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SUBJECT: Forwards clarification &/or addl info on SSER 18 Open
Item 29 re jet impingement.Original design basis validated.
No further evalation necessary.

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SUBJECT: Forwards clarification &/or addl info on SSER 18 open Item 29 re jet impingement.Original design basis validated. No further evaluation necessary.

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	IE/DQASIP/QAB 21	1	1	NRR/DE/AEAB	1	0
	NRR/DE/CEB 11	1	1	NRR/DE/EHEB	1	1
	NRR/DE/EQB 13	2	2	NRR/DE/GB 28	2	2
	NRR/DE/MEB 18	1	1	NRR/DE/MTEB 17	1	1
	NRR/DE/SAB 24	1	1	NRR/DE/SGEB 25	1	1
	NRR/DHFS/HFEB40	1	1	NRR/DHFS/LQB 32	1	1
	NRR/DHFS/PSRB	1	1	NRR/DL/SSPB	1	0
	NRR/DSI/AEB 26	1	1	NRR/DSI/ASB	1	1
	NRR/DSI/CPB 10	1	1	NRR/DSI/CSB 09	1	1
	NRR/DSI/ICSB 16	1	1	NRR/DSI/METB 12	1	1
	NRR/DSI/PSB 19	1	1	NRR/DSI/RAB 22	1	1
	NRR/DSI/RSB 23	1	1	REG FILE 04	1	1
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J. O. SCHUYLER
VICE PRESIDENT
NUCLEAR POWER GENERATION

October 12, 1983

Mr. Darrell G. Eisenhut, Director
Division of Licensing
Office of Nuclear Regulatory Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Re: Docket No. 50-275, OL-DRP-76
Diablo Canyon Unit 1
Safety Evaluation Report, Supplement No. 18

Dear Mr. Eisenhut:

The Diablo Canyon Safety Evaluation Report, Supplement No. 18 (SSER 18) identified items which the Staff considered unresolved as of June 30, 1983. PGandE provided responses to these items on August 30, September 6, September 9, October 6, October 7, and October 11, 1983.

Pursuant to discussions resulting from the September 28, 1983 meeting between the Staff and PGandE, enclosed are clarifications and/or additional information on SSER 18 open item 29 (listed in Enclosure 5 of SECY-83-366), jet impingement.

Sincerely,

J O Schuyler

J. O. Schuyler

Enclosure

cc: R. L. Cloud, RLCA
W. E. Cooper, TES
J. B. Martin, NRC
H. E. Schierling, NRC
F. Sestak, Jr., S&W
Appeal Board
Service List

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ENCLOSURE

Jet Impingement Loads (SECY-83-366, Enclosure 5, Item 29)

ITEM 29: "Consideration of jet impingement loads in design and qualification of all safety-related piping and equipment should be clearly demonstrated. (C.4-29)"

DCP RESPONSE:

The following discusses the Project's position on jet impingement analysis.

Jet Impingement Analysis Description

Upon receipt from the IDVP of EOI 7002 regarding PGandE's commitment to perform a jet impingement analysis, the Project initiated a jet impingement reanalysis program to demonstrate that Diablo Canyon did, in fact, meet its FSAR commitment on jet impingement. An initial review of the applicable sections of the FSAR did not indicate that there existed a commitment as extensive as that interpreted by the IDVP. However, the decision was made to conduct a reanalysis utilizing current criteria pending the completion of a more thorough review and assessment of the actual licensing commitment on jet impingement.

On this basis, the program was initiated by determining the systems and the locations within those systems where design basis (circumferential and/or longitudinal) breaks might occur. To ensure that the evaluated systems list on page 3.6-11 of the FSAR were applicable and complete, the criteria of FSAR Section 3.6.4 (page 3.7-16, item 1) and Branch Technical Position (BTP) MEB 3-1 (SRP Section 3.6.2) and the guidance of the March, 1978, version of Westinghouse Systems Standard Design Criteria SS1.19 (SS1.19) were applied. As a result, all of the systems listed in the FSAR were considered in the

current reanalysis with the exception of the excess letdown line (diameter $\leq$ 1 in.), reactor coolant pump seal vent and leakoff lines (diameter $\leq$ 1 in., pressure < 275 psig), and reactor coolant pump seal water injection (temperature < 200°F). No additional systems were found to require assessment.

