AUTOMOTIVE COMMITTEE
Quality Working Group

Reference guide for quality rules and practices for fastening products

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The Working Group

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The group also owes thanks to Mr Tremblais and AFFIX who took care of the logistics and helped meetings come together as smoothly as possible.

Foreword

We could describe our profession as an industry that supplies, at a low value (€150 on average per vehicle), very large quantities of parts that provide an essential function: assembly of the different elements of a vehicle.

In a context of heightened competition, the AFFIX Automobile Commission decided to create a guide, geared towards facilitating relationships between members and their customers (car manufacturers or tier one suppliers). We will therefore be able, while further developing the field of fasteners, to help our customers become the best in the quality with the products they produce.

A true overview of the current state of our profession, this guide explains the relationship between manufacturing costs and quality requirements, and it explains how the level of quality of our products is measured. With this tool in hand, the members of AFFIX will reach a new level of performance in terms of the quality of products they manufacture each day.

"Price forgotten, quality remembered"

Georges Lammoglia
Chairman of the AFFIX Automobile Commission

1/ Objective of this guide

Relationships between members of the profession and all of its customers are developing on a global scale. They are becoming more complex due to the large number of participants, and their respective cultures and policies in an environment of heightened competition.

During interactions with our customers, we are confronted more and more often with different practices in terms of quality, even though they all have the same underlying concerns.

For example:

- counting technical and/or logistical ppm,
- the cost of incidents compared to the cost of the part used and billing methods for these costs,
- product qualification files and their formal approval process,
- the format of documents exchanged (e.g. 8D analysis) where each wants its version to be used via its portal,
- and so on.

These practices frequently lead the supplier to implement management methods for each customer, most often different from their own centralised information management. They generate multiple entries to maintain internal, opposable traceability.
This extravagant attitude makes superfluous administrative tasks more complex even though we have everything to gain (in energy and in time) by using standardized exchange protocol built on shared agreements.

This guide is meant to facilitate relationships between fastener manufacturers and their customers. It offers a group of practices judged to be the best and most useful practices and developed by its members to advance the field and allow for a fruitful collaboration between OEM's (car manufacturers) and tier one suppliers in the best interests of all parties concerned.
It in no way claims to be a standard or a quality reference specific to a profession and its recommendations have not been established to limit the responsibility of fastener manufacturers.

Note:

Over the course of the work, the group also made use of normative documents and the work of Deutscher Schraubenverband:

- ISO standard 16426 (01/2003): "Fastening elements – Quality assurance system",
- BMW Group Standard GS 97054-1 (10/2004): "Delivery quality of mechanical fasteners – Deviation quotas in ppm,
- ICS (Draft November 1996): "Guideline – Delivery Quality of fastener".

2/State of art in the profession

2.1/Importance of fasteners in the automobile sector

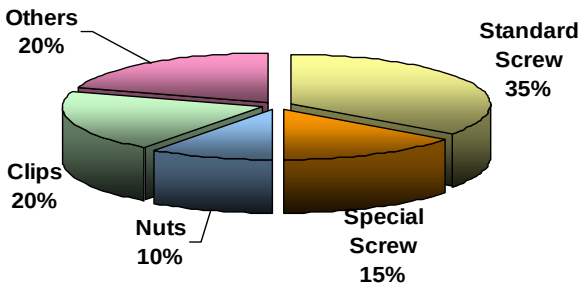
Manufacturers have begun to assemble complete sub-assemblies more often and there are fewer preparation operations that take place away from the production lines. Fasteners have therefore become an important facet of final vehicle assembly and this

Fasteners in figures
(mid-range vehicle)

