THE ANALYSIS OF A NEW ENTRY INTO THE INDUSTRIAL MARKET

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I certify that A have read this thesis, and in my opinion it is fully adequate, in scope and quality, as a thesis for the degree of the Master of Business Administration.

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ABSTRACT

The use of random co-polymer polypropylene (PP-R) in hot water sanitary systems has grown substantially in Europe over the last five years. It is expected that the numerous benefits of PP-r over other materials will help this trend continue, and expand beyond Europe. Ongoing work on standards and specifications promises to further strengthen PP-r pipes' competitiveness. Therefore, the performance of such a new product is worth investigation. Apart from the PP pipe industry, analyzing the overall performance of the whole sanitary pipe sector (Steel and PP pipe) is as important in order to understand major differences.

The aim of this study is to analyze the development of a new entry in the Turkish industrial market at a Turkish company that operates as the six largest producer of longitudinally welded steel pipes in Europe. Throughout this study, the market development of PP-r pipes in Europe and in Turkey, together with the various success factors that have contributed to the substitution of traditional non-plastic pipe solutions with PP-R systems in sanitary tap water installations are also introduced. Afterwards, the steps that necessitate a successful entry from the design to launch and the areas where the company shortfell are identified, a new marketing strategy for a successful penetration is developed, and necessary corrections are made for a better competitive action. Finally, in the conclusion part, the internal (company specific) factors that delayed the success of the new product is conveyed.

Key words: New Entry, New Product, PP Pipes, The Pipe Industry, Borusan, PP Pipe Production, Feasibility, Marketing Mix, Strategy.

ÖZET

Son beş yıl içerisinde sıhhi sıcak su tesisatlarında polipropilen random kopolimer (PP-r) boru kullanımı gerçekten büyük artış gösterdi. Beklenen o ki, polipropilenin (PP-r) metal malzemelere karşı sayısız faydaları sayesinde bu trend devam edecek ve Avrupa dışına da yayılacak. Standartlar ve ayrıntılar üzerinde süregelen çalışmalar PP-r boruların rekabet gücünü daha çok artırmayı taahüt ediyor. Bu nedenle böylesine yeni bir ürünün genel performansını araştırmaya değer. PP boru sektörü bir yana bırakacak olursak, tüm sıhhi tesisat boru sektörünün genel performansını analiz etmek çelik ile plastik boruların arasındaki ana farklılıkları anlamak açısından aynı derecede önemlidir.

Bu çalışmanın amacı, Avrupanın altıncı boyuna kaynaklı çelik boru üreticisi olan bir Türk firmasının endüstriyel ürün pazarına yeni sürdüğü bir ürününün gelişimini analiz etmektir. Bu amaç doğrultusunda PP-r boruların Türkiye ve Avrupadaki pazar gelişimi, plastik borularının sıhhi su tesisatlarında geleneksel metal borulara karşı tercih edimesinin sebepleriyle beraber ortaya konulmuştur. Daha sonra, başarılı bir pazar girişi için uygulanacak basamaklar ve bu süreç içinde şirketin yetersiz kaldığı noktalar belirlenmiş, yeni bir pazarlama stratejisi geliştirilmiş ve daha rekabetçi bir ortam yaratmak için gerekli düzenlemeler yapılmıştır. Sonuç bölümünde ise, yeni ürünün pazardaki başarısını geciktiren iç nedenler ele alınmıştır.

Anahtar kelimeler: Yeni Giriş, Yeni Ürün, PP Borular, Boru Endüstrisi, Borusan, PP Boru Üretimi, Önhazırlık Çalışması, Pazarlama Karışımı, Strateji.

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I. INTRODUCTION

Plastic pipe systems have increasingly replaced traditional metal, clay, and concrete pipes in cold water distribution, gas distribution, sewerage and drainage applications over the last 50 years. Polyethylene and PVC piping systems have been particularly prominent in this development. The use of metal pipes for hot and cold water sanitary systems inside buildings have long prevailed, however, because of the demanding requirements related to operating temperatures of between 60 ^{0}C and 70 ^{0}C and short-term requirements up to 95 ^{0}C.

Plastic pipes became a real alternative with the introduction of cross linked polyethylene (PEX) and polybuthylene (PB) in the 1970s. During the last 10 years, new polypropylene random copolymers and complete PP-R plastic sanitary systems have been developed and approved in a number of countries. These systems have proved very competitive solutions for indoor house installations and the use of polypropylene random copolymer (PP-R) in hot water sanitary systems has grown substantially in Europe over the last five years.

As an alternative to steel pipes, PP pipes (polypropylene random co-polymer) are being used in water transmission, presently at a considerable rate. PP pipe was not expected to be a strong substitute against steel pipes in Turkey. However, at the end of 1994, the plastic pipe industry with its 48 PP pipe producers, unexpectedly, became a serious threat for the steel pipes that were extensively used in water transmission till the last decade. Due to a substantial decrease in the market share in water transmission steel pipe category, and with the restraint of buyers who really appreciate Borusan's quality, the company decided to enter into the plastic pipe market with a brand name " **Borusan P^{2}3 Boru ve Fittings Sistemleri**" (**Borusan P ^{2}3 Pipe and Fitting Systems**)at the end of July in 1995.

Borusan is the leading manufacturer of steel pipes and tubes in Turkey. Pipe and pipe manufacturing is the core business of Borusan Group, a conglomerate made up of 30

companies spread over eight different industries ranging from iron and steel to automotive spare parts to construction.

II. LITERATURE SURVEY

The design of a new product or service begins with the conception of an idea and continues through a variety of development and testing phases until detailed production specifications are determined. Then, the production begins, and the product is introduced into the market place. Marketing plays a major role in the early stages of product design and development by assessing consumer needs and communicating these to research and development. The operations function is responsible for designing and implementing the production process for the product. (Evans, 1993)

New product decisions affect not only the production system, but other functional areas in the organization as well. For instance, the financial division must raise capital and prepare budgets for research and development for new products and processes, as well as for the other large expenditures that may be necessary. The purchasing department must interact with the engineering group to determine what materials are required to produce the product so that appropriate vendors can be selected. All these activities require good communication from initial product design through the introduction of product into the market. (Evans,1993)

Perhaps the most important strategic decision that a firm can make involves the selection and development of new products. Determining what products should be offered and how they should be positioned in the market place will determine the growth, profitability, and even the survival or the future direction of the firm. In this regard, significant competitive advantage can be achieved by producing superior design; appealing, reliable, easy to operate, and economical features to service products. (Evans,1993)

Product development is at the hearth of the marketing process. New products should be developed, or old ones modified, to cater new and changing customer needs. At the same

time, corporate objectives of technical feasibility and financial profitability must be satisfied. (Kotler,1991)

Given the intense competition in most markets today, companies that fail to develop new products are exposing themselves into great risk. Their existing products are vulnerable to changing consumer needs and tastes, new technologies, shortened product life cycles and increased domestic and foreign competition. Given rapid changes in the tastes, technology, and competition, a company cannot rely only on its existing products. Customers want and expect new and improved products and competition will do its best to provide them. (Mc Dougal, Armstrong, Kotler 1988)

With increasing competition, able to react quickly when new products are introduced, world-wide planning at the product level provides a number of tangible benefits. A firm that adopts a world-wide product management approach is better able to develop products compatible on a world-wide scale. (Kotler,1991)

The main goal of the product design and development process is therefore, is not the development of a standard product or product line, but to build adaptability into products that are being developed to achieve world-wide appeal.

A company can obtain new products in two ways. One is through ***acquisition***, by buying a whole company, a patent, or a license to produce someone else's product. As the cost of developing and introducing a major new product climbed rapidly in the late 1980s, many large companies decided to acquire existing brands rather than to create new ones. (Mc Dougal,Armstrong, Kotler 1988)

The company can also obtain new products through ***new product development***, by setting up its own research and development department.

Innovation can be very risky. It is found that the new product failure rate for consumer products was 40%. This rate for industrial products and services is 20% and 18% respectively. Moreover, in a recent study of 700 industrial and consumer firms, it is stated

that the overall success rate for new products is only 65%. (Mc Dougal,Armstrong, Kotler 1988)

There might be several reasons for the failure of a new product. The idea may be good but the market size might be overestimated. A senior executive might push a favourite idea in spite of poor marketing research findings, or the actual product might be incorrectly designed or positioned, priced too high or low, or poorly promoted and advertised. A major reason for failure of a new industrial product might be a poor marketing effort. The marketing problems may include inadequate assessment of competitors' strengths, a lack of market research to identify product deficiencies, or inadequate attention to customer requirements. (Mc Dougal,Armstrong, Kotler 1988)

II.1. Product Design and Development Sequence

Every new product starts with an idea. However, a good idea does not necessarily indicate a successful product. A significant amount of development effort is necessary before a product can be produced and made available to the consumer. For a number of companies, especially those producing industrial goods, customers provide the best source of ideas for new products. This situation is quite advantageous because the developing company is not obliged to limit its marketing efforts to the company that provided the idea. The steps leading from the idea stage to actual production product are outlined in Table 1 Appendix A. The sequence consists of idea generation, initial screening, product design and development, initial economic analysis, prototype testing, and final product and production process design. At each of these stages, a potential product idea may be scrapped. (Chase & Aquilano, 1989)

Many ideas can be immediately rejected because of marketing factors; for being impractical to produce, or because it is concluded that they are technically infeasible. Others may be eliminated for not meeting corporate goals and objectives, or because of budgetary considerations. Product ideas that survive in the initial screening may later be eliminated during formal economic analysis. An idea may even become obsolete during the initial design and development stage because of a new technological discovery, and testing

of prototypes may uncover serious problems that cannot be technically or economically corrected. Finally, even if the product survives test marketing and is introduced into the market place, it may not guarantee a commercial success. Sometimes this is the result of ineffective planning of marketing strategies, inherent technological problems, or poor management in general. Product development therefore needs to be systematic in order to be effective. The following sections depict a systematic approach for the product development process.

II.1.1 Origin of the Product Idea.

The new product-development process starts with the search for ideas. Top management should define the products and markets to emphasize. It should state the new product objectives, whether, it is high cash flow, market share domination, or some other objective. It should also state how much effort should be devoted to developing original products, modifying existing products, and copying competitors products. In other words, the search for new product ideas should be systematic rather than haphazard, otherwise the company will expend energy in generating ideas that are not necessarily suited to its business. (Mc Dougal,Armstrong, Kotler 1988)

New product ideas may originate from many sources including customers, scientists, competitors, employees, channel members, or top management.

In addition to the traditional market research, listening the consumer may take the form of managers and engineers visiting users of the company's existing products, or; going into production on inventions and prototypes developed by users. While these companies have extensive R&D functions, they also encourage their own employees to generate new product ideas and contribute to the development of those currently being investigated. (Chase & Aquilano, 1989)

II.1.2. Choosing Among Alternative Products.

A screening procedure is instituted to eliminate those ideas that can be translated into produceable products that clearly are infeasible. Generally, four major criteria are used in initial screening: i) managerial criteria, ii) product development criteria, iii) market criteria, and iv) financial criteria. In the screening process, the managers reject some ideas because they do not meet the objectives of the company or the criteria of marketing, operations and finance. Operational criteria considers the process/product compatibility with the current product/process, equipment, facilities and suppliers. Marketing criteria include competition, market substantiality and penetrability, ability to cross sell, promotional requirements, and distribution considerations. Financial criteria combine marketing and operational concerns and focus on investment requirements of the product/process, the risk borne by the company, anticipated profit (loss) margin, length of the life cycle and cost accounting of the product. Most of the time, to display the decision factor based on quantitative comparisons (best estimates) of the project a project value index (PVI) or a scoring model is used. (see Table 2 in the Appendix A.) (Chase & Aquilano, 1989)

To develop a scoring model, each criterion is broken down into a set of attributes. For example, attributes of product development usually include the length of time required to develop the product, experience of the firm in producing similar products, length of the product life, materials availability, and equipment. Several levels for each attribute must be determined, and a value or score must be assigned to each. The results of the scoring model must be reviewed by top management for evaluation since the use of such a model helps top management conveniently summarize important variables and provides a means for analysis and discussion in the initial screening process. (Evans,1993)

A product idea at some stage that fails to earn a go-ahead is not necessarily scrapped. Most progressive companies maintain data banks of "miscellaneous opportunities." Often, data from these banks are used in the development of other products.(Cooper, 1979)

Whenever a product passes the screening procedure, it is undertaken a more rigorous analysis of cost and revenue calculations. In other words, the tools (break even charts) of financial analysis come into play. It generally yields information on how many units must be sold. However, the marketing department focus on studies to determine how many units are likely to be sold by conducting a marketing mix analysis to determine how they are to be sold. (Chase & Aquilano, 1989)

New product ideas in most companies are required to be written up on a standard form that can be reviewed by a new product committee. They describe the product, the target market, the competition, make some rough estimates of the market size, product price, development time and costs, manufacturing costs, and rate of return.((Mc Dougal,Armstrong, Kotler 1988)

II.1.3. Product Design and Selection.

Production managers concern with the product's specifications which they consider it as the critical output of the product design activity. The purchase of raw materials, equipment selection, assignment of workers and the size and lay out of the production facility provide the basis for a host of production related decisions.

II.1.4. Preliminary Design.

When a new product idea earns a go-ahead, preliminary design is usually devoted to developing several alternative design that meet the conceptual features of the selected product. During preliminary design, it is also common to specify the key product attributes of reliability, maintainability, and service life.

Preliminary design phase includes:

-the function of the product,

-conformance to customer needs,
-manufacturing costs,
-engineering documentation,
-make or buy decisions,
-reliability requirements,
-scheduling of the design and development process,
-liability issues,
-completeness of specifications,
-testing plans,
-process capability,
-value and appearance,
-environmental conditions and product testing,
-marketing considerations.(Evans, 1993)

The design of the product includes much more than simply a physical description of the item. Three major factors must be taken into account: (1) the function of the product; (2) technical requirements and specifications; and (3) the economics of production and distribution.

(1) Functional influences:
In order to be a commercial success, a product must be functional and appealing to consumers. Some of the important design considerations can that relate to a product's function and appeal are:

- size, weight and appearance,
- safety,
- quality and reliability
- product life, service, and maintenance.

(2) Technological Influences:
Technical requirements in product design include the selection of the materials and component parts to be used and the manufacturing methods to be employed. Materials must be chosen to satisfy the functional requirements of the product. For instance certain

materials can be machined to much closer tolerances than others; thus, parts that require close tolerances must be made from the appropriate material.

(3) Economic Influences:

The price that a consumer must pay for a product depends on the direct and indirect costs of manufacturing and distribution. Products are targeted toward specific markets. It would make little sense for a company to produce a product for mass consumer appeal if the costs of manufacturing and distributing the product are very high. (Evans,1993)

Two techniques that assist in reducing costs associated with product design and development are *value engineering* (VE) and *value analysis* (VA). VE/VA consist of asking fundamental questions of about a product such as the following:

1. What are the functions of a particular component? Are they necessary? Is it possible to accomplish it in a different way?
2. How much material is wasted during manufacturing? Can this be reduced by changing the design?
3. What materials are used? Can it be substituted with less costly material?

The benefits of VE/VA analysis programs include not only cost reduction, but increased sales volume through improved product value, performance, reliability, quality, maintainability, delivery through faster production flow, improved productivity, increased innovation and creativity of human resources.(Evans,1993)

To ensure these three important design objectives described are accounted for, the companies should institute design reviews during the product planning process as they help to facilitate standardization and reduce the costs of frequent design chances by anticipating problems before they occur.

II.1.5. Economic Analysis

Scoring models provide a rough, quantitative measurement of product potential. But the purpose of economic analysis is to determine more specific quantitative measures of profitability and return on investment. Such an analysis is necessary in order to decide whether or not to commit further resources toward development of an idea.(Evans,1993)

An accurate estimate of the demand is required in order to perform a formal economic analysis. Therefore, forecasting is an important tool in the product development process. Statistical forecasts of industry sales prepared by the private marketing research companies and trade associations provide excellent information on future trends for product lines. Judgmental estimates of the market share can be incorporated with such forecasts to determine an estimate of product demand.

In addition to demand forecasts, estimates of production costs must be obtained. Accounting and engineering are responsible for estimating manufacturing costs, cost of materials, supplies, personnel, equipment, depreciation, and other indirect operating expenses. Finally, the selling price of the product must be estimated in order to compute financial measures such as the rate of return, pay back period, and net present value.

II.1.6. Prototype Testing

Once a product has been designed, a prototype is usually constructed to test its physical properties or used under operating conditions. Actual testing is important in order to uncover any problems and correct them prior to full-scale production.(Evans,1993)

II.1.7. Final Design.

The ultimate output of final design includes the complete specification of the product and its components, and assembly drawings, which provide the basis for its full-scale production. For this purpose, product prototypes are developed and "bugs" are worked out so that the product is sound from an engineering stand point. (Chase & Aquilano, 1989)

The effectiveness of alternative designs must also be balanced with cost considerations, and inevitable compromises such as in selecting the true configuration and material for manufactured items must also be made.

II.1.8. Concept Testing.

Surviving ideas must now be developed into product concepts. A product concept is a detailed version of the idea stated in meaningful consumer terms. Concept testing calls for testing these concepts with a group of target consumers. The test might include a seminar where the consumers are shown the new product and given instructions on its operation. The relative importance of the new product may be determined by asking the consumers to rank a set of alternatives from most to least desirable. This requires the consumer "to trade off" various characteristics- a situation faced by all buyers in real life.(Mc Dougal,Armstrong, Kotler 1988)

II.1.9. Marketing Strategy Development.

If the consumers react favourably to the new product concept, next step is to design a new marketing strategy for introducing the new product into the market.

Generally, the marketing strategy statement should consist of three parts:

The first part describes the target market, the planned product positioning, and the sales, market share, and profit goals for the first few years.

The second part of the marketing study statement outlines the product's planned price, distribution, and marketing budget for the first year.

The third part of the marketing strategy statement describes the planned long-run sales and profit goals, and marketing mix strategy overtime. (Mc Dougal,Armstrong, Kotler 1988)

II.1.10. Process Selection.

Manufacturing operations, that have the general sense of transforming some material input into some material output, can be categorized into several types of process structures.

Those that must be carried out 24 hours a day to avoid expensive shutdown and start-ups are called continuous processes. These are typified by process industries such as steel, **plastics**, chemicals and petroleum. Continuous-process industries generally provide fewer operations and options since the technology is often analogous to one big machine, rather than a linkage of several individual machines. (Chase & Aquilano, 1989)

II.1.11. Scale up Phase.

In this phase, which precedes full-scale commercialization, preliminary production units are tested on site or in limited mini-launches.

The final stages of the product development process may involve testing the product in terms of both its performance and its projected market acceptance. Depending on the product, testing procedures range from reliability tests in the pilot plant to mini launches, from which the product's performance in the market will be estimated. Any testing will prolong full-scale commercialization and increase the possibility of competitive reaction.

However, it will give the management the information needed to make a final decision about whether to launch the new product.(Kotler, 1991)

In launching a new product, the company must make the following four decisions:

When

The first and the hardest decision is the right time to introduce the new product. If the sales of the new product cannibalize the sales of the company's other product(s), its introduction may be delayed. Or if the economy is worse the company may chose to wait.

Where

The company must decide whether to launch the new product in a single location, one region, several regions, the national or the international market. Small companies usually select a an attractive city and put on a blitz campaign to enter the market. They may prefer to enter other cities one at a time. Large companies introduce their product into a whole region and then move to the next region. Companies with national distribution networks will often launch their new products in the national market.

To Whom

The company must target its distribution and promotion to the best prospect groups. It must identify the market looking especially for early adopters, heavy users, and opinion leaders.

How

An action plan must be developed for introducing the new product into the selected markets. A marketing budget must be allocated for the marketing mix activities. (Mc Dougal,Armstrong, Kotler 1988)

II.2. The Product Life Cycle

Figure 1 depicts a graph of sales volume versus time for a typical new product. It is referred to as the life-cycle curve. When a product is first introduced, sales begin to grow

slowly, and there is a period of rapid growth as the product gains acceptance and markets for it develop (assuming, of course, the product survives the initial phase). During the growth phase, new consumers are being made aware of the product through advertising, and the product becomes competitive with other brands. This phase is followed by a period of maturity, in which demand levels off and no new distribution levels are available. The product design becomes standardized, causing competitors to focus marketing strategies more on offering best price for a similar product than on offering a significantly better product for a similar price. Finally, the product may begin to lose appeal as substitute products are introduced and become more popular. This is the decline phase. At this point the product is either discontinued or replaced by a modified or an entirely new product.

In maintaining sales volume, particularly in the face of new competition, and preventing the product from entering the decline phase in the product life-cycle, advertising and minor product improvements play a key role.(Evans,1993)

II.3. Productivity and Quality Considerations in Product Design

A product's design must include the determination of the technical specifications that meet a customer's needs. Operations personnel must document the process specifications that determine how the product is to be made, the controls that will monitor incoming materials and purchased parts, the controls of monitoring the manufacturing process itself, the packaging and distribution of the product, and what "the customer sees", including instruction manuals and service policies.

Conformance to specifications is the responsibility of purchasing and manufacturing. If purchased parts are used, methods for checking their performance to specifications are needed. Poor manufacturing methods may result in a product with low quality and frequent breakdowns. Packaging and distribution are important to assure that the product reaches the customer in good operating condition. This must also be considered during the initial design phase. Finally, the quality of user manuals and after-the-sale service is critical to successful product.

Many aspects of product design can adversely affect quality and productivity. Some parts may be designed with features that are difficult to fabricate repeatedly or with tolerances that are unnecessarily tight. Some parts may lack details for self-alignment or features that prevent insertion in the wrong orientation. In other cases, parts may be so fragile or so susceptible to corrosion or contamination that a fraction of the parts may be damaged in shipping or by internal handling. Sometimes a design, because of lack of refinement, simply has more parts than are really needed to perform the desired functions, so there is a greater chance of assembly error. Thus problems of poor design may show up errors, poor yield, damage, or functional failure in fabrication, assembly, test, transport, and end use.(Evans,1993)

III. THE COMPANY: BORUSAN BİRLEŞİK BORU FABRİKALARI A.Ş.

Borusan is the leading manufacturer of steel pipes and tubes in Turkey. Pipe and pipe manufacturing is the core business of Borusan Group, a conglomerate made up of 30 companies spread over eight different industries ranging from iron and steel to automotive spare parts to construction.

These diverse companies all share a common set of guiding principles, which helps this vast enterprise operate in complete harmony. These principles, represented by the Groups new corporate identity and emblem, are **commitment to productivity, innovation, and environmental responsibility.**

Ongoing research and development activities are aimed at further improving quality and increasing the product range through use of new technology along with innovative and more cost-effective marketing techniques.

A dynamic, highly-qualified staff regularly trained in new manufacturing and management techniques make sure that production confirms to exacting quality standards.

Borusans water and gas pipes, line pipes and casting, industrial and structural pipes, boiler and cylinder tubes, green house and precision tubing are produced using the-state-of-the-art technology and know-how accumulated over three decades of pipe manufacturing. Production is carried on in four plants with a combined capacity of over 420,000 tpy. Half of the production is exported world-wide.

Borusan pipes and tubes are certified and their quality is approved by world's various independent national agencies such as the German Union of Technical Inspection (TÜV) and the American Petroleum Institute (API).

III.1. Company Profile

-Highly respected brand name and quality recognition.

-Among the top ten steel manufacturers in Europe.

The combined annual capacity of Halkalı (İstanbul) and Gemlik (Bursa) facilities is 350,000 tons. This represents 60 % of Turkeys longitudinally welded steel pipe production.

-Exports 48 % of its production.

Borusan Boru represents 42% of Turkeys total pipe exports, of which 89 % of the sales are made to EU, USA and EFTA countries.

-Market Leader and price setter.

1994 sales acceded US $ 145 million with a domestic market share of 38 %. Borusan Borus image of quality allows the company to differentiate its products and price them at the higher end of the market. It is able to sell its products at a 5 to 8 % premium in the domestic market.

-Wide distribution network.

Borusan Borus distribution network is made up of 78 nation-wide dealers and 8 regional distribution companies. Total network accedes 1000 outlets.

-Diverse product range.

The product range varies between 4.76 mm. and 323 mm. diameter pipes with most grades of material and industrial standards. **The company has already launched a polypropylene pipe line in 1995.** The investment objective is to achieve 40 % market share in this segment with an expected US$ 10 million turnover per annum.

-Acquired Kartal Boru (İstanbul) and Bosaş (Trabzon) facilities from competitors.

Borusan Boru expanded its market share and penetration through the acquisition of Kartal Boru and Bosaş facilities which have annual production capacities of 60,000 tons and 45,000 tons respectively.

-Employs 860 personnel of which 140 are white collar.

-Potential to expand export sales after the lifting of protective measures with European Union.

Borusan Boru, a leading exporter to developed countries has proven its competitiveness in quality, pricing and cost structures.

IV. THE NEW PRODUCT
Borusan "P 23" Pipe and Fitting Systems"

The product, made of PPRC (Polypropylene Random Co-polymer) Type 3, has entered the market at the end of July in 1995. It is basically a substitute of steel pipes used in clean water transmission produced from a raw material, a polymer; namely polypropylene.

IV.1. The Raw Material

Polypropylene is a thermoplastic polymer with a low specific gravity and good resistance to chemicals and fatigue. It has gained wide acceptance in applications ranging from fibers and films to injection molded parts for automobiles and food packaging.

Polypropylene , first entered commercial production in 1957, was the first group of stereo regular homopolymers. Its historical significance is underscored by the fact that it is remains the fastest growing major thermoplastic, having reached a world-wide production of 100,000 tons at the end of 1995. It has found very broad use particularly in the fibre and filament, film extrusion, injection molding and pipe industry used for water transportation.

IV.2. Chemistry and Properties

Isotactic PP is a stereospecific polymer in which the polypropylene units are attached in a head-to-tail fashion and the methyl groups are aligned on the same side of the polymer backbone. This structure gives the polymer high stiffness, good tensile strength, and resistance to acids, alkalis and solvents. However, the tertiary hydrogens do react with free radicals, so stabilizers are added during manufacture to prevent oxidation.

Polypropylene can be readily colored and has a good fatigue resistance, making it ideal for injection molded systems such as extrusion dies. Films have low permeability to water and moisture, are unaffected by bacteria and fungi, and have good electrical resistance.

With a specific gravity of 0.90 to 0.91, polypropylene is the lightest of the major plastics. Its melting point ranges from 180 to 270 ^{0} C and is usable up to 130 ^{0} C. The melt flow rate can range from 1 up to 100 g/ 10 minutes.

About 20% of the polypropylene is sold as a co-polymer. Random co-polymer are made by adding 2 to 5 % ethylene in to the polymerization reactor. The resulting polymer has increased clarity, greater toughness and flexibility, and a lower melting point.

IV.2.1. Special Grades

Polypropylene can be compounded with fibers and reinforcements such as calcium carbonate, talc, mica, and glass fibre.

Other additives are available. Nucleating agents cause the resin to crystallize faster, leading to better injection molded parts, improved clarity, fewer sink marks and faster molding cycles. Other additives are used for static control, UV light resistance, and improved long term heat aging.

IV.2.2. PP Homopolymer

Homopolymer resins are generally classified by flow rate and by end-use. Flow rate depends on both average molecular weight and molecular weight distribution. While some specialized applications require flow rates up to about 400 dg./min., typical commercial homopolymers fall into the range of 0.5 to 50 dg./minute. *The flow rate is usually the most critical factor in determining processing characteristics.*

Lower flow rates meet the processing needs for extruded strapping, ribbon filament, and monofilament applications. They also impart tensile strength and low elongation to the finished product while retaining sufficient transverse integrity to minimize splitting and dusting on winder guides.

Note that polypropylene homopolymer can also be processed by a state owned enterprise- **Petkim**, and is extensively used by the users in the textile and automobile spare parts industry in Turkey. This material, although prohibited by laws and standards, is also used for pipes used in the clean water transmission lines by some producers that operate independent from the quality standards. Although the mechanical properties of these pipes are similar to those produced by PPRC-Type 3 they are rigid and fragile at temperatures below 20 ^{0} C and according to the aging test results under 5 MPA fixed pressure and 60 ^{0} C temperature they have a maximum service life of 3 years. However, if the pipe is used with the real raw material, that is, PPRC type 3, it will serve for 50 years under the same pressure and temperature and will provide a large spectrum of usage for applications at temperatures 0 to 130^0 C.

