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DEPARTMENT OF BIOMEDICAL ENGINEERING

VI Semester

24BM501 BIOMEDICAL DEVICE DESIGN

UNIT- V REGULATORY AFFAIRS, QUALITY MANAGEMENT AND COMMERCIALIZATION

5.1 Medical Device Regulations

➢Introduction and Need for Regulation

A **medical device** is any instrument, apparatus, implant, in-vitro reagent, software or other article intended by its manufacturer to be used for diagnosis, prevention, monitoring, treatment or alleviation of disease or injury, or for investigation or support of an anatomical or physiological process, and which does **not** achieve its principal action by pharmacological, immunological or metabolic means. Examples range from a clinical thermometer to a pacemaker, an MRI scanner or a diagnostic software application.

Medical devices can seriously harm patients if they are badly designed, badly made or misused. Historic incidents (for example, faulty heart valves, the Dalkon Shield intrauterine device in the 1970s, and the radiation overdoses of the Therac-25 machine in the 1980s) led governments to introduce **pre-market approval, quality-system requirements and post-market surveillance**. The purpose of regulation is therefore to ensure that every device placed on the market is **safe, effective and of consistent quality** throughout its life.

- ✓ **Protect public health:** prevent unsafe or ineffective devices reaching patients.
- ✓ **Ensure quality and performance:** manufacturers must follow documented design and production controls.
- ✓ **Build trust and enable trade:** harmonised rules allow a device approved in one region to be accepted in others.
- ✓ **Traceability and accountability:** unique device identification, vigilance and recalls allow quick action when problems occur.

