OpEx Shared Practice & Applied Practice

ชื่อโครงการ : Repair Caterpillar G3516NA Gas Engine water ingested

บริษัท : PTTEP

คณะทำงาน

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วันที่ 31 กรกฎาคม 2562

1. Key Word (Taxonomy)

Project Type	Maintenance
Business Line	Exploration & Production
Operational Function	Maintenance and Inspection
Operational Unit	Bongkot Well Head Platform 06
Equipment Type	Gas Engine
Product Group	Booster Compressor

2. Project Details

No.	Title	Details
1	Project Name*	(English*) Repair Caterpillar G3516NA Gas Engine water ingested inside crankcase (Thai) การซ่อมน้ำรั่วภายในเครื่องยนต์แก๊ส Caterpillar รุ่น 3516NA
2	Objective*	To repair water ingested into engine crankcase due to manifold plug o-ring deteriorate and extend engine change out for almost 3 years
	Project Type *(please select)*	◉ Operation [โครงการที่เกี่ยวข้องกับ core operation ของบริษัท ซึ่งส่งผลโดยตรงต่อประสิทธิภาพหรือประสิทธิผลของการผลิต] ○ Operation-support [โครงงานที่สนับสนุนและส่งผลโดยตรงต่อการดำเนินงานของสายปฏิบัติการ/ธุรกิจหลัก อาทิ โครงการที่เป็นกิจกรรมในสายโซ่อุปทาน (supply chain) ซึ่งได้แก่ Procurement, Inventory, Logistic, Sale & Marketing]
3	Executive Summary*	WP06 gas engine was informed water ingested inside engine crank case around end of april. Later, it was found that water leak from manifold plug underneath gear cluster (shaft-gear plate) due to plug O-ring deteriorate. After replace plug O-ring, unit was back on service. Repair water ingested into engine crankcase due to manifold plug o-ring deteriorate and extend engine change out for almost 3 years.
3.1	Detail	WP06 was tripped with water surge tank low level function, and found lube oil mixed with cooling water. Later, during cylinder block pressurize test, it was found cooling water droplets seeping between gear cluster, inside flywheel housing, rear end. Thus, WP06 gas engine was decided to replace plug O-ring instead of remove engine to overhaul onshore, which is very high cost. 

Figure 1: Lube oil mixed with cooling water inside engine crankcase

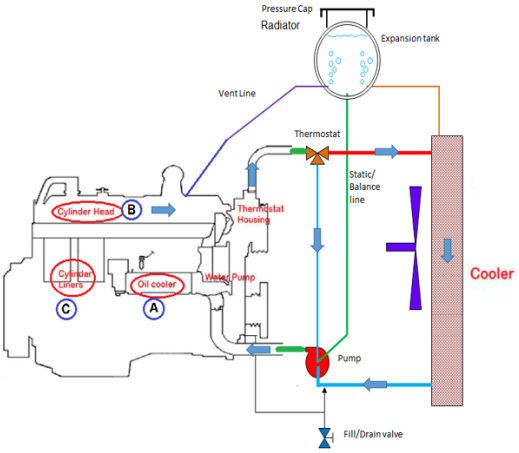


Figure 2: Cooling water flow diagram

To make more clarification on water leak problem, figure 2 shown cooling water flow diagram. Cooling water flow in cycle. Cooling water is top up intocooling system at expansion tank, then it is pressurized by jacket water pump which driven by engine crankshaft, flow to transfer heat from engine oil at oil cooler, through cylinder liners, cylinder heads and exhaust manifold. If the cooling water temperature still not reach thermostat working temperature (80 °C approximately), it will recirculate to jacket water pump suction. Once water temperature reached thermostat working temperature, thermostat will be open to make cooling water flow to cooling down though radiator (fin fan cooler, also driven by engine crank shaft).

