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# 1. GENERAL

## 1.1. Manufacturer Identification and Contacts

ACME INC.

## 1.2. Generator Identification

## 1.3. General Information

The descriptions and instructions provided in this Boiler Instruction and Maintenance Manual refer to the ACME INC. CTR type boiler, specifically to the dimensions and details shown in the header of this document. The boiler is supplied with a nameplate (see AAAAA-000-000-M-1641-NPL-0001) that provides detailed information about the equipment: type, series, and dimensions are indicated along with the main operating and design data, year, and production number; all this will facilitate future contacts for further commercial activities, technical requests, clarifications, or spare parts orders.

ACME INC. boilers are designed according to the most advanced technologies: equipment design and construction have been carefully executed to ensure all their purposes are met, allowing operation, maintenance, and final dismantling without any risk to Operators. Materials used for construction are selected for each specific application, considering constraints due to operating conditions (design pressure and temperature) and site environmental conditions (altitude, weather, seismic risk), as well as the physical layout of the installation (expansion lines and related stresses on flanges and welds). Fuel characteristics have been duly considered during project development to avoid damage and problems during operation.

This document describes the correct and safe use of the generator during all operating phases: the boiler must not be used beyond the limits indicated in the technical data or in any way other than specified in the Manual. The Operator must consider the information provided in Chapter 4 or other parts of this document or in the documentation attached to the contract.

The manual cannot foresee all possible events that may occur during operation or maintenance of the generator; whoever operates the boiler must ensure that all necessary safety measures are respected and that applicable regulations are applied. The Operator is responsible for ensuring that safety regulations applicable at the installation site are observed. All safety instructions included in this document and in all applicable documents, as well as the indications shown on labels installed on the various generator equipment, must be observed. This manual must always be available on site for easy and convenient consultation. It must also be read carefully and fully understood by the Personnel operating the plant. Any operation not included among the activities indicated in this Manual requires specific knowledge and, therefore, must be carried out by specialized ACME INC. personnel. If further information is needed, contact the ACME INC. headquarters.

## 1.4. Information Contained in the Manual

This manual includes information on the design and operation of the boiler. It is intended to familiarize the operator with all operations to be performed during normal boiler operation,

maintenance activities, and final dismantling. This manual also generally refers to elements, equipment, and operating logic not included in the scope of supply of ACME INC. because they are related to the correct and safe use of the boiler. The information contained in this manual must be validated and/or specified in detail by the plant integrator for every aspect related to boiler safety and operation.

This manual must be read carefully and fully understood by Operators, in strict compliance with all related documents/plans included in the corresponding sections. This manual must always be available at the generator operating site for easy consultation.

# 2. SAFETY

## 2.1. 2.1 General Information

This manual includes basic guidelines for the safe operation and maintenance of the generator, which must be followed during normal operational activities.
This manual must be read and understood by all dedicated personnel and be available at the installation site.
All instructions included in the various sections of the manual must be observed; likewise, instructions for the various equipment of the plant must be followed and always kept perfectly legible.
Local standards, even if not indicated in this manual, must also be observed.
If further information or instructions are required, please contact the ACME INC. headquarters.

### 2.1.1. General Safety Recommendations

**SAFETY**
Most accidents resulting from the use and maintenance of the generator described below are caused by failure to observe the most fundamental and basic safety and prevention rules.
Often, accidents can be avoided by considering the potential hazards and risks of a given situation before the incident occurs.
The generator described is intended to be operated by licensed and qualified personnel, to whom all technical information and instructions provided below are addressed.
The information in this Manual must also be supplemented by legislative provisions and/or current technical standards issued by the Authority for safety purposes.

The **SAFETY MANAGER** appointed by the Customer must therefore be able to ensure that the supplied generator, including its auxiliaries, is installed, commissioned, operated, controlled, maintained, and repaired only and exclusively by licensed and qualified personnel who must possess:

- Specific technical information and practical knowledge of applicable technical and legislative standards
- Knowledge of safety requirements at national and local levels specific to the generator in question
- The ability to recognize and avoid potential hazardous situations of various kinds

Only operators who have read and fully understood this Manual may work and operate on the generator. Any other personnel without the necessary knowledge will be excluded from operational and maintenance activities of this plant.

It is recommended to pay particular attention to all "NOTES" in the following paragraphs of this manual, especially when it comes to instructions to Operators regarding the execution of tests to verify the correct and safe operation of the generator or to avoid any dangerous or risky situation.

Do not perform maintenance activities on the device until you have read and fully understood the instructions provided in this manual.

Do not make modifications to the system (mechanical, hydraulic, or electrical), as explained in this manual, without prior written consent from ACME INC.

**ANY ALTERATION OR TAMPERING WITH THE BOILER OR ITS AUXILIARIES/ACCESSORIES MAY CAUSE EVEN SERIOUS DANGEROUS SITUATIONS FOR WHICH ACME INC. DISCLAIMS ALL CIVIL AND CRIMINAL LIABILITY.**
**AS A RESULT OF ALTERATIONS OR TAMPERING, ANY EXISTING WARRANTY WILL IMMEDIATELY EXPIRE.**

ACME INC. does not control the operational management phase of the generator and does not know the actual conditions of use of the supplied equipment. Therefore, ACME INC. cannot provide a complete list of risks in its technical manuals.

For this reason, the WARNINGS and NOTES in this Manual may not cover all possible hazardous situations, especially if the equipment is used improperly.
Additionally, this manual also includes recommendations for items not supplied by ACME INC. because they are related to the safe operation of the boiler. Specific analyses must be carried out by the integrator of the ACME INC. generator in the plant to ensure proper operation and safety.

If, during various operational and/or maintenance activities, procedures, equipment, and methods not expressly recommended by ACME INC. are adopted, the SAFETY MANAGER appointed by the Customer must ensure that the work is still carried out within the limits of personal safety for both the executor and anyone else.
The SAFETY MANAGER must also ensure that the machine is not damaged and is not rendered unsafe due to the procedures adopted.