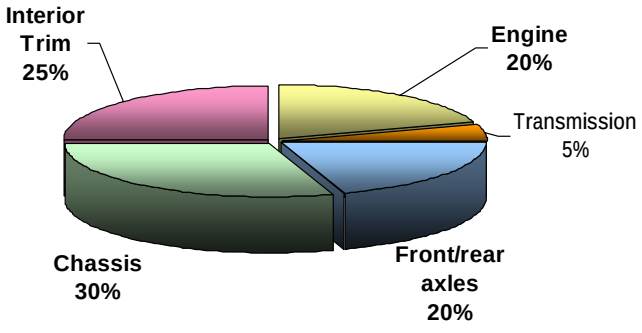
Value of fasteners per vehicle: 150 €

1000 references
1800 fastening points
Weight = 15 Kg

Usage cost:
1/3 fastener
2/3 assembly



Distribution by product line



Distribution by function

sector represents the main high quantity purchase point for manufacturers.

Tier one suppliers (or their sub-contractors) produce sub-systems for OEM's. This transfer of business leads to an increase in customers: where there was one OEM there are now several tier one suppliers.
Nevertheless, efforts made by the tier one manufacturers to standardise some elements of sub-assemblies increase the quantity supplied for each fastener.
In addition, customer requirements have evolved significantly increasing the technicity of fasteners and their processes: weight reduction, size limitation, increase in technical performance and quality classifications, increase in capability index objectives, standardisation, additional functions, etc.
However, the risk of dissatisfaction is on the rise among customers who use fasteners:

- large delivery quantities and higher performance products make the appearance of defects more common,
- rapid automation of customer assembly operations that do not allow for disruptive failures (previously a NOK fastener would have been removed by the operator),
- incorrect use of products due to poorly thought out ergonomics (sometimes forgotten) of manual or semi-automatic assembly stations and to the increase of stations with multiple functions torque/tolerances/drive,
- carry over of existing parts with higher functional requirements (appearance, acoustics, quality, etc.),
- increasingly restrictive requirements of documentation.

2.2/Industrial process

The processes used are complex and must retain operational availability despite:

- the diversity of products to be manufactured with a single process,
- quantities to be produced (generally in millions per day),
- cycle time to be kept up (from 5,000 to 40,000 parts/hour),
- complexity of tools (dies with many elements, progressive punches, multi part moulds, etc.),
- numerous interruptions in flow with intermediary handling and storage (production line start-up made difficult by the diversity of processes and their cycles)
- mechanical damage risks (shocks), retention and pollution (foreign parts).

Despite all the special measures implemented to control process and flow, their level of performance cannot be maintained in a constant manner for every process and product.
This level of conformity cannot be reached solely by controlling production processes. It also requires implementation of supplementary inspection or sorting operations.

2.3/Economic aspects

The unit cost of fasteners is low (average unit cost = €0.05).
Despite this unit cost, many efforts have been made in terms of increasing productivity over many years.

Even though current developments have lead to aiming for "zero ppm", the cost of dealing with failures as well as questionable practices of some customers drive up the ppm cost in terms of unit cost for fasteners (min factor 50,000).

