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E-BOOK 04 PRACTITIONER EDITION

Pressure Switch & Pump Controller Field Manual

Cut-in / Cut-out Settings, Wiring, Auto-Start Logic and Failure Diagnosis

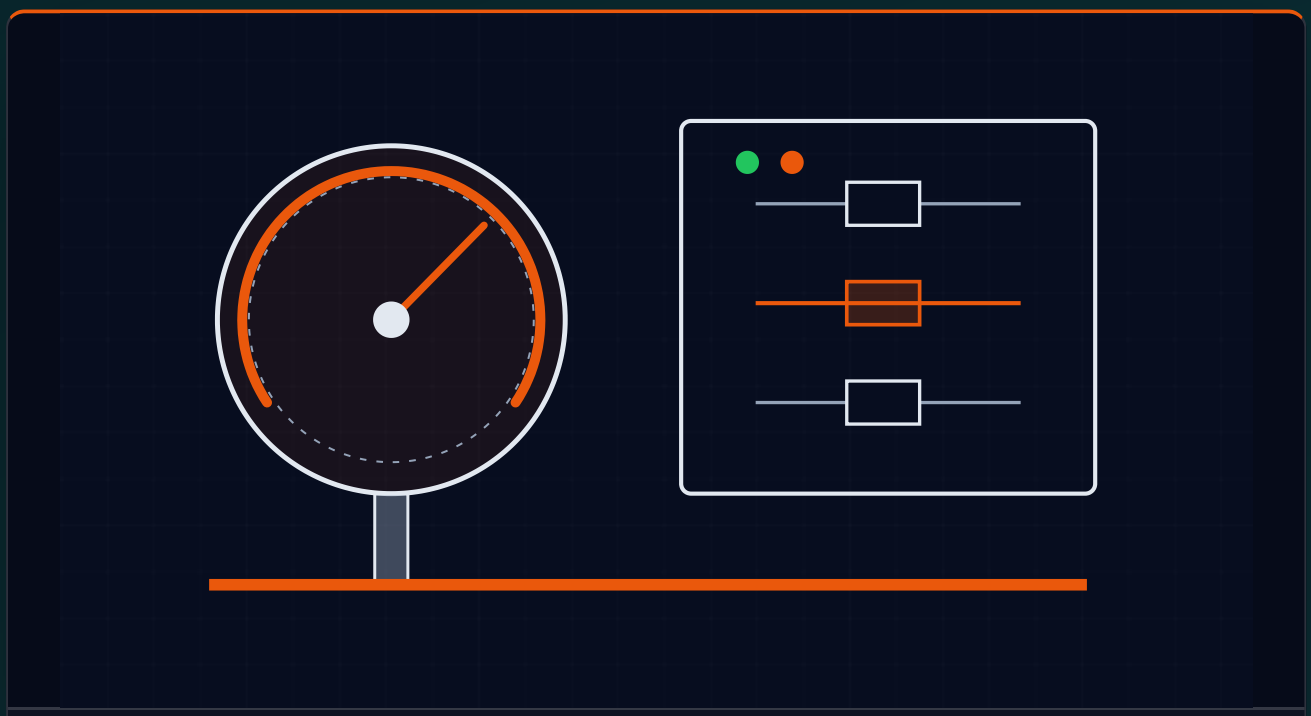


FIG 04.1 — PRESSURE SWITCH MANIFOLD & AUTO PUMP CONTROLLER LOGIC

SYLLABUS
10 Structured Chapters

CALCULATIONS
Worked SI Examples & Tables

SITE READY
Forms & Hinglish Glossary

Shree Ganesh Enterprises (SGE) — AMC MEP 24x7
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Pressure Switch & Pump Controller Field Manual

Cut-in / Cut-out Settings, Wiring, Auto-Start Logic and Failure Diagnosis

A practitioner field manual focused on the fire system's most failure-prone link: the pressure-sensing loop, pressure switch range and differential calibration, cascaded Jockey/Main/Diesel controller wiring, chattering/hunting resolution, and step-by-step multimeter fault diagnosis.

Intended Audience: Fire electricians, pump-house technicians, commissioning engineers, and AMC maintenance teams fixing auto-start failures and jockey short-cycling.

