



BFPA MINIMUM EDUCATIONAL RECOMMENDATIONS - ELECTRICAL/ELECTRONICS APPLIED TO FLUID POWER SYSTEMS CONTROL



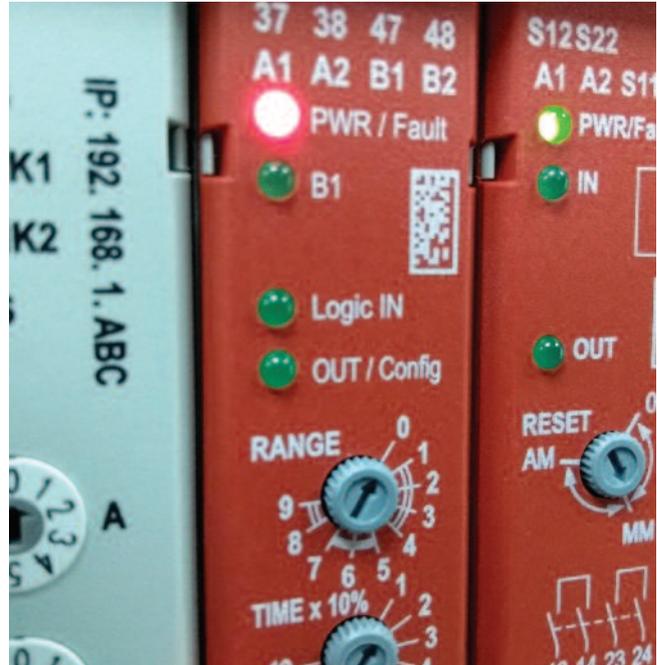
BRITISH FLUID POWER ASSOCIATION

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Introduction

“In every sector of industry whether it be Fluid Power or otherwise, the evolution and convergence of different technologies has long been recognised to be growing at an exponential rate. The role played by digitalisation and IoT is now becoming evident in every aspect of our business lives. Hardware oriented functions such as electronic control circuitry for valve actuation are being integrated into devices to an ever-increasing extent. This is resulting in a standardisation of input and output signals, thereby simplifying the design, commissioning and repair of fluid power systems. It is no longer enough for an engineer to be a specialist in Hydraulics or Pneumatics. The future belongs to those Fluid Power engineers who can embrace the ever-increasing role played by electronics in developing what are now referred to as ‘Integrated Fluid Power Systems’ or simply; ‘Integrated Systems.’ To be a part of this new world, engineers must be equipped with at least the basics of electronic and control technology; embracing the learning opportunity, however alien it may feel to them. Failure to do so is tantamount to ‘burying ones head in the sand’ and can only result in, at best, lost opportunity and at worst – extinction!”

Chris Buxton CEO – British Fluid Power Association



Foreword

Members of the BFPA Educational and Training Committee, representatives from BFPA member companies, and UK industry, developed this document and its contents on behalf of the British Fluid Power Association.

The BFPA has always taken the lead within the UK relating to the provision of educational recommendations for those involved in the maintenance and management of Fluid Power Systems and Control and many of its recommendation now form competence based qualifications provided by CETOP in Europe.

The Health and Safety of all personnel maintaining and managing Fluid Power Systems remains paramount.

To this end the BFPA has decided to introduce, following a one-year consultation programme with members, OEMs and end users, these recommendations, which are applicable to everyone in every sector where Fluid Power is employed.

These recommendations, which are one of three publications covering hydraulics, pneumatics and electronic control of fluid power systems respectively, are to be considered as an Industry standard. They form the minimum levels of knowledge and understanding necessary to support the skills development of our workforce, thus ensuring safe working practices are followed at all times whilst working with and around systems employing hydraulics, pneumatics and control.

In today's world of fluid power motion and control, very rarely are hydraulics and pneumatics applied as a single technology, they now encompass electrical/electronic control and therefore these recommendations should consider those, be it at an introductory level.

This guideline is formulated as a series of outcome related statements. It is not a training course, however, from these recommendations approved education and training establishments will be able to formulate effective training programmes and modules to meet these minimum recommendations and more.

