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A Study of Training, Feedback, & Goal Setting for Improving Quality in an Organizational Setting

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A STUDY OF TRAINING, FEEDBACK, AND GOAL SETTING FOR IMPROVING QUALITY IN AN ORGANIZATIONAL SETTING

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A Study of Training, Feedback,

and Goal Setting for Improving

Quality in an Organizational Setting

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A STUDY OF TRAINING, FEEDBACK, AND GOAL SETING FOR IMPROVING QUALITY IN AN ORGANIZATIONAL SETTING

C. Richard Moore, III   May 1989   116 pages

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The current study investigated the effects of training, knowledge of results (KR), and goal setting on improving product quality in a field setting. Both practical and theoretical issues were addressed through the experimental design. A practical concern was the improvement of product quality in an organization. The theoretical issue was the increased understanding and utility of goal setting and knowledge of results for motivating workers' quality behavior.

Two existing departments (n=60 employees) of an aluminum window manufacturing plant were studied with the use of a multiple-baseline, within-subjects design across four experimental phases: a) baseline, b) training only, c) visual presentation of feedback, c) goal setting. The principal dependent variable was the percentage of inspected products conforming to established quality criteria. A secondary measure was the change in rework costs resulting from nonconforming quality.

The time series data were found to be stationary with the use of an Autoregressive Integrated Moving Average (ARIMA) analysis. A repeated measures analysis of variance showed a significant effect for group and phase. Individual Bonferroni tests compared means between phases within each group and revealed that the quality index improved for both groups after KR was introduced to the groups. Goal setting did not have a significant effect over the KR phase in either experimental group. The results provide potential support for the theory that goal setting occurs upon presentation of feedback. Significant reductions in rework costs were also found as a result of the interventions.

INTRODUCTION

The present study examines the practical application of behavioral management techniques to quality assurance programs. Several theoretical principles were incorporated into a practically designed experiment to determine the effectiveness of a behavioral management approach for improving the quality of a company's products. Training, presentation of feedback, and goal setting were systematically studied through a multiple-baseline design to determine the effects on product quality.

The following literature review presents both practical and theoretical principles related to understanding and improving the "Human Factor" in quality control. First, the evolution of quality programs, statistical quality control techniques, quality circles, and zero defect methods of quality assurance will be briefly discussed. Second, techniques focusing on improving the behavioral aspects of quality assurance will be discussed as viable options to quality management.

LITERATURE REVIEW

Quality Control Programs

During the last century great gains have been made in industrial techniques to stimulate the growth of mass production. Each progression in the modern method of production has contributed to the disintegration of the individual's responsibility for quality. Frederick Taylor introduced the first "scientific management" of work by developing methods to optimize efficiency in 1911 (cited in Muchinsky, 1983). This rational approach divided mass production work into short, repetitive job tasks requiring workers to behave in an automatic manner. The evolution of the rational approach into industrial engineering continues to show the value of improved production methods today, though the result is often a monotonous and repetitious job for the individual worker.

Prior to the introduction of the rational approach, workers were generally employed in home industry and production was typically completed by an individual worker from the conceptual stage through the final product. As a result, workers experienced increased job satisfaction and pride in responsible, high-quality workmanship.

Removal of the individual worker's identity from the final product of today's industrial methods contributes to the loss of meaning in quality responsibility. The importance of reversing this trend is evidenced by the proliferation of articles concerning the necessity of quality improvement during the 1980's. Various methods of improving quality have been introduced in the literature during the last few years, though this investigator could find no comprehensive review of quality programs in the literature. Usually the approaches to quality assurance are company-specific or oriented toward a total system of quality.

Other than individual companies' quality programs, the first systematic approach to quality improvement was statistical quality control, introduced by W. S. Shewhart in 1924 (cited in Juran, 1962). Shewhart's statistical quality control process provided specific technical definitions for a product's "quality characteristics" through comprehensive testing of manufacturing processes during product development. Measurements of the quality characteristics during manufacturing provided comparisons to the previously defined specifications. Deviations from the specifications were statistically analyzed to gain insight into the technical factors effecting quality (Shewhart, 1931).

Statistical control techniques continued to be refined and expanded during World War II when the government sponsored training programs for the application of these techniques. The nature of this approach used the same engineering techniques as the Scientific Management manufacturing method and proved to have similar positive effects on manufacturing quality (Harris & Chaney, 1969). Though the overall effects of statistical quality control continue to assist the progress of quality assurance, the emphasis is on determining when something needs to be done to improve quality instead of what needs to be done.

Quality Circles were introduced in Japan in the post-war era as another approach to improving quality. This approach involved the use of a limited number of employees that met as a group with a facilitator to discuss quality issues and identify possible problems and solutions. Although the concept of employee participation was good, usually quality circles were not empowered for action on issues and participants found themselves locked into a "we-they" operating attitude. As a result, fewer than ten-percent of companies surveyed in 1981 had existing quality circle programs (Lawler & Mohrman, 1985; Townsend, 1986).

A third approach to quality assurance was originated by the U.S. government during the early 1960's. "Zero Defects" was established to meet the reliability demands for the new generation of nuclear and space age technology. Zero Defects programs typically used a "bandwagon" approach for motivating workers' commitment to improving quality and preventing defects. The motivational part of a Zero Defect program was typically a kick-off day with fanfare designed to inspire workers to do their job right the first time. A preventive action was the installation of a quality problem identification system to eliminate the causes of errors as recommended by the individual worker (Fouch, 1965; Pierce & Streep, 1966).

Generally, the Zero Defects concept met several of the government contractors' needs to meet stringent production standards. Other positive results included reduced scrap, errors, and reworks as well as indirectly improving employee attitudes through job enrichment (Pierce & Streep, 1966). However, most quality assurance specialists doubted the permanent benefits of Zero Defects programs.

A survey by Juran (1966), found only twenty-percent of companies used Zero Defect programs and less than twenty-percent of those reported positive results. Juran further contended Zero Defect programs were undertaken for public relations reasons and targeted at the wrong group. Juran proposed that only twenty-percent of quality errors are controllable by the worker and eighty-percent are caused by companies' failures to provide the worker with the necessities for controlling quality production behavior (Juran, 1966).

Harris and Chaney (1969) reported actual analyses showing support of the 20/80 percent ratio proposed by Juran. Juran's behavioral necessities included: 1) the means for the worker knowing what to do, i.e. clear instructions; 2) the means for the worker knowing what he is actually doing, i.e. knowledge of performance; and 3) the means for determining how to change the behavior, i.e. corrective action (Juran, 1966).

Despite the efforts of many quality assurance improvement programs, only fifty-percent of people surveyed by a Gallup poll during 1988 gave American products high marks for quality. This statistic improved only two percent from a 1985 survey and the number of people reporting exceptionally poor quality was up by ten percent (Ryan, 1988). Although some of these statistics can be explained by consumers' increased assertiveness in recent years, obviously the quest for improving quality is not over.

Each of the programs reviewed above has made a contribution to quality assurance management. However, each failed to produce long-term results due to the treatment of quality assurance as a single dimensional motivation or technical problem. The following section will present programs utilizing behavioral techniques for improving quality.

Human Behavioral Factors in Quality Assurance

A reality of quality assurance management is the fact that humans are fallible and do make errors. Thus, an effective approach must take into account a system for ensuring that workers have the necessary job instructions and performance information. Training, presentation of feedback, and goal setting will be discussed in the following sections to review how behavioral research has blended with the technical aspects of quality assurance to produce pragmatic quality improvement programs.

Training: Training is the fundamental foundation of all quality assurance programs. Quality training usually includes technical product information regarding specifications, standards, facilities, processes, tools, and materials. Usually, technological information is documented by the engineering and manufacturing organizations for use in training. Numerous quality researchers stress the importance of accurate technical information required for production (Crosby, 1984; Feigenbaum, 1983; Groocock, 1986; Juran, 1962).

Although development of accurate technical information is essential and usually available, the process of making it understandable to all workers can be very challenging. Hence, clarification of the worker's responsibilities for their interaction with each of the technical elements is also necessary (Juran, 1980). The importance of allowing discussion with presentation of technical instructions was demonstrated by a study showing a significantly increased level of quality output for groups who were given instructions plus discussion over groups given only instructions (Tomekovic, 1962).

Further evidence of the importance of presenting clear work instructions is provided by a correlational field study attempting to identify the motivational dimensions of quality (Schein, 1968). Schein's study found "perceived standards or instructions" to be the second highest of seven dimensions contributing to motivating quality production and first for quantity production.

Visual aids were used by Adam (1971) to improve differentiation between acceptable and unacceptable quality work behaviors, referred to as "discriminate classification." Juran (1962) also recognized the need to clarify quality work behaviors by recommending the inclusion of audiovisual aids in quality training to make technological information more understandable. Photographs showing examples of acceptable and unacceptable electronic assemblies and soldering were used to improve workers' evaluation of product quality conformance (Harris & Chaney, 1969). Harris and Chaney found that presentation of instructions or visual aids alone significantly improved interrater agreement for discriminate classification, but the use of both increased interrater reliability by seventy-percent. Harris and Chaney hypothesized that visual presentation of the examples allowed workers to create a mental image to clearly distinguish between borderline quality and acceptable quality.

Knowledge of Results: Effective presentation of understandable principles, facts, and practices for quality production has an obvious value for increasing the knowledge of the worker. A second necessity for improving the knowledge of workers is presentation of feedback. Besides satisfying an individual's natural need for self-evaluation (Festinger, 1954), feedback offers workers the opportunity to evaluate the quality of their output and the behavioral methods used to produce the results. The use of feedback in organizations is based on the assumption that the feedback is meaningful and will be used to change behavior of the individual, group, or organization (Nadler, 1979).

The concept of feedback, or knowledge of results (KR), as a control was introduced by Wiener in the early 1900's to describe the performance information used to monitor deviations of a production process and to return the process to normal. Theorists and practitioners of the science of control, termed "cybernetics", have made use of these cyclic feedback information loops to effectively monitor and improve automated processes for many years (Stok, 1965). Cyberneticists explain the utility of feedback in terms of "directive" or "informative effects" due to its application in a computer systems environment. On the other hand, organizational psychologists have realized the utility of feedback in organizations to effect future performance through both "informative" and "incentive" effects of feedback (Eldridge, Lemasters, & Szypot, 1978; Feeny, 1973; Ilgen, Fisher, & Taylor, 1979; Stok, 1965).

Informational effects of feedback facilitate early detection of technical disturbances in the production process so remedial measures can be taken. Usually the information describes the nature and magnitude of the deviations from the quality norm similar to statistical quality control.

Incentive effects are derived through presentation of performance measurements and comparison of the performance level to a standard (Ilgen et al., 1979; Payne & Hauty, 1955). Although the informative effects serve a real purpose for problem identification in quality assurance, this literature review will explore the research and controversy related to the incentive effects of feedback.

Much research on a broad range of issues has been completed regarding the impact of feedback on behavior. Feedback was found to enhance learning and positively effect motivation of individuals' behavior in an extensive literature review by Annett (1969). Ilgen et al. (1979) found further evidence of feedback's ability to improve the individual's performance in organizational settings. A literature review by Nadler (1979) of 34 experimental studies on the impact of feedback on task groups found general support for the effectiveness of feedback for improving group task performance. A major contribution of Nadler's research was the development of a theoretical model describing the interactions of the many variables effecting presentation of feedback upon subsequent group behavior.

Nadler described the process of using feedback to stimulate workers' motivation. A motivational effect was demonstrated through an increased level of effort, whereas simple presentation of feedback served an informational purpose of directing a worker's behavior toward the defined outcome. Both effects were moderated by individual differences and group task structure. Nadler also indicated the practical difficulties in separating the informational and motivational effects of feedback. Separate effects of feedback and goal setting to change group strategies for improved group performance were not conclusively described in the model. Nadler used only research directly related to feedback rather than to goal setting or both. More discussion is directed to the controversy regarding the relative effects of feedback and goal setting later in this study.

Further elaboration on the importance of feedback is presented by Kreitner (1982). Kreitner introduces Organizational Behavior Management (OBM) as a technical application of behavior modification for changing workers' behaviors. Feedforward is used to describe the antecedent conditions of behavior, e.g. work instructions. Feedback is used to communicate meaningful positive and negative performance measurements. The OBM approach recognizes the individual worker's role in collecting and processing feedback information to determine future levels of performance. OBM concepts were tested in a field experiment by Eldridge et al. (1978). Eldridge et al. demonstrated the successful OBM feedback techniques to systematically reduce the amount of packaging waste by over fifteen-percent. Other outcomes included a significant cost reduction in waste and favorable responses by workers to the feedback program.

Stok (1965) conducted a multi-industry study of fourteen European companies using visual presentation of feedback to improve the quality of produced goods. Stok's research thoroughly examined the effects of feedback on workers' quality attitudes, workers' job satisfaction, and actual product quality. The premise of the research was that visual presentation of feedback provides workers the opportunity to evaluate the quality of their work as the older handicraft trades used to, thus improving the task variety and interest in the work being done.

Stok drew three conclusions from the studies. First, he confirmed the existence of both informational and incentive effects of feedback through presenting average-only or average-compared-to-standard data and measuring the resulting outcome. Workers who received KR only in terms of performance had consistently lower quality than those receiving KR presented in relation to quality standards. Workers who received feedback in relation to the standard reported having "motivation" to reach the quality standard. The apparent results of this pilot experiment were confirmed by structured interviews with the workers to determine their subjective responses to the two conditions.

A second conclusion by Stok was that workers' job satisfaction was positively effected by the presentation of KR. Workers' job satisfaction was measured before and after presentation of feedback with a ten-item questionnaire of unknown reliability. Very little quantifiable information was found in the study to clearly show how Stok reached this conclusion regarding workers' job satisfaction.

The third conclusion derived from the analyses of the quality control information was that the incentive effects of feedback had a favorable influence on quality. Although few analyses are provided by Stok, the quality measurement graphs definitely show a drastic reduction in error rates following the presentation of visual feedback.

