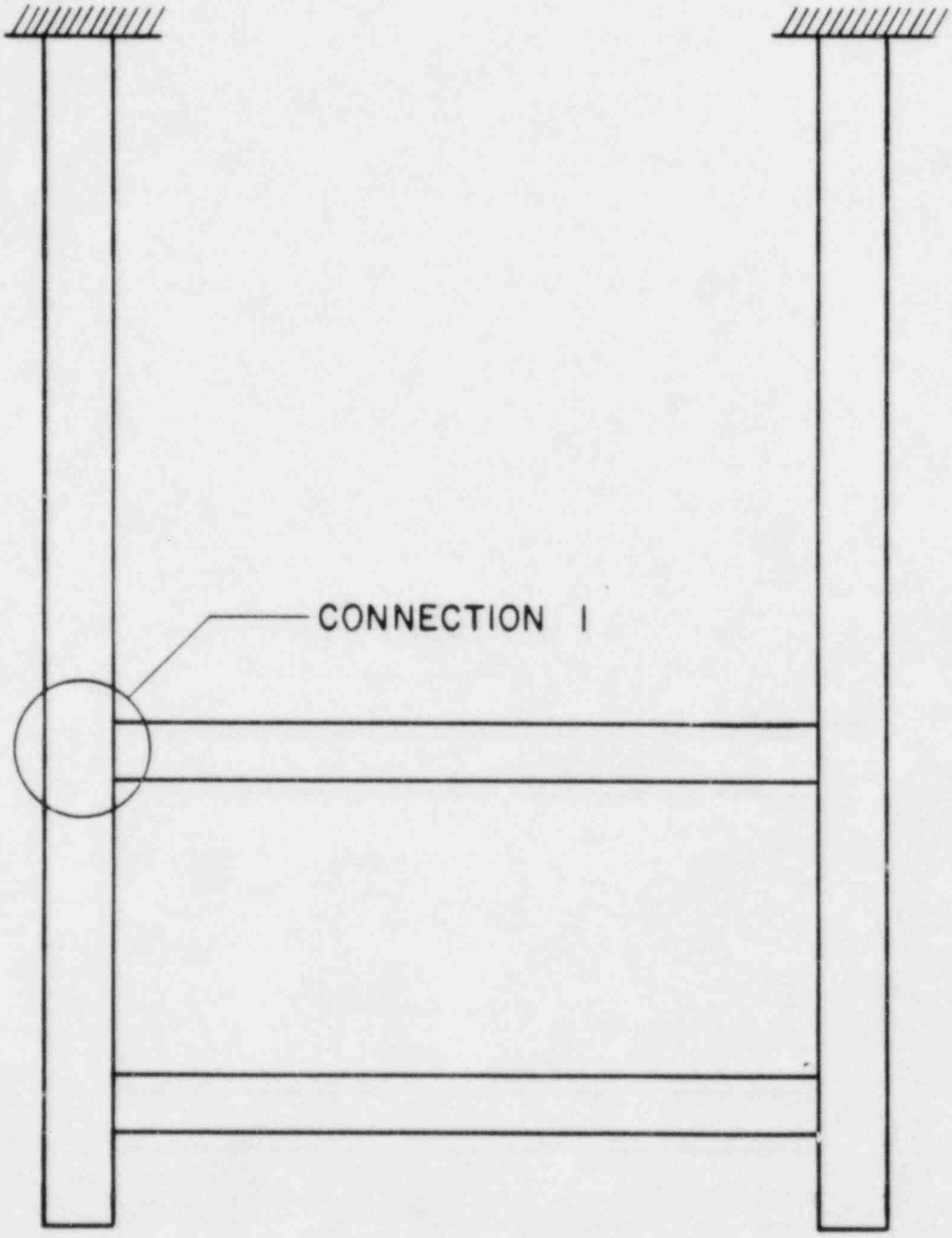

FIGURE 7

HATFIELD AWS WELDING
FOR CABLE TRAY SUPPORT

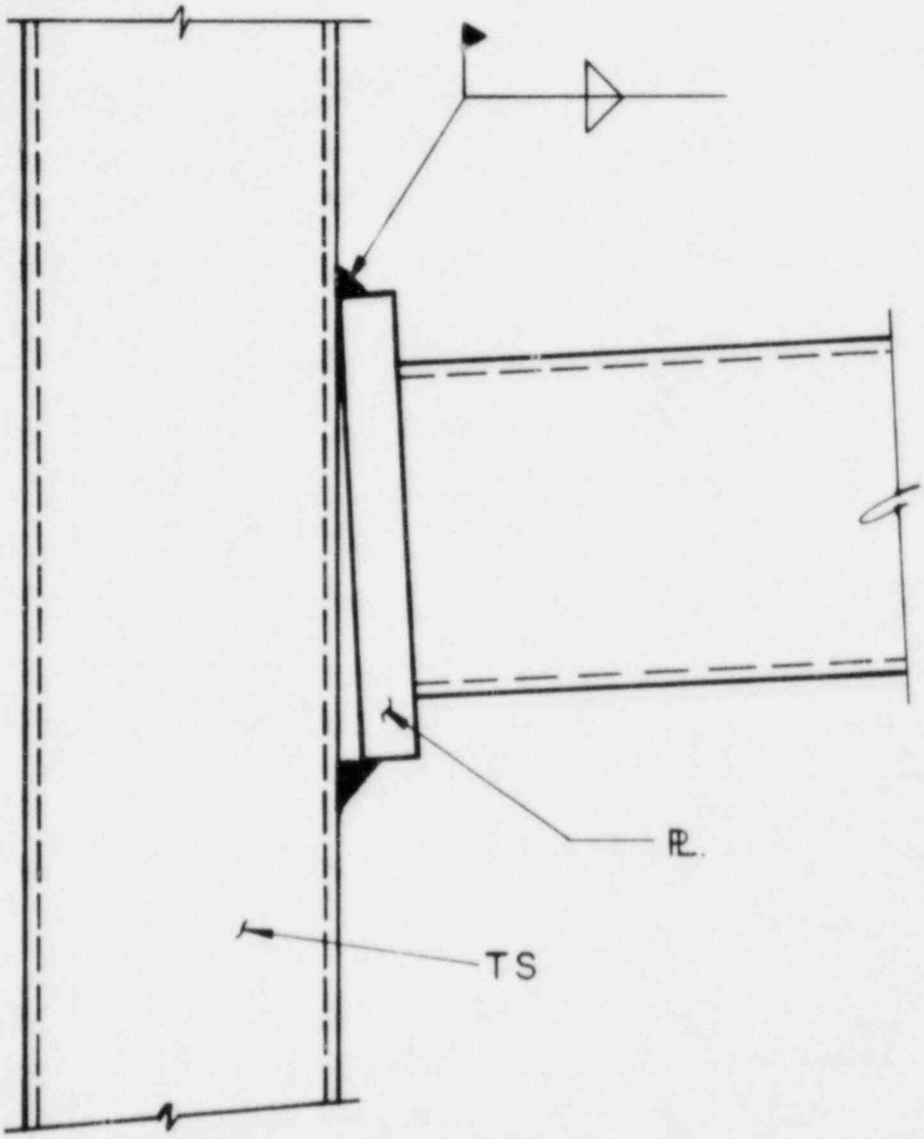

FIGURE 8

HATFIELD AWS WELDING
WITH FIT-UP GAPS FOR
CABLE TRAY SUPPORTS

