U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 2.4.3 PROBABLE MAXIMUM FLOOD (PMF) ON STREAMS AND RIVERS

REVIEW RESPONSIBILITIES

Primary - Site Analysis Branch (SAB)

Secondary - None

I. AREAS OF REVIEW

In this section of the safety analysis report (SAR) the hydrometeorological design basis is developed to determine the extent of any flood protection required for safety-related plant systems, as discussed in Regulatory Guide 1.59. The areas of review include the precipitation potential, precipitation losses, the runoff response characteristics of the watershed, the accumulation of flood runoff through river channels and reservoirs, the estimate of the discharge rate trace (hydrograph) of the probable maximum flood (PMF) at the plant site, the determination of PMF water level conditions at the site, and the evaluation of coincident wind-generated wave conditions that could occur with the PMF. Included is a review of the details of design bases for site drainage (which is summarized in SAR Section 2.4.2) and a review of the probable maximum precipitation (PMP) potential and resulting runoff for site drainage and drainage areas adjacent to the plant site, and including the roofs of safety-related structures. The analyses involve modeling of physical rainfall and runoff processes to estimate the upper level of possible flood conditions adjacent to and onsite.

Regulatory Guide 1.59 describes two positions with respect to flood protection. While both require an estimate of the PMF in determining the controlling design basis conditions, Position 2 limits the applicability of the design bases to specific equipment and facilities. If Position 2 is applicable, the review will be limited to the equipment and facilities identified in the guide.

II. ACCEPTANCE CRITERIA

The probable maximum flood as defined in Regulatory Guide 1.59 has been adopted as one of the conditions to be evaluated in establishing the applicable stream and river flooding design basis referred to in General Design Criterion 2, Appendix A, 10 CFR Part 50. The criteria for accepting the applicant's PMF-related design bases depend on the relative significance of the flood. PMF estimates are required for all adjacent streams or rivers

and site drainage (including the roofs of safety-related structures). One of three conditions may exist at the site under review, as follows:

1. The elevation attained by the PMF (with coincident wind waves) establishes a required protection level.

2. The elevation attained by the PMF (with coincident wind waves) is not controlling; the design basis flood protection level is established by another flood phenomena (e.g., the probable maximum hurricane).

3. The site is "dry", that is, the site is well above the elevation attained by a PMF (with coincident wind waves).

When condition 1 is applicable the staff will estimate the flood level as described below. The estimate may be made independently from basic data, by detailed review and checking of the applicant's analyses, or by comparison with estimates made by others which have been reviewed in detail. Acceptance is based on agreement of the staff and applicant estimates of static flood level to within about 2 feet or higher and of coincident wave action to within about 1 foot or higher.

When conditions 2 or 3 apply, the staff analyses may be less rigorous, as described below. For condition 2, acceptance is based on the protection level estimated for another flood-producing phenomenon exceeding the staff estimate of PMF water levels. For condition 3, the site grade must be well above the staff estimate of PMF water levels. The evaluation of the adequacy of the margin (difference in flood and site elevations) is generally a matter of engineering judgement. The judgement is based on the confidence in the flood level estimate and the degree of conservatism in each parameter used in the estimate.

III. REVIEW PROCEDURES

The review procedure is outlined in Figures 2.4.3-1 and -2, attached to this plan. In addition, Appendix A to Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants," is a codification of techniques used by the staff during the review and verification of PMF estimates. The evaluation of flooding potential is, for review purposes, separated into two parts; PMF on adjacent streams and local PMF. The review procedure for the former is indicated on Figure 2.4.3-1. The review procedure for evaluating a local PMF is indicated on Figure 2.4.3-2. (The procedure for evaluating the adequacy of site drainage facilities based on a local PMF is outlined in Standard Review Plan 2.4.2.) PMF estimates approved by the Chief of Engineers, Corps of Engineers, and contained in published or unpublished reports of that agency, or generalized estimates may be used in lieu of staff-developed estimates. In the absence of such estimates, the staff will use both large and small basin PMP estimates by the National Oceanic and Atmospheric Administration (NOAA) and published techniques of the World Meteorological Organization in conjunction with Corps of Engineers' runoff, impoundment, and river routing models to estimate PMF discharge and water level at the site. These methods are used for conditions 1 and 2, described in the acceptance criteria. When detailed independent estimates are necessary (see acceptance criteria), the applicant will be requested to provide any necessary basic data. Wind-generated wave action

will be independently estimated using Corps of Engineers criteria. Where sufficient water depth is available, the significant wave height and runup are used for structural design purposes, and the maximum (one percent) wave height and runup are used for flood level estimates. Where depth limits wave height, the breaking wave height and runup is used for both purposes.