The price per kg of PP homopolymers are 3-4 times cheaper than PPRC type 3. This sector is therefore a profitable sector for swindlers seeking to gain huge profits in a short period by using PP homopolymers in pipes and fittings instead of PPRC Type 3 raw material. According to a research conducted by Polydan International-Plastic-Chemicals H.m.b.H, almost half of the PP pipes and fittings in Turkey are being produced with PP homopolymer raw material.

For this reason, the customers must choose serious producer companies in selecting PP pipes and fittings.

IV.2.3. Polypropylene Impact Co-polymers

Impact PP, has a density less than 1, is usually processed at moderate temperatures, on the order of 140 to 230 ^{0} C.

Impact PP copolmers are available over a broad spectrum of melt flow rates, commonly ranging from fractional melt flow rates to about 30. Resins with low melt-flow rates, typically less than 2, can be extruded into tubing or film that offers good puncture resistance.

The chief commercial application of impact PP is injection molding, where articles used in automotive applications, housewares, and appliances are produced. Medium-impact-grade PP is used to injection mold interior parts for automobiles. High impact grades are used in more demanding applications such as battery cases and fender liners.

An important note is that impact copolymers, like polypropylene homopolymers, can not be used in extrusion to produce water transportation pipes as they are not resistant enough to impacts at temperatures below 20 ^{0} C.

IV.2.4. PP Random Co-polymers

Polypropylene random co-polymer is a group of olefinic-based thermoplastic featuring a low specific gravity, toughness and flexibility. They offer the chemical resistance and barrier properties of PP homopolymer plus clarity, impact resistance, and a lower melting point. PP random copolymers are especially well-suited for film, injection molding, blow molding and sheet extrusion applications in packaging, medical, and consumer products.

The copolymers typically contain 1.5 to 7.0 % ethylene by weight as a comonomer. The specific gravity is 0.89 to 0.90, making random copolymer slightly lighter than homopolymer.

Random copolymers are handled as specialty grades by producers. This requires a wide variety of products made during short manufacturing runs. Careful handling, slower rates, and short runs contribute significantly to the higher costs of random copolymers, especially at higher comonomer levels.

Polypropylene random co-polymers are consumed primarily in three key processes: blow molding, film, and injection molding. Sheet extrusion, secondary compounding, and limited fibre applications make up the remainder of material uses. Random co-polymer is

used in numerous medical packaging applications, as well as hot-filled and multilayer barrier bottles in food packaging. Random copolymer key properties for blow molding include clarity and moisture barrier for medical and food packaging, superior stiffness for hot filled applications, and good impact for refrigerated products. Major uses for random copolymers in injection molded products include durable goods and rigid and semi-rigid packaging. Cookie trays and medical devices are presently being produced.

Polypropylene random copolymer (type 3) is extensively used in the pipe industry especially as a substitute of steel pipes for the clean water transportation lines during the last decade as it can also resist to impacts up to the freezing temperature of water.

IV.3. Identifying the Market

The main market for PP pipes are the clean tap water transportation systems used in the construction industry. They are a serious threat for the galvanized steel pipes used in the buildings, especially for those that have 1/2" - 3/4" and 1" diameter. This portion constitutes %80 of the total water transportation pipe market. Borusan, like almost all the other PP manufacturers, should consider to achieve a significant share from this portion while entering into this PP pipe business.

According to the data gathered from DİE (Devlet İstatistik Enstitüsü) the annual consumption of 1/2"-3/4" and 1" diameter pipes (the steel pipes and others) is as follows:

Diameter	1/2"	3/4"	1"
Total Consumption (million meters)	50	11.5	5
W. transportation Pipes	40	9.2	3.5
*Others	10	2.3	1.5

Table 1: The annual consumption of 1/2-3/4 and 1 diameter pipes in Turkey

Source, DİE 1994

Note that *Others represent industrial pipes, column pipes, constructive pipes, etc.

And, according to the data taken from the "Plumbers Association", the name and the consumption of fittings for every 10 m. of water pipes is as follows:

Diameter	1/2"	3/4"	1"
Elbow (in numbers)	6.25	8.3	5.7
T Part	2.5	2.5	2.3
Coupler	1.25	1.6	2.2
Sockets	0.5	-	-
Other	0.4	0.8	2.3

Table 2: The name and the consumption of fittings for every 10m. of water pipes

Source, Plumbers Association, Turkey 1994

Combining the annual pipe and fittings consumption tables together, Turkey's annual plumbing market can be found as:

Diameter	1/2"	3/4"	1"
Pipe (million meters)	40	9.2	3.5
Elbow (millions)	25	7.6	2
T Part (millions)	10	2.3	0.8
Coupler (millions)	5	1.5	1.8
Sockets (millions)	2	-	-
Other (millions)	1.6	0.8	0.8

Table 3: Turkeys annual plumbing market

Today, the PP pipe market is considered in the growth stage with a 20% market share in the total water pipe market, and is expected to be around %40 when the advantages of the PP pipes against traditional steel pipes are considered. Borusan targets to dominate 40% of the PP pipe market for the first two years.

IV.4. Machine Selection

In line with the data gathered and the target Borusan will try to achieve (40% market share), the plastification capacity that will play an important role for machine selection is calculated as follows:

Diameter	1/2"	3/4"	1"	TOTAL
Pipe (unit weight, gr./m)	175	250	445	
(Production, Million.m)	6.4	1.5	0.56	
(Raw material, t/yr.)	1120	375	250	**1745**
Elbow (unit weight, gr.)	17	26	43	
(Production, Millions.)	4	1.25	0.32	
(Raw material, t/yr.)	68	32.5	13.7	**114.2**
T Part (unit weight, gr.)	22	34	59	
(Production, Millions.)	1.6	0.37	0.13	
(Raw material, t/yr.)	35.2	12.6	7.7	**55.5**
Coupler (unit weight, gr.)	12	17	28	
(Production, Millions.)	0.8	0.4	0.4	
(Raw material, t/yr.)	9.6	6.8	11.2	**27.6**
Other				**70**
Raw material, t/yr.				**2012.3**

Table 4: The determination of plastification capacity for machine selection

There is 2-3% scrap in extrusion and 15% scrap in injection molding technology, then the raw material requirement will be around 2100 tons/year.

IV.5. Equipment

PP pipe and fitting production generally consists of three main sections.

1. Pipe production

The extruder, pipe molds, vacuuming calibrator, cooling unit (chiller), haul off unit, cutting and wrapping unit, packaging unit are used accordingly.

2. Fitting Production

Injection presses and fixed or multi-purpose material molds are used.

3. Scrap Recycling Unit

Crusher and grinders are used.

IV.6. Investment

It is considered that there are 270 working days or 6480 working hours in a year. The time consumed for repairs, set ups, and holidays, national days are taken as 480 hours. Then it can easily be found that the new investment will necessitate extruders that have 2100 tpy/6000 hrs= 350 kg./hr. capacity.

This could be provided by two extruders each having 200 kg/hr. plastification capacity. The critical units for the pipe line are extruders, pipe molds, calibrators and haul offs. The remaining (that consisted 80% of the price) cooling cutting and packaging units can be purchased from local producers.

Bids were taken from German Battenfeld and Reinfenhauser, Austrian Cincinatti Milacron, Italian Amut and Bausano for the PP pipe extrusion lines. Reinfenhauser, Battenfeld and Cincinatti Milacron's extrusion lines, together with their markers and controllers, that cost around DM 430,000-450,000 are found suitable.

Four injection presses each having a compression capacity of 200 tons (according to the production of 10.5 million fittings annually) is necessary. The price per injection press is around DM 140,000-160,000.

The bids for molds are taken from the 3 Portuguese, 1 Finnish and 2 Dutch companies. The price per mold ranges between DM 20,000-40,000 and the delivery time is 14-17 weeks. The mold price in the domestic market is around DM 12,000. The molds of the low sales volume fittings would be supplemented from the domestic market. The company made a budget of DM 520,000 for the production of the molds in abroad and convinced a competitor in the domestic market, Söğüt Plastik Kalıp A.Ş. (who has just terminated its partnership with Çamlıca A.Ş.) to produce the molds of some of the low sales volume fittings.

Each pipe line requires 120-150 kW. electrical power and needs a closed area of $250m^2$ for the lay out. Similarly, the company needs $200m^2$ for the injection presses. The total electrical power for the new foundation is approximately 600 kW.

The total fixed cost for the foundation is;

2 extruder lines (Battenfeld Extruders)	DM 595,000
4 Injection Presses (Battenfeld)	DM 690,000
Molds	DM 1,150,000
Chiller	DM 17,000
Compressor	DM 6,500
Crushers	DM 16,000
Feeders	DM 14,000
Packagers	DM 23,000
Auxiliaries	DM 38,000
Total	**DM 2,549,500**

After the acquisition of the Al. reinforced stabilized pipe production line (contains an extrusion line, a perforator, an Al. coater, a cutting and separating unit, and a packaging unit) in December 1995, the total investment reached DM 3,590,000. Together with the two buildings and the quality control unit (equipment) it exceeded DM 4,200,000.

After all these investigations, a simple scoring model was also developed (see Table 3 in Appendix C). Even though the score is zero the company decided to go ahead thinking

that PP pipes may wipe out the leadership of Borusan in the water transmission pipe category in the long run.

IV.7. Raw Material Selection

There are various PPRC type 3 producers in the European market. The most famous ones are Vestolen, Hülls AG (Germany)., Daplen, Borealis (Italy) and Hoechst AG (Germany).

Currently, it is not possible to supply the raw material from Hülls AG. It offers a different color for each and every pipe producer. As the remaining colors offered by the company was not suitable to our new product, we have no chance to work with them. Daplen, which has been extensively used in the market for so many years was withdrawn after being understood that it was odouring. Nowadays, asserting that they had solved that problem, the company made a new entry to the market with a lower price than its competitors. This material was tested by SPK (20 tons) and just as the company managers had said, no problem existed. Borealis was also in consideration because of its high thermal expansion coefficient, as high expansion coefficient would lead to problems both in the design and installation stage. Hoechst's Hostalen PPH 5416 is the most expensive material, but it has the highest perceived quality image. However, it is said that its resistance to direct impacts is lower when compared with its competitors. Borusan gave orders to three of the companies in order to test them in the laboratory. It is also decided that the raw material should be purchased transparent and would be colored with Hoechst's masterbatch. Within three months, the suppliers would be decreased to two. After three months, according to laboratory reports, Borusan abandoned coloring the raw material with the masterbatch reasoning that the inhomogenous mixing of PP and masterbatch would lead to several quality problems (such as micro cracks and pores in the internal structure that lead to failures after the installation of the pipes), and which, at the same time, lead to color differences between the parties produced at different times.

Nowadays, after trial and error, and together with laboratory experiments, **Borusan** takes polypropylene random co-polymer from the two of the most famous producers,

namely; "Hoechst AG. (a German producer) with a brand name of Hostalen PPH 5416, and Montel, Bimont Moplen Co. (an Italian producer, also a branch of Shell Co) with an original beige color. The metal (brass) couplings of the fittings are acquired from a Turkish manufacturer, Kalde Klima A.Ş., each of which are 10μ chromium- nickel plated according to the German standards DIN 8078.

V. THE OPPORTUNITY AND ISSUE ANALYSIS

V.1. Strengths

Polypropylene random copolymer pipes :

-Have high stiffness,

-Have good tensile strength,

-Have good resistance to Acids, Alkalis, and Solvents, and especially to water solutions of non-oxidative salts even at elevated temperatures.

-Can be readily colored,

-Have very low permeability to water and moisture,

-Are unaffected by bacteria and fungi,

-Have good electrical resistance,

-Are rust and rupture free, and do not scale up (no obstruction problems thanks to the absence of calcareous stains) and do not lead to lime,

-Have low load loss, and consequent possibility of using smaller diameter pipes for a given flow per second.

-Are noise free at high flow rates,

-Have smooth surfaces, therefore frictional losses are negligent.

-Are flexible enough to be produced and delivered on coils.

-Are recyclable. The scraps of pipe and fittings can be added to the new production by 10%.

-Can be joined to fittings by a fusion welding at around 260 ^{0} C. with a short and simple operation.

-Can be given required forms easily under hot air flow of 140 ^{0} C.

-With a specific gravity of 0.89 to 0.90 is the lightest of the major plastics, connected and laid simply, saves time, labor and transport costs.

-With their good long term pressure resistance, easy processing, and convenient installation, hot water systems made of PP-r have proven a competitive alternative to systems made of traditional materials, such as copper and galvanized steel pipes.

-Can also be used for under floor heating systems (since the floor heating systems normally operate at low pressure; approx. 3-4 bars) as well as for complete indoor water supply systems without fear of the type of corrosion damage encountered with traditional metallic materials.

In line with the strengths stated below, it is also inevitable that Borusan will make use of 1).its well known and highly regarded brand name, 2). good reputation for quality at international standards, 3). wide distribution network domestically, long standing export contracts internationally, 4). ISO 9001 Quality Assurance Certificate for the sales of PP pipes while launching its new product; **Borusan "P ^{2}3 Pipe and Fitting Sisters** into the market.

V.2. Weaknesses

-Relatively higher prices as compared to steel pipes especially when the diameter is above 1".

-Problem of elongation at welded ends,

-Enhancing risk of damage accidents like fire, etc.

-Although UV radiation resistance of black colored PP pipe corresponds to approximately 1 to 2 years outdoors, The other colored versions of PP pipes are only intended for indoor use, and should be suitably packaged and/or stored inside prior to installation at a building site.

-When subject to lengthy exposure of copper ions at elevated temperatures, polypropylene show a deterioration of the physical properties. (Its properties in applications are not adversely affected by direct contact with brass at temperatures **below 60 ^{0} C**, however. Brass couplings may be used therefore to connect PP pipes.).Note that if the brass couplings are not chromium-nickel plated they can not be used at elevated temperatures.

-Requires careful treatment regarding shock and impact during transport and installation.

-It is important to consider the oxygen permeability of PP-r in under floor heating systems. Molecular oxygen diffuses through the material (pipes and fittings) and can cause corrosion to metal parts in a circulating heating system.

-They have high linear thermal expansion coefficients, therefore have tendency to expand at elevated temperatures, in other words, at temperatures around 80 ^{0} C this material undergoes dilations/deformations that can create problems. These are to be taken into consideration during planning and installation.

-PPRC pipes can not be used for outdoor applications where the temperature is below 0 ^{0} C as its impact resistance decreases substantially below the freezing temperature of water, which means it is rigid and consequently fragile at low temperatures.

-Chlorine and Chloro-dioxide act corrosively on PP, therefore cannot be used for saturated chlorine- water solutions above 60 ^{0} C.

-It is impossible to separate a polypropylene random copolymer pipe from a polypropylene homopolymer one with a bare eye. The difference can only be identified through polar microscopes and/or with aging tests and taste-odor tests. The cost of PP homopolymer corresponds 1/3 of the cost of PP random copolymer. Therefore, forgery by some of the producers who expect a considerable profit in the short run is very likely.

V.3. Opportunities

-Current world-wide price levels coupled with a weak TL, and the labor force is cheaper in the country when compared to EU countries, therefore the new product increased chances for exports.

-Western economies have started to recover and construction industry has started to pick up.

-Natural Gas Project and new subscribers (approx. 160,000 in İstanbul) will increase the demand for PP pipe consumption.

-Recovery of old Yugoslavian countries may also increase the chances for exports.

-Middle East peace may bring in new markets.

-Completion of GAP- and South-eastern development and irrigation project may accelerate the construction industry in this region, and hence the consumption of PP pipes.

V.4. Threats

-Distressed domestic producers may cut prices and offer credit sales and the collection period may also be extended with the entry of our new product.

VI. POWER GROUPS.

VI.1. Buyer Power

Buyers of domestic PP pipes are domestic distributors, and dealers in the local market. In export markets, buyers are mainly traders and industrialists. Product loyalty for this industry, unlike with steel pipes, depends basically on price, but little on the degree of differentiation based on quality and area of use.

There is relatively less concern in the domestic market for quality as compared to that in some export markets like the EU and the US. For standard products with equal quality characteristics, price and sales terms represent the core criteria in purchasing decisions.

Switching costs tend to be high in the short term due to the procurement contracts established and considerable time it takes for buyers to test products from new suppliers.

VI.2. Supplier Power

Polypropylene random copolymer type 3 granules are used in the production of PP pipes. The sole suppliers are Hoechst AG. and Hülls AG. in Germany, Enichem Montel Bimont Moplen and Borealis in Italy, and Neste Chemicals in Belgium . The domestic pipe producers occasionally import PP material from the EU and other sources depending on special quality requirements, procurement terms and exchange rate adjusted price differences. Couplings used in fittings are supplied from various domestic producers like Kalde Klima A.Ş. The Al. foils which are used for stabilization of PP pipes at high temperatures are supplied from Alcan covered with a 40 g. of thin PP film to provide better sticking to the outer surface of PP pipes. But there are also low quality domestic suppliers for those who want to enjoy low costs.

Pipe producers represent PP producers' most favored buyer group. Borusan, is one of the largest buyers of Hoechst AG.

VII. INDUSTRY PROSPECTS

The pipe industry is separated into two different categories, namely, 1) the steel pipe industry, and 2) the PP pipe industry.

VII.1. The Steel Pipe Industry

The steel pipe industry is composed of business engaged in the design, manufacturing and trade of steel pipes for use in various industrial applications. The steel pipes are classified into subsections according to their area of use, sizes, and production types.

Classification by area of use:

a. Water and Gas Pipes
b. Line Pipe and Casing
c. Square and Rectangular Tubes.
d. Structural Tubes
e. Precision Tubes

Classification by size:

a. Small diameter pipes (up to 168.3 mm external diameter)
b. Medium sized pipes (with external diameters between 168.3 mm to 406.4 mm)
c. Large diameter pipes (with external diameters more than 406.4 mm)

Classification by production method:

a. Welded pipes
    1. Longitudinally welded
    2. Spiral welded
b. Seamless pipes
c. Ductile pipes.

VII.1.1. Global Outlook

The steel pipe industry in the world suffers from excess capacity and tough competition. There has been a marked decrease in production and sales of steel tubes in the EU in recent years which resulted in a 30% employment reduction in the last ten years. Although there has been a steady, however small, increase in consumption during the same period, the increase has mostly been to the advantage of newly industrialized and developing countries. The EU, the US and Japan suffered setbacks in terms of their shares of world production in the 1980s. Some newly industrialized and developing countries like Turkey, Mexico, Venezuela, Brazil, Argentina, Taiwan, Republic of Korea and Thailand have in the meantime continued to expand their capacities. In addition, the imports from the former Soviet Union were reduced due to lack of adequate hard currency.

In the short term, the issues that will concern market players will be production and sales strategies of producers in Central and Eastern Europe that tend to more concern over gaining hard currency rather than covering costs.
In the coming years, production capacity of the industry will continue to exceed domestic demand. No additional investments in the industry other than technology upgrading are anticipated. While the contraction in the economy may have a negative effect on capacity utilization in 1995 and 1996, measures to vitalize the overall economy through construction industry may benefit the pipe industry.

The substitute materials that penetrate the Turkish market in the last three years gained a considerable market share in the standard water pipes in small diameter category.

The most important development for the industry is the customs union with the EU in 1996 which helped the Turkish steel pipe producers to compete with players in the EU on the basis of technology and costs, but have to invest in some quality and productivity improvement programs. The advantages of the customs union for the Turkish producers are, of course, the removal of trade barriers, i.e. antidumping duties.

VII.1.2. Turkeys Steel Pipe Industry

Production of steel pipes in Turkey started in the late 1950s. The industry grew very rapidly especially between the years 1975 and 1985, and many pipe manufacturing facilities were established, mostly in the Marmara Region. There are over 25 pipe production plants in Turkey, 19 of them are longitudinal or spiral welded pipe production plants. Only five of those producers have capacities over 100,000 tons. The Table 5 in Appendix D summarizes the steel pipe manufacturers in Turkey. The figures show the theoretical rather than actual capacities of the producers for the year 1993. It is not practically possible to achieve full utilization of these capacities. Therefore, actual capacities that allow a sellable production mix are estimated to be about 70 % of the theoretical values. Note that Borusan together with the new investments and the acquisition of Bosaş and Kartal Boru has reached an actual production capacity of 420,000 tpy at the end of 1995.

VII.1.2.1. Production

While capacity utilization rates differ, the average rate for the industry is around % 65. Besides some companies that conduct regular production programs, producers perform manufacturing on order upon various procurement tenders and either cease or keep their production at minimum level at other times.

The table 5 shows the total pipe production in Turkey in the last four years:

Pipe production (ktons)	1991	1992	1993	1994
Welded	610	610	625	650
Seamless	3	5	5	6.5
Other	0	0	0	0

Table 5: The total pipe production in Turkey

Source, Borusan Prospectus, 1994

VII.1.2.2. Cost Structure

In the pipe industry, the most important cost item is raw material. As of 1995 year end, the share of raw material costs in overall costs was around 60-70 % for water and gas pipes, 72-75 % for structural tubes and sections, and 62-65 % in oil pipes. The figure is 58-60 % on average for spiral welded pipes while it is 45-47 % for seamless pipes. Another cost item is overhead allocated per ton of output due to low capacity utilization. Other cost factors, such as labor, indirect material, and energy are generally considered to be commensurate with the EU levels. Increase in wages after 1990, in addition to the relatively higher cost of electricity as compared to the EU appear to be disadvantages in exports. However, the current contraction in the Turkish economy reduced real wages in 1994-95 and beyond.

VII.1.2.3. Domestic Sales

Domestic consumption of steel pipes is related to the overall economic conditions, infrastructure investments (oil, natural gas and water lines) and especially on the construction industry.

The steel pipe consumption per capita in Turkey is around 14 kg. as compared to about 23 kg. in developed countries. From that stand point there is a significant growth potential for steel pipe consumption in Turkey The following table shows the domestic steel pipe consumption in Turkey.

(ktons)	1991	1992	1993
Welded	355	425	430
Seamless	63	65	65
Other	20	22	22
Total	**438**	**512**	**517**

Table 6: Domestic steel pipe consumption in Turkey

Source, Borusan Prospectus, 1994

The domestic sales of welded pipes according to product type have typically been as follows:

Water and gas pipes	45%
Structural tubes	35%
Spiral welded	12%
Oil, natural gas and boiler pipes	5%
Special tubes	1%
Other	2%
	100%

VII.1.2.4. Exports

The steel pipe industry in Turkey enjoys significant export potential given its quality and cost parameters. From 1984 to 1990 the industry enjoyed a steady upward trend in exports. This was followed by a downturn in the subsequent years due to the following factors:

a. Trade barriers in the US and the EU, i.e. dumping practices.
b. Economic Problems in Iran,
c. Embargo on Iraq market following Gulf Crisis,
d. Foreign currency shortage in Syria and in some countries of Eastern Europe,
e. Collapse of the Soviet Union and financial and managerial problems that arouse in the Ex-soviet Republics.

The following table shows the steel pipe exports of Turkey for the years 1991-1992 and 1993:

(1000 tons)	1991		1992		1993		1994	
	Tons	$	Tons	$	Tons	$	Tons	$
Welded	295	146.8	215	108.4	210	na	270	na
Other	0	0	0	0	0	0	0	0
Total	295	146.8	215	108.4	210	na	270	na

Table 7: Steel pipe exports of Turkey

Source, Borusan Prospectus, 1994

Turkey exports steel pipes mainly to CIS, North Africa, The US and the EU.

VII.1.2.5. Imports

Despite available capacities in the domestic market, some product types (ductile pipes, natural gas tubes etc.) are occasionally imported in significant quantities. The reasons for such imports may be outlined as follows:

a. Advantages gained from the incentives offered on a project basis,
b. Import procurement terms of foreign loan agreements for Government contracts,
c. Urgent demand.

The following table shows the steel pipe imports of Turkey for the years 1991-1992 and 1993:

Imports(ktons)	1991	1992	1993
Welded	4	15	8
Seamless	60	60	60
Other	9	20	22
Total	**81**	**95**	**90**
Imports($millions)	71.2	84.4	79.3

Table 8: Steel pipe imports of Turkey

Source, Borusan Prospectus, 1994

In recent years, imports with inferior quality and low prices from Eastern Europe and the CIS have not yet reached volumes high enough to adversely affect the domestic industry.

VII.1.2.6. Domestic Competition

Although the market seems to be fragmented with 19 steel pipe producers in longitudinally welded pipes, only five large producers with production capacities over 100,000 tons determine market mechanics.

Distribution of Domestic Market Share
Borusan % 32
Kartal Boru *(Borusan) % 5
Yücel %27
Mannesman % 16
Erbosan % 12.5
Profil % 3
Other % 4.5

Table 9: Distribution of domestic market share

Source, Zet Neilsen, 1995

Borusan is the leader in the market with around 40 % market share. Yücel boru with similar production capacity has 27 % market share and is active in the export market as

well. Sümerbank Mannessman is a semi-state owned company producing longitudinal and spiral pipes.

The companies find it hard to charge anything other than the on-going market prices although Borusan enjoys consistently higher sales prices than its competitors. Companies try to gain competitive advantage by reducing costs and differentiating products on the basis of size and quality.

VII.1.2.7. Barriers to Entry

The domestic supply in steel pipes exceeds domestic demand. Furthermore, the industry is a mature one globally, it is capital intensive and large initial investment outlays are required. Strong competition causes firms to invest heavily in working capital and also leads to squeezed profit margins in the industry. Therefore, new producers entering the market is highly unlikely.

As for imports, the following customs duties are applicable:

	Customs	Fund	Total
ERW Steel Pipe (over 2 mm Wall Thickness)	10%	16%	26%
ERW Steel pipe (Under 2 mm. Wall Thickness)	10%	8%	18%

Table 10: Custom duties for import steel pipes

Source, Borusan Prospectus

Aside from above duties, an important barrier to imports seems to be in distribution channels. The companies that will penetrate the Turkish market with imported products have to establish a distribution network for geographic coverage for long-lasting presence.

VII.2. The PP Pipe Industry

VII.2.1. The European Market

The use of random copolymer polypropylene (PP-r) in hot water sanitary systems has grown substantially in Europe over the last five years. Considering the numerous benefits of PP-r over other materials, it is expected that this trend will continue and expand beyond Europe. Ongoing work on standards and specifications promises to further strengthen PP-R's competitiveness. Many complete pipe and fitting systems are already available in Austria, the Czech Republic, Germany and Italy.

The market for plastic pipes in sanitary tap water installations inside buildings has grown in importance in various countries during the last five years. This can be seen in the development of the German market. Figure 1 in Appendix E shows the development between 1988 and 1994 for sanitary tap water pipes based on market figures.

Sales statistics expressed in million meters of pipe show an annual growth of 2.5 % for the German sanitary market as a whole since 1989. Over the same period, plastic sanitary systems have grown by 38% a year, to achieve a market share of 33%, replacing traditional copper and steel pipes.

The introduction of PP-R piping systems for hot and cold tap water, radiator connections, and floor heating systems started mainly in Germany and in Italy. When German DIN standards covering PP random copolymers were established in 1989, the basis was created for sanitary tap water system approvals. The market development in Germany between 1988 and 1994 shown in Figure 2 Appendix E has been extremely rapid. The estimated annual growth rate for PP-R tap water systems since 1989 has been 34.8%, which must be among the highest rates for any plastic pipe segment.

During 1994, the dominant plastic piping materials for sanitary tap water installations were PP-R and PEX, with roughly equal market shares and representing some 70% of the plastic pipe market in the application (see Figure 3 in Appendix E).

A similar trend can be seen in Italy (see Figure 4 in Appendix E). In fact, the substitution of traditional pipe materials has been even faster in Italy. PP-R systems have grown annually by 22% since 1989, while the total market for sanitary water pipes over the period has been rather stable., with an estimated annual growth of less than 1%. This has resulted in a dominant position for PP-R systems, with a total market share of 32% in 1994.

The relative market size in 1994 for different plastic piping systems is shown in Figure 5 Appendix E. PP-R's closest competitor in terms of volume is PEX, with just under half the market penetration of PP-R. Other countries such as Austria, the Czech Republic and Poland show similar trends.

The leading PP pipe and fitting manufacturers in the European pipe market and their market shares (%) are as follows;

Producer	***nation***	***Total share in the pipe mkt***	***share in PP market***
Aquatherm	Germany	31	53
EPB Prandelli	UK-Italy	17	14
Scantec	Sweden	13	-
Nupi	Italy	12	21
CO.E.S.	Italy	6	10
TOTAL		79	98

Table 11: The PP pipe and fitting manufacturers and their market shares in the European market

Source Euromet Publisments, January 1992.

