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INTERIM REPORT ON EFFECTS OF A PIPING BREAK OUTSIDE THE CONTAINMENT

RANCHO SECO NUCLEAR GENERATING STATION

MAY 1, 1973

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INTERIM REPORT ON EFFECTS OF A PIPING BREAK OUTSIDE THE CONTAINMENT

INTRODUCTION

This interim report covers the effects of a piping system break outside the containment. A double ended rupture of the main steam or feedwater line has been considered. The effects of a pipe break including pipe whip, jet stream impingement, environmental effects and compartment flooding are covered.

In analyzing the steam or feedwater line break accident, loss of offsite power is assumed to occur concurrently with pipe failure. In analysis of the accident single failure of an active component is assumed to occur during subsequent cooldown to cold shutdown conditions.

The question numbers in this report refer to the app' cable sections of the AEC requirements for information on the subject of pipe break outside the containment transmitted to SMUD on December 14, 1972.

Inservice Inspection

The District will perform 100 percent inservice inspection of all circumferential welds in the main steam and feedwater lines to allow installation of the terminal end restraints and guard pipe restraints after fuel loading.

Actual stress values are much lower than allowable. For the main steam line the maximum calculated stress is 0.460 of allowable. For the main feedwater piping the maximum calculated stress is 0.536 of allowable.

10 CFR- 50 Paragraph 50.55a provides the code requirements for the design fabrication inspection and installation of piping systems. As indicated in this regulation, it would have been acceptable for the District to use ANSIB31.1 for the piping under consideration. Instead, for added conservatism, the District elected to use 1969 ANSIB31.7 Nuclear Power Piping Code. In addition, the District imposed other stringent requirements on the fabrication and installation of these piping systems to assure the quality of welds and material and provide additional confidence in the integrity of these systems. The additional requirements imposed include:

1. Radiograph of all welds on feedwater main (code only requires radiograph on section from stop valve to OTSG).

2. Material test reports for physical and chemical characteristics.

3. Certified stress analysis.

4. Review and maintenance of

   a. Welding procedure qualifications

b. Welder qualification records

c. Weld repair charts

d. Welder identification to welds

e. Heat treat charts

All piping systems have been fabricated by organizations with quality assurance programs meeting the requirements of 10 CRF 50 Appendix B. The piping systems, 2½ inch and larger were fabricated by either of two manufacturers in the Los Angeles area. The 2 inch and smaller pipe was fabricated by the site erection contractor who also performed all field erection work and assembly welding. All three organizations have been surveyed by ASME and are current holders of "N" stamp authorization.

Prior to contract award these contractors were audited by the SMUD Quality Assurance Director. Subsequent audits by him have verified performance in accordance with their respective manuals.

All pipe and fittings have been procured under requirements for furnishing heat numbers and material chemical and physical test results and non-destructive examination, as required to meet the project specifications. These specifications incorporate all requirements of ANSI B31.7.

Throughout all of the fabrication and site erection work control has been exercised over all welding operations. Strict weld rod control has been observed and all welding has been performed in accordance with welding procedures approved by the engineer. The engineer specified the procedure used for each field welded joint.

Non-destructive examination of all welds has been in accordance with ANSI B31.7 for the classification of system involved.

Prior to the acceptance of piping systems they are subjected to all requirements of the SMUD Quality Assurance Program. This includes complete documentation of non-conforming items and disposition in accordance with the Manual. Assurance of all Code requirements is met by the State of California who are performing site inspection.

A dynamic analysis of the main steam line was made for steam hammer affect upon turbine stop valve closure.

During hot functional testing and power transient tests, piping will be monitored for displacement and movement and stresses will be evaluated and compared with calculated values. The use of strain gages and scratch plates where applicable will be used to verify that the as-built plant is in agreement with the design. Strain gage determinations will be made on safety valve mounting welding nozzles.

For piping systems, where modifications have not been completed by power operation an inservice surveillance program will be implemented until the modifications are complete. Work will continue during plant operation on a timely basis to complete the modifications. At least once per shift, a visual inspection of all high energy lines where the modifications have not been completed will be conducted for the detection of leakage or enrionmental conditions that might adversely effect the integrity of those lines. If the plant is shutdown and cooled down for any other reason for a three month interval, the insulation will be removed from the affected piping and the piping will be inspected for signs of structural distress and leakage. For any modification that is not completed by the end of the first refueling, the affected welds will be x-rayed during the first refueling.

Because of conservative design methods and thorough inspection of these systems during construction, the District believes that their inservice inspection program will be adequate to insure that catastrophic failures will not occur.

QUESTION 1. The systems (or portions of systems) for which protection against pipe whip is required should be identified. Protection from pipe whip need not be provided if any of the following conditions will exist:

(a) Both of the following piping system conditions are met:

(1) the service temperature is less than 200°F; and

(2) the design pressure is 275 psig or less; or

(b) The piping is physically separated (or isolated) from structures systems, or components important to safety by protective barriers, or restrained from whipping by plant design features, such as concrete encasement; or

(c) Following a single break, the unrestrained pipe movement of either and of the ruptured pipe in any possible direction about a plastic hinge formed at the nearest pipe whip restraint cannot impact any structure, system, or component important to safety; or

(d) The internal energy level associated with the shipping pipe can be demonstrated to be insufficient to impair the safety function of any structure, system, or component to an unacceptable level.

ANSWER:

The following systems are required for cold shutdown. Portions of these systems requiring pipe failure protection are identified in table 1.

Class I batteries & busses both a-c & d-c

NS busses & switchgear

Control room emer. air conditioner

Reactor protection system

NSCW system including all cables to P-462 A&B

NSRW system including all cables to P-482 A&B

Decay heat system including all cables to P-261 A&B and to room coolers

Emer. FW system including all cables to P-319 & FV-30801

Auxiliaries for diesel generators & rooms including cables & lines to F.O. Pumps P-888A-D and all cables to fans A-544A-D

Make-up system including power to P-236 & P-238A&B and L.O. pumps and room coolers A529A-E

Ductwork for emer. control room air conditioner and power cables

Class I structures housing or supporting impactees

Suction from BWST to HPI, DH & RB spray pumps

Boric acid supply to suction of HPI pumps including cables to heat tracing and pumps P-705A&B

Borated water storage tank

Condensate storage tank

INSTRUMENTATION

Instrumentation source range detectors

Instrumentation rod position indication

TE-21023A, 24B RC inlet temp.

PT-21092, 38, 40, 42, 43, 39, 37 reactor coolant pressure

LT-20503A, B&C pressurizer level

LT-20504C&D Stm. gen. level

Question 1a above as modified by the following criteria defines high energy systems:

Definition of a high energy line - Lines which do not exceed 200 F or 275 psig do not need to be considered high energy lines. In this case, the pipe whip and environmental effects resulting from breaks need not be considered. If a line exceeds 200 F and 275 psig, it is a high energy line and both the local and environmental effects in pipe whip must be investigated. Lines which exceed either the temperature limit or the pressure limit but not both simultaneously, were evaluated considering the environmental effects due to cracks but not evaluated for pipe whip effects. The following diagram illustrates this:

(2) any intermediate locations between terminal ends where the primary plus secondary stress intensities Sn (circumferential or longitudinal) derived on an elastically calculated basis under the loadings associated with one-half safe shutdown earthquake and operational plant conditions[4] exceeds 2.0 S_m[5] for ferritic steel, and 2.4 S_m for austeritic steel;

(3) any intermediate locations between terminal ends where the cumulative usage factor (U)[6] derived from the piping fatigue analysis and based on all normal, upset, and testing plant conditions exceeds 0.1; and

(4) at intermediate locations in addition to those determined by (1) and (2) above, selected on a reasonable basis as necessary to provide protection. As a minimum, there should be two intermediate locations for each piping run or branch run.

(b) ASME Section III Code Class 2 and 3 piping breaks should be postulated to occur at the following locations in each piping run or branch run:

(1) the terminal ends;

(2) any intermediate locations between terminal ends where either the circumferential or longitudinal stresses on an elastically calculated basis under the loadings associated with seismic events and operational plant conditions exceed 0.8 (S_h + S_A)[7] or the expansion stress exceed 0.8 S_A; and

(3) intermediate locations in addition to these determined by (2) above, selected on reasonable basis as necessary to provide protection. As a minimum, there should be two intermediate locations for each piping run or branch run.

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[4]Operational plant conditions include normal reactor operation, upset conditions (e.g., anticipated operational occurrences) and testing conditions.

[5]S_m is the design stress intensity as specified in Section III of the ASME Boiler and Pressure Vessel Code, "Nuclear Plant Components."

[6]U is the cumulative usage factor as specified in Section III of the ASME Boiler and Pressure Vessel Code, "Nuclear Power Plant Components."

ANSWER:

(a) Question 2a is not applicable to Ranch Seco. There are no ASME Section III Code Class I piping outside the containment structure.

(b) Pipe break locations were postulated for high energy lines at the terminal ends and at least two intermediate points at the most adverse locations where the relative stress values were the highest. There are no locations on lines considered where the stress values exceeded 0.8 ($S_h + S_a$) or 0.8 S_a. For the most highly stressed line the calculated valves are 0.524 ($S_h + S_a$) and 0.542 S_a.

QUESTION 3. The criteria used to determine the pipe break orientation at the break locations as specified under 2 above should be equivalent to the following:

(a) Longitudinal[8] breaks in piping runs and branch runs, 4 inches nominal pipe size and larger, and/or

(b) Circumferential[9] cracks in piping runs and branch runs exceeding 1 inch nominal pipe size.

ANSWER:

The consideration given for breaks in which plant structures, systems, and components important to safety could be affected included full circumferential breaks in high energy lines in 1 inch and larger sizes; and, in addition, longitudinal breaks in pipe 4 inches nominal pipe size and larger.

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[7] S_h is the stress calculated by the rules of NC-3600 and ND-3600 for Class 2 and 3 components, respectively, of the ASME Code Section III Winter 1972 Addenda.

S_A is the allowable stress range for expansion stress calculated by rules of NC-3600 of the ASME Code, Section III, or the USA Standard Code for Pressure Piping, ANSI B31.1.0-1967.

[8] Longitudinal breaks are parallel to the pipe axis and oriented at any point around the pipe circumference. The break area is equal to the effective cross-sectional flow area upstream of the break location. Dynamic forces resulting from such breaks are assumed to cause lateral pipe movements to the direction normal to the pipe axis.

[9] Circumferential breaks are perpendicular to the pipe axis, and the break area is equivalent to the internal cross-sectional area of the ruptured pipe. Dynamic forces resulting from such breaks are assumed to separate the piping axially, and cause whipping in any direction normal to the pipe axis.

QUESTION 4. A summary should be provided of the dynamic analyses applicable to the design of Category I piping and associated supports which determine the resulting loadings as a result of a postulated pipe break including:

(a) The locations and number of design basis breaks on which the dynamic analyses are based.

(b) The postulated rupture orientation, such as a circumferential and/or longitudinal break(s), for each postulated design basis break location.

(c) A description of the forcing functions used for the pipe whip dynamic analyses including the direction, rise time, magnitude, duration and initial conditions that adequately represent the jet stream dynamics and the system pressure difference.

(d) Diagrams of mathematical models used for the dyanmic analysis.

(e) A summary of the analyses which demonstrates that unrestrained motion of ruptured lines will not damage to an unacceptable degree, structure, systems, or components important to safety, such as the control room.

ANSWER:

(a) Design basis break locations are discussed in the answer to Question 2 and are identified on table 1 and figures 1, 2, 3, 4 & 5.

(b) Postulated break orientations are discussed in the answer to Question 3.

(c) The pipe whip forcing function used in the analysis for all pipe restraints other than guard pipe restraints is derived in reference (1) as modified by reference (2). Jet stream dynamics are approximated in the reference document by calculating a jet thrust force based on the pressure difference inside and outside the break using appropriate impact factors and thrust multiplication factors for single or two phase flow from the break.

The reaction force acting on the pipe caused by momentum change of fluid flowing through the pipe can be expressed as a function of the

(1) BN-TOP-2 Design for Pipe Break Effects - Bechtel Corporation, September 20, 1972, Revision 0.

(2) AEC Letter to Bechtel Corporation. DeYoung to Allen, February 27, 1973.

