DIGITAL SERVICES
Condition-based Maintenance

EcoStuxure Asset Advisor
Marine application
Condition-Based Maintenance offer via Asset Advisor

Marine application

- Offer overview & benefits
- EcoStruxure Asset Advisor web portal
- How does EcoStruxure Asset Advisor work?
- Cybersecurity concern
Condition-Based Maintenance offer via Asset Advisor

Marine application

• Offer overview & benefits

• EcoStruxure Asset Advisor web portal

• How does EcoStruxure Asset Advisor work?

• Cybersecurity concern
22% of fires are due to electrical equipment failure (1st cause in industry)

77% can be avoided with regular maintenance

17% are due to poorly performed services

Maintenance plays a key role in securing the ship processes
An advanced maintenance model is needed to reduce OPEX

**CONDITION-BASED**

- I prevent asset failure & downtimes
- I optimize my maintenance cycles
- I optimize my operational process

**PREVENTIVE TIME-BASED**

- I can hardly anticipate failures and mitigate risk
- Attempting to prevent downtimes is time consuming and costly

Source: FM Global insurance company
ShipOwner Benefits

Minimize OPEX
Maximize Peace of Mind

• Reduce downtime costs
  ✓ Reduce the risk of unscheduled downtime
  ✓ Reduce unscheduled downtime duration

• Reduce repair costs vs reactive maintenance
  ✓ Reduce time to repair thanks to anticipated remote diagnosis
  ✓ Reduce the qty of device breakdown/replacement
  ✓ Reduce the qty of corrective actions in emergency

• Reduce costs vs the constraining preventive time-based maintenance in Marine (optimize maintenance cycles)

• Be compliant with Class Societies at minimized cost

Condition-based Maintenance offer

• Failure prediction, anticipate parts replacement
• Optimize maintenance cycles
• Optimize operational process (electrical network)

Thanks to

EcoStruxure Asset Advisor
Online access to your data everywhere, at anytime

Remote Support

Experts Periodical Report

WW Intervention Management
Condition-Based Maintenance application in Marine

Avoid useless or emergency maintenance with the analysis of key data from critical assets only

1. Data collection
2. Data storage, consolidation, modelling, automated analytics
3. Data analysis
4. Notifications, recommendations & support
5. Activation of the local Field Services Engineer
6. Intervention
7. On-line access to data via a friendly web portal

EcoStruxure Asset Advisor application
Platform on a secured server

Schneider Electric
Global Service Center
Service Bureau Experts

Schneider Electric
local Field Services

MV switchgear/CB  TFO  LV switchboard/CB  Drives  UPS
Condition-Based Maintenance offer via Asset Advisor

Marine application

- Offer overview & benefits
- EcoStruxure Asset Advisor web portal
- How does EcoStruxure Asset Advisor work?
- Cybersecurity concern
A user-friendly web portal
On-line access to your data
Overall risk level + health level of all assets
Overall risk level + health level of all assets

You have 1 asset in Medium / Poor Health at High Criticality

TR3
Single line diagram with risk level / asset
Asset view with raw data trends
Selection of asset to monitor
Selection of parameters to monitor
Asset view with raw data trends

Asset Health

Thermal Aging Trip unit: 1
Correct Aging Trip unit: 1
Correct Aging: 1

Raw Data

Asset Location: Schneider Electric Demo > Building A > Room Low Voltage 2 > LV Panel 2 > Cell LV 2

Last Maintenance Date: N/A

Commission Date: 01/01/2014

Functional Label: ACB1

Manufacturer: Schneider-Electric

Range: Masterpact

Type: LV Circuit Breaker
Notifications history
All reports registered
Condition-Based Maintenance offer via Asset Advisor

Marine application

- Offer overview & benefits
- EcoStruxure Asset Advisor web portal
- How does EcoStruxure Asset Advisor work?
- Cybersecurity concern
What data are gathered and analyzed?
From both SE assets and other providers

- Active, reactive powers
- 3 phase currents and voltage
- Number of operation: Trip, Draw out
- Time for operation: tripping, charging…
- Level for Corrosive gas, Salty atmosphere
- Cumulative breaking current (kA²)
- Trip circuit, auxiliary voltages
- Output velocity and torque
- Driver Thermal State
- Temperatures: Cables, bush bars, windings, oil
- Ambient temperature and humidity
- Status information: diagnosis on edge point
- Channels and signal from specialized devices…