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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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What You Will Learn

- Trace every link in the pressure-sensing chain from main header to pump starter contactor coil
- Distinguish Range Spring vs Differential Spring adjustments and understand NO, NC, and COM terminals
- Calculate safe non-overlapping cascaded Cut-In and Cut-Out settings for Jockey, Main, and Diesel pumps
- Install air-cushioned sensing manifolds with isolation valves, test bleed cocks, and snubbers
- Read control panel Auto/Manual/Off wiring diagrams and verify contactor interlocks safely
- Diagnose jockey continuous running, switch chattering, and dead-start faults with systematic checklists

Chapter 1: Why One Failed Pressure Switch Cripples the Entire System

The Smallest Box Holds All the Authority

You can install a crore-rupee stainless-impeller split-case pump, massive RCC tanks, and a heavy steel wet riser —yet if a compact Rs 2,500 pressure switch fails on its impulse manifold, **not a single pump starts automatically when a fire breaks out**. Worse still, if a switch jams shut, a pump can run endlessly at churn pressure until shaft seals boil and motors burn out.

Every component between the header pipe and the motor starter is a single-point failure link unless installed, set, and tested properly.

The Pressure-Sensing Chain

Link	Component	Failure Mode Observed on Site	Prevention Measure
1	Header Tapping Point	Slag/rust plugs tiny hole on bottom of header	Tap cleanly from **top or side** of header; install isolation cock
2	Impulse Tube / Line	Crushed by ladders, or air-locked loop	Rigid heavy gauge tubing with mechanical guard + clean slope
3	Test Drain & Snubber Valve	No drain cock fitted -> impossible to test switch safely	Always install dedicated 3-way test/bleed manifold & pressure gauge
4	Pressure Switch Mechanism	Diaphragm ruptured or microswitch contact pitted/welded	Periodic full-drop test & replacement every few years per wear
5	Control Wiring & Contactor	Loose ferrule at terminal block, or panel left on MAN/OFF	Crimped ferrules, annual terminal torque check, AUTO key lock

HINGLISH

Impulse line = main pipe se pressure switch tak jaane wali patli nali. Single-point failure = ek chhoti kharabi jiski wajah se poora system fail ho jaye.

Chapter 2: Mechanical and Electrical Anatomy of a Pressure Switch

Inside the Pressure Switch Housing

Most industrial mechanical pressure switches used on Indian fire headers (Danfoss / Honeywell / Indfos styles) operate via two mechanical elements pushing against a snap-action electrical microswitch:

1. **Sensing Element (Bellows or Stainless Steel Diaphragm):** Moves upward cleanly as system water pressure rises.

2. **Range (Main) Spring & Adjusting Screw:** Sets the primary trigger threshold (Cut-Out or Cut-In depending on brand convention—**always read the datasheet engraved directly inside the lid**!).
3. **Differential Spring & Adjusting Screw:** Determines the **deadband width** between switching ON and switching OFF.

> **FORMULA**
> `For standard Upper-Cut-Out / Differential switches: Lower Switch Point (Cut-In) = Upper Switch Point (Cut-Out) – Differential` *(Note: Some brands specify Main Scale as Lower Cut-In and Differential sets Upper Cut-Out = Cut-In + Differential. Always confirm which convention your switch uses before turning any screw!)*

Reading NO, NC and COM Terminals Correctly

Inside the microswitch block sit three terminals:

- **COM (Common):** Live control phase (or 24V DC diesel trigger supply) enters here.
- **NC (Normally Closed — Closed when pressure is LOW / atmospheric):** Opens when pressure rises above the set threshold; **this is the terminal used for fire pump AUTO-START on pressure drop!**
- **NO (Normally Open — Open at atmospheric pressure):** Closes when pressure rises above threshold; sometimes used for high-pressure cutoff or indicator lights.

> **WARNING**
> Confirm whether your microswitch terminal labels refer to the shelf state (0 bar atmospheric pressure = NC closed) and double check with a continuity tester during calibration! Connecting the pump coil to the wrong terminal flips logic completely backward.

> **HINGLISH**
> Microswitch = pressure par tiktik karke bijli on/off karne wala chhota switch. Differential = on hone aur off hone ke pressure ke beech ka faasla (antar).

Chapter 3: Cascaded Pump Start-Stop Settings and Differential Design

Why Overlapping Thresholds Destroy Pumps

Fire pumps must wake up sequentially like staircase steps as water demand increases—never fighting each other at identical pressures.

