"What are some of the Communications Issues in Training?"

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Disclaimer

The opinions expressed in this research report are those of the author.
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Contents

Abstract

The study and research report reviewed a training module and training methods used by a national gas pipeline company to train valve technicians who maintain and service a gas transmission system.

Communications is a part of training. Communications factors in training include the design and appearance of print-based materials, the handling of physical training models and equipment, the methods used to deliver the training, the training setting and interpersonal communications used in training. All of these areas of communication are combined in the training that helps valve technicians to safely and effectively maintain and service a gas pipeline system. An independent research-based study focussed on improving communications in the training materials, the training process and the setting and delivery of the training was considered quite significant by trainers within this particular gas pipeline company.

To this end the research question asked was:

"What are some of the communications issues in training?"

The training materials focus area considered communications issues related to the materials that are used to support the training. The training process focus area considered communications issues related to instructional design approaches that could improve the communication of the training material and the retention of the concepts that are part of the training process. The training setting focus area investigated communications issues around the training environment or setting, training presentation techniques and how the knowledge created and shared in training could be extended to the post-training workplace.

Specific suggestions for improving communications in training are introduced in this research report.

Introduction

The training of professionals is an area of considerable focus within organizations today. In an organization dedicated to creating a learning environment, training is a top priority. Learning organizations do not simply appear. They are fostered by devoting time, energy and resources on a continuous basis to the training and development of employees. The learning organization of today, described by Sims (1998), is characterized as places where people continually expand their capacity to create results they truly desire, where new patterns of thinking are nurtured, and where people are continually learning how to learn together. Block (2000) reinforces this view of organizational learning when he says that the challenge of organizational life is to connect people to common effort. Accepting this challenge demands cooperation and a willingness to acknowledge how we are connected in our efforts to work effectively and to ensure lasting learning.

The training of employees represents an investment that can bring huge returns in the form of work effectiveness. Nowhere is this return on investment encouraged more than in the oil and gas sector of our economy, where the expectation is that a dollar

spent will return more than a dollar. This industry was described by one of the trainers interviewed during the research phase of this study as a “mature” industry wherein the focus is placed on maintaining the system in good working order for the long-term and not making major infrastructure additions or changes. The role of training, as it relates to system maintenance and integrity, is going to continue to be an important part of how this organization does business in the future.

Along with workplace effectiveness, training can mean helping to create an environment that is safe for workers. In areas of the oil and gas business, workplace safety is of paramount importance.

One such area where safety and workplace effectiveness go hand-in-hand, is the gas pipeline work environment of the gas transmission business. The training of valve technicians is the particular area of focus for this study. These valve technicians service the valve systems that regulate the flow of natural gas at it is transported in pipelines from the gas fields to processing plants, sometimes many hundreds of miles away. System integrity is very important to companies operating these systems, and training plays a key role in keeping the transmission system well serviced and in good working order.

Training sessions for the valve technicians take place on a regular basis at a variety of field office locations along the natural gas pipeline system. The training sessions usually last one or two days and deal with a variety of topics related to the servicing of these pipeline valves. The particular training module that will be considered in this study is entitled “Valve and Valve Operator Program: Level 1 and Level 2”.

An independent research-based study focussed on the training materials, the training process and the setting and delivery of the training is considered quite significant to people within this particular gas pipeline company, as they are always looking for ways to make their training more effective for their employees. To this end the research question being asked of the three training areas mentioned above is:

"What are some of the communications issues in training?"

The training materials focus area will look at selected communications materials that are used to support the training. The goal is to look for examples where visual design communications principles applied to print-based materials would help the training process. Key feature areas for review and comparison will be written or displayed information, tabular information, and drawn or diagrammatic information.
The training process focus area will consider instructional design approaches that could improve the communication of the training material and the retention of concepts that are part of the training process. The training setting focus area will investigate how communications is affected by the training environment or setting and by the delivery techniques used to communicate of training.

Specific suggestions for improving communications in training will be introduced in the discussion section of the paper. This will allow the people responsible for training to consider incorporating the suggestions into overall improvements to the training materials. The literature review that follows will help to establish some of the theory and practical aspects of communications as it relates to training.

Literature Review

This study is looking specifically at a training module used by a national gas pipeline company to train valve technicians who maintain and service the gas transmission system. The subject of this research report is the material used in training, the training process and the setting for the training, with a focus on improving communications.

As stated in the introduction, training is a very important part of the company's business culture. Many books have been written on the subject of training and what people do when they train others. In his book Reinventing Training and Development, author Ronald Sims (1998) makes the point that training must be delivered from the standpoint of the knowledge, skills and other characteristics (KSOC). These features must be developed with a clear understanding of the results expected with regard to the organization and its employees. The steps taken through the effective design of training materials, the training process and the training settings is essential for the improvement of understanding, performance and effectiveness on the job. Some basic rules of communication can be applied that will help improve how people grasp the content of training and get the most out the training session.

1. Training Materials

This research report is looking at a training module that is delivered in a live, face-to-face lecture format, using a variety of materials. The following list of materials has been provided by the trainers, and includes:

1. Power point presentation, both in transparencies and in electronic form. The trainers usually use the transparencies for the delivery of the lecture.

2. The course handout consists of a summary print out of the power point presentation as well as number of equipment summaries that are pertinent to the use, maintenance and repair of valves and valve operators.

3. Table top models of:

- small valves
- models of larger valves
- cutaway models of both of the above
- grease system parts such as in line check valves and fittings

4. Samples of valve grease and lubricants.

5. Real valves and operators that are mounted on portable stands. These can be connected to shop air and operated. This is set up in a shop area. These models give us an opportunity to get up and get away from the classroom.

6. Large schematics of valve operator control logic.

7. Actual in-service valves and valve operators in the compressor station yard. The trainer and the trainees walk through the yard and review the design and function of this equipment. Occasionally, they will try to repair or service a valve and operator but this opportunity exists only when they present the course on site.

8. Specialty tools such as power greasers and pressure meters.

This will give some idea of the scope and variety of the training materials used. A main focus of the study will be the investigation of displayed or written information, and tabular and diagrammatic information materials. Much of the learning is occurring through the use of visualization and hands-on approaches.

These training materials are learning aids, and for Milano and Ullius (1998), have to function in the following ways:

- to focus learners on objectives
- to reinforce key points
- to provide illustrations or directions
- to provide a common experience for reflection or analysis

- to stimulate thinking
- to provide a visual or auditory reference point or model
- to meet the needs of various learning styles
- to simulate the real world of application as closely as possible

We know that we use language to learn. Understanding the visual language of our environment is sometimes as important as the verbal and spoken language that we use. Reading and understanding traffic control signs is one example of this. The author of Information Design: An Introduction, Rune Pettersson (2002) has made the point that everyone learns to use words, but we must learn to "read pictures" as well. Therefore, picture language must be adapted to the viewer's capacity for interpreting it. Communications can be said to function successfully between the picture maker and the viewer, if the viewer understands, to the fullest extent, what the picture maker wants the picture to say, and if the picture conveyed is unambiguous. He goes on the say that a balance of visual and verbal elements in presentations, or a dominance of visual elements was found to be superior to verbal dominant presentations when tested for spontaneous recall.

The overhead projection of written and visual information is used to deliver the training module being studied. Edward Tufte (2003) has some interesting observations regarding the use of Power Point or overhead slide materials for lecture purposes. Tufte argues that Power Point slides come "bundled" with a cognitive model that is counter to what we should do in order to make people understand what we are communicating. He makes the point that Power Point slides should not be spoken from but rather that they should represent points of visual concept organization that will help people to use more traditional paper-based handouts more effectively. These paper-

based handouts would have a higher rate of information transfer that would approximate books, magazines and Internet screens and allow for a more detailed visual and verbal description of a situation or process. He suggests that Power Point presentations be used primarily for low-resolution images, graphics and video projection that cannot be reproduced effectively as part of a printed handout for a presentation. The more detailed information provided in a handout would, as far as Tufte is concerned, be the part of the presentation that is most useful to people for reviewing purposes.

Tufte (2003) reinforces his view, citing George Miller's 1956 paper "The Magic Number Seven, Plus or Minus Two" in relation to the presentation of visual information and its effect on levels of memorization and retention. Building visual context models to support the more detailed hand-out information makes the best use of Power Point presentations, thus avoiding the endless linking of bulleted lists that dominate most of these types of presentation.

Petersson (2002) has views on the use of information design principles when working with type dominant projected visuals. A major focus for him is the correct use of text in visual presentations for overhead projection and in video. In his opinion,15 to 20 is the maximum number of words per slide that should be used for effective communication. The visual weight of type fonts should be considered carefully, and the use of lowercase letters should be encouraged in order to help legibility. Other points to consider are:

- the effective use of colour,
- the consistent use of uppercase and lowercase letterforms,
- the use of letterforms with high readability,

- the use background textures that do not conflict,
- the use of a flush left orientation for the text,
- and the use of a horizontal format for slides.

The consideration of these kinds of principles could have a major influence on what information was chosen for use in an overhead transparency presentations, and the way that the information would be displayed on overhead transparencies.

The training materials used in the valve training module is predominantly text-based. The text pages are part of the handouts package, that consists of the photocopied overhead power point transparency pages, textual descriptions of valve components and operations, comparative charts for reviewing valve design characteristics, trouble-shooting flow diagrams and schematic images of valves and valve components.

The literature that is part of this subject review area stems from the world of information design. The person who sometimes provides information design is a graphic designer. Graphic design is a kind of “all-purpose design”. In graphic design the main objective is to provide functional, aesthetic and organized structure to all kinds of information sets. Graphic design is used in mass media design, marketing, instruction design and information design and is a natural part of these design areas. (Pettersson 2002)

In recent years, especially with the explosion of digital media applications and the wider use of the Internet, there has been an increased interest in the area of information design. Some basic tenets of information design include:

- to develop documents that are comprehensible, rapidly and accurately retrievable, and easy to translate into effective action
- to design interactions with equipment that are easy, natural and as pleasant as possible (Horn 2000)

Related closely to information design is instructional message design. Instructional message design theories provide principles for the design of instruction. Audiovisual instruction, educational technology, instructional design, and instructional message design all function as guides for designers in the work of designing and producing courses and lessons of instruction. (Pettersson 2002)

The layout of textual material is very important to instruction. As early as the 1950s and 1960s, information layout was being promoted for practical purposes as a "lexi-visual layout" that included words, pictures and graphic design applied in unison to support the theme of the content of documents, pedagogical purposes and aesthetic form. (Pettersson 2002)

The design of textual material begins by using good principles of typography.
The literature related to text organization and structuring divides into two categories, internal text structuring and external text structuring. Internal text structuring has more to do with the prose style in a document, how topics are cued verbally or introduced. External text structuring deals more with the visual design cues that are found in documents. This includes linguistic, spatial and typographic cues such typographic emphasis and linear structural elements that help the reader to retrieve information more easily. (Pettersson 2002)

The Canadian master of typographic design, Carl Dair (1967) helped to put the importance of the building blocks of letters and words into words. Dair maintains that when a word is created, it takes a typographic form that makes it instantly recognizable without reference to the phonetic structure symbolized by the separate characters that form the word. The word is the picture of the thing, or the idea. This “word-picture”, that is the product of the arrangement of letters, can often be strengthened by the kind of type used to convey it. The type can, by its particular form, emphasize the quality of the meaning of the word, or approximate its sound. Spencer (1969) and Tinker (1963) have both made the point that a word’s shape and a word’s internal structure play an important role in our ability to perceive a word. For instance, in the English language we quickly recognize a particular word, such as the word “spot” by virtue of its overall shape and also by recognizing the visual elements that make up the word. Word structure begins with letterforms. Letterforms are the basic building blocks for text-based communication. Bringhurst (1992) recognizes that letterforms have tone, timber and character, just as words and sentences do. The moment that text (content) and typeface (form) are brought together, two streams of thought, two rhythmical systems, two sets of habits or in you like, two personalities, intersect. For Gerstner (1974) typography has an expressly functional purpose. This purpose is linked to what he refers to as “integral typography” or the greatest possible harmony of all parts: the integration of content and form.

Along with typographic layout and the choice of type fonts, the designer of instructional materials will also use letter spacing, word spacing, line spacing or the leading between lines of type and line length as additional tools to help design documents that are easy to read and to retrieve pertinent information from. When it comes to line length, the rule of thumb is not to exceed two and one half times the

alphabet length for any font (Lichty 1989), or roughly 65 characters, including punctuation and word spaces. This paper has been typeset using Stone Sans Medium and is averaging 80 characters per line. This is over the recommended line length, but in this case the added line spacing or leading compensates to help readability.

Tables are used in the training module to help describe the comparative feature of various valve products. Tabular material can be challenging to the reader. Tables should be well designed with type and other graphic structures such as lines that allow for categories of information to stand out clearly and to be compared. For Tufte (1990), the visual relationships must be in relevant proportion and in harmony to the substance of the ideas, evidence and data conveyed. Tufte quotes Jan Tschichold, a virtuoso of typographic design, from his 1935 book Asymmetric Typography:

> "tables should not be set to look like nets with every number enclosed" and continues, "the setting of tables, often approached with gloom, may with careful thought, be turned into work of great pleasure. First, try to do without rules (typographic line elements) altogether. They should be used only when they are absolutely necessary. Vertical lines are needed only when the space between columns is so narrow that mistakes will occur when reading without them. Tables without rules look better; thin rules are better than thick ones."

