API 541 5th Edition – Understanding the Changes and Updates to one of the Petroleum Industry’s Premier Specifications

Bart Sauer - Siemens Industry, Inc. Norwood Motor Plant
Mark Chisholm – Siemens Industry, Inc.
American Petroleum Institute – 541 History

- RP 541 introduced in 1972
- 541 2nd Edition introduced in 1987
- 541 3rd Edition introduced in 1995
- 541 4th Edition released June 2004

- End User Driven Specification, with representation by Motor Suppliers.
API 541 5th - Timing / Process of Revision

- Working group assembled April 2008
  - End users, Consultants ... and motor OEMs
- Open discussions on suggested improvements
  - Incorporate API 546 revisions as appropriate
  - Sub-groups to discuss/recommend broader changes
- Ballot (second) approval May 2011
- Print proof reviewed in July 2012
- Published December 2014
Why Use API 541?

- Standard specification that provides customized product
  - Creates motor definition
  - Dictates proposal preparation
  - Simplifies proposal evaluation
  - Provides for a reliable machine

- Utilizes comprehensive data sheets
  - Important to everyone involved from manufacturer to user
API 541 5th Edition - Scope

This standard covers the minimum requirements for special purpose form-wound squirrel-cage induction motors 375 kW (500 Horsepower) and larger for use in petroleum, chemical and other industry applications.

Note 1: Special purpose machines typically have one or more of the following characteristics:

1. Is in an application for which the equipment is designed for uninterrupted, continuous operation in critical service, and for which there is usually no installed spare equipment.

2. Is larger than 2250 kW (3000 hp) for speeds 1800 RPM and below.

3. Is rated 600 kW (800 hp) or greater for two-pole (3000 or 3600-RPM) machines of totally-enclosed construction, or rated 930 kW (1250 hp) or greater for two-pole machines of open or guarded construction (including machines with WP-I or WP-II type enclosures).

4. Drives a high-inertia load (in excess of the load WK2 listed in NEMA MG 1 Part 20).

5. Uses an adjustable speed drive as a source of power.

6. Is an induction generator.

7. Is a vertical machine rated 375 kW (500 hp) or greater.

8. Operates in abnormally hostile environments.
Baseline.....

API 541 4th Edition – Standard Motor Features – Basic Design

- Class B temperature rise at 1.0 SF by RTD (2.3.1)

<table>
<thead>
<tr>
<th>HP</th>
<th>Voltage</th>
<th>Method of Determination</th>
<th>A</th>
<th>B</th>
<th>F</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP &lt; ∞</td>
<td>V &lt; ∞</td>
<td>RESistance</td>
<td>60</td>
<td>80</td>
<td>105</td>
<td>125</td>
</tr>
<tr>
<td>HP ≤ 1500</td>
<td>V &lt; ∞</td>
<td>DETector</td>
<td>70</td>
<td>90</td>
<td>115</td>
<td>140</td>
</tr>
<tr>
<td>HP &gt; 1500</td>
<td>V ≤ 7000</td>
<td>DETector</td>
<td>65</td>
<td>85</td>
<td>110</td>
<td>135</td>
</tr>
<tr>
<td>HP &gt; 1500</td>
<td>V &gt; 7000</td>
<td>DETector</td>
<td>60</td>
<td>80</td>
<td>105</td>
<td>125</td>
</tr>
</tbody>
</table>

- Maximum sound pressure level = 85 dB(A) @ 3 feet (2.1.3)

- Suitable for 80% voltage starting
- Special starting duty: 2 Hot / 3 Cold Starts, Minimum Safe Stall Time criteria: the greater of 150%, or 5 sec more than acceleration time.
- Inrush current <= 650% of full-load current

- C-5 stator lamination core plate
- Both ends of each stator-phase winding brought out to main box (1000 hp & +)
Baseline.....

API 541 4th Edition – Standard Motor Features – Basic Design

- Metal fan-covers
- WPII - stainless steel filters & provisions for differential pressure switch
- Stainless steel hardware (up to \( \frac{1}{2} \)"
- Specific mounting surface dimension tolerances

- Heat-treated forged shafts (A4000 Series) for:
  - Motors with finished shaft diameter \( \geq 8 \) inches
  - 2-pole motors \( \geq 1000 \) hp
  - Motor operating above first critical speed
  - Reciprocating loads and motors using tapered hydraulic-fit couplings
API 541 4th Edition – Standard Motor Features

- Specific TEWAC and Vertical Motor design criteria.

