



BFPDA/D8

QUALITY CONTROL PROCEDURES AND CERTIFICATION REQUIREMENTS FOR BFPDA DISTRIBUTORS

FOR THE MANUFACTURE OF FLEXIBLE HOSE ASSEMBLIES FOR FLUID POWER



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FOREWORD

Since its formation in 1988, member companies of the British Fluid Power Distributors Association (BFPDA) have been concerned at the practice of manufacturing hose assemblies on an ad-hoc basis and the mismatch of components. Not only does this reflect on the good reputation of the fluid power industry it can also lead to safety hazards.

In bringing their concerns to BFPDA's manufacturing members, Distributors and Manufacturers agreed that they should co-operate to prepare a document for members of the Association. This Document forms the basis of a system for registered participating member companies of the Approved Hose Assemblies Mark Scheme. This document contains elements that should be seen as Mandatory alongside those that should be viewed as guidelines, both types of elements are separately identified.

Mandatory clauses are marked up in blue.

These Guidelines reflect the opinion of the Association. Users should also consider manufacturer's instructions before using any particular product, especially if they have health and safety implications. Whilst the Association has taken all reasonable care to ensure the accuracy of this Document, no liability or responsibility for negligence or otherwise shall be accepted by the Association, its members, servants or agents as to the content or interpretation of these Guidelines.

The Association would like to express its appreciation to individuals and companies for the preparation of this Document.



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NOTICE OF MANDATORY CLAUSES

<i>Clause</i>	<i>Subject</i>
3	Health and Safety
4	Public and Product Liability
5.1	Quality Assurance - Training
5.5	Quality Assurance – In-process quality control
5.6	Quality Assurance – Final Inspection
5.9	Quality Assurance – Production Equipment Requirements
5.10	Quality Assurance – Test and Inspection Equipment Requirements
6.7	Additional Requirements – Micrometer check slips
7 (7.1-7.6) including Table 1 Calibration of test, inspection and production equipment	
8 (8.1-8.4) including Table 2 Testing and final inspection	
9 (9.2-9.3) including Table, 4, 5, 6 and 7 Handling, Storage, Packaging and Maintenance	
10.2	Waste and Disposal of Stock
11	Records and Traceability
Appendix III	Quality Control – Calibration of Inspection Equipment Record
Appendix IV	Hose Production Order/Record
	Figure 2 'Orientation'
	Figure 1 'Measuring'
Appendix VIII	Don't Mix and Match
Appendix IX	Simple rule for re-ending hose assemblies – Don't!

1. NORMATIVE REFERENCES

BS EN 853:2015 Rubber hoses and hose assemblies - Wire braid reinforced hydraulic type – Specification

BS EN ISO 1402:2009 Rubber and plastics hoses and hose assemblies — Hydrostatic testing

BS ISO 2230:2002 Rubber products - Guidelines for storage

BS ISO 4406:2017 HFP — Fluids — Method for coding the level of contamination by solid particles (under review)

BS ISO 4407:2002 HFP — Fluid contamination — Determination of particulate contamination by the counting method using an optical microscope (under review)

BS EN ISO 4413:2010 HFP — General rules and safety requirements for systems and their components

BS EN ISO 4414:2010 PFP — General rules and safety requirements for systems and their components

BS EN ISO 7751:2016 Rubber and plastic hose and hose assemblies — Ratios of proof and burst pressure to design working pressure

BS EN ISO 8331:2016 Rubber and plastics hoses and hose assemblies — Guidelines for selection, storage, use and maintenance

BS EN ISO 9001:2015 Quality management systems — Requirements

BS ISO 11171:2016 HFP — Calibration of automatic particle counters for liquids

BS ISO 11500:2008 HFP — Determination of particulate contamination by automatic counting using the light interruption principle

BS EN ISO 14978:2018 Geometrical product specifications (GPS) — General concepts and requirements for GPS measuring equipment (*superseded BS EN ISO 3611:2010*)

SAE Surface Vehicle Standard — J517: February 2013 Hydraulic hose

SAE Surface Vehicle Recommended Practice — J1273: February 2009 Recommended practices for hydraulic hose assemblies

COSHH (The Control of Substances Hazardous to Health Regulations):2002

2. INTRODUCTION

Quality is a key operating priority recognised as the objective in relation to product service to our customers. The Association recommends that BFPDA members consider becoming BS EN ISO 9001 accredited.

The BFPDA requires that the procedures within this Document are implemented to ensure customers receive a quality, and qualified hose assembly. These requirements are essential to assure customers that only fully certified, tested and approved hose assembly products are assembled in a manner recommended by the original hose and coupling supplier when sold.

The supplier should ensure that replacement hose assemblies are compatible and suitable for use with the fluid used, as well as the system application.

Components for an assembly must be compatible by design, size, type and manufacture, and components must have compatibility that is proven by testing in accordance with BS EN ISO 1402. Also the mixing of inserts and ferrules from different or unknown manufacturers, or the use of unmatched hose and end couplings is potentially dangerous and therefore unacceptable.

The use of unbranded or unmarked hose, or the re-working of used hose, is dangerous and is unacceptable.

NOTE 1: *The Association considers that 'mix and match' is an unacceptable practice and recommends that only suppliers who can prove the hose and fitting combinations have been successfully tested in accordance with the relevant hose/hose end termination specification, such as hydrostatic, impulse and leakage testing. In addition, suppliers must ensure materials can be traced back to the point of manufacture, (see Appendix VIII).*

All hose assembly practices must conform to the international recommendations within BS EN ISO 4413 and BS EN ISO 4414, and meet the Guidelines.

The following procedures are the minimum BFPDA requirement for a certified Distributor and form the basis of the BFPDA Approved Hose Assemblies Mark Scheme.

NOTE 2: *Customers may have requirements in excess of those contained within this Policy that may require negotiation between the Distributor and the Customer.*

MANDATORY

3. HEALTH AND SAFETY

3.1 It is incumbent upon the participating members to ensure that employees manufacturing flexible hose assemblies are provided with, and use appropriate protective clothing. These items include:

- a) suitable overalls
- b) toe protection boots or shoes
- c) safety spectacles/goggles
- d) oil-resistant gloves
- e) dust extractor/face mask
- f) ear defenders/plugs

3.2 Hose assembly machinery must be used in compliance with the manufacturer's instructions and be suitably guarded to ensure accidents are avoided. Guards fitted by the equipment supplier shall not be removed or tampered with.

NOTE 3: *A fire extinguisher should be readily available for emergency use.*

3.3 A 'first aid kit' plus an Accident Book should be kept in case of any injuries.

3.4 In addition to the above, it is necessary to comply with any additional Statutory or Legal requirements such as Health and Safety, fire regulations or COSHH.

MANDATORY

4. PUBLIC AND PRODUCT LIABILITY

It is a legal requirement that any employer must have employers' Liability Insurance to an appropriate level consistent with their likely liability, and in accordance with the recommendations of their insurance provider.

Specific caution should be exercised when in a working environment such as nuclear and/or chemical plants, oil refineries and airports, as existing cover may not be sufficient. Many municipal authorities are now asking for minimum public liability cover.

NOTE 4: *Public and product liability insurance advice is not within the Mandate of this document, therefore suitable professional instruction should be taken.*

In the event of any possible claim against the Company, it is essential that any instructions from the insurance company, are followed immediately and evidence retained.

5. QUALITY ASSURANCE

If the Company is already quality assured, the following key elements shall be included within their 'Company Procedures'.

MANDATORY

5.1 Training

It is a requirement that each operator shall be trained on each of the pieces of equipment to be used and must be fully conversant with the content of this Document and, where appropriate, any specific quality procedures such as BS EN ISO 9001.

A record of operators and the equipment on which they have been trained shall be maintained by the Company.

It is a requirement that sales staff be trained to a level to enable them to interpret customer's orders, and to specify requirements.

It is also a requirement that as part of the training all persons involved in the assembly of hose products should attend the 'BFPA Foundation Course in Working Safely with Hydraulic Hose and Connectors', 'BFPA Hose Assembly Skills Training Programme' or equivalent training approved by the BFPA.

