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(1/9)

Subject : Recommendations about the use of 2020 SOx regulation compliant fuels	Application	UEC Diesel Engine
	Type	See text
	No.	USI-10022E Rev.2
If necessary		

To comply with the 2020 SOx regulation, various types of fuel oils have been used and cylinder lubrication oil types have been changed accordingly. Some unfavorable cases have been reported that piston ring(s) and/or cylinder liner(s) wear down after using compliant fuel(s). At first, BN40 cylinder oils could be applicable as the standard selection for the compliant fuel oils, however, based on the analysis of the current situations, BN40 cylinder oil having insufficient detergency / dispersancy (see page 7) and anti-scuffing ability might possibly give negative effects on piston ring(s) / cylinder liner excessive wear. Please be informed, for all the UEC engines, that the following guidance about cylinder oil selection and temperature adjustment of jacket cooling water for compliant fuel oils.

1. Cylinder oil selection

BN has been selected according to the fuel oil sulfur contents, for fuel oils with sulfur content of 0.1% or below, BN15~25, 0.1%~0.5% Sulfur content, BN40 is the basic selection with an optional use of BN70 when higher detergency / dispersancy is required as informed by our service information USI-10004.

Considering the current service results with compliant fuel oils, **for fuels having sulfur content of 0.1% or below and 0.1%~0.5%, BN70 cylinder oils with ample service experiences with higher detergency / dispersancy and anti-scuffing ability, are to be recommended.**

Category II (UEC-LSE/ LSH or later)

Sulfur content of fuel oil	Current BN guidance	BN guidance from now on
Sulfur \leq 0.1%	BN 15~25	BN70
0.1% \leq Sulfur \leq 0.5%	BN 40(~70 ^{*1})	
0.5% \leq Sulfur \leq 1.5%	BN40~70	BN70(~100 ^{*2})
1.5% \leq Sulfur	BN100	BN100

※1) Can be applied when piston crown cleanness is required(in case combustion sludges, usually blacky, are noticed in piston ring grooves and piston lands) carefully monitoring the amount of white sludges on the piston top combustion surface and piston top land.

※2) When excessive residues on piston top lands are observed, adjust the cylinder oil feed rate and/or select cylinder BN.

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Plan record	Newly issued 22nd Apr. 2020 (K.Y, H.H, T.N) Rev.1 30 th Jun. 2020 (K.Y, H.H, T.N) Rev.2 31 st Aug. 2020	Approved	<i>K. Yoshida</i>	SERVICE ENGINEERING DEPARTMENT
		Checked	<i>H. Hirabayashi</i>	DESIGN DEPARTMENT
		Designed	<i>T. Nagashima</i>	DATE OF REVISED: 31 st Aug. 2020

Category I (UEC-LA/ LS/ LSII or older models)

Sulfur content of fuel oil	Current BN guidance	BN guidance from now on
Sulfur \leq 0.1%	BN 15~25	BN(40~ ^{*3})70
0.1% \leq Sulfur \leq 0.5%	BN 40(~70 ^{*1})	
0.5% \leq Sulfur \leq 1.5%	BN40~70	BN70 (~100 ^{*2})
1.5% \leq Sulfur	BN70~100	BN70~100

※1) Can be applied when piston crown cleanliness is required(in case combustion sludges, usually blacky, are noticed in piston ring grooves and piston lands) carefully monitoring the amount of white sludges on the piston top combustion surface and piston top land.

※2) When excessive residues on piston top lands are observed, adjust the cylinder oil feed rate and/or select cylinder BN.

※3) In case no trouble with BN40 cylinder oil, the BN40 cylinder oil can be used as it is.

