INVESTIGATION OF SEAWATER INGESTION INTO THE AUXILIARY SALT WATER PUMP ROOM DUE TO SPLASH RUNUP DURING THE DESIGN FLOOD EVENTS AT DIABLO CANYON

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Summary

Observations from the 1:45 scale model studies performed on the breakwater and the intake structure by Offshore Technology Corporation (OTC) for O..J. Lillevang have shown that splash run-up from the control building exceeded the elevation of the extended Auxiliary Saltwater (ASW) Pump air vents during model tests of both "Design Flood Events" with the breakwater degraded to MLLW. An investigation was conducted at the request of the NRC to determine the resulting potential for ingestion of the splash run-up through the vents, and to determine the effects of such ingestion on the ASW pumps.

Data on the frequency and dimensions of the splash run-up were obtained from tests conducted by OTC. Based upon analysis of test observations and other available data it was determined that:

1. For significant ingestion to occur strong offshore winds would be required to blow the splash run-up from the control building into the air vents.

2. More than 800 ft^3 of water would need to be ingested into each ASW pump room in order to potentially affect the operation of the pumps.

3. An offshore windspeed of more than 150 fps (102 mph) must be sustained for a period of two hours, coincident with the Design Flood Events, in order to cause ingestion of 800 ft^3 of seawater into an ASW pump room.

On the basis of wind statistics at Diablo Canyon, the intake area being sheltered from offshore winds, and the occurrence of the design flood events requiring strong regional onshore winds, it was determined that the combination of windspeed, direction and duration neccessary to cause ingestion of 800 ft^3 is not conceivable.

Therefore it is concluded that the operation of the ASW pumps would not be affected by splash run-up exceeding the elevation of the extended ASW pump air vents.

1.0 Introduction

1.1 Purpose

The purpose of this report is to answer questions raised by the Nuclear Regulatory Commission (NRC) as to the possibility of ingestion of seawater into the air intake vents of the Auxiliary Saltwater Pumps, to the extent that pump operation would be affected by the subsequent flooding of the Pump Room. The analysis of test data presented herein shows that the ingestion of sufficient water to affect the operation of the ASW pumps is not conceivable.

1.2 Background

The overall configuration of the Auxiliary Saltwater Pump (ASWP) room and modified ventilation structures is shown in Figure 1. Details of the ventilation structure are shown in Figure 2. In the original design the air vents were at approximately 30 ft MLLW. This design was modified based on model tests on the structure under the Design Flood conditions (see Reference 1, Lillivang, Cox and Raichlen, 1982). These tests, performed on a 1:45 scale model, showed that under extreme conditions, the transient water level could exceed the original vent elevation. The design modification consisted of adding extensions (snorkels) to the ventilation structures so that the vent openings are now between El. 48.0 ft and El. 52.0 ft (MLLW), i.e. approximately 20 ft higher than the previous elevation. Each of the four ASWP rooms is ventilated by a separate snorkel. The air intake is an annular opening, internal diameter 2.3 ft, and external diameter 3.7 ft. The air intake velocity is approximately 15 fps. The exhaust opening is located in the center of the snorkel, 0.8 ft outboard from the plane of the intake opening, and has a diameter of 2.2 ft. The exhaust velocity is 26 fps. Both the intake and exhaust openings are angled at 45° from the vertical, facing onshore and downwards, to prevent ingestion of wind driven onshore spray or splash up from the seaward face of the ventilation structures (see Figure 2).

The Lillivang report documented the height of splash runup during the Design Flood Events, and showed that under these extreme water level and wave conditions it was possible for splash runup to exceed the invert levels of the vent openings (approximately El. 48.0 ft). The question to be addressed here is whether it would be possible under these conditions to ingest sufficient water through the vents to affect the operation of the ASW pumps. Based on observations during the model tests, including careful review of test films, it appeared that the most feasible way for significant ingestion to occur was for the splash runup from the control building, located shoreward of the ventilation structures, to be blown into the vent openings by a strong offshore wind. This study addresses the speed, direction and duration of the wind necessary to cause significant ingestion during the Design Flood Event, and shows that unrealistically high sustained windspeeds would be necessary to affect the operation of the ASW pumps.

Details of the model tests, from which basic data were obtained for this study, are given in Reference 1, Lillivang, Cox and Raichlen (1982), in Reference 2, Raichlen (1982), and in Reference 3, Offshore Technology Corp. (1983).

1.3 Ingestion Scenarios

Three ingestion scenarios were considered. These are illustrated in Figure 3.

In scenario 1, a disk shaped splash, with length and width considerably greater than the thickness, d, was propelled vertically above the control building, was acted on by the wind, and immediately began to accelerate in the direction of the intake. The splash was not allowed to rotate and therefore was subject to maximum wind drag. At the intake a segment of the splash was ingested. This scenario is conservative in one respect, and non-conservative in another. Due to the orientation of the splash, the wind drag per unit mass of water is a maximum. However, the splash orientation also tends to limit ingestion compared to scenario 2.

In scenario 2 the splash was allowed to rotate as shown in Figure 3b. This scenario could result in greater ingestion per splash than scenario 1. However, during part of its trajectory the area of the splash exposed to the wind was considerably reduced, hence the drag per unit mass was reduced, and a higher wind speed was necessary to cause ingestion.

In scenario 3, shown in Figure 3c, a non-rotating splash was assumed over most of the trajectory, thus maximizing the drag per unit mass of water. Just before contact with the air intake the splash was assumed to rotate so that its long axis is parallel to its trajectory. This scenario is extremely conservative since it maximizes both the amount of ingestion, and the drag for a given wind speed.

For conservativism, scenario 3 was used in estimating the wind speed required to cause a critical level of ingestion.

1.4 Study Approach

The basic approach taken in the study was as follows:

1. Estimate the number of splash runup events above El. 48, the invert level of the intake, during the Design Flood Events, on the basis of the model test data.

2. Determine the dimensions of the "average" splash required to cause significant ingestion (800 ft^3 of water per ASWP room) on the basis of the above number of splash events.

3. Calculate the offshore wind speed required to cause the "average" splash to be ingested by the intake.

4. Evaluate the probability of the required windspeed, duration, and direction, in the light of the wind statistics at the site, the plant configuration, and the assumptions leading to the splash events.

2.0 Basic Criteria

Much of the information given in this section is taken from Raichlen (1982), the Final Safety Analysis Report (FSAR) and Supplement 5 to the Safety Evaluation Report (SER5). All dimensions given are for the prototype.

2.1 Design Flood Events

The concept of a "Design Flood Event" was defined at a meeting between NRC and PG&E staff on September 25, 1981. The events were defined as:

A. A probable maximum tsunami combined with storm waves of mean annual severity and high tide with anomaly.

B. A "Maximum Credible Wave Event" combined with high tide with anomaly.

For Case A, the still water level has been defined by SER5 as consisting of a maximum change in water level relative to the plant due to the tsunami of 9.2 ft, combined with a maximum astronomical and storm tide of 6.3 ft, resulting in a total still water surface elevation relative to Mean Lower Low Water (MLLW) of 15.5 ft. Hwang and Brandsma (1974) indicate that the peak water level exists for only a relatively short period of time (of the order of 2 to 3 minutes). For conservatism, a still water level of +17 ft was used in the model tests. The storm consisting of waves of mean annual severity has not been defined. Waves simulating the January 1981 storm were imposed in the model. The simulated 1981 storm is based on the wave spectrum measured for the January 28, 1981 storm, which damaged the breakwater. This storm had a significant wave height at the site of 21.8 ft and is defined by Borgman (1982) as having a recurrence interval of about 15.6 years. Thus it can be seen that the "Design Flood Event" test conditions imposed in the model were considerably more severe than those required by the NRC.