VII.2.2. Domestic Competition

There over 70 domestic producers of this type of pipes in Turkey. Most of them operate in regional basis with single screw dies and are not very solid in accomplishing a good distribution network. However, there are major suppliers namely: Çamlıca A.Ş.; the market leader, Dizayn Teknik A.Ş., Fırat Plastik A.Ş., SPK (Söğüt Plastik ve Kalıp) Sanayi ve Ticaret A.Ş., Ege Yıldız A.Ş., Aquatherm Gmbh, Pilsa A.Ş.

As the PP pipes are in the growth stage of the product life cycle it is very likely that the annual growth rate exceeds 15 %. Moreover, the strong impulse of Çamlıca's, Dizayn and Fırat's activity, Borusan's entry on the market and the probable arrival of other minor producers allow the forecast of very strong increases for the forthcoming years.

VII.2.2.1. Çamlıca A.Ş.

Established in 1991, by Selçuk Berksan, Faruk Berksan, Aydın-Betül Karagöz, and Ercan Erden it belongs to a large group with 24 companies, namely Kar Şirketler Topluluğu, and operates as the market leader in PP pipe industry.
The company imports the PP raw material from a German producer; Hüls AG, with a name of Vestolen P 9421 PPRC Type 3. The company's annual production is around 2,500-2,750 tons in 1995 which constitutes 250 tons of monthly production. Having in mind that 250 tons of PP raw material is identical to 1750 tons of steel in terms of total production of pipes in metrical terms, and also considering that only 60% of the PP raw material is consumed for the production of PP Pipes (40% is consumed for fittings) only Çamlıca's production of PP pipes is equivalent to ~10,500tons of galvanized steel pipes (In ø ½" and ¾" pipes the ratio of galvanized steel pipe (kg/m)/ PP pipe (kg/m) is ~ 7).

Considering that Borusan's market share is 33% in galvanized steel pipe category with ~ 83000 tons of sales annually, and 65% of these constituting ø ½" and ¾" pipes , it can be concluded that the total demand for ½" and ¾" diameter galvanized steel pipe category is ~ 165,000 tons annually.

Similarly, considering Çamlıca's market share being around 23% in the PP pipe market with 2,750 tons of yearly sales (which is equivalent to 10,500 tons of galvanized steel pipes), the annual demand in the PP pipe and fittings market can be roughly estimated as 14,000 tons. With a simple calculation, it can be said that 8,400 tons of the raw material is consumed only for the PP pipes which is also equivalent to ~58,800 tons of galvanized steel pipe. Therefore, with a very rough estimation, Çamlıca's market share in the total ½" and ¾" diameter water pipe category is around 10,500/(58,800+165,000) x100= 4.45%.

The company, producing plastic based water transportation, sewerage, drainage and discharge pipes and fittings under the trademark "Vesbo, Vesbo Super and Rib Loc Spiral Plastic Pipe Systems" in a closed area of 10,000 m^2 with 145 personnel had achieved $17 million of domestic sales and $3 million of exports in 1995.

The extruders and injection machines for fittings are purchased mainly from German Battenfeld and Weber and are then supplemented with Turkish machines purchased from Özmak A.Ş. in order to give quick response to an increasing market demand. The molds used for fitting production are also prepared in Germany. Currently, they offer PP pipes in two colors to the consumers; blue and white, and sell the former one at a 35+12%=42.8% discount, the latter one at a 45+12%=51.6% discount and the stabilized pipe (reinforced with aluminum foil) at a 25+12%=34% discount all with a collection period of 60 days.

Çamlıca A.Ş. is the market leader in high quality and high price segment in PP pipe market and is considered the most serious competitor. Being the pioneer of PP pipe industry, the company provided the opportunity to promote the importance of attributes that are most important to the largest segment of customers and favored its brand.

Thus, Vesbo became the standard of reference which customers use to evaluate other brands. This made it more difficult for Borusan and other high quality followers with their me-too products to convince existing customers that their new brands are superior to the older and more familiar pioneer.

They have established wholesalers in 50 cities and three regional sales points in Marmara, Ege and İç Anadolu Region. They leave a considerable budget for the promotions and advertisements in TV and in newspapers and sector periodicals. For the year 1995, it is said that the company has a loss of around 300 billion TL.

In the first quarter of 1996 they applied to BVQI to take ISO 9001 Quality Assurance Certificate and some other international associations to certify that their quality is not only approved in the domestic market by TSE but also in international platforms (like Germany's TÜV, DVGW, SKZ, and Singapoor's SISIR, etc...) as well. They also made a joint venture with Sing Mavi Boru Ltd. in Singapore to produce and sell PP pipes in the Far Eastern Asian market. In 1996, the forecasted exports is expected to exceed $10 million and the investments are decided to be around $80 million concentrating especially in The Gap Region in Urfa.

The company is known as the highest spender for promotions in the industry and their total promotional budget for PP pipes and fittings amounts to TL 90 billion for the new year.

VII.2.2.2. SPK (Söğüt Plastik ve Kalıp) Sanayi ve Ticaret A.Ş.

Established in İstanbul by Mustafa Söğüt and his father in 1989 it mainly operates in the molding sector. As their main business is mold production the molds used for fitting production is considered as "premium" quality. They started PP pipe business with a joint venture of Kar Group in 1989. The capital investment was mainly made by Çamlıca A.Ş., SPK being the party responsible for the production and Çamlıca A.Ş. being the only responsible for the marketing and distribution. At the end of 1993, while there were very few producers, they were the market leader with approximately 70% market share in the PP

pipe business with a monthly production of 200-250 tons. However, the joint venture was annulled at the end of 1993 due to some managerial problems and each company started to operate alone in the PP business. In the first half of 1994, SPK made use of their already positioned trademark "SPK Mavi Boru" in the sector and made a considerable revenue and market share although Kar Group was busy making heavy advertisements and promotions to position their new trademark Vesbo. But at the end of 1994, Çamlıca A.Ş., through heavy advertisements and promotions, together with the highest possible technology and their experience in establishing a successful distribution chain began to conquer SPK's distributors with attractive discounts and credit sales.

Now the company has a 100-140 tons of monthly production with a market share of around 10-11% in the PP pipe sector, and sales are mainly concentrated in Marmara and Ege Region. They sell the standard PP pipes and fittings with a 45% discount, and the Al. reinforced stabilized PP pipes for operations above 65 ^{0} C with a 35% discount with a collection period of 60 days. The company continues to produce molds for the new entries and is also a subcontractor of Borusan for the production of a few fittings with 63 mm. diameter that have very low sales. Note that each mold costs around 750-1100 million TL's and it is not feasible to order a mold for a fitting that have yearly sales less than 100 million TL.

The PP raw material is purchased from a variety of producers: Daplen, Borealis, Hoechst, etc... as the company is trying to achieve a competitive advantage by determining a relatively cheap but high quality PP raw material to decrease the production costs and hence the sales price per product to steal some more market share. In customer perceptions the quality of SPK's pipes range from "Just OK " to "Good quality". They offer three colors: blue, white and green.

VII.2.2.3. Gelişim Teknik Ticaret ve Sanayi Pazarlama Ltd. Şti.

Established in 1987 in Antalya by Ali Bıdı it is the only import pipe in the domestic sector. The company is the distributor of German Aquatherm Gmbh. and is the first in the domestic PP pipe sector that served to innovators ("consumption pioneers") and early

adopters. Till 1993, before some other domestic companies entered into the PP pipe business, the company's yearly sales was around DM 3 million, however, after the saturation of demand with so many domestic suppliers, their sales decreased to less than DM 250 thousand.

Aquatherm is considered as the "innovator" of PP based pipes and is currently in the leader position in other countries of Europe. It has got the "highest perceived quality image" in the eyes of customers and it in fact, is the only trademark that achieves and even surpasses customer expectations in terms of both quality and technology. The pipes are produced by Aquatherm Gmbh which is the biggest PP pipe producer in the world. The raw material is acquired from Hüls AG. with a brand name of Vestolen P 9421 PPRC Type 3 with its original green color. It has got all the necessary quality standards both in Turkey and in other countries of Europe such as TS 9937-11451, DIN 8077-8078 and German's DVGW, SKZ etc...

Aquatherm PP pipes are sold with a guarantee of ten years undertaking to pay a compensation of DM 3 million for any material damages, and DM 1 million for individual damages.

The company has 5 distributors in İstanbul, and one regional distributor in İzmir and Bursa, and the general management is in Antalya. They make 10% discount for advanced sales and 5% discount for a 30 days collection period with each sale being made in foreign currency (DM). Although this firm is an "appreciated innovator" in the pipe industry that meets all the quality standards , nowadays it is not considered as a serious threat for the domestic producers since the sales price per product is 2.8-3.25 times higher than its high quality domestic "followers".

VII.2.2.4. Ege Yıldız A.Ş. (Egetherm)

Ege Yıldız started production in 1992 with a trademark "Egetherm PP Pipes". Though the company operates in the plastics industry for 35 years they are considered one of the

late producers of PP pipes. However, they state that their late entry was due to long and tedious researches about PP pipes.

The raw material is acquired either from Hoechst (as Hostalen PPH 5216) or Neste Chemicals (as XA 3021 D) with its original gray color. They have 10 extruders. Since they have problems in producing some fittings they are giving periodical orders to a competitor "Saral Sistem A.Ş.". Sales are mainly concentrated in İzmir and Ege region (as the factory and the general management is in İzmir.) but it has also regional administrations in İstanbul, Adana, Ankara, Antalya and Samsun. They have more than 700 sales points in Turkey.

The company makes 60% discount for advanced sales and 45% discount for a collection period of 3 months to its big wholesalers. Even though Egetherm pipes have a considerable market share (12%) in the PP pipe sector, it is not perceived as a " good quality" product and serves mainly to "price sensitive customers" in the "low price and low quality segment". It is also questionable that the raw material is taken from Hoechst. Because such a low price can not even recover the costs of the raw material. The producers in the industry strongly believe that they might be using another PP raw material. Perhaps, this is the reason of the problems they face especially in fittings production. The high difference in thermal expansion coefficients of PP raw material (polymers) and brass couplings (metals) cause brass couplings "slip off" (or sneak away) at high temperatures and hence leads to failures. In order to prevent such problems related with expansion, Egetherm uses Al. slip-knots in some fittings.

VII.2.2.5. Fırat Plastik A.Ş.

Established in 1981, the company produces PVC, PE, and PP based clean tap water pipes, sewerage and drainage pipes, deep well agricultural irrigation pipes, PTT cable protection pipes, LPG pipes, industrial and automotive hose pipes and Fıratpen PVC door and window systems.

Fırat Plastik began PP pipe production in February 1993 under the trademark Fırattherm. The company acquires the raw material from Belgium-NESTE Chemicals (as XA

3021 D) in transparent form, and then colors it with a gray color masterbatch. However, coloring with a masterbatch causes some quality problems like color differences and micro pores, inclusions due to inhomogeneous mixing, and also increased the hardness and therefore lead to low resistance to impacts. For this reason, the company faced with difficulties in launching their new product till 1995. However, having solved all the quality problems probably with the addition of some nucleating and blowing agents or by using originally colored raw material, the company is trying to increase its market share (9%) in the "medium price medium quality segment" with the help of 400 sales points and regional administrations in İstanbul, İzmir, Antalya, and Ankara. They make a 40% discount for a collection period of 3 months to its big wholesalers.

In 1996 Fırat Plastik plans to invest DM 30 million for the mechanical infrastructure, capacity increases and product variety applications and DM 10 million for research and development and education and targets to achieve $ 5 million from exports.

VII.2.2.6. Dizayn Teknik Sanayi ve Ticaret Ltd. Şti.

Dizayn Teknik is another company entered into PP pipe business lately in 1992. The company is successful in taking most of the government contracts from municipalities due to their good relations with a religious party but are not considered very efficient in the retailer and wholesaler market. As the company is the sole domestic producer of PEX (polyethylene cross linked) pipes which is used in under floor heating systems they have an advantage in taking the contracts about PP pipes when the construction company has in mind to purchase PEX pipes for under floor heating. The company usually gives a "package offer" including both the PP pipes and PEX pipes for the construction companies who use under floor heating and wins the contracts. There is no standard discount and collection period for the sales, the wholesalers determine them through negotiation. They mainly serve to "medium price medium quality segment and the customer perception for Dizayn PP pipes is "just OK ". They use green color for PP pipe production, for this reason they are considered the domestic imitators of German Aquatherm.

VII.2.2.7. Pilsa A.Ş.

Established in 1994 as a plastic autospare part supplier of Toyotasa A.Ş. After a horizontal integration, the company began to produce PP pipes at the end of 1994. It is said that the raw material is acquired from USA with its original white color, but, as a matter of fact, the inferior quality of the pipes and fittings causes conflicts and disappointments of endusers especially for those who trust the quality of the product produced by a "Sabancı Company". It is also important to state that there is no polypropylene producer outside Europe that could take a quality certificate from any of the European quality authorities(DVGW; SKZ;etc...) since the PP raw material they produce is not considered suitable to produce PP pipes and fittings for internal tap water systems. Pilsa PP pipes' list sales price corresponds to the advanced sales price of high quality domestic producers. (Note that the companies make the highest discount for advanced sales.), therefore it mainly serves to "price sensitives" and operates in the "low price low quality segment". As it is a product with one of the cheapest sales price it is widely spread in the retailer market especially in İstanbul, Adana and İzmir. It is expected that the Pilsa pipes' market share is not more than 10%.

There are other companies that operate in the PP pipe sector, however, they are not considered as a serious threat since 1) they are not financially strong enough, 2) most of them are regional companies that carry out their production with the traditional single screw extruders, 3) they do not have serious distribution channels, 4) they operate illegally and without any quality certificates, 5) most of them use unsuitable raw materials (like PP homopolymer type 1, or Colombian raw material such as Propilco) for unjust enrichment. (Please refer to the list prices of competitors in the Appendix F in Table 5.)

VII.2.3. Barriers to Entry

The domestic supply in PP pipes, like the steel pipe industry, exceeds domestic demand. However, the industry is still in the growth stage. As the PP-r is a thermoplastic polyolefin which is easy to process into pipes and fittings, no special extruders are needed. In principal, a conventional single screw extruder and high quality PP granules are all that is needed to start production of high-quality pipes for clean hot water sanitary systems. Therefore the industry is not capital intensive, and, as large initial outlay investments are not necessary, new producers entering the market is very likely.

As the Turkish Standards Organization is unfortunately insufficient to fulfill most of the requirements and tests of PP pipes taking a TS standard is easy. And, moreover, as there is no legal .punishment for the producers who benefit high profit margins by producing low quality pipes from unsuitable raw materials (like PP Homopolymer type 1, and PP impact copolymer type 2) it is possible to find many different brands produced in a variety of colors with many different type of extruders at the end of April 1996.

The difficulty of establishing a successful distribution channel also helps some new producers gain some market share in southern regions of the country.

VII.2.4. The Buyer Behavior

The consumer in the PP pipe and fittings industry is highly involved in a purchase basing it on the fact that the purchase is expensive and infrequent but sees little or no difference in brands. They shop around to learn what is available but buy fairly quickly because brand differences are not pronounced. In this case, the buying decision is mainly made through advice or directives of plumbers who play the role of both influencers and users.

After the purchase, the consumer experiences dissonance that stems from noticing certain disquieting features of the brand or hearing favorable things about other PP pipes. The consumer is alert to more information that might justify his/her decision to reduce the dissonance. In other words, they first act and then acquire some new beliefs, and end up with set of attitudes which is called the "dissonance-reducing buying behavior".

VII.2.5. The Target Market

The target market will be the plumbers, civil engineers, dealers, and construction companies (major accounts) that respond a sufficient level of interest to high quality PP pipes and fittings and are willing to pay a slightly higher price for it.

VIII. THE PRODUCTION

The company produces Borusan PP pipes and fittings with the latest possible technology. The pipes are produced with 2 decompression screw extruders, and fittings are produced with five injection machines which are assembled by German Battenfeld Gmbh. The technology is identical with Aquatherm Germany, which is currently the pioneer of the plastic based pipe business and the world's leader in exports. The actual annual production capacity of the two extruders in meters are calculated with the linear programming method by considering 85% efficiency for each machine. (Please refer to the Appendix G Table 6).However. the actual production capacities of the two extruders far exceed the targeted sales.

In order to achieve net sales of 500 billion TL at the end of 1996, the company had to produce PP pipes that worth 300 billion TL and fittings that worth 200 billion TL since the sales of fittings correspond to 40% of the total sales.

As the fittings are considered the complements of PP pipes (like sugar and tea) the annual production program of fittings for 1996 are calculated after the actual production program of pipes. The consumption (in numbers) of fittings used for each 100 m. of different diameter (ø 20-25-32-40-50 and 63 mm.) PP pipes are calculated for the year 1995 together with the forecasted demand and targeted market share. (The results are given in the Appendix, however again for privacy, rather than the ratios taken from Borusan's sales, the 1995 ratios taken from the market leader's biggest dealers which Borusan used while initiating the production in 1995 will be given in the Appendix G Table 6-7.)

The pipes and fittings are produced according to TSE quality certificates; TS 9937 and TS 11451. Although it is one of the latest entry in the PP pipe and fitting **Borusan "P 23" Pipe and Fitting Systems** is the first company that took TS 11451 by October 21 1995.

However, no attempts are made to take serious quality certificates of the leading European Institutions such as DVGW and SKZ and German standards namely DIN 8077-and 8078.(For a detailed information about the standards please refer to the Appendix H related with Borealis.). This makes exporting efforts to European Countries difficult, therefore applying to the necessary institutions after fulfilling the necessary obligations is in consideration.

In order to prevent hazardous effects caused by the use of cold water PP pipes in hot water transportation systems the company draws a line on the PP pipes. The blue lines on the pipes symbolize that these pipes are only suitable for cold water applications with a nominal pressure of 10 bars, and, similarly, yellow lines symbolize that such pipes are suitable for hot water applications with a nominal pressure of 20 bars.

VIII.1. Quality Problems

At the end of December, there were only 4 quality problems which the company has to find a solution. Three of the quality problems were from the 20-25 mm. diameter PP pipes and one of them was from 20 mm. diameter elbows.

Although the quality control department stated that reports of statistical process controls show no changes that led to product failures, two of the failed pipes each of which were produced in the last five days of August 1995 led the manufacturers think that there might be a problem in this party. After a tedious work full of experimentation the production department stated that the pipes in this party cracked because of the huge temperature difference in day and night which caused a "quenching effect" that increased the internal stress of the product (Note that August 31 is the day where the temperature difference between the day and the night is the highest.) Moreover, it is also learnt that coloring with a masterbatch could also cause some quality problems like color differences and micro pores, inclusions due to inhomogeneous mixing, and also increase in the hardness which will lead to low resistance to impacts. To prevent such failures, the product department decided to increase the duration of cooling stage in seasons where the temperature difference

between day and night is the highest and terminated coloring PP pipes and fittings with a masterbatch and began to order the raw material with its original beige color.

The other failure in PP pipes were, as the manufacturers reported, due to the high moisture content of the raw material which was exposed to rain. The evaporation of the moisture in the raw material during the plastification stage (at 200 ^{0} C) initiated micro-cracks and pores that can not be seen by a bare eye. These pores, when used in a clean tap water system were exposed to high water flow rates and pressures and acted as "crack initiators" in PP pipes. To prevent such failures, the company decided to make an additional closed area to store and protect the raw material from the hazardous weather conditions and deliver a preheating oven to eliminate the moisture from the PP raw material.

The problem of 20 mm. diameter elbows was due to the mistake of a workmen who packaged them into a box although they were separated to scrap. In order to avoid the repetition of such a mistake the workers are subjected to a trainee program which was mainly designed for the blue collar workers in Japan , namely "5 S Management ",

IX. THE MARKETING MIX.

IX.1. The Product

The new product, as explained in the earlier sections of the thesis, is basically a substitute of steel pipes used in clean water transmission produced from a raw material, a polymer; namely polypropylene. The product range varies between 20 mm (1/2") to 63 mm (2") in diameter.

IX.2. Designing the Pricing Strategy

Through most of history, price has operated as the major determinant of buyer choice. That is still the case in poorer nations, among poorer groups. However, non price factors become relatively more important in buyer-choice behavior in recent decades. Yet price still remains one of the most important elements determining company market share and profitability.

Price is the only element in marketing mix that produces revenue; the other elements produce costs. Many companies do not handle pricing well. The most common mistakes are; Pricing is too cost oriented; it is not revised often enough to capitalize on market changes; set independent of the rest of the marketing mix rather than as an intrinsic element of market positioning strategy, and is not varied enough for different product items and market segments.

Borusan, while introducing its new product **Borusan "P ^{2}3" Pipe and Fitting Systems"** into the market decided to use "Premium Strategy" by positioning its product on highest possible quality and high price while the industry mainly coexists so many firms offering average quality at an average price (Medium -value Strategy) and low quality at a

low price (Economy Strategy). There were only two companies applying premium strategy when Borusan entered into the PP pipe business, namely Çamlıca A.Ş., (a company of Kar Group) the domestic market leader with the highest perceived quality, and Aquatherm, the "Pioneer" and world's biggest importer of PP pipes. Borusan entered into the market with 52,000 TL/m list price offering 30% discount for a collection period of 45 days when Çamlıca A.Ş. was offering 55,000 TL/m list price and 35% discount for a collection period of 90 days. Offering such a high price and extremely short collection period especially when the general market trend was through extending it to over 90 days was a big launching mistake for Borusan and acquired "Snob Appeal". It is important to note here that the product price should be commensurate with the perceived value of the offer, or else buyers will turn to competitors in choosing their products. But, if the company had revised the price to capitalize on market changes, it could have positioned itself by pricing just in between the high quality high price and medium quality and medium price competitors and could have achieved a successful market penetration together with heavy advertising and promotion. This "High-value strategy" would help Borusan steal a considerable market share and the customers would also appreciate the company as it would offer "the same high quality with a relatively lower price".

After 2 months from the launch (in August), Borusan decided to extend the collection period to 75 days. But this late response to the market trend and improper analization of competitors' prices not only led competitors share the biggest portion of the undertakings of the apartments that have already transformed their central heating from fuel oil to natural gas, but also helped them take the contracts opened by construction companies for clean water transportation and central heating systems in new buildings. As the construction season was almost finished and the natural gas transformations were over, **Borusan "$P^2$3" Pipe and Fitting Systems"** could not successfully penetrate into the market in 1995.

At the end of 1995, due to the increase in the price of petrochemicals, like most of the competitors, Borusan had to increase its list price to 77,000 TL (other conditions remain unchanged.). In March, this time not making the same mistakes again, the company achieved a net monthly sales of 49 billion TL. However, it is important here to state that the influence of another tool in the marketing mix; heavy **advertising** provided to charge

premium prices as most of the customers in the PP pipe industry is willing to pay higher prices for known brands than for unknown products.

In July, due to the increase in raw material and other operational costs, this time the company made a 30% increase in the list prices and the new list price for 20 mm. diameter pipes corresponded to 95,000 TL/m. (The list is also given in Appendix I Table 8.)

For the big bids and contracts Borusan preferably applies "the sealed bid pricing method" which means that the firm bases its price on expectations of how competitors will price rather than on a rigid relation to the firm's cost or demand. Sometimes it may, depending on the amount of contract and importance of the reference taken by the job, submit a price slightly below the cost but not below a certain level that may worsen its position.

In order to stimulate the sales Borusan had interchangeably used "Special event pricing method" by establishing special prices (or discounts) in the off-season (from November to March) and " Product bundling pricing method" by bundling some selected lower cost products at a set price to draw in more customers.

The company sets its price to maximize its sales revenue. It estimated the demand for PP pipes and fittings will be around 25 million meters and 62.5 million fittings (totally 14,000 tons) and it is expected that the total market, in monetary terms, will be around 3,125 billion TL. Borusan, targeting to achieve 16% market share in 1996, decided to produce 2,000 tons of PP pipes and fittings that correspond to 500 billion TL of total net sales.

IX.3. Distribution

A company that operates in the global market must make a whole-channel view of the problem of distributing its products to the final users. Borusan has a strong distribution network with 78 nation wide dealers, 8 regional distribution companies all through the country and a direct sales organization. However, only one third of the dealers decided to sell the PP pipes as some of them were only dealing with the square and rectangular steel

tubes, industrial steel pipe and precision tubes (profiles) and only serve to manufacturers, industrialists and hardware manufacturers. In 1995 the company organized a distribution channel with 32 dealers and 8 regional distribution companies for the PP pipes to serve the contractors, plumbers and construction companies.

In 1995 about 35% of the total sales are realized by regional distribution companies, 62% by dealers and 3% by direct sales. The company has controlling stakes in many of the regional distribution companies including; Boru ve Profil Ticaret A.Ş., Bozoklar İnşaat Malzemeleri Ticaret A.Ş., İmpa-Bursa İnşaat Malzemeleri Pazarlama A.Ş., Borusan Akdeniz İnşaat Malzemeleri Pazarlama A.Ş., Samsun Çelik Ticaret A.Ş., Gaziantep Boru Profil A.Ş., Borusan İnşaat Malzemeleri Pazarlama A.Ş. Kıbrıs. These regional companies and dealers collect and disseminate marketing research information about potential and current customers, competitors, and other actors and forces in the marketing environment and periodically send them to the direct sales organization of Borusan. For this reason, the company, unlike its competitors, prefers **"selective distribution"** by dissipating its efforts to fewer outlets to develop a better working relation with the selected middlemen and expect a better than average selling effort. To achieve this result, it offers adequate margins, product training, and promotional support to its distributors. Moreover, all the dealers are guaranteed against defective merchandise or price declines and their territorial rights are preserved when another distributor wants to dominate the territory of the other. As it represents a commitment to a set of policies and practices that constitute the basic fabric on which is woven an extensive set of long term relationships, management peevishnessly chooses the new channels (dealers) with an eye on tomorrow's likely selling environment as well as today's.

Polypropylene pipes can be sold in three ways:

Alternative 1) In addition to the present steel pipe dealers who are also willing to sell Borusan's PP pipes and fittings, the distribution channel can be reinforced with the addition of new dealers who currently sell the competitors' PP pipes. Among the competitors' dealers, those who have high personal skills, have diversified knowledge about the product and consider it as his/her core business, and have preferably mobile sales force and a high

sales turnover can be selected and then convinced to sell Borusan's PP pipes and fittings with attractive offers.

Such a strategy may provide;

- A better market penetration in a short time,
- A substantial decrease in technical training time and cost of the dealers.
- A "push effect" on Borusan's present dealers to accelerate the activities to establish a sales potential before the competition gets tough.
- More than average customer visits, and hence a better product awareness. As the core business of the new dealers is the sales of PP pipes and fittings, or in other words, these sales constitute a significant portion of their endorsement, they will make more visits to customers than the present Borusan dealers and act as the cheapest source for building product awareness ("the word of mouth") by communicating the product's features.
- Reaching easily and directly to the targeted population and the competitors' customer group, and steal a considerable market share from them. Note that it takes quite a long time of Borusan's present steel dealers to establish a sales potential in the territory as i) they lack knowledge about the new product, ii) give little effort just because the PP pipe and fitting sales constitute a negligible portion of their endorsement.

However, some unfavorable results may also occur;

-the present Borusan dealers who wish to sell the new product may suffer from the new dealer agreements.

-the dealers who only sell steel pipes may see the new dealers' intense selling efforts as a threat for the steel pipes as the PP pipes are considered the direct substitutes. (Cannibalization effect)

Alternative 2) Supplementing the present Borusan dealers who wish to sell the new product by establishing an intensive distribution channel where the competitors' wholesalers are convinced to work as the distributor of Borusan's 8 regional distribution companies. In other words, the regional companies will establish their own channels and act as a wholesaler. In this case, the regional companies will distribute the new product to the new outlets after taking a 2-3% profit.

Such a strategy will provide;

-the diversification of the business risk among Borusan and its regional distribution companies (which belong to Borusan Group).

-solutions to active distribution problems of the regional companies with the contribution of the new outlets.

- the prevention of dissatisfaction of the present dealers who also wish to sell PP pipes.

On the other hand, such a strategy may also lead to;

- Giving more incentives to provide the attractivity of being an outlet. The competitors' big wholesalers that will become the outlets of Borusan's regional companies will not tend to become an outlet unless otherwise they are offered to some incentives that will provide them more benefit.
- The new outlets may think that they will lose their chances in contracts as the 2-3% profit taken by the regional distributors may leave no chances to win the contracts against Borusan dealers.
- The new dealer companies that will act as the distributors of Borusan's regional companies may request a territory isolated from all other retailers and dealers. However, the other Borusan dealers (private companies) who wish to sell PP pipes will oppose this idea fearing that their territory will contract.
- Borusan will have hard times because of the growing bargaining power of the 8 regional companies which do not want to carry the risk of the new retailers (or jobbers) for a 2% profit.