A more recent field study using a multiple-baseline experimental design to examine the effects of feedback on behavior was conducted by Komaki, Heinzmann and Lawson (1980). Komaki et al. studied the effects of a behavioral safety training intervention for a vehicle maintenance group. Results of the field study showed significant increases in the number of observed safe work behaviors only after feedback was presented to employees by supervisors. Komaki et al. concluded that feedback was a pragmatic approach to motivating workers but also recognized the possible effects of goal setting upon workers' safety performance.

Locke (1980) presented a "cognitive solution" of Komaki's results based on the idea that feedback serves as an "informational" source for individuals to compare their performance to formal or informal goals. Locke suggested that if feedback is understandable, individuals compare this information to a standard and change behavior accordingly. Thus, Locke gained more support for the importance of goals in moderating the effects of KR.

Goal Setting Research: Utilization of Goal Setting to influence behavior has gained widespread acceptance by a variety of theorists and practitioners (Adam, 1972; Ilgen & Moore, 1987; Locke et al, 1981; Payne & Haughty, 1955; Reber, 1984). The simplicity of goal setting as a theory of motivation is appealing because it is not dependent upon a variety of internal personality traits or external environmental factors. The cognitive nature of goal setting is based upon an individual's ability to consciously process feedback information and regulate behavior accordingly.

Locke (1968) proposed the following basic tenets of goal setting theory: 1) Goals direct an individual's behavior; 2) motivation is positively correlated to the difficulty and specificity of the goal; 3) knowledge of results assists individuals with comparing performance to the goal; 4) acceptance of goals leads to improved goal attainment.

A review of over twenty-five applications of goal setting in organizations by Latham and Yukl (1975) found that presentation of knowledge of results (KR) may motivate individuals by causing them to initiate goal setting, increase goals, and/or increase effort to reach the goals.

Many experiments have been conducted to explore how or why the effects of goal setting are produced in individuals or groups (Ilgen & Moore, 1987). Each experimental manipulation of goal setting has added understanding to the goal setting process.

First, participation by workers in goal setting was found to increase the acceptance of the goals that were set (Erez, Early, Hulin, 1985; Latham & Lukl, 1975). Contrary to most managers' beliefs today, participation in goal setting does not lead to higher levels of performance (Latham, Steele, & Saari, 1982). Research by Latham et al. (1982), Erez et al. (1985), Latham and Steele (1983), and Huber (1985) indicates individuals participating in setting performance goals do not perform significantly better than individuals who have assigned goals. Another study by Chang and Lorenzi (1983) concluded assigned goals effect internal motivation more than participative goals.

A second general finding of goal setting research is the fact that specific, difficult goals usually result in increased task performance. Mento, Steele, and Karren (1987) completed a meta-analysis of goal setting studies covering eighteen years. The results of the analysis showed general support for the goal specificity and difficulty elements of Locke's 1968 goal setting theory across a variety of field and laboratory studies. Other studies showed similar increased motivation for higher goal levels (Locke & Bryan, 1969; Erez, 1977).

A third common finding in goal setting research is the necessity of feedback for goal setting to be effective. A laboratory experiment by Erez (1977) manipulated KR and goal setting on a clerical aptitude test. Results showed that feedback was necessary to maximize performance. A review of feedback research by Balcazar, Hopkins, and Suarez (1985) indicated feedback alone does not uniformly improve performance on various tasks, yet the combination of goal setting and feedback did improve the effects of feedback. Locke, Shaw, Saari, and Latham (1981) determined that neither goal setting or feedback alone is sufficient for performance improvement. Instead, both goal setting and feedback together are necessary for performance improvement.

A field study of clerical workers conducted by the U.S. Air Force (Pritchard, 1981) found meaningful increases in productivity through the use of feedback and goal setting. Goal setting with feedback was found to be more effective than either intervention by itself. Additional support for the necessity of KR was found in other laboratory experiments (Kim & Hamner, 1976; Locke, et al., 1981: Strang et al., 1978).

Austin and Bobko (1985) recognized the difficulty of measuring quality and the resulting differences between quality and quantity goal setting. As a result, Austin and Bobko presented five hypotheses related to quality goal setting research. First, goal achievement is dependent upon goal characteristics such as difficulty and specificity.

The second point indicates that participation is useful in goal setting for providing information to develop strategies to deal with product quality. Third, organizations may develop systems to facilitate the strategy development concept presented in point two. Fourth, quality improvement may require the combination of goal setting and incentives for long-term quality assurance maintenance. Lastly, examination of goal setting effects for quality goals will not be possible for meta-analysis until more quality goal research is completed (Austin & Bobko, 1985).

Summary of Literature

The "evolution" of quality management has led to an improved understanding of the individual worker's importance in quality assurance. Various techniques have been used to improve the quality of goods and each has made significant contributions to the process of quality management. However, any approach to quality management requires the recognition of a "total process" of quality across nearly all organizational functions. All quality assurance programs must recognize the interrelationship of workers' behaviors and corporate systems for effective quality assurance programs in organizations (Caplan, 1980; Crosby, 1984; Feigenbaum, 1983; Groocock, 1986; Juran & Gryna, 1980; Townsend, 1986).

This literature review has summarized some of the more widely accepted methods of changing workers' behaviors to improve quality. The importance of presenting good technical information to ensure workers understand what is asked of them has been reviewed.

Presentation of feedback to provide knowledge of how well the worker is performing has also been reviewed. Evidence has been provided for the effects of improving workers' task performance through feedback (Feeny, 1973; Nadler, 1979). Similar support has been found for improving quality (Eldridge et al.,1978; Harris & Chaney, 1969; Stok, 1965). However, none of these studies adequately addressed the possibility of goal setting as an alternative explanation for the feedback effects described.

The last behavioral ingredient for motivating the worker toward improving quality performance is the use of goal setting. Though several consistent effects have been documented for goal setting, a complete explanation of goal setting and its resulting generalization remains to be discovered (Austin & Bobko, 1985).

Very little, if any, research has tested the effectiveness of goal setting for improving quality in either field or laboratory settings (Austin & Bobko, 1985). Hence, more research is needed to determine the utility of goal setting in comparison with feedback in quality assurance management.

RESEARCH OBJECTIVES

The primary objective of the current study is to determine the effectiveness of a behavioral approach for improving quality. Training, presentation of visual feedback, and goal setting were used to improve the quality of goods produced. The study also called attention to the need for improved training and simple use of quality statistics and goals to improve quality.

A secondary purpose is to gain understanding of the relative individual importance of feedback and goal setting in quality improvement programs. A within-subjects, multiple-baseline design was used across two groups to determine the effects of feedback and goal setting upon a measurement of quality.

Specific experimental hypotheses for this study are as follows:

1. Quality performance will increase after workers are trained to differentiate acceptable and unacceptable quality.

2. Quality performance will increase after workers receive visual presentation of feedback.

3. Quality performance will increase after workers are challenged by a specific and difficult quality goal.

METHOD

Setting and Subjects

Setting: The study was conducted in an aluminum window and door manufacturing plant located in Miami, Florida. The company operates in a very competitive product market, thus the company's upper management had established quality as one of its main objectives. A quality control department was established two years prior to this study to develop inspection procedures, monitor product quality, and identify problem areas.

Subjects: Workforce analyses for the project showed 130 employees were employed for direct and indirect labor duties in the plant. Ninety-two percent of the workers were of Latin extraction and spoke little English. Two existing departments composed of sixty direct labor manufacturing workers were selected as the two experimental groups for the present quality program intervention. The departments were Residential Window Assembly and Glazing (N = 32) and Commercial Window Assembly and Glazing (N = 28). A brief description of each department appears in Appendix A. The relative location of each department is shown in Appendix B.

Criteria Measures

Two criteria measures were used to measure the effects of the study's intervention upon quality.

Quality Index: The principle dependent variable in this study was the Quality Index which was recorded daily for each department and the total plant. This index is a simple ratio of number of nonconforming pieces (i.e. reworks or rejects) to the total number of pieces or products inspected. Decision rules for determining product conformance or nonconformance were established in the Inspection Procedures Manual section of the Quality Assurance Manual (Appendix C).

Quality Costs: A second dependent variable was the cost of reworks and rejects. The costs of reworks and rejects can be determined through company labor and material costs combined with time studies that provide a standard cost for each rework, reject, or defect. Multiplication of the number of reworks and rejects by the respective rework costs resulted in a measure of the costs calculated by day, week, month, or year.

Quality Specifications: A Quality Assurance Manual explicating each job's general and quality control responsibilities was previously developed by the investigator and may be found in Appendix C. A combination of interviews, task analyses, job observations, review of assembly procedures, and engineering specifications were used to define the responsibilities for each functionally different job in the plant.

The Quality Assurance Manual outlines all responsibilities and procedures necessary to ensure a high quality product will be manufactured as efficiently as possible. This manual was translated into Spanish by the plant staff and later retranslated and reviewed by a professional bilingual consultant to ensure that differences in meaning had not occurred during translation.

Collecting Quality Index Data: Quality checklists were designed to provide consistent criteria for discriminate classification of conformance or nonconformance during inspections. Refer to Appendix C for the entire inspection procedures and checklists. In order to determine how easily and accurately the inspection checklists allowed data collection, a two-week pilot study was conducted when the Quality Assurance Manual and checklists were originally designed. In the subsequent meetings of the inspection committee, several ambiguities were discovered and the procedures and definitions were amended as necessary. Some operational definitions of defects were restated and problems with the inspection procedure and checklist were corrected.

Two employees were selected to serve as permanent quality inspectors. During the first few days of the pilot study the investigator worked individually with each of the inspectors to develop a high level of interrater reliability on defect judgements. Inspectors began data collection when product conformance and nonconformance judgements reached ninety percent agreement between inspectors. Interrater reliability was reviewed on a weekly basis during the study. From a practical standpoint, the need to divide inspection station responsibilities between the two inspectors allowed only the Quality Control Manager to act as an independent reliability check. The Quality Control Manager, who was thoroughly knowledgeable of product specifications and inspection procedures, re-checked at least five percent of the pieces or products the inspectors inspected during the day to determine whether inspectors correctly judged the product's quality.

Design and Procedures

This section will describe the design and procedure for the present study, including the needs analysis; an explanation of the multiple-baseline experimental design; and descriptions of the experimental phases and procedures.

Needs Analysis: Assessment of the organization's needs was completed by conducting interviews with the President, Engineering Manager, Sales Manager, Plant Manager, and other managers. Clearly, quality was stressed as the number one goal along with the reduction of rework and reject costs. Managers also conveyed an interest in increasing workers' quality consciousness and job satisfaction. Historical records of the quality level and customer complaints served as sources to identify specific product problems needing attention in a quality assurance program. Managers and supervisors also identified approximately 24 percent of the total plant personnel who were performing their job duties inadequately due to the absence of formal training instructions or programs. Each of these findings confirmed management's perceived need for improved quality.

Training Objectives: The following training objectives were developed based on the needs assessment information:

1.) To increase percentage of conforming products inspected to 95 percent.

2.) To reduce costs of reworks by 75 percent.

3.) To positively influence job attitudes toward quality during the study by using slogans such as "QUALITY COUNTS" and posters emphasizing quality.

Multiple-Baseline Experimental Design: Effects of interventions in a field setting are often difficult to measure with traditional experimental designs (Cook & Cambell, 1979). Therefore, a multiple-baseline design was chosen to facilitate interpretation and analysis of the quality intervention. The multiple-baseline design allowed the investigator to measure the dependent variable over time and construct a model of its variance (Komaki et al., 1980; Reber, 1984). By comparing the staggered introduction of the independent variables, the investigator determined the effects of the intervention .

Threats to internal validity are minimized with a multiple-baseline design. Statistical regression can be ruled out if the dependent variable is consistently affected for both groups during the interventions at regular intervals. History is accounted for as a possible threat due to the small probability of extraneous events affecting the dependent variable in the same manner at different intervals in the time series.

The four phases of the multiple-baseline quality intervention are as follows: Phase I-baseline; Phase II-Training Only; Phase III-Visual Presentation of Feedback; and Phase IV-Goal Setting. The interventions were introduced in a staggered sequence across the two groups so that Group I began Phase I followed by Group II beginning Phase I four weeks later. A diagram of the phases is presented in Figure 1 on page 111.

Phase I - Baseline: Quality index data were collected for both groups following the pilot study revisions to the quality index inspection process. The baseline for Group I included fifty-two daily quality index measurements and twenty-seven measurements for Group II.

Phase II - Training: The first experimental group (Group I) in the multiple-baseline design attended a quality training session once a stable baseline had been recorded. Group II began the training phase four weeks after Group I. Prior to the training meeting, employees in the group were given the relevant sections of the Quality Assurance Manual describing their general and quality control responsibilities (see Appendix C). Employees also received a memo asking them to read the Quality Assurance Manual information prior to attending the training session. Due to production demands, half of the Group I employees attended the meeting in the morning and the remainder of Group I employees attended a second session in the afternoon. The quality training session took place during the regular work day and lasted approximately 45 minutes.

The company's President began the quality training session with a statement explaining the company's emphasis on producing only "Prime Quality" windows and doors for customers. The President stated "responsibility for quality assurance is found at all levels of production." He also asked for the workers' cooperation in following the requirements stated in the quality assurance manual in order to reduce the number of defects found during the production process. Following this introduction, the meeting was turned over to the investigator, hereafter referred to as the trainer.

The trainer, assisted by an interpreter, then reviewed the quality assurance manual with the employees. The manual was the first written set of quality control responsibilities presented to employees. Next, the trainer presented each employee with a copy of the list of operationally defined potential product defects found in their department. As explained earlier, this list was a set of decision rules for determining product conformance or nonconformance during inspection.

Presentation of these two documents served an informational purpose. The trainer allowed some time to answer questions and clarify ambiguities of purpose since employees were not familiar with the guidelines provided in these documents.