1. **System Operating / Jockey Stop Pressure:** Highest static + friction design setpoint (e.g., 8.0 bar).
2. **Jockey Pump Cut-In:** ~0.8 to 1.0 bar below Jockey Cut-Out. Jockey starts first on tiny weeping drops and **auto-stops** when restored.
3. **Main Electric Pump Cut-In:** ~0.5 to 1.0 bar *below* Jockey Cut-In so an ordinary faucet drip never pulls an 80-amp electric motor online! **Manual stop only.**

4. **Standby / Diesel Engine Pump Cut-In:** ~0.8 to 1.0 bar *below* Main Electric Cut-In. Kicks in automatically if electric power is dead OR fire demand exceeds one pump. **Manual stop only.**

WORKED EXAMPLE

Cascaded Pressure Settings Schedule (Illustrative). System normal static + header duty pressure = **8.0 bar**. Let's construct a clean, non-overlapping pressure cascade table:

Pump Unit	Pressure Switch Action	Cut-In (Start) Pressure	Cut-Out (Stop) Pressure	Stopping Rule
Jockey Pump	Starts & Stops Automatically	**7.0 bar**	**8.0 bar**	Auto-Stop via Switch (Diff = 1.0 bar)
Main Electric	Starts on Fire/Breakage Drop	**6.0 bar**	Manual Push-Button	**NEVER Auto-Stop!**
Standby Diesel	Starts on Blackout or Heavy Flow	**5.0 bar**	Engine Panel Key/Button	**NEVER Auto-Stop!**

FIELD TIP

Always maintain at least **0.5 to 1.0 bar** deadband separation between steps so pressure gauge bounce and water-hammer ripples never accidentally start the Main Electric Pump during normal Jockey shut-off!

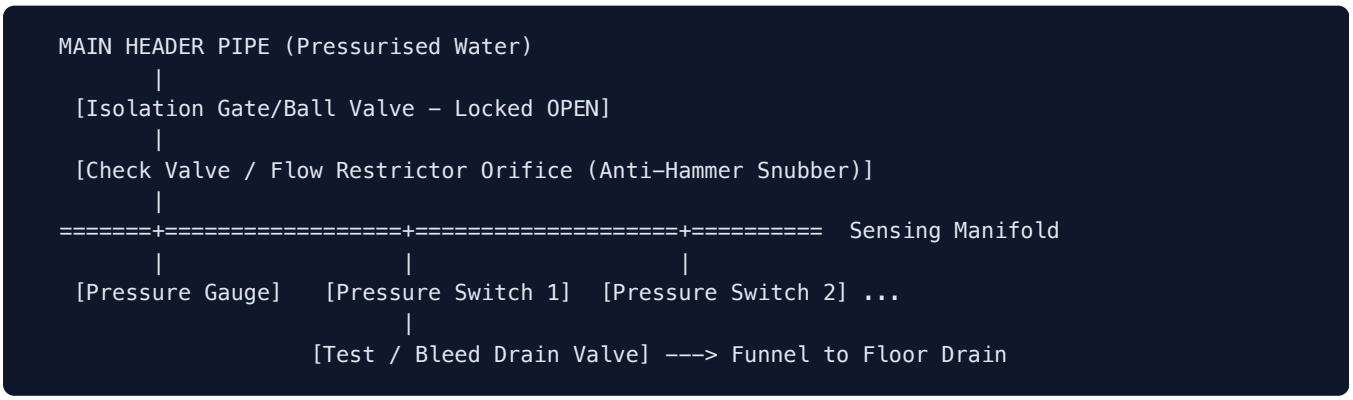
HINGLISH

Cascaded setting = ek ke baad ek seedhiyon ki tarah alag-alag pressure par pumps chalu hona. Deadband = do setting ke beech ka surakshit gap.

Chapter 4: Impulse Line Piping, Snubber, Pressure Tank and Drain Manifold

Building a Serviceable Sensing Tree

Never tap a pressure switch straight off a vibrating pump nozzle without an isolation, dampening, and test-drain arrangement.



Why You Need an Air-Cushioned Hydro-Pneumatic Vessel

Water is almost completely incompressible. Without a small air-charged diaphragm pressure tank (typically 25 to 50 litres pre-charged to near Jockey Cut-In pressure) tied to the header, losing even **one cup of water** drops header pressure by 2–3 bar instantly, making the Jockey chatter on and off every 10 seconds (**hunting**).

> **HINGLISH**
> Pressure vessel / diaphragm tank = hawa bhari chhoti tanki jo paani ka dabav stable rakhti hai aur jockey ko baar-baar chalu-band hone se bachati hai. Snubber = jhatke rokne wala chhota chhed.

