

# SUPPLIER QUALITY IMPROVEMENT PROCESS

by

Richard M. Dubner

Chairman, Chevron Supplier Quality Improvement Steering Committee

Chevron Corporation

San Francisco, California



*Richard M. (Dick) Dubner received a B.S. degree in Mechanical Engineering from the Berkeley Campus-University of California in 1954. He worked for Tidewater Oil Company and then Phillips Petroleum Company at their Avon, California, refinery. For most of the 13 refinery years, he was the Mechanical Equipment Engineer. He specialized in design, installation, operation, and maintenance of mechanical equipment. In January 1968, he joined Chevron Corporation, then known as*

*Standard Oil of California, working for the Mechanical Equipment Division of the Corporation Engineering Department. In March 1969, he became Supervisor of that division. In 1981, he was made Chief Mechanical Systems Engineer, and in 1987, Senior Engineering Consultant.*

*Mr. Dubner is past Chairman of the American Petroleum Institute Subcommittee on Mechanical Equipment. He has also served as chairman of task groups for reciprocating compressors, noise control, vibration monitoring systems, and headed the Subcommittee's Steering Committee. He is a member of the Pacific Energy Association's Board of Directors.*

*He has authored and co-authored several ASME papers on mechanical equipment selection and failure analysis, and he has lectured at the Texas A&M Turbomachinery Symposium, and elsewhere, on quality assurance surveillance for machinery.*

*Mr. Dubner is now on a special assignment. He is Chairman of the Steering Committee for the Chevron Supplier Quality Improvement Process (CSQIP). This joint Chevron Engineering/Purchasing initiative will establish a new approach to supplier relationships based on long term, mutually beneficial alliances.*

## INTRODUCTION

The Chevron Supplier Quality Improvement Process is described herein. It starts by recalling the history of major mechanical equipment failures in the oil business. These problems led Chevron to the development of a specification and inspection dependent response. Eventually, when this self defense reaction proved to be less effective than required, Chevron Engineering began to think about improving quality by improving the business relationships with our suppliers. An investigation of problems in newly constructed facilities was carried out. This confirmed the extensive financial losses to Chevron Corporation, caused by poor quality in a wide range of process plant hardware. To correct this problem, they set about learning how companies like Xerox and Ford had, over a period of years, made significant improvements in the quality of components and materials they bought to go into their products. And now we have started to apply these proven successful methods. The Chevron approach and the current status of our supplier quality improvement process will be outlined.

## HISTORY OF FAILURES

In the 1970s, a joint study, initiated by Exxon and participated in by Arco, Chevron, and others, examined the causes for failure of major mechanical equipment during initial startup and the first year of operation. The results were analyzed for pumps, compressors, turbines, and other equipment categories. Analysis of the data indicated that 70 percent of these problems resulted from supplier errors (Figure 1). Most mistakes were made in the machine's design and many were made during the manufacturing process. There were also numerous installation problems.

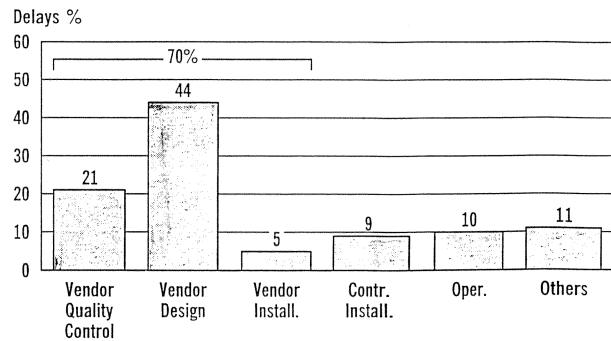


Figure 1. Failure Causes.

## THE QUALITY ASSURANCE SURVEILLANCE PROGRAM (QASP)

Chevron's Mechanical Equipment engineers had to find a way to avoid these expensive failures. Over a period of ten years, step by step, they developed QASP, a self defense, specification, and inspection centered program for large, critical mechanical equipment systems. The elements of the program are supplier prequalification, detailed specifications, design auditing, manufacturing quality surveillance, and intensive factory testing (Figure 2). Typical costs for just the manufacturing quality surveillance portion of this program ranged from one percent to four percent of the capital cost of the equipment (Figure 3). Insistence by surveillance people that all requirements were met before delivery to the field resulted in significant shipment delays, particularly for some categories of equipment, such as large, high pressure, multistage centrifugal pumps. These delays were as much as 12 to 14 months for 134 items of such equipment on a major Gulf Coast refinery modernization project (Figure 4). Additionally, there were approximately 2100 miscellaneous equipment items not covered by QASP, purchased by three major contractors on this project. Thirty percent of those items were rejected in the field and required rework to be usable, even though they had been inspected by conventional means at the factories prior to shipment. Quality improved later for a large West Coast refinery project, where more inspector monitoring was used, but was still unacceptably poor at a 13 percent reject rate (Figure 5).

