



TA 2300-0005

Technical Instruction

Safety instruction



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1 Scope

This Technical Instruction (TA) applies to the following Jenbacher Engines:

- Type 2 engines
- Type 3 engines
- Type 4 engines
- Type 6 engines
- Type 9 engines

2 Purpose

This Technical Instruction [TA] describes the residual risks in the product which persist despite an inherently safe design and the use of technical and supplementary protective measures. The safety information gives an overview of hazardous areas and possible hazard scenarios, as well the necessary associated preventive measures and behaviour to avoid injuries.

3 Additional information

Relevant documents:

ANSI Z535.2 – American National Standard for Environmental and Facility Safety Signs

IEC 60079-10 – Explosive atmospheres

ISO 3864-2:2016 – Graphical symbols - Safety colours and safety signs

ISO 7010:2012-10 – Graphical symbols - Safety colours and safety signs - Registered safety signs

ISO 13849-1:2015 – Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design General principles for design

TA 1100-0110 – Boundary conditions for Jenbacher gas engines

TA 1100-0111 – General Conditions - operation & maintenance

TA 1100-0114 – Installation of electrical equipment for INNIO Jenbacher generator sets

TA 1100-0116 – J920 Service installation requirements

TA 1100-0120 – J920 Compressed Air Requirements

TA 2300-0010 – LOTO measures and LOTO kit

4 General instructions

While the safety instructions below are intended for your safety, they cannot cover in detail the scope of all accident risks posed by industrial machinery.

When operating this plant it is your duty to comply with all current official and quasi-official safety rules and codes applicable to your sector. You should also use your own powers of judgement to avoid hazards and dangerous situations.

Most accidents are caused when people disregard simple, basic safety rules. Any manipulation of the machine or its control cabinets which causes the plant to operate outside of its specified operating range (load range), is prohibited and could result in serious indirect damage.

Any modifications of the item supplied, including changes to the program and software, which are carried out by the customer or third parties without Jenbacher's prior consent will result in the lapse of any right to damages or the exercise of a warranty claim against Jenbacher.

4.1 Health and safety during operation and maintenance

The customer will take all necessary precautions to ensure the safety of the contractors personnel at the site. This includes provision of the safety instructions of the customer for review by the contractor, safety training by the customer, proper safe handling and disposal of hazardous substances and the protection of the contractors personnel from exposure to such substances, activation and deactivation of all power systems (electrical, mechanical and hydraulic) using a safe and effective lock-out tag procedure, and conducting periodic safety meetings.

The contractor will comply with reasonable health and safety requirements imposed from time to time by the customer at the facility.

The contractor may conduct occasional safety audits to ensure that safe conditions exist and make recommendations to the customer concerning such conditions. Neither the performance or non-performance of safety audits nor the making of any recommendation by the contractor will relieve the customer of the responsibility to provide a safe place to work. If the contractor's staff require medical attention, the customer's local facilities will be made available to the contractors staff for as long as necessary.

If, in the contractors opinion, the safe performance of work at the site is or may be endangered by local conditions, the contractor may remove some or all of its staff from the site and/or supervise performance of all or any part of its work and/or evacuate its staff. The customer will assist with any such evacuation.

The operation of equipment at the site will be the responsibility of the customer. If the customer requires or permits the contractor's staff to operate equipment at the site, the customer will indemnify the contractor, its employees and its agent for all costs and liability (including any reasonable attorney's fees) incurred by or imposed upon the contractor, its employees and agents, based upon injury to persons (including death) or damage to property resulting from the operation of equipment at the site by the contractors staff.

If the customer provides the contractors staff with any tools and equipment to perform work at the site, these tools and equipment must be in a safe working condition (i.e. subject to inspections and preventive maintenance). Tools must also conform to the Jenbacher standard.

If the contractor encounters any hazardous material at the site which requires special handling and/or disposal, the customer will immediately take whatever precautions are required to legally eliminate such hazardous conditions so that the work under contract may proceed safely. The customer must ensure that all hazardous materials produced or generated in the course of the contractors work at the site are removed.

All decontamination necessary for the contractors work (including any repair work) will be performed by the customer.

5 Definitions

5.1 Hazard classification

The hazard classification used in this document is also used on Jenbacher products. They refer to each of the hazards as described in this document.



DANGER (as per ISO 3864 -2:2016)

denotes a high-risk hazard. If this hazard sign is ignored, death or severe injury will follow as a direct consequence.



WARNING (as per ISO 3864 -2:2016)

denotes a medium-risk hazard. If this hazard sign is ignored, death or severe injury may result.



CAUTION (as per ISO 3864 -2:2016)

denotes a low-risk hazard. If this hazard sign is ignored, minor or moderate injury may result.



NOTICE(similar to ANSI Z535.2)



denotes information which is regarded as important but not safety relevant. If information is disregarded, faults or damage to property are possible.

5.2 Explanation of pictograms

The pictograms used in this document are taken mainly from **ISO 7010:2012-10** and national annexes to this Standard. Pictograms deviating from this are derived from the **ISO 3864** series of standards. A detailed description of these specific pictograms can be found in the ⇒ Appendix of this document.

6 Product related residual risks

6.1 Main hazards

⚠ DANGER	
 	<p>Failure to comply with the essential health and safety regulations</p> <p>Death or serious injury due to failure to comply with the essential health and safety regulations.</p> <ul style="list-style-type: none"> ➤ Read the operation and maintenance manual (user manual) and follow the safety instructions in this document before use to avoid injury ➤ Warning, prohibition and mandatory action signage must be respected ➤ In case of any doubt about the content of this document, contact your local Jenbacher representative. ➤ Always keep the current manual readily available to the machine operator. ➤ Operation of the product or work on the product shall only be carried out by respectively trained, electrically and mechanically skilled specialist staff

⚠ DANGER**Mobile machine parts, automatic startup (turbo charger, compressor or turbine)**

Serious injury such as cutting, crushing or severing or shearing of bodily parts due to inadvertent contact with rotating hardware of turbocharger assembly (compressor or turbine) during maintenance in the event of rotor being driven by stack-effect (vertical airflow).



- Refer to respective maintenance instruction related to the turbocharger assembly for hazard avoidance.



- Prevent stack-effect by exhaust path closure (e.g. butterfly valve, temporary shut-off plate or similar), otherwise secure rotor against spinning during maintenance tasks.



- Check that the original condition (safeguard in place) is restored immediately after finishing the work to ensure the effectiveness of the guarding or safety equipment prior to release for operation.

**⚠ DANGER****Mobile machine parts, automatic startup (cranktrain, valvetrain or geartrain)**

Death or serious injury such as cutting, crushing or severing or shearing of bodily parts due to inadvertent contact with rotating hardware of cranktrain, valvetrain or geartrain during maintenance by assisted turning of machinery (engine turning device) in the event of guarding or safety equipment has been dismantled or rendered ineffective for maintenance or servicing purposes.



- For safe site work practices involving the engine turning device refer to the product related maintenance instruction.
- Do not access the interior of the machine or touch moving parts unless the machinery is securely locked out.
- Do not access the interior of the machine or touch moving parts during the turning sequence of the crankshaft.
- Pay special attention to acoustic warning before turning commences.



⚠ DANGER**Mobile machine parts (flywheel)**

Death or severe injuries caused by long hair or loose clothing being pulled into rotating components of the flywheel at the time of commissioning, maintenance, repair or troubleshooting (e.g. balancing procedure) when the protective devices have been dismantled.



If the operation mode selector is in "OUT" position, or in cases where various operating stations (local clients) with remote acknowledgement option exist, the possibility of automatic start-up at any time must be taken into account.



- Utilisation of a special Lock-Out Tag-Out (LOTO) procedure prior to maintenance work, repair work, fault elimination or when adjusting the balance weights (switching off and blocking the automatic start).



- No reaching in permitted. Do not reach into the interior of the machine and do not touch any moving/rotating parts unless the machine has been safely put out of operation.
- Before balancing procedures can be undertaken on the flywheel, a risk evaluation must be carried out on-site to define suitable alternative protective measures to protect personnel from accessing the rotating flywheel (e.g. access limitations, physical barriers).



