Chinese Petroleum Resources / Reserves Classification System

By Yundong Hu

Petroleum Reserves Office
Ministry of Land and Resources, PRC
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Chinese Petroleum Resources / Reserves Classification System

- Background
- Standards Setting
- Basic Features of Current System
- New Features of Newly Amended System
China was the first country to discover and use oil and gas, but China only began developing a modern oil and gas industry in the 1950s.

In 1952, the Ministry of Geology and Mineral Resources was set up. The first oil geologic reserves (OOIP) estimation was made in Yumen oilfield, Gansu Province, with the help of FSU experts.

Since the 1970s, China has explored and developed hundreds of field in 26 basins. The oil and gas reserves were estimated under the regulations of the government until 1984.

In 1998, the Ministry of Land and Resources was set up. The mineral resources/reserves management is one of its main responsibilities.
Three Major Corporations: PetroChina, Sinopec, CNOOC

Reserves were estimated by local experts and audited by government appointed evaluators.
Reserves Activity Organization

Senior Management
Corp. Upstream

Local Reserve Management
Regional E&P Company

Reserves Estimation
Reserve Project Teams
Regional E&P Research Institute

Government Registration and Record
Ministry of Land and Resources

Government Audit (P1 only)
Petroleum Reserves Office
Ministry of Land and Resources
In 1977, the Ministry of Petroleum issued a geologic reserves calculation guideline.

In 1982, the Research Institute of Petroleum E&D set up criteria for oil and gas reserves estimation.

In 1984, China National Mineral Reserves Committee was formed. The study and setting of mandatory criteria for oil and gas reserves estimation was begun.
In 1988, China National Standard Bureau adopted and issued the Committee’s criteria.

Since 2000, the Ministry of Land and Resource has been working on the amendment of the criteria taking into consideration of SPE/UNFC definitions.

The new criteria will be approved and issued by the National Standard Committee around the end of this year.
Basic Features of Current System

The current system is also a three-class system but mainly for the classification of OOIP/OGIP (Geologic reserves in Chinese).

- **Undiscovered Resources**
  - Inferred
    - Inferred Reserves
      - Nonrecoverable Volume
  - Indicated
    - Indicated Reserves
      - Nonrecoverable Volume
  - Measured
    - Measured EUR or GUR
      - Nonrecoverable Volume

**Total Oil & Gas Resources**

**Discovered Geologic Reserves (OOIP/OGIP)**
Technically, the assignment of different classes of geologic reserves is based on the phases of exploration and development or the maturity of E&D and the knowledge of the specific reservoirs or blocks (mainly on geology).

<table>
<thead>
<tr>
<th>Main Phases</th>
<th>Resource Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early exploration and discovery</td>
<td>Inferred</td>
</tr>
<tr>
<td>Exploration well test with industrial flows</td>
<td>Indicated</td>
</tr>
<tr>
<td>End of exploration</td>
<td>Measured</td>
</tr>
</tbody>
</table>
Criteria to determine industrial flows in a well (the lowest limits to calculate reserves):

<table>
<thead>
<tr>
<th>Depth of Reservoir (m)</th>
<th>Well Test Production</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oil (tonne/d)</td>
<td>Gas ($10^4 m^3/d$)</td>
</tr>
<tr>
<td>≤ 500</td>
<td>0.3</td>
<td>0.05</td>
</tr>
<tr>
<td>500 - 1000</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>1000 - 2000</td>
<td>1.0</td>
<td>0.3</td>
</tr>
<tr>
<td>2000 - 3000</td>
<td>3.0</td>
<td>0.5</td>
</tr>
<tr>
<td>3000 - 4000</td>
<td>5.0</td>
<td>1.0</td>
</tr>
<tr>
<td>4000</td>
<td>10.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Different classes of geologic reserves require different amounts of data acquired as well, from seismic, drilling, logging, and production tests, to sampling analysis, to reflect the phases of E&D and the certainty of geologic understanding to the specific reservoir(s).
The classes of recoverable reserves are the same classes as corresponding geologic reserves.