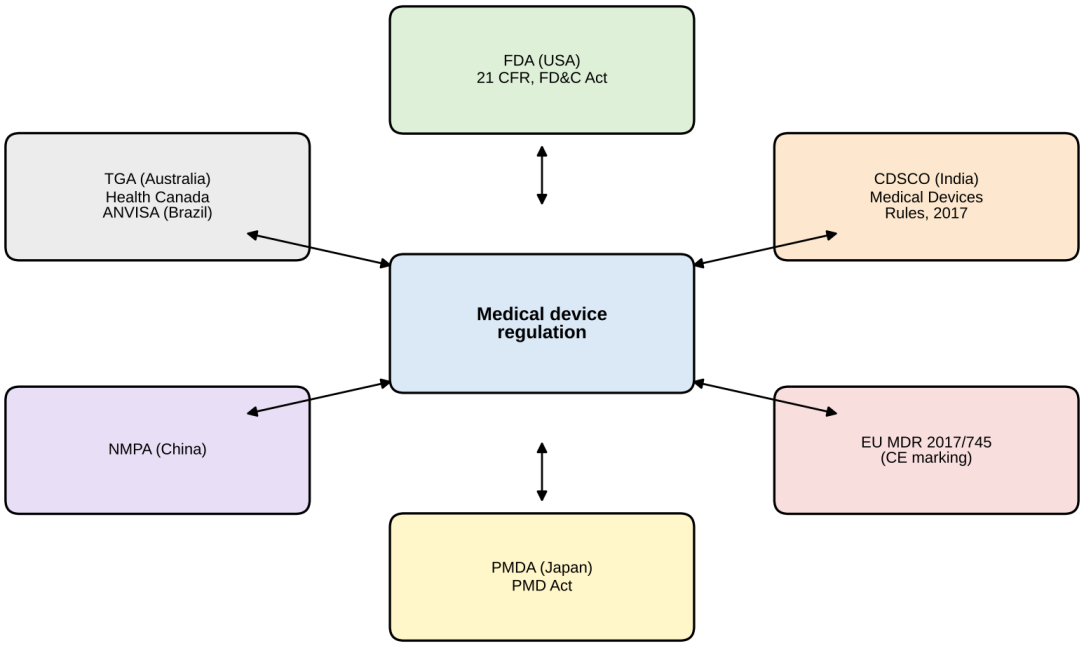


Fig. 5.1 Global medical device regulatory landscape

Regulatory activity across the device life cycle

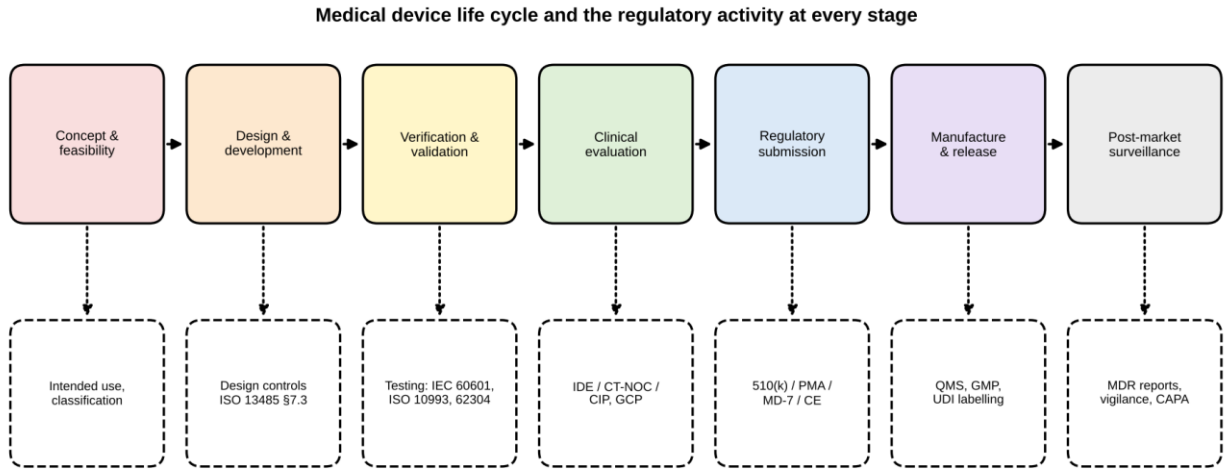


Fig. 5.2 Medical device life cycle and the regulatory activity at each stage

Risk-based classification – the common idea

Almost every regulator classifies devices according to **risk to the patient and user**, which depends on the intended use, invasiveness, duration of contact, whether it is active (powered), and whether it supports or sustains life. The higher the class, the more evidence (clinical data, audits, technical documentation) is needed before the device is allowed on the market.

➢A. US FDA – Food and Drug Administration

Legal basis and organisation

In the USA devices are regulated by the **Center for Devices and Radiological Health (CDRH)** of the FDA under the **Federal Food, Drug, and Cosmetic Act (FD&C Act)**, particularly the **Medical Device Amendments of 1976**, and the regulations in **Title 21 of the Code of Federal Regulations (21 CFR Parts 800–898)**. Key parts include Part 807 (establishment registration, 510(k)), Part 812 (IDE), Part 814 (PMA), Part 820 (quality system), Part 803 (medical device reporting) and Part 830 (UDI).

