

## Wind and Water Loading on Antennas, Vessels, Buildings and Dams

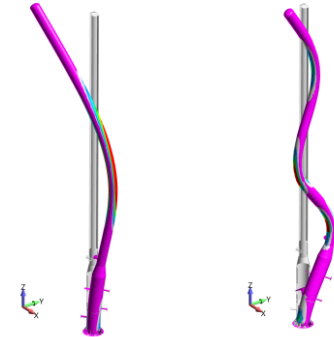
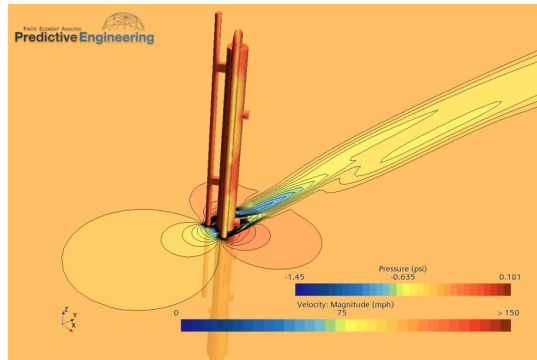
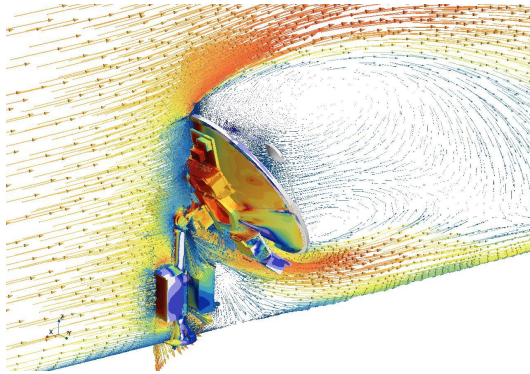
### Accurate Loads = Accurate Stress and Fatigue Results

A key challenge to any analysis project is load determination. Although one can use formulas and code guidelines to approximate wind and water loading (e.g., ASCE/SEI 7-22 which supersedes ASCE 7-16), these approximations provide guidance but can leave structures exposed to unforeseen effects or require unnecessary material additions. With today's CFD and FEA tools, it is not necessary to guess but just map the actual wind or water induced loading onto the structure. Predictive Engineering has been doing such combined fluid structure interaction (FSI) analyses for many years across diverse industries from automotive, aerospace, civil engineering and military applications. We are particularly proud of our work in the detailed mapping of wind loading onto vibration sensitive structures such as antennas and tall slender ASME Section VIII, Division 2 pressure vessels. Other applications have involved hypersonic aerospace structures down slowly rotating hydroelectric dam impellers. This breadth of experience allows us to provide insights and new ideas to our clients regardless of the type of wind or water or squishy material (soil, gravel, mineral processing, etc.) may be interacting with their structure of interest.

## Wind and Water Loading on Engineered Structures and Systems

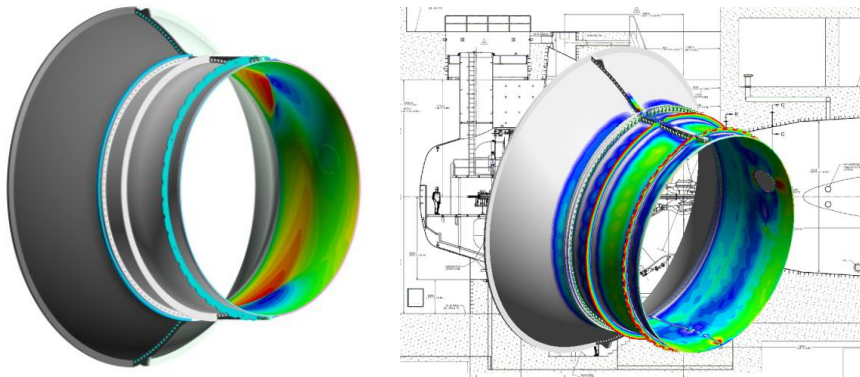
Accurate Wind Loading = Accurate Stress and Fatigue Analyses