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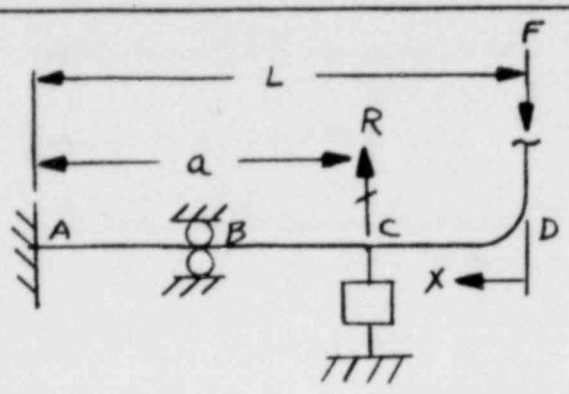
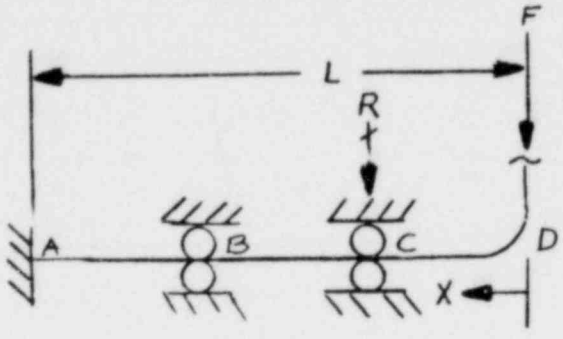
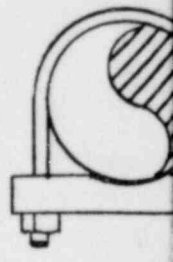
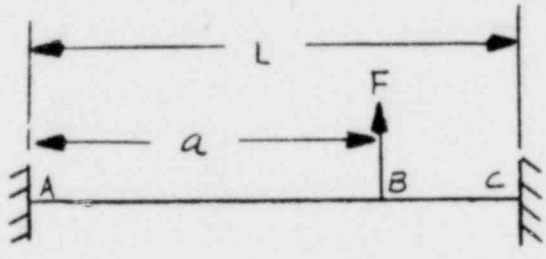
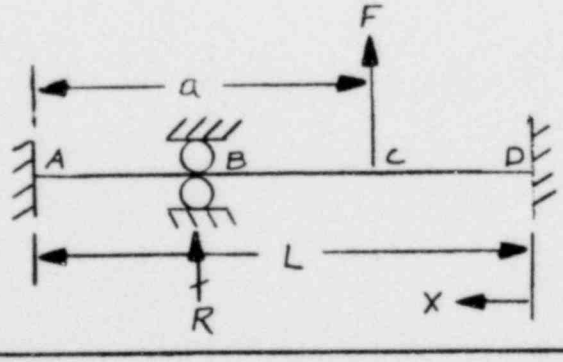
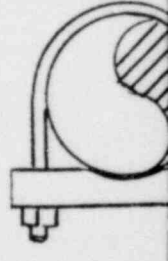
5		
6		
7		
8		

ION (R)	DESCRIPTION OF MODEL
	IN THE ELASTIC ANALYSIS THE LENGTH (L) IS SMALL AND CONSEQUENTLY THE STRESS IN THE PIPE WILL NOT EXCEED THE ELASTIC LIMIT. IN THE PLASTIC ANALYSIS HINGES ARE ALLOWED TO FORM ALONG THE PIPE. IN ALL CASES IN WHICH HINGES ARE ALLOWED TO FORM THE DECISION HAS BEEN BASED ON THE ACCEPTABILITY OF ANY ATTENDANT PIPE WHIP AND CHANGING ENVIRONMENTAL EFFECTS CAUSED BY THE SWEEP OF THE JET OR ITS REDIRECTION.
	IN THE ELASTIC ANALYSIS THE LENGTH (L) IS SMALL AND CONSEQUENTLY THE STRESS IN THE PIPE WILL NOT EXCEED THE ELASTIC LIMIT. IN THE PLASTIC ANALYSIS A PLASTIC HINGE IS ALLOWED TO FORM ANYWHERE ALONG THE LENGTH OF THE PIPE. IN ALL CASES IN WHICH HINGES ARE ALLOWED TO FORM THE DECISION HAS BEEN BASED ON THE ACCEPTABILITY OF ANY ATTENDANT PIPE WHIP AND CHANGING ENVIRONMENTAL EFFECTS CAUSED BY THE SWEEP OF THE JET OR ITS REDIRECTION.
	UNLIKE THE PREVIOUS CASES WHERE GUILLOTINE FAILURES WERE POSTULATED, THIS CASE INVOLVES A SLOT RUPTURE IN THE LONGITUDINAL DIRECTION. IN THE ELASTIC ANALYSIS THE LENGTH (L) WILL BE SMALL AND PIPE STRESSES WILL BE IN THE ELASTIC RANGE. IF THE LENGTH (L) BECOMES QUITE LARGE, A PLASTIC ANALYSIS WILL BE PERFORMED. IN ALL CASES IN WHICH PLASTIC HINGES ARE ALLOWED TO FORM THE DECISION HAS BEEN BASED ON THE ACCEPTABILITY OF ANY ATTENDANT PIPE WHIP AND CHANGING ENVIRONMENTAL EFFECTS CAUSED BY THE SWEEP OF THE JET OR ITS REDIRECTION.
	A SLOT RUPTURE IN THE LONGITUDINAL DIRECTION IS POSTULATED TO OCCUR AT POINT C. IN THE ELASTIC ANALYSIS THE LENGTH (L) WILL BE SMALL. IN THE PLASTIC ANALYSIS THE LENGTH (L) CAN BE LARGER AND PLASTIC HINGES CAN OCCUR ALONG THE LENGTH OF THE PIPE. IN ALL CASES IN WHICH HINGES ARE ALLOWED TO FORM THE DECISION HAS BEEN BASED ON THE ACCEPTABILITY OF ANY ATTENDANT PIPE WHIP AND CHANGING ENVIRONMENTAL EFFECTS CAUSED BY THE SWEEP OF THE JET OR ITS REDIRECTION.

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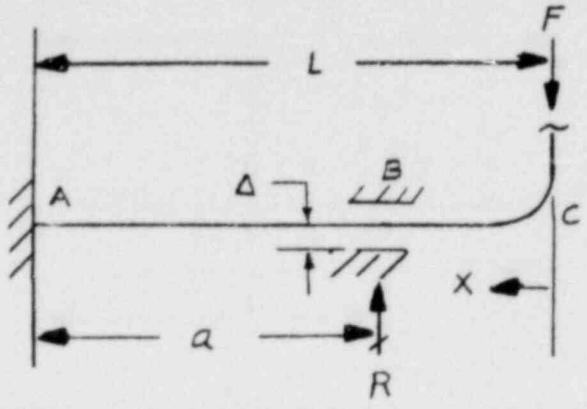
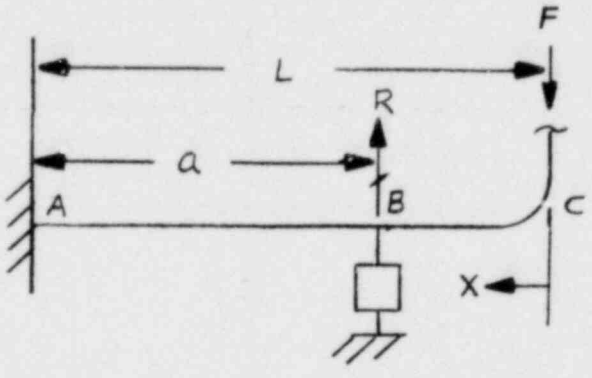
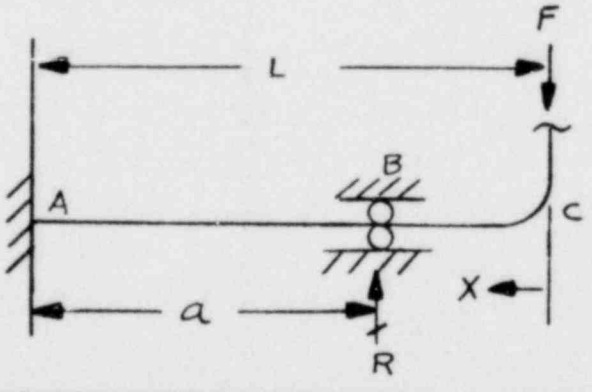
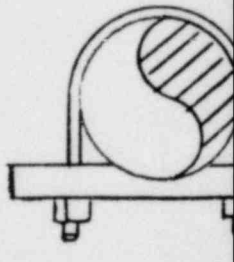
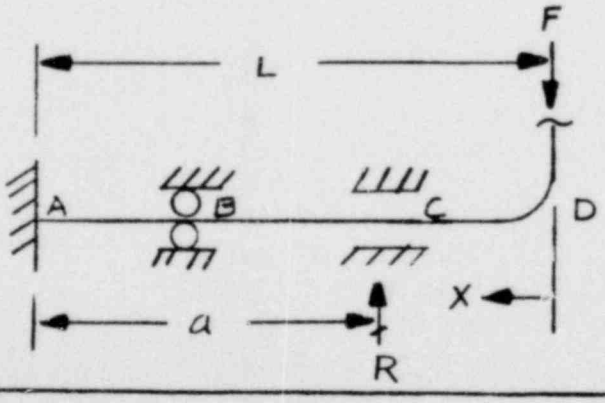
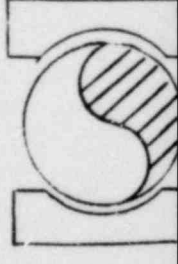
1		
2		
3		
4		

TION (R)	DESCRIPTION OF MODEL
	IN THE ELASTIC ANALYSIS THE LENGTH (L) AND THE RESTRAINT GAP (Δ) ARE SMALL. IN THE PLASTIC ANALYSIS THE LENGTH (L) AND THE RESTRAINT GAP (Δ) CAN BECOME LARGER AND A PLASTIC HINGE WILL OCCUR AT THE POINTS OF MAXIMUM MOMENT. (i.e., A, B, OR, A AND B.) THE PRINCIPAL OF VIRTUAL WORK REQUIRES THAT THE WORK DONE DURING PLASTIC STRAINING BE EQUAL TO THE WORK DONE BY THE JET FORCE (F). IN ALL CASES WHERE PLASTIC HINGES ARE ALLOWED TO FORM THE DECISION HAS BEEN BASED ON THE ACCEPTABILITY OF ANY ATTENDANT PIPE WHIP AND CHANGING ENVIRONMENTAL EFFECTS CAUSED BY THE SWEEP OF THE JET OR ITS REDIRECTION.
	IN THE ELASTIC ANALYSIS THE LENGTH (L) IS SMALL AND CONSEQUENTLY THE STRESS IN THE PIPE WILL NOT EXCEED THE ELASTIC LIMIT. IN THE PLASTIC ANALYSIS THE LENGTH (L) CAN BE LARGER AND PLASTIC HINGES CAN OCCUR AT A, B, OR, A AND B. THE VIRTUAL WORK PERFORMED BY THE JET FORCE WILL BE EQUAL TO THE COMBINED TOTAL WORK PERFORMED BY THE HYDRAULIC SWAY COMPRESSOR AND THE PLASTIC HINGES. IN ALL CASES IN WHICH HINGES ARE ALLOWED TO FORM THE DECISION HAS BEEN BASED ON THE ACCEPTABILITY OF ANY ATTENDANT PIPE WHIP AND CHANGING ENVIRONMENTAL EFFECTS CAUSED BY THE SWEEP OF THE JET OR ITS REDIRECTION.
	IN THE ELASTIC ANALYSIS THE LENGTH (L) IS SMALL AND CONSEQUENTLY THE STRESS IN THE PIPE WILL NOT EXCEED THE ELASTIC LIMIT. IN THE PLASTIC ANALYSIS THE LENGTH (L) CAN BE LARGER AND PLASTIC HINGES CAN OCCUR AT A, B, OR, A AND B. THE VIRTUAL WORK PERFORMED BY THE JET FORCE WILL BE EQUAL THE TOTAL WORKED STORED IN THE PLASTIC HINGES. IN ALL CASES IN WHICH HINGES ARE ALLOWED TO FORM THE DECISION HAS BEEN BASED ON THE ACCEPTABILITY OF ANY ATTENDANT PIPE WHIP AND CHANGING ENVIRONMENTAL EFFECTS CAUSED BY THE SWEEP OF THE JET OR ITS REDIRECTION.
	IN THE ELASTIC ANALYSIS THE LENGTH (L) IS SMALL AND CONSEQUENTLY THE STRESS IN THE PIPE WILL NOT EXCEED THE ELASTIC LIMIT. IN THE PLASTIC ANALYSIS THE LENGTH (L) CAN BE LARGER AND A PLASTIC HINGE WILL OCCUR AT THE POINT OR POINTS OF MAXIMUM MOMENT. THE POINT OR POINTS OF MAXIMUM MOMENT MAY OR MAY NOT BE LOCATED AT THE RESTRAINTS. IN ALL CASES IN WHICH HINGES ARE ALLOWED TO FORM THE DECISION HAS BEEN BASED ON THE ACCEPTABILITY OF ANY ATTENDANT PIPE WHIP AND CHANGING ENVIRONMENTAL EFFECTS CAUSED BY THE SWEEP OF THE JET OR ITS REDIRECTION.

PIPE BREAK OUTSIDE CONTAINMENT- MATHEMATICAL MODELS

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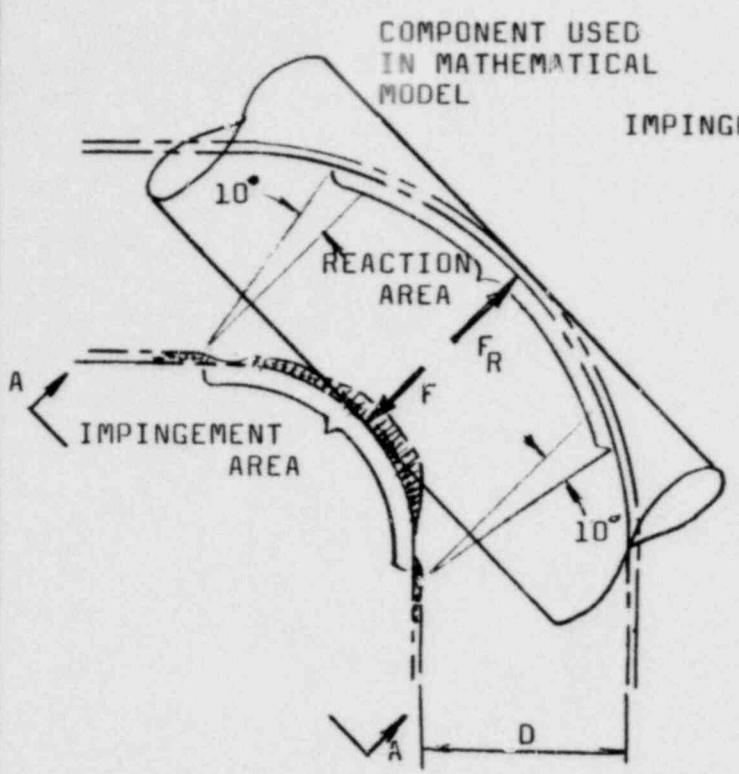
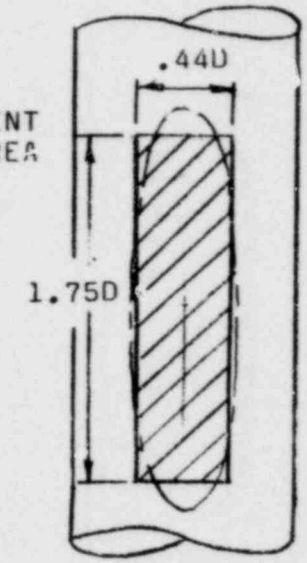
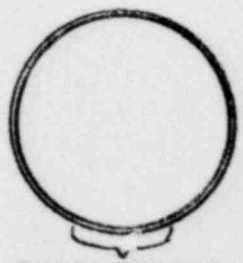
(9)		 SECTION A–A  IMPINGEMENT AREA	IMPINGEMENT PHASE EFFECT ON GUARD PIPE LOAD EMPLOYS THRUST FACTOR FOR IMPACT PHASE MODEL PLEASE SEE NEXT SHEET

