

MEDIUM VOLTAGE VARIABLE FREQUENCY DRIVES ACCEPTANCE TESTING

MV VFDs are complex engineered systems that work in concert with each other and auxiliary equipment that support it.

Oftentimes, acceptance testing of VFDs is specified; however, the terminology used in testing by vendors, consultants, and operators can get intertwined, and end-user expectations can be misaligned with equipment vendors' procedures and deliverables. This application edge series outlines what a factory acceptance test is, the different kinds of testing available for a VFD system, when a test should be selected, and recommendations for the type of test to select.

Factory acceptance testing (FAT) – definition

A factory acceptance test, commonly known as acceptance testing, is a series of tests performed by the equipment supplier. The purpose of these tests is to demonstrate to the end user that the supplier meets all the contractual agreements, which consist of the latest sets of drawings, data sheets, project specifications, and any deviations that have been approved by the end user or their representative.

It is the supplier's responsibility to perform these tests, record the test data, and issue a final test report to the equipment purchaser. These tests are usually witnessed by the end user, or their representative, at the equipment supplier's facility or a third-party test stand and are executed before the final installation at the site. In limited cases, the equipment supplier will perform the tests without anyone witnessing them.

The testing requirements MUST be defined at the purchase-order stage of the equipment procurement cycle and NOT after.

Figure 1 shows a typical MV- motor and VFD-driven system. In order to test this system, an end user can make a selection from up to four types of testing varying in breadth and scope as shown below. This paper will focus only on VFD testing (blue highlight).

Types of VFD testing

Considering the VFD by itself, there are seven variants of testing that can be done. These tests can be witnessed or unwitnessed. Figure 2 outlines the major types of tests and what is typically included in each one of them.