For Case B, a still water level of 6.3 ft has been defined by SER 5 as representing high tide with anomaly. For conservatism a still water level of 7.5 ft was used in the model. The "Maximum Credible Wave Event" has not been defined. Previous model tests (Lillivang et al, 1982) have indicated that the wave height in front of the intake is limited by the offshore terrain and the levelled breakwater. The tests showed that the "limited" wave height in the basin, in combination with the still water level, determined the splash runup effect, and that the offshore wave height was of marginal importance. The approach taken in the model tests was to expose the intake to waves simulating four severe storms (the 1905, 1914, 1981 and 1981+ storms), plus large periodic waves with

periods in the range observed at the site under storm wave conditions. The 1905, 1914 and 1981 storm spectra modeled were those as hindcast by Strange, 1982 and analyzed by Borgman (1982). The 1981^{+} storm was a magnified version of the 1981 storm, with a significant wave height of 26.8 ft and a recurrence interval of 41 years. Further discussion of the storm characteristics is given in Raichlen (1982).

2.2 Wave Direction

In general, two wave directions were used in the model tests. The first direction in deep water was 180^{o} , which due to refraction caused by the offshore bathymetry becomes 203^{o} at the location of the wave machines in the model. The second was for a direction in deep water of 225^{o} which is unchanged when it arrives at the site. The southerly (203^{o}) direction was considered of primary importance because it provided the most direct path to the intake structure with waves traveling between natural terrain features and through the breakwater gap. This direction was used for most tests, although the predominance of wave attack at the site, as determined from hindcasts, was from more westerly directions.

Further details on the importance of wave direction are given in Raichlen (1982) and in a supplemental letter to the Lillivang et al (1982) report.

2.3 Breakwater Condition

All tests in the model, for which data were obtained for this study, used "degraded" breakwaters, i.e. the crests of both the East and West breakwater were reduced to the MLLW level. Further details are given in Raichlen (1982).

2.4 Auxiliary Salt Water Pump (ASWP) Flooding Criterion

Each ASWP room can hold up to 800 ft^3 of water without the pumps being affected because the pump motors are elevated 6.0 ft. above the floor. Since each ASWP room is vented by a separate snorkel, this means that each vent opening can ingest 800 ft^3 of water before a critical condition is reached.

3.0 Basic Data

In order to calculate the wind speed required to cause a critical volume of ingestion, it was first necessary to determine the number of splash run-up events during the Design Flood Event, plus the average dimensions of the splashes. These basic data were obtained from the model tests.

3.1 Number of Splash Runup "Events"

The number of splash runup events per unit time was obtained for four storms (the 1905, 1914, 1981 and 1981^{+} storms) and for three still water levels, +7.5 ft, +13.0 ft and +17.0 ft (MLLW). A storm duration of

approximately three hours was simulated in the model. A plexiglas plate was installed with the bottom of the plate slightly below El. 48.0 ft., the invert level of the vent opening. The plate had dimensions equivalent to 48 ft x 27 ft in the prototype. In the offshore direction the plate extended from the centerline of the snorkel tubes to just shoreward of the offshore edge of the control building. The plate also extended 10 ft on either side of the exterior snorkels. Figure 4 shows the plate location. Each splash on the underside of the plate was counted as an event. Table 1 shows the number of splash events in three hours (prototype) for each of the three water levels for the 1981 storm, plus for the +7.5 and +17 ft water levels for the 1905, 1914 and 1981^{+} storms.

Using the water level versus time history of the Design Flood Event, plus the information in Table 1, the number of events for each design flood condition could be estimated. Further details are given in Section 5.1.

3.2 Splash Dimensions

Figure 3c illustrates that the amount of ingestion per splash is affected by both the splash thickness and the splash length. A value for the average length was obtained by filming the splash events with a highspeed camera (124 frames/sec) and plotting the duration of the splash above El. 48.0 (the invert level of the snorkel) versus the height of rise. Figure 5 shows the results obtained. For a single particle the height versus duration curves could be obtained from simple dynamic theory. The deviation of the data from this curve was due to the fact that the splashes had a finite length, i.e. consisted of a stream of water being ejected for a finite period above the intake invert level. This length was determined by first calculating the mean difference between the observed durations of the splashes above El. 48.0 and the theoretical duration for single particles. This time difference, approximately 0.3 secs, was then multiplied by the splash velocity at the intake level to obtain the appropriate splash length.

In determining the mean splash length, only splash heights between El. 48.0 and El. 57.0 were considered, since splashes higher than El. 57.0 would cross the plane of the air vent at a steep angle, greater than 45^{o}, and could not be ingested by the bevelled face of the air vent (see Section 5.2).

4.0 Assumptions

A series of conservative assumptions were used in the present study, and these, in combination with the conservative criteria and extreme test conditions used to acquire the data base described in the previous sections, result in an extremely conservative approach. The key assumptions were:

1. All splash events above El. 48.0 ft MLLW could result in ingestion in all four snorkels. This is a very conservative assumption, since most splash events consisted of a water mass of limited width, typically much less than the lateral separation of the outside snorkels (28 ft). It is therefore unlikely that all the air vents would be affected by a particular splash, or that any of the air vents would ingest water each time a splash occurred.

2. A conservative water level versus time hydrograph was assumed for Design Flood Event A which includes the probable maximum tsunami and high tide with anomaly. In estimating the number of splash events the water level was assumed to remain at +17 ft (MLLW) for 7 minutes, and at +13 ft for 2 hours. The actual times (see Figure 6) would be 2-3 minutes for +16.5 ft, and 30 minutes for +12.0 ft.

3. Water was assumed to be ingested through both the intake annulus and the exhaust opening. A rectangular opening, width 3.7 ft (44") was assumed, rather than the actual shape of the opening. Figure 7 illustrates this point.

4. The full length of each splash was assumed to be ingested. This is illustrated by Figure 7.

5. Each splash was assumed to consist of a disk shaped mass of water, with both length and width considerably greater than the thickness. Over most of the splash trajectory the disk orientation was such that the maximum surface area was normal to the wind (see Figure 3c). A drag coefficient of 1.0 was assumed.

6. Each splash was assumed to begin as a vertical jet at the top edge of the control house. Based on observations during the tests, and examination of test films, it appears that in general the splashes had an onshore component, and tended to land on top of the control house. Occasional splashes were seen which appeared to have an offshore component, but these were rare. In general, the assumption of vertical jets is considered to be conservative.

7. During the whole period of the storm a strong offshore wind was assumed to blow directly from the control building towards the air vents. Strong winds from this direction are unlikely for several reasons.

    a. The high water levels include a 1.0 ft storm tide which means that, on a regional basis at least, the winds must be strongly onshore.

    b. Immediately behind the intake building the cliff rises to approximately El. 85 ft (MLLW). Inshore from the plant the ground continues to rise steeply, to approximately 1400 ft within 1.2 miles from the coast, so that the intake structure is relatively sheltered with respect to offshore winds.

8. The horizontal velocity of the water particle in the direction of the wind was neglected in calculating the drag of the wind on the splash. Therefore, the maximum wind force was assumed to act on the water mass throughout its trajectory. The effects of the exhaust and intake velocities were also neglected. This was a reasonable assumption since it was found that wind velocities required for ingestion were an order of magnitude higher than the air vent intake velocity.

9. The analysis indicated that there was a critical splash height which led to maximum ingestion for a minimum wind speed. This height was approximately El. 55 ft (MLLW) or 7 ft above the invert of the air vent opening. Higher splashes, which require a lower windspeed for their trajectory to impact the vent, arrive at the vent opening with an angle of incidence which prevents a critical level of ingestion. This is discussed further in Section 5.2. Lower splash heights are exposed to the wind for a shorter period, and require higher windspeeds to reach the vent. An additional conservative assumption was made that all splash runups above El. 48.0 (including those over El. 57.0 ft) reached the critical height.

With the exception of the neglect of the air intake velocities, the above assumptions are all conservative, some extremely so, and provide assurance that the estimated wind speeds required to drive the splashes into the air intake are on the low side.