Additional hose-related courses are available from the BFPA:

- 'BFPA Hose Integrity, Inspection and Management'
- 'Hydrostatic Proof Pressure Testing'

5.2 Customer Orders (Contract Review)

When quoting for business it is essential that the following be checked:

- a) that latest drawing issue is available (state drawing issue and date when quoting);
- b) that all engineering specifications stated on the drawing are available and all the requirements contained therein can be met;
- c) that the tolerances on the customer's drawing are attainable, if no tolerances are specified see Table 9 and Figure 2, Appendix IV;
- d) any amendment to the original customer order shall be approved by both the Customer and Distributor, and must be recorded;
- e) it is imperative that the fluid type, and extremes of temperature, being used are known so that suitable and compatible hose (and O-rings) can be selected.

NOTE 5: Where indicated, care shall be taken on coupling dimensions, as these are normally based upon the original supplier's product. In addition, the method used for the manufacture of hose assemblies on how assemblies are dimensioned and orientated as these can be depicted in a variety of ways.

5. QUALITY ASSURANCE

5.2 Customer Orders (Contract Review)

NOTE 6: Where it is not possible to meet the Customer's requirements (for example, drop dimension on a swept coupling is different), inform the customer, in writing. Where authorisation is given to deviate from specification, agreement must be given in writing. Any deviations should be recorded in accordance with the relevant quality assurance procedure and appropriate action taken.

5.3 Goods Receiving Audit

All goods received should be subjected to the following:

- a) place goods in holding area with goods receiving paperwork and hold label, pending release;
- b) check the following as a minimum:-
 - (i) correct product
 - (ii) correct hose and coupling identification
 - (iii) shipping damage
 - (iv) despatch paperwork
- c) a competent person within the Company should authorise release of materials to main storage area – the products accepted should be placed in store in such a manner as to ensure rotation of stock when material is withdrawn from stock;
- d) products found to be incorrect should be held in a quarantine area and identified with reject label, pending return to the supplier;
- e) a record of materials received should be maintained for traceability. Hose is invariably marked on the cover and coded. It states manufacturer, type of hose, working pressure and cure date (see Appendix I).

5.4 Holding Areas

- a) Areas shall be designated and clearly defined:
 - (i) goods received: material or product received from external suppliers identified with hold label, awaiting inspection
 - (ii) rejected material/quarantine: any material or product considered suspect identified with reject label pending return to supplier

NOTE 7: Materials or products within rejected/quarantine area identified with reject label shall only be removed from said area by authorised personnel.

5. QUALITY ASSURANCE

MANDATORY

5.5 In-process Quality Control

- a) the use of unbranded hose is forbidden. All hose must carry manufacturer's name or trademark, cure date, type, size, working pressure or type designation and the requirements of relevant hose standard (see BS EN 853);
- b) the re-working of used hose or the re-use of crimped end fittings is potentially dangerous and unacceptable;
- c) it is essential to ensure that the hose end couplings are designed to match and are compatible with the hose to be used;
- d) it is essential that the hose and coupling manufacturer's crimping/swaging data is adhered to implicitly.

NOTE 8: *In the event of a product failure, the legal responsibility is that of the producer of the hose assembly.*

- e) the following items should be checked during hose assemblies manufacture:-
 - (i) hose type and size against works order (check each coil and date code). Some customers have specific use-by-dates from date of hose manufacture
 - (ii) each coupling and type against works order and manufacturer's recommendations - are the hose and couplings compatible
 - (iii) cut hose – first-off and to a sample plan – cut length to specification allowing for stretch
 - (iv) skived hose – first-off and to a sample plan – skive lengths to manufacturer's recommendation
 - (v) hose cleanliness – blow out hose with compressed air (or ideally a jet plug) before assembly
 - (vi) coupling cleanliness – ensure there are no burrs etcetera
 - (vii) where appropriate, the coupling parts are lubricated in accordance with the manufacturer's recommendation
 - (viii) hose protection is fitted (if required)
 - (ix) crimped/swaged coupling parameters (for example, to a diameter or insert bore collapse) first-off then subsequently as manufacturer's recommendation
 - (x) angular orientation (if elbows are used at both ends of the assembly)
 - (xi) consideration of hose bias may be necessary on certain hose assembly routing
 - (xii) assembly identified with the hose identification number and manufacturing date code
 - (xiii) the appropriate pressure testing plan has been carried out and recorded
 - (xiv) that hose assemblies, where required, meet the Customer's specification for cleanliness

5. QUALITY ASSURANCE

MANDATORY

5.6 Final Inspection

Final inspection and assembly protection are recorded:

- a) hose assemblies have been cleaned by blowing out with compressed air, inert gas, or other suitable method. Hose assemblies can be rinsed through with a solution of nitrate-free neutral liquid cleaner or similar fluid taking care to dry out and cap afterwards;
- b) Ensure hose assemblies meet specification and have been examined for:-
 - (i) internally (where possible) and externally for cuts, bulges etcetera
 - (ii) ensure nuts swivel freely
 - (iii) O-rings are correctly fitted (if required)
 - (iv) check hose guards are fitted (if required)
- c) labelled and protected as appropriate (dust caps are fitted, bagged, or protected).

5.7 Sampling Plan

The sampling plan is a practical method of assuring the quality of a product without 100% inspection (see Appendix II). The plan is based upon zero (0)% defective which is normally accepted by industry unless there are special contractual requirements when the Customer may stipulate the inspection levels required.

Final inspection records and assembly protection:

- a) final inspection shall be carried out and recorded in accordance with a sample plan;
- b) labelled, protected and packaged appropriately for despatch;
- c) certify conformity, if required.

NOTE 9: *Some contracts require a unique and traceable certificate for each hose assembly supplied, not just a 'global certificate' to cover the full order.*

5. QUALITY ASSURANCE

5.8 Status Identification

One most important aspect of any product during manufacture is identification and status. For example, the part number is clearly identified at what operation in manufacture the product has reached and whether the product is of an acceptable quality level that can typically be achieved as follows:

- a) *route card or first-off label*: by signing off each stage, all personnel can ascertain which stage production has reached. The checking of the first-off at the start of each production stage will safeguard against a complete batch being made incorrectly;
- b) *hold label*: identifies that the product has not been cleared for use or able to proceed to the next operation;
- c) *reject label*: where product has been found not to meet specification the label can clearly identify the reason for rejection and the action to be taken;
- d) *acceptance label*: this identifies that the product has been checked and conforms to specification;
- e) *quality assurance label (Conformity Certificate)*: these are used to identify to the Customer that products shipped have passed the quality checks and been found to conform to specification (see Appendix VII).

NOTE 10: Labels can be colour-coded to assist with recognition.

MANDATORY

5.9 Production Equipment Requirements

The following is the minimum equipment required for the successful production of quality hose assemblies:

- a) good quality steel tape measure and/or steel rule;
- b) vee or support rail for the accurate measure and cutting of hoses;
- c) cutting machine (a system of producing a straight, accurate and clean hose cut);
- d) skiving or brushing equipment (if required by the hose type);
- e) means of setting and measuring orientation;
- f) compressed air supply;
- g) crimping/swaging machine with suitable dies for the hose size and type used;
- h) quick reference charts, cross reference charts for swage parameters, die sizes and skive lengths (for hose and coupling combinations which require skiving) for hose and fittings being used.

5. QUALITY ASSURANCE

MANDATORY

5.10 Test and Inspection Equipment Requirements

The following equipment is the minimum requirement necessary to ensure the outgoing quality levels will meet the Customer's requirements:

- a) 150mm or larger Vernier, or micrometer;
- b) means of measuring angular orientation;
- c) means of measuring length (for example, good quality tape measure, a steel rule, plus vee support);
- d) gauges to test for internal collapse of insert (for straight couplings) where appropriate;
- e) compressed air supply.

NOTE 11: *When swaging to an insert bore collapse then a straight coupling can be used to derive the correct swage diameter. This diameter can then be used for hose assemblies that have elbow couplings at each end.*

6. ADDITIONAL REQUIREMENTS

- 6.1 Calibration system or contract service.
- 6.2 Identification labels as applicable.
- 6.3 Quality records – inspection and pressure test.
- 6.4 Certificates.
- 6.5 Hose assembly part number tags, means of marking or stamping identification on hose assemblies.
- 6.6 Hose and coupling assembly lubrication fluid.
- 6.7 Pressure test equipment.