In particular, the following instructions must be strictly observed:

- Do not replace or modify equipment/instruments or parts thereof with materials different from those originally supplied and installed, as this could cause serious problems and must be absolutely avoided.
- Do not modify or alter equipment/instruments or their accessories dedicated to the safety of the generator, as this could cause serious problems and must be absolutely avoided.
- Do not modify or alter the control and protection logic of the system, as this could cause serious problems and must be absolutely avoided.

When any of the following events occur, the generator must be immediately shut down and appropriate corrective actions must be carried out only by competent and authorized personnel before any further attempt to restart:

- Loss of water and/or uncontrolled decrease in pressure in the generator
- Fuel leaks (for example, such leaks may be detected by suspicious odors)
- Poor electrical insulation
- Burner operation with low or high excess air (for example, the color of the flue gases at the stack and/or the color of the flame may indicate poor combustion)
- Unstable combustion
- Abnormal vibrations
- Abnormal noises

Additionally, the following further conditions must be absolutely avoided:

- Changes to the start-up sequence and/or the duration of timed phases
- Changing the calibration values of safety devices (such as pressure, level, temperature, flow limiters, etc.)
- Disconnecting or bypassing limit switches and/or other elements associated with generator safety
- Disconnecting or bypassing flame detectors or using them incorrectly and unreliably
- Reducing the duration of air purging of the generator and its ducts
- Modifying the set air/fuel ratio
- Modifying burners
- Starting the burner with a load higher than recommended
- Modifying or altering connections of safety-related devices/instruments
- Modifying the duration or sequence of burner and/or generator shutdown
- Alterations by mechanical stops or similar to any valve installed on the fuel line
- Pollution and/or contamination of feedwater and the generator process circuit with unauthorized substances, particularly oil, grease, hydrogen, seawater, and similar
- Operating the generator/plant with chemical parameter concentrations of feedwater and/or generator outside the limits allowed in the instructions of this Manual
- Operating the generator/plant in the presence of oil, water, or other impurities in the instrument air circuit
- Operating the generator/plant with abnormal pressure in the instrument air circuit, above or below design values
- Modifying electrical and/or pneumatic connections of safety-related devices and accessories
- Further ignition attempts of a burner after two failed ignition attempts. In such cases, after two failed attempts and before any further attempt to restart, it is mandatory to identify the causes of such failures, eliminate them with certainty, and perform an air purge for a longer time than normal (or multiple purges).

After any incident (even minor), the Operator must conduct a thorough investigation before attempting to restart the generator. All causes of the incident must be identified and definitively removed to prevent recurrence.

**NOTE:**
This manual, as well as all detailed documents/plans in each section, must be read and fully understood by Operators.

### 2.1.2. General Recommendations for Generator/Plant Operation

**SAFETY**
Competent personnel must ensure continuous presence in the boiler area where the generator/plant is installed (ensuring direct view and control of regulation and safety devices) or in the control room.
Periodic inspections must be carried out in the boiler area and in electrical rooms (where transformers, power centers, distribution panels, MCC, VFD, and control panels are installed).

The regular operation of the generator/plant and its safety/control equipment must be periodically verified by Operators.
ACME INC. strongly recommends that the results of these checks, as well as information related to boiler operation, be recorded in the "Operation Log," which must be kept up to date and made available to personnel involved in generator operation.

### 2.1.3. General Recommendations for Generator Maintenance

**SAFETY**
The Operator must keep the Generator/Plant efficient and in good working condition, especially equipment/instruments and accessories directly related to the safety of Operating and Maintenance personnel and the safety of the supplied machine.

Among these, the following are of primary importance:

- Flame detectors
- Level limiters (level transmitters)
- Pressure limiters (pressure transmitters)
- Flow limiters (flow transmitters / differential pressure transmitters)
- Temperature limiters (thermocouples / temperature transmitters)
- Air/fuel ratio
- Safety valves

The Operator must also perform the following checks:

- All electrical equipment, including its connections, must be in good and efficient condition, well protected from possible water ingress, humidity, or similar events resulting from adverse conditions
- The cooling/ventilation system, where present, must function correctly
- The grounding system must be periodically inspected and verified

Qualified personnel must perform maintenance and periodic inspections of safety valves and all safety equipment.

## 2.2. Explosion Hazard

Since the boiler is installed in the following classified zone:

- Zone: 2
- Gas group: IIB+H2
- Temperature class: T3
- Ambient temperature range: -1.1 to +39°C

A technical report has been prepared to provide the customer with the necessary information for the application, or possible exclusion, of Directive 2014/34/EU to pressure parts to be installed in areas classified as explosion risk.

The document contains general information and a detailed analysis related to the case study identified in the supply of two waste heat steam generators to be installed at the XXX refinery of YYY. The document is number 19050 61DC.

Below are the recommendations resulting from the risk analysis indicated in the document:

**Table: Potential Ignition Hazards**

| No. | Ignition Hazard | Frequency Assessment Without Additional Protection | | | | Measures to Prevent Ignition Source Effectiveness | Potential Ignition Source | Reason for Assessment |
|---|---|---|---|---|---|---|---|---|
| | | During normal | During foreseeable | During rare malfunction | Not relevant | | | |
| 1 | Hot Surface | X | | | | Not an intrinsic characteristic of the boiler but a consequence of hot flue gases passing through the boiler. Metal temperature = 292/490°C | Customer responsibility | |
| 2 | Hot Gases | | X | | | Escape of hot gases from ducts or casing from pressure parts. Flue gas temperature = 700/950°C | Customer responsibility | |
| 3 | Static Electricity | X | | | | Parts may become electrically charged due to: - electrical leakage - electrical charges carried by non-conductive fluids passing through - atmospheric discharges | Customer responsibility | |

### 2.3. Safety Symbols

This Manual contains instructions to be followed for the prevention of harm to people and property. Specific instructions regarding the risks associated with operation, maintenance, and general management of the generator are widely distributed throughout the text of this Manual, represented by a symbol that is detailed and explained below.