Alternative 3.) In addition to the Borusan dealers, the new industrial product may also be sold in competitors' distributor and dealer display rooms, where it may stand next to the dealer's other products, and most of the time next to the competitors' products. Sales executives believe that this method may yield preference and pricing information in the normal selling atmosphere for the product.

Whatever the solution is, due to the fixed lot size of the product , the company should prefer a three level channel where the manufacturer sells to the wholesaler or dealer and the dealer sells to jobbers or small outlets who then sell to plumbers.

The first two of the following strategies are tested in pilot territories in 1995, and better results are taken from the first strategy. In the new year the company decided to supplement the present distribution channel by the contribution of 25 new dealers.

XI.3.1. The Delivery

The delivery time for the Marmara region does not exceed 2 days where as it ranges from 2 to 7 days in the other regions. Another company from Borusan Group, "Boru Nakliyat ve Ticaret A.Ş" is responsible from the delivery of all the Group's products. The international shipments are carried out by a pier located near Borusan's Gemlik plant on the south-eastern coast of Marmara. The international shipments from the pier is under the control of another Borusan company; namely "Bortrans Denizcilik Hizmetleri A.Ş."

XI.4. Promotion

Modern marketing calls for more than developing a good product, pricing it attractively, and making it accessible to target customers. In order to communicate the product's merits and to persuade the customers to buy them companies must set up communication and promotion programs consisting of advertising, sales promotion, and public relations, and a sales force for personal selling activities.

In July 1995, the new product is broadcasted in several private television channels to communicate the message; "A new alternative product from Borusan, the market leader of the steel pipe industry whose quality is certified by the world's most serious authorities."

Advertisements are given to the leading sector periodicals, direct mailing to the leading construction companies are made and technical catalogues are printed to distribute to the wholesalers and dealers.

Afterwards, a two step training program is applied to supplement the middlemen that lack requisite knowledge about the new product for about eight weekends, and they are then subjected to another sales training program by a professional consultant company; "Karya Business Services" as well.

Borusan, after five months from the launch of its new product **Borusan "P ^{2}3" Pipe and Fitting Systems"** into the market, made an audience analysis to asses the audience's current image of the new product believing that people's attitudes and actions toward a product are highly conditioned by their beliefs about the product. According to the results, the customers knew little about the new product. Then, in order to build greater awareness, the company not only started to advertise heavily to sector periodicals and newspapers but also displayed the new product in Construction 95-96 Fairs held in Ankara, İzmir and İstanbul (See Appendix J Exhibit 1 & 2 for the advertisements in sector periodicals.). The marketing communications aimed to supply beliefs and evaluations that helped the customer feel good about his or her brand choice.

Posters and leaflets are sent to dealers who in turn distribute them to the endusers, appointments from the purchasing agents of construction companies are taken, and samples are given as a part of the new "Awareness" program (A catalogue and a poster is also given in the Appendix J). Tables that consist of all the PP products and fittings are also prepared for every sales point to display them in the show rooms. In addition to these, sales executives tried to persuade dealers to take more stock and devote more shelf space to the company's new brand by communicating the common feeling "you'll just put the products on the shelves and advertising will take them off".

In order to give a give a quick response to the market leader's sales promotion the marketers started to apply the same premium strategy for the dealers in the new year. However, these promotions were not very successful as it mostly attracted brand switchers who primarily look for a lower price or a cash refund offer (rebate) as means of a premium. It produced a high sales response in the short run but little permanent gain in the market share. Moreover, it has caused some problems with some regional distributor companies that thought that it is a relatively cheaper brand and often wanted to buy it on deal. For this reason, Borusan, targeting to achieve a reputation for high product quality should be

reluctant to cut prices in response to lower priced challengers for fear of cheapening its product image.

For the new year, the new total promotional budget for the new product amounts to 10 % (TL 50 billion) of the forecasted sales. However, the expenditures for fair displays and the plumbers' insurance programs and certifications (it will be detailed in the strategy planning section) is not included to this budget.

It should be kept in mind that sales and price promotions do not tend to yield new long term buyers in growing markets (especially when the industry is saturated with so many suppliers) because they attract mainly deal-prone consumers who switch among brands as deals become available. Therefore, it is evident that these promotions do not build high category volume. They usually build short-term volume that is not maintained.

And, according to the experience gained so far, the general attitude towards heavy use of sales promotion based on price discounts results in a decrease in brand loyalty, an increase in consumer price sensitivity, brand-quality-image dilution, a tendency to focus on short-run marketing planning, and enable PP pipe and fitting manufacturers to charge a higher list price to test "how high is up". Small brands find it advantageous to use promotions based on price, because they cannot afford to match the large "advertising budgets" of the "market leaders". Nor can they obtain shelf space without offering trade allowances or stimulate consumer trial without offering consumer incentives.

IX.4.1. So, can we proceed with sales and price promotions?

As Borusan tries to be a "category leader" whose growth lies in "expanding the entire category (which is the highest possible quality category)", its strategy should not depend on price competition like some other small brands who seek to enlarge their share. It has the confidence, capital, and capacity to launch new products into full national distribution by developing a full marketing roll out over time!

Till today, the Borusan's promotional mix is influenced by manufacturer marketing activities; a "push strategy" directed at channel intermediaries to induce them to order and carry the product and promote it to end users. But now, the marketing department must implement a "pull strategy" by formulating some kind of benefit, "unique selling proposition", motivation, identification, or reason why the audience should think about or investigate the product. In other words, a serious marketing plan directed to endusers to induce them to ask intermediaries for the new product is necessary! That is the only way, we believe, the company can differentiate itself from other competitors that operate in the same category.

IX.4.2. Then, what will Borusan do?

As the company cannot have a market expansion program for fear that it may cannibalize the galvanized steel pipe category it has no chance other than stealing away some of the repeat purchase or replacement demand from the competitors' current customers.

X. THE STRATEGY: Guerrilla Warfare Marketing

Starting from this point, a "Guerrilla Warfare Marketing Strategy" ,is proposed.

In today's marketing environment it is evident that it is not very possible to take the desired response from all of the customers by only using rational or emotional appeals. Because marketing PP pipes and fittings in the domestic market where there is a chronic overcapacity and depressed earnings is a guerrilla warfare!. As Stephen P. Arbeit says; "You can no longer fly over in your network B 52's and drop coherent, heavy messages, saturating communities with what you want to say, and hope for a response. (Stephen P. Arbeit 1982. "Confronting the Crisis in Mass Marketing" Viewpoint 2, PP 29.)
Just as Guerrilla Warfare Marketing the battle for the heart and mind and pocketbook of the customer will be won on a block-by-block, store by store, purchase by purchase basis.

The guerrilla warfare strategy will consist of a program or "a unique selling proposition" that will indirectly augment the attractivity of the new product. It is simply a warranty for a competitive differentiation, but it is somewhat different than the competitors' product warranties or maintenance contracts because it also comprises the installers, namely "the plumbers". In other words, the new program will not only consist of warranty certificates for the new product but also include a professional education where the foremen will have a certificate approved both by Borusan and Ministry of Education and an insurance policy that will insure them for any of the installation mistakes that may cause a material damage to the endusers' houses as well. This policy will be "Borusan's Profession Responsibility Insurance Policy (Borusan Mesleki Mesuliyet Sigorta Poliçesi)" and the plumbers who have this policy will always be under the guarantee for any of their installation mistakes unless they dont use a brand other than Borusan "P ^{2}3" Pipe and Fitting Systems". This insurance policy is a unique one, as none of the competitors, even the ones outside the country have never tried such a thing before, and is directed especially to the plumbers since they influence the buying behavior of consumers significantly by playing the three of the five roles of the buying decision; "an initiator, an influencer and a user".

Such a program may;

-Provide the chance and honor of being the "pioneer" of such applications in the industry.
-Give the company the chance of repositioning itself as an "innovator, or the category leader" rather than a "follower" in the PP pipe and fitting industry.
-Contribute to establish a higher brand awareness, credibility and trustworthiness.
-Be a peerless way to communicate the audience that the company's aim is "to satisfy and even exceed customer expectations for unconditional customer satisfaction".
-If becomes successful, increase the dealership applications, will be an excellent opportunity for the sales executives to determine the dealers that can best represent Borusan among a diversified pool of candidates.
-Strengthen the company's position by increasing the company and brand image
-Initiate the soft-core and switching loyals to become hard-core loyals
-Provide the acquisition of a considerable portion of the market until the competitors respond with another superior innovation, which is very unlikely. Even the imitation of the strategy by most of the competitors is impossible due to the financial constraints.
-Let the company to go one step behind to establish excellent supplier-influencer relationships. Note that the company's reputation in the steel pipe industry was the result of its excellence in supplier-customer relationships.
-Initiate potential customers willingness to buy our new product by minimizing the risk associated with buying something new.
-Be a good intimidation (fright or scare) to the competitors who belittle or neglect Borusan's power.
-Provide nonusers (who will be the potential customers in the future) believe that "a heavily promoted and advertised brand must offer "good value"; otherwise why would Borusan spend so much money touting the product?"
-Extend the entire quality sensitive category by reinforcing the new program with heavy advertisements that enhance the importance of quality products.
-Let the company capture and maintain a commanding share of the total market, drive down unit costs and build a large contingent of loyal customers.

-These certificates and insurance policies will not only incorporate some concession, inducement, or contribution that will give value to the plumber but also will include a distinct invitation to them to engage in the transaction with Borusan and its dealers!.
-Bring a guaranteed work potential for the certified plumbers in their territory for the consumers who want to consume Borusan "P ^{2}3" Pipe and Fitting Systems". In order to provide this, the addresses and phone numbers of the certified plumbers will be distributed to the dealers. This will, on the other hand, provide a guaranteed sales potential for the dealers as well. Therefore such a strategy is favorable for both sides.
-And more important of all, Borusan's actions on such variables (guarantees and warranties) together with its high product quality, distribution, post sale service and other promotional appeals will set standards that subsequent competitors must meet or beat. If Borusan sets these standards high enough, it can raise the costs of entry and perhaps preempt some potential competitors. In other words, it may be the biggest bang to drive out competitors which have limited financial resources and, hence avoid future direct confrontation in the long-run.

Note that such a strategy is particularly attractive as (1) there are very few barriers to the entry in the PP pipe and fittings market, and (2) most of the existing competitors have only limited resources and competencies to defend any advantage they gained through early entry.

However, to be perceived as unique, or close to it, in areas of importance in a highly competitive context, means a sustainable competitive advantage, and- c'est la vie- a sustainable competitive advantage has costs! Therefore, the program will;

-Necessitate the highest promotional budget for the company's new brand,
-Take quite a long time to organize,
-Bring uneasiness among other plumbers who could not attempt the program.

To initiate the new strategy, the negotiations with the leading insurance companies are already done to determine the cost to be borne by Borusan.

It is important to note here that the rapid expansion of output necessary to keep up with a stimulated demand in a growing market can lead to quality control and stockout problems. Thus, Borusan must pay particular attention to quality control, superior production scheduling, inventory control and logistics systems to minimize such problems and shorten delivery times in this stage.

As competitors prepare to respond with an alternative strategy, Borusan's advertising and sales promotion emphasis must shift from stimulating "primary demand" to building "selective demand" by creating appeals that emphasize and approve the brand's superior features and benefits. Thus, the last step will be to establish a "purchasing criteria" among customers where the European quality standards and ISO 9001 Quality Assurance Certificate is considered the major concern. Note that, the marketing environment currently considers that price is almost the only concern for a purchasing decision.

Therefore, in line with the last step, Borusan must acquire the ISO 9001 Quality Assurance Certificate, the approvals from the leading European institutions such as German's DWGV, and the European standards for PP pipes and fittings in sanitary tap water systems such as DIN 8077-78, to certify that the new brand is really "internationally competitive" and offers a superior quality than all of its domestic competitors.

X.1. The Action Plan

The action plan will start with a two step heavy advertising and broadcasting program. The first part will consist of an advertisement campaign specially designed to communicate the product's merits and the second part will inform the audience about the plan.

Moreover, in order to take full support of the audience, especially the leading construction companies, a 5% special discount coupon is going to be sent to each by direct mailing.

Only the plumbers who have memberships from the Plumber Association will be accepted to the program since it is the only possible way to keep in contact with them in the following years.

The program will cover all the regions in Turkey and will be done on a regional basis. In the first part, the plumbers in the Marmara Region will be subjected to the program. This region is considered the biggest and the most profitable portion of the customer group as it contains most of the building constructors. However, the sales potential is not limited with them; together with the replacement of central heating systems in buildings which transform to natural gas heating the segment expands to 25 million consumers (Geographically Concentrated Buyers). Note that this segment is the highest income segment in the market according to the data of income distribution.

The second party will consist of plumbers in the Ege Region. And, consequently, the following parties will be the plumbers in the Karadeniz, Akdeniz, İç Anadolu, Doğu Anadolu and Güneydoğu Anadolu Regions respectively. As it can easily be understood from the sequence, the company will pay special attention to the first three regions where it has got the highest sales potential, and then, in line with its Guerrilla Warfare Marketing Strategy, will try to strengthen its position in the lower sales potential regions.

The program will be made up of two parts. In the first part, the features of the new brand will be communicated to the attendees (but the ones that provide advantages against steel pipes) by Borusan sales executives and in the second part instructors of Ministry of Education will lecture the technique for a proper installation with PP pipe and fittings and the common mistakes during an installation.

The program will be supported with heavy advertising and personal confrontation activities with the leading construction companies;

-To provide a diversified pool of candidates.

-To extend the market in the lower sales potential regions.

-To provide an alive, immediate, and interactive relationship to observe the customers need's and characteristics at close hand. The data will then be collected and directed to the manufacturing to make immediate adjustments.

After each regional education program the Borusan "P ^{2}3" Pipe and Fitting Systems" printed aprons will be distributed to the attendees. The aprons are a part of the strategy and will be used as "the cheapest communication instrument" to gain the attention of the customers. It is expected that the customer (the households) may tend to provide further information that may lead him/her to the product when he/she is exposed to the brand name printed on the plumbers' apron. Moreover, in order to provide the commitment of the plumbers and to stimulate the attractivity of the new brand in the following years, 1% special discount coupons for the certified plumbers may also be distributed periodically.

XI. CONCLUSION

Marketing is one of the major areas where rapid obsolescence of objectives, policies, strategies and programs is a constant possibility. A giant company, like the Borusan case, can fall on hard times because it did not watch the changing marketplace and make the proper adaptations. There are several other reasons, however. The firm has achieved a world-wide success with the steel pipe production technology, and has committed substantial resources to plant and equipment dedicated to steel pipe production and was reluctant to switch to a new one because of the large investments involved ($ 110 Million), and a fear of disrupting current customers, and/or stimulating the cannibalization effect.

With a short-run planning, rather than fighting in the clean tap water transportation category by producing both the galvanized steel pipes and high quality PP pipes, the company preferred to concentrate on new other markets such as boiler and natural-gas steel pipes where the-state-of-the-art technology and know-how accumulated over three decades of steel pipe manufacturing provides a room for further development. Concentrating on such new markets not only provided the company to achieve a leading position in these newly growing markets but also helped it to allocate the excess capacity (that resulted from the significant loss in the market share of galvanised steel pipes) to more profitable markets before the competition gets tougher. However, as the company was so busy developing some other new markets, the competition in the PP pipe category got tougher and establishing a brand reputation in a highly fragmented plastic pipe industry where there is over capacity and depressed earnings became even more difficult.

Because of the rapid changes in the marketing environment, each company needs to reassess periodically its marketing effectiveness through a marketing audit. In this case, Borusan made a late entry to the PP pipe and fittings market. Its late response to the market's changing conditions provided some advantages, too. The company did not bear the cost of educating the market while the competitors did. It avoided the competitors' product revealed faults and the company learnt the size of the market. However, these

advantages were very costly, the company missed a turn on the road and plunged into a lower place in a growing market, and to recover its leading position again, it decided to under go an expensive, riskier and wearisome program.

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Appendix A

Product Design and Development Sequence

Project Value Index

TABLE 1.

Product Design and Development Sequence

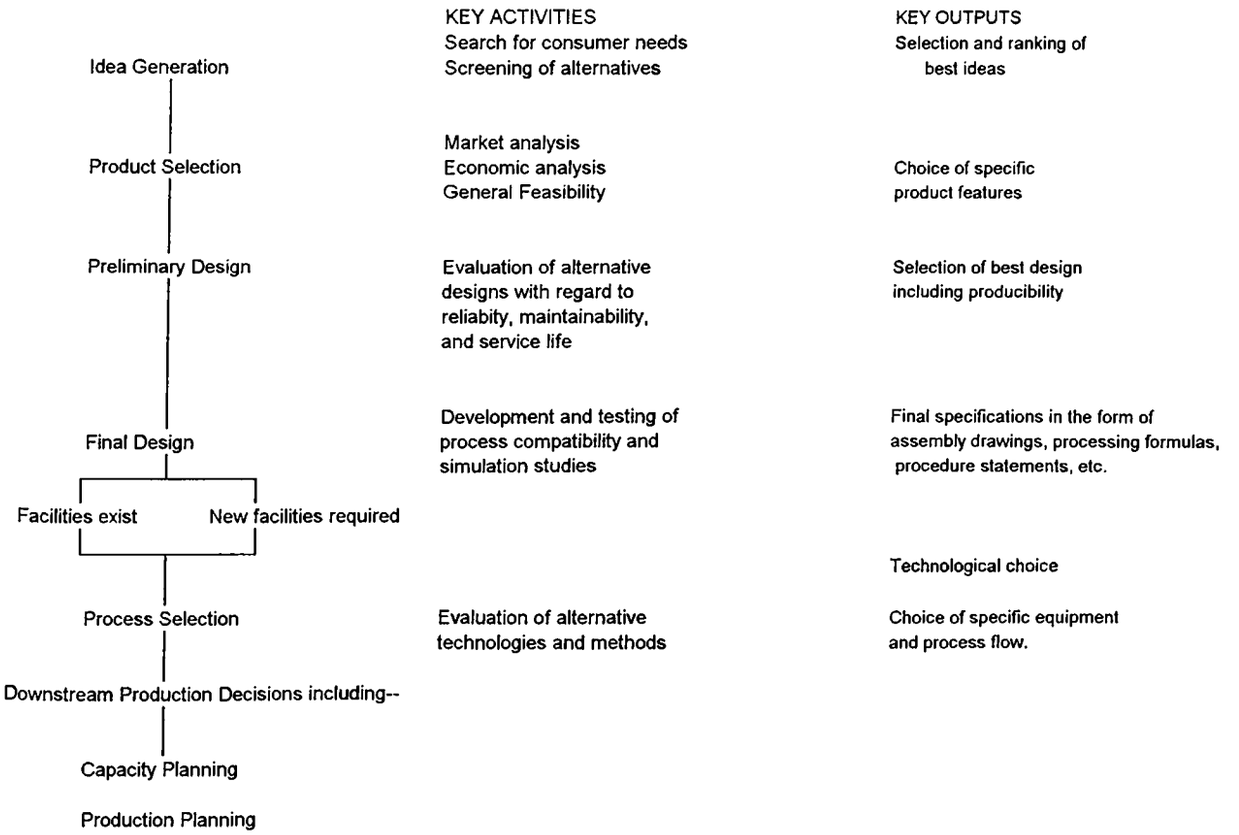


TABLE 2.

Project Value Index

PVI=(CTSxCCSxAVxPxL)/TPC

where

PVI= Project value index
CTS= Chances for technical success on an arbitrary rating scale, say 0 to 10
CCS= Chances for commercial success on an arbitrary rating scale, say 0 to 10
AV= Annual volume (total sales of product in units)
P= Profit in TL per unit (i.e., price minus cost)
L= Life of product in years
TPC= Total project cost in TL.

Appendix B

Product Life Cycle Curve

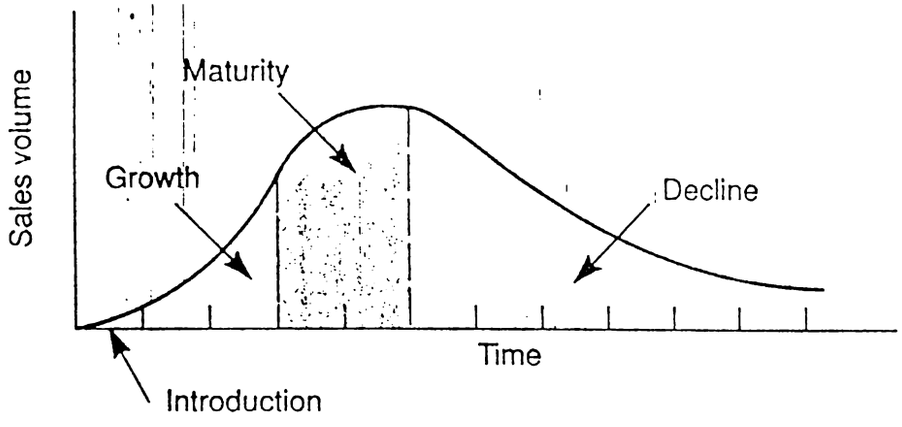


FIGURE .1

Product Life-cycle Curve

Appendix C

Scoring Model for Borusan P [2]3 Boru ve Fittings Sistemleri

Table 3.

Scoring Model for Borusan "P²3" Boru ve Fitting Sistemleri

Criteria	Level		Score
	Product Development		
1. Development Time	Less than 6 months	✓	2
	6 months to 1 year		1
	1-2 years		-1
	More than 2 years		-2
2. Experience	Considerable		2
	Some		1
	Little	✓	-1
	None		-2
3. Lenght of product life	More than 8 years		2
	5-8 years	✓	1
	3-5 years		-1
	3 or less		-2
4. Materials	Available inside firm		2
	Available outside	✓	1
	Limited availability inside		-1
	Limited availability outside		-2
5. Equipment	Present equipment usable		2
	Some new equipment		1
	Mostly new equipment		-1
	New production facility	✓	-2
	Market		
6. Marketability	Current customers		2
	Mostly current customers		1
	Some current customers	✓	-1
	All new customers		-2
7. Stability	High stable		2
	Fairly stable		1
	Unsteady	✓	-1
	High volatile		-2
8. Trend	New market		2
	Growing	✓	1
	Stationary		-1
	Decreasing		-2
9. Advertising	Little required		2
	Moderate requirements	✓	1
	High requirements		-1
	Extensive		-2
10. Competition	None		2
	One or two		1
	Several		-1
	High competitive	✓	-2
11. Demand	Stable		2
	Subject to business cycle	✓	1
	Seasonal		-1
	Seasonal & subject to business cycle		-2
	Financial		
12. Return on investment	30 % or more		2
	25-30 %		1
	20-25 %	✓	-1
	Less than 20 %		-2
13. Capital outlay	Low		2
	Moderate	✓	1
	High		-1
	Extensive		-2

Appendix D

The Steel Pipe Manufacturers in Turkey

TABLE 4.

Company	Product Type	1993 Theoretical Capacity (tons)	Ownership	Location
Borusan Birleşik Boru	Longitudinally Welded	310,000	Private	Gemlik, Bursa
		115,000	Private	Halkalı, İstanbul.
Marınesmann Sümerbank	Long.& Spiral Welded	160,000	State & Foreign	İzmit
Yücel Boru	Longitudinally Welded	180,000	Private	Çayırova, İstanbul
Çayırova Boru (*)	Longitudinally Welded	210,000	Private	Çayırova, İstanbul
Erbosan	Longitudinally Welded	140,000	Private	Kayseri
Sevil Boru	Longitudinally Welded	90,000	Private	Ereğli
Bosaş Boru	Longitudinally Welded	40,000	Private	Trabzon
Profil Boru	Longitudinally Welded	30,000	Private	Kartal, İstanbul
Ümran Boru	Long.& Spiral Welded	150,000	Private	Ümraniye
		250,000	Private	Akçakoca
Kartal Boru (**)	Longitudinally Welded	70,000	Private	Kartal, İstanbul
Noksel Boru	Spiral Welded	60,000	Private	İskenderun
Borutaş	Longitudinally Welded	25,000	Private	Adapazarı
Emek Spiral	Spiral Welded	50,000	Private	Ankara
Habaş	Spiral Welded	25,000	Private	Aliağa, İzmir
Erbotaş	Longitudinally Welded	40,000	Private	Ereğli
Depaş	Longitudinally Welded	40,000	Private	Denizli
Gabosan	Longitudinally Welded	40,000	Private	Gaziantep
Oto Profil	Longitudinally Welded	10,000	Private	Topkapı, İstanbul
Tüzün Boru	Longitudinally Welded	10,000	Private	Çobançeşme, İstanbul
Ostar Boru	Longitudinally Welded	20,000	Private	Kartal, İstanbul
MKEK	Seamless	10,000	State	Kırıkkale
Karabük DÇ. (Not operating)	Cast	5,000	State	Karabük
Other	Longitudinally Welded	20,000	Private	Miscellaneous

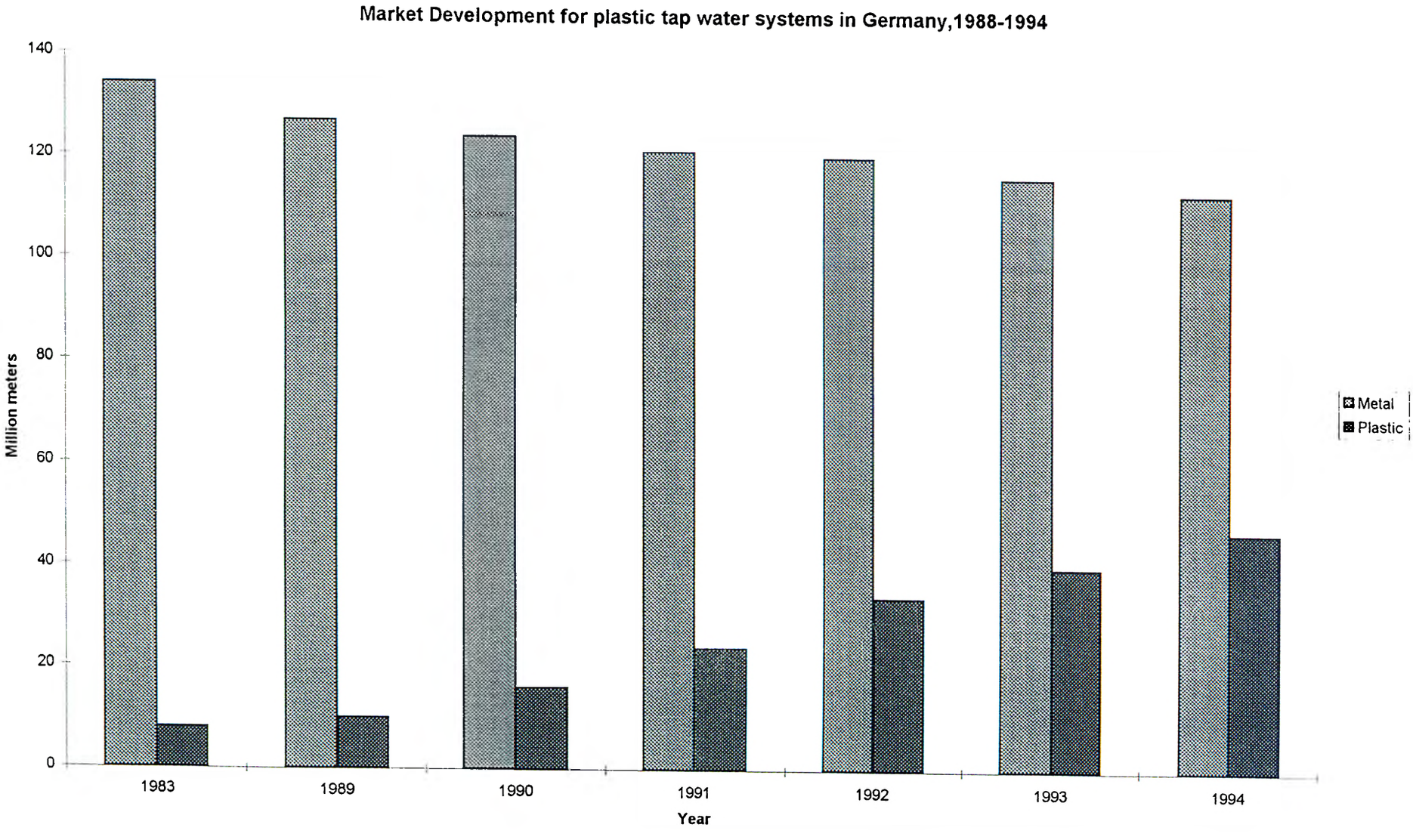
(*)Yücel Boru
(**) Borusan.
These figures show the theoretical rather than actual capacities of the producers.