To further demonstrate differences between product conformance and nonconformance, a series of 35 mm slides depicting acceptable and unacceptable quality, as specified by the potential defect list, was shown. The slides, previously taken during actual production and inspection, provided visual examples of defects operationally defined in the quality assurance manual. Slides of products representing very good quality were chosen to show "acceptable quality" and slides of nonconforming defects showed "unacceptable quality." A written description of each slide was developed to ensure that the same meaning and description were presented consistently to the two groups. Written descriptions of the slides used and the presentation schedule can be found in Appendix D.

During the slide presentation, employees first viewed a slide showing an example of nonconforming quality. As a group, the workers were asked to state what they observed to be correct or incorrect in the slide, i.e. "What's wrong with this product?" Once employees described the defect and judged its conformance according to the operational definitions, a slide illustrating acceptable quality was shown and the corresponding quality tolerances reviewed with the group.

During this meeting, the trainer also displayed an inspection checklist for their department and explained how the information was used to identify recurring quality problems and calculate the quality index.

Phase III - Visual Presentation of Feedback: Four weeks after the beginning of the Training Only phase for Group I, the Feedback phase began for Group I. Group II began Phase III four weeks after Group I. Feedback of the quality index calculations and notes from the previous day's inspection were posted on the department bulletin board of Group I. Each day the quality index was plotted on a 2-foot by 3-foot graph posted in the department by 10:30 a.m. The graph's vertical axis showed the quality index as a percent and the horizontal axis displayed the day of the month. A copy of the feedback chart used in the experiment is shown in Appendix E. Once both groups entered the feedback phase of the study, a company-wide quality index was posted where all employees could view the performance of all groups.

Phase IV - Goal Setting: The goal setting phase involved communicating a quality assurance goal to each group. Group I began the goal setting phase eight weeks from the beginning of Phase II. Management previously decided on a 95 percent goal for the quality index based on customer service and marketing data even though this implies that

five-percent of products will not conform to quality standards. Departmental goals were discussed with employees at the beginning of the phase for the group to encourage acceptance but remained at the 95 percent Quality Index level. A poster was posted on the department bulletin board stating that the quality index goal was 95 percent.
A reproduction of the goal setting poster can be found in Appendix F.

RESULTS

Visual Analysis

Data were collected for a total of 144 days for Group I and 69 days for Group II over 30 weeks of study. A visual analysis of the multiple-baseline interrupted time series design data was completed to determine the effectiveness of each of the interventions. Figure 2 on page 112 graphically displays the Quality Index measurements for each of the phases in the study. Groups I and II both have a visual trend of an increasing Quality Index from baseline to training and from training to feedback. Only Group I showed this continuing trend through goal setting in phase four.

Autoregressive Integrated Moving Averages (ARIMA) Analysis

An ARIMA analysis was completed to identify a model of the serial dependencies within the time series data. The ARIMA model (p,d,q) allows visual and statistical analysis of the stochastic time series component. The stochastic, or error component of the time series is analyzed by identifying and removing any serial dependencies in the data. Serial dependencies in the data are identified by examining the autocorrelation (p) and moving average (q) statistics for each data point in the time series (Cook & Campbell, 1979; Hartmann, Gottman, Jones, Gardner, Kazdin, & Vaught, 1980). Further elaboration of this approach can be found in Box and Jenkins (1970) and McCleary and Hay (1980).

A review of the autocorrelation and partial autocorrelation statistics and examination of the correlograms indicated no significant serial dependencies of error terms in the time series data. As a result, no differencing (d) was required in the time series and a "white noise," stationary (0,0,0) model was identified for analyzing the experimental intervention with an analysis of variance.

Repeated Measures ANOVA

The stationary nature of the data allowed a repeated measures analysis of variance for testing the hypotheses. A significant main effect was found for phase, $F(3, 192) = 8.96$, $p<.001$. The main effect for Group variable was non-significant $F(1, 14) = 2.45$. A significant interaction was also discovered between phase and group variables $F(3, 192) = 6.42$, $p<.001$. Refer to Table 1 on page 107 for the results of the ANOVA tests.

Individual ANOVA tests were conducted to confirm the interaction discovered. A significant interaction was found for the Group II and phase four intervention. This interaction is visible in the visual presentation of the experimental data shown in Figure 2.

Differences in the quality index were explored between the individual phases of the experiment with modified Bonferroni tests (Keppel, 1982). The tests were conducted assuming a total alpha level of .05 for the Bonferroni tests. Test results for each of the phase comparisons are displayed in Table 2 on page 108. As expected in the original hypotheses, Group II had significantly different quality index means between baseline, training, and feedback. However, a significant interaction was found in the goal setting phase for Group II that shows a significant decrease in the quality index.

Results of the Bonferroni tests of phase means for Group I showed differences between consecutive phases, i.e., baseline to training and feedback to goal setting, were not significant. However, significant increases in the quality index level were found in comparisons between both baseline and feedback and baseline and goal setting.

Inspection of the means in Table 3 on page 109 indicates a general trend for the dependent variable means in both groups consistent with the expectation of the experimental effect, i.e., increased quality index. The trends in the phase means for both groups are plotted in Figure 2 on page 112.

Quality Cost Data

The average expense for reworking nonconforming products during production was measured by computing the number of each category of defect on a daily basis and multiplying it by the average direct cost for rework. Phase data were made comparable by dividing the resulting daily rework expense by the number of days in the phase and multiplying times a standard month, i.e., 30 days.

Group I decreased quality costs by 57.3% from baseline to Phase IV and Group II decreased its quality costs by 29.9% for the same time period. The overall improvement of 45.1% was actually short of the training goal of 75% but, nevertheless, was significant in terms of real savings to the organization. Table 4 on page 110 displays the quality cost data during the study.

Threats to Validity

Maturation, history, and statistical regression were eliminated as possible alternative hypotheses due to the introduction of the interventions separated by time. History was eliminated as a source of internal invalidity because it was unlikely that an uncontrolled, coincidental event would have consistent effects on the dependent variable across the phased interventions. Maturation did not effect validity in this study due to the increase in the dependent variable immediately after each phase of the intervention. Statistical regression was also ruled out because any regression effects would be expected during the entire series of the data instead of the increases noted following the intervention phases.

Reactivity to the measurement is the only threat to validity that is plausible in this study of quality. However, the expected result would be an increase in the quality index at the time measurements began. In this study, the baselines were begun at different times and no immediate increase in the dependent variable was noticed. Hence, this last threat to validity does not seem to be evidenced in this study.

DISCUSSION

The major finding in this study is the positive effects on quality improvement from presentation of knowledge of results, or feedback. Quality index levels for both groups were significantly higher than baseline data following presentation of KR.

Training

Training alone did not improve the quality index significantly, although the mean quality performance for both groups was increased. This may indicate workers already had the information regarding acceptable quality. The effect of training may also provide support for the "informative" effect of feedback having little or no motivational value.

Visual Presentation of Feedback

Presentation of KR increased the Quality Index of both groups in the time series. The effect of KR in this study can be used to support Latham and Yukl's findings regarding the motivating qualities of KR (1975). Workers could have motivated themselves by initiating goal setting; increasing existing goals; or simply increasing their effort. This author believes the nature of quality assurance, i.e., typically defect-free products, defines a quality goal for workers in an organization. Hence, feedback showing that performance is below the unofficial goal serves as a directive to increase the quality performance.

The probability of unofficial goal setting in quality assurance makes it difficult to separate the informative and motivational aspects of feedback. This author recognizes the obvious importance of presenting feedback for informative purposes to organizations which do not have formal quality standards and quality assurance programs. The current study is an example of the need for organizations to create a formal feedback system to keep workers informed of the quality performance. If goal setting occurs as a result of the nature of quality assurance, the only real differences in goals may be between individuals or working groups.

Competition may have started in the study by the presentation of KR to the groups. Observation of group dynamics in the current organization would indicate the workers are of a competitive nature. However, no experimental data were collected to support this hypothesis. No coincidental effects were noted when feedback was introduced at different times in the two groups.

Goal setting

Each of the hypotheses discussed above are consistent with Locke's cognitive approach to goal setting (1980). It is reasonable to assume goal setting occurred in the groups considering the general acceptance in the literature of the necessity of KR and goal setting to improve performance (Balcazar et al., 1985; Locke et al., 1981). Further support for the conclusion that KR led to goal setting in this study is indicated by the finding that goal setting provided no significant addition to the quality level that was already attained in the KR phase.

The interaction of the goal setting phase and Group II is visible in the reduced quality index. This effect could have been due to the method of intervention or an extraneous variable effect. For example, several changes in the product and respective specialized quality requirements took place during the goal setting phase for Group II.

Other positive outcomes from presentation of KR included reduced variance in the quality level and sizeable savings in rework costs. Overall, there is a reasonable cost-benefit from feedback and its ability to motivate workers toward improving quality through its informative and motivational attributes.

Multiple-baseline design

The use of a multiple-baseline design in this study has practical implications for quality assurance management. A within-subjects, multiple-baseline design allows researchers to conduct experiments in field settings and to make meaningful conclusions regarding the effects of interventions. The absence of a control group also makes it easier to work with existing groups in organizations. Another consideration with a repeated measures design is the ability to evaluate the intervention effects during the study and allow adaptations in the methodology to maximize results.

Conclusion

Generally, the recognition of the human factors in quality management and the utilization of behavioral techniques to improve quality is an important consideration for all corporations. Of course any approach to quality management must incorporate all other organizational sources of quality control. Hence, the findings of this study must not be construed as an oversimplified approach to improving product quality that replaces the concept of "total quality assurance."

Future studies exploring human factors in quality control should include as many experimental groups as possible to strengthen the findings of this study. In addition, as much data should be collected as possible for each phase. The use of a survey instrument may lead to improved understanding of individual and group cognitive reactions to goal setting and feedback as it relates to quality assurance.

Overall, the presentation of knowledge of results is a simple, effective behavioral method of improving the quality of workers'output.

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APPENDIX A

DESCRIPTION OF DEPARTMENTS

Group I

Group I is the Residential Window Assembly and Glazing department which produces approximately seven types of aluminum windows. An unlimited variety of combinations of glass, color, style, specialty options, and sizes can be ordered by customers. Production order quantities range from two-thousand to twenty in a production run. Thus, this production unit can be described as having a "job-shop" orientation.

The basic demographics of the group are as follows:

Average Age = 31 years
60% Latin origin and 40% Haitian origin
Most have a highschool equivalent education
Less than 10% speak any English

Group II

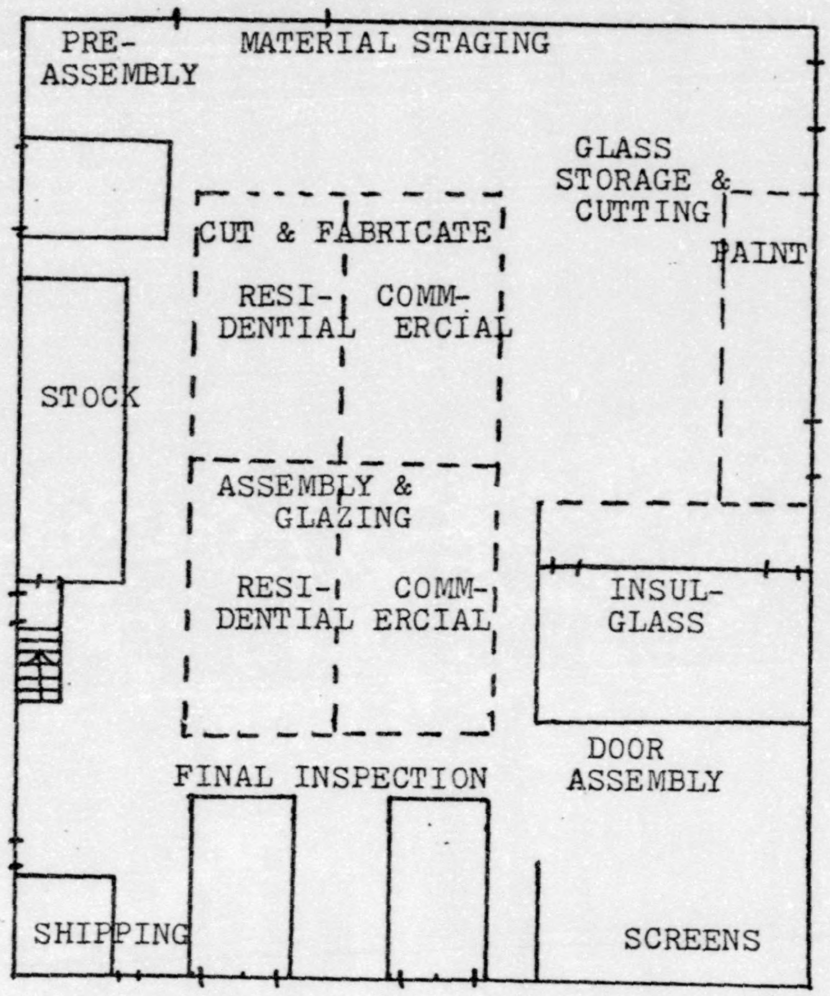
Group II is the Commercial Window Assembly and Glazing department which produces approximately eleven types of aluminum windows and door frames. Most production orders are for large numbers of windows and doors for a particular contract, e.g. a high-rise in New York. Windows and doors produced by this group are larger and more complicated due to the stringent commercial safety standards. Although the duration of producing orders is longer for this group, the unit can be described as being "job-shop." This group was merged into the organization through an acquisition nearly two years prior to the beginning of the study.

The basic demographics of the group are as follows:

Average Age = 33 years
95% Latin origin and 5% Haitian origin
Most have a highschool equivalent education
Less than 7% speak any English

APPENDIX B

DEPARTMENT LOCATION DIAGRAM


PRE-
ASSEMBLY
MATERIAL STAGING
GLASS
STORAGE &
CUTTING
PAINT
CUT & FABRICATE
RESI-
DENTIAL
COMM-
ERCIAL
STOCK
ASSEMBLY &
GLAZING
RESI-
DENTIAL
COMM-
ERCIAL
INSUL-
GLASS
DOOR
ASSEMBLY
FINAL INSPECTION
SHIPPING
SCREENS

APPENDIX C

QUALITY ASSURANCE MANUAL

QUALITY ASSURANCE MANUAL

of

WALLACE - CROSSLY CORPORATION

Manufacturers of Prime-Quality
Commercial and Residential
Aluminum Windows and Doors

Miami, Florida

January, 1985
revised August, 1988

Written and Compiled by
C. Richard Moore, III

The purpose of this manual is to establish an in-plant Quality Assurance Policy and Procedure that will enable the corporation to maintain AAMA/ANSI Certification Program requirements and provide quality control standards necessary to assure Wallace-Crossly customers of receiving only "Prime Quality" certified windows and doors. It sets forth the Quality Assurance Program relative to the inspection of raw materials, work in-process, finished products and storage, and includes gauge control and responsibility for vendor and customer prints.