Misanchuk (1992) supports this view with his own guidelines for the use of rules in tables:

- Use white space instead of rules whenever possible to delineate rows and columns.

- Use horizontal rules when necessary to span columns and define the range over which column headings apply.
- Avoid vertical lines unless they are necessary to reduce confusion caused by columns being crowded together.

Misanchuk (1992) also makes an interesting distinction between regular tabular material and what he refers to as “text tables’ or tables that present a topic with text that can be represented in a matrix. The training materials examples in the findings section of this report show several examples of this kind of table. Misanchuk emphasizes that the information should be kept a simple and a brief as possible, that the type font used should be very legible and that text set within the cells of the table should be set flush left and not in a centred fashion.

Diagrams and schematic drawings are used in the training materials. The ability for people to understand the content of drawn images will have a marked effect on their ability to retrieve and retain knowledge from them. Allmendinger (1998) has argued that people use the same high level skills to read diagrams as they do to read prose. Reading diagrams involves perception, domain knowledge, narrative, motivation and bias, as well as social consensus. Diagrams are visual models representing data. They depend on point, line, plane, plane, volume, value, colour, texture, as well as text. Each visual element corresponds to something in the real world, and relationships between visual elements in the diagram mirror relationships between actual objects in the real world. For Allmendinger, it is a case of getting people to make better decisions based on fairly sophisticated graphic information. It would make sense then to have diagrammatic material that had as many similar features as possible, within a given

context, so that people did not have learn a new “visual language” for each new diagram that they were required to refer to and learn from.

According to Dwyer (1985), the overall effect of visuals in the learning environment is dependent on the following factors:

- the amount of realistic detail in the visual
- the method for presenting the visual
- student characteristics, such as intelligence and prior knowledge of the subject matter
- educational objectives
- the techniques used to focus student attention on the essential learning characteristics

Decision flow diagrams are also used in the valve technician’s training module. These diagrams help to indicate the steps to be taken and documented as the technician work through various maintenance and trouble-shooting procedures. Clear communication in this type of visual aid is very important to the safety of the individual and to making the maintenance procedure efficient and effective. These schematics are often *visuospatial* in nature – that is they combine visual representations with the apprehension of spatial relationships. This faculty can be particularly important in conceptual thinking and skills and can be extremely effective for communicating complex concepts. (Dawson 2000)

From this initial overview, it can be seen that the materials used in the training by valve technicians are varied and represent challenges and opportunities as far as improving communications.

2. Training Process

The training process represents an area where communications issues might arise. The adult learner and the trainer are the focus of much of the literature relating to training techniques and process. The adult learner is the individual within an organization who is on the receiving end of any number of training initiatives geared to making the individual a more productive or effective member of the organization's workforce. What are some of the principles of adult learning that might be useful when considering training module design and delivery methods?

David A. Kolb's (1984) definition of learning is "the process whereby knowledge is created through the transformation of experience". Transforming through experience implies using as many of the five senses as possible in the training process. The more that a trainer can bring these senses to bear within a training context the more that the learning experience will create a lasting impression.

There are a number of accepted principles related to adult learning. Many authors in have articulated these principles in many ways. One such set of general principles is Knowles's (1990) five foundation stones for effective training and design related to adult learners:

- personal experience is the key learning tool
- motivation for learning is driven by needs
- adults are independent learners
- protecting the learner's self-esteem is critical
- adults have clear expectations about learning
- adults learn in variety of ways and have preferences for learning styles

A more articulated list of principles from Margolis and Bell (1986) includes a few that are not on the previous list:

- adults will learn when they feel a need to learn – they want to know that training is going to help the right now
- adults learn when they are actively involved in the process – they want to immediately practice what they have learned and continue to use this knowledge
- adults learn best by solving realistic problems – the problems must to true to life
- experience effects adult learning – they must be able to relate training to what they already know
- adults learn best in an informal environment – if the environment is too much like a classroom, adults will not learn as well
- learning is more effective if participants use more than one of their five senses – Confucius said: "I hear and I forget, I see and I remember, I do and I understand."

- the “law” of 2-way communication states that the training process involves communication with participants, not at them – some positive verbal interaction is needed between trainers and trainees
- adults want to know how they are doing, what progress they are making – the trainer and the trainees need feedback

Communication plays a part in many of the items listed above. Learning styles are also indicated in these lists. The more that those delivering training can understand the basic learning styles of those they are training, the better the knowledge and skills will be transferred in training.

This is not to suggest that trainers should make too much of a science out of this kind of learning style typologies. Trainers might not want to subject trainees to the types of testing that would help to define specific learning styles. And to what end? The features of training in some instances may tend to be a “one size fits all” approach, with little or no room for adjusting to learning styles. Some basic styles have been identified, though, and here are the four basic learning styles from Kolb (1984):

- the **convergent style** seeks to bring together information into the one correct answer
- the **divergent style** seeks to generate alternate ideas and implications
- the **assimilative style** seeks to create and understand theory that is logically sound and precise
- the **accommodative style** seeks to respond to the circumstances in which it finds itself – it adapts and acts

Given a period of time working with one training group, a trainer might identify several of these traits within a group of trainees. Perhaps the best procedure would be for the trainer to learn to recognize these learning styles and find out how they can be reinforced in training situations.

Training must provide a process that is clearly communicated and effective.
No matter what the characteristics of the adult learner are and no matter what learning style traits are exhibited by the adult learner, the training work must be done in accordance with a model.

The Sequential-Iterative Model (SIM) for training design, developed by Milano and Ullius (1998), has five clear design stages. Here are the five stages with key questions for the training designer attached:

1. **Training Goals and Objectives:** What do you want participants to get out of the training?

2. **Key Topics:** What would a categorized list of the content to be taught in the training look like?

3. **Training Flow:** How will you select and sequence learning activities that will respect the integrity of the content and draw the learners towards the desired outcomes?

4. **Training Materials:** Does the choice of training materials match the needand resources and the characteristics of the learners?

5. **Evaluation Tools:** Are you able to get answers to questions such as: Did they like it? Did they get it? Did they apply it back on the job? Did it really make a difference?

Training models such as SIM are communicational frameworks that allow for more topic-specific training tools to be brought into the picture. The materials used in the training of the gas pipeline valve technicians include three-dimensional models and life-sized valve details that bring the training closer to the real world of their experiences in the field. This approach fits with the needs of valve technician trainees. Along with the materials used in training, people bring their own experience to the solving of problems in the field. For pipeline technicians, these problems may have a routine nature, but these problems may also be very complex.

In his recent working paper, Personal Knowledge Management, Wright (2003) gives a description of routine workplace problems. The routine problem, be it simple or complex in nature, has been faced by the experienced worker before. Workers rely on their knowledge and skills to solve them. Comparability is of extreme importance in these situations, where one must identify the cause of a problem and use the aspects of learning that have been memorized or have been taken into tacit knowledge to address the situation. Norman (1999) talks about the link between developed intuition and teaching by saying that the things we call intuition are simply skills that we have practiced for some many years that we no longer recall how difficult it was to learn them in the first place. Skills such as using a pencil, reading and writing are intuitive to the skilled adult, but took years to learn. Difficult tasks will always have to be taught.

The addressing of routine problems speaks clearly to the situations that valve technicians face on a daily basis. Building some form of knowledge exchange system could help to describe and codify situations encountered in the field and become a record of best practices that could be accessed by other technicians. These descriptions might start with anecdotal accounts of situations experienced in the field. These accounts could be used to emphasize key points during the training session. Codifying, and having access to this type of knowledge could have positive implications for training beyond the training session itself.

Cognitive models are an equally important part of the training process. A decision tree diagram such as a trouble shooting flowchart is a cognitive model that maps out actions and reactions in the procedures used to service gas pipeline valves. According to Dawson (2000), the value of mental or cognitive models stems from our understanding that our knowledge is our capacity to act effectively. To be able to act effectively within a system requires us to have a model not only of how the system has worked in the past, but also how it will act in the future, and our relationship with that system. That is what will allow us to act in a way that will achieve the results we desire.

One idea that seems to fit well with this idea of cognitive models and training is the concept of chunkiness and hierarchies. Dawson brings the concept of models for memorization and retention into the picture with the idea that we should create cognitive groupings of knowledge around topics and try to remember this grouping as a single unit or chunk. This frees up our limited thinking capacity to take in additional concepts. This process of chunking concepts to form hierarchies is in fact the basis of the development of expertise.

This concept of chunking information can be linked to how our long-term and short-term memory systems work. The long-term memory has *episodic* memories of specific things we have done, seen, heard, felt, tasted, and so on. They are tied to specific contexts. *Semantic* memories consist of conceptual information such as our knowledge of the names of birds and flowers. Information is processed and remembered in chunks that are organized hierarchically. We have to think about and work with new information in order to get it into our long-term memory. (Pettersson 2002)

Perhaps it is possible to combine the concept of information chunkiness and hierarchies with a concept of action steps that would assist the long-term memory storage process. The connection between how we create mental models to help others to proceed through a series of activities would seem to be at the centre of training design. Through training we are able to introduce knowledge into the long-term memories of individuals through the use of training activities and visual reminders. Gaining a basic understanding of how cognitive or mental models and our memory systems work would be of great benefit to trainers and trainees. Together, they might then become active collaborators in helping to refine the design principles that give form to the training materials and the training process.

Principles of good design are fundamental to the development of the training materials and the training process, particularly when the training has to do with the servicing of physical mechanisms on a gas pipeline.

Norman's (1998) principles of good design are hinged on four main themes:

1. **Visibility:** By looking, the user can tell the state of the device and the alternatives for action.

2. **A good conceptual model:** The designer provides a good conceptual model for the user, with consistency in the presentation of the operations and results and a coherent, consistent system image.

6. **Good mappings:** It is possible to determine the relationships between actions
and results, between the controls and their effects, and between the system state and what is visible.

7. **Feedback:** The user receives full and continuous feedback about the results of actions.

Some consideration of these design themes could have an important effect on how we plan and communicate the training process, with the learner in mind. Training principles based on themes like these could also help to make the adult learner an active participant in the process.

The training process has many areas where communications plays a role. Communications in training must take into account who the learners are, how to effectively communicate with them and how to design models for learning that will help them to solve problems in the field.

3. Training Setting/Delivery/Extension

The environment or setting of the training, and the way that the training is delivered has a major impact on communications in training. The points listed below represent a list of best practices and practical suggestions. These details are very important within the context of establishing good communications in training.

The following list of communications features, sourced from several authors, have been put into practical reference categories. These listings have not been ranked in any way.

Visual aids:

- all visual aids should be clearly visible by all participants
- visual aids should be considered talking points to be talked about and not just shown
- keep the visual form of the visual aid as simple as possible
- use visual aids to explain concepts
- give people a chance to absorb the content of the image while verbally labelling it and explaining its purpose
- projectors should be in stable positions to avoid jumpy image movement on the screen
- readability is important when overhead transparencies are used

- a good rule of thumb is no more than seven lines of text with no more than seven words per line
- the use of colour will add interest – too many colours are distracting
- consider having the visual aids, such as power point presentations or slides, designed professionally

Training room:

- the training room should be spacious enough to allow easy movement
- provide comfortable seats for participants with good back support
- if the room is too large, create a corner area or boundary
- rearrange the room together to "take ownership" of the environment
- try to use a training room that does not have distracting decoration
- keep the temperature of the training room as even as possible – 68 degrees Fahrenheit (20 degrees Centigrade) is recommended
- a cooler room would be preferred over a hot room
- make sure there is good air circulation in the room
- lighting in the training room should be even and adjustable so that the room can be dimmed for the use of overhead projected images and still allow for note taking
- the seating arrangements should fit the presentation style and the variety of visual aids such as audiovisual screens or flipcharts that will be used – the rule of thumb is good lines of sight and sound
- semicircular seating allows for the attention to be focussed away from doorways, windows or other potential distractions

Trainer:

- review the training session requirements
- design the activities and materials with clear communications in mind
- make sure that all terminology is clear – prepare a glossary if necessary
- create a mood of relaxed concentration – casual, but with focus
- make sure that all participants can see and hear you
- rehearse with any visual aids before the presentation
- make eye contact continually with your audience
- talk about your visual aid, don't just show it
- do not pass learning objects while you are speaking
- use handouts only if the material is required during the presentation
- speak with a clear voice and use your voice to add emphasis
- try to avoid as many "ums" and "ahs" as possible
- use your voice and gestures to convey interest for your audience
- plan an activity in the afternoon that gets people actively thinking
- do not block the screen when you are projecting an image
- use visualization to explain a concept – change perspectives
- allow for questions and feedback for clarification
- participants learn better when they enjoy the experience- a little well-considered humour might not be out of place – Victor Borge said that laughter is the shortest distance between two people
- be organized about the wrapping up of the training session

Trainees:

- use relaxation and breathing techniques
- consider posture while seated
- try standing and stretching from time to time
- drink water – dehydration can have negative effects
- take advantage of any periodic breaks to grab some fresh air
- have a solid, well lighted surface to write on during sessions

Other environments:

- shop floor areas usually are well lit for demonstration purposes
- outdoor lighting can cause extreme shadows on objects
- shop and outdoor noise levels may cause distractions

[Beebe and Masterson (2000), Klatt (1999), Doyle and Straus (1993), Lawlor and Handley (1996), Block (2000)]

There are many details to be considered in the training setting and in how the training is delivered and received. The preceding list clearly puts the onus on a trainer in terms of making the environment, the training materials and the delivery of the training as beneficial as possible. The preceding lists are practical guidelines that will help to improve the polish of the training delivery, the comfort of the trainees and the overall quality of the communications that are part of the training process.