- Ensure that the original state (safeguards) is restored immediately after completion of the work in order to ensure the effectiveness of the protective devices or safety devices before releasing for operation.

⚠ DANGER**Electricity**

Electrocution due to exposure to electrical shock or fault arc in the event of inadvertent contact with live electric parts when guarding or safety equipment has been dismantled or rendered ineffective, bridging of parts at different voltage levels, overriding of insulation capability during installation, commissioning, maintenance & repair, troubleshooting.



- Access to electrical equipment only for expert staff. Work on electrical machines and devices by electrically qualified person and electrically instructed person only.
- Apply specific Lock-Out Tag-Out (LOTO) procedure prior to maintenance and repair or troubleshooting tasks. De-energize the system and lock the automatic start-up.
- Connect an earth terminal to the ground prior to working on electrical equipment.
- Do not touch electrical equipment. Especially when equipment is found exposed to moisture or water. In principle components must be considered energized. As specific circuits may remain energized despite interrupted line disconnectors always assure yourself of the proper de-energization of the respective electrical circuits and components. These exceptional electrical circuits are specially tagged and described within the wiring diagram.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.
- Check that the original condition (safeguard in place) is restored immediately after finishing the work to ensure the effectiveness of the guarding or safety equipment prior to release for operation.
- Keep electrical cabinets closed during operation.

NOTE**Failure to comply with the necessary safety regulations**

Death or serious injury due to intervention in safety equipment. All modifications to the safety equipment are prohibited. This includes all types of mechanical, electrical or control engineering modifications that directly or indirectly affect the intended function of the safety equipment.



- Make sure that technicians who commission, operate and/or service Jenbacher engines do not impair the safety equipment.
- An exception is only permitted for the purpose and duration of the fault diagnosis by qualified and authorised persons who, taking the function of the system into account, have determined that the measure does not constitute an additional safety risk.

6.2 General residual hazards

6.2.1 Mechanical hazards

WARNING



Stored Energy, unexpected ejection of machine parts

Serious injury due to exposure to stored energy impact by sudden accidental release of spring load during tasks on the crankcase explosion pressure relief valves.



- Maintenance involving the crankcase explosion pressure relief valve springs is only to be performed by qualified technicians in the OEM factory and is not intended to be carried out in the field.
- With reference to the respective work instruction related to tasks involving the explosion pressure relief valve springs, specific procedures, tools and PPE to be used for safe maintenance/assembly/ disassembly must be considered.



WARNING



Danger of falling

Death or severe injury due falling from elevated positions.



- Do not step on equipment which is not intended to be used as step.
- The end user is expected to provide appropriate temporary access provisions as needed during installation or maintenance.
- The end user is expected to provide permanent and safe means of access for work at heights with reference to the applicable Technical Instruction for platform/catwalk design.
- Make sure that all temporary access equipment (platforms, ladders, etc.) are stable and firmly secured before use.
- Wear a safety harness attached to a suitable anchor point.



⚠ WARNING**Slippery surfaces**

Serious injury due to exposure to slip/trip hazard in the event of spilled liquid contamination of walking surfaces.



➤ With reference to daily inspection work instruction the end user is responsible for performing daily inspections to observe for any potential leakage, and if a leakage is detected, to put countermeasures in place to avoid further propagation. Typical areas at risk: Flange connections, sealings, locks and covers.



➤ Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition:

➤ Wear safety shoes (non-slip).

➤ Wear head protection.

➤ Engine room floor as well as working platforms shall to be applied with slip and liquid resistant floor.



➤ The end user/ maintenance team is expected to enforce good housekeeping practices for the expeditious clean-up of spilled fluids.

⚠ WARNING**Moving machinery, automatic start-up**

Death or serious injury (by cutting, crushing or severing, shearing of bodily parts, entanglement of long hair or loose parts of clothes into rotating/oscillating/moving hardware of the machinery) in the event that guarding or safety equipment has been dismantled or rendered ineffective for maintenance/ servicing purposes.



In the case that the operating mode selector switch is in position "AUT", or in the case of various operator stations (local clients) with remote acknowledgement option, automatic start-up must be expected at any time.



➤ Apply specific Lock-Out Tag-Out (LOTO) procedure prior to maintenance and repair or troubleshooting tasks. De-energize the system and lock the automatic start-up.

➤ Check that the original condition (safeguard in place) is restored immediately after finishing the work to ensure the effectiveness of the guarding or safety equipment prior to release for operation.



➤ Do not access the interior of the machine or touch moving parts unless the machinery is securely locked out.

➤ Tie back or cover long hair to prevent it from being caught in moving equipment. Bandanas, disposable caps, hairnets and turbans may be used, providing they cover the hair completely and do not themselves present a hazard to the wearer of hair or garment. Wear close-fitting garment.



⚠ WARNING**Overhead load**

Death or serious injury due to exposure to falling objects from suspended overhead load in the event of wrong lifting.



- Do not stand under suspended loads.
- Do not use lashing points for lifting. These are designed for transport securing only!
- Refer to the specific lifting instruction for proper transport, lifting, positioning and installation of genset, spare parts and auxiliary equipment.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition:
- Wear head protection.
- Wear safety footwear.

⚠ ATTENTION**Overhead obstacle**

Serious injury (head injury, laceration) due to striking against obstacles at head height.



- The end user is responsible to mark respective hazardous areas and overhead obstacles.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.
- Wear head protection.

⚠ ATTENTION**Unexpected ejection of fluids and sudden loud noise**

Minor or moderate injury (e.g. poisoning, burn injury, sensitisation) due to exposure to hot exhaust gases (substance inhaled, repeated exposure, direct skin contact, eye contact) or temporary hearing threshold shift due to sudden loud noise in the event of activating the crankcase explosion pressure relief during occasional crankcase-internal deflagrations.



- Stay distant from engine crankcase explosion pressure relief valves on the A-bank side during operation. Defined hazardous area 2m radial, 0,5m axial distance from explosion pressure relief valve.



- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.



- Wear head protection.



- Wear eye protection (sealed safety glasses).



- Wear protective clothing (long-sleeve working garment).



- Wear hearing protection.

⚠ ATTENTION**Falling objects**

Minor or moderate injury (laceration) due to exposure to falling objects (e.g. bolts, nuts, tools) from elevated positions.



- Maintain a clean environment (good housekeeping) to avoid objects from falling from elevated positions.

- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.

- Wear head protection.

⚠ ATTENTION**Sharp edges**

Minor or moderate injury (snag) due to inadvertent contact with sharp edges.

- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.
- Wear protective gloves.
- Wear protective clothing (long-sleeve working garment).

**6.2.2 Thermal hazards****⚠ WARNING****Hot surfaces**

Danger of burns due to inadvertent contact with hot surfaces of genset.

Genset related equipment can reach high temperatures during all operating conditions.

- Allow the engine to cool down prior to accessing system parts.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition:
- Wear protective gloves.
- Wear protective clothing.
- Check that the original condition (safeguard in place) is restored immediately after finishing the work to ensure the effectiveness of the guarding or safety equipment prior to release for operation.



⚠ WARNING**Flammable material, fire**

Serious injury (breath apparatus irritation, burn injury) due to exposure to fire impact (flame/ fire/smoke) in the event of a fire occurrence.

- End user is responsible for consideration of flame/ fire/ smoke detection in order to enable early detection of an initial fire event as well as a secure shutdown of the engine, further allowing for conducting of countermeasures such as fire fighting.
- End user is responsible for preventive fire protection measures related to the plant (e.g. use of non-flammable construction material, fire retarding sealings for cable glands and pipe penetrations).
- The end user must ensure a means of interrupting the fuel gas supply in the event of fire is provided external to the engine room, e.g. safety shut-off valve or manual shut-off valve and the applicability of LOTO-equipment (Lock-out / Tag-out) must be given.
- Consideration of appropriate emergency escape routes incl. emergency escape route lighting (24 V DC) and emergency escape route signage.
- Installation of warning device (signal lamp and signal horn 24 V DC)
- Provision of emergency lighting (24 V DC)
- Keep doors closed to prevent dispersion of smoke in the case of a fire
- Leave area immediately in the case of a fire.
- Keep emergency escape routes free at all times
- In the event of fire, isolate the fuel gas supply and the electrical supply from a safe location

⚠ WARNING**Flammable material, explosion**

Serious injury (burn) due to exposure to explosion impact (e.g. explosion pressure, debris, collapsing structures, fire/flames, hot gases) in the event of a deflagration of accumulated vapours from volatile solvents.



