THE SPRING RESEARCH AND MANUFACTURERS' ASSOCIATION

QUALITY

A Guide for Spring Manufacturers

by

G. B. Graves, A. Met., C.Eng., M.I.M.

DECEMBER 1985

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SUMMARY

This article has been specially written to help springmakers understand the implications in applying sound technical and administrative procedures to their manufacturing operations, for the purpose of improving the quality of their product.

The benefits to be gained from a properly structured Quality Assurance system, based on the national standard BS 5750: Part 2, have been highlighted, and each of the seventeen elements comprising the standard have been considered in detail. Under each of the seventeen headings, an attempt has been made to interpret the meaning of the formal clauses which appear in the standard, and to offer guidance to springmakers in the implementation of these requirements into practical systems.

Since BS 5750: Part 2 is a general quality standard, applicable to all manufacturing situations, the need for a supplement, in the form of Quality Assessment Schedules is discussed.

National recognition of a spring manufacturer's good Quality Assurance practice is available from BSI Quality Assurance Services and from Lloyd's Register. Some likely pitfalls, which springmakers may encounter during their preparation for accreditation, have been illustrated.

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1. INTRODUCTION

In July 1982 a Government White Paper "Standards, Quality and International Competitiveness" was published. This document set out the British Government's policy with respect to enhancing the quality of British manufactured products by the application of sound technical and administrative procedures which would lead to an improvement in product quality and thereby increased export potential. In support of the Government's proposals the National Quality Campaign was launched with the aim of drawing the attention of British Industry and the general public at large to the need for a re-appraisal of our attitude to quality and its effect on international competitiveness and the nation's wealth. Using the media, printed literature, films, videos, public and private meetings, training courses and national advertising, the publicity surrounding the campaign still continues.

The term 'Quality' can have different meanings to different people, but in the context of the manufactured product is defined, according to BS4778, as "The totality of features and characteristics of a product or service that bear on the ability to satisfy a given need", in other words - fitness for purpose. In order to assure customers that they are getting the right level of quality, it is necessary to institute procedures which will measure, control, and where necessary, improve quality. This leads to two further definitions which should not be confused. The first is "Quality Assurance" which is concisely defined as "All activities and functions concerned with the attainment of quality" (BS4778) and "Quality Control" defined as "The operational techniques and activities that sustain the product or service quality to specified requirements. It is also the use of such techniques and activities" (BS4778).

This guide is one of a number of quality activities in which SRAMA is currently engaged. As registered consultants to the Government's financed Business and Technical Advisory Services (Quality), SRAMA is in an ideal position to provide assistance and advice to springmakers on all quality related matters. In addition, the Association acts in an educational capacity by providing training courses on quality assurance.

A second report on quality is planned and will cover statistical process control as applied to spring making.

2. BENEFITS

It is important for both management and workforce to realise that the introduction of a properly structured and comprehensive Quality Assurance system operated by manufacturing industry can lead to significant and lasting benefits to the springmaker and also to his customer. These include:-

i Increased reliability of the product

ii Reduction in rejects and scrap levels

iii Reduction in re-work of products

iv Rapid identification of problem areas in production

v Ultimate cost savings in production

vi Customer confidence

vii Improved sales potential

To achieve the above benefits senior management must have a clear idea of the objectives they must meet and, of course, ensure that all personnel involved in quality are aware of these objectives and their implementation. The task of management therefore is one of communication and persuasion, since the success or otherwise of the introduction of a total Quality Assurance scheme will depend on the attitudes of all personnel within the company.

The growing demand by purchasers for goods which meet a specified level of quality has led to an increased reliance on quality assurance principles by manufacturers as described in British Standard BS5750.

3. QUALITY ASSURANCE ELEMENTS

The adoption of the principles laid down in BS5750 is at the very heart of the approach now being made towards quality assurance. First published in 1979, the standard is in six parts of which Part 2 is devoted to manufacturing situations such as those found in the spring industry. The principles adopted in BS5750: Part 2 are equally applicable to companies employing a handful of people as well as to those employing many thousands. Only by the introduction of a properly structured quality system, as exemplified in BS5750, which identifies the basic disciplines and defines the procedural arrangements to be followed, can springmakers and their customers be assured that the product meets the purchaser's requirements with respect to quality.

Under seventeen separate headings, Part 2 of the standard sets out the various elements which must be implemented if a fully comprehensive system is to be established.

3.1 Quality System

The first requirement is for the springmaker, or any other manufacturer for that matter, to recognise the need for a documented management system which has as its primary objective the supply of manufactured goods which meet the customer's specified needs. In order to satisfy this requirement, it will be necessary to state the company's objectives with respect to quality, and to show how the adoption of management policies, organisation and procedures are structured and executed.

The quality system operated by a company is best described in the form of a Quality Manual which is made available to all personnel connected with the quality of the manufactured product or service. It is, however, emphasised that the production of a Quality Manual is only a means to an end and not an end in itself. No matter how simple or complex the documented procedures may be, they must reflect the organisational methods actually employed by the company and be shown to be fully implemented at all stages.

3.2 Organisation

All good management systems require effective organisation and to achieve this it is necessary to appoint a suitable individual having the necessary authority and status within the company to be responsible for all aspects of the quality assurance system and answerable directly to the chief executive. Wherever possible, the Quality Manager's duties should be independent of other duties within the company, particularly those concerned in any way with production. Ideally, the appointee should have received formal training in quality assurance and quality control techniques, but it is accepted that many senior personnel from other departments within a company, due to their experience in engineering and production, make admirable Quality Managers. However, there is no substitute for formal training and all quality personnel should be encouraged to undertake training through local colleges or by correspondence.

Not withstanding the responsibilities of the Quality Manager and the Quality Control department staff, it is emphasised that the achievement of quality also rests with production management and the operatives.

3.3 Quality Systems Review

Once a quality system has been established it is essential that procedures are laid down to ensure its continued effectiveness. To accomplish the requirements as specified in BS5750:Part 2 it is necessary to institute periodic and systematic investigtions into the operation of the quality system. In the standard these activities have been entitled "Audit" and "Review" and their purpose should not be confused.

The first requirement involves an internal audit of all the seventeen elements comprising the standard which, of course, will have been detailed in the Quality Manual. The person carrying out this duty must be named, and in the majority of cases is likely to be the Quality Manager, although there is provision within the standard for some other named senior manager to perform the task. To aid the audit procedure a detailed question sheet can be prepred and guidance on such a check list can be found as Appendix A in BS5750:Part 5. The important thing to remember is that the individual findings of the audit need recording and a copy made available to the company's Chief Executive. To be of any value the audit must be undertaken in a methodical and systematic manner and any unsatisfactory situations discovered during the audit should be actioned for remedial treatment. A further audit of the deficient area will also be necessary within a reasonable space of time depending on the circumstances.