POOR ORIGINAL

PIPE BREAK OUTSIDE CONTAINMENT-MATHEMATICAL MODELS

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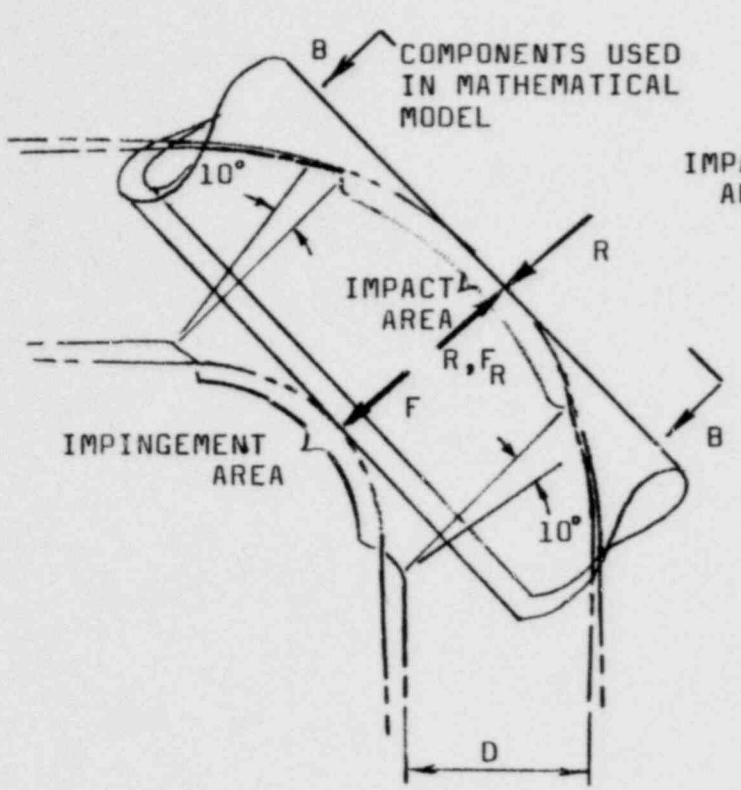
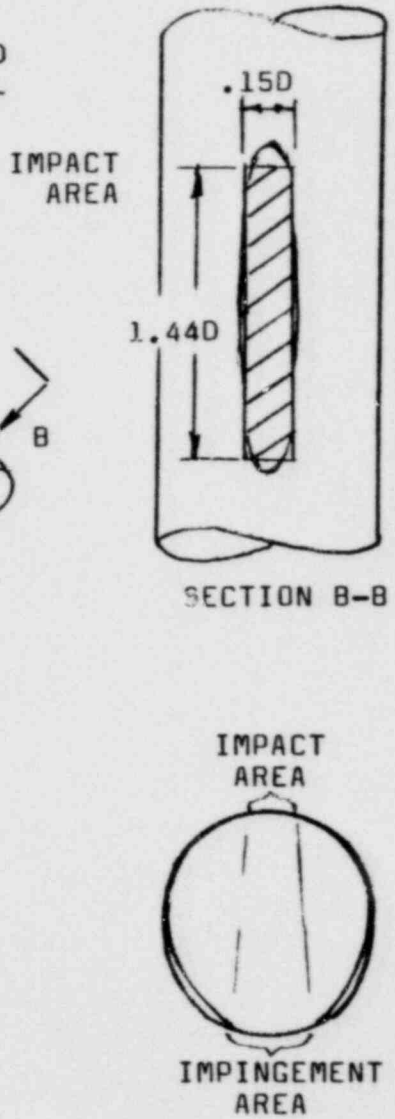
(9)			IMPACT PHASE EFFECT ON GUARD PIPE RESTRAINT LOAD EMPLOYS IMPACT FACTOR

POOR ORIGINAL

PIPE BREAK OUTSIDE CONTAINMENT–MATHEMATICAL MODELS

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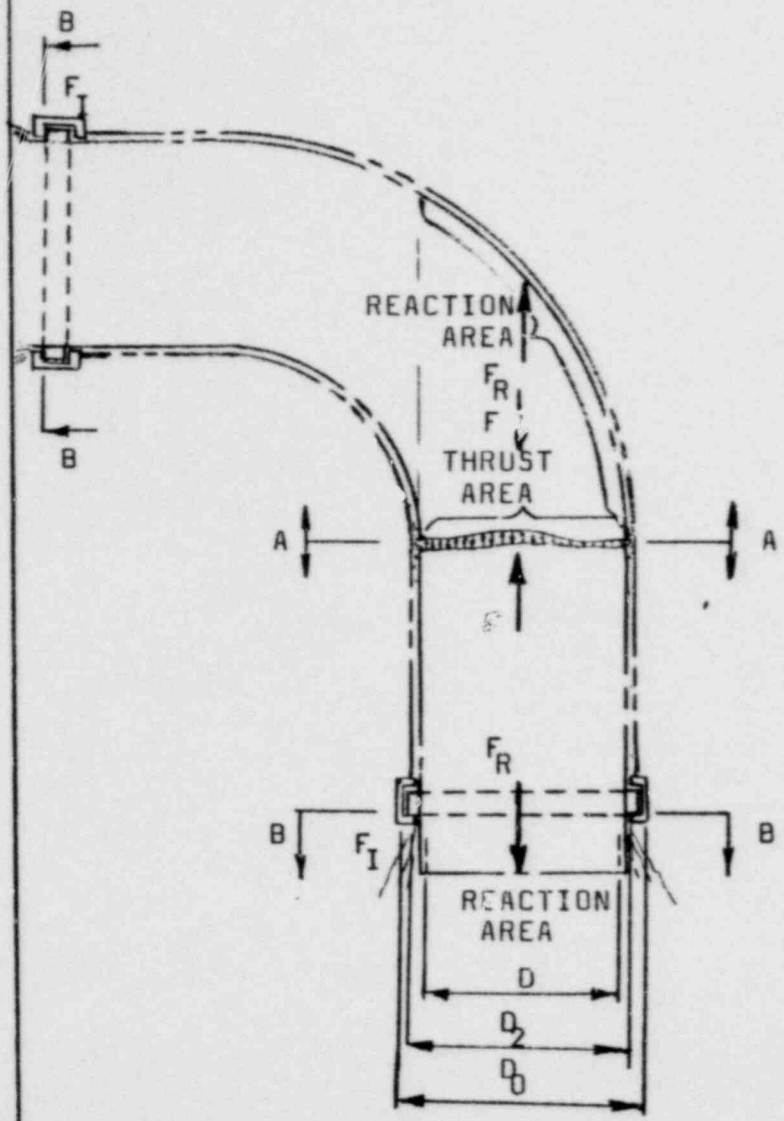
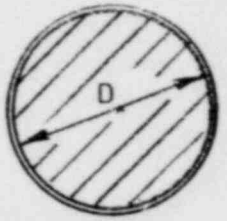
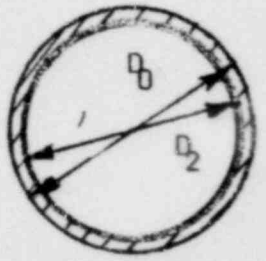
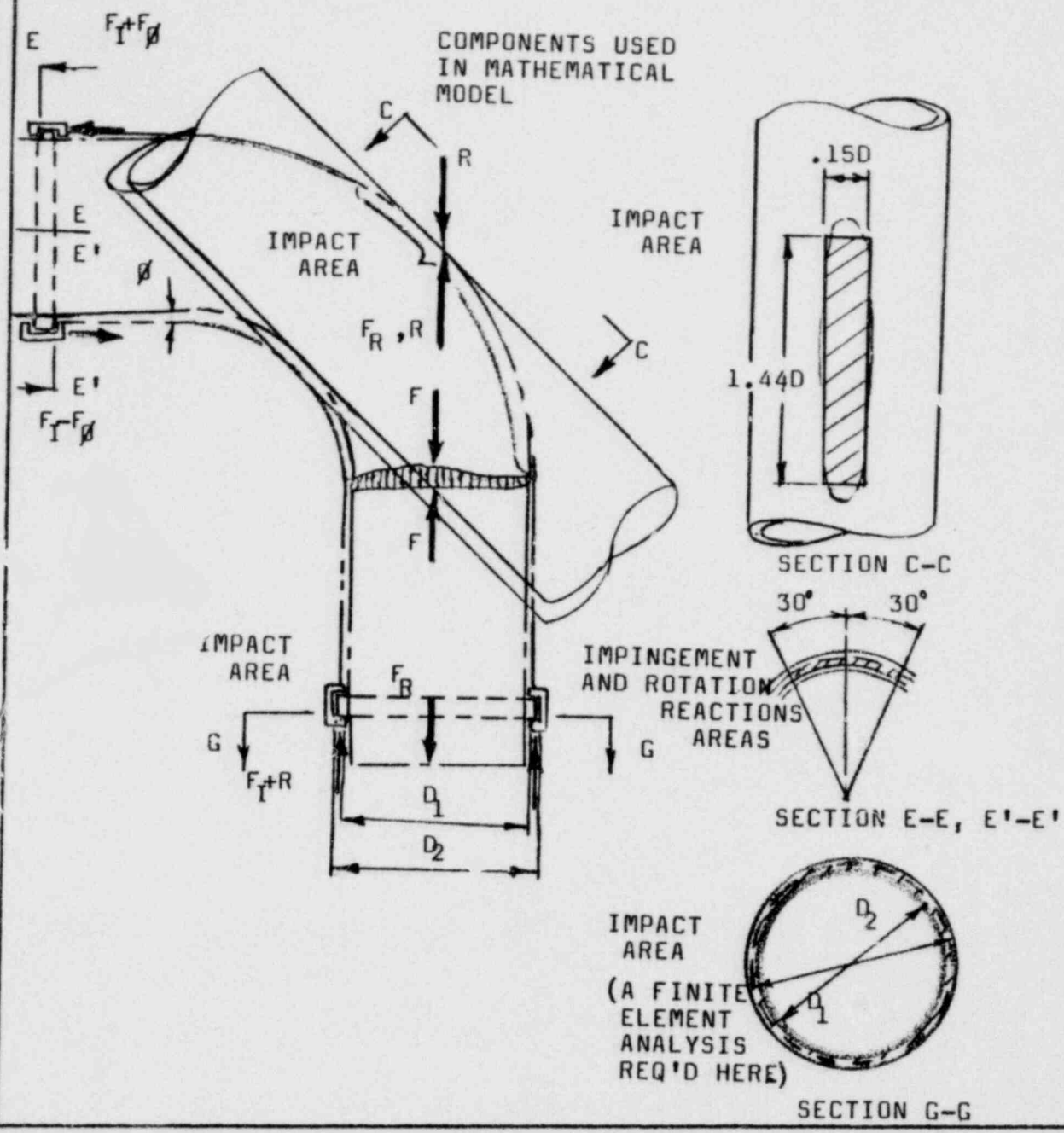
9		 	THRUST PHASE EFFECT ON GUARD PIPE LOAD EMPLOYS THRUST FACTOR FOR IMPACT PHASE PLEASE SEE NEXT SHEET

POOR ORIGINAL

PIPE BREAK OUTSIDE CONTAINMENT–MATHEMATICAL MODELS

CASE NUMBER	MATHEMATICAL MODEL	CROSS SECTION AT FORCE (R)	DESCRIPTION
(9)			IMPACT PHASE EFFECT ON GUARD PIPE RESTRAINT LOAD EMPLOYS IMPACT FACTOR

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QUESTION 5. A description should be provided of the measures, as applicable, to protect against pipe whip, blowdown jet and reactive forces.

(a) Pipe restraint design to prevent pipe whip impact.

(b) Protective provisions for structures, systems, and components required for safety against pipe whip and blowdown jet and reactive forces;

(c) Separation of redundant features;

(d) Provisions to separate physically piping and other components of redundant features; and

(e) A description of the typical pipe whip restraints and a summary of number and location of all restraints in each system.

ANSWER:

(a) Measures to protect against pipe whip blowdown jet and reactive forces will be guard pipe restraints. (See figure 6 for typical device), pipe whip restraints and structural shielding.

1. Guard Pipe Restraints:

Restraints alone are sufficient to protect against pipe whip, blowdown jet and reactive forces. In some cases, the combined effects associated with postulated pipe breaks require partial encasement to protect adjacent components. An articulating encasement can be provided to redirect the fluid and control pipe movement. The guard pipe restraint may be installed inside of the normal insulation with small clearances between it and the main pipe or spacers may be provided and the encasing device installed outside of the normal insulation. In either case, the impact is substantially reduced by limiting the distance through which the pipe accelerates. Impact, jet forces and internal pressure dictate the design of the installation.

Generally, the impact is through a distance less than one inch, and though the pressures are less than the main line pressure by a significant amount because of venting no credit for reduction is taken. The unbalanced jet forces are controlled by the placement and sizing of ports. In most cases, the unbalanced jet forces are less than 10 percent of the design basis value and well within the capacity of the normal supports and restraints.