The literature review has revealed some interesting and useful theories and practical suggestions regarding the improvement of communications in the training process. The next stage of the report will define a specific research approach and how the relevant information related to the research topic was collected.

Research Methodology

The research method that was applied in this study was a qualitative research method. Qualitative research is an eclectic process in which you try to make sense of information. The researcher may cycle through a database several times, first to scan the information, second to code or categorize the information and finally to generate themes. (Creswell 2002) This method of research is more closely related to what Stringer (1999) refers to as the "social world" of the practitioner by looking at the communicative value of knowledge exchanges and by bringing findings from the daily work experiences of both the valve technicians and of the trainers into focus.
The qualitative research method used in the report can also be described with Ragin's (1994) definition of qualitative research as a "data enhancer" that allows key aspects of cases to been seen more clearly. The overall goal of the research was to draw on a combination of skills and materials in order to investigate the research question: "What are some of the communications issues in training?"

The research began with the collecting of information. This information gathered was physical in the form of material evidence or anecdotal in the form of verbal responses to research questions. The goal was to gather adequate information relating to the issues

or situations defined in the research question, and bring evidence forward to illustrate potential improvements in communications. The collecting of project information is an essential part of this researcher's role in the real world of business communications. This fact helps to underline the important role that research plays in a communications consultant's work. The outcome of this study was to indicate ways to improve communications in the training process. Along the way, certain existing practices used in training would be investigated and perhaps endorsed, but the focus would be on making specific recommendations in areas where improved communications could positively impact training.

The research study included two main areas of information collection. One area was the direct collection and critique of visual print-based or projected information used by the trainers to support their training. Specific communication examples were considered within this information collection area. These examples were copies of overhead transparencies that are provided as training course handouts, a supplementary text-based course handout, examples of tables provided in the course handouts, and examples of diagrams provided in the course handouts. The method used here was to select an example of the existing training material from each of the print-based example areas outlined above. A redesigned example of each of the print-based training materials, supported by the literature regarding how to make improvements to the communications, was then produced.

The other method used to collect information for the study was through the use of one-on-one telephone interviews. The research group included two of the trainers involved in the design and delivery of the training module and five valve technician trainees.

The interview questions asked addressed the training materials, the training process and the training setting. Semi-structured interview questions were developed for the interviews. These questions are listed below. Each interview averaged ten to fifteen minutes in duration. Each interviewee was reminded of the research question and asked if there were any questions prior to starting the formal part of the interview. Brief notes were taken during the interview. These notes were then fleshed out after each interview was completed, while some of the thoughts and responses were still fresh in the mind. The responses were collated and placed in the Findings section of this paper.

An initial research meeting took place between the researcher and the research group. This was an opportunity for introductions and to declare the nature and purpose of the research. An outline of the research project was distributed to the group members along with a research consent form. **(Please see appendices 1 and 2)** The consent from was signed at that time, and a follow-up letter was sent to each member of the research group. This letter included a copy of the signed consent form, the research questions to be asked in the one-on-one telephone interview, and the materials list as presented in the training materials section of this paper.

These are the research questions used in the interviews:

Training materials:

1. What features of the training materials were most effective for you?

2. If you were asked to make improvements to the training materials, what Improvements would you make?

Training process:

3. What aspects of the training process were the most effective for you?

4. If you were asked to make improvements to the training process, what improvements would you make?

Training setting/delivery/extension:

5. Can you think of any suggestions that could be made in order to improve the training setting?

6. What would be useful to you in your work setting that could be a product of the training session?

The last question under training setting was introduced to allow for any answers relating to the potential usefulness of field-based reminder cards or other field extensions of the training materials. There are also areas of communications technology as they relate to a valve technicians daily work that the researcher may wish to speculate on in the discussion section of this paper. Any responses from this question that relate to having communications materials or systems in place to support work in the field could prove interesting for future training and communications technology research.

It should be noted that supplementary questions were used in order to probe a little more deeply into the interview responses or to clarify a point. All of the responses were recorded by hand, collated and transcribed for use in the Findings section of this paper.

Research Findings

The Findings section of this paper contains comparative critiques of the training materials from four print-based areas in the training handout booklet and the documented responses to the one-on-one interview questions listed in part two of this section. These findings provide information that gives value and form to the discussion to follow.

1. Training materials critique

The print-based examples collected in the study included seven photocopied pages from the training handout booklet. The handouts include photocopied transparencies that were originally power point slides, two text example pages, two examples of tables and two diagrams. The purpose, in the case of the print-based findings, was to uncover potential communications issues or problems and build comparative examples that would show how these problem situations might be improved.

Textual material can influence the way that people perceive and use a document. As mentioned in the literature review, certain rules of thumb or conventions do exist that will help to make text-based communication more effective. White (1999) has said that:

> "our job as visual communicators is to understand the material and show it in scannable, easy-to-perceive segments. Differentiating elements on a page is helpful, but too many variations are counter-productive and can confuse the reader. Keep your typography simple. Develop a system of defining kinds of information and stick to it. Consistency is perceived as quality. Inconsistencies, even minor ones are perceived as disorderly and incoherent."

Misanchuk (1992) believes that visual consistency must prevail when designing instructional materials and learners should not be challenged in finding important information on page. He also makes the point that grammatical consistency in terms of an editorial "house style" goes hand in hand with visual consistency.

With consistency in mind, an opportunity exists with training materials to build a basic publication style into the instructional materials. This "house style" approach would build basic visual and verbal characteristics into the materials. Reeves and Nass's (1996) research into how people perceive media indicates that people are built to reduce complexity. Rather than empowering through endless choices, media can empower through ease of use, and that often means freedom from choice.

The person using the materials is then not faced with having to decipher a wide variety of choices imposed by the designer of the materials. The hope is that this

standardization would lead to users being able to move through training material more efficiently and to be able to retrieve information from the material more effectively.

The choice of type font is very important when building the publication style for training materials. Debate continues as to whether a serif font or a sans serif font is more legible. Tinker's (1963) research indicates that there is no appreciable difference in legibility among a wide range of fonts, but that a serif font does tend to be more legible overall. Dreyfus, (1985) found that there is no statistically significant difference between the legibility of a serif versus a sans serif font. As mentioned earlier in this paper, Stone Sans, a sans serif font, is the type font that was chosen to set the text for this paper. One of the features of this particular family of type is that the height of the body of the lowercase letters, often referred to as the "x-height" of a letter, is somewhat larger than more traditional type fonts. **(Please see figure 1, page 37A)** This feature means that the counters, the white spaces inside the letterforms, are larger in this particular typeface and this helps with legibility. Legibility is the first principle of readability, and readability can help people to gather in text-based information. The Stone Sans typeface has been used in the redesign of all of the examples that follow.

The redesign of the materials that follow often created situations where more space would be required to accommodate the changes. From a design standpoint, this is consistent with making improvements regarding the visual spacing of elements on a page, and was done purposely.

Example A: Transparencies

Example A shows a Power Point page from the training materials handout booklet. The page shows six power point transparency frames displayed on the page. **(Please see figure 2, page 38A)** The type font used in the design the power point slides is Times Roman. These pages of multiple frame images represent a major part of the instructional flow in the training process. The text and headings in these transparencies are used to guide the lecture room portion of the training.

Transparency design was one area where an opportunity existed to begin a visual style approach that could be carried forward to the other text-based training materials.
Very basic typographic principles were applied to the revised slides.
The original slides seem to follow the basic tenets of short line lengths and less copy that Pettersson has suggested in the literature. The idea in revising the slides was to set up a solid instructional typographic approach in the slides that would allow the steps in the training to be clearly marked and that could be carried through in the design of the other materials in the handout booklet. **(Please see figure 3, page 38B)** The Stone Sans font, described above, was used in the redesign of the slides. Apart from the use of clear typographic approaches, having the slides reproduced at a larger size for better readability and allowing for note taking by the side of the slides was considered useful for communications. If Pettersson's (2002) guidelines for the design of transparencies were to be strictly applied, then even the reduced listing shown in Slide 3 represents too much copy. Some form of visual relief, in the form of topic-related images at the front of the instructional sections could create interest, as could the staggering of type lists in a contents section, as shown in Slide 2.

Colour was used in the revised versions of the slides to show how colour could support the building of type hierarchies within the materials. The consistent use of a running head or page header helps to remind us regarding what section of what document we are working in. Each Power Point slide and each page of the training handout booklet, for that matter, should have a page number for easier reference.

Example B: Text samples

The text-based communications material used in the training module has a major role to play in supporting the instructional sequencing of the training and in emphasizing key aspects of the actions to be taken in the field.

The Frozen Valve Stem Extensions page uses Times Roman type with capitalization to show emphasis for important messages at the top of the page. The use of type in this way was emphasizing the cautions regarding the procedure being described. **(Please see figure 4, page 39A)** The body of the document contains small type in line lengths that exceed 100 characters per line. The redesigned page used the Stone Sans font and placed the emphasis on readability and making the steps in the procedure clear. **(Please see figure 5, page 39B)** Notes of caution were given emphasis with bolder type and a convention for the main titling of pages was introduced and carried forward to other example pages.

Most of the text pages in the handout booklet do not contain long text passages. The Hydraulic Fluid Levels page and the page mentioned above are typical pages with text emphasis in the handout. **(Please see figure 6, page 39C)** This particular page contains a

listing of types of valve operators and the oil levels that are specified for the hydraulic tanks. The revised page design shows clear areas divided by keylines to help bring emphasis to the operator categories. **(Please see figure 7, page 40A)** The line length in the body of the text was shortened and an overall flush left configuration was used with the text to overcome the somewhat distracting nature of the indenting and tabbing in the original page design.

Example C: Tables

Information is placed into tables in order to accommodate the faster retrieval of specific categories of information. In the case of this training module, one table is used to make comparisons between valve system component models and their notable features. Another table describes discovered situations in the field and defines remedial actions that should be taken immediately in order to fix a problem. Even minor design improvements in the layout of tables can have an impact on how well the information is communicated. The consistent use of the Stone Sans font and the convention for naming these pages, established in the previous section, was maintained in the redesign of the tables.

The Key Valve Design Characteristics table is used when identifying the types of valves, the makes of valves. **(Please see figure 8, page 40B)** It also includes the notable features of those valves in addition to information regarding how to make the valve serviceable. Times Roman type is used here and it is apparent that the design crowds the notable features into narrow spaces. The page redesign places an emphasis on increasing white space and type emphasis to help with communications. **(Please see figure 9, page 40C)**

One valve design per page could be considered in this approach as opposed to crowding both valve types on to one page. This allows for more white space on the page and the use of a larger type size.

The Leakage Diagnostics chart is an example where the table contains remedial action steps that are critical to reducing increased pressures in the gas transmission system. **(Please see figure 10, page 41A)** The type describing recommended actions is crowded into confining spaces and creates a solid texture of poorly defined type as opposed to clearly describing discreet points of importance.

If this is the only reference material that the technician has in the field, then this material must be clear and easy to read. The redesigned page gives the type some much needed breathing room and helps to flag the steps to be taken in a clear way. **(Please see figure 11, page 41B)**

Example D: Diagrams

Two types of diagrams are being considered in this example area. One example is a decision-making troubleshooting flow diagram. **(Please see figure 12, page 41C)** Flow diagrams of this sort have visual text framing conventions in the form of square shapes, diamond shapes and lozenge shapes that are derived from the world of engineering and are used to emphasize decision points, actions to take and when to end procedures. This convention creates quite a crowded looking diagram where the frames themselves create a visual clutter and obscure the messages that are needed to describe the actions to be taken. The redesigned diagram replaces the boxes and the

centred type treatment with flush left type that uses type weights for emphasis. **(Please see figure 13, page 42A)** The overall flow of the diagram is more apparent as the spacing between the fields of actions is more open. The two sizes of arrows used in the diagram help to clearly distinguish between decision points and procedural steps.

The other diagram in this example area is a cross-sectional view of a ball valve seat ring. **(Please see figure 14, page 42B)** The overall quality of this visual is very poor and many of the pieces that are used to label features of the diagram are so visually obtrusive that they almost look like they are part of the diagrammed object itself. Very coarse visual textures are used that also distract from the information and communications value of this image. The revised diagram maintains the Stone Sans type font visual style convention and uses finer tones to help to distinguish between the major component parts shown in the cross-sectional view. **(Please see figure 15, page 42C)** Labeling is achieved by using a convention called "callout" lines that travel from the object or area label text to the object or area itself. Reducing the number of arrow styles used in the diagram helped to create a quieter and more evenly communicating diagrammatic image.