The systems review is most conveniently handled by a small elected management team, whose objective is to monitor the effectiveness of the systems in operation within the company and to check on the efficiency of management at all levels. The facts revealed from the internal audit will provide an essential input to the review and thereby allow senior management to identify any irregularities and shortcomings in the system and provide a forum for discussion which will eventually lead to corrective action where appropriate. The review team should always be mindful of the need to remove duplicated or redundant procedures and paperwork wherever possible, provided of course, the essential elements of the quality standard BS5750 are still being satisfied.

The standard gives no guidance as to the frequency of internal audits and management reviews, the choice is left entirely to the individual company concerned.

With respect to internal audits it is recommended that the whole system be examined every six months either by a rolling programme of auditing selected areas each month, such that after a period of six months all seventeen elements of the standard have been investigated, or by a more concentrated investigation examining all aspects of the quality system over a shorter time period. From a practical point of view the former has much to recommend it.

Management reviews should be geared to the availability of a full internal audit and therefore six monthly intervals would seem sensible. Clearly the frequency of audits and reviews are flexible depending on the outcome of previous experience and in cases of serious non-compliance it would be necessary to arrange more frequent audits and reviews. It is not however recommended that the interval between meetings be extended beyond six months.

3.4 Documentation

Unambiguous but concise written instructions, work and inspection records, identification labels etc. are the very essence of an effective quality assurance scheme. Under this heading the standard specifies the minimum documentation requirements with respect to:-

i Written inspection and test procedures
ii Records
iii Technical data and changes

Written inspection and test procedures are important in that they clearly define the manner in which specific inspection or testing operations are to be performed. Access to such documents by inspection and where necessary production staff eliminate the problems of interpretation and provide a common basis for comparisons of test data. It is accepted that simple inspection operations such as dimensional measurements involving micrometers, verniers and similar instrumentation are unnecessary provided the person involved has received training in their use. On the other hand inspection operations concerned with load testing springs, materials property testing, corrosion testing, any form of acceptance rig test and

the most sophisticated metrology techniques will require written procedures. Criteria for approval or rejection of a particular batch is best indicated on the appropriate works order and/or inspection sheet which will accompany the job in question.

The maintenance of all inspection records is a vital part of the quality system and provides objective evidence that the product meets the customer's specified requirements. The inspection records should also encompass information concerning any re-work or corrective action which may have been necessary during production, and details of concessions which have been agreed with the customer. All inspection records must be retained in suitable storage and provide an excellent source of information for any subsequent analysis designed to identify problem areas in production, as well as unsatisfactory conditions in the system as a whole. It should be noted that inspection documentation provided by sub-contractors is also evidence that they are capable of meeting the quality requirements and these need similar treatment and storage.

It is imperative that springmakers maintain strict control of all technical data sheets, customer's specifications, customer's drawings and other relevant documents to ensure only the pertinent up-to-date issues are circulated to the appropriate manufacturing and inspection locations. With the majority of springmakers, this usually involves a separate section within office administration, whose primary function is to operate a library of customers' drawings and other technical information and schedules. Through direct contact with the customer (in some cases indirect via the Sales Department) and by means of a drawings/technical data register, only the current issues of documents will be available for use. For the purpose of any future reference, it is desirable to maintain a historic superceded drawings/technical data file, but great care should be exercised in keeping such information separate.

All changes in the content of customers' drawings/technical specifications require their written approval. Likewise any modifications to the technical data generated by the manufacturer, will require written authority from the Quality Manager or other nominated senior management member before such changes can be implemented.

3.5 Inspection Equipment

Sprinmakers who intend to set up a quality assurance system which satisfies the requirements of BS5750: Part 2 need to know that the measuring equipment they use for inspection is accurate and of sufficient precision to demonstrate to their customers that the specified dimensional and technical requirements have been met. To ensure the integrity of the measurements made during inspection, all instruments and test equipment need to be calibrated at regular intervals against standards which are traceable to national measurement standards.

In general, springmakers will find it more cost effective to undertake the calibration of simple hand-held instruments, such as micrometers, vernier callipers, dial gauges etc., in-house provided they possess the right calibre of staff. The procedures will be against written calibration

methods using gauge blocks of suitable accuracy, which have themselves been calibrated by an external authority against NPL standards.

On the question of calibrating the more sophisticated equipment, such as furnace instrumentation, hardness testers, spring load testers and mechnanical testing machines, this is best left to the experts. Calibration organisations who are members of the British Calibration Service offer such facilities and ensure calibration traceability to NPL prime standards.

3.6 Inspection of Purchased Material or Services

Clearly a springmaker who has devoted a lot of time and effort in ensuring his own internal organisation is designed to produce a quality product, would be foolish not to exercise some control on his own suppliers and sub-contractors. If the required quality is to be achieved in the final product then it is important that the materials from which the springs are produced are to the specified level of quality to start with. The old adage, "you can't make a silk purse out of a sow's ear" is equally true in the context of quality.

It is necessary therefore, for the springmaker to develop confidence in his materials suppliers' and sub-contractors's ability to provide what has been ordered.

To assist in the selection of suitable material suppliers and sub-contractors an assessment of their previous performance (where possible), their technical ability and attitudes to quality assurance needs to be made. As a first step the supplier/sub-contractor should be asked by correspondence to complete a quality assessment questionnaire which lists simple pertinent questions about the quality systems he employs. At a later stage this can then be followed up by a personal visit to the company concerned to inspect their facilities and talk to their staff. Besides checking on the validity of the questionnaire, much can be learnt from personal contact.

Another method of monitoring the performance of suppliers/sub-contractors is to introduce a vendor rating system. This can be generated internally and is based on historic percentage reject information over a given period of time and the performance related to meeting promised delivery dates.

It should be mentioned that suppliers/sub-contractors who have themselves been accredited against BS5750 and listed in the Government's Register of Quality Assessed UK Firms would, of course, provide a guarantee of their quality competence and thereby circumvent the need for in-depth investigations by the springmaker.

The first essential requirement is the purchase order which should contain all the necessary technical information to fully describe the material or service being ordered. Where appropriate this document should make reference to any accompanying drawings, specifications, technical information sheets etc. and where required details of any in-process ins-

pection. This last aspect is particularly important where material or process characteristics can only be determined by the supplier and cannot be confirmed at a later stage. In such cases a test certificate or certificate of conformance should always be requested.

