NRC ACCEPTANCE CRITERIA

FOR THE

MARK I CONTAINMENT

LONG TERM PROGRAM

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1. INTRODUCTION

The purpose of the Mark I Containment Long Term Program is to perform a complete reassessment of the suppression chamber (torus) design to include suppression pool hydrodynamic loads which were neglected in the original design, and to restore the original intended design safety margins of the structure. This reassessment will be accomplished by a Plant-Unique Analysis (PUA) for each BWR plant with a Mark I containment, using load specifications and structural acceptance criteria that are appropriate for the life of the plant.

The following acceptance criteria have been developed from the staff's review of the Long Term Program Load Definition Report (LDR), the Plant Unique Analysis Applications Guide (PUAAG), and the supporting analytical and experimental programs conducted by the Mark I Owners Group. These criteria specifically address the dynamic loading conditions. Unless otherwise specified, all other loading conditions and structural analysis techniques (e.g., dead loads and seismic loads) will be in accordance with the plant's approved Final Safety Analysis Report (FSAR). Similarly, references to original design criteria or original loading conditions shall be defined as those criteria or loading conditions which were found acceptable by the staff during the operating license review of the FSAR.

For ease of reference, LDR refers to "Mark I Containment Program Load Definition Report," NEDO-21888, PUAAG refers to "Mark I Containment Program Structural Acceptance Criteria Plant Unique Analysis Applications Guide," NEDO-24583, and other supporting topical reports are referred to by their report numbers. A complete set of the references used in these criteria, listed in numerical order, is presented in Section 4.

2. SUPPRESSION POOL HYDRODYNAMIC LOADS

2.1 CONTAINMENT PRESSURE AND TEMPERATURE RESPONSE

The pressure and temperature transients for the drywell and wetwell shall be determined by the use of the analytical models and assumptions set forth in Section 4.1 of the LDR. These techniques have, in the past, been found to provide conservative estimates of the containment response to a LOCA, by comparison to the staff's CONTEMPT-LT computer code. Plant-specific results for each break size shall be presented in the PUA, along with the input conditions, in sufficient detail to allow the staff to perform confirmatory analyses to assure proper application of these models.

The timing and duration of specific loads are based primarily on the plant-specific containment response analysis for the pool swell-related loads, while the condensation periods are non-mechanistically maximized. However, the duration of the generic SBA condensation loads are assumed to be limited by manual operation of the Automatic Depressurization System (ADS) at 10 minutes into the accident. Therefore, as part of the PUA, each licensee shall identify procedures (including the primary system parameters monitored) by which the operator will identify the SBA, to assure manual operation of the ADS within the specified time period. Longer time periods may be assumed for the SBA in any specific PUA, provided (1) the chugging load duration is correspondingly increased, (2) the procedures to assure manual operation within the specified time period are identified, and (3) the potential for thermal stratification and asymmetry effects are addressed in the PUA.

2.2 VENT SYSTEM PRESSURIZATION AND THRUST LOADS

The vent system pressurization and thrust loads shall be defined in accordance with the procedures set forth in Section 4.2 of the LDR, with the following exception. In order to assure the proper transition between vent clearing and bubble breakthrough for those plants that propose operation with a differential pressure control, the vent clearing time shall be derived from a containment analysis assuming no drywell/wetwell differential pressure and this time shall be applied to the vent system transients calculated from a containment response with the proposed drywell/wetwell differential pressure. In addition, for clarification, in the equation for F2V in Section 4.2.1c of the LDR, P3 shall be replaced by P2.

2.3 NET TORUS VERTICAL PRESSURE LOADS

The downward and upward net vertical pressure loads on the torus shall be derived from the series of plant-specific QSTF (Quarter Scale Test Facility) tests, in accordance with Section 4.3.1 of the LDR. However, based on our review of the pool swell tests conducted by the Mark I Owners Group and confirmatory tests performed for the NRC by the Lawrence Livermore Laboratory, we will require that the following margins be applied to each loading phase:

$$UP = UP_{mean} + 0.215\,(UP_{mean})$$

$$DOWN = DOWN_{mean} + 2 \times 10^{-5}\,(DOWN_{mean})^2$$

where "mean" refers to the average of the QSTF plant-specific test results (lb_f). These margins shall be applied to the QSTF "mean" load function prior to scaling the load function to full-scale equivalent conditions. The margin for the downward loading function

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shall be derived in terms of a fraction of the load at the time of the peak downward load, and that fraction shall be applied to the entire downward loading phase.

The margins specified above may be reduced or omitted where minimum conservatisms (i.e., smallest parameter deviation from the nominal plant condition over the range of tested conditions) in the QSTF tested conditions for a specific plant can be demonstrated by the application of the QSTF sensitivity test series (NEDE-23545-P). The sensitivity tests may not be used to adjust the mean torus vertical pressure loads. If the plant configuration is changed to the extent that a single QSTF test series no longer represents a conservative configuration of the plant, then a new series of QSTF tests shall be performed. Application of the sensitivity tests and interpolation between plant-specific test series will be reviewed on a case-by-case basis.

For those plants that use drywell/wetwell differential pressure control as a load mitigation feature, an additional structural analysis shall be performed assuming a loss of the differential pressure control to demonstrate the capability of the containment to withstand this extreme condition, as specified in Sections 5.3, 5.4, and 5.6 of the PUAAG. For this analysis, a single plant-specific QSTF test run may be used to define the loading function; however, the downward and upward loading phases shall be increased by the margins specified above for the base analysis.

2.4 TORUS POOL SWELL SHELL PRESSURES

The spatial distribution of the torus shell pressures during pool swell shall be defined from the plant-specific QSTF test results and the azimuthal and longitudinal distribution factors defined in Section 4.3.2 of the LDR.

However, the QSTF results shall be adjusted to incorporate the margins specified for the net torus vertical pressure loading function as follows:

1. During the downward loading phase, the average pool pressure shall be increased by the equivalent differential pressure, as a function of time, corresponding to the margin for the downward load.

2. During the upward loading phase, the torus airspace pressure shall be increased by the equivalent differential pressure, as a function of time, corresponding to the margin for the upward load.

3. The pressure distributions shall be maintained such that the integral of the torus shell pressures will equal the net vertical pressure function with the margins included.

2.5 COMPRESSIBLE FLOW EFFECTS IN SCALED POOL SWELL TESTS

The QSTF plant-unique test series are based primarily on a "split-orifice" vent flow scaling relationship. Preliminary calculations performed by EPRI and GE indicate that compressibility effects, which could not be accurately scaled in the testing program, could result in a higher loading condition at full-scale conditions than that derived from "scaled-up" test data. The original intent of these analyses was to provide justification for the scaled flow distribution in the EPRI 1/12-scale, three-dimensional pool swell test program.

The loading functions predominantly affected by this finding are the torus downward and upward vertical pressure loads, the torus pool swell pressure distribution, the vent header pool swell impact timing, and the vent header deflector impact timing. Based on our review of the preliminary analyses performed by EPRI and GE, which were presented to the staff in a meeting on July 24, 1979, we concluded that there is sufficient margin in the loading functions to justify proceeding with implementation of the Mark I LTP, while this assessment continues. We will require, however, that the Mark I Owners Group complete the assessment of compressible flow effects and justify the adequacy of these load specifications prior to the issuance of the staff's Safety Evaluation Report, which is currently scheduled for December 1979. In the event that the adequacy of the load specifications cannot be demonstrated, these loading conditions will have to be reassessed.

The vent header and vent header deflector impact timing do not, however, appear to be sufficiently conservative. Based on our review of the material presented thusfar concerning the EPRI 1/12-scale three-dimensional pool swell tests and the compressible flow effects analyses, we conclude that the downcomer orificing used for the "split-orifice" tests do not provide a prototypical pool swell response. Therefore, the vent header and vent header deflector impact timing shall be derived from the "main vent orifice" tests (using the same longitudinal load distribution methodology in the LDR), until a flow distribution analysis, acceptable to the staff, can justify some less severe loading conditions.

2.6 VENT SYSTEM IMPACT AND DRAG LOADS

2.6.1 Vent Header Impact and Drag Loads

The load definition procedures set forth in Section 4.3.3 of the LDR are acceptable, subject to the following clarifications:

1. The experimental data of local vent header pressure in each of the Mark I plants shall be obtained from the QSTF plant-unique tests.

2. The specification, for each Mark I plant, of the pressure inside the vent header relative to that in the torus airspace at the time of water impact on the vent header shall be determined from the QSTF plant-unique tests.

3. The plant-unique header impact timing (i.e., longitudinal time delay) shall be based on the EPRI "main vent orifice" tests as described in Section 2.5.

2.6.2 Downcomer Impact and Drag Loads

The load definition procedures set forth in Section 4.3.3 of the LDR are acceptable, subject to the following clarifications. A pressure of 8 psid is to be applied uniformly over the bottom 50° of the angled portion of the downcomer, starting from the time at which the rising pool reaches the lower end of the angled section and ending at the time of maximum pool swell height. The pressure is to be applied perpendicular to the local downcomer surface. The structural analysis for the downcommer impact shall either be dynamic, accounting for the approximate virtual mass of water near the submerged parts of the downcomer, or a dynamic load factor of two shall be applied.

2.6.3 Main Vent Impact and Drag Loads

The impact and drag loads on the main vent shall be evaluated in the following manner:

1. Subdivide the submerged portion of the main vent pipe into six equally wide segments (see Figure 2.6-1). If this subdivision results in $\Delta L < 0.3D$ fewer segments may be used such that $\Delta L \sim 0.3D$.

2. Determine the velocity and acceleration histories at Points 1 through 7 in Figure 2.6-1 from the QSTF data and appropriate corrections for longitudinal variations along the torus (at Point 7, only the initial impact velocity is required).

3. Using the velocity components normal to the vent pipe, calculate the impact and "steady" drag pressure using the method in Section 2.7.1 (Cylindrical Structures). At Point 7, only impact force is to be considered.

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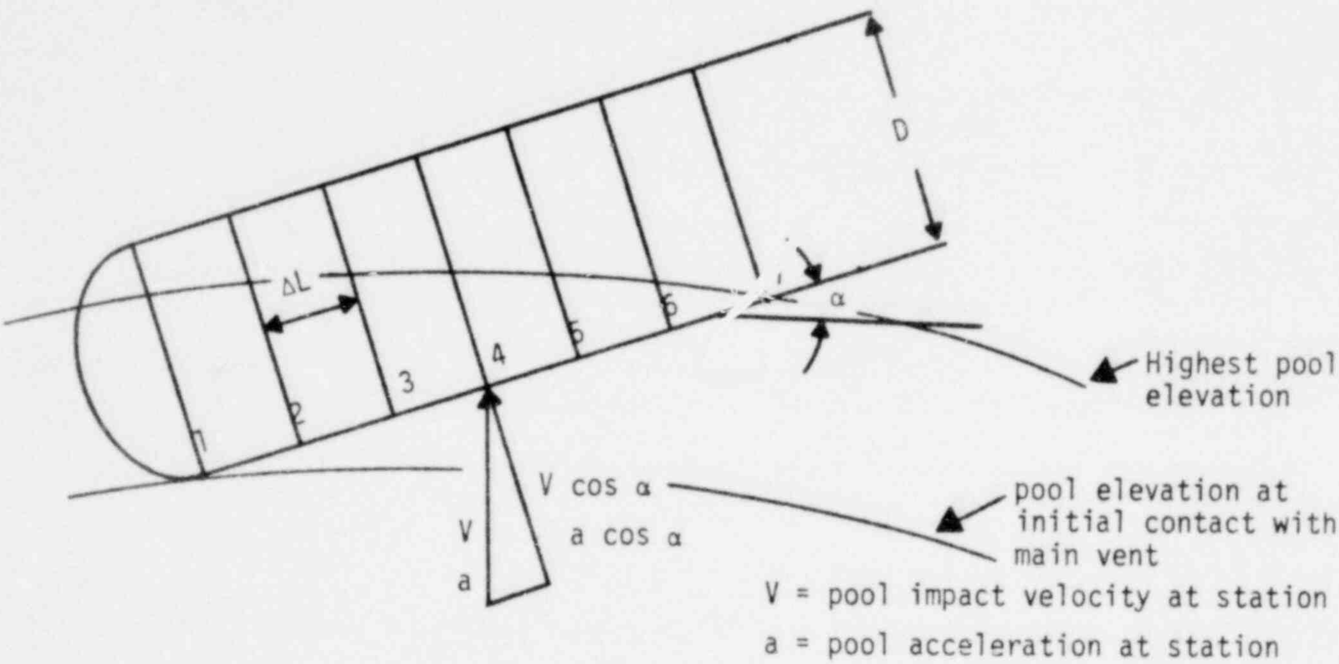

Figure 2.6-1 Schematic Diagram Illustrating the Methodology for Main Vent Impact and Drag

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Using the acceleration components normal to the vent pipe, calculate the acceleration drag pressure using the equation

$$P_a = \frac{\rho}{2g_c} \left(\frac{\pi D}{144}\right) \dot{V} + \frac{F_{static\ buoyancy}}{DL}$$

Where P_a is the acceleration pressure averaged over the projected area (psi), ρ is the density of water (lbm/ft^3), D is the diameter in feet, $\dot{V}$ the cross flow acceleration (ft/sec^2) and g_c is the acceleration due to gravity (ft/sec^2).