We leverage electrical, mechanical & thermal data from critical assets…

...to store & organize them, then some key indicators are computed, in a model ready for experts analysis
LV Circuit Breaker

Analytics

<table>
<thead>
<tr>
<th>Electrical</th>
<th>Mechanical</th>
<th>Load Profile</th>
<th>Corrosion / thermal Aging of CB and TU</th>
<th>Health Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Wearing</td>
<td>Mechanical Wear</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ambient Temperature / Humidity</td>
<td>Corrosive gas / Salty atmosphere</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Opening / SD Trip / SDE Trip / Draw Out Counters</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
## LV Circuit Breaker Analytics

### BASE - Asset Health Monitoring

<table>
<thead>
<tr>
<th></th>
<th>Electrical Wear</th>
<th>Mechanical Wear</th>
<th>Load Profile</th>
<th>Health Index</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical</strong></td>
<td><img src="true" alt="✓" /></td>
<td><img src="true" alt="✓" /></td>
<td><img src="true" alt="✓" /></td>
<td><img src="true" alt="✓" /></td>
<td><img src="true" alt="✓" /></td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td><img src="true" alt="✓" /></td>
<td><img src="true" alt="✓" /></td>
<td><img src="true" alt="✓" /></td>
<td><img src="true" alt="✓" /></td>
<td><img src="true" alt="✓" /></td>
</tr>
<tr>
<td><strong>Mechanical</strong></td>
<td><img src="true" alt="✓" /></td>
<td><img src="true" alt="✓" /></td>
<td><img src="true" alt="✓" /></td>
<td><img src="true" alt="✓" /></td>
<td><img src="true" alt="✓" /></td>
</tr>
</tbody>
</table>

- **Current Wearing**
- **Ambient Temperature / Humidity**
- **Corrosive gas / Salty atmosphere**
- **Opening / SD Trip / SDE Trip / Draw Out Counters**

CONFIDENTIAL PROPERTY OF SCHNEIDER ELECTRIC | PAGE 21
<table>
<thead>
<tr>
<th>LV Panels</th>
<th>Analytics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical</strong></td>
<td><strong>Environmental</strong></td>
</tr>
<tr>
<td>Current</td>
<td>Ambient Temperature</td>
</tr>
<tr>
<td><strong>BASE - Asset Health Monitoring</strong></td>
<td><strong>Temperature Profile</strong></td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## MV Cubicle

### Analytics - Extended

<table>
<thead>
<tr>
<th></th>
<th>BASE+ Wireless Thermal Monitoring</th>
<th>EXTENDED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical</strong></td>
<td>Current</td>
<td></td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td>Ambient Temperature</td>
<td>Partial discharge</td>
</tr>
<tr>
<td><strong>Thermal</strong></td>
<td>Cables / Busbar / CB Arm Temperature (3 Phases)</td>
<td>Estimated Warming</td>
</tr>
</tbody>
</table>

- Temperature Discrepancy
- Estimated Warming
- Partial discharge
## MV Circuit Breaker Analytics

### BASE - Asset Health Monitoring

<table>
<thead>
<tr>
<th>Electrical Wear</th>
<th>Mechanical Wear</th>
<th>Load Profile</th>
<th>Health Index</th>
<th>Temperature Profile</th>
<th>Temperature Discrepancy</th>
<th>Contact Quality</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
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</tr>
</tbody>
</table>

### BASE+ Wireless Thermal Monitoring

<table>
<thead>
<tr>
<th>Electrical Wear</th>
<th>Mechanical Wear</th>
<th>Load Profile</th>
<th>Health Index</th>
<th>Temperature Profile</th>
<th>Temperature Discrepancy</th>
<th>Contact Quality</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Electrical
- Current Breaked current