When an applicant has chosen to demonstrate a "dry" site (i.e., condition 3, one not subject to stream flooding by virtue of local topographic considerations), the following procedures apply:

1. Use Corps of Engineers PMF estimates for other sites in the region to develop "regional drainage area vs. PMF discharge (cubic feet per second/square mile)" data, for extrapolation to the site.
2. Envelope the above data points to obtain an estimate of the PMF applicable to the site.
3. Increase the estimate based on a judgement as to the applicability of the basic estimates. An increase in the range of 10 to 50 percent is generally appropriate.
4. Estimate the flood level at the site using slope-area techniques or water surface profile computations, if warranted by relative elevation differences between the site and adjacent stream.
5. Estimate wind (40 mph over land) wave runup based on breaking, or maximum (one percent) wave.
6. Compare resultant water level with proposed plant grade and lowest safety-related facility that can be affected.

Consultants may be employed in an advisory role in developing independent staff flood effect estimates, depending on the complexity of the analysis required and available staff manpower. The consultants may be from the Hydrometeorological Branch of the U. S. Weather Service, the Corps of Engineers Coastal Engineering Research Center, or private contractors.

The above items of review are performed only when applicable to the site or site region. Some items of review may be done on a generic basis.

IV. EVALUATION FINDINGS

For construction permit (CP) reviews the findings consist of a statement describing the applicant and staff estimates of the peak PMF runoff rate and water level (including allowance for coincident wind-generated wave activity) at the site. If the estimates are similar, staff concurrence will be stated. If the staff predicts substantially more severe flood conditions which may adversely affect the proposed plant, and the applicant has been unable to support his estimates, a statement requiring use of the staff bases will be made. If the flood conditions do not constitute a design basis, the statement will so indicate.

For operating license (OL) reviews which have received detailed PMF reviews during the CP review, the CP conclusions will be referenced. If no CP PMF review was undertaken (of the scope indicated), this fact will be indicated in the OL findings. Any flood potential not identified during the CP review will be noted.

If Regulatory Guide 1.59, Position 2, is elected by the applicant, a statement describing lesser design bases will be included in the findings with a staff conclusion of adequacy.

A sample statement for a CP review follows:

"The Probable Maximum Flood (PMF) resulting from the Probable Maximum Precipitation (PMP) on the ABC River drainage basin yielded an estimated maximum stillwater level at the intake structure on the D & E Canal of about 5.0 feet MSL.

"The PMF resulting from a local PMP storm on the drainage basins for the small streams near the site yielded an estimated maximum stillwater level of about 60 feet MSL, which is about 20 feet below plant grade.

"The local PMF resulting from the estimated local PMP was found not to cause flooding of safety-related facilities, since the site drainage system will be capable of functioning adequately during such a storm. Catch basins will be provided as part of the storm drainage system and will be located throughout the plant site to drain local areas. The plant yard will be graded with gentle slopes away from high points at the plant buildings, and storm water will drain away from the buildings into the local streams at lower elevations."

V. REFERENCES

In addition to the following specific references, Design Memoranda, Civil Works Investigations and research and development reports of the Corps of Engineers and reports of other federal and state agencies relevant to flood estimates at a specific site will be used on an "as available" basis.

1. Reports of the Corps of Engineers, Department of the Army:
EM 1110-2-1411, "Standard Project Flood Determinations", 26 March 1952 (rev. March 1965).

EC 1110-2-27, "Policies and Procedures Pertaining to Determination of Spillway Capacities and Freeboard Allowances for Dams," 19 February 1968.

EM 1110-2-1405, "Flood Hydrograph Analysis and Computations," 31 August 1959.

EM 1110-2-1408, "Routing of Floods Through River Channels," 1 March 1960.

EM 1110-2-1406, "Runoff from Snowmelt," 5 January 1960.

EM 1110-2-1603, "Hydraulic Design of Spillways," 31 March 1965.

EM 1110-2-1409, "Backwater Curves in River Channels," 7 December 1959.

Technical Bulletin No. 8, Sacramento District, "Generalized Snowmelt Runoff Frequencies," September 1962.

EM 1110-2-1601, "Hydraulic Design of Flood Control Channels," 1 July 1970.

EM 1110-2-1607, "Tidal Hydraulics," 2 August 1965.