4. Sum the pressures due to impact, viscous drag and acceleration drag and multiply by D to obtain force per unit length at Stations 1 through 7.

5. To obtain a smooth loading history for the main vent as a whole, the linear interpolation method suggested for the vent header deflector in Section 3.5 of NEDO-24612 may be used.

2.7 POOL SWELL IMPACT AND DRAG ON OTHER INTERNAL STRUCTURES

The impact and drag loads for internal structures above the suppression pool (except the vent header, downcomers, and vent header deflectors), as specified in Section 4.3.4 of the LDR, shall be modified such that the structures are classified as either cylindrical (e.g. pipes), exposed flat surfaces (e.g., "I" beams), or grantings. The following load specifications for each of the three structural classifications shall be used to replace the methodology in the LDR. Any structures that cannot reasonably be classified as one of these geometries will be reviewed on a case-by-case basis. The longitudinal velocity distribution shall be based on the "main vent" EPRI pool swell tests, as discussed in Section 2.5.

2.7.1 Cylindrical Structures

For cylindrical structures, the pressure transient which occurs upon water impact and subsequent drag is depicted in Figure 2.7-1. The parameters in Figure 2.7-1 shall be defined as follows:

1. The maximum pressure of impact P_{max} will be determined by

$$P_{max} = 7.0 \times \frac{1}{2} \left(\frac{\rho}{144} \frac{V^2}{g_c}\right)$$

where P_{max} is the maximum pressure averaged over the projected area (psi), ρ is the density of water (lbm/ft^3), V is the impact velocity (ft/sec) and g_c is the acceleration due to gravity (ft/sec^2).

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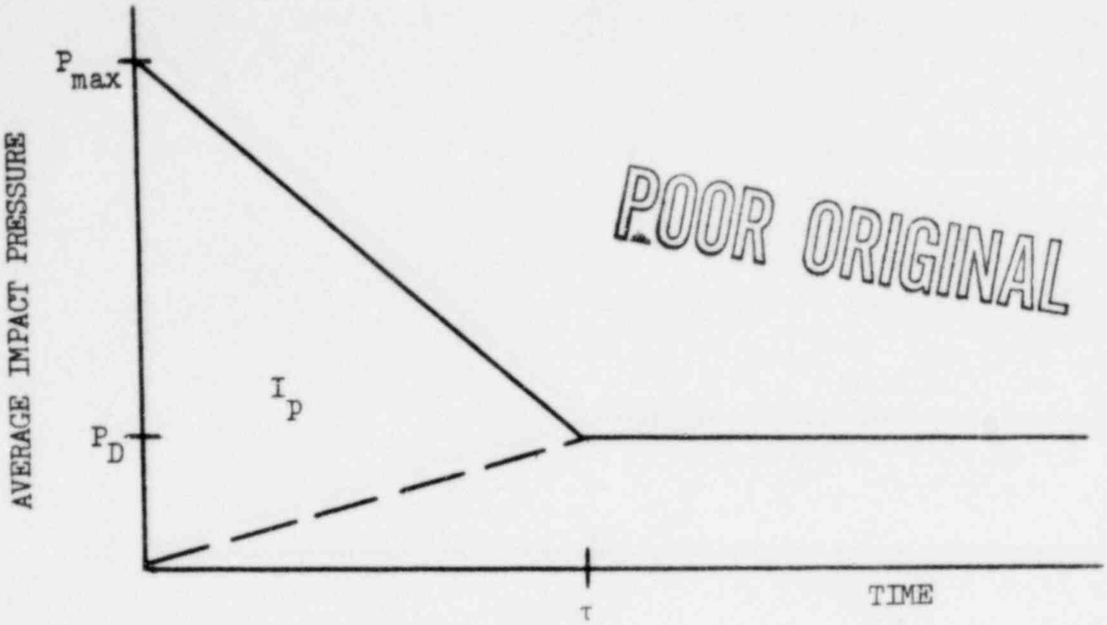

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Figure 2.7-1 Pulse Shape for Water Impact on Cylindrical Targets

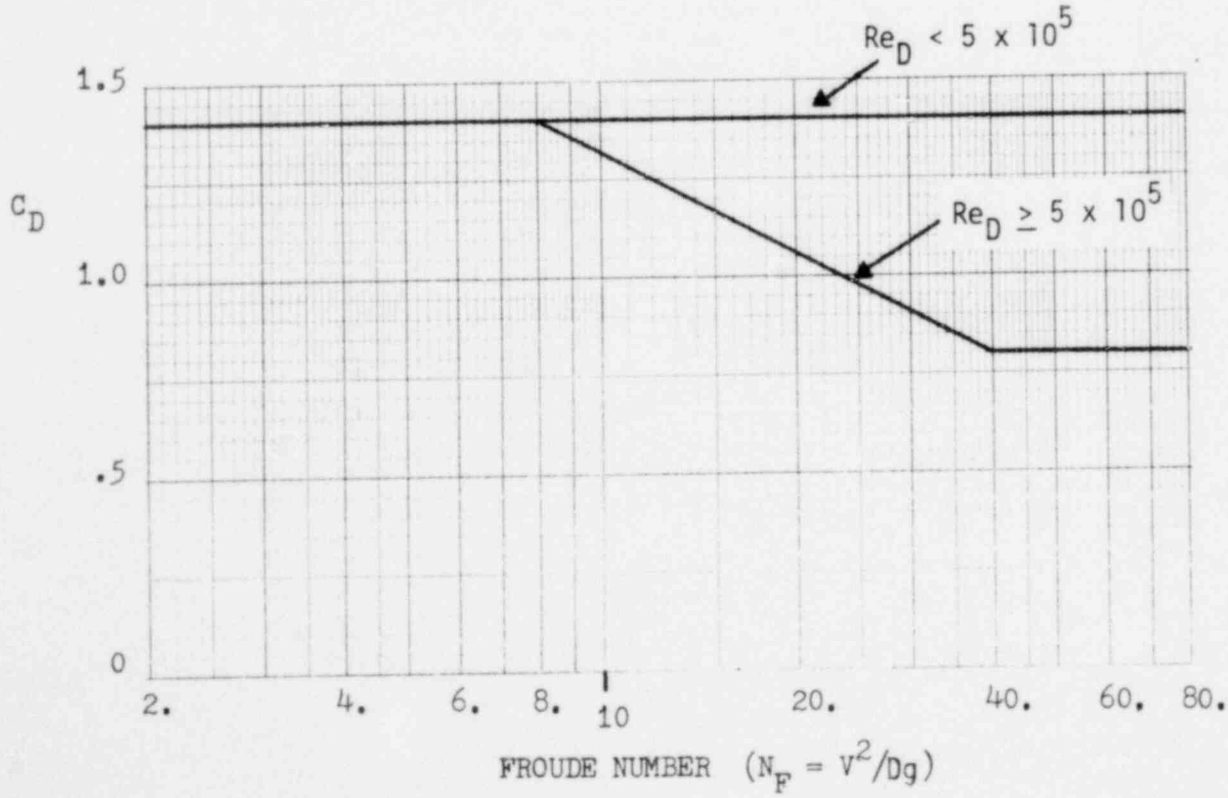

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Figure 2.7-2 Drag Coefficient for Cylinders Following Impact

2. The hydrodynamic mass per unit area for impact loading shall be obtained from the correlation (cylindrical target) depicted by Figure 6-8 in NEDE-13426-P. A margin of 35% will be added to this value to account for data scatter.

3. The impulse of impact per unit area shall be determined by:

$$I_p = \frac{M_H}{A}\left(\frac{V}{144\ g_c}\right)$$

where I_p is the impulse per unit area (psi-sec), M_H/A is the hydrodynamic mass per unit area (lbm/ft^2) and V is the impact velocity (ft/sec).

4. The pulse duration will be determined from the following equation:

$$\tau = 2I_p/P_{max}$$

5. The pressure due to drag following impact shall be determined by:

$$P_D = \frac{C_D}{2}\left(\frac{\rho V^2}{144\ g_c}\right)$$

where P_D is the average drag pressure acting on the projected area of the target (psi), C_D is the drag coefficient as defined by Figure 2.7-2, and ρ is the density of water (lbm/ft^3).

2.7.2 Flat - Surface Structures

For flat-surface structures, the pressure transient which occurs upon water impact and subsequent drag is depicted in Figure 2.7-3. The parameters in Figure 2.7-3 shall be defined as follows:

1. The pulse duration (τ) is specified as a function of the impact velocity:

$$\tau = 0.0016W \qquad \text{for } V \leq 7 \text{ ft/sec}$$

$$\tau = \frac{0.011\ W}{V} \qquad \text{for } V > 7 \text{ ft/sec}$$

where W is the width of the flat structure (feet) and V is the impact velocity (ft/sec).

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2. The pressure due to drag following impact shall be determined by:

$$P_D = \frac{C_D}{2}\left(\frac{\rho V^2}{144\ g_c}\right)$$

where P_D is the average drag pressure acting on the frontal area of the structure (psi), C_D is the drag coefficient (C_D = 2, flat strips normal to flow, independent of Reynolds number), and ρ is the density of water (lbm/ft^3).

3. The hydrodynamic mass per unit area for impact loading shall be obtained from the correlation (flat targets) in Figure 6-8 in NEDE-13426-P. A margin of 35% shall be added to this value to account for data scatter.

4. The impulse of impact per unit area shall be determined by:

$$I_P = \frac{M_H}{A}\left(\frac{V}{144\ g_c}\right)$$

where I_P is the impulse per unit area (psi-sec), M_H/A is the hydrodynamic mass per unit area (lbm/ft^2), and V is the impact velocity (ft/sec).

5. The maximum pressure (P_{max}) shall be calculated from the impulse per unit area and the drag pressure as follows:

$$P_{max} = \frac{2I_P}{\tau} + P_D$$

2.7.3 Gratings

The static drag load on gratings in the pool swell zone of the wetwell shall be calculated for gratings with open areas greater than or equal to 60% by forming the product of the pressure differential (figure 2.7-4) and the total grating area (not only the area of the metal bars). The pressure differential curve in Figure 2.7-4 is based on a velocity of 40 ft/sec. If the maximum pool velocity in the area where gratings are located differs from 40 ft/sec, the force on the grating will be calculated as follows:

$$F = \Delta P \times A_{grating}\left(\frac{V_{max}}{40}\right)^2$$

To account for the dynamic nature of the initial loading, the load shall be increased by a multiplier given by:

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$$F_{SE}/D = 1 + \quad [1 + (0.0064\ Wf)^2]^{1/2}; \text{ for}$$

$Wf < 2000$ in/sec.

