Table 4-6: Commissioning and Initial Operations: FCBs – Challenges and Best Practice Solutions.

Challenges	Best Practice Solutions
Performance / Technical Issues/Faults <u>Standard Bus components</u> The issues reported have been more to do with the standard bus components or the electrical system than with the H_2/FC related components. For example: • Coolant pressure • Malfunctioning doors /lights <u>Electrical System</u> • Drive train wiring • Power distribution unit incorrectly installed <u>FC Propulsion System</u> • Different starting process of the FCBs compared with diesel buses • New symbols and (error) messages at the driver-dashboard	• Expect and be prepared to overcome faults collaboratively with FCB supplier • Testing phase should be adequate for a new technology and the planned work cycle and route (see also Table 4-4). Once the bus has passed this phase, they should perform equivalently to any other bus (diesel or BEB) • If bus testing is local, then test close to the depot so that return to base can be easier if faults are discovered. Alternatively, some sites have chosen to test at the manufacturer's premises <u>but test with local conditions in mind</u>, e.g., fully loaded with hill starts • Arrange timelines so that about 10% of the buses are delivered some months ahead, to have most 'teething issues' cleared away before the rest of the order arrives • Set up regular communication arrangements between onsite technicians/drivers/operators and the supplier in the early stages • If FCB supplier and HRS supplier have not worked together before, expect issues with refuelling to arise during this sub-stage • Have the appropriate expertise on hand to answer queries **Bright Idea: Close the Feedback Loop** One site made the following suggestion: Have a weekly presence of a technical inspector from the manufacturer when the first vehicles to arrive are tested. This person can report back any changes that need to be made in the bus production line. This ensures real time updating of FCB construction.
Data Logging / Data Delivery	

• Data collection software does not all deliver the operational data required • No access to CAN Bus data • Faulty data logger and no authorisation for the data logging dashboard, so that possible data issues could not be checked • Not all the required data in the dashboard available • Dashboard was not ready at the beginning of operations • Poor Wi-Fi connections	• Find out early about the most useful data collection software (and prescribe an adequate system in your tender documents) • Aim for one system for all buses, otherwise you may have different systems / dashboards with different data point availability for every individual supplier • Make sure that the data system can be integrated with other operational systems, such as depot planning • If data availability and provision is not adequate, keep the final retention payment until this is resolved • Be in regular contact with the relevant person whose role it is to carry out updates or swaps of the data logger and chase them early

Table 4-8: Commissioning and Initial Operations: FCB Maintenance Procedures – Challenges and Best Practice Solutions.

Challenges	Best Practice Solutions
• Acquiring maintenance expertise for FCBs. New technology needs to be watched and problems pre-empted. • The training for FCBs is a "step up" from that needed for BEBs.	• Most FCB operators have their own maintenance technicians trained by the bus supplier and supported for a period of time on site by the supplier's technician/s. After that period, the supplier in many cases have provided 'flying doctor' support. See Table 4-5 for more information on Awareness Raising and Training. One site has fully outsourced their maintenance as they do for diesel buses • During the early commercial deployment of FCBs, geographically close operators should consider pooling their maintenance technician resources • Oversight by the manufacturer of local maintenance activities may be required for a time to ensure the adequacy of servicing.
• Scheduling of FC Buses for maintenance	• Some sites have chosen to adjust (shorten) their preventative maintenance schedule intervals and contents for the new technology for the time being • Manufacturers are starting to use pre-emptive maintenance to monitor when parts are likely to need replacing • Keep existing other procedures adapted for the requirements of a FCB e.g. car wash, indoor fuelling, etc. – these will help reduce costs
• Despite maintenance agreements some delays in receiving spare parts have to be anticipated	• This challenge has been a perennial issue, occurring in every FCB demonstration project. Clearly specifying expected timeframes for the provision of spare parts and imposing penalties for these not being met must be in contracts with the FCB suppliers (see Table 2-6 and Table 3-1) • In addition, when the FCBs come from a different supplier than diesel buses in the same fleet, the need for conventional spare parts (e.g. wipers or windows) must be considered

Table 4=9: Commissioning and Initial Operations: Refuelling – Challenges and Best Practice Solutions.

Challenges	Best Practice Solutions
Performance / Technical Issues / Faults HRSs as deployed at the JIVE/JIVE 2 sites are still not standardised or fully mature. Operators have encountered a wide range of challenges, including (as also mentioned in Table 4-3): • Component failure (e.g. compressors – probably still the most troublesome components/dispensers/electrolysers) • Software failures • Unacceptable long duration of fills • Safety check failures • Pre-cooling of the hydrogen • Noise (chiller) and leakage issues • Clear need for backup plan for refuelling	• Testing the refuelling process in slow and careful stages • Check H_2 purity at the dispenser outlet after washing the system with nitrogen e.g., during initial start-up, until nitrogen concentration is below its threshold limit. • Having and using backup refuelling arrangements (see Table 4-3) • Be aware that adjacent neighbours may be affected by noise from the compressor or other components • Ensure there is an adequate monitoring system on the HRS with quick response to alarms – specify supplier's response time to problems in hours (see also Maintenance below) • While pre-cooling is still being standardised, one site – in cooperation with the HRS manufacturer – has reconfigured dedicated refuelling protocol tailored to their FCBs to avoid the need to pre-cool as much as possible (at a reduced but satisfying speed of refuelling). • Using contract requirements to ensure ongoing technical support from supplier
Maintenance / After-Sales Service • Lack of local maintenance expertise and slow response time from supplier to fix issues	• Agreements should include: ➢ 24/7 service hotline ➢ Remote access to the HRS ➢ Local support (incl. flying doctor) ➢ Training of local technicians to support maintenance
Bus-to-HRS Data Interface • Infrared data transmission is still relatively new/sensitive. A lot of trouble shooting on this issue was necessary.	• Data transfer from the bus (tank) to the HRS is important to ensure quick and complete fills. If there is no communication, a more rigorous/conservative fuelling protocol needs to be followed to ensure safe refuelling while slowing down the filling process

• HRS hydrogen nozzles have an infrared sensor connection mounted on them. These can be easily knocked/damaged or for some reason fail to connect with the bus transmitter on the bus • Replacement nozzles are expensive (>€10,000), the infrared sensor cannot be replaced without the whole assembly	• Ensure bus refuelling staff are trained in use of the nozzles. • Put protective measures in place, e.g. rubber mats on the floor where the nozzles are used, to prevent damaging the infrared sensor when the nozzle is dropped accidentally
Data Logging / Data Supply • Accessing data has not always gone smoothly (technical issues) • Not all suppliers of HRSs are willing to the share data that they log anyway (but which are required by a co-funding entity or for warranty claims or generally for the integration of data flows into the PTO's IT system) • Not all operators are willing to the share data that they log anyway	• Request demonstration of data output and format prior to contracting • Data needs and data supply must be specified in contracts. Ideally contracts should be with the party responsible for producing the data or, at the very least, the responsible party should be nominated and clear to all • Make reliable data supply part of the acceptance test • Include penalties in contracts • In some instances, data from the buses have been used to gather refuelling data as an interim solution to secure meeting (part of the) reporting requirements from the institution providing co-funding