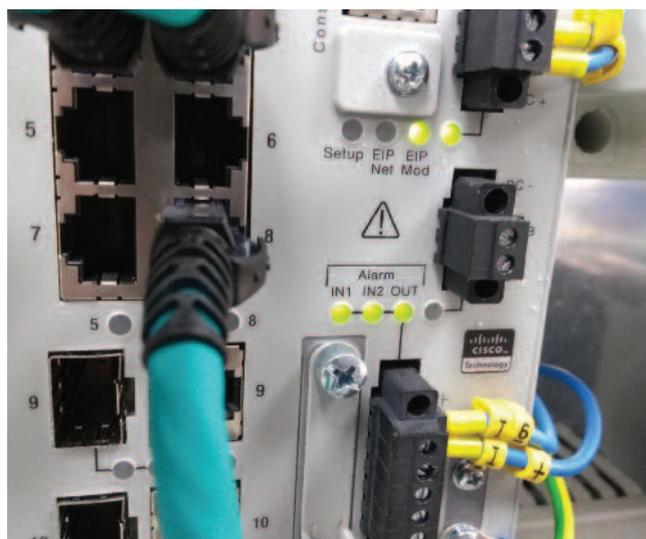
The learning process must be supported by the development of key practical skills thus 'hands on' training should be incorporated throughout involving electro-hydraulic or electro-pneumatic systems.

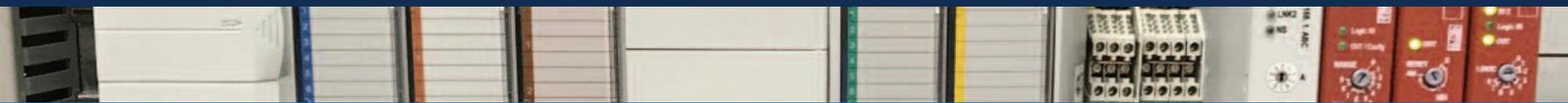
For whom are these recommendations intended?

These minimum recommendations are primarily intended as an initial introduction for those involved in the maintenance and management of electrical and electronic control of Fluid Power Systems. However, many other key professions would benefit across a range of levels from Apprentices to Service Engineers, Technical Representatives and Project Engineers. These recommendations establish a foundation to build upon as individuals develop their engineering careers and become more involved with Integrated Systems Engineering.

Everyone can learn by following these recommendations and improve their health and safety knowledge making them more aware of the potential dangers and how to manage them accordingly.

ANY COURSES developed from these Minimum Recommendations should place great emphasis on explaining the application of this technology relating to Fluid Power Systems and Components. Course candidates should fully understand why they need to know this. Candidates should be left in no doubt as to the relevance and importance of this increased level of knowledge and associated skills aligned to their employability.





Introduction to the application of Fluid Power Control

Candidates should:

Know how electrical/electronic control influences fluid power in today's modern society and the realisation of its importance in the provision of power and motion control.

A range of examples should be introduced at this stage clearly showing the extent to which this technology is applied.

Technical Recommendations:

On completion of any programme of study involving these recommendations candidates should know:

Basic Principles (equate to fluid power analogies where possible)

1. The Law relating to conservation of energy.
2. What is an isolator and what is a conductor.
3. What the difference is between AC and DC current and their applications.
4. The fundamentals of Conductors, Insulators and Semi-Conductors.
5. What is meant by the terms digital and analogue.
6. The relationship between Current, Voltage and Resistance.
7. Ohm's law and its application in simple circuits.
8. The effects of electrical power on a system
9. The relationship between current, voltage and resistance effects on system losses, power rating and heat generation.

This section shall involve simple calculations, associated units and terminology.

Magnetism and Electro-Magnetism (Relays and Solenoids)

Candidates should:

10. Be able to describe the functions of a permanent magnet.
 - a. Like poles repel
 - b. Un-like poles attract
11. Know the applications of permanent magnets in modern control systems.
 - a. Sensors
 - b. Safety devices
 - c. Door locks

12. Know the principles of electro-magnetism.
 - a. Effects of increasing current
 - b. Effects of increasing the length of wire and coiling the wire
13. Know the applications of electro-magnetism in modern control systems.

Electronic components and their applications

Candidates should:

14. Know what resistors are, the different types and their applications.
15. Know what inductors are, the different types and their effects in a system.
16. Know what capacitors are, the different types and their applications.
17. Know what semiconductors are, the different types and their applications.