Vibration Inducted Wind Loading



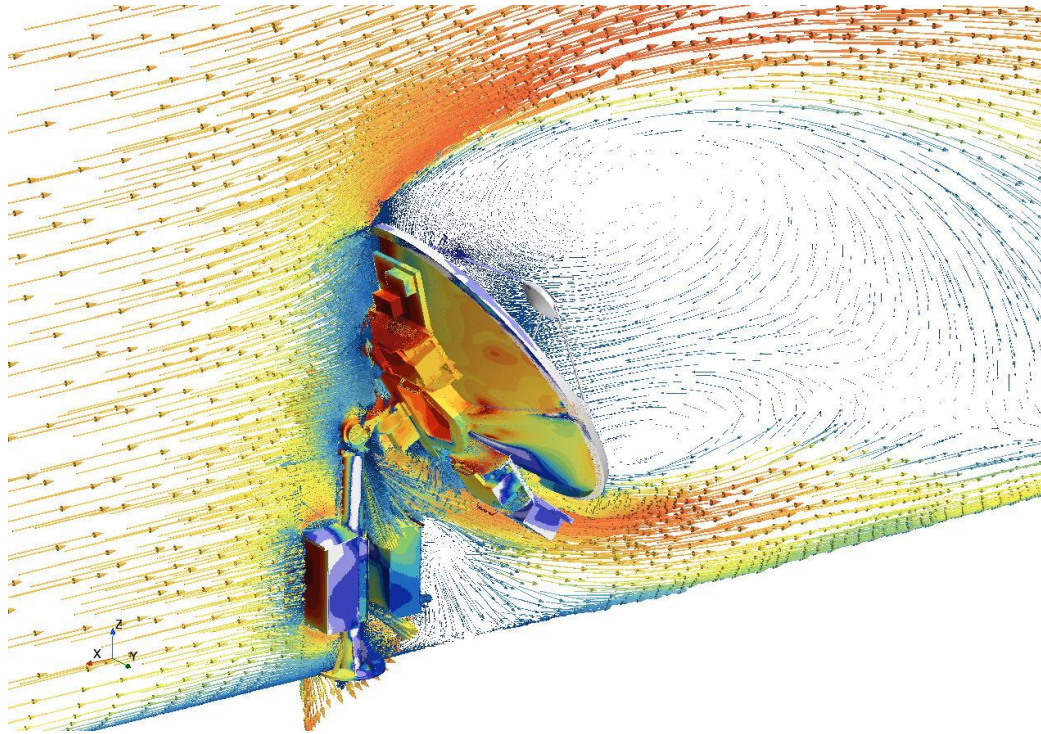
CFD Pressure Mapping to FEA Structural

Diverse FSI Simulation Experience



For those that are video inclined, this video provides a quick overview of our work on water and wind loading on structures and systems.