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ENGINEERS
CHICAGO

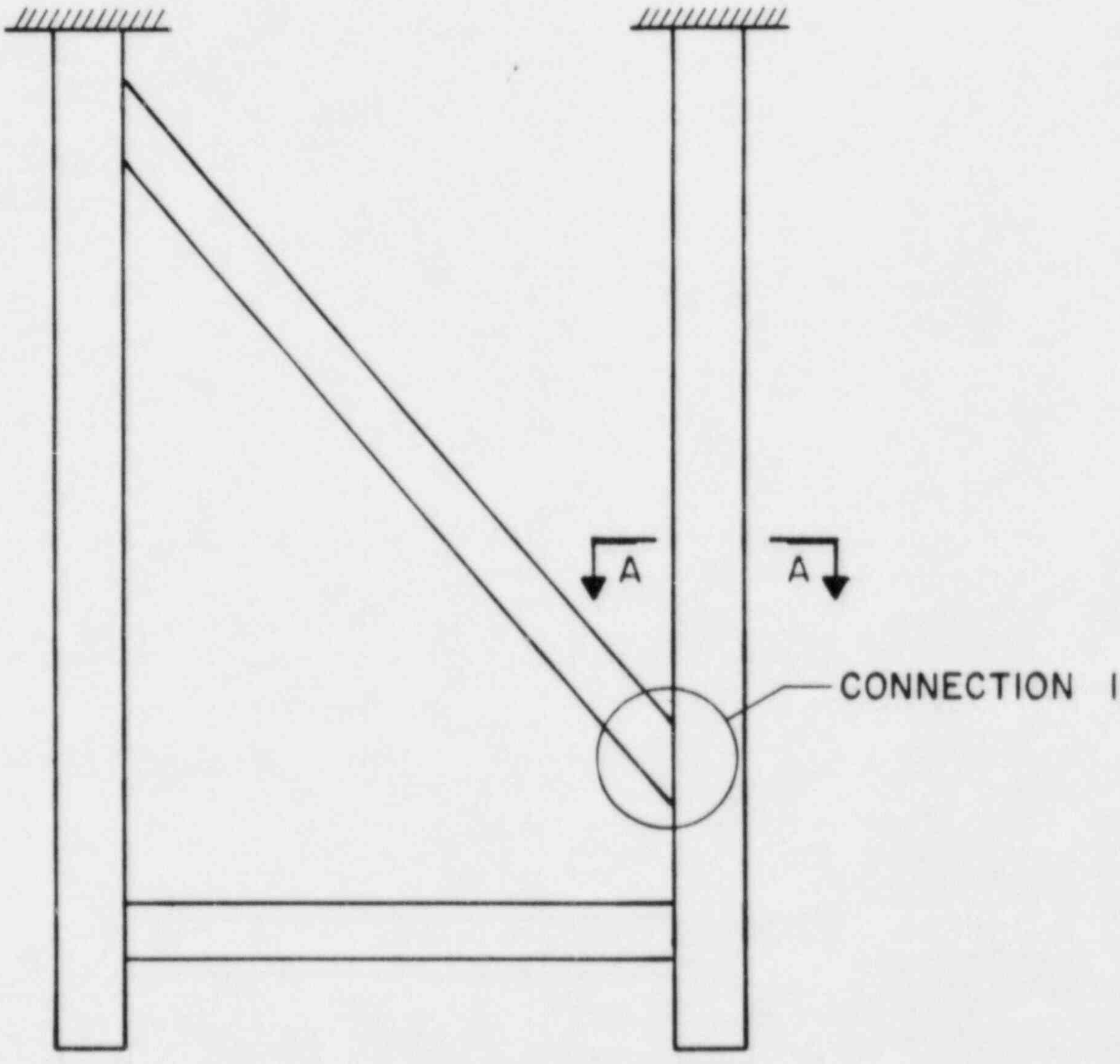

FIGURE 9

HATFIELD AWS WELDING
CABLE TRAY INTERNAL
DIAGONAL CONNECTION

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