Introduction to API Specification 2C

6th Edition vs. 7th Edition
Goals of API Spec 2C 7th Edition

- Address gross overload/supply boat entanglement issue

- Incorporate all types of offshore cranes, including:
  - Construction
  - Derrick Barges
  - Pipe Lay Vessels
  - Support Vessels
  - Shipboard Cranes
  - Knuckle Boom Cranes

- Provide design requirements for new crane uses without significantly affecting cranes currently covered by previous editions

- Differentiate between crane designs based on intensity or frequency of use
Significant Changes from 6th Edition

• Gross overload / supply boat entanglement

• Duty cycle consideration (frequency / intensity of use)

• Wire rope design factors

• Structural design factors
Background

- API Spec 2C 6th Edition and European standard EN 13852-1 and -2 both published 2004 addressing offshore crane sizing and safety requirements

- **API Spec 2C 6th Edition**
  - Focused on cranes for oil production and drilling facilities
  - Safety based on structural design and integrity
  - Increased safety factors are emphasized above instrumentation / gadgets as a means of providing safe cranes

- **EN 13852**
  - Covers cranes for all offshore applications
  - Safety focused on instrumentation / gadgets instead of increased safety factors
  - Main requirement is an Automatic Overload Protection System (AOPS) that takes control away from the operator and releases the brakes while over the supply boat
Background

- API Spec 2C 7th Edition drafted to incorporate additional crane uses, expanding on previous versions and maintaining safe operations as governing theme
  - Designed as a superior international standard for offshore cranes based on more realistic criteria and more definitive guidance
### Gross Overload Conditions / Failure Mode Assessment

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Did not specifically address Gross overload conditions</td>
<td>Addresses gross overload using failure mode assessment</td>
</tr>
<tr>
<td>Failure mode calculations only required upon request of purchaser</td>
<td>Requires failure mode results to be provided to the customer</td>
</tr>
<tr>
<td>Protects the crane operator in the event of an unbounded gross overload (supply boat entanglement)</td>
<td></td>
</tr>
<tr>
<td>If failure mode cannot be met, gross overload protection system (GOPS) required to assure that structure holding the operator does not fail in the event of a gross overload</td>
<td></td>
</tr>
<tr>
<td>No AOPS required</td>
<td></td>
</tr>
</tbody>
</table>

*All information provided is for educational purposes only and should not be used for legal or professional guidance.*
Supply Boat Entanglement Causing Gross Overload

- Not to be confused with exceeding the SWL of the crane
### Gross Overload Conditions
(From Supply Boat Entanglement)

<table>
<thead>
<tr>
<th>EN 13852</th>
<th>API 7th Edition</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Seems to consider supply boat entanglement to be a common event</td>
<td>• Considers supply boat entanglement an extremely rare but serious event with special attention required</td>
</tr>
<tr>
<td>• Damage to equipment unacceptable in catastrophic events</td>
<td>• Equipment damage considered acceptable in this rare catastrophic event</td>
</tr>
<tr>
<td>• Accomplished through Automatic Overload Protection System (AOPS) which senses an overload and releases the load</td>
<td>• Accomplished through failure mode assessment showing structure holding operator’s cabin will not be first to fail in any condition</td>
</tr>
<tr>
<td>• AOPS creates increased risk of malfunction and dropped loads</td>
<td>• Considers hazards created by AOPS to be worse than the potential benefits</td>
</tr>
</tbody>
</table>
Pitfalls of AOPS

• AOPS requirements over emphasize protection of replaceable components/machinery to the extent of creating additional hazards to personnel.