To be assured the purchased materials/goods/services are to the specified requirements as given on the purchase order incoming inspection will be necessary. The amount of inspection will depend on the type of product/service and the degree of control exercised by the supplier/sub-contractor and the documentary records provided (i.e. test certificates, certificates of conformance). In situations where the springmaker is confident in his source of supply, then the degree and type of incoming inspection could be kept to a minimum and be designed to supplement rather than duplicate that already undertaken elsewhere. It should, however, be remembered that ultimately the springmaker is responsible for the quality of material or sub-contacted process he employs.

Materials or sub-contracted processing not meeting the order requirements, should be isolated and not used for production until the problem is resolved. However, there may be occasions where in order to maintain production it is necessary to release material to the shop floor prior to inspection approval. In these circumstances, strict procedural arrangements should be followed. These written procedures (included in the Quality Manual) should indicate how the consignment is identified, who is authorised to release the unproven material for production, and what actions would be necessary to segregate the suspected products should the subsequent incoming inspection show the consignment to be defective. Methodical record keeping is required at the incoming inspection stage to provide unique consignment identification which will remain with the batch throughout all subsequent manufacturing operations and despatch.

Finally, one last observation concerning this section of BS5750 which is not always realised by aspiring quality conscious springmakers, is the need for manufacturers to allow the customer's quality representative access to incoming materials inspection records and documentation. Also the facility to verify at the material suppliers' or sub contractors' premises, the quality of the consignment/product or process. Should the customer wish to exercise this option, then the springmaker should make certain such a request is included on the original customer's purchase order/contract placed with the springmaker. For his part, the springmaker must, in turn, include in his order placed on a material supplier/sub-contractor, a statement that the quality of the material/process will be verified at source by the springmaker's customer.

3.7 In-Process Inspection

A springmaker must have the capability of controlling the quality of his product at all stages of manufacture. Systems are therefore needed to identify at what stage in-process inspection should be carried out. A correct choice of these inspection stages will allow prompt and effective action to be implemented to enable the segregation of defective parts and allow the cause of the faults to be established and remedied.

The standard does not attempt to lay down the amount or nature of the inspection, this is left to the individual company, who from their past experience of that product is in the best position to decide such details. Whatever inspection methods or combination of process control techniques are employed, the manufacturer is required to show his product is meeting conformance to the customer's specified requirements.

With certain manufacturing operations, it is difficult or virtually impossible to ascertain the quality level achieved after the event, and in these cases it is important to resort to strict manufacturing procedures in order to ensure the required quality level.

3.8 Workmanship

The springmaker is obliged to provide a documented system which transmits the customer's specified spring requirements to all personnel involved in the execution of the order. Documentation, in the form of a Works Order/Route Card should accompany the product throughout all stages of manufacture and should be styled to ensure the parts are directed through the correct manufacturing sequence. Sufficient technical information should be provided on the Works Order/Route Card to instruct the operator(s) at every manufacturing stage, to ensure the part is made correctly and so meets the customer's order requirements. The Works Order/Route Card should also detail the stages at which inspection should be carried out, and have provision for recording the results of the tests. Where it is impractical, due to space limitations, to include such data on the Works Order/Route Card, then a separate Inspection Records Card should be included.

Where drawings are provided by the customer, these should accompany the Works Order/Route Card, which should be endorsed with the drawing number and issue number. In circumstances where drawings are not available, then a written specification for the parts should be generated and included on the Works Order/Route Card.

Good work instructions provide direction, eliminate misunderstandings, and are a means of assessing acceptable workmanship. Without written instructions, differences in procedures may arise and variations in manufacturing practice can occur, leading to confusion and possible variable quality.

Remember, documents issued to the works should contain details of:-

i what is to be done
ii when it is to be done
iii how it is to be done
iv by whom it is to be done

3.9 Corrective Action

The purpose of an efficient quality system is to provide goods which are of sufficient quality to meet the customer's requirements. Springmakers, like other manufacturing concerns, from time to time produce goods which are sub-standard due to a variety of reasons. Shortcomings in engineering

practice, lack of technical information, communication difficulties, inferior materials, inadequate manufacturing machines, deficincies in inspection etc., can all lead to products being rejected.

It therefore makes good business sense, since rejects and sub-standard products mean additional costs, to be able to promptly identify non-conforming items and institute corrective action to remedy the fault where economically feasible.

Written operational and inspection procedures are therefore necessary to cover the receipt of defective raw materials, sub-contracted parts or processes, internal production of sub-standard items as well as the rejection of springs by the customer.

With respect to defective raw materials or sub-contracted items/processes, these are identified by incoming inspection and it is the responsibility of the Quality Manager to raise the necessary paperwork to advise the supplier of the situation. At all times the purchase department should be kept informed.

Problems associated with the internal production of items below the specified requirements are in many cases first noticed by the operative, failing this, routine inspection should identify the problem. If an acceptable level of quality is not being achieved then Quality Control should inform the appropriate production manager/supervisor and between them steps should be taken to correct the fault. All suspect products should be suitably labelled and segregated to avoid mixing with satisfactory items.

The rejection of springs by customers are normally handled by the Quality Control department, and the first action is to verify the complaint by re-inspection of the product and to record the results. The sales and production departments should be notified in writing of the circumstances.

No matter from what source the rejections may arise, management systems are required to continuously monitor and analyse the occurence of rejects, scrap, re-work and concessions to ensure corrective action is being undertaken and is effective. It is also pointed out that springmakers have a responsibility for the quality of the products/processes provided by sub-contractors, and where it is considered necessary, they should liaise with their suppliers to satisfy themselves that the sub-contractor is taking action to overcome any quality problems.

3.10 Purchaser Supplied Material

Although the provision of "Free Issue" material to springmakers may be a rare occurrence, it is important for the springmaker to have documented procedures for handling material provided and owned by his customer.

On receipt of the material, the springmaker should satisfy himself that the consignment is as stated by the customer, by using inward inspection controls, and is suitable for its intended purpose. The batch must be clearly labelled to indicate its status and preferably kept separate from

material owned by the springmaker.

Whilst in the care of the springmakers, the material should be correctly stored and handled and be subject to periodic inspection to ensure no deterioration is taking place. In a nutshell, the springmaker should take all the precautions necessary to preserve the quality of the material, just as he would with his own material stocks.