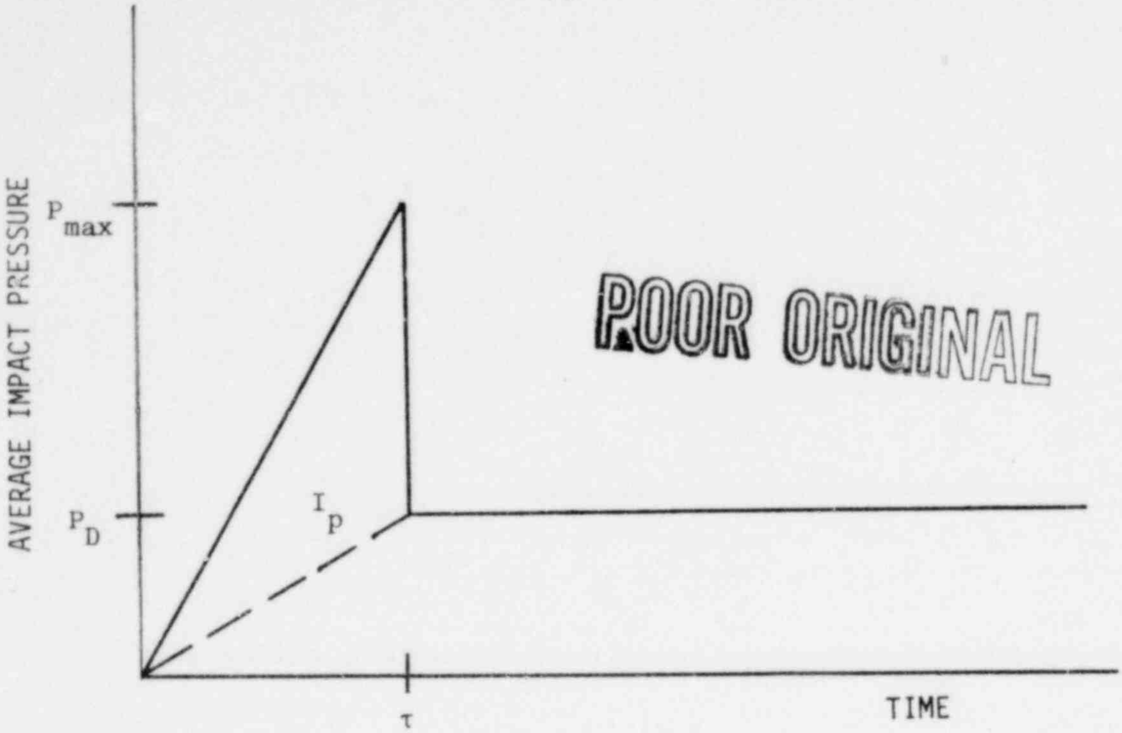

Figure 2.7-3 Pulse Shape for Water Impact on Flat Targets

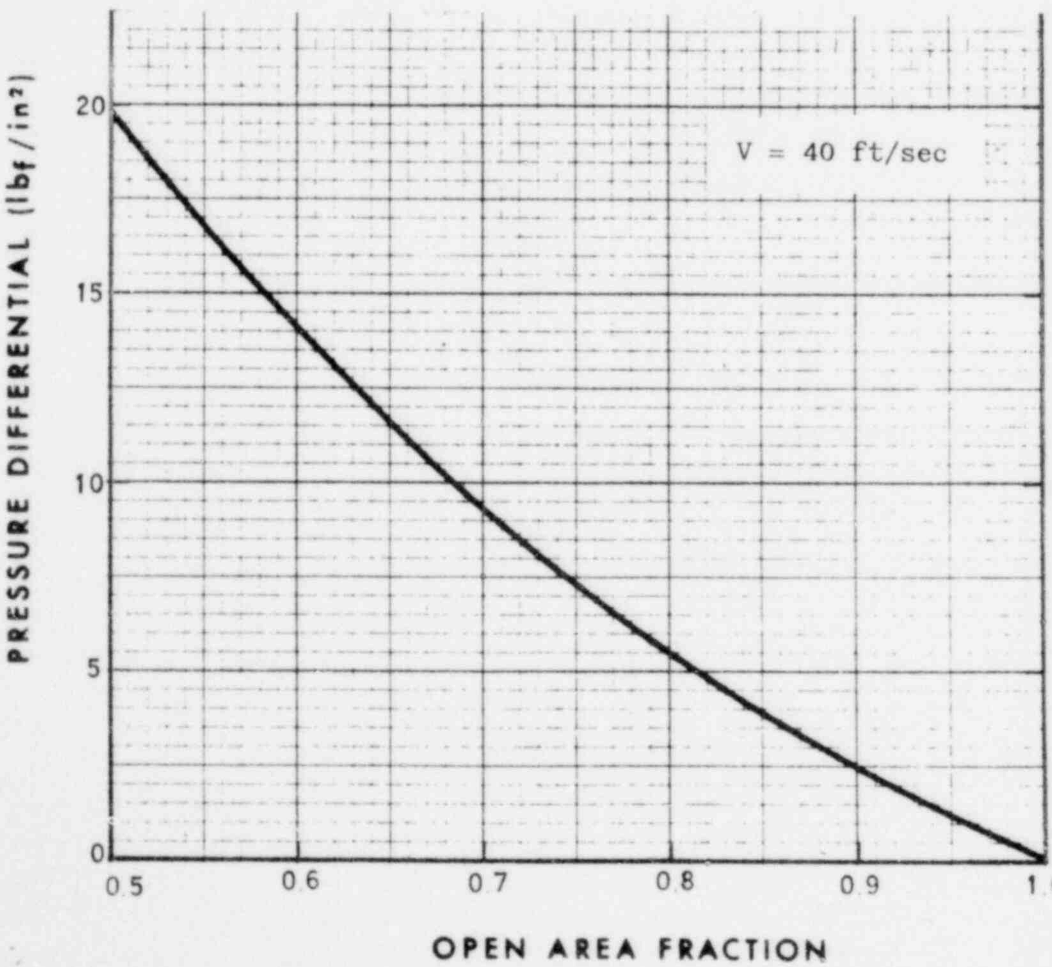

Figure 2.7-4 Pressure Drop Due to Flow Across Gratings

where:

F_{SE} = static equivalent load
W = width of grating bars, in.
f = natural frequency of lowest mode, Hz
D = static drag load

If Wf > 2000 ft/sec (not expected for gratings) the force on the bars of the gratings will be calculated by the method outlined above for flat-surfaced structures.

2.7.4 Load Application

These load specifications correspond to impact on "rigid" structures. When performing the structural dynamic analysis, the "rigid body" impact loads shall be applied; however, the mass of the impacted structure shall be adjusted by adding the hydrodynamic mass of impact, except for the gratings. The value of the hydrodynamic mass shall be obtained from the appropriate correlation in Figure 6-8 in NEDE-13426-P.

When the impact loading is primarily impulsive and calculations have already been performed in accordance with the LDR methodology, simple adjustments may be made to the LDR analyses. Under these conditions, a parabolic pulse shape, as proposed in LDR, is acceptable provided corrections are made to account for the 35% margin in the impulse and with additional corrections for the drag force immediately following impact.

For structures with a natural frequency less than 30 Hz, loading can be treated impulsively (i.e., independent of pulse shape) when the conditions fall into the region above the straight line shown in Figure 2.7-5.

The following corrections must be applied to the previously calculated stresses:

1. The calculated stresses will first be multiplied by a factor of 1.35 to account for the data scatter in the impulse data.

2. The calculated stresses will then be multiplied by an additional factor to account for the presence of drag following the impact. This factor is determined as follows:

TYPICAL IMPACT STRUCTURES:

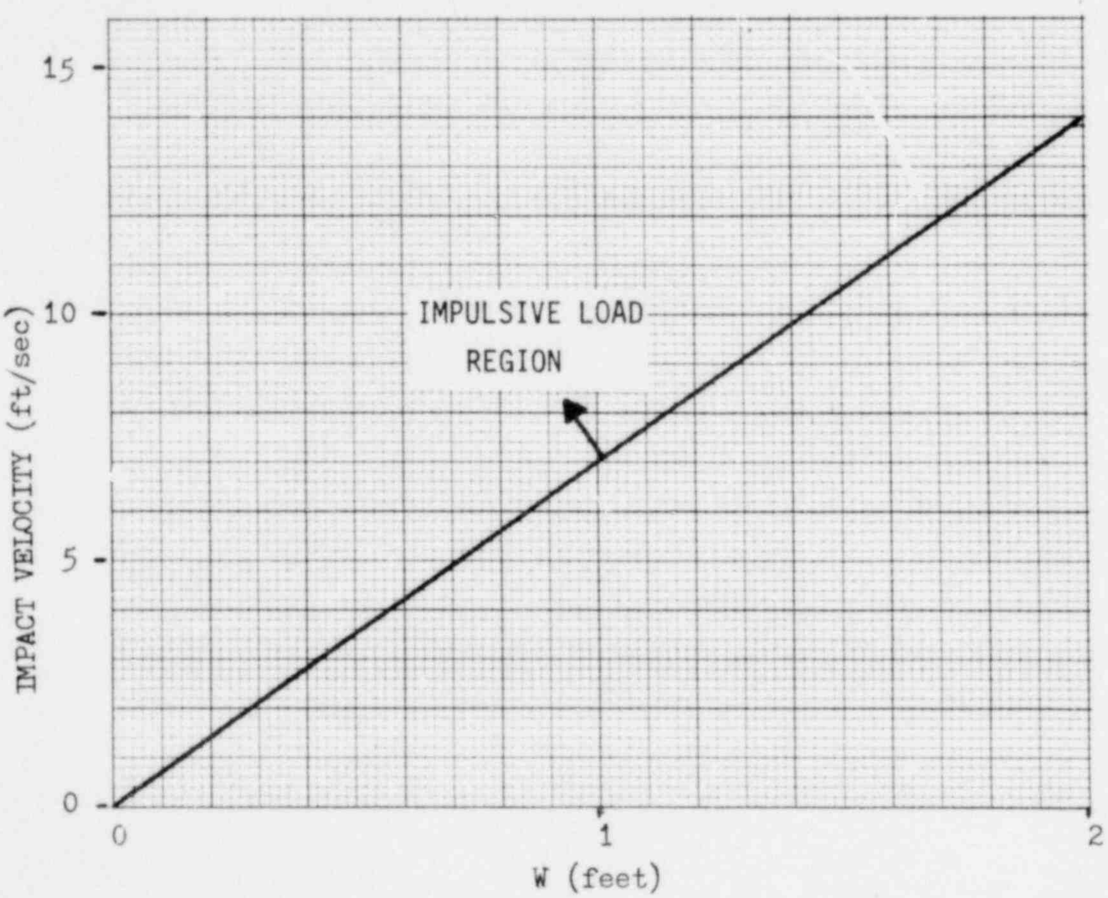

Figure 2.7-5 Impulsive Impact Loading Region for Structures with a Natural Frequency Less Than 30 Hz

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a. Calculate the drag pressure, (P_{drag}) corresponding to the impact velocity by the methods of Sections 2.7.1 or 2.7.2.

b. Form the ratio:

$$P_{drag}/P_{max}$$

where P_{max} is the amplitude of the parabolic pulse used in the original stress analysis multiplied by 1.35.

c. Determine the dynamic load factor (DLF) from Figure 2.7-6, corresponding to the two cases: (1) parabolic pulse without drag and (2) parabolic pulse followed by drag.

d. Multiply the calculated stress by the factor

$$DLF_{with\ drag}/DLF_{w/o\ drag}$$

2.8 FROTH IMPINGEMENT AND FALLBACK LOADS

Froth is generated by (1) impact of the rising pool surface on the vent header and (2) bubble breakthrough, as described in Section 4.3.5 of the LDR. The following load specification was derived from the high-speed film records of various pool swell tests and an analysis of pool acceleration following vent header impact. The impingement loads for Region I and Region II and the froth fallback loads, as described in Section 4.3.5, shall be defined as follows:

$$P_f = \frac{\rho_f V^2}{144\ g_c}$$

where:

P_f = froth impingement pressure (psi)

ρ_f = froth density (lb_m/ft^3)

V = froth impingement velocity (ft/sec)

g_c = gravitational constant (ft/sec^2)

Region I: The froth velocity shall be based on a source velocity equal to 2.5 times the maximum pool surface velocity prior to vent header impact, which is corrected for subsequent deceleration due to gravity starting at the 45° tangent on the bottom of the vent header, as shown in Figure 4.3.5-1 of the LDR. The froth density shall be assumed to be 20% water density for structures or sections of structures with a maximum cross-sectional dimension of less than