Breaks were postulated in those portions of these systems that would normally meet the criteria for more than 1% of plant operating time. The postulated break points and types were determined by the Diablo Canyon Project (DCP) for secondary system and RCS branch lines utilizing the criteria of BTP MEB 3-1, except that breaks were postulated at all points where the calculated combined stresses exceed $0.8\ (S_A + S_H)$, rather than $0.8\ (1.2S_A + S_H)$, to be more consistent with the criterion applied outside containment. Postulated break points and pipe separation distances for the main reactor coolant loop piping were determined by the NSSS supplier. As a result of this process, 340 different break points were postulated. Profiles for the jets resulting from these breaks were then calculated using the methodology of Bechtel Topical Report Number 2 (BN-TOP-2) and ANSI/ANS 58.2, 1980 based on break separation, line size, break type, and fluid pressure and temperature. This review resulted in a modification of the assumed reactor coolant loop break jet profile from an axial to a radial jet.

Utilizing piping and mechanical area drawings and piping isometrics marked to indicated break locations and jet directions, as well as other graphs and tables giving jet profiles and pressure gradients, a walkdown of these systems was subsequently conducted. Specific directions and criteria were provided for the performance of this effort. They included pressure threshold tables or graphs for conduit and piping based on size and support span and a list of items not considered as targets due to a lack of safety significance. The latter included such items as sample lines, drains and vents downstream of their isolation valves, noncolor-coded conduit, cable trays (which, at Diablo Canyon, carry no safety-related cables inside

containment), component cooling water lines to the RCPs, and relief valve discharge lines. All other items within the jet zone of influence, including all color-coded conduit, all instrument tubing, civil structures, piping systems, including valves and supports associated with those systems, and instrumentation were listed as targets on the walkdown review sheets. Also included was any additional information necessary to indicate the target's position relative to the break.

In addition to jet impingement, both pipe whip and traveling jet effects were assessed for those small lines which were not restrained as a result of the original review of pipe break dynamic effects. As discussed below, the original review was limited only to the consideration of such whip effects as committed to in the FSAR. Again, specific direction and criteria were provided for the performance of this review including the postulation of pipe whip motion.

As a result of this walkdown process, 1789 different jet-target or whip-target interactions* were identified. Since the majority of the break points considered as jet sources in this effort occur inside the crane wall, the vast majority of identified targets were found in the interior of the containment. These included: 1) piping and piping supports of the reactor coolant, safety injection, chemical and volume control, and steam generator (S/G) blowdown systems; 2) detectors and instrument tubing associated with temperature, pressure, flow, and level measurement for the RCS and steam generators; 3) conduit carrying electrical leads associated with this instrumentation, as well as with valves located inside the crane wall; 4) air lines; and 5) civil structures within the jet zone of influence, including

*These interactions define a unique source-system or source-structure relationship. Any given system or structure could experience a number of these interactions, each of which is referred to and counted as a "target".

walls, floors, equipment supports, and platforms. Outside the crane wall, the jet sources, with the exception of a single CVCS break, were associated with breaks in the main steam, main feedwater, or S/G blowdown systems. The resultant targets included: 1) the crane and containment walls; 2) annulus platforms and structural steel; 3) containment fan coolers; 4) piping of the main steam, feedwater, S/G blowdown, safety injection, containment spray, and CCW systems; 5) electrical leads and air lines for containment isolation valves on these and other systems; and 6) other safety-related (i.e., color-coded) conduit.

The targets thus identified were then subjected to a safety evaluation process to determine whether they were essential for the postulated initiating event and, if so, whether they could be expected to survive the resultant effects. The first step of this evaluation process was performed essentially as a systems analysis based on the break propagation criteria of SS1.19 (3/78), the accident analyses of FSAR Chapter 15, standard industry guidelines, the guidance of BTP ASB 3-1 (SRP Section 3.6.1), and a knowledge of plant and system operation.