#### 2.3.1. Physical Hazards

Safety instructions, whose non-observance may result in a hazardous situation and cause very serious injury to personnel involved in the management and/or maintenance of the generator and its accessories, are marked with the warning "DANGER":

- **DANGER**: This symbol indicates a hazardous situation for people, which may cause death or serious injury.
- **DANGER**: This symbol indicates a hazardous situation for people, related to the presence of energized equipment, which may cause death or serious injury.
- **DANGER**: This symbol indicates a hazardous situation for people, related to the presence of high-temperature surfaces, which may cause severe burns upon contact.
- **DANGER – Use hearing protection devices**: This symbol indicates a hazardous situation for people, related to the presence of noise sources, which may cause hearing loss or reduction.

#### 2.3.2. Material Hazards

Safety instructions, whose non-observance may result in a hazardous situation and cause damage to the generator, its accessories, and/or the surrounding environment, are marked with the warning "CAUTION":

- **CAUTION**: This symbol indicates a potentially hazardous situation. If not avoided, the generator, accessory equipment, and/or the surrounding environment may be damaged.

#### 2.3.3. Miscellaneous

- **NOTE**: Recommendations and important information regarding equipment management.
- **NOTE**: Important information for environmental protection.

## 3. STEAM GENERATOR AND AUXILIARIES

The generator described in this document consists of:
No. 1+1 water tube steam generator – type CTR 22/33 & 15/220SH:

- Each complete with No. 1 superheater

ACME INC. has supplied exclusively the pressure parts with its base and the stairs and walkways for access to the cylindrical body (see drawing AAA-000-000-M-1641-GA2-0001 – 12BB).

### 3.1. Steam Generator

The purpose of the generator supplied by ACME INC is to produce superheated steam. For more details regarding installation, refer to the supplied documents listed below:

| No. | Document No. | ACME INC Prefix “19050” | Title |
|---|---|---|---|
| 1 | AAA-000-000-M-1641-SDI-0002 11AA | Document List | |
| 2 | AAA-000-000-M-1641-GA2-0001 sh1 12BB | General Arrangement Drawing for WHB (sheet 1) | |
| 3 | AAA-000-000-M-1641-GA2-0001 sh2 12BB | General Arrangement Drawing for WHB (sheet 2) | |
| 4 | AAA-000-000-M-1641-CD2-1001 20AA | Pressure Parts for Authority: Generator Assembly and Details | |
| 5 | AAA-000-000-M-1641-CD2-2001 24BA | Pressure Parts for Authority: Superheater Assembly and Details | |
| 6 | AAA-000-000-M-1641-NPL-0001 | Data Plate Drawing | |
| 7 | AAA-000-000-M-1641-SHP0001 11DI 82AD | Data Plate Drawing | |
| 8 | Foundation Drawings for Generator (including wind, seismic, and external load calculations) | | |
| 9 | AAA-000-000-M-1641-CD2-0002 | Refractory: Assembly and Details | |
| 10 | WELDING BOOK: Weld Location Plan, WPS, PQR, WPAR, WPQR, Welder List, Consumable List & Certificates | | |
| 11 | AAA-000-000-M-1641-QMP0601 11FA | Painting Specification | |
| 12 | AAA-000-000-M-1641-FP3-0001 11BC | Installation Instruction Manual | |
| 13 | AAA-000-000-M-1641-CD2-0004 36AC | Insulation: Assembly and Details | |
| 14 | AAA-000-000-M-1641-CD2-0005 33FC | Expansion Joints: Assembly, Details, and Technical Data | |

For further process details, refer primarily to the following documents:

| No. | Document No. | Description |
|---|---|---|
| 15 | AAA-000-000-M-1641-CD2-1002 23AC | Evaporator Tube Bundle |
| 16 | AAA-000-000-M-1641-CD2-1003 22AE | Return Tubes |
| 17 | AAA-000-000-M-1641-CD2-1004 22AD | Feedwater Tubes |
| 18 | AAA-000-000-M-1641-CD2-1005 21AE | Arrangement of External Welded Connections on Cylindrical Bodies |
| 19 | AAA-000-000-M-1641-CD2-0001 32AA | Generator Base: Assembly and Details |
| 20 | AAA-000-000-M-1641-CD2-0003 33BE | Flue Gas Duct: Assembly and Details |
| 21 | AAA-000-000-M-1641-GA6-0001 34BG | Boiler Top Walkway: Assembly and Details |
| 22 | AAA-000-000-M-1641-QCP1101 11DFa | Site Inspection Sequence Plan (ITP) for Items Code "A" |
| 23 | AAA-000-000-M-1641-QCP1102 11DFb | Site Inspection Sequence Plan (ITP) for Items Code "B" |
| 24 | AAA-000-000-M-1641-QMP1601 11FA | Site Painting Specification |
| 25 | AAA-000-000-M-1641-QMP1501 | Site Hydraulic Test Procedure for Boiler & Steam Drum |
| 26 | NA 61DC | Technical Report: Application of Directive 2014/34/EU |

Additional process documents:

- AAA-000-000-M-1641-DST-0001 - 13CA Process Flow Diagram
- AAA-000-000-M-1641-DST-0002 - 5119F Superheater Data Sheet

### 3.2. Water/Steam Circuit

The water/steam circuit of the steam generator operates as follows:

- The boiler feedwater arriving from the supply system enters the cylindrical body of the boiler.
- The boiler operates based on "natural steam/water circulation," with evaporation circuits formed by the hottest tubes of the convective bundle.

- The remaining tubes act as downcomers, feeding the circulation.
- Water circulation inside the tubes ensures proper cooling of the pressure parts.
- An external connecting tube guides the saturated steam from the cylindrical body to the superheater, where the steam is superheated and subsequently tempered by the desuperheater to the nominal temperature.