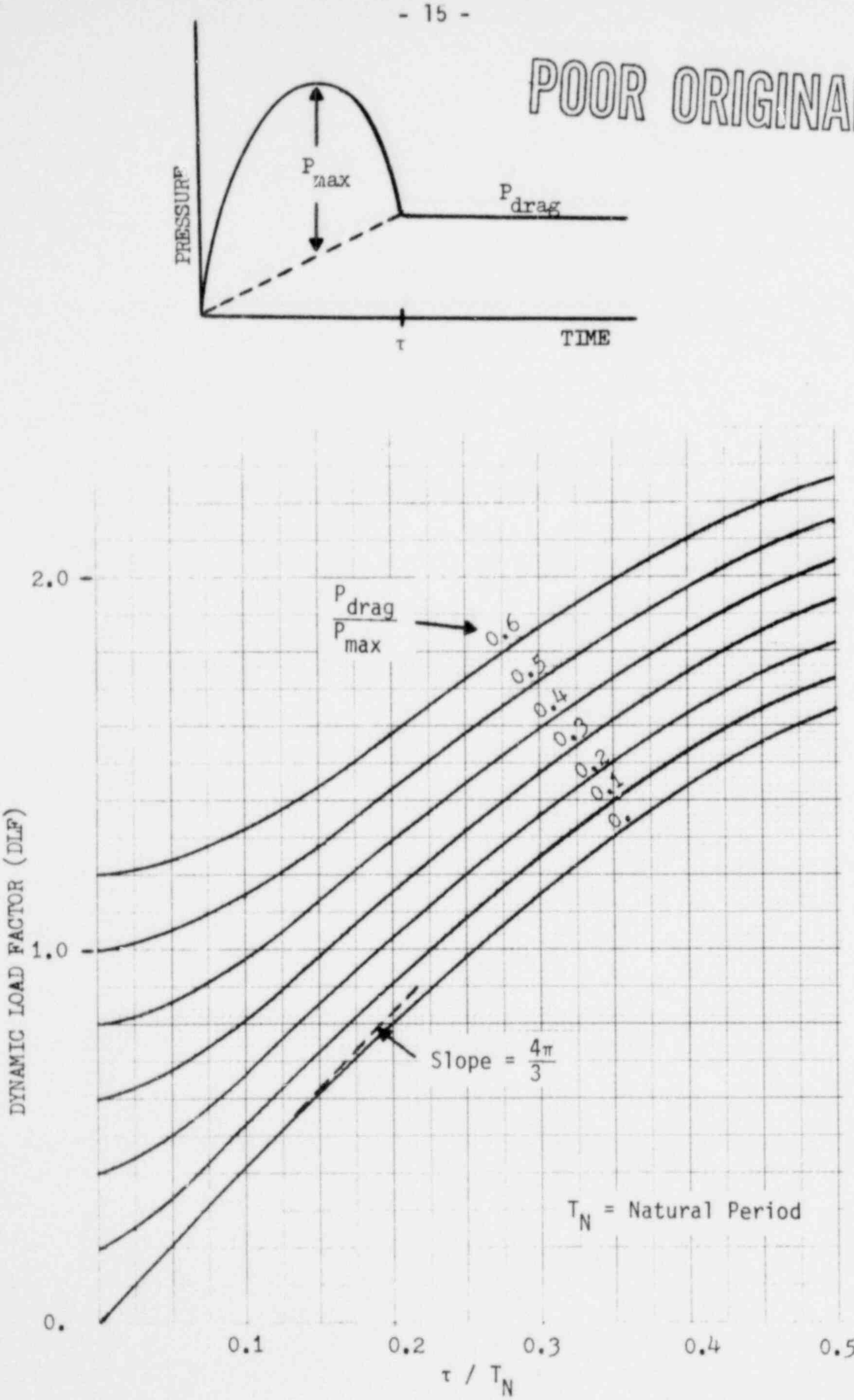

Figure 2.7-6 Effect of Drag Following a Parabolic Impact Pulse

or equal to one foot, and a proportionately lower density for structures greater than one foot; i.e., $\rho = (0.2/x)\ \rho_w$, where x is the dimension in feet. The load shall be applied in the direction most critical to the structure within the 90° sector bounded by the horizontal opposite the vent header to the vertical upward as shown in Figure 2.8.1. The load shall be assumed to be a rectangular pulse with a duration of 80 milliseconds.

Region II:

The froth velocity shall be based on a source velocity equal to the maximum pool surface velocity, directly beneath the structure under consideration, which is corrected for subsequent deceleration from the elevation of the maximum velocity. The froth density shall be assumed to be 100% water density for structures or sections of structures with a maximum cross-sectional dimension less than or equal to one foot, 25% water density for structures greater than one foot, and 10% water density for structures located within the projected region directly above the vent header. The load shall be applied in the direction most critical to the structure within the ± 45° sector of the upward vertical. The load shall be assumed to be a rectangular pulse with a duration of 100 milliseconds.

Fallback:

The froth fallback velocity shall be based on the freefall velocity from the upper surface of the torus shell directly above the subject structure. The froth density shall be assumed to be 25% water density, with the exception of the projected region directly above the vent header which is 10% water density. The load shall be assumed to directly follow the froth impingement load, with a duration of one second.

2.9 POOL FALLBACK LOADS

The proposed load definition procedures set forth in Section 4.3.6 of the LDR for suppression pool fallback loads on internal structures following pool swell are acceptable.

2.10 Vent Header Deflector Loads

The load definition procedures set forth in Section 4.3.9 of the LDR are applicable only to the four deflector types shown in Figure 4.3.9-2 of the LDR, and are generally acceptable, subject to the following constraints and/or modifications:

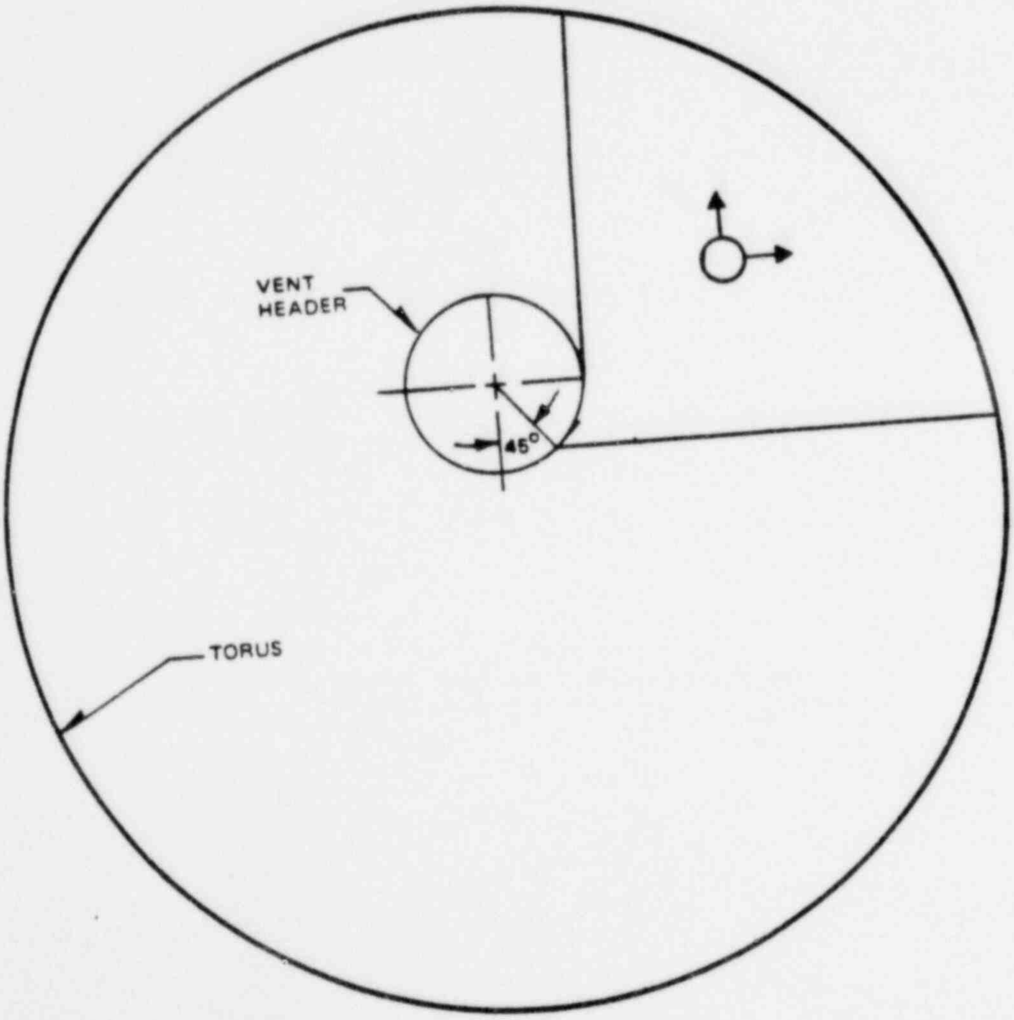

Figure 2.8-1 Direction of Load Application for Froth Region I

2.10.1 QSTF Deflector Load

An individual plant may choose to use deflector load data taken directly from the QSTF plant-unique tests. This technique is subject to the following requirements:

1. If the QSTF deflector load measurement does not have a sufficiently fast response time to resolve the initial impact pressure spike for the deflector types 1 - 3, inclusive, the loading transient shall be adjusted to include the empirical vertical force history of the spike shown in Figure 2.10-1. This impulse need not be applied for the type 4 deflector.

2. The QSTF plant-unique loads shall be adjusted to account for the effects of (a) impact time delays and (b) pool swell velocity and acceleration differences which result from uneven spacing of downcomer pairs. The longitudinal load variation shall be evaluated at the instant when the undistrubed pool surface would have reached the local elevation of the center (half-height elevation) of the deflector. The three-dimensional load variation shall be based on the EPRI "main vent orifice" tests, as discussed in Section 2.5.

3. In applying the load to the deflector, the inertia due to the added mass of water below the deflector shall be accounted for. The added mass per unit lengtn of deflector may be estimated by:

$$M_H = \frac{I g_c}{V\,w}$$

where: M_H = hydrodynamic mass per unit length (lb/ft)

I = total impulse per unit length associated with the impact transient (lb-sec/ft)

V = impact velocity (ft/sec)

w = deflector width (ft), as shown in Figures 2.10-2 through 2.10-5

g_c = gravitational constant

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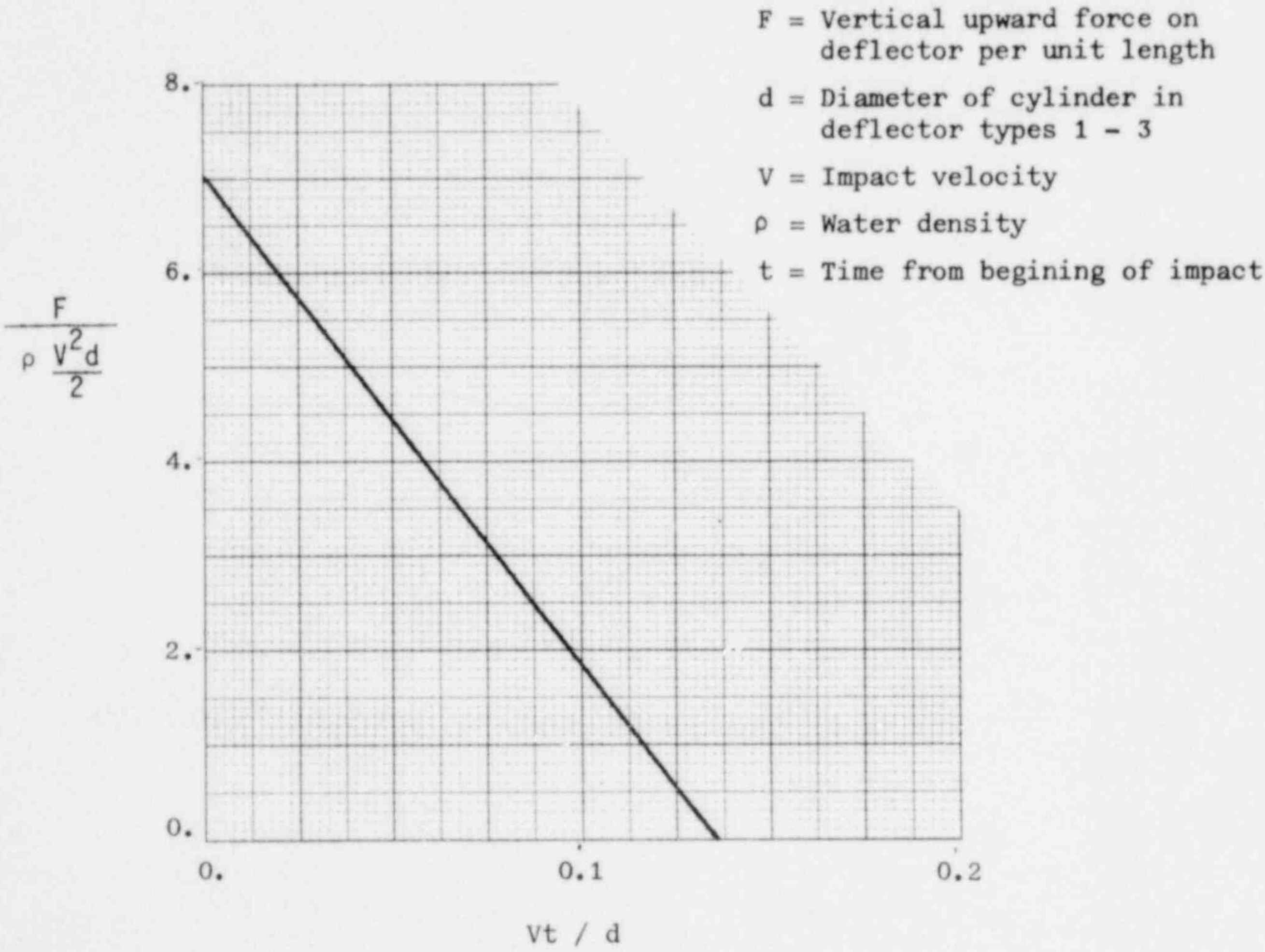

Figure 2.10-1 Impact Force Transient for Addition to the Empirical Data for Deflector Types 1 - 3.