### Functionnal Status
- SF6, CTVT Trip Circuit
- Auxiliary voltage

### Mechanical
- Breaker Position
  - Opening / Draw Out Counters
  - Opening / Charging time

### Environmental
- Ambient Temperature

### Thermal
- Cables / Busbar / Temperature (3 Phases)
### Variable Speed Drive & connected motor

#### Analytics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameters/States</th>
<th>Standardized Thermal State</th>
<th>Fault detection</th>
<th>Field Failure Rate</th>
<th>Failure Probability/Long-term</th>
<th>Health Index</th>
<th>Motor Fault detection</th>
<th>Motor Thermal aging</th>
<th>Motor Health Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Power</td>
<td>Current Voltage Power</td>
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<td><img src="true" alt=" " /></td>
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<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
</tr>
<tr>
<td>Mechanical Power</td>
<td>Torque Velocity</td>
<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
</tr>
<tr>
<td>Environmental Power</td>
<td>Ambient Temperature</td>
<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
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<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
</tr>
<tr>
<td>Internal Status</td>
<td>Thermal State Status, Drive fault</td>
<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
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<td><img src="true" alt=" " /></td>
<td><img src="true" alt=" " /></td>
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</tr>
</tbody>
</table>
## Dry Transformers

### Analytics

<table>
<thead>
<tr>
<th></th>
<th>BASE - Asset Health Monitoring</th>
<th>BASE+ Wireless Thermal Monitoring</th>
<th>EXTENDED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
</tr>
<tr>
<td><strong>Thermal</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winding temperature (PT100Sensors)</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient Temperature</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
</tr>
</tbody>
</table>

- **Load Factor**
- **Aging**
- **Hot spot temp. profile**
- **Ambient temp. profile**
- **Ambient Temperature**
- **Temperature Discrepancy**
- **Contact Quality**
- **Partial discharge**

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## Oil Transformers

### Analytics

<table>
<thead>
<tr>
<th>BASE - Asset Health Monitoring</th>
<th>BASE+ Wireless Thermal Monitoring</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Load Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health Index / Aging</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot spot temp. profile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient temp. profile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature discrepancy</td>
<td>Contact Quality</td>
<td></td>
</tr>
<tr>
<td>Partial discharge</td>
<td></td>
<td>Oil analysis</td>
</tr>
<tr>
<td>Hot spot temp. profile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient temp. profile</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Electrical
- **Current**: Yes
- **Oil temp**: Yes

### Thermal
- **Oil temp**: Yes, Connection temp: Yes

### Environmental
- **Ambient Temperature**: Yes

### Other physical parameters
- **Device output channels**: Yes

*Measurement not mandatory can be computed*
EcoStruxure concept

No IoT without connected devices integrated into a smart architecture

Help turn data into actionnable plans thanks to experts services

Help take informed decisions to secure uptime & operation efficiency thanks to advanced platforms

Get visibility on your electrical distribution by measuring, collecting, aggregating and communicating data
Data collection from MV switchboard

- **Thermal & humidity sensor**
  In the technical room

- **Protection relay**
  Number of operations, cumulated broken amps, etc.

- **Wireless & batteryless thermal sensors**
  Patented by Schneider Electric
  Embedded inside cubicles on most critical connections: cable connections and drawers connections

Modbus TCP Zigbee concentrator (Sologate)
Asset monitoring: MV/LV transformer

Data collection is made through

- Service conditions with **thermal and humidity sensor** in the technical room
- **Wireless and batteryless thermal sensors** patented by Schneider Electric, on HV and LV connections
- **Thermal relay with communication** internal temperature from 2 sets of PT100 sensors
Asset monitoring: LV switchboard

Data collection is made through:

- Service conditions with **thermal and humidity sensor** in the technical room

- **Wireless and batteryless thermal sensors** patented by Schneider Electric, on drawer connections

- **Micrologic with communication**: number of operations, cumulated broken amps, etc...

- Easiest instrumentation with **Masterpact MTZ**
Technical specification of Wireless Sensors that enables Base+

Zoom on technology for Thermal sensors developed by Schneider Electric

**Energy harvested** by the network current
- Using magneto-generator based on solenoid coil and ferromagnetic core

**High performances**
- Reduced leakage current even at **high temperature**
- Withstand up to **125°C** operating temperature
- Low starting current, around 5A network current.