3.11 Completed Item Inspection and Test

Some form of final inspection should always be carried out on springs to ensure the customer is getting what he ordered. The type and degree of final inspection can vary enormously according to the product and its complexity. A simple viewing operation of the product and an examination of route cards and inspection record cards to check that in-process inspections have been carried out, and are satisfactory, may be sufficient for some items. On the other hand, the more technically demanding items may, in addition, require extensive dimensional and physical property tests to be made on the final spring in order to ensure the quality requirements have been met. Irrespective of the amount of final inspection all observations and measurements need to be recorded by Quality Control to demonstrate the consignment is in full conformance with the specified requirements. With the exception of simple dimensional measurements, all physical and mechanical testing for the purpose of inspection should be conducted in accordance with written test procedures.

3.12 Sampling Procedures

Under this heading BS5750:Part 2 defines the requirements as "Sampling procedures used by the supplier shall be in accordance with the specified requirements or shall be subject to agreement by the Purchaser's Representative."

From this it is clear that the number of items to be inspected by the springmaker (i.e. the sample size) should be stated by the customer on his purchase order. Alternatively, if no level of inspection has been specified by the customer, then the springmaker is obliged to prepare sampling plans for that order and submit these to the customer for his written approval prior to order acceptance.

In the first case, the situation is simple in that the springmaker is aware of the stage(s) and amount of inspection he is required to undertake and the criteria for acceptance/rejection and therefore can generate his quotation accordingly. The second approach is somewhat more difficult, in that it will be necessary to review the technical requirements of the spring and assess the difficulties in manufacturing the item (often based on past experience) and from this information arrive at a suitable level of inspection for the pertinent characteristics of the spring to ensure the required level of quality is being achieved.

Full use should be made of established British Standards (BS5750, 5701, 5703, 6000, 6001, 6002) in developing suitable sampling plans. The most widely used method is likely to be BS6001, inspection by attributes, and

is particularly suitable for the final inspection of springs. It should be appreciated that, with the exception of 100% inspection, all statistical methods of sampling involve a risk factor both to the springmaker and to his customer. The choice of a suitable sampling plan will therefore be governed by the complexity of the spring and the consequences of any sub-standard springs finding their way into service. Clearly, springs operating in critical applications, where failure to perform satisfactorily could lead to hazardous conditions, will require a much more stringent sampling plan than those produced for clothes pegs.

Statistical inspection methods based on the measurement of variables (BS5700, 5701, and 5703) lend themselves to the process control of such operations as spring coiling, strip forming etc. When properly applied, these methods provide a useful and economical means of achieving the required level of quality. They can also act as warning signals to management when manufacturing processes begin to drift, and thereby allow timely corrective action to be effected before the particular characteristic being measured exceeds the tolerance band placed on the spring.

All inspection data collected from the application of sampling plans, needs to be recorded, to provide objective evidence that the item being produced meets the customers specified requirements. In addition, the data provides a valuable source of information for the purpose of refining engineering practice in order to reduce the variability of the product.

3.13 Control of Non-Conforming Material

An essential part of any Quality Assurance scheme is the provision for identifying and controlling sub-standard raw materials, items in production, sub-contracted parts and customer rejects. Systems are therefore necessary to prevent the mixing of sub-standard materials/springs with similar material/springs which are to specification, and to circumvent any possibility of accidental despatch to the customer.

Having established a material or batch of springs is sub-standard, the lot in question should be labelled immediately to identify its status, using distinctive "Hold" or "Reject" labels, and moved to designated areas preferably away from the immediate vicinity of production. Documentation should be raised by Quality Control giving the identity of the lot, the quantity involved, the nature of the non-compliance, any re-work instructions, concession details or directions for disposal.

In every case of non-conformance, records must be kept giving details of Works Order, material identification, production stage at which the defect occurred, nature of the defect and the quantity, proposed further action and instructions to the appropriate production area concerning rectification/re-work. Although separate record cards can be used for this purpose, it is often more convenient to record all the information on either the Works Order/Route Card or the Inspection Record Card.

In circumstances where the springmaker wishes to request a concession on a sub-standard batch then this should be made in writing, preferably on a

specially designed form which gives all the pertinent information to allow the customer to reach a decision as to whether the product is acceptable for his purpose.

3.14 Alternative Inspection Procedures and Equipment

On occasions where, due to the cost of special purpose test equipment, the springmaker wishes to use alternative test methods to inspect springs, then it will be necessary, before employing such techniques, to describe the method in writing and demonstrate its suitability to the customer. A typical case where such a situation could arise, is the load testing of torsion springs where the availability of machines of suitable capacity can often create a problem. It should be remembered, however, in designing simple test rigs, that any dimension which has an effect on the characteristic being measured, should be manufactured with precision and calibrated against appropriate standards which have traceability to national standards. Similarly any force measuring device used should be calibrated and possess traceability to NPL standards.

3.15 Indication of Inspection Status

This requirement is a simple matter of ensuring that all raw materials, items in course of manufacture, and finished products are suitably labelled. Most spring manufacturers operate a system of labelling to identify rejected material, parts in production and customer rejects but to satisfy BS5750: Part further labelling is called for so that the inspection status of material and parts in production can be immediately recognised. The following distinctive cards or tie-on labels, preferably in different colours, will be needed:-

i	Not inspected	(white)
ii	Passed inspection	(green)
iii	Rejected	(red)
iv	Hold	(yellow)

The written procedures included in the quality manual should indicate the personnel responsible for issuing status labels. As is the case with identification labels all containers used for work in progress should be marked with their inspection status; this is particularly important where a semi-processed consignment, manufactured against one works order, is split to allow part of the batch to go forward to the next manufacturing stage.

3.16 Protection and Preservation of Product Quality

This element of the standard is devoted to maintaining the quality of springs by the implementation of suitable written operational procedures for material/product handling, storage, packaging and delivery to customers. Paramount to the QA scheme is the need for identification of materials and products which should commence immediately material is received and remain with the subsequent items throughout their manufacture and ultimate despatch to the customer.

Handling:-

Careless handling of raw materials and work in progress is probably the most likely cause of mechanical damage and distortion of parts. To avoid such occurrences, particularly when unloading wire and strip coils from vans and lorries, adequate lifting and handling equipment should be provided. Care should also be exercised when drawing material from stores and when mounting coils on swifts. For instance, without recourse to mechanical aids, man-handling materials can lead to accidental surface damage when coils are dragged across concrete floors, and every effort should be made to avoid such incidents. The second important consideration is the design, shape and size of containers for holding the work in progress. Ideally boxes should be self-stacking so that the weight is taken by the box below and not by the springs and be of a suitable total weight to facilitate manual handling if necessary. In addition, the number of components per box needs to be controlled to prevent the possibilities of distortion due to their own weight.

