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Wind Tunnel Phase 4B Test Plan, Investigation of the Effects of Siting on the Wind Behavior of the Westinghouse AP600 System

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WIND TUNNEL PHASE 4B TEST PLAN
INVESTIGATION OF THE EFFECTS OF SITING ON THE WIND BEHAVIOR OF THE WESTINGHOUSE AP600 SYSTEM

OBJECTIVES

The objectives of the Phase 4B tests are to explore variations in site layout and in topography to determine whether or when such variations significantly affect the net pressure difference between the inlet and chimney of the AP600, and, by implication, the convected flow and the net baffle loads.

BASIC APPROACH

The study shall be comparative. A small scale model of the site buildings and local topography shall be built at a scale of between 1:500 and 1:1000. This scale range ensures that both the reactor and cooling tower models shall be in the same Reynolds number range (subcritical), while remaining of a size that allows straightforward modelling and instrumentation techniques to be used. The final scale shall be determined by the topographic areas to be modelled in the specimen sites. The maximum site area, at 1:1000, shall have a diameter of two miles, since the available wind tunnel area has a 10' diameter.

The following cases shall be examined:

1) a reference case, consisting of the current site layout, including all site buildings and a cooling tower on flat open-country terrain.

2) a series of other cases, idealized sites based on 1) Diablo Canyon and 2) Trojan and/or Indian Point. The Diablo Canyon type site shall address speedup due to an escarpment and the Trojan/Indian Point site shall look at the effects of a river valley site.

The same AP600 model shall be used in each instance. It shall be built of a form similar to that of the closed Phase 4A model - i.e. the open interior of the chimney shall be represented only to its bottom, while the inlets shall be modelled, but the internal annulus shall be continued only for a small distance internally. The inlets shall connect with an internal volume designed to model the volume of the internal annulus. Pressure taps shall be installed as an internal ring within the chimney[ ]and within the inlet volume[ ]. An external ring of pressure taps[ ]shall also be installed on the outer surface of the containment building model just below the inlets[ ]and on the exterior of the chimney[ ]. In addition, a ring of pressure taps[ ]shall be installed around the exterior of the throat of the cooling tower in the reference case. Cooling towers would be modelled using a distorted (smaller) diameter so as to give the correct net drag and hence wake properties at the AP600 location as determined by comparison with the wake results measured as part of the Phase 4A tests. a,c

The resulting flow model is not expected to provide the correct mean values of the pressures on the AP600; however, since the (inlet - chimney) peak pressure differences are of primary concern, and since these peaks are primarily associated with either wind turbulence or the buffeting wakes of upstream structures, the proposed model will provide good comparative results between cases.

TEST MATRIX

The following test matrix shall be carried out:

1) An appropriate open country simulation at the required scale shall be established at the main high speed test section of BLWT II.

2) A preliminary set of experiments shall be carried out using distorted cooling tower models constructed from foam or wood. Horizontal traverses of the flow in the wakes of these models would be measured at a distance downstream corresponding to the normal distance between the AP600 and the cooling tower. From these tests, the correct distortion of the cooling tower geometry would be verified for future tests. These tests shall be experimental in nature.

3) Based on the preliminary experiments (item 2), final cooling tower models shall be built as required by the siting plans. One of these shall be equipped with a ring of pressure taps around the throat for use in the reference case.

4) The reference case shall be set up and tested at one speed for[ ]a,c equi-spaced wind angles. For each wind angle, all AP600 pressures shall be recorded as time histories so that instantaneous pressure differences can be computed between inlet and chimney. Instantaneous pressure distributions at all individual locations shall also be available. Pressures on the cooling tower shall be recorded only for a few representative wind angles, in order to confirm that the drag, and hence the wake, has been modelled correctly.

5) Subsequent cases shall be modelled and tested as in (4). These shall include:

   (a) a repeat of the reference case, with the addition of multiple cooling towers.

   (b) an idealized coastal site based on Diablo Canyon, which would include a significant escarpment siting and simplified mountain backdrop.

   (c) the same as (b), but without the mountain backdrop.

   (d) an idealized river valley site, based on the Trojan and Indian Point sites.

RESULTS

The results of the tests shall include comparative variations of peak and mean (inlet - chimney) pressure differences plotted versus wind angle, which should clearly indicate whether any case tested produces significantly different results from those of the reference case (4). All measured pressure coefficients shall be referenced to the equivalent mean hourly wind dynamic pressure at the top of the AP600 in an open country terrain, regardless of the site complexity. In this way, the resulting coefficients will essentially provide a comparison of actual pressures for the same design storm so that valid comparisons can be made.

For any cases in which the AP600 experiences significantly higher pressure differences than the reference case, the complete time histories of the data will be available for more in-depth analysis.