Electrical Specification Writing

IEEE-CED
Houston, Texas

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Presentation Objectives

- Understand why we need specifications.
- Types of specifications.
- Who creates specifications and why?
- Who uses specifications and why?
- The anatomy of a specification
- What makes up a complete specification package?
- You send out a RFP and you get back a bid…

Sometimes the objectives that I think are important are not necessarily the same that you think are important. Oops… Lets discuss so I can do better next time.

Competence Skill Set

At the 2014 PCIC Paul Owen, Shell, London, presented a paper titled, *Electrical Engineers Competence Mapping in an IOC and Possibilities for Industry Collaboration*. In the paper is a list of items that helps to define the competence of an up and coming EE as being competent or not. Item #7 on his list was Equipment Selection.

Owen said, Equipment Selection entails... *Interpret and specify electrical equipment, including QA/QC*.

That is why this topic is necessary to cover as a mistake here is something that may not be simply rectified in the field later on.

IOC = International Oil Company

Our Job

We are application engineers. We apply what is available and what is known. We are not design engineers going to design a motor, transformer, swgr, protective relay, etc.,

Or to look at it another way…

Our job is to take equipment of known design and put them together in such a way that they function in a safe, successful, and reliable manner to produce the desired outcome over the expected lifetime.

And we shall be doing…

Since we are application engineers we shall be buying equipment of proven design from companies around the world that have manufacturing facilities around the world. That is the environment we are in.

Our Job

Our job may involve RFP's going out to Bidders who make items to different standards. Which means our job might entail reconciling bids of dissimilar equipment looking for the lowest installed cost and lowest overall cost.

Say bidding a 480V MCC to three vendors. Two makes MCC's to IEEE/NEMA while another makes MCC's to IEC standards.

Or the Bidder provides a IEEE/NEMA bid per the RFP and provides an IEC alternate bid.

If you are a global player in a global market, then cost savings have to be hunted out and looked at.

Request for Proposal

Why three vendors? What if only two bid? Bid five and qualify only three? Keep two on file?

Why do we need Specifications?

We need a specification to ensure what we purchase is in agreement with what is written down.

Which means…

What is written down is what we want. Which means you know what you want.

To be more formal we could say a specification is…

A detailed description of the measurable characteristics desired in an item to be purchased, such as quality, size, weight, performance parameters, safety requirements, etc.

Why do we need Specifications?

Personal

- Buying a house ($200,000 - $450,000)
- Buying a King Ranch F250 P/U ($60,000)
- Picking a wife or husband (priceless)
- Mowing service ($35/wk)
- Rely more on word of mouth & social media (the new frontier)

Work

- Buying engineered items - Spec YES
- Qualified bidders list - List YES (pick at least three)
- Buying commodity items - Spec NO
- Qualified bidders list - List NO (Note vendor and put 'or approved equal')

Work – Engineered Items

Engineered Items usually Include some or all of the following

- To be sized, designed, built to specifications
- QA & QC, inspections, hold points & a detailed FAT
- Final, sealed or certified drawings
- Special packing and special delivery to site
- Special handling, storage and installation at site
- Detailed installation, operation & maintenance (IOM) documentation with each engineered item
- Maybe a repeat of the FAT once all is installed at site
- Maybe specialized installers req'd at site.

Hopefully, this description is general enough to cover any engineered item.

Work – Commodity Items

Commodity Items

- An off the shelf item, NO modifications
- "Typical" drawings or data sheets
- No inspections
- Special handling at site as req'd
- Typically *small* items – Small may be relative.
- Typically shown on details, conduit & cable lists, BoM's Pages from Standard Electrical Details.pdf Unistrut_17_catalog_09-2013_v1web.pdf
- Enduro-FRP-Solutions-for-Cable-Management-Systems-Catalog.pdf

Work – Commodity Items

Commodity Items… Cont.

- Typically purchased by brand name and part number with an “Or approved equal” statement BOM001.pdf

Originally constructed circa 1982. Pre CAD. First 345kV expansion added in 2006/7.

Work – Commodity Items

Even though we call them commodity items, time, effort, and care should go in to selecting the right item.

Behind every reviewed standard detail should be a complete set of cut-sheets, notes, and any other item(s) to validate each selected item.

With today's technology I would expect one pdf file per standard detail showing all the items in the same order as on the detail.

Test #1

Test #1 Cont.

Item	Type
138kV Substation	Engineered turnkey
Substation building	Engineered turnkey
Cogen	Engineered turnkey
138kV-480Y/277V xfmrs	Engineered
138kV-4160Y/2401V xfmrs	Engineered
13.8kV motors	Engineered
480V motors	Engineered by rotating engineer with pump
480V bus duct	Engineered
Cooling tower with motors	Engineered
Red & black cables	Commodity
13.8kV & 480V cable terminations	Commodity
Cable tray & fittings	Commodity
Conduit & fittings	Commodity

Overlook

ITEM		Who Provides
	High cost	
Engineered Equipment.		Technology / R&D provides.
Custom Fabrication.		Low cost production.
Std materials & major bulks.		Mass production & distribution.
Minor Bulks & consumables.		Low cost capabilities.
	Low cost	

Who Does What?