### 3.3. Flue Gas Circuit

The flue gas circuit of the steam generator operates as follows:

- High-temperature incoming flue gases pass through the convective bundle of the steam generator.
- The flue gas path within the convective bundle encounters the superheater bank located approximately halfway.
- Upon exiting the boiler, the exhaust gases pass through a refractory-lined flue gas duct.
- At the boiler inlet and at the outlet of the flue gas duct, there are fabric expansion joints.

### 3.4. Generator Design and Auxiliary Information

The following paragraphs summarize the main information about the steam generator.

#### 3.4.1. Boiler Cylindrical Body and Lower Header

The cylindrical body is equipped with two access points (manholes) that allow personnel to perform complete inspection and access the tubes for maintenance operations.
The upper cylindrical body (CCS) is equipped with connections for feedwater inlet, two saturated steam outlets, two safety valves, level indicators and transmitters, pressure gauges, and pressure transmitters.
The lower header is equipped with two nozzles for inspecting its internal volume.

#### 3.4.2. Evaporator Bundle

The set of evaporation tubes is located in the convection section, formed by sufficiently spaced tubes where water is heated by the flue gases.
The external tubes, which form the outer walls, are welded along their entire length to obtain a continuous membrane wall that is perfectly sealed.
Connections have been provided on the membranes near the headers for inspecting the flue gas side using probes.
The external tubes at the superheater have an inspection port on one side to access the housing cavity of the bank when it is removed.

#### 3.4.3. Superheater

The superheater (SH) is located within the evaporator bundle.
The total area of the superheater is sized to ensure the required temperature conditions during the production phase.

#### 3.4.4. Refractories

Refractory material is present at the inlet mouth, inspection port, outlet mouth, and outlet duct.
The refractory is applied to protect the sheet metal from the flue gases.

### 3.4.5. Insulation and External Cladding

The steam generator is insulated with high-density mineral wool panels of adequate thickness applied over the entire surface of the external walls.
The external thermal insulation panels are appropriately spaced, fastened with screws for easy removal, and covered with cladding.

### 3.4.6. Flue Gas Ducts

At the inlet mouth, the insulation is replaced by a perforated mesh to allow proper heat dissipation.
The steam generator is supplied with a refractory-lined flue gas outlet duct. The outlet flue gas duct is equipped with an inspection port. Both the inlet mouth and the outlet duct are equipped with a fabric expansion joint with bolster.

### 3.4.7. Stairs and Walkways

The boiler is equipped with stairs, platforms, and walkways to allow easy access to the boiler itself and/or to equipment installed on the upper part.

## 3.5. Drain Manifold

The boiler is equipped with connections for continuous blowdown, intermittent blowdown, and cold drains.
Continuous blowdown is taken from the cylindrical body of the boiler, via a perforated pipe (with regularly distributed holes) along the entire length of the cylindrical body. The blowdown flow rate must be regulated to keep the boiler water analysis data within the standard limits.
Intermittent blowdown is taken from the lower header.
The drains for the boiler and the superheater are located at the bottom of the evaporator bundle.

# 4. 4. COMMISSIONING, START-UP, AND OPERATION

## 4.1. Preliminary Checks

Before putting the boiler into operation, it is important that all the checks described below are carried out correctly.

**On-site checks:**

- Complete cleaning of work areas, removing any type of obstacle for easy access to work and/or maintenance areas.
- Verify that the designated escape routes are free of obstacles to facilitate evacuation if necessary.
- Check for the presence of adequate fire-fighting equipment.
- Adequate lighting of work and maintenance areas.
- Presence of warning signs in areas where required.

**Mechanical checks:**

- Proper connection of all lines within the installation perimeter (including water, steam, compressed air, fuel, etc.).
- Complete cleaning of flue gas ducts.
- Internal inspection of the cylindrical body and lower header of the boiler to verify correct positioning and cleanliness of internal parts.
- Closure of all inspection doors for access to the inside of the boiler and ducts.
- Proper tightening of all flanges (water/steam - air/flue gas) and, where provided, verification of the presence of protections against gasket loss.
- Correct tightening of mounting bolts.
- Absence of hot areas with incomplete insulation.
- Vent and drain lines properly routed to the designated points.
- Presence of noise-limiting equipment (silencers).
- Presence of handrails and guardrails on service stairs and walkways.
- Gratings in the correct position, with no uncovered areas that could cause falls.
- Low-clearance passage points properly marked and protected against impact risk.

**Installation operation checks:**

- Completion and correctness of all electrical wiring.
- Proper connection of all equipment to ground.
- Functionality of instrumentation.
- Functionality of control and regulating valves.
- Functionality of protection, alarm, and shutdown systems.
- Functionality of alarm sirens.

Additionally:

- Availability of boiler feedwater with the required quality and temperature.
- Availability of fuel according to the required chemical analysis, at the correct temperature and pressure.
- Availability of all necessary auxiliary fluids (pneumatic instruments, service air, cooling water, chemical reagents, lubricants, etc.) in the required quantity, quality, pressure, and temperature.
- Good working condition of auxiliary equipment.

At first start-up, the boiler must undergo boiling, refractory curing, and blowing of the superheated steam line. All or part of these operations must be repeated after major maintenance/repair activities.

**DANGER:**
During commissioning and operation of the boiler, pay attention to all electrical hazards.
During commissioning and operation of the boiler, pay attention to all hot surfaces.
Use hearing protection devices near noisy equipment.

## 4.2. Boiler Feedwater

Special attention must be paid to the management of feedwater to protect the steam generator from any risk of damage and to ensure personnel safety.
During generator operation, attention must be paid to the treatment and monitoring of feedwater to ensure the integrity of the boiler.
It is important that operators working at the plant use boiler feedwater that complies with the parameters indicated below from standard EN 12952-12.