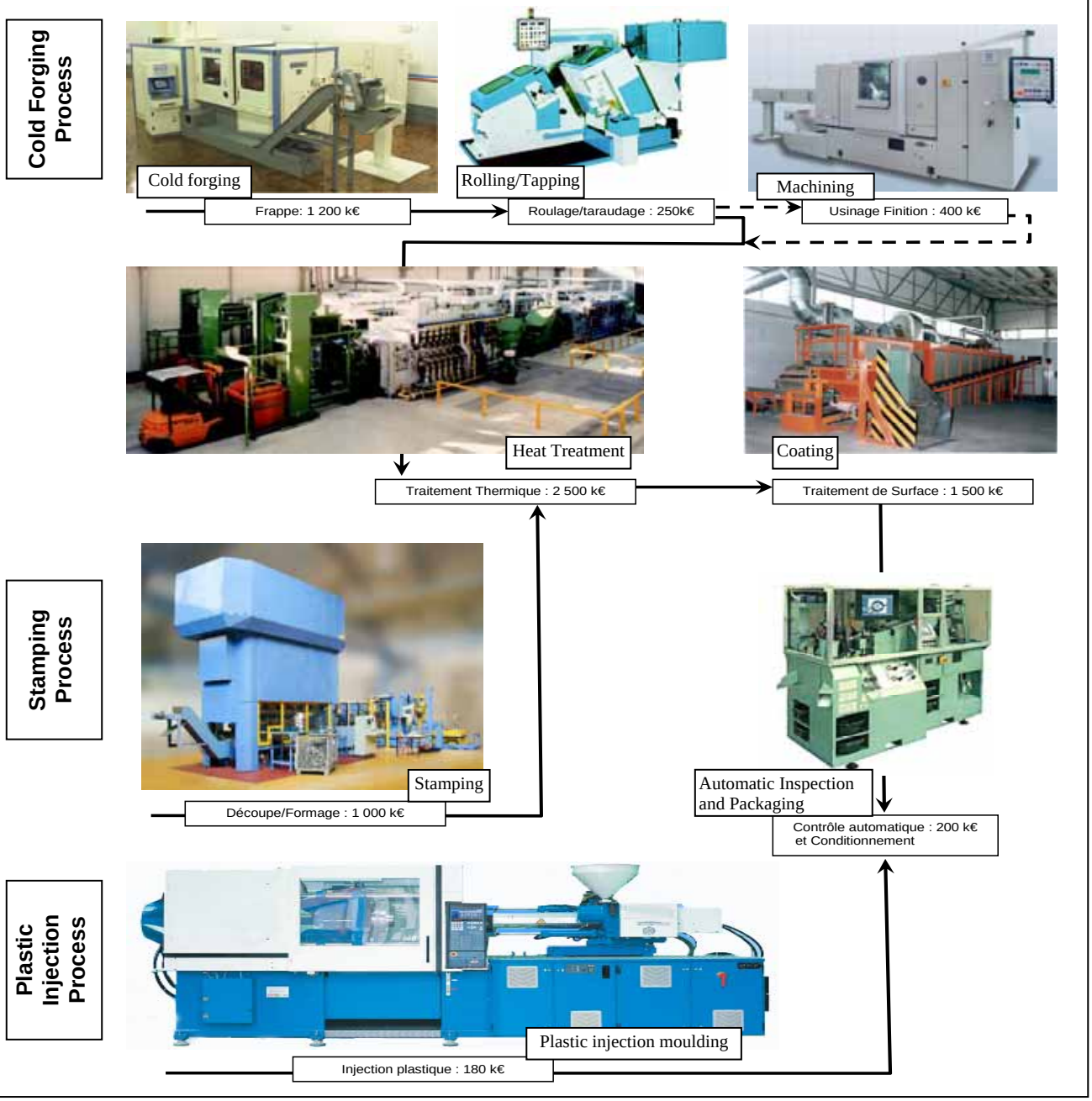
Finally, reaching "zero defect" and the increase in product performance necessitates process improvement and development of new technologies. These investments can only be carried out by increasing margins on large production runs.

If cost reductions for existing fasteners have become very low today, earnings can still be increased by optimising assembly time.

For manual assembly, it is necessary to pursue:

- better ergonomics for manual assembly stations (less movement for operators),
- standardisation of assembly characteristics (less tool changing, saving in investments and tool maintenance),
- grouping of several assembly operations for one part.

Main processes used
(and level of investments)



3/Product quality costs versus required quality level

3.1/Assurance of conformity by production processes

Products manufactured through forging, stamping or plastic injection moulding depend mainly on the condition of tools used (dies, punches, moulds, etc.) for which trends are slow and possibilities for operator adjustment are limited.

The characteristics are affected by variations inherent to each manufacturing process so the level of conformity obtained depends on the capability of the process and the errors affecting the measurement method.
The control of process parameters, based on an adequate control plan, provides assurance of product characteristics conformity.