• Examples of additional personnel hazards
  – Holds loads over supply boat personnel with brakes intentionally disabled
  – Loads supported only by retention or containment of hydraulic oil pressure
  – Can and have inadvertently dropped loads on supply boat
  – Complexity of components adds to number of parts that must be maintained, inspected, and tested
  – Numerous components increase likelihood of failure
  – Creates a false sense of security
Example of Failure Assessment
(From Supply Boat Entanglement)
Example of Failure Assessment
(From Supply Boat Entanglement)
Example of Supply Boat Entanglement

- Crane on semi-submersible subjected to event while handling anchors
- Instantaneous overload in excess of 200% SWL
- Wire rope pulled off the hoist drum, hydraulic motor destroyed due to overspeed
- *No personnel injuries*
- Crane returned to service following replacement of wire rope and hydraulic motor
- Outcome acceptable under API 7th Edition but not EN 13852
## Structural Fatigue

### API 6th Edition

- Structural fatigue requirement is 25,000 cycles at 133% of max SWL
- Crane structures expected to last 30-40 years

*EN 13852 and ISO assume machinery and structures have same useful life*

### API 7th Edition

- Structural fatigue requirement is 1,000,000 cycles at 50% onboard SWL
- Equivalent fatigue damage of 6th Edition
- Differentiates between structures and machinery*
- Crane structures expected to last at least 30-40 years
### Machinery and Wire Rope Duty Cycle

**API 6th Edition**
- Did not address duty cycle, only structural fatigue

**API 7th Edition**
- Differentiates between structures and machinery*
- Machinery expected to last 5 years before major overhaul / replacement
- API machinery is replaced or overhauled multiple times before crane structure is retired
- Duty classifications based on actual historical crane usage data

*EN 13852 and ISO assume machinery and structures have same useful life
Duty Classifications Examples

Production Duty

Construction Duty

Intermediate Duty

Drilling Duty
# Crane Duty Classifications

<table>
<thead>
<tr>
<th>Crane Duty Cycle Classification</th>
<th>Typical Annual Operating Hours</th>
<th>Typical Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Duty</td>
<td>200</td>
<td>Offshore cranes on fixed production platforms</td>
</tr>
<tr>
<td>Construction Duty</td>
<td>1000</td>
<td>Offshore cranes on barges or vessels, heavy lift cranes</td>
</tr>
<tr>
<td>Intermediate Duty</td>
<td>2,000</td>
<td>Offshore cranes on fixed or floating platforms with temporary rigs or intermittent periods of intensive use</td>
</tr>
<tr>
<td>Drilling Duty</td>
<td>5,000</td>
<td>Offshore cranes on MODUs or floating production facilities with full-time, heavy-use drilling operations</td>
</tr>
</tbody>
</table>

*Note: Where possible, purchaser specified data used in place of duty classifications*
## Historical Crane Usage Data

<table>
<thead>
<tr>
<th>Year</th>
<th>Usage (Hours)</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling Contractor Data: (based on logs &amp; engine hours)</td>
<td>Average of Jackups-Primary Crane</td>
<td>2340</td>
<td>2656</td>
<td>2550</td>
</tr>
<tr>
<td></td>
<td>Max of Jackups-Primary Crane</td>
<td>6552</td>
<td>6300</td>
<td>6009</td>
</tr>
<tr>
<td></td>
<td>No. of Primary Cranes</td>
<td>19</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Average of Semi/DrillShips-Primary Crane</td>
<td>1746</td>
<td>2208</td>
<td>2325</td>
</tr>
<tr>
<td></td>
<td>Max of Semi/DrillShips-Primary Crane</td>
<td>3120</td>
<td>4868</td>
<td>4416</td>
</tr>
<tr>
<td></td>
<td>No. of Primary Cranes</td>
<td>10</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

| Production Platform Data #1: (based on Engine Hours) | Average of Platform Cranes w/o Drilling | 46 |
| | Max of Platform Cranes w/o Drilling | 312 |
| | No. of Cranes | 33 |

| Production Platform Data #2: (based on Hoist Hour Meters) | Average of Platform Cranes w/o Drilling | 46 |
| | Max of Platform Cranes w/o Drilling | 408 |
| | No. of Cranes | 164 |

<table>
<thead>
<tr>
<th>Floating Production / Drilling Systems:</th>
<th>Ave / Max</th>
<th>2315 / 5000 engine hr/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spars/TLP with Drilling Rig (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spars/TLP w/o Rig (1)</td>
<td></td>
<td>650 engine hr/yr</td>
</tr>
</tbody>
</table>

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**Spars/TLP with Drilling Rig (4) Ave / Max 2315 / 5000 engine hr/yr**