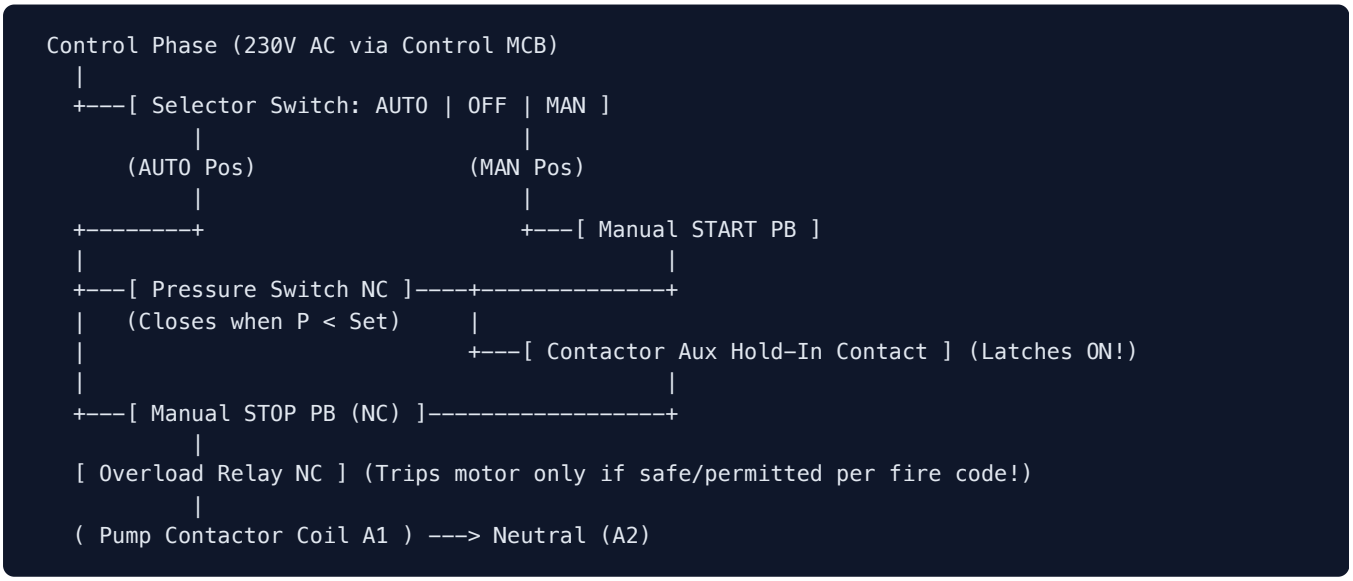
Sensing Manifold Checklist

- ☐ Install a dedicated **calibrated glycerine-filled pressure gauge** directly on the sensing manifold adjacent to the switches (never walk across the room to calibrate!).
- ☐ Verify separate sensing lines or individual test drain valves so each pump switch can be tested independently without dropping whole-building risers.
- ☐ Pre-charge rubber bladder pressure vessel with clean dry air/nitrogen cleanly per OEM sheet when isolated from water pressure.

Chapter 5: Control Panel Wiring — Selector Switches, Contactors and Interlocks

Clean Electrical Control Architecture

Below is a conceptual schematic showing how the pressure switch controls a direct/star-delta electric pump coil cleanly while maintaining mandatory manual stop latching:



Important Note: For life-safety Main Electric Fire Pumps, check governing fire code rules (NBC/NFPA 20) regarding thermal overload tripping vs locked-rotor / alarm-only protection! Never wire domestic non-fire overload cut-outs blindly where code prohibits tripping during emergency fire demand.

WARNING

High voltage (415V 3-phase and 230V control) resides directly behind panel doors. Engage Lockout-Tagout (LOTO) at main incomer MCB/MCCB and test with a calibrated multimeter before touching terminals! Qualified licensed electricians only.

HINGLISH

Hold-in latching = ek baar chalu hone ke baad dabav wapas badhne par bhi pump ko band na hone dene wala wiring lock. Manual stop only = haath se button dabane par hi pump band hoga.