In fact, the booking of recoverable reserves of a reservoir is the estimated ultimate recoveries up to the product of an estimated OOIP (or OGIP) times an estimated recovery efficiency during the appraisal and development phases, even at the stage of production decline in Chinese standard.

For the estimate of oil reserves, Chinese standards typically take into account water drive factors whenever water injection will be performed, since most of the oil reservoirs need and are produced with secondary drive energy.
**Basic Features of Current System**

- **Measured geologic reserves** are estimated after completion or near completion of evaluation drilling. Under the present technical and economic conditions, they are reliable resources for development and social economic profit. Measured geologic reserves are the basis to make a development plan and to determine investment in construction of field development and to study production performance.

- In estimation, modern geophysical exploration technology and reservoir boundary detecting approach should be used as much as possible to identify reservoir type, structure feature, reservoir thickness, lithology, petrophysics, water saturation and/or fluid boundaries.
Resources may be classified as **Measured geologic reserves** as follows:

(a) All petrophysical data have been acquired in the discovery well(s) with industrial flow(s), the resources/reserves can be calculated in a reasonable area surrounding the well(s);

(b) Basic necessary petrophysical data have been taken in a small fault block or lithologic trap which area is less than 1 km²;
Resources may be classified as **Measured geologic reserves** as follows (cont.):

(c) For simple types of medium and small size reservoirs, detail seismic survey has been done and structure conformation is identified, fluid contacts and hydrocarbon bearing boundaries have been determined or estimated, all the petrophysical data have been taken, though only a few appraisal wells showed industrial flows;
Resources may be classified as **Measured geologic reserves** as follows *(cont.)*:

(d) For large hydrocarbon bearing traps, though the boundary hasn't been identified, appraisal wells control optimal locations of the reservoirs and other parameters have been taken, and the Measured area is constrained by external tangent lines of radius of oil/gas deliverabilities.
Under the Chinese definition of reserves, economic viability is not emphasized or lacks clarification, except under the criteria of industrial flows (as above).

On geologic grounds, the geologic interpretation in the E&D phases convey simplified reservoir models, especially in the estimation of fluid contacts for complex multi-layer systems with continental sedimentary characteristics. So the extent of proved geology is subject to uncertainties or highly graded in some reservoirs.
On feasibility, the approvals of applying to install or operate technically applicable projects (water injection for instance) in the fields outside natural reserve areas in China are a matter of course.

So the consideration on field project grounds in the definitions of reserves is much weaker.

To some extent, the E&D phases reflect the feasibility of projects but in a different way as to technical data acquisition systematically.
Basic Features of Current System

Sketch comparison

Chinese Measured Recoverable Reserves
- Production
  - SPE Proved
  - SPE Probable
  - P₄

Chinese Indicated Recoverable Reserves
- SPE Proved
  - SPE Probable
  - SPE Possible
  - SPE Contingent Resources (P₄₊₅)

Chinese Inferred Recoverable Reserves
- SPE Probable
  - SPE Possible
  - SPE Contingent Resources (P₆)
### Sketch comparison

<table>
<thead>
<tr>
<th><strong>Chinese (1988-2003)</strong></th>
<th><strong>UNFC Codes</strong></th>
<th><strong>Key Number of F axis</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured Geologic Reserves</td>
<td>I1</td>
<td></td>
</tr>
<tr>
<td>Indicated Geologic Reserves</td>
<td>I2</td>
<td></td>
</tr>
<tr>
<td>Inferred Geologic Reserves</td>
<td>I3</td>
<td></td>
</tr>
<tr>
<td>Prospective Resources in Place</td>
<td>I4</td>
<td></td>
</tr>
<tr>
<td>Measured Recoverable Reserves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Developed</td>
<td>111, 211</td>
<td>11</td>
</tr>
<tr>
<td>- Undeveloped</td>
<td>112, 121, 122, 221, 222</td>
<td>12, 13, 21, 22, 23</td>
</tr>
<tr>
<td>- Basic Measured</td>
<td>112, 122, 222</td>
<td>12, 13, 21, 22, 23, 24</td>
</tr>
<tr>
<td>Controlled Recoverable Reserves</td>
<td>122, 222, 322</td>
<td>23, 22</td>
</tr>
<tr>
<td>Inferred Recoverable Reserves</td>
<td>223, 333</td>
<td>23, 24, 31</td>
</tr>
<tr>
<td>Prospective Recoverable Resources</td>
<td>234, 334</td>
<td>30, 40</td>
</tr>
</tbody>
</table>
Basic Features of Current System