**Spars/TLP w/o Rig (1) 650 engine hr/yr**
Wire Rope Design Factors

**API 6th Edition**
- Fixed design factor of 5 for running rigging without reeving efficiency
- Fixed design factor of 4 for standing rigging
- Impractical for larger cranes, such as construction cranes and derrick barges

*Certifying authorities for larger cranes use design factor of 3 for lifts over 160 tons and account for reeving efficiency*

**API 7th Edition**
- Little to no effect on cranes covered by API 6th Edition
- Sliding factor based on SWL that allows larger cranes lower factors in line with industry practice*
- Reeving efficiency now considered due to high number of parts of line required for larger construction cranes
- Higher capacity cranes, such as derrick barges, have similar factors to current certifying authorities
Wire Rope Design Factors

Note: API 7th Edition, EN 13852-1, DNV and Lloyds curves are all overlapping.
Structural Design Factors

**EN 13852**
- Uses same factor of safety for pedestal / slew bearing as the rest of the crane structure
- No additional factor on the pedestal / slew bearing

**API 7th Edition**
- Uses higher factor of safety for pedestal / slew bearing compared to the rest of the crane structure
- Significant additional factor of safety applied to the pedestal / slew bearing to help ensure that the main crane structure and operator remain attached to the platform in a catastrophic event
Structural Design Factors

API 6\textsuperscript{th} Edition

- Minimum onboard dynamic coefficient (Cv) of 1.33
- Additional Pedestal factor of 1.5
- Impractical for large construction cranes, derrick barges or shipboard cranes in calm waters

*Certifying authorities use approximately 1.1 for Cv for lifts over 160 tons and many do not use a pedestal factor*

API 7\textsuperscript{th} Edition

- Little to no effect on cranes currently covered by API 6\textsuperscript{th} Edition
- Sliding minimum onboard dynamic coefficient from 1.33 to 1.1 based on SWL
- Additional sliding pedestal factor from 1.5 to 1.2 based on SWL
- Offboard dynamic coefficients for typical oil production cranes have not changed
- Higher capacity cranes, such as derrick barges, have similar factors to current certifying authorities
API 7th Edition Structural Design Factors

Graph showing the relationship between SWL (lb) and factors such as Onboard Cv and Pedestal Factor.
## Minimum Hook Velocity

### API 6th Edition

- Calculations given but was not mandatory
- Minimum hook velocity of 20 ft/min at 0 ft significant wave height

### API 7th Edition

- Mandatory for all offboard ratings
- If not met, load chart cannot be provided for the specific conditions
- Minimum hook velocity of 2 ft/min at 0 ft significant wave height
- Above 6 ft significant wave height minimum hook velocity is the same as the 6th Edition
Other Changes

- Cylinder design factors updated to include dynamic load factor $C_v$
- Hoist section updated to require separate dynamic and static brakes
- Load/moment indicators required on intermediate, drilling, and construction duty cranes
- Personnel capacity increased to 50% of SWL as opposed to 33% of SWL to more adequately align with OSHA and other standards and simplify ratings
- Align noise requirements with OSHA
Other Changes

- Material requirements clarified and aligned throughout the standard
- Minimum toughness (Charpy) requirements provided instead of relying on crane manufacturer to determine ductility requirements
- Example calculations updated to reflect changes
- Default Dynamic Method (fixed Cv of 2.0) renamed Legacy Dynamic Method to discourage use
- Drastically reduced number of references to external standards for ease of use internationally
Summary

• API 7th Edition is a viable international standard incorporating all offshore crane applications

• Failure mode calculations/GOPS ensure operator safety without increasing the risk of dropping the load

• In the rare event of supply boat entanglement, injury to personnel is prevented

• Cranes covered by the 6th Edition essentially unchanged while higher capacity cranes use similar to factors used by certifying authorities

• Entire standard reviewed and updated to match current technology and practice
Summary

- API 7th Edition provides definitive technical guidance and unambiguous design rules to ensure cranes are designed to safely operate in the challenging offshore environment.

- Cranes designed to API 2C 7th Edition provide a superior balance of safety and simplicity.