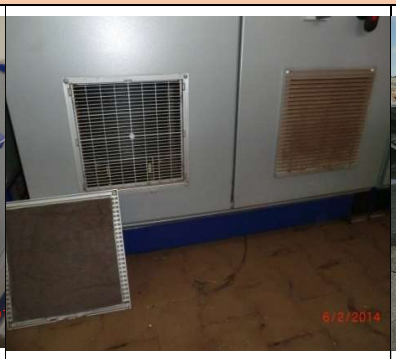
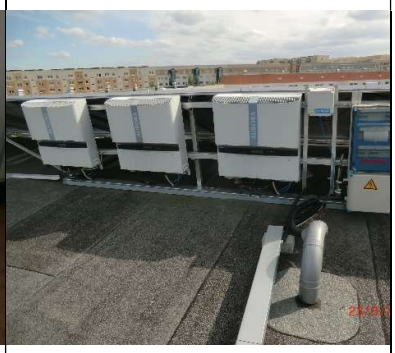
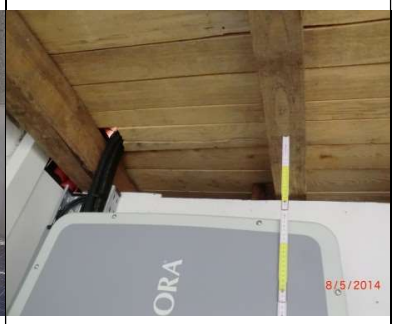
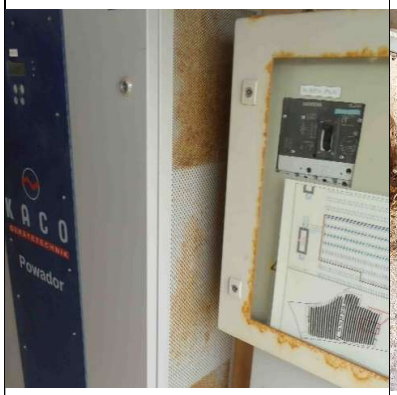
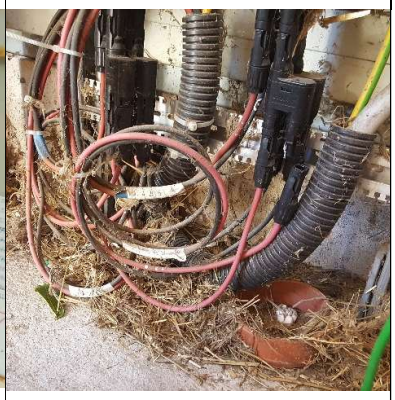
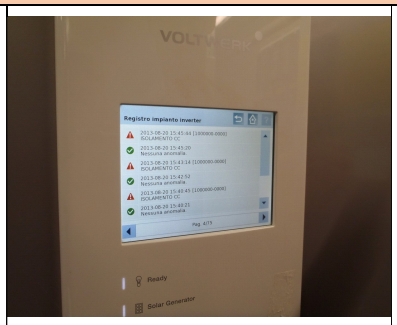
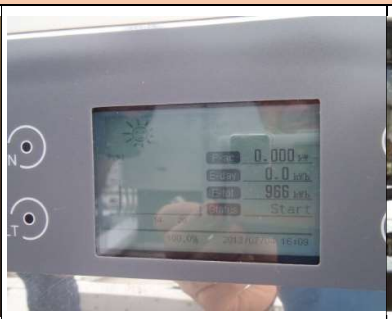
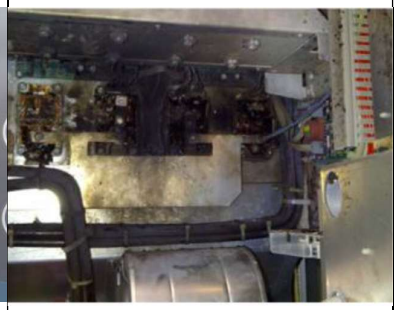
Component Defect	**Inverter** **Overheating**		**PVFS 4-1vs.01**
Appearance	The inverter reduces its power or switches off to protect components from overheating (temperature derating). Inverters do not always deliver a corresponding status message "power reduction" or "derating". For this reason, it is recommend to check the inverter behaviour by determining and analysing performance curves (Power vs Irradiance).		
Detection	MON, (IV, IRT)		
Origin	Temperature derating of the inverter can occur for various reasons, e.g. improper installation of the inverter, fan failure, dust blocking heat dissipation or an incorrect programming of the inverters.		
	Production ☐	Installation ☐	Operation ☐
Impact	When the monitored components in the inverter reach the maximum operating temperature, the inverter shifts its operating point to a lower power. During this process, power is reduced step-by-step. In the extreme case, the inverter switches off completely. As soon as the temperature of the threatened components falls below the critical value, the inverter returns to the optimal operating point. The partial or complete failure of the inverter leads to performance losses, which will get worse if the problem is not solved. In the worst case inverter will switch off. Inverter overheating do not affect module safety.		
	Safety: 	Performance: 	
Action	Corrective actions	Preventive actions (recommended)	Preventive actions (optional)
	Once identified the origin of the temperature derating the failure should be repaired. The filters and in general heat dissipation path should be cleared of obstruction.	Follow the given installation procedure, use of adequate cooling technology, perform regular inspections of the ventilation units.	Monitoring of inverter temperature