**TABLE 1: Feedwater Quality (limit values)**
**TABLE 2: Boiler Water Quality (limit values)**

| Parameter | Unit | Note |
|---|---|---|
| Appearance | - | Clear, colorless, no suspended solids (EN 12952-12 Table 5.1) |
| Direct conductivity at 25°C | µS/cm | - (EN 12952-12 Figure 5.1) |
| Acid conductivity at 25°C | µS/cm | < 0.2 (EN 12952-12 Figure 5.1) |
| pH | - | > 9.2 (EN 12952-12 Table 5.1) |
| Total hardness (Ca+Mg) | mmol/l | - (EN 12952-12 Table 5.1) |
| Sodium and potassium concentration (Na+K) | mmol/l | < 0.010 (EN 12952-12 Table 5.1) |
| Iron (Fe) | mg/l | < 0.02 (EN 12952-12 Table 5.1) |
| Copper (Cu) | mg/l | < 0.003 (EN 12952-12 Table 5.1) |
| Silica ($SiO_2$) | ppm | < 0.020 (EN 12952-12 Table 5.1) |
| Oxygen ($O_2$) | mg/l | < 0.1 (EN 12952-12 Table 5.1) |
| Oil and grease concentration | mg/l | 0.5 (EN 12952-12 Table 5.1) |
| TOC | mg/l | < 0.2 (EN 12952-12 Table 5.1) |
| Permanganate index | mg/l | 5 (EN 12952-12 Table 5.1) |

**Boiler Water Quality:**

| Parameter | Unit | Note |
|---|---|---|
| Appearance | - | Clear, no foam (EN 12952-12 Table 5.2) |
| Direct conductivity at 25°C | µS/cm | < 100 (EN 12952-12 Figures 5.1 and 5.2) |
| pH | - | 9.5 - 10.5 (EN 12952-12 Table 5.2) |
| Alkalinity | mmol/l | 0.05 – 0.3 (EN 12952-12 Table 5.2) |
| Silica ($SiO_2$) | mg/l | 45 (EN 12952-12 Figure 5.3) |
| Phosphates ($PO_4$) | mg/l | < 6 (EN 12952-12 Table 5.2) |

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To achieve values below the above limits, the Operator must closely monitor the parameters of the feedwater and boiler water through routine sampling and subsequent chemical analysis at least once per shift (8 hours) or more frequently.
All test results must be recorded to simplify the control of all data, comparing them with the load quantities and chemical additive injection into the boiler.
This database also allows immediate verification of any data variations and, consequently, the necessary corrective actions.

Feedwater characteristics must be continuously maintained correctly to allow control of boiler water quality by acting on continuous blowdown.
Generally, the continuous blowdown flow, with proper and regular boiler operation, should be about 2–3% of the saturated steam flow rate.
The blowdown percentage may be higher depending on the quality of the feedwater and the chemicals used for treatment.
Operations with higher blowdown values clearly indicate to the Operator that boiler water is not properly controlled and corrective action is needed.
Higher blowdown values correspond to lower efficiency.
The Operator must also verify that the chemical dosing system is available for proper operation with the required chemicals.

**CAUTION:**
The following limits are established in the EN 12952 standard for boiler operation. Also check the legislation, regulations, and provisions for downstream equipment and apply the most restrictive limits.

**CAUTION:**
BE informs that, regarding chemical packaging, it is strictly forbidden to use strong alkaline compounds, especially those containing sodium hydroxide and potassium hydroxide.
However, volatile alkaline compounds may be used, dosed correctly and in the recommended quantity, with coordinated phosphate treatment.

**NOTE:**
Risk of pollution due to improper handling of hazardous substances.
Comply with applicable requirements and regulations regarding pollution, safety, and international, national, and local standards.
Handling and disposal must be performed by qualified personnel.

### 4.3. Water Filling

Before starting any operation, the boiler must be filled with water to the correct level.

Before filling the boiler, all vent valves (manual or automatic) must be fully opened.
Additionally, the boiler drains and SH drains must be opened (to verify their operation).
The boiler drain valves should be closed a few minutes later, while the SH drain should remain open.
All vent valves must remain open to allow air inside the steam generator tubes to be discharged to the atmosphere.
During filling, when water exits the vents, the manual vent valves must be closed.
Water filling ends when the level in the upper cylindrical body is about 50 mm below the normal water level (NWL), leaving enough space for expansion due to water heating.

### 4.4. Cold Start

The term “Cold Start” refers to putting the boiler into operation starting from atmospheric pressure and ambient temperature.
Before starting, the Operator must check that:

- The water level inside the CCS is about 50 mm below the NWL.
- The level indicators are working correctly.
- Ensure water is discharged through the drainage system and that no impurities obstruct the drain pipe. If in doubt, and if necessary, remove the base valves from the drain and release the pipe.
- All boiler drains and air vents are closed.
- All SH drains are open.
- The main steam stop valve and the corresponding bypass valve are fully closed.
- All shut-off and control valves are working correctly.
- All equipment inspection doors are properly closed.
- The feedwater has the required quality.

**CAUTION:**
Feedwater must always be introduced slowly into the boiler. The filling water flow also depends on its temperature.
In general, the minimum recommended temperature for feedwater is 5°C.
The maximum water temperature for filling the boiler, as recommended by ACME, is a maximum of +35°C above the temperature of the pressure parts when empty.
The filling rate when water is above 40°C is 5 $m^3$/h to avoid stress on boiler components (especially the cylindrical body).

**Boiler Start-Up and Operation**

**Boiler Thermal Load and Initial Start-Up**

The thermal load of the boiler must be maintained at the minimum value.

When saturated steam begins to escape from the vents installed on the saturated steam line and on the superheater (SH)—which indicates that the boiler pressure is slightly above atmospheric pressure—the vents installed on the saturated steam line and on the SH can be closed by the Operator, allowing the boiler steam pressure to increase. At this point, the SH drains can be partially opened to allow any condensate to be discharged. To evacuate the first steam produced, it is possible to use the line to the low-pressure network at approximately 4 barg.

During start-up, the operator must follow the boiler pressurization curve shown in the figure below ("Boiler Start-Up Curve"). To follow the start-up curve, the Operator must operate the burner at the minimum permissible combustion power.