*Taken from Borusan Prospectus page 22

Appendix E

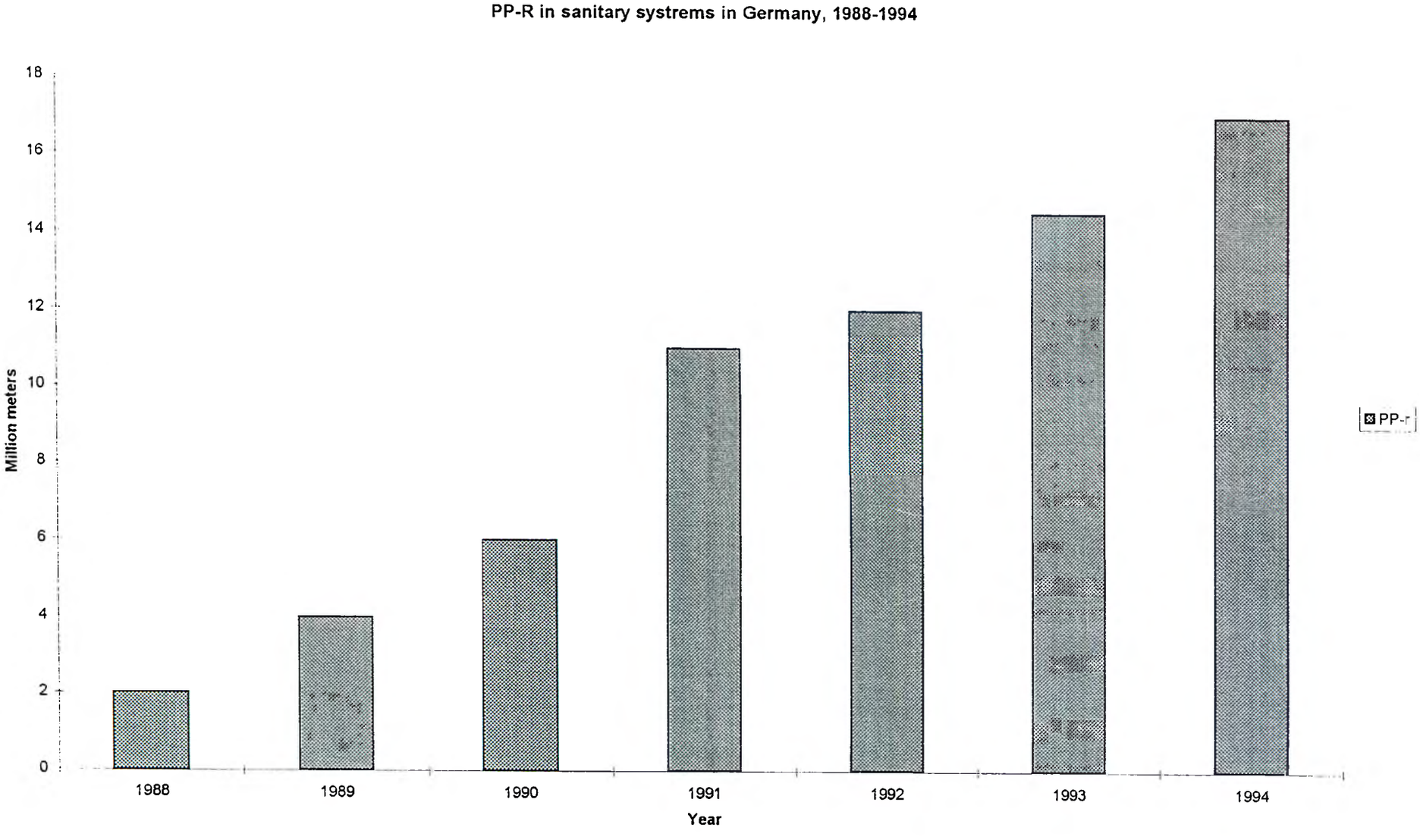
The European Market for Plastic Tap Water Systems

Figure1



Source, KWD Germany

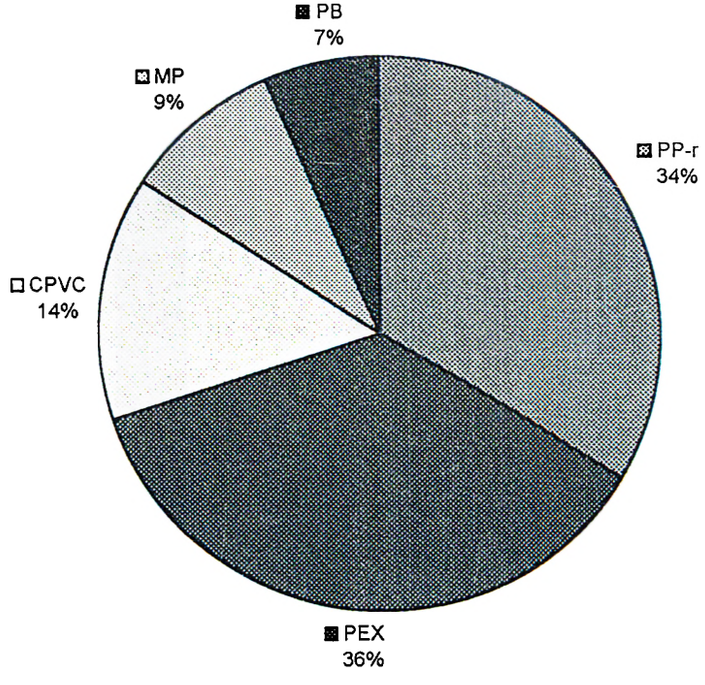
Figure 2



Source, KWD Germany

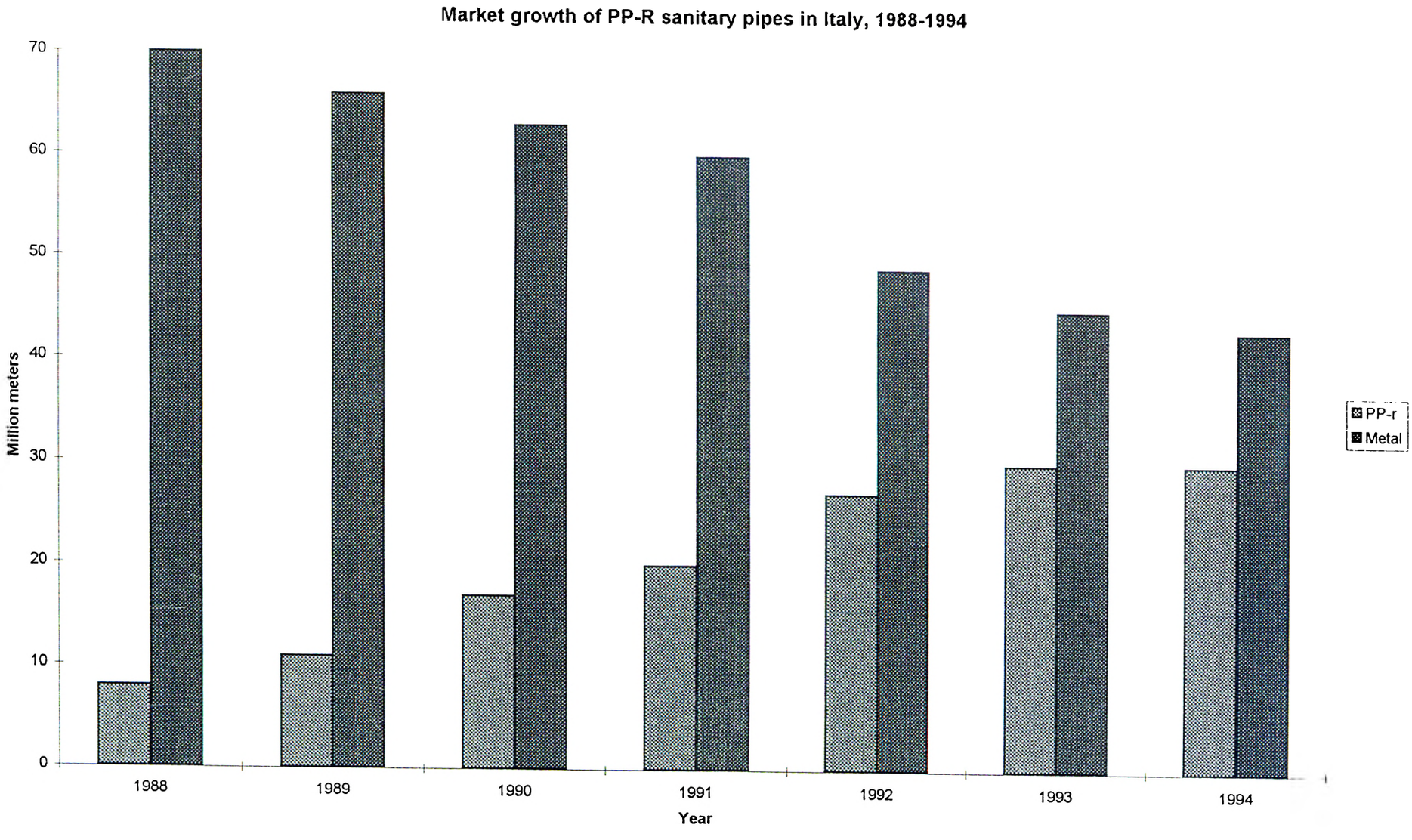
Figure 3

Relative market shares of different plastics in the sanitary pipe sector in Germany in 1994



Source, KWD Germany

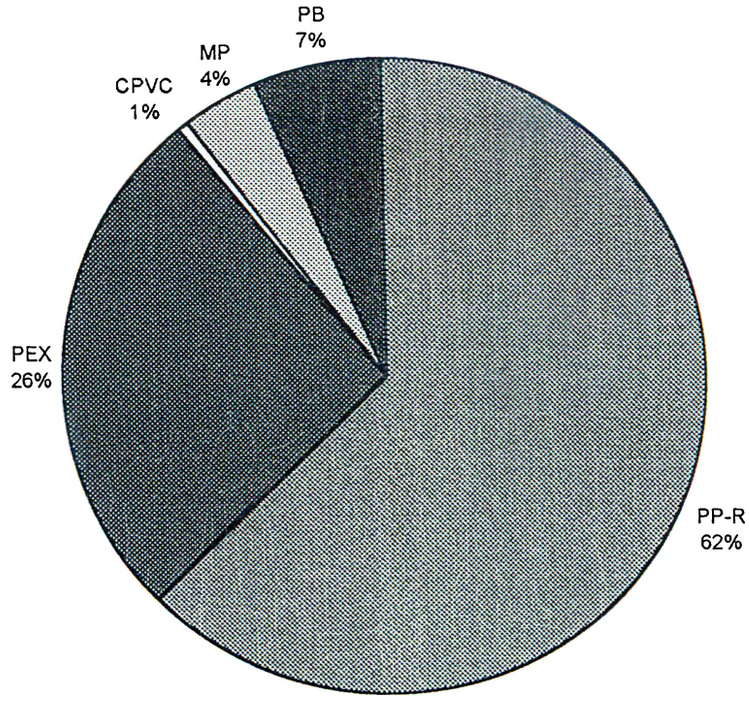
Figure 4



Source, KWD Germany

Figure 5

Relative market shares of different plastic sanitary systems-Italy 1994



Source, KWD Germany

Appendix F

Comparison of Borusans List and Net Sales Prices with the Competitors List and Net Sales Prices

BORUSAN "P³3" BORU VE FİTTİNGS SİSTEMLERİ

COMPARISON OF BORUSAN "P³3" PIPE AND FITTINGS SYSTEMS NET SALES PRICE WITH THE COMPETITORS NET SALES PRICE (FOR A TWO MONTHS COLLECTION PERIOD.)

1	COLD WATER PLASTIC PIPES																				
			1/6/96	BORUSAN	1/6/96	ÇAMLICA	8/4/96	EGETHERM	22/4/96	FIRAT	90 days 1/1/96	PİLKAR	10/4/96	SARAL SİS.	1/5/96	SPK	28/12/1995	DİZAYN YB	90 days 31/5/1996	PİLSA	1DM= 1/4/96
	DIMENSION		BORUSAN	35% DISCOUNT	ÇAMLICA	40% DISCOUNT	EGETHERM	45% DISCOUNT	FIRAT	35% DISCOUNT	PİLKAR	10% DISCOUNT	SARAL SİS.	45% DISCOUNT	SPK	40% DISCOUNT	DİZAYN YB	45% DISCOUNT	PİLSA	40% DISCOUNT	50,500
CODE NO	(mm.)		PRICE TL/m.	PRICE TL/m.	TL/M	PRICE TL/m	TL/M	PRICE TL/m	TL/M	PRICE TL/m.	TL/M	PRICE TL/m.	TL/M	PRICE TL/m.	TL/M	PRICE TL/m.	TL/M	PRICE TL/m.	TL/M	PRICE TL/m.	AQUATHERM PRICE TL/m.
801 020 0190	20X1.90		65,000	42,250									70,000	38,500				0			60,600
801 025 0230	25X2,30		95,000	61,750									105,000	57,750				0			84,840
801 032 0300	32X3,00		170,000	110,500									190,000	104,500				0			139,380
801 040 0370	40X3,70		250,000	162,500	266,000	159,600							235,000	129,250	235,000	141,000	204,000	112,200			212,100
801 050 0460	50X4,60		360,000	234,000	391,000	234,600							350,000	192,500	346,000	207,600	300,000	165,000			363,600
801 063 0580	63X5,80		570,000	370,500	625,000	375,000							550,000	302,500	552,000	331,200	480,000	264,000			545,400
2	HOT WATER PLASTIC PIPES																				
802 020 0340	20X3,40		95,000	61,750	103,000	61,800	78,920	43,406	91,870	55,122	71,000	63,900	82,500	45,375	92,000	55,200	84,000	46,200	59,010	35,406	84,840
802 025 0420	25X4,20		150,000	97,500	161,000	96,600	123,070	67,689	142,270	85,362	108,500	97,650	127,500	70,125	143,000	85,800	132,000	72,600	91,500	54,900	127,260
802 032 0540	32X5,40		250,000	162,500	282,000	169,200	201,660	110,913	230,470	138,282	178,400	160,560	222,800	122,540	248,000	148,800	216,000	118,800	145,890	87,534	199,980
802 040 0670	40X6,70		370,000	240,500	406,000	243,600	318,050	175,478	359,620	215,772	275,750	248,175	325,000	178,750	357,000	214,200	312,000	171,600	276,180	165,708	303,000
802 050 0840	50X8040		590,000	383,500	625,000	375,000	495,300	272,415	590,100	354,060	417,000	375,300	499,500	274,725	549,000	329,400	480,000	264,000	353,900	212,340	484,800
802 063 0105	63X10,50		950,000	617,500	1,015,000	609,000	780,640	429,352	918,750	551,250	679,000	611,100	815,000	448,250	896,000	537,600	780,000	429,000	555,630	333,378	787,800
3	PN 25 AL. FOIL REINFORCED PLASTIC PIPES																				
803 020 0390	20X3,90		138,000	89,700	144,000	108,000					122,000	109,800			135,500	81,300	137,500	75,625			145,440
803 025 0470	25X4,70		195,000	126,750	196,000	147,000					170,000	153,000			185,000	111,000	187,500	103,125			206,040
803 032 0590	32X5,90		320,000	208,000	325,000	243,750					259,000	233,100			308,000	184,800	312,500	171,875			293,910
803 040 0720	40X7,20		500,000	325,000	520,000	390,000									494,000	296,400	500,000	275,000			424,200
803 050 0890	50X8,90		700,000	455,000	645,000	483,750															666,600
803 063 0110	63X11,00			0	1,236,000	927,000															1,030,200
FITTINGS																					
4	SOCKET																				
CODE NO	DIMENSION (mm.)	PRICE TL																			
804 020 0000	20		9,500	6,175	9,500	5,700	10,220	5,621	10,500	6,300	9,850	8,865	7,725	4,249	9,000	5,400	7,800	4,290	8,760	5,256	7,070
804 025 0000	25		13,000	8,450	13,000	7,800	19,900	10,945	14,180	8,508	15,900	14,310	10,900	5,995	12,000	7,200	11,000	6,050	10,510	6,306	12,120
804 032 0000	32		21,000	13,650	21,000	12,600	27,660	15,213	23,100	13,860	24,250	21,825	16,700	9,185	18,500	11,100	17,200	9,460	12,250	7,350	8,180
804 040 0000	40		36,000	23,400	35,000	21,000	52,610	28,936	47,780	28,668	42,250	38,025	28,700	15,785	32,000	19,200	28,600	15,730	29,810	17,886	27,270
804 050 0000	50		65,000	42,250	61,000	36,600	75,550	41,553	72,450	43,470	78,250	70,425	51,000	28,050	56,000	33,600	50,400	27,720	39,880	23,928	66,660
804 063 0000	63		125,000	81,250	120,000	72,000	106,650	58,658	127,050	76,230	104,000	93,600	102,000	56,100	113,000	67,800	99,000	54,450	83,070	49,842	133,320
5	REDUCER																				
805 025 2000	25 / 20		9,500	6,175	9,500	5,700	14,340	7,887	13,000	7,800	12,000	10,800	9,100	5,005	8,900	5,340	7,800	4,290	13,020	7,812	12,120
805 032 2000	32 / 20		18,000	11,700	18,000	10,800	22,620	12,441	17,050	10,230	26,500	23,850	14,000	7,700	16,000	9,600	14,850	8,168	14,870	9,922	18,180
805 032 2500	32 / 25		18,000	11,700	18,000	10,800	22,620	12,441	17,050	10,230	25,000	22,500	14,000	7,700	16,000	9,600	14,850	8,168	14,870	8,922	18,180
805 040 2000	40 / 20		33,000	21,450	22,000	13,200	49,090	27,000	44,000	26,400	55,750	50,175	29,900	16,390	25,000	15,000	17,950	9,873	28,960	17,376	24,240
805 040 2500	40 / 25		33,000	21,450	22,000	13,200	49,090	27,000	44,000	26,400	56,000	50,400	29,800	16,390	25,000	15,000	17,950	9,873	28,960	17,376	24,240
805 040 3200	40 / 32		35,000	22,750	28,000	16,800	49,090	27,000	44,000	26,400	60,000	54,000	29,800	16,390	27,000	16,200	22,700	12,485	28,960	17,376	24,240
805 050 2500	50 / 25		49,000	31,850	33,000	19,800	64,580	35,519	47,300	28,380	64,500	58,050	44,400	24,420	37,000	22,200	26,900	14,795	31,300	18,780	66,660
805 050 3200	50 / 32		50,000	32,500	35,000	21,000	71,030	39,067	47,300	28,380	64,500	58,050	44,400	24,420	37,000	22,200	28,600	15,730	33,360	20,016	66,660
805 050 4000	50 / 40		52,000	33,800	42,000	25,200	71,030	39,067	52,800	31,680	70,000	63,000	44,400	24,420	41,000	24,600	34,500	18,975	39,740	23,844	66,660
805 063 3200	63 / 32		75,000	48,750	63,500	38,100	80,330	44,182	71,400	42,840	80,000	72,000	68,700	37,785	62,500	37,500	52,200	28,710			133,320
805 063 4000	63 / 40		80,000	52,000	70,000	42,000	91,530	50,342	78,100	46,860	80,000	72,000	68,700	37,785	69,500	41,700	57,600	31,680			133,320
805 063 5000	63 / 50		90,000	58,500	86,500	51,900	101,720	55,946	84,150	50,490	88,500	79,650	68,700	37,785	83,500	50,100	71,100	39,105			133,320
6	ELBOW 90°																				
806 090 2000	20		13,500	8,775	13,500	8,100	14,740	8,107	14,500	8,700	12,600	11,340	10,800	5,940	12,000	7,200	11,000	6,050	13,160	7,896	12,120
806 090 2500	25		21,000	13,650	21,000	12,600	21,550	11,853	22,050	13,230	19,900	17,910	17,250	9,488	19,500	11,700	17,200	9,460	19,270	11,562	18,180
806 090 3200	32		32,000	20,800	32,000	19,200	31,190	17,155	36,225	21,735	32,000	28,800	26,500	14,575	38,000	22,800	26,600	14,630	26,280	15,768	30,300
806 090 4000	40		61,000	39,650	58,000	34,800	61,960	34,078	59,325	35,595	99,000	89,100	48,000	26,400	54,000	32,400	47,100	25,905	44,150	26,490	48,480
806 090 5000	50		120,000	78,000	112,000	67,200	112,020	61,611	121,800	73,080	135,000	121,500	96,400	53,020	107,000	64,200	92,400	50,820	77,650	46,590	109,080
806 090 6300	63		225,000	146,250	217,500	130,500	200,740	110,407	220,500	132,300	208,000	187,200	185,800	102,190	206,000	123,600	180,000	99,000	165,150	99,090	181,800
7	ELBOW 45°																				
807 045 2000	20		24,000	15,600	13,500	8,100	33,490	18,420	26,775	16,065	23,500	21,150	18,000	9,900	19,500	11,700	11,000	6,050			12,120
																					18,180

		1/6/96	BORUSAN	1/6/96	ÇAMLICA	8/4/96	EGETHERM	22/4/96	FIRAT	1/1/95	PİLKAR	10/4/96	SARAL SİS.	1/5/96	SPK	28/12/1995	DİZAYN YB	31/5/1996	PİLSA	1DM=	50.500
		BORUSAN	35% DISCOUNT	ÇAMLICA	40% DISCOUNT	EGETHERM	45% DISCOUNT	FIRAT	35% DISCOUNT	PİLKAR	10% DISCOUNT	SARAL SİS.	45% DISCOUNT	SPK	40% DISCOUNT	DİZAYN YB	45% DISCOUNT	PİLSA	40% DISCOUNT	AQUATHERM	
10	PIPE BRIDGE	PRICE TL/m.	PRICE TL/m.	TL/M	PRICE TL/m	TL/M	PRICE TL/m	TL/M	PRICE TL/m.	TL/M	PRICE TL/m.	TL/M	PRICE TL/m.	TL/M	PRICE TL/m.	TL/M	PRICE TL/m.	TL/M	PRICE TL/m.	PRICE TL/m.	
810 020 0000	20	38,000	24,700	34,000	20,400	41,640	22,902	39,000	23,400	37,200	33,480			40,000	24,000	28,100	15,455	38,550	23,130	115,140	115,140
810 025 0000	25	48,000	31,200	45,500	27,300	52,330	28,782	57,000	34,200	52,500	47,250			49,500	29,700	37,500	20,625	45,560	27,336	167,155	167,155
810 032 0000	32	82,000	53,300	80,000	48,000	75,750	41,663	91,000	54,600	89,500	80,550			80,000	48,000	65,600	36,080	52,550	31,530	245,430	245,430
13	WALL CONNECTION ELBOW FEMALE																				
813 020 1200	20 X 1/2	105,000	68,250	116,000	69,600	103,340	56,837	122,850	73,710	81,000	72,900			101,000	60,600	91,400	50,270	83,610	50,166	111,100	111,100
14	T PART																				
814 020 0000	20	18,000	11,700	18,000	10,800	18,390	10,115	17,850	10,710	21,500	19,350	14,500	7,975	17,000	10,200	15,000	8,250	14,020	8,412	151,500	151,500
814 025 0000	25	26,000	16,900	26,000	15,600	25,560	14,058	24,675	14,805	26,000	23,400	21,000	11,550	24,000	14,400	21,100	11,605	17,500	10,500	24,240	24,240
814 032 0000	32	42,000	27,300	42,000	25,200	47,810	26,296	45,150	27,090	45,000	40,500	34,000	18,700	40,000	24,000	34,500	18,975	26,280	15,768	42,420	42,420
814 040 0000	40	77,000	50,050	74,500	44,700	77,350	42,543	75,075	45,045	83,000	74,700	62,000	34,100	69,000	41,400	61,500	33,825	57,930	34,758	60,600	60,600
814 050 0000	50	142,000	92,300	135,000	81,000	137,340	75,537	155,400	93,240	158,000	142,200	115,400	63,470	129,000	77,400	112,000	61,600	93,610	56,166	212,100	212,100
814 063 0000	63	282,000	183,300	278,500	167,100	239,980	131,989	281,400	169,840	237,000	213,300	238,000	130,900	263,000	157,800	230,400	126,720	174,430	104,658	333,300	333,300
15	UNEQUAL T																				
815 025 2020	25 / 20 / 20	34,000	22,100	30,000	18,000	31,060	17,083	27,825	16,695	28,000	25,200	25,000	13,750	28,000	16,800	25,000	13,750	21,230	12,738	26,260	26,260
815 025 2025	25 / 20 / 25	34,000	22,100	30,000	18,000	28,910	15,901	29,400	17,640	28,000	25,200	25,000	13,750	28,000	16,800	25,000	13,750	20,560	12,336	26,260	26,260
815 032 2032	32 / 20 / 32	43,000	27,950	41,000	24,600	44,980	24,739	43,575	26,145	53,000	47,700	31,500	17,325	38,500	23,100	33,600	18,480	30,800	18,480	39,390	39,390
815 032 2532	32 / 25 / 32	43,000	27,950	41,000	24,600	45,830	25,207	43,575	26,145	53,000	47,700	31,500	17,325	38,500	23,100	33,600	18,480	29,320	17,592	39,390	39,390
16	CAP																				
816 020 0000	20	9,000	5,850	9,000	5,400	19,620	10,791	15,225	9,135	8,200	7,380	10,200	5,610	10,500	6,300	7,100	3,905	14,020	8,412	21,210	21,210
816 025 0000	25	13,000	8,450	13,000	7,800	27,070	14,889	21,000	12,600	17,500	15,750	14,850	8,168	14,500	8,700	10,200	5,610	15,270	9,162	27,270	27,270
816 032 0000	32	16,000	10,400	16,000	9,600	29,120	16,016	25,200	15,120	33,500	30,150	15,200	8,360	16,000	9,600	13,500	7,425	20,120	12,072	33,330	33,330
816 040 0000	40	43,000	27,950	32,000	19,200	60,110	33,061	48,825	29,295	41,500	37,350	39,250	21,588	34,000	20,400	26,100	14,355	36,200	21,720	55,550	55,550
816 050 0000	50	65,000	42,250	59,000	35,400	98,600	53,130	58,200	34,920	76,500	68,850	52,000	28,600	58,500	35,100	48,800	26,840	45,500	27,300	79,285	79,285
816 063 0000	63	124,000	80,600	120,000	72,000	134,730	74,102	108,900	65,340	124,000	111,600	99,000	54,450	111,500	66,900	99,000	54,450			142,915	142,915
17	ADAPTOR FEMALE																				
817 020 1200	20 1/2	98,000	63,700	106,000	63,600	93,440	51,392	115,000	69,000	64,500	58,050	83,000	45,650	92,000	55,200	83,600	45,980	77,080	46,248	98,475	98,475
817 020 3400	20 3/4	126,000	81,900			126,680	69,674	155,000	93,000	93,250	83,925	108,500	59,675	112,000	67,200	98,820	54,351	101,610	60,966	116,150	116,150
817 025 3400	25 3/4	130,000	84,500	135,000	81,000	114,820	63,151	180,000	108,000	92,750	83,475	108,600	59,730	112,000	67,200	106,500	58,575	101,610	60,966	116,150	116,150
18	HEXAGONAL ADAPTOR FEMALE																				
818 032 1000	32 1	355,000	230,750	390,000	234,000	284,140	156,277	417,900	250,740	270,000	243,000	321,800	176,990	355,000	213,000	448,740	246,807	233,890	140,334	360,065	360,065
818 040 1140	40 11/4	650,000	422,500	631,000	378,600	522,100	287,155			515,000	463,500	524,400	288,420	578,000	346,800	498,600	274,230	381,150	228,690	951,925	951,925
818 050 1120	50 11/2	700,000	455,000	685,500	411,300	615,770	338,674			550,000	495,000	573,000	315,150	637,000	382,200	541,800	297,990			1,460,965	1,460,965
818 063 2000	63 2	1,240,000	806,000	954,500	572,700	882,760	485,518			815,000	733,500	1,027,000	564,850	1,100,000	660,000	754,200	414,810			2,181,600	2,181,600
19	ADAPTOR MALE																				
819 020 1200	20 1/2	133,000	86,450	144,000	86,400	116,810	64,246	157,500	94,500	100,000	90,000	115,000	63,250	126,500	75,900	113,500	62,425	96,350	57,810	127,765	127,765
819 020 3400	20 3/4	198,000	128,700			129,790	71,385	189,000	113,400	147,000	132,300	182,000	100,100	198,000	118,800	150,000	82,500	119,140	71,484	162,610	162,610
819 025 3400	25 3/4	198,000	128,700	225,000	135,000	152,780	84,029	215,250	129,150	146,500	131,850	181,500	99,825	198,000	118,800	177,500	97,625	124,380	74,628	162,610	162,610
20	HEXAGONAL ADAPTOR MALE																				
820 032 1000	32 1	495,000	321,750	527,000	316,200	423,530	232,942	522,500	313,500	340,000	306,000	439,500	241,725	484,000	290,400	606,690	333,680	350,370	210,222	418,140	418,140
820 040 1140	40 11/4	852,000	553,800	854,000	512,400	764,170	420,294	840,000	504,000	610,000	549,000	715,000	393,250	789,000	473,400	674,100	370,755	438,040	262,824	1,164,025	1,164,025
820 050 1120	50 11/2	875,000	568,750	874,000	524,400	777,190	427,455	887,250	532,350	650,000	585,000	738,200	406,010	813,000	487,800	690,300	379,665			1,431,675	1,431,675
820 063 2000	63 2	1,445,000	939,250	1,438,000	862,800	1,275,760	701,668	1,336,500	801,900	1,200,000	1,080,000	1,212,000	666,600	1,334,500	800,700	1,136,000	624,800			2,242,200	2,242,200
21	ELBOW FEMALE																				
821 020 1200	20 1/2	100,000	65,000	115,000	69,000	91,750	50,463	110,250	66,150	74,500	67,050	91,000	50,050	99,500	59,700	90,500	49,775	81,990	49,194	111,100	111,100
821 020 3400	20 3/4	150,000	97,500			140,510	77,281	159,000	95,400	125,000	112,500	145,000	79,750	158,500	95,100	166,250	91,438			177,760	177,760
821 025 1200	25 1/2	123,000	79,950	122,000	73,200	113,870	62,629	124,950	74,970	100,000	90,000	100,000	55,000	110,500	66,300	95,700	52,635	80,220	54,132	113,625	113,625
821 025 3400	25 3/4	148,000	96,200	148,500	89,100	134,010	73,706	172,000	103,200	124,000	111,600	145,000	79,750	158,500	95,100	117,000	64,350	157,690	94,614	177,760	177,760
821 032 1000	32 1	410,000	266,500	410,000	246,000	360,140	198,077	457,800	274,680	270,000	243,000	345,000	189,750	380,500	228,300	324,000	178,200	350,370	210,222	371,175	371,175
22	ELBOW MALE																				
822 020 1200	20 1/2	146,000	94,900	159,000	95,400	115,690	63,630	173,250	103,950	110,000	99,000	127,500	70,125	140,500	84,300	125,300	68,915	96,350	57,810	183,315	183,315
822 020 3400	20 3/4	220,000	143,000			160,820	88,451	190,000	114,000	177,000	159,300	200,400	110,220	220,500	132,300	181,250	99,688			209,575	209,575
822 025 3400	25 3/4	220,000	143,000	244,000	146,400	184,890	101,690	211,500	126,900	177,000	159,300	200,400	110,220	220,500	132,300	192,600	105,930	175,200	105,120	209,575	209,575

