

# ETAP Transient Stability Validation Cases and Comparison Results

## Case No. 3 Post-Fault System Transient Response ETAP TS V&V Case Number TCS-TS-295

### Comparison with Field Measurements from a Fault Recorder

#### Highlights:

- Comparison between the ETAP Transient Stability simulation results and actual fault-recorder measurements before and after a three-phase fault in an industrial system
- A post-fault system transient response simulation study for a real industrial power system
- Simulation of 3-phase fault, followed by fault isolation and then a generator trip
- System includes multiple voltage levels, a power grid connection, on-site generators, motors, and lumped loads
- ETAP built-in round-rotor subtransient synchronous machine model
- ETAP built-in IEEE ST type turbine/governor model
- ETAP User-Defined Dynamic Model (UDM) for client excitation/AVR model
- ETAP Transient Stability simulation results compared to the filed fault recorded instantaneous waveforms including generator current and voltage, and a feeder fault current

#### 1. System Description

The modeled system, shown in Figure 1, is an actual industrial power system located in Japan. This system has four generators, five large pumps, and one utility connection. All other loads are modeled as lumped loads. In this study, generators Gen-A, Gen-B, and Gen-C are out of service. Generator Gen-M is modeled in ETAP as a round-rotor type with ETAP IEEE Standard ST type Turbine/Governor model. The Exciter/AVR model, shown in Figure 2, was modeled with a User-Defined Dynamic Model (UDM).