**BE strongly recommends** that, when increasing temperature and/or pressure in the boiler, the following limits are not exceeded:

- **30 °C/h** from ambient temperature up to approximately 120–130°C (steam pressure up to 1.2–1.5 barg)
- **55 °C/h** from steam pressure of 1.2–1.5 barg up to the operating pressure at Maximum Continuous Rating (MCR)

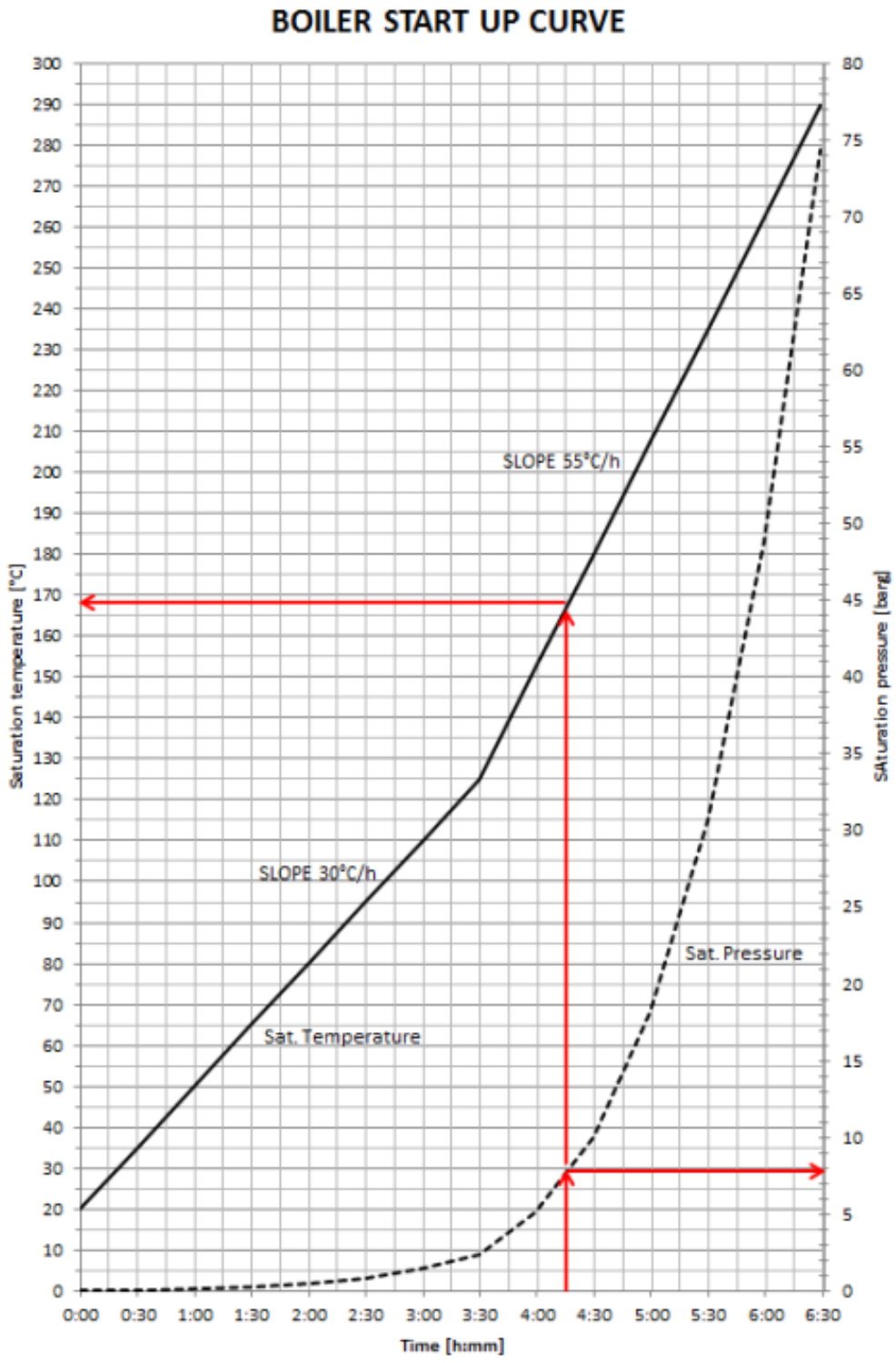
The valve to the low-pressure network must remain open at all times to ensure that the SH tubes are flushed with a sufficient flow of steam to prevent overheating.

**CAUTION:**
BE recommends following the sequence indicated in the following sections. In the initial phase, there is no steam tension and no steam flow in the SH tubes. Therefore, the combustion rate must be kept at its minimum value to avoid any risk of overheating the SH tubes.

**CAUTION:**
A very rapid start-up could cause serious damage to the boiler.

**CAUTION:**
These limits may only be exceeded with written consent from ACME INC.

**Boiler Start-Up Curve**




**NOTE:** The curve must be applied in accordance with the boiler design.

**Heating and Burner Load Increase**

During boiler heating, when the correct steam pressure is reached, it is possible to increase the burner load; however, the boiler pressurization curve must be followed correctly. It is also important to always pay attention not to exceed the maximum steam flow rate at the outlet of the low-pressure line.

**CAUTION:**
During start-up with the burner in operation, the line to the low-pressure network must never be closed, to allow continuous cooling of the SH tubes by the steam flow.

**DANGER:**
During commissioning and operation of the boiler, pay attention to all electrical hazards.

**DANGER:**
During commissioning and operation of the boiler, pay attention to all high-temperature surfaces.

**USE HEARING PROTECTION:**
Near noisy equipment, use hearing protection devices.

### 4.5. Hot Start

If the generator is started "hot" (i.e., the boiler contains pressure and temperature values close to operating conditions), the following considerations must be taken into account:

- The main steam stop valve and the bypass valve are closed.
- The valve on the line to the low-pressure network is closed.

Before restarting the boiler, the operator must check the differential pressure between the boiler and the line downstream of the steam take-off valve. This allows proper monitoring and supervision of when and how to align the two systems.