		1/6/96	BORUSAN	1/6/96	ÇAMLICA	8/4/96	EGETHERM	22/4/96	FIRAT	1/1/96	PİLKAR	10/4/96	SARAL SİS.	1/5/96	SPK	28/12/1995	DİZAYN YB	31/5/1996	PİLSA	1DM=	50,500
		BORUSAN	35% DISCOUNT	ÇAMLICA	40% DISCOUNT	EGETHERM	45% DISCOUNT	FIRAT	35% DISCOUNT	PİLKAR	10% DISCOUNT	SARAL SİS.	45% DISCOUNT	SPK	40% DISCOUNT	DİZAYN YB	45% DISCOUNT	PİLSA	40% DISCOUNT	AQUATHERM	
		PRICE TL/m.	PRICE TL/m.	TL/M	PRICE TL/m	TL/M	PRICE TL/m	TL/M	PRICE TL/m.	TL/M	PRICE TL/m.	TL/M	PRICE TL/m.	TL/M	PRICE TL/m.	TL/M	PRICE TL/m.	TL/M	PRICE TL/m.	PRICE TL/m.	
23	T PART FEMALE																				
823 020 1220	20/1/2/20	121,000	78,650	121,500	72,900	108,570	59,714	124,950	74,970	80,200	72,180	98,000	53,900	108,500	65,100	95,700	52,635	105,110	63,066	116,150	116,150
823 025 1225	25/1/2/25	126,000	81,900	126,000	75,600	122,040	67,122	143,500	86,100	115,000	103,500	108,800	59,840	120,000	72,000	99,200	54,560	126,130	75,678	116,150	116,150
823 025 3425	25/3/4/25	160,000	104,000	148,500	89,100	155,380	85,459	189,000	113,400	140,000	126,000	138,800	76,340	153,000	91,800	116,400	64,020	148,920	89,352	196,950	196,950
823 032 1032	32/ 1/ 32	430,000	279,500			440,140	242,077	493,000	295,800			349,500	192,225	385,000	231,000	481,250	264,688	402,940	241,764	467,125	467,125
24	T PART MALE																				
824 020 1220	20/1/2/20	155,000	100,750	157,000	94,200	128,430	70,637	173,250	103,950	116,000	104,400	126,800	69,740	141,000	84,600	123,600	67,980	105,110	63,066	196,950	196,950
26	VALVE																				
826 020 0000	20	365,000	237,250	334,000	200,400	372,240	204,732			207,000	186,300	295,000	162,250	320,000	192,000	262,800	144,540	289,050	173,430	575,700	575,700
826 025 0000	25	385,000	250,250	385,500	231,300	382,880	210,584			266,000	239,400	333,500	183,425	367,000	220,200	304,200	167,310	306,590	183,954	575,700	575,700
826 032 0000	32	620,000	403,000			393,510	216,431					546,800	300,740	603,000	361,800			350,370	210,222	1,641,250	1,641,250
27	CHROMIUM PLATED VALVE																				
827 020 0000	20	893,000	580,450	607,500	364,500	542,190	298,205	421,050	252,630	475,000	427,500	594,000	326,700	599,000	359,400	480,000	264,000			1,237,250	1,237,250
827 025 0000	25	915,000	594,750	713,500	428,100	568,030	312,417	432,600	259,560	505,000	454,500	605,000	332,750	621,000	372,600	564,000	310,200			1,237,250	1,237,250
28	CLAMP																				
828 020 1000	20	7,500	4,875	7,800	4,680	7,450	4,098	7,250	4,350	6,100	5,490	6,000	3,300	7,950	4,770	14,400	7,920	4,200	2,520		
828 025 1000	25	9,500	6,175	9,600	5,760	9,140	5,027	9,140	5,484	7,600	6,840	7,000	3,850	9,800	5,880	16,800	9,240	4,710	2,826		
828 032 1000	32	12,500	8,125	12,600	7,560	16,850	9,268	10,400	6,240	12,000	10,800	8,000	4,400	13,600	8,160	17,820	9,801	5,950	3,570		
29	TWIN CLAMP																				
829 020 2000	20 1/2	14,500	9,425	14,400	8,640					12,300	11,070	14,200	7,810	15,850	9,510	10,125	5,569	8,140	4,884		
829 022 2000	22 1/2	14,500	9,425									17,500	9,625	15,850	9,510						
829 025 2000	25 3/4	17,000	11,050	16,800	10,080					14,000	12,600			19,600	11,760						
829 027 2000	27 3/4	17,000	11,050											19,600	11,760						
30	THREADED CAP																				
830 020 1200	20 1/2	7,800	5,070	7,800	4,680	12,770	7,024	7,700	4,620	10,500	9,450			7,950	4,770	7,800	4,290	4,400	2,640		
830 025 3400	25 3/4	9,500	6,175	9,000	5,400	23,490	12,920	9,350	5,610	11,600	10,440			9,800	5,880	9,000	4,950	4,900	2,940		
							%40+10 30 days														
					%40 for 2 months		%40 1-2-3 months check in series								%35+5+3						
		Al. foil Reinforced Plastic pipes			%25 for 2 months		Advanced sales %40+22								2 months						

Appendix G

The Data to Determine the annual Production

The Calculation of Annual Production

Table 5.

The data to determine the annual production of extruders

The consumption of other Vesbo PP pipes with different diameters for every 100m. 1/2" (20mm.) Vesbo PP pipes.

Dimension	Name	Unit	Borsaç	Kayatepe	Borsaç/ Kayatepe Average
20x3.4	PP pipe	meters	100	100	100
25x4.2	PP pipe	meters	50	36.5	43.2
32x5.4	PP pipe	meters	20	15	17.5
40x6.7	PP pipe	meters	7	7.7	7.4
50x8.4	PP pipe	meters	1	2.1	1.6
63x10.5	PP pipe	meters	0.7	1.1	0.9

The data to determine the annual production of fittings

The consumption of 20mm. diameter fittings for every 100m. 20mm. diameter PP pipes

Dimension	Name	Unit	Borsaç	Kayatepe	Borsaç/ Kayatepe Average
20x3.4	PP pipes	meters	100	100	100
20	Socket	units	25	26.1	25.55
20	90^0 Elbow	units	100	83.8	91.9
20	45^0 Elbow	units	1.5	0.2	0.85
20	T Part	units	30	30.9	30.45
20	Valve	units	2	1.7	1.85
20	Clamp	units	20	14.2	17.1
20	Twin Clamp	units	8	0.1	4.05
20	Cap	units	2.1	2.1	2.1
20	Pipe Bridge	units	6	4.6	5.3
20x1/2"x20	W. Conn. Elbow Female	units	6	12.5	9.25
20x3/4"	Adaptor Female	units	-	-	0
20x1/2"	Adaptor Female	units	5.5	5	5.25
20x3/4"	Adaptor Male	units	-	-	0
20x1/2"	Adaptor Male	units	5.6	9.4	7.5
20x3/4"	Elbow Female	units	-	-	0
20x1/2"	Elbow Female	units	27	26.9	26.95
20x3/4"	Elbow Male	units	-	-	0
20x1/2"	Elbow Male	units	5	3.1	4.05
20x1/2"x20	T Part Female	units	8	7.2	7.6
20x1/2"x20	T Part Male	units	0.4	0.8	0.6
20	Threaded Cap	units	20	18.8	19.4

Table 6.

The calculation of annual production of extruders and injection machines

The calculations below are done considering;

85 % efficiency, 3% scrap, and 6000 theoretical working hours annually.

According to the research conducted in the market the consumption of other pipes for each 100m. 20mm.diameter pipes are as follows,
(Resource; Vesbo pipes sales of Borsaç and Kayatepe dealers)

Diameter (mm.)	Sales (m.)	Production Speed (m/min.)
20	100	16.7
25	43	13.2
32	17.5	9
40	7.4	4.5
50	1.6	2.9
63	0.9	1.85

Question:
Given this data, what should be the ratio (%) of each different diameter pipes for a given production period?
Note: sales=production.

Answer:
In line with the production speeds of each pipe, the production in unit time is;

16.7x+13.2y+9z+4.5p+2.9r+1.85w=A meters. **.(1)**
and x+y+z+p+r+w=1unit time **.(2)**
where,
x= the time allocated for the production of 20mm. pipes.
y= the time allocated for the production of 25mm. pipes.
z= the time allocated for the production of 32mm. pipes.
p= the time allocated for the production of 40mm. pipes.
r= the time allocated for the production of 50mm. pipes.
w= the time allocated for the production of 63mm. pipes.

A meters of sales=A meters of production. **.(3)**

With a simple calculation, in every 170.4 m (100+43+17.5+7.4+1.6+0.9= 170.4)
we sell 100m. 20mm. diameter pipe.

the ratio of 20mm. diameter pipes then correspond to (100A)/170.4 of total production.
Taking Production= Sales
Then the formula will be;

16.7x=100A/170.4 x=100A/(170.4x16.7)
Similarly,

13.2y=43A/170.4	Which can be transformed to;	y=43A/(170.4x13.2)
9z=17.5A/170.4		z=17.5A/(170.4x9)
4.5p=7.4A/170.4		p=7.4A/(170.4x4.5)
2.9r=1.6A/170.4		r=1.6A/(170.4x2.9)
1.85w=0.9A/170.4		w=0.9A/(170.4x1.85)

Then equation (2) becomes,
100A/(170.4x16.7)+43A/(170.4x13.2)+17.5A/(170.4x9)+7.4A/(170.4x4.5)+1.6A/(170.4x2.9)+0.9A/(170.4x1.85)=1
A= 170.4/13.8658
A= 12.2892

Replacing the value of A, x is then
x= 0.43

x= 43%

similarly, y= 23.50%

z= 14.10%

p= 11.90%

r= 3.90%

w= 3.60%

then the annual production for each diameter pipe can be calculated as follows:

for 20mm. diameter pipes= 6000hrx60 minx0.85 efficiencyx0.97productivityx16.7m/min pr. speedx0.43
= 2,131,464 meters.

similarly,

Diameter (mm.)	annual production for every different diameter pipe (m.)
20	2,131,464
25	920,736
32	373,993
40	157,611
50	33,570
63	19,220
TOTAL	3,636,594 meters.

Table 7.

then, considering 15% scrap for the injection machines, the annual production of each fitting is:

20	Socket	=25.55x2,131,464x0.85/100	=	462,901 units
20	90^0 Elbow	=91.9x2,131,464x0.85/100	=	1,664,993 units
20	45^0 Elbow	=0.85x2,131,464x0.85/100	=	15,400 units
20	T Part	=30.45x2,131,464x0.85/100	=	551,676 units
20	Valve	=1.85x2,131,464x0.85/100	=	33,517 units
20	Clamp	=17.1x2,131,464x0.85/100	=	309,808 units
20	Twin Clamp	=4.05x2,131,464x0.85/100	=	73,376 units
20	Cap	=2.1x2,131,464x0.85/100	=	38,047 units
20	Pipe Bridge	=5.3x2,131,464x0.85/100	=	96,022 units
20x1/2"x20	W. Conn. Elbow Female	=9.25x2,131,464x0.85/100	=	167,586 units
20x1/2"	Adaptor Female	=5.25x2,131,464x0.85/100	=	95,117 units
20x1/2"	Adaptor Male	=7.5x2,131,464x0.85/100	=	135,881 units
20x1/2"	Elbow Female	=26.95x2,131,464x0.85/100	=	488,265 units
20x1/2"	Elbow Male	=4.05x2,131,464x0.85/100	=	73,376 units
20x1/2"x20	T Part Female	=7.6x2,131,464x0.85/100	=	137,693 units
20x1/2"x20	T Part Male	=0.6x2,131,464x0.85/100	=	10,870 units
20	Threaded Cap	=19.4x2,131,464x0.85/100	=	351,478 units

Appendix H

Borealis Prospectus

BOREALIS

BOREALIS TECHNICAL FILE ON PP-R FOR HOT WATER PIPES, RA130E

BOREALIS

1. INTRODUCTION

A general overview of the current status for PP-r as a material in hot water pipe systems is given in an article,"PP-r for hot water pipes - the continuing success story" by R. Bresser, C. Lind and R. Åsman. The article discusses the market development for PP-r hot water systems, the advantages of the systems in hot water installations and the quality aspects of random copolymer pipe materials in different applications.

2. PP-R FOR HOT WATER

2.1. RA130E products

Borealis PP-r RA130E is a high molecular weight low-MFR propylene-ethylene random copolymer. It is available in the following colours:

Colour	Grade name	Remark
Natural	RA130E	
Grey	RA130E-8427	RAL 7032
Black	RA130E-8229	
Opaque blue	RA130E-2491	
Opaque dark blue	RA130E-2492	
Opaque light green	RA130E-4352	
Opaque dark green	RA130E-4347	
Opaque beige	RA130E-7544	
Opaque brown	RA130E-5326	
White	RA130E-1413	
Opaque red brown	RA130E-5324	only for floor heating

Some colours are shown on the cover of this document.

In some countries, such as Germany and Italy, different colours are used by different pipe system producers or pipe system suppliers as a trademark for their systems. In others, such as the Czech Republic, a predominant colour is used by tradition for PP-r hot water systems to serve as an identification colour.

For special requests regarding colours, please contact your Borealis representative.

2.2. RA130E production

RA130E products are produced at Borealis' Porvoo site in Finland and at Beringen in Belgium. Both the Porvoo and the Beringen plants are certified according to ISO 9002 (under BS 5750 Part 2).

BOREALIS

2.3 Classification and designation

RA130E is recommended for pressure-pipe manufacturing and injection moulding of fittings for use at elevated temperatures, in application areas such as domestic drinking water, radiator connections, floor heating, or industrial applications, according to the relevant standards and specifications covering PP-r systems.

DIN designation according to DIN 16744:

- RA130E,	PP-R, EHN, 85, M 003
- RA130E coloured grades	PP-R, ECN, 85, M 003

ASTMD classification according to ASTMD 2146 -

- RA130E,	Type II-1 5 0 0 0

SEM classification according to ISO/DIS 12162,2/SEM-ISO/TR 9080:

- At 20°C and 50 years,	MRS 8.0 MPa (PP80)

3. PHYSICAL PROPERTIES

3.1 Mechanical and thermal properties

A list of general mechanical and thermal properties is given in Table 1. The mechanical properties have been measured on injection-moulded test specimens.

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Table 1: Mechanical and thermal properties of RA130E

Property	Test method	Result
Tensile strength at yield	ISO 527/1A, 50 mm/min	26,1 MPa
Tensile strength at break	ISO 527/1A, 50 mm/min	21,5 MPa
Elongation at break	ISO 527/1A, 50 mm/min	>400 %
Tensile Elastic Modulus	ISO 527/1A, 50 mm/min	808 MPa
Flexural Modulus	ISO 178, 2 mm/min	874 MPa
Flexural Strength	ISO 178, 2 mm/min	30,5 MPa
Charpy, notched at	ISO 179/1A	
23°C	1.00 J	22.9 kJ/m²
0°C	0.50 J	4.5 kJ/m²
-20°C	0.50 J	1.9 kJ/m²
Charpy, unnotched at	ISO 179/1D	
23°C	4.0 J	NB
0°C	4.0 J	NB
-20°C	4.0 J	53.7 kJ/m²
Izod, notched at	ISO 180/1A	
23°C	2.75 J	22.5 kJ/m²
0°C	1.0 J	5.6 kJ/m²
-20°C	1.0 J	3.4 kJ/m²
Izod, unnotched at	ISO 180/1C	
23°C	5.5 J	NB
0°C	5.5 J	NB
-20°C	2.75 J	38.4 kJ/m²
Shore D Hardness (15 sec value)	ISO 868	60
Rockwell Hardness	ISO 2039-2	50
Vicat Softening Temperature	ISO 306, method A, 50K/h	131.3°C
Melting range	ISO 3146-19	142.4°C
Specific heat at 20°C	DSC	2.0 J/g K
Coefficient of thermal expansion (30-90°C)	Dilatometer	1.8×10^{-3} /K
Thermal Conductivity (10-60°C)	DIN 52 612	0.21 W/m°C
HDT	ISO 75, method A	45.2°C

3.2 Hydrostatic pressure testing - Creep rupture diagrams

Basic documentation of the pressure resistance of RA130E material has been performed at the Studsvik Material Test Institute in Sweden. More than 400 pipes have been tested at different temperatures and in different environments:

Test laboratories:	Studsvik Material Test Institute Sweden, Borealis
Test method:	ISO 1167
Temperatures:	20 - 120°C
Environments:	water/water water/air

Figure 1: Creep rupture diagram for RA130E versus DIN E 8078 (1989)

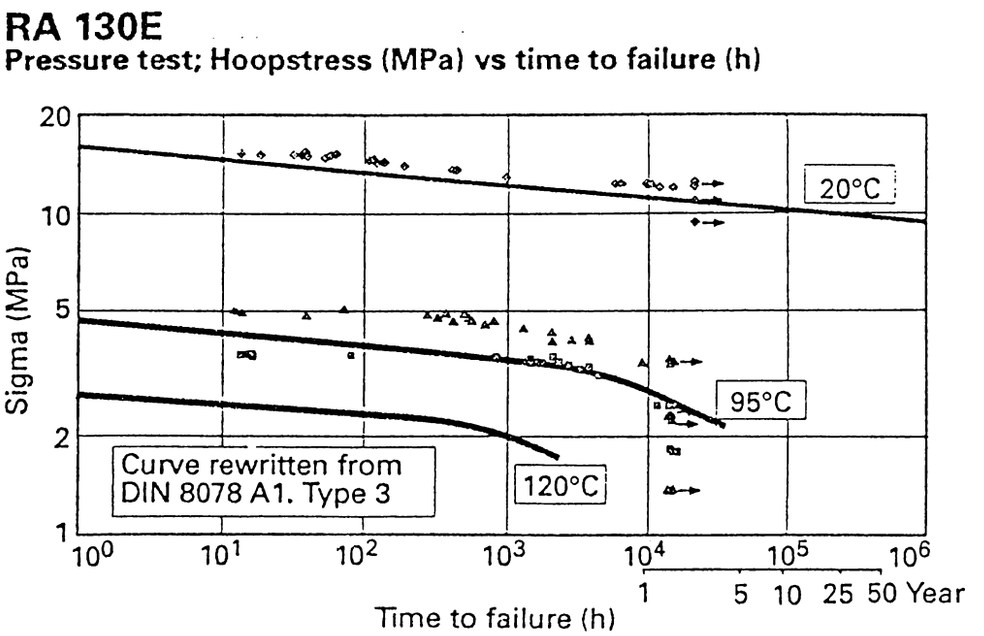


Figure 1 shows pressure test results for RA130E in comparison with the minimum hoop stress curves according to DIN E 8078, Aug 1989, type 3 material at 20, 95 and 120°C.

Figure 2: Creep rupture diagrams for RA130E versus CEN draft SS25: Part2

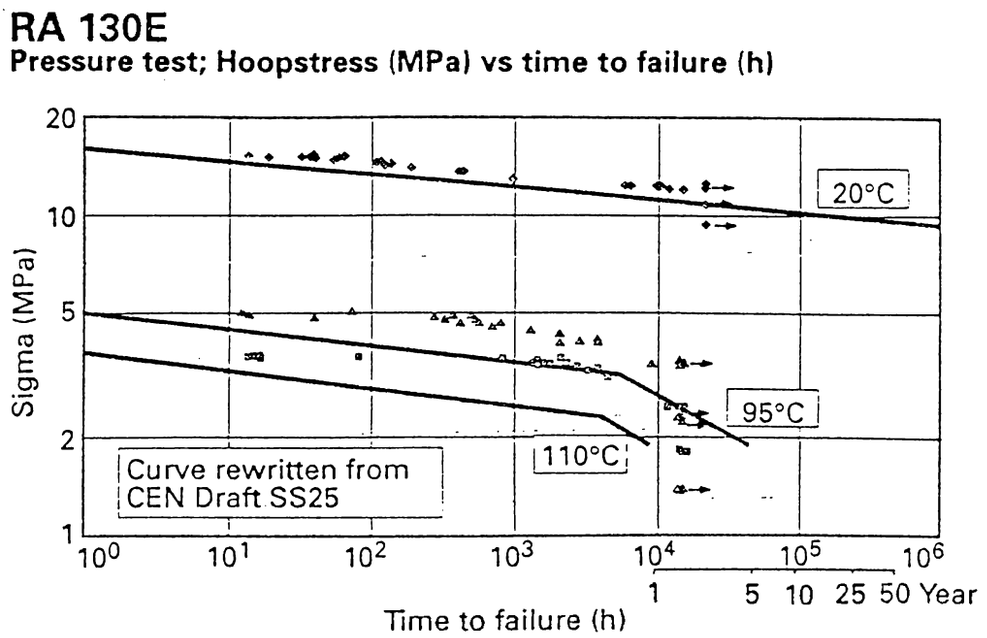


Figure 2 shows the pressure test results for RA130E in comparison with the proposed minimum curves in CEN draft SS 25 for PP-r at 20, 70, 95 and 110°C . The minimum curves are identical to the curves in DIN E 8078 (1994).

3.3 Chemical resistance

Generally speaking, the chemical resistance of PP is very good. PP has a somewhat higher temperature resistance than PE. Information is provided below on the chemical resistance of PP for some major groups of chemicals, for use in areas such as industrial pipe applications. More detailed information on chemical resistance to specific chemicals is given in ISO/TR 7471.

Non-organic salts
PP has a very good resistance to water solutions of non-oxidative salts. However, at elevated temperatures above 70°C and at high concentrations, certain metal ions, such as copper, can accelerate the thermal oxidation of the material.

Non-organic acids
PP has a very good resistance to non-oxidative acids, even at elevated temperatures. Its resistance to oxidative acids, such as sulphuric acid, in concentrations above 60% is less good, especially at elevated temperatures; this also applies to nitric acid. Compared to sulphuric acid, nitric acid easily migrates into PP. Hydrochloric acid does not immediately react chemically with PP, but will migrate into the material and influence its mechanical properties in concentrations above 30%, especially at elevated temperatures.

Alkalis
PP has a good resistance to alkalis. Creep resistance can be affected, however. In 30% sodium hydroxide at 80°C, creep resistance is 0.7 of that in water.

Chlorine and chloro-dioxide act corrosively on PP.

Organic substances
Organic acids, alcohols, or esters usually do not react with PP. However, they do swell the material, and influence mechanical behaviour. A cautious approach is recommended for PP in organic substances if mechanical strain is present.

3.4 Resistance to weathering/UV

UV radiation resistance for black RA130E-8229 is under evaluation. After 2,000 hours exposure in a weather-o-meter (WOM), which corresponds to approximately 1 to 2 years outdoors, the mechanical properties of pipe test specimens remain virtually unchanged (see Table 2).

Table 2: Weather-o-meter testing of RA130E-8229, DIN 53 387, tensile test results

Property, ISO 62598	Reference 0 h	After 500 h in WOM	After 2000 h in WOM
Elongation at yield	12,3 %	14,4.%	13,8%
Stress at yield	24,7 MPa	29 MPa	29,3 MPa
Elongation at break	690,3 %	711,4%	849,8%
Stress at break	33 MPa	34,5 MPa	41,4 MPa

Outdoor ageing of RA130E-8229 pipes is ongoing. The other coloured versions of RA130E are only intended for indoor use, and should be suitably packaged and/or stored inside prior to installation at a building site.

3.5 Effects of copper and brass

When subjected to lengthy exposure of copper ions at elevated temperatures, polypropylene show a deterioration of the physical properties. Its properties in applications are not adversely affected by direct contact with brass at temperatures below 60°C, however. Brass couplings may be used therefore to connect RA130E pipes.

3.6 Rheological data

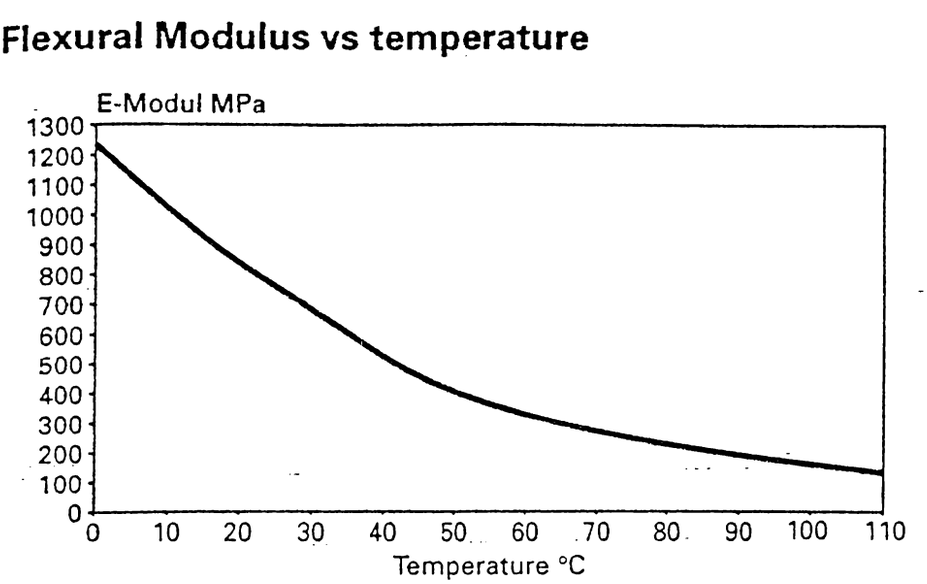
As polymers flow when molten, rheological data are measured at elevated temperature. Such data provides information about a material's response to stress and can be used to determine processing properties.