However, processes are usually disrupted by random situations, which makes them difficult to control (e.g. cracks, chips on fittings, filling defects, sudden tool breakages, etc.).
In addition, frequent intervention, assembly, disassembly, and equipment adjustment, induce:

- the risk of human error,
- process instability (temperature settings, jolts, etc.)

which are not or cannot be always evaluated and controlled by control and inspection plans.

Finally, fastener product flows are subjected to many container handling, which carries the frequent risk of damages due to shocks and pollutions by foreign parts.

3.2/SPC Conditions of use

SPC could constitute an effective method of controlling processes for characteristics adjustable by operators (e.g. machines where trend can happen quickly).

This method, based on the control of process stability, is only useful when applied to a process that shows trends fast enough to be seen by the operator while he is at his workstation.
Monitoring should also be performed on a dimension representative of this stability (characteristic of product or process) and where the operator can intervene to correct trends.

SPC is not always useful to control processes:

- where the tool is dominant in machining the part (e.g. heading dies, blanking punches, plastic injection moulds, etc.) and shows very slow wear or sudden breakage,
- with high capabilities (e.g. process with auto-adjustment) or with slow trend,
- with multi-spindle/multi-axis, whose tools work independently,
- where incoming products are not uniform.

In particular, using SPC cannot be required by the customer for a specific dimension of the drawing (e.g. special characteristic) without having already checked the applicable conditions listed above.
In these cases, other statistical tools should be used like to regularly perform process capability.

3.3/Additional 100% inspections

Considering the quantity of fasteners delivered daily, the risk of delivering non-conform products remains a sensitive problem.

For characteristics, where non-conformity causes an important disturbance for customers or creates safety risks, only a part by part inspection can reduce the proportion of non-conform product.
These characteristics must therefore be clearly specified by the customer at the initial demand in order to ensure the proper process is implemented.

Manual/visual inspection

The effectiveness of this inspection method is relative. It depends, among other things, on:

- the nature of the inspection:
  -subjective, visual inspection
  -dimensional inspection with measurement equipment
  -go/no go inspection
- the experience and motivation of the employee carrying out the inspection
- the organisation of the sorting area and workstations

For a defined characteristic, the estimated gain for ppm between a process with or without manual/visual inspection is a ratio of 2 to 5.

However, this inspection method requires many inspectors to be able to supply required quantities.

Automatic inspection by producer

The effectiveness of this complex process is limited by:

- the speed of the inspection equipment and the part shapes: feeding system, part evacuation
- the number of characteristics to be checked: information processing
- the type of characteristic being inspected:
  -precision of the measuring systems,
  -duration needed for checking: presence/absence, assembly testing, dimensional inspection,
  -appearance criteria, that are difficult to characterise and quantify.

For a specific characteristic, the estimated gain for ppm between a process with or without automatic inspection is a ratio of 10 to 50, but without giving an absolute "Zero Defect" assurance.

However:
- the additional cost for this inspection method is estimated between +10% to +30% (taking into account the final packaging system that is usually built into the automatic inspection line).
- automatic inspection requires a large number of equipments, the quantity of checked parts (4000p/h) being much lower than regular machining production (15,000p/h).

Inspection at customer location

An alternative, more economical solution for automated assembly lines would be the installation of poka-yoke's or simple and effective mistake-proofing devices, integrated directly into customer feeding systems.

These systems could generate considerable gains:

- guarantee of the supply chain without disrupting the assembly process,
- limitation of the investments (methods specific to a reference and adapted to assembly speed),
- increased effectiveness of mistake proofing placed just before assembly,
- product cost (without automatic inspection).

4/Measurement of performance by the customer

There are different ways for customers to measure a supplier's performance (demerits, ppm, number of incidents, composite index, etc.).
However, these measurable elements should not be regarded as indicators and are in no way contractual with any kind of consequences, financial or otherwise.

Ppm (parts per million) is considered as the most powerful indicator for evaluating the quality of the supplied products, and for monitoring a product and qualifying a manufacturing process.
It is a reliable, indisputable indicator that is in line with the requirements of automobile industry customers.

