화학공학 마스터즈 심포지엄

스팀 터빈 Trip Valve의 Reaction Time 개선 사례

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1. Introduction

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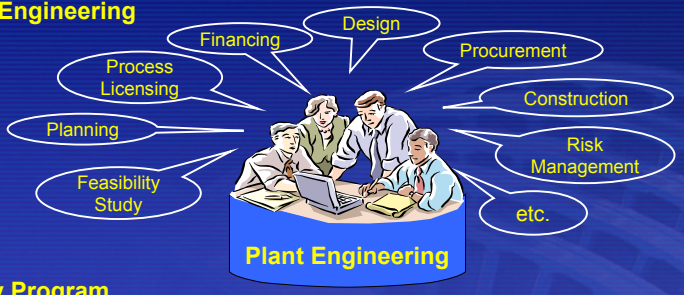
Plant Engineering



Safety Program

Trip Signal → Machine Trip → Standby Start-up → Trouble Shooting

- Unspared machine? → • Plant shut down. Plant start-up after trouble shooting
  • If not, long period plant shut down due to fatal machine damage

Site Modification

Deviation between design and actual one → Modification at Site

Experience sharing : modification of reaction time for steam turbine trip valve

2. Steam Turbine General

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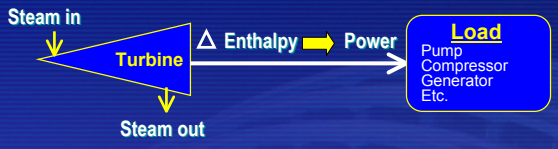
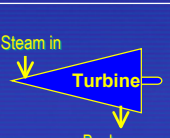
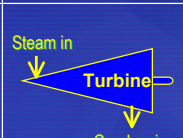
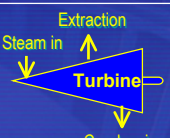
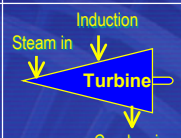
Principle ;



Type

Back pressure type	Condensing type	Extraction type	Induction type
			

Control Device

(Example : Woodward)

	Mechanical type	Electronic type
Governor	TG, PG, PG-PL, UG	Peak150, Micronet TMR, 5009, …
Overspeed trip	Manufacturer's standard	ProTech203

3. Steam Turbine Trip System

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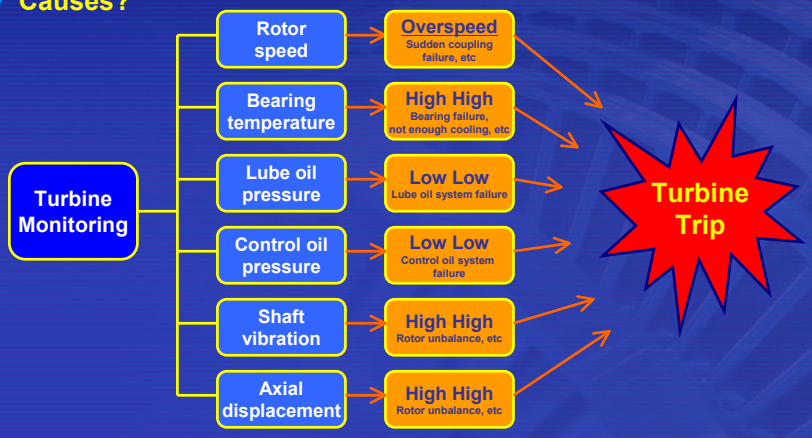
Why & How?

-. Trip system is required for the protection of steam turbine

-. Steam supply is shut off by closing trip valve immediately

Causes?



4. Trip Device

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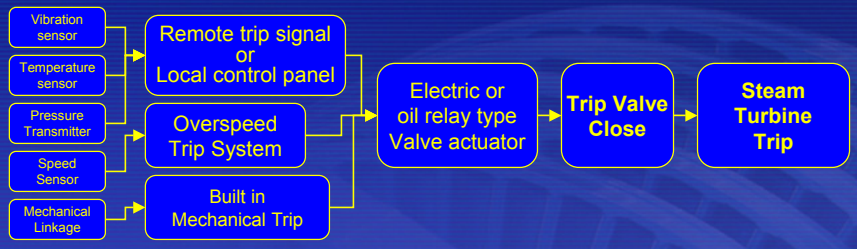
Trip Process



Example of overspeed trip device

ProTech203

-. Manufacturer : Woodward

-. Electronic overspeed trip device

-. Actuated by remote trip signal

-. Redundancy design (2oo3 voting)

(Digital overspeed trip controller)