**Wireless and world-wide free communication**
- ZigBee Green Power (ZGP) protocol @ 2.4GHz
- Monitoring of all MV critical contacts (i.e. withdrawable CB contacts)

**Easy installation**
- Only one antenna in the switchboard LV cabinet
- Compact sensor footprint (30x30mm) for MV and LV installation
- No cabling and drilling required in the MV compartment
Smart architecture to connect to the Schneider DSP

New or upgraded ship

Modbus protocol, serial or over TCP

*May be required additional parts or modules: I/O, IFM, IFE*

Modbus protocol over TCP, with specific add-on and driver

*May be required additional parts or modules: EGX or ION*
Condition-Based Maintenance offer via Asset Advisor

Marine application

• Offer overview & benefits

• EcoStruxure Asset Advisor web portal

• How does EcoStruxure Asset Advisor work?

• Cybersecurity concern
Cyber security concern: use of a secured platform

- Data collected through secured gateways

- **Secured Data transport** to prevent data access or manipulation

- Data encrypted and hosted in Schneider Data Center

- Results displayed on secured customer dashboard (reports, diagnostics, alerts...)

- Customers stay **owners** of their data

---

**Customer network**

- **Gateway on customer network:**
  - Secure assets data collection
  - Only pre-authorized devices can connect to the gateway/network

**Schneider Electric gateway**

**Secure Data Transport**

- **Secure Data Transport:**
  - Secure connection to Data center
  - Full data encryption

**Schneider Electric Data Center**

**Data Center (France):**

- Connection from internal network only
- Sensitive customer data isolated and encrypted
- Access log monitoring and audit
- Security controls to comply with regulations
- Backup and recovery procedures

**EAA Web Portal**

- **EAA Portal:**
  - Strong authentication required to access dashboard and results
  - Users can see only their own data
Tailored cyber security offer by Schneider Electric

Turned key solution & program based on 4 main pillars

Specifications based on international standards

- Compliant with a process Secure Development Lifecycle (SDL)

Recommendations to implement

- Information on vulnerability

Core product (hardware & embedded software)

Security product (platform & software)

Cyber security partner eco-system with key cyber industrial security leaders

Led by cyber security experts specialized for an industrial environment

Competency center

Cyber security services

1. Audit & evaluation
2. Conception
3. Mise en œuvre
4. Exploitation MCS
Condition-based Maintenance

- Failure prediction, anticipate parts replacement
- Optimize maintenance cycles
- Optimize operational process (electrical network)

Our Digital Service Offer

EcoStruxure Asset Advisor
- Online access to your data everywhere, anytime!
- Single view of multiple ships
- Assets overview on each ship (risk level, health matrix)
- Electrical diagram with risk level per asset
- Individual assets view
- Historical data, reports, trends, events, notifications

Remote Support
- Remote expertise & analysis
- Remote pro-active notifications & recommendations

Experts Periodical Report
- Asset report each week/month/or quarter (automated)
- Summary report each quarter & yearly (from expert, analysis & recommendations)

WW Intervention Management
Maintenance frequency recommended by SE

<table>
<thead>
<tr>
<th>Maintenance</th>
<th>Minimal frequency (1) (every)</th>
<th>Who</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exclusive</td>
<td>4 years</td>
<td>🔄</td>
</tr>
<tr>
<td>Advanced</td>
<td>2 years</td>
<td>🔄</td>
</tr>
<tr>
<td>Light</td>
<td>1 year</td>
<td>🔄</td>
</tr>
</tbody>
</table>

(1) Recommended under normal operating conditions (minor equipment criticality and optimal environmental conditions). However, this recommended frequency should increased according to: a) the level of criticality (low, major, critical) b) the severity of environment conditions (i.e. corrosive, naval, offshore) following recommendations of Manufacturer’s services (see table p. 15)

For equipments under environment (corrosive, humidity, heat, dust)

<table>
<thead>
<tr>
<th>For equipments with a level of criticality</th>
<th>Normal</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>Advanced every 1 year</td>
<td>Exclusive every 1 year</td>
</tr>
<tr>
<td>Major</td>
<td>Advanced every 1 year</td>
<td>Exclusive every 3 years</td>
</tr>
<tr>
<td>Critical</td>
<td>Advanced every 1 year</td>
<td>Exclusive every 2 years</td>
</tr>
</tbody>
</table>

