A first-in-class “on-demand” potency assay was developed for flu vaccines produced in response to the most concerning emergent influenza A subtypes. Specifically, the World Health Organization has recommended the development of new candidate vaccine viruses for deadly avian influenza H5 and H7 subtypes. The VaxArray Influenza Pandemic HA (VXI-pHA) potency assay was designed to probe multiple subtype-specific conserved epitopes on the hemagglutinin protein for H5, H7, and H9 subtypes. The goal was to optimize the probability that the ready-to-use assay would work for a new H5, H7, or H9 flu vaccine in order to streamline potency determination, potentially reducing the time to deliver life-saving vaccine by weeks or possibly even months. The performance of this new potency test was evaluated using a large set of influenza viruses and vaccines spanning 16 years of antigenic drift, including the most recent pre-pandemic vaccine being developed against the deadly “5th wave” A/H7N9 virus. Against a panel of 46 potentially pandemic influenza strains, the VXI-pHA assay demonstrated coverage of 93%, 91%, and 100% for H5, H7, and H9 antigens, respectively. The assay demonstrated high sensitivity with linear dynamic ranges more than 150-fold and quantification limits ranging from 1-5 ng/mL. For three production lots of H7N9 monobulk drug substance, the assay exhibited excellent accuracy (100 ± 6%) and analytical precision (CV 6 ± 2%). The high assay sensitivity enabled robust detection and quantification of hemagglutinin in crude in-process samples and low dose adjuvanted vaccines with an accuracy of 100 ± 10%.