4.1/Manufacturing process performance

One must remember that the finished product is the result of all related manufacturing processes, and it is affected to all random factors involving these processes. These random factors explain that the fastener manufacturer cannot maintain a ppm level which meets the customer requirements for all manufacturing lots and for each process.

In this overview, the performance (all defects included) of production processes used by fastener manufacturers were estimated:

Process without sorting	Process capabilities
Forging	500 ppm
Stamping	250 ppm
Plastic injection moulding	100 ppm
Assembly	100 ppm

When 100% inspections are implemented, the conformity level for each sorted criterion becomes:

Process with sorting	Automatic sorting	Manual/visual sorting
Forging	10 ppm	100 ppm
Stamping	10 ppm	50 ppm
Plastic injection moulding	10 ppm	50 ppm
Assembly	10 ppm	50 ppm

It must be acknowledged that these values vary according to:

- characteristics (precision, shape, type, etc.).
- number of process operations (forming, thermal treatment, assembly, etc.).

4.2/ Disturbance for customer or end user

Today, if the quantity of non-conform products is now very low (just a few ppm), the presence of such products in deliveries to customers is too frequent considering the quantity delivered daily.
Non-conform products cause many more problems for customer assembly lines as they are becoming more and more automated.

For this type of failure, customers mainly pass on cost of dealing with the disruption (production losses, stock recovery, administrative fees, etc.).

Although the actual costs of a disruption *must be estimated* by accounting for ppm or frequency of disruption, the average cost of an incident billed to a supplier is around €3000, often completely unrelated to the unit price for the part.

4.3/Hierarchical organisation of risks

Risks must be organized in a hierarchy in order to prioritize improvement actions and to limit the cost of dealing with failures.
More specifically, for failures that have no effect on the final user, immediate actions should be limited to supplier process in cases of high ppm or costly reworks for the customer.

A risk evaluation matrix was developed for commonly encountered failures - it takes several criteria into account:

- severity of the failure (according to FMEA evaluation),
- detection by the customer and its impact on the assembly process,
- disruption of the assembly line (automatic or manual assembly),
- possibility of using the part (fittability or non-fittability, use with concession),
- functional assurance,
- detection by final user and its impact on safety.

The risks were compared to the performance of fastener manufacturer processes in order to create the following diagram.

This diagram is meant to be a guide:

- for the profession: to define methods to be implemented to ensure the best level of product conformity with the best level of incurred risks,
- for customers: to act as a decision making tool for detection of non-conformity and determination of actions to be taken:
  - "information" (internal supplier actions, without allocation of costs) for suppliers,
  - a "claim" (request for immediate correction with application of problem resolution methods).