Life Is On | Schneider Electric
Simplify parts sourcing

Digital Services bundled with the right service contract

Global Service Center

- Faster & easier identification of part to be replaced
  Before or after a failure occurs

- Provide part number & characteristics
  If obsolete parts, equivalent new ranges proposed

- Price & lead-time already known
  Parts list pre-defined into a service contract

- Fast delivery to the preferred sea-port WW
  VIP stock management by the supplier, into a service contract
  Sea-port list pre-defined into a service contract

- VIP stock replenished in parallel of the delivery
  Automatically activated by the supplier supply chain IT system

Remote Diagnosis = Expert analysis + Automated analytics
Connected devices integrated into a smart “Energy & Automation” architecture

Wheelhouse Control
On Board Integrated Monitoring and Control System

TCP/IP Backbone

Alarm, Monitoring & Control System

- PLC
- Hot Standby
- Extension Alarm Panels In Cabins
- UPS
- In Engine Control Room

Video Security

- IP camera

Power Management System

- PLC
- Diesel Generators
- Shore Connection
- Power Meters

Power Monitoring

- PLC
- Power Meters

Aux. Control & Monitoring Systems

- PLC
- Pumps
- Bow Thruster
- Valves

Remote Monitoring

Ship-owner HQ Suppliers Services

Satellite Communication

TCP/IP Backbone

Ethernet
Serial line
Hardwire
Power
On board implementation principle

1 - Identify asset to monitor
2 - Implementation of data acquisition
3 - Gather and collect data
LV Circuit Breaker

Masterpact NT / NW

Compact NS & NSX

Base

Micrologic
5.0 / 6.0 / 7.0
P / H
BCM ULP Module
CCM
Modbus
Serial

Micrologic
x.2 / x.3 E
Modbus
Serial

COM’X

OR

PME

Confidential Property of Schneider Electric | Page 44
LV Panels

- Thermal monitoring using TH110 sensors
  - Wireless (Zigbee Green Power)
  - Self powered by current in the bar
  - Sensors located on bolted connections (cable & busbar)
- Modbus TCP Zigbee concentrator (Sologate)
MV Cubicles

**Base +**
- Thermal monitoring
- Zigbee Green Power
- eMag Th110 sensors
- Sensors located on CB arms / cables connections / busbar
- Zigbee concentrator

**Extended**
- Partial Discharge Monitoring Module
- Modbus Serial / TCP protocol
- VPIS V2 required

**MC SET**
**SM6 (24&36Kv)**
**PiX**
Variable Speed Drive (and connected motor)

AC Motors
- ATV 61
- ATV 71

COM’X 200 OR PME

Base
- ATV 61/71 Modbus Serial
- Profibus available using PLC or gateway

Base + (Futur)
- Thermal monitoring
- Zigbee Green Power
- eMag Th110 sensors
- Zigbee concentrator
Dry Transformers

**Base**
- Upstream or downstream protection for U, I
- Winding temperature
  - Qualitrol model 98
  - NT935AD
  - MET148-2 (SEPAM)
- Modbus Serial or IP
- PT100 in windings mandatory *
  - If PTC need to be upgraded

**Base +**
- TH110 sensors on connections
- Zigbee concentrator

**Extended**
- Partial Discharge Monitoring Module
- Modbus Serial / TCP protocol

* 2 x 4mm pipes fitted in each winding for TRIHAL
Oil Transformers

### Base
- Upstream or downstream protection for U, I
- SEPAM T Series with MET148 Modbus TCP
- Oil temperature if available
- DGPT2/Buchholz status through relay
- In some cases, Oil pressure and Cooling temperature sensor
- TH110 sensors on connections
- Zigbee concentrator

### Base +
- Partial Discharge Monitoring Module
- Modbus Serial / TCP protocol

### Extended
- Dissolve Gaz Analyzer (*)
  - MC
  - Oil temp
  - H2
  - multiple gaz

* Attention shall be paid to suitable location and fittings

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COM’X 200 OR PACiS PME