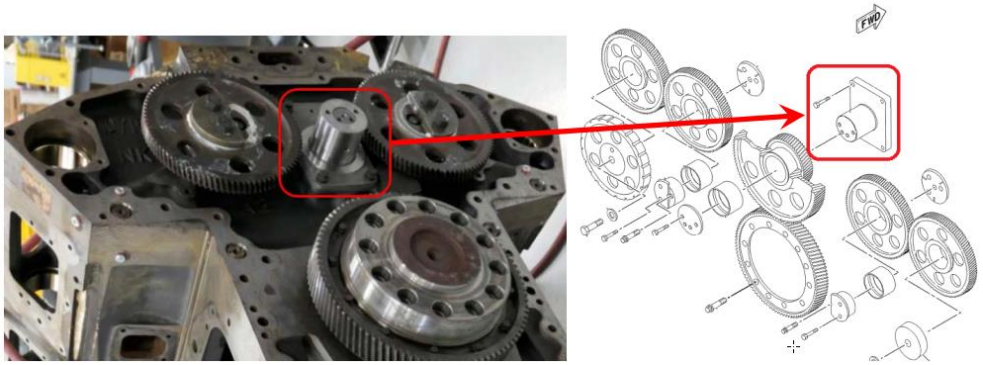
Cooling water can be leak into oil system at:

- Oil cooler
- Around liner and engine cylinder block area (included inside flywheel housing and housing front)
- Cylinder head, incas of cracked
- Exhaust manifold

In this case, it was leak at water manifold plug as shown in figure 3, while figure 4 shown combined water path of cylinder liner and manifold plug.

Figure 3: Water droplets seeping at gear cluster rear end during pressure test

Figure 4: Path conneting between manifold plug and cylinder liner in cylinder block



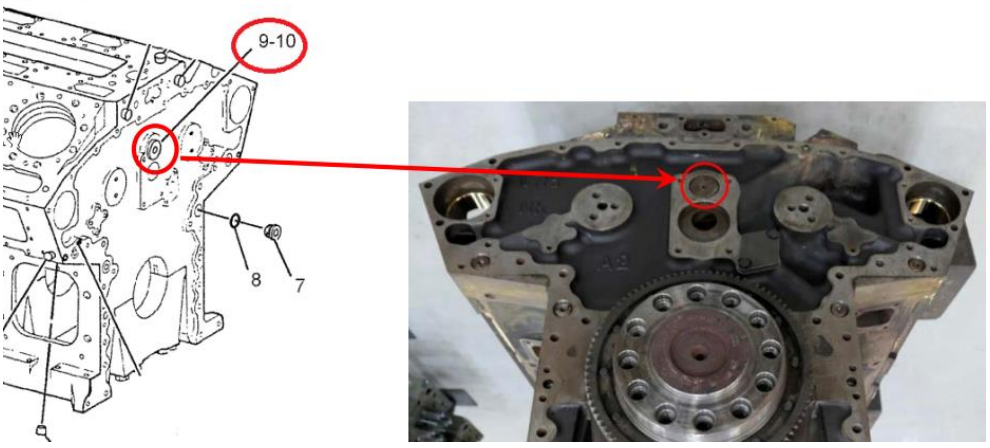


***Figure 5**: Water manifold plug location front and rear*

The location of manifold plug are underneath gear clusters, both front and rear side, for O-rings replacement, it is needed to disassemble housing and gears prior remove cluster and pull out the plugs.

To find out leaking point, it is required cylinder block pressure test up to 70 psi. Figure 5 shown spade point with rubber gasket.

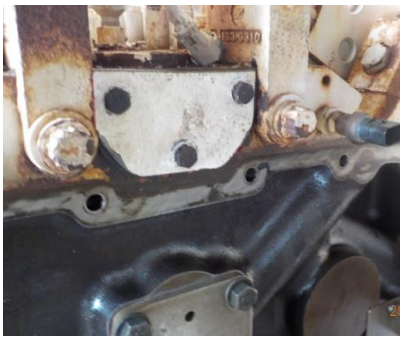



Figure 5: Spade points for pressure test

Condition of manifold plug O-rings after removal found deteriorated O-rings display in figure 6.


Figure 6: Plug O-rings condition front and rear respectively

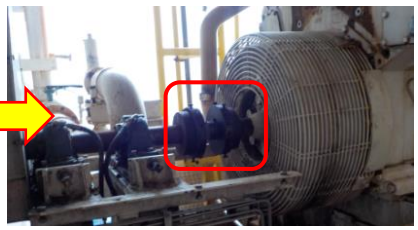
Finally, WP06 has decided to replace manifold plug O-rings onsite to be extend engine change out to meet target at 72,000 running hour (currently is 57,378 hrs base on Jul 4th 2019), and minimize operational cost.