After correctly opening the valve on the line to the low-pressure network and starting the burner at minimum load, as soon as the boiler pressure rises above the downstream pressure, the produced steam can be admitted to the network by opening the main steam stop valve (ensuring, of course, that the network is available to receive it).

At all times, the Operator must ensure that the SH tubes are cooled by the steam flow when exposed to combustion gases.

If the steam pressure is lower than the boiler pressure and the main stop valve is closed, it may be necessary to heat/pressurize the downstream line by slightly opening the main steam bypass valve. This may take some time, depending on the extent of the downstream process line. When heating/pressurization is complete, the operator must proceed to fully open the main steam stop valve. Subsequently, the valve on the line to the low-pressure network will be gradually closed (if required) during this transfer, and the combustion rate must be kept constant. Finally, it will be possible to increase combustion.

**BE strongly recommends** not exceeding the following limits during boiler start-up:

- **55 °C/h** from steam pressure of 1.2–1.5 barg up to operating pressure at MCR.

**CAUTION:**
If the steam take-off valve is closed during the combustion start-up procedure, the valve on the line to the low-pressure network must be sufficiently open to allow cooling of the SH tubes by the steam flow.

**CAUTION:**
During "hot" start-up procedures, the Operator must constantly monitor the steam flow through the SH tubes to prevent overheating.

### 4.6. Effective Start-Up

Once the system operating pressure is reached, the main steam stop valve can be fully opened (provided the downstream steam line is heated and ready to receive steam from the boiler), and the valve on the line to the low-pressure network can be closed if necessary. Once this transfer is completed and alignment between the steam generator and the steam network is stabilized, the boiler load can be increased.

### 4.7. Normal Operation

During normal boiler operation, it is necessary to verify that all equipment and services are functioning correctly. The safe and reliable operation of the steam generator depends on continuous monitoring of control and safety systems. Monitoring must be continuous, even if the system operates in automatic mode. Any changes in operating parameters will indicate a change in boiler performance, and appropriate measures should be taken to restore previous conditions.

**CAUTION:**
The indicated limits may only be exceeded with prior written communication from ACME INC.

**DANGER:**
During commissioning and operation of the boiler, pay attention to all electrical hazards.

**DANGER:**
During commissioning and operation of the boiler, pay attention to all high-temperature surfaces.

**USE HEARING PROTECTION:**
Near noisy equipment, use hearing protection devices.

#### 4.7.1. Boiler Water Level

The correct water level in the upper cylindrical body must be maintained by the level regulator. The theoretical level is indicated as Normal Water Level (NWL). If the water level is too high, steam purity may be compromised due to water carryover into the SH tubes. If the water level drops too low, the boiler is at risk of overheating.

#### 4.7.2. Blowdown, Water Column, and Glass Indicators

Opening the boiler blowdown valve regulates the continuous blowdown flow. This may vary depending on boiler load and water conductivity. The steam generator sampling system is used for comprehensive analysis of feedwater and boiler water.

**DANGER:**
If the boiler is operating normally and, in any case, when the water/steam pressure in the boiler is above atmospheric pressure, no manual blowdown valve of the boiler pressure elements should be opened.

**CAUTION:**
Since chemical corrosion and salt deposits on the internal walls of the boiler pressure parts increase slowly, BE recommends periodically sampling and analyzing a water sample from the boiler. BE also recommends recording the results of chemical analysis (conductivity, pH, alkalinity, TDS, and others) in a logbook. Thus, throughout the life of the steam generator, it will be possible to immediately verify all possible variations and take the necessary corrective measures as soon as possible.

**NOTE:**
For disposal of blowdown water, refer to local regulations in force.

**Water Column and Glass Level Indicators** The water column and glass level indicators must be periodically purged with utmost care at least once a week to prevent sediment accumulation in these components. Lack of maintenance and cleaning may result in incorrect water level readings.

**4.7.3. Superheated Steam Temperature The temperature of the superheated steam must be** maintained within the defined operational values. Special attention should be paid during transients to avoid imbalances between the heat input from the flue gases and the steam flow passing through the superheater bank.

### 4.8. Boiler Tube Cleaning

Boiler output and efficiency largely depend on the cleanliness of the heat exchange surfaces. It is crucial to always ensure the cleanliness of these surfaces to maximize heat transfer. Cleaning should be performed using compressed air and a lance to reach the central parts of the tube bundle.

### 4.9. Tube Failure

High-pressure steam or water escaping from a small hole can perforate adjacent tubes, causing a chain reaction and damage to multiple tubes. Minor leaks can be detected by the operator by observing increased water or chemical consumption, or increased noise due to vaporization. If a leak is suspected, the boiler must be immediately shut down. After inspection to locate the leak, appropriate repair procedures must be followed in accordance with applicable regulations.

**DANGER:** In case of water or steam leaks from pressurized components of the steam generator, the boiler must be immediately shut down.

**DANGER:** Major leaks can be extremely hazardous: boiler water may spread throughout the boiler perimeter, increasing local pressure. Consequently, membrane walls may be seriously damaged, posing a risk to personnel. [AAA-000-00...cleaned_31]

### 4.10. Emergency Shutdown of the Boiler

If any of the conditions required for normal operation are missing, the boiler must be shut down. Pay particular attention when shutting down due to very low water level, for example, when it is not possible to maintain the level in the cylindrical body (likely due to a leak in pressurized components). In this case, the operator is advised to fully close all steam outlets from the boiler and switch the level controller to manual mode. This procedure minimizes the drop in boiler steam pressure and the corresponding decrease in boiling water temperature. It also protects the boiler from thermal shock caused by introducing cold feedwater into overheated pressurized parts due to insufficient water level.

Once the unit has cooled, a thorough visual inspection must be performed to identify any overheated areas. To identify leaks and the causes of shutdown, all pressurized components must be inspected to prevent possible failures. If a tube leak is found, the inspection must include careful observation of all adjacent tubes; in some cases, it may be useful to take a sample from the tube and perform metallurgical analysis. It is strongly recommended to do everything possible to understand the cause of tube failure before restarting the boiler.