Engineered Items:- Engineered items are usually handled by engineers on the project.

Commodity Items:- Commodity items are usually selected by the designers on the project. Items are selected based on existing go-by's, site or personal choice/experience, already available, etc., Items are noted on drawings or commodity lists. Resulting in a safe and maintainable design with no traps!

Purchasing Commodity Items:- If there is sufficient quantity, high enough cost, or long lead time, commodity items might be bought by the purchaser. If the quantity is small, then bidder usually purchases and installs.

Are you with me?

Are you with me as to understanding the difference between Engineered Items and Commodity Items?

We need to be sure at this point before moving on.

From this point on we shall be dealing with Engineered Items not Commodity Items. Okay, there are always exceptions to the rules.

Engineered Items

When we talk about an engineered item it is automatically assumed there will be a formal RFP for that engineered item. The RFP *usually* consists of two main parts:-

1. Commercial section
2. Technical section

In front of both sections is the RFP cover sheet(s). One of these cover sheets should be a list of all documents included on the RFP.

Even though engineers associate with the technical side of the RFP, they must be familiar with and understand the commercial section as we can offer assistance there.
Xfmr_RFP_Quote\RFP-4288.pdf

The above Xfmr spec is called a narrative spec.

Engineered Items

The RFP takes time to put together. The electrical engineers usually works on the technical section. Once complete, reviewed and approved, the technical section is handed over to the procurement group who add the commercial section and then go out on the street with the completed RFP.

Again, about the most complex item Petro/Chem EE's buy is the PCR because it has such a wide range of equipment located inside and has xfmrs outside.

A decent PCR could take up to three or four months of hard work to put together the technical side of the RFP.

Engineered Items

Engineered items are usually considered long lead items. That means they have to be bought a while before they are needed. For example, a large xfmr might take 52 weeks from cutting the PO to delivery –delivery time.

That means you should have issued the Request For Proposal (RFP) three months ago.

1. **Issue RFP and give 4 weeks for proposals**
2. **Review technical section in 4 weeks**
3. **2 weeks of padding**
4. **Have pre-award meetings**
5. **Issue PO** Motor PreMtg.pdf

Is 4 wks too tight?
What if it is a PCR?

Which means you usually are purchasing items using preliminary, or best guess, data to make delivery to site on time.

And since Electrical is always tail-end-Charlie, this guessing is predicated on information from all other disciplines!

Engineered Items

Since Engineered items are usually considered long lead items, the EE shall work closely with the scheduler to make sure what you are buying is delivered on time to site for immediate installation.

Remember...

Engineering	is ≈10% of the overall cost
Equipment & Construction	is ≈90% of the overall cost

That means you can make or lose a lot of money if you get equipment and construction wrong.

Which means the project is always construction driven.

Commercial Section

CSI Masterformat is a well established specification format that is well worth knowing, understanding and using. CSI Masterformat is broken into two sections.

1. **Procurement & Contracting Requirements Group**
2. **Specification Group**

This matches the standard approach of commercial & technical sections. Lets have a quick look at commercial side of CSI...

Masterformat\MasterFormat_2014_Numbers&Titles.pdf

Bidders List

DIGRESSION STARTS HERE.

Purchaser: The person buying or purchasing the item

Bidder: The entity bidding on the RFP documentation

Usually the Purchaser has an approved vendor list (AVL) that purchasing keeps for the Bidder to use.

Should the Bidder ask a fourth company to bid knowing they are usually lower then the approved three?

If the Bidder has knowledge of under or poor performance of one of the approved vendors, should the Bidder bring it to the attention of the Purchaser?

If the Purchaser does not have an AVL, what criteria would the Bidder use to create one?

Approved Vendor List

Even though not usually a part of the job, an understanding of how and why the (AVL) is created. In some companies, changing the AVL takes an act of Congress. Things can be that entrenched. Then, again, you don't want to be changing every other month.

Usually end users create and keep an AVL based on experience and a long term relationship.

Usually end users have a supply system created for the facility. Can take several forms. The usual form is a long term contract between the end user and a specific supply company. This way items are readily available to site.

Engineers can and should be involved in the AVL by offering technical opinion's on the equipment.

Overall Cost

The overall cost of any item is not necessarily the lowest bidder that complies with the RFP.

The overall lifecycle of the item, once installed, should be considered. This approach is vital to the Purchaser, not necessarily so to the Bidder. This is usually done on transformers as they consume energy.