4	**Best Practice Process / Procedures***	1. Unit shut down, isolate fuel and starting gas. 2. Erect scaffold for coupling and cover lifting 3. Drain out cooling water and lube oil 4. Mark up instrument and disconnect instrument sockets which obstruct housing removal, included ignition primary harness     5. Disconnect alternator power cables  6. Remove gas starter

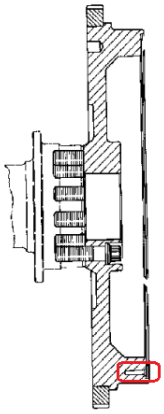

7. Remove couplig and fan shaft guard

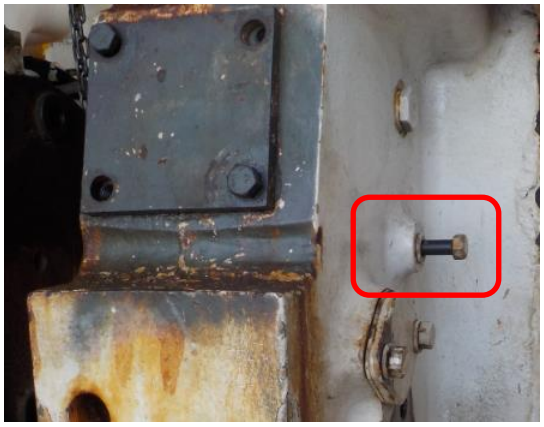


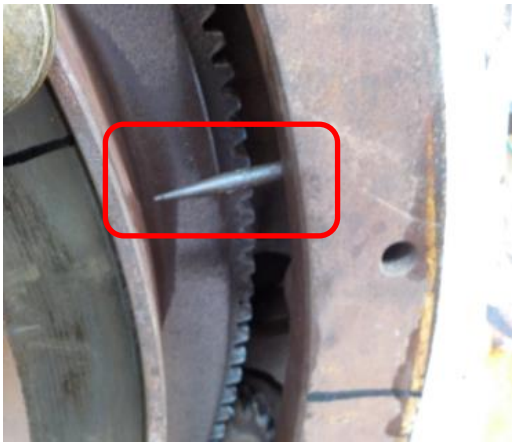
8. Remove drive coupling and fan shaft

9. Bar the engine to make 1st piston reach top dead center (TDC) at compression stroke, recheck position with flywheel marked hole, and timing indicator pin.



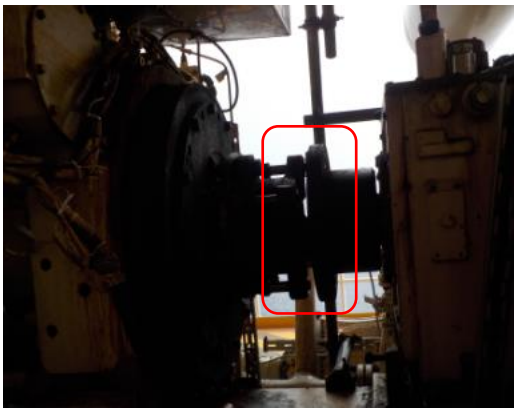




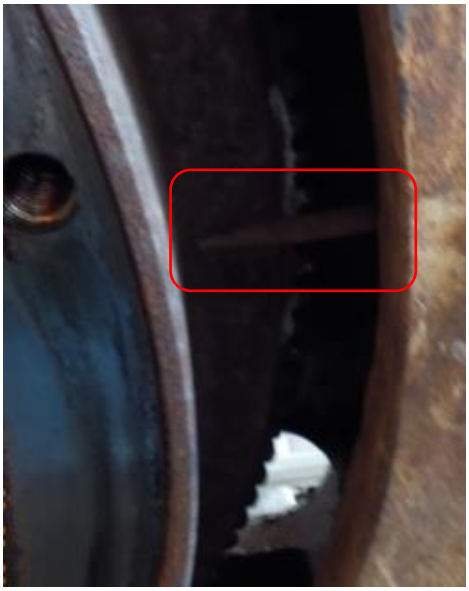
10. Lock camshaft with timing plate which equipped inside rear end camshaft cover both side, to prevent camshaft rotation.

11. Remove stub shaft and vibration damper. During remove stub shaft it is need to counter torque or fix flywheel, otherwise it need to yank flywheel with flywheel housing or skid.

