NEXT IAS

DAILY EDITORIAL ANALYSIS

TOPIC

SEMICONDUCTOR SECTOR NEEDS SOPS

SEMICONDUCTOR SECTOR NEEDS SOPS

Context

- The **semiconductor industry** is a critical pillar of modern technology, driving advancements in **smartphones, computing, and AI-driven systems**. As **demand surges**, the **implementation of Standardized Operating Procedures (SOPs)** becomes essential to ensure **quality, efficiency, and global competitiveness**.

Understanding Semiconductors

- **Definition:** Semiconductors have electrical properties **between conductors and insulators**, enabling them to regulate electrical flow.
- **Composition:** Made from elements like **silicon and germanium** and commonly referred to as **integrated circuits (ICs) or microchips**.
- **Global Semiconductor Market Share:**
  - **Taiwan (44%)** => **Largest chip producer**
  - **China (28%)**
  - **South Korea (12%)**
  - **United States (6%)**
  - **Japan (2%)**

India's Semiconductor Sector

- **Growth and Market Potential:**
  - **Projected market size:**
    - **$63 billion by 2026**
    - **$103 billion by 2030**
  - **Milestone:** India's **first indigenous semiconductor chip** is expected to debut in **2025**, marking progress toward **self-reliance in chip manufacturing**.
- **India's Competitive Advantages:**
  - **Cost-Competitiveness:** Lower labor costs and a **large domestic market**.
  - **Skilled Workforce:** India leads in **STEM graduates**, crucial for **R&D and manufacturing**.
  - **Rising Domestic Demand:** Increasing use of **smartphones, IoT devices, and AI-driven systems**.
  - **Strategic Global Partnerships:**
    - Collaborations with **the U.S., Japan, Singapore, and Taiwan** to secure investments and technology transfer.

Key Challenges in India's Semiconductor Sector

- **Supply Chain Vulnerabilities:** Semiconductor production involves **multiple stages**, requiring seamless **coordination of raw materials, components, and logistics**.
  - Any **disruption** (e.g., geopolitical tensions, natural disasters) can **cause delays and shortages**.
- **Technological Upgradation:** Advanced semiconductor manufacturing demands **state-of-the-art research facilities** and a highly **skilled workforce**.
  - **Continuous innovation** is necessary to compete with global leaders.
- **Geopolitical Risks: Trade restrictions and sanctions** can disrupt access to **critical semiconductor components**.
  - **Ongoing U.S.-China tech rivalry** influences supply chain strategies.
- **Intellectual Property (IP) Protection:**
  - Risks of **IP theft and chip cloning** lead to **revenue losses and security concerns**.
- **High Capital Investment:** Establishing **semiconductor fabrication plants (fabs)** requires **billions in investment**, making funding a challenge.
- **Environmental Concerns:** Semiconductor manufacturing involves **hazardous materials** and generates **significant waste**.
  - Strict **environmental regulations and sustainability measures** are necessary.

Need for Standardized Operating Procedures (SOPs) in Semiconductor Manufacturing

SOPs ensure consistency, efficiency, and compliance in chip production. Key areas where SOPs are crucial include:

- **Manufacturing Process Control:** Prevents contamination and ensures precise storage and movement.
- **Equipment Calibration & Maintenance:** Regular checks on **lithography, etching, and deposition tools**.
- **Process Monitoring:** Standardized defect detection ensures **high-quality semiconductor production**.
- **Quality Assurance & Testing:** Uses **automated optical inspection (AOI)** and manual verification to detect defects.
- **Data Documentation:** Tracks **process deviations, lot traceability, and corrective actions**.
- Supply Chain & Logistics Management: Criteria for selecting **raw material and component suppliers**.
  - **Inventory Management:** Real-time tracking of **raw materials, work-in-progress, and finished products**.
- **Environmental Compliance:** Waste disposal, water usage, and **emission control standards**.
- **Intellectual Property Protection:** Security protocols for **trade secrets and patent protection**.
- **Industry Certifications:** Compliance with **ISO 9001 (Quality Management) and ISO 14001 (Environmental Management)**.

Why Are SOPs Essential?

- **Enhances production reliability and quality control**.
- **Minimizes operational risks and inefficiencies**.
- **Ensures global competitiveness and regulatory compliance**.

As **technology advances**, companies must **continuously refine SOPs** to meet evolving industry demands. By **standardizing processes**, businesses can achieve **cost efficiency, innovation, and long-term success** in the rapidly evolving semiconductor landscape.

Government Initiatives to Strengthen India's Semiconductor Industry

- **India Semiconductor Mission (ISM): Aims to boost semiconductor design, manufacturing, and innovation**.
  - **$10 billion incentive program** to attract investments.
  - Targets **25% local value addition by 2025-26** and **40% by 2030**.
  - Financial Incentives for Manufacturing: **Semiconductor Fab Scheme:** 50% fiscal support for all technology nodes.
- **Display Fab Scheme:** 50% fiscal support for display panel manufacturing.
  - **Compound Semiconductor Scheme:** 50% support for fabs producing **discrete semiconductors**.
  - Design Linked Incentive (DLI) Scheme: Financial support for **semiconductor design, chipsets, and IP development** over five years.
- **Semicon India Programme (2024): Four semiconductor manufacturing units approved** to boost domestic production.
  - Scheme for Promotion of Manufacturing of Electronic Components & Semiconductors (SPECS): **25% financial incentive** for capital expenditure on **electronic components, micro/nano-electronics, and solar PV wafers**.

Conclusion

- The **competitiveness of India's semiconductor sector** depends on its ability to maintain **efficiency, quality, and compliance with global standards**.

■■■■

Mains Practice Question

[Q] How can standardized operating procedures (SOPs) transform the semiconductor sector in terms of quality control, safety, and operational efficiency?