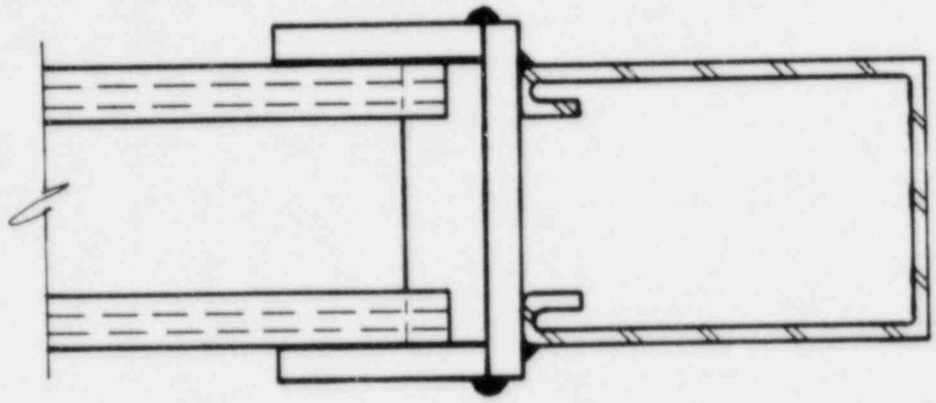
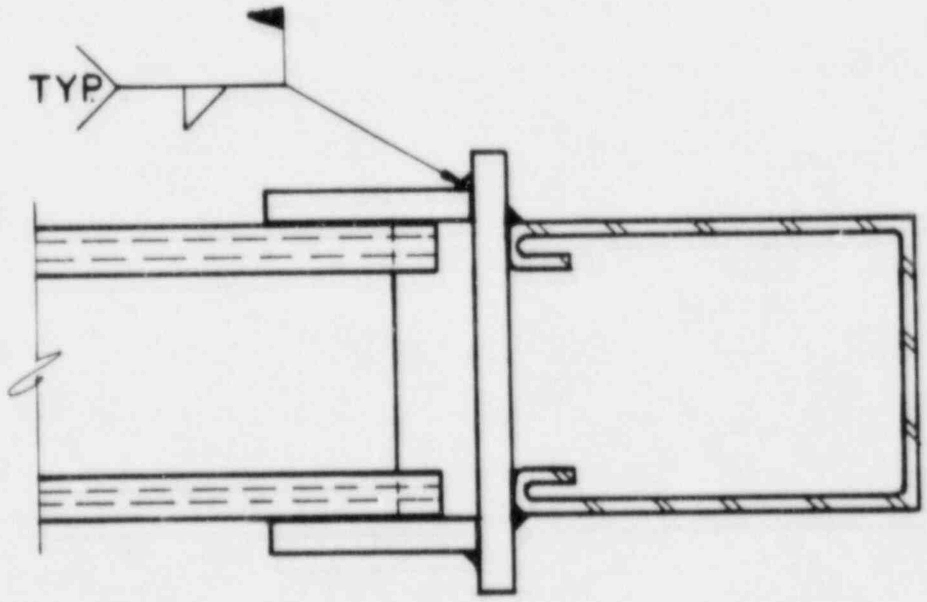


DETAIL 2



DETAIL 1

FIGURE 10

SECTION A-A NOTED ON FIGURE 6
HATFIELD AWS WELDING
CABLE TRAY INTERNAL
DIAGONAL CONNECTION