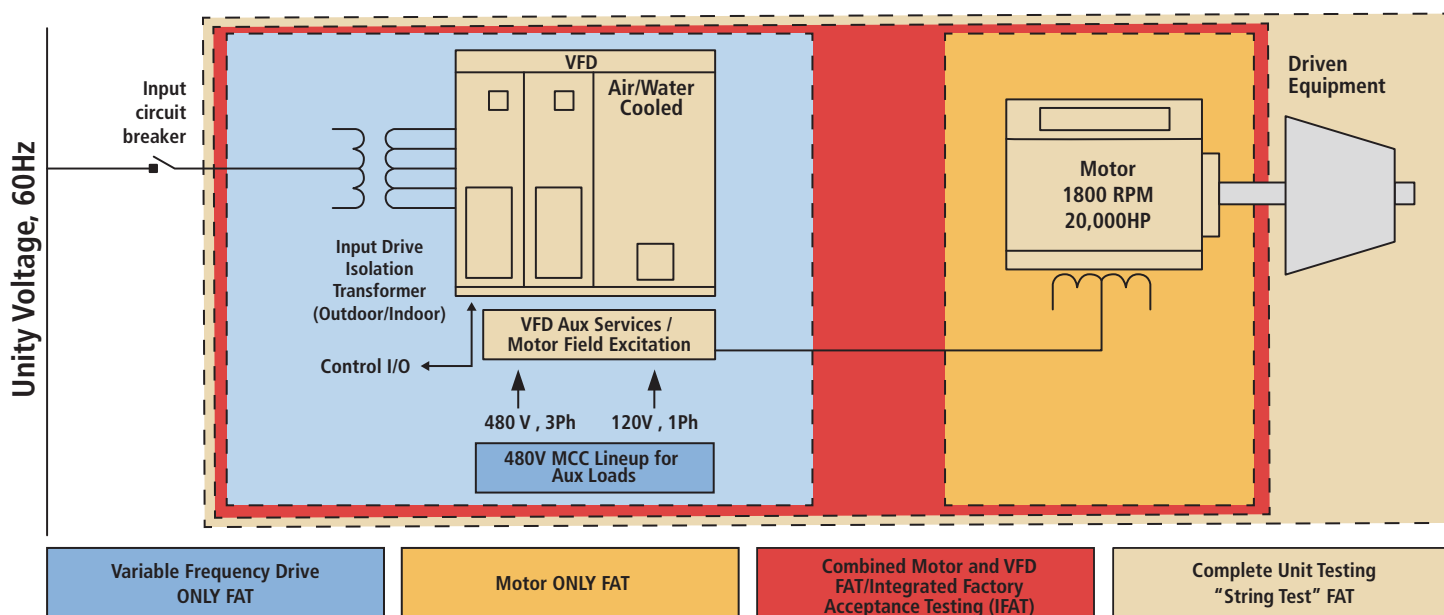


Figure 1: MV motor and VFD driven system

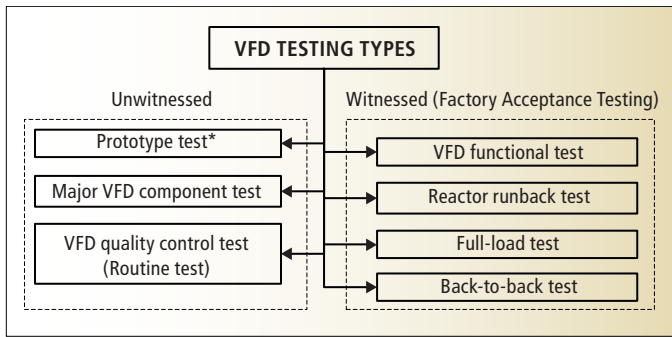


Figure 2: Types of MV VFD testing available from the equipment supplier

1. **Prototype testing:** This testing, also known as “type test” is done by the manufacturer before a new VFD product lineup is introduced to the market. This rigorous test is done to validate the design, safety, and performance of the drive. Testing to certify the drive to a particular regulatory body, such as UL, CSA, CE, etc., is also done at this stage in the presence of appropriate inspectors. Usually, test reports documenting line-side, load-side, and thermal performance of the VFD can be provided by the manufacturer upon request.
2. **Major VFD component testing:** Depending on the type of VFD, the major components in its design, such as the drive isolation transformer, power semiconductor devices (diode, IGBT), DC link capacitor, power inverter modules, printed circuit boards, and incoming switchgear, are tested as individual components by their respective manufacturers or the VFD vendor. These tests are also unwitnessed; however, test reports are available if requested by the purchaser.
3. **VFD quality control/routine tests:** These tests are done on production VFDs regardless of whether the purchaser requests an acceptance test. Figure 3 outlines some of the major testing areas that are conducted on VFDs.
4. **VFD functional test:** When an end user requests a FAT, this is the test that is usually referred to. This is the least costly of the witness tests, and it demonstrates to the client that the VFD is designed as per the mechanical and electrical specifications. Figure 4 shows typical items in a functional test. For air-cooled drives, a functional test will last approximately one day and for water-cooled drives about two days. Note that a functional witness test is not to be confused with a full-load test.