5. Malaysia Project Experience

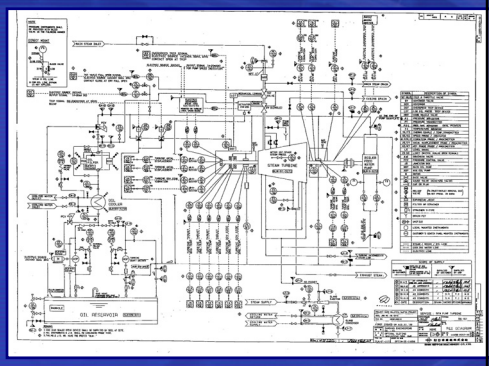
- **Project 개요**
  - -. Ethylene Plant (600,000 MTPA), Licensor : Linde AG
  - -. Client : Petronas/UCC Joint Venture
  - -. Site : Kerteh, Malaysia, Year of Completion : 2001
- **Steam Turbine short specification**

1. OLM-GT-1571

- -. Quench Water Pump Turbine
- -. API 611, 430 kW, 3590 rpm
- -. Back Pressure Type
- -. Vendor : Shin Nippon Machinery

2. OLM-GT-3171

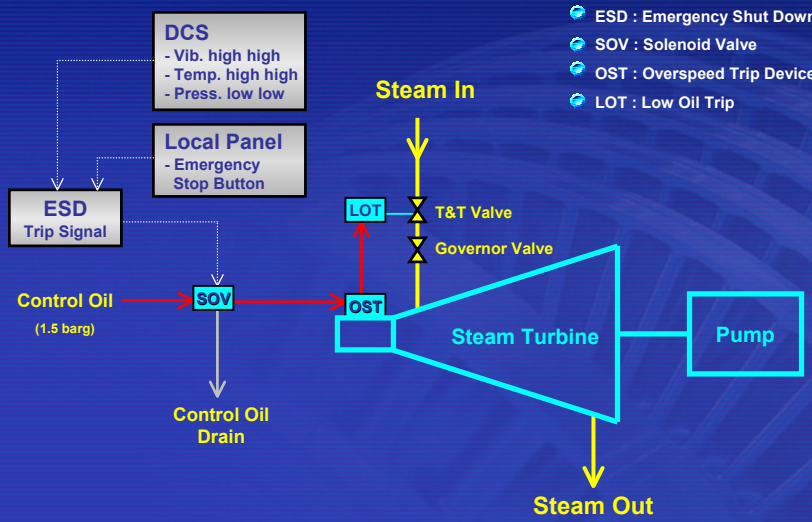
- -. Boiler Feed Water Pump Turbine
- -. API 611, 1958 kW, 4000 rpm
- -. Back Pressure Type
- -. Vendor : Shin Nippon Machinery



<P&ID for OLM-GT-3171>

6. Schematic of Trip Mechanism

- DCS : Distributed Control System
- ESD : Emergency Shut Down
- SOV : Solenoid Valve
- OST : Overspeed Trip Device
- LOT : Low Oil Trip



7. Trouble Detail

- **Trip valve reaction time**
  - -. Time interval between overspeed trip detection and trip valve closure
  - -. The shorter, the better
- **Acceptance Criteria**
  - -. ASME PTC 20.2 : Test code for the decision of overspeed trip response time
  - -. It depends on steam condition, load, vendor's model
  - -. Vendor information during design stage : 1 second
  - -. Engineering practice is around 1 second
- **Actual test after installation at site**

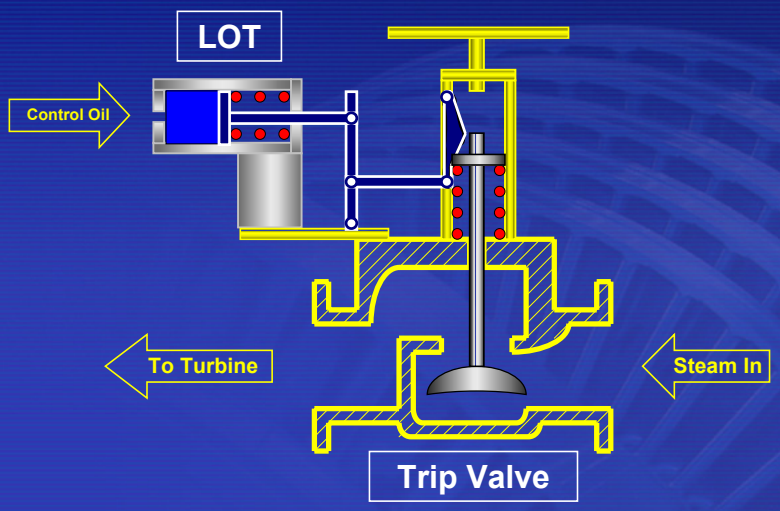
  Trip valve reaction time : 2.0 sec → **Not Acceptable**
- **Analysis of the cause**