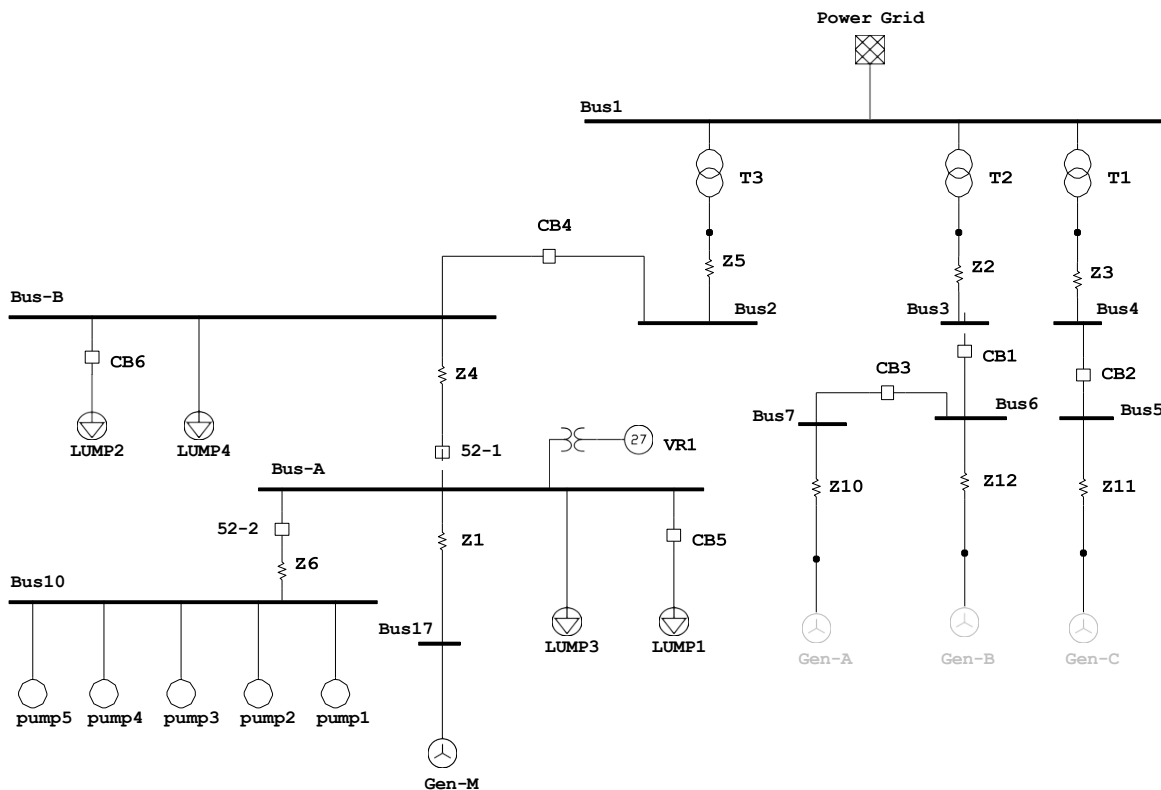


Fig. 1. Short-Circuit Fault Simulation Study System

### Exciter/AVR Model

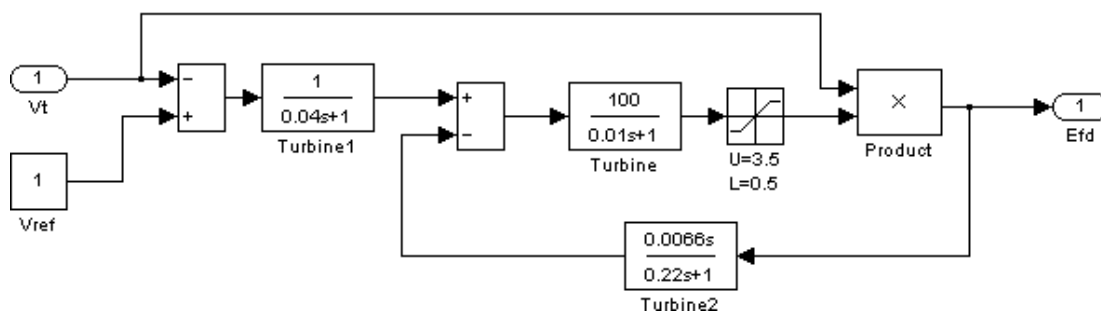


Fig. 2. ETAP User-Defined Dynamic Model (UDM) for Client Exciter/AVR Model

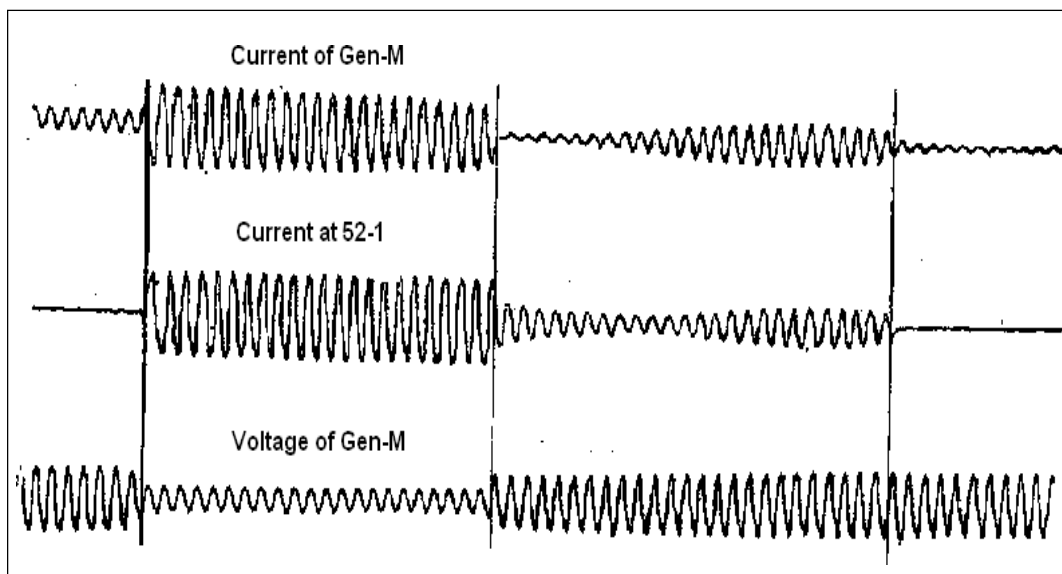
## 2. Simulation Events

The simulation events in this study are set the same as the recorded events from the fault recorder, which are as follows:

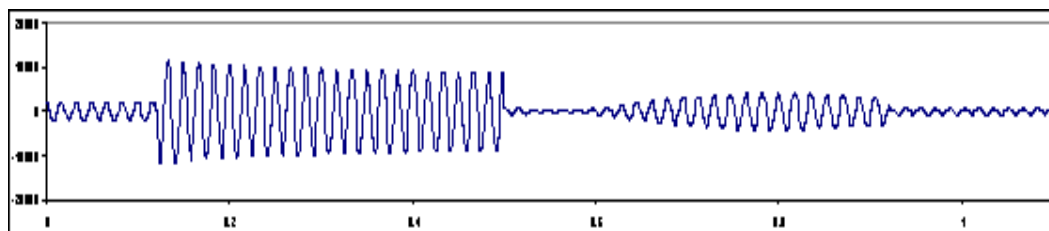
- 3-phase fault at Bus10 @ t = 0.12 second
- Open CB 52-2 @ t = 0.5 second
- Open CB 52-1 @ t = 0.92

### 3. Simulation Result Comparisons with the Field Measured Data

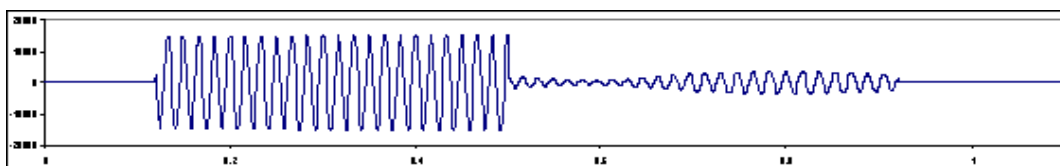
In this study, the instantaneous values of the generator current contribution to the fault and its terminal voltage, and the fault current from the feeder upstream to the fault (through CB 52-1) are compared against the field-measured data which is obtained from a digital fault recorder (DFR), as shown in Figure 3. For the comparison, RMS value results from ETAP are converted to the corresponding instantaneous values based on the RMS magnitude, frequency, and phase angles of the currents and voltages. The ETAP results are shown in Figures 4 and 6.



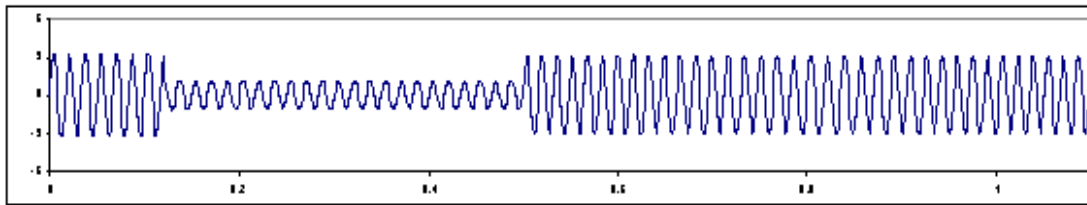
**Fig. 3. Field Measurement Data from a Fault Recorder**



**Fig. 4. Generator Gen-M Instantaneous Current by ETAP**



**Fig. 5. CB 52-1 Instantaneous Current by ETAP**



**Fig. 6. Generator Gen-M Instantaneous Voltage by ETAP**

From the comparison, the generator current and voltage responses as well as the feeder fault current response demonstrate a very close agreement with the field recorded data. A slight difference in generator and feeder currents during a short period of time immediately after opening CB 52-1 can be attributed to the fact that the actual model of the turbine/governor and parameters for the exciter/AVR model are not available and typical models and parameters are assumed in the ETAP simulation. Additionally, the pre-fault and post-fault loadings of the real system were not given and estimated loads are used for the simulation study.

#### **4. Conclusions**

As shown from the comparison plots, a very close agreement is clearly demonstrated between the ETAP Transient Stability simulation results and the field measurements for the generator voltage and current, and the feeder fault current.

#### **Reference:**

ETAP Transient Stability V&V Documents, Case Number TCS-TS-295, 2023.

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