CE 1308, "Stone Protection," January 1948.

EM 1110-2-1410, "Interior Drainage of Leveed Urban Areas: Hydrology," 3 May 1965.

Technical Report No. 4, Coastal Engineering Research Center, "Shore Protection, Planning and Design," 1966 and "Shore Protection Manual," (1973).

Waterways Experiment Station, "Hydraulic Design Criteria," continuously updated.

TSP37, "Riprap Stability on Earth Embankments Tested in Large and Small-Scale Wave Tanks," June 1972.

ETL 1110-2-120, "Additional Guidance for Riprap Channel Protection," May 1971.

2. Hydrometeorological Reports of the U. S. Weather Bureau (now U. S. Weather Service, NOAA), Hydrometeorological Branch:
No. 1., "Maximum Possible Precipitation Over the Ompompanoosuc Basin above Union Village, Vt." (1943).

No. 2., "Maximum Possible Precipitation over the Ohio River Basin above Pittsburgh, Pa." (1942).

No. 3., "Maximum Possible Precipitation over the Sacramento Basin of California" (1943).

No. 4., "Maximum Possible Precipitation over the Panama Canal Basin" (1943).

No. 5., "Thunderstorm Rainfall" (1947).

No. 6., "A Preliminary Report on the Probable Occurrence of Excessive Precipitation over Fort Supply Basin, Okla." (1938).

No. 7., "Worst Probable Meteorological Condition on Mill Creek, Butler and Hamilton Counties, Ohio" (1937), unpublished. Supplement (1938).

No. 8., "A Hydrometeorological Analysis of Possible Maximum Precipitation over St. Francis River Basin above Wappapello, Mo." (1938).

No. 9., "A report on the Possible Occurrence of Maximum Precipitation over White River Basin above Mud Mountain Dam Site, Wash." (1939).

No. 10., "Maximum Possible Rainfall over the Arkansas River Basin above Caddoa, Colo." (1939) Supplement (1939).

No. 11., "A Preliminary Report on the Maximum Possible Precipitation over the Dorena, Cottage Grove, and Fern Ridge Basins in the Willamette Basin, Oreg." (1939).

No. 12., "Maximum Possible Precipitation over the Red River Basin above Denison, Tex." (1939).

No. 13., "A Report on the Maximum Possible Precipitation over Cherry Creek Basin in Colorado"(1940).

No. 14., "The Frequency of Flood-Producing Rainfall over the Pajaro River Basin in California" (1940).

No. 15., "A Report on Depth-Frequency Relations of Thunderstorm Rainfall on the Sevier Basin, Utah" (1941).

No. 16., "A Preliminary Report on the Maximum Possible Precipitation over the Potomac and Rappahannock River Basins" (1943).

No. 17., "Maximum Possible Precipitation over the Pecos Basin of New Mexico" (1944), unpublished.

No. 18., "Tentative Estimates of Maximum Possible Flood-Producing Meteorological Conditions in the Columbia River Basin" (1945).

No. 19., "Preliminary Report on Depth-Duration-Frequency Characteristics of Precipitation over the Muskingum Basin for 1- to 9-week Periods" (1945).

No. 20., "An Estimate of Maximum Possible Flood-Producing Meteorological Conditions in the Missouri River Basin above Garrison Dam Site" (1945).

No. 21., "A Hydrometeorological Study of the Los Angeles Area" (1939).

No. 21A., "Preliminary Report on Maximum Possible Precipitation, Los Angeles Area, California" (1944).

No. 21B., "Revised Report on Maximum Possible Precipitation, Los Angeles Area, California" (1945).

No. 22., "An Estimate of Maximum Possible Flood-Producing Meteorological Conditions in the Missouri River Basin Between Garrison and Fort Randall" (1946).

No. 23., "Generalized Estimates of Maximum Possible Precipitation over the United States East of the 105th Meridian, for Areas of 10, 200, and 500 Square Miles" (1947).

No. 24., "Maximum Possible Precipitation over the San Joaquin Basin, Calif." (1947).

No. 25., "Representative 12-hour Dewpoints in Major United States Storms East of the Continental Divide" (1947).

No. 25A., "Representative 12-hour Dewpoints in Major United States Storms East of the Continental Divide," 2d edition (1949).

No. 26., "Analysis of Winds over Lake Okeechobee during Tropical Storm of August 26-27, 1949" (1951).

No. 27., "Estimate of Maximum Possible Precipitation, Rio Grande Basin, Fort Quitman to Zapata" (1951).