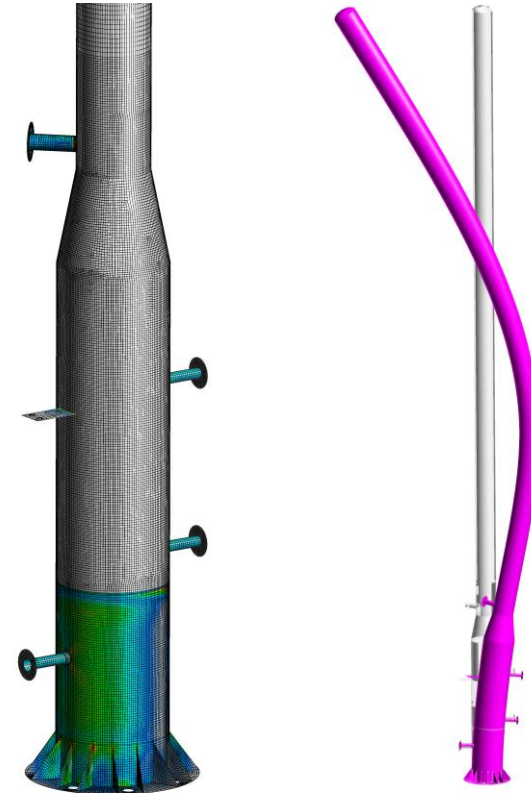
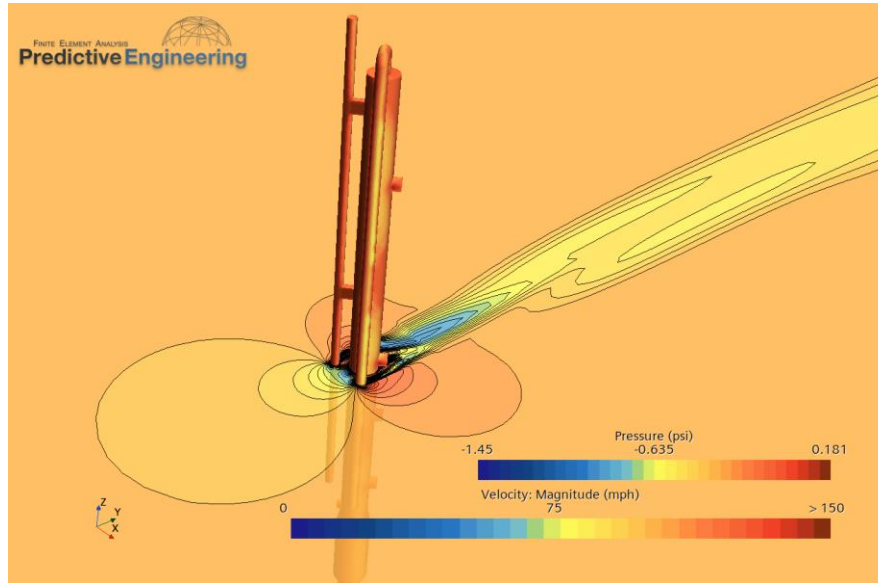
## Wind Loading on Antenna System for Optimized Tracking Accuracy



CFD wind loading from gentle breezes to hurricane levels were simulated and then mapped onto the antenna system. The mechanical response of the antenna system to wind loading allowed the client to optimize their control algorithm for precision tracking accuracy. Vibration analysis of the system showed that wind loading would not harmonically excite the antenna.

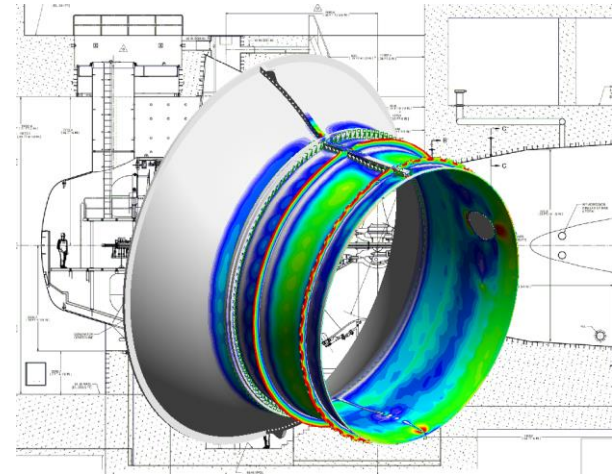
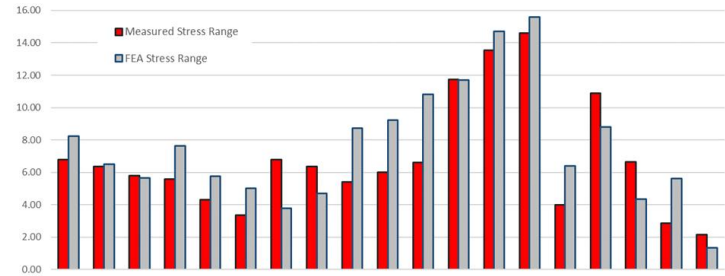
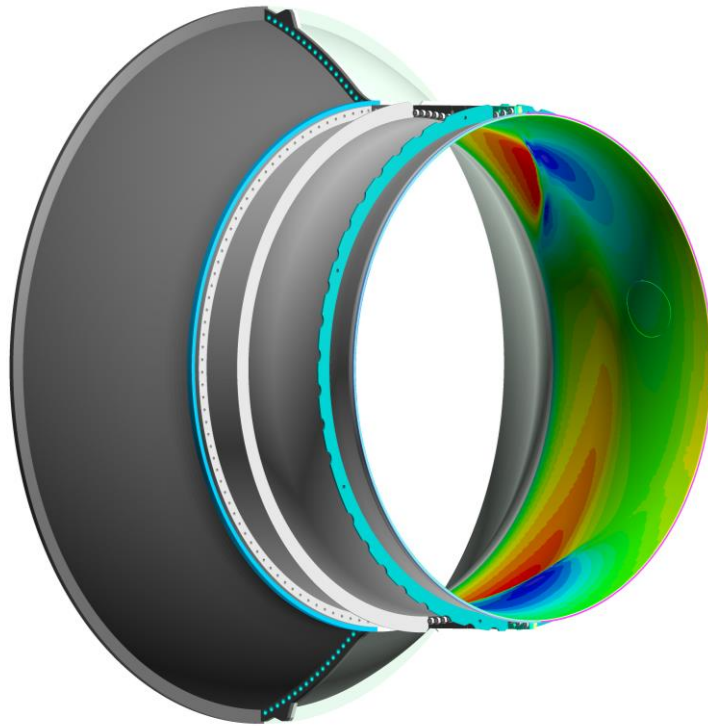