All effects of each given break were considered in concert and the worst single active failure for each case was assumed in conjunction with a loss of offsite power. The application of the break propagation criteria was based on the additional Westinghouse clarification that, at the time of the Diablo Canyon design development, the RCP suction and discharge piping were considered to be part of the same RCS leg. Those systems or portions of systems deemed necessary to function in mitigation of the effects of the postulated event or to remain intact to acceptably limit the propagation of the break were, therefore, considered essential.

The ability of these essential systems to withstand the postulated effects to which they are being subjected was then assessed. All instrument tubing was assumed to fail, doing so in such a manner that the pressure

boundary would be breached. Impacted detectors were assumed to cause the most adverse indication or signal output. In those cases where threshold tables for conduit were not applied in the field, they were utilized in the safety evaluation process. Those that exceeded the applicable threshold value were assumed to sustain complete severance. Pressure threshold values for piping were similarly applied and the lines which remained were placed into one of two categories, either essential pressure boundary or essential flow. For the former, it was assumed that, if the diameter and wall thickness of the impacted line was equal to or greater than that providing the jet source, any damage incurred would not be sufficient to breach the pressure boundary. All other cases in either category would require specific analysis or additional review to determine their ability to withstand the effects of jet impingement. A similar criterion was applied in the case of pipe whip, except that no differentiation was made between essential pressure boundary and essential flow piping.

The assessment of civil/structural targets was an exception to this process, since they could not be treated on a systems basis and no threshold values were available. Thus, every such target was identified as requiring an analysis of the applicable jet impingement effects.

Upon the completion of this safety evaluation process, 593 targets were identified as requiring additional information or performance of specific analyses to permit closure of the uncompleted evaluation items. Of these open items, 486 were civil/structural. Of the remaining 107 items, 19 were electrical or instrumentation and control items, all of which have been resolved; 5 were concerned with jet impingement effects on containment fan coolers following a feedwater line break (for which no specific containment pressure/temperature analysis has been performed); and 83 involved jet impingement on piping systems, their valves, and/or their supports, of which 48 remain unresolved. Further discussion of these remaining unresolved items is provided below.

Both the procedures followed and criteria applied throughout this reanalysis effort are contained in Jet Impingement Analysis Criteria for Inside Containment, DCM M-65, Rev. 1, and the Engineering Procedure for the Analysis of Jet Impingement Effects Inside Containment, MEP-1, Rev. 0. These documents, as well as an independently-selected 50% sample of the walkdown review sheets and associated safety evaluations, were provided to the IDVP for their review and use during their verification effort. This effort included check walkdowns and a review of the conclusions reached in the safety evaluations; it resulted in certain IDVP open items and requests for additional information, all of which were satisfactorily resolved. The details and conclusions of the entire IDVP jet impingement verification effort are contained in ITR 48; the Project comments on this document may be found in DCVP-TES-1316.

In parallel with the DCP reanalysis effort, a review was conducted not only of the DCP commitment on jet impingement as set forth in the FSAR, but also of the commitments made by other plants of a similar vintage. The results of this review have been provided in our response of September 9, 1983, to unresolved items identified in SSER 18. In summary, while a specific commitment as well as detailed criteria do exist for the consideration of pipe whip, it was determined that, with the exception of certain containment internal structures specified in FSAR Section 3.8, no such commitment exists to specifically consider jet impingement effects in the analysis of any safety-related system, component, or support inside containment. Consistent with this commitment, a walkdown and safety evaluation effort was conducted for pipe whip as part of the initial Diablo Canyon plant design development process, resulting in the installation of a large number of pipe whip restraints. Other than the specified civil/structural analyses, however, no such effort was made for jet impingement. Rather, jet impingement effects were considered to be limited by inherent system separation and existing structural barriers. This was all determined to be consistent with the approach taken on other plants designed

in the late 1960's and early 1970's and with the recommendations of the 1970 draft version of SS1.19.