6. ADDITIONAL REQUIREMENTS

MANDATORY

6.8 Micrometer check slips

The equipment listed above is required at each of the Distributor's depots. The only exception to this is the micrometer check slips. It is only necessary for a Distributor to hold one set of these, providing the following points are maintained:

- a) the depot where the micrometer check slips are held must be responsible for maintaining the calibration of micrometers and verniers at the other BFPDA certified depots;
- b) that each depot must hold the calibration records for micrometers and verniers that are the depot's responsibility along with a copy of the calibration certificate for the micrometer check slips.

MANDATORY

7. CALIBRATION OF TEST, INSPECTION AND PRODUCTION EQUIPMENT

7.1 Equipment used to confirm that a product meets the required standard must be checked at regular intervals to ensure that it is in a fit condition and that the information it provides is acceptable. This is achieved by checking the equipment against a standard traceable to a National standard. It is mandatory that the Distributor must have a calibration system.

NOTE 12: *Customers may require the frequency be increased or results may indicate that the periods should be changed.*

7.2 All equipment requiring calibration shall be issued with a unique number and the information recorded on a Register.

7.3 Each piece of equipment on the Register shall be checked and calibrated in accordance with the laid down frequency within this Document. Information obtained during the calibration of equipment should be recorded onto an individual calibration sheet (see Appendix III). Any adjustments or repairs carried out should also be recorded on the sheet.

7.4 All reports on servicing or calibration carried out externally should be retained to enable demonstration to external parties that the maintenance of equipment is an ongoing practice by the Distributor. External services must comply with National or International standard.

7.5 Table 1 identifies the equipment requiring calibration to satisfy the requirements of a BFPDA certified Distributor and the maximum periods when the equipment should be calibrated, based upon normal usage. If any of the equipment identified is subjected to abnormal use, for example, if the micrometer is dropped on the floor or crimper jammed, the equipment must be calibrated before re-using.

MANDATORY

7. CALIBRATION OF TEST, INSPECTION AND PRODUCTION EQUIPMENT

7.6 Self-calibration and maintenance of swage machines

This section articulates the criteria for maintaining quality standards and procedures that qualify a Hose Scheme member to exhibit the associated BFPDA quality mark. Under normal circumstances, calibration and first-stage servicing of swage machines should be undertaken by an appropriately qualified, independent third party — usually in the employ of the machine manufacturer or supplier. The rationale for this approach resides in ensuring the competence level of the technician or engineer undertaking the work. The body ultimately best qualified to determine that competency is the swage machine manufacturer or official distributor.

To this extent, provided that the technician (or engineer) undertaking the calibration and maintenance procedure on a given swage machine has passed a practical competency test by the manufacturer or official distributor of the said machine, the Hose Scheme member may undertake self-calibration and first-stage maintenance of their own swage machine. This accreditation process shall include auditable evidence of having passed practical training and subsequent one-to-one assessment by the supplier and the manufacturer, and must be refreshed on a three-year cycle. Measuring equipment used in the process of calibration shall meet the requirements of Section 7. Such evidence should include a dated, written certificate of compliance with this process. The definition of 'first-stage maintenance' shall be agreed between the customer and the swage machine supplier, and should be described in the associated paperwork.

Evidence of having completed such training will not absolve the hose scheme member from any of their obligations under the Health and Safety at Work Act 1974 (also referred to as HSWA, the HSW Act, the 1974 Act or HASAWA) and are still expected to exercise best practice and observe recognised health and safety procedures at all times.

This Policy makes no reference to the willingness or otherwise of a given Swage Machine supplier to undertake such training but stipulates that training is undertaken to a level that ensures the personal safety of the customer and/or technician under the terms of the above referenced legislation.

MANDATORY

Table 1
Calibration of Equipment

	<i>Equipment</i>	<i>Method</i>	<i>Frequency</i>
1.	micrometer	micrometer check slips BS EN ISO 14978	3 months
2.	verniers	micrometer check slips BS EN ISO 14978	3 months
3.	micrometer check slips	manufacturer or test house	every 5 years
4.	crimping/swaging machines	calibration crimping/shell + micrometer (see 7.6)	service: 12 monthly maximum or period laid down in operating manual
5.	pressure test equipment	manufacturer or test house	service: 12 monthly. If used frequently the standby gauge to be changed at regular intervals and spare calibrated by manufacturer
6.	insert bore collapse mandrels/gauges	micrometer based upon manufacturer's tolerances	3 months

NOTE 13: Calibration of equipment not listed above or within clause 5.10 remains the responsibility of the Distributor.

MANDATORY**8. TESTING AND FINAL INSPECTION**

8.1 Assemblies manufactured by a Distributor can be defined into two categories:

- (i) *over the counter:* using the failed hose assembly as a pattern. Normally one-off in quantity
- (ii) *to customer order:* in accordance with a customer order to a drawing, written description or pattern sample (can be one-off or more in quantity)

NOTE 14: Re-work or used hose shall NOT be undertaken at any time. Re-ended hoses are NOT to be used at any time, since they will not conform to the international safety standard BS EN ISO 4413, see Clause 5.4.6.5.1 a) that states:

"Hose assemblies shall be constructed from hoses that have NOT been previously used in operation as part of another hose assembly and that fulfil all performance and marking requirements given in appropriate standards."

8.2 The use of any disclaimer does not negate the operator of their responsibility in the event of a hose assembly failure (any disclaimer proves that the Distributor knows he should not do it).

8. TESTING AND FINAL INSPECTION

8.3 Where a Distributor is only involved in category (i) (see 8.1) type work, it is necessary that they are able to demonstrate to third parties (for example, potential customers, quality assurance inspectors and legal assessors) that reasonable precautions are taken during the manufacture of a hose assembly. This can be done in the following ways:

- a) ensure that the replacement hose is at least equal in specification to the sample. Select correct coupling style and end termination type/size, check crimp/swage parameters (for example, to a diameter or insert bore collapse) against crimp/swage data supplied by the hose and coupling manufacturer
- b) on a regular basis, at least weekly, a person in a supervisory position will, at random, select an assembly manufactured by the counter-staff and subject the hose assembly to the following checks:-
 - (i) that the replacement assembly is equal to the specification of the sample supplied
 - (ii) that the correct couplings have been assembled and that the assembly length and crimp parameters are correct
 - (iii) proof pressure test to BS EN ISO 7751 the hose assembly for thirty to sixty (30-60) seconds (see Table 2), if specified by the customer
 - (iv) record the information on the record sheet.

8.4 Where a Distributor manufactures to category (ii) (see 8.1) type work, then each batch should be subjected to a final inspection, prior to despatch. The quantity to be inspected and tested should be in accordance with the sampling plan (see Appendix II) of this Guideline. The following should be checked:

- a) hose type, size and date code;
- b) correct coupling and crimp parameters;
- c) assembly length and orientation;
- d) hose protection fitted, where specified;
- e) visual appearance of hose and couplings;
- f) documentation of pressure test, if required;
- g) cleanliness standard, where specified, defining how measured;
- h) correctly protected;
- i) hose part number and date code has been applied to assemblies;
- j) record information on record sheet.

NOTE 15: *This is in addition to the first-off crimp/swage parameter carried out during the manufacturing operation.*

MANDATORY**8. TESTING AND FINAL INSPECTION**

Table 2 shows the ratios that should be applied if pressure testing equipment is available, and used.