Articulation and some clearances are required to allow the main pipe to expand and contract. Articulation is provided by the use of loose couplings to tie the sections together. Straight runs are used to provide the anchorage points, since straight portions of the main pipe are not stressed as highly as tees and elbows. Structurally, therefore, the piping retains continuity through the encasement device even through the main pipe is completely severed or split open. Typical details of this device are shown on figure 6.

Detailed calculations will be provided for guard pipe coupling sleeves, attachment rings welded to the main lines and other special components. Attachments welded to the main line and the guard pipe restraint will be designed supported and installed so as to not introduce significant strain concentrations during normal upset or faulted conditions on the encapsulated section of pipe.

Axial displacement and motion within the sleeve following a postulated circumferential pipe break will be precluded by suitable attachments to the main line or at the terminal end restraint.

The encapsulation sleeve will be designed to withstand the dynamic forces of internal pressurization resulting from the escape of high energy fluid at the postulated pipe break location assuming complete pipe severance and axial separation.

The encapsulation sleeve will be provided with open vent and drain pipe nipples which extend beyond the pipe insulation as a means of monitoring the encapsulated pipe section for any leaks which might develop in service.

The design of the encapsulation sleeve will permit either its removal by machinery or flame cutting techniques for the replacement of encapsulated pipe section in the event leaks develop which require repair or replacement of the pipe.

The guard pipe restraint system will be designed, constructed and erected as a quality and seismic Class 1 item.

Guard pipe restraints will be designed and constructed in accordance with ANSI B31.7 Class 2 as noted below:

(a) Material mill test reports giving chemical and physical data will be provided.

(b) Radiographic examination will be made of all possible subassembly welds.

(c) Dye penetrant or magnetic particle inspection will be made of each pass of installation welds and welds which could not be radiographed during such assembly.

(d) Stress levels will meet the requirements for emergency conditions.

(e) Only qualified and approved welding procedures will be used in fabrication and installation.

(f) Only code materials will be used.

In addition, strict control will be exercised over all weld rod in accordance with documented standards.

2. Pipe Whip Restraints

Postulated severance at the terminal anchor on the main steam and feedwater lines causes severe pipe whip. To prevent pipe whipping, attachments will be made to the existing penetration sleeve. (See figure 6.) The restraint will be attached to the containment sleeve, which is a structural element rather than a pressure part of the containment in the Rancho Seco Unit 1 design.

These sleeves are designed to accept the load of such failure in the main steam and feedwater. The restraint is attached to the straight pipe outside the containment opening by means of a ring.

(b) Protective provisions are described on table 1.

(c)&(d) Separation of redundant features was taken into account as described in the answer to Question 11 which outlines the steps involved in the analysis. Where adequate separation was not provided the solutions are identified in table 1.

(e) Typical pipe whip restraints are described in the answer to item 11. Restraints will be used on two systems: The main steam and main feedwater lines. Locations of these restraints are shown on figures 1 and 2.

QUESTION 6. The procedures that will be used to evaluate the structural adequacy of Category I structures and to design new seismic Category I structures should be provided including:

(a) The method of evaluating stresses, e.g., the working stress method and/or the ultimate strength method that will be used;

(b) The allowable design stresses and/or strains; and

(c) The load factors and the load combinations.

ANSWER:

(a) The method of evaluating stresses for existing structures will be accomplished by the use of the ultimate strength method.

(b) Stresses are as follows:

1 Concrete

(a) Auxiliary Building above grade f'c=3000 psi

(b) Auxiliary Building below grade f'c=4000 psi

(c) Strains limited to 0.003 in/in

(d) Reinforcing steel f y=60,000 psi

2 Structural Steel

(a) ASTM A-36 Steel fy=36,000 psi

(c) The load combinations and load factors are as follows:

1 $C \phi \geq (1 \pm 0.05) D + 1.0R$

2 $C \geq (1 \pm 0.05) D + 1.0R + 1.0E'$

c = Required capacity to resist factored loads

d = Dead load of structure, piping and equipment

E' = Design bases earthquake

R = Force or pressure on structure due to rupture of any one pipe.

Yield capacity reduction factors:

Ø = 0.90 for concrete in flexure

Ø = 0.85 for tension, shear, bond, and anchorage in concrete

Ø = 0.75 for spirally reinforced concrete compression members

Ø = 0.70 for tied compression members

Ø = 0.90 for fabricated structural steel

Ø = 0.90 for reinforcing steel in direct tension

Ø = 0.90 for welded or mechanical splices of reinforcing steel

Ø = 0.85 for lap splices of reinforcing steel

QUESTION 7. The structural design loads, including the pressure and temperature transients, the dead, live and equipment loads; and the pipe and equipment static, thermal, and dynamic reactions should be provided.

ANSWER:

The main steam lines and feedwater lines will be restrained at the containment penetration.

The design loads from the main steam line reaction is 1200 kips and from the feedwater line reaction is 671 kips.

QUESTION 8. Seismic Category I structural elements such as floors, interior walls, exterior walls, building penetrations and the buildings as a whole should be analyzed for eventual reversal of loads due to the postulated accident.

ANSWER:

Seismic category I structural elements such as floors, interior walls, exterior walls, building penetrations and the building as a whole were analyzed for reversal of loads due to a postulated accident using the ultimate strength method.

QUESTION 9. If new openings are to be provided in existing structures, the capabilities of the modified structures to carry the design loads should be demonstrated.

ANSWER:

In the event new openings are required in the existing structure the structural elements will be analyzed by the ultimate strength method. The elements will be checked for flexure, longitudinal and transverse shear.

QUESTION 10. Verification that failure of any structure, including nonseismic Category I structures, caused by the accident, will not cause failure of any other structure in a manner to adversely affect:

(a) Mitigation of the consequences of the accidents; and

(b) Capability to bring the unit(s) to a cold shutdown condition.

ANSWER:

No structural failure will result from any postulated pipe rupture.

The compartment above the diesel generator rooms structure will be subjected to a pressure of 0.83 lbs per square foot which will not create any structural failures. In the compartments in the Auxiliary Building basement the reinforced concrete walls will be subjected to a pressure of 27.4 lbs per square foot and at this pressure the walls are capable of withstanding this load with no adverse effect.

See table 1 for specific areas of interest.

QUESTION 11. Verification that rupture of a pipe carrying high energy fluid will not directly or indirectly result in:

(a) Loss of required redundancy in any portion of the protection system (as defined in IEEE-279), Class IE electric system (as defined in IEEE-308), engineered safety feature equipment, cable penetrations, or their interconnecting cables required to mitigate the consequences of that accident and place the reactor(s) in a cold shutdown condition; or

(b) Environmentally induced failures caused by a leak or rupture of the pipe which would not of itself result in protective action but does disable protection functions. In this regard, a loss of redundancy is permitted but a loss of function is not permitted. For such situations plant shutdown is required.

ANSWER:

A. Each system including piping, valves, equipment, electrical power, control cables and switchgear was evaluated for high energy line failures using the Guidelines given in the "General Information Required for Consideration of the Effects of a Piping Break Outside Containment." Each line was assumed to fail in the proximity of any equipment required for cold shutdown. Each potential problem was evaluated on the basis of the guidelines, i.e.: if a failure of a line could damage a piece of equipment and the failure of the line did not result in protective action as defined in item 11.b single failure was not assumed and credit was taken for redundancy.

B. The areas where rupture of a pipe carrying high energy fluid might result directly or indirectly in loss of function of equipment included in (A) and (B) above have been determined and are listed as items 3,4,8,9,10,14,15,16,17,19,20,21,23I,23J,23L,23M,25,27, and 29 on table 1. The equipment exposed to the pipe rupture accident and the action required to avoid damage to this equipment in those areas is also given on table 1.

The steps involved in the analysis were as follows:

1 From AEC letter and errata

a. Develop guidelines

The following assumptions were made to develop the guide lines for the analysis:

(1) The most stringent requirement for shutdown was postulated to be the double ended rupture of one main steam line with a turbine stop valve stuck open on the uneffected line such that both steam generators blow down through the single break.

(2) Loss of offsite power was assumed to occur following the accident.

(3) Cold shutdown capability would be required with one stuck rod.

(4) For all line breaks which would result in a reactor trip single failure of an active component was assumed. For all line breaks which would not result in a reactor trip credit was taken for redundancy of active and passive components.

b. List of impactees

c. List of impactors

2 a. Develop marked up P&I diagrams of impactees and impactors.

b. Develop list of electrical equipment required for cold shutdown.

3 Using information from Item 2, develop general arrangement drafts from electrical and piping area drawings.

4 Transfer information from 3 in simplified form to vellum using only one elevation and general arrangement as a guide.

5 Make overlays of impactees and impactors.

6 Using guidelines, overlays and drawings developed in 3, list potential problem areas.

7 Make isometrics of potential problem areas.

8 Investigate isometrics and firm up list of problem areas.

9 Independently consider (assuming reasonable operator action)

a. Flooding from failure of high energy lines or any other source.

b. Impingement effects where high energy lines have large energy reservoirs.

c. (1) Environmental effects on items from 2b above for impactees which have large energy reservoirs and high temperatures.

(2) Compartment pressure effects for impactees which have large energy reservoirs and high temperatures.

10 Investigate problem areas and develop solutions.

QUESTION 12. Assurance should be provided that the control room will be habitable and its equipment functional after a steam line or feedwater line break or that the capability for shutdown and cooldown of the unit(s) will be available in another hatitable area.

ANSWER:

There are five paths that steam could travel through the Auxiliary Building to reach the control room as follows:

Main steam line break which is outside of the Auxiliary Building.

Path 1 Steam enters Auxiliary Building at Elev. 40'. Steam must travel 212 lineal feet and must pass through 5 doors.

Path 2 Steam enters Auxiliary Building at Elev. 20'. Steam must travel 138 lineal feet and must enter stairway No. 2 at Elev. 20' and pass through 5 doors.

Path 3 Steam enters Auxiliary Building at grade. Steam must travel 188 lineal feet and must enter stairway No. 2 and pass through 7 doors.

Auxiliary steam line break which is in the basement at Elev. -20 feet.

Path 4 Steam must travel up stairway No. 6 to grade, down the corridor to stairway No. 2 to Elev. 40'. Must travel 282 lineal feet and pass through 4 doors.

Path 5 Steam must travel up stairway No. 5 to grade and enter stairway No. 2 exit at Elev. 40 feet, a distance of 215 lineal feet and pass through 5 doors.

The emergency air conditioning intake is located on the roof of the Auxiliary Building on the South side and steam must travel a distance of 224 feet before entering the intake. The normal control room air conditioner intake

is located on the East end of the Auxiliary Building. Intakes will not be affected by steam from any high energy line.

Considering the large volume of the building in which the steam can dissipate before reaching the control room, the control room would be habitable and the equipment would remain functional.

QUESTION 13

Environmental qualification should be demonstrated by test for that electrical equipment required to function in the steam-air environment resulting from a high energy fluid line break. The information required for our review should include the following:

(a) Identification of all electrical equipment necessary to meet requirements of 11 above. The time after the accident in which they are required to operate should be given.

(b) The test conditions and the results of test data showing that the systems will perform their intended function in the environment resulting from the postulated accident and time interval of the accident. Environmental conditions used for the tests should be selected from a conservative evaluation of accident conditions.

(c) The results of a study of steam systems identifying locations where barriers will be required to prevent steam jet impingement from disabling a protection system. The design criteria for the barriers should be stated and the capability of the equipment to survive within the protected environment should be described.

(d) An evaluation of the capability for safety related electrical equipment in the control room to function in the environment that may exist following a pipe break accident should be provided. Environmental conditions used for the evaluation should be selected from conservative calculations of accident conditions.

(e) An evaluation to assure that the onsite power distribution system and onsite sources (diesels and batteries) will remain operable throughout the event.

ANSWER:

(a) The following electrical equipment is required to mitigate the consequences of the steam line break accident and to place the reactor in a cold shutdown condition:

Equipment

P-236 Make-up pump
P-238A&B HPI pumps
P-261A&B DH pumps
P-472A&B NSRW pumps
P-482A&B NSCW pumps
G-886A&B Diesel gen., including local and remote controls
A-544A-D Diesel gen. room exhaust fans
P-888A-D Diesel gen. fuel oil pumps
P-319 Motor Driven Aux. FW pump
FV-30801 Steam to Aux FW pump P-318
A-529A-E Emerg. operating pump room coolers
P-705A&B Boric acid pumps
- Class I batteries & buses d-c & a-c
- Nuclear services buses
U-545 Control room Emer. air conditioner

Instrumentation:

- Source range detectors
- Rod position indication
TE-21023A, 24B R.C. Inlet temp.
PT-21092, 38, 40, 42, 43, 39, 37 RC pressure
LT-20503A, B&C pressurizer level
LT-20504C&D Steam generator level

(b) Item 21 table 1 is the only case where electrical equipment will be subjected to sustained temperature. Electrical equipment required to place the reactor in a cold shutdown condition that may be exposed to a steam environment is the following:

P-236 MU pump motor
P-238 A&B HPI pump motors
P-261 A&B DH pump motors
P-705 A&B boric acid pump motors

The motors for the MU pump, HPI pumps, and DH pumps have class F insulation systems which can withstand a total continuous temperature of 130 C (40 C ambient, 90 C temperature rise). In addition, these motors are provided with weather protected type I enclosures. The motors for the boric acid pumps have Class B insulation systems which can withstand a total continuous temperature of 125 C (40 C ambient, 85 C temperature rise). These motors have totally enclosed fan cooled enclosures. Refer to item 21 on table I and to answer to question 20. For this case a 6 inch auxiliary steam line with a crack equal to the cross sectional area was assumed to break. This break would not require the operator to shut down. If the above mentioned pumps

are running they may be damaged. However the redundant pump would not be running and would not be damaged if the building was heated to 212 F and would be available should the operator elect to shutdown. Alarms are provided in the control room which would warn the operator of a failure of the auxiliary steam line. These alarms would be low auxiliary steam pressure and high Auxiliary Building pressure.