12. Remove compressor couling by remove discs first. For ease to transfer coupling, inertia ring and flywheel to safe area, it is recommended to install 2 chain hoist with lifting structure (scaffold).



13. Remove speed magnetic pick up and timing indicator to avoid damage



14. Remove inertia ring by lifting with lifting bracket

15. Remove flywheel, install guide bolt to support flywheel while removing

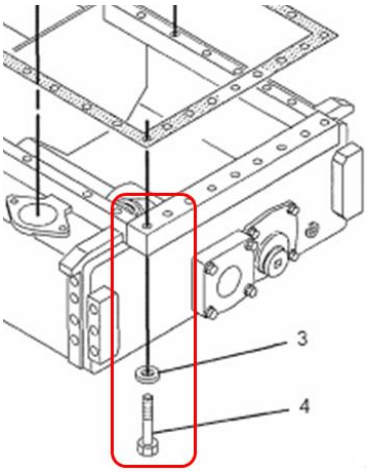
16. Remove lube oil filter bracket

17. Remove front gear drive accessories and oil pump

18. Remove camshaft drive ear both side with pulley remover

Caution: Gear might bounce violently, be careful during operate puller

19. Remove all bolts which attached front cover and flywheel housing to cylinder block and oil pan



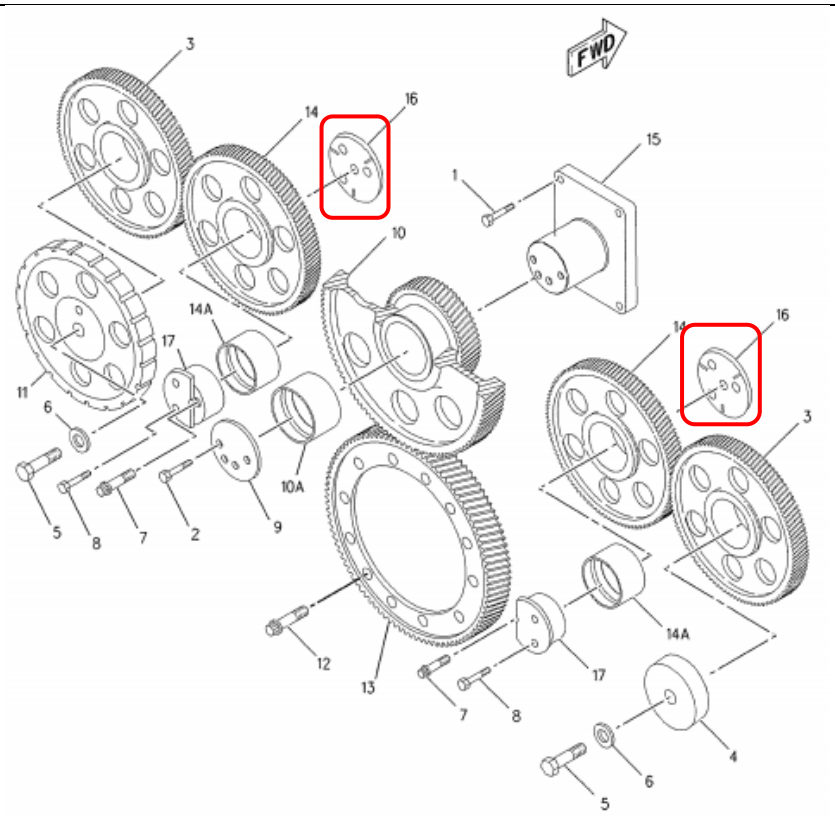
20. Remove front cover and flywheel housing

Front Cover:

Flywheel housing:

21. Remove all 3 idler gear at the rear end

Caution: Be careful washer thrust behind idler gear dropped and damaged



22. Remove shaft-gear (cluster or plate)

Front end:

Rear end:

23. Pull out manifold plug by slide hammer or bolt and socket

Front end:

Rear end:

24. Clean water manifold, prepare for install plug after replace o-ring

Front end:

Rear end:

25. Replace plug o-ring both plugs

26. Install manifold plug together with RTV applied, both ends

Front end:

Rear end:

27. Install shaft-gear (cluster or plate) both ends

Front end:

Rear end:

28. Clean crank case prepare for pressure test

29. Clean oil pump strainer

30. Replace cylinder blockside door seal

31. Leave RTV dried, then top up coolant and pressure test, step up to approx. 60 psig to confirm no other leak points

Spade point for pressure test

Cooling water inlet to cylinder block - right rear end

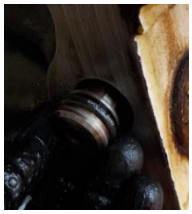
Cooling water inlet to cylinder block - top front end

Cooling water outlet to cooler and bypass - top front end

Step pressure test up to 60 psi



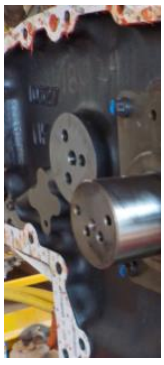
32. Replace all oil plug o-rings

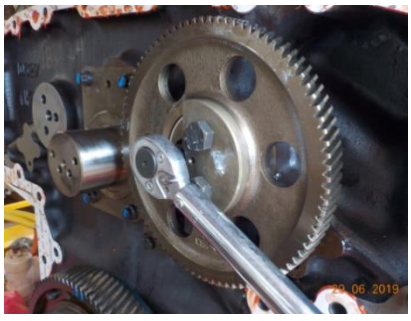
33. Replace crankshaft wear ring both end by punhing and yank out both front and rear end

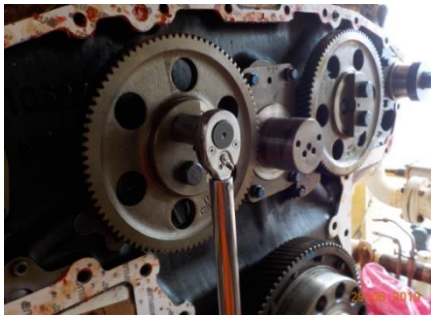

34. Removeve crank shaft seal from front drive cover and wlywheel cover

35. Install gasket to cylinder block, both front and rear end



36. Install idler gear rear end





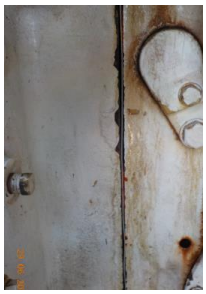

37. Apply RTV on gasket, then install front drive cover and flywheel cover, torque all bolts which attache covers to cylinder block and also oil pan

Front drive cover


Flywheel cover





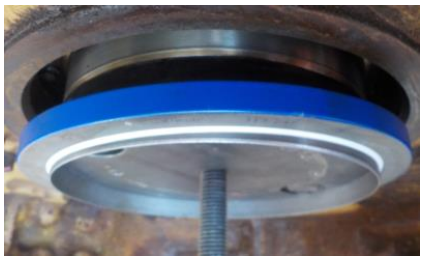



38. Install crankshaft seal into front drive housing and flywheel housing.
    Crankshaft sleeve and shaft seal come together as one part number, it is required special tool to install to the crankshaft, and
    it is needed to knok special tool to push sleeve and seal into its position, otherwise only tighten special tool center bolt is hard to push sleeve and seal into its position.