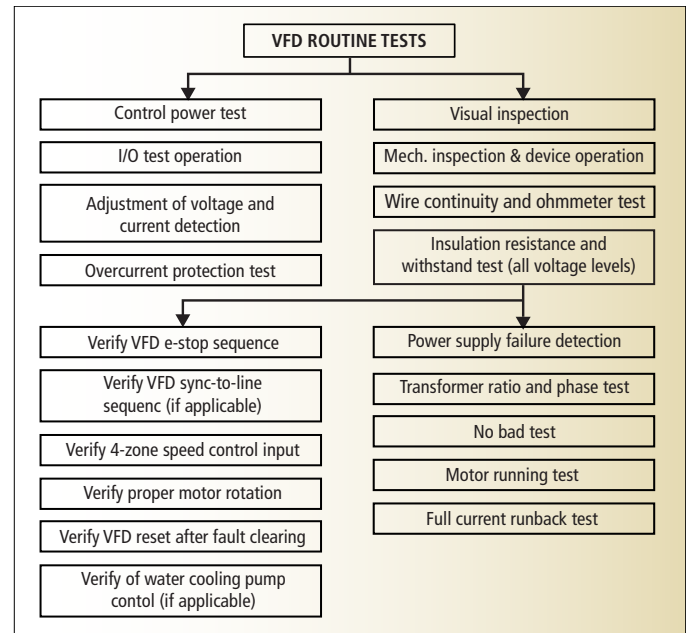


Figure 3: VFD quality control and routine tests

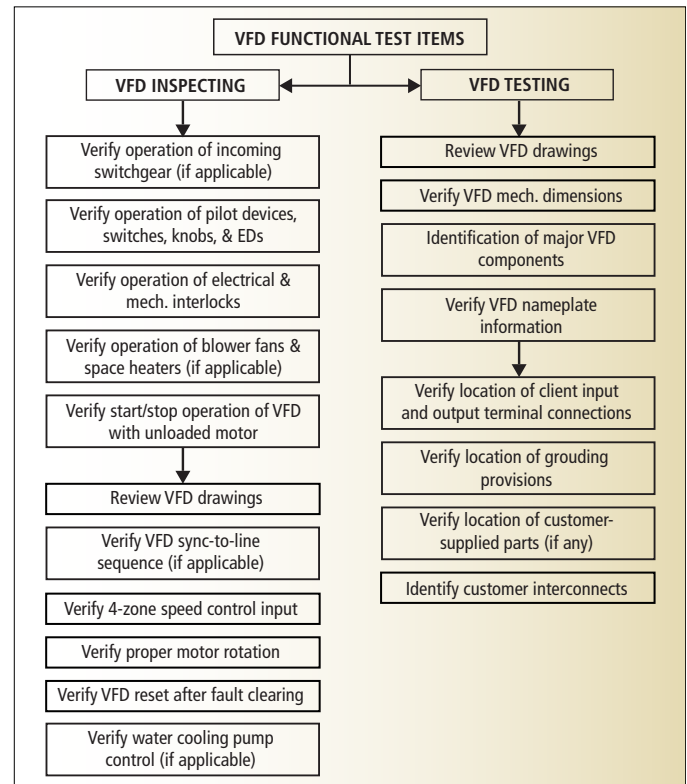


Figure 4: VFD functional witness test

5. **Reactor runback test:** This test is considered a full-load test where the VFD is operated at rated voltage and rated current. The reactor acts as a load to the VFD. It is called a runback test because the power is recirculated through the reactor back into the VFD, thus minimizing the power demand from the grid during testing. Figure 5 shows an electrical illustration of a reactor runback test.

6. Full-load test / back-to-back test: As the name suggests, a full-load test is carried out with the project VFD and motor that is run at near-rated conditions. A back-to-back test is similar to a full-load test; however, this testing terminology is usually applied when two active front-end drives are tested together that can recirculate current among themselves. Regenerative drives, such as LCIs or active front-end voltage source inverter (VSI) drives can be tested in a back-to-back arrangement.