This difference is also reflected in how an end user sees things as compared to an EPC contractor.

All this should be hammered out and addressed in the Design Criteria specification.

DIGRESSION OVER.

The Anatomy of the RFP

Purchaser: The person buying or purchasing the item

Bidder: The entity bidding on the RFP documentation

The names may vary, such as Owner & Supplier, but the intent is for the Bidder to bid on the RFP documentation. If successful, commercially (T's & C's) and technically, the Bidder then enters into a contract with the Purchaser to deliver said goods & services for said price and deliver it to said location in said condition.

→ Until the contract is signed things can be changed, up to and including annulling the RFP.

→ Once the contract is **signed** by both parties, both parties are bound by the T's & C's. Now the Bidder can commence work.

Moving forward

From now on we are going to concentrate on the Technical not Commercial section of the RFP. Okay, there are always exceptions to the rules.

Everybody OK with that???

Technical Portion - RFP

Because electrical has so many spec's to write, not every RFP is going to be the same.

At a minimum the technical section usually consists of items 2 & 3. The other items are added as req'd.

1. **Technical Index (as against the overall index)**
2. **Specification(s)**
3. **Data Sheet(s)**
4. **Drawing(s)**
5. **Sketch(es)**
6. **Photograph(s)**
7. **Technical report(s)**
8. **Etc.,**

A Spec without a data sheet is really quite useless!

PCR – Package Example

Of all the engineered items most probably a prefabricated control building (PCR) is the most challenging because it has so much stuff in side and possibly with bus duct and an xfmr outside. The usual way to have a PCR built is to work with a company familiar doing this type of work.

My personal choice is to use vendors here in Houston as I can be at their office within 30 minutes seeing what is going on.

Specs\PCR_1.pdf

Specs\PCR_2.pdf

Electrical Specifications

Electrical Spec's		
Basic Design	DC Charger (DC system)	HV Ckt Switchers
Batteries	Design Criteria	HV Disc Switches
Building – Electrical Services	Diesel Engine Set	Inspection & Testing
Building Prefab	Electric Heater	Interface
Cables	Electrical Construction	Load Int Switches – MV
Cable Installation	Electrical for Skid Mounted Equipment	Motors – LV
Capacitors	Engines – Diesel	Motors – MV
Cathodic Protection	Generators	Navigational Aides
CCTV	Grounding Equipment – High Res	Protective Devices
Compressors – Centrifugal	Grounding Equipment – Neutral	Public Address & Alarm Systems
Compressors – Reciprocating	Heat Tracing – Electrical	Rectifiers
Conduit	HV Ckt Bkrs	Switchgear Assemblies

Electrical Specifications

More Electrical Spec's		
Switchrack – Outdoors	Turbines – Steam	VFD's
Transfer Switch	Unit Substations	Wood Poles & Crossarms
Transformers	UPS Systems	
Turbines – Gas		

Out of all engineering disciplines electrical has the second most (that is numerically) spec's to know and understand. The problem is, we don't use them enough to become proficient in all the nuances of the spec's we use and the underlying IEEE, NEMA, ANSI, etc., documents.

How many EE's do you know are skilled in both North American standards/spec's and IEC standards/specs? And really understand them?

Electrical Specifications

Electrical specifications are many, multifaceted, challenging, picky and put together by opinionated engineers hell bent on doing a good job because that is what engineers do.

The question is, how much of the specification is technical choice, now much is personal choice, and now much is company mandated?

Since there are few EE's in high places, very few people (think PM's & PE's) know and understand what we do… and remember electrical is only ≈10% of the overall project budget.

Spec Order

Believe it or not, there is an order to specifications. It is a very simple order.

The master spec is the Design Criteria or Basic Design Document. This document sets the tone of the electrical portion of the project. All other spec's key off this document. Lets look how PIP does it.

Specs\ELCGL01.pdf

Specs\ELCGL01D.pdf

Spec -v- Data Sheet

There is a tight relationship between the spec and the data sheets. Look for, “If so stated on the data sheets…” That is, the data sheet is, to a point, amending or fine tuning the spec.

That is why the data sheet is usually the last document to be completed because the data is the last to become available.

If there is a reference in the spec and it is not on the data sheets, then problems start. The Bidder has to request clarification and the Purchaser has to issue clarification documents to everyone.

Simply put, it is cheaper to get it right up front. Then again things happen.

If it is a motor RFQ using IEEE 841-2009 Fig B.1 – Motor Data Sheet, then the spec better match the data sheet.

Data Sheets

The normal order of technical refinement goes something like this.

1. **Recognized IEEE, NEMA, API, etc., standards**
2. **The equipment specification based on #1 above and, if using a narrative style, includes statements like, If stated on the data sheets... Or, If listed on the data sheets... Or, If shown on the data sheets...**
3. **The data sheets that have the specifics for #2 above.**

That is why the data sheets are so important and need to be filled out, reviewed, checked etc., before being used.