This manual describes the general responsibilities and quality assurance outlines for each individual job. This means each employee in addition to their regular job duties, is responsable for producing a product that meets Wallace-Crossly standards. Quality Assurance requirements in this manual are explained in order from inspection of raw materials at the receiving area, and throughout the manufacturing process, assuring that units are fabricated and assembled according to specifications and engineering requirements.

The Quality Control Manager shall have the responsibility, authority, and organization freedom to identify quality problems, initiate action to correct such problems, and to verify implementation of solutions. The Quality Control Manager responsabilities also include, tests, and records necessary to fullfill AAMA Standards. It is to be understood that the authority given to the Quality Control Manager cannot be overridden by other department heads except on the consent of the President of the Corporation.

Written Quality Assurance Procedures for implementing the policy described herein shall be provided as dictated by complexity of the product, design, manufacturing techniques and customer requirements.

This manual will be reviewed and revised as required to keep it current and in compliance with AAMA/ANSI specifications. All policy or procedure changes will be approved by the President of the Corporation.

____
President of Wallace-Crossly Corp.

____
Engineering Manager

____
Quality Control Manager

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I. SCOPE

1.1 The Quality Assurance program at Wallace-Crossly Corporation encompasses receipt, identification, stocking, processing, manufacturing, packaging, and shipping of parts, materials and finished products.

1.2 The program is designed to assure the company's customer that products shipped meet all the requirements and specifications as set forth by purchase orders and drawings provided by the customer.

1.3 Written inspection and test procedures are prepared to supplement applicable drawings and other specifications to the extent deemed necessary.

1.4 The Quality Assurance responsibilities encompass individual worker responsibilities to assure that non-conforming materials do not continue through further production steps.

II. RESPONSIBILITY

2.1 The Quality Control Manager reports to the President.

2.2 The Quality Control Manager's responsibilities shall encompass the following:

2.2.1 Planning, developing, initiating, coordinating, implementing and maintaining the most effective and efficient procedure for optimum Quality Assurance satisfying all AAMA certification requirements.

2.2.2 Regular review of the Quality Assurance program to evaluate its strategy and effectiveness.

2.2.3 Determination of necessary inspection station points.

2.2.4 Documentation of vendors' quality programs and conformance to AAMA standards using the "Supplier Quality Assurance Survey Report" (see Appendix A) and other written communication.

2.2.5 Interpretation of conformance to customer Quality requirements.

2.2.6 Computing and monitoring the Quality Index statistic.

2.2.7 Review of customer drawings and specifications.

2.2.8 Research and follow-up of vendors' corrective action for non-conforming products.

2.2.9 Original and continuing inspection and documentation of all special and standard gauges, test equipment and tooling used to manufacture products. This does not imply general maintenance.

2.2.10 Coordinate in-plant corrective action on items requested by inspectors or customers, and notify customers of the action taken and evaluate the actions effectiveness.

2.2.11 Assure that inspection personnel are capable of rendering an unbiased decision to accept or reject any material inspected.

2.2.12 Provide Quality Control Data Sheets listing critical, major, and minor defects for all products manufactured.

2.2.13 Establish an in-plant Audit System that will effectively monitor the integrity of the Quality Assurance Program.

2.2.14 Distribution of all sales orders and special production information to Quality Inspectors.

III. RECEIVING INSPECTION

3.1 Raw material and supplies are received and recorded on a receiving report by the Receiving Department, then submitted to Quality Control for Receiving Inspection.

3.2 Receiving Inspector will not accept parts, or materials for production until it has been determined that they conform to required specifications established by Wallace-Crossly Corporation.

3.3 Accepted materials are transported to and stored in their respective warehouse areas.

3.4 Rejected materials are identified by inspection with a red tag. The reason for the rejection is documented on the Incoming Extrusion Report and then the Quality Control Manager is notified.

3.5 Inspection of Aluminum Extrusions and Purchased Parts will be conducted by the Receiving Quality Control Inspector as follows:

3.5.1 Identifies materials received by computer part number using the computer inventory book.

3.5.2 Inspects aluminum extrusions by using the Incoming Extrusion form (see Appendix B) as a checklist. Takes bundle weight and divides by number pieces, then divides by length to get weight per foot, and checks against specification print weight for conformance. Results of the inspection are recorded on the Incoming Extrusion form and filed to fulfill AAMA reporting requirements.

3.5.3 Inspects Purchased parts for conformance to engineering specifications and records the results of inspection on the Incoming Purchased Parts form (see Appendix C).

3.5.4 Completes a Quality Control Discrepancy Report (see Appendix D) and notifies the Quality Control Manager of any defects discovered during inspection.

3.6 Quality Control Manager reviews the Quality Control Discrepancy Report and notifies materials management of non-conforming materials.

RECEIVING INSPECTION cont'd

3.7 Corrective action to prevent recurrence of discrepancies found by Receiving Inspection is the responsibility of the vendor. The Quality Control Department is responsible for follow-up to ensure that corrective action taken by the vendor was effective. Repeated discrepancies by any supplier may result in disqualification of the vendor. The Quality Control Manager will maintain a file to record non-conforming materials for each vendor.

IV. RAW MATERIAL CONTROL

4.1 Raw materials are identified by series numbers, name of material, material computer number and size, inspected by the Receiving Department inspector and then transported to the appropriate warehouse area by a warehouse material handling team.

4.2 Only raw materials inspected by Quality Control are released for production.

4.3 If materials are rejected, the stock is identified by a red hold tag and material is stored in an area isolated from production, until the Quality Control Manager can make a final determination of quality for production or dispostion.

4.4 Approved materials are issued from the warehouse storage area according to withdrawal slips for the specific requirements of the production order.

V. IN-PROCESS INSPECTION

5.1 In-Process inspections are performed by the Quality Control Department at inspection stations to provide early detection of work stations producing non-conforming pieces of products.

5.2 In-Process inspections are to be conducted according to the procedures set forth in the Inspection Procedure Manual. (See Section X.)

5.3 Records for in-process inspection are maintained by the Quality Control Department. These are filed by series number and dated for review.

5.4 Rejected pieces or products which cannot readily be reworked by normal means, as determined by the Department Supervisor, are clearly identified by a red rejection tag and moved to an area apart from the normal flow of in-process material to await disposition that will be acceptable to the customer.

5.5 Reworkable items are processed and approved by the Quality Department prior to shipment.

5.6 The Quality Control Department is responsible for obtaining corrective action and for performing a follow-up review to assure that effectiveness of the corrective measures taken.

VI. FINAL INSPECTION

6.1 Final inspection of finished products is conducted by the Quality Control Department according to the procedures set forth in the Inspection Procedures Manual and taking into consideration any specific customer requirements.

6.2 Commercial and Residential final inspection records (see Appendices F through L), are maintained by the Quality Control Department and are available for review.

6.3 Records of final inspection include: the series number, order number, date of inspection, inspector identification, types of defects, number of pieces inspected, and number of reworks and rejects.

6.4 All non-conforming products which cannot be readily reworked by normal means are held pending a decision for disposition. Reworkable items are processed and approved by the Quality Control Department prior to shipment.

6.5 The Quality Control Department is responsible for obtaining corrective action and for performing a follow-up review to assure the effectiveness of corrective measures taken.

VII. NON-CONFORMING MATERIAL

7.1 All non-conforming parts and/or products are held by Quality Control and placed in a segregated area, except those which are readily reworkable by normal means, as determined by the Production Supervisor. When processed and accepted by inspection, after rework, they are placed with the balance of acceptable items in the staging area.

7.2 All production held by Quality Control become the "property" of that department and production department is not permitted to move or rework materials until the Production Supervisor is notified of the product's defects and rework required to bring material into conformance to engineering and customer standards. All materials are expected to be reworked immediately once this notifiction is carried out. Hold tags are removed from material in question only by Quality Control personnel.

7.3 When it is not possible or practical to rework the item by normal means the Quality Inspector should notify the Production Supervisor and Quality Control Manager in order to make a judgement on a specific repair procedure which is unlike the normal process used. If the material cannot be repaired the material is scrapped.

7.4 The integrity of all products submitted to acceptance inspection are maintained under the Quality Department. The inspection status of items in process or finished products in stock is by Quality Control inspector's stickers indicating acceptance or Hold tag for rejections or reworks.

7.5 The cause of defects discovered by inspection while work is in process is searched out by Quality Control with the aid of production supervisors, operators, and engineers, as required. The tools, methods, and skills are examined and the steps necessary to correct and eliminate the cause of defects are taken immediately, in the form of tool modification, method improvement, and/or operator training, prior to continuation of production. Major discrepancies will be documented as to cause and corrective action. Defects found during inspection of products are reviewed and the cause determined by the same personnel above. Action taken and date of effectivity is documented on the inspection record.

NON-CONFORMING MATERIAL cont'd

7.6 All plant personnel have the responsibity of visually inspecting materials and parts for defects. They should also have knowledgeable determination of whether a part is in conformance with the criteria established in the operational definition for each potential defect.

7.7 When the Quality Control Manager is not available for consultation concerning a product non-conformance, other engineering staff or the Sales Manager shall be consulted to assist in quality judgement decisions.

VIII. PACKAGING AND SHIPPING

8.1 All items are packaged in a manner that prevents damage. These quality assurance responsibilities are to be fulfilled by the shipping department and periodically audited by the quality control department.

8.2 The Quality Control Manager is responsible for the determination of the correct method and type of preservation and marking on each order which is the packaged in plant. The Quality Control Manager obtains packaging requirements, requested by the customer, and issues work instructions to Production and Shipping Departments.

8.3 No material will be shipped until all required inspections are complete and the product is adequately protected to assure that the order will reach the customer free from damage.

IX. QUALITY ASSURANCE RESPONSIBILITIES FOR PLANT POSITIONS

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9.1 Receiving Materials, Receiving Department.

General Responsibilities: inspects shipment and completed identification papers for incoming extrusion shipments. Collects and records information for inventory cards including: measurements, quantity, date of arrival, and material description. Compares extrusion order information with purchase order; marks each set of extrusions with a felt tip pen with purchase order number and extrusion number.

QA Responsibilities: Determine received materials' conformance to Engineering specifcations. Maintain accurate records of all received materials and report all nonconforming materials to the Quality Control Manager immediately. Notify Quality Control Inspector for certification of all conforming materials for production use.

9.2 Insulated Glass Duties (1 or 2 operators)

9.2.1 Install Plastic Connectors in Spacer Frame Section

General Responsibilities: Obtain bundle of cut-to-length spacer sections; place on table and remove ties; install plastic connector in one end of each spacer section; tie into bundle; complete spacer frame sections and place in rack.

QA Responsibilties: Check length of one spacer section in bundle to assure proper length; visually inspect each spacer section for physical imperfections; assure that connectors are properly seated in the metal; keep accurate record of quantity produced.

9.2.2 Pour Dessicant in Spacer Frame Sections.

General Responsibilities: Obtain bundle of spacer sections with connectors installed in one end, hold over barrel and pour dessicant over bundle until spacer sections are filled; set aside bundle to table.

QA Responsibilities: Make sure all spacer sections in the bundle have connectors in one end before filling and are all completely filled with dessicant; keep accurate record of quantity produced; daily perform water test on dessicant to ensure the effectiveness of the dessicant.

9.2.3 Assemble Spacer Frame.

General Responsibilities: Obtain needed bundles of spacer sections; place on table and untie; assemble frame using plastic connectors installed in one end of the required four sections; hang assembled frame on rack.

QA Responsibilities: Check length of bundles of spacer sections and assure the correct lengths are being assembled for the production order; assemble in a way that does not allow dessicant to spill out of sections; visually inspect physical appearance of spacer sections and connectors during assembly; keep accurate record of quantity produced.

9.2.4 Wash and Stack Insul-Glass Panels. (3 operators)

A. Loader (1 or 2 operators).

General Responsibilities: Obtain lites of glass from crate or cart and place on washer conveyor at proper intervals to allow the unloaders to stack properly; monitor washing machine to assure proper operation; assist unloaders as needed with preparation and material handling.

QA Responsibilities: Visually inspect each lite of glass for cracks, scratches, or chips in edge as they are loaded; first piece inspection of the length and width of glass for each order; verify the correct type and thickness of glass is being used for the production order.

B. Unloaders (2 operators)

General Responsibilities: Move empty cart and rack of assembled spacer frames to position at unloading area; cover cart with sheets of brown paper; unload lite of glass from washer conveyor and place on cart; position spacer frame on lite of glass; unload opposite lite of glass from washer conveyor and position on spacer frame; repeat the unloading and stacking process until the desired stack of insul-glass panels is reached; place white sticker on outside lite of glass on each glass assembly so that assembler knows which way to install the glass; on large glass assemblies, place tag with size information on last glass assembly on stack; place weights on stack of glass assemblies; apply sealant to glass stack and move full cart to curing area ensure proper application especially corners. Change insul-sealant batch barrels as needed.

cont'd
QA Responsibilities: Assure the correct size and type of glass and correct size spacer frame is being used for the order; carefully inspect each lite of glass while unloading for any physical imperfections, dirt, lint or smudges; wipe off glass with regular or re-run through washer if needed; properly stack glass lites and spacers so that good sealant application can be accomplished; assure that correct size description is placed on each different stack of glass assemblies; keep accurate record of quantity produced; maintain insul-glass machine as required.