The examples explored here represent seven pages out of twenty-six pages in the Valve and Valve Operator Training Program handout booklet. These examples represent only minor adjustments to layout and type treatment design. What is evident is that there are many instances of mixed typefaces, overly crowded information pages and poorly rendered diagrams. Over the course of a regime of technical training, people are asked to assimilate some basic understandings of how to perform servicing and repairs

in the field. The use of clear visual communication principles, tied to some form of instructional visual style in the training materials, would go along way in helping these people to learn how to do a better job.

2. Responses to interview questions

The following are some of the collated responses to the one-on-one interview questions received from the research group.

2.1 Training materials:

It should be noted that the redesigned print-based materials were not made available to the interviewees. Any of the comments made by an interviewee relating to print-based training materials were based on viewing or remembering the unrevised training materials.

Question 1: What features of the training materials were most effective for you?

Responses:

Three-dimensional models are very effective for describing valve actions and components to trainees.

Practical approaches to training is best – I learn best by experiencing things

We have developed a few full-sized models for use in training.

All of the interviewees placed a high value on the ability to do "hands on" work as part of the training process.

One person found the visit to a manufacturer or fabricator's plant to be very helpful. This was a chance to see how the valve components were made and to better understand the working relationship between the components. This also was an opportunity to make contacts with people at these plants who might be good resource people if questions arose later.

One interviewee found that "print reading", or learning how to interpret technical schematics and drawings, to be very effective. Understanding the language of schematics was considered very important because the systems run on very basic principles related to valve actions and service access points.

People placed a high value on the manufacturer specification drawings that are included as a separate package with the other training materials. **(Please see figure 16, page 44A)**

These drawings are perspective views of valves with cutaway sections that expose the inner components. One comment related to this was that people who have a background in drafting or engineering drawing might have an easier time deciphering the drawings.

Basic spreadsheet or tabular information was considered very useful, particularly when the specifications referred to on the sheets had a web site or e-mail contact attached for further information.

One interviewee found the power point slide approach to be quite effective, especially since the handouts that are identical to the slides.

Question 2: If you were asked to make improvements to the training materials, what improvements would you make?

Responses:

We may start to use "case maps" in the future. These are "off the shelf" right now, but we may want to adapt them to our particular areas of focus in the future. **(Please see figure 17, page 45A)**

One interviewee did not like bar charts and would rather understand the information that was used to create the chart.

The basic valve configurations are clear, but in the field the valves often have additional

components that may confuse people… how can this be made clearer?

An animated version of the two dimensional valve schematic drawings would be a useful investment. People do not always get the cause or action and effect relationship in these dynamic systems. Computer-based learning tools like this would help.

Don't like block diagrams – find them very confusing at times – information is packed to close together. If there were a problem in reality, confusing flow charts would not help much.

Can only get so much out of manuals – some of the material is quite abstract - manuals have value after the experience of hands on work - more practical training is needed.

Projectors for overhead slides not always available – sometimes the trainer must work from handouts only… this can be mind-numbing if there is no break for practical training work.

The work in the field is based on standard operating procedures. However, some people may have developed their own "best practice" steps for solving work problem situations. How do we share those experiences with others?

Some photographs are used now in the training…there may be some value in exploring the use of video clips in training.

Very few comments were made regarding the presentation of any of the print-based material used in the handouts or in the slide materials.

It might be helpful to have a glossary of terms available in one place…perhaps on the company intranet system or in the handouts.

2.2 Training process:

Question 3: What aspects of the training process were the most effective for you?

Responses:

"Hands-on" approaches to understanding the various aspects of training was cited by every person interviewed as being the most effective.

A combination of classroom time and hands-on time works best because the theory and the practical are reviewed and experienced in close order. This is the best opportunity to influence how well and how safely the job is done. Clear procedures are established and good understandings are formed at this time.

It was valuable to work with a very experienced person during my field training or apprenticeship…perhaps this "seasoned" knowledge would help others.

Our job is to make the process as concise as possible, and make it real – the quicker that we get people into the field, the better – the immediate payback exists in having people who are working effectively in the field working.

The process, as it exists, is good enough.

Building in discussion time in the training sessions for the sharing of knowledge on specific training topics is valuable. The experiences that people have had in the field can come forward in the form of stories and this can be as valuable as any other part of the training. Close monitoring should be part of this approach, so that time is not wasted, and so that those with something of value to contribute get a chance to speak.

The presenter's training "style" was considered important by several of the interviewees. An enthusiastic trainer, keen to teach and not tired of the job is potentially one of the most effective features of a training session. Monotones of voice and general lack of enthusiasm is not what people want – the material is often repetitive and dry, but the presenter must try to engage people. People may be complacent…they may have heard this all before and may not be attuned to information that is important and new.

Question 4: If you were asked to make improvements to the training process, what improvements would you make?

Responses:

More "hands-on" experience in the form of working models or training at sites that have the various valve configurations would be good. Can't shut down a whole gas compression system in order to explain the working parts…must model it at times.

There might be some value in having some general understanding of how people typically solve problems. Unraveling situations in the field…recording the actual steps taken might help… this is part of the operating procedures and is often spelled out in the work order.

Understanding the learning styles of adult learners may also have value. Small adjustments might be made to the training modules if these styles could be identified.

Have to look at using other media to help with the process… video clips used to document actual situations might be of value…experiences could be shared more widely.

The uses of animated process schematics to better understand the action/effect aspects of how valve systems work would be valuable.

Must deal with the problem of retaining what is learned and the time of year that the training takes place… there is often a gap between the time when training is delivered and when people get to use what they have learned. Training may take place in the "off season" or winter months when spring summer and fall are used for active field work… need to keep this fresh in a person's mind.

How do we measure what is retained?… some pre- and post-training short answer testing is used, but there are no standards in place.

The training process is extended in a way through the use of computers… people have access to e-mails in order to share information and images regarding system queries and general procedures.

2.3 Training setting/delivery/extension:

Question 5: Can you think of any suggestions that could be made in order to improve the training setting?

Responses:

The best training setting has comfortable classrooms or meeting rooms combined with easy access to real working situations in the valve control system.

Can't do much about the weather… it can play a role in getting access to the real equipment in the field.

Sometimes the training area is not ideal, but sometimes other things like the weather affect our daily working conditions… you just deal with it.

Training at field stations has the benefit of easy access to the equipment…the down side is that you may have a classroom in a shop garage or you may have to deal with noise and interruptions.

We can rent any kind of space that is needed to help with the training… a meeting room could be rented at a local hotel near a gas plant or valve site, for instance.

Question 6: What would be useful to you in your work setting that could be a product of the training session?

Responses:

Several respondents said that they like to keep all of the training materials in one place for easy reference. There are many documents and other binders with manufacturer specifications around in the office.

One person suggested that having a simplified check list for some procedures identified in the training sessions close at hand might be helpful.

Should consider some way of extending the active part of training setting into the world of daily work… using video clips or photographs.

Each employee has access to the company intranet system that includes a training site containing all of the training materials. This training site has material added to it on a regular basis.

Computer-based communications is starting to play a greater role in helping people to do their jobs… the computer does not replace the possible observations and actions that a person brings to their work. Some use of computers in extending the training process can be explored.

Computers can be used to monitor gas transmission/compression sites.

There is some thought being given to establishing an "ask the expert" section on the intranet. This would be a place where field questions could be addressed and answers could be documented.

Another existing location for general discussion within the organization is the intranet "watercooler" site where more general engineering topics are introduced and where some knowledge is exchanged.

Discussion

The discussion section of this paper will follow a structure that will help to place the research findings and the background literature into contexts that bring a focus to what was revealed about communications issues in training. This discussion will also help to focus on what might be acted on in a practical way to improve communications in training, and it will look at what future research areas could be explored regarding communications issues in training.

1. Summary

In summary, the research question being discussed is: “What are some of the communications issues in training?”

The focus areas for the discussion section of this report include the training materials, the training process and the training setting. The review of these training areas was undertaken to identify communications issues in the training process. It is hoped that improved training through improved communications might represent a long-term benefit and a valuable return on investment to the organization as far as workplace safety and effectiveness goes. The literature review section of this report included theory and practical suggestions to improve the effectiveness of communication in the three focus areas of the training.

The findings section of this report had two parts to it. The first part of the findings section sampled a cross-section of print-based materials, and critiqued these materials Revised examples were created for comparison, using sound graphic design communications principles. The second part of the findings section looked at responses to questions relating to the training materials, the training process and the training setting. It should be noted here again that the revised print-based materials were not made available to the interviewees.

2. Interpretation

The findings show several instances where communication issues arise from within the areas of training materials, the training process and the training setting or delivery.

Interpreting Training Materials

From the standpoint of visual information design principles and the researcher's point of view, there are several observations that can be made about the training materials. One observation is that the general visual quality of the print-based training material is not high. The findings do show that very fundamental visual principles that can assist clear communication are sometimes not present in the existing materials. Those who design the training materials do not always have the best tools, the skills or the budgets available to create high quality training materials. Those who are receiving the training do not always have the background or the opportunity to be critical. The literature supports the use of solid communications principles and defines quite clearly areas where communications professionals could help to improve these materials.

People are not normally taught visual language, the way that Allmendinger and Pettersson have describe it, as a subject in grade school, high school, or university and college. Each person brings a background of learning to training that will include varying degrees of ability when it comes to visual interpretation. One group of people, such as professional visual communicators, may have more well-developed "eyes" for

how to sort visual information than others. The point here is that training materials should lessen the burden for people by building visual clarity and consistency into the communications materials.

The surprising finding, given the previous discussion, is that there were very few comments on the general quality of the print-based training materials.
If one is to interpret a lack of comment as a comment, then it can only be assumed that the people who receive this training regard the visual presentation of the material as adequate to the purpose. In hindsight, it might have been a good idea to provide the redesigned sample material to the group and include observations or reactions to the revised sample material in the findings. Perhaps this point can be addressed in the future research section of this discussion.

What was said in the interviews regarding the print-based materials had more to do with personal comfort levels and preferences when it came to retrieving information details after the fact. One suggestion was to have a glossary of common terms available to all trainees, located in one place. Another interviewee commented on the need for current contact information for people to be located in one place in the training materials. Comments like this speak to the need for common background and orientation information to be developed as clearly distinct handouts that can be kept at the front of a training binder.

The overwhelming champions in the training tools arena would appear to be the use of three-dimensional models and the handling of real equipment. The availability of the combination of comfortable and adequately appointed meeting rooms to study theory, combined with models or actual equipment to practice with is the most desirable

situation, as expressed in the findings. “I do and I understand”, part of that saying from Confucius is very active in training within this organization.

The suggested improvements to the training materials are linked to the way that things get done on the job. This speaks to the desire to make aspects of training as real as possible. Animating flow and schematic diagrams make things more real for people. On-line power point “case map” presentations allow people to review how decisions are made in the field at any time. Training related to the use of other media such a video cameras or how to write clear and concise descriptions might be areas for consideration in the future. The interpretive point here is that training must continue to explore and challenge the tools and materials used in communication in order to help people to learn and to communicate more effectively.

Interpreting Training Process

The training process findings were somewhat disappointing. The interviewees did not respond to the question in ways that addressed how they learn. The responses related more to how the training was delivered and emphasized again the need to make training fit closely to the daily work environment. This type of response was practical. The research question may have been too abstract and there may have been some reluctance to respond within what seems, on the surface, to be a trainer focus area. The training process did not become a real point of discussion. The idea of the questions was not to legitimize the literature reviewed, but to listen to what was considered important. Much like the previous section, the one-sided response to the question might suggest that the practical and expeditious features of training do not offer much

opportunity to be critical of the process. Questionnaires that would stimulate critical discussions around the training process might be helpful.

What was present in the findings was evidence relating to the importance placed on the person who delivers the training. Training process seems to be an area where the responsibility lies more with the trainers and than with the trainees. The interpersonal skills and the training "style" of the presenter were considered crucial to keeping people engaged in the process and to adding life to the training experience. The literature review in this research area focused on the adult learner and the training process, including the use of cognitive models. If this type of information has value in the training process and directly affects the way that trainers train, then there is a large amount of good reference material available. Looking more closely at the training process might also suggest that trainers get their share of training from master trainers from time to time.

Another interesting finding that resulted from the training process questions was the issue of evaluation. One trainer commented that they do not always know how well people have learned and retained the training. Testing for pre and post training levels of understanding may play a greater role in the future. This is a very important communications issue that could open a channel for dialogue around how the training is delivered and what the role is of evaluation both from a learner or trainee perspective and from a trainer perspective.

Computers are playing a greater role in work settings today. The findings in this process area suggest that computers are not used as part of the training process, except to display power point types of presentations. All employees have access to the company

intranet where the training materials can be found. The intranet site does not contain mastery level testing elements for any trainable procedures at this time. The training process is extended with the use of computers, however, when people use e-mail to ask questions of each other around procedures or to refresh their minds about a training detail.

Interpreting Training Setting/Delivery/Extension

The training setting findings reinforced the idea that training locations do not always have the ideal combination of a meeting room that is located just steps away from a maintenance shop or a working valve system. There are times when the training must take place in a maintenance garage or a site lunchroom or a rented hotel meeting room. The desire is always to provide a place to deal with the theory or visual review side of the training that is quiet and comfortable, with easy access to working models or a short drive to working valve system situations.