Xerox went from 2,000-3,000 suppliers down to 350. 3M now has only 160 suppliers providing most of their components. In another example, Union Carbide had been taking bids from 100 steel fabricators. Now they work with only the 15 very best ones (Figure 12).

- Dow from 15,000 Suppliers to 600
- Xerox from 3,000 Suppliers to 350
- Motorola from 109 Capacitor Suppliers to 3
- Union Carbide from 100 Steel Fabricators to 15

Figure 12. Narrow the Supplier Base.

Each of these companies has developed a standard evaluation system to rate their suppliers. They typically consider quality as the number one factor, but they also look at cost, service, and delivery. The suppliers may be rated as "green," "yellow," or "red" (unacceptable). For some company evaluation systems, numerical rating factors were developed. Once the suppliers are rated, picked, and signed on, they are introduced to a rigorous program of continuous quality improvement leading to the status of "preferred" or "certified." In many cases, public recognition of that status is given, and award plaques are posted prominently at the supplier's factory.

An ongoing relationship is encouraged so that after the hardware is supplied, vital feedback information is given on how well it has performed. Excellent field service and reliable spare parts follow up are all important.

The goal of Chevron's supplier quality improvement process is not necessarily single sourcing. It is to optimize the supplier base. In some cases however, that might be a single source. The firms with years of supplier improvement experience have found that the single source risks of supply security and fair pricing were not significant. In fact, supply security was often improved by single source, certified suppliers, compared to traditional competitive bidding, lowest price suppliers.

Establishing and maintaining a fair sales price is a vital component of these relationships. Typically, the supplier develops an open price book showing his costs and margins. Benefits from increases in productivity, which naturally result from joint quality improvement efforts, are shared by the supplier and the purchaser. Ford and 3M have experienced such price reductions from their suppliers over a period of time.

## SUPPLIER ALLIANCES

The second step in a quality improvement process is developing long term, cooperative, trust based, continuously improving, mutually beneficial relationships with the suppliers (Figure 13). This step often includes training the suppliers in statistical process control and total quality control. Major programs to provide such supplier training exist at Motorola, Ford, and Xerox.

A valuable possibility within an alliance is early supplier involvement; bringing them in during plant process design or the concept stage for a new mechanical design. This allows utilizing the suppliers' expertise and experience effectively. The purchaser works jointly with their suppliers to improve the specifications and solve problems at the design stage. Xerox estimated that a dollar spent to solve a problem during design saves the \$1,000 it would cost to fix this problem under warranty after the hardware is shipped to customer.

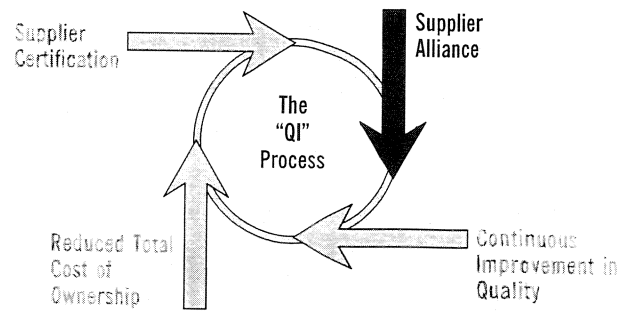


Figure 13. The Quality Improvement Process.

## WORKING WITH DISTRIBUTORS

Frequently, commodities, such as fasteners, bearings, and pipefittings, are purchased through local distributors. In discussions with Union Carbide and several others, the team learned that those companies' alliance agreements were reached first with the hardware manufacturers and then with the local distributors to ensure continuous quality improvement for all aspects of the supply process. This really amounts to a three way alliance (Figure 14).

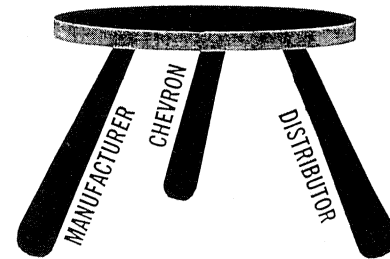


Figure 14. Distributors.