5.0 Calculation of Critical Windspeed

The trajectory of a single splash is shown in Figure 7. A disk of water, length l, thickness d, is ejected vertically at the top of the control building. The splash is deflected by an offshore wind, velocity V_W, and propelled towards the air intake, where it arrives with an angle of incidence θ_A . If the angle of incidence is less than the angle of the intake opening (approximately 45^o), some of the water will be ingested into the intake. As discussed in Section 1.4, the calculation of the offshore windspeeds required to cause a critical level of ingestion (800 ft^3/snorkel) followed three basic steps:

- o determine the number of splash runup events
- o determine the dimensions of the average splash event required to cause a critical level of ingestion
- o calculate the minimum windspeed to move the splash to the intake.

5.1 Number of Splash Events

For Design Flood Event A (probable maximum tsunami + high tide with anomaly + annual storm) the number of splash events was estimated by combining the number of splashes/unit time for the 1981 storm and still

water levels of 13.0 ft and 17.0 ft (MLLW) (Table 1), with the assumed hydrograph in Figure 6. The 17.0 ft water level was assumed to exist for 7 minutes and the +13.0 ft water level for two hours. This was conservative in regard to both water levels. The 1981 storm has a return period of 15.6 years and was therefore far more severe than required by the "mean annual storm" criterion. This conservative combination resulted in a total of 35 splash events exceeding the elevation of the invert of the vent opening.

Design Flood Event B (high tide with anomaly plus maximum credible wave) was determined to be a much less severe case than Design Flood Event A. As shown by Table 1, a total of five tests, including four storms and two wave directions, were tested for the +7.5 ft water level. Only one of those tests, the 1981$^+$ storm (recurrence interval 41 years) produced splashes above the intake invert, and the number of occurrences was very small. The Lillivang et al (1982) report also indicated that the splash events for the +7.5 ft water level using regular "limit" waves were much less severe than those for higher water levels. The videotapes for the regular wave tests performed by Lillivang were examined and it was determined that the amount of water splashing above the vent invert (El. 48.0 ft) was not significant for the +7.5 ft water level tests. This fact, combined with zero splash events for the 1905, 1914 and 1981 storms, and small number (9 events/3 hours) for the 1981$^+$ storm indicate that Design Flood Event B is not a critical case and can be neglected compared to Design Flood Event A.

5.2 Splash Dimensions

The length of the splash was determined, as discussed in Section 3.2, by multiplying the velocity of the splash at the level of the intake invert (El. 48.0 ft) by 0.3 seconds, the average duration of the splash ejection.

The width of each splash was assumed to be sufficient to blanket all four snorkels, i.e. approximately 32.5 ft.

The thickness of the "average" splash was assumed to be that required to cause significant flooding in the ASWP room, i.e. ingestion of greater than 800 ft^3 of water, if 35 splashes hit the vent opening during the storm. The thickness, d_{crit}, was therefore given by

$$d_{crit} = \frac{800}{Nlb} \qquad (1)$$

where N = number of splash "events" = 35
l = length of splash (a function of splash height) (ft)
b = width of intake = 3.7 ft

For simplicity a rectangular rather than oval intake opening was assumed (see Figure 7).

For a given splash height, the duration of the splash from the time it appeared above the control house, until it enters the air intake, was calculated from simple dynamics. The vertical and horizontal (and hence the resultant) velocity at the intake could therefore be computed. The splash length was deterimined by multiplying the velocity by 0.3 seconds. The required splash thickness, d_{crit}, was then calculated.

For each splash height an angle of incidence of the splash could be determined. This angle is a unique function of the splash height. The relationship between the angle and the splash height is shown in Figure 8. Due to the orientation of the intake opening, ingestion cannot occur for angles greater than 45^{o} (see Figure 7). This angle of incidence occurred for a splash height of El. 57.0 ft, and thus high splashes, which would have longer exposure to the wind, and therefore require lower windspeeds to hit the vent opening, were eliminated due to their approach angle. For angles slightly smaller than 45^{o}, i.e. splashes close to El. 57 ft, the effective height of the vent opening was small, and limited ingestion. This effective vent opening, d_{eff}, is given in Table 2 for a range of splash heights. It is readily seen from Table 2 that splashes above El. 55 ft approach the vent at too acute an angle to cause critical ingestion, i.e. the required thickness, d_{crit}, is greater than the effective vent opening, d_{eff}, allowing only a portion of the splash to be ingested.

5.3 Calculation of Critical Windspeed

Using the assumptions given in Section 4.0 and simple dynamic theory, a relationship between the splash thickness d, the splash elevation, and the offshore wind speed was readily obtained. The splash thickness used was the time average of the thickness over the splash trajectory, which is slighly larger than the splash thickness at the vent opening. Figure 9 shows the curves of windspeed versus splash thickness for three splash heights. The curves demonstrate, as may be expected, that the windspeed required to force the splash to hit the vent opening increases with splash thickness, and decreases with splash height. The minimum required splash thickness at the vent (to result in ingestion of greater than 800 ft^3/snorkel) was approximately 0.7 ft and occurred for a splash height of just under El. 55.0 ft (see Table 2). The corresponding average splash thickness (over the trajectory) was approximately 1.0 ft, and the required windspeed was slightly greater than 150 fps or approximately 102 mph. Figure 10 shows the variation in critical windspeed with splash height.

Table 2 and Figure 10 demonstrate that for splash heights below the top of the intake opening (El. 52.0 ft) windspeeds greater than 200 fps are required to cause critical ingestion.

6.0 Probability of Occurrence of Critical Windspeed

Windspeeds at the site were addressed in the FSAR, Volume 2, both in terms of the regional windspeeds and site measurements. The annual fastest mile (30 ft elevation) with a 100 year recurrence interval is given by Thom (1968) as 80 mph for the North Central California coastal region. The duration of this event would be less than 1 minute, and the equivalent hourly average windspeeds would be considerably smaller. As shown in Thuillier (1982), site measurements over a period of 15+ years at Station E, on the bluff adjacent to the intake, indicated a peak gust of 58 mph, and a maximum hourly average windspeed of 42 mph. Examination of the site windspeed and direction statistics indicate that offshore winds (from the NNE) above 15 mph are rare, which is reasonable since the ground level rises to an elevation of 1400 ft within 1.2 miles from the coast in the NNE direction, and therfore the site is well sheltered from winds from this direction.

It should also be noted that Design Flood Event A assumes a 1.0 ft storm tide, which implies strong regional onshore winds, and thus makes the required local offshore winds very unlikely.

On the basis of the above information it can be stated that the probability of a 102 mph offshore wind, with a duration exceeding two hours, is extremely low.

7.0 Conclusions

Data on splash runup during the Design Flood Event were obtained from the scale model studies performed by OTC. These data were used both to determine the frequency of splash runup above the invert of the air vent opening, and to obtain an estimate of the splash dimensions. This information, plus a number of conservative assumptions, were used to determine that a minimum offshore wind speed greater than 150 fps (102 mph) sustained for a period of two hours, is required to result in critical ingestion. This windspeed, duration and direction is considered totally unrealistic, given the windspeed statistics for the site, the fact that the intake is sheltered from offshore winds, and the fact that the high water levels during the Design Flood Event assume strong regional onshore winds.

It can be concluded, therefore, that the combination of degraded breakwater, tsunami, high tide, severe storm and extreme offshore winds necessary to result in a critical volume of water ingestion (800 ft^3 per ASWP room) is extremely unlikely to occur, and that operation of the ASW pumps will not be affected.