Chapter 6: Step-by-Step Field Calibration Procedure

Safe Calibration Using Test Drain & Gauge

1. **Permit & Inform:** Log work at security/control desk; keep building risers pressurised; switch Main & Diesel selectors strictly to **OFF/SAFE** temporarily ONLY while calibrating their individual switches (restore to AUTO immediately upon completion!).
2. **Verify Static Datum:** Check static header gauge matches Jockey Cut-Out (e.g., 8.0 bar).
3. **Close Main Manifold Isolation Valve Slowly** isolating ONLY the switch branch under test (keep building main pressurised!).
4. **Crack Open Test Bleed Valve Very Gently:** Watch the local manifold pressure gauge creep downward slowly (`0.1 bar/sec`). Do NOT slam open—rapid drops trigger overshoot reading errors.
5. **Observe Exact Click Point:** Record the gauge bar pressure the instant continuity triggers across `COM` – `NC` (use multimeter buzzer mode on dead control terminals or verify panel pilot light).

WORKED EXAMPLE

Range vs Differential Adjustment Arithmetic (Illustrative). A brand-new pressure switch claims on its faceplate: **Range scale sets Upper Cut-Out; Differential sets width downward**. Target Jockey settings: Start = **7.0 bar**, Stop = **8.0 bar**.

Target Cut-Out = 8.0 bar -> Turn main **Range screw** until indicator points to 8.0 bar. Required Differential = Cut-Out - Cut-In = `8.0 – 7.0 = 1.0 bar` -> Turn **Differential screw** until differential pointer matches 1.0 bar. Live Bleed Check: Open bleed drain slowly -> Microswitch MUST click closed at **7.0 bar**. Close drain -> As jockey restores header pressure, switch clicks open at **8.0 bar**. If click occurs at 7.3 bar instead of 7.0, widen differential by +0.3 bar and repeat 3 consecutive trials!

HINGLISH

Bleed cock kholna = thoda sa paani nikal kar pressure dheere-dheere girana taaki switch ki asli setting check ho sake.

Chapter 7: Fixing Jockey Hunting, Chattering and Continuous

Running

Stopping Nuisance Motor Burnouts

Jockey pumps fail predominantly from rapid start-stop cycling (**hunting/chattering**) or endless running without reaching Cut-Out.

Symptom Observed	Primary Technical Root Cause	Exact Engineering Cure
Starts every 1–3 minutes, runs 5 seconds, shuts off (**Hunting**)	Dead/waterlogged bladder pressure tank OR differential band too narrow (e.g. 0.2 bar)	Isolate tank, drain water, re-charge air bladder; widen differential >= 0.8–1.0 bar
Switch relay buzzes loudly (**Chattering**) at trigger point	No orifice snubber on sensing line -> pump pulsation shakes diaphragm violently	Fit threaded brass flow-snubber restrictor or needle valve throttled slightly ahead of switch
Jockey runs non-stop and gauge stalls at 6.5 bar (Cut-out 8.0)	Major underground yard leak, stuck open drain valve, or passing Jockey NRV/foot valve	Isolate risers one-by-one to isolate leak section; check Jockey NRV flapper
Jockey reaches 8.0 bar instantly when Main Pump idle -> then drops immediately	Main pump or Diesel pump NRV passing water backwards into tank through pump	Isolate Main/Diesel delivery valve briefly; if header stops dropping -> overhaul NRV!

WORKED EXAMPLE

Jockey Leak Diagnosis Check (Illustrative). Air-charged diaphragm vessel releases **12 litres** of reserve water between 8.0 bar Cut-Out and 7.0 bar Cut-In. Site log shows the Jockey runs automatically every **8 minutes**.

System leakage rate = Drawdown Volume / Interval Time = `12 litres / 8 minutes = 1.5 lpm`. Next test: Close the Zone Isolation Valve feeding the yard ring main for 15 minutes. If Jockey suddenly stops hunting for hours, the **1.5 lpm underground leak** sits somewhere on that yard hydrant circuit (suspect underground flange gasket or weeping hydrant gland!).

HINGLISH

Hunting / Chattering = switch aur motor ka baar-baar jhatke se chalu-band hona. Foot valve / NRV pass hona = pipe ka paani ulta wapas tanki mein chala jaana.

Chapter 8: Systematic Fault-Diagnosis Flowcharts & Multimeter Checks

Decision Tree 1: System Pressure Dropped Below 4.0 bar, Yet Main Pump Did NOT Start

Walk sequentially down these numbered steps (use insulated probes and LOTO safely):

1. Check panel selector switch -> Is it on **AUTO**? (If left on MAN/OFF, fix human error immediately).
2. Check control circuit MCB / control fuse inside starter panel -> Is control 230 V power live?