No. 28., "Generalized Estimate of Maximum Possible Precipitation over New England and New York" (1952).

No. 29., "Seasonal Variation of the Standard Project Storm for Areas of 200 and 1,000 Square Miles East of the 105th Meridian" (1953).

No. 30., "Meteorology of Floods at St. Louis" (1953), unpublished.

No. 31., "Analysis and Synthesis of Hurricane Wind Patterns over Lake Okeechobee, Florida" (1954).

No. 32., "Characteristics of United States Hurricanes Pertinent to Levee Design for Lake Okeechobee, Florida" (1954).

No. 33., "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24, and 48 Hours" (1956).

Draft Report, "All-Season Probable Maximum Precipitation, United States East of the 105th Meridian for Areas From 1,000 to 20,000 Square Miles and Durations From 6 to 72 Hours" (1972).

No. 34., "Meteorology of Flood-Producing Storms in the Mississippi River Basin" (1956).

No. 35., "Meteorology of Hypothetical Flood Sequences in the Mississippi River Basin" (1959).

No. 36., "Interim Report, Probable Maximum Precipitation in California" (1961), revised (1969).

No. 37., "Meteorology of Hydrologically Critical Storms in California" (1962).

No. 38., "Meteorology of Flood-Producing Storms in the Ohio River Basin" (1961).

No. 39., "Probable Maximum Precipitation in the Hawaiian Islands" (1963).

No. 40., "Probable Maximum Precipitation, Susquehanna River Drainage above Harrisburg, Pa." (1965).

No. 41., "Probable Maximum and TVA Precipitation over the Tennessee River Basin above Chattanooga" (1965).

No. 42., "Meteorological Conditions for the Probable Maximum Flood on the Yukon River above Rampart, Alaska" (1966).

No. 43., "Probable Maximum Precipitation, Northwest States" (1966).

No. 44., "Probable Maximum Precipitation over South Platte River, Colorado, and Minnesota River, Minnesota" (1969).

No. 45., "Probable Maximum and TVA Precipitation for Tennessee River Basin up to 3,000 Square Miles in Area and Durations to 72 Hours" (1969).

No. 46., "Probable Maximum Precipitation, Mekong River Basin" (1970).

No. 47., "Meteorological Criteria for Extreme Floods For Four Basins in the Tennessee and Cumberland River Basins" (1973).

No. 48., "Probable Maximum Precipitation and Snowmelt Criteria for Red River of the North Above Pembinz, and Souris River Above Minot, North Dakota" (1973).

3. Technical Papers of the U. S. Weather Bureau (Now U. S. Weather Service, NOAA):
No. 2., "Maximum Recorded United States Point Rainfall for 5 Minutes to 24 Hours at 207 First Order Stations," Rev. (1963).

No. 5., "Highest Persisting Dewpoints in the Western United States" (1948).

No. 10., "Mean Precipitable Water in the United States" (1949).

No. 13., "Mean Monthly and Annual Evaporation Data from Free Water Surface for the United States, Alaska, Hawaii, and the West Indies" (1950).

No. 14., "Tables of Precipitable Water and Other Factors for a Saturated Pseudo-Adiabatic Atmosphere" (1951).

No. 15., "Maximum Station Precipitation for 1, 2, 3, 6, 12, and 24 Hours:" Part I: Utah (1951); Part II: Idaho (1951); Part III: Florida (1952); Part IV: Maryland, Delaware, and District of Columbia (1953); Part V: New Jersey (1953); Part VI: New England (1953); Part VII: South Carolina (1953); Part VIII: Virginia (1954); Part IX: Georgia (1954); Part X: New York (1954); Part XI: North Carolina (1955); Part XII: Oregon (1955); Part XIII: Kentucky (1955); Part XIV: Louisiana (1955); Part XV: Alabama (1955); Part XVI: Pennsylvania (1956); Part XVII: Mississippi (1956); Part XVIII: West Virginia (1956); Part XIX: Tennessee (1956); Part XX: Indiana (1956); Part XXI: Illinois (1958); Part XXII: Ohio (1958); Part XXIII: California (1959); Part XXIV: Texas (1959); Part XXV: Arkansas (1960); Part XXVI: Oklahoma (1961).

No. 16., "Maximum 24-Hour Precipitation in the United States" (1952).

No. 25., "Rainfall Intensity-Duration-Frequency Curves for Selected Stations in the United States, Alaska, Hawaiian Islands, and Puerto Rico" (1955).