In certain cases, particularly where the progress of work through the factory is interrupted, use should be made where necessary of wrappings, temporary corrosion protectives, VPI papers etc to protect the semi-finished parts.

Finally, under this heading the handling methods and documentation employed should ensure the product does not miss any manufacturing operation.

Storage:-

To preserve the quality of raw materials and finished products calls for methodical good housekeeping. Storage areas need to be dry, free from acidic fumes or any other aggressive environment which could cause corrosion problems, and thereby a deterioration of the quality of the materials or springs. All stores areas must be weatherproof and provided with means of heating to prevent condensation of water vapour on the material/product.

The design and construction of storage racks is an important consideration with respect to the preservation of quality, ready identification of stores and ease of handling. Wherever possible, material stores and despatch areas should be isolated from other operations, have restricted access and be in the control of a storeman or other designated employee to prevent the unauthorised use of material or despatch of goods.

Systems should be used to allow for stock rotation where appropriate and for the periodic examination of raw materials and springs in stock to detect any deterioration in surface quality.

Packaging and Delivery:-

The springmaker's responsibility for maintaining the quality of his springs remains right up to the receipt of the consignment by the customer. It is therefore necessary to conform to written operational procedures which detail any preservation which is necessary, the type of packaging to use and a prescribed method of identifying the consignment with respect to the customer's order number, the springmaker's works order and material identification number. Due regard should also be paid to any special packaging or despatch instructions specified by the customer on his order.

When considering the type of packaging to employ, due account should be taken on the fragile or robust nature of the springs, their suceptibility to corrosion, the mode of transport and the atmospheric conditions the springs are likely to encounter en route and the length of time in transit.

It is recommended that the company's standard packaging and despatch methods are fully described in the Quality Manual and provision made to allow modifications to be incorporated to take into account the various factors mentioned above, should this be necessary.

3.17 Training

All quality control staff and production operatives whose duties involve inspection tasks, are required to have gained sufficient experience or acquired skill through training to enable them to carry out the assigned inspection functions correctly and in a manner which provides accurate results.

To meet this objective the Quality Manager should have overall responsibility for the training of staff, but may delegate the training of operatives to the appropriate departmental manager. In all cases, however, the Quality Manager must be satisfied of the ability of employees, by careful and systematic monitoring or examination of their performance.

A documented system, operated by the Quality Manager, will be necessary to record the competence of all quality control staff and production operatives for all inspection techniques for which they are accredited. Training is simple inspection methods can be accomplished by on-the-job training under the guidance of a senior member of the QA department or by a production supervisor. Training in the more complicated techniques of inspection and quality control could involve the assistance of outside agencies.

4. QUALITY ASSESSMENT SCHEDULES

BS 5750: Part 2 is a general quality systems standard and as such can be applied to any manufacturing activity or service. In order to give confidence to purchasers of springs and to enable a third party independent assessment of the springmaker's capability to produce springs to the required level of quality, as detailed in the purchase specification, further documentation is required to supplement the requirements as defined in BS 5750: Part 2.

Each section of manufacturing industry is therefore required to generate documents which lay down in precise terms the scope and special requirements related to that specific group of products or processes. These documents are prepared jointly by the manufacturing sector concerned and the chosen third party assessment and registration body in consultation with purchasers.

At the present time the British Standards Institution, Quality Assurance Services and Lloyd's Register Quality Assurance Certificaton Association Ltd provide third party assessment and certification against BS 5750: Part 2 and the necessary Quality Assessment Schedules (BSI) or Quality System Supplements (Lloyd's Register).

The Council of SRAMA, after lengthy consideration of the relative merits of the two accreditation organisations, favour a sector based scheme with assessment by and registration with BSI on the grounds of their national standing, the existence of approved Quality Assessment Schedules for spring manufacture and the preferential assessment and registration fees being offered to members of SRAMA. This recommendation does not, of course, prevent individual spring companies making their own choice of an accreditation body based on their own criteria for selection.

Examples of the two Quality Assessment Schedules prepared jointly by the British Standards Institution and SRAMA are contained in this report as Appendices 1 and 2 and cover the manufacture of mechanical springs requiring lot traceability (QAS 3137/12 Issue 2) and the manufacture of mechanical springs where lot traceability is not a mandatory condition (BSI 84/92006).

Clearly the requirements for lot traceable springs are more stringent then those for non-lot traceable products but provided the quality system has been structured to meet the conditions defined in BS 5750: Part 2 spring manufacturers should find little difficulty in satisfying the additional demands placed on them by the Quality Assessment Schedules.

5. QUALITY MANUAL LAYOUT

The purpose of a Quality Manual is to document all quality related procedures employed by the company concerned and to control all activities which have an influence on the ultimate quality of springs produced against specified requirements. The layout of the Quality Manual is therefore important in that it should be a definitive account of all the management systems employed to meet the requirements of BS 5750: Part 2 and act as a ready reference document to all personnel involved.

Apart from a number of preliminary headings, the main chapters of the manual should, as far as is possible, follow a chronological sequence from the initial stages of order enquiry through to despatch to the customer. There will, however, be certain aspects of the quality system which are of a general nature, which are best included towards the end of the document. When compiling a Quality Manual the important thing to remember is that each of the seventeen elements of BS 5750: Part 2 need to be adequately covered but not necessarily under the precise headings used in the standard. For completeness, the Manual should contain copies of the relevant Quality Assessment Schedules applicable to the spring industry.

The eventual size of the Quality Manual is not necessarily an indication of its value, and every attempt should be made to keep the content as concise as possible consistent with meeting the BS 5750: Part 2 requirements. The manual is a working document, there to be used by all concerned and the sheer physical size can be a deterrent to many.

Where manuals become unwieldy it is possible to split the documentation into a number of volumes according to the activity being described. As an example, the essence of the quality system should remain in the principal document but certain operational procedures such as material procurement, inspection and test methods, calibration, staff training, supplier audits, etc, could be contained in supplementary publications if desired. It is emphasised that the principal document should make reference to these additional publications if they are used.