## CONTINUOUS IMPROVEMENT IN QUALITY

The next arrow in the quality improvement circle highlights never ending, continuous improvement as a vital ingredient for these long term relationships (Figure 15). A good example was described at 3M. One of their high volume assembly lines was experiencing significant downtime, primarily caused by defective small coil springs. These parts were studied and found to have a 500 ppm reject rate. The spring was being purchased from three suppliers on a low price bid basis. 3M decided to select the best spring supplier and work with him for quality improvement. In less than a year, the spring reject rate was only 40 parts per million, significantly reducing downtime for overall assembly (Figure 16). Another example was given at Shell. They decided to focus their oil country tubular goods business on a single supplier with cooperative efforts to improve quality. The reject rate has fallen by a factor of 10 and further improvements are expected.

Some companies require their suppliers to fully implement the concepts of total quality management in order to become certified. Xerox has trained all 350 of their suppliers in Statistical Process Control and other improvement techniques. They have benefitted from a reduction in combined failure rates for all components going into their copiers from 10,000 parts per million in 1982, to only 350 parts per million in 1988. The Xerox target is 125 parts per million or less.

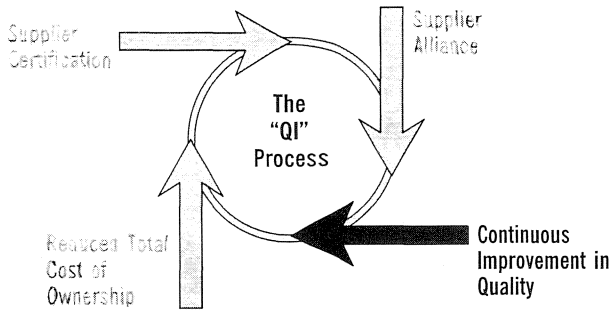


Figure 15. The Quality Improvement Process.

**3M Coil Springs**

➤ 500 PPM Rejects to <40 PPM in 9 Months

**Xerox Components - Overall**

➤ 10,000 PPM Rejects to 350 PPM From 1982 to 1988

Figure 16. Quality Improvement.

**REDUCED TOTAL COST OF OWNERSHIP**

The final arrow on the circle of quality improvement highlights the importance of looking beyond price in making decisions about purchasing commodities (Figure 17). Motorola's supplier quality improvement process saved more than \$40,000,000—10 percent of their purchase costs—in 1987. Xerox improved their supplied material quality and reduced rejects by a factor of 30. Purchase cost for commodities at Ford went down as quality and productivity of their suppliers improved. The cited example of coil springs for 3M not only resulted in a drastic step up in quality, but the unit purchase price of the springs reduced by 41 percent.

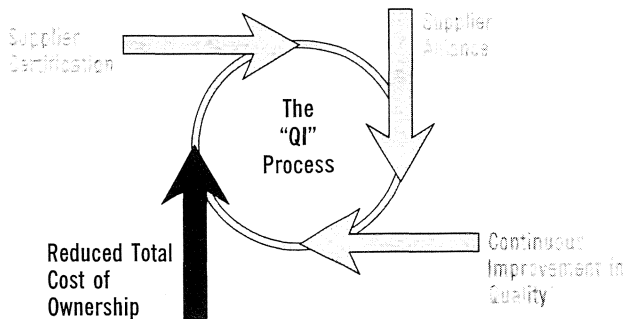


Figure 17. The Quality Improvement Process.

An outcome of improving quality in purchased commodities is a reduction in your own cost of quality assurance. Xerox cut their materials quality assurance budget from \$30,000,000 annually in 1981, to only \$12,000,000 in 1986. Reducing inspection costs were mentioned at Ford and at Union Carbide, where the quality assurance budget of \$8,000,000 was cut by 15 percent in the first year.

Another result of continuous quality improvement leading to certified suppliers is the feasibility of employing just in time (JIT) delivery of parts and components. This scheme, which

eliminates incoming inspection of parts and reduces inventories, can only succeed with high quality suppliers. Ford is beginning to use this approach in a luxury car plant. Xerox has reduced from three or four months inventory to two or three days. Cardboard boxes delivered to one of the 3M factories now come in once a day; the quality of these containers has become so reliable that they do not have to maintain a supply on-hand.

**OPTIMIZATION OF CHEVRON'S SUPPLIER BASE**

Chevron Purchasing Departments spend about two billion dollars annually. In recent years, we have placed orders with 30,000-40,000 suppliers. A supplier quality improvement effort and supplier base reduction leading to procurement cost savings of 10 percent certainly seems feasible. Simplifying procurement processes, cutting inspection, expediting, rejection, and rework costs, while reducing plant startup delays and improving operating factors, will result in major savings to Chevron.