References

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TABLE 1

INGESTION TESTS

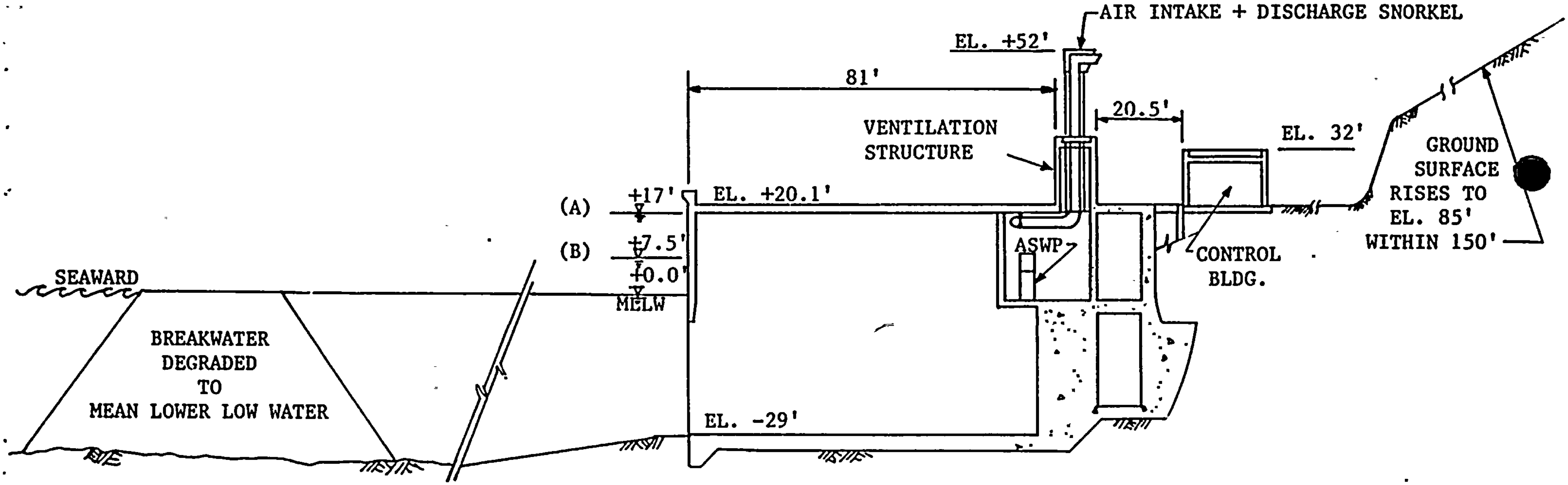
(From OTC Report, Reference 3)

Storm Condition	Water Depth Above MLLW (ft)	Wave Direction (deg)	Number of Splashes Above Vent Opening/3 Hrs.
IRREGULAR			
WAVES			
1905	+7.5	225	0
1981+	+7.5	225	9
1914	+7.5	225	0
1914	+17	225	26
1905	+17	225	49
1981+	+17	225	209
1981+	+17	225	119
1914	+17	225	0
1905	+17	225	74
1905	+7.5	203	0
1981	+7.5	203	0
1981	+13	203	44
1981	+17	203	119

TABLE 2
CRITICAL WIND SPEED VERSUS SPLASH HEIGHT

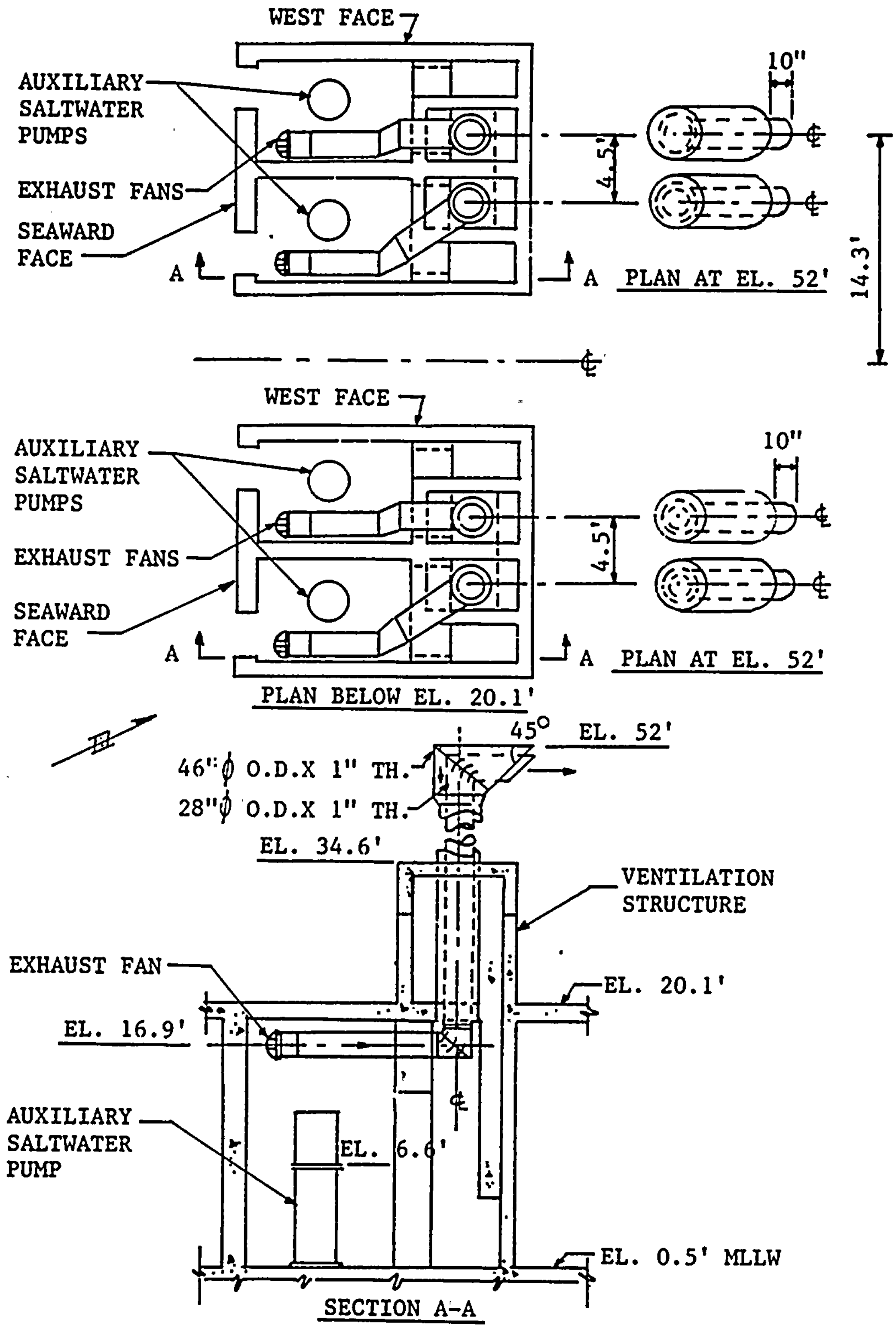
Splash Height Above MLLW (ft)	Angle of Incidence At Intake, (deg)	Effective Intake Opening, d_{eff} (ft)	Critical Splash Thickness, d_{crit} (ft)	Critical Wind Speed, V_w (fps)
56.0	42.5	0.23	0.69	(138)
55.0	38.8	0.56	0.70	(150)
54.5	36.5	0.77	0.70	155
54.0	35.0	0.90	0.70	161
53.5	32.5	1.12	0.70	170
53.0	29.0	1.43	0.70	178
52.0	25.0	1.80	0.69	200
51.0	18.5	2.32	0.67	231
50.0	9.0	3.10	0.61	285

NOTE: Parentheses indicate that splash approach angle is too steep for critical ingestion to occur i.e. that the effective intake opening, d_{eff}, is less than the critical splash thickness, d_{crit}.