- Split-sleeve, ring-oil lubricated bearings (horizontal units)
  - Bearing temperatures not to exceed 93°C at rated output
  - Provisions for shaft displacement probes (motors operating >= 1200 rpm)

- Both bearings insulated

- 3-Wire, 100 Ohm Stator RTD’s (2/Phase)
- Flanged Forced/Flood Lube Provisions (when applicable)

- Shaft material certificate
- Foundation loading data on GA drawing

Sleeve Bearing w/ Insulation
API 541 4th Edition –Standard Motor Features

- **Copper rotors** (Aluminum allowable if approved by purchaser) with Phosphorous-free braze material (Cu bar rotors)
- Special rotor balance procedures (Step Balance 2 & 4-poles)
- 1.5 mils (0.0015”) p-p shaft displacement vibration limit (unfiltered)
- 0.1 IPS (inches/sec) vibration limit on bearing housing
- 0.6 mil (max), cold-to-hot magnitude resultant vector change (1x) vibration criteria (4.3.3.11).
Aluminum Die Cast Rotors

- Shaft
- Laminated steel core
- Rotor bars/short circuit rings
- Air duct
- Internal fan
- External fan
Copper Bar Rotor

- Shaft
- Laminated steel core
- Copper rotor bars
- Copper short circuit rings
- High tensile retaining rings
- Internal fans
API 541 4th Edition – Form-wound Squirrel Cage Induction Motors

- **Routine Testing**
  - Coil Surge comparison tests
  - Soft-foot check must be made prior to any mechanical running test
  - High-potential test
  - Polarization index
  - No-load bearing run + bearing temperature rise
  - Bearing inspection (sleeve bearings)
  - Vibration test
API 541 5th - Notable Changes

- Service life and Service Factor
- Insulation temperature limits
- Enclosures
- Accessories
- Shaft forgings
- Thermal capacity data
- Magnetic stator slot wedges
- Main terminal box features

- ASD design requirements
- Testing
- Data sheet & guide
API 541 5TH Edition – Basic Design

- Minimum service life / years of un-interrupted operation now required to be 25 / 5 years
  - Was 20 / 3 years (4.1.1)

- Machines **shall** have a 1.0 service factor
  - Stronger, clear wording (1.15 SF undesirable) (4.2.1.4)
  - Must address temperature rise if customer requires 1.15 SF.

➢ *If overload capacity is required, a higher nominal motor rating shall be selected*
➢ *Avoids operating motors above rated power, which increases winding temperatures and shortens motor life*
Meet class B temperature rise by resistance **AND** by RTD (4.3.1.1.b).

<table>
<thead>
<tr>
<th>HP</th>
<th>Voltage</th>
<th>Method of Determination</th>
<th>A</th>
<th>B</th>
<th>F</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP &lt; (\infty)</td>
<td>V &lt; (\infty)</td>
<td>RESistance</td>
<td>60</td>
<td>80</td>
<td>105</td>
<td>125</td>
</tr>
<tr>
<td>HP (\leq) 1500</td>
<td>V &lt; (\infty)</td>
<td>DETector</td>
<td>70</td>
<td>90</td>
<td>115</td>
<td>140</td>
</tr>
<tr>
<td>HP &gt; 1500</td>
<td>V (\leq) 7000</td>
<td>DETector</td>
<td>65</td>
<td>85</td>
<td>110</td>
<td>135</td>
</tr>
<tr>
<td>HP &gt; 1500</td>
<td>V &gt; 7000</td>
<td>DETector</td>
<td>60</td>
<td>80</td>
<td>105</td>
<td>125</td>
</tr>
</tbody>
</table>

- RTDs measure “hot spot” temperature
- RTDs inserted between coils in the slots
- Average temperature determined by change of winding resistance
- Permitted hot spot rises are 0 to 10°C above average rises
- Occasionally average exceeds hot spot meaning hot spot is not the worst case
- Now required to meet the limits by both methods
- Ensures temperature limits are met throughout windings
API 541 5TH Edition – Enclosure Changes