2.10.2 Analytic Deflector Loads

The deflector load definition which is based on empirical expressions for impact and drag forces together with plant-specific definition of the pool swell velocity and acceleration transients, as described in Sections 4.3.9.1, 4.3.9.3, and 4.3.9.4 of the LDR, is acceptable, with the following modifications:

1. The impact transient and "steady drag" contributions to the load shall be computed from the correlations shown on Figures 2.10-2 through 2.10-5, for deflector types 1 - 4, respectively. For times past the periods shown, the last value shall be extended for the duration of the transient.

2. The three-dimensional load variation and timing shall be based on the EPRI "main vent orifice" tests, as discussed in Section 2.5.

3. The gravitational component of the acceleration drag shall be included in F_A, as defined in NEDO-24612.

4. In computing the deflector response to the load, the added mass of the water shall be accounted for, as described in Section 2.10.1.3 above.

2.11 CONDENSATION OSCILLATION LOADS

The following criteria have been developed in consideration of the fact that the "condensation oscillation" loads (i.e., high vent flow rate with low air content) have been derived from a single FSTF test run (M8). The condensation oscillation regime is a harmonic phenomena and, therefore, statistical variance or load magnitude uncertainty cannot be established from one test run. Although we conclude that the M8 tested conditions are conservative and prototypical for the Mark I design, a reasonable measure of the uncertainty in the loading function is necessary to assure the margins of safety in the containment structure. However, based on our assessment of the phenomenological studies conducted by the industry and the NRC Office of Nuclear Regulatory Research, we believe that the following load specifications are probably conservative and form a sufficient basis to proceed with implementation of the Mark I Long Term Program. We will require that the Mark I Owners Group confirm the condensation oscillation loads (i.e., torus shell loads, downcomer lateral loads, vent system pressure, and submerged drag source) by performing a sufficient number of additional large break, liquid blowdown tests in FSTF to establish the uncertainty in the load magnitudes.

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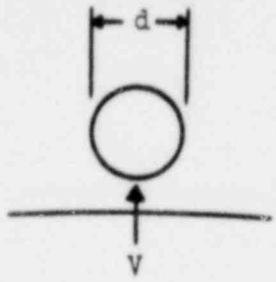

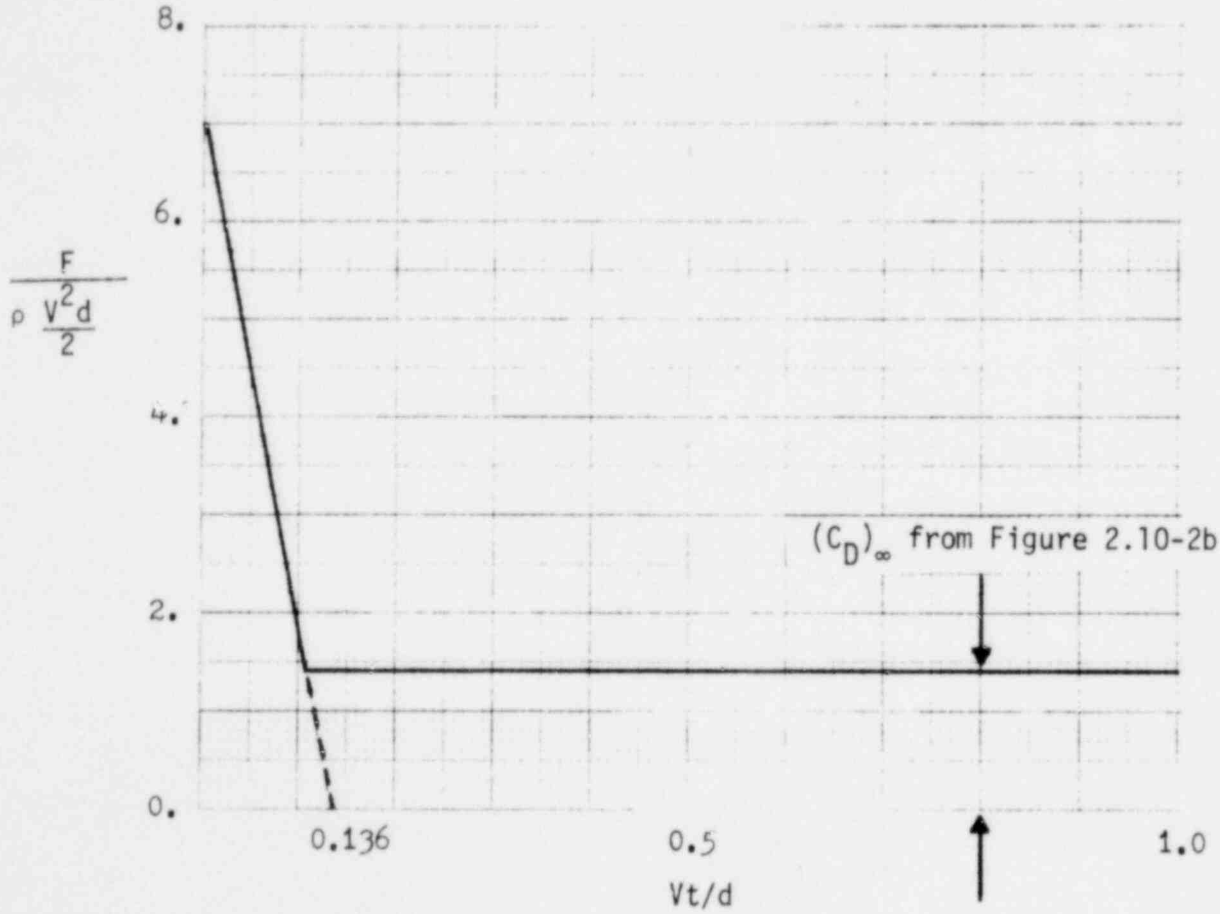

Figure 2.10-2 Impact and Steady Drag Force Correlation for Type 1 Deflector

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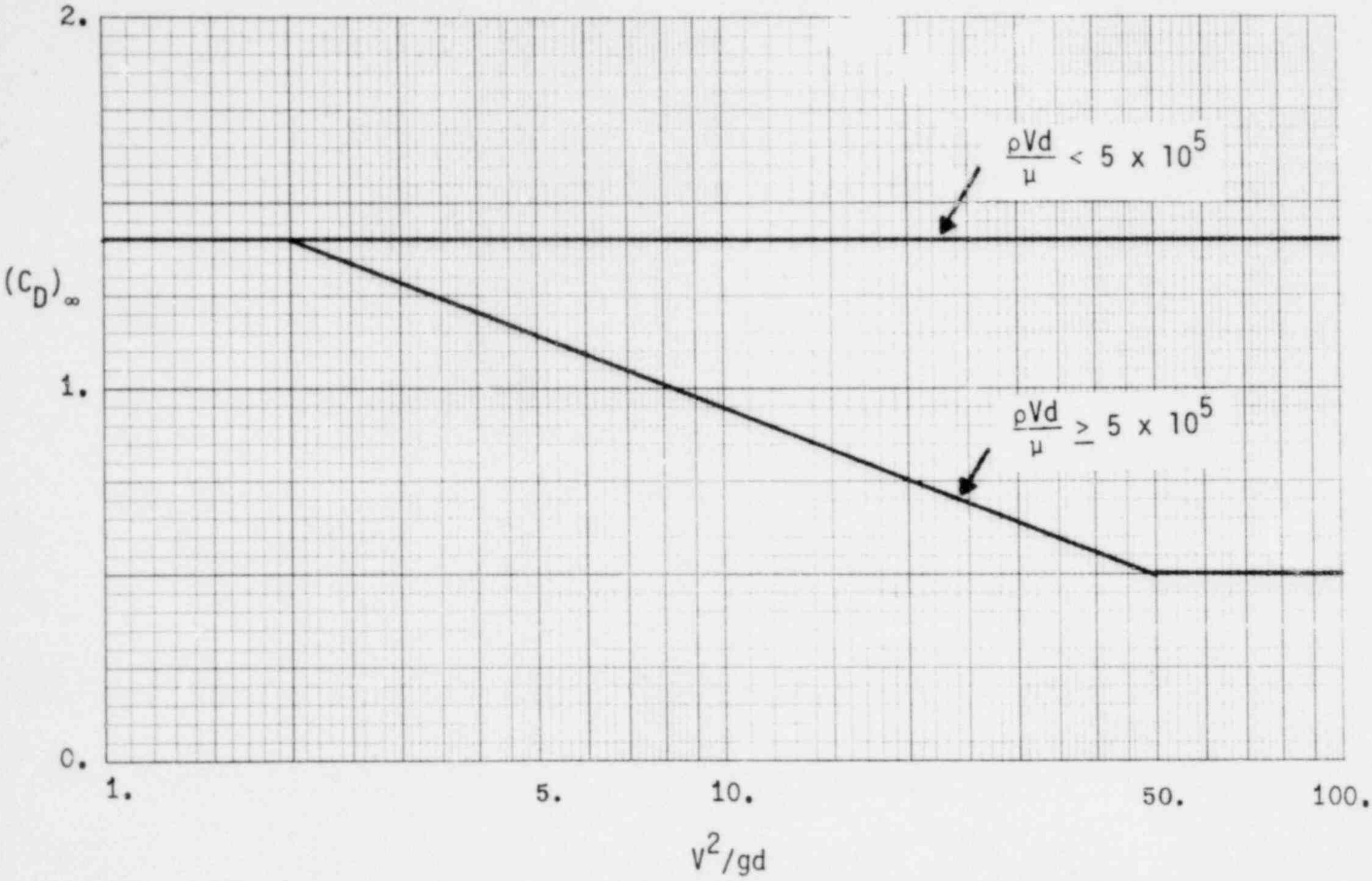

Figure 2.10-2b $(C_D)_\infty$ for Type 1 Deflector

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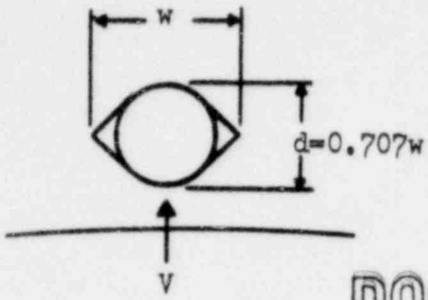