Electrical Components used in control systems

Candidates should:

18. Know the function and application of the different types of:
 - a. Switches
 - b. Relays
 - c. Contactors
 - d. Timers/Counters
 - e. Proximity Sensors
 - f. Protective Devices

Power Supply Methods

Candidates should:

19. Know what batteries are, their functions, applications and safety requirements.
20. Know how Alternating Current (AC) is supplied and an overview of the various methods used to generate it.
21. Know how Direct Current (DC) is derived and how it can be conditioned for various applications.
22. Know the function and applications of Switched Mode Power Supplies (SMPS).
23. Know the function of an Uninterruptable Power Supply (UPS).



Electrical Symbols

24. Candidates should be able to recognise the electrical symbols in current use such as IEC 60617 and ANSI.

Electrical Test and Measurement

25. Candidates should be able to demonstrate the safe use of a Digital Multi-Meter (DMM) to measure:
 - a. Voltage
 - b. Resistance
 - c. Current
26. Candidates should be aware of other common test equipment and their applications.

Electric Motors and Motor Control

Candidates should:

27. Know the types of motors in use and have an overview of their applications.
28. Be introduced to motor control, start, stop and latching circuits.
29. Be introduced to Variable Speed Drives (VSD) and their advantages.

Introduction to Control Systems

Candidates should:

30. Know the difference between the terms Analogue and Digital in control systems.
31. Know the difference between Open Loop and Closed Loop Control systems.
32. Have an overview of Data Transmission Systems.
33. Know what Pulse Width Modulation means and its application to fluid power systems.

Cables and Termination Methods

Candidates should:

34. Know the types of cables used and their application.
35. Know about the most common types of terminations/connectors available and their applications.
36. Know the effects of Electro Magnetic Interference (EMI) on a control system

Maintenance Procedures

Candidates should:

37. Know the common causes of failure in an integrated control system.
38. Know the importance of being able to identify normal key system performance indicators.
39. Know the symptoms associated with a change in performance.
40. Know the importance of a pro-active maintenance scheme and associated record keeping.
41. Know the importance of following safe working procedures at all times when carrying out such activities as: installation, commissioning, servicing/testing, inspections, checking performance, and any other activities that fall within your job role.

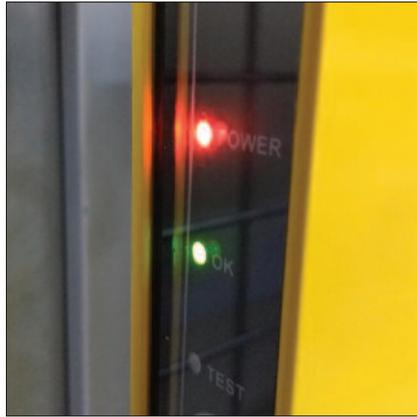
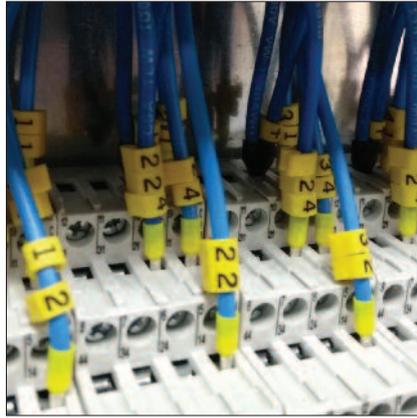
Health and Safety Issues

Candidates must:

42. Know the importance of personal protection associated with the working environment.
43. Know the importance of following SAFE ISOLATION procedures.
44. Know the dangers of stored energy and how to deal with it.
45. Know the basic emergency procedures for dealing with someone who has received an electric shock.
46. Know the importance of training and working within their trained capability.
47. Know the importance of following all safe working procedures and rules laid down by their Employer.

Practical Recommendations

To support the implementation and effectiveness of these Recommendations, candidates “MUST” be given the opportunity to install and commission small working systems, whilst interpreting circuit diagrams follow safe working practices and setting up procedures.



Contributing Organisations

- A C Hydraulics
- Bachy Soletanche Limited
- Bosch Rexroth Limited
- British Fluid Power Association
- Fluid Power Design Solutions Limited
- FPI NorthWest Limited
- Hercules Hydraulics Limited
- Hydrasun
- Mechatronics International Limited
- Moog Industrial Group
- National Fluid Power Centre
- Parker Hannifin Limited
- Pirtek UK
- Regent Trist Hydraulics
- SMC Pneumatics Limited
- Systems Services



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