RECOMMENDATION #1

This is what I'd recommend any engineer to do…

1. **Get a 3-ring binder**
2. **Put equipment names on the tab**
3. **Place copies of like specifications under each tab**
4. **Place manufacturer's cut sheets along with the specs to have a look at the pictures. That way you can see what you are thinking about.**
5. **Do exactly the same on your PC using PDF's and make it all searchable.**

Quiz #2

I am modernizing several sections of a 30 year old facility and adding in two new areas.

What spec's should I use?

1. **Reuse the old spec's everywhere?**
2. **Reuse the old spec's in the old area and new spec's in the dew area?**
3. **Use new spec's everywhere?**
4. **Or… what???**

Do You Need to…

Whenever you write a specification, do you need to be implicit or go for explicit understanding?

What's the difference???

Implicit…

The horizontal bus bars shall be fully sized to carry 100% of the rated current the entire length of the MCC.

Explicit…

The horizontal bus bars shall be fully sized to carry 100% of the rated current the entire length of the MCC. Tapered horizontal bus is not acceptable.

Am I being picky???

Specification Style

Okay, we are going to use a spec, but what style are we going to use? As far as I know there are only two style types.

1. Narrative Style

A narrative specification is one that describes what you want in a paragraph by paragraph description based upon published recognized industrial standards.

2. Exception Style

A exception specification defines supplemental requirements, additions, modifications, or deletions to a published recognized industrial standard.

Spec Anatomy - Narrative

This is one view of an specification anatomy.

1. **General**
   a. Scope
   b. Reference documents
   c. Conflicting requirements
   d. Seller documentation

2. **Design** → **Equipment specific**
   a. General
   b. Etc.,

3. **Fabrication, Inspection & testing**
   a. Fabrication
   b. Inspection and testing
   c. Test reports

4. **Shipment and storage**

Spec Anatomy - Scope

- This Specification provides requirements for design, materials, fabrication, inspection, testing, documentation, and preparation for shipment for the following power transformer(s).
- This specification covers the general requirements of liquid-immersed power transformers above 750 KVA which will be installed in an outdoor area.
- This specification, Purchasing Standard XX-XXX, applicable data sheets and job specifications cover the materials, design, and fabrication requirements for Power Distribution Transformers to be used on the project. These units are rated up to 10 MVA with primaries at or below 15 KV and secondary's at or below 7.2 kV.

Spec Anatomy – Reference's

- **The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.**
  a. **The list follows here.**
- **The transformers shall be designed, engineered, constructed, manufactured, wired, and tested in accordance with the following:**
  a. **The provisions of this specification and attachments**
  b. **The current edition of the following standards and code insofar as they apply: NEMA, IEEE, ANSI NEC**
- **This unit shall be manufactured in accordance with the requirements of the NEC, IEEE, NEMA, ANSI, NESC; latest editions as of the date of the order or as herein specified.**

Spec Anatomy – Conflict

- **The order of precedence (high to low) of the codes and standards quoted in this specification shall be:**

  1. **Purchase order**
  2. **Requisition**
  3. **Data sheets**
  4. **This specification**
  5. **Referenced national and international codes.**

- **Any conflict between the requirements of this specification and related codes, standards, data sheets, drawings, requisition, etc., shall be brought to the Purchasers attention for written clarification /resolution.**

Spec Anatomy – Seller Doc'

Sellers documentation requirements are usually broken down in to three sections:

1. **Information to be supplied with quotation**
2. **Information to be submitted for approval after receipt of order**
3. **Certified information to be supplied**

The above three sections are usually listed on a matrix with dates against the various items required under each section.

Spec Anatomy – Shipment

- **Preparation for Shipment shall be in accordance with manufacturer's standards, unless otherwise noted on the Request for Quotation and Purchase Order.**
- **Preparation for Shipment shall be in accordance with Seller's standard, unless otherwise noted on the Request for Quotation and Purchase Order. The Seller shall be solely responsible for the adequacy of the Preparation for Shipment provisions employed with respect to materials and their application, to insure delivery of materials to their destination in ex-works condition when handled by commercial carriers.**
- **The type of packing to be used must be suitable for all commonly used means of transportation from manufacturer's location to the installation site.**

Where is ex-works defined?