## Wind Loading on Nitrogen Rejection Unit (NRU) Column for Stress and Vibration Analysis



Within our CFD virtual wind tunnel, the NRU column was subjected to wind loading up to 120 mph. These wind loads were mapped onto the FEA structural model for stress analysis and interrogation of the results per ASME Section VIII, Division 2 rules. Vibration analysis showed that the column would not be harmonically excited by the wind loading.

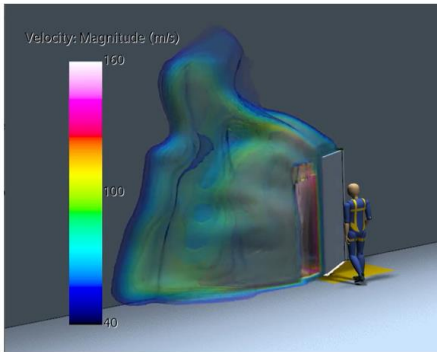
## Hydroelectric Turbine Blade CFD Loading to Nozzle Ring Stress and Fatigue Analysis



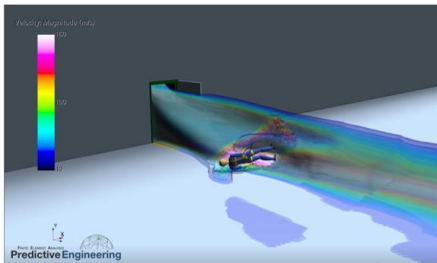
Hydroelectric dam turbines provide rich territory for the mechanical engineer interested in CFD pressure loading. The turbine is enclosed within a nozzle structure that guides the water flow through the turbine blades. As the blades spin, the tips of the blades create pressure pulses as it sweeps across the inside of the nozzle ring. The magnitude of these pulses can be accurately calculated and then mapped to the FEA model for stress and fatigue analysis.

## Predictive Engineering's Generalized Fluid-Structure-Interaction (FSI) Experience

High-Pressure Steam as a Load



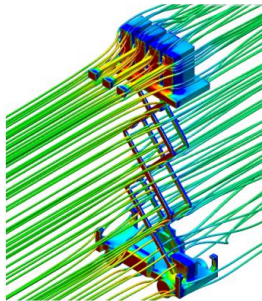
Ohhhh Nooooo Mr. Bill (SNL)



Wind as a Load



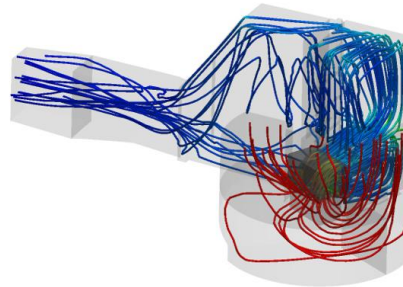
Will it Fall Over?