[Remarks for Category I / Category II]

- Adjust the cylinder oil feed rate based on the inspection results of piston ring/cylinder liner running behavior and piston underside drain analysis. (See page 4 for judgement criteria.)
- Keep monitoring the piston top land condition of combustion residues while applying BN70 cylinder oil, though sound running will be expected based on the past experiences. Especially the conventional lubricating system may supply higher feed rate than the other lubricating system, close inspection is recommended. If evaluation is hesitated onboard, please contact J-ENG with evidences, such as photos of piston ring/cylinder liner(as shown in Page 8) and analysis records of piston underside drain(Fe content and residual BN) for further guidance.
- If it is difficult to prepare BN70, BN100 can be used, however, excessive residues on piston top lands(usually white sludges) are concerned. Keep monitoring the piston top land condition of combustion residues. Especially the conventional lubricating system may supply higher feed rate than the other lubricating system, close inspection is recommended. If evaluation is hesitated onboard, please contact J-ENG with evidences, such as photos of piston ring/cylinder liner(as shown in Page 8) and analysis records of piston underside drain(Fe content and residual BN) for further guidance.
- When applying stocked BN40 cylinder oil in global area (non-SOx regulated areas), inspection of piston ring / cylinder liner and analysis of piston underside drain shall be done and cylinder oil feed rate will be adjusted accordingly. When applying BN15~40 cylinder oil in SECA (SOx Emission Control Area), follow the actions as instructed on Page 5~6. After using up BN15~40 cylinder oil, application of BN70 cylinder oil is recommended.
- BN40 cylinder oil(s), verified the improved detergency / dispersancy and anti- scuffing ability, will be evaluated by J-ENG for its application.

2. Adjustment of cylinder cooling water temperature

Cylinder cooling water temperature has been adjusted targeting at the upper limit of 90degC in the normal range of 80degC~90degC to avoid low temperature corrosion for low load operation of 50% or below and full operation range of UEC-LSE/LSH or later engines, when using high sulfur content fuel oils. (Refer service information USI-10001, USI-10008)

When using 2020 SOx compliant fuel oils with low sulfur content (max. 0.5%), possible risk of low temperature corrosion is reduced and jacket cooling water temperature shall be adjusted targeting at the lower limit of 80degC from viewpoint of the oil film formation.

If it is difficult to adjust the temperature at 80degC considering heat balance of other onboard equipment, such as fresh water generator, adjust the temperature at 80degC as close as possible.

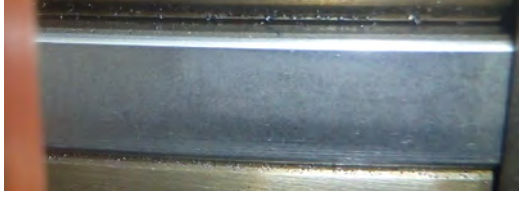





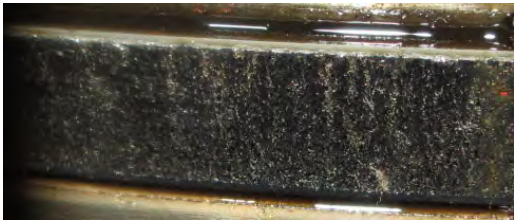
If the vessel equips SOx scrubber to use high Sulphur fuel oils, adjust the temperature targeting at 90degC for low load operation of 50% or below and entire operating range of UEC-LSE/LSH or later engines.

3. Application of higher durability piston ring

To cope with various properties of 2020 compliant fuel oils, following candidate piston rings are being studied. Please contact us when necessary. (See page 9 in detail.)

- Surface coating : Cr-plating / Bare cast iron ⇒ Cr-Ceramic (Wear resistance/Anti-scuffing)
- Butt shape of Top ring: straight ⇒ Gas tight (to improve gas tightness)

Evaluation of piston ring condition and action to be take (Photos show Cr-Ceramic ring's cases.)

	Piston ring running state	Recommended Actions
Case.1 Normal & Good		Reduce the cylinder oil feed rate according to guidance.
Case.2 Minor micro cracks		
Case.3 Extended micro crack		<Engines with A-ECL, ECL-T and SIP lubricating system> Increase by 0.20g/kWh and keep monitoring
Case.4 Peeling off of coating		<Engines with conventional lubricating system> Increase by 0.30g/kWh and keep monitoring.
Case.5 Local hard contact		※If peeling-off penetrates vertically or peeling-off area exceeds half the circle, replace the piston ring with a new one. (Refer USI-24505)
Case.6 Early stage of adhesive wear (remaining of coating)		<Engines with A-ECL, ECL-T and SIP lubricating system> • Increase up to 1.70g/kWh <Engines with conventional lubricating system> • Increase up to 2.30g/kWh.
Case.7 Adhesive wear		<Common notice> • Replace piston ring(s) at early opportunity. • Replace cylinder liner according to liner actual conditions.