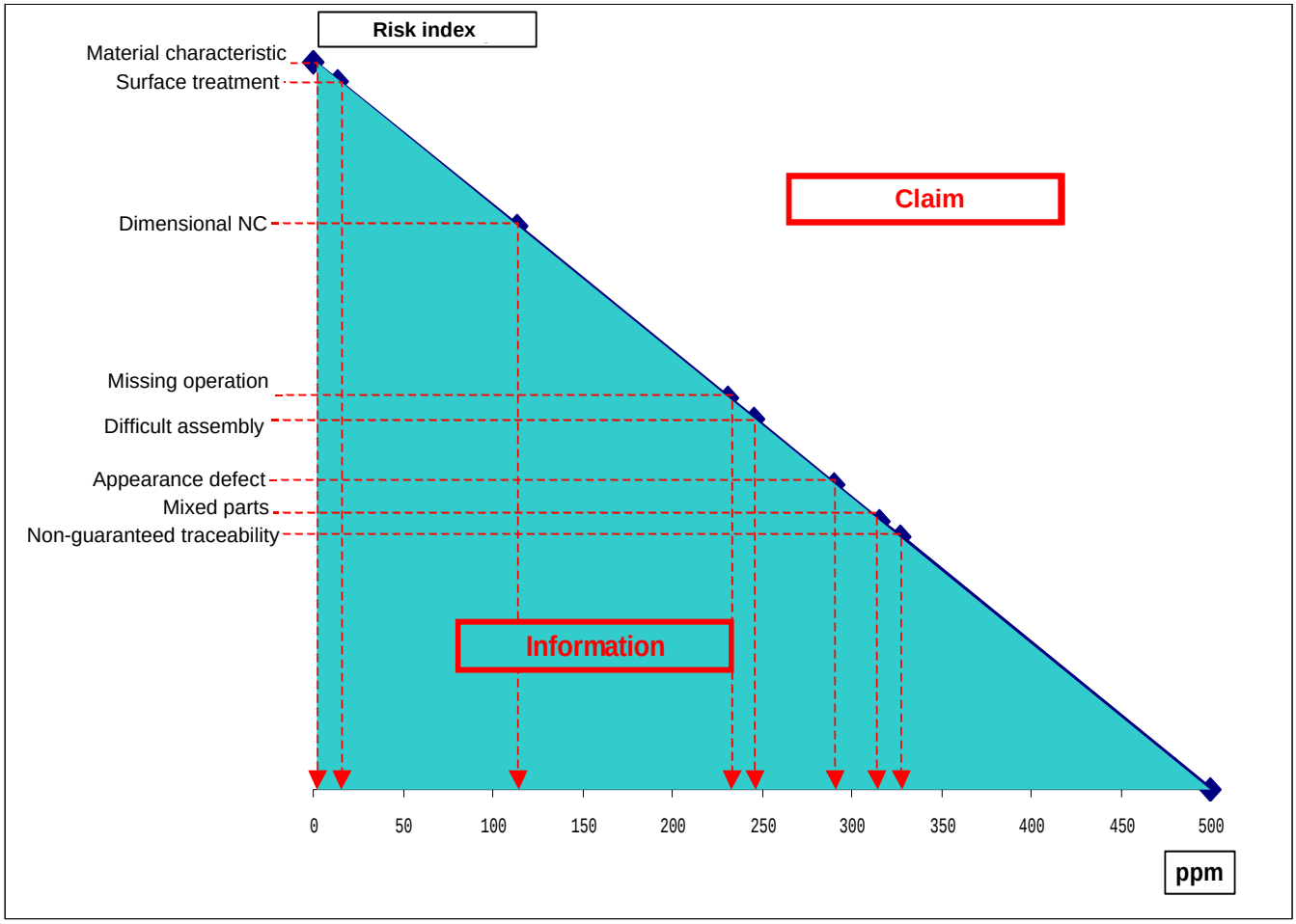
5/Effect of customer practices on supplier responsibility

5.1/Development processes

Development of fasteners is not always at the level of other products. These products, most of them quite specific, must now perform a number of miscellaneous functions, provide increased performance and participate towards weight and cost reduction goals.

However, we are often hindered by:

- poor formalization of customer needs and unavailability of specifications: these specifications often develop after the order is placed and differ from those originally expressed,
- differences between the requirements of the final customer and requirements of tier one's,
- difficult communication with different development teams involved with the surroundings of fasteners, which are often contradictory requirements,
- incompatibility between times required for industrialization and validation (if they are carried out in compliance with customer development procedures) and start of production deadlines,
- carrying over of an existing definition without considering the specific function of a part.



The interactive questionnaire is a tool that helps improve how customer requirements are taken into account during large projects. In fact, this checklist leads the customer to specify their needs using the supplier's experience. It also helps them list all implicit and explicit expectations.
Currently, this document is rarely used due to the lack of desire to use it.

5.2/Catalog and carried over parts

For products that are carried over for new uses, we are confronted with extra demands from our customers, who consider them as completely new products:

- addition of extra performance criteria (appearance, acoustics, etc.),
- higher quality objectives (capabilities, ppm, incidents, guarantee, etc.),
- application of current development procedures (qualification, IS, etc.).