There were no specific responses to the training setting question that provided details of training rooms used or addressed issues such as the perceived level of preparation that went into the training sessions and details regarding effective delivery. In most cases there was an acceptance of the training situation as being as good as it can be at the time. The way that the training was delivered related in some way to the way that situations are sometime encountered in the field. Conditions in the field may not always be perfect, but you work around these things and get on with the work at hand.

What proved very interesting in this findings area, were the responses to the question regarding what might be useful extensions to training that could find their way into the daily workplace.

People did not respond to the question with thoughts regarding the use of checklists or mnemonics. A few people commented on the fact that they keep the training materials in designated areas so that they will not be confused with manufacturer information and specification binders.

There are operating procedures defined by the company for working situations encountered. The checklist idea was introduced by one person as an example of a way to remind people of the stages of decision-making. This might take a visual form similar to the flowchart diagrams introduced in the training materials review section of this report.

There is an on-going use of computer technology by the valve technicians. Technicians have access to the company's intranet site where all training materials and other support services exist. These technicians regularly use computers to remotely monitor valve compressor sites. The interviewees seemed quite interested in using this kind of tool to help to solve problems encountered in the field and to share what they know about situations that may be common to other technicians and engineers. The technicians are the eyes, ears and hands of the system, supported by the engineered technology that is used to monitor it. There were interesting suggestions regarding how to use digital images and video clips that would be attached to requests for technical support in the field. One example of a digital image is included here.

(Please see figure 18 - Page 59A))

The other use of computers relates to communicating and sharing of knowledge in a formal and an informal on-line setting. The more formal setting is an on-line company intranet location that would house an “ask the expert” department. This is only an idea right now, not an active part of the company’s intranet. Questions from the field or follow-ups from the training sessions would be fielded by people with the expertise to respond. The people “manning” the site might be technicians with a specialities or engineers.

The other less formal setting for discussion and knowledge exchange would be the “watercooler” site that presently exists within the company. There is an opportunity to introduce discussions in this area of the company intranet that would focus on technical topics and problems encountered that could potentially benefit from input from a wider company audience.

Both of these on-line settings raise the issue of how best to create a knowledge resource and exchange centre and how to codify the knowledge that is being created and shared. There is nothing like this in place within this organization at the present time.

The company’s intranet site allows for access to a large amount of information related to training, operating procedures and manufacturers. Earlier in this report there was mention of the value of having two-dimensional schematics that would be animated to clearly show a cause/action and affect relationship for valve operations. If this type of information could be accessed through the intranet site, it would make an worthwhile extension to the training, and allow technicians to work through scenarios as many

times as required in order to fully understand the dynamics of a particular valve configuration.

3. Integration

In this section of the discussion the findings and the background literature-based knowledge related to communications issues in training will be brought together in order to determine some meaningful answers to the research question. A similar discussion structure will be used here as was used in the interpretation section.

Integrating Training Materials

A large amount of literature related to building clear visual communications into training materials exists. Print-based training material examples have been introduced in the research findings portion of this report and revised according to basic principles of visual communication introduced in the literature. It is fair to say at this point that one principle that could be introduced to improve communications would be a common well-designed visual treatment for the print-based training materials. This would make for easier reading and visual segmentation of the relevant training features and help to create a set of visual cues that would not cause the trainee to have to decipher multiple type treatments in the materials. This “visual style” idea is a very simple principle to describe. Implementing it would have a wide positive effect on the clear communication of information in training.

The value of “hands on” approaches to assisting training was reinforced in the findings section of this report. The use of three dimensional models in training links well to the concept of cognitive models and aspects of effective training processes introduced in the training process literature. Three-dimensional models, be they table top scale models, full scale models or working equipment found in operating situations play a valuable role in the training process. The observation from one trainer that there should be more models used more often to make training as real as possible is a good guiding principle that comes out of this discussion.

The materials or tools used in training must support the transfer of knowledge in order to reinforce the experiential side of training. Any mediums of communication that are new or can be repurposed to assist this transfer, especially computer/digital-based mediums can have value in training. Training in how to effectively use these communications mediums themselves might become a bigger part of training in the future.

Integrating Training Process

Much of the literature relating to the training process introduced in this report introduces communication approaches that would be effective for adult learners in training settings. The literature also looked at basic instructional training process models and how the use of cognitive models could support the training process. The findings delivered information to this discussion that relates more closely to the way that training is delivered. The link between the literature and the findings can be made if one considers that the focus in the training process is on the trainer.

The training of the trainer is a principle worth exploring here. Not all training would require the use of sophisticated methods, but it is important for those doing the training to have a good idea of what the learning dynamics are and how and when it might be appropriate to introduce process models or cognitive models into the training setting.

Perhaps the best way for people who are responsible for delivering training to become better at what they do, is to get help from those who are master trainers or professional communicators. For instance, this type of master trainer work might include how to use new media to more closely integrate the training content into the daily work scenarios of the technicians. Having a better working understanding of Donald Norman's principles of good design, as another example, might make a huge difference in how one would approach the building of physical or a cognitive model for use in training. Being comfortable with how learning styles affect the outcomes of learning might create opportunities to introduce process models that are targeted towards adult learners with engineering and technology backgrounds. Being able to write well and use clear language in training communications might be a small but enormously effective addition to a trainer's skill base.

Integrating Training Setting/Delivery/Extension

The literature review related to this part of the discussion represents a list of best practices introduced from several sources. The list is presented in this report to allow the reader to think about the details of preparation and how to make the training

setting as helpful as possible. The broad principle at work here is to be as thorough as possible with all of the features that play a part in communicating to others. Deep breathing exercises may not feel like the right thing to be doing with a room full of technicians involved in training, but it might be exactly the right thing to introduce to help a technician try to relax when confronted with a challenging task in the field.

Again, much of the focus in this discussion area is on the trainer. They are the facilitators who make training happen. They have control over the visual aids that are used, the training location that is selected and their own actions. Trainers are also responsible to make their expectations clear to those who are receiving the training. Communicating clearly can establish an environment for effective two-way exchanges and could open the door for dialogue focussed on making improvements to the training. The responsibility that goes along with making all the forms of communications in training work collectively is daunting, but not unmanageable. A checklist that would be tailored to the specific requirements of this type of training would be a useful tool and help to build structure into the training process as well.

There is no overall principle that can be introduced that would cover the use of computer-based technology in training. The most that can be said is that these kinds of e-mail and intranet-based technologies will continue to evolve and become more sophisticated. These technologies will also become more closely integrated into the daily work of these valve technicians. Bandwidths that will allow for richer data base searches or richer digital media applications will continue to be introduced by communications technology product and service providers. The guiding principle at work should perhaps be that training may have to accommodate learning how to effectively use the new tools of communication in the future. Teaching people how to

use clear language in writing, how to use the correct protocols and courtesies when communicating on-line or how to search databases effectively may be as important in future training as the information and knowledge being exchanged. Using on-line training modules and developing personalized time-sensitive training schedules may become a complimentary part of the face-to-face training in the future.

4. Theory

Given the wide variety of the literature reviewed in this report, it is difficult to pick any single body of theory that this discussion would fit within. Some of the literature points to visual information design theory. Other aspects of the literature review and research findings relate to theories for training process and modelling. Some of the information and feedback points to simply being practical, organized and clear with our communications. The broad principles introduced in the integration section and the interpretations made of the findings in the earlier section of this discussion, point to a general position of using clear communications approaches for all aspects of face-to-face training and training process development. Being open to change and improvement are understated but important compliments to this position.

5. Applications and Future Research

There are several areas in the report that suggest possible communications applications in training and where future research into communications might be worthwhile.

The application of visual design principles to the task of developing a visual “style” for the print-based training materials could yield beneficial results. Future research in this area might include the interviewing of trainees who have used to existing training materials and who have used redesigned training materials.

The development of more sophisticated and detailed physical training models, introduced more frequently in training, could help trainees to better understand the “hands on” dynamics of valve configurations and actions. Another action arising out of this discussion could be the development of a more sophisticated view of the role of the trainer within the organization and to paying closer attention the needs of the trainer, including the training of the trainer.

Cognitive models related to understanding working principles in the pipeline system and to decision-making could be developed and tested. Moving these types of models out into the field in some visual form could also be explored.

The use of computer-based instruction and training scheduling could be explored. Research in this area would involve doing testing for how well people mastered certain aspects of on-line training compared with people who received that part of the training as part of the face-to-face training only.

The development of a more comprehensive company intranet site could be explored that would integrate knowledge exchange activities and a repository for the best practice knowledge generated, training activities and personalized training schedules, operating procedures and system management specifications.

Conclusion

Communications issues are a part of training. The communications dynamics of training includes the design and appearance of print-based materials, the handling of models and equipment, the structuring of learning and personal interactions. All of these areas of communication are combined in the training that helps valve technicians to go about the business of maintaining and servicing the gas pipeline system safely and effectively.

The training of valve technicians is considered by the gas pipeline company to be an important part of their long-term operations. The industry is driven from the viewpoint that a dollar invested must return more than its value in return. The direct contribution that technicians make to the business of gas transmission is not quantifiable, but one does not have to use one's imagination much to see what would happen if there were not skilled and well-trained professionals on the job.

The areas of training considered in this study included the training materials, the training process and the setting and delivery of the training. Each area has revealed communications issues that can be addressed in order to improve training.

From an information design standpoint, the active communications issue is being clear about what information is used for, who will use the information and how the information is displayed. Communications is part of the design of training materials. Print-based information is abstract to a large degree, but it can very useful for recalling

details and for following complicated procedures. Thus it must be designed to allow for this use. Training materials that are three-dimensional or model-based and link more closely to the real world of daily activities help to remove abstractness and let people assimilate and internalize knowledge.

The tools of communication, be they computer-based or part of our personal resources, must be open for review and improvement. New communication media applications are evolving that may represent opportunities to expand what is learned in training. Every opportunity should be taken to match a learning experience to additional information and knowledge support resources. Well-designed and delivered training materials are an important part of what Senge (1994) refers to as the learning organization, wherein people work and learn together to achieve desired results.

From a training process standpoint, the active communications issues stem from linking the learning to the activity in the field. Cognitive models can help people to better understand complex processes. Learning sequences that are geared to how adults learn will be more effective than those that do not. The trainer plays a central role in the training process. This is the person who must take the content of training and shape that content into a form that can be clearly delivered and acted on by the trainees. Communications affects every part of this content forming and delivery process. Trainers must be open to reviewing training strategies or best practices in training an incorporating this knowledge into their training approaches. They must consider when to bring outside resources into the picture in order to help them build more effective materials and processes. Finally, if they have a genuine interest in what they do as trainers, they must try to build a personal professional agenda into their activities and allow themselves to be trained for the job.

Communications issues around setting and delivery are numerous. This is the world of detail and polish in training delivery as well as the world of the communications extensions to training. Best practices are part of this kind of review that relates to making the training setting and physical delivery of the training all work to the benefit of those in the training session. A checklist has already been suggested as a way of dealing with the details in this area of communication in training. People are delivering the training and people are receiving the training. All of the subtle messages that are exchanged between people are active in this area of study. Words like packaging and performance are not out of place here, as they talk to the notion of designing useful training materials and engaging people in the process.

When the training framework is extended to the computer-supported world of knowledge creation and exchange, communications issues still persist. Here the issues of competency with the mediums and willingness to participate may play a major role. These should not be an issue and should be part of the training, if required, in order to make people comfortable with the tools of communication. People within the organization who have the background, and a keen interest in helping to be information and knowledge brokers and codifiers should be supported, especially if the computer-based communications is linked to training issues.

The communications issues in training represent a wide range of opportunities for consultants and service providers. Communications specialists, working in the fields of training, information design, graphic design, instructional design, new media and computer technology can work with trainers and trainees to improve the content and delivery of training. As stated earlier in this paper, the communications thinking that

goes into the effective design of training materials, the training process and the training settings has a direct impact on the effectiveness and safety of valve technicians in the workplace.

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Appendix

The following pages contain the appendices.

Figure 1 - Page 37A

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72 point Times Roman

Figure 2 - Page 38A

Valve and Valve Operator Training Program

- Level 1
  - Basic Valve and Valve Operator Principles
- Level 2
  - Level 1 plus Valve and Operator Maintenance and Troubleshooting

Level 2 Course Agenda

- Valve Management Plan
- Overview - Block Valves
- How Valves Work
- How Valve Operators Work
- Valve Maintenance
- Procedures, TOPS
- Resources and Contacts

Valve Management Plan

- Pipe Engineering uses two processes to help prioritize and justify work

1. Valve Prioritization Models
   - considers factors such as P/L class location, P/L probability of failure, leakage rate, associated facilities affected, redundant valves, valve size, normal operating position, flow interruption, consecutive leaking valves, valve design, etc.