NOT TO SCALE
ELEVATIONS REFERENCED TO MLLW

BECHTEL SAN FRANCISCO		
Diablo Canyon Project-- Report on Ingestion into ASW Pump Room		
Schematic of Intake Structure		
JOB No.	DRAWING No.	REV.
15320	Figure 1	



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Diablo Canyon Project-- Report on Ingestion into ASW Pump Room

A Schematic of the Vent Extension

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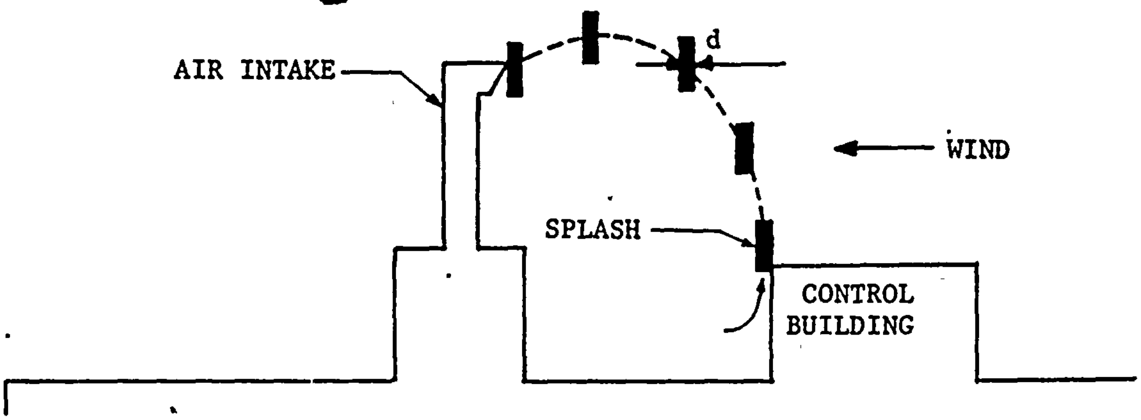
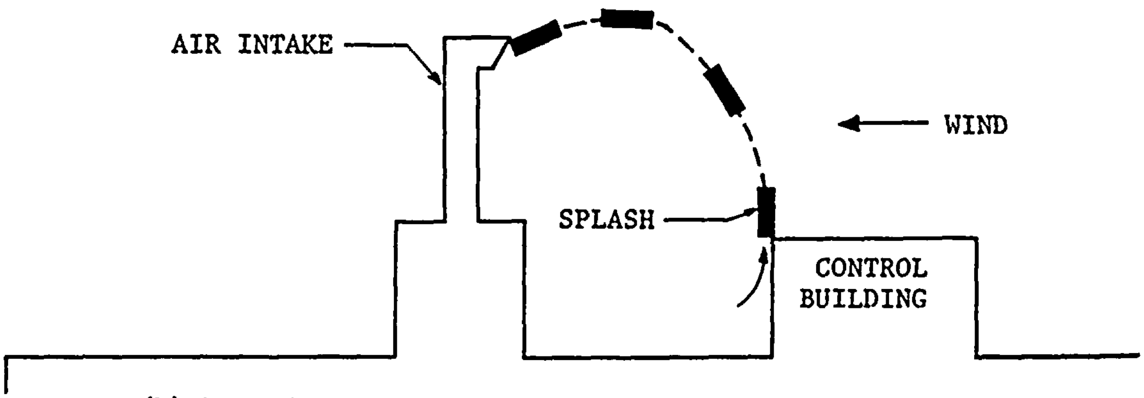
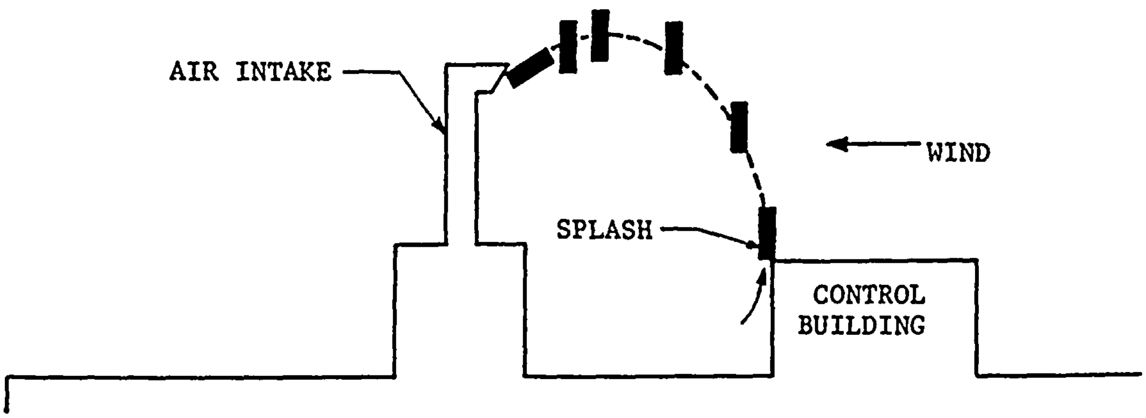
15320	Figure 2	