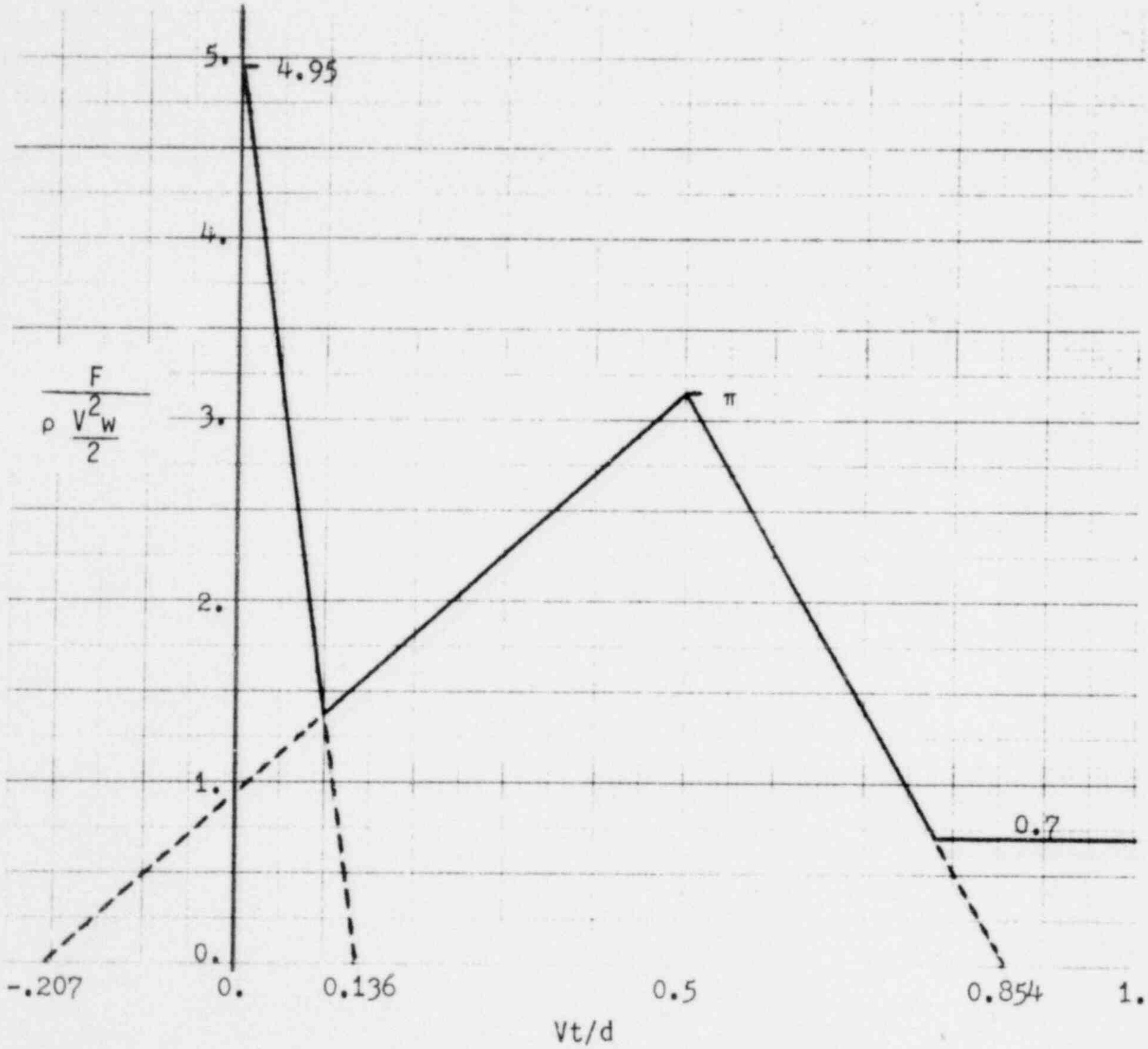

Figure 2.10-3 Impact and Steady Drag Force Correlation for Type 2 Deflector

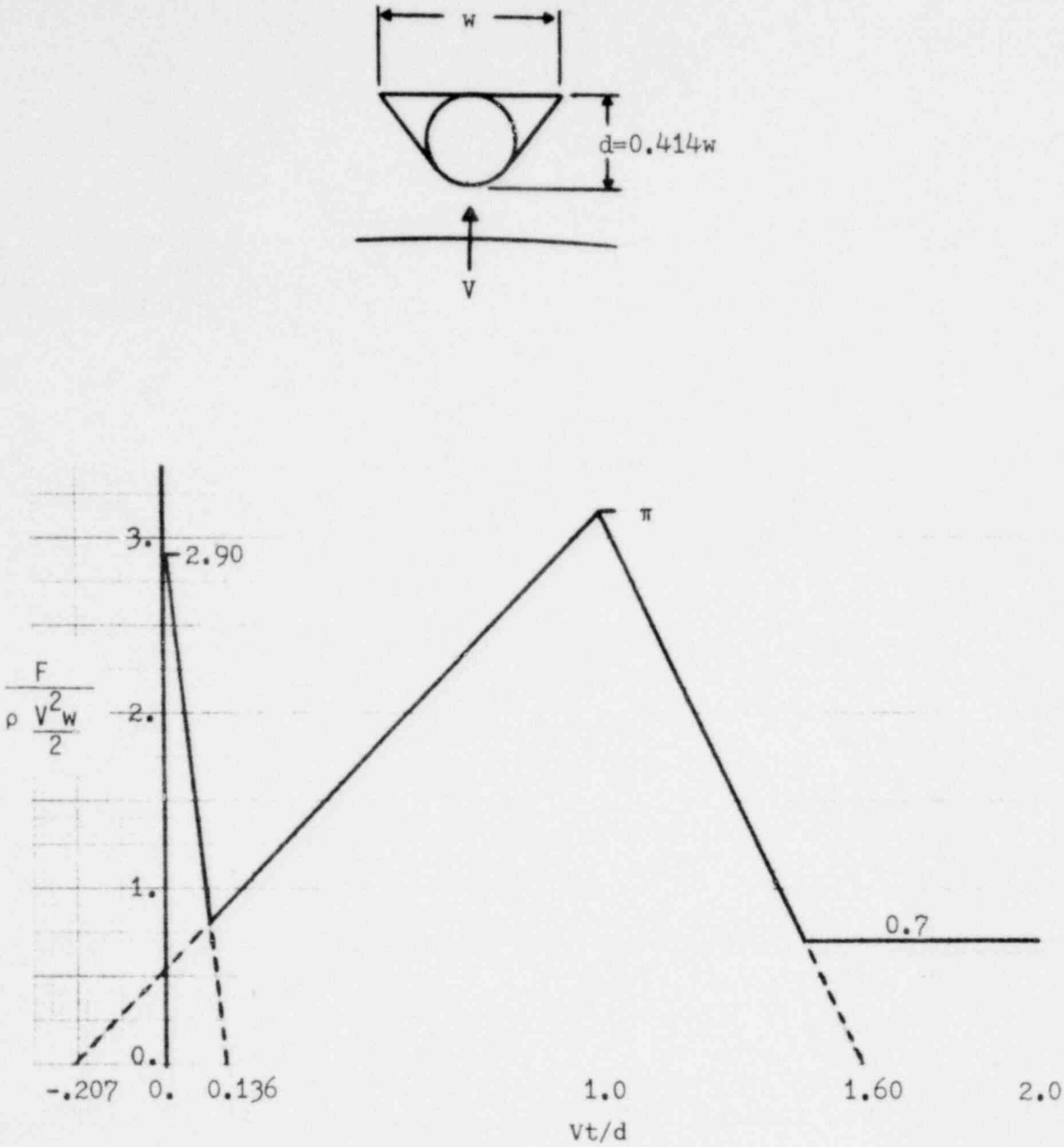

Figure 2.10-4 Impact and Steady Drag Force Correlation for Type 3 Deflector

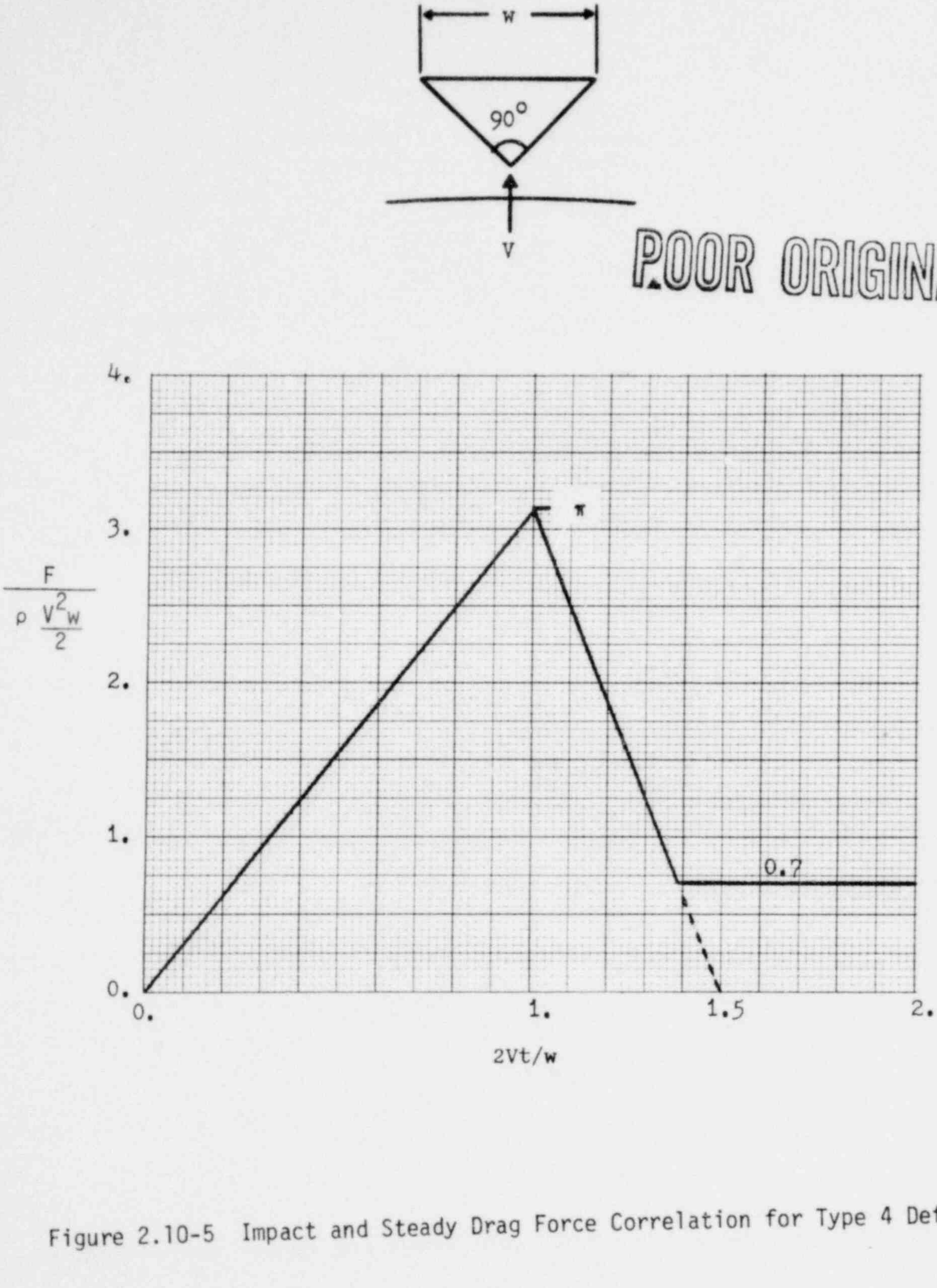

Figure 2.10-5 Impact and Steady Drag Force Correlation for Type 4 Deflector

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2.11.1 Condensation Oscillation Torus Shell Loads

The load definition and assessment procedures set forth in Section 4.4.1 of the LDR for the condensation oscillation loads on the torus shell are acceptable, subject to the following confirmation:

1. Provided that the "rigid wall" load derivation technique described in NEDE-24645-P is demonstrated to be conservative, in response to Question 7 in our request for additional information (D. Eisenhut, NRC, to L. Sobon, GE, dated July 30, 1979).

2. Provided that sufficient justification can be provided to exclude a condensation oscillation asymmetric loading condition, in response to Question 2 in our request for additional information.

3. Provided that the uncertainty in the load magnitude is demonstrated to be less that the demonstrated conservatisms in the load specification, by the testing program described above.

For clarification, the load specification set forth in Section 4.4.1 of the LDR shall be used in conjunction with a coupled fluid-structure analytical model. The condensation oscillation loading for the IBA is a continuous sinusodial function with a peak amplitude and frequency range of that specified for the "pre-chug" load. We will require that the conservatism in the IBA condensation oscillation loads be demonstrated as part of the response to Question 7 in our request for additional information for the specific flow regimes of interest.

2.11.2 CONDENSATION OSCILLATION DOWNCOMER LOADS

2.11.2.1 Untied Downcomer Loads

The condensation oscillation downcomer lateral loads for "untied" downcomers shall be defined as described in Section 4.4.3 of the LDR, based on the methodology in NEDE-24537-P. However, in computing the dynamic load factors

$$P_{max} = P_1 \left(\frac{DLF}{DLF_1}\right)$$

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where: P_{max} = maximum static equivalent lateral load for plant-unique downcomer

P_1 = maximum static equivalent lateral load in FSTF

DLF = plant unique downcomer dynamic load factor

DLF_1 = FSTF downcomer dynamic load factor

the plant-unique loading condition shall be derived as follows. The plant-unique DLF shall be calculated using a damping value consistent with the requirements of Regulatory Guide 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," and a natural frequency determined from the structural analysis of the downcomer - vent header system. The plant-unique driving frequency shall be specified as that frequency in the range 4 - 8hz which produces the maximum structural response. The natural frequency and damping values for the FSTF DLF shall be conservatively established from a "pluck" test of an untied downcomer in FSTF, with a nominal water level of 3 feet 4 inches and an amplitude in the range of the response level. The driving frequency for the FSTF DLF shall be assumed to be 5.5hz.