**PROJECT-SPECIFIC CAPITAL EQUIPMENT**

Improving product design and process designs through early involvement with alliance suppliers is a definite advantage. A major example of this approach at Chevron is the Central Energy System for the proposed Richmond Refinery Modernization Project. This set of boilers generating high pressure steam and turbine driven electric generators, will be fueled by waste gas from a refinery processing unit. It will generate approximately 140 megawatts of power.

The conventional way of building such a plant would be to design it using a contractor and consultants, write detailed specifications which attempt to fully define the requirements, send these out for competitive bids, and buy from the lowest acceptable bidder. What the group did for this project was to first carry out a detailed audit of five potential suppliers of boilers and another five for steam turbines and generators. This exhaustive review by a group of Chevron and Bechtel technical and commercial people led to the selection on of each category of suppliers. Then, working together with them as a team, the group has started the process of designing the plant around the equipment. The plant design will optimize the use of proven equipment offered by these suppliers.

The team has hired each of them using an engineering service contract to do the detailed design and to develop the price. All pricing will be based on an open book approach, in which full details of labor, materials, overhead, profit, and so forth, will be disclosed. This designing and costing process will carry on in parallel with obtaining permits to build the plant. Once permits are obtained and the project is funded, they will be in a position to order the equipment immediately. And at this point, they will be confident that all the equipment for this boiler plant will be safe, reliable, and the best value that can be obtained.

**MULTIFUNCTIONAL COMMODITY TEAMS**

Chevron has incorporated many of the ideas the team acquired from the quality improvement study and started teams to improve the supply situation with hardware items which are routinely purchased in quantity. These Commodity Action Teams (CAT) will be multifunctional to secure widespread buy-in to the process and its results, and to benefit from the experience and knowledge of different sorts of company people. The teams will typically include persons from Purchasing, Quality Assurance, Engineering, Operations, and Maintenance, representing a variety of facility locations.

There are now a number of functioning Commodity Action Teams. They started out with three pilot teams which were selected from suggestions provided by the Corporate Purchasing Advisory Committee. These pilots were five gallon plastic pails

used for marketing lube oil, cast steel gate valves used widely throughout the business, and steel sucker rods found in the oil fields.

In addition to these groups, a number of other Commodity Action Teams sponsored by various operating companies have started up. Their Marketing Department established CATs for modular steel buildings, signs, and service station gasoline dispensers. A team studying forms will eventually set up a CAT for office supplies. Other groups have been at work on autos and trucks, steel drums, wellheads, and paints (Figure 18).

Plastic Pails	Richmond Refinery Modernization Project Steam Plant
Valves	Gasoline Dispensers
Service Station Bldgs.	Office Supplies
Office Furnishings	Steel Sucker Rods
Service Stations Signs	Steel Drums
Autos and Trucks	ERW Line Pipe
Anti-Fouling Paints	

Figure 18. Current Commodity Action Teams (C.A.T.).

SUPPLIER CERTIFICATION AND ALLIANCING

The commodity teams have designed specifically tailored supplier survey methods. They obtained examples from Ford, Xerox, and others, of survey forms and process flow charts showing exactly how rating and certification are carried out. The commodity teams visit and carefully audit the suppliers' factory. They then select the best one or more firms and negotiate a multiyear agreement. A significant feature of these alliance agreements are a requirement for continuous quality improvement and documentation to prove that this is happening. Gains from productivity improvements will benefit both Chevron and the suppliers.

Periodic monitoring of the suppliers' performance in mutually agreed upon aspects of quality improvement, delivery, cost control, and so forth, will be carried out. When a supplier attains a quality performance level where Chevron's expectations are fully and consistently met, they will be recognized as "certified." Appropriate plaques may be awarded and public recognition provided (Figure 19).

- Form the CAT
- Supplier Self-Assessment
- Manufacturing Site Visits, Audits, Rating
- Selection of Preferred Supplier(s)
- Negotiating Long-Term Alliance
- On-Going Teamwork to Build Trust, Understanding, Quality Improvement, and Mutual Benefit
- Performance Measurement
- Certification

Figure 19. Certification Steps.

The membership of these Commodity Action Teams is highly diversified. Currently, there are about 100 Chevron people from many company organizations working on CATs. There are design engineers, buyers, quality assurance engineers, finance specialists, operating engineers, and Bechtel alliance people participating. Most of them are doing this work in addition to their normal jobs.

The CATs are at various stages in the CSQI process. Several have already finished surveying and rating and have signed alliance agreements with a supplier or suppliers. A few CATs are in the process of visiting supplier factories, and several teams are just getting organized (Figure 20).