6. PITFALLS TO ACCREDITATION

Spring manufacturers must realise that Quality Assurance is a fully documented and workable system involving all employees. Having established a system on paper much effort will be required to implement these ideas throughout the factory by a process of education and persuasion. Personnel must appreciate that the quality systems introduced are not just a cosmetic exercise purely for the benefit of management but for the benefit of all. Grandoise paper systems are useless unless they are applied in the workplace, and it is this area where third party assessors are likely to delve at length to satisfy themselves the systems introduced by the springmaker are effective.

Quality assurance systems involve effort, and therefore management must be ever mindful of the dangers from a proliferation of unecessary paperwork. The management review requirement of BS 5750 is a convenient occasion to sit back and ask the question - Do we really need this?

On the question of verbal instructions to employees on matters concerning quality, on needs to strike a sense of balance. Important decisions, however, concerning changes in production route, inspection stages and methods, rework details etc. should always be documented.

One activity where probably most springmakers are deficient, concerns the auditing of material suppliers and sub-contractors. Many member companies are familiar with quality assurance visits from their own customers but little evidence has been observed of similar visits being made by springmakers to their suppliers.

The conditions for the storage of materials and finished springs can vary enormously from plant to plant, and in many cases much effort will be required to bring them up to an acceptable level to meet the requirements of BS 5750: Part 2. One area where some companies could fall foul of the third party assessors, is the poor handling methods employed when moving heavy wire and strip coils.

Designated areas for work in progress, hold and reject areas, require space on the shop floor, which in many spring shops is at a premium. No matter how large or small these areas may be, it is important they do not become depositories for old rubbish, machine parts, and surplus materials. Only by strong management will such situations be avoided.

Problems can arise due to the indiscriminate use of personal micrometers, verniers and similar measuring equipment for the purpose of inspection. This problem is more acute where production operatives are undertaking formal inspection procedures and steps should be taken to either prohibit their use or include them in the company's calibration programme. In the latter case these instruments, although remaining the property of individuals, would need to be allocated a unique identification number and colour marked to provide a ready indication of their suitability for use in inspection.

Other measuring and testing equipment which, due to their age and general mechanical condition, are unable to provide the necessary degree of accuracy and/or reliability required, are best removed from production and inspection areas and either scrapped or placed in a quarantine store. There could, however, be instances where it is impracticable to move the suspect equipment and in such cases the equipment should display a prominent label indicating lack of calibration.

Experience has shown that not all organisations offering calibration services employ calibrated standards, which have ultimate traceability to prime national standards. Spring companies are therefore advised to obtain written assurance on this point from the companies they employ or may commission in the future. Simply asking a company to carry out a

service on a testing machine is not enough; always insist on a certificate which can then be used to prove the accuracy of the equipment to your customers and to third party assessors. The use of organisations who are members of the British Calibration Service is recommended since it is a condition of membership that they possess traceability of their standards and employ prescribed calibration methods.

The calibration of heat treatment instrumentation is also an essential element of BS 5750 and again calls for traceability. Calibration, however, only checks the integrity of the measuring instrument and temperature sensing device within the furnace or oven, but not the uniformity of the indicated temperature within the heating chamber. Temperature gradients can occur within furnaces and ovens which could affect the quality of the parts being treated. It is important to be aware of this fact and occasionally check the uniformity of temperature by carrying out a survey of temperatures within the heated zone.

At the present time few springmakers indicate in writing the full sequence of production steps necessary to manufacture a spring. Similarly, in a number of companies there is a lack of heat treatment details given by management to the operative - he is left to his own devices in arriving at suitable temperatures and times. The shortcomings identified above would almost unevitably come to light during an assessment visit, and would be considered as a non-compliance with respect to BS 5750, possibly leading at best, to a deferment of registration with BSI/Lloyd's or at worst complete rejection.

Turning to possible pitfalls in inspection, one weak area often observed in spring companies, is the lack of specific instructions to quality control staff and/or operatives concerning the stages at which formal inspection should be carried out and on what number of samples. Mention has been made elsewhere in this paper (see 3.12) of the need to develop suitable sampling plans. Without these procedures, spring companies could find themselves in serious non-compliance with BS 5750 and a possible rejection by accreditation and registration bodies.

The majority of inspection routines, currently undertaken by the spring industry, involve either simple viewing of the product or the measurement of dimensions and spring properties, to ensure they are to specification. Although the operations involve measurements, the individual results are rarely recorded, since the criteria for pass or failure is based on whether the results fall within or outside the tolerance band placed on the particular characteristic being examined. This approach; inspection by attributes, is quite acceptable, particularly for finished goods inspection, but more use could be made of the data if individual measurements were recorded. For example, recorded data would show the variability of the parameter being measured and would therefore be helpful in refining production methods applied to repeat orders.

Although there is no mandatory requirement in BS 5750 for manufacturers to apply statistical process control (SPC) techniques in order to control quality, more and more emphasis is being placed on these techniques by some major purchasers of springs. This has led, in a number of cases, to situations where the application of SPC is a mandatory order requirement. These techniques, when correctly used, provide a powerful means of monitoring critical dimensions as springs are being produced and therefore allow adjustments to be made to the process to ensure the springs are within the prescribed limits.

It can be argued that the use of SPC is only of value where very long runs are involved but statisticians might challenge this idea. Factors which have to be taken into account when deciding whether SPC is viable are the order size, speed of production, frequency of sampling and the effort required in inspection and data logging. Modern inspection equipment coupled to micro-computers have reduced greatly the manpower needed to undertake these latter two tasks.

It has been noted that many spring companies are not familiar with these methods of quality control nor realise their full implication, and clearly there is an urgent need for education in this area.

7. ASSESSMENT AND APPROVAL

The purpose of assessment and approval of a company's quality system is to demonstrate to existing and potential customers that the spring firm concerned is capable of meeting the requirements of BS 5750: Part 2 - the national standard on Quality Systems, for manufacturers.

Whether springmakers wish to be assessed and registered by BSI or Lloyd's, a pre-requisite is a Quality Manual which describes in detail the quality systems the company employ, supplemented by, where appropriate, a Quality Assessment Schedule or a Quality System Supplement. Both registration authorities make provision for either individual firm assessment or sector based schemes participation.

The procedures to follow when seeking assessment and approval are given below:-

BSI Route:-

i) The springmaker completes the BSI pre-printed questionnaire and returns it to the BSI Quality Assurance Services. This will enable BSI to advise on the most appropriate scheme for individual needs.

ii) A formal application form is completed and this, together with a copy of the Quality Manual and a combined application/assessment fee is forwarded to BSI. This will enable BSI staff to advise on the content of the Manual and its practicability within the factory prior to the assessment visit.

iii) The assessment visit is then arranged and is likely to involve 2 people from BSI for about 1 to 2 days depending on the size of the company concerned. The assessment involves an in-depth study of the quality systems employed and their compliance with BS 5750: Part 2. It has been indicated elsewhere that the Quality Manual is not window dressing, and springmakers will be obliged to demonstrate the effective application of these documented procedures throughout the works.