The rheological characteristics of RA130E have been measured on a Göttfert rheograph 2002 at 210 and 230°C with a die of L/D=20/1.The apparent viscosity at 100 s-1 and 210°C is ~1500 Pas. Rheological measurements can be carried out on request.

3.7 Modulus of elasticity as a function of temperature

Flexural modulus is a measure of the stiffness of a pipe at a certain temperature. The flexural modulus according to ISO 178 has been measured at a temperature interval of 0°C to 110°C (see Figure 3).

Figure 3: Flexural modulus for RA130E according to ISO 178



3.8 Resistance to slow crack growth

Damage to pipes and fittings should be avoided wherever possible during installation.

To test resistance to such damage, pre-notched pipes have been pressure-tested at 80°C, and notched test specimens from plaques have been subjected to constant tensile load at 80°C (see Tables 3 and 4).

Table 3: RA130E, notch testing at 80° C, 110 mm pipes SDR11

Notch testing of pipes.	
Test method:	EN 33479, ISO/CD 13479, BGC/PS/PL2:Part 2
Test specimen:	110 mm SDR 11 pipes with notch 19,5%
Test conditions:	80°C at 4,6 MPa and 4,0 MPa nominal stress
Result:	At 4,6 MPa >6520 h, At 4,0 MPa >12070 h
Test laboratory:	Borealis, SC Pipe, and Swedish National Testing and Research Institute, Sweden.

Table 4: RA130E, slow crack growth resistance according to the "PENT test method"

PENT testing on plaques.	
Test method:	ASTM draft
Test specimen:	10 mm moulded plaques, notched, nominal stress
Test conditions:	80°C
Result:	2,8 MPa >1000 h 2,4 MPa >1000 h
Test laboratory:	Borealis, SC Pipe.

The tests show that no dramatic influence could be detected relating to slow crack growth in static loading conditions in the case of RA130E. This applies for the chosen test period and the chosen stress levels.

3.9 Thermal conductivity / heat transfer

The thermal conductivity of PP-r is of interest for floor heating applications, where heat is transferred from the hot water in the pipe to the surroundings.

The thermal conductivity measured according to SS 024211/DIN 52 612 at 10° C is 0.21 W/m° C. The thermal conductivity value for RA130E can be considered as practically constant between 10 and 60° C.

4. PHYSIOLOGICAL PROPERTIES

4.1 Conformance with toxicological requirements

The chemical composition of RA130E products conforms to national and international regulations for materials in contact with drinking water.

The chemical composition of RA130E has been examined by the VTT Food Research Laboratory in Finland, and has been found to be in accordance with:

- The monomer list in Decision 260/92 of the Ministry of Trade and Industry.
- The monomer list in the European Community Directive 90/128/EEC and its amendments 92/93/EEC and 93/9/EEC.
- The positive list of BGA (Bundesgesundheitsamt Germany) on polypropylene
- The positive list of KTW recommendations (Germany) on polypropylene coming into contact with water.

VTT has found that RA130E meets the requirement of Decree 539/91 (Directive 89/109/EEC) with regard to composition.

RA130E fulfils the requirements on products for food contact in the following countries:

Belgium
Germany
Great Britain
Italy
The Netherlands
Spain
U.S.A
EEC

For further information or the issue of a certificate, please contact your Borealis representative.

4.2 Organoleptic properties

The organoleptic properties of pipe materials and pipes and fittings, including taste and odour, are regulated by specifications in some countries, such as Britain, Denmark, and Germany. In others, no such regulations exist.

Pipes of RA130E have been tested and approved according to the German KTW regulations by the Hygienic Institute in Gelsenkirchen and by Technologiezentrum Wasser (TZW) in Karlsruhe, for both cold and hot water (60° C).

The KTW recommendations for drinking water coming into contact with plastics can be divided into:

1. Influence on colour, transparency, odour, taste, and foam.
2. Emission of organic compounds
3. Consumption of free chlorine

Borealis is well-equipped for taste and odour testing. A specific calibrated test panel performs tests according to the German KTW regulations:

- pellets test 70° C, 4 h (proposed test in Germany)
- pipe test 60° C, 3 x 2 h, qualification test for hot water pipes
- pipe test 20° C, 3 x 24 h, qualification test for cold water/hot water pipes

The test panel is constantly calibrated with one of the test institutes in the field, such as Technologi Zentrum Wasser (TZW) in Karlsruhe Germany, which tests organoleptic properties for drinking water pipes.

Taste and odour testing is regularly carried out on production samples of RA130E, and forms an integrated part of our quality system. Taste and odour testing on pellets and pipes can be performed on request, eg. quality check on pipe production/type testing.

5. PIPE SYSTEM STANDARDS AND CODES OF PRACTICE

The following section describes the standard situation for PP-r in terms of standards and codes of practice. Information is given on the most important existing standards and/or specifications, and draft specifications and standards, applicable to RA130E. Compliance of RA130E products with the main specifications is shown.

5.1 General overview

The first country to issue specifications for PP-r in hot and cold water applications was Germany, in the shape of DIN E 8077/E 8078, 1989. These "Entwurf" (draft) standards are referred to in other specifications. According to German practise, references to these published draft standards can be given before they are processed into a final DIN. Within Europe (EEC/EFTA), there is a standstill agreement for standardization in prioritized areas, such as PP for hot water systems. This means that no final standards will be published before the upcoming European CEN standard.

The requirements given in DIN E 8077/E 8078,1989 have been used as the basis for specifications and regulations in most other countries using PP-r for hot water pipes, such as the Czech Republic, Poland, Austria, and Italy.

5.1.1 European standardization

Work is ongoing at the European level on a system standard for hot water pipes, under CEN/TC 155/WG 16 -System standard 25; "Plastics piping system for hot and cold water - Polypropylene (PP)"

The current timetable envisages a published standard in 1997.

5.1.2 German standards

Standardization work has been going on in Germany to adapt DIN 8077/DIN 8078 to the upcoming CEN standard requirements, based on 70° C and 50 years lifetime expectancy for PP-r compound, as against the previous parameters of 60° C and 50 years lifetime expectancy. New draft standards ("Entwurf") have been issued (see Section 5.2).

The most commonly used standards for PP pipes today are the German ones. A list of standards applicable to PP-r pipe systems is given below:

DIN 1988
Drinking water supply installations on premises; specifications for installation and service.

DIN 4109
Sound-proofing in buildings; sound-proofing in water piping

DIN 16 774
Plastic moulding materials, polypropylene and propylene copolymer thermoplastics; classification and designation.

DIN 16 887
Testing of thermoplastic pipes; determination of behaviour under long-term internal pressure

DIN 4725
Hot water floor heating systems; thermal testing

DIN 4726
Pipelines of plastic materials used in warm water floor heating systems; general requirements.

DIN 4728
Pipelines of polypropylene type 2 and type 3 used in warm water floor heating systems; special requirements and testing

DIN 8076
Pipelines of plastic materials under pressure; screwed metal joints for pipes of PE; general quality requirements and test methods.

DIN 8077
Polypropylene (PP) pipes; dimensions.

DIN 8078
PP pipes; general quality requirements and testing

DIN 16 928 T1-T11
Thermoplastic pipes, pipe fittings, elements for pipes, installations

DIN 16 960
Welding of thermoplastic materials; general directions.

DIN 16 962
Pipe joint assemblies and their elements for type 1, type 2 and type 3, polypropylene (PP) - pressure pipelines; general quality requirements, testing.

DVS 2203
Tests of pipe fittings for welding of thermoplastic materials.

DVS 2207, part 11
Welding of thermoplastic materials, PP type 1 and 2, pipes and accessories.

DVS 2208, part 1
Machines and equipment for welding thermoplastic materials, fusion tool welding.

DVGW EW 534
Connecting pipe elements and pipe connections for pipes in drinking water installation; requirements and testing

5.2 Compliance of RA130E with DIN 8077/8078

DIN 8077/8078 are the base standards for PP pipes and cover general quality requirements and related testing procedures. Special requirements for specific applications, frequency of testing, and monitoring are prescribed by specialist organizations in Germany, such as the Waterworks specifications (NAW), "Gütegemeinschaft Kunststoffrohre" (GKR) and "Deutscher Verein des Gas- und Wasserfaches e.V. " (DVGW).

Over the years, different versions of DIN8077/8078 have been utilized and are utilised in Germany and other countries:

DIN 8077, 01. 1989 (PP-h, PP-b)
DIN 8078, 04. 1984 (PP-h, PP-b)
DIN E* 8077/A1, 08. 1989 (PP-r amendment) not valid/replaced by DIN 8077, 06. 1995
DIN E 8078/A1, 08. 1989 (P-r amendment) not valid/replaced by DIN E 8078, 04. 1994
DIN E 8077, 06. 1995 (PP-h, PP-b, PP-r)
DIN E 8078, 04. 1994 (PP-h, PP-b, PP-r)

*E stands for "Entwurf", i.e. draft standard.

The conformance of RA130E to the above standards is shown in the paragraph. Versions of DIN E 8077/E8078 that are no longer valid are included since the requirements stated in these old versions are still used in industry specifications and national specifications in countries outside Germany.

5.2.1 DIN 8078/DIN E 8078/A1, 1989 - PP pipes, general quality requirements and testing

The PP-r polymer/product shall in pipe form fulfil the minimum pressure test curves shown in DIN E 8078 (1989). This is shown for RA130E in Section 3.2.

The PP-r material used in production of pipes shall be characterized according to DIN 16 774, Teil 1 as follows. (see Section 2.3 for the classification for RA130E)

PP-R,E,H,85 T 003 (006 or 012)

PP= Polypropylene
R=Random copolymer
E=Extrusion
H=Heat stabilized
85=Isotacticity Index
T=MFR 190° C/5kg
T...=MFR group 003, 006 or 012

The quality requirements for pipes are contained in Chapter 3 of DIN 8078/DIN E 8078/A1, 1989 and are summarized in Table 5.

Table 5: DIN 8078/DIN E 8078/A1 PP pipes, general quality requirements and testing

Characteristic	Unit	Require-ment	Test parameters				Test method	RA130E result
			Hydrostatic stress MPa	Temp °C	Mass kg	Duration h		
Hydrostatic strength	h	no leakage or bursting	16 2.1 3.6 2.9	20 and 120 or 95 95		1 1000*) 1000 8000**)	DIN 53 759	> 10 > 7000 > 10000 > 15000
Longitudinal reversion	%	< 2		135 ±2		2±0.03	DIN 53 752 DIN 50 011 part 1 (oven)	< 2
Impact resistance	%	< 10		0±2			DIN 53 453 DIN 51 222	No failure

*) Quality control to be performed at the start of production and material or supplier is changed.

**) Quality control when production is started and/or material or supplier changes

Impact testing
A minimum 10 test pieces is used (see Table 6). If the number of failures is larger than one, testing should be repeated on 20 specimens from the same pipe. The failure ratio from the total number of tested specimens should then be calculated.

Table 6: Test specimens for impact testing according to DIN 8078.

Shape of test specimen	Pipe		Test specimens			Distance between supports
	Outer diameter d_y mm	Wall thickness e mm	Length mm	Width mm	Height mm	mm
1	< 25	e	(100±2) mm long piece cut from the pipe			70
2	≥ 25	≤ 4.2	50±1	6±0.2	e	40
3	> 25	> 4.2	120±2	15±0.5	max 10.5	70

Longitudinal reversion

After cooling the test specimen to 23° C, the distance between the marks is measured to 0.25 mm precision (see Table 7).

Table 7: Test specimen from a longitudinal reversion test according to DIN 8078

Shape of test specimen	Pipe		Test specimens			Distance between marks
	Outer diameter d mm	Wall thickness e mm	Length mm	Width mm	Height mm	mm
1	< 200	= e	200 mm long piece cut from the pipe in axial direction			100 (50 from ends)
2	> 200	= e	200	200	=e	100

As a guideline, typical physical properties for PP-r polymers are given in DIN E 8078/A1. These are shown in Table 8.

Table 8: Typical physical properties of PP-r polymers for hot water pipes

Properties	Type 3
Density (tested according to DIN 53 479)	- 0.9 g/cm³
Mean linear thermal coefficient of expansion from 0 to 110°C (tested according to DIN 53 752)	- 1.5 $10^{4}K^{-1}$
Heat conductivity (tested according to DIN 52 615 Teil 1)	- 0.24 W K^{-1} m^{-1}
Modulus of elasticity (tested according to DIN 53 457)	- 800 N/mm²
Surface resistance (tested according to DIN 53 482/VDE 0303 Teil 2)	> 10^{12} Ohm

5.2.2 DIN 8077/DIN E 8077/A1-PP pipes; dimensions

DIN E 8077/A1, 1989/DIN 8077 covered the dimensioning of pipes fulfilling DIN 8078/DIN E 8078/A1, 1989.

5.2.3 Compliance of RA130E with DIN E 8078 (1994)

A revised DIN E 8078 (1994) has been issued. There are principally two changes in the requirements between the 1994 version of DIN E 8078 and the 1989 version. These refer to the pressure resistance of pipes in Section 3.4 and the regression curves. The requirements covering longitudinal reversion and impact resistance remain unchanged.

The new quality requirements on pipes for PP-r are shown in Table 9.

Table 9: PP-r, quality requirements for pressure testing according to DIN E 8078 (1994)

Test temperature °C	Test media	Wall tension Sigma N/mm²	Minimum time h	RA130E Result
20	Air or water	16	1	> 10
95	Air or water	3.5	1000	> 8000*)
110	Air	1.9	8760**)	> 15000

*) Calculated value from test data at higher and lower stress values

**) Quality control when production is started and/or material or supplier changes

Compliance with the minimum curves for PP-r (also see Section 3.2) also needs to be shown by DIN 16 887 "Testing of thermoplastic pipes; determination of the behaviour to long term internal pressure". The requirements of this standard are summarized in Appendix 3.

5.2.4 DIN E 8077, 1995 - PP pipes; dimensions

A revised DIN E 8077 has been issued in 1995. This covers all three PP types for pipes; PP-h, PP-b and PP-r. Other changes have been implemented compared to DIN 8077 and DIN E 8077/A1. The maximum outer pipe diameter has now been set at 1600 mm, and tolerances for outer diameters and wall thicknesses have been modified.

The pipe dimensions are shown in Appendix 1. There are seven pipe series called "Reihe 1-7". The corresponding SDR or S values are given in the table. By convention, a PN name is used referring to a nominal pressure at 20° C. The maximum allowable pressure for different PP-r pipe series are given in Appendix 2. These pressures have been calculated from the regression curves in DIN E 8078. An example is given below on how to use DIN E 8077.

Example:

Hot water service pipe in PP-r

Service conditions:	70° C/50 years
Operating pressure:	10 bar
Outer diameter:	20 mm

What pipe dimension could be used?

Go to Table 8 in Appendix 2. At 70° C and 50 years, the closest maximum allowable working pressure compared to 10 bar is 10.7 in pipe series 7. Looking at Table 1 in Appendix 1, we can obtain a thickness of 4.0 mm for an outer diameter of 20 mm.

The resulting pipe dimension will be 20 x 4 mm.

5.3 Compliance of RA130E with CEN draft SS 25, EN [155wi025]

The CEN System Standard 25 (Plastic piping systems for hot and cold water, Polypropylene - PP) will eventually be structured into 6 or 7 different parts:

Part 1: General
Part 2: Pipes
Part 3: Fittings
(Part 4: Auxiliary equipment)
Part 5: Fitness for purpose
Part 6: Code of practise
Part 7: Assessment of conformity

Parts 1, 2, 3, 5, and 7 are currently under preparation. The important sections of Part 1 and 2 are described below with references to the performance of RA130E.

5.3.1 CEN draft SS 25: Part 1: General

Part 1 specifies the general aspects of polypropylene pipes, fittings, and components for hot and cold water systems within buildings. The service conditions are classified in 4 groups for 4 different applications.

Table 10: Temperature - application classes

Class	Typical field of application
1	Hot water supply 60°C
2	Hot water supply 70°C
4	Underfloor heating and low temperature radiators
5	High temperature radiators
20°C for 50 y	Cold water supply

Material
The standard is applicable to polypropylene homo polymer, block copolymer, and random copolymer. Some typical pipe material characteristics for PP-r are shown in Table 11:

Table 11: Typical pipe material characteristics for PP-r as given in CEN draft SS25 part 1

Characteristic	Unit	Value for PP-r	Test method
Modulus of elasticity	MPa	-800	ISO 527
Melt flow rate MFR 230/2.16	g/10 min	< 0.5	ISO 1133, cond 12
or MFR 190/5 of raw material	g/10 min	< 1.0	ISO 1133, cond 18

Effect on water quality
European-level requirements have not yet been set. At the moment, the only requirement is that all components in contact with potable water must meet the water quality and health regulations in the country of use. Furthermore, it is stated that all materials in contact with water intended for human consumption must not affect water quality to such an extent as to be in contravention of the EC-Council Directive 80-778-EEC, Pb. Nr. L 229-11, 74/869 and 75/449.

5.3.2 CEN draft SS 25: Part 2: Pipes

Part 2 specifies the characteristics of PP pipes to be used in hot and cold water systems.

Material characteristics
Pipe material shall be pressure-tested and evaluated in accordance with EN 155wi052 (ISO TR 9080) or an equivalent method. The LCL value shall be at least as high as the corresponding values in the plot for PP-r. The conformance of RA130E is shown in Section 3.2.

Geometrical characteristics
To demonstrate how to use CEN SS 25 for pipe dimensioning, we will take the same example we used for DIN 8077 (see Section 5.2.2)

Example: Hot water pipe in PP-r, 70° C

Service conditions: Specified in CEN draft SS 25 part 1, table 1 class 2
Operating pressure: 10 bar
Outer diameter: 20 mm

Go to CEN draft SS 25 Part 2 Table 3, Appendix 4. For class 2 and Poper =10 bar, we get Smax = 2.1. Going to Table 4 (SS 25 part 2) Appendix 5, we have to choose the nearest lower value to 2.1 in the table, i.e. 2.0. For an outer diameter of 20 mm, we obtain a thickness of 4.0 mm. This is the same result that we obtained when applying the dimensioning rules in DIN E 8077.

The resulting pipe dimension is 20x4.0 mm.

Mechanical characteristics
The PP-r pipe shall conform to the requirements in Table 12.

Table 12: Pressure test requirements for PP-r pipes

Characteristic		Requirement	Test parameters			Test method	RA130E result
			Hydrostatic stress MPa	Temp °C	Duration h		
Resistance to internal pressure	a)	No leakage or bursting	16.0	20	1	EN 155wi052	> 10
	b)	No leakage or bursting	4.2	95	22		> 2000
	c)	No leakage or bursting	3.8	95	165		> 8000*)
	d)	No leakage or bursting	3.5	95	1000		> 9500

*) Calculated value

Physical and chemical characteristics for PP-r

The requirements for physical and chemical characteristics for pipes are given in Table 13.

Table 13: Physical and chemical characteristics of PP-r pipes

Characteristic	Unit	Requirement	Test parameters			Test method	RA130E result
			Hydrostatic stress MPa	Temp °C	Duration h		
Longitudinal reversion e: < 8 mm e: 8 - 16 mm e: > 16 mm	%	< 2		135	 1 2 4	EN 155wi056 method B Oven	< 2%
Impact resistance	%	< 10		0		ISO/DIS 9854	No failure
Melt flow rate (compound)	g/10 min	≤ 0.5 ≤ 1.0		230 190		ISO 1133, Cond 12 ISO 1133, Cond 18	0.3 0.5
Melt flow rate (pipe)	g/10 min	30 % max difference compared with compound		230		ISO 1133	
Thermal stability by hydrostatic pressure		No leakage or bursting	1.9	110	8760	EN 155wi052	> 15000

5.4 RA130E approvals

5.4.1 Material approvals

It is rare for material approvals to be given for PP-r products for hot water applications. The common practise is for pipe/fitting producers to have an approval for a pipe system based around a certain PP-r product.

RA130E does, however, have [illegible] approval [illegible] and Slovakia. The requirements for [illegible] to DIN E 8[illegible] (1993).

Süddeutsche Kunststoff Zentrum (SKZ) has issued a letter stating that RA130E is suitable for hot water systems and stating its conformance to DIN E 8077/E 8078 (1989).

5.4.2 Pipe/fitting manufacturing approvals

In certain countries such as Turkey, it is possible to manufacture PP-r hot water systems based on industry standards established by individual producers. In other countries, pipe manufacturers have industry-application approvals based on test and performance requirements issued by an independent test institute, such as SKZ approval in Italy.

Examples of countries where formal PP-r manufacturing approvals exist include Austria, the Czech Republic, Germany, and Poland.

The two most recognized approvals are given by DVGW and SKZ in Germany.

DVGW registration - Germany
DVGW issues approvals for many different products used inside and in connection with buildings. In the case of PP-r pipe systems, there are no final DVGW documents describing the requirements for the total system. Two documents covering PP-r are under preparation: DVGW EW534 for fittings and system tests, and another document covering pipe test requirements.

To obtain a DVGW registration, the pipe/fitting manufacturer applies for the registration, and a test programme for the system is decided, together with requirements for the frequency of QC testing and surveillance testing by a third party. When finalized, a registration number is obtained. One condition for approval is conformance to the KTW organoleptic testing requirements.

The DVGW approval is based on PN25 pipes according to DIN E 8077/E 8078 and a maximum operating temperature of 70° C and maximum 10 bar pressure.

SKZ guidelines
SKZ have issued an independent industry specification for drinking water and hot tap water indoor pipe installations using PP-r, HR 3.10, 10.88. The specification covers quality requirements, QC testing, and surveillance testing for pipes and fittings. The approval is based on PN20 pipes for a maximum operating temperature of 60° C and maximum 10 bar pressure.

Different pipe/fitting manufacturers have SKZ approvals for their systems in combination with RA130E.

6. PIPE AND FITTING MANUFACTURING

6.1 Pipe extrusion

Borealis PP-r grades have been successfully run on a variety of single-screw extruders at customer and machine manufacturer locations, with and without grooved feed sections. As a guideline, we suggest the following extruder parameters:

Cylinder:	180, 190, 200, 210° C
Head:	210° C
Die:	210° C
Melt temperature:	210-220° C
Tools:	commercially available extruder heads

Vacuum sizing is recommended; sizing sleeves or sizing discs can also be used. As a rule of thumb, the sizing diameter should be about 4% larger than the final pipe diameter. A water ring or water spray should be uniformly applied before the sizing sleeve to prevent sticking.

6.2 Injection moulding of fittings

RA130E has been used successfully for injection moulding fittings for heat fusion jointing. The most important issue in injection moulding is the design of the mould to facilitate flow and optimize the position of welding lines. It is also very important not to stress the material too much during transformation to avoid breakdown of the polymer. Both these factors can cause failure during pressure testing of a fitting. Standard injection moulding equipment with normal settings can be used. To determine parameters, consider the following:

Injection pressure:	Depends on: 1) Flowability of the polymer 2) Melt temperature 3) Injection speed 4) Wall thickness and flow length
Melt temperature:	190-240° C
Injection speed:	Fast to avoid low crystallization of the surface, but not too high to avoid shear.
Holding pressure:	Low pressure and long time. The pressure should be just high enough to avoid sinkmarks and keep the surface in contact with the mould for fast cooling.

For more specific information, please contact your Borealis representative for assistance.

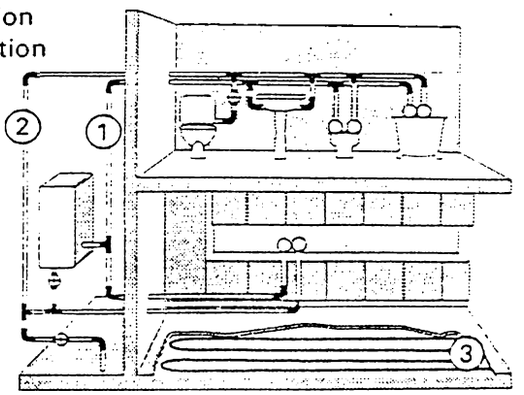
7. GENERAL RECOMMENDATIONS ON INSTALLATIONS

7.1 Typical applications

PP-r can be used for cold and hot water supply, underfloor heating, and both low and high-temperature radiators. Examples of the service conditions for different applications are given in CEN draft SS 25, part 1:table 1, see Section 5.4.

Figure 4: Typical PP-r hot water installations

1. Hot water distribution
2. Cold water distribution
3. Floor heating



7.2 Jointing techniques

The two most commonly used jointing methods for PP-r systems are socket fusion or electrofusion.

7.2.1 Mechanical fittings

Semi-mechanical fittings are injection-moulded with threaded metal inserts to allow for one-part mechanical jointing, as adapters between metal parts and/or other parts for socket-fusion jointing to a plastic system. The metal part is often Ni plated brass.

Standards: DIN 8076, DVGW EW 534

7.2.2 Socket fusion

Socket welding is an established method commonly used to connect tap water systems using PP-r. The external surface of the pipe and the internal surface of the fitting are preheated and the pipe is then inserted in the fitting, creating a fusion joint between the two surfaces. This type of welding can be carried out with inexpensive equipment. If carried out according to good working procedures, it should result in a tight joint lasting the lifetime of the pipe system.

Standards: DIN 16 960, DIN 16962, DVS 2207, DVS 2203

7.2.3 Electrofusion

Electrofusion fittings are available in PP-r, although they are less commonly used than socket fusion. The electrofusion fitting has a conductive thread incorporated into the wall. The fusion is performed by inserting the pipe ends into the fitting and applying an electrical current. The current heats the conductive thread, which melts the PP interfaces to form a fusion joint. Electrofusion is a safe method and easy to control.

7.2.4 Welding compatibility of RA130E

Tests have been carried out using butt welding and socket fusion techniques on RA130E and Vestolen P9421 to evaluate the welding compatibility of RA130E with other PP-r grades. The mechanical characteristics and pressure resistance of the welded assemblies have proved comparable with unwelded material. Test reports are available on request.

7.3 Linear expansion by temperature

PP pipes have a relatively high linear thermal expansion. This has to be considered in installations, which have to be able to absorb longitudinal changes. This is done by a combination of fixed and sliding points and compensating bows.

The linear thermal coefficient of expansion for RA130E is $\alpha=0{,}18 \cdot 10^{-3}\ K^{-1}$. The length variation is calculated as follows:

$$\Delta L = \Delta T \times L \times \alpha$$

ΔL = length variation (m)
ΔT = temperature variation between the assembling and max working temperature (° C)
L = pipe length (m)
α = expansion coefficient (K^{-1})

Example:

ΔT=80-20=60° C = 60 K
L=5 m
α=0.18 10^{-3} K^{-1}

$\Delta L=60 \times 5 \times 0.18 \times 10^{-3} = 54 \cdot 10^{-3}m = 54$ mm

Changes in length can largely be compensated for by a directional change, providing the pipe can move freely axially. In cases where this is not possible, a compensating bow has to be used. The dimension of the bow length (LS) can be calculated as follows:

$$LS = F \times (dy \times \Delta L)^{0.5}$$

F = material constant (=30 for PP)
dy = external diameter of the pipe in mm
ΔL = length variations as calculated previously (mm)

Example:

dy = 40 mm

$LS = 30 \times (40 \times 54)^{0.5} = 1394$ mm

Fixed points are connected between a pipe joint like a coupling or a fitting and the building. Sliding points are attached between the external surface of the pipe and the building.

7.4 Tap water installations

PP-r pipes and fittings can be used to build complete internal tap water systems. Pipe sizes for tap water normally range in diameter from 16 mm to 75 mm. Pipes are rather thick and inflexible. Installations are made in straight lengths, using fittings for bends.

PP-r pipe systems are used in PN20 dimensioning according to DIN E 8077 for a maximum operating temperature of 60° C and maximum 10 bar pressure. For a 70° C maximum operating temperature, a PN25 system is used according to the same standard at maximum 10 bar pressure.

Typical service conditions for hot water supply are given in CEN draft SS 25. For a service-life of 50 years, this standard specifies 49 years operation at 60 and 70° C; and a maximum operating temperature of 80° C for 1 year and a malfunction temperature of 95° C for 100 hours.

The CEN draft SS 25 covers pipes operating at 4, 6 or 10 bar. The most commonly used pressure for PP-r tap water pipes is 10 bar, with a safety factor of 1.5. The dimensions of the pipes are determined according to DIN E 8078/E 8077 or the CEN draft SS 25, as detailed in Sections 5.4 and 5.5.

7.5 Floor heating installations

In floor heating, hot water is conveyed through pipes laid under the floor. Since the heating surface is large, the water temperature can be lower than in radiators (30 - 60° C compared to up to 80° C). Floor heating gives a very comfortable climate. The best comfort level is reached with a floor temperature of 27 - 29° C (35° C in bathrooms).

