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>
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</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></td>
<td>• Protects the crane operator in the event of an unbounded gross overload (supply boat entanglement)</td>
</tr>
<tr>
<td></td>
<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>
</tr>
<tr>
<td></td>
<td>• No AOPS required</td>
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</table>
Supply Boat Entanglement Causing Gross Overload

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

**EN 13852**

- Seems to consider supply boat entanglement to be a common event
- Damage to equipment unacceptable in catastrophic events
- Accomplished through Automatic Overload Protection System (AOPS) which senses an overload and releases the load
- AOPS creates increased risk of malfunction and dropped loads

**API 7th Edition**

- Considers supply boat entanglement an extremely rare but serious event with special attention required
- Equipment damage considered acceptable in this rare catastrophic event
- Accomplished through failure mode assessment showing structure holding operator’s cabin will not be first to fail in any condition
- Considers hazards created by AOPS to be worse than the potential benefits
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>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></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average of Jackups-Primary Crane</td>
<td>2340</td>
<td>2656</td>
<td>2550</td>
</tr>
<tr>
<td>Max of Jackups-Primary Crane</td>
<td>6552</td>
<td>6300</td>
<td>6009</td>
</tr>
<tr>
<td>No. of Primary Cranes</td>
<td>19</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Average of Semi/DrillShips-Primary Crane</td>
<td>1746</td>
<td>2208</td>
<td>2325</td>
</tr>
<tr>
<td>Max of Semi/DrillShips-Primary Crane</td>
<td>3120</td>
<td>4868</td>
<td>4416</td>
</tr>
<tr>
<td>No. of Primary Cranes</td>
<td>10</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Platform Data #1: (based on Engine Hours)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average of Platform Cranes w/o Drilling</td>
<td></td>
<td></td>
<td>46</td>
</tr>
<tr>
<td>Max of Platform Cranes w/o Drilling</td>
<td></td>
<td></td>
<td>312</td>
</tr>
<tr>
<td>No. of Cranes</td>
<td></td>
<td></td>
<td>33</td>
</tr>
</tbody>
</table>

| 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>

- Floating Production / Drilling Systems:
  - Spars/TLP with Drilling Rig (4)
  - Spars/TLP w/o Rig (1)
# Wire Rope Design Factors

## API 6\(^{th}\) 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 7\(^{th}\) Edition

- Little to no effect on cranes covered by API 6\(^{th}\) 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 6th 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 7th Edition

- Little to no effect on cranes currently covered by API 6th 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
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
Minimum Hook Velocity

![Graph showing Minimum Hook Velocity against Significant Wave Height in feet. The graph includes lines representing API 6th, API 7th, and EN 13852 standards.](image)

- **API 6th**
- **API 7th**
- **EN 13852**
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.