FDA device classification

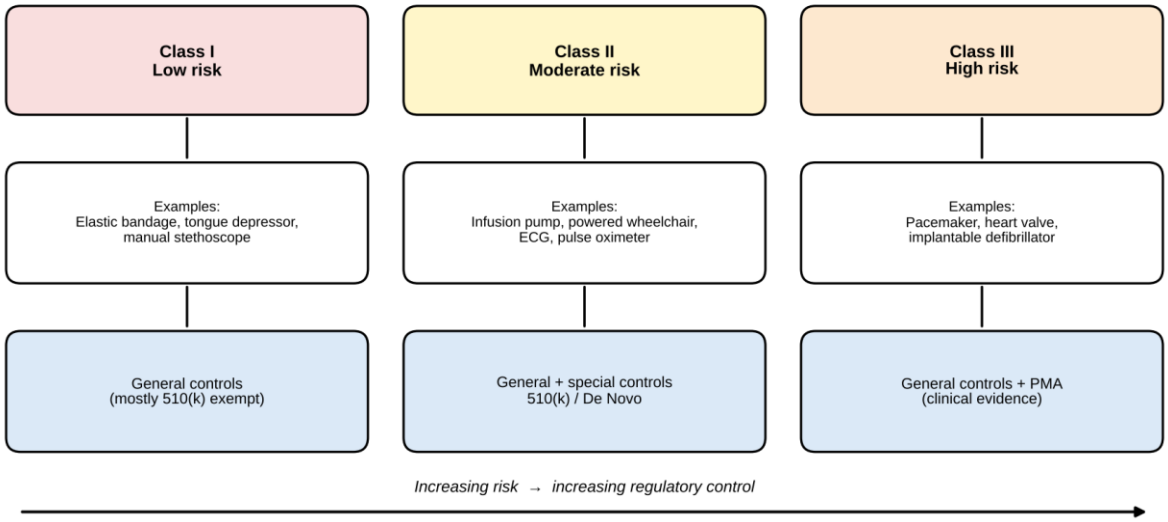


Fig. 5.3 FDA risk-based classification of medical devices

Class	Risk	Controls	Typical pathway	Examples
Class I	Low	General controls	Mostly exempt from 510(k); registration & listing	Bandages, manual stethoscope, tongue depressor
Class II	Moderate	General + special controls (standards, guidance, performance testing)	510(k) premarket notification, or De Novo if no predicate	Infusion pumps, ECG, pulse oximeters, powered wheelchairs
Class III	High (life-supporting / implanted)	General controls + premarket approval	PMA with valid scientific (clinical) evidence	Pacemakers, heart valves, ICDs, breast implants

- ✓ **General controls** apply to all devices: establishment registration and device listing, labelling, good manufacturing practice (QMSR), adverse-event reporting and the prohibition of adulterated or misbranded devices.
- ✓ **Special controls** are device-specific measures (performance standards, special labelling, post-market surveillance, guidelines) used for Class II.