Table 2**Ratios of Proof and Minimum Burst Pressure to Maximum Working Pressure**

<i>Number</i>	<i>Type of service (for guidance only)</i>	<i>Ratio of proof pressure to maximum working pressure</i>	<i>Ratio of minimum burst pressure to maximum working pressure</i>
1	Water hose, maximum working pressure 1 MPa (10 bar)	1,5	3,0
2	Hose for all other liquids, solid materials suspended in liquids or air, and water hose, working pressure over 1 MPa (10 bar)	2,0	4,0
3	Hose for compressed air and other gases	2,0	4,0
4	Hose for liquid media that change into the gaseous state when subjected to a reduction in pressure i.e. released to atmosphere	2,5	5,0
5	Steam hose	5,0	10,0
6	Jetting hose	1,5	2,5

Source: BS EN ISO 7751:2016

9. HANDLING, STORAGE, PACKAGING AND MAINTENANCE

9.1 The handling of materials from the point of receipt, through manufacturing, test and to final despatch should be undertaken in such a manner that will prevent damage or deterioration (BS EN ISO 8331):

- a) hose storage should be such that it does not damage or artificially accelerate the normal rate of deterioration;
- b) couplings should be kept in a dry and clean environment;
- c) hose should be kept in a dry environment, out of direct sunlight, not subjected to extremes of temperature or stored near electric motors and electrical weld equipment that may be operational or where ozone may be generated or is present;

NOTE 16: Housekeeping should be conducive to good quality.

- d) The storage temperature should be below 25°C (77°F) and articles stored away from direct heat sources. Storage above 25°C (77°F) may shorten the life of the hose or hose assembly. Articles should not be subjected to temperatures over 50°C (122°F) or below - 30°C (-22°F) or to abnormal fluctuations in temperature during the storage period. See ISO 2230 for information on the effect of higher and lower temperatures on the storage time.

MANDATORY**9. HANDLING, STORAGE, PACKAGING AND MAINTENANCE**

- e) before fitting all hose assemblies should be subjected to visual examination for evidence of deterioration

Recommendations for maximum storage life for hose and assemblies are:-

- (i) rubber hose (see Table 3)
- (ii) rubber hose assemblies (see Table 4)
- (iii) thermoplastic hose should be stored to the manufacturer's recommendation (see Table 5)
- (iv) thermoplastic hose assemblies (see Table 6)
- (v) for recommended storage life for hose assemblies fitted onto stored equipment (see Table 7).

NOTE 17: *The recommendations within Tables 4 and 5 apply to stored rubber hoses and assemblies dependent upon their age; Tables 6 and 7 apply to stored thermoplastic hoses and assemblies, dependent upon their age; Table 8 applies to hose assemblies fitted onto stored equipment.*

9.2 Each Distributor should establish their minimum packaging standard. This should include such items as capping, sleeving and identification labels etcetera.

9.3 Distributors should remind customers of the following maintenance requirements:

- a) hose and hose assemblies should be subjected to periodic testing/ inspection to establish their suitability for continued use
- b) particular attention should be paid to the condition of the connections and adjacent areas for the appearance of deterioration of hose, due to ageing, damage, mal-treatment or accident during use.

NOTE 18: *It should be recognised that many customers have their own specifications for packaging and failure to meet these requirements can result in rejection. Such requirements should be included at costing stage.*

Table 3

Test Recommendations for Rubber Hoses

Age	Recommendations
up to 3 years	use without further testing
3 to 5 years	use after representative samples subjected to proof pressure test
5 to 8 years	use after representative samples subjected to proof, impulse, burst pressure tests, cold-bend and electrical tests
over 8 years	scrap

MANDATORY**9. HANDLING, STORAGE, PACKAGING AND MAINTENANCE****Table 4****Test Recommendations for Rubber Hose Assemblies**

<i>Age</i>	<i>Recommendations</i>
up to 3 years	use without further testing
3 to 5 years	use only after subjecting each assembly to a pressure test of 1.5 x design working pressure and representative samples to a burst pressure test
5 to 8 years	use only after subjecting each assembly to a pressure test of 1.5 x design working pressure and representative samples to a burst pressure test. Plus impulse pressure test, cold-bend and electrical tests on representative samples
over 8 years	scrap

Table 5**Test Recommendations for Thermoplastic Hoses**

<i>Age</i>	<i>Recommendations</i>
up to 5 years	use without further testing
5 to 8 years	use after representative samples subjected to pressure test
8 to 12 years	use after representative samples subjected to impulse, burst pressures tests, cold-blend and electrical tests
over 12 years	scrap

Table 6**Test Recommendations for Thermoplastic Hose Assemblies**

<i>Age</i>	<i>Recommendations</i>
up to 5 years	use without further testing
5 to 8 years	use only after subjecting each assembly to a pressure test of 1.5 x design working pressure and representative samples to a burst pressure test
8 to 12 years	use only after subjecting each assembly to a pressure test of 1.5 x design working pressure and representative samples to a burst pressure test. Plus impulse pressure test, cold-bend and electrical tests on representative samples
over 12 years	scrap

Table 7**Test Recommendations for Stored Equipment**

<i>Age</i>	<i>Recommendations</i>
up to 3 years	use without further testing
3 to 5 years	use only after subjecting each assembly to a pressure test of 1.5 x design working pressure and representative samples subjected to a burst pressure test
over 5 years	scrap

9. HANDLING, STORAGE, PACKAGING AND MAINTENANCE

NOTE 19: *It is important that hose assemblies fitted to stored equipment should be filled with the operating fluid with which they will be used on that equipment.*

NOTE 20: *It is highly recommended that hose assemblies fitted to stored equipment in conditions of extreme temperature over 25°C (77°F), humidity (over 70%) or ozone concentration should be tested after one (1) year according to the criteria stipulated for three to five (3 to 5) year old assemblies.*

10. WITHDRAWAL, WASTE AND DISPOSAL OF STOCK

10.1 Withdrawal

The following defects would be sufficient justification for withdrawal of hose assemblies from service:

- a) puncture
- b) splits
- c) tears
- d) exposure of reinforcement
- e) weathering
- f) localised deformations – kinked, crushed, flattening or twisting
- g) blistering or loose cover
- h) swelling
- i) soft or sticky patches
- j) leakage
- k) hard, stiff, heat cracked or charred cover
- l) slippage of couplings on hose
- m) cracked, damaged or badly corroded couplings

Where expiry dates can be identified on hose markings against the appropriate external specifications, these should be observed even if the hose shows no apparent signs of deterioration.

10. WITHDRAWAL, WASTE AND DISPOSAL OF STOCK

MANDATORY

10.2 Waste and Disposal of Stock

The disposal of waste and old stock shall be either by return to the supplier under an agreed procedure or by scraping:

- a) hose returned to the supplier should be by pre-arranged procedure and accompanied by all appropriate documentation;
- b) disposal of scrap hose and hose assemblies is the responsibility of each operator or approved waste contractor;
- c) disposal of scrap shall be in accordance with, and conform to, local authority bye-laws and environmental requirements on the disposal of waste products;
- d) waste fluids, used granules, oil pads, rags etcetera shall be disposed of by an approved waste contractor who must comply with current COSHH Regulations including any confirmed exemptions (see also BFPDA/P115^[3]).

NOTE 21: Scrapped hose should be disposed of in such a way as to prevent it from being used or offered for use again in a hydraulic fluid power application.

NOTE 22: It is illegal to dispose of waste fluids into drains, or contaminate gullies, ditches or by dumping.

11. RECORDS AND TRACEABILITY

- 11.1 Final assembly and pressure test methods, when complete, should be passed to the depot office for filing.

NOTE 23: It is important that these records, together with any other form of quality control (e.g. certification and calibration), are filed in date order and held in such a manner as to assist in the traceability of any material found subsequently to be suspect.

Table 8

Record Retention

The following records will be maintained as specified below:

Record	Period
Final assembly and pressure test record	6 years (unless stated otherwise by customer)
Certification (supplied by Distributor)	6 years
Calibration records	6 years
Service contract reports	6 years

MANDATORY

11. RECORDS AND TRACEABILITY

11.2 From time to time, it will be necessary for the hose and coupling supplier to update Distributors on new products or changes to existing products. Some of this information shall require action being taken by Distributors and other self-assembly users. For example, change to gauge settings and crimp/swaging parameters.