No. 28., "Rainfall Intensities for Local Drainage Design in Western United States for Durations of 20 Minutes to 24 Hours and 1- to 100-Year Return Periods" (1956).

No. 37., "Evaporation Maps for the United States" (1959).

No. 38., "Generalized Estimates of Probable Maximum Precipitation for the United States West of the 105th Meridian for Areas to 400 Square Miles and Durations to 24 Hours" (1960).

No. 40., "Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years" (1961).

No. 42., "Generalized Estimates of Probable Maximum Precipitation and Rainfall-Frequency Data for Puerto Rico and Virgin Islands" (1961).

No. 43., "Rainfall-Frequency Atlas of the Hawaiian Islands for Areas to 200 Square Miles, Durations to 24 Hours, and Return Periods from 1 to 100 Years" (1962).

No. 47., "Probable Maximum Precipitation and Rainfall-Frequency Data for Alaska for Areas to 400 Square Miles, Durations to 24 Hours, and Return Periods from 1 to 100 Years" (1963)

No. 48., "Characteristics of the Hurricane Storm Surge" (1963).

4. Unpublished Hydrometeorological Reports of the U. S. Weather Bureau (now U. S. Weather Service, NOAA):
"Rappahannock River above Salem Church Dam Site, Va." (11/28/50).

"Potomac River, Va., Md., W. Va., (12 sub-basins)" (6/29/56).

"Delaware River above Trenton, Chestnut Hill, and Belvidere Dam Sites" (11/19/56).

"Delaware River above Tock's Island Dam Site" (12/16/65).

"St. John River above Dickey Dam Site, and Between Dicky and Lincoln School Dam Sites, Maine" (12/20/66).

"Coosa River above Howell Mill Shoals Dam Site, Ala." (3/3/50).

"Cape Fear River above Smiley Falls Dam Site, N.C." (11/16/50).

"Savannah River above Hartwell Dam Site, N.C." (1/5/51).

"Alabama and Appalachicola Rivers, Ala. and Fla." (3/19/52).

"Black Warrior River above Holt Lock Dam Site, Ala." (12/10/59).

"South Fork of Holston River above Boone Dam Site, Tenn." (8/14/50).

"Allegheny River above Allegheny River Reservoir, Pa." (9/28/56).

"Kentucky River, Ky. (2 basins)" (3/12/58).

"New River above Moores Ferry Dam Site, Va." (5/13/63).

"Licking River, Ky, and White River, Ind." (11/9/64).

"Iowa River above Coralville Dam Site, Iowa" (11/20/47).

"Des Moines River above Saylorville, Iowa and Howell Dam Site, Iowa" (3/19/48).

"Salt River, Mo." (1/21/55).

"James River above Jamestown Dam Site, N. Dak." (9/16/48).

"Big Blue River above Tuttle Creek Dam Site, Kans." (10/23/51).

"Republican River at (a) above proposed Milford Dam Site, Kan.; and (b) between Harlan Co. Dam and proposed Milford Dam Site, Kans." (11/24/58).

"Meramec River Basin, Missouri" (12/21/61).

"Republican River above Harlan Co. Res., Neb." (3/7/69).

"Canadian River above Eufaula Dam Site, Okla." (12/19/47).

"White River above Table Rock Dam Site, Mo." (3/19/48).

"Eleven Point River above Water Valley Dam Site, Ark." (3/19/48).

"Kiamichi River above Hugo Dam Site, Okla." (4/9/48).

"Boggy Creek above Boswell Dam Site, Okla." (4/9/48).

"North Canadian River above Optima (Hardesty) Dam Site, Okla." (12/22/49).

"Lower Canadian River, Okla." (6/10/48).

"Gaines Creek Dam Site, Okla." (5/13/48).

"Onapa-Canadian (combined) Dam Site, Okla." (5/13/48).

"Verdigris River above Oologah Dam Site, Okla." (5/4/50).

"Little Red River above Green Ferry, Ark." (7/24/50).

"Grand (Neosho) River above Strawn Dam Site, Kans." (11/14/51).

"Pinon Canyon above Trinidad, Colo." (4/10/52).

"Beaver Reservoir, White River, Ark." (12/1/55).

"Kisatchie Dam Site on Kisatchie Bayou, La." (3/1/56).

"Cypress Creek above Mooringsport, La." (8/27/56).

"Little River above at (a) Millwood Dam Site, Ark.; and (b) Broken Bow, Okla." (5/14/59).

"White River Drainage above Wolf Bayou, Ark." (3/31/66).