- **Totally enclosed motors required at 6kV and up** (4.4.1.1.f)
  - For example, TEFC, TEAAC or TEWAC
  - Default requirement
    - Free to specify open enclosure if good experience at site
    - Data sheet field added to give user place to waive this in favor of WP-II
  - Minimizes airborne contaminants
    - Reduced risk of electrical tracking
    - Reduced risk of early winding failure

- **TEWAC motors** are required to include a flow-sensing device and air RTD's (into and out of cooler) now as standard (4.4.1.2.4)
API 541 5TH Edition – Accessory Changes

- **New auxiliary terminal box design criteria:**
  - 316 SS required for Offshore and Marine duty (5.1.4.1)
  - Breather/Drain required (5.1.4.1)
  - Flexible conduit length is not to exceed 0.9 meters (5.1.12)
  - Customer conduit and cable entrances to be in bottom or sides only (5.1.13)

- **Bearing RTD’s** are now required as standard on motors with hydrodynamic radial and thrust bearings (5.3.1)
  - 100 Ohm RTD unless otherwise specified on the motor data sheet.
(3) Stator RTD’s per phase (5.2.1.2)
   - 2 per phase was former standard.

Revised Space Heaters Criteria (5.4.1-3)
   - T3 temp code, not to exceed 160°C lower
     (Space heaters remain a “when specified” option).
4.4.5.1.3 Heat-treated forged steel shafts shall be used for machines having any of the following characteristics:

- a) finished shaft diameter 200 mm (8 in.) and larger;
- b) two pole machine;
- c) operation above the first lateral critical speed;
- d) driving a reciprocating load; or
- e) using a tapered hydraulic fit coupling.

Hot-rolled shafts may be used for all other machines if the vendor can demonstrate a minimum of two years successful operating experience with the design in that application.

4.4.5.1.4 When specified, the shaft and spider shall be machined from a one-piece heat-treated forging.

4.4.5.1.5 Heat-treated forged steel shafts shall be AISI 4000 series and comply with ASTM A668 or equivalent in EN 10250.

- **ALL 2 pole motors (4.4.5.1.3.b)**
  - Was 1000 hp & larger (4th)
  - All 2-poles (3rd)
Thermal Capacity Data

- Supplier now required to provide thermal capacity data, including:
  - Thermal limit curves
  - Acceleration curves
  - Required stop/running cool times after max starts

  ➢ Useful for programming motor protection relays
New

Magnetic Stator Slot Wedges (4.3.10)

- Not previously been addressed
- Used by many vendors and can improve performance but some have durability issues
- Requirements –
  - Rigid and VPI’d in place, amorphous or composite construction, 10 year track record, 630 mm shaft height limitation
- Advise use on proposal data sheet
API 541 5TH Edition - Main Terminal Box Features

- NEMA Type II T-box with bus bar on standoffs now standard. (5.1.1)
  - Large box - may require support
  - Standoff insulators shall be either porcelain or cycloaliphatic resin material (not glastic).

- Optional Surge Capacitors now must be three separate single phase caps, vs. common “three-phase” single assembly surge cap (5.6.2.1)
  - “3-ph” version shown, is common

- Default requirement now for fault withstand capability / rupture disc in main t-box (5.1.2), it was optional
Many new requirements and notes throughout the standard created for ASD applications and for purchaser information/review of application

- When specified, mutually agreed sound level on ASD (4.1.4)
- When specified, mutually agreed over-speed capability (4.1.5)
- Mutually agreed upon voltage and frequency ratings (4.2.1.2.3)
- Starting & Running, new note for ASD starting (4.2.3.3)
- Supply from ASD only, starting characteristics can differ from ACL requirements (4.2.4.5)
  - Note: Rotor and Stator temps
  - Note: Torsional oscillations from drive harmonics
  - Note: Damage due to improper application
- Purchaser to advise significant ASD harmonic content (4.3.1.2)
- Purchaser to advise ASD voltage spikes (4.3.1.2.1)
- Purchaser to advise ASD common mode voltage (4.3.1.2.2)
- Mutually agree on strategy to avoid structure resonances (4.4.2.1.1)
- Well damped rotor natural frequency if within speed range (4.4.6.1.2)
Motor Power Source: **Sine Wave Power**