Supplier Recommendation Submitted: 5 Commodities	
	- Anti-Fouling Paints
	- Richmond Refinery Modernization Project Steam Plant
	- Service Station Buildings
	- Plastic Pails
	- Steel Sucker Rods
Supplier Audits Ongoing:	4 Commodities
	- Valves
	- Gasoline Dispensers
	- Office Furnishings
	- Service Station Signs

Figure 20. Commodity Action Team Status.

The team has some early predictions of financial benefit from supply optimization. A Chevron Shipping Company team studied their antifoulant paint purchasing situation. The team started by evaluating the seven suppliers they had been doing business with. They then short listed to two, and after the detailed review, recommended one paint company. The expected saving from this optimization for planned ship overhauls in 1990 is almost \$400,000.

A team from Chevron U.S.A. Marketing evaluated modular steel buildings for service station reconstruction. They recommended a change from three competing suppliers to one alliance supplier. This five year program, covering buildings for 500 to 600 stations, is expected to expend \$100 million, approximately \$20 million a year. The team has estimated savings of about \$3 million per year.

The team for plastic five gallon lube oil pails has submitted their recommendation, which would reduce the number of suppliers from six to three. Single sourcing is not recommended in this case because Chevron has lube oil filling locations around the country. It would not be economical to ship all of the containers from one factory. They estimate savings of close to \$200,000 per year (Figure 21).

Commodity	Team Sponsor	Current No. of Suppliers	Recommended No. of Suppliers	Reduction	Projected Annual Savings
Anti-Fouling Paints	Shipping	7	1	6	\$390 M
Modular Steel Buildings	Marketing	3	1	2	\$3 M
Plastic Pails (5 Gallon)	Marketing	6	3	3	\$193 M

Figure 21. Supply Optimization First Results.

## CSQIP SUPPORT TEAM

Started in January 1990, a staff of people in the Chevron U.S.A. Purchasing and Materials Management Department is working full time on CSQIP. This group consists of five Buyers and three Quality Improvement Engineers. They will all be involved with Commodity Action Teams. They will be writing and publishing documentation such as brochures and the CSQIP handbook. And they will have a number of other tasks, including training CAT members in total quality concepts.

## PLANS FOR 1990

There are a number of new activities and growth in existing items underway in 1990.

- Chevron will form a Supplier Council, where our strategic suppliers, primarily those the teams have already selected as alliance partners for long term quality improvement, will meet periodically with management to discuss mutual goals and business plans.
- The CSQIP handbook, which will tell Chevron organizations everything they need to know about selecting commodities, forming Commodity Action Teams, and going through the process of optimizing their supplier base, will be published in 1990.
- The teams plan to divide their extensive list of commodities into 23 basic subsets. Eventually we will form "Commodity Focus Groups," which are multidisciplinary teams having continuing responsibility for monitoring supplier optimization in that particular group of commodities. An example might be a group looking at valves, fittings, and line pipe.
- New Commodity Action Teams are being formed for oilfield drilling fluid additives, lube oil additives, ERW line pipe, antifriction bearings, and control valves. Several project construction groups are considering the CSQIP approach for purchasing capital items. And we are also looking at application of the process for selecting service organizations, such as quality improvement consultants.

## CONCLUSION

CSQIP started in the spring of 1989 and a great deal has happened. Several Commodity Action Teams have already finished their surveys, recommended reduction of the supplier base, signed contracts, and estimated significant savings. Within the next two or three years, the Commodity Action Team approach, supplier quality improvement, and total quality improvement concepts will be the basic way of doing business at Chevron. This corporate cultural change will not come quickly, but it has begun.

The symbol the company is using for CSQIP depicts an old puzzle, a box with nine points (Figure 22). You must connect

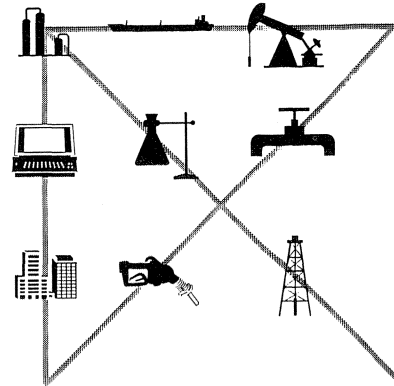


Figure 22. Illustration of Today's Business Challenge.

all of the points using only four straight lines. It's impossible unless you go outside of the box. This illustrates today's business challenge. We must reach beyond traditional boundaries to complete our tasks in order to become "Better Than the Best."