On the basis of this commitment, the majority of those analyses identified as required to permit closure of unresolved safety evaluation findings need not be performed. Nonetheless, to validate the original plant design basis and to provide additional confidence in Diablo Canyon's ability to accomodate such an event, DCP elected to perform analyses or initial assessments for most cases, summarized as follows:

<u>Civil/Structural (486 cases)</u>

- As required by the licensing commitment, detailed verification analyses of the specified containment internal structures identified as potential jet impingement or pipe whip targets were completed and found acceptable (159 cases).

- The radial jets now assumed from breaks in the main reactor coolant loop piping impinge upon an additional 162 civil targets. However, based on the proposed revision to the NRC position on RCS pipe breaks as presented by the Staff to the ACRS, further consideration of these breaks can be eliminated (162 cases).

- All other open civil/structural items involving pipe whip were resolved through on-site assessment of potential interactions; the appropriate application of FSAR criteria covering small bore pipe whip against RCS component supports; or an interdisciplinary review of S/G blowdown pipe whip in the annulus (43 cases).

- Fifty-four cases involving jet impingement interactions not required to be considered based on the FSAR commitment have had enveloping "worst case" analyses performed and were found acceptable (54 cases).

- The remaining 68 cases, which also involve jet impingement only, have not had a rigorous analysis or a detailed review. An initial cursory assessment, however, indicated that such an effort, if performed, would show that the postulated jet impingement effects to be acceptable (68 cases).

Piping (48 cases)

- There are eight cases where jets from postulated main loop piping breaks impinge on piping and, thus, can be eliminated from further consideration on the same basis as discussed above.

- In 3 cases, study case analyses have indicated that the target lines might be overstressed. These three cases all involve small lines in the RTD loops. Experience has shown that a more realistic and detailed analytical method which takes into account the inherent strength and ductility of stainless steel and other available supports and structures not normally included in a pipe stress analysis would show that these lines could survive the postulated events without structural failure.

- Similar study calculations performed on 13 of the remaining 37 open items have shown the resultant stress levels to be acceptable. It is expected that similar results would be obtained if calculations were performed on the balance.

Other (5 cases)

- To resolve the remaining five open items, a specific analysis would be required of containment pressure/temperature response following a main feedwater line break in which the availability of only two fan coolers and one containment spray system is assumed. Such an analysis is beyond the FSAR commitment and, thus, not required; nonetheless, it is expected that such an analysis would show the results to be acceptable.

As shown above, a total of only 113 civil, piping, and mechanical items have not been closed by engineering evaluation. They represent less than 6% of the total number of recorded interactions. Further, they all involve jet impingment effects not required for consideration in the plant design basis by the FSAR licensing commitment. If it is conservatively assumed that ten of these cannot be acceptably resolved by additional analysis, a further perspective on jet impingement can be obtained by considering it on a mechanistic basis. It is generally acknowledged that failure of high pressure piping inside containment is a very low probability event. Beyond this fact, each potential jet impingement problem is generally confined to a particular pipe break location out of the total population of potential break locations. Further, the nature of the piping failure is confined to consideration of those with significant damage potential, i.e., instantaneous guillotine breaks. The total probability of a guillotine pipe break occurring at a particular break location is approximately 10^{-8} per plant per year, or two orders of magnitude below the probability generally used as the cut-off point for design purposes. In performing these analyses, yet another low probability event (generally less than 10^{-2} per year) must be assumed in the form of a random single failure in required response systems. With this perspective, jet impingement on a single case basis is virtually irrelevant to public risk. Only if the aggregate of all such potentially unacceptable interfaces found were to be in the order of 1000 cases would jet impingement approach a level of significance such that specific design provisions to mitigate their effects would be justifiable. On this basis, further analysis is not warranted.

In summary, these walkdowns, detailed evaluations, and mechanistic considerations of jet impingement provide a validation of the original design basis. The small number of items which remain unresolved simply because specific detailed analyses have not been performed supports our position that the Diablo Canyon design also generally meets current criteria on jet impingement. Therefore, no further evaluation effort is considered necessary.