Premarket pathways

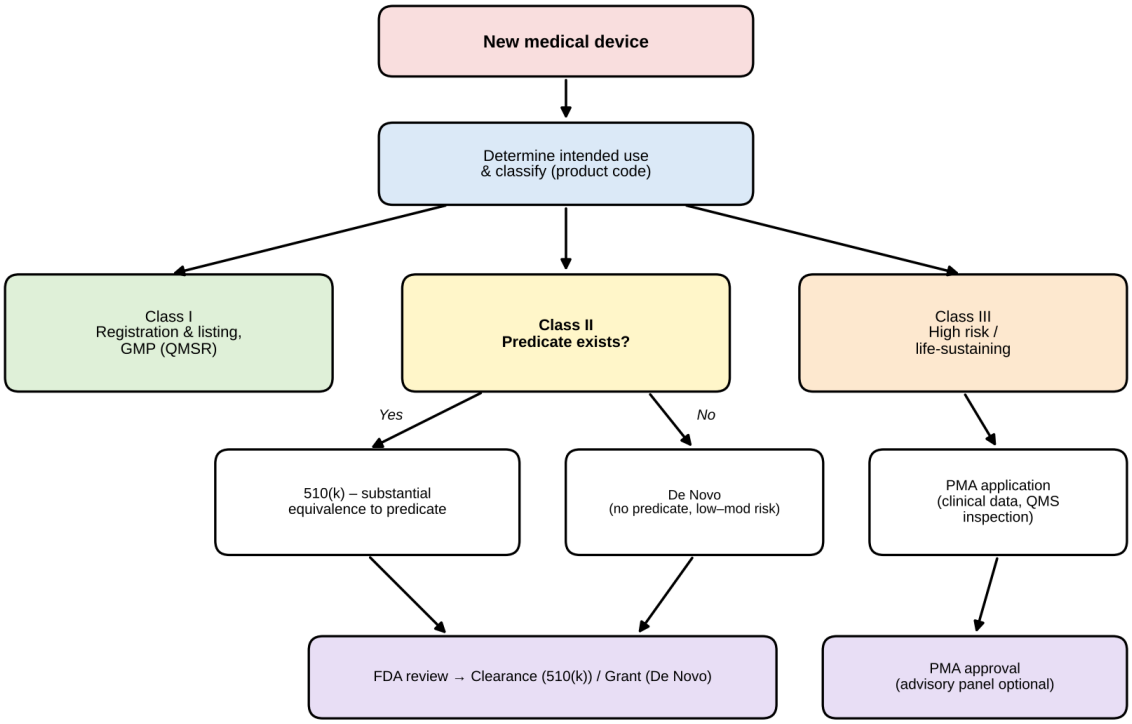


Fig. 5.4 FDA premarket pathways – 510(k), De Novo and PMA

Pathway	What is shown	Evidence needed	Outcome
510(k) premarket notification	Device is **substantially equivalent** (SE) to a legally marketed predicate in intended use and technological characteristics	Comparison with predicate, bench/performance testing, software and biocompatibility data; clinical data only sometimes	"Clearance" (not approval)
De Novo classification	Novel low-to-moderate risk device with no predicate	Risk assessment and proposed special controls, performance and often clinical data	Granted – creates a new device type that can serve as predicate
PMA (Premarket Approval)	Reasonable assurance of **safety and effectiveness** for Class III devices	Full non-clinical and clinical studies, manufacturing information, QMS inspection, labelling	Approval order; annual reports; post-approval studies
Humanitarian Device Exemption (HDE)	Device for rare conditions (< 8,000 patients/year in US)	Probable benefit; safety	Limited marketing
Breakthrough Devices Program	Expedited review of devices giving more effective treatment of life-threatening conditions	Interactive FDA feedback, prioritised review	Faster access

Investigational Device Exemption (IDE)

A device that has not been approved can be tested on humans only under an **IDE** (21 CFR 812), with Institutional Review Board (IRB) approval and informed consent. **Significant-risk** studies need FDA approval of the IDE; **non-significant-risk** studies need only IRB approval.

Quality system and post-market requirements

- ✓ **Quality Management System Regulation (QMSR) – 21 CFR Part 820:** the QMSR, in force since **2 February 2026**, replaced the earlier Quality System Regulation by **incorporating ISO 13485:2016 by reference**, with a few additional FDA-specific requirements. It aligns the US with the international QMS standard and ended the old QSIT inspection technique in favour of a new inspection compliance program.
- ✓ **Unique Device Identification (UDI):** every device label carries a UDI (device identifier + production identifier) that is submitted to the **GUDID** database for traceability.
- ✓ **Medical Device Reporting (MDR, 21 CFR 803):** manufacturers must report deaths, serious injuries and malfunctions; user facilities and importers also report.
- ✓ **Recalls and corrections (21 CFR 806):** classified Class I (reasonable probability of serious harm or death), Class II, Class III.
- ✓ **Post-market surveillance studies (Section 522)** and the Total Product Life Cycle approach.
- ✓ **Cybersecurity (Section 524B):** "cyber devices" must include a secure design, a plan to monitor and fix vulnerabilities and a software bill of materials (see Section 5.4).
- ✓ **Software as a Medical Device (SaMD) and AI-enabled devices:** FDA allows a Predetermined Change Control Plan (PCCP) so that algorithms can be updated within agreed limits.

➢B. India – CDSCO and the Medical Devices Rules, 2017

Regulatory framework

In India medical devices are regulated as "drugs" under the **Drugs and Cosmetics Act, 1940**. The **Central Drugs Standard Control Organisation (CDSCO)**, headed by the **Drugs Controller General of India (DCGI)** under the Ministry of Health and Family Welfare, is the national regulator. Detailed requirements are in the **Medical Devices Rules, 2017 (MDR 2017)**, effective from **1 January 2018**, which for the first time created a separate regulatory regime for devices with **risk-based classification, quality-system requirements, licensing and clinical investigation rules**. The **National Medical Devices Policy, 2023** supports domestic manufacturing and regulatory streamlining.