Valve Management Plan

2. Investment Valuation Model
   - establishment of total Risk (Probability of events X Consequences of events), converted into dollars
   - weighs cost of Remedy against cost of Risk
   - Each remedy option is evaluated

Valve Management Plan

- Prioritization Model results:

Generally, valve criticality is ranked as follows:

1. Two or Three line crossovers (tie-overs)
2. C/S bypass and suction/discharge S/V's
3. Mainline block valves
4. Blowdown valves

Valve Management Plan

- We are assuming:
  - Valves & Operators are essentially not considered at risk of catastrophic failure
  - 95% of valves can be reached within 2 hours, virtually all the rest within 4 hours
  - Many "leaking" valves will seal under differential pressure
  - Trained technicians, given enough time, can service a valve and reduce or eliminate a large percentage of reported leaks

Figure 3 - 38B

Slide 1

Valve and Valve Operator Training Program

Level One

Basic Valve and Valve Operator Principles

Level Two

Level One plus
Valve and Valve Operator
Maintenance and Troubleshooting

Slide 2

Valve and Valve Operator Training Program: Level Two

Level Two Course Agenda

1. **Valve Management Plan**
2. **How Valves Work**
3. **Overview of Block Valves**
4. **How Valve Operators Work**
5. **Valve Maintenance**
6. **Procedures,TOPS**
7. **Resources and Contacts**

Slide 3

Valve and Valve Operator Training Program: Level two

1. Valve Management Plan

Pipeline Engineering uses two processes to help prioritize and justify work:

1.1 Valve Prioritization Models

Considers factors such as:
P/L class location, P/L probability of failure, leakage rate, associated facilities affected, redundant valves, valve size, normal operating position, flow interruption, consecutive leaking valves, valve design, etc.

Slide 16

Valve and Valve Operator Training Program: Level two

Ball Valves

Advantages

Full opening bore
More easily operated with AP than gate valves
Relatively small physical size

Disadvantages

Cannot be repaired in-line
Not suitable for throttling or pinching flow

Figure 4 - Page 39A

Frozen Valve Stem Extensions

THE FOLLOWING PROCEDURE IS RECOMMENDED TO ADDRESS FROZEN VALVE STEM EXTENSIONS. IT ASSUMES THE EXTENSION HAS BEEN THAWED.

CAUTION: THERE IS POTENTIAL FOR THE PRESENCE OF GAS IN THE STEM EXTENSION (SHOULD THE VALVE STEM BE LEAKING), THEREFORE ANY THAWING PROCEDURES EMPLOYED SHOULD RECOGNIZE THIS POTENTIAL.

Pipe Engineering recommends the following actions as a "standardized practice":

1) If not already present, drill and tap a 1/2" hole within approx. 4 inches from the underside of the top flange on the extension (just below the mounted valve operator)

2) If not already present, drill and tap a 1/4" to 1/2" hole at ground level
   - note that there's a reasonable chance of gas in the extension. Take suitable precautions if levels approach 10% LEL

3) drain water from stem to the level of the lower (ground level) hole

4) OPTIONAL: use a plastic hose or similar snaked down the extension and suck out as much water as possible. This is not critical to the process but will enhance the effectiveness. It is not always possible or practical to remove all the water.

5) plug the lower hole

6) pour RV type antifreeze into the top vent hole to fill

7) replace the vent plug in the top hole.

8) for valves with a history of freezing, consider doing this process yearly. This should be locally managed, as only a small percentage of our valves are so affected.

Figure 5 - Page 39B

Frozen Valve Stem Extensions

The following procedure is recommended to address frozen valve stem extensions. It assumes the extension has been thawed.

CAUTION: There is potential for the presence of gas in the stem extension (should the valve stem be leaking), therefore any thawing procedures employed should recognize this potential.

Pipe Engineering recommends the following actions as a "standard practice":

1. If not already present, drill and atp a 1/2 inch hole within approximately 4 inches from the underside of the top flange on the extension (just below the mounted valve operator)

2. If not already present, drill and tap a 1/4 inch to 1/2 inch hole at ground level **Note: There is a reasonable chance that gas may be prsent in the extension. Take suitable precations if levels aproach 10% LEL.**

3. Drain water from the stem to the level of the lower (ground level) hole

4. Optional: Use a plastic hose or similar device snaked down the extension and suck out as much water as possible. This is not critical to the process but will enhance the effcetiveness. It is not always possible or practical to remove all the water.

5. Plug the lower hole.

6. Pour RV type antifreeze into the top vent hole to fill.

7. Replace the vent plug in the top hole.

8. For valves with a history of freezing, consider performing this procedure on a yearly basis. This should be managed locally, as only a small percentage of our valves are affected in this way.

Figure 6 - Page 39C

Gas / Hydraulic Valve Operator

HYDRAULIC FLUID LEVELS

- Hydraulic fluid levels should be checked and adjusted prior to cycling the valve. This will minimize fluid spills from operator exhaust and assist in diagnosing the condition of internal seals.
- **Approved fluids** are: (a) Esso Univis J-13, (b) Shell Tellus T-22, (c) Maryn Research Marinus VAO (highly biodegradable for environmentally sensitive applications)

1. Shafer Rotary Vane Operators

- NOTE: reference to Shafer tank sizes are in terms of volume of the tank relative to the volume of the actuator. e.g. a 1.5 X volume tank will hold 1 1/2 times the oil volume that the actuator will hold.

a) pre-1964 models (equipped with 1.5 X volume tanks)

- should always be equipped with anti-leveling check valves, installed on either the suction or discharge side of the hand pump

Oil Levels: 3/4 full for "ready" tank
1/4 full for "receiving" tank

b) post-1964 models (equipped with 3X volume tanks)

- equipped with a shuttle valve installed between the tanks to allow tank levels to equalize

Oil Levels: 1/2 full for both the "ready" and "receiving" tanks

2. Shafer Linear Operators

All models are equipped with 1.25 X volume tanks

Oil Levels: 3/4 full for "ready" tank
1/4 full for "receiving" tank

3. Bettis – Erichsen Scotch Yoke (1/4 turn) Operators

All models except 33DH

Oil Levels: 3/4 full for "ready" tank
1/4 full for "receiving" tank

Model 33DH

Oil Levels: 2/3 full for "ready" tank
1/3 full for "receiving" tank

4. Bettis – Erichsen Linear Operators

All models

Oil Levels: 3/4 full for "ready" tank
1/4 full (min.) for "receiving" tank

Note: Oil can be transferred from one tank to another in a Bettis/Erichsen operator by: (a) open selector valve for the tank with the "high" oil level, (b) raise pump handle, (c) close that selector valve, (d) open other selector valve 1/2 way (approx. 45 degrees), (e) push pump handle down, (f) repeat as necessary

Hydraulic Fluid Levels for Gas/Hydraulic Valve Operator

Hydraulic fluid levels should be checked and adjusted prior to cycling the valve. This will minimize fluid spills from the operator exhaust and assist in diagnosing the condition of internal seats.

The approved fluids are:

Esso Univis J-13 **Shell Tellus T-22** **Maryn Research Marinus VAO**
(Highly biodegradable for environmentally sensitive applications)

Shafer Rotary Vane Operators

Note: Reference to Shafer tanks sizes are in terms of volume of the tank relative to the volume of the actuator. For example: A 1.5 X volume tank will hold 1 1/2 time the oil volume that the actuator will hold.

1. **Pre-1964 models (equipped with 1.5 X volume tanks)**
   Should always be equipped with anti-levelling check valves, installed on either the suction or discharge side of the hand pump

Oil levels: 3/4 full for "readfy" tank... 1/4 full for "receiving" tank

2. **Post -1964 models (equipped with 3X volume tanks)**
   Equipped with a shuttle valve installed between the tanks to allow tank levels to equalize.

Oil levels: 1/2 full for both the "ready"and the "receiving" tanks

Shafer Linear Operators

All models equipped with 1.25 volume tanks

Oll levels: 3/4 full for "ready" tank... 1/4 full for "receiving" tank

Bettis - Erichsen Scotch Yoke (1/4 turn) Operators

All models (except 33DH)

Oils levels: 3/4 full for "ready" tank... 1/4 full for "receiving" tank

Model 33DH

Oil levels: 2/3 full for "ready" tank... 1/3 full for "receiving" tank

Bettis - Erichsen Linear Operators

All models

Oil levels: 3/4 full for "ready" tank... 1/4 ful for "receiving" tank

Note: Oll can be transferred from one tank to another in a Bettis Operator by:

a) opening the selector valve for the tank with the "high" oil level,

b) raising the pump handle, etc.

Figure 8 - Page 40B

Key Valve Design Characteristics

Manufacturer	Model (s)	Type	Mech. Stops?	Blow-down open?	Notable features / remarks
Adamson-Chronister	C2100	Gate	See ACV	See ACV	See ACV
Advance Concept Valves (ACV)	DCR	Gate	Yes - if manual gearset No - if power actuated	Yes	cylindrical body, slab gate, four sealant ports per seat ring (12,3,6,9 o'clock) on valve body side of soft seal. Mfgd. by Diversified Energy Products, Houston
Canron	G-4, G-12	Gate	See Dresser/Grove	See Grove	Canron mfgd. Grove valves in Canada under licence in the 70's/80's See Dresser/Grove
Dresser/Grove	G-4	Gate	Yes - if manual gearset No - if power actuated	Yes	rectangular body, slab gate, one seat sealant port at 12 o'clock P/L side of soft seal (i.e. aids upstream sealing)
Dresser/Grove	G-12	Gate	Yes - if manual gearset No - if power actuated	Yes	cylindrical body, slab gate, one seat sealant port at 12 o'clock P/L side of soft seal (i.e. aids upstream sealing)
Hayward Tyler	See ACV	Gate	See ACV	See ACV	See ACV
M&J (Daniel)	M303	Gate	Yes - if manual gearset No - if power actuated	Yes	rectangular body, slab gate, two seat sealant ports @ 3 & 9 o'clock, valve body side of soft seal (i.e. aids down- stream sealing)
Dresser/Valgro	G-4, G-12	Gate	See Dresser/Grove	See Grove	See Dresser/Grove
WKM	Saf-T-Seal	Gate	Yes - if manual gearset No - if power actuated	Yes	cylindrical body, slab gate, sealant port on body side of soft seal (i.e. aids downstream sealing)
WKM	Pow-R-Seal	Gate	Yes - inherent in this valve design	Yes	split wedge gate design
Manufacturer	**Model (s)**	**Type**	**Mech. Stops?**	**Blow-down open?**	**Notable features / remarks**
Borsig Hartmann	Superbloc "G"	Ball	No	Yes	welded body, **self relieves downstream !!** Sealant capacity = 2 oz/dia, inch
Cameron	T 31	Ball	Yes	Yes	welded body, ratcheting seats, stem stop viewports, **self relieves downstream !!** Sealant capacity = 1 oz/dia. Inch Sealant ports on P/L side of soft seal
Cameron	T 32	Ball	Yes	Yes	welded body, stem stop viewports, no ratcheting seats, does not self relieve. Sealant cap. Same as T31
Canron	B5	Ball	See Dresser/Grove	See Grove	Licencee for Grove in 70's/80's
Dresser/Grove	B5	Ball	Yes - stop collar only	No	bolted body sealant capacity = 1.5 oz./dia.inch Sealant ports on P/L side of soft seal
Dresser/Grove	B8	Ball	Yes - stop collar only	Yes, for valves supplied after '97	welded body sealant capacity = 1.5 oz./dia.inch Sealant ports on P/L side of soft seal
Nuovo Pignone	WB	Ball	No	Yes	welded body
Rockwell	Hypresphere Model III, Model IV -TM	Ball	No	No	Model III - floating ball d/s seating bolted body Model IV-TM trunnion mounted welded body sealant capacity = 2 oz./dia.inch
Dresser/Valgro	B5	Ball	See Dresser/Grove	See Dresser/Grove	Licencee for Dresser/Grove
WKM	DynaSeal 370	Ball	Yes	Yes	welded body, **self relieves downstream !!**

Gate Type Valve Design Characteristics

Manufacturer	Model	Mechanical Stops	Blow-down open?	Notable features / remarks
Adamson-Chronister	C2100	See ACV	See ACV	See ACV (Advance Concept Valves)
Advance Concept	DCR	Yes - if manual gearset No- if power actuated	Yes	cylindrical body, slabe gate, four sealant ports per seat ring at the 12, 3, 6 and 9 o'clock locations on the valve body side of the soft seal Maunfactured by Diversified Energy Products, Houston
Canron	G-$, G-12	See Dresser/ Grove	See Grove	Canron manufacured Grove valves in Canada under licence in the 1970s and 80s. See Dresser/Grove
Dresser/Grove	G-4	Yes - if manual gearset No- if power actuated	Yes	**rectangular** body, slab gate one seat sealant port at 12 o'clock P/L side of soft seal (i.e. aids upstream sealing)
	G-12	Yes - if manual gearset No- if power actuated	Yes	**cylindrical** body, slab gate one seat sealant port at 12 o'clock P/L side of soft seal (i.e. aids upstream sealing)
Hayward Tyler	See ACV	See ACV	Yes	See ACV
Dresser/Valgro	G-4, G-12	See Dresser/ Grove	See Grove	See Dresser/Grove
M&J (Daniel)	M303	Yes - if manual gearset No- if power actuated	Yes	rectangular body, slab gate, two seat sealant ports at 3 and 9 o'clock, valve body side of soft seal (i.e. aids upstream sealing)
WKM	Saf-T-Seal	Yes - if manual gearset No- if power actuated	Yes	cylindrical body, slab gate sealant port at the body side of the soft seal (i.e. aids downstream sealing)
	Pow-R-Seal	Yes - inherent in this valve design	Yes	split wedge gate design