Excessive use of volatile solvents (especially brake cleansing agent) in confined and/or rarely vented spaces (e.g. engine crankcase) in combination with the presence of ignition sources (e.g. hot surfaces, electrical devices, open flame, fire, open ignition source or smoking) can lead to the build-up and ignition of an explosive atmosphere.



- No open flame. Fire, open ignition sources and smoking prohibited. Do not use cleansing agents at the presence of hot engine surfaces.
- Do not use cleaning spirit, paint thinner or other volatile solvents which are not approved by Jenbacher as cleansing agent.



- Refer to the material specific material safety data sheet (MSDS) for the material specific hazards and protective measures.



- No excessive use of cleansing agents with compounds of volatile solvents.
- Ensure proper ventilation to avoid explosive atmosphere build-up.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.



- Wear protective gloves.
- Wear eye protection (sealed safety glasses).
- Wear protective clothing.

Note:

Direct application of brake cleansing agent onto engine components can lead to contaminants ingress into clean lube oil circuit and to further increased wear of engine components. Apply brake cleansing agent onto lint-free cloth instead!

⚠ ATTENTION**Hot surfaces**

Serious injury (burn) due to inadvertent contact with hot surfaces of crankcase explosion pressure relief valves.

Crankcase explosion pressure relief valves are designed for flameless pressure relief. Nonetheless the valve housing can reach temperatures of ~200°C in the event of or immediate after crankcase explosion events.



- Keep distance and allow for proper cooling prior to accessing it for inspection.
- Do not touch the crankcase explosion pressure relief valves.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.
- Wear protective gloves.
- Wear protective clothing (long-sleeve working garment).

⚠ ATTENTION**Low ambient temperature**

Discomfort (severe cold) due to exposure to cold draft air inside of the engine room in the event of winter operation of engine room ventilation



- Avoid exposure or reduce exposure duration to cold air draft.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.
- Wear protective clothing. In winter operation, wear closed fitted protective garment or coat.

⚠ ATTENTION**High ambient temperature**

Discomfort, loss of awareness or fatigue due to exposure to heat radiation and high ambient temperature in close proximity to hot genset or auxiliary system surfaces.



- The end user shall take appropriate steps to ensure that the exposure duration for site personnel who are performing extended maintenance in a hot environment over 25°C (77°F) Heat Index is limited and that the personnel is provided with sufficient water and is monitored for heat stress disorders.
- Wear the relevant personal protective equipment (PPE).

6.2.3 Noise hazards

⚠ ATTENTION**Loud noise**

Serious injury (permanent hearing loss, temporary hearing threshold shift) due to excessive exposure to operational noise emission.



- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.
- Wear ear protection suitable for the noise emitted during operation of the genset. Noise level must be according to project specific Technical specification).
- The end user shall take appropriate steps (e.g. implementation of a hearing conservation program) to ensure that the noise exposure duration for site personnel is limited and that the personnel is observed for hearing distress disorders.

6.2.4 Hazards arising from materials or other substances

⚠ WARNING**People under the influence of pharmaceuticals, alcohol or drugs**

Death or serious injury due to working under the influence of pharmaceuticals, alcohol or drugs. In consequence of the influence on the ability to respond, the concentration and the readiness to assume a risk, people under the influence of pharmaceuticals, alcohol or drugs represent a hazard to occupational health and safety, to themselves and other people.



- The employer must not concern people with tasks, who are observably not able to carry out a task without hazard to themselves or other people
- People under the influence of pharmaceuticals, alcohol or drugs must not enter the engine room under any circumstances.

⚠ ATTENTION**Poisoning**

Sensitization or breathing difficulties due to exposure to dust and residues while handling used exhaust system parts and thermal insulation, or replacing clogged air filters.



- Refer to material specific material safety data sheet (MSDS) for material/ substance related hazards and protective measures.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition:
 - Wear a mask (dust respirator for particles)
 - Wear disposable protective gloves, coverall, and overshoes
 - Wear eye protection (sealed safety glasses)



- To prevent potentially hazardous substances becoming airborne particles, obvious dusts and residues on surfaces shall be carefully wiped away with a clean damp cloth.



- Where used thermal insulation is to be refitted, obvious dusts and residues must be removed as far as possible with a Class H vacuum cleaner and/or damp cloths, according to surface type. Cleaning by compressed air or abrasive techniques is strictly forbidden!



- At the end of the work period, used disposable PPE shall be removed carefully and disposed of in a sealed bag together with used cleaning cloths.

**⚠ ATTENTION****Poisoning**

Minor or moderate injury (e.g. breathing difficulties, poisoning, sensitization) due to exposure to fumes (substance inhaled, repeated exposure, direct skin contact, eye contact) in the event of fumigating insulation materials, paint coatings, evaporating lubricants and coolants during initial commissioning or after maintenance tasks.



Components or substances contained within insulation material, enamel varnish, lubricants used during engine manufacturing etc. may release fumes during first hot operation.

- Avoid exposure or limit exposure duration.
- Avoid inhalation of fumes.
- Ensure sufficient ventilation and fresh air supply to allow for dilution and evacuation of fumes.

⚠ ATTENTION**Skin irritation and long-term consequences**

Short-term skin irritations can occur as a result of contact with pyrolysis gas components. Depending on the exact composition of the pyrolysis gas, long-term consequences arising from contact with certain pyrolysis gas components cannot, however, be ruled out.



Contact with liquid or solid deposits of pyrolysis gas components can occur if the gas piping is opened during dismantling, repair, maintenance, disposal or draining of condensate.

Contact with dust from pyrolysis gas components in the air can take place due to a leak in the engine exhaust gas system or fuel gas system during engine operation.



- Within the framework of the plant risk assessment, the plant operator must, therefore, determine the substance-specific hazards resulting from the precise composition of the pyrolysis gas and the resulting protective measures to be taken, including fitting the necessary signage of the hazards at the plant itself.



- Special training must also be given to employees to inform them of the hazards arising from the ascertained components of the pyrolysis gas and the necessary protective measures.



- Make sure that personal protective equipment (PPE) appropriate for the ascertained substance-specific hazards is available, is actually used in everyday practice and is - and remains - in good condition.
- Wear a protective mask (dust-proof breathing mask) fitted with a filter for the pyrolysis gas components in question.
- Wear long nitrile gloves.
- Wear eye protection (sealed safety glasses).
- Wear full-body overalls.
- The water level must be checked regularly in accordance with IW 8095 A0 to minimise exposure to pyrolysis gas.
- Engines for pyrolysis applications and their components must be disposed of in accordance with local regulations at the end of their service life. Engines and components should not be sent back to the suppliers or manufacturers for the purposes of inspection, overhaul or re-use.
- Exceptions to the above may occur if an analysis shows that no hazards will arise from the individual components of the pyrolysis gas.

6.2.5 Hazards from ignoring ergonomic principles

! ATTENTION**Manual lifting of heavy loads**

Serious injury (e.g. musculoskeletal disorder, crush, pinch) due to manual lifting of heavy parts.



- Do not manually lift equipment above 25 kg individual load.
- Use appropriate lifting devices during assembly, disassembly of heavy load equipment.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition:
 - Wear safety footwear.
 - Wear protective gloves.
 - Wear protective clothing.
 - Wear head protection.

6.2.6 Combination of hazards

⚠ DANGER**Failure to use personal protective equipment (PPE)**

Death or serious injury due to failure to use necessary personal protective equipment. By correct selection and utilisation of PPE, injuries can be avoided.