9.2.5 Apply Sealant to Glass Assemblies. (1 operator)

General Responsibilities: Fill tub with sealant mix, apply sealant to edges of stack of glass assemblies with paddle; brush sealant into space between two lites of glass and to the spacer using short bristled brush; smooth sealant application with paddle; maintain proper operation of sealant mixing machine. Run batch of sealant thru applicator at least every ten minutes to keep material from hardening in applicator hose and gun.

QA Responsibilities: Visually inspect physical appearance of insul-glass assemblies before applying sealant; ensure sealant is uniformly applied and completely fills space between glass lites to the spacer; conducts break test on sealant on a daily basis; assures spacer is not displaced during sealant application. Test the ratio of the mix when each barrel of sealant & activator is changed . This is to be done in the presence of a Q. C. Inspector.

9.2.6 Separate Insul-Glass Panels (1 operator)

General Responsibilities: Move cart of insul-glass panels into room; trim excess sealant from top glass and each corner of stack; cut insul-glass panels apart and stack on vertical stand or cart; scrape paper from edge of bottom panel in stack; dispose of brown paper. Push cart of finished insul-glas panels to storage; return empty horizontal cart into insul-glass room.

QA Responsibilities: Visual inspection of insul-glass panels is critical at this point. Check each panel for dirt, lint or other foreign substances between lites; check application of sealant to assure complete coverage; check outside appearance of lites for scratches or cracks; assure that paper and excess is completely cleaned from panels; properly stack finished panels on cart; check results of sealant test before separating panels; keep accurate record of quantity produced. Assure that no cutting of the sealant material has been done directly and that the panel is hermetically sealed; check panels for over-filling or under-filling of sealant along the perimeter of the aluminum spacer. ensures sealant penetration is up to the shoulder of the spacer.

9.3 Sawman. (1 operator)

General Responsibilities: The leadman gets the cutting orders and writes down the quantity and length of parts required on a slip of paper gives this to the operator. The operator then sets the stop on the saw gauge to cut the correct length. The leadman has the raw extrusion delivered to the operator on a cart. The operator then moves the raw lengths to the saw bed; positions the extrusion on the saw; cuts the part to length; and stacks the finished parts on a cart.

QA Responsibilities: First piece inspection of the length of part to assure saw stop is set correctly; check angularity of extrusion, and check finish on extrusion before cutting. These items should be checked every 20 cuts and last piece inspection during the run of an order. The operator should be aware of the appearance of material; scratches, dents, and bows in the metal as they cut the pieces. All thermo-break material should be examined for angularity, hardness of thermo-break fill, and completely debridged; keep accurate count of quantity of cut pieces; inspect saw cut to insure clean cut; inspects blade squareness periodically.

9.4 Fabrication. (1 operator)

General Responsibilities: Position cart of cut-to-length parts near press; positions workpiece against fixtures, or stops and activates press to notch both ends and punch the required holes; stacks finished parts on cart. Assist with die setting changes when required.

QA Responsibilities: First piece inspection check for correct length of part, location of notches, weep holes, assembly holes, and installation holes; inspects these items every 20th piece during the run of an production order; inspects pieces for dents, scratches, and bows before and after fabrication; assures parts are properly and safely stacked on the cart; notifies leadman of damaged parts so replacements can be cut; keeps loose metal blown out of die so that parts seat correctly in the die and punch press and to prevent damage to the die; keeps accurate record of quantity produced.

9.5 Painting Pre-Treatment Operation. (1 operator)

General Responsibilities: Locates correct extrusion for painting operation per schedule and order sheet; stacks extrusion pieces in dip basket; moves dip basket to bath area; hoists dip basket into wash bath; basket remains in wash for designated time then hoists basket of pieces into rinse bath; moves basket from rinse to pre-treatment bath where basket remains for designated time. Basket is hoisted out of pre-treatment tank and allowed to drip-dry. Operator then hoists basket to floor and removes extrusion pieces and sets aside pieces to completely dry. Information regarding PH levels of baths are recorded on data sheet.

QA Responsibilities: Checks PH levels daily to ensure adequate pre-treatment process; checks that all pieces are submerged in the baths; ensures complete dryness of extrusion pieces; ensures correct extrusion pieces undergo process per schedule and order sheets; keeps accurate record of quantity treated.

9.6 Painting Operation. (1 operator, 1 helper)

General Responsibilities: Helper places pre-treatment pieces on painting table or hangs them from racks; painter selects and mixes paint and maintains spraying apparatus; paints extrusion pieces in a mechanical motion applying an adequate amount of paint. Helper removes wet painted pieces and stacks or hangs pieces on drying carts; drying carts are rolled into the oven; sets oven time and temperture controls.

QA Responsibilities: Checks extrusion pieces for adequate paint coverage; checks for runs in paint; checks thickness of paint; keeps accurate records of quantity painted.

9.7 Cut Glass to Size. (1 operator)

General Responsibilities: Set-up nails in table to use for gauges with the straight edge; places stock sheet of glass on table; positions glass on straight edge and against stops; run glass cutter down straight edge; removes straight edge and positions glass on table with line of cut on edge of table and break away excess glass by hand or tool; put aside cut piece to rack and drop-off of stock glass to rack to be used on some other order if of sufficent size.

QA Responsibilities: Assure that the correct stock glass is used for the order; on large orders of the same size, check dimensions of cut glass; check physical appearance of all glass cut; keep accurate record of quantity produced.

9.8 Cut Torque Bar to Length. (1 operator)

General Responsibilities: Set-up press stop for proper length cut; obtain stock lengths of extrusions from cart to work conveyor; position stock length to press, cut to length and notch both ends of torque bar; stack cut bar in a bin.

QA Responsibilities: First piece inspection of length of cut and thereafter every 20th piece; check appearance of metal before cutting during a run; inspects for "burs" on the metal; keep acurate record of quantity produced.

9.9 Rivet Vent Jamp Locking Stud. (1 operator)

General Responsibilities: Obtain box of cut-to-length vent jambs and move to work area; position place vent jamb on rivet machine anvil and install rivet; place vent on jamb in box.

QA Responsibilities: Measure length of first piece in box to check for proper length; visually inspect the quality and size of both rivets; visually inspect physical appearance of each vent jamb as order is run. Keep accurate record of quantity produced.

9.10 Rivet hinge to Cam Lock - Vent Link Assembly. (1 operator)

General Responsibilities: Obtain needed parts to work place; assemble hinge to vent link, position assembly to fixture and rivet in place; aside completed assembly to storage.

QA Responsibilities: Check for proper hinge movement on each assembly produced; check quality and size of rivet; check for defective parts keep accurate record of production.

9.11 Rivet Cam Lock Pivot Nut to Vent Transfer Link. (1 operator)

General Responsibilities: Obtain needed parts to work area assemble cam lock pivot nut to vent transfer link, position to fixture, and rivet assembly; aside assembly to box.

QA Responsibilities: Check length of first transfer link in box; check each assembly after riveting for proper movement; visually inspect each assembly for physical defects. Keep accurate record of quantity produced.

9.12 Assemble Vent Awning Window Harness. (1 operator)

General Responsibilities: Obtain needed parts to work area; assembles nylon runners and transfer link assemblies to runner bar, position to fixture and rivet in place; aside vent harness assembly to storage.

QA Responsibilities: Check physical appearance of all parts used in assembly; check for proper movement of all parts after assembly; check quality and size of rivets; keep accurate record of quantity produced.

9.13 Hardware Assembly Single Hung. (1 operator)

General Responsibilities: Retrieves vent head pieces and placed on work table; determines correct size and type of latch per order; screws latch into place using correct size screws; carries finished vent head with latch to next work station or storage rack.

QA Responsibilities: Checks that latch is attached and correctly centered; check physical appearance of parts used in assembly; keep accurate record of quantity produced; checks that correct latches are attached.

9.14 Weatherstrip (W/S) Assembly. (1 operator)

General Responsibilities: Operator retrieves pre-cut extrusions from cart and places them on work table; determines correct size and type of W/S per order and applies glue to W/S channel; W/S is inserted into W/S channel; W/S is cut with approximately one-half inch excess extending beyond end of extrusion piece; some extrusions require a staking operation, using a small press, to lock W/S in place. Left and right harness assemblies are attached to frame with screws. Finished pieces are placed on cart or carried to the next work table.

QA Responsibilities: Checks correct size and type of W/S per order and extrusion; checks condition of W/S; inspect and repair W/S channel damage; assures free operation of harness assembly on awning windows; keep accurate record of quantity produced.

9.15 Frame and Vent Assembly. (1 operator)

General Responsibilities: Obtains pre-cut extrusion pieces and stacks them on work table; labels one jamb piece for each window with order number and type of glass per order sheet; assembles head, sill, jamb, and meeting rail pieces using correct size screws; attaches vent stops to vents; sets completed frame to the side for the next assembly.

QA Responsibilities: Checks length of pre-cut extrusions; inspect appearance of extrusion pieces for blemishes; inspects cleaness of punch holes; assures correct labeling of pieces per order sheet; keep accurate record of quantity produced.

9.16 Series 200 Frame Assembly. (1 operator)

General Responsibilities: Operator sets correct dimensions for frame jig, obtains jamb, head, sill, and meeting rail extrusion pieces and positions them in frame jig; taps pieces together where needed to ensure correct alignment; places board across the face of the frame pieces to prevent bowing of metal during staking operation; activates jig press staking the frame together; removes frame assembly from jig and sets frame aside.

QA Responsibilities: Assures correctness-of-fit of frame pieces inspects W/S application; check physical appearance of frame parts; keep accurate record of quantity produced.

9.17 Frame to Vent Assembly. Series 250 (sash) (1 operator)

General Responsibilities: Place frame on sash installation frame; applies corner sealant to jamb-sill corners; installs sash stops using mallet; inserts vent sash into frame using screwdriver; pulls balance out of tube 2"; uniformly adjusts tension on sash balances; seals head-jamb joints with caulking; carries completed frame assembly to back-bedding compound rack; inserts vent stops into frame head.

QA Responsibilities: Inspect vent sash assembly; checks W/S installation; check for proper operation of sash or vents; checks latch movement; check physical appearance of parts used in assembly; correctly tensions balance for window according to balance tension chart; checks stops for correct position and tightness in frame; keep accurate record of quantity produced.

9.18 Awning Type Window (ATW) Torque Bar (TB) Assembly. (1 operator)

General Responsibilities: Operator obtains TB pieces and uses grinder to bevel end of TB, aligns TB arms and TB in the press and activates press, attaching TB to TB arms.

QA Responsibilities: Checks fabrication of TB and TB arms; ensures squareness of fit of TB and TB arms; checks physical appearance of torque bar and torque bar arms; keep accurate record of production.

9.19 Torque Bar Installation. (1 operator)

General Responsibilities: Obtains completed frame and places on work rack, seals inside of sill to jamb joints with small joint sealer, inserts left and right TB bearings in frame then places TB in torque bar bearing part; TB installation screws are applied and transfer link is attached to TB arm with screw. vent link arms are manipulated into frame and set aside for vent installation.

QA Responsibilities: Inspects TB assembly for squareness; checks harness assembly for proper operation; check physical appearance of parts used in assembly; checks sill jamb joint sealing. Keep accurate record of quantity produced.

9.20 Vent Frame Assembly (ATW). (1 operator, 1 helper)

General Responsibilities: Operator measures pre-cut extrusion pieces to determine press dimensions; sets dimensions on vent jig to fit fabricated pieces; obtains work pieces and places vent heads and sills in correct vent jig slots and activates press, staking the pieces together. The first staked vent frame is removed from vent jig and checked for correct dimensions; operator hands the vent frame assembly to a helper who applies corner sealant and then carries finished vent frame to location where vent frames are inserted in window frames.

QA Responsibilities: Inspects jamb and sill pieces for cosmetic defects; checks measurements of extrusion pieces for correct dimensions per order; vent frames should be inspected on a frequency basis for correct dimensions and squareness; check that vent frame is securely staked together; keep accurate record of quantity produced.

9.21 Assembling Awning Vents to Frame (1 operator)

General Responsibilities: Places frame on assembly rack; inserts vent frame into frame in open position; applies necessary screws to secure vent frames to window frame; all awning windows over 37" wide are to have plastic shipping spacers installed 12" in from each jamb between vents (2 per vent); assembly is closed and locked with locking lever.

QA Responsibilities: Inspects vent frame assembly for adequate amount of corner sealant; checks appearance and squarenee of vent frame asssembly; checks for proper operation of harness assemblies; check physical appearance of parts used in assembly; keep accurate record of quantity produced.

9.22 Back-Bedding Compound Application. (1 operator)

General Responsibilities: Operator places frame on compound frame; apply adequate bead of glazing compound to center of glazing leg on frame using glazing compound applicator gun; cleans glazing gun to prevent excess glazing from getting on frame; periodically checks amount of glazing compound applied; carries frame and places it on glazing table.

QA Responsibilities: Assures adequate amount of glazing compound is applied to center of the glazing leg; inspects window for excess glazing compound; checks physical appearance of frame; regularly cleans applicator and checks glazing compound material keep accurate record of quantity produced.

9.23 Install Glass and Glazing Bead into Window Frame. (2 glazers per team).

General Responsibilities: Glazing person retrieves appropriate size and type of glass per order and supervisor's instruction; places glass centered in the vent; cuts glazing bead correct length; place glass blocks between glass and frame or vent sill; installs glazing bead.

QA Responsibilities: Checks frame for appropriate amount of glazing compound; assures that glass lites are not scratched, chipped, or cracked; inspects glazing bead around glass; checks application of hardware; assures that glass lites are placed in frames correctly; checks to make sure glass blocks are in place; verifies that glass complies with glass size table and/or prototype test unit.

9.24 Removing Windows from Glazing Table. (1 operator)

General Responsibilities: Inspects completed window; cleans, corrects or reports any defects in window; removes completed window from glazing table and carries window to inspection area then to cart or staging area.

QA Responsibilities: Inspects completed window for correct installation of glazing bead; ensures glass is free from chips, scratches, or cracks; checks for excess glazing compound on window; checks corner sealant application; checks application of hardware; inspects weather strip contact of vents to frame.