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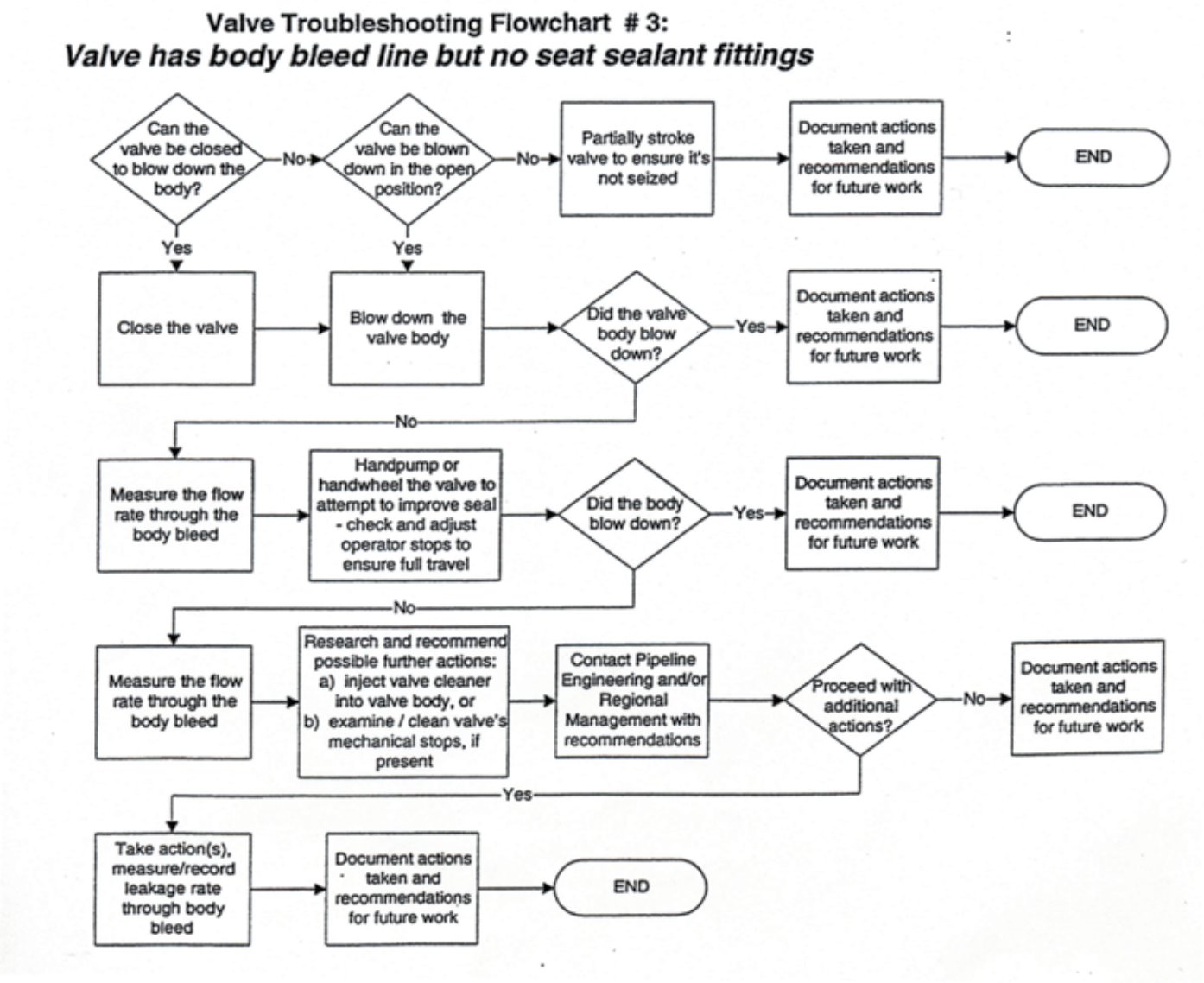
Table 1
Leakage Diagnostics using Orifice Flow Tester

Measured flow rate	Probable Causes of leakage	Recommended remedial actions
Very high (> 500 psi)	Valve not fully closed	1) Handpump or handwheel the valve in both directions to locate the "sweet spot". This may improve any leakage condition. 2) Back off the operator stops to permit more closing travel; observe gauge pressure to note any improvements 3) Expose and clean the mechanical stops in the valve stem area (only certain valves permit this), handpump/handwheel to closed position 4) Cycle valve open then closed again and observe rotational movement of operator to stem flanged connections. Tighten as necessary, then reset operator stops at the position of least leakage. Recheck and adjust stops for open position.
Very high (>500 psi)	Seat(s) hung up	1) Close body bleed valve, allow time for pressure to rebuild in valve body, then re-open body bleed valve quickly to allow rapid body de-pressurization. This may "shock" the seats from their hung up position. 2) Inject valve cleaner into seat sealant ports sufficient to displace all grease in sealant system. Allow to dwell (min. 1 hour), repeat step 1 above. 3) Inject sealant into seat sealant ports sufficient to displace all cleaner in sealant system. 4) Inject solvent or mineral oil into valve body cavity sufficient to fill body to top of seats (at least), allow to dwell (min. 2 hrs). Much of the solvent/oil can be vented back into a container from the body bleed line. Excess goes into the pipeline.
High (100-500 psi)	Any of above causes, or Seat/ball/gate damage in the form of severe scores or gouges	1) Inject valve sealant, cycle the valve partially several times, inject more sealant 2) Inject extra heavy or PTFE enhanced sealant (e.g. Sealweld 5050) sufficient to displace all sealant in the sealant system, cycle the valve partially several times, inject more sealant
High (100-500 psi)	Any of the above causes, or build-up of contaminants on face of ball or gate (e.g. asphaltines)	1) Inject solvent or mineral oil into valve body cavity sufficient to nearly fill valve body, allow to dwell (min. 2 hrs). Much of the solvent/oil can be vented back into a container from the body bleed line. Excess goes into the pipeline.
High (100-500 psi)	Any of the above causes, or gas bypassing behind the seat rings	1) Inject valve cleaner into seat sealant ports sufficient to displace all grease in sealant system. Allow to dwell (min. 1 hour), inject more cleaner and allow to dwell overnight if possible. Purge cleaner from system by injecting lubricant/sealant to completely refill the sealant system and risers.
High (100-500 psi)	Any of the above causes, or damaged or missing elastomer seat inserts	1) Sealant injection can help reduce leakage rate 2) Usually this condition is improved when the valve is subjected to high differential pressure when the seats are pressed tightly against the ball/gate and a metal to metal seal is formed
Moderate (50-100 psi)	Any of the above causes, or seat/ball/gate damage in the form of deep scores or gouges	1) Inject valve sealant, cycle the valve partially several times, inject more sealant 2) Inject extra heavy or PTFE enhanced sealant (e.g. Sealweld 5050) sufficient to displace all sealant in the sealant system, cycle the valve partially several times, inject more sealant
Low (under 50 psi)	Any of the above causes, or seat/ball/gate damage in the form of scores or gouges	1) Inject valve sealant, cycle the valve partially several times, inject more sealant 2) Inject extra heavy or PTFE enhanced sealant (e.g. Sealweld 5050) sufficient to displace all sealant in the sealant system, cycle the valve partially several times, inject more sealant

Table 1: Leakage diagnostics using Orifice Flow Tester

Measured flow rate	Probable causes of leakage	Recommended remedial actions
Very High (500 psi)	**Valve not fully closed**	**1.** Handpump or handwheel the valve in both directions to locate the "sweet spot". This may improve any leakage condition. **2.** Back off the operator to permit more closing travel: observe guage pressure to note any improvements. **3.** Expose and clean the mechanical stops in the valve stem area (only certain valves permit this), handpump/handwheel to closed postion **4.** Cycle valve open then closed again and observe rotational movement of operator to stem flanged connections. Tighten as necessary, then reset operator stops at the postion of least leakage. Recheck and adjust stops for open position.
Very High (500 psi)	**Seat(s) hung up** Any of above causes,or	**1.** Close body bleed valve, allow time for pressure to rebuild in vlave body, then re-open body bleed valve quickly to alllow rapid body de-pressurization. This may "shock" the seats from their hung up position. **2.** Inject valve cleaner into sealant ports sufficient to displace all grease in sealant system. Allow to dwell (minimum 1 hour), then repeat step 1 above. **3.** Inject sealant into sealant ports sufficient to displace all cleaner in sealant system. **4.** Inject solvent or mineral oil into valve body sufficient to fill body to top of seats (at least), allow to dwell (minimum 2 hours). Much of the solvent/oil can be vented back to a container from the body bleed line. Excess goes into pipeline.
High (100 - 500 psi)	**Seat/ball/gate damage in the form of severe scores or gouges**	**1.** Inject valve sealant, cycle the valve several times, inject more sealant **2.** Inject extra heavy or PTFE enhanced sealant (e.g. Sealweld 5050) sufficient ot displace all sealant in the sealant system, cycle the valve sveral time, inject more sealant

Figure 12 - Page 41C



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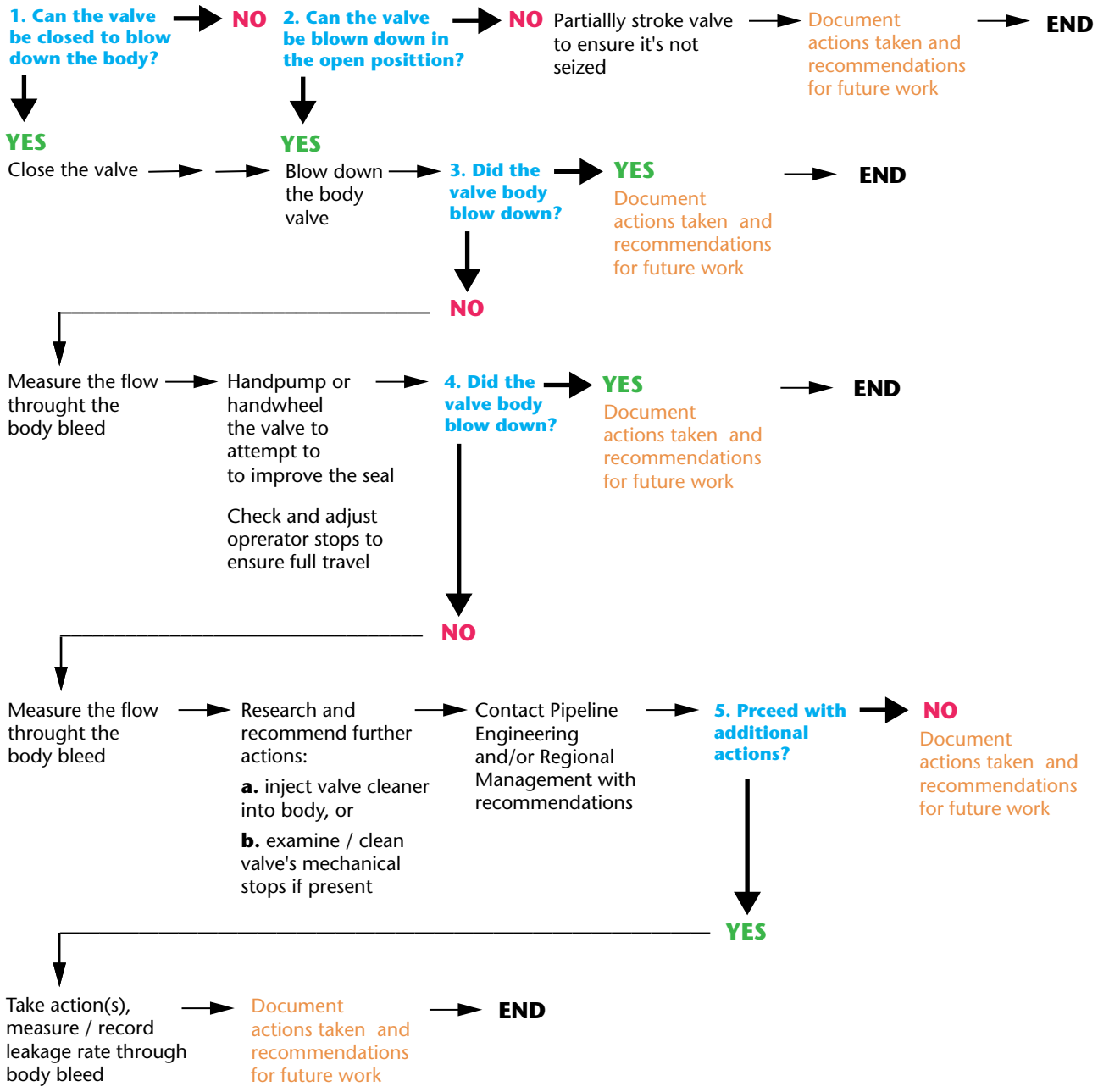
Valve Troubleshooting Flowchart: **Number 3**