Spec Anatomy – Shipment

Do I need the following…

1. **GPS tracking impact recorders on xfmr**
2. **Rider to go with xfmr to make sure it does not get lost**
3. **O2 blanket, not H2 in xfmr**
4. **Fungal treatment**
5. **Moisture absorbing bags inside**
6. **Air conditioned shipping**
7. **Export packaging**
8. **Container or pallet shipping**
9. **Certified drawings & IOM with equipment**
10. **Touch-up paint with equipment**
11. **PCR split for shipment. Does site know what is coming and when?**
12. **Rubber mats rolled up inside PCR**
13. **Paper or plywood floor covering in PCR**
14. **PCR spreader bars**

Spec Anatomy – Storage

‘Storage of items’ refers to the time after the item has been received on site and before installation. What, if any, are the storage requirements? Usually poorly addressed in specs.

1. **In an dry, air conditioned location.**
2. **With space heaters powered up.**
3. **Outdoors, on pallets and out of the mud.**
4. **Rotate shaft seven times every seven days.**
5. **Packing slip on all four sides.**
6. **Clearly marked “this way up” with arrow.**
7. **Both ends of cable brought out for testing.**
8. **If over 6 months then do …**

Spec Anatomy – Another One

1. Scope
2. Seller responsibility
3. Regulations
   a. Codes
   b. Standards
4. Design
   a. Main stuff goes here…
   b. More stuff in here…
5. Nameplate requirements
6. Inspection and Testing
7. Painting
8. Seller Documentation
   a. Information supplied with quotation
   b. Information submitted for approval ARO
   c. Final or certified information

Spec Anatomy – Another One

1. General
   a. Scope
   b. Codes, stds & buyer docs
   c. Quotations
   d. Bidder drawings & data
2. Technical Requirements
   a. General
   b. Enclosure & cubicle design
   c. Incoming line section
   d. Transforming section
   e. Outgoing section
   f. Bus duct
   g. Relaying, metering & control accessories
      i. Grounding resistor
      ii. Cooling fans
3. Testing and Inspections
   a. General
   b. Mechanical tests
   c. Electrical tests
   d. Reports of test results
4. Tagging and Shipment
   a. Tagging
   b. Packaging and crating
   c. Special instructions for marine shipments

Spec Anatomy – ISO

ISO 9001-2000 uses the term "normative" in it. As in…

"The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard."

Does it really matter?

Which can be rewritten into…

"The following normative documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies."

Basically speaking, the term "normative references" is an European term creeping across the Atlantic.

Normative = prescriptive = how to comply

Informative = descriptive = help with conceptual understanding

Narrative Style

To each electrical item there is usually an underlying recognized standard. For example, for small motors most Petro/Chem companies use IEEE 841 – IEEE Standard for Petroleum and Chemical Industry – Premium-Efficiency, Severe-Duty, TEFC Squirrel Cage Induction Motors – Up to and including 370kV (500HP).

Since we are talking about NEMA size motors, and the standard is only 20 pages, this is an excellent candidate for an Narrative Style specification.

Specs\Mogul Motor.pdf
Specs\ELSMT01.pdf
Specs\ELSMT01D.pdf
Specs\IEEEStd841_DataSheet.pdf
L10 Bearing Life.pdf

This PIP data sheet is dated 2012 while the PIP data sheet in IEEE Std 841-2009 is different.

Narrative Format

Okay, we are going to use a spec, but what narrative format are we going to use? There are several available for use.

1. **CSI Masterformat (The government and people doing business with the government)**
2. **Internal -proprietary- Standards (Owners & Contractors)**
3. **PIP Standards (Owners & Contractors)**
4. **Manufacturer's specification**
5. **Commercially available specification**
6. **Bespoke specification (Usually done for highly specialized or unique items like a water cooled transformer for an FPSO.)**

CSI Masterformat

Okay, lets have a closer look at CSI Masterformat.

1. **What is CSI Masterformat?**
   Masterformat\SectionFormat.pdf
   Masterformat\PageFormat.pdf

Pro's and con's of CSI Masterformat.

1. **Loads of companies, the Fed's and vendors, use it**
2. **Estimating tools in Masterformat**
3. **Everything has a numbered place. If not, make one.**
4. **Easy to follow, systematic, no hiding places**
5. **Rigid in format**
6. **Not used by Petro/Chem**

CSI Masterformat

Examples of Masterformat are as follows. Looking at MV Swgr under 26 13 13.

1. http://www.geindustrial.com/your-business/consulting-design-engineer/2004-csi-master-format
2. http://products.schneider-electric.us/technical-library/?event=type.list&docType=sqd_csi_spec
3. http://www.eaton.com/Eaton/ProductsServices/Electrical/YourBusiness/ConsultantsandEngineers/ProductSpecificationGuide/index.htm?sfield=dDocTitle&sorder=Desc&pagenum=1
4. **Not Powell Industries**

Internal Company Standards

Internal company standards fall under two types

1. EPC companies
2. End users.

They are not the same: why?

1. The EPC company is looking for the bottom dollar that does the job. No fluff or padding as that costs time and money and may lose the bid.
2. The End User is looking to avoid previous pitfalls/goof-ups as well as a low CapEx and OpEx.