If evaluation is hesitated onboard, please contact J-ENG with evidences, such as photos of piston ring/cylinder liner and analysis records of piston underside drain(Fe content and residual BN) for further guidance.

<How to adjust cylinder oil feed rate in SECA with BN15~BN40 cylinder oil>

Case 1) when operating an engine in SECA for a short period (within 2 weeks)

<Engines with A-ECL, ECL-T, SIP lubricating system>

Before entering SECA:

- Increase the cylinder oil feed rate (before exchanging fuels) by +0.20g/kWh (upper limit: 1.50g/kWh).

While operating in SECA:

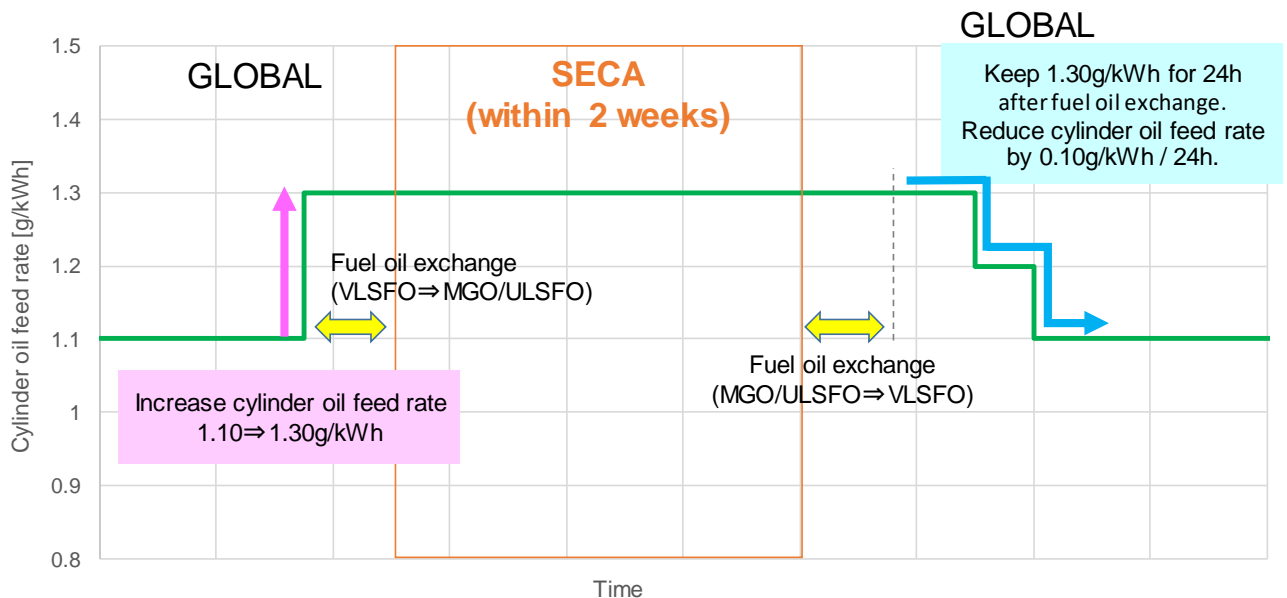
- Maintain the cylinder oil feed rate after the increase during SECA operation.

After leaving from SECA:

- Reduce the cylinder oil feed rate (after changing over fuels) to the level of before entering the SECA by 0.10g/kWh every 24 hours.

※This guidance is for the case where the cylinder oil feed rate is less than 1.50g/kWh. Maintain the current cylinder oil feed rate for the case where cylinder oil feed rate is 1.50g/kWh or more.

If BN70 (or BN100) cylinder oil is used, it is not necessary to adjust the feed rate.



A sample adjustment case of cylinder oil feed rate at 1.10g/kWh (Case 1)

<Engines with conventional lubricating system>

Before entering SECA:

- Increase the cylinder oil feed rate (before exchanging fuels) by +0.30g/kWh (upper limit: 2.00g/kWh).

While operating in SECA:

- Maintain the cylinder oil feed rate after the increase during SECA operation.