(c) Refer to items 8, 9, 14, 15, 16, 17, 19, 20 and 23J on table 1 on the pipe break problem areas tabulation.

(d) As explained in answer to question 12 it is not credible that steam ejecting from postulated ruptured pipes will enter the control room and affect safety related equipment.

(e) Steam ejecting from postulated ruptured pipes will not enter the electrical switchgear rooms and the battery rooms. (Refer to table 1 item 3). Steam from postulated pipe failures will not enter the diesel generator rooms (Refer to table 1 item 25).

QUESTION 14 Design diagrams and drawings of the steam and feedwater lines including branch lines showing the routing from containment to the turbine building should be provided. The drawings should show elevations and include the location relative to the piping runs of safety related equipment including ventilation equipment, intakes, and ducts.

ANSWER:

1. The following drawings were previously provided for AEC review.

   A. Marked up P&I diagrams with impactors and impactees.

   B. Overlays

LINES CONSIDERED	IMPACTEE
1. Main FW, steam & aux. stm.	6. NSRW & CR AC
2. Cond., LD, aux. blr FW & N_2	7. Emer FW, DG & NSCW
3. HPI & MU pump disc.	8. DH system
4. DH disc.	9. Elec
5. Emer. FW	10. DH & MU Suct from BWST & BA pump

OVERLAYS MADE & INVESTIGATED

1 on 6,7,8,9,10
2 on 6,7,8,9,10
3 on 8,9,10
4 on 8,9,10
5 on 7

C. Isometrics of potential problem areas.

2. The following drawings have been submitted previously and will be submitted with the final report; plan and cross sections of area between spent fuel building and reactor building (area of concern for failure of main steam and main feedwater affecting equipment required for cold shutdown).

QUESTION 15. A discussion should be provided of the potential for flooding of safety related equipment in the event of failure of a feedwater line or any other line carrying high energy fluid.

ANSWER:

In the event of the failure of the feedwater line, in the area, bounded by the Reactor Building, Fuel Storage Building, the transfer tube structure and the Auxiliary Building, the area will be drained by the utilization of the tendon access gallery. The gallery can store 175,830 gallons of water. An overflow will be provided by utilizing a tendon gallery shaft to drain the excess of 175,830 gallons to the plant drainage system. The tendon gallery will be pumped dry using the existing pump. Concrete curbs will be installed to protect the Auxiliary Building from flooding through the doors. The louvered wall at the diesel generator room will be replaced with a wall to prevent flooding of the diesel generators.

In the event of a tank rupture in the yard area north of the Reactor Building the existing plant drainage system is adequate to drain the area without build-up of water which could endanger class I systems. See table 1 for specific areas of interest.

QUESTION 16. A description should be provided of the quality control and inspection programs that will be required or have been utilized for piping systems outside containment.

ANSWER:

All piping systems have been fabricated by organizations with quality assurance programs meeting the requirements of 10 CRF 50 Appendix B. The piping systems 2½ inch and larger were fabricated by either of

two manufacturers in the Los Angeles area. The 2 inch and smaller pipe was fabricated by the site erection contractor who also performed all field erection work and assembly welding. All three organizations have been surveyed by ASME and are current holders of "N" stamp authorization.

Prior to contract award these contractors were audited by the SMUD Quality Assurance Director. Subsequent audits by him have verified performance in accordance with their respective manuals.

All pipe and fittings have been procured under requirements for furnishing heat numbers and material chemical and physical test results and non-destructive examination, as required to meet the project specifications. These specifications incorporate all requirements of ANSI B31.7.

Throughout all of the fabrication and site erection work control has been exercised over all welding operations. Strict weld rod control has been observed and all welding has been performed in accordance with welding procedures approved by the engineer. The engineer specified the procedure used for each field welded joint.

Non-destructive examination of all welds has been in accordance with ANSI B31.7 for the classification of system involved.

Prior to the acceptance of piping systems they are subjected to all requirements of the SMUD Quality Assurance Program. This includes complete documentation of non-conforming items and disposition in accordance with the Manual. Assurance of all Code requirements is met by the State of California who are performing site inspection.

QUESTION 17. If leak detection equipment is to be used in the proposed modifications, a discussion of its capabilities should be provided.

ANSWER:

No new leak detection system is required as a result of the analysis.

Although no credit was taken in the analysis, the main steam line failure protection as described in section FSAR 14.2, would reduce the blowdown for failures of the main steam lines and branches and main feedwater failures between the isolation valves and the Reactor Building.

QUESTION 18. A summary should be provided of the emergency procedures that would be followed after a pipe break accident, including the automatic and manual operations required to place the reactor unit(s) in a cold shutdown condition. The estimated times following the accident for all equipment and personnel operational actions should be included in the procedure summary.

ANSWER:

The worst pipe break accident considered is the double ended rupture of a 36 inch steam line between the steam generator and the steam stop valves with concurrent failure of one turbine stop valve to close in the unbroken steam line causing the blowdown of both steam generators. The following procedure will be employed in this incident. The response of the reactor coolant system to this accident is shown graphically on FSAR Figure 14.2-1, sheets 3 and 4.

About 15 seconds after the accident, the safety features systems actuate; the reactor is tripped. The systems are secured as soon as the control room operator realizes there is a steam line break and not a LOCA. The operator secures appropriate pumps after the accident. The high pressure injection pumps will be secured to prevent the reactor coolant system from going solid and causing undesirable pressure transients.

The reactor coolant pumps are tripped at the start of the accident because it is assumed that off-site power is lost at that time. Automatic feedwater isolation on low steam line pressure causes the steam generators to blow dry.

At one minute after the accident, the plant is in the following condition:

Average RC temperature	540 F
RC Pressure	Saturation
Steam Generators	Empty
Control Rods	Inserted

Both diesel generators are available to supply the power to both auxiliary feed pumps. Since the steam generators are dry no heat can be removed from the system. The operator will start the motor driven auxiliary feed pump as soon as possible to remove energy from the reactor coolant system caused by the high decay heat rate immediately after shutdown. A small feed rate is used until natural convection begins and the operator determines the cooldown rate. Cooldown by this means, with the steam venting to the atmosphere through the break, continues until reactor coolant temperature reaches 280 F. When reactor coolant reaches 280 F, cooldown is shifted to the decay heat removal system.

During cooldown the makeup pump is operated as necessary to add borated water to the system to maintain proper level in the pressurizer. Adding water from the BWST and concentrated boric acid from the boric acid pumps directly to the suction of the HPI or MU pump (required only if a stuck rod is assumed) as the plant cools down insures sufficient negative reactivity to maintain at least a 1 percent $\Delta K/K$ subcritical margin.

Once the reactor is being cooled by the decay heat removal system, cooldown is continued to less than 200 F, and the reactor is maintained in a cold shutdown condition.

A discussion of a steam line break which does not rupture piping on the other steam line is given in subsection 14.2 of the FSAR.

QUESTION 19. A description should be provided of the seismic and quality classification of the high energy fluid piping systems including the steam and feedwater piping that run near structures, systems, or components important to safety.

ANSWER:

	Seismic/Quality	Operating Temp/Pres F / psia
1. Main steam lines and branches out to the first remote operated valve.	1/1	595/925
2. Main feedwater between isolation valves and Reactor Building.	1/1	464/1000
3. Main feedwater upstream of the isolation valves.	2/2	464/1000
4. Auxiliary Boiler F.W. pump discharge.	2/2	212/350

The above list does not include project class of lines considered for impingement, temperature and flooding or list of high energy lines considered which will not affect equipment required for cold shutdown.

QUESTION 20. A description should be provided of the assumptions, methods, and results of analyses, including steam generator blowdown, used to calculate the pressure and temperature transients in compartments, pipe tunnels, intermediate buildings, and the turbine building following a pipe rupture in these areas. The equipment assumed to function in the analyses should be identified and the capability of systems required to function to meet a single active component failure should be described.

ANSWER:

Analysis of compartment pressure or temperature transients were restricted to those areas where a pipe failure could damage equipment required for cold shutdown. These areas are identified in table 1 as items 26, 27 and 29. The only case where equipment could be affected by a pipe break is item 27 which is a postulated failure of a 6 inch auxiliary steam line in the Auxiliary Building. Failure of this line would not result in protective action as defined in 11(b) such that failure of an active component is not required for the analysis. Electrical equipment required for cold shutdown which may be affected by impingement are identified in schedule item 3 and temperature affects were investigated in table 1 item 21.

This steam line is not required for normal operation and plant shutdown would not be required if the line is isolated outside of the Auxiliary Building. Electrical equipment in the Auxiliary Building required for cold shutdown would not be damaged by the resulting 212 F temperature except in the case of a high pressure injection, low pressure injection or boric acid pump unless the motor was running for an extended period of time in this environment. If a motor did fail the redundant pump would be used to shutdown.

The energy releases used for the compartment pressure analysis were critical crack size as defined by question item 2 for table 1 item 26, double ended rupture of the main steam or feedwater line for table 1 item 29 and a crack equal to the area of the pipe for table 1 item 27.

All postulated failures were analyzed for these effects on structures and in no case was a secondary missile (spalled concrete, doors etc) generated with enough energy to affect the equipment required for cold shutdown.

QUESTION 21. A description should be provided of the methods or analyses performed to demonstrate that there will be no adverse effects on the primary and/or secondary containment structures due to a pipe rupture outside these structures.

ANSWER:

Main steam and feedwater lines will be restrained to prevent impact on the secondary containment structures.

See table 1 for specific areas of interest.

ITEM	PRO
1.	Steam Line t Breaking NS
2.	Main Feedwat Lines Damagi Stacks
3.	Auxiliary St Indication a switchgear r
4.	Steam to Eme Affecting Po
5.	Letdown Line Raw Water Li
6.	Letdown Affe and from R.V
7.	Letdown Affe From BW Stor
8.	Letdown Line Power to HPI Pump and Fan Make-Up Pump
9.	Letdown Line Both Boric A
10.	Aux. Boiler Power to Bot

PRELIMINARY - ALL PLANS SU

TABLE 1

POSTULATED PIPE FAILURE OUTSIDE OF CONTAINMENT STRUCTURE

LEM	TYPE OF ANALYSIS	SOLUTION
Emer. F.W. Pump aw Water Piping	Pipe Whip & Impingement	No Solution Required for Pipe Whip. High Stress Points and Terminal Ends are Not Near Small Piping - Main Header is Larger and has Thicker Wall than Steam Line - Small Piping to be Supported for Impingement
r and Main Steam g Diesel Generator	Pipe Whip & Impingement Critical Crack Size Only to be Considered	Pipe Whip - Restrain Terminal Ends & Install Guard Pipe Restraint on MS & FW - Install Additional Supports for Impingement (See Item 23)
am Affecting CRD d electrical oms	Impingement and Temperature	Line to be Abandoned and Source to come from Line 61250-6"
r. F.W. Pump ver to NSCW Pump	Pipe Whip, Impingement and Temperature	Reroute Cable in Uneffected Area
Affecting NS e	Impingement	Install Additional Supports for Impingement
cting NSRW to Emer. Coolers	Impingement	No Solution Req'd. Letdown is 2½" w/.375 in. wall & NSRW is 10" w/.365 in wall. Calculations Not Req'd.
cting Pump Suction ge Tank	Impingement	Existing Hangers Are Adequate to Prevent Damage
Affecting 'B' Pump, Makeup s and 'A' Power to	Impingement and Temperature	Encase Letdown Line
Affecting Power to cid Pumps	Impingement and Temperature	Item 8 also solves 9
F.W. Line Affecting h Boric Acid Pumps	Impingement and Pipe Whip	No Problem. Conduit is 10' Apart at all points

JECT TO FURTHER REFINEMENT BY DESIGN OR ANALYSIS

ITEM	P
11.	Letdown Line Pump Disc L Suction Line
12.	Aux. Boiler of Boric Ac
13.	R.C. Pump S Decay Heat
14.	HPI and Mak Affecting ' Pump and 'B
15.	HPI and Mak Affecting ' Make-Up Pum Pump
16.	HPI and Mak Affecting P and 'B' Pow
17.	HPI and Mak Affecting P Acid Pumps
18.	HPI and Mak Breaking Dis Acid Pumps
19.	D.H. Discha to Both Bor
20.	'A' D.H. Di Power to DH
21.	Aux. Stm Li Affecting E
22.	Any Line Br Both Decay

PRELIMINARY - ALL PLANS S

TABLE 1

POSTULATED PIPE FAILURE OUTSIDE OF CONTAINMENT STRUCTURE

ROBLEM	TYPE OF ANALYSIS	SOLUTION
Affecting Boric Acid nes & HPI Pump s	Impingement	Add Supports to Boric Acid Line for Impingement
F.W. Breaking Discharge d Pumps	Pipe Whip and Impingement	3" Line Impingement will not Effect 2" Line. Restrain F.W. line for pipe whip protection
al Supply Breaking Suction	Impingement	Install Supports on D.H Line to Withstand Impingement
-Up Pump Discharge A' Power to Make-Up Power to HPI Pump	Impingement	Remove Power Cable from Tray and Install in Pipe Thru MU Pump Room
-Up Pump Discharge A' or 'B' Power to and 'B' to HPI	Impingement	Encase 2-4" Lines 23822 & 23620 for 25' from MU Pump Room Wall
-Up Pump Discharge wer to Make-Up Pump r to HPI Pump	Impingement	See Item 15 for Fix
-Up Pump Discharge wer to Both Boric	Impingement	See Item 15 for Fix
-Up Pump Discharge charge of Both Boric	Impingement	Install Hangers on Boric Acid Line for Impingement
rge Affecting Power ic Acid Pumps	Impingement	Reroute Power for Pump 'B' from affected area.
scharge Affecting 'B' Pump and Room Fan	Impingement	Encase Cable Tray M34B1 in 3/8" Thick Formed Channel for Approx. 15 ft. - Encase Cable Tray M39AD8 with Steel Plate
ne Break in Aux. Bldg. lec. Equipment	Temperature	o Solution Required - Motors Good for 212 F Continuous not Running.
eaking and Flooding Heat Pumps	Flooding - Investigated Large Sources of Water and Operator Would Have Adequate Warning	No Solution Required