  Time for electric cabling and ESD system < 0.1 second

  ↓

  Quick control oil drain from LOT is inevitable ⇒ **How to drain quickly?**

7.1 Trip Valve Mechanism



7.2 Trouble Shooting Ideas

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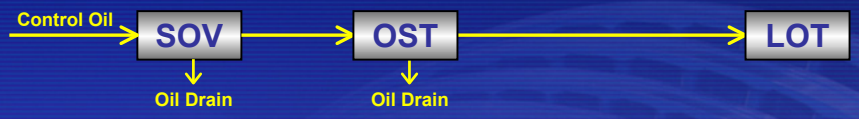
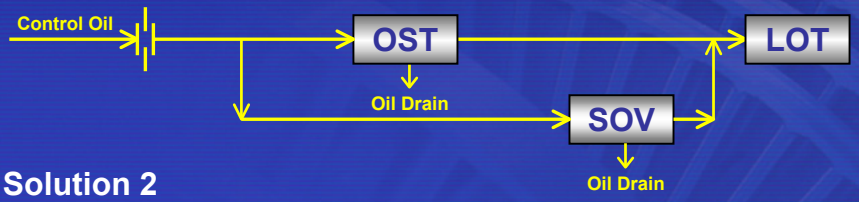
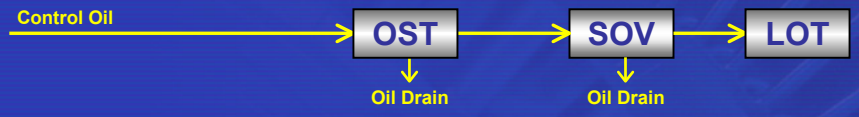
Original System



Solution 1



Solution 2



7.3 Selected Modification Method

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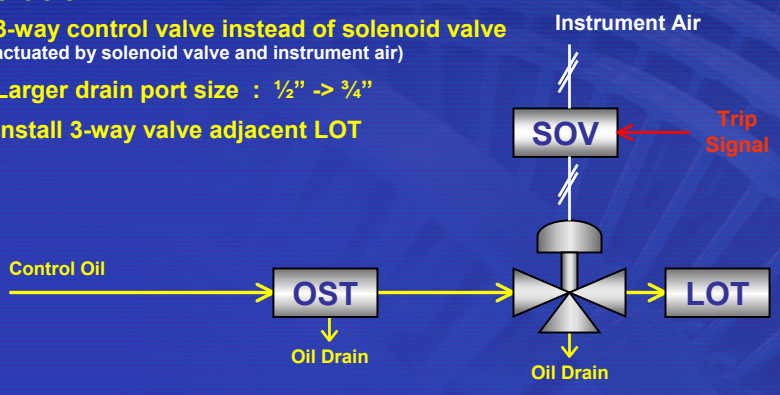
Solution 1 → Not chosen

Function time is not so short because oil in piping between OST and LOT shall be released from solenoid valve.

Solution 2 → Selected with modification

- 3-way control valve instead of solenoid valve
  (actuated by solenoid valve and instrument air)
- Larger drain port size : ½" -> ¾"
- Install 3-way valve adjacent LOT



8. Final Test Result

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Test Record (OLM-GT-3171)

TEST ITEM		Unit	DESIGN VALUE	TEST RECORD			RESULT
Governor Changeable Speed Range Check	Max. speed	rpm	4203 ± 42	4203			Good
	Min. speed	rpm	3403 ± 34	3402			Good
Governor No-Load Stability Check		rpm	± 0.25% of total speed (i.e. 21 rpm)	5			Good
Overspeed Trip Test	Mechanical	rpm	4623 ± 92	4583	4561		Good
	Electrical	rpm	4476 ± 44	4471			Good
Hand Trip Test		-	-	Good			Good
Remote Trip Test (Trip Valve Reaction Time)		sec	1 sec	0.6	0.67	0.7	Good
Limit Switch Check	For T&T Valve Open Signal	-	-	Good			Good
	For Overspeed Trip Signal	-	-	Good			Good
Oil Filter Changeover Check		-	-	Good			Good
Leakage Check of Steam and Oil		-	-	Good			Good

Result

Trip valve reaction time : 2.0 sec → 0.7 sec, 0.68 sec