- Make yourself familiar with the specific hazards as well as with local regulations and the necessary safety precautions prior to beginning to work on the product
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition
- Tie back or cover long hair to prevent it from being caught in moving equipment. Bandanas, disposable caps, hairnets and turbans may be used, providing they cover the hair completely and do not themselves present a hazard to the wearer.
- Wear protective clothing (close-fitting and long-sleeve)
- As a minimum PPE for entering the engine room as well as for work on equipment parts (also exterior to the engine room), protective eyewear, protective garment, protective gloves and protective shoes shall be worn
- Depending on the situation additional personal protective equipment may be necessary, such as e.g. ear protection, head protection, fall restraint harness, gas detectors, breath protection etc.
- Electrical work may require additional special PPE, such as special helmet with face protection, tools with respective dielectric strength etc.

⚠ WARNING**Lighting outage**

Serious injury (e.g. trip, fall, strike against obstacles, burn, limited means of escape) due to loss of orientation in the event of a general lighting outage.



- End user is responsible for provision of safety lighting in addition to the general lighting allowing for illumination of areas representing special hazards during an outage of the general lighting.
- End user is responsible for provision of emergency lighting in addition to the general lighting allowing for illumination of emergency and escape routes during an outage of the general lighting.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.

⚠ ATTENTION**Limited circumferential visibility**

Minor or moderate injury due to delayed awareness of hazardous situations due to limited circumferential visibility and spatial arrangement of the equipment within the engine room.



- End user is responsible to ensure the consideration of proper means of warning from hazardous situations (e.g. fuel gas leak, fire, critical operating states) allowing for warning, evacuation and conducting of countermeasures in a timely manner, e.g. by caution lights in combination with acoustical warning devices in the engine room.
- End user is responsible to ensure the consideration of proper means of evacuation routes in accordance with local regulations allowing for evacuation from the engine room in a timely manner.

⚠ ATTENTION**Inadequate lighting**

Minor or moderate injury (e.g. discomfort, fatigue, loss of awareness, trip, fall) due to exposure to inadequate lighting (such as flickering lighting, dazzling lighting, shadow, stroboscopic effect).



- End user is responsible for provision of adequate general lighting near the equipment allowing for shadow and dazzling-free lighting in accordance with TA 1100-0116.
- End user is responsible for provision of additional lighting to allow for proper fulfilment of service tasks during maintenance. This can include temporary portable lighting.
- Avoid stroboscopic effect, e.g. by two-phase or three-phase connection or a suitable electronic probe.

6.2.7 Hazards arising from energy supply failure, breakage of machinery parts or other functional failures**⚠ WARNING****Earthquake**

Death or serious injury due to equipment failing in the event of a seismic activity (e.g. dislocation and/or overturning of genset, rupture of energy supply lines, discharge of hazardous fluids leading to fire/explosion etc.).



- The end user is responsible for consideration of applicable local regulations and preventive protection measures for the proper installation of the equipment related to the respective seismic zone.

6.2.8 Hazards arising from (temporarily) missing or incorrectly-fitted safety accessories

⚠ WARNING**Missing or inadequate information**

Serious injury (e.g. burn injury, breathing difficulties, poisoning, sensitization) due to inadvertent discharge of hazardous substances (pressurized, flammable, poisonous, hot, cold etc.). This can occur by opening the wrong media circuit due to lack of adequate media marking during maintenance tasks.



➤ Apply specific Lock-Out Tag-Out (LOTO) procedure prior to maintenance tasks. De-energize the system and lock the automatic start-up.



➤ End user is responsible for provision of proper means of isolation from energy source immediate at the machinery interface connection.



➤ End user is responsible to consider the applicability of Lock Out Tag Out procedures (LOTO) for the selected means for isolation (lockability).



➤ The end user is responsible for adequate marking of the means for isolation to allow clear identification for the application of LOTO procedure.

➤ Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.

➤ Wear eye protection (sealed safety glasses).

➤ Wear protective clothing (long-sleeve working garment).

➤ Wear protective gloves.

6.3 System-related residual hazards

6.3.1 Engine mechanical

⚠ WARNING**Unexpected ejection of machine parts or fluids**

Death or serious injury due to exposure to debris released from cranktrain in the event of engine re-start without proper root cause analysis (e.g. resetting the fault contrary to instructions or without the cause of the failure being remedied, or after a trip due to a fault) in response to hydro-lock or heavy-knock related trip.



Hydro-lock induced by inleaking coolant into combustion chamber from engine coolant system during standstill.

Heavy-knock induced by either improper combustion or other evolving mechanical damage.

➤ With reference to TA 1100-0111, alarms must not simply be reset. The root cause must be determined and rectified prior to re-starting the genset.

⚠ WARNING**Unexpected ejection of machine parts or fluids**

Serious injury due to exposure to debris released in the event of the reasonable foreseeable misuse of tripping the emergency stop function in response to generator reverse power.

Auxiliary systems trip in response to emergency stop activation, leading to loss of engine cooling capability. Insufficient cooling and lubrication can lead to a scenario with potential for severe machinery damage.



- Do not trip emergency stop in response to generator reverse power.
- Utilise alternative grid disconnection options, such as the superordinate line disconnect switch or transformer circuit-breaker in the case of a generator circuit breaker failure.

⚠ ATTENTION**Stored Energy, unexpected ejection of machine parts**

Serious injury due to exposure to stored energy impact by sudden accidental release of spring load during maintenance tasks on the cylinder head.



- Maintenance involving the cylinder head valve springs is only to be performed by qualified technicians in the OEM factory and is not intended to be carried out in the field.
- With reference to the respective maintenance instruction related to tasks involving the cylinder head valve springs, specific procedures, tools and PPE to be used for safe maintenance/assembly/disassembly must be considered.

**6.3.2 Cooling water system****⚠ WARNING****Overpressure, unexpected ejection of machine parts or fluids**

Death or serious injury due to exposure to debris released in the event of a coolant system component burst induced by overpressurization (e.g. due to badly maintained safety pressure relief valve).



- With reference to the coolant system related maintenance tasks, the end user is responsible to check the proper functionality of the safety pressure relief valve on a regular basis.

⚠ WARNING**Hot liquids and vapours**

Serious injury (e.g. burn, scald) due to exposure to hot coolant or coolant vapours in the event of coolant discharge (due to pressurised leaks or blow-off from pressure relief valves).



- Apply specific Lock-Out Tag-Out (LOTO) procedure prior to maintenance tasks. De-energise/depressurise the system and lock the automatic start-up.



- Consider routing exhaust gas lines to a safe location.



- Consider adequate cooling down of coolant prior to accessing parts of the system (pipework, latches and covers or media-bearing equipment).



- With reference to daily inspection work instruction the end user is responsible for performing daily inspections to observe for any potential leakage, and if a leakage is detected, to put countermeasures in place to avoid further propagation. Typical areas at risk: Flange connections, sealings, locks and covers.



- Defective or worn hose-pipes, gaskets etc. must be replaced immediately.

- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.

- Wear eye protection (sealed safety glasses).

- Wear protective gloves.

- Wear protective clothing (long-sleeve working garment).

- The following points must be observed when bleeding-off of the cooling system: a flexible hose should be securely attached to the bleed valve (e.g. with a clip) to route the coolant to a collecting vessel. The bleeding-valve should be opened slowly.

- Refer to the material specific safety data sheet (MSDS) for material/substance related hazards and protective measures.

⚠ ATTENTION**Flammable material, fire**

Minor or moderate injury (breathing difficulties, poisoning, burn injury) due to exposure to flame/fire/ smoke in the event of coolant discharge (spray or splashes) onto hot engine surfaces



Engine coolant may contain flammable anti-freeze additives



- No open flame. Fire, open ignition sources and smoking prohibited.
- With reference to daily inspection work instruction the end user is responsible for performing daily inspections to observe for any potential leakage, and if a leakage is detected, to put countermeasures in place to avoid further propagation. Typical areas at risk: flange connections, sealings, locks and covers.
- The following points must be observed when bleeding-off of the cooling system: a flexible hose should be securely attached to the bleed valve (e.g. with a clip) to route the coolant to a collecting vessel. The bleeding-valve should be opened slowly.
- Keep engine room free of flammable material e.g. wooden pallets, packaging, waste rags, fluids, etc.
- Refer to material specific safety data sheet (MSDS) for material/substance related hazards and protective measures.
- End user is responsible for consideration of means of fire extinguishing suitable for the specific material/ substance (refer to MSDS) in order to enable immediate countermeasures on detection of an initial fire event.
- End user is responsible for consideration of flame/fire/smoke detection in order to enable early detection of an initial fire event as well as a secure shutdown of the engine, further allowing for conducting of countermeasures such as fire fighting.