The assessment usually commences with a round-the-table interview with the Quality Manager and other members of the senior management team during which the overall structure of the system will be considered. Accompanied by firm's representatives, the assessors often split up and separately carry out detailed examinations of any part of the quality system they may choose.

Any discrepanies from the published documentation which are discovered are noted by the assessor and are drawn to the attention of the Company's representative. At the conclusion of the visit a closing meeting is held during which the lead assessor gives a verbal report on their findings and a written summary of the results of the inspection.

Companies whose systems are found to satisfy both BS 5750: Part 2 and the appropriate Quality Assessment Schedule are given immediate registration. In cases where a number of minor faults have been unearthed, companies may be given qualified approval provided there can be rectified quickly. Most companies, provided they have prepared properly, may find themselves in this category but with little additional effort should be able to satisfy the assessors without much difficulty. The third possibility is a situation where there is a serious shortcoming in the system, as defined in BS 5750: Part 2 and the Quality Assessment Schedule. In such instances the company will not be granted approval as a BSI Registered Firm and considerable modifications to their methods of working will be necessary.

iv) For the successful company, registration is granted and a Certificate of Registration giving details of the scope of the accreditation is issued by BSI on payment of the annual registration and surveillance subscription.

v) Following registration, BSI will monitor the continued effectiveness, by up to four surveillance visits per year.

vi) Companies who fullfil the BSI conditions will be included in the annual BSI 'Buyers Guide' and be eligible to use the Registered Firm's logo on letterheads and advertising matter.

Lloyd's Route:-

The procedure adopted by Lloyd's Register is in many respects similar to that operated by BSI. Initial contact with Lloyd's is made by letter in which the springmaker gives details of his products. This will then be followed by a discussion between the springmaker and Lloyd's to arrive at the type of Quality System Supplement required. Once this is agreed, the springmaker makes a formal application to Lloyd's for assessment and at the same time provides a copy of his Quality Manual along with the application fee. From the information supplied, Lloyd's are then able to quote the springmaker for the cost of carrying out the assessment.

The assessment visit is made to the company and the quality systems are examined against BS 5750: Part 2, the appropriate Quality System Supplement and the documentation given in the Quality Manual. An opportunity is given to allow amendments to the system and corrective action to be made where non-compliances are found. Any follow-up visits which may be necessary by Lloyd's to review action on non-compliance are chargeable.

Where Lloyd's Register are satisfied the system meets the requirement, or where the necessary remedial action has been instituted, a Certificate of Approval is issued on payment of a certification fee. Routine surveillance of the quality system follows every six months, with a full systems re-assessment taking place after a period of three years.

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APPENDIX 1.

QUALITY ASSESSMENT SCHEDULE TO BS 5750 : PART 2
APPLICABLE TO THE MANUFACTURE OF MECHANICAL SPRINGS
REQUIRING LOT TRACEABILITY

WRITTEN BY : T.J. NASH

APPROVED BY : J.W. CHARTER,
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The following Organisations were consulted in the preparation of this Quality Assessment Schedule :-

British Industrial Fasteners Federation
British Nuclear Fuels Limited
British Steel Corporation
British Telecom
Cable & Wireless Plc.
Central Electricity Generating Board
Defence Manufacturers Association
Electronic Engineering Association
London Transport Executive
Ministry of Defence (Procurement Executive)
National Coal Board
Pressure Vessels Quality Assurance Board
Society of British Aerospace Companies
Spring Research & Manufacturers Association

QUALITY ASSESSMENT SCHEDULE TO BS 5750 PART 2 APPLICABLE TO THE MANUFACTURE OF MECHANICAL SPRINGS REQUIRING LOT TRACEABILITY

This Quality Assessment Schedule has been agreed between the British Standards Institution and the Spring Research and Manufacturers Association. It will be maintained and revised as necessary, with the full co-operation of the Spring Research and Manufacturers Association.

1. SCOPE

This Quality Assessment Schedule relates to the manufacture of mechanical springs, including helical springs, laminated springs, leaf springs, volute springs, torsion bars, clock-type springs, spring washers, bellville washers, ring-springs, diaphragm springs, spring presswork and wire forms for which lot traceability through inspection and test records is required for a minimum period of two years following despatch. Additional requirements relating to parts classified by customers as Control Items are specified in Appendix A.

The detailed scope of a firm's Registration is given in the Appendix which is attached to its Certificate of Registration.

2. SPECIFICATION

Springs shall be manufactured to, and satisfy, the requirements of the appropriate British Standard or other national or international standard, the manufacturers own specification or to such other specification agreed between the firm and the customer.

3. TECHNICAL REQUIREMENTS

3.1 General

The quality systems requirements of this Scheme are contained in BS 5750 : Quality Systems : Part 2 : 1979 Specification for Manufacture and Installation. Those requirements are supplemented and amplified in relation to spring manufacture by this Quality Assessment Schedule.

3.2 Records

Records in accordance with BS 5750 : Part 2 shall be retained for a minimum period of two years. For these records specified in clause 4.4.2 of BS 5750 : Part 2 this period shall commence when the last consignment from a lot is despatched.

The appropriate records specified in clause 4.4.2 shall ensure traceability of goods through manufacture, inspection and test records.

3.3 Raw Material

Each coil or bundle of incoming raw material shall be identified. The firm shall ensure that each delivery is supplied with a Certificate of Conformity providing the information specified in Appendix B as appropriate to the end usage of the material and as stated on the purchase order.

3.4 Lot Control

The firm shall define the construction of a lot and/or sub-lot. Where sub-lotting occurs at any process, each sub-lot shall be separately identified.

Sub-lots shall only be combined with other of the same original lot once it has been verified that each sub-lot conforms to the specification.

3.5 Process Control

3.5.1 The applicable standard and processes to be performed shall be fully defined prior to processing. There shall be a prescribed system for maintaining control of process variables to ensure that they remain within their designated limits.

3.5.2 There shall be a documented procedure for ensuring that the process has been satisfactorily completed.

3.5.3 All process equipment shall be regularly maintained and process control equipment and instruments shall be calibrated in accordance with BS 5781 Measurement and Calibration Systems : Part 2 : 1979 Specification for system requirements.