UBJECT TO FURTHER REFINEMENT BY DESIGN OR ANALYSIS

ITEM	PRO
23.	Main Steam and Main F.W. and
	A. Breaking N Removal Co Surge Tank
	B. Breaking N Diesel Gen
	C. Breaking H from BWST Connection
	D. Breaking S Pump Sucti
	E. Breaking E 'A' & 'B'
	F. Breaking D from Under
	G. Breaking D Return to
	H. Affecting to NSCW Pu
	I. Affecting Tr and Indicat Room for Di
	J. Affecting Power to Steam Inle
	K. Damaging Water Tank
	L. Affecting Cable to Grounding
	M. Affecting Neutral G

TABLE 1

POSTULATED PIPE FAILURE OUTSIDE OF CONTAINMENT STRUCTURE

BLEM	TYPE OF ANALYSIS	SOLUTION
Branches and Branches in Area 7.	Pipe Whip	Install Guard Pipe Restraint over Portions of Both Lines & Restraints at Terminal Ends
SCW to and from DH olers and Branch to	Impingement	Add Hangers as Required
SRW to and from erators	Impingement	Add Hangers as Required for both systems
PI & DH Pump Suction Warming Pump Disc	Impingement	Add Supports as Required
pent Fuel Cooling on from BWST	Impingement	Line is not close enough to be Affected by Impingement
mer. F.W. Pump Disc.	Impingement	Reroute Loop A - Provide Supports for Loop B
iesel F.O. Supply ground Tank	Impingement	No Impingement Effects
iesel F.O. Overflow Underground Tank	Impingement	No Impingement Effects
Tray and Power Cable mp 'A'	Impingement & Temperature	Reroute Cable (See Item 4)
ay Containing Control on Cable to the Control esel Gen. A	Impingement & Temperature	Reroute Cable in encased Conduit
Conduit Con. ning mer. F.W. Pump Turbine t Mov.	Impingement & Temperature	Reroute through duct bank to manhole near pump
Condensate and Borated	Impingement	No Problem with Critical Crack Impingement Effects
Conduit Containing Diesel Gen. Neutral Resistors 'A' & 'B'	Impingement & Temperature	Reroute See Item M
Diesel Generator rounding Resistors A&B	Impingement & Temperature	Move Resistors

ALL PLANS SUBJECT TO FURTHER REFINEMENT BY DESIGN OR ANALYSIS

ITEM	PROBL
24.	Flooding of Dies Room, Aux. Build Gear Rooms from Between Fuel Sto Building
25.	Steam Effects on and Ele rical E Generator Rooms Line or F.W. Lin Between Fuel Sto Building
26.	Main Steam Line Line Pressurizin Above Diesel Gen
27.	Aux. Steam Line Aux. Building
28.	Rupture of Large 450,000 Gas Capa
29.	Main Steam Line and Condensate L Breaking in Turb
30.	Fail e of One M nd Failure of T to Close.

PRELIMINARY - ALL PLANS SUBJEC

TABLE 1

POSTULATED PIPE FAILURE OUTSIDE OF CONTAINMENT STRUCTURE

M	TYPE OF ANALYSIS	SOLUTION
l Generator ng, Switch- ine Break age & Reactor	Flooding - Worst Case F.W. Line Break	Provide Adequate Drain to Tendon Gallery Raise Doors and Install 1' High Curbs
Engine Intake uip in Diesel rom Steam Break age and Reactor	Temperature & Moisture	Close East Wall of Rooms and Provide Cooling and Combustion Air from Roof at Elevation 60 ft.
ranch or F.W. Compartment rator Room	Pressure - Critical Crack Size Calculation for Either Line	No Remedial Work Required - Compartment is vented and will not fail.
ailure in	Pressure and Temperature - Failure was Assumed to be a Crack Equal to the Pipe Cross Sectional Area	No Solution Required - Steam will vent out thru Normal Vent Ducts and Temperatures will not Affect Elec. Equipment
Storage Tanks ity	Flooding or Undermining Redundant Equipment Required for Shutdown	No Solution Required - Water Level Will not be High Enough to Effect Shutdown Equipment. All tanks are Seismic Category I
r Main F.W. ne & Branches ne Building	Flooding	No Solution Required - Water will all be Contained in Condenser Pit.
	Temperature	No Solution Required - Steam will be Exhausted to Atmosphere and Cannot Reach Equipment Required for Cold Shutdown
	Pressure	No Solution Required - Calculation Was Not Made but Vent Areas are Large and Exterior Panels will relieve pressure. Panels are not heavy Enough to Cause Damage to Equipment Required for Shutdown
in Steam Line rbine Stop Valve	Inability to Supply Emergency Feedwater if the Motor Driven F.W. Pump is Inoperative	Add Second Motor Driven F.W. Pump Capability with Power Supplied from Diesel Generator 'B'

T TO FURTHER REFINEMENT BY DESIGN OR ANALYSIS

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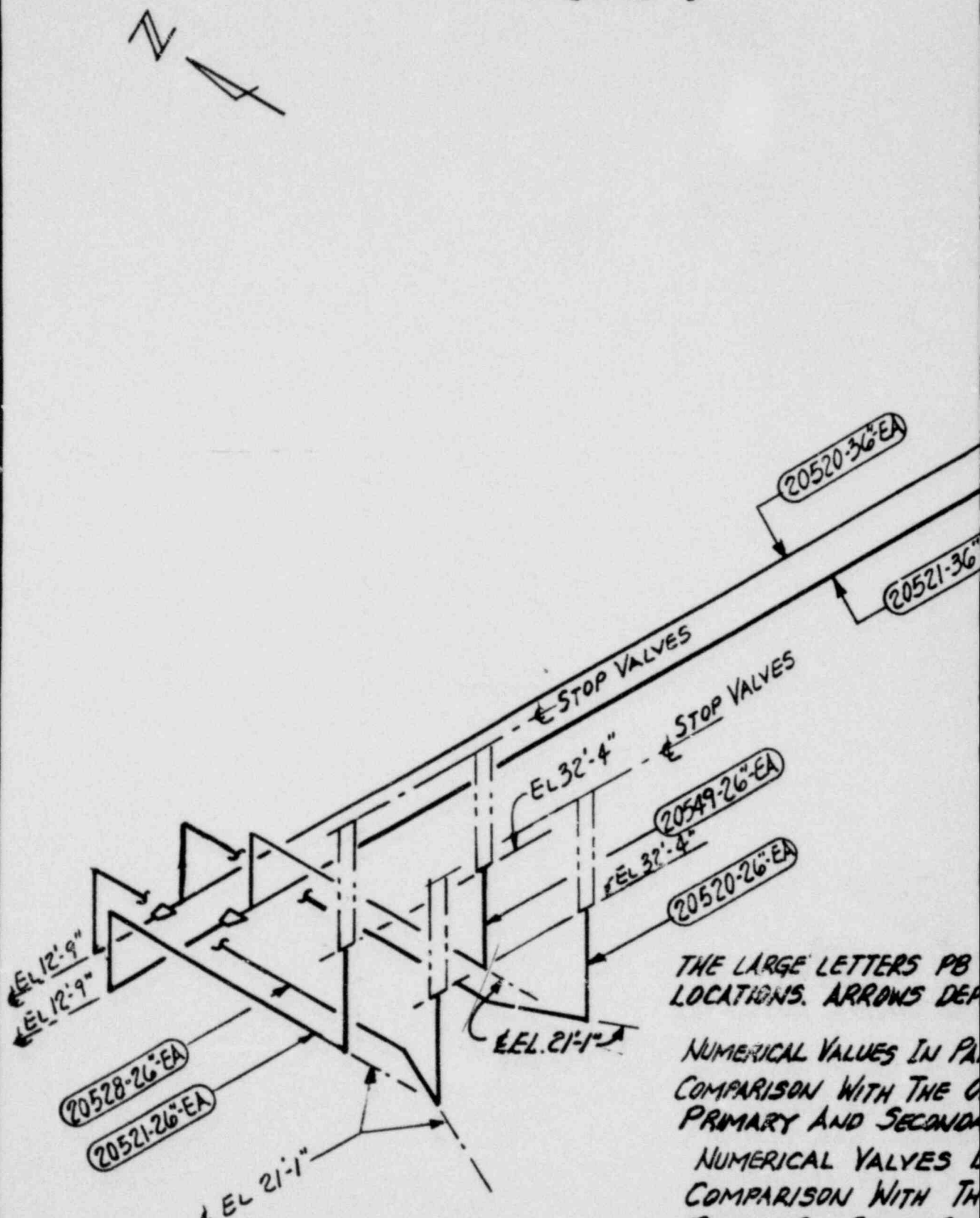
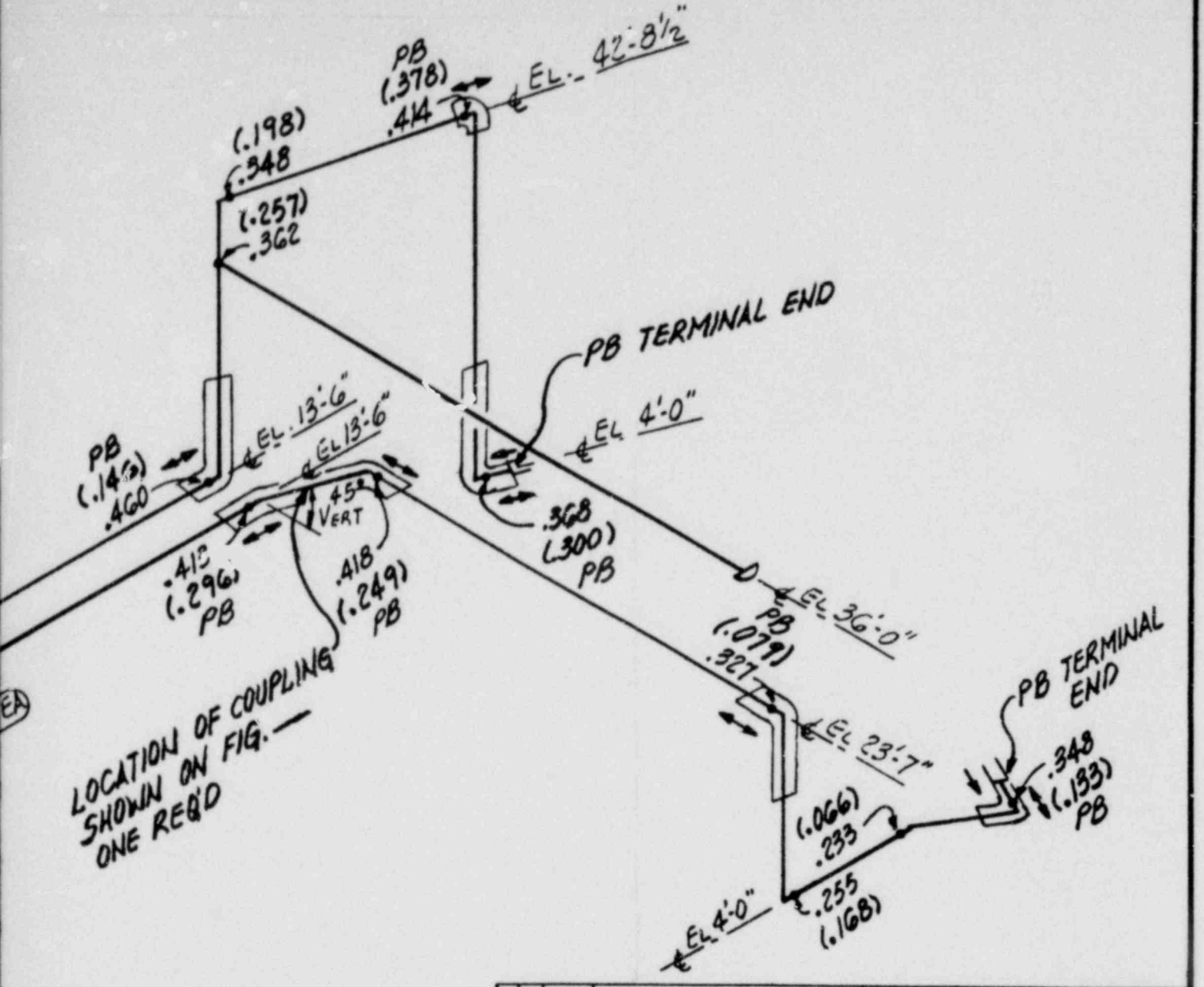
FIGURE 1



THE LARGE LETTERS PB
LOCATIONS. ARROWS DE

NUMERICAL VALUES IN PA
COMPARISON WITH THE
PRIMARY AND SECONDA

NUMERICAL VALYES
COMPARISON WITH TH
BASED ON SUM OF
STRESSES



REPRESENT POSTULATED BRAKE
YCIT POSTULATION LINE BREAK VECTORS

RENTHESIS DEPICT COEFFICIENTS FOR
8 IN 0.8 SA BASED ON SUM OF
RY STRESSES.
DEPICT COEFFICIENTS FOR
0.8 IN 0.8 (Sh + SA)
PRIMARY AND SECONDARY

No.	Date	Revisions	By	Ch'k	Sect. Proj. Eng'r.	Sect. Chief Eng'r.	Proj. Eng'r.	Client
△								
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LOS ANGELES NEW YORK

SACRAMENTO MUNICIPAL UTILITY DISTRICT
RANCHO SECO NUCLEAR STATION - UNIT 1

MAIN STEAM ISOMETRIC

Designed	Date	Sect. Proj. Eng'r.	Sect. Chief Eng'r.	Proj. Eng'r.	Client
Drawn RM	Job No.	Drawing No.			Rev.
Checked					
Scale 1/16"=1'-0"	6292				