⚠ ATTENTION**Toxic substances/materials**

Minor or moderate injury (e.g. sensitisation, breathing difficulties) due to exposure to coolant additives (anti-freeze agent, corrosion inhibitors) in the event of substance swallowed, mist inhaled, repeated exposure, direct skin contact or eye contact.



No eating or drinking to avoid ingestion of dangerous substances by food and drink contaminated.



➤ Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.



➤ Wear eye protection (sealed safety glasses).



➤ Wear protective gloves.



➤ Wear protective clothing (long-sleeve working garment).

➤ Refer to the material specific safety data sheet (MSDS) for material/substance related hazards and protective measures.

➤ Consider sufficient ventilation and fresh air supply during handling with material/substance.

NOTE**Environmentally hazardous substances**

Minor or moderate environmental damage due to inadvertent discharge to the environment, e.g. in the event of a coolant system leaking.



➤ With reference to daily inspection work instruction the end user is responsible for performing daily inspections to observe for any potential leakage, and if a leakage is detected, to put countermeasures in place to avoid further propagation. Typical areas at risk: flange connections, sealings, locks and covers.

➤ Defective or worn hose-pipes, gaskets etc. must be replaced immediately.

➤ End user is responsible to ensure physical embankment to avoid release to the environment in the case of a leak.

➤ The end user/maintenance team is expected to enforce good housekeeping practices for the expeditious clean-up of spilled fluids.

➤ Refer to material specific safety data sheet (MSDS) for material/substance related hazards and protective measures.

6.3.3 Lubricating oil system

⚠ WARNING**Hot liquids and vapours**

Serious injury (e.g. burn, scald) due to inadvertent contact with hot lube oil.



- Apply specific Lock-Out Tag-Out (LOTO) procedure prior to maintenance tasks. De-energize/depressurize the system and lock the automatic start-up.
- Consider adequate cooling down of the lube oil prior to accessing parts of the system (pipework, latches and covers or media-bearing equipment).
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.
- Wear eye protection (sealed safety glasses).
- Wear protective gloves.
- Wear protective clothing (long-sleeve working garment).
- Refer to material specific safety data sheet (MSDS) for material/substance related hazards and protective measures.

⚠ WARNING**Confined space**

Death or serious injury due to unsupervised access to genset oil sump including exposure to lube oil fumes at high ambient temperatures.



- No unsupervised trespassing to confined space for non-expert staff.
- Apply specific Lock-Out Tag-Out (LOTO) procedure prior to maintenance and repair or troubleshooting tasks. De-energize the system and lock the automatic start-up.
- Ensure local safe site work practices are followed when confined spaces are accessed (e.g. access permit procedure)
- Ensure appropriate personal protective equipment (PPE) is available, in good order and is correctly used.
- Allow adequate cooling down period prior to accessing the confined space (<40°C).
- Adequate ventilation must be provided

⚠ WARNING**Flammable material, fire**

Minor or moderate injury (breathing difficulties, poisoning, burn injury) due to exposure to fire impact (flame/ fire/ smoke) in the event of lube oil discharge (spray or splashes) onto hot engine surfaces



- No open flame. Fire, open ignition sources and smoking prohibited.
- With reference to daily inspection work instruction the end user is responsible for performing daily inspections to observe for any potential leakage, and if a leakage is detected, to put countermeasures in place to avoid further propagation. Typical areas at risk: flange connections, sealings, locks and covers.
- Keep engine room free of flammable material e.g. wooden pallets, packaging, waste rags, fluids, etc.
- Refer to material specific safety data sheet (MSDS) for material/substance related hazards and protective measures.
- End user is responsible for consideration of means of fire extinguishing suitable for the specific material/ substance (refer to MSDS) in order to enable immediate countermeasures on detection of an initial fire event
- End user is responsible for consideration of flame/ fire/ smoke detection in order to enable early detection of an initial fire event as well as a secure shutdown of the engine, further allowing for conducting of countermeasures such as fire fighting.

⚠ ATTENTION**Poisoning**

Minor or moderate injury (sensitization, breathing difficulties) due to exposure to lube oil in the event of substance swallowed, mist inhaled, repeated exposure, direct skin contact, eye contact.



No eating or drinking to avoid ingestion of dangerous substances by food and drink contaminated

- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition:
- Wear eye protection (sealed safety glasses).
- Wear protective gloves.
- Wear protective clothing (long-sleeve working garment).
- Refer to material specific safety data sheet (MSDS) for material/substance related hazards and protective measures.
- Sufficient ventilation and fresh air supply must be provided during handling with material / substance

NOTE**Environmentally hazardous substances**

Minor or moderate environmental damage due to inadvertent discharge to the environment in the event of e.g. lube oil system leaking



➤ With reference to daily inspection work instruction the end user is responsible for performing daily inspections to observe for any potential leakage, and if a leakage is detected, to put countermeasures in place to avoid further propagation. Typical areas at risk: flange connections, sealings, locks and covers.



➤ Defective or worn hose-pipes, gaskets etc. must be replaced immediately.

➤ End user is responsible to ensure physical embankment to avoid release to the environment in the case of a leak

➤ The end user/ maintenance team is expected to enforce good housekeeping practices for the expeditious clean-up of spilled fluids

➤ Refer to material specific safety data sheet (MSDS) for material/substance related hazards and protective measures.

6.3.4 Engine fuel supply system**⚠ WARNING****Overpressure, unexpected ejection of machine parts or fluids**

Death or serious injury due to exposure to debris released in the event of a system component burst induced by an excessive fuel gas supply pressure



➤ End user is responsible for limitation of excessive fuel supply pressures including expectable pressure peaks during typical switching modes (e.g. forced shutdown from full load with resulting main gas valve closure) Limitation to 16.0 bar(g) by e.g. means of pressure relief valves with blow-out line routed to a safe location

⚠ WARNING**Flammable material, explosion**

Death or serious injury due to exposure to explosion impact (explosion pressure, debris, loss of structural integrity, fire/flames, hot gases) in the event of fuel discharge triggered by overpressurization due to external thermal load (e.g. hot works, external fire)



➤ No open flame. Fire, open ignition source and smoking prohibited

➤ Hot works prohibited (e.g. welding on fuel gas system equipment once the system is commissioned and pressurized)

➤ Adequate countermeasures to avoid pressure build-up under external thermal load need to be taken into consideration by the end user with reference to local regulations



➤ Limit the amount of leaking fuel induced by external heat load, by means of secure fuel interruption for the respective fire zone (e.g. quick acting valve, thermostatic valve, manual operated isolation valve external to the fire zone)

⚠ WARNING**Flammable material, explosion**

Death or serious injury due to exposure to explosion impact (explosion pressure, debris, loss of structural integrity, fire/flames, hot gases) in the event of uncontrolled fuel discharge



- The end user is responsible to avoid the build-up of explosive atmospheres by proper means of engine room ventilation for dilution of potential residual minor gas leaks (aim to reach Zone 2 NE acc. IEC 60079-10 by provision of an adequate air-change rate with reference to TA 1100-0110)
- An interface signal must be provided which allows for interruption of the fuel supply in response to the detection of a failed or insufficient ventilation and/ or the detection of gas leakages during engine operation. The signal reliability has to meet the requirements of ISO 13849-1:2015, which is needed to reach an overall Performance Level PL = c for the safety-related controls function
- An interface signal must be provided which allows for full-ramp-up of the ventilation in response to the detection of gas leakages during engine standstill. The signal reliability has to meet the requirements of ISO 13849-1:2015, which is needed to reach an overall Performance Level PL = c for the safety-related controls function.
- Tightness check for all bolted, screwed and clamped connections prior to commissioning start-up and after maintenance tasks as per the Jenbacher user manual.
- The end user has to ensure the secure interruption of the fuel supply by means of e.g. safety shut-off valve or manual shut-off valve to also cover the case of potential leakages outside of Jenbacher scope of supply (e.g. shut-off device positioned outside of engine room).
- With reference to daily inspection work instruction the end user is responsible for performing daily inspections to monitor any potential leakage, and if a leakage is detected, to put countermeasures in place to avoid further propagation.
- Pay attention to applications where the fuel is not odorised. Observation for potential fuel leakages during daily inspection task requires additional measuring equipment to identify a potential leak. Wear a personal gas detector.