After leaving from SECA:

- Reduce the cylinder oil feed rate (after changing over fuels) to the level of before entering the SECA by 0.10g/kWh every 24 hours.

※This guidance is for the case where the cylinder oil feed rate is less than 2.00g/kWh. Maintain the current cylinder oil feed rate for the case where cylinder oil feed rate is 2.00g/kWh or more.

If BN70 (or BN100) cylinder oil is used, it is not necessary to adjust the feed rate.

Case 2) To operate engine in SECA more than 2 weeks

<Engines with A-ECL, ECL-T, SIP lubricating system >

Before entering SECA:

- ▶ Increase the cylinder oil feed rate (before changing-over fuels) by +0.20g/kWh (upper limit: 1.50g/kWh).

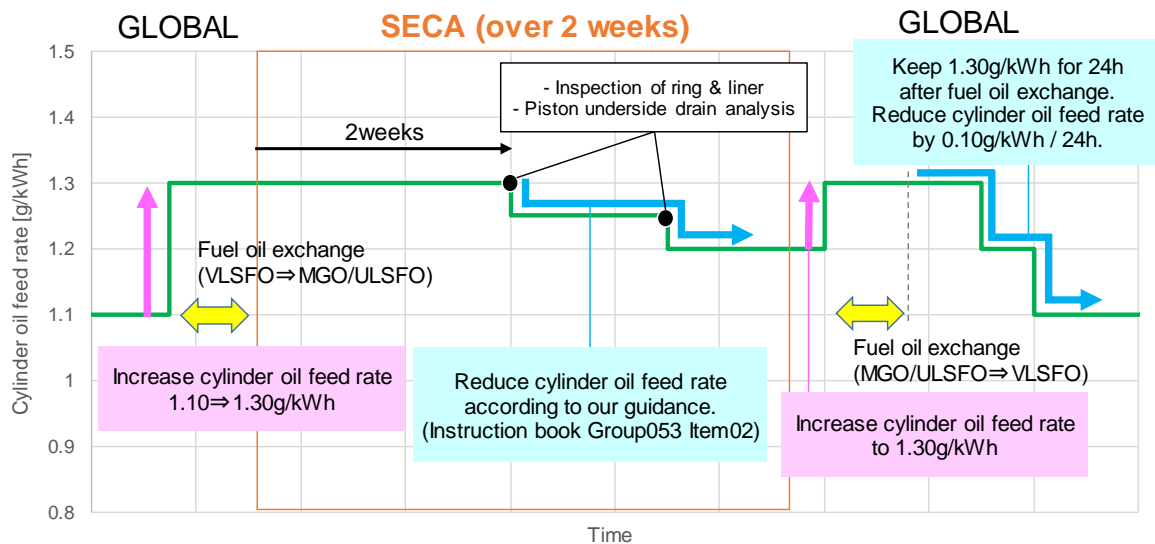
While operating in SECA:

- ▶ Maintain the cylinder oil feed rate for 2 weeks after the increase.
- ▶ After 2 weeks, visually inspect the piston ring & cylinder liner and make sure that there is no problem with the piston underside drain analysis. After ensuring, reduce cylinder oil feed rate according to the guideline for reducing the cylinder oil feed rate in the Operation Manual Section Group053 Item02.

After leaving from SECA:

- ▶ Restore the cylinder oil feed rate once again(before changing over fuels) to the level of before the reduction.
- ▶ Reduce the cylinder oil feed rate (after changing over fuels) to the level of before entering the SECA by 0.10g/kWh every 24 hours.

※This guidance is for the case where the cylinder oil feed rate is less than 1.50g/kWh. Maintain the current cylinder oil feed rate for the case where cylinder oil feed rate is 1.50g/kWh or more.
If BN70 (or BN100) cylinder oil is used, it is not necessary to adjust the feed rate.



A sample adjustment case of cylinder oil feed rate at 1.10g/kWh (Case 2)

<Engines with conventional lubricating system >

Before entering SECA:

- ▶ Increase the cylinder oil feed rate (before changing-over fuels) by +0.20g/kWh (upper limit: 1.50g/kWh).