NOTE 24: *It is important that when there are changes to existing data, the Distributor has a system with return receipts to ensure that the Customer's information is updated within their Company and passed to other self-assembly users under their jurisdiction.*

BFPDA

HOSE STOCK RECORD

Manufacturer: _____

Type: _____ Size: _____

<i>Order number</i>	<i>Quantity</i>	<i>Advice note</i>	<i>Date received</i>	<i>Quantity received</i>	<i>Cure date/ batch code</i>	<i>In</i>	<i>Out</i>	<i>Free stock</i>

INSPECTION SAMPLING PLAN

<i>Lot size</i>	<i>Sample size</i>	<i>Defects for acceptance</i>	<i>Defects for rejection</i>
5 or less	all	0	1
6-8	5	0	1
9-15	8	0	1
16-150	13	0	1
151-280	20	0	1
281-500	29	0	1
501-1,200	34	0	1
1,201-3,200	42	0	1
3,201-10,000	50	0	1
10,001-35,000	60	0	1
35,001-150,000	74	0	1
150,001-500,000	90	0	1
500,001 and over	102	0	1

Example

An example of how to use the Sample Plan is as follows:

A batch of hose assemblies, quantity 65, requires inspection:

- a) from the Sample Plan take the lot size between 16-150 which gives a sample size of 13 to be selected at random from the 65. For example, not the first 13 manufactured
- b) during inspection of the 13 assemblies the batch can only be accepted if no faults are found. If a fault is found the complete batch must be checked for the fault that has been identified
- c) all assemblies found to be defective should not be supplied unless they can be re-worked or authorisation is given, by way of formal concession, in writing, by the Customer

MANDATORY

QUALITY CONTROL – CALIBRATION OF INSPECTION EQUIPMENT RECORD

Item inspected: _____ Calibration media: _____

Calibration period: _____

<i>Unique identification number</i>	<i>Description</i>	<i>Date introduced</i>	<i>Nominal allowable deviation</i>	<i>Remarks</i>	<i>Inspected by</i>	<i>Date inspected</i>	<i>Next inspection date</i>

HOSE PRODUCTION ORDER/RECORD

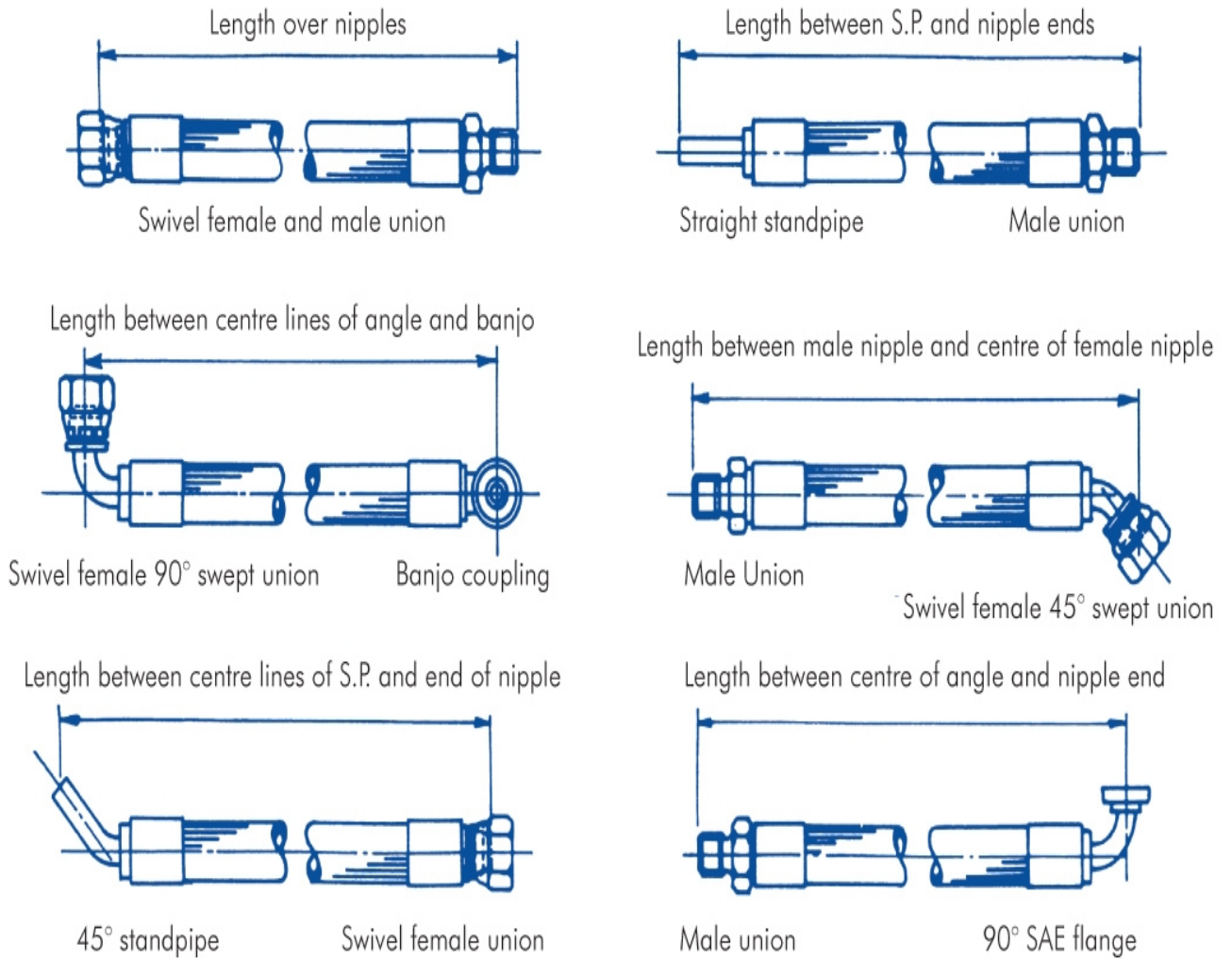
Customer:			
Customer order number:		Internal reference number:	
Quantity:		Date required:	
Application:		Fluid:	
Temperature:		Working pressure:	
Minimum bend radius:			
Test:.....yes/no			
Quality assurance inspection:.....yes/no			
Certification of conformity:.....yes/no			
Hose:		Size:	Code Number:
Theoretical hose cut length:		Actual hose cut length:	
Date code/Batch number:			
Permanent swaged ends:			yes/no
Hose end 1	Insert part number:		Description:
	Ferrule part number:		Description:
Hose end 2	Insert part number:		Description:
	Ferrule part number:		Description:
Assembly length:		Hose guard:yes/no	Type:
Hose guard details (e.g. full length):			
Crimp/Swage parameters:			
Angle if hose fitted with elbows both ends:			
Code (see Figure 2):			
Specified by:			
Assembled by:			

HOSE PRODUCTION ORDER/RECORD

MANDATORY

Figure 1

Measuring



HOSE PRODUCTION ORDER/RECORD

Table 9

Tolerances on hose assembly lengths

Hose assembly length mm	up to and including 25	Nominal bore over 25 and including 50	over 50
	Tolerance	Tolerance	Tolerance
up to and including 630	+7 mm - 3 mm	+ 12 mm - 4 mm	+ 25 mm - 6 mm
over 630 and including 1 250	+ 12 mm - 4 mm	+ 20 mm - 6 mm	
over 1 250 and including 2 500	+ 20 mm - 6 mm		+ 25 mm - 6 mm
over 2 500 and including 8 000		+ 1,5 % - 0,5 %	
over 8 000		+ 3 % - 1 %	