"Upper Arkansas River, Colorado (sub-basins)" (2/13/67).

"Arkansas River Drainage Between John Martin Dam, Colo. and Great Bend, Kans." (9/23/69).

"Leon River above Belton Dam Site, Tex." (12/9/47).

"Jemez Creek, N. Mex." (12/9/49).

"Chama River above Chamita Dam Site, N. Mex." (1/18/50).

"Rio Hondo above Two Rivers Reservoir, N. Mex." (12/19/56).

"Richland Creek, Tex." (4/6/56).

"Basque River above Waco Reservoir, Tex." (4/6/56).

"Leon River above Proctor Reservoir Project near Hasse, Tex." (12/5/56).

"Pecos River above Alamogardo Reservoir, N. Mex." (7/24/57).

"Pecos River above Los Esteros, N. Mex." (7/24/57).

"Intervening Drainage between Los Esteros and Alamogardo, N. Mex." (7/24/57).

"Rio Grande between Cerro and Cochiti Dam Site, N. Mex." (2/26/58).

"Combined Drainage of Santa Fe Creek and Rio Galisto above Galisto Dam Site, N. Mex." (2/26/58).

"Lamposas River above proposed Lamposas Dam Site, Tex." (4/17/58).

"Navasota River, Tex. (7 sub-basins)" (11/2/59).

"Colorado River above Fox Crossing, Tex." (11/12/63).

"Lower Rio Grande, United States and Mexico (between Falcon and Anzalduas Dams)" (7/68).

"Gila River above Coolidge Dam Site, Ariz." (9/14/53).

"Queen Creek, Gila River Basin, Ariz." (4/26/55).

"Bill Williams River above proposed Alamo Dam Site, Ariz." (1/14/58).

"Santa Rosa Wash Basin, Ariz." (8/2/68).

"Black Creek, Ariz." (6/20/69).

"Preliminary Estimate for Drainages North of Phoenix, Ariz." (9/29/72).

"Humboldt River, Devils Gate Dam Site, Nev." (11/20/51).

"Mathews Canyon Dam Site (Virgin River), Nev. and Pine Canyon Dam Site (Virgin River), Nev." (8/9/54).

"Dell Canyon Reservoir, Utah" (8/26/57).

"Las Vegas Wash, Nev." (11/22/60).

"Henderson Wash, Nev." (11/22/60).

"West Fork (Mojave River), Calif." (11/22/60).

"Tahchevah Creek, Calif." (11/22/60).

"San Gorgonio River above Cabazon Dam Site, Calif." (4/13/62).

"Whitewater River above Garnet Dam Site, Calif." (4/13/62).

"Martis Creek, Calif." (3/18/64).

"Merced River, Calif." (6/4/62).

"American River above Folsom Dam, Calif." (8/1/68).

"North and Middle Forks of American River above Auburn Dam Site, Calif." (8/1/68).

"Intervening Drainage between Auburn Dam Site and Folsom Dam" (8/1/68).

"Yuba River above Marysville, Calif." (11/29/68).

"Los Angeles District, Calif. (18 basins in Calif, Nev. and Ariz.)" (12/2/68).

"San Diego River Watershed, Calif. (13 sub-basins)" (3/16/73).

"Skagway River, Alaska" (7/8/47).

"Bradley Lake Basin, Alaska" (5/19/61).

"Chena River, Alaska" (8/1/62).

"Long Lake portion of the Snettisham Project" (4/19/65).

"Takatz Creek, Baranof Island, Alaska" (2/21/67).

"Tanana River Basin for (a) Chena River above Chena Dam Site; (b) Little Chena River above Little Chena Dam; and (c) Tana River between Tanacross and Nenana, Alaska" (6/5/69).

"Preliminary Estimates, Vicinity of Junea: Mendenhall River, Lemon Creek, and Montana Creek" (11/7/69).

"Preliminary Estimates, Vicinity of Ketchikan: Whipple Creek near Wards Cove, Carlanna Creek near Ketchikan, Hoadley Creek near Ketchikan, and Ketchikan Creek near Ketchikan" (1/7/74).

"Eastern Panama and Northwest Colombia" (9/65).

"Hypothetical Rainstorms over Rio Atrato Basin, Colombia, South America" (7/67).

"Probable Maximum Thunderstorm Precipitation Estimates Southwest States" (3/30/73).

5. J. R. Weggel, "Maximum Breaker Height," Jour. Waterways, Harbors and Coastal Engineering Division, Proc. Am. Soc. of Civil Engineers, Vol. 98, No. WW4, pp. 529-548 (1972).