SEC Estimated:
- Proved Area: 8.6 km²
- OGIP: 15.84 × 10⁸ m³
- Reserve: 11.09 × 10⁸ m³

Chinese Standards:
- Proved Area: 28.8 km²
- OGIP: 64.12 × 10⁸ m³
- Reserves: 44.88 × 10⁸ m³
Basic Features of Current System

<table>
<thead>
<tr>
<th>$S_w$ (%)</th>
<th>$\Phi$ (%)</th>
<th>Lithology</th>
</tr>
</thead>
</table>

SPE Proved limit — LKG

Chinese estimated Measured limit — middle point of LKG and the top of perforated dry interval.
There are no probable reserves at production decline phase in Chinese standards.
To consist with SPE/UNFC classification, the Ministry of Land and Resources has revised the 1988 criteria.

The new system

—— keeps the basic features of current system in: phases and maturity of E&D, industrial flows and technical data acquisition requirement;

—— combines the SPE definitions of Proved reserves and parts of those considerations of Probable and Possible reserves of SPE;

—— adopts international comparable terms of reserves (3P system) for the use of international cooperation, evaluation and study;
The new system (cont.)

—— Corresponds technically proved initial reserves exactly to Proved Estimated Ultimate Recovery;

—— Narrows down the connotation of proved reserves on geologic grounds, especially for the meaning of proved limits (LKH/LKO/LKG);

—— Corresponds Proved Remaining Reserves exactly to SPE Proved Reserves;

—— Keeps the economically sub-marginal reserves but separately classified as sub-economic reserves (as part of technical reserves).
New Features of Newly Amended System

Total Petroleum Initially In Place

Undiscovered

- Inferred
  - Possible Reserves
    - Nonrecoverable Volume
- Discovered
  - Indicated
    - Probable EUR or GUR
      - Nonrecoverable Volume
  - Measured
    - Proved EUR or GUR
      - Nonrecoverable Volume
New Features of Newly Amended System

Proved Estimated Ultimate Recovery

- Proved sub-economic Initial Reserves
- Proved Initial Reserves

Proved Developed Initial Reserves

- Production
- Proved Developed Remaining Reserves

Proved Undeveloped Initial Reserves
## New Features of Newly Amended System

### Comparison to UNFC

<table>
<thead>
<tr>
<th>Chinese (new system)</th>
<th>UNFC Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured Petroleum Initially In Place</td>
<td>I1</td>
</tr>
<tr>
<td>Indicated Petroleum Initially In Place</td>
<td>I2</td>
</tr>
<tr>
<td>Inferred Petroleum Initially In Place</td>
<td>I3</td>
</tr>
<tr>
<td>Petroleum Initially In Place in Prospects</td>
<td>I4</td>
</tr>
<tr>
<td>Proved Estimated Ultimate Recovery</td>
<td>111, 121, 211</td>
</tr>
<tr>
<td>Proved Initial Reserves</td>
<td>111</td>
</tr>
<tr>
<td>- Proved Developed Initial Reserves</td>
<td>111</td>
</tr>
<tr>
<td>- Proved Developed Remaining Reserves</td>
<td>111</td>
</tr>
<tr>
<td>- Proved Undeveloped Initial Reserves</td>
<td>121, 111</td>
</tr>
<tr>
<td>Proved sub-economic Initial Reserves</td>
<td>211</td>
</tr>
<tr>
<td>Probable Reserves</td>
<td>122, 112</td>
</tr>
<tr>
<td>Probable sub-economic Initial Reserves</td>
<td>222</td>
</tr>
<tr>
<td>Possible Reserves</td>
<td>223</td>
</tr>
</tbody>
</table>