3. Inspect pressure gauge right beside the switch -> Does local switch gauge read 4.0 bar, OR does it read 8.0 bar while header gauge reads 4.0 bar? (If switch gauge reads high while main dropped -> **Isolation valve closed or sensing orifice plugged with rust!**).
4. Isolate panel control voltage and disconnect `COM/NC` leads -> Measure continuity across `COM–NC`. Is it **0 Ohm (closed)** at 4.0 bar? If Open Line (`OL`) -> **Diaphragm seized or microswitch burned -> replace switch!**
5. If switch closes cleanly at 4.0 bar -> Track 230 V phase wire downstream cleanly through Overload Relay `95–96` NC contact to Contactor Coil `A1`. Find broken terminal ferrule or burned contactor coil.

Decision Tree 2: Main Electric Pump Starts, Pressure Reaches 8.5 bar, Yet Pump Never Stops on Stop Button

1. Inspect `STOP` Push-Button `NC` block -> Stuck plastic plunger or bridged jumper wire inside panel?
2. Check contactor mechanical armature -> Heavy short-circuit arc welded silver power contacts shut (**welded contactor**)!
3. Action: Trip upstream incomer MCCB **only under emergency isolation**, lockout, replace welded main contactor and inspect motor phase currents!

Chapter 9: Periodic Testing, Maintenance Templates and Calibration Register

Printable Pump Controller & Pressure Switch Calibration Tag Log

Keep a laminated copy inside the pump house panel door:

Tag ID	Controlled Unit	Sensing Header	Set Cut-In (bar)	Set Cut-Out / Mode	Date Calibrated	Actual Measured Drop Test (bar)	Tested By	Next Due Date
PS-01	Jockey Pump	Common Header	7.0 bar	8.0 bar (Auto Stop)	_____	_____ / _____ bar	_____	_____
PS-02	Main Electric	Common Header	6.0 bar	Manual Stop Only	_____	_____ bar (Start)	_____	_____
PS-03	Diesel Engine	Common Header	5.0 bar	Manual Stop Only	_____	_____ bar (Start)	_____	_____
PS-04	Terrace Booster	Terrace Line	2.5 bar	3.5 bar (Auto Stop)	_____	_____ / _____ bar	_____	_____

Quick Pressure-Switch PM Checklist

- ☐ Exercise sensing isolation & bleed valves monthly so brass stems do not seize.
- ☐ Drain condensation/sediment cleanly out of bottom sensing pockets.
- ☐ Verify panel selector stays strictly in **AUTO** with pilot healthy lamps lit.
- ☐ Check contactor contacts annually for carbon pitting or loose control ferrules.

Chapter 10: Cheat Sheet, FAQ and Hinglish Instrumentation Glossary

Golden Control Formulas & Rules

- **Safe Cascade Rule:** `P_jockey_cutout > P_jockey_cutin > P_main_cutin > P_diesel_cutin`
- **Minimum Separation:** Always keep `>= 0.5 to 1.0 bar` spacing between consecutive pump start points.
- **Main & Diesel Pumps:** Connect via **Hold-In Auxiliary Latching Contact** -> starts via `NC` switch drop -> stops **ONLY** via manual Stop Push-Button!
- **Jockey Pump:** Controlled directly by `COM–NC` differential window -> stops automatically when upper setpoint clears.

Frequently Asked Questions (Site Controls)