While operating in SECA:

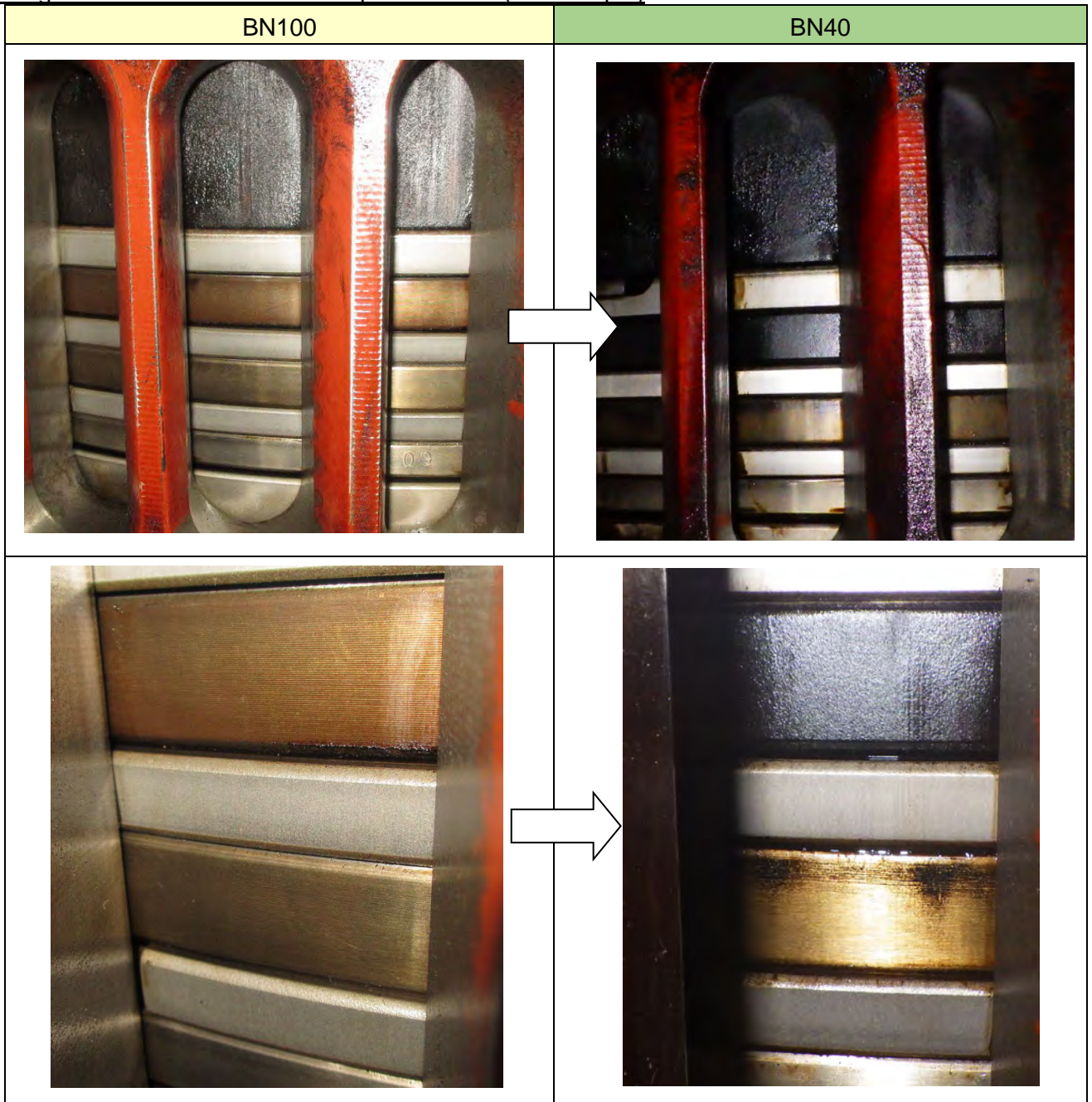
- ▶ Maintain the cylinder oil feed rate for 2 weeks after the increase.
- ▶ After 2 weeks, visually inspect the piston ring & cylinder liner and make sure that there is no problem with the piston underside drain analysis. After ensuring, reduce cylinder oil feed rate according to the guideline for reducing the cylinder oil feed rate in the Operation Manual Section Group053 Item02.