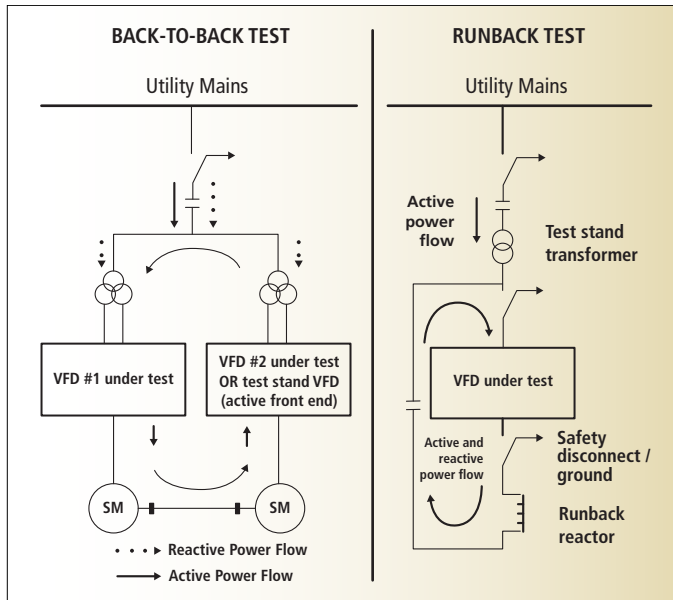


Figure 5: Electrical illustration of runback reactor and back-to-back test

When should a factory acceptance test be chosen?

The decision on a FAT is generally made by the end user and the equipment supplier before a purchase order is issued. Since a FAT is an expensive proposition, there are several factors to consider when selecting one. Figure 6 outlines a decision-making flow chart to guide a purchaser on FAT and the specific FAT that he or she should select.

Final recommendations for VFD acceptance test

With the exception of VFD testing for gaining certification from regulatory bodies, such as UL, CSA, CE, etc., VFD vendors are free to create their own sets of routine tests, functional tests, full-load tests, etc. The absence of an industry-recognized testing document for VFDs creates confusion as to what tests a particular VFD vendor will do.

The IEEE Standards Association outlines a test plan

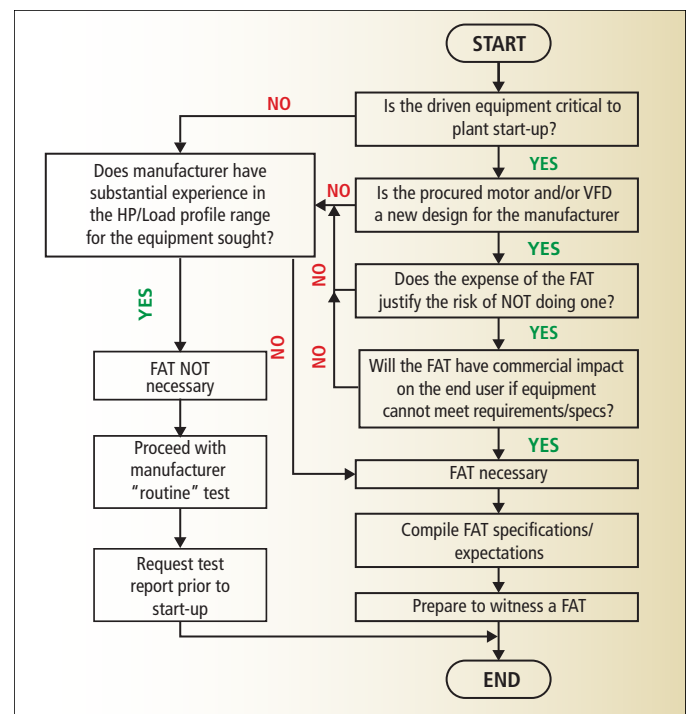


Figure 6: Decision making flow chart for FAT selection

that VFD vendors must execute when requested on the data sheet in Section 14 of IEEE Standard 1566-2015 - Standard for Performance of Adjustable-Speed AC Drives Rated 375 kW and Larger. [1]

Depending on the comfort level of a purchaser, a witness FAT might not be needed. However, if the need does arise to perform a FAT, a functional witness test, as mentioned above, with an option of temperature rise test and/or runback reactor test for four hours would suffice. This type of test can usually be accomplished in a day or two depending on the size of the equipment.

[1] "IEEE Standard for Performance of Adjustable-Speed AC Drives Rated 375 kW and Larger," in *IEEE Std 1566-2015 (Revision of IEEE Std 1566-2005)*, vol., no., pp. 1-74, Feb. 27, 2015

For specifications not mentioned here, contact TMEIC

WWW.TMEIC.COM