3.6 Sub-Contracting

Where processes or components are sub-contracted the firm shall ensure that the sub-contractor can maintain controls and perform the work in accordance with the specification. The firm shall obtain a Certificate of Conformity, providing the information specified in Appendix B, from the sub-contractor, for each lot.

Bought out finished springs shall only be supplied under the firm's Registration if they have been purchased from another firm registered to this Quality Assessment Schedule and are supplied with a Certificate of Conformity providing the information specified in Appendix B.

3.7 Marking

Finished parts, or containers of finished parts where marking of individual parts is impracticable, shall be marked with the lot identification.

3.8 Corrective Action

The corrective action procedures shall include a prescribed procedure for dealing with customer complaints. The firm shall keep records of all corrective action taken. Action, where appropriate shall include recall of suspect parts or notification to the customer that parts are suspect.

4. CERTIFICATES OF CONFORMITY

When requested by the customer, the firm shall supply at the time of despatch, a Certificate of Conformity which provides the information specified in Appendix B.

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APPENDIX A - ADDITIONAL REQUIREMENTS FOR CONTROL ITEMS

A1 Definition

Control Item

A lot traceable part subject to critical quality requirements imposed by customers. or governments and other regulatory authorities.

NOTE:- It is the responsibility of the customer to specify if a part should be classified as a Control Item and not the responsibility of the firm.

A2 Technical Requirements

2.1 General

The quality systems requirements and technical requirements specified in this Appendix are additional to those specified in BS 5750 : Part 2 and QAS 3137/12 ISSUE 2.

2.2 Records

Records in accordance with BS 5750 : Part 2 shall be retained for a minimum period of ten years, and shall include the following:-

a) records of policy and procedures employed to achieve effective control of quality, including the capability testing of machines

b) engineering records of product acceptance tests and final inspection records

c) records of drawings, specifications, modifications and concessions

d) records of testing and measuring equipment used for production and inspection

e) records of control charts related to production processes and product

f) laboratory records of material tests

g) records of significant problems encountered together with corrective action taken

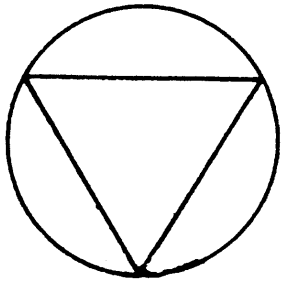
h) the firm's advice note and certificate of conformity

2.3 Batch Segregation of Raw Material

Cast and batch segregation shall be maintained at all times and a change of raw material (cast or batch) shall require a change of lot identification.

2.4 Control Item Symbol

When a part is designated as a Control Item all documentation shall incorporate the symbol illustrated below:-



2.5 Packing

Every package of Control Items shall display the Control Item Symbol.

2.6 Certificates of Conformity

The firm shall supply a Certificate of Conformity, providing the information specified in Appendix B, and displaying the Control Item Symbol, with each consignment at the time of despatch.

APPENDIX B

CERTIFICATE OF CONFORMITY

When a customer requests a Certificate of Conformity it shall contain the following minimum information as appropriate to the goods or processes in question:

(a) the suppliers name and address,

(b) the serial number and date of the certificate,

(c) the customer's name and address,

(d) the customer's purchase order number,

(e) a description of the goods or the process, the quantity and the firm's lot identification,

(f) the customer's part number and any other identification and/or serial numbers,

(g) the identification of the specification/drawing to which the goods are supplied or the process has been performed,

(h) the raw material cast number or batch number,

(i) the condition of the materiel on despatch,

(j) any necessary further treatment,

(k) any agreed concessions,

(l) the following statement, signed by the person nominated by the firm as responsible for quality control or his deputy:

"Certified that the supplies/services detailed hereon have been inspected and tested in accordance with the conditions and requirements of the contract or purchase order and unless otherwise noted below, conform in all respects to the specification(s), drawing(s) relevant thereto."

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British Standards Institution

Our tel ext/ref QAD/M/TJN/JW

Date 3 January 1984

APPENDIX 2.

DRAFT TECHNICAL SCHEDULE TO BS 5750: PART 2
APPLICABLE TO THE MANUFACTURE OF
MECHANICAL SPRINGS.

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TECHNICAL SCHEDULE TO BS 5750: PART 2: APPLICABLE TO THE MANUFACTURE OF MECHANICAL SPRINGS

This Technical Schedule has been agreed between the British Standards Institution and the Spring Research and Manufacturers Association. It will be maintained and revised as necessary, with the full co-operation of the Spring Research & Manufacturers Association.

1. SCOPE

This Technical Schedule relates to the manufacture of mechanical springs, including helical springs, laminated springs, leaf springs, volute springs, torsion bars, clock-type springs, spring washers, belleville washers, ring-springs, diaphragm springs, spring presswork and wire forms. It does not relate to mechanical springs requiring lot traceability which are covered by TS/M/12.

The detailed scope of a firm's Registration is given in the Appendix which is attached to its Certificate of Registration.

2. SPECIFICATION

Springs shall be manufactured to, and satisfy, the requirements of the appropriate British Standard or to such other national or international standard, the manufacturers own specification or to such other specification agreed between the firm and the customer.

3. TECHNICAL REQUIREMENTS

3.1 General

The quality systems requirements of this Scheme are contained in BS 5750: Quality Systems: Part 2: 1979 Specification for manufacture and installation. Those requirements are supplemented and amplified in relation to spring manufacture by this Technical Schedule.

3.2 Records

Records in accordance with BS 5750:part 2 shall be retained for a minimum period of two years.

3.3 Raw Material

Each coil or bundle of incoming raw material shall be identified with its grade and specification.

3.4 Process Control

3.4.1 The applicable standard and processes to be performed shall be fully defined prior to processing. There shall be a prescribed system for maintaining control of process variables to ensure that they remain within their designated limits.

3.4.2 There shall be a documented procedure for ensuring that the process has been satisfactorily completed.

3.4.3 All process equipment shall be regularly maintained and process control equipment and instruments shall be calibration in accordance with BS 5781 Measurement and calibration systems Part 1 1979 Specification for system requirements.

3.5 Sub-contracting

Where processes or components are sub-contracted the firm shall ensure that the sub-contractor can maintain controls and perform the work in accordance with the specification.

Bought out finished springs shall only be supplied under the firms Registration if they have been purchased from another firm registered to this Technical Schedule.

3.6 Corrective action

The corrective action procedures shall include a prescribed procedure for dealing with customer complaints. The firm shall keep records of all corrective action taken.