1. **Why did my Main Electric Pump burn its starter contactor?** Usually a loose main power terminal, low supply voltage, or missing pressure vessel causing rapid Jockey/Main overlap chattering.
2. **Can one pressure switch trigger both Electric and Diesel pumps?** Never! Use independent, physically dedicated pressure switches for each pump so a single failed switch never blinds both primary and standby sources.
3. **Why is a glycerine-filled gauge mandatory on the test manifold?** Pump vibration destroys dry gear-teeth gauges within weeks and makes needles bounce too fast to read exact click pressures.
4. **How do I know whether to wire `NO` or `NC`?** At zero atmospheric pressure (during wiring bench test before pressure is applied), a pump must **start** -> so pick the contact pair showing Continuity (`NC` to `COM`) when idle!
5. **Can I use a digital pressure transmitter instead of a mechanical switch?** Yes, in modern PLC/UL listed panels—provided the transducer fails safely and drives dedicated relay thresholds clearly; always maintain physical gauge validation alongside.
6. **Why does the Diesel engine attempt 3 crank cycles and lock out?** Fuel solenoid jammed, air lock in diesel injector line, or depleted battery bank cranking below starter minimum volts.
7. **Should thermal overload trip the Main Fire Pump?** Standards generally warn against tripping off life-safety fire pumps on minor overload unless locked-rotor backup is engineered per NFPA 20/NBC rules—always confirm your panel spec sheet!
8. **What happens if someone puts Teflon tape across the pressure-switch inlet hole?** Loose shreds block the tiny sensing orifice -> reading freezes at 8 bar even when hydrant opens! Keep tape strictly 2 threads back from pipe end.
9. **What is the use of a 3-way gauge cock?** Allows isolating, bleeding air/water safely, and venting gauge zero to atmosphere without shutting down the pump room.
10. **How long can a fire header sit idle without opening bleed valves?** Never go past 30 days; sediment settles directly inside vertical downward sensing loops.
11. **Does elevation change pressure switch readings?** Yes—every 10.2 m of water column equals ~1.0 bar! A basement pump panel reads ~1.0 bar higher static pressure than a ground-level gauge 10 m above it.
12. **Who can alter cut-in/cut-out screws inside the panel?** Only authorized commissioning or AMC technicians; unauthorised tampering should be blocked using tamper seals or locked switch housings.

Hindi–English Bilingual Glossary

English Term	Hinglish / Site Hindi	Technical Meaning
Pressure switch	Dabav se chalne wala switch	Electro-mechanical pressure contact device
Cut-in pressure	Chalu hone ka pressure	Lower pressure threshold where pump starts
Cut-out pressure	Band hone ka pressure	Upper pressure threshold where jockey stops
Differential	On aur off ke beech ka antar	Pressure deadband width between start and stop
Range screw	Mukhya dabav setting screw	Screw setting the baseline threshold scale
Microswitch	Chhota snap switch	Rapid-action electric contact inside switch
Normally Closed (NC)	Aam halat mein juda hua contact	Closed when pressure drops below set value
Normally Open (NO)	Aam halat mein khula contact	Open when pressure is below set value
Common (COM)	Mukhya taar jodne ka point	Input terminal feeding NC and NO
Impulse line	Pressure pahunchane wali patli line	Small diameter sensing tube from main pipe
Snubber / Orifice	Jhatka rokne wala chhota chhed	Flow damper shielding diaphragm from surges
Bleed cock / Test valve	Test ke liye paani nikalne ka valve	Small valve dropping pressure locally to check start
Hydro-pneumatic tank	Hawa aur paani ki tanki	Pressure cushion tank stopping short cycling
Hunting / Short cycling	Baar-baar tezi se chalu-band hona	Excessive start frequency due to leaks or narrow band
Chattering	Relay ya contactor ka thartharana	Rapid vibrating contact make-and-break
Selector switch (A/M/O)	Auto-Manual chunnane wala switch	Switch picking Automatic or Manual mode
Contactor	Pump chalane wala bada magnetic switch	Power relay connecting motor phases
Auxiliary hold-in contact	Lock karke rakhne wala chhota contact	Maintains coil latched after start trigger clears
Overload relay	Motor zyada current par bachav	Thermal/electronic current sensor
Terminal ferrule	Taar ke sire par laga plastic/copper cap	Numbered sleeve ensuring tight reliable connection
Continuity test	Multimeter se taar janch	Buzzer check confirming unbroken electrical path
Passing NRV	Ulta leak hone wala NRV	Faulty check valve letting pressure bleed back
Locked-rotor current	Jaam motor ka heavy current	High stall amps if impeller freezes
Auto-start latch	Khud chalu hokar atka rehna	Control state keeping main pump running until reset
Tamper seal	Chhed-chhad rokne ki seal	Wire seal proving settings remain untouched
Pre-charge pressure	Tanki ke bladder mein bhari hawa	Dry air pressure inside empty expansion tank

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02 Fire Protection Design Handbook
03 The Fire Pump House Manual
04 **Pressure Switch & Pump Controller Field Manual**
05 Sprinkler System Design Workbook
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07 Special Hazard Suppression Guide
08 Fire NOC & Building Approval Playbook
09 Fire Extinguishers, Home & Office Safety
10 Cable Sizing, LT Panel & Short-Circuit (kA) Guide
11 HT Cable Hi-Pot Testing & Fault Location
12 The Site Engineer's Calculation Handbook

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