9.25 Pre-Assemble Door Panel or Frame Parts. (1 operator)

General Responsibilities: Move cart of frame or door panel sections to sub-assembly station; place pieces on table and install the necessary hardware (roller wheel assemblies, lock and handle assemblies, W/S etc.); stack frame sections on cart.

QA Responsibilities: Ensures correct frame parts and hardware parts are being used; visually inspect each frame and hardware part, for physical imperfections, during sub-assembly; keep accurate record of quantity produced; check that hardware is securely attached to the frame or door; check correct type and length of W/S.

9.26 Assembly Glass Door Panels. (1 operator)

General Responsibilities: Move component parts on carts to assembly area; place glass on table with assistance; cuts and applies correct glazing vinyl to edge of glass panel; uses wood mallet to position stiles and rails onto edge of glass to make frame around glass; install required screws in frame to hold the frame securely around glass; stack door panels against wall with help of an assistant.

QA Responsibilities: Assure correct frame parts, glass, screws, and hardware are being used; verifies dimensions of parts to production order before the run of an order; visually inspect each frame part and glass panel during assembly for physical imperfections; make sure vinyl W/S is seated properly between glass and frame parts; keep accurate record of quantity produced.

9.27 Cut Screen Parts to Length. (door or window) (1 operator)

General Responsiblilties: Set up bench saw stop to proper length of cut; move raw frame extrusions to work station; position raw extrusion against saw stop and cut to proper length (saw cuts opposite 45 degree angles); stack finished parts on cart.

QA Responsibilities: Set up saw stop to proper length of cut; move raw frame extrusions to work station; position raw extrusion against saw stop and cut to proper length (saw cuts opposite 45 degree angles); stack finished parts on cart; first piece inspection of cut length and angle; check the above items every 20th piece during run; check appearance of metal before cutting; and check quality of cut to detect a dull saw blade. Periodically check 45 degree angle of saw blade with an engineering protrator; keep accurate record of quantity produced.

9.28 Pre-Assembly Titan Screen Frame Parts for Door. (1 operator)

General Responsibilities: Move cart of cut-to-length horizontal frame sections to sub-assembly area; install metal corner connectors into each end of frame section; install two roller wheels with spring assemblies into frame section with screws; stack sub-assembled parts on cart.

QA Responsibilities: Check length of frame sections every 20th piece; assure that the correct components are being used in the sub-assembly; check appearance of frame sections for dents, scratches and other cosmetic faults; keep accurate record of quantity produced.

9.29 Assemble Door Screen Frame (1 operator)

General Responsibilities: move cart of vertical frame sections and sub-assembled horizontal frame sections to assembly area; obtain one frame upright with handle holes and one frame vertical without handle holes to assembly table; obtain two sub-assembled horizontal frame sections to assembly table and connect to the two verticals to make the door screen frame assembly; drive two screws in each upright section to hold frame together; set aside completed frame against the wall.

QA Responsibilities: check length of frame sections every 20th piece; visually check assembly of wheels to horizontal frame section; check appearance of frame sections for dents, scrathces, and other cosmetic faults during the run of an order; check tightness of corner joints; keep accurate record of quantity produced.

9.30 Assembly Window Screen Frame. (1 operator)

General Responsibilities: Move cut-to-length frame sections to assembly area; assemble four window screen frame sections together using four plastic corner connectors; set aside assembled window screen frame to storage.

QA Responsibilities: Check length of window screen frame sections every 20th piece; check appearance of frame sections for dents, scratches, and other cosmetic faults during the run of an order; keep accurate record of quantity produced.

9.31 Install Screen Mesh in Door or Window Screen Frame. (1 operator)

General Responsibilities: Obtain assembled screen frame to work table; roll out required length of screen mesh over the frame; trim screen mesh and install in frame with spline material and two lifting tabs using roller tool; set aside the finished screen in rows on floor; set-up wood blocks to hold frames in place when changing frame sizes, switching from door screen frames to window screen frames or vice-versa.

QA Responsibilities: Assure that screen mesh is tight after installation in the frame; check that spline is seated fully in groove of screen frame; check for cuts or tears in the screen material; check appearance of assembled frame for dents, scratches, and other cosmetic faults during the run of an order; lifting tabs should be installed deep enough into frame so that they cannot be pulled out; check for excess mesh material; keep accurate record of quantity produced.

9.32 Install Bug Flap and Handle in Door Screen. (1 operator)

General Responsibilities: Obtains door screen and positions to install vinyl bug flap along length of one door stile; trims bug flap to exceed length of stile by one inch; assemble door handle to frame with two screws; rotate door screen and install bug flap in opposite stile and trim to length; set aside door screen to row on floor for storage until order is complete.

QA Responsibilities: Check physical appearance of door screen for dents, scratches, and other cosmetic faults in metal, tightness of screen, loose edge on screen, cuts or tears in screen mesh, and proper installation of wheel assemblies.

9.33 Sliding Glass Door (SGD) Wheel to Yoke Assembly (1 operator)

General Responsibilities: Obtains box of wheels and yokes to work area; assemble wheel to sleeve, position to riveting fixture in press and rivet wheel to sleeve; put assembly aside for further assembly.

QA Responsibilities: Check physical appearance of wheels and sleeves during production; check length of sleeve every 20th piece; check quality and length of rivet; check for proper operation of wheel in sleeve; keep accurate record of quantity produced.

9.34 Rivet Wheel - Yoke Assembly to Wheel Housing. (1 operator)

General Responsibilities: Obtain box of wheel-yoke assemblies and wheel housings to work place; assemble wheel-yoke assembly to wheel housing; position to fixture in press and rivet wheel-yoke assembly to wheel housing; set aside assembly.

QA Responsibilities: Check physical appearance of parts used in assembly; check length of yoke and housing every 20th piece; check quality and size of rivet; check for proper operation of wheel after assembly; keep accurate of quantity produced.

9.35 Sliding Glass Door (SGD) Knock-Down (KD) Frames. (1 operator)

General Responsibilities: Read ship order to determine frame required; move cart of frame sections to work area; obtain the four frame sections to table; stack and band frame sections together with paper and tape; write frame description on paper; stack bundled frame sections on cart. Attach hardware package to bundle.

QA Responsibilities: Assure correct frame sections are used for the order; visually inspect each frame section for physical imperfections, proper installation of hardware, if required, and proper screw holes, weep holes, etc.; check length of frame sections; keep accurate record of quantity produced; clearly mark a description of the completed package on the exterior to identify the order and contents.

9.36 Package Bundled KD Frames (1 operator)

General Responsibilities: For orders which require packaging, obtain and assemble a carton; attach hardware bag to bundle of frames; place bundles of frames in carton along with packing slip; close carton and run through strapping machine; write customer name and frame description on carton; stack cartons on cart.

QA Responsibilities: Assure that frame bundle matches the order; write correct information on carton; correct hardware bag enclosed; strapping is tight and secure around carton; carton is not torn or damaged in any way; inspect frame sections for any damage; keep accurate record of quantity packaged.

9.37 Shipping

General Responsibilities: Shipping person retrieves correct finished screen, door, window assemblies and hardware per order; stacks and boxes screens for protection; correctly labels assemblies with destination; packs and secures shipments in the correct truck as necessary; completes packing list and places in the truck; notifies supervisor of any discrepencies regarding order or finished product.

QA Responsibilities: Final visual inspection of finished assemblies during handling; inspects packing of truck for security of load; checks destination labels and packing list for completeness and correctness; checks order against production for correct number, size, finish, and correct type glass.

9.38 Glass Handler (1 operator)

General Responsibilities: Removes glass from packing crates; locates correct type and size of glass per order; transports glass to location where needed.

QA Responsibilities: Inspects glass for chips, scratches, cracks or finish flaws, and reports defects to QC inspector.

9.39 Material Handler. (1 operator)

General Responsibilities: Receives and unloads incoming extrusions, weighs bundles and counts number of pieces compared against delivery ticket. Furnishes copy of delivery ticket to Q. C. Inspector (see par 3.5.2. pg.5) Locates and retrieves correct type, size, and number of extrusions per Material Retrieval (MR) form and leadman; manipulates extrusion pieces in a safe manner; proper handling of materials to prevent damage to the finish.

QA Responsibilities: Inspects extrusion pieces for cosmetic or structural defects.

9.40 Milling Machine (1 operator)

General Responsibilities: Sets dimensions for milling operation; safely operates milling machine; reads drawings or breakdown sheets; cleans and lubricates machine on regular basis; inspects first milled piece to verify correct milling operation.

QA Responsibilities: Inspects milled parts on a frequency basis for precision cut matching the template; keeps accurate count of finished pieces; visually inspects extrusion pieces prior to milling opertion.

9.41 Set - up Person.

General Responsibilities: Reading fabrication drawings; locates correct press die as order requires installs dies into power press and locks specified dies into machine according to plant safety standards; sets stops and guides; installs jigs or fixtures for positioning workpiece per fabrication drawing; lubricates press as needed; repairs or adjusts dies as necessary.

QA Responsibilities: Examine stamped out metal parts to verify location of notches, weep holes, assembly holes, installation holes to detect malfunctioning machine, and/or defects in dies; checks punch press set-up for safe operation.

9.42 Lead Person. (Foreman)

General Responsibilities: Material breakdown to determine lineal measurements; calculate cut and punch dimensions from cut sheet provided for the order; assists with set-up of press operations to ensure correct size and type of die are placed in the press; communicates with engineering and other production personnel; communicates instructions to punch and saw operators; completes and files material retrieval forms.

QA Responsibilities: Verifies that correct extrusion pieces are retrieved for the order; rechecks calculations for cut sizes; inspects extrusion pieces for cosmetic and angularity defects, and notifies QC of any problems with dies or extrusions.

INSPECTION PROCEDURES

10.1 Inspection Stations.

Inspection stations are areas in the production flow where detection of defects is critical for determining a piece or product's conformance to an order, and product specifications.

A committee composed of product engineers, plant operators, sales representatives, quality control inspectors, and managers has designated the following areas as inspection stations; screen, insul-glass, commerical and residential window final inspection, door assembly, cut and fabrication, paint, and sub-assembly.

10.2 Procedure:

Go to first inspection station. Verify sequence of orders being run with supervisor or leadman. Determine required number for inspection sample. Draw 1, 2, and 3 digit random numbers from random numbers table. To read the table the inspector places the table on their clip board and, with eyes closed, arbitarily points a finger onto the table. Read the last two digits of the random number where the finger points. If the number falls within the size of the lot then this number corresponds to the sequence number of the product in the lot. If the lot is less than ten only the first digit is read for values of one to nine. If a lot number is larger than 99, three digits should be read. If the numbers chosen are larger than the size of the lot then the next digit(s) should be used for sample numbers.

During the day pieces of products are inspected that correspond to products that are produced in sequence of production. The inspector should attempt to inspect pieces or products in sequence corresponding to the random numbers obtained from the random numbers table to obtain a random sample.

10.3 Checklist and Inspection.

Using the appropriate checklist for the inspection station, record product type and order number at the top of columns. Record a tally mark for each piece inspected in the space labeled "no. pcs. inspected." Check product or piece for each and every potential defect described on the left-hand side of the checklist in the priority in which they appear from top to bottom. For each defect detected, record a single tally mark in the space on the checklist corresponding to that defect and product or piece. Once a defect is detected and judged as a rework or a reject, record a single tally mark in the area labeled "no. reworks" or "no. reject" box. When a defect is found that is classified as a reject then other potential defects do not have to be inspected. When the inspector finishes the inspection of the window any defects or rejects must be briefly described and recorded on a yellow (rework) or red (reject) inspection sticker and fastened to the piece or product at a location near the defect. If no defects are detected then a blue (passed) sticker should be attached to the window frame near the order number. The supervisor should be kept informed of defects found.

10.4 Fitness for Use Classifications:

Fitness for use is defined according to the operational definitions of classification levels for each defect listed on the master description sheet of potential defects.

A <u>REWORK</u> is defined as any piece or product that does not conform to the order or product specifications during inspection but will be fit for use when defects described on the yellow tag are corrected and the piece is re-inspected.

A <u>REJECT</u> is defined as any piece of product that exceeds the tolerance limits defined in the potential defect description checklist and cannot be corrected by normal means to meet product or customer specifications.

10.5 Sampling Plan:

Based on an historical 8% defect rate and a 95% confidence level of accepting a lot with less than an 8% defect rate, the following sampling plan is to be used to inspect pieces and products in daily inspection:

LOT SIZE	NUMBER TO BE INSPECTED	
200+ units	12%	24
141 - 199 units	12%	20
81 - 140 units	14%	16
51 - 80 units	20%	13
31 - 50 units	30%	12
16 - 30 units	40%	10
6 - 15 units	70%	8
0 - 5 units	100%	all

If one defect occurs in the sample group occurs then check another piece from the lot at random. If the same defect occurs in the second piece the entire lot must be inspected, i.e. 100% inspection. If a different defect is discovered in this second piece then another sample must be inspected to determine if this defect occurs again. If the same defect is found the entire lot must be inspected.

10.6 Sampling Plan for Window Final Assembly.

Windows are removed from the glazing table or rack and carried to the area designated for inspeciton. The window remains in this location until the inspection procedure is completed and the product is judged as passing, rework, or reject. When a window is judged as a rework it is returned to the glazing table as necessary and the inspector must inspect the repair(s) to insure correction of the defect.

10.7 Totaling the Inspection results.

Add the number of tally marks for defects and record the number at the bottom of the vertical column in the space designated "Total Defects" when the required number of sample inspections for a lot has been completed. The total number of pieces inspected and the total number of rejects and reworks must also be recorded.

10.8 Computing the Quality Index

The Quality Index is computed or supervisedby the Quality Control Manager. This statistic is calculated by summarizing the results of daily inspections shown on the inspection checklists for all departments. The Quality Index will be computed for both departmental and total plant on a daily and monthly basis. The Quality Index will be used by the management to monitor the accuracy of production methods in producing Prime-Quality window and door products.