After leaving from SECA:

- ▶ Restore the cylinder oil feed rate once again(before changing over fuels) to the level of before the reduction.
- ▶ Reduce the cylinder oil feed rate (after changing over fuels) to the level of before entering the SECA by 0.10g/kWh every 24 hours.

※This guidance is for the case where the cylinder oil feed rate is less than 1.50g/kWh. Maintain the current cylinder oil feed rate for the case where cylinder oil feed rate is 1.50g/kWh or more.
If BN70 (or BN100) cylinder oil is used, it is not necessary to adjust the feed rate.

Sludge accumulation condition on piston crown (an example)



Inspection sample photos of piston rings/cylinder liner

(4-stage rings, Top, 2nd:Cr-coating ring)

Piston rings



Top/2nd rings (enlarged)



Piston skirt



3rd/4th rings (enlarged)



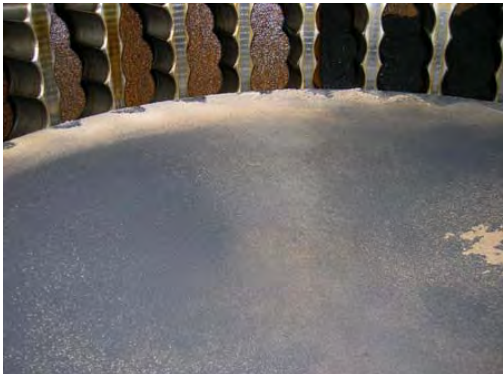
Piston top land



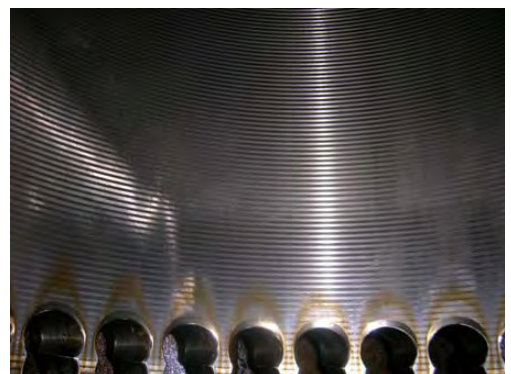
Cylinder liner upper area



Combustion side of piston



Cylinder liner lower area



Higher durability piston rings under study

Target engines are equipped with Cr-coating and/or bare cast iron rings

		Original	Higher durability	
Top	Coating Butt shape	Cr Straight or Angle-cut	Cr-Ceramic Gas tight	Cr-Ceramic Straight
2 nd		Cr or bare cast iron Straight or Angle-cut	Cr-Ceramic Straight	
3 rd		Bare cast iron Straight or Angle-cut	Cr-Ceramic Straight	
4 th		Cr or bare cast iron Straight or Angle-cut	Cr-Ceramic Straight	
Target engine models			UEC60LS/LA UEC50LSII UEC60LSII UEC45LSE-1 UEC52LSE UEC60LSE-1 UEC68LSE	UEC45LA* UEC52LA UEC52LS

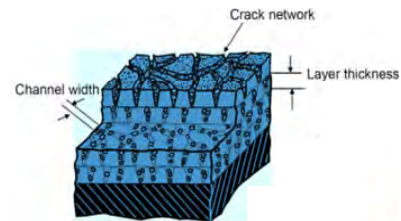
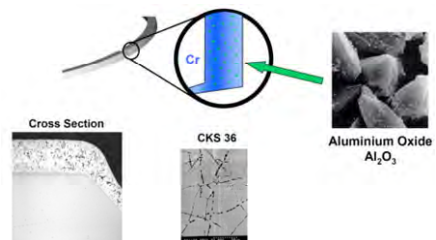
For UEC45LA, the butt shape of higher durability spec. is angle-cut

Butt shape : Gas tight



In case that wear of piston ring / cylinder liner progresses, gas sealing performance can be kept good.

Coating : Cr-Ceramic



Origin: Material introduced by ENGINEERING DEPT., FEDERAL MOGUL

Al₂O₃ is included in the channel crack of multi-layer chrome plating, which has higher wear & scuff resistance compared to Cr plating.