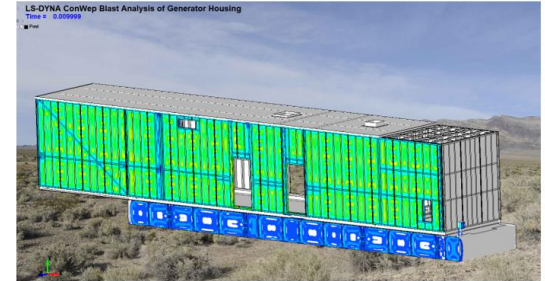
Water as a Load



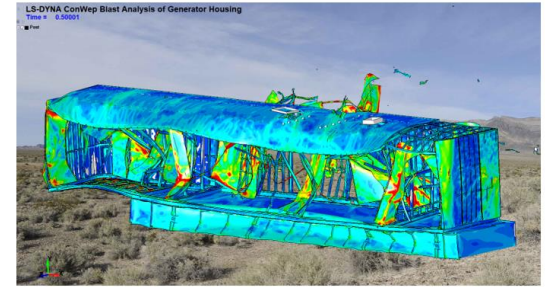
Do We Really Need 1" Plate?



Explosion as a Load



Time to Buy a New Emergency Generator?



Some other projects that our CFD and FEA consulting engineers have tackled over the years. We have experience in explosive decompression to just explosive loading using the ConWep program for the calculation of blast effects from high explosives and weapons.

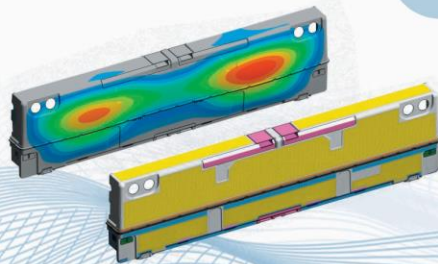


# Predictive Engineering – The Advantage of Getting it Right the First Time

FINITE ELEMENT ANALYSIS  
**Predictive Engineering**

Finite element analysis consulting services, software, training and technical support.

- Composites, Pressure Vessels, Vibration.
- **NASTRAN**: Linear Dynamics.
- **LS-DYNA**: Drop-test, Impact, Burst Analysis.
- **STAR-CCM+**: CFD Thermal/Flow Analysis.

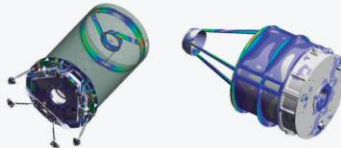


## Project Examples

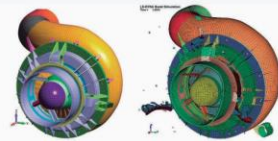
FAA 16G SLED TEST VERIFICATION



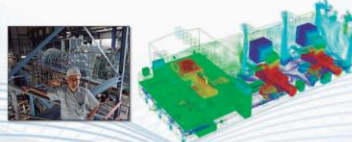
STRESS AND VIBRATION ANALYSIS OF SATELLITES



LS-DYNA TURBINE BURST SIMULATION



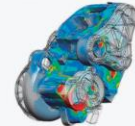
CFD STUDY ON CO-GENERATION POWER PLANT BUILDING



## Our Services

### FEA

Predictive Engineering brings to bear more than 20 years of finite element analysis FEA consulting experience in solving the most difficult mechanical engineering analysis challenges. Our validated experience ranges from transmissions to submarines to satellites.



### TRANSIENT NONLINEAR

At Predictive Engineering, we pride ourselves on the ability to idealize complex structures and systems into predictive numerical models. Our nonlinear, static and transient dynamic work has been validated against strain-gauges, drop and sled test results, accelerometers, crack growth and fracture and in extreme service environments.



### ASME-BPVC

From seismic to buckling to cyclic service (fatigue), Predictive can assist in verifying the most challenging pressure vessel designs. Our hard-earned experience allows us to safely classify tanks and vessels as "fit-for-service" that would typically have required extensive redesign or re-work.



### CFD

Our expertise in computational fluid dynamics (CFD) comes from hundreds of thermal-fluid projects in medical, aerospace, marine, HVAC (data centers), civil and automotive. This experience gives us the capability to quickly optimize and provide accurate digital prototypes.