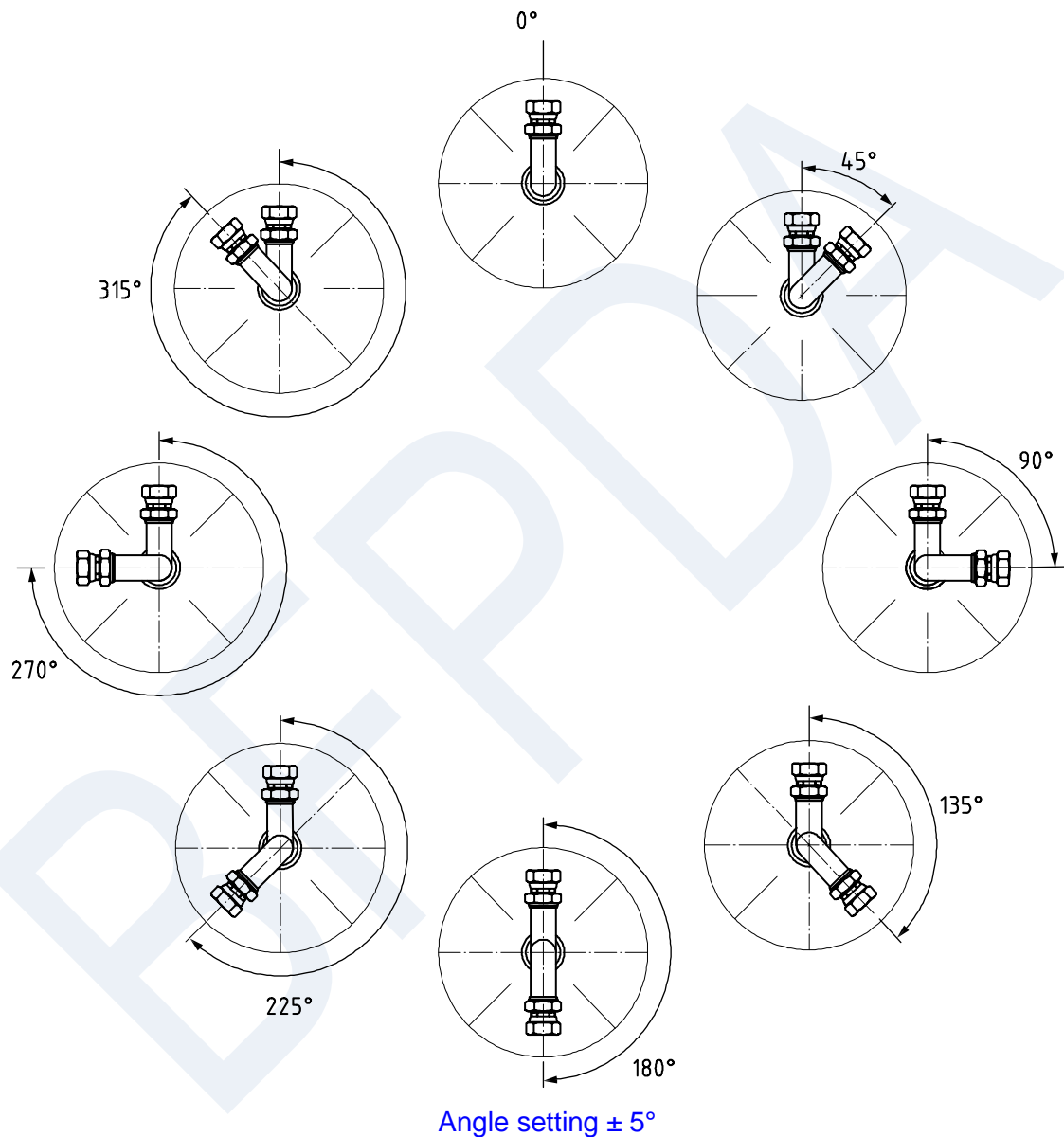
NOTE 25: Some customers/applications may require specific/tighter tolerances.

HOSE PRODUCTION ORDER/RECORD

MANDATORY

Figure 2

Orientation



Angle Settings

With an end fitting in each hand, and with the left hand end fitting pointing upwards, bring your right hand towards you and move the left hand away until you are looking along the hose. The end fitting in the right hand then may be set to the required number of degrees clockwise to the fitting in the left hand

HOSE PRODUCTION ORDER/RECORD

Table 10

Test Data

	<i>Bar</i>	<i>psi</i>
Working pressure:		
Test pressure:		
Test pressure held for (seconds):		
Test fluid:		
Electrical continuity check:	yes/no	
Hose cleaned (method):		
Hydraulic application:	yes/no	
Gas application:	yes/no	
Pin prick outer hose cover (only on gas > 200psi):	yes/no	
Test conducted by:		
Witnessed by:		

Table 11

Quality Control

Final inspection:	tagged:
Capped:	hose guard:
Certificate of conformity:	yes/no
Approved for despatch:	date:
Inspector:	

Table 12

Dash References for Hose and Thread Size (Imperial)

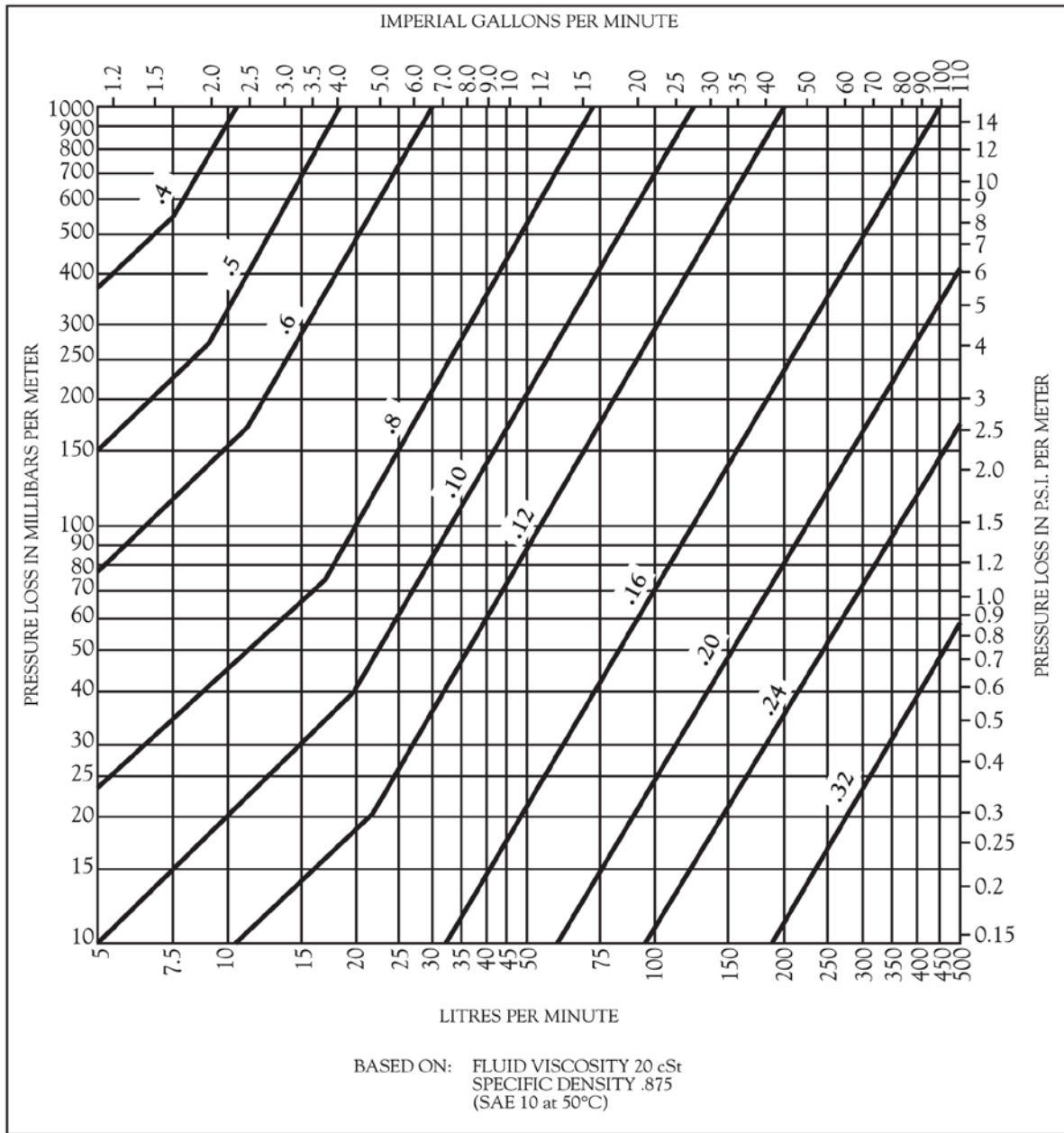
<i>Dash size</i>	<i>Hose inside diameter (inches)</i>	<i>BSP/BSPT</i>	<i>NPT</i>	<i>ORFS</i>	<i>JIC 74° cone and O-ring Boss</i>	<i>SAE 90° cone</i>
-2	1/8	1/8 - 28	1/8 - 27		5/16 - 24 UNF	5/16 - 24 UNF
-3	3/16				3/8 - 24 UNF	3/8 - 24 UNF
-4	1/4	1/4 - 19	1/4 - 18	9/16 - 18 UNF	7/16 - 20 UNF	7/16 - 20 UNF
-5	5/16				1/2 - 20 UNF	1/2 - 20 UNF
-6	3/8	3/8 - 19	3/8 - 18	11/16 - 16 UNF	9/16 - 18 UNF	5/8 - 18 UNF
-8	1/2	1/2 - 14	1/2 - 14	13/16 - 16 UNF	3/4 - 16 UNF	3/4 - 16 UNF
-10	5/8	5/8 - 14		1-14 UNS	7/8 - 14 UNF	7/8 - 14 UNF
-12	3/4	3/4 - 14	3/4 - 14	1 ³ / ₁₆ - 12 UN	1 ¹ / ₁₆ - 12 UN	1 ¹ / ₁₆ - 14 UNS
-14	7/8	7/8 - 14			1 ³ / ₁₆ - 12 UN	1 ¹ / ₄ - 12 UNF
-16	1	1-11	1-11 ¹ / ₂	1 ⁷ / ₁₆ - 12 UN	1 ⁵ / ₁₆ - 12 UN	1 ³ / ₈ - 12 UNF
-20	1 ¹ / ₄	1 ¹ / ₄ - 11	1 ¹ / ₄ - 11 ¹ / ₂	1 ¹¹ / ₁₆ - 12 UN	1 ⁵ / ₈ - 12 UN	
-24	1 ¹ / ₂	1 ¹ / ₂ - 11	1 ¹ / ₂ - 11 ¹ / ₂	2-12 UN	1 ⁷ / ₈ - 12 UN	
-32	2	2-11	2-11 ¹ / ₂		2 ¹ / ₂ - 12 UN	

