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E-BOOK 05 INTERMEDIATE EDITION

Sprinkler System Design Workbook

Hazard Classes, Coverage, Pipe Sizing and Installation Checks

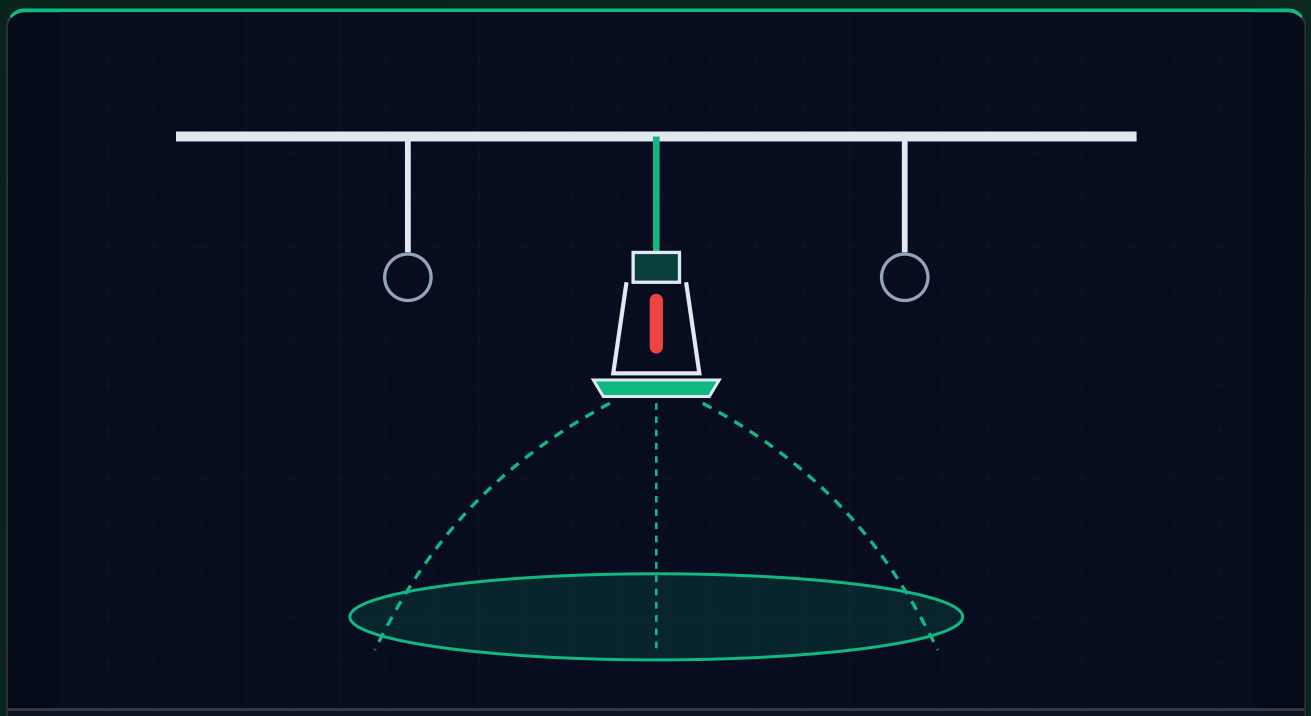


FIG 05.1 — PENDENT SPRINKLER HEAD GEOMETRY & BRANCH HYDRAULIC GRID

SYLLABUS
10 Structured Chapters

CALCULATIONS
Worked SI Examples & Tables

SITE READY
Forms & Hinglish Glossary

Shree Ganesh Enterprises (SGE) — AMC MEP 24x7
Fire Fighting · Fire Alarm · Electrical · Plumbing · HVAC · IBMS · AMC

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Sprinkler System Design Workbook

Hazard Classes, Coverage, Pipe Sizing and Installation Checks

A complete engineering workbook for automatic fire sprinkler systems covering wet, dry, pre-action, and deluge architectures, quartzoid bulb ratings, hazard classifications, hydraulic pipe sizing vs pipe schedules, progressive Hazen-Williams branch balancing, ZCV alarm trim, and safe installation checks.

Intended Audience: Fire fighting design engineers, sprinkler execution supervisors, MEP project managers, and facility teams testing alarm valves and flow switches.