6. Technical Note 98, "Estimation of Maximum Floods," WMO-No. 233, World Meteorological Organization (1969).

7. C. O. Clark, "Storage and the Unit Hydrograph," Trans. Am. Soc. Civil Engineers, Vol. 110, No. 2261, pp. 1419-1488 (1945).

8. U.S. Department of Commerce, "Snow Hydrology," PB-151660, undated.

9. Bureau of Reclamation, "Effect of Snow Compaction from Rain on Snow," Engineering Monograph No. 35, U. S. Department of the Interior (1966).

10. Bureau of Reclamation, "Design of Small Dams," Second Edition, U. S. Department of the Interior (1973).

11. Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants."

12. Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," Revision 2.

FIGURE 2.4.3-1

STANDARD REVIEW PLAN 2.4.3
FLOODS ON STREAMS & RIVERS

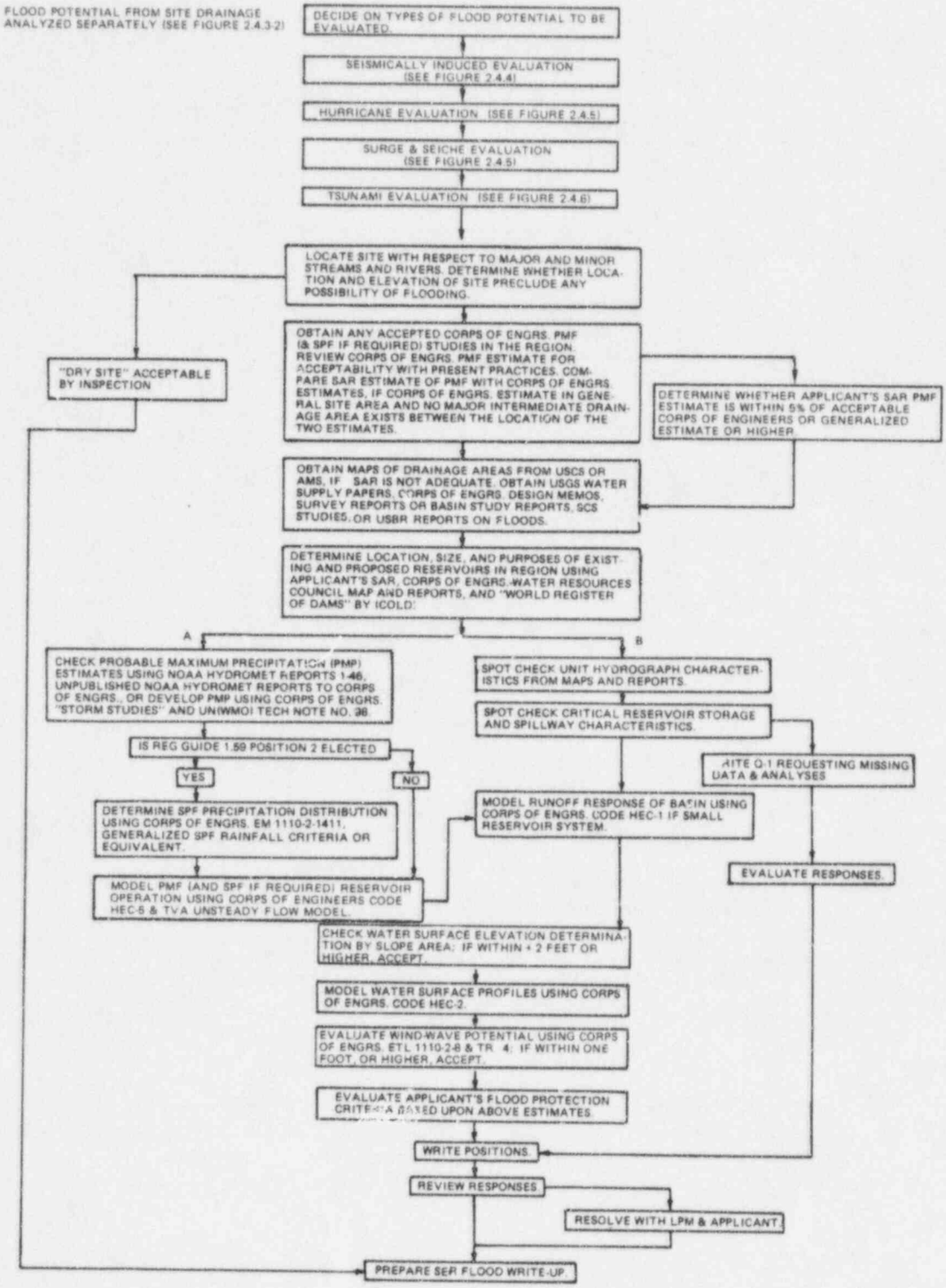
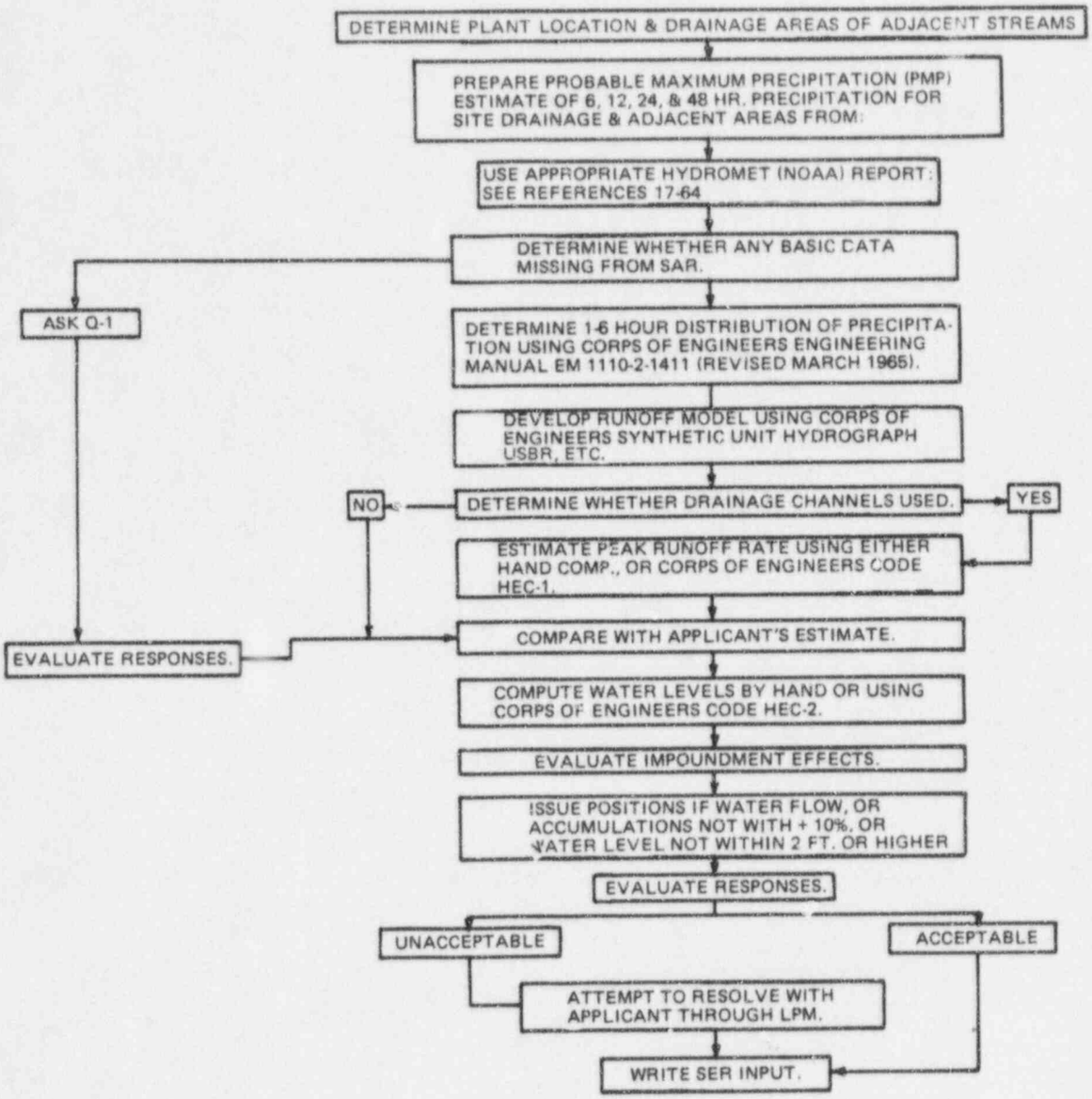


FIGURE 2.4.3-2

STANDARD REVIEW PLAN 2.4.3
SITE DRAINAGE & ADJACENT DRAINAGE



SRP 2.4.4