Table 13

Dash References for Hose and Thread Size (Metric)

<i>Dash size</i>	<i>Hose inside diameter (inches)</i>	<i>French metric DKF CEF</i>	<i>French metric stand-pipe NOM O/D RSF</i>	<i>German metric (Light) DKL DKO-L CEL</i>	<i>German metric stand-pipe (Light) NOM O/D RSF</i>	<i>German metric (Heavy) DKS DKO-S CES</i>	<i>German metric stand-pipe (Heavy) NOM O/D RSS</i>	<i>Metric DKM CEM</i>
-3	$\frac{3}{16}$			M12 x 1.5	6	M16 x 1.5	8	M12 x 1.5
-4	$\frac{1}{4}$	M16 x 1.5	10 G	M14 x 1.5	8	M18 x 1.5	10	M14 x 1.5
-5	$\frac{5}{16}$			M16 x 1.5	10	M20 x 1.5	12	M16 x 1.5
-6	$\frac{3}{8}$	M20 x 1.5	13 G	M18 x 1.5	12	M22 x 1.5	14	M18 x 1.5
-8	$\frac{1}{2}$	M24 x 1.5	17 G	M22 x 1.5	15	M24 x 1.5	16	M22 x 1.5
-10	$\frac{5}{8}$	M30 x 1.5	21 G	M26 x 1.5	18	M30 x 2	20	M26 x 1.5
-12	$\frac{3}{4}$	M36 x 1.5	27 G	M30 x 2	22	M36 x 2	25	M30 x 1.5
-16	1	M45 x 1.5	33 G	M36 x 2	28	M42 x 2	30	M38 x 1.5
-20	1 $\frac{1}{4}$	M52 x 1.5	42 G	M45 x 2	35	M52 x 2	38	M45 x 1.5
-24	1 $\frac{1}{2}$	M58 x 2	49 G	M52 x 2	42			M52 x 1.5
-32	2							M65 x 2

Figure 3
Pressure Loss Graph



NOTE 26: The above graph is to calculate the pressure loss for any given bore of hose and flow rate. Significant reduction of bores in adaptors, elbows, banjos etc also increases losses and care should be taken to avoid restriction of flow.

HOSE ASSEMBLY CONFORMITY CERTIFICATE

Customer:		
Address:		
Telephone:		Email:
Certificate number:		Date of issue:
Order number:		
Hose assembly reference number:		
Hose end 1	Insert part number:	Description:
	Ferrule part number:	Description:
Hose end 2	Insert part number:	Description:
	Ferrule part number:	Description:
Quantity:		Hose type:
Size:		Length:
Date code/Batch number:		
End fitting 1:	End fitting 2:	Angle set:
Pressure tested:	yes/no	Maximum Working Pressure (bar):
Test/Proof pressure (bar):		
Test pressure held for (seconds):		
Hose cleaned:	yes/no	Method used:
Cleanliness code/specification:		
Level of cleanliness obtained:		
Approval and final inspection:	yes/no	
Inspector:		

This is to certify that the hose assembly(ies) as listed above have been assembled, tested and cleaned to the Hose Manufacturer's Assembly Instructions and to the quality control procedures contained within this guideline which conforms to BS EN ISO 4413 and BS EN ISO 4414.

Signed:

Date:

MANDATORY**DON'T MIX AND MATCH****What is the definition of Mix and Match?**

Mix and match is the practice of using a different manufacturer of hose/fitting/ferrule combination that has not been verified by successful testing.

The BFPDA considers that the practice of mix and matching is unacceptable as all components for an assembly must be compatible by design, size and type, and must have been compatibility proven by successful testing in accordance with the relevant hose/end termination specification.

NOTE 27: *Only use suppliers who can prove that all hose and coupling combinations have been successfully tested in accordance with the appropriate standard. Such tests shall include hydrostatic, impulse and leakage testing and ensure that materials can be traced back to the point of manufacture.*

In the final analysis, the producer of the hose assembly is responsible for its performance.

Within the American standard, SAE J1273, recommended practice states:

- a) hose fitting components from one manufacturer are not usually compatible with fitting components supplied by another manufacturer (for example, do not use a hose fitting nipple from one manufacturer with a hose socket from another manufacturer)

NOTE 28: *It is the responsibility of the fabricator to consult the manufacturer's written instructions or the manufacturer directly for information on proper fitting components.*

- b) care must be taken to determine proven compatibility between the hose and fitting. Base selection on the manufacturers' recommendations substantiated by testing to industry standards such as SAE J517. Hose from one manufacturer is not usually compatible with fittings from another. Do not inter-mix hose and fittings from two manufacturers without approval from both manufacturers.

NOTE 29: *Other industry standards (for example, BS, EN, ISO etcetera) also specify suitable test methods to ensure hose and fitting compatibility. Tests include hydrostatic, impulse and leakage testing.*

- c) These Guidelines recommend that all hoses must carry the manufacturer's name or trademark, date of manufacture, type, size and working pressure.

NOTE 30: *It is important that the hose used meets the standard marked on it (i.e. SAE, BS, EN, ISO). It should have a date of manufacture (rubber hose particularly has a known shelf life, size, working pressure, maker's name, mark, or logo, to ensure it is traceable to the source of production.*

- d) the BFPDA advises that the fittings used are size and type marked, carry the manufacturer's identification and show compatibility recommendations. The manufacturer of the fitting will be able to provide guidance as to swaging criteria. It is always prudent to view all unmarked or untraceable fittings as suspicious!

MANDATORY

SIMPLE RULE FOR RE-ENDING HOSE ASSEMBLIES – DON'T!

During BFPDA inspection visits for the Approved Hose Assembly Mark Scheme and discussions with fluid power distributors – to both BFPDA members and non-members alike – quality assurance is an important issue. Producers of hose assemblies continually raise the practice of re-ending hose. The response is to refer to BS EN ISO 4413 Hydraulic Fluid Power - General rules and safety requirements for systems and their components and BS EN ISO 4414 Pneumatic Fluid Power – General rules and safety requirements for systems and their components.