2.11.2.2 Tied Downcomer Loads

The condensation oscillation downcomer loads for "tied" downcomers, as described in Section 4.4.3 of the LDR, are unacceptable. We will require that a load specification be derived from the maximum dynamic load components on each downcomer in a tied pair. The load definition and structural analysis technique shall be confirmed by comparisons of the predicted structural responses to the measured strains in the FSTF vent header and tie-bar. The FSTF natural frequency and damping values shall be conservatively established by performing a "pluck" test for a tied downcomer pair in FSTF, with a nominal water level of 3 feet 4 inches and an amplitude in the range of the response level.

2.11.3 Condensation Oscillation Vent System Pressure Load

The load definition procedures set forth in Section 4.4.4 of the LDR for the oscillatory pressures in the vent system during the condensation oscillation period, are acceptable subject to confirmation by the additional testing as described above.

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2.12 CHUGGING LOADS

2.12.1 Chugging Torus Shell Loads

The load definition and assessment procedure set forth in Section 4.5.1 of the LDR for the chugging condensation loads on the torus shell are acceptable, provided the "rigid wall" load derivation technique is demonstrated to be conservative in response to Question 7 in our request for additional information (D. Eisenhut, NRC, to L. Sobon, GE, dated July 30, 1979). This load specification shall be used in conjunction with a coupled fluid-structure analytical model.

2.12.2 Chugging Downcomer Loads

2.12.2.1 Untied Downcomer Loads

The chugging lateral loads on untied downcomers shall be defined as described in Section 4.5.3 of the LDR, which is based on the methodology in NEDE-24537-P, with the following exceptions:

1. The load specification for comparison to the ASME code primary stress limits shall be based on the maximum measured resultant static equivalent load in FSTF.
2. The fatigue usage analysis for each downcomer shall be based on a statistical loading with a 95% probability of non-exceedance.
3. The multiple-downcomer loading to assess statistical directional dependence shall be based on a non-exceedance probability of 10^{-4} per LOCA.

2.12.2.2 Tied Downcomer Loads

For tied downcomers, the strains in the downcomer itself shall be evaluated exactly as in the case of the untied downcomers, using tied downcomer data. The strain in the tie bar shall be evaluated by assuming that one of the two tied downcomers is subjected to a dynamic load of triangular shape, with an amplitude of:

$$F_{max} = \frac{RSEL}{\pi f t_d} \qquad \text{(RSEL = Resultant Static Equivalent Load)}$$

where RSEL is the maximum measured RSEL for an untied downcomer during chugging, f is the lowest natural frequency of vibration of an untied downcomer for the specific plant, and the duration of the load, t_d, shall be assumed to the 3 milliseconds. The load direction shall be taken as that (in the horizontal plane) which result in the worst loading condition for the tie bar and its attachments to the downcomers.

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2.12.3 Chugging Vent System Pressure Loads

The load definition procedure set forth in Section 4.5.4 of the LDR for the oscillatory pressures on the vent system during the chugging period are acceptable.

2.13 SAFETY-RELIEF VALVE DISCHARGE LOADS

2.13.1 Safety-Relief Valve Discharge Device

The acceptance criteria set forth below for the quencher discharge loads and submerged structure drag load source strengths are applicable only to the "T" quencher configuration described in Section 1.1 of NEDE-24542-P. For plants using other types of quencher discharge devices, the SRV discharge load definition, submerged structure drag load source strength, and pool temperature limits will be evaluated on a plant-specific basis.

2.13.2 SRV Discharge Line Clearing Transient

The load definition and assessment procedure, described in Section 5.2.1 of the LDR, for the pressure and thrust loads on the SRV discharge line and quencher, which is based on the methodology presented in NEDE-21864-P and NEDE-23749-1-P, is acceptable.

2.13.3 SRV Air-Clearing Quencher Discharge Shell Pressure Loads

2.13.3.1 Methodology for Bubble Pressure Prediction

The load definition procedures described in Section 5.2.2 of the LDR and the methodology in NEDE-21878-P for predicting the quencher bubble pressure are acceptable, with the following exceptions:

1. The load definition procedures set forth in Section 5.2.2 of the LDR are acceptable for SRV discharge line water-leg lengths less than or equal to 13.5 feet. In the event that the water-leg length for a particular discharge line exceeds 13.5 feet, the load prediction for a 13.5 foot water-leg length shall be used.

2. The proposed methodology for predicting bubble pressures due to SRV subsequent actuations is not acceptable. The pressure amplitude predicted for the SRV first actuation shall be used in conjunction with the bubble frequency range for subsequent actuation, as specified below, for structure, equipment, and piping assessment in response to events containing SRV subquent actuations.

2.13.3.2 Methodology for Torus Shell Pressure Prediction

Based on the predicted air bubble pressure-time histories, as discussed above, the torus shell pressures at various locations in the suppression pool shall be calculated by the load definition procedures described in Section 5.2.2.3 of the LDR in conjunction with the appropriate pressure attenuation model. For quenchers located on the torus center-line, the pressure attenuation model described in Section 2.4 of NEDE-21878-P in conjunction with the bounding factor presented in Section 3.2 of NEDE-21878-P shall be used.

The load adjustment and attenuation factors proposed for the "off-center" T-quencher configuration presented in a meeting with the staff on May 30, 1979, are acceptable. We will require, however, that this load specification and its bases be documented in a supplement to the LDR.

2.13.3.3 Multiple - Discharge Loads

The torus shell loads due to multiple SRV actuations shall be calculated as follows:

1. The peak values of bubble pressure due to a single valve actuation shall be combined by linear superposition (ABSS method) with the appropriate pressure attenuation model, as discussed above. All bubbles shall be assumed to oscillate in-phase with the frequency ranges specified below for both first and subsequent actuations.

2. In the event that the combined peak torus shell pressure exceeds 1.65 times the local predicted peak <u>bubble</u> pressure due to a single valve actuation, the resultant torus shell peak pressure for the design assessment may be taken at the lower value.

2.13.3.4 Frequency of Pressure Wave Form

The pressure wave form predicted by the methodology described in Section 5.2.2 of the LDR within the following uncertainty ranges (stretched or compressed time scale) that will produce the maximum structural, equipment, or piping system response shall be used for the design assessment:

1. First Actuation - the frequency range shall be 0.75 times the minimum predicted frequency to 1.25 times the maximum predicted frequency.

2. Subsequent Actuation - the frequency range shall be 0.60 times the mimimum predicted frequency to 1.40 times the maximum predicted frequency.

2.13.4 SRV Discharge Line Reflood Transient

The transient analysis technique to compute the plant-specific reflood heights in the SRV discharge line following valve closure, as described in Section 5.2.3 of the LDR and based on the methodology in NEDE-23898-P and NEDE-21864-P, is acceptable.

2.13.5 SRV Air and Water Clearing Thrust Loads

The load definition and assessment procedure for the quencher and quencher support thrust loads, described in Section 5.2.6 of the LDR, is acceptable.

2.13.6 SRV Discharge Line Temperature Transient

The transient analysis technique to compute the maximum temperature loads on the discharge line and quencher device, as described in Section 5.2.7 of the LDR, is acceptable.

2.13.7 SRV Discharge Event Cases

The kind and number of SRV discharge events shall be based on the plant-specific system configuration and a conservative assessment of plant operational history. The following load cases shall be considered for the design assessment:

1. A first actuation, single valve discharge shall be considered for all event combinations involving SRV events. Single valve subsequent actuations shall be considered for the SRV, SBA, and IBA event combinations, as determined from a plant-specific primary system analysis.

2. Asymmetric SRV discharge, both first and subsequent actuations, shall be considered for SRV, SBA, and IBA event combinations. The degree of asymmetric discharge for each event combination shall be determined from a plant-specific primary system analysis designed to maximize the asymmetric condition.

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3. ADS valves discharging on first acutations shall be considered for the SBA and IBA event combinations, followed by subsequent acutations determined from a plant-specific primary system analysis.

4. The maximum number of valves that will actuate for the SRV event combinations shall be determined from a plant-specific primary system analysis for the design basis transients, which assumes that all valves actuate at their set-point pressures. All first actuations shall be assumed to occur in phase, followed by subsequent actuations determined from the primary system analysis.

All of the event combinations above include the earthquake events (OBE and SSE) in combination with the SRV discharge events.

2.13.8 Suppression Pool Temperature Limits

As part of the PUA, each licensee is required to either demonstrate that previously submitted pool temperature analyses are sufficient or provide plant-specific pool temperature response analyses to assure that SRV discharge transients will not exceed the following pool temperature limits.

1. Local Temperature Limit

   The suppression pool local temperature shall not exceed 200 F throughout all plant transients involving SRV operations, for any quencher device that has (a) the hole diameter equal to and (b) greater than or equal hole spacing than that of the generic Mark I T-Quencher.

2. Local and Bulk Pool Temperature

   The local to bulk pool temperature difference shall consider the plant-specific quencher discharge geometry and RHR suction and discharge geometry. The analysis of the plant-specific local to bulk pool temperature difference shall be supported by test data from either the existing Monticello pool temperature data or in-plant tests.

   The "local" temperature is defined as the temperature in the vicinity of the quencher device during discharge. For practical purposes, the water temperatures observed in the sector containing the discharge device at shell locations on the reactor side of the torus downstream of the quencher centerline at the same elevation as the quencher device may be considered "local" temperatures. The "bulk" temperature, on the other hand, is the temperature calculated assuming a uniform distribution of the mass and energy discharged from the SRV.

3. Suppression Pool Temperature Monitor System

The suppression pool temperature monitoring system is required to ensure that the suppression pool is within the allowable limits set forth in the plant Technical Specification. The system shall meet the following design requirements:

a. Each licensee shall demonstrate that there is a sufficient number and distribution of pool temperature sensors to provide a reasonable measure of the bulk temperature.

b. Sensors shall be installed sufficiently below the minimum water level, as specified in the plant Technical Specifications, to assure that the sensor properly monitors pool temperature.

c. Pool temperature shall be recorded in the control room. A sufficient number of temperature monitors shall be provided to permit the operator to establish the bulk pool temperature. Operating procedures and alarm set points shall consider the relative accuracy of the measurement system.

d. Instrument set points for alarm shall be established, such that the plant will operate within the suppression pool temperature limits discussed above.

e. All sensors shall be designed to seismic Category I, Quality Group B, and energized from onsite emergency power supplies.

2.14 SUBMERGED STRUCTURE DRAG LOADS

2.14.1 LOCA Water Jet Loads

The load definition and assessment procedure described in Section 4.3.7 of the LDR, which is based on the "Moody Jet Model" (NEDE-21472-P), is acceptable subject to the following constraints and/or modifications:

1. The plant-specific jet discharge velocity, $V_D(t)$, and acceleration, $a_D(t) = dV_D/dt\ (t)$, from the QSTF plant-specific test series shall be used as the driving sources for the jet model.

2. Forces due to the pool acceleration and velocity induced by the advancing jet front shall be computed for structures that are within four downcomer diameters below the downcomer exit elevation, even if the structure

is not intercepted by the jet. The flow field shall be computed by modelling the moving jet front as a hemispherical cap centered one downcomer diameter (D) behind the "Moody" jet front positions, containing the same amount of water as the "Moody" jet, and moving with the velocity of the "Moody" jet front. The formulas for the hemisphere radius (R_s) and the trajectory of the hemisphere center (x_c) are:

$$R_s(t) = \frac{D}{2} \left(\frac{3}{2} + (3x_f(t)/D)^{\frac{1}{2}}\right)^{1/3} \quad \text{for } x_f(t) > D$$

$$R_s(t) = \frac{D}{2} \left(\frac{9x_f(t)}{2D}\right)^{1/3} \quad \text{for } x_f(t) \leq D$$

$$x_c(t) = x_f(t) - D \quad \text{for } x_f(t) > D$$

$$x_c(t) = 0 \quad \text{for } x_f(t) \leq D$$

where $x_f(t)$ is the position of the "Moody" jet front as a function of time, as computed in NEDE-21472-P.

Using formulas 1 and 2 in NEDE-21472-P and assuming an average constant acceleration of the particles contained within one downcomer diameter behind the "Moody" jet front, the cross-sectional area in this region can be approximated by:

$$A\,(x,t) = \frac{\pi D^2}{8} \left(1 + 1/(1 - x/x_f)^{\frac{1}{2}}\right)$$

where $x_f(t)$ is the "Moody" jet front position as computed in NEDE-21472-P. The volume contained in this portion of the jet can be obtained by integrating $A(x,t)$ from $(x_f - D)$ to x_f for x_f greater than D, and from x=0 to $x = x_f$ for x_f less than D. When the jet is modelled by a more realistic hemispherical cap, while conserving the total volume of the fluid, the cap radius and position is given by the equations above.