Engineering Notice & Standards Policy

This publication is an educational and field-reference guide prepared by **Shree Ganesh Enterprises (SGE)**. It is **not** a substitute for a stamped project design, statutory approval, or the governing text of the National Building Code of India (NBC), Bureau of Indian Standards (BIS) codes, Indian Electricity Rules / CEA Regulations, or your State/Municipal Fire Service Bye-Laws. Standards are cited at document level; always verify the **current applicable edition**, manufacturer datasheets, and local amendments before design, procurement, testing, or certification.

Worked numerical examples across this book are illustrative engineering demonstrations. All design inputs, pipe friction factors, battery deratings, and protective clearances must be re-checked for project conditions by a competent licensed professional. High-voltage electrical testing, pump-room servicing, and gaseous fire suppression operations can be fatal if undertaken without qualified personnel, written Permits-to-Work, and Lockout-Tagout (LOTO) controls.

Roman-script Hindi/Hinglish site terms are included cleanly to assist execution teams; formal English engineering terminology governs contractual and code interpretations.

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10 Chapter 10: Cheat Sheet, Remote-Area Worksheet, FAQ and Bilingual Glossary

What You Will Learn

- Select Wet, Dry, Pre-Action, or Deluge sprinkler architectures based on building temperature and water sensitivity
- Decode sprinkler head orientations (pendent, upright, sidewall) and glass-bulb temperature colour codes
- Understand Light, Ordinary, and Extra/High hazard design densities and ceiling clearance rules
- Execute progressive Hazen-Williams node balancing across multi-head sprinkler branches
- Verify K-factor flow rates (Q = K * sqrt(P)) and total combined sprinkler + hose water demand
- Inspect Zone Control Valves (ZCV), alarm check valves, flow switches, hangers, and hydrotests cleanly

Chapter 1: Types of Sprinkler Systems and Selection Criteria

Matching System Architecture to Environment

An automatic fire sprinkler system detects heat directly at the seat of a fire through individual thermal elements and applies controlled water spray locally—usually extinguishing or containing the fire using only 1 to 4 heads rather than flooding the entire building. Choosing the correct pipe-filling method prevents freezing, false flooding, or slow response.

System Type	Pipe Condition	Release Trigger	Best Application
Wet Pipe	Always filled with pressurised water	Heat shatters individual glass bulb	Offices, apartments, malls, hospitals, basements (above 4 C)
Dry Pipe	Filled with compressed air/nitrogen	Bulb breaks -> air vents -> dry valve opens	Unheated cold-storage outside chillers, semi-open frosty canopies
Pre-Action	Dry pipe + electric fire detector interlock	Needs BOTH detector trip AND broken bulb (double interlock)	Archives, museums, server corridors, high-value IT rooms
Deluge	Open heads (no bulbs!) on empty piping	Smoke/heat/linear detector opens Deluge Valve -> ALL heads discharge at once	Transformer bays, aircraft hangars, curtain glazing, chemical tanks

NOTE

System design densities, maximum head spacings, and water durations depend on IS 15105, NFPA 13, and NBC 2016 Part 4. Confirm the governing standard, edition, and insurance underwriter rules (e.g., TAC / FM) before freezing design.

HINGLISH

Wet system = pipe mein hamesha paani bhara rehta hai. Deluge system = khule hue nozzles jinme fire detector se signal aane par ek saath tez baarish hoti hai.

Chapter 2: Sprinkler Heads, Deflectors and Bulb Temperature Colour Codes

Every Bulb Colour Tells a Temperature Story

Inside a standard frangible-bulb sprinkler sits a hermetically sealed glass vial containing expanding alcohol-based liquid and a tiny air bubble. As ceiling gas heats the bulb to its rated nominal temperature, expanding liquid shatters the glass, releasing the cap plug against a shaped metal **deflector** that breaks water into a uniform spray umbrella.

Bulb Colour	Typical Nominal Rating (C)	Typical Area Use Case
Orange	57 C	Low ambient spaces
Red	**68 C**	**Standard offices, apartments, lobbies, shops (max ceiling <= 38 C)**
Yellow	79 C	Hotter utility rooms, kitchens away from fryers
Green	93 C	Boiler rooms, sunlit skylight domes, drying areas
Blue	141 C	Over hot industrial furnaces or curing ovens
Mauve / Purple	182 C	Extreme process heat hoods

(Always confirm exact rating on OEM datasheet against local ambient ceiling temperature—never fit a 68 C Red bulb right above a skylight or boiler hood where solar heat can cross 55 C and burst it falsely!)