Front drive housing side


Flywheel housing side







39. Install front drive gear, alternator, and cooler pump






40. Install oil pump

41. Install water pump

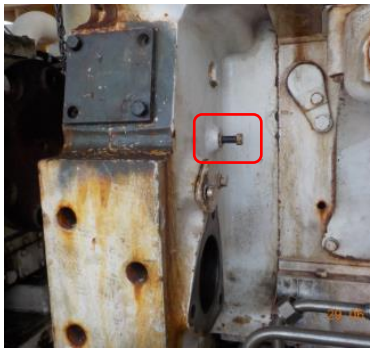
42. Install vibration damper

43. Install stub shaft

44. Install damper guard and fanshaft

45. Rechecl fan pulley and install fan belts

46. Install flywheel and recheck its position



47. Install inertia ring, apply anti seize before install

48. Install camshaft drive gear



49. Install ignition timing gear

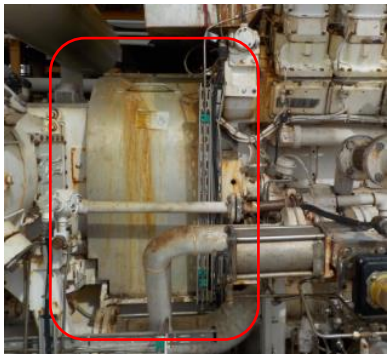


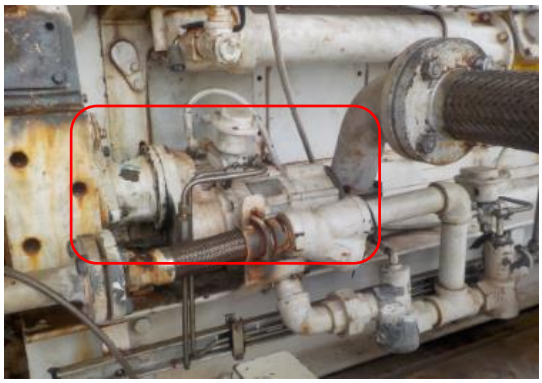


50. Install coupling

51. Recheck alignment engine to compressor

52. Install coupling guard



		53. Install gas starter  54. Install all sensor back 55. Unlock camshaft and change camshaft cover seal  56. Top up lube oil 57. Unit test run
5.1	Operation Duration*	**start date**: Jun 26th 2019 **end date** : Jul 4th 2019
5.2	Lifetime of Project*	Extend engine change out for almost 3 years
6	Application*	Can be apply for all gas CAT series 3500 engine.
7	Project Cost & Investment (Mil.Baht)*	Material (Parts and consumable) : 0.155335.50 MTHB Service (Worikg time , OT, Traveling) : 0.591100 MTHB
8	Project Cost & Investment per year (Mil.Baht/ Yr)*	0.75 / 3 = 0.25 Mil THB / Y

9	Benefit*	To bring back WP06 gas production approximately 6 MMSCFD and condensate 61.9 BOPD. Extend engine change out from 48,000 to be 60,000 Hr. as per new engine change out strategy.
10	Benefit Value (Mil.Baht/ Yr)*	Benefit Value / Yr = 8.52 Mil THB
11	Benefit Value Calculation	Totol Engine change out cost = New engine (approximately) 10 MTHB. + Direct purchase 2.2 MTHB + Service cost 4.5 MTHB + Indirect cost 9.6 MTHB = 26.3 MTHB Benefit Value / Yr. = 26.3 / 3 (extention period) = 8.77 Mil THB/yr. Net benefit value = 8.77 – 0.25 (investment cost) = 8.52 Mil. THB/yr.
12	Apply From	N/A
13	Company	PTTEP
14	Team member*	1. นายปิลันธน์ สุวรรณ 2. นายณัฏฐวัฒน์ เรืองโอชา 3. นายปริญญ์ จิตอธิศีล 4. นายพฤทธ์ ศรีศุภลักษณ์
15	Contact Person*	Name : Peelun Suwan Phone: 02-537-7474 Email: peeluns@pttep.com
16	Year Contest	2021
17	Project Type*	Maintenance
18	Business Line*	Exploration & Production
19	OEMS Element	OMI
20	Operational Function*	Maintenance
21	Operational Unit*	Bongkot Production Well Head Platform WP09
22	Equipment Type*	Gas engine (Booster Compressor)
23	Product Group	Natural gas
24	Community of Practice	Mechanic

25	People Tag Account	1. peeluns@pttep.com 2. nattawatr@pttep.com 3. prinj@pttep.com 4. pruts@pttep.com
26	People Tag Name	N/A

5. Support Information

- ระบุรายละเอียดเพิ่มเติมของการดำเนินโครงการ (หากมี) เพื่อให้ผู้อ่านท่านอื่นเข้าใจแนวคิด หลักการ วิธีการดำเนินงาน เพื่อไปปรับใช้กับ โครงการอื่นๆได้ เช่น
  - แนวคิดหรือทฤษฎีอธิบายการดำเนินงาน
  - รูปภาพประกอบ ก่อน และ หลังการดำเนินงาน
  - Flowchart หรือ Plant Layout ที่มีการติดตั้งหรือปรับปรุงอุปกรณ์ต่างๆ
  - ผลของการดำเนินงาน เทียบมูลค่าก่อน และ หลัง ปรับปรุง

- ระบุวิธีการคำนวณ Benefit Value เพิ่มเติม (หากมี)