⚠ WARNING**Flammable material, explosion**

Death or serious injury due to explosion hazard in the event of inadvertent fuel discharge during tasks requiring the opening of fuel gas-bearing system parts.



- Extreme care is required when carrying out maintenance or repair work on the fuel system. These components contain quantities of residual fuel gas which will escape and may form a potential hazardous explosive atmosphere.
- Maintenance tasks at the gas train assembly have to be carried out according to the respective work instruction for the fuel supply system; this includes the application of engine shutdown and Lock-Out-Tag-Out (LOTO) procedure prior to maintenance tasks (depressurize the system and vent to a safe location).
- With reference to TA 1100-0110 the end user is responsible to ensure that blow off line(s) of the gas train assembly are routed to a safe location.
- End user has to ensure the secure interruption of the fuel supply, e.g. by means of a safety shut-off valve or manual shut-off valve. The shut-off device must be positioned outside of engine room, and the applicability of LOTO-equipment must be given.
- Explosion hazard avoidance by application of the system specific work instruction related to the purging of gas-bearing system parts.
- Utilize spark-free tools when working at fuel gas bearing parts.
- No open flame. Fire, open ignition sources and smoking prohibited.

⚠ WARNING**Flammable material, explosion**

Death or serious injury due to exposure to explosion impact (e.g. explosion pressure, debris, loss of structural integrity, fire/flames, hot gases) in the event of uncontrolled discharge of operational fuel gas blow-off.



- With reference to the respective Technical Instruction for installation of Jenbacher gas engines and equipment, the end user is responsible to ensure that blow off line(s) of the gas train assembly is/are routed to a safe location.
- With reference to the respective technical instruction for installation of Jenbacher gas engines and equipment, the end user is responsible for identifying the hazardous areas due to the operational release of fuel gases.

⚠ WARNING**Flammable material, explosion**

Death or serious injury due to exposure to explosion impact (explosion pressure, debris, collapsing structures, fire/flames, hot gases) in the event of a backfire triggered by an engine fault and propagating into the fuel gas supply system.



Presence or build-up of explosive atmosphere internal to the fuel gas supply system induced by air-ingress or supply of fuel within explosive range.

- With reference to the ATEX declaration in respect of Directive 2014/34/EC of the European Parliament and as described in the section on "fuel gas" in Technical Instruction TA 1100-0110, it is a mandatory requirement that the fuel gas used in Jenbacher gas engines must not be flammable in ambient conditions at any time during their operation (including starting and stopping the engine).
- Specific local statutory regulations may apply related to fuel gas type, properties and equipment to allow for safe operation.

⚠ WARNING**Toxic materials, substances**

Death or serious injury (suffocation, poisoning) from exposure to toxic components of fuel gases (inhalation, repeated exposure, direct skin contact, eye contact), such as CO or H₂S, in the event of fuel gas system leaks.



Depending on the gas properties (density), gases may accumulate in areas below the ground (e.g. recesses, depressions, reservoirs).



- Extreme care is required when carrying out maintenance or repair work on the fuel system. These components contain residual gas that escapes into the environment.
- Maintenance tasks at the gas control assembly have to be carried out according to the respective work instruction for the fuel supply system; this includes the application of engine shutdown and Lock-Out-Tag-Out (LOTO) procedure prior to maintenance tasks (depressurise the system and vent to a safe location).
- With reference to TA 1100-0110 the end user is responsible to ensure that blow off line(s) of the gas control assembly are routed to a safe location.
- End user has to ensure the secure interruption of the fuel supply, e.g. by means of a safety shut-off valve or manual shut-off valve. The shut-off device must be positioned outside of the engine room but as close as possible to the engine room and the safe use of LOTO-equipment must be given.
- Refer to the material specific safety data sheet (MSDS) for material/substance related hazards and protective measures.
- Ensure sufficient ventilation and fresh air supply to allow for dilution and evacuation of residual gases.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.
- Use gas detector.
- Have gas detectors serviced and calibrated regularly.

6.3.5 Engine combustion air and pressure charging system

⚠ DANGER**Fire**

Severe injury from flames, fire or smoke when opening the crankcase cover immediately after immediately after an engine failure due to ignition of the combustible mixture by hot component surfaces or power tools.



- Ensure a cool-down period of at least 30 minutes before opening the crankcase.

⚠ WARNING**Flammable material, explosion**

Death or serious injury due to exposure to explosion impact (e.g. explosion pressure, debris, loss of structural integrity, fire/flames, hot gases) in the event of intake of unburned fuel induced by an external gas leak.



Presence or build-up of explosive atmosphere outside of the fuel gas-supply system of the engine.

- With reference to the declaration in respect of Directive 2014/34/EC (ATEX) of the European Parliament and as described in the section on “potentially explosive atmospheres” in Technical Instruction TA 1100-0110, it is not permitted to operate Jenbacher gas engines in Zone 2, 1 or 0 areas as specified in IEC 60079-10-1:2008.
- It is the responsibility of the plant operator to guarantee these conditions throughout the period of operation (including starting and stopping the engine).

⚠ WARNING**Flammable material, explosion**

Death or serious injury due to internal self-ignition of the charge-air system due to combustible mixture backflow from the combustion chamber to the intake duct due to valve overlap during cycle change of the 4th (exhaust) stroke to the 1st (intake) stroke. Premature opening of the inlet valve.



- Make sure that appropriate personal protective equipment (PPE) is available and that it is used and that it is in good condition.



- Wear eye protection (sealed safety glasses).



- Wear protective clothing (long-sleeve working garment).
- Wear protective gloves.

⚠ ATTENTION**Unexpected ejection of fluids**

Minor or moderate injury (such as eye damage, laceration) due to exposure to blown particles (e.g. dust or paint particles) in the event of uncontrolled charge air leak.



- With reference to daily inspection work instruction the end user is responsible for performing daily inspections to observe for any potential leakage, and if a leakage is detected, to put countermeasures in place to avoid further propagation.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition:
- Wear eye protection.

**⚠ ATTENTION****Unexpected ejection of fluids**

Minor or moderate injury (e.g. Discomfort or shock) due to exposure to sudden air blasts emitted from intake air filter assembly in the event of turbocharger pumping during operation.



- Limit exposure duration to areas in close vicinity to the air intake filter during genset operation.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition:
- Wear eye protection.

6.3.6 Engine exhaust gas system

! WARNING**Unexpected ejection of fluids**

Death or serious injury (asphyxiation, poisoning, burn injury) due to excessive exposure to hot and poisonous exhaust gases (substance inhaled, repeated exposure, direct skin contact, eye contact) in the event of exhaust gas system leakage.



- Avoid exposure or limit exposure duration.
- Exhaust gases must always be discharged into the atmosphere.
- Consider sufficient ventilation in areas where exhaust gas equipment is located.
- With reference to daily inspection work instruction the end user is responsible for performing daily inspections to observe for any potential leakage, and if a leakage is detected, to put countermeasures in place to avoid further propagation. Inspection visually for cracks, corrosion, faulty sealings, discolouration of insulation as well as observation for exhaust smell. Typical areas at risk: flange connections, weld seams, sealings, locks and covers.
- End user is responsible to maintain connection tightness. This includes including retightening for all bolted connections after initial run-in period as well as after recommissioning run-in periods following exhaust gas system maintenance tasks. These require accessible flange connections.
- End user is responsible to avoid external mechanical load beyond the specification limits at the interface between the genset and the exhaust gas system.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.
 - Wear eye protection (sealed safety glasses).
 - Wear protective gloves.
 - Wear protective clothing (long-sleeve working garment).
 - Use gas detector. Consider the presence of CO when sufficient ventilation cannot be ensured.