Typical service conditions for floor heating systems are given in CEN SS 25. For a service-life of 50 years, this standard specifies 20 years operation at 40° C and 25 years operation at 60° C; and 2.5 years at 70° C and 100 hours at 100° C (malfunction temperature).

The CEN draft SS 25 covers pipes operating at 4, 6, or 10 bar. The dimensions of the pipe according to CEN is determined as shown in Section 5.4.

Floor heating systems normally operate at low pressure, for instance 3 bar as specified in DIN 4726. The dimensions of pipes according to this standard are calculated with a safety factor of 2.5, using a Miners rule and a temperature-time profile specified in the standard.

Small-diameter pipes (typically 12, 16, and 20) are used in floor heating because of the larger surface per volume and for easy installation. The smallest allowable bending radius is 6 times the outer diameter of the pipe to avoid buckling of the pipe.

Tabelle 1: Rohr-Reihen (Grenzabmaße siehe Tabellen 2 bis 4)

d	Reihe 1		Reihe 2		Reihe 3		Reihe 4		Reihe 5		Reihe 6		Reihe 7	
	Nennruck PN 2,5		PN 4		PN 6		PN 10		PN 16		PN 20		PN 25	
	S[4]) 20		12,5		8,333		5		3,125		2,5		2	
	SDR[2]) 41		26		17,666		11		7,25		6		5	
	s[3])	Gewicht[4]) kg/m	s[3])	Gewicht[4]) kg/m	s[3])	Gewicht[4]) kg/m	s[3])	Gewicht[4]) kg/m	s[3])	Gewicht[4]) kg/m	s[3])	Gewicht[4]) kg/m	s[3])	Gewicht[4]) kg/m
10	-	-	-	-	-	-	-	-	-	-	2,0	0,046	2	0,046
12	-	-	-	-	-	-	-	-	2,0	0,057	2	0,062	2,4	0,071
16	-	-	-	-	-	-	1,8	0,080	2,2	0,096	2,7	0,110	3,2	0,128
20	-	-	-	-	1,9	0,103	1,9	0,107	2,8	0,148	3,4	0,172	4	0,191
25	-	-	-	-	1,9	0,132	2,3	0,164	3,5	0,230	4,2	0,266	5	0,301
32	-	-	-	-	1,9	0,18	3	0,267	4,4	0,376	5,4	0,434	6,4	0,493
40	-	-	1,8	0,217	2,3	0,273	3,7	0,412	5,5	0,583	6,7	0,671	8	0,765
50	1,8	0,274	2	0,301	2,9	0,422	4,6	0,638	6,9	0,896	8,3	1,05	10	1,19
63	1,9	0,349	2,5	0,476	3,6	0,669	5,8	1,01	8,6	1,42	10,5	1,65	12,5	1,89
75	1,9	0,438	2,9	0,647	4,3	0,955	6,8	1,42	10,4	2,02	12,5	2,34	15	2,66
90	2,2	0,613	3,5	0,936	5,1	1,33	8,2	2,03	12,5	2,91	15	3,35	18	3,86
110	2,7	0,903	4,3	1,4	6,3	1,99	10	3,01	15,3	4,32	18,4	5,04	22	5,76
125	3,1	1,18	4,9	1,8	7,1	2,55	11,4	3,91	17,3	5,58	20,9	6,45	25	7,43
140	3,5	1,48	5,4	2,23	8	3,2	12,9	4,9	19,4	7	23,4	8,14	28	9,32
160	3,9	1,87	6,2	2,92	9,1	4,17	14,6	6,39	22,1	9,12	26,7	10,6	32	12,2
180	4,4	2,35	7	3,68	10,2	5,25	16,4	8,07	24,9	11,5	30	13,4	36	15,4
200	4,9	2,92	7,7	4,5	11,4	6,5	18,2	9,95	27,8	14,2	33,4	16,6	-	-
225	5,5	3,7	8,7	5,7	12,8	8,19	20,5	12,6	31,1	18	37,5	20,9	-	-
250	6,1	4,56	9,7	7,06	14,2	10,1	22,8	15,5	34,5	22,2	-	-	-	-
280	6,9	5,73	10,8	8,79	15,9	12,5	25,5	19,5	38,7	27,9	-	-	-	-
315	7,7	7,19	12,2	11,2	17,9	16	28,7	24,6	-	-	-	-	-	-
355	8,7	9,14	13,7	14,1	20,1	20,3	32,3	31,2	-	-	-	-	-	-
400	9,8	11,5	15,4	17,9	22,7	25,7	36,4	39,7	-	-	-	-	-	-
450	11	14,7	17,4	22,7	25,5	32,5	41	50,2	-	-	-	-	-	-
500	12,2	18	19,3	28	28,3	40,1	-	-	-	-	-	-	-	-
560	13,7	22,5	21,9	35	31,7	50,3	-	-	-	-	-	-	-	-
630	15,4	28,6	24,3	44,3	35,7	63,7	-	-	-	-	-	-	-	-
710	17,4	36,4	27,4	56,3	40,2	80,8	-	-	-	-	-	-	-	-
800	19,6	46,1	30,8	71,2	-	-	-	-	-	-	-	-	-	-
900	22	58,1	34,7	90,2	-	-	-	-	-	-	-	-	-	-
1000	24,4	71,7	38,5	111,2	-	-	-	-	-	-	-	-	-	-
1200	29,3	103	46,2	159,9	-	-	-	-	-	-	-	-	-	-
1400	34,2	140,6	53,9	217,6	-	-	-	-	-	-	-	-	-	-
1600	39,1	183,9	61,6	284,1	-	-	-	-	-	-	-	-	-	-

[1]) Serie $S = \frac{\sigma_{v,\,zul}}{p_{e,\,zul}} = \frac{1}{2}\left(\frac{d}{s} - 1\right)$

[2]) Standard Dimension Ratio $SDR = 2\,S + 1 = \frac{d}{s}$

[3]) Die Wanddicken s der Rohre wurden (in Übereinstimmung mit den Angaben in ISO 161/1 : 1978) nach der Gleichung:

$$s = \frac{p_{e,\,zul} \cdot d}{2\sigma_{v,\,zul} + p_{e,\,zul}}$$

berechnet.

Hierin bedeuten: - $\sigma_{v,\,zul}$ zulässige Vergleichsspannung
- $p_{e,\,zul}$ zulässiger Betriebsüberdruck bei 20 °C

Zahlenwerte wurden auf 0,1 mm aufgerundet; Zahlenwerte < 0,005 mm werden nicht aufgerundet.

Die kleinste Wanddicke wurde mit s = 1,8 mm festgelegt.

[4]) Berechnet mit einer mittleren Dichte von 0,91 g/cm³. Bei schwerentflammbar eingestelltem PP erhöht sich die mittlere Dichte auf etwa 0,95 g/cm³. Der Wanddicke wurde dabei das halbe Grenzabmaß der Wanddicke zugeschlagen; die Zahlenwerte wurden gerundet und auf 3 Ziffern begrenzt.

Tabelle 8: Zulässige Betriebsüberdrücke für PP-R Rohre, für Durchflußmedium Wasser

Temperatur °C	Betriebsjahre	Reihe 1	Reihe 2	Reihe 3	Reihe 4	Reihe 5	Reihe 6	Reihe 7
		Nenndruck PN 2,5	PN 4	PN 6	PN 10	PN 16	PN 20	PN 25
		zulässiger Betriebsüberdruck PB[1])						
10	1	4,4	7,0	10,6	17,6	28,2	35,2	44,0
	5	4,1	6,6	9,9	16,5	26,5	33,1	41,3
	10	4,0	6,5	9,7	16,1	25,8	32,3	40,3
	25	3,9	6,2	9,4	15,6	25,0	31,2	39,0
	50	3,8	6,1	9,1	15,2	24,3	30,4	38,0
	100	3,7	5,9	8,9	14,8	23,7	29,6	37,0
20	1	3,7	6,0	9,0	14,9	23,9	29,8	37,3
	5	3,5	5,7	8,5	14,1	22,6	28,3	35,3
	10	3,4	5,5	8,2	13,7	22,0	27,5	34,3
	25	3,3	5,3	8,0	13,3	21,3	26,7	33,3
	50	3,2	5,2	7,8	12,9	20,7	25,9	32,3
	100	3,1[2])	5,0[2])	7,5[2])	12,5[2])	19,5[2])	25,1[2])	31,3 [2])
30	1	3,2	5,1	7,7	12,8	20,5	25,6	32,0
	5	3,0	4,8	7,2	12,0	19,2	24,0	30,0
	10	2,9	4,6	7,0	11,6	18,6	23,2	29,0
	25	2,8	4,5	6,7	11,2	17,9	22,4	28,0
	50	2,7	4,4	6,6	10,9	17,5	21,9	27,3
40	1	2,7	4,3	6,5	10,8	17,3	21,6	27,0
	5	2,5	4,1	6,1	10,1	16,2	20,3	25,3
	10	2,5	4,0	5,9	9,9	15,8	19,7	24,7
	25	2,4	3,8	5,7	9,5	15,2	18,9	23,7
	50	2,3	3,7	5,5	9,2	14,7	18,4	23,0
50	1	2,3	3,7	5,5	9,2	14,6	18,3	22,8
	5	2,1	3,4	5,1	8,5	13,7	17,1	21,3
	10	2,1	3,3	5,0	8,3	13,2	16,5	20,7
	25	2,0	3,2	4,8	8,0	12,8	16,0	20,0
	50	1,9	3,1	4,6	7,7	12,4	15,5	19,3
60	1	1,9	3,1	4,6	7,7	12,4	15,5	19,3
	5	1,8	2,9	4,3	7,2	11,5	14,4	18,0
	10	1,7	2,8	4,2	6,9	11,1	13,9	17,3
	25	1,7	2,7	4,0	6,7	10,7	13,3	16,7
	50	1,6	2,6	3,9	6,5	10,4	12,9	16,2
70	1	1,6	2,6	3,9	6,5	10,5	13,1	16,3
	5	1,5	2,4	3,6	6,0	9,6	12,0	15,0
	10	1,5	2,3	3,5	5,8	9,3	11,6	14,5
	25	1,2	2,0	3,0	4,9	7,9	9,9	12,3
	50	1,1	1,7	2,6	4,3	6,8	8,5	10,7
80	1	1,4	2,2	3,3	5,5	8,8	10,9	13,7
	5	1,2	1,9	2,9	4,8	7,7	9,6	12,0
	10	1,0	1,6	2,4	4,0	6,4	8,0	10,0
	25	0,8	1,3	1,9	3,2	5,1	6,4	8,0
95	1	1,0	1,5	2,3	3,9	6,2	7,7	9,7
	5	0,6	1,0	1,6	2,6	4,1	5,2	6,5
	(10)	0,5	0,9	1,3	2,2	3,5	4,3	5,4

[1]) und [2]) siehe Tabelle 6.

Sicherheitsfaktor SF = 1,5

BOREALIS

Appendix 3

DIN 16 887-Testing of thermoplastic pipes determination of the behaviour to long term internal pressure

Chapter 3. Conditions for testing

3.1 Test pressures

Minimum 3 different pressures and temperatures
Minimum 5 pipes/pressure
This means at least 15 failure points.

The testing pressures should be chosen so that at least 2-3? failures /interval as shown below are obtained

10	-	100 hours
100	-	1000 hours
1000	-	10.0000 hours
	>	10.0000 hours

If a knee appears 2 of the failure points should occur after the knee. In this case a deviation from the above intervals is allowed.

3.2 Test temperatures

If base standards for pipes of the thermoplastic material exists and contains regression curves the testing should be carried out at a minimum of three temperatures as follows:

t_1	20°C
t_2	The highest temperature in the regression curve
t_3	~20 K below t_2

5. Realization of the testing

The inner media should be water except at temperatures above 95°bC.

6. Evaluation

When official regression curves exists for the material the failure point are plotted in these diagrams. If 97,5% of all failure points are above the official curves the material agrees (complies) with the standard.

Table 3: S_{max} values for PP-R

	Values of S_{max} *)		
	P_{oper} 4 bar	P_{oper} 6 bar	P_{oper} 10 bar
Class 1	6,9	5,1	3,0
Class 2	5,3	3,6	2,1
Class 4	6,9	5,5	3,3
Class 5	4,8	3,2	1,9

*) values given are rounded to the nearest first decimal place

Note: The derivation of S_{max} is provided in Normative Annex XX. The method given takes account of the properties of PP under the service conditions of the application classes given in EN[155wi025]-1, table 1.

6.2.1 Pipe dimension class A: applicable for all classes of service conditions

Table 4: Pipe dimension class A: sizes in accordance with ISO 4065

Nominal size	Nominal outside diameter	Minimum mean outside diameter	Maximum mean outside diameter	Minimum wall thickness ($e_{y,min}$)*) relative to S values (mm)			
				S values			
DN/OD	d_n mm	$d_{em,min}$ mm	$d_{em,max}$ mm	5	3,15	2,5	2
12	12	12	12,3	1,8	1,8	2,0	2,4
16	16	16	16,3	1,8	2,2	2,7	3,2
20	20	20	20,3	1,9	2,8	3,4	4,0
25	25	25	25,3	2,3	3,5	4,2	5,0
32	32	32	32,3	2,9	4,4	5,4	6,4
40	40	40	40,4	3,7	5,5	6,7	8,0
50	50	50	50,5	4,6	6,9	8,3	10,0
63	63	63	63,6	5,8	8,6	10,5	12,6
75	75	75	75,7	6,8	10,3	12,5	15,0
90	90	90	90,9	8,2	12,3	15,0	18,0
110	110	110	111,0	10,0	15,1	18,3	22,0
125	125	125	126,2	11,4	17,1	20,8	25,0
140	140	140	141,3	12,7	19,2	23,3	28,0
160	160	160	161,5	14,6	21,9	26,6	32,0

*) This value is the same as the nominal wall thickness e_n

It is important to consider the oxygen permeability of PP-r in under floor heating systems. Molecular oxygen diffuses through the material (pipes and fittings) and can cause corrosion to metal parts in a circulating heating system. There are three ways in principle to prevent this type of corrosion:

1) Utilization of corrosion inhibitors. The type of inhibitor must not have any detrimental effect on the PP-r material. The concentration of the inhibitor in the system must also be controlled.

2) Use of non-corroding materials in the heating circuit.

3) Oxygen barrier coating on the pipe/fitting system. Preventive measures must be taken to avoid any leakage in fitting points, etc.

8. END-USER ADVANTAGES OF EMPLOYING PP-R FOR HOT WATER SYSTEMS.

With their good long-term-pressure resistance, easy processing, and convenient installation, hot water systems made of PP-r have proven a competitive alternative to systems made of traditional materials, such as copper and galvanized iron. PP-r pipes can be used for underfloor heating systems as well as for complete indoor water supply systems, including fittings.

Pipe systems for indoor water supply made of PP-r offer a number of advantages both to the pipe producer and the end-user. Since PP-r is a thermoplastic polyolefin it is easy to process into pipes and fittings. No special extruders are needed. In principal, a conventional single-screw extruder is all that is needed to start production of high-quality pipe for hot water applications. PP-r can also be used to injection-mould fittings, thus providing the end-user with a complete system. Different suppliers offer fitting systems in different colours. Contact your Borealis representative for further information.

The straight-forward production of PP-r pipes and fittings, combined with PP-r's good weldability, result in indoor water supply systems that are very easy to install. For dimensions up to and including DN 50 mm, welding can be carried out with easy-to-use, handheld equipment.

For floor heating, where operating pressures are lower and small-diameter pipes are used, PP-r pipes are flexible enough to be produced and delivered on coils. The flexibility of the pipes ensures easy laying.

The excellent corrosion resistance of PP-r guarantees long operating life in indoor installations, without fear of the type of corrosion damage encountered with traditional metallic materials. PP-r is a good choice for pipe systems for hot and cold water.

For further information or test data/test reports referred to in this document, please contact your local sales representative or write to:

Borealis AB
Skill Centre Pipe
S-444 86 Stenungsund
Sweden

Appendix I

The List Prices of Borusan P ^{2}3 Boru ve Fittings Sistemleri

BORUSAN BİRLEŞİK BORU FABRİKALARI A.Ş.

BORUSAN "P²3" BORU VE FİTTİNGS SİSTEMLERİ

PPRC TYPE3 PRICE LIST — **Date: 01/6/1996**

Telephone: (0-212) 251 34 10 (20 Lines)
Fax (Sales): (0-212) 252 90 84

TSE TS 9937 | TSE TS 11451 | ISO 9001

PIPES

	I. PN 10 (10 BAR, PLASTIC COLD WATER PIPES)				II. PN 20 (20 BAR, PLASTIC HOT WATER PIPES				III. PN 25 (25 BAR, AL. FOIL REINFORCED PIPES).			
	CODE	Dimension/mm.	METERS	PRICE/m.	CODE	Dimension/mm.	METERS	PRICE/m.	CODE	Dimension/mm.	METERS	PRICE/m.
1	8010200190	20x1.9	200	65,000	7 8020200340	20x3.4	200	95,000	13 8030200340	20x3.4	160	138,000
2	8010250230	25x2.3	132	95,000	8 8020250420	25x4.2	132	150,000	14 8030250420	25x4.2	100	195,000
3	8010320300	32x3.0	80	170,000	9 8020320540	32x5.4	80	250,000	15 8030320540	32x5.4	60	320,000
4	8010400370	40x3.7	52	250,000	10 8020400670	40x6.7	52	370,000	16 8030400670	40x6.7	40	500,000
5	8010500460	50x4.6	32	360,000	11 8020500840	50x8.4	32	590,000	17 8030500840	50x8.4	32	700,000
6	8010630580	63x5.8	20	570,000	12 8020631050	63x10.5	20	950,000				

FITTINGS

	SOCKET				X. T PART				XVII. ELBOW FEMALE			
	CODE	Dimension/mm.	Units/box.	Unit Price	CODE	Dimension/mm.	Units/box.	Unit Price	CODE	Dimension/mm.	Units/box.	Unit Price
18	8040200000	20	320	9,500	49 8140200000	20	160	18,000	79 8210201200	20x1/2"	80	100,000
19	8040250000	25	200	13,000	50 8140250000	25	90	26,000	80 8210203400	20x3/4"	80	150,000
20	8040320000	32	120	21,000	51 8140320000	32	64	42,000	81 8210251200	25x1/2"	80	123,000
21	8040400000	40	84	36,000	52 8140400000	40	35	77,000	82 8210253400	25x3/4"	80	148,000
22	8040500000	50	48	65,000	53 8140500000	50	16	142,000	83 8210321000	32x1"	36	410,000
23	8040630000	63	27	125,000	54 8140630000	63	12	282,000	XVIII. ELBOW MALE			Unit Price
	REDUCER			Unit Price	XI. UNEQUAL T			Unit Price	84 8220201200	20x1/2"	80	146,000
24	8050252000	25/20	300	9,500	55 8150252020	25x20x20	90	34,000	85 8220203400	20x3/4"	80	220,000
25	8050322000	32/20	240	18,000	56 8150252025	25x20x25	90	34,000	86 8220253400	25x3/4"	80	220,000
26	8050322500	32/25	200	18,000	57 8150322032	32x20x32	60	43,000	XIX. T PART FEMALE			Unit Price
27	8050402000	40/20	150	33,000	58 8150322532	32x25x32	60	43,000	87 8230201220	20x1/2"x20	120	121,000
28	8050402500	40/25	120	33,000	XII. CAP			Unit Price	88 8230251225	25x1/2"x25	80	126,000
29	8050403200	40/32	120	35,000	59 8160200000	20	400	9,000	89 8230253425	25x3/4"x25	80	160,000
30	8050502500	50/25	90	49,000	60 8160250000	25	320	13,000	90 8230321032	32x1"x32	36	430,000
31	8050503200	50/32	90	50,000	61 8160320000	32	200	16,000	XX. T PART MALE			Unit Price
32	8050504000	50/40	60	52,000	62 8160400000	40	90	43,000	91 8240201220	20x1/2"x20	80	155,000
33	8050633200	63/32	48	75,000	63 8160500000	50	60	65,000	XXI. VALVE			Unit Price
34	8050634000	63/40	48	80,000	64 8160630000	63	32	124,000	92 8260200000	20	40	365,000
35	8050635000	63/50	48	90,000	XIII. ADAPTOR MALE			Unit Price	93 8260250000	25	32	385,000
	ELBOW 90°			Unit Price	65 8170201200	20x1/2"	160	98,000	94 8260320000	32	12	620,000
36	8060902000	20	240	13,500	66 8170203400	20x3/4"	160	126,000	XXII. CHROMIUM PLATED VALVE			Unit Price
37	8060902500	25	120	21,000	67 8170253400	25x3/4"	160	130,000	95 8270200000	20	24	893,000
38	8060903200	32	80	32,000	XIV. HEXAGONAL ADAPTOR FEMALE			Unit Price	96 8270250000	25	24	915,000
39	8060904000	40	48	61,000	68 8180321000	32x1"	36	355,000	XXIII. CLAMP			Unit Price
40	8060905000	50	24	120,000	69 8180401140	40x1 1/4"	24	650,000	97 8280201000	20	600	7,500
41	8060906300	63	18	225,000	70 8180501120	50x1 1/2"	24	700,000	98 8280251000	25	450	9,500
II.	ELBOW 45°			Unit Price	71 8180632000	63x2"	16	1,240,000	99 8280321000	32	360	12,500
42	8070452000	20	280	24,000	XV. ADAPTOR MALE			Unit Price	XXIV. TWIN CLAMP			Unit Price
43	8070452500	25	150	27,000	72 8190201200	20x1/2"	160	133,000	100 8290202000	20	240	14,500
44	8070453200	32	80	37,000	73 8190203400	20x3/4"	120	198,000	101 8290222000	22	240	14,500
III.	PIPE BRIDGE			Unit Price	74 8190253400	25x3/4"	120	198,000	102 8290252000	25	200	17,000
45	8100200000	20	112	38,000	XVI. HEXAGONAL ADAPTOR MALE			Unit Price	103 8290272000	27	200	17,000
46	8100250000	25	70	48,000	75 8200321000	32x1"	30	495,000	XXV. THREADED CAP			Unit Price
47	8100320000	32	32	82,000	76 8200401140	40x1 1/4"	24	852,000	104 8300201200	20	800	7,800
	W. CONNECTION ELBOW FEMALE			Unit Price	77 8200501120	50x1 1/2"	24	875,000	105 8300253400	25	600	9,500
48	8130201200	20X1/2"	120	105,000	78 8200632000	63x2"	16	1,445,000				

XVI. INSTALLATION SET AND SHARPENER			Unit Price
106	6800010000	Installation Set	12,000,000
107	6800022025	20-25mm. Al. Foil. Pipe Sharpener	2,300,000
108	6800033240	32-40mm. Al. Foil. Pipe Sharpener	3,000,000

Appendix J

The Advertisements in the Sector Periodicles.

BORUSAN "P³" TS 9937-TS 11451 PN20 20x3.40 18.7.1995 08.30 M1

Ve Borusan plastiğe de su verdi.

Borusan "P³3" Polipropilen Boru ve Fittings Sistemleri... Türk boru sektörünün lider kuruluşu Borusan Birleşik Boru Fabrikaları, çağdaş üretim teknolojisi, titiz ve dinamik hizmet anlayışıyla şimdi polipropilen boru sektörüne de imzasını atıyor. 37 yıllık Borusan tecrübesinin en son ürünü Borusan "P³3" ile polipropilen boru sektörüne kalite geliyor, güven geliyor. Üstelik Borusan'a özel geniş ürün yelpazesi, yurt çapına yayılmış uzman satış, dağıtım ve servis kanallarıyla...

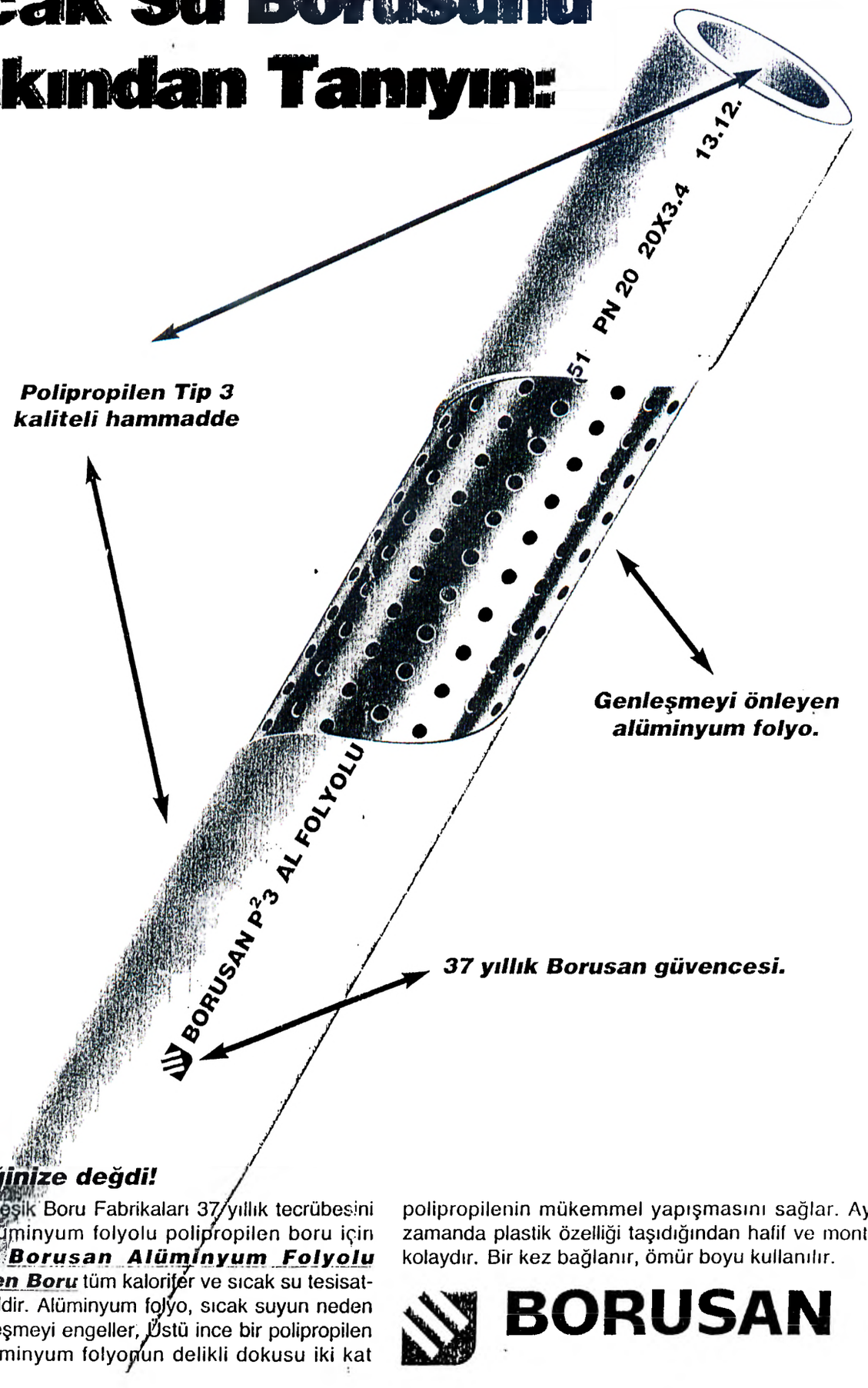
BORUSAN BİRLEŞİK BORU

BORUSAN "P³3" TS 9937-TS 11451 PN20 20x3.40 18.7.1995 08.30 M1

BORUSAN "P³3" TS 9937-TS 11451 PN20 20x3.40 18.7.1995 08.30 M1

BORUSAN "P³3" TS 9937-TS 11451 PN20 20x3.40 18.7.1995 08.30 M1

Türkiye'nin En Güvenli "PP" Sıcak Su Borusunu Yakından Tanıyın:



Beklediğinize değdi!

Borusan Birleşik Boru Fabrikaları 37 yıllık tecrübesini şimdi de alüminyum folyolu polipropilen boru için kullanıyor. ***Borusan Alüminyum Folyolu Polipropilen Boru*** tüm kalorifer ve sıcak su tesisatları için idealdir. Alüminyum folyo, sıcak suyun neden olduğu genleşmeyi engeller. Üstü ince bir polipropilen ile kaplı alüminyum folyonun delikli dokusu iki kat polipropilenin mükemmel yapışmasını sağlar. Aynı zamanda plastik özelliği taşıdığından hafif ve montajı kolaydır. Bir kez bağlanır, ömür boyu kullanılır.

BORUSAN