At the end of the day, the EPC company tosses the keys and walks away. The End User has to live with it for the next 30+ years.

EPC Company Spec's

In the good old days all EPC companies had their own spec's. The spec's usually were written around the particular segment of the market the EPC company operated in.

Companies that operated in the small end of the market had thin spec's as their projects were generally small and not complex.

Companies that operated in the large end of the market had fatter (more developed) spec's as equipment and risk were larger.

Today, things have changed.

End User Spec's

Most End Users have their own spec's that have evolved over the years. The reason for developing own specs is to capture lessons learned and design for their specific situation.

For example, buying a 480V, 3ph, 60Hz, 10HP motor for Alaska is not the same as buying the same motor for Oman. Yes, it is still a motor but they are worlds apart in many respects.

Some End User's have blue commentary text inside the spec to give guidance to the nuances embedded in the spec.

Some End User's have complete commentary/guidance documents separate from the spec's to provide detailed understanding of how and why the End User does things.

End User Spec's

However, writing specs, creating data sheets, making QA/QC sheets, etc., all cost money.

If you are an International Oil Company (IOC), then there is North America specs and IEC specs to worry about.

Is it worth the time, effort, manpower, organization to have employees on specification committees?

Is it worth the time, effort, manpower, organization to do internal company specifications and keep them up-to-date?

Saudi Aramco Presentation.ppt

PIP

The Process Industry Practices (PIP) is a self-funded consortium of process industry companies that publishes common industry practices for projects and maintenance work. PIP develops "Practices" that are a compilation of company engineering standards from many engineering disciplines. While PIP is an initiative of the Construction Industry Institute (CII), related industries such as power, pulp & paper, and pharmaceuticals find the PIP harmonization process and published practices to be of value in their industries.

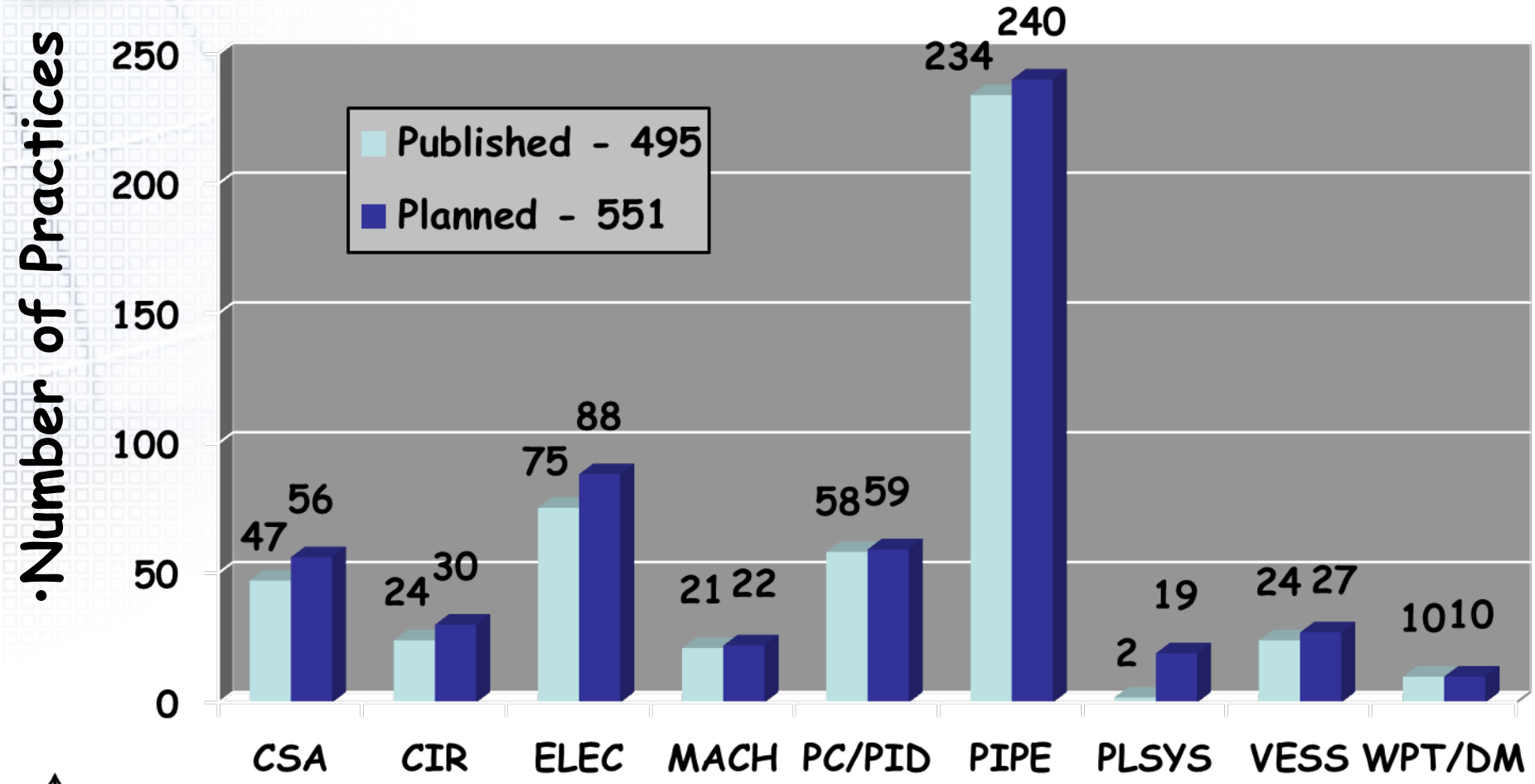
Think 'consensus'.