Risk-based classification

Class	Risk level	Examples	Licensing authority (manufacture)
Class A	Low	Thermometers, tongue depressors, bandages	State Licensing Authority (SLA)
Class B	Low–moderate	BP monitors, nebulisers, suction apparatus, hypodermic needles	State Licensing Authority (SLA)
Class C	Moderate–high	Ventilators, bone-fixation plates, infusion pumps, haemodialysis machines	Central Licensing Authority (CLA – CDSCO)
Class D	High	Heart valves, coronary stents, implantable pacemakers, IVD reagents for blood screening	Central Licensing Authority (CLA – CDSCO)

Licences for the **import** of devices of **all classes** are granted by the CLA. Phase-wise implementation brought **Class A and B devices into the licensing regime from October 2022** and **Class C and D from 1 October 2023**; as a result all risk classes are now under CDSCO's licensing framework (with

certain Class A devices that are neither sterile nor measuring treated more leniently – check current CDSCO notices).

Licensing process

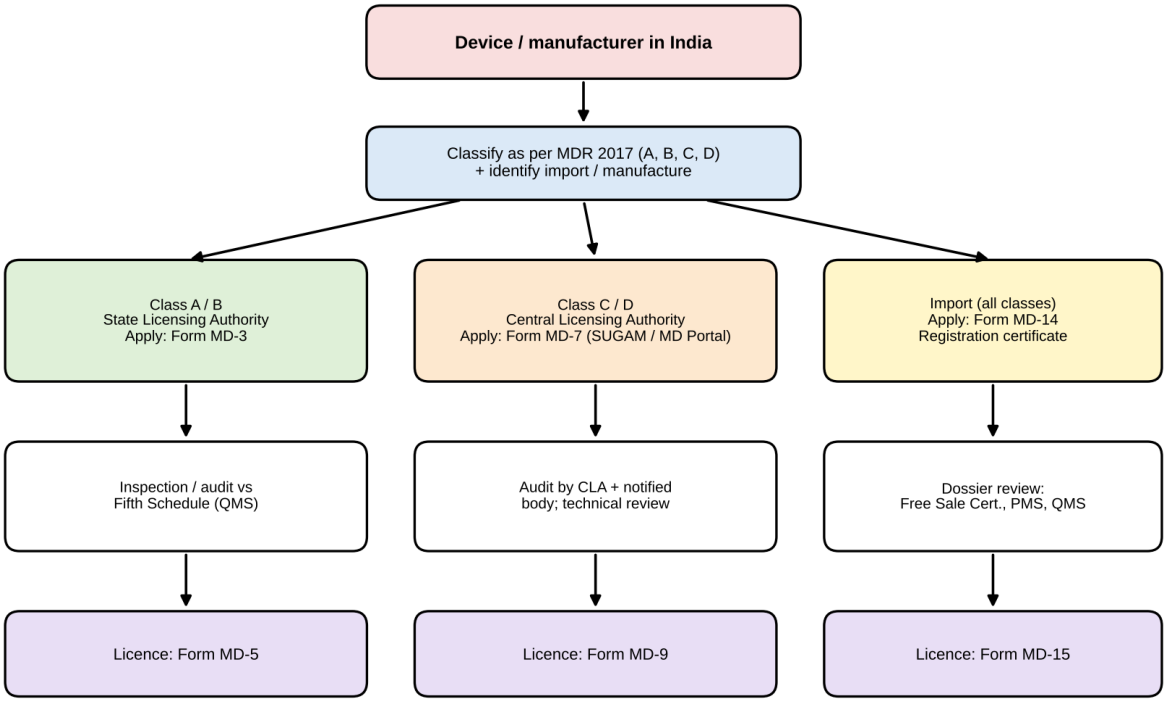


Fig. 5.5 Licensing pathway for medical devices under MDR 2017 (India)

