

**JAA Administrative & Guidance Material**  
**Section Six: Synthetic Training Devices (STD/FSTD), Part Three: Temporary Guidance Leaflet**

LEAFLET No 14:           **GUIDANCE ON EVALUATIONS OF ELECTRICAL MOTION SYSTEMS FOR FSTDs**

**NOTE:** The material contained in this Leaflet has been issued in accordance with Chapter 9 of the Administrative & Guidance Material Section Six: Synthetic Training Devices (STD), Part Two: Procedures (JAR-FSTD). The purpose of this leaflet is to provide guidance on evaluations of electrical motion systems for FSTDs.

## **1. Introduction**

Pilots use continuous information systems to regulate the state of the aircraft. Whole-body motion feedback is essential in assisting the pilot to control the aircraft dynamics, particularly in the presence of external disturbances. Whilst a simulator can never perfectly represent the six degrees of freedom of the aircraft motion, the standard of realism achieved by current hydraulic motion systems fitted to Level C and D full flight simulators is very high. It is essential that, with the advent of new technologies, no reduction in the current standards of realism be accepted. The existing hydraulic motion systems use hydraulic rams to provide six degrees of freedom motion. The hydraulic power packs used to drive these rams are expensive and have high power consumption. A new method of activating the legs of a simulator by means of electric motors is now being introduced throughout the JAA community. Whilst having significant advantages, there are some areas that require special attention when evaluating and certifying such equipped FSTDs, in order to ensure that the existing standards of realism are not compromised.

## **2. Types of Electrical Motion Systems**

At present, a limited number of FSTDs have been equipped with these new electrical motion systems. So far, the following types of devices can be recognised:

1.     Electro-Mechanical Motion (EMM) Systems
2.     Electro-Pneumatic Motion (EPM) Systems
3.     Electro-Hydraulic Motion (EHM) Systems

1) The EMM systems use electric motors to physically operate the legs of the simulator. The best way to describe this type of system is “direct drive”, because the electric motor drives the lead-screw of the motion leg directly.

2) The EPM system also uses electric motors to drive the lead-screw of the legs directly, but separate (or internal) actuators operated pneumatically are used to balance the weight of the simulator platform itself. Since the electric motors now do not have to carry the weight of the platform, typical electric power consumption is much lower than the EMM system.

3) The EHM system uses fluid pressure to balance the weight of the simulator platform and electric pumps to displace fluid to actuate the motion legs. Since the electric motors do not sustain the weight of the simulator, typical electric power consumption is much lower than the EMM system.

## **3. Experiences so far and recommendations for evaluation**

A number of simulation devices that use one of the previously described electrically driven motion systems have now been certified by JAA member states. A number of areas have been identified where specific attention is required due to the different characteristics of the new technology:

- a. Noise originating in the motion system and being transferred to flight deck level.
- b. Motion cues for certain manoeuvres like flare, touchdown etc.

- c. Frequency response for models of runway roughness and turbulence.
  - d. Issues of safety and reliability.
- a: Due to the mechanical construction and the way the electric drive functions, the noise levels generated can be high. To date, the problem has been found to be noise transferred mechanically through to the simulator cab, causing distraction to flight crew, especially when performing demanding yawing manoeuvres such as making turns on ground (taxiing) where all six legs of the motion system are actuated at the same time. Improved noise insulation and different software to drive the electric motors has proven to influence this noise level. The quieter the aircraft aerodynamically and engine wise, the more intrusive this noise might be. Due to the sound level of propeller driven aircraft, this phenomenon might be less noticed in this type of aircraft. The potential impact of high noise levels on other devices located close-by should also be checked.
- b: The new electrical motion systems have the potential ability to react much faster to steering commands than the existing hydraulic systems. This high onset rate can cause stronger outputs than normally seen with hydraulic systems resulting in motion movements that are perceived as too strong or too sharp. Conversely, examples have been seen, particularly with shorter stroke electric systems, where the motion system has been unable to present acceptable cues in cases where a very high demand was placed on the system, such as at flare and touch down. Tuning of the software driving the motion actuators is required in these cases and the point of acceptability should be a level of performance equal to or better than current hydraulic systems.
- c: The basic models used in hydraulic motion systems for surface roughness and turbulence have been developed over several years to a very high standard of realism. The different frequency characteristics of the electric actuators require modification to existing models to achieve the same level of realism. The systems evaluated to date have been found to be both lacking in the higher frequency, sharp edged elements of roughness and turbulence motion, but, also, with the electric systems using lead-screws, to feel too harsh. The mechanically transmitted motion is incompressible, unlike the air in which the real aircraft operates, or hydraulic fluids of the existing motion systems.
- d: Due to the inherent ability to react very rapidly and very violently to control inputs from the motion software, it is important to verify that the built in protection of the motion system, that will limit the response from the motion actuators, functions correctly and that possible erroneous signals from the flight data software do not result in dangerous motion responses. Especially when operating outside the normal flight envelope or when making non-standard manoeuvres the functioning of this protection is crucial to the safety of the persons inside the flight simulator. Taxiing into buildings or obstacles, stall penetration, steep turns and crash landings are examples of such manoeuvres. It should also be noted that the feature built into hydraulic motion systems to return the platform to a neutral position if power is lost has to be re-created on the new electric motion systems using a variety of energy back-ups schemes best suited to each implementation.

Whilst the reliability of the new systems cannot be established at initial qualification, it should be noted that some installations have suffered from initial reliability issues. This has been exacerbated by excessive time needed to recover the system after failure, resulting in significant impacts on training. This area should be monitored.