The equivalent uniform velocity and acceleration at the location of the structure (x,y) shall be obtained from the time dependent potential $\phi_j(x,y,t)$ induced by the jet front:

$$\phi_j\ (x,y,t) = -\left(\frac{R_s}{r}\right)^2 r\left(\frac{dR_s}{dt}\right) - \frac{1}{2}\left(\frac{R_s}{r}\right)^3 (x - x_c)\ \frac{dx_c}{dt}$$

where $r = \{(x-x_c)^2 + y^2\}^{\frac{1}{2}}$ and y is the transverse distance of the structure from the jet axis, and $(x-x_c)$ is the distance from the structure to the effective jet front center along the jet axis. The potential is the superposition of the expansion and motion of the sphere as given in any standard hydrodynamics text (e.g. Milne Thomposon, Theoretical Hydrodynamics, Fourth Edition, pp. 455-566).

The local uniform flow velocity is

$$U_\infty\ (x,y,t) = \nabla\phi_j$$

as in NEDO-21471, while the acceleration is $a(x,y,t) = \frac{\partial U_\infty}{\partial t}$

This calculation need only be performed for $r > R_s$ and $x > x_c$. If either of these conditions are not satisfied, the methodology in the LDR will bound the load and is, therefore, acceptable.

2.14.2 LOCA Bubble Drag Loads

The load definition and assessment procedures described in Section 4.3.8 of the LDR, which are based on the methodology in NEDO-21471 and experimental confirmation in NEDE-23817-P, are acceptable subject to the following constraints and/or modifications:

1. Flow Field

   a. QSTF plant-specific test results (NEDE-21944-P) will be used.

   b. Model E in NEDE-21983-P will be used for the method of images simulation of the torus cross-section.

   c. After contact between bubbles of adjacent downcomers, the pool swell flow field above the downcomer exit elevation will be derived from the QSTF plant-specific tests.

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2. Drag Load Assessment

a. Drag forces can be computed for circular cylinders as given in NEDO 21471, but a conservative drag coefficient of $C_D = 1.2$ must be assumed, independent of the Reynolds number.

b. Drag forces on structures with sharp corners (e.g., rectangles and "I" beams) must be computed by considering forces on an equivalent cylinder of diameter $D_{eq} = 2^{1/2} L_{max}$, where L_{max} is the maximum transverse dimension. L_{max} is defined as the diameter of a circumscribed cylinder about the cross-section of the structure. For example, L_{max} equals $(a^2 + b^2)^{1/2}$ for a rectangular cross-section of sides a and b.

c. Long slender structures must be considered in segments of length (L), which do not exceed the diameter (D or D_{eq}). Alternatively longer segments may be used as long as the equivalent uniform flow velocity and acceleration are evaluated conservatively for every point on any such segment.

d. Interference effects due to the proximity of walls shall be considered for each structural segment that has its center less than 1.5 diameters from a boundary. Interference effects between neighboring structures shall be considered whenever the centers of the segments are less than $3\bar{D}$, where $\bar{D} = 1/2 (D_1 + D_2)$, the average diameter of the two structures.

For structures near walls, the multiplier $(1 + A_w)$ shall be used to increase the acceleration drag and the multiplier $(1 + D_w)$ shall be used to increase the standard drag. A_w and D_w that bound theory and experiments are given below as functions x_w ($x_w = r/D - 1/2$, where r is the distance from the segment center to the boundary).

$$0.05 \leq x_w < 1.0 \qquad A_w = 0.05/x_w$$

$$D_w = 0.12/x_w$$

$$x_w < 0.05 \qquad A_w = 1.0$$

$$D_w = 2.4$$

For structures with neighbors that are less than $3\bar{D}$ away and within 30° of being parallel, the multipliers $(1 + A_I)$ and $(1 + D_I)$ shall be applied to the acceleration and standard drag components respectively. Bounding expressions for A_I and D_I are given below as functions of x_I ($x_I = r_{12}/\bar{D} - 1$ where r_{12} is the distance between segment centers).

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$0.05 \leq X_I < 2 \qquad A_I = \frac{0.2}{X_I}\left(\frac{D_2}{D_1 + D_2}\right)$

$$D_I = 0.2/X_I$$

where D_1 is the diameter of the structure under consideration and D_2 is the diameter of the neighbor. If more than one neighbor must be considered, the A_I and D_I values may be summed over the neighbor structures. For x_I less than 0.05, the two neighbor structures shall be considered as an effective single structure.

The effects of wall proximity and neighbor structures may be superimposed in order to compute overall multipliers as follows:

$$(1 + A_W + \sum_k A_{Ik})$$

$$(1 + D_W + \sum_k D_{Ik})$$

In situations where interference effects must be considered, but the correction techniques outlined above are not applicable, a detailed interference effects analysis shall be performed.

2.14.3 QUENCHER WATER JET LOADS

The load definition procedure described in Section 5.2.4 of the LDR, which is based on the methodology in NEDE-25090-P, is acceptable, subject to the appropriate documentation of the confirmatory tests discussed in NEDE-25090-P.

2.14.4 QUENCHER BUBBLE DRAG LOADS

The load definition and assessment procedures described in Section 5.2.5 of the LDR, in NEDE-21878, and in NEDO-21471-2, are acceptable subject to the following constraints and/or modifications:

1. Flow Field

   a. The determination of the charging, formation, and rise of the oscillating bubbles is subject to the same conservative factors that are used for the quencher torus shell pressure loads, as described in NEDE-21878-P.

   b. Drag loads on the quencher arms and the SRV discharge line shall be computed on the basis of asymmetric bubble dynamics. Either a full 180° phase shift shall be considered for full strength bubbles on opposite sides of these structures, or a more detailed assessment of the asymmetry of the bubble source strengths and phasing must be obtained from the experimental information in NEDE-21878-P.

   c. Model E in NEDE-21983-P shall be used for the method of images representation of the torus cross-section.

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2. Drag Load Assessmen

   a. Drag forces for circular cylinders shall be computed on the basis of acceleration drag alone, under the condition that $U_mT/D \leq 2.74$, where U_m is the maximum velocity, T is the period of bubble oscillation, and D is the cylinder diameter. For $U_mT/D > 2.74$, the standard drag shall be included with the drag coefficient $C_D = 3.6$ in order to bound the relevant experimental data.

   b. The constraints specified for the LOCA bubble drag load assessment also apply to the quencher bubble drag loads, with the exception of the drag coefficient.

2.14.5 LOCA CONDENSATION OSCILLATION DRAG LOADS

The load definition and assessment procedures described in Section 4.4.2 of the LDR and the methodology described in NEDO 25070 are acceptable subject to the following constraints and/or modifications:

1. Flow Field

   a. An average source strength shall be established by considering equal source strengths at all eight downcomers in equation B-4 in NEDO 25070. A maximum source strength shall be defined as twice the average source strength. For each structure, the loads shall be computed on the basis of both the average source at all downcomers and for the maximum source applied at the nearest downcomer.

   b. The fluid-structure interaction effects shall be included for any structural segment for which the local fluid acceleration is less than twice the torus boundary acceleration. This may be accomplished by adding the boundary acceleration to the local fluid acceleration.

2. Drag Load Assessment

   a. The constraints and modifications specified for the quencher bubble drag loads apply.

   b. These loads may be applied quasi-statically to structures, only if the highest significant Fourier components occur at frequencies less than half the lowest structural frequency.

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2.14.6 LOCA CHUGGING DRAG LOADS

The load definition and assessment procedures described in Section 4.5.2 of the LDR and the methodology in NEDO-25070 for the pre-chug drag loads are acceptable subject to the constraints in Section 2.14.5 for the condensation oscillation drag loads. The application for the post-chug drag loads is subject to the following constraints and/or modifications.

1. Flow Field

   a. The maximum source strength history shall be obtained by using the maximum measured pressure (not necessarily at the bottom center) in a Type 1 chug in equation B-4 of NEDO 25070, with f(r) based on the single nearest downcomer. For each structure, the phasing between the two nearest downcomers that maximizes the local acceleration shall be established. The local acceleration shall then be computed on the basis of the two nearest downcomers chugging at maximum source strengths at the above established phase relation.

   b. The fluid-structure interaction effects shall be included for any structural segment for which the local fluid acceleration is less than twice the torus boundary acceleration. This may be accomplished by adding the boundary acceleration to the local fluid acceleration.

2. Drag Load Assessment

   a. The constraints and modifications specified for the quencher bubble drag loads apply.

   b. Unless the lowest structural natural frequency times the duration of the "spike" in the source strength is greater than 3, the loads shall be applied dynamically. Either sufficient Fourier components will be included to bound the "spikes" or the load shall be applied in the time domain using the source time history. The term "spike" refers to the short-duration high overpressure peak, such as that exhibited in Figure 6.2.1-20 of NEDE-24539-P.

2.15 SECONDARY LOADS

The following loading conditions may be neglected for the PUA:

   a. seismic slosh pressure loads

   b. post-swell wave loads

   c. asymmetric pool swell pressure loads

   d. sonic and compression wave loads

   e. downcomer air clearing loads

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2.16 DIFFERENTIAL PRESSURE CONTROL REQUIREMENTS

Those licensees that use differential pressure control (ΔP) as a pool swell load mitigation feature for the LTP, shall demonstrate conformance with the following design criteria as part of the PUA:

1. There shall be no unacceptable change in the radiological consequences of an accident as a result of the inclusion of the ΔP system.

2. Steam bypass of the suppression pool via the ΔP system shall be eliminated by appropriate system design, or such bypass shall be demonstrated to be acceptable by calculation.

3. Design and installation of the ΔP system shall be commensurate with other operational systems in the plant.

4. When the ΔP system involves the addition of containment isolation valves, the additional valves shall be included in the plant's Technical Specifications and the valve design and arrangement shall conform to the requirements of General Design Criterion 56 in Appendix A to 10 CFR 50 and the regulatory positions in Standard Review Plan Section 6.2.4.

Subsequent to the PUA, a license amendment shall be submitted to incorporate the following Technical Specification requirements for the ΔP system:

a. Differential pressure between the drywell and suppression chamber shall be maintained equal to or greater than "X" (where X is the plant-specific differential pressure and values less than one psid will not be credited for load mitigation), except as specified in b and c below.

b. The differential pressure shall be established within 24 hours after placing the plant in the RUN mode, during plant startup. The differential pressure may be reduced below "X" psid 24 hours prior to a scheduled plant shutdown.

c. The differential pressure may be reduced to less than "X" psid for a maximum of four hours during required operability testing of (specify here those safety-related systems for which operability tests either release significant amounts of energy to the suppression pool or cannot be performed with the ΔP established).

d. In the event that the specification in a above cannot be met, and the differential pressure cannot be restored within six hours, an orderly shutdown shall be initiated and the reactor shall be in a cold shutdown condition within the subsequent 24 hours.

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e. A minimum of two narrow range instrument channels shall be provided to monitor the differential pressure. Error in the ΔP measurement shall be no greater than ± 0.1 psid or the allowable ΔP shall be increased to offset the error in the measurement. The instrument channels shall be calibrated once every six months. In the event that the measurement is reduced to one indication, operation is permissible for the following seven days. If all indication of the differential pressure is lost, and cannot be restored in six hours, an orderly shutdown shall be initiated and the reactor shall be in a cold shutdown condition within the subsequent 24 hours.

3. STRUCTURAL ANALYSIS AND ACCEPTANCE CRITERIA

The staff finds the general analysis techniques and proposed structural acceptance criteria set forth in the "Mark I Containment Program Structural Acceptance Criteria Plant Unique Analysis Applications Guide," (PUAAG), NEDO 24583, Revision 1, dated July 1979, acceptable. The proposed criteria will provide a sufficient basis for demonstrating the margins of safety required for steel structures and piping in the ASME Boiler and Pressure Vessel Code and for concrete structures in the American Concrete Institute Code.

Revision 1 to the PUAAG was presented to the staff in a meeting on June 29, 1979. We will require that this revision be formally submitted to complete the documentation required for this program.

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4. REFERENCES (Listed by Report umber)

NEDE-13426P "Mark III Confirmatory Test Program One-Third Scale Pool Swell Impact Tests, Test Series 5805," General Electric Proprietary Report, August 1975.

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