Adjustable Speed Drive (ASD) Conditions, if applicable (4.1.4; 4.1.5; 4.2.1.2.3, 4.3.1.2):

- ASD only operation (4.2.4.5)
- ASD+DOL Start capability
- ASD only w-Bypass

Variable Torque Speed Range: Min Speed ___________ RPM ___________

Constant Torque Speed Range: Min Speed ___________ RPM

Constant Power Speed Range: Max Speed ___________ RPM ___________

ASD Description and Information affecting motor design (Obtain from ASD Supplier; refer to Data Sheet Guide):

ASD type / topology: ____________________________

ASD Output Harmonics, describe and/or attach data (4.3.1.2): ______________

ASD Maximum Voltage Spike Amplitude and Rise-Time at drive output (4.3.1.2.1): ______________

ASD Maximum Common Mode Voltage (CMV) at drive output (4.3.1.2.2): ______________

Other ASD information / motor requirements:

- Abrasive Dust Protection, Open Enclosures (4.4.1.2.a):
- Corrosive Agents in Environment, re: stress corrosion cracking (4.4.10.1.2):
New

API 541 5TH Edition – Testing Changes

- Main T-Box requested to be mounted during performance testing (6.3.1.3)

- New Optional TEWAC Heat Exchanger Performance Test (6.3.5.5)
  - Test verifies performance during factory load testing
  - Verify flow and temperatures per specification

- New Optional Overspeed Test (6.3.5.6)
  - Test shall be run for two minutes at the overspeed listed in NEMA MG 1, Part 20; IEC 60034-1; or to the specified trip speed (including overshoot) of the connected equipment (whichever is greater).
Optional tests to verify coil integrity and VPI process
(Two extra coils VPI’d with stator)

- Impulse test
  - Ground wall
    - 5 PU, 1.2 µs
  - Turn-to-turn
    - 2.0 & 3.5 PU 0.1 to 0.2 µs
    - Then test to destruction

- Cut coils (3 segments) and examine

- Coils that use semi-conductive coating in the slot section shall be subjected to a partial discharge test at rated line-to-neutral AC voltage.
New option. 6kV & Higher

- an off-line partial discharge test shall be performed on the stator windings, in accordance with Clause 10.2 of IEEE 1434 or IEC TS 60034-27.
- Test voltage shall be 120% of the rated phase-to-neutral voltage, maintained for at least five minutes.
- The vendor shall provide the purchaser with partial discharge test data of similar machines with the same insulation system for comparison. The acceptance criteria shall be mutually agreed upon between the vendor and purchaser prior to performing the tests.
New

API 541 5TH Edition – Mount ½ Coupling (6.3.1.5)

- Vibration check test now required when ½ coupling hub is mounted by motor manufacturer
API 541 5TH Edition – Unbalanced Response Test (6.3.5.3)

- Mass moment simulator included during testing (option before)
- Vibration levels reduced, e.g. -
  - 3600rpm: 2.25 mils from 2.74 mils
  - 1800rpm: 2.25 mils from 3.87 mils
- First critical speed must match predicted (LCSA) results (within 5%)
  - If not, correct model
DRINK COFFEE
Do Stupid Things Faster with More Energy
Data Sheets completely redesigned

1.1.2 This standard requires the Purchaser to specify details and features. The Purchaser **shall** complete the data sheets in Annex A.
# Changes To Data Sheets

<table>
<thead>
<tr>
<th>API 541 4th Edition</th>
<th>API 541 5th Edition</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 pages</td>
<td>12 pages</td>
</tr>
<tr>
<td>Purchaser responsible for 5 of 6 pages</td>
<td>Purchaser responsible for 7 of 12 pages</td>
</tr>
<tr>
<td>Purchaser data and supplier data interwoven</td>
<td>Separate purchaser and supplier sections</td>
</tr>
<tr>
<td>Multiple color-coded symbols, sections</td>
<td>One color, one symbol</td>
</tr>
<tr>
<td>Covered most 541 content</td>
<td>Covers all 541 content</td>
</tr>
<tr>
<td>Starting and driven equipment data on separate pages</td>
<td>Single page for starting and driven equipment data</td>
</tr>
<tr>
<td>Proposal data mixed throughout 4 pages</td>
<td>Proposal data all on single dedicated page</td>
</tr>
<tr>
<td>Contract data by Supplier mixed throughout 5 pages</td>
<td>All contract data on 4 dedicated pages</td>
</tr>
</tbody>
</table>
Instructions on how to change data sheet symbols to make selections