In this case, new requirements must be considered and extra costs passed on to the customer, in particular those generated by:

- preparation and supply of new Quality assurance documents,
- development of the existing process to meet the level of compliance and capability of the customer.

Standard products

These products refer to national or international standards. They are supplied to multiple customers, are listed in the catalogue, with prices and are usually in-stock.

No development procedures are applied for these products, but conformity certificates can be provided upon request.

For other documents (e.g. inspection reports, material analysis,…), the rate listed in the catalogue will be charged.

Standard customer products

These are products that meet general specifications from customers. They are repetitive, multiple-use parts.

For products already manufactured by the supplier:

- no development procedures are applied,
- the latest qualification report and a copy of the original IS file for other documents are provided on request.

For products not yet manufactured by the supplier:

- the supplier's development procedure is applied (but in compliance with supplier schedule and the timeline for delivery to the client),
- an IS file is supplied.

5.3/New products

Products specific to one customer refer to functional plans and specific specifications. They are single-customer in nature and are not yet manufactured by the supplier.

For new products, the development procedure must be adapted to the timeline for making the product available to the customer, as well as to the complexity of the product.

If the product is similar to an existing group of products and manufactured using a validated process:

- working by generic family is recommended: duration of industrialisation is therefore governed by availability of materials and equipments.
- an IS file is created with a copy of generic elements and product specifics.

If the product is new or manufactured by using a new process:

- the customer's development procedure is followed, but the schedules of the customer and supplier are taken into account to carry out the development and make the products available.
- products and/or reports are supplied at each development phase.

In the specific case of a specific product carried over by another customer or for a different application, a file is established with the latest qualification report, a copy of the original IS file for other documents and the specific requirements negotiated with the customer.

5.4/Customer use of products

Greater participation of the supplier in defining loading systems and assembly methods could also help the customer to define the most adequate processes for the products.

Particularly, information is required for:

- implementation of new or modified process (e.g. automation) or modification of parts to be assembled,
- transferring production to new sites in order to ensure proper use of the products on assembly lines and proper preservation of the products during transport, storage and handling.

These situations very often lead to disputes and mutual misunderstanding that we wish to avoid by anticipating such changes.

Finally, resulting from these problems, loss of traceability of customers and intermediaries (e.g. platforms logistics):

- makes difficult problem analysing,
- leads to incriminating a higher quantity than should be

5.5/ Non-negotiated or non-justified demands

Contractual requirements

We know that there are a multitude of requirements coming from different customer departments: "quality commitments", "logistics agreements", product specifications, etc.

These requirements are meant to be contractual and are often superfluous with each other or with sales contracts.

Only requirements negotiated within the framework of sales contracts should be considered.

Documentation

Due to the increase of customer demands to use specific forms, it is recommended to systematically use supplier documents, ensuring that they thoroughly cover the different customer requirements.

When the customer maintains its requirements for using documents, it is possible to charge for this requirement or to include an extra fee in invoicing for the IS order.

Pricing for non-negotiated or non-justified demands

The following activities should have specific pricing:

- preparation of inspection reports and IS files on imposed documents,
- translation into a language other than the national language,
- request for technical analysis and reports,
- preparation and distribution of inspection reports (in addition to IS reports),
- supply of conformity certificates, copy of material analysis, declaration of compliance with ROHS regulations,
- IMDS database update,
- treatment of unrecognized incidents (travel to customer location, analyses, etc.)

5.6/General recommendations

General Conditions of Sales laid out by AFFIX include general recommendations that specify the responsibilities of suppliers and customers.

In addition, the recommendations specific to products delivered and their packaging must be clearly displayed in the specific recommendations to be attached to the file given to a customer during the first deliveries (IS or PPAP file).

Specific recommendations can include:

- storage conditions and maximum duration before use,
- handling and use conditions at customer location and on the field,
- the extent of the supplier's responsibility:
  -for standard products or parts designed by customer: limited to the first use by the customer (on the assembly line).
  -for products co-designed by the supplier: limited to the first repair on the field (in garage,..)