10.9 Identification Stickers Used in Inspection

REWORK = Yellow 1" x 3" rectangle

placement - locate near defect

REJECT = Red 1" x 3" rectangle

placement - locate near defect and obviously visible

PASSING = Blue Circle

placement - adjacent to order number on window jamb

OPERATIONAL DEFINITIONS OF POTENTIAL DEFECTS:

11.1 Final Window Inspection: (see checklist in Appendix F)

1. Overall height and width measurements.
   height or width measurements off > 1/16" -- reject

2. Squareness.
   diagonal measurements differ > 1/8 " -- reject

3. Frame and vent parts' joint and corner assembly.
   head/jamb, sill/jamb, meeting rail/jambs,
   gaps at the above locations > 1/32" -- reject

4. Incorrect glass type. -- stop and rework

5. Difficulty operating window.
   operate single hung and horizontal slider vents.
   difficulty operating vents. -- rework
   vent will not remain in operated position -- rework
   vent over-tensioned i.e. opens by itself -- rework

6. Hardware movement.
   latch does not operate easily and/or
   does not engage properly. -- rework

7. Glazing bead fit.
   incorrect glazing bead installed -- rework
   miter fit off > 1/32" -- rework
   indentations or perferations in the bead -- rework
   bead off glass >1/32" -- rework
   bead leg not uniformly in place -- rework

8. Finish damage.
   Scratch > or = 1/16" wide and >2" long
   to the bare metal -- rework/reject
   presence of water stains -- rework/reject
   bent or dented metal frame pieces -- reject/rework

9. Excess glazing compound.
   compound extending from metal onto glass > 1/4" -- rework
   excess compound on glass or frame >1" diameter -- rework

10. Inadequate corner sealant coverage.
    screw heads not covered -- rework
    joint not filled completely -- rework
    ATW interior sill joints not sealed -- rework

11. Glass blocks missing.
    check with suction cup test to check for
    glass slippage downward > 1/8" -- rework

11.2 Insul - Glass Potential Defects: (see checklist in Appendix G)

1. Incorrect Thickness of glass.
   check against order specifications -- reject

2. Incorrect size glass.
   check against order specifications -- reject

3. Incorrect type glass.
   check against order specifications -- reject

4. Poor assembly of glass panels.
   over/under size spacer/grill assembly -- reject
   spacer/grill incorrectly assembled or installed -- reject
   grills not square -- reject

5. Bowed spacer.
   displaced > 1/16" toward center of assembly -- reject
   measure the distance from the edge of the glass to the inside edges of spacer at ends and middle of the glass lite. If the center and end measurements differ > 1/16" -- reject

7. Debris between glass lites. -- reject

8. Inadequate sealant coverage.
   sealant thickness less than 1/8" -- reject

11.3 Screen Assembly Potential Defects: (see checklist in Appendix H)

1. Finish Damage.
   scratch 1/16" wide 2" long to the bare metal -- reject (2nd)
   any smaller scratch, touch up paint -- rework
   dents present -- reject (2nd)

2. Inoperable wheels. -- rework

3. Damaged screen material -- rework

4. Screen material not taunt. -- rework

5. Poorly attached hardware and lifts. -- rework

6. Corner construction.
   45 degree gaps > 1/16" -- rework

11.4 Cut and Fabricate Potential Defects: (see checklist in Appendix I)

1. Incorrect length measurement.
   short > 1/32" -- reject
   long > 1/32" -- rework

2. Incorrect hole measurements.
   short > 1/32" -- reject
   long > 1/32" -- rework

3. Incorrect angularity. -- reject

4. Bowed extrusion. -- reject

5. Finish damage.
   scratches 1/16" wide and >2" long to bare metal -- reject
   smaller scratches, touched up with paint -- rework
   water marks present -- reject, rework

11.5 Paint Potential Defects: (see checklist in Appendix J)

1. Inadequate Coverage. -- rework

2. Incorrect Finish. -- rework

3. Debris in paint finish. -- rework

4. Runs in paint. -- rework

11.6 Pre-assembly Potential Defects: (see checklist in Appendix K)

1. Length measurements off.
   short > 1/32" -- reject
   long > 1/32" -- rework

2. Difficult movement of harness assembly -- reject
   inspect runner bar, vent links, and cams

3. Location of punch holes off > 1/32" -- reject

4. Burrs on pieces.
   any burr on glazing leg -- rework
5. Difficult movement of wheel assembly -- rework

6. Warped metal in assembly -- reject

7. Weather Strip incorrect -- rework

8. Weather Strip incorrect length -- rework

9. Weep valve inoperable -- rework

10. Hardware, e.g. sash lock, installed
    incorrectly or difficult to move -- rework

11.7 Door Assembly Potential Defects: (see checklist in Appendix L)

1. Incorrect length measurements.
   short > 1/32" height or width -- reject
   long > 1/32" height of width -- rework

2. Unsquare dimensions.
   diagonal measurements short > 1/8" -- reject
   diagonal measurements long > 1/8" -- rework

3. Incorrect glass. compare with order. -- rework

4. Glass installed improperly. -- rework

5. Incorrect w/s installed. -- rework

6. Incorrect length w/s installed. -- rework

7. Poor fit of glazing vinyl. -- rework
   incorrect type.
   presence of waves.
   poorly seated.
   unsquare vinyl.

8. Damaged Finish
   scratches > 1/16" wide and > 2" long to bare metal -- reject
   scratches under the measurement given to be touched-up with spray paint -- rework

9. Difficult lock movement. -- rework

10. Difficult roller wheel assembly movement. -- rework

11. Damaged glass. (e.g. scratch, chip) -- rework

12. Incorrect length of type of screws. -- rework

13. Glazing vinyl off panel parts.
    length vinyl out from panel part > 1" -- rework

14. Wheels not completely installed in bottom rail -- rework

Appendix A

WALLACE - CROSSLY CORPORATION
SUPPLIER QUALITY ASSURANCE SURVEY REPORT

Division:_____________________ Date:_________ Surveyor:________________
Reason for Survey:
Introductory ____ Scheduled ____ Unscheduled ____ Investigation ____

==

______________________________ __________________ ______________
Supplier Name Parent Company Phone

____
Address
Name of Contact:________________________ Title ________________________
Part Name: Part Number:
______________________________ ____

==

Quality Program Survey:

1. The Quality Organization reports to:
Plant Mgr. __ Production Mgr. __ Other ________________

2. The Quality Organization consists of:
Engineers __ Inspectors __ Analysts __

3. The Inspection function reports to:
Quality Manager __ Production __

4. Does the Quality Organization havea Quality Manual? __ Yes __ No

5. Is there a program for training Quality personnel? __ Yes __ No

6. Does Quality review new products before they are introduced?
__ Yes __ No

7. Is quality involved in purchase materials selection and approval?
__ Yes __ No

8. What method and freqency of inspection is used?
100% ____ Mil Std 105 ____ SPC ____ Other _______________

9. Are production operations promptly corrected or shut down until corrected when quality problems occur? __ Yes __ No

10. Are inspections performed according to written instructions?
__ Yes __ No

Appendix B

QUALITY CONTROL INCOMING EXTRUSIONS

DATE ______

VENDOR	WCC DIE NO.	VENDOR DIE NO.	PURCH. ORD. #	NO. LBS.	NO. PCS.	LGH.	COL.	SOLID Hollw	WEB. READ.	WT. PER FT.	PASS OR FAIL	COMMENTS	Q.C. DISP. REP. NO

Appendix C

QUALITY CONTROL INCOMING PURCHASED PARTS

DATE	DESCRIPTION	PART NO.	SUPPLIER	TEST REPT DATE	TEST SPEC. NO.	LTR. COMP. DATE	PASS FAIL	Q.C. DISP. REPT.	INSP. BY

Appendix D

WALLACE - CROSSLY CORPORATION
QUALITY CONTROL DISCREPANCY REPORT

TO: Purchasing and Material Manager Report No. _____

DATE: _____________

Wallace - Crossly Part Number _______________ P.O. _____________

Description ____
____

Quantity __________________ Size ________________ Finish ______

Vendor ____________________ Vendor Part Number ______________

Status of Material - Raw ___ Cut ___ Fab. ___ W/S ___ Assem. ____

Cause of Discrepancy: ____
____

Recommended Disposition: ____

Disposition: Use & notify vendor _________ Return to vendor _____

Vendor contact: ______________________________ Date: ___________

Remarks: ____

Q.C. Mgr. _____________________ Material Mgr. ____________________
****
Purchasing's request for authorization to return, or remarks:
____
____
___________________________________ Dir. of purchasing _____ Date: __
****

Return to vendor per: __________________ Ship via: ________ Date: __

Material returned via: _______________________________ Date: ______

Shipping ticket number: _______________ Foreman: ________________

Appendix E

Daily Quality Index Summary Sheet

Department ---->>>	Screen	Residential Window Assembly	Commercial Window Assembly	Insul- Glass	Door Assembly	Door Cut & Fabricate	Window Cut & Fabricate	Paint	Pre- Assembly	Plant Total
# Pcs. Inspected										
Total # Defects										
Total # Reworks										
Total # Rejects										
Reworks + Rejects/ No. inspected										
Positive Conversion										

Quality Remarks:

Quality Incidents:

Inspector Reliability Checks and Notes:

POTENTIAL DEFECT CHECKLIST

Inspection Station: Window Final Assembly Inspector: ____________________ Date: __________

Time Series #										
Order #										
measurement										
squareness										
glass type										
operation										
hardware movement										
glazing bead fit										
finish damage										
excess glaze compound										
inadequate corner sealant										
glass blocks missing										
o. inspected										
o. defects										
o. reworks										
o. rejects										

Appendix G

POTENTIAL DEFECT CHECKLIST

Inspection Station: Insul - Glass Assembly Inspector: ____________________ Date: __________

Time										
Series #										
Order #										
ıcorrect :hickness glass										
ıcorrect size glass										
ıcorrect type glass										
anel assembly										
pacer misplacement										
pacer bowed										
ebris between lites										
nadequate sealant coverage										
). pcs. inspected										
). defects										
). reworks										
). rejects										

Appendix H

POTENTIAL DEFECT CHECKLIST

Inspection Station: Screen Assembly ____ Inspector: ____________________ Date: __________

Time Series #									
Order #									
Finish damage									
Inoperable wheels									
Damaged screen material									
Tauntness of screen material									
Poorly attached hardware									
no. pieces inspected									
no. defects									
no. reworks									
no. rejects									

Appendix I

Inspection Station: Cut and Fabricate Inspector: ____________ Date: ________

Time										
Series #										
Order #										
ıcorrect ıngularity										
owed extrusion										
ıcorrect length ms't										
ıcorrect ıole ms't										
inish lamage										
ıo. pieces inspected										
ıo. defects										
ıo. reworks										
ıo. rejects										

Appendix J

POTENTIAL DEFECT CHECKLIST

Inspection Station: Paint______________ Inspector: ____________________ Date: __________

Time Series #										
Order #										
nadequate coverage										
ncorrect finish										
lebris in paint										
'uns in paint										
10. pieces inspected										
10. defects										
10. reworks										
10. rejects										

Appendix K

POTENTIAL DEFECT CHECKLIST

Inspection Station: Pre - Assembly Inspector: ____________ Date: ________

Time Series #										
Order #										
easurements										
ovement of harness assembly										
ocation of punch holes										
urrs on pieces										
ovement of wheel assembly										
arped runner bar										
10. pcs. inspected										
10. defects										
10. reworks										
10. rejects										

Appendix L

POTENTIAL DEFECT CHECKLIST

Inspection Station: Door Assembly Inspector: ____________ Date: ________

Time Series #										
Order #										
measurements										
squareness										
incorrect glass										
glass installed incorrectly										
incorrect w/s										
incorrect length w/s										
fit of glazing bead										
damaged finish										
difficult lock movement										
wheel assembly movement										
damaged glass										
incorrect length or type screws										
no. inspected										
no. defects										
no. reworks										
no. rejects										

APPENDIX D

DESCRIPTIONS OF QUALITY TRAINING SLIDES

Slide No.	Acceptable Quality Yes or No	DESCRIPTION	100 Quality Inspection Reference
1	No	Height and Width Measurement off >1/16"	11.1.1
2	Yes	Exact Height and Width Measurements	
3	No	Corner sealant not covering screws and joint completely	11.1.10
4	Yes	Corner sealant covering screws and corner cracks 100%	
5	No	Bent Frame Pieces	11.1.8
6	Yes	Normal, straight frame edge	
7	No	Scratched Frame Piece 1/4" x 3"	11.1.8
8	Yes	Scratched Frame Piece Scratch 1/8" x 2"	
9	No	Glazing Compound smeared on surface of glass 2" from glazing bead	11.1.9
10	Yes	Glazing Compound extending only 1/8" onto glass from glazing bead edge	
11	No	Frame parts' corner assembly crack width >1/16"	11.1.3
12	Yes	Zero Crack width	
13	No	Glazing Bead not seated against glass and vent pieces	11.1.7
14	Yes	Glazing Bead symmetrically installed.	
15	No	Inadequately Debridged extrusion showing metal not removed entirely	11.1.8
16	Yes	Group of properly debridged extrusions together to show how one bad one should stand out	

Slide No.	Acceptable Quality Yes or No	DESCRIPTION	Quality Inspection Reference
17	No	Glass that has slid in vent from absence of glass blocks	11.1.11
18	Yes	Glass sitting properly in vent	
19	No	Measuring tapes showing diagonal window measures off 1/4"	11.1.2
20	Yes	Exact diagonal measurements	
21	No	Missing vent stop	11.1.3
22	Yes	Both Jambs with vent stops	
23	No	Broken Glass pane	11.2.2
24	Yes	Unbroken glass	
25	No	Runs in paint	11.5.4
26	Yes	Painted extrusion with smooth appearance	
27	No	Missing Screws in Frame	11.1.3
28	Yes	Properly assembled frame	
29	No	Glazing bead with putty knife shown inserted between glazing bead and glass	11.1.7
30	Yes	Glazing bead with no space between glass and glazing bead	
31	No	Frame with no weather strip installed	11.7.5
32	Yes	Open Frame showing proper length and installation of weather strip	
33	No	Slider Window Roller Wheels Not installed completely in extrusion housing	11.7.14
34	Yes	Wheels properly seated and screwed into rail extrusion	