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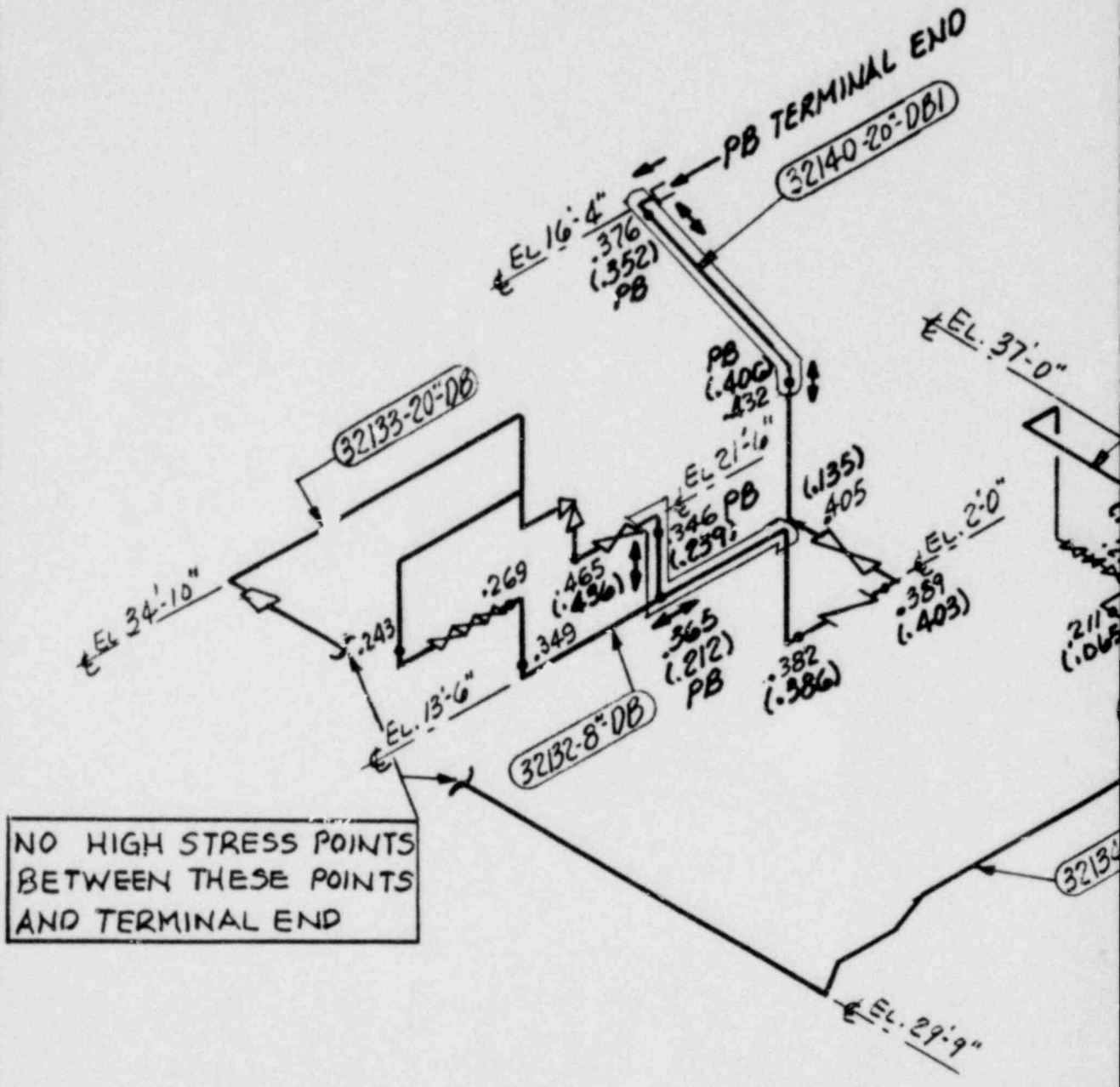
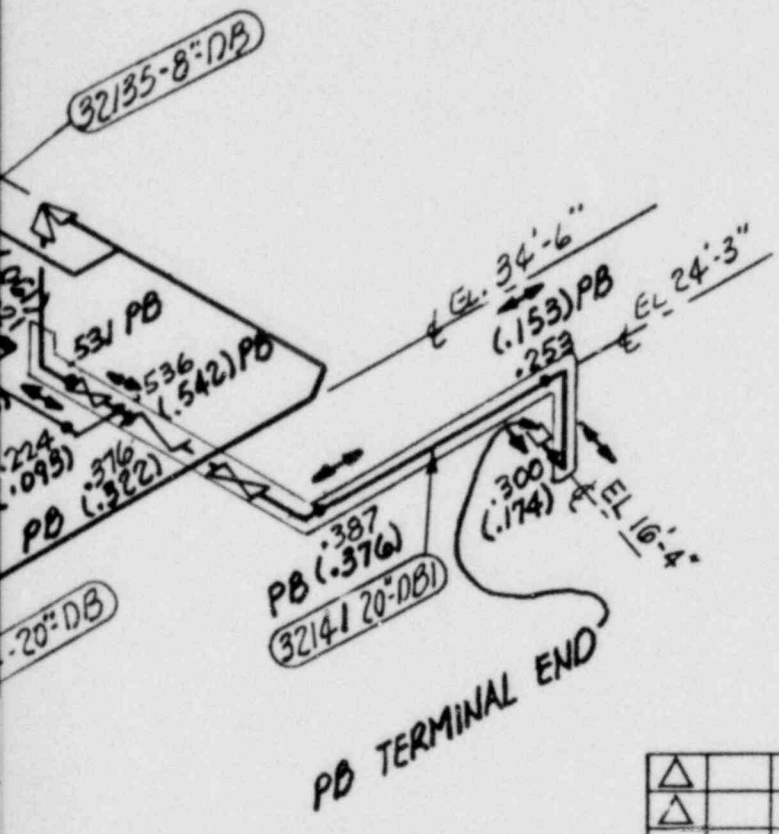
FIGURE 2



NUMERICAL VALUES DEPICT COEFFI
WITH THE 0.8 IN 0.8 (Sh + Sa) BA
PRIMARY AND SECONDARY STR

NUMERICAL VALUES IN PARENTHESIS
COMPARISON WITH THE 0.8 IN 0.8
PRIMARY AND SECONDARY STRESS

THE LARGE LETTERS PB REPRESENT
ARROWS DEPICT POSTULATION LINE E



CIENT FOR COMPARISON
SED ON SUM OF
ESSES.

DEPICT COEFFICIENTS FOR
SA BASED ON SUM OF
SES.

POSTULATED BREAK LOCATIONS
REAK VECTORS

No.	DATE	REVISIONS	BY	CH'K	SECT. PROJ. ENG'R.	SECT. CHIEF ENG'R.	PROJ. ENG'R.	CLIENT
△								
△								

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RANCHO SECO NUCLEAR STATION - UNIT 1

MAIN FEEDWATER ISOMETRIC

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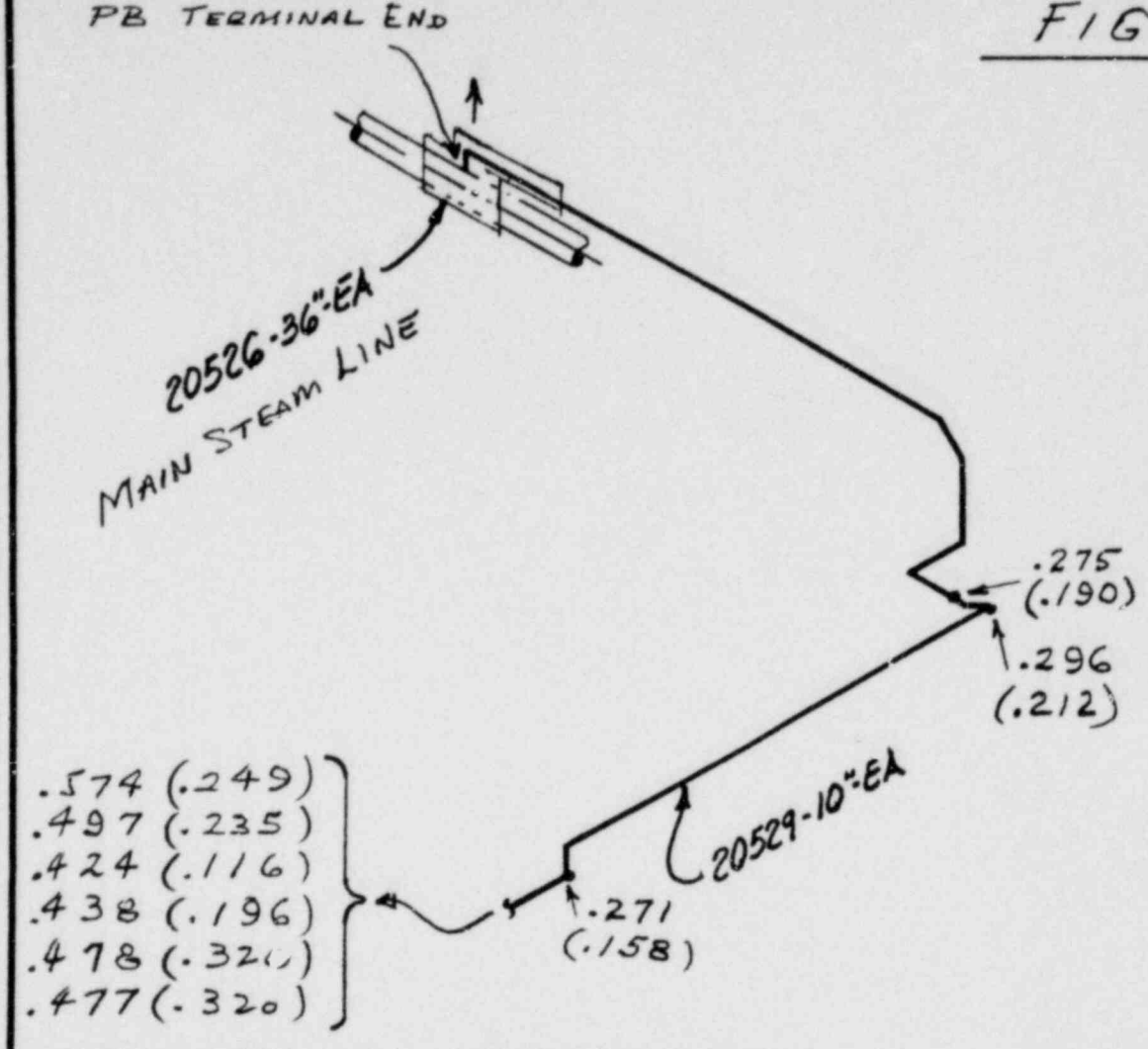
FIGURE



THESE VALUES ARE HIGHER IN THE TURBINE AREA BUT THERE ARE NO ITEMS REQUIRING PROTECTION FROM PIPE WHIP.

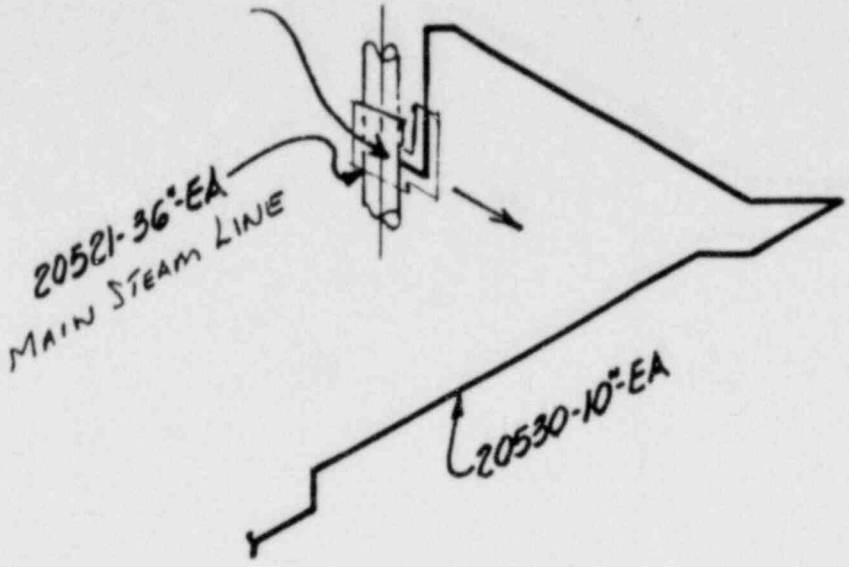
THE LARGE LETTERS PB REPRESENT POSTULATED
LOCATIONS. ARROWS DEPICT POSTULATED LINE BR

NUMERICAL VALUES DEPICT COEFFICIENTS FOR CO
WITH THE 0.8 IN 0.8 $(S_h + S_A)$ BASED ON SUM OF PR
SECONDARY STRESSES.

NUMERICAL VALUES IN PARENTHESIS DEPICT COEFF
COMPARISON WITH THE 0.8 IN 0.8 S_A BASED ON SU
PRIMARY AND SECONDARY STRESSES.