Valve has body bleed line but no seat sealant fittings



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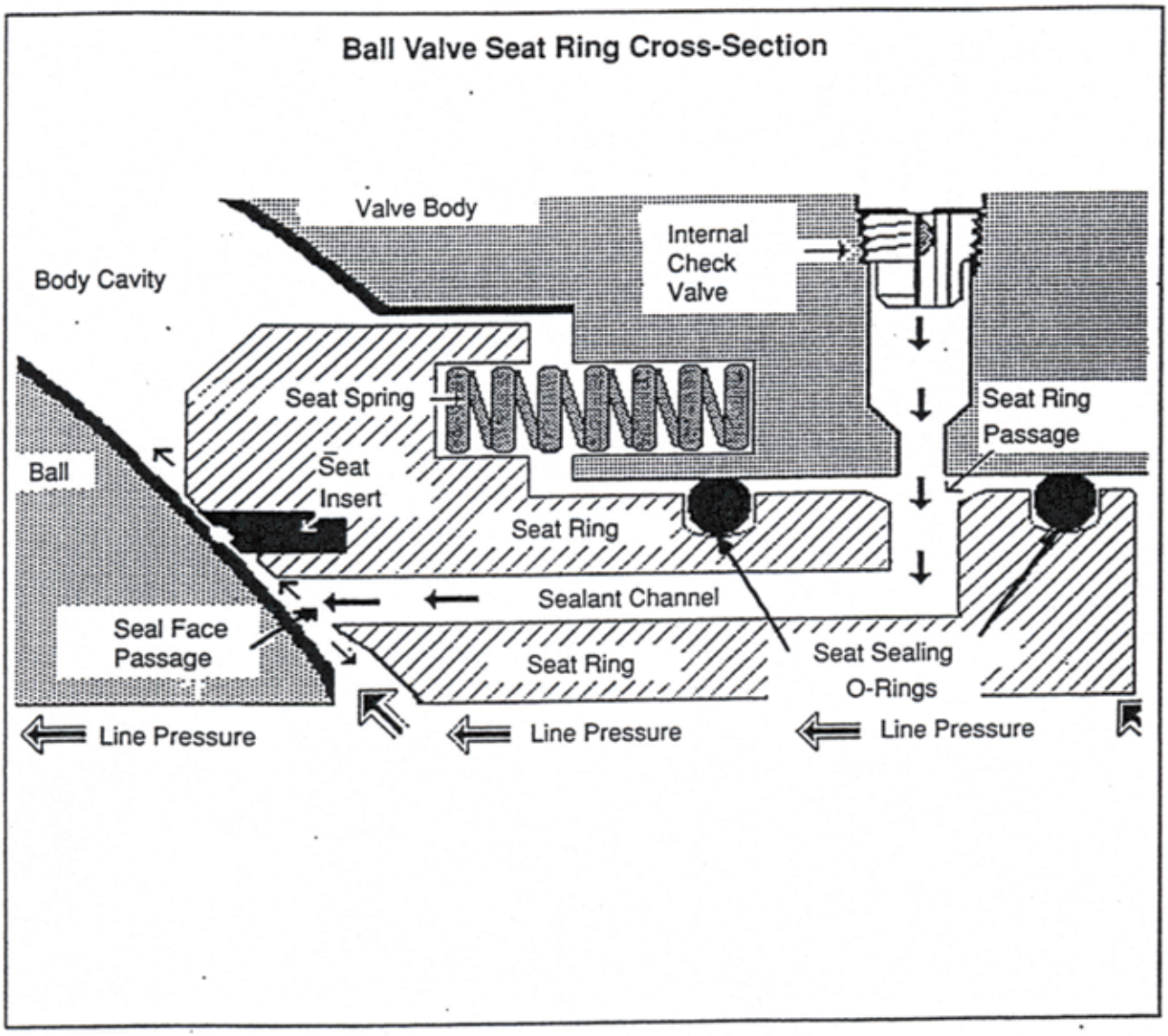

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Ball Valve Seat Ring Cross-Section

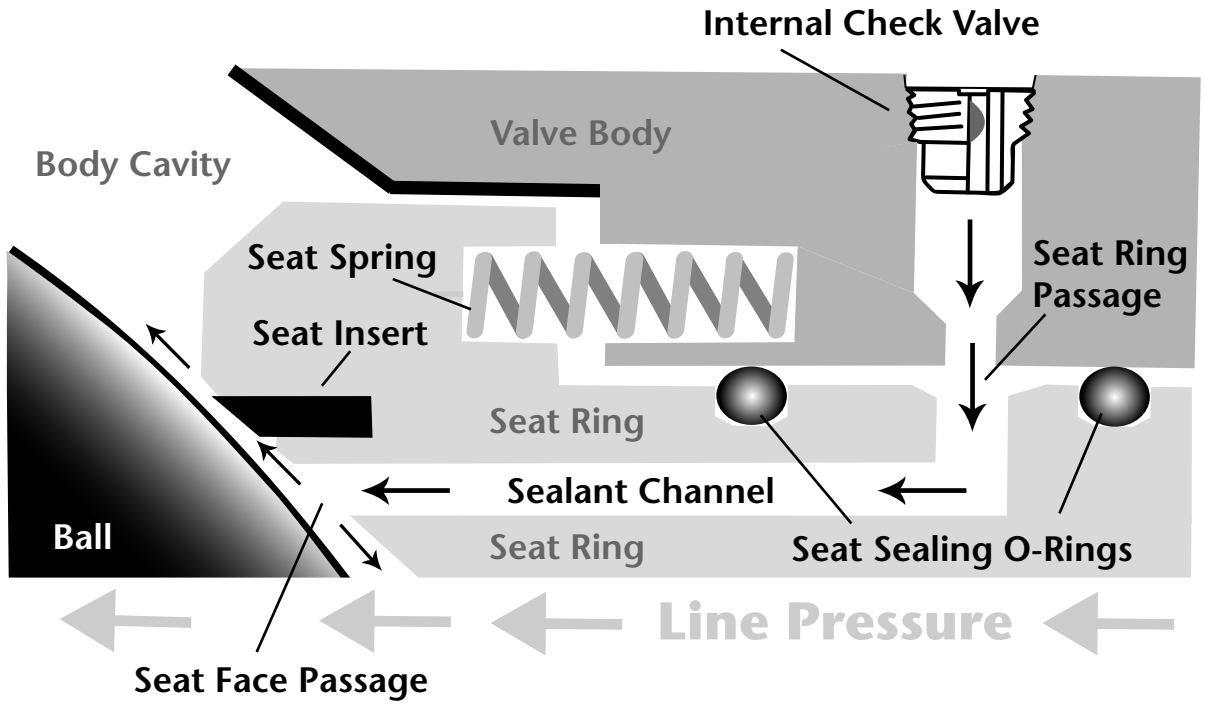
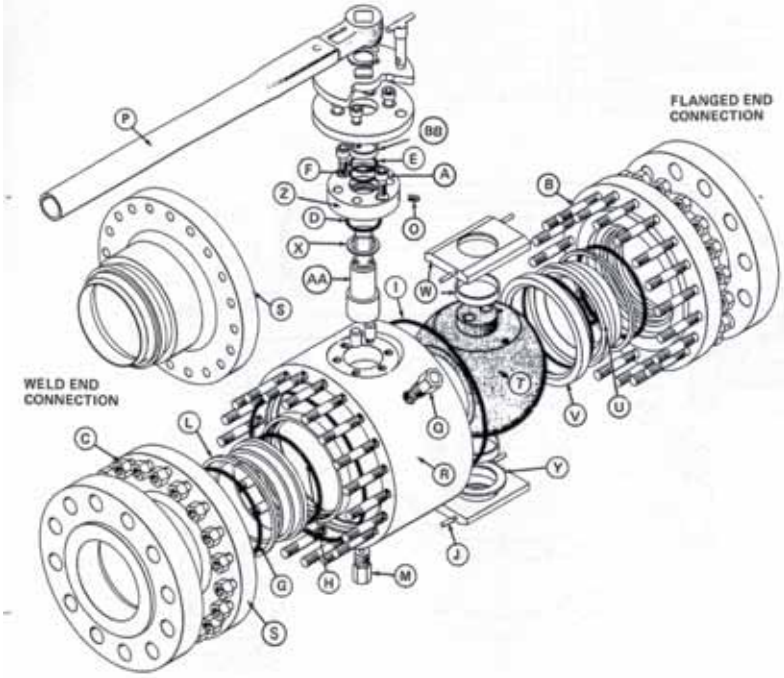


Figure 16 - Page 44A

GROVE B-5 BALL VALVE

MATERIAL SPECIFICATIONS

CLASS 150-900, 6"-36"



	PART NAME	MATERIAL
A	Capscrew (Gland Plate)	Steel
B	Stud (Body)	Steel
C	Nut (Body)	Steel
D	O-Ring (Gland Plate)	GROVEX
E	O-Ring (Upper Stem Seal)	GROVEX
F	O-Ring (Lower Stem Seal)	GROVEX
G	O-Ring (Seat Gasket)	GROVEX
H	Seal-O-Ring	GROVEX
I	O-Ring (Body)	GROVEX
J	Pin (Bearing Retainer)	Steel-Cadmium Pl
K	Spring (Seat)	18/8 C.Re.S.
L	Seat Lock Ring	18/8 C.Re.S.
M	Drain Valve	Steel
N	Nameplate	18/8 C.Re.S.
O	Vented Plug	Steel
P	Wrench	Ductile Iron and Steel
Q	Relief Valve	Steel
R	Body	Steel
S	Closure	Steel
T	Ball	Ductile Iron-Chrome Pl
U	Inner Seat Ring	Steel †
V	Outer Seat Ring	Steel †
W	Bearing Unit	Steel and TEFLON
X	Upper Thrust Washer	Nylon
Y	Lower Thrust Washer	Nylon
Z	Gland Plate	Steel
AA	Stem	Steel †
BB	Gland Bushing	Steel †

Body and Closure - steel conforming to API 6D material specifications for "Bodies, Bonnets and Covers."
† Electroless Nickel Coated
Welding Ends are ASTM - A441 or A242 Steel

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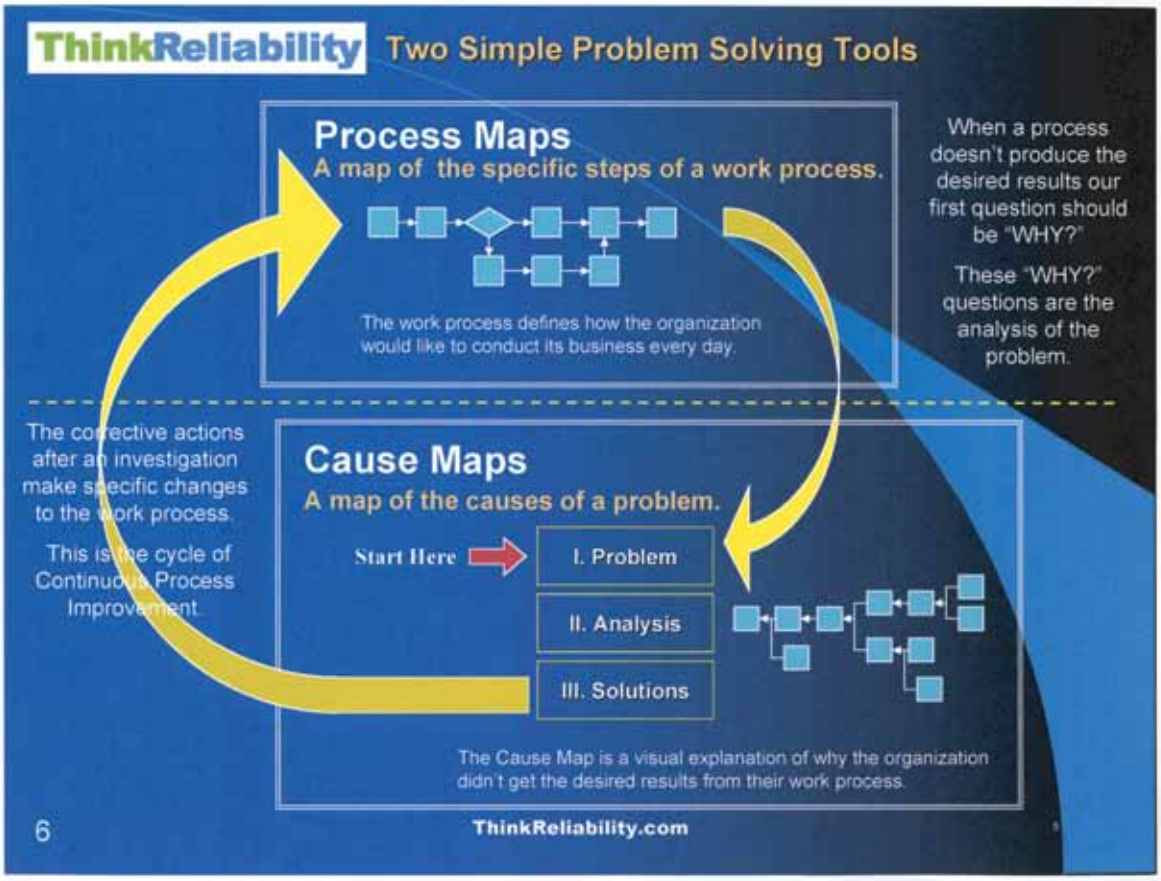

Figure 18 - Page 59A