Activity	Application form	Licence form	Authority
Manufacture – Class A/B	MD-3	MD-5	State Licensing Authority
Manufacture – Class C/D	MD-7	MD-9	Central Licensing Authority
Import – all classes (registration of overseas manufacturer / device)	MD-14	MD-15	Central Licensing Authority
Clinical investigation of a new device	MD-22	MD-23 (permission)	CDSCO with Ethics Committee approval

- ✓ **Quality management system:** manufacturers must comply with the **Fifth Schedule of MDR 2017**, which follows ISO 13485 principles (design controls, risk management, traceability, CAPA, post-market surveillance). Audits are done by CDSCO / notified bodies.
- ✓ **Documents needed:** device master file, plant master file, essential principles checklist, risk management file, test reports, free sale certificate (for imports), labelling and instructions for use.
- ✓ **Indian Authorised Agent:** foreign manufacturers must appoint an Indian agent holding the import licence.
- ✓ **Clinical investigation / performance evaluation:** required for new Class C and D devices without an Indian predicate; follows ISO 14155 / GCP, Ethics Committee and Clinical Trial Registry (CTRI) registration.

- ✓ **Post-market: Materiovigilance Programme of India (MvPI)** collects adverse-event reports; manufacturers must handle complaints, recalls and field safety corrective actions.
- ✓ **Online system:** applications are filed through the CDSCO medical devices online portal (SUGAM / MD Online). Licences are valid perpetually subject to payment of a retention fee.
- ✓ **Standards:** Bureau of Indian Standards (BIS) standards (e.g. IS 13450 for electrical safety) and NABL-accredited laboratories support testing.

➢C. European Union – Medical Device Regulation (EU MDR 2017/745)

The **EU MDR (Regulation (EU) 2017/745)** replaced the Medical Devices Directive (93/42/EEC) and Active Implantable Medical Devices Directive (90/385/EEC). It became applicable on **26 May 2021** and is directly binding in all EU member states. Devices that comply receive the **CE mark**, which allows free movement within the European Economic Area. Compared with the old directives the MDR is much stricter on clinical evidence, traceability and post-market surveillance.

Classification and conformity assessment

Class	Risk	Rules / examples	Conformity route
Class I	Low	Non-invasive, non-sterile devices e.g. wheelchairs, stethoscopes	Manufacturer self-declaration (Notified Body only for Is, Im, Ir – sterile, measuring, reusable surgical)
Class IIa	Medium	Hearing aids, dental fillings, short-term invasive devices	Notified Body (QMS + sampling of technical documentation)
Class IIb	Medium–high	Ventilators, infusion pumps, X-ray equipment	Notified Body (QMS + technical documentation review)
Class III	High	Implants (heart valves, stents), active implantables, devices incorporating medicinal substances	Notified Body + clinical evaluation consultation; PMCF mandatory

Classification is made using **22 rules in Annex VIII** based on duration of contact, invasiveness, active nature and anatomical site. Active implantable devices (e.g. pacemakers) are in Class III.