⚠ WARNING**Flammable material, explosion**

Death or serious injury due to exposure to explosion impact (e.g. explosion pressure, debris, collapsing structures, fire/flames, hot gases) in the event of occasional deflagrations within the engine exhaust gas system.



Adjustment of engine operating parameters during commissioning (e.g. to suit different gas properties) or during diagnosis of starting problems may cause an unburned air-fuel mixture to propagate into the external exhaust gas system and accumulate there. This increases the likelihood of deflagration in the exhaust gas system, impacting the system integrity and safety.



The same applies to failures or incorrect operation (e.g. frequent unsuccessful start attempts, resetting the fault contrary to instructions, cause of the failure not remedied, etc.).



- With reference to TA 1100-0110 the end user is responsible to commence risk mitigation measures related to explosion protection when designing the exhaust gas system downstream of the genset.
- According to TA 1100-0110, the end user is responsible for providing the gas pressure within the defined limits.
- In the case of explosion pressure relief, flameless venting must be considered in order to allow for elimination of additional fire and burn hazards. General venting to a safe location must be considered.
- No access to hazardous areas for non-expert staff (close vicinity of hazardous areas related to sensitive exhaust gas system equipment during commissioning, adjustment of engine operating parameters or starting problems diagnosis).
- With reference to TA 1100-0111, failures must not simply be reset. The root cause must be rectified prior to restarting the genset.

Note:

System design shall also consider underpressures in response to deflagration induced pressure surges with impact on the system integrity.

! WARNING**Hot Surface, Fire**

Serious injury (e.g. breath apparatus irritation, burn injury) due to exposure to fire impact (flame/fire/smoke) in the event of flammable material in contact with hot genset surfaces or with engine related hot ancillary systems



In particular, the engine exhaust system and its components have a high operating temperature which can cause a fire if flammable material is in the vicinity.

Ancillary system surfaces such as the exhaust gas system further present a fire hazard if not sufficiently insulated.

Special attention has to be paid to pipe penetrations through walls and/or ceilings made from flammable material.

- Keep away flammable material from hot engine surfaces at any time.
- Secure oil-soaked rags in fire resistant bins only.
- Keep flammable material away from hot exhaust gas lines at any time.
- End user is responsible for consideration of preventive fire protection measures related on the plant location (e.g. use of non-flammable construction material, exhaust line insulation, fire retarding sealings for cable glands and pipe penetrations).
- Ensure that electrical equipment is not affected by thermal radiation of the ancillary exhaust gas system and its system equipment parts.

! WARNING**Overpressure, unexpected ejection of fluids**

Death or serious injury (asphyxiation, poisoning, burn injury) due to excessive exposure to hot exhaust gases (substance inhaled, repeated exposure, direct skin contact, eye contact). Fire hazard in the event of continuous exhaust gas system escape to the engine or auxiliary installation room induced by system overpressurisation.



The presence of shut-off possibilities in the exhaust system of the engine that can completely block the exhaust path in the event of failure, can lead to the following secondary hazards.



- If rupture discs are used for explosion pressure relief, the shutdown of the module must be ensured in response to rupture disc activation, for example by a rupture indicator connected to the module control system.
- If the exhaust system has butterfly valves that can shut off the entire system in the event of valve failure or actuator failure, the shutdown of the module in response to blockage of the exhaust gas path must be ensured.
- In any case, the reliability of the module shutdown signal shall comply with the requirement established by the application of a suitable risk assessment procedure (e.g. EN 13849-1, EN 62061, IEC 61511-1), taking into account the specific circumstances at the installation site.

Note:

The Performance Level may differ due to the requirements specified in the HAZOP of the plant, which is the responsibility of the plant operator.

NOTE

**Environmentally hazardous substances**

Minor or moderate environmental damage due to inadvertent discharge of untreated exhaust gases to the environment.

- End user is responsible for providing proper means of exhaust gas after treatment in accordance with local regulations as per the provided exhaust gas raw emissions report.

6.3.7 Engine compressed air system

⚠ WARNING**Unexpected ejection of machine parts or fluids**

Death or serious injury due to exposure to debris in the event of a compressed air system (starting air system) equipment burst induced by excessive stress/overstraining (overpressurization).

- The end user is responsible for limitation of excessive compressed air supply pressures e.g. by means of pressure limitations/relief valves (refer to TA 1100-0120).

⚠ ATTENTION**Unexpected ejection of fluids**

Minor or moderate injury (eye damage, laceration) due to exposure to blown particles (e.g. dust or paint particles) in the event of starter assembly blow-off during start attempts.



- Maintain a clean environment (good housekeeping) to avoid particles being whirled up during sudden compressed air blow-off.
- The end user is expected to reinstall machine guards/covers immediately after maintenance.
- Keep distance from the starter assembly during starter operation.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.
- Wear eye protection (sealed safety glasses).

⚠ ATTENTION**Stored energy, unexpected ejection of fluids**

Minor or moderate injury (eye damage, laceration) due to exposure to pressurized fluid in the event of inadvertent compressed air discharge during tasks requiring opening of compressed air-bearing system parts (e.g. starter system related).



- Maintenance tasks at the compressed air system must be carried out with reference to the respective work instruction for the compressed air system; this includes the application of an engine shutdown and Lock-Out-Tag-Out (LOTO) procedure prior to maintenance tasks (depressurize the system and vent to a safe location).



- End user is responsible for provision of proper means of isolation from energy source immediate at the machines' interface connection.



- End user is responsible to consider the applicability of Lock Out Tag Out procedures (LOTO) for the selected means for isolation (lockability).

- The end user is responsible for adequate marking of the means for isolation to allow clear identification for the application of LOTO procedure.

- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.



- Wear protective gloves.

- Wear protective clothing (long-sleeve working garment).

- Wear eye protection (sealed safety glasses).

**6.3.8 Engine, electrical****⚠ WARNING****Electricity**

Minor or moderate injury (electric shock, sudden fright reaction) due to inadvertent contact with live electric parts of high-voltage (40 kV) ignition system.

The ignition system may also produce dangerous voltages when the equipment is not operating. This applies to all ignition system related parts, such as ignition cabling, ignition coil, spark plug connector etc.



- Do not touch ignition system components such as the cable, coil, connector etc. while the engine is running.



- Do not pull ignition cables off the coils while the engine is in operation.

- Ignition cables must not get in contact with other plant parts.

- Pay attention to side-effects due to exposure to electrical shock hazards, such as falling from heights.

- Watch out for disintegration of cable insulation materials, deterioration of spark plug wire insulation etc. and initiate a safe shutdown and apply Lock Out Tag Out (LOTO) prior to accessing the system parts for maintenance or repair (de-energize the system and lock the automatic start-up).

⚠ WARNING**Battery charging, Explosion, Corrosive substance**

Serious injury (chemical burn, eye damage) due to battery overload/overcharging or bridging of battery terminals (lead acid buffer batteries for engine control, starting batteries).



During charging, batteries produce electrolytic gases which under certain conditions may form an explosive atmosphere which can be ignited at the presence of an ignition source (e.g. battery terminal points). Explosive gases can cause blindness or injury.

Electrolyte (sulphuric acid) can cause blindness or severe chemical burns.



- No open flame, fire, ignition source or smoking allowed in close vicinity to batteries.
- Ensure to follow the battery maintenance instructions to maintain battery integrity (e.g. battery acid level, acid density).
- Ensure proper ventilation to avoid explosive gas accumulation.



- With reference to daily inspection work instruction the end user is responsible for performing daily inspections to observe for unintended equipment conditions and to conduct countermeasures to avoid hazards from arising.



- Observe for unexpected high battery temperatures and/or battery bloating while charging and immediately disconnect battery if necessary.
- Observe for unexpected high charging voltages (> 24 V DC) and immediately disconnect a battery that becomes very hot while charging.
- Check that the battery terminal points are firmly secured.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.