Orientation Matters

- **Pendent:** Hangs downward beneath false ceiling tiles; spray umbrella points downward.
- **Upright:** Stands upward *above* exposed distribution piping in basements/warehouses; deflector curves spray outward and down around pipe shadow.
- **Sidewall:** Mounts horizontally along room walls for narrow hotel corridors or small cabins.

WARNING

NEVER paint, tape, whitewash, or apply joint compound onto sprinkler bulbs or deflectors! Paint acts as thermal insulation, delays actuation catastrophically, or glues moving caps shut. Replace any painted head immediately!

HINGLISH

Quartzoid bulb = sprinkler mein laga rangin kaanch ka bulb jo garmi se phoot jata hai. Pendent = neeche latakne wala sprinkler. Upright = pipe ke oopar khada sprinkler.

Chapter 3: Hazard Classification, Design Density and Area of Operation

Fires Differ Vastly by Fuel Quantity

You cannot protect a warehouse storing cardboard cartons to 8 metres using the same pipe spacing as a carpeted corporate office. Standards divide buildings by fire severity into hazard classes. The numbers below illustrate **typical engineering practice** from IS 15105 / NFPA 13 concepts—verify exact table limits in the governing document:

Hazard Category (Illustrative)	Typical Buildings	Typical Design Density	Typical Assumed Area of Operation (AMA)
Light Hazard	Offices, schools, hospitals, hotels, residences	~2.25 to 4.1 mm/min	~84 to 139 m2
Ordinary Hazard (OH Group 1–3)	Basement car parks, retail shops, light factories, commercial kitchens	~5.0 mm/min	~144 to 360 m2
High / Extra Hazard	High-piled storage, foam/plastic/paint manufacturing	~7.5 to 12.5+ mm/min	~260 m2+

Remember: **1 mm/min of water density over 1 m2 equals exactly 1 litre/min per m2!** Thus a 5.0 mm/min density requires 5.0 lpm for every square metre in the assumed operating remote zone.

HINGLISH

Design density = har square metre farsh par ek minute mein kitne litre paani girna chahiye. Area of operation = fire pump ko kitne bade area ke sprinklers ek saath khulne par paani dena hoga.

Chapter 4: Coverage Area, Spacing and Clearance from Obstructions

Letting the Spray Umbrella Form Cleanly

Even with high water pressure, placing sprinklers inside deep structural concrete beam pockets or blocking them behind wide HVAC ducts leaves burning dry spots underneath.

Geometric Layout Rules Checklist (Verify Governing Code)

- **Coverage Limit per Head:** Typically ~12 m2 for Ordinary Hazard (e.g., 3.0 m x 4.0 m spacing) and up to ~20–21 m2 max for Light Hazard (lower for High Hazard ~9 m2).
- **Maximum Spacing Between Heads:** Do not exceed maximum spacing limits (commonly ~4.0 m in OH or ~4.6 m in LH) and never space closer than ~1.8–2.0 m without baffle shields (cold-soldering risk: one operating head sprays and cools the neighbour's bulb!).
- **Distance from Walls:** Keep heads within half maximum spacing (commonly <= 1.5–2.0 m) and minimum ~100 mm off wall surfaces.
- **Deflector-to-Ceiling Slab Gap:** Mount upright deflectors closely under ceiling soffit (typically 25–150 mm unobstructed zone; avoid deep heat pockets > 300 mm below roof slab unless concealed ceilings demand drop assemblies).
- **Wide Duct / Cable Tray Rule:** Wherever rectangular HVAC ducts or stacked cable trays exceed typical width (~1.0 to 1.2 m) in basements/industrial bays, provide extra **pendent sprinklers underneath** the obstruction!

HINGLISH

Cold soldering = jab do sprinkler bahut paas lage hon aur pehla sprinkler chalu hokar bagal wale bulb ko thanda kar de. Obstruction = duct ya beam jo spray ko neeche jaane se rok de.