(a) Non Rotating Splash --- Scenario 1



(b) Rotating Splash --- Scenario 2



(c) Conservative Orientation --- Scenario 3

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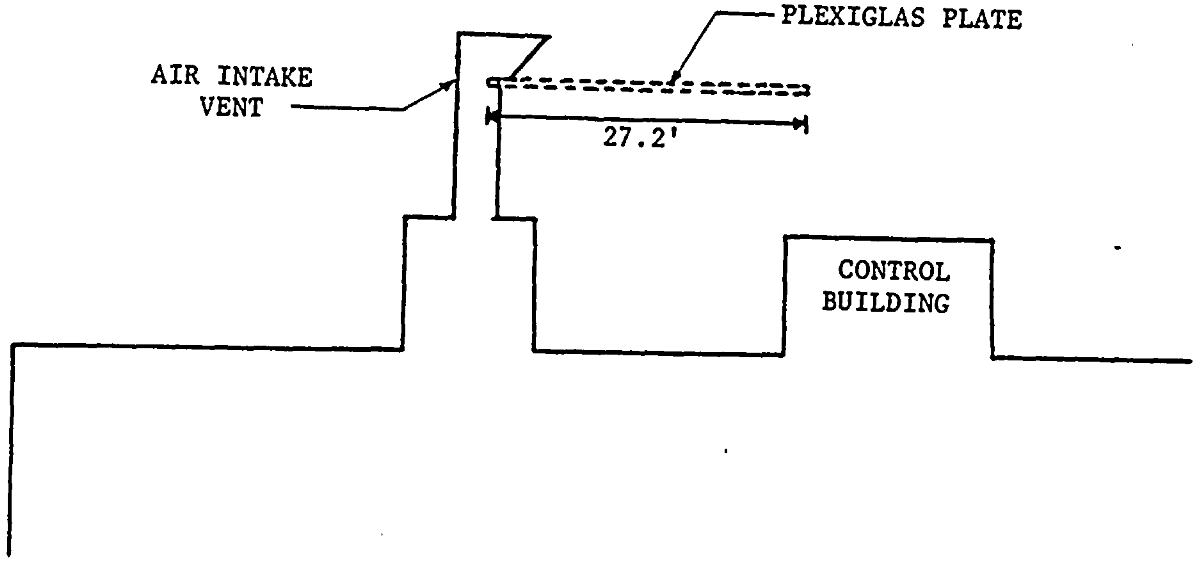
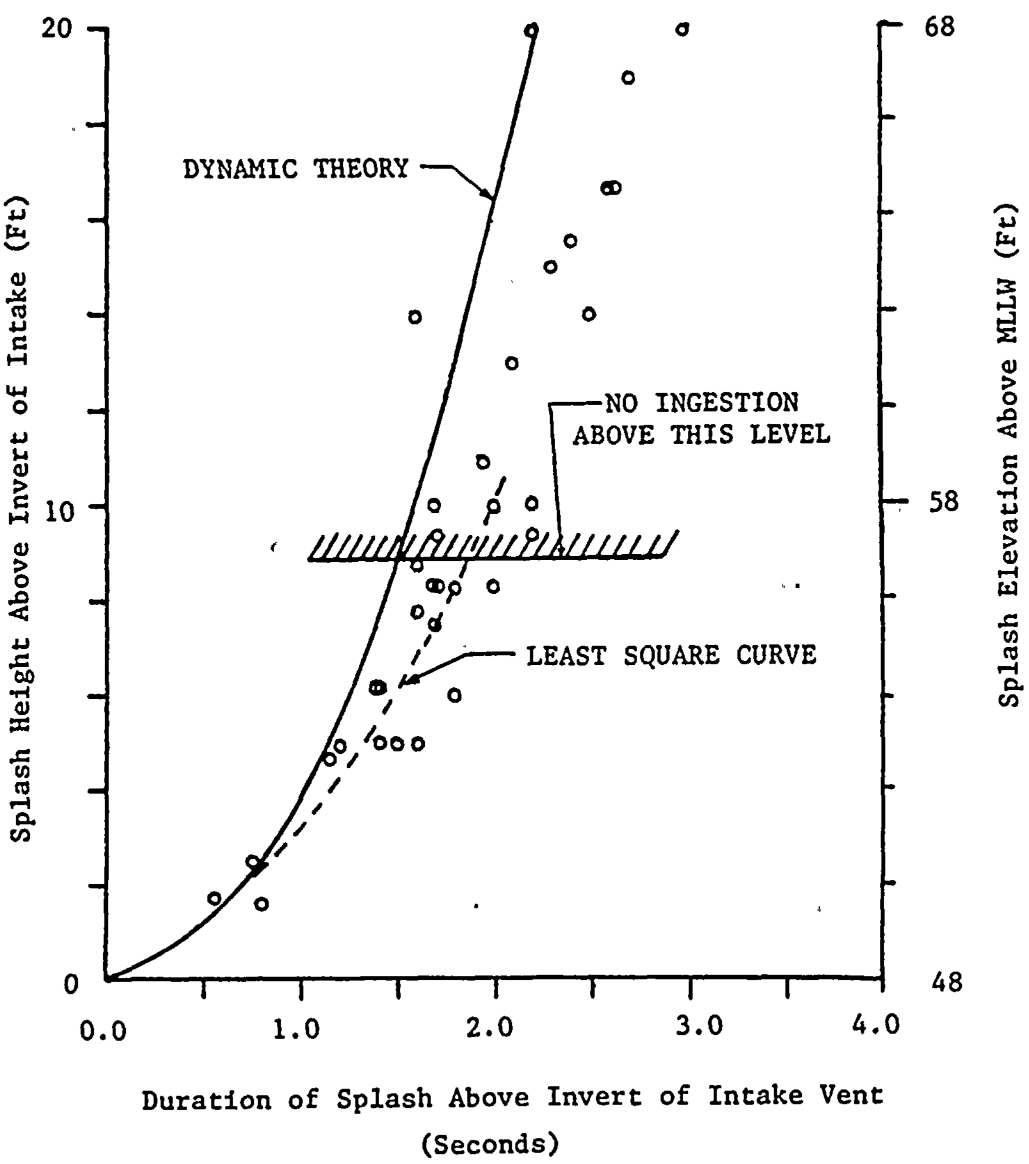
Diablo Canyon Project -- Report on Ingestion into ASW Pump Room

Scenarios for Splash Ingestion

JOB No.	DRAWING No.	REV.
15320	Figure 3	



BECHTEL SAN FRANCISCO		
Diablo Canyon Project -- Report on Ingestion into ASW Pump Room		
Plexiglas Plate for Counting Splash Runup "Events"		
JOB No.	DRAWING No.	REV.
15320	Figure 4	



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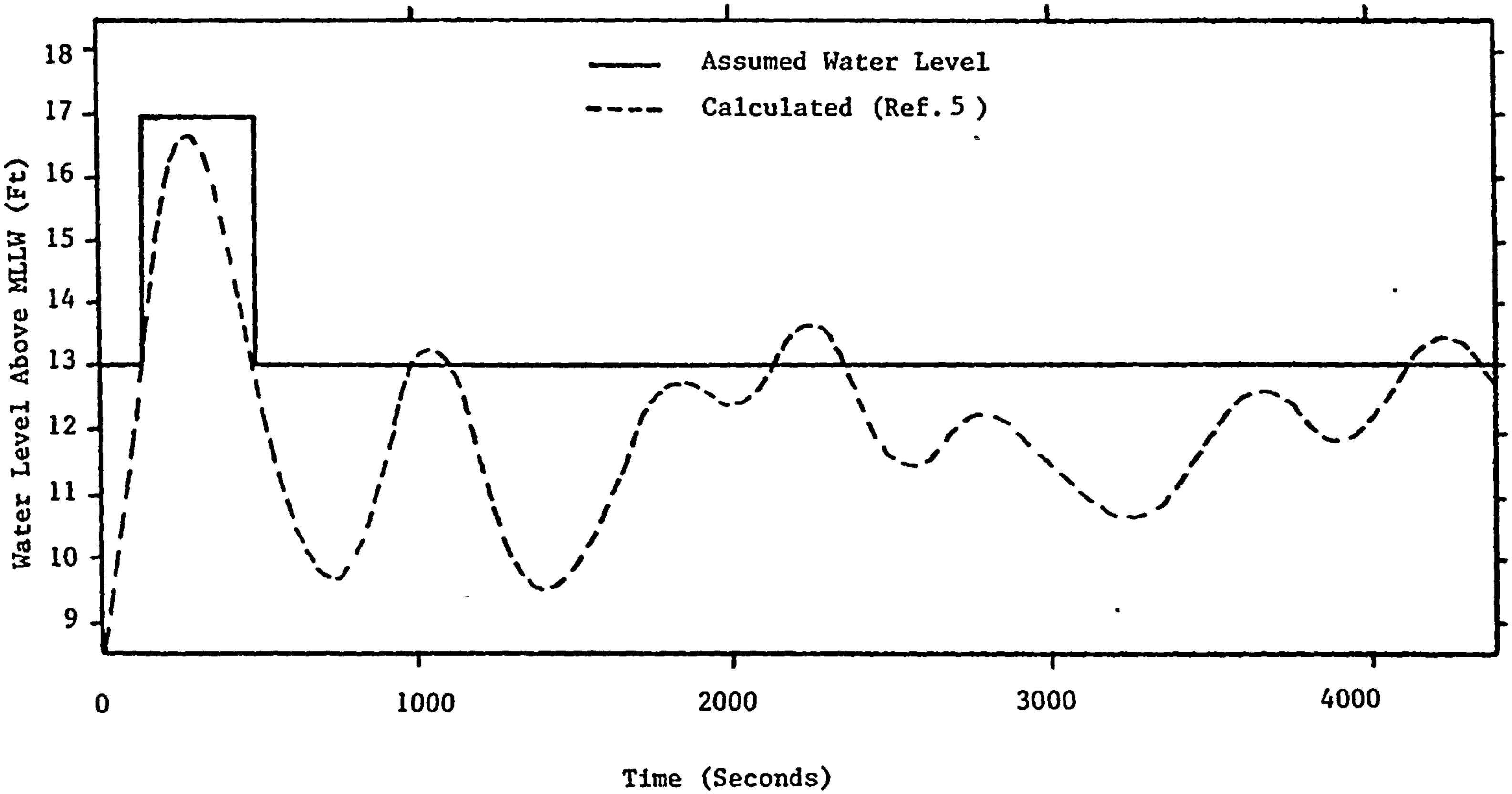
Diablo Canyon Project -- Report on Ingestion into ASW Pump Room		
Duration of the Splash-up Versus Elevation		
JOB No.	DRAWING No.	REV.
15320	Figure 5	