Found under http://www.pip.org/

PIP_001.ppt

PIP Practices by Discipline

January 15, 2014



Manufacturer's Spec's

Most good manufacturer's will have a typical spec somewhere. If they are good, as we have seen, the spec's will be readily available on the Internet and in a decent format.

TEFCSpec - Baldor.pdf

Commercial Spec's

I have never used commercially available spec's even thought they are out there.

While out there on the Internet I did come across City of LA and their spec web site.

Specs\16800 Electric Motors.pdf

Bespoke Spec's

I have never been in a position to need a bespoke spec. I would guess cutting edge or trying something unusually new would require the EE to delve into this area.

Spec Anatomy - Exception

This is one view of an exception anatomy.

1. **General**
   a. Scope
   b. Reference documents
   c. Conflicting requirements
   d. Bids
   e. Drawings and data
2. **Modifications to Industry Standard**
3. **Fabrication, Inspection & testing**
   a. Fabrication
   b. Inspection and testing
   c. Test reports
4. **Shipment and storage**

Exception Style

To each electrical item there is usually an underlying recognized standard. For example, for small motors most Petro/Chem companies use IEEE 841 – IEEE Standard for Petroleum and Chemical Industry – Premium-Efficiency, Severe-Duty, TEFC Squirrel Cage Induction Motors – Up to and including 370kV (500HP).

Since we are talking about NEMA size motors, and the standard is only 20 pages, this is an excellent candidate for an Exception Style specification.

Specs\Mogul IEEE 841 Motor.pdf

Which *Style* is Best?

We have looked at two spec styles, the Narrative and the Exception style. The question is, which style is best?

The answer is, it depends.

From what I can tell, most spec's are narrative. We seem to like, or prefer, this way. Maybe because revisions are not needed every time one of the underlying standards are changed.

However, if the underlying standard is robust enough, then the exception style could be used. However, updates shall be required every time the underlying standard is modified or ammended.

I've seen IEEE 841 motors and IEEE C57.12.01, 10, 20 & 34 for xfmrs.

Which *Style* is Best, Cont.

Exception style

- Forces you to look, read and understand the underlying standard(s) while the narrative style does not
- Not that simple to include purchaser specific requirements.
- Shall have underlying std open while reading spec

Narrative style

- Only references the underlying standards , it does not force you to read them
- Easier to include purchaser specific requirements
- Underlying stds can stay on the shelf

Moving on to QA & QC

QA & QC

Going to look at QA & QC because at the beginning I referenced Paul Owen who said, Equipment Selection entails... *Interpret and specify electrical equipment, including QA/QC*.

So... what is QA & QC?

Quality Assurance (QA) is process oriented and focuses on defect prevention.

Quality Control (QC) is product oriented and focuses on defect identification.

QA & QC

In the scheme of things, low cost items generally have a low QA & QC requirement while high cost items generally have a high QA & QC requirement.

Generally speaking, low cost items are quickly replicable while high cost items take more time to replace. In this case TIME = MONEY.

Generally speaking the entire QA & QC process helps eliminate defects so that the work can continue on schedule and on cost. So QA & QC is an integral part of the purchasing process.

Limit vendor list to three vendors you know and trust.

What's the difference between QA & QC???

QA & QC Comparison #1

Comparison	Quality Assurance	Quality Control
Definition	QA is a set of activities for ensuring quality in the processes by which products are developed.	QC is a set of activities for ensuring quality in products. The activities focus on identifying defects in the actual products produced.
Focus on	QA aims to prevent defects with a focus on the process used to make the product. It is a proactive quality process.	QC aims to identify (and correct) defects in the finished product. Quality control, therefore, is a reactive process.
Goal	The goal of QA is to improve development and test processes so that defects do not arise when the product is being developed.	The goal of QC is to identify defects after a product is developed and before it's released.