1) Select (click on) symbol
2) Type listed letter on keyboard
3) Press enter or click onto next item

To change: Use your Keyboard and enter: Description

○ to ● lower case " l " Changes an item from default or not required to an item that is required

● to ○ lower case " m " Changes an item from being required to the default or not required

▲ to ▼ lower case " t " Changes an Inspection or Test from applying to one unit only to applying to ALL machines of a multi-unit order.

▼ to ▲ lower case " v " Changes an Inspection or Test from applying to ALL machines of a multi-unit order to applying to one unit of a multi-unit order.
Motor Power Source: **Sine Wave Power**

Adjustable Speed Drive (ASD) Conditions, if applicable (4.1.4; 4.1.5; 4.2.1.2.3, 4.3.1.2):

- ASD only operation (4.2.4.5)
- ASD+DOL Start capability
- ASD only w-Bypass
- ASD only operation (4.2.4.5)
- ASD+DOL Start capability
- ASD only w-Bypass
- ASD only operation (4.2.4.5)
- ASD+DOL Start capability
- ASD only w-Bypass
- ASD only operation (4.2.4.5)
- ASD+DOL Start capability
- ASD only w-Bypass

Variable Torque Speed Range: Min Speed __________ RPM __________ ft-lb

Constant Torque Speed Range: Min Speed __________ RPM

**Area Classification (4.1.8):**

- Nonclassified
- Classified as: Class _____ Group _____ Division _____ or Zone _____

Temperature code (T-code): __________ Autoignition temperature (AIT): __________ °C

- Other:

ASD Output Harmonics, describe and/or attach data (4.3.1.2):

ASD Maximum Voltage Spike Amplitude and Rise-Time at drive output (4.3.1.2.1):

ASD Maximum Common Mode Voltage (CMV) at drive output (4.3.1.2.2):

Other ASD information / motor requirements:
Enclosure for motors rated 6kV and above: (4.4.1.1,f):

**TEFC, TEAAC, or TEAAC (IP44 or higher)** or

- Use enclosure selected in line 2

**Paint System:** *Supplier's Paint System*

- Purchaser Specified Paint System

**Paint System Specification:**

- Define Paint Color and Code:

**Paint Color:** *Supplier's Paint Color*

- Purchaser Specified Paint Color

**Define Paint Color and Code:**
## BASIC DESIGN - Bearing Lubrication

### Hydrodynamic Bearings

- **Type/Viscosity of oil**: (4.4.8.5; 4.4.8.8; 5.1.4.2) - **Supplier decision**
- Pressurized oil required (4.4.8.4) - **Supplier decision** or Other, define:
- System supplied by (4.4.8.4): **Driven equipment supplier**
- Lube system to comply with API 614 (4.4.8.6): Part 3 General Purpose
- Main oil pump driven by: **Supplier decision**
- Other lube system information:
  - Meet cleanliness requirements of API 614 for 5 GPM & above capacity (6.2.3.2)
  - Purge oil mist (4.4.7.4.1) (describe or attach requirements):

### Antifriction Bearings

- **Grease type**: **Supplier decision**
- Pure oil mist (4.4.7.4.1; 4.4.7.4.5) - **Supplier decision**
- Oil mist ready or Oil mist provisions only (bearing grease removal may be required - see guide)

### Vertical Motor Bearings

- **Thrust bearing**: **Supplier decision**
- Grease lubrication
- Oil Sump lubrication

### Other:

- Notes / Other Requirements:
Frame Space Heaters (5.4.1; 5.4.2; 5.4.3): Sheath Material: Supplier Decision

- Single Voltage Design
  - Operating Voltage
- Dual Voltage Design
  - Operating Voltage

Bearing Heaters (4.4.8.3):
- Operating Voltage

Main Terminal Box Space Heaters required: also see Main Terminal Box section.