EXAMPLES (page1)						PVFS 4-1vs.01
Examples 1-3						
	Dust blocking heat dissipation [TUV Rheinland]		A soiled air filter causes over-heating [TUV Rheinland]		Installation not appropriate (direct exposition to sun) [TUV Rheinland]	
Severity						

<table>
<tr><td>Component
Defect</td><td colspan="3">Inverter
Incorrect installation</td><td>PVFS 4-2vs.01</td></tr>
<tr><td>Appearance</td><td colspan="4">The inverter must be installed according to the installation instruction. A common failures is the installation near flammable, explosive, corrosive or humid sources. Also the minimum distances to bottom, top or to the sides are not always fulfilled. If the input cables are not fixed properly, increased temperatures can occur at the loose contact point which lead to lower performance or risk of fire. Inverters must always be accessible for operation and maintenance and properly secured to an appropriate base.</td></tr>
<tr><td>Detection</td><td colspan="4">VI (MON)</td></tr>
<tr><td rowspan="2">Origin</td><td colspan="4">Violating instruction manual, e.g. installed nearby flammable materials as wood or in direct sun light.
Minimum distance to adjacent components not maintained.</td></tr>
<tr><td>Production ☐</td><td colspan="2">Installation ■</td><td>Operation ☐</td></tr>
<tr><td rowspan="2">Impact</td><td colspan="4">Incorrect installation of the inverter can cause danger to users and hazardous conditions and can result in overheating of the inverter. The use of the inverter in the presence of flammable vapours or gases can lead to explosions. The inverter housing can become very hot under operation. Follow the instruction to provide gaps from both sides and top for adequate cooling. Direct sunlight on the inverters must be avoided. The inverter must be safely accessible to avoid accidents during maintenance work.</td></tr>
<tr><td>Safety:</td><td> 
</td><td>Performance:</td><td> 
</td></tr>
<tr><td rowspan="2">Action</td><td>Corrective actions</td><td>Preventive actions (recommended)</td><td>Preventive actions (optional)</td></tr>
<tr><td>Dismount the component and follow the installation procedure.</td><td>Follow the given installation procedure, use of adequate cooling technology, perform regular inspections of the ventilation units.</td><td>Monitoring of inverter temperature.</td></tr>
</table>

EXAMPLES (page1)						PVFS 4-2vs.01
Examples 1-3						
	Installation in direct sun light. [TUV Rheinland]		Inverters are not or difficult accessible for operation and maintenance. [TUV Rheinland]		Distance to bottom, top or to the sides too low. [TUV Rheinland]	
Severity		3	e m	2	f	3
Examples 4-5						
	Housing not appropriate. [TUV Rheinland]		Presence of inflammable material. [SUPSI]			
Severity		1	f	1		

<table>
<tr><td>Component
Defect</td><td colspan="3">Inverter
Not operating (complete failure)</td><td>PVFS 4-3vs.01</td></tr>
<tr><td>Appearance</td><td colspan="4">If the inverter does not work despite good production conditions, common problems are the lack of restart after grid faults or isolation faults. The inverter may show fault codes to help understanding the problem. This can be observed by checking the display or the data log of the monitoring system. Examples for hardware defects in the inverter are discoloured or burned cable interconnections or fuses. Damaged parts can be found by visual inspection or infrared thermography (IRT).</td></tr>
<tr><td>Detection</td><td colspan="4">MON, (VI, I-V, VOC)</td></tr>
<tr><td rowspan="2">Origin</td><td colspan="4">A complete failure of the inverter occurs due one or more malfunctions of single hardware or software component of the inverter or faults due to grounding issues, e.g. high humidity inside the inverter, or a firmware issue.</td></tr>
<tr><td>Production ☐</td><td>Installation ☐</td><td colspan="2">Operation ☐</td></tr>
<tr><td rowspan="2">Impact</td><td colspan="4">The complete failure of the inverter leads to significant performance losses and immediate actions must be taken. When the restart does not work or the fault occurs recurrently the origin must be identified in most cases by a service team. Software issues can be solved by updating the firmware for technical reasons or to update the system to new standards/grid technical requirements. While damaged hardware components of central inverters are usually repaired, string inverter are replaced more often for economic reasons. Damaged hardware can cause fire and electric shock hazards and must be repaired by qualified personnel.</td></tr>
<tr><td>Safety:</td><td>  </td><td>Performance:</td><td colspan="2">  </td></tr>
<tr><td rowspan="2">Action</td><td>Corrective actions</td><td>Preventive actions (recommended)</td><td colspan="2">Preventive actions (optional)</td></tr>
<tr><td>Restart the inverter. Replace the components with defect or abnormal temperature. Update the software.</td><td>Use IRT and VOC to check the components and connection to find poor connection or defect components.</td><td colspan="2"></td></tr>
</table>

EXAMPLES (page1)						PVFS 4-3vs.01
Examples 1-3						
	Insulation failure. [TUV Rhein-land]		Not operating inverter. [TUV Rheinland]		Damaged hardware component. [Sinclair17]	
Severity	e	3 4 5		3	f e	5