These standards, which most fluid power machinery manufacturers use in order to achieve a 'presumption of conformity' with the Machinery Directive, are nothing if not clear on the subject:

BS EN ISO 4413:

Clause 5.4.6.5.1 a) states: "hose assemblies shall be constructed from hoses that have NOT been previously used in operation as part of another hose assembly and that fulfil all performance and marking requirements given in appropriate standards"

BS EN ISO 4414:

*Clause 5.4.5.9.1 a) states: "hose assemblies **shall** be constructed from hoses that have not been previously used in operation as part of another hose assembly"*

In CEN and ISO parlance, the word 'shall' is taken as 'must comply – it is non-negotiable. If the 'shall' requirements of such a standard are not met, compliance with the standard concerned is not possible.

Both BS EN ISO 4413 and BS EN ISO 4414 are 'transposed harmonised standards' which means that the members of the European Union have adopted the standards and have withdrawn any conflicting national standards. If you are supplying fluid power 'machinery' in the EU it is very likely indeed that you will have to comply with the requirements of these standards.

Even if the product is intended for export outside the EU, the customer may require compliance with BS EN ISO 4413 and BS EN ISO 4414.

As well as being effectively banned in Europe by BS EN ISO 4413, the practice of re-ending hose also destroys all the hard work that goes into an effective quality assurance programme.

Reputable distributors refuse to re-end hoses. There are, however, some who display a sign or annotate their invoices with a disclaimer to the effect that, "should the re-ended hose fail they are not responsible, as this is a 'service' demanded by their customers". It is likely that a court will reject any disclaimer as the hose assembly producer stated it was an unacceptable practice but still went ahead and re-ended the hose. In other words, the Company who manufacture the hose assembly is liable.

NOTE 31: *Re-ending causes problems because as soon as a hose assembly is put into service it is subjected to heat, flexing, pulsation, sun light and ozone. The latter de-generates the rubber, even after a short time, and causes the rubber to harden. This means that when the hose is re-swaged the wire may lose its bonding to the rubber. The hardened rubber does not flow so well over the insert and a correct swage therefore is not possible.*

MANDATORY**SIMPLE RULE FOR RE-ENDING HOSE ASSEMBLIES – DON'T!**

Another practice that should have ceased a long time ago is that of cutting the insert out from an old swaged assembly and re-using it which is **highly dangerous**. If the original swage was made correctly, the insert could have been collapsed, therefore stretched within/to its design limits and would have work hardened in the process. Any attempt to re-swage the insert shall increase the likelihood of failure. This will result in a leak at blow-off of the coupling. Indeed the hose may not be fully held by the swaged fitting assembly. This of course does not necessarily apply to re-usable hose fittings as with these *the metal is not always deformed*. If in good condition (specifically without insert bore collapse) they can safely be used again on new un-used hose, providing they are compatible.

BFPDA

WHAT IS A CLEAN HOSE ASSEMBLY AND HOW DO YOU DEFINE CLEAN?

Clean is a relative term and every OEM or user will have a different interpretation of what is defined 'clean'. There are a number of hydraulic fluid cleanliness specifications currently in use within the fluid power industry dependent upon, to some extent, the application sector and/or the industry in question. For example, systems for use in machine tools, mobile plant, military, aerospace, may quote different requirements. What is common is that this cleanliness requirement is expressed in terms of a 'Cleanliness Coding System' that has been developed to simplify the communication of particle count data, whether it is the widely used BS ISO 4406 system or the old NAS 1638. This generally means that fluid in the system must always be kept below this level from build, through installation and finally in use. This means that any replacement parts must be cleaned to the same level of cleanliness as the system that they are being fitted to, including hoses.

The usual way to clean components and piping systems is to pass clean/filtered fluid through them at high flow rate (flushing), which picks up the particles from the component's surface, carries them to a filter where they are removed (see BFPDA/P9). The accepted way for flushing made-up hoses is using a little flushing rig, however it is recognised that this may not be practical in a lot of instances. A solution is to use the 'slosh' test described below. This may have to be carried out a number of times to achieve the required cleanliness.

A significant problem in evaluating cleanliness is that the naked eye generally cannot see an object smaller than 40 microns (1micron = $1\mu\text{m}$ = 1 millionth of a metre). White blood cells are 25 microns and bacteria 5 microns, so it is of little use to look up the bore of a hydraulic hose to see if it is clean, all that will be visible are the large pieces of contaminant! A practical method to check if a hose is clean is the 'slosh' test. A hose is half-filled (the volume needs to be known) with petroleum based solvent (be careful about its flammability and do not use petrol), capped and then 'rocked' or 'sloshed' to transfer the dirt into the solvent. The solvent and particles is then vacuum-filtered to deposit the dirt on the surface of a membrane filter for evaluation of the hose cleanliness. The number of particles is then counted, using a microscope (see BS ISO 4407 for microscopy procedure). Alternatively the solvent can be counted using an Automatic Particle Counter (APC) as described within BS ISO 11500.

Establishing the 'cleanliness level' by these methods may not be practical as it involves specialist equipment, high levels of skill and often a laboratory environment. Most users are expressing fluid cleanliness in terms of BS ISO 4406 codes. This standard defines a coding system based upon three sizes. If the sample is counted using an APC, the counts are converted to a scale number or 'ISO code', whereby the first scale number represents the number of particles larger than $4\mu\text{m}$ (c) per millilitre of fluid. The second scale number represents the number of particles larger than $6\mu\text{m}$ (c) and the third number represents the number of particles larger than $14\mu\text{m}$ (c) per millilitre of fluid (note the use of ' μm (c)' denotes calibration using BS ISO 11171). For simplicity the ISO cleanliness code is expressed as three figures, for example 'ISO 18/16/10'. If a microscope is used to count the sample then the particle counts are obtained at two sizes: 5 and $15\mu\text{m}$ as there is no equivalent size to the $4\mu\text{m}$ (c) and the ISO code becomes: 'ISO -/16/10'. This is further explained in BFPDA/P5 which also includes general comparison to other standards.

WHAT IS A CLEAN HOSE ASSEMBLY AND HOW DO YOU DEFINE CLEAN?

The customer will usually specify the cleanliness code for his system and perhaps even for the hose assemblies. This will invariably be as an ISO Cleanliness code and this also allows a quick solution for evaluating hose cleanliness. The general concentration of particles on the membrane filter prepared above can be viewed (rather than counted) and compared to either a series of 'master' membrane filters, or photographs representing known ISO levels issued by some companies. If it is dirtier than the required ISO level then further cleaning is required. Note that account must be taken of both the volumes of both the solvent used and the hose.

In the event of a hose replacement, the hose assembly should be cleaned prior to fitting to avoid fresh contaminant being introduced.

There are a number of ways of cleaning hose assemblies including proprietary systems that use pellets or foam plugs for removing contaminant. Manufacturers of these systems claim to achieve 'high' standards of cleanliness. Another alternative is the use of a small flushing rig as previously mentioned. Perhaps the simplest method is to use the 'slosh' test as this process removes dirt and it may therefore be necessary to repeat the 'slosh' and 'patch' procedures until the desired degree of cleanliness is reached. Whatever method is employed, the BFPDA are always emphasising the need to ensure hydraulic hose assemblies reach the customer with acceptable cleanliness levels.

NOTE 32: *It is recommended that filtered compressed air be used to blow out contaminant immediately after cutting hose and again when, the assembly is completed, prior to capping. This is a cost-effective way to remove loose materials and achieve a "respectable" level of cleanliness. This, however, is not a cleanliness standard and most likely will give a result that is dirtier than the Required Cleanliness Level (RCL).*

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BFPA/P9 Guidelines for the flushing of hydraulic systems

BFPA/P115 Disposal and Handling of Waste Hydraulic Oil, Hoses and Associated Waste

BS 5244:1986 Application, storage and life expiry of hydraulic rubber hoses and hose assemblies

ISO/TR 10949:2002 HFP — Component cleanliness — Guidelines for achieving and controlling cleanliness of components from manufacture to installation

BS ISO 17165-1:2007 HFP — Hose assemblies — Part 1: Dimensions and requirements

BS ISO 17165-2:2018 HFP - Hose assemblies - Part 2: Practices for hydraulic hose assemblies

BS ISO 18413:2015 HFP — Cleanliness of components — Inspection document and principles related to contaminant extraction and data reporting



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