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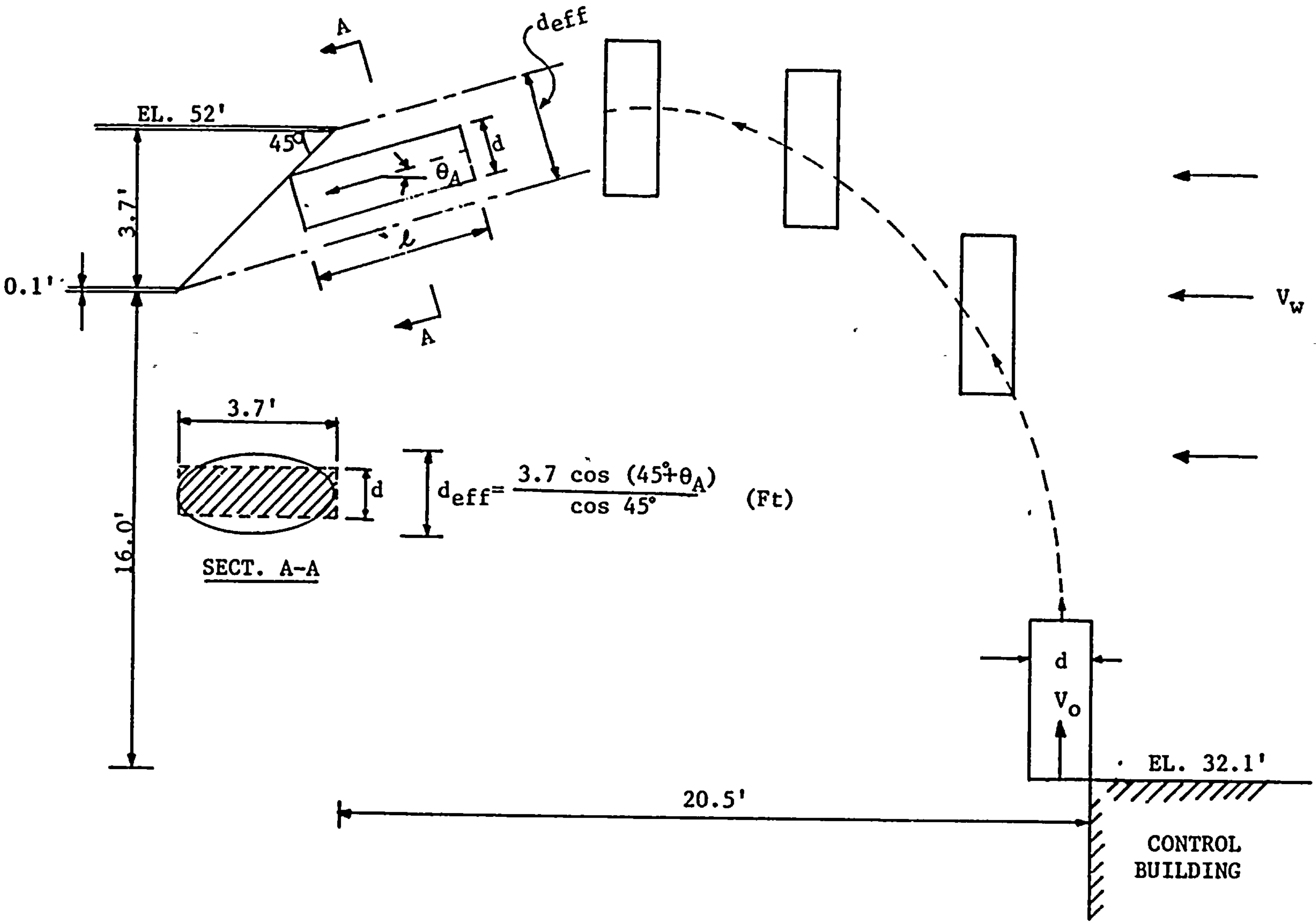
Diablo Canyon Project-- Report on Ingestion into ASW Pump Room

Time History of the Still Water Level in the Intake Basin

JOB No.	DRAWING No.	REV.
15320	Figure 6	



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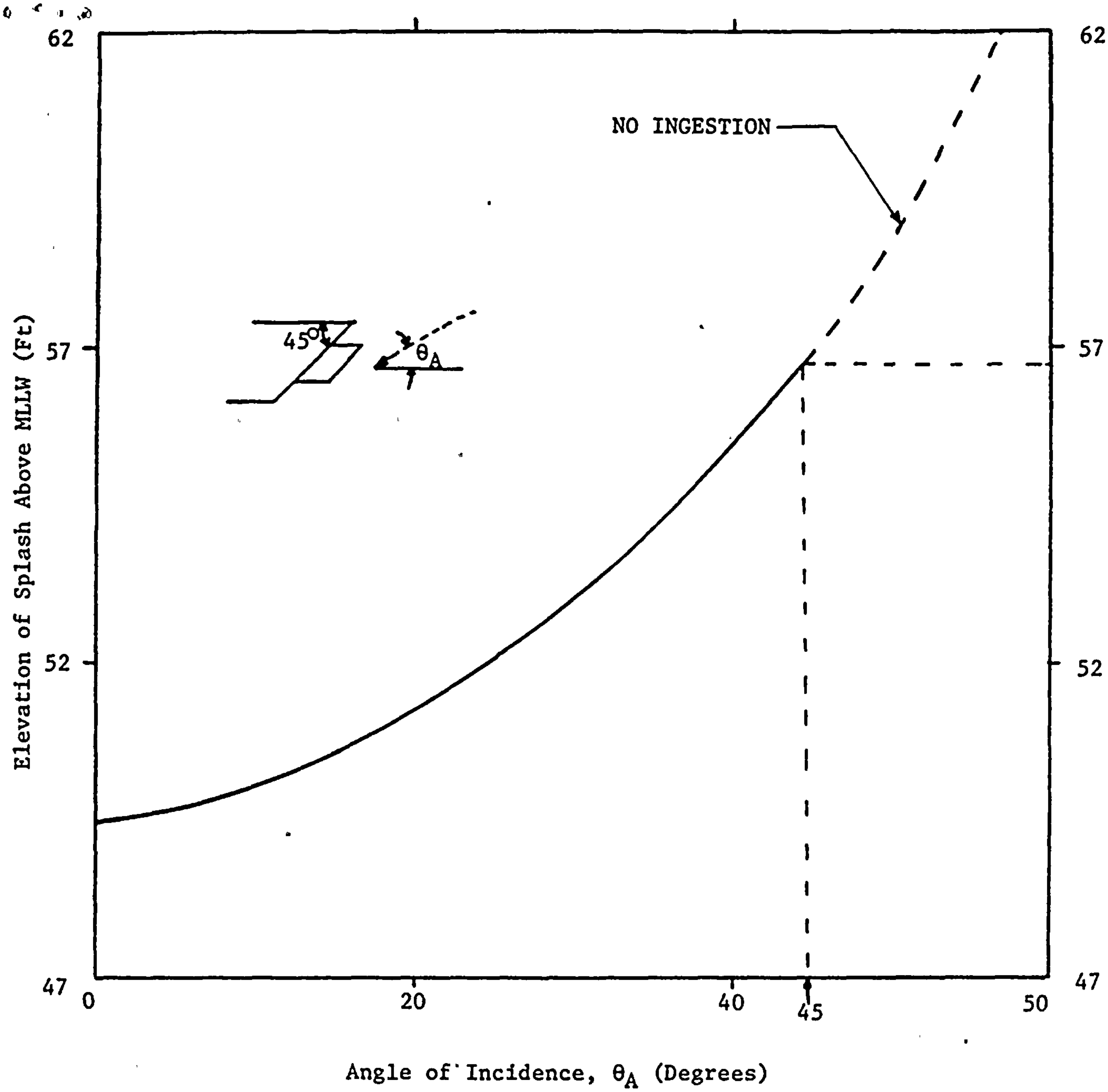
Sketch of the Splash-up Movement