Non-contact Shaft Probes (5.8.1):
- Shaft Probes (X-Y) (5.8.1): Provisions required
  - Motors operating at 1200 rpm and higher
    - Two (2) Installed
  - Motors operating at less than 1200 rpm
    - Two (2) Installed

Phase Reference-Probe (5.8.1):
- Provisions
  - Installed

Number per bearing (X-Y) (5.8.2):
- Two (2) Installed
- Four (4) Provisions
- Two (2) Installed
PAGE 5 – MAIN T-BOX REQUIREMENTS, MISCELLANEOUS

- Qty. Special Tools and Lifting Devices (4.1.11, 4.1.12, 4.4.2.14):  
  - Proof of Nonsparking, Corrosion-Resistant Fan (4.4.10.6.1)

- Separate Nameplate with Purchaser's Information - list below (4.4.11.4):  
  - Electronic Vibration Test Data - Define Digital Format below (6.3.3.17)

- Packaging (6.4.1):  
  - Domestic  
  - Export Boxing  
  - Special Shipping Bearings (6.4.1, k)  
  - Outdoor Storage More Than Six Months (6.4.2)

- Proposals (8.1):  
  - Typical Drawings & Literature with Proposal (8.1.8)  
  - Purchaser defined Efficiency Method (8.1.3,f):

- Separate Price For Each Test on Data Sheet (8.1.14)  
  - Packaged Price For All Tests on Data Sheet (8.1.14)

- Provide requirements for Special Weather & Winterizing Protection (8.1.15)  
  - Provide safe stall time calculation method and limits (4.2.4.3)

- Provide Quote for Supervision of Installation and Erection (8.1.17)  
  - Provide Quote for Start-Up Commissioning Service (8.1.17)

- Materials to be identified with ANSI, ASTM, or ASME Numbers (8.1.18):

- Contract Data (8.3):  
  - Special Identification for Transmittals (8.3.2)  
    - Define below or specify where this information is to be found

- Drawings (8.5):  
  - System of Units for Drawings / Data (1.3.1):  
    - U.S. / N.Am. Customary only  
    - SI (Metric) only  
    - U.S. (SI)  
    - SI (U.S.)

- Manufacturer To Supply Curve Data in Tabular Format (8.5.1):  
  - Define preferred Digital Format:

- Quantities of Documents & Drawings, and Documentation Schedule (or define source for this information) (8.5.1):

- After Purchaser Review of Drawings, Quantity of Certified Drawings to be provided (8.5.2):

- Instruction Manuals (8.7):  
  - Quantity of Instruction Manuals to Provide (8.7.1) (Typically supplied in digital format):

- Detailed instructions and photo's, etc. for disassembly and inspection of bearings and seals (8.7.4, c)

- Photos showing machine assembly steps required; including each step of bearing assembly (8.7.5)

- Copies of Applicable Certifications, including NRTL, Material Certifications (including PMI), and other Certifications for the machine(s) (8.7.6)

  - Define any/all Certifications required, including materials:
Load Torque and Inertia Requirements (4.2.2):  

- Per NEMA MG 1-20 or Per specified load curve & data (4.2.2.1,a)

Design Load Curve Condition:  ○ Unloaded (e.g. closed valve or damper)

Motor Starting (4.2.3):  Across-The-Line Starting at 80% of Rated Voltage (4.2.3.1) or

- Other ATL % of rated voltage %
- Other Starting Method (4.2.3.2, a):  ○ Autotransformer ○ Captive Transformer ○ Reactor ○ Solid State Soft Starter ○ ASD

If Soft Starter, define Percent Locked Rotor Current Limit during acceleration:
**ANALYSIS, SHOP INSPECTION, AND TESTS**

- (m) Indicates line item is not required.
- (l) Indicates Purchaser required line item.
- (v) Indicates line item applies to only one machine in a multiple machine application/order.

**Unbalance Response Test (6.3.5.3)** (Purchaser to select one of below options):
- ○ Purchaser to supply Half-Coupling or Mass Moment Simulator required for test.
- ○ Purchaser to provide data for Supplier to obtain Simulator.

---

**Partial Discharge Test for Machines 6kV and Greater (6.3.4.6)** (Purchaser to select one of below options):
- ○ Provided by Supplier.
- ○ Required for all machines.