Think Dr. Deming and his TQM.
(Total Quality Management)

QA & QC Comparison #2

How	Establish a good quality management system and the assessment of its adequacy. Periodic conformance audits of the operations of the system.	Finding & eliminating sources of quality problems through tools & equipment so that customer's requirements are continually met.
What	Prevention of quality problems through planned and systematic activities including documentation.	The activities or techniques used to achieve and maintain the product quality, process and service.
Responsibility	Everyone on the team involved in developing the product is responsible for quality assurance.	Quality control is usually the responsibility of a specific team that tests the product for defects.

QA & QC Comparison #3

Example	Verification is an example of QA	Factory acceptance testing (FAT) is an example of QC
Dr Deming and his TQM	Statistical Tools & Techniques can be applied in both QA & QC. When they are applied to processes (process inputs & operational parameters), they are called Statistical Process Control (SPC); & it becomes the part of QA.	When statistical tools & techniques are applied to finished products (process outputs), they are called as Statistical Quality Control (SQC) & comes under QC.
Statistical Techniques		
As a tool	QA is a managerial tool	QC is a corrective tool

QA & QC How???

Quality Assurance (QA)

1. **API Specification Q1 – Specification for Quality Programs for the Petroleum, Petrochemical and Natural Gas Industry**
2. **ISO 9001 – Quality Management Systems Requirement**

Quality Control (QC)

1. **Requirements spelled out in the spec.**

QA & QC What???

Quality Assurance (QA)

1. **Review program during bid review.**
2. **Site visit to review actual tools, reporting methodology and document control. Especially if you have never used the company before or in some podunk location. Actually this should have been done a long time ago to get on the AVL.**
3. **What you see today might not be the same tomorrow.**

Quality Control (QC)

1. **Commodity items – No.**
2. **Engineered items – Yes… as needed. QC a NEMA frame 10 HP motor… probably minimal. QC a 10,000 HP motor… definitely higher number of requirements.**

QA & QC When???

Quality Assurance (QA)

1. **Before award of bid.**

Quality Control (QC)

1. **Have the list of applicable tests in the spec.**
2. **Create as needed set points during manufacture and construction.**
3. **Witness applicable testing.**

QA & QC Whom???

Quality Assurance (QA)

1. **Not something an EE normally does. Best get in someone who does this for a living.**
2. **Normally handled by the purchasing group.**

Quality Control (QC)

1. **On commodity and low cost items, a generic list should already be generated and in the spec.**
2. **On higher cost generic items a higher quality generic list could be used.**
3. **On specialized systems, such as ENMCS, a highly detailed list of requirements shall be in the spec.**

More on QA & QC

The RFP should contain two QA key items.

1. **A request for a copy of the Bidders Quality Assurance (QA) program requirements**
2. **A document containing the Purchasers Quality Surveillance (QS) plan. The QS is to keep an eye on the Bidders QA plan. The QS plan could be split into four levels as in…**
    a. **None**
    b. **Final inspection prior to shipment**
    c. **Limited scope of QS**
    d. **Full scope of QS**
    e. **Resident inspector**

On more complex items the RFP should contain a document listing all the post QC FAT activities.

It Failed the QC !!!

What are you going to do if the QC reveals the item is not going to meet nameplate requirements?

First, congratulations! The QC did it's job of revealing there is a flaw in the design. It also means QA failed to do its job in stopping the flaw in the first place –think Swiss cheese.

Second, the manufacturer will have to discover if the flaw is recoverable or not.

Third, everything transitions from a technical issue over to a commercial issue. Now the commercial boys take over and start going through the T's & C's of the contract. That is why the T's & C's are such an integral part of the overall RFP.

Factory Acceptance Test (FAT)

After QC and before shipping there is the factory acceptance testing (FAT).

In engineering and its various sub-disciplines, FAT is a test conducted to determine if the requirements of a specification or contract are met. It may involve chemical tests, physical tests, or performance tests.

Testing generally involves running a suite of tests on the completed system. Each individual test, known as a case, exercises a particular operating condition of the user's environment or feature of the system, and will result in a pass or fail outcome. The test environment is usually designed to be identical, or as close as possible, to the anticipated user's environment, including extremes of such.

QC & FAT

Once item is complete, it is time to turn on, power up, and check it out.

1. **Bidder's QC should have eliminated initial out-of -the-box issues and infant mortality failures.**
2. **The Bidder better have had a good look at the equipment prior to the Purchaser FAT. Don't want to waste my time!**
3. **Purchaser FAT should be a perfunctory run through with all issues already resolved.**

Why?

Cheaper to resolve issues in the factory, before shipping; not in the field, during construction.

SAT

If equipment is not ready, complete, or other issues arise, then a FAT might not be feasible. The alternative to the FAT is the Site Acceptance Testing (SAT).

Same type of testing at FAT only now carried out at the site.

The End.

Thank you for your attention and

are there any questions?