JOB No.	DRAWING No.	REV.
15320	Figure 7	



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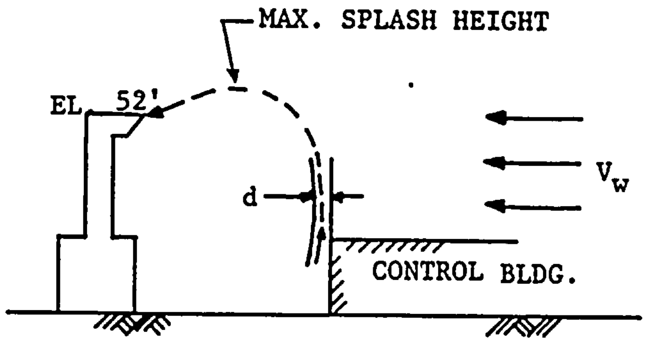
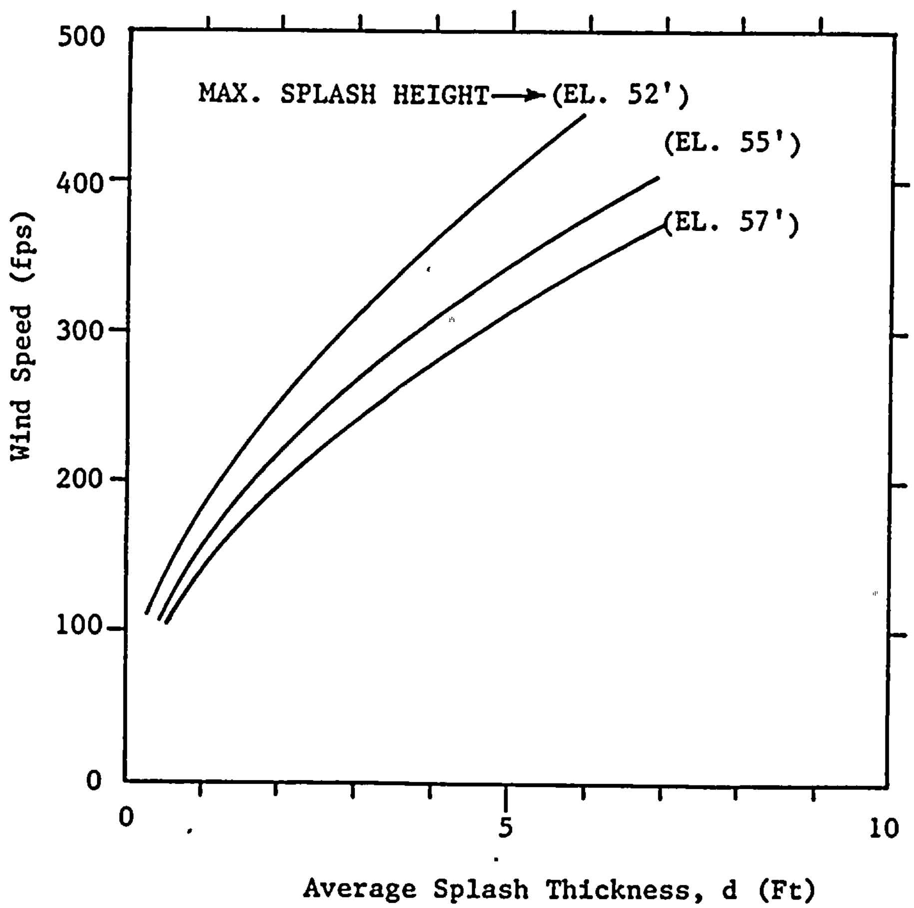
Diablo Canyon Project-- Report on Ingestion into ASW Pump Room		
Angle of Incidence of the Splash-up at the Air Vent		
JOB No.	DRAWING No.	REV.
15320	Figure 8	





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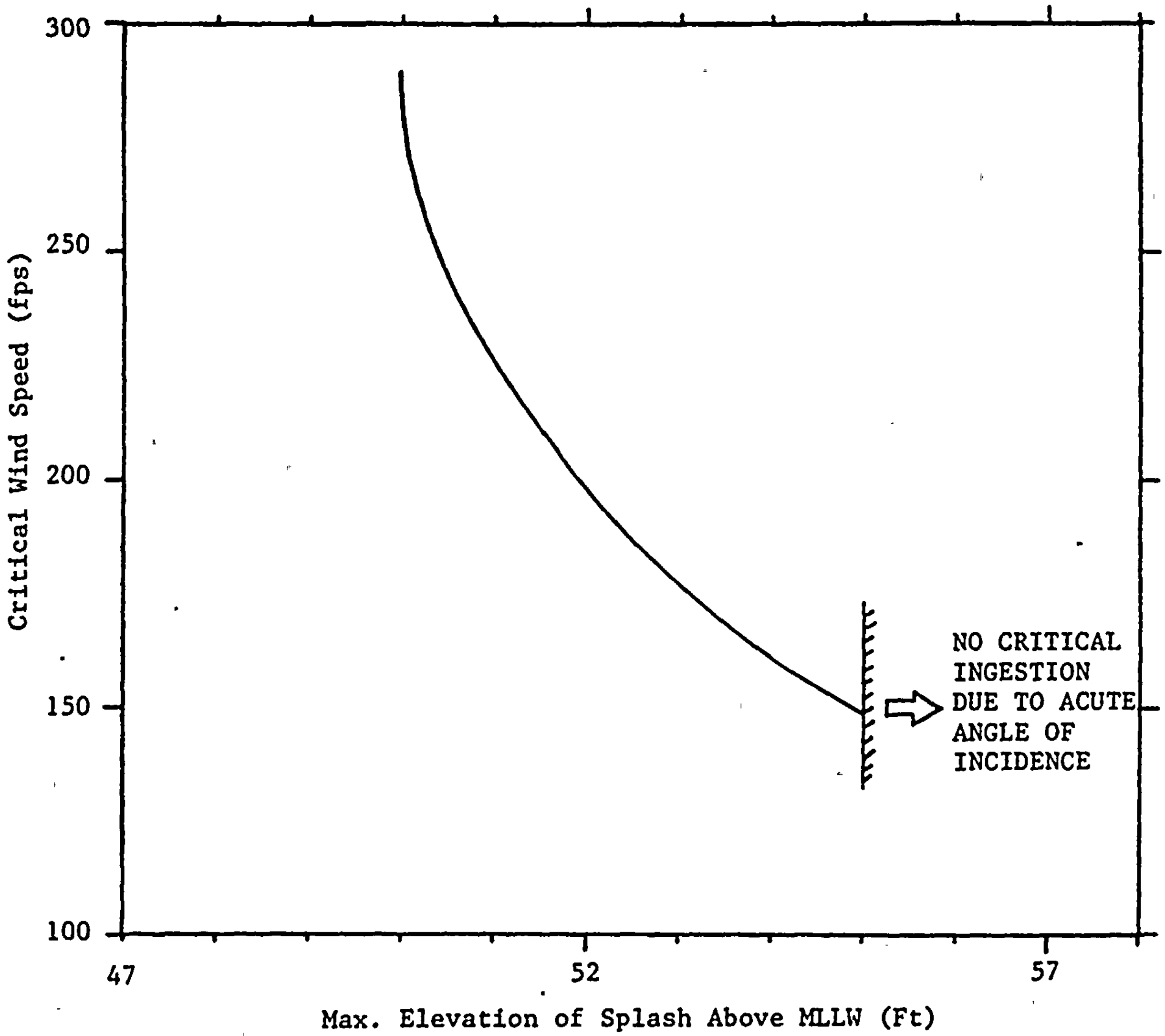
Relation of Wind Speed and Splash Thickness for Various Splash Heights		
JOB No.	DRAWING No.	REV.
15320	Figure 9	



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Diablo Canyon Project -- Report on Ingestion into ASW Pump Room		
Required Minimum Wind Speed for Critical Water Ingestion		
JOB No.	DRAWING No.	REV.
15320	Figure 10	