---

**Notes**

- Rotor Residual Unbalance Verification Test (4.4.6.3)
- Special Surge Test of Coils (6.3.4.2.1)
- Torsional Analysis Data (4.4.6.2.2) Analysis By: [Vendor Name]

---

**Certified Data Prior to Shipment (8.6.2, a)**
- ○ Purchaser to provide data for Supplier to obtain Simulator (Purchaser to select one of below options)

---

**Inspection of Equipment, Piping for Cleanliness before Final Assembly (6.2.3.3)**
- ○ Provided by Supplier.
MOTOR SUPPLIER / MANUFACTURER PROPOSAL DATA

Magnetic Stator Slot Wedges Used (4.3.10):  ○ Yes  ○ No

When Enclosure Pre-Start Purging is specified, vendor defined maximum allowable pressure

Low Ambient Temperature Precautions (4.4.10.4):

Special Winterizing Requirements (8.1.15):

Machine Net Weight (8.1.5): __________________________ lbs.

Special Tools Included in Proposal (4.1.11, 8.1.13):

Machine Proposed is in Strict Compliance with API 541 5th Edition? (8.1.9)
○ Yes  ○ No  ○ List of Applicable Exceptions Attached
PAGES 9-12 – ORDER DATA
Revised

Data Sheet Guide – Annex 6

- Vastly revised vs. 4th edition
- Covers every data element on every line in all of the Purchaser’s pages
- Gives recommendations based on working group experience
  - Could be used as the basis for a tutorial on API 541 and induction machines
How to Optimize the Use of API 541
How To Optimize Use of API 541

- Decide what is needed for the application
- Thoroughly complete the data sheet
- Evaluate manufacturer responses
- Maintain communications
- Test to ensure satisfactory results
- Install correctly
- Startup, operate, monitor and maintain properly
What Is Needed for the Application

- Power, speed and voltage
- Enclosure and cooling method
- Starting requirements
  - Electrical & mechanical
- Site Data
- Accessories
- Factory tests
Complete the Data Sheet

- Include essential information
  - It’s a requirement
- Use data sheet guide
- Equipment environment
- Mechanical system characteristics
- Electrical system characteristics
- Auxiliary systems
Evaluate Manufacturer Responses

- Review proposals in detail
- Ask clarification questions
- Look at alternatives
- Review/discuss any comments & exceptions
- Select the best option
Maintain Communications

- Face-to-face meetings
  - Coordination meeting
    - Verify scope of supply & expectations
  - Design review meeting
    - Finalize and confirm design
- Discuss & resolve issues before they affect the outcome
Test to Ensure Satisfactory Results

- Testing time/cost almost always worthwhile
- Test to suit application requirements
- Reduces risk of site problems
- Issues easier to remedy in factory
- Witness/observe where appropriate
- Consider impacts on the schedule
Install Correctly

- Suitable foundation requirements
- Installation & alignment
- Use OEM personnel when needed
- Review power system and protection
- Preservation prior to start-up
Startup, Operate, Monitor & Maintain

- Confirm start calculations
- Avoid excessive starts
  - There is a limit!
- Availability of spares
  - Commissioning & long term
- Monitor the motor condition
- Maintain per manufacturer’s instructions and user experience
Conclusions

- API 541 5th edition has significant changes
  - Insulation, vibration, protection & testing
- Aimed at improving reliability & durability
- Extensive data sheet and guide enhancements
  - Use the data sheets!
- Available now
Bart Sauer - Bio

- Bart Sauer graduated from Case Western Reserve University (Cleveland, Ohio, USA) in 1989 with a Bachelor of Science degree in Mechanical Engineering. He has been an employee of Siemens Industry, Inc. at the ANEMA motor plant in Norwood, OH, since 1990, serving in roles as a Mechanical Product Engineer, Sales Application Engineer, and his current role as a Market Segment Manager for the oil and gas industry since 2009. In this role he serves as the technical lead for the API 547/541 specifications for Siemens AboveNEMA motors.
- Bart has been an author on three previous IEEE papers, and is a current committee member of the 2018 Cincinnati IEEE-IAS PCIC conference.
- Bart has 3 daughters and has been happily married for 27 years. He is an avid fisherman, a high school Sunday school teacher and a Canadian Olympic hockey team fan.