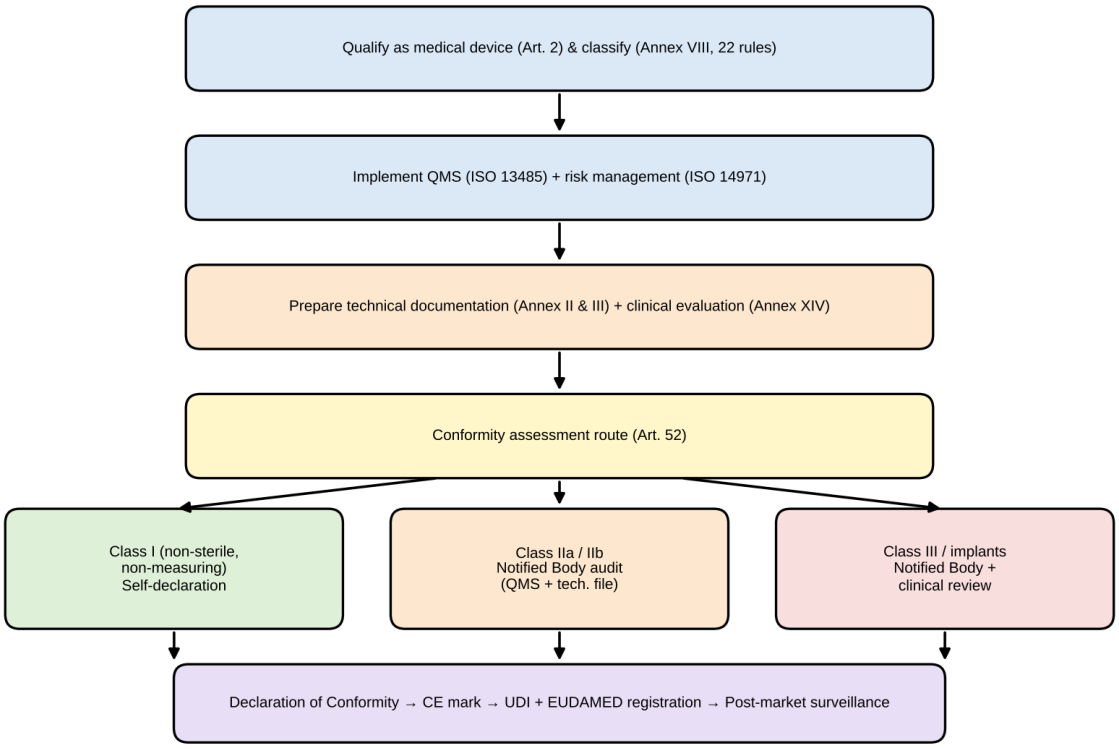


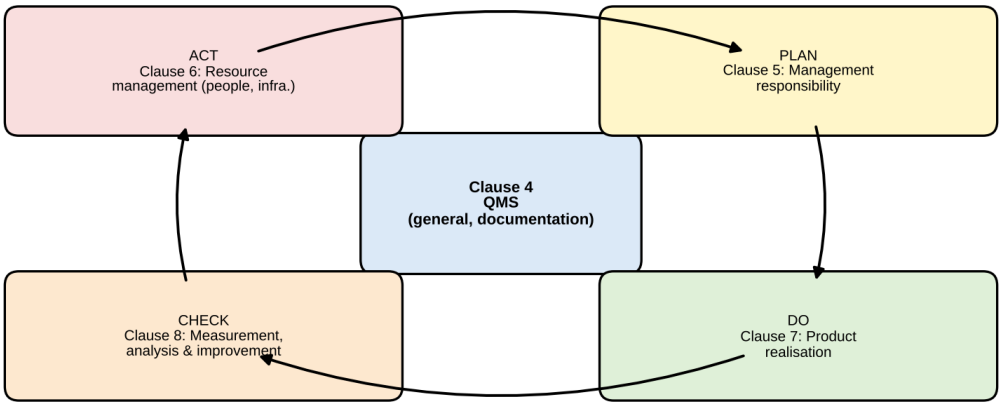
Fig. 5.6 Route to CE marking under the EU MDR