3

PB TERMINAL END



(STRESS VALUES LATER)

BREAK
EAK VECTORS.
MPARISON
MARY AND

CIENTS FOR
M OF

NO.	DATE	REVISIONS	BY	CH'K	SECT. PROJ. ENG'R.	SECT. CHIEF ENG'R.	PROJ. ENG'R.	CLIENT
△								
△								

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MAIN STEAM DUMP ISOMETRIC

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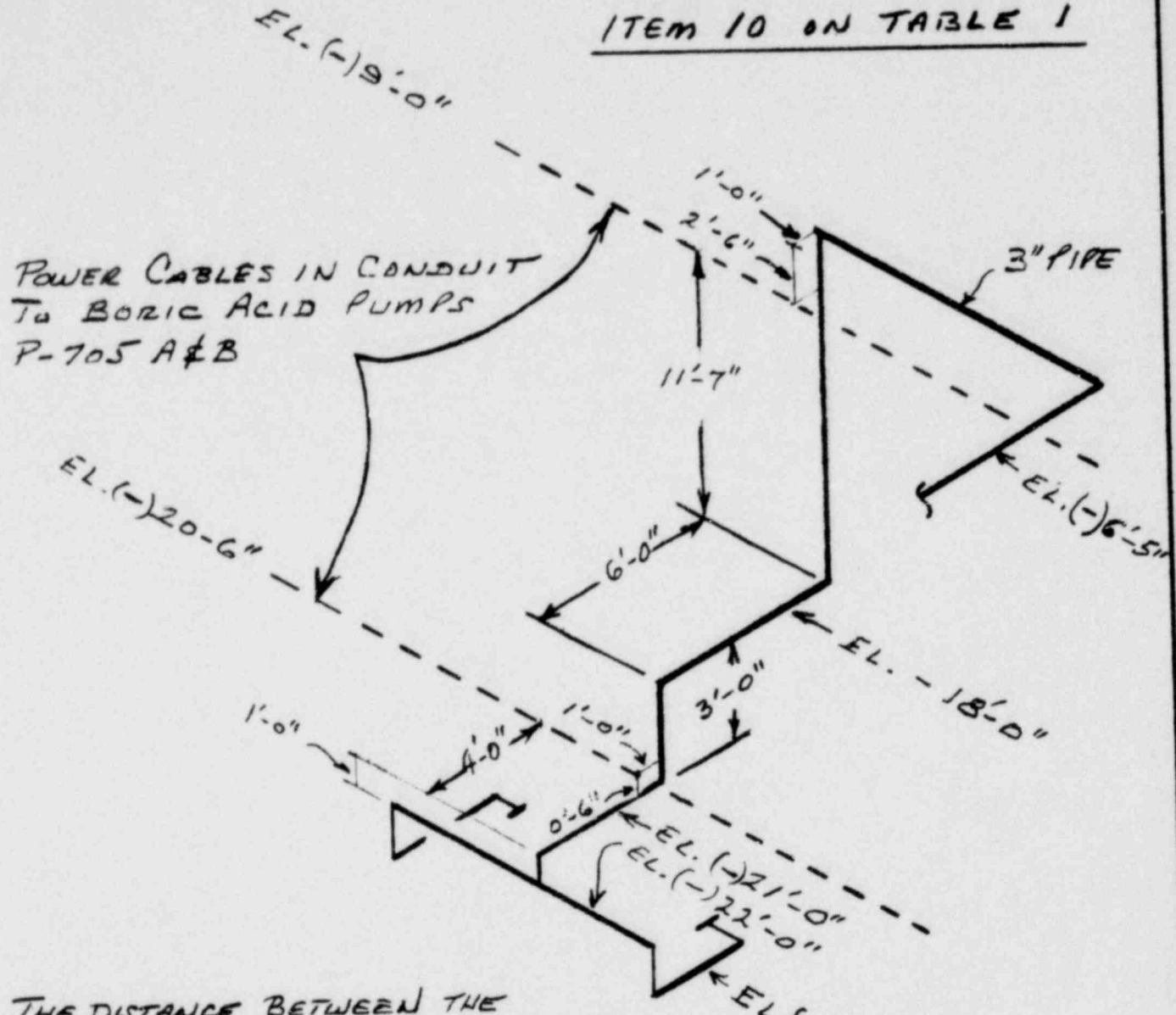
DRAWN RAM	JOB NO.	DRAWING No.			REV.
CHECKED	6292				
SCALE 1/8"-1'-0"					

FIGURE 4

ITEM 10 ON TABLE 1



THE DISTANCE BETWEEN THE TWO BORIC ACID PUMP ELECTRICAL SUPPLY CABLES PREVENT BOTH PUMPS FROM BEING TAKEN OUT BY A SINGLE POSTULATED RUPTURE OF THE AUXILIARY BOILER FEEDWATER LINE.

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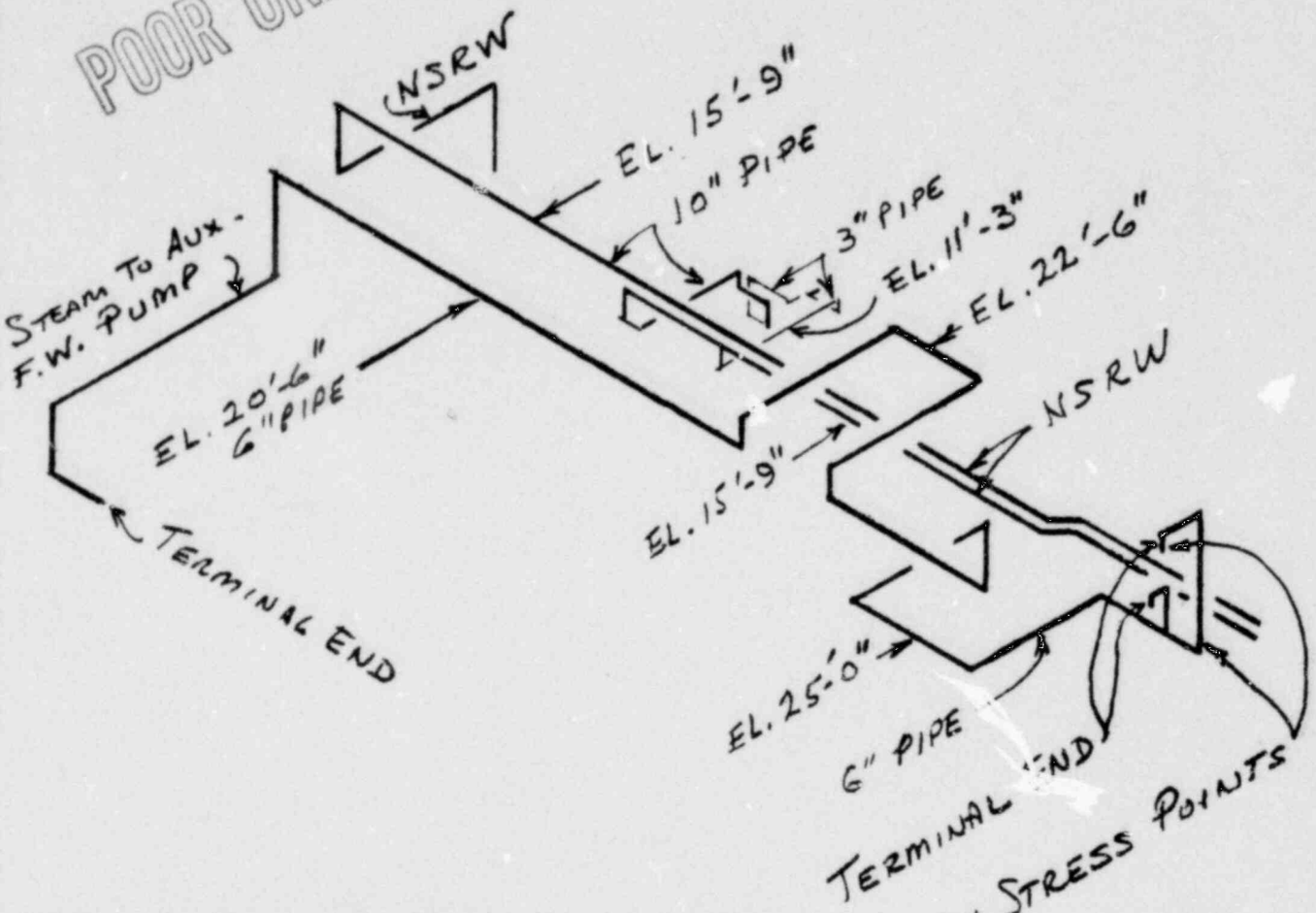
RANCHO SECO NUCLEAR STATION - UNIT 1

AUX. BLR. FW. AGAINST BOTH BORIC ACID PUMP SUPPLIES (ELECTRICAL)

FIGURE 5

ITEM 1 ON TABLE 1

POOR ORIGINAL



THE NUCLEAR SERVICE RAW WATER LINE IS SMALLER AT ONE POINT THAN THE AUXILIARY PUMP STEAM LINE BUT THE DISTANCE BETWEEN THEM PREVENTS A POSTULATED RUPTURE OF THE STEAM LINE FROM BREAKING THE WATER LINE. ALL OTHER POINTS OF A POSTULATED RUPTURE OF THE STEAM LINE WOULD BE AGAINST A LARGER SIZE AND WALL THICKNESS.

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STEAM TO AUX. PUMP AGAINST N.S.R.W. TO DIESEL GENERATOR

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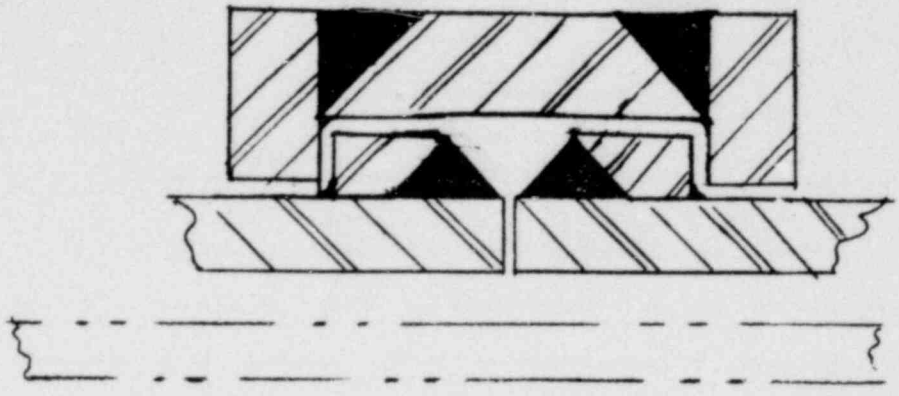
FIGURE

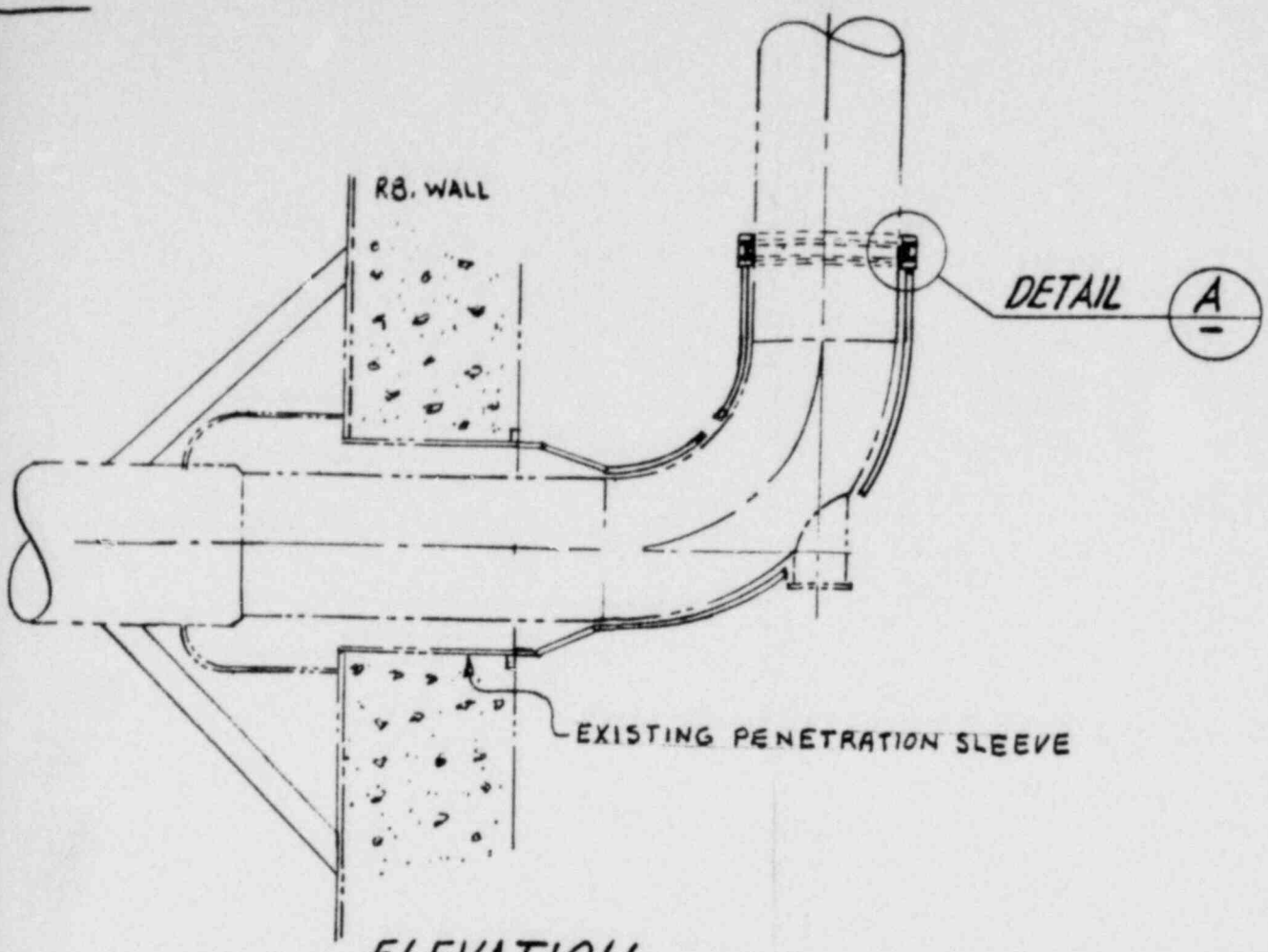


TYPICAL GUARD PIPE COUPLING

DETAIL (A) / NO SCALE

PRELIMI

6



ELEVATION
SCALE: ¼" = 1'-0"

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RANCHO SECO NUCLEAR STATION - UNIT 1

MAIN STEAM GUARD PIPE RESTRAINT

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