- Wear eye protection (sealed safety glasses) when working with batteries.
- Wear protective gloves when working with batteries.
- At contact with the electrolyte flush eyes immediately with water and get medical help quickly.

6.3.9 Generator mechanical**⚠ ATTENTION****Unexpected ejection of fluids**

Minor or moderate injury (eye damage, discomfort) due to exposure to escaping objects (e.g. dust or paint particles) in the event of generator cooling air whirling up particles.



- Maintain a clean environment (good housekeeping) to avoid small particles being whirled up during generator operation.
- The end user is expected to reinstall machine guards/covers immediately after maintenance.
- Keep distance from generator air outlet during operation.
- Ensure proper personal protective equipment (PPE) is available, is used and is in good order and condition.
- Wear eye protection (sealed safety glasses).



6.3.10 Generator electrical

⚠ WARNING



Magnetic field

Death or serious injury due to interference with or damage to active implanted cardiac devices (cardiac pacemaker) from equipment generating strong electromagnetic fields during operation (e.g. generator, ignition system, cables, etc.).



- No access to the machine room for people with active implanted cardiac devices (cardiac pacemaker).

⚠ ATTENTION



Electricity, electro dynamic forces

Minor or moderate injury due to exposure to uncontrolled movement of assembly or parts of it (especially auxiliary cabling, power cabling) as a consequence of dynamic forces in the event of a short-circuit (e.g. whiplash effect of power cables).



- The end user must ensure proper installation and fixation of auxiliary cabling including power cabling with reference to TA 1100-0114.

6.3.11 Hot water and district heating system

⚠ WARNING



Overpressure, unexpected ejection of fluids

Death or serious injury due to debris from bursting system components caused by separation of the module from the heat consumer (hot water circuit/district heating circuit).



- As part of safety measures for pressure equipment, the end user is responsible for providing adequate means for thermal expansion.
- Separation of the module from the district heating system during operation must be prevented. If the module is disconnected from the district heating system during maintenance work, the module must be switched off and secured against unauthorised start-up by means of suitable lock-out tag-out measures.

7 Appendix



The pictograms described need not necessarily occur in this document, but may occur in other documents, machine stickers, warning signs, etc.

Mandatory signs (GEM)



Registration number

GEM001

Safety meaning

Use a carbon monoxide monitor

Function

Sign that a carbon monoxide detector must be worn.

Danger

Asphyxiation

Behaviour that should be achieved if the meaning of the safety sign has been understood

Wear a CO detector.

**Registration number**

GEM002

Safety meaning

Secure against unauthorised restarting

Function

Sign that the machinery must be correctly secured against unauthorised restarting.

Danger

Unauthorised restarting or unexpected start-up of machinery

Behaviour that should be achieved if the meaning of the safety sign has been understood

Use of LOTO procedure as per TA 2300-0010.

Prohibition signs (GEP)**Registration number**

GEP001

Safety meaning

Touching electric equipment prohibited

Function

Sign that touching electrical objects / parts of electrical equipment is prohibited.

Danger

Electricity

Behaviour that should be achieved if the meaning of the safety sign has been understood

Electrical objects or parts of electrical equipment are not touched.

Warning signs (GEW)**Registration number**

GEW001

Safety meaning

Warning against lifting heavy loads

Function


Warning against lifting heavy loads

Danger

Lifting heavy loads

Behaviour that should be achieved if the meaning of the safety sign has been understood

Ensuring that no object heavier than 25 kg is lifted without an aid (e.g. a crane).


	Registration number
	GEW002
	Safety meaning
	Warning against poisonous gases
	Function
	Warning against poisonous gases

Danger

Asphyxiation, poisoning

Behaviour that should be achieved if the meaning of the safety sign has been understood

Pay attention to the harmful substance levels in the direct environment. Wear personal protective equipment (gas detector, protective mask).


	Registration number
	GEW003
	Safety meaning
	Warning against carbon monoxide
	Function
	Warning against carbon monoxide

Danger

Asphyxiation, poisoning

Behaviour that should be achieved if the meaning of the safety sign has been understood

Pay attention to the carbon monoxide levels in the direct environment. Wear personal protective equipment (gas detector, protective mask).


	Registration number
	GEW004
	Safety meaning
	Warning against live parts
	Function
	Warning against live parts

Danger

Electricity

Behaviour that should be achieved if the meaning of the safety sign has been understood

Circuits marked with this symbol must be regarded as live.

	Registration number
	GEW005
	Safety meaning
	Warning against escaping liquids
	Function

Warning against escaping liquids

Danger

Escape of hot and/or pressurised liquids

Behaviour that should be achieved if the meaning of the safety sign has been understood

Avoidance of coming into contact with hot and/or pressurised liquids. Use of LOTO procedure as per TA 2300-0010 before starting work on the system.

**Registration number**

GEW006

Safety meaning

Warning against substances harmful to health, or irritants

Function

Warning against substances harmful to health, or irritants

Danger

Substances harmful to health or irritants

Behaviour that should be achieved if the meaning of the safety sign has been understood

Take personal protective precautions and do not come into contact with harmful or irritant substances.

**Registration number**

GEW007

Safety meaning

Warning against hot liquids and vapours

Function

Warning against hot liquids and vapours

Danger

Hot liquids and vapours

Behaviour that should be achieved if the meaning of the safety sign has been understood

Take personal protective precautions and do not come into contact with hot liquids and vapours.

**Registration number**

GEW008

Safety meaning

Warning against noise

Function

Warning against noise

Danger

High noise pollution levels, hearing loss

Behaviour that should be achieved if the meaning of the safety sign has been understood

Take personal protective precautions in areas where exposure to noise can occur.

8 Revision code

Revision history

Index	Date	Description / Revision summary	Expert Auditor
15	31.10.2019	Sicherheitshinweis für „Nichteinhaltung der erforderlichen Sicherheitsvorschriften“ in Kapitel 6.1, „Giftige Materialien, Stoffe“ in Kapitel 6.3.4, „Feuer“ und „Entzündliche Stoffe, Explosion“ in Kapitel 6.3.5, „Überdruck, unerwarteter Austritt von Medien“ in Kapitel 6.3.11 hinzugefügt; Sicherheitshinweis für „Entzündliche Stoffe, Explosion“ und „Überdruck, unerwarteter Austritt von Medien“ in Kapitel 6.3.6 angepasst / Safety information for „Failure to comply with the necessary safety regulations“ in chapter 6.1, „Toxic materials, substances“ in chapter 6.3.4, „Fire“ and „Flammable material, explosion“ in chapter 6.3.5, „Overpressure, unexpected ejection of fluids“ in chapter 6.3.1 added; Safety information for „Flammable material, explosion“ and „Overpressure, unexpected ejection of fluids“ in chapter 6.3.6 adapted	Seitz F. <i>Eastburn C.</i>
14	27.08.2019	Sicherheitshinweis für Vergiftung in Kapitel 5.2.4 angepasst / Safety information for Poisoning in chapter 5.2.4 adapted	Eastburn C. <i>Eastburn C.</i>
13	26.08.2019	Sicherheitshinweis für Vergiftung in Kapitel 5.2.4 angepasst / Safety information for Poisoning in chapter 5.2.4 adapted	Eastburn C. <i>Eastburn C.</i>
12	26.08.2019	Sicherheitshinweis für Bewegliche Maschinenteile in Kapitel 5.2.1 ergänzt / Safety information for moving machine parts in chapter 5.2.1 added	Seitz F. <i>Eastburn C.</i>
11	16.04.2019	Sicherheitshinweis für Pryolyseanwendungen ergänzt / Safety information for pyrolysis applications added	Prast J. <i>Eastburn C.</i>
		Sicherheitshinweis für Absturzgefahr angepasst / Safety information for fall hazard adapted	Eastburn C. <i>Eastburn C.</i>
10	30.01.2018	Keine inhaltliche Änderung, nur die englische Übersetzung angepasst / No change of content, just the english translation adapted	Unterrainer R. <i>Eastburn C.</i>