Key requirements of the EU MDR

- ✓ **General Safety and Performance Requirements (GSPR, Annex I)** that every device must meet, including risk management, software, cybersecurity and biocompatibility.
- ✓ **Technical documentation (Annexes II and III)** and **clinical evaluation (Annex XIV)** with Clinical Evaluation Report; clinical investigations for implants and Class III.
- ✓ **Notified Bodies:** independent organisations designated by member states to audit manufacturers and certify devices.
- ✓ **Person Responsible for Regulatory Compliance (PRRC)** in every manufacturer; an **Authorised Representative** for non-EU manufacturers (e.g. Indian companies exporting to the EU).
- ✓ **UDI system and EUDAMED** (European database on medical devices) for registration of devices, economic operators, certificates and vigilance.
- ✓ **Post-market surveillance (PMS):** PMS plan, **PSUR** (periodic safety update report), **SSCP** (summary of safety and clinical performance) for implants and Class III, **vigilance** reporting of serious incidents.
- ✓ **Transition:** under Regulation (EU) 2023/607, legacy devices with valid directive certificates may stay on the market until **31 December 2027** (Class III and IIb implantables) or **31 December 2028** (other Class IIb, IIa and I devices needing a Notified Body), provided they are not significantly changed and a MDR application and QMS are in place.

➢D. ISO 13485 – Quality Management Systems for Medical Devices

ISO 13485:2016 *Medical devices – Quality management systems – Requirements for regulatory purposes* is the international standard that specifies the QMS requirements for an organisation that designs, manufactures, installs, services or supplies medical devices and related services. Unlike ISO 9001 (which emphasises customer satisfaction and continual improvement), ISO 13485 emphasises **regulatory compliance, risk management, documented procedures, traceability and safety**.



ISO 13485:2016 – process-based QMS following the PDCA model (Clauses 4–8)

Fig. 5.7 Structure of ISO 13485:2016 based on the PDCA model

Clause	Title	Key content
1–3	Scope, normative references, terms	Applicability and definitions
4	Quality management system	General requirements, risk-based approach, documentation, quality manual, medical device file, document and record control
5	Management responsibility	Management commitment, customer focus, quality policy, planning, responsibility and authority, management review
6	Resource management	Human resources and competence, infrastructure, work environment and contamination control
7	Product realisation	Planning, customer requirements, design and development, purchasing, production and service provision, validation of processes, identification and traceability, control of monitoring and measuring equipment
8	Measurement, analysis and improvement	Customer feedback, complaint handling, reporting to authorities, internal audit, monitoring of processes and product, control of non-conforming product, data analysis, CAPA

Importance and uses of ISO 13485

- ✓ It is a **harmonised standard** for presumption of conformity with the QMS requirements of the **EU MDR** and is the basis of the **FDA QMSR** and the **Fifth Schedule of India's MDR 2017**.

- ✓ Certification by an accredited certification body is demanded by hospitals, tenders and distributors.
- ✓ **MDSAP (Medical Device Single Audit Program)** lets one audit based on ISO 13485 satisfy regulators of the USA, Canada, Brazil, Australia and Japan.
- ✓ Certification cycle: Stage 1 and Stage 2 audit → certificate (valid 3 years) → annual surveillance audits → recertification.

➢Comparison of the Major Regulatory Systems

Parameter	US FDA	India CDSCO	EU MDR
Authority	FDA (CDRH)	CDSCO / DCGI; SLA for A/B	Member-state competent authorities + Notified Bodies
Legal basis	FD&C Act; 21 CFR	Drugs & Cosmetics Act 1940; MDR 2017	Regulation (EU) 2017/745
Classes	I, II, III	A, B, C, D	I, IIa, IIb, III
Premarket route	Exempt / 510(k) / De Novo / PMA	Manufacturing or import licence (MD-5 / MD-9 / MD-15); clinical investigation for new devices	Conformity assessment → CE mark
QMS requirement	QMSR (ISO 13485-based, 21 CFR 820)	Fifth Schedule (ISO 13485-based)	ISO 13485 / MDR Annex IX
Identification	UDI – GUDID	UDI being phased in; licence numbers	UDI – EUDAMED
Post-market	MDR reports, recalls, 522	MvPI, complaint handling, recalls	PMS, PSUR, vigilance, PMCF
Foreign manufacturer needs	US Agent	Indian Authorised Agent	EU Authorised Representative