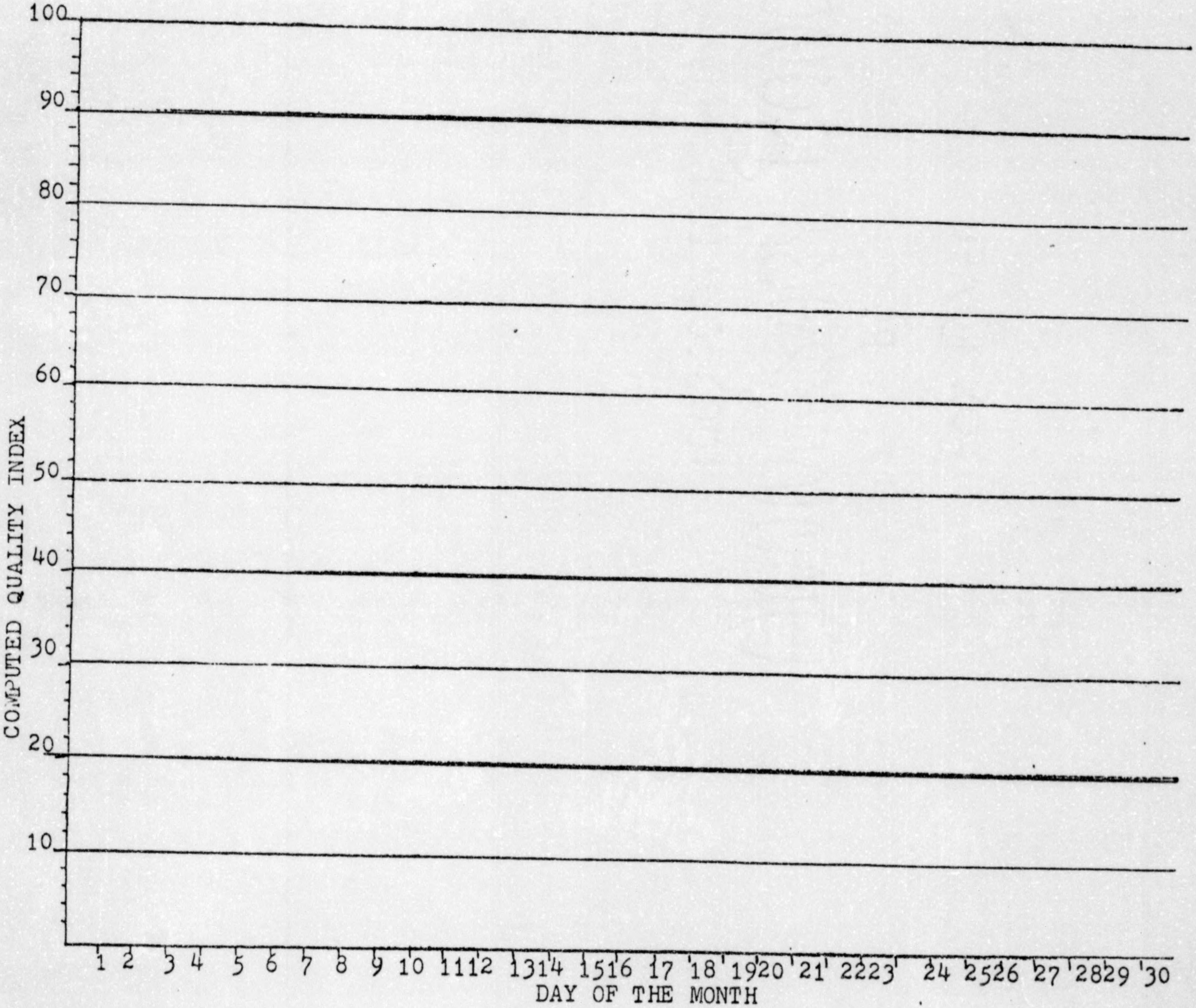
Slide No.	Acceptable Quality Yes or No	DESCRIPTION	Quality Inspection Reference
35	No	Glazing vinyl not seated on glass	11.7.7
36	Yes	Panel with glazing vinyl installed symmetrically	
37	No	Dented glazing bead	11.1.7
38	Yes	Undamaged glazing bead	

APPENDIX E

FEEDBACK CHART*

note: * reduced to approximately 25% of original size

DEPARTMENT ____________



COMPUTED QUALITY INDEX
100
90
80
70
60
50
40
30
20
10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
DAY OF THE MONTH

APPENDIX F

GOAL SETTING POSTER

QUALITY INDEX

GOAL

95 %

Table 1

Results of the ANOVA tests

Source	Sum of Squares	DF	Mean-Square	F-ratio
Group	2,816.88	1	2,816.88	2.45
Error	16,097.37	14	1,149.81	
Phase	1,858.91	1	619.64	8.96**
Group x Phase	1,332.98	3	444.33	6.42**
Repeated Measures Error	13,281.25	192	69.17	

Individual Interaction ANOVA tests

Source	Sum of Squares	DF	Mean-Square	F-ratio
Group x Phase I	286.10	1	286.10	3.630
Group x Phase II	98.71	1	98.71	1.253
Group x Phase IV	1129.54	1	1129.54	14.333*

* p level .01
** p level .001

Table 2

Results of the modified Bonferroni tests

Phase Comparison	Group I F value	Group II F value
I vs. II	1.320	29.215 *
I vs. III	15.762 *	401.440 *
I vs. IV	26.017 *	100.309 *
II vs. III	5.080 ***	193.265 *
III vs. IV	0.217	619.608 **

* p level .01
** p level .01 but opposite of hypothesized direction
*** p level .05

Table 3

Mean group quality index level and standard deviation for each phase

	Baseline Phase I		Training Phase II		Feedback Phase III		Goal Setting Phase IV		All Phases	
Group	M	SD	M	SD	M	SD	M	SD	M	SD
Group I	75.9	11.2	82.3	8.6	87.6	5.8	88.6	6.3	83.7	10.2
Group II	79.6	8.3	81.5	10.7	87.4	8.6	75.3	8.4	81.0	9.8

Table 4

Calculated average expense for nonconforming product reworks *

Group	Baseline Phase I	Training Phase II	Feedback Phase III	Goal Setting Phase IV	Total % Change
Group I	$7,292	$5,126	$4,638	$3,112	-57.3%
Group II	$5,876	$4,936	$3,268	$4,117	-29.9%
Total	$13,168	$10,062	$7,906	$7,229	-45.1%

* note: Calculated monthly rework expense, i.e. (calculated daily rework expense divided by the number days in phase) multiplied by 30 days

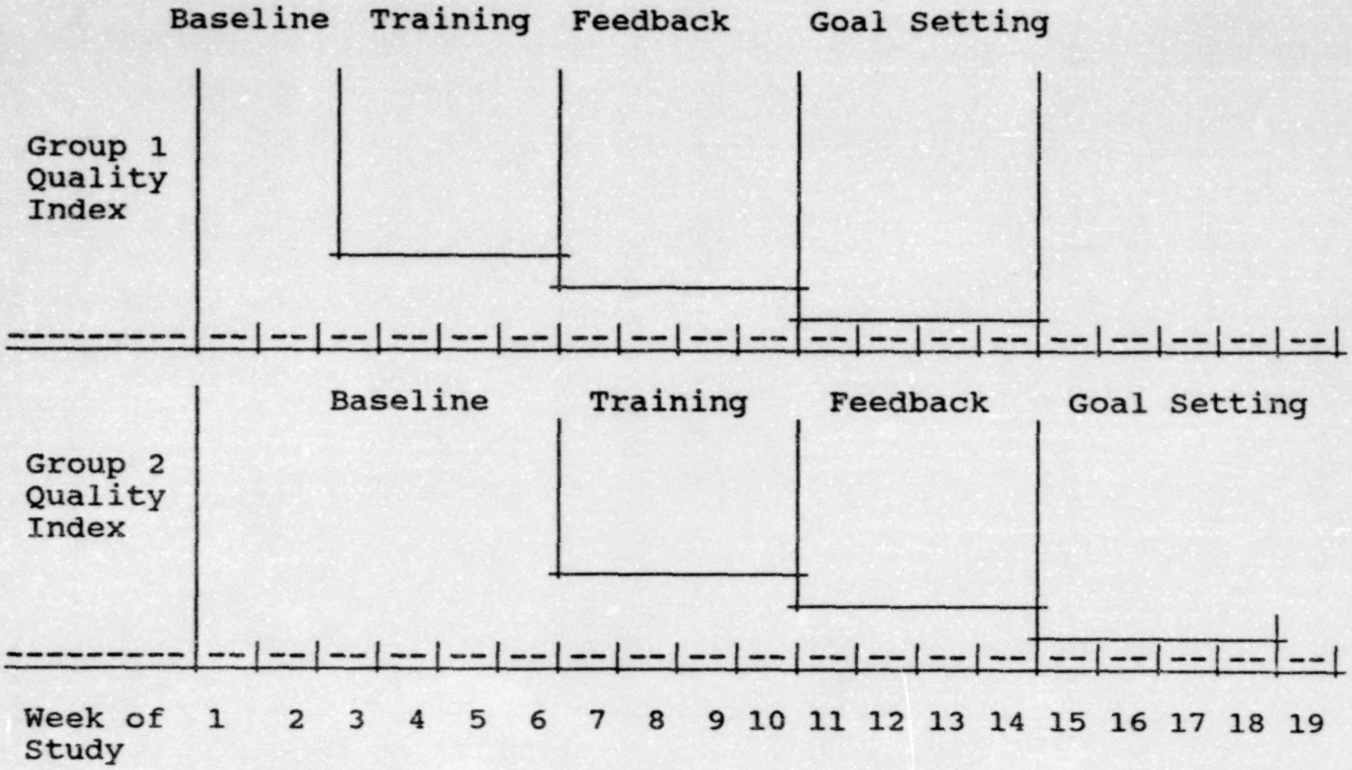


Figure 1: Multiple-baseline schedule

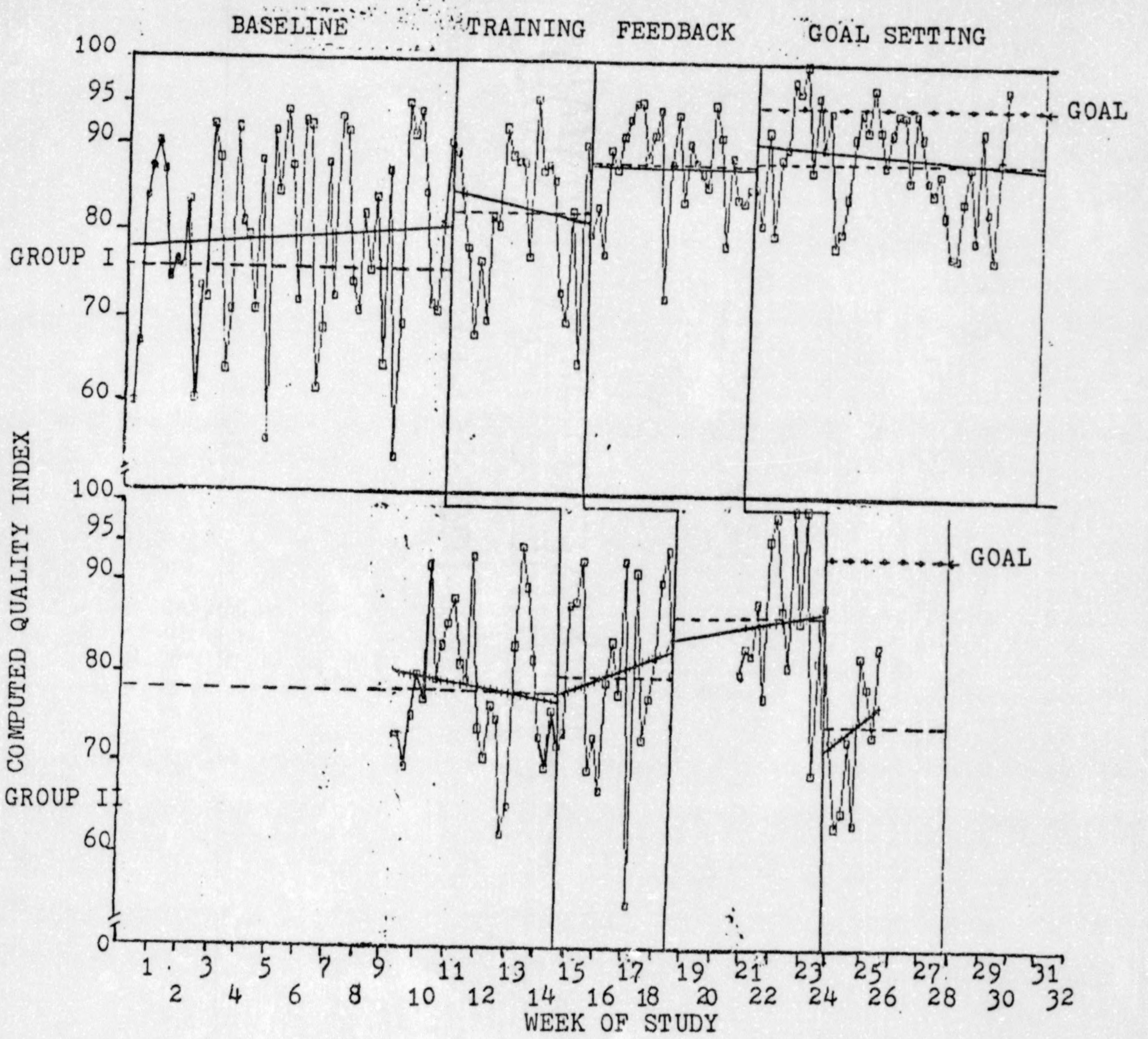


Figure 2: Quality Index for two groups under four experimental conditions