### 4.11. Normal Shutdown of the Boiler

When the steam generator needs to be shut down (normal shutdown) during regular operation (e.g., for scheduled shutdown), combustion power must be gradually reduced to minimum. Only then should the burner be commanded to stop. After manual shutdown of the burner, the operator must allow the fan to continue running to complete post-ventilation of the boiler. Once done, the fan must be turned off to avoid excessive and rapid cooling of the boiler. Cooling will continue slowly due to natural airflow in the flue circuit. Rapid cooling with the combustion air fan, due to the large amount of cold air passing through, may cause unnecessary stress to pressurized parts and damage to refractory materials. In exceptional cases (e.g., emergency), rapid cooling may be necessary by flushing with air at minimum flow.

**DANGER:** In case of emergency shutdown due to excessively low water level, never inject cold feedwater into the cylindrical body to try to maintain the level. Risk of EXPLOSION. [AAA-000-00...cleaned_31]

- The water level must be maintained via the controller at the normal level.
- When the steam generator pressure is below 1 barg, the vent valve must be opened.
- If the boiler needs to be drained, water discharge should be delayed until a suitable discharge temperature is reached (normally between 50 and 80 °C), using the drains.
- After draining and complete cooling to ambient temperature, all access points can be opened for inspection and maintenance.

### 4.12. Detailed Operating Mode

The purpose of these instructions is to outline the preliminary checks and detailed operations for starting and stopping the ACME INC. boiler. ACME INC.'s scope of supply is limited to pressurized components only; the following guidelines must be supplemented by the system integrator's operating instructions. The initial state of the steam generator is "off."

### 4.12.1. Boiler Start-Up

#### *4.12.1.1. Preliminary Checks*

On the generator:

- Check that the boiler water level is at the normal level.
- Verify that the condensate traps on the steam lines are not blocked.

In the control room:

- Check that the valve on the line to the low-pressure network is open as soon as boiler pressure exceeds 4 barg (low-pressure network pressure).
- Ensure the steam take-off valve is closed.
- Set the continuous blowdown valve controller to MANUAL and minimum output.
- Set the master pressure controller to MANUAL and minimum output.
- Verify the water level controller setpoint is at 50%.
- Verify the steam temperature controller setpoint is at 215 °C.

#### *4.12.1.2. Boiler Ignition*

After completing preliminary checks, perform the following operations:

**CAUTION:** During boiler draining, ensure vent valves are open to facilitate water discharge from the boiler. [AAA-000-00...cleaned_31]

- Check boiler feedwater pressure.
- Start the combustion air fan.
- Acknowledge and reset alarms.
- Start the burner (the BMS will execute the sequence automatically).
- With the burner at minimum, gradually increase pressure.
- Set the master pressure controller to AUTOMATIC upon reaching operating pressure.

#### *4.12.1.3. Grid Connection*

- Heat the superheated steam outlet piping.
- Gradually open the steam take-off valve.
- Set all controllers to AUTOMATIC mode.

#### *4.12.1.4. Boiler Shutdown*

- Set the boiler pressure controller to MANUAL.
- Gradually reduce load to minimum.
- Close the steam take-off valve.
- Manually shut down the burner.
- Close the valve on the line to the low-pressure network.
- Turn off the combustion air fan after post-wash and refractory cooling.
- Turn off feedwater pumps.
- Close manual fuel shut-off valves.

#### *4.12.1.5. Boiler Anomaly While Online*

What procedure should the operator follow if the boiler shuts down while online? The scenario considered is a transient that brings to the boiler a stream of flue gases, composed of purge air and Claus tail gas, which is heated by passing over refractory material, with the burner off. As reported by the client, the temperature of this purge flow is below the tube design specification and rapidly drops below steam generation temperature (< 200°C). In this situation, the control system will continue to manage:

- Boiler pressure by operating the steam circuit valve to vent the generated steam fraction. As heat decreases, the control system will close the steam take-off valve to maintain boiler pressure.
- BFW inflow for level control in the cylindrical body. [AAA-000-00...cleaned_31]

# 5. INSPECTION AND MAINTENANCE

In addition to necessary maintenance and repairs following inspections during operation and shutdown (e.g., cleaning internal surfaces, repairing refractory cracks, realigning fan/pump, etc.), as described in previous sections, the generator must undergo a regular preventive maintenance program. The frequency and type of maintenance should be based on operating hours and inspections performed with the system offline. The following procedures should be considered as a typical maintenance schedule; the actual program is dictated by the generator's operational experience.

**DANGER:** Maintenance operations must be performed by qualified personnel.

**DANGER:** Ensure there is no residual steam pressure in the boiler before opening flanges or inspection holes or disassembling instruments connected to steam lines.

**DANGER:** Hot surfaces, risk of burns. Allow the boiler to cool before performing maintenance.

**NOTE:** During maintenance, replaced materials must be disposed of according to local regulations.

**CAUTION:** Disassemble and reassemble service parts according to operational instructions in MIF&MC. Use original spare parts and appropriate equipment.

**NOTE:** ACME INC. recommends using ORIGINAL COMPONENTS and SPARE PARTS and declines any responsibility for damage caused by unauthorized modifications or installation of non-original equipment. Furthermore, any unauthorized intervention or replacement of non-original components IMMEDIATELY voids warranty conditions. [AAA-000-00...cleaned_31]

## 5.1. Daily Maintenance

- Check the combustion system and flame shape.
- Verify that the low water level device operates correctly by comparing readings with the local glass indicator.
- Check the characteristics of feedwater and boiler water. (Some daily activities may be performed weekly depending on actual operation.)

### 5.2. Weekly Maintenance

- General verification of instrument effectiveness by comparing readings with local indicators.
- Check level indicators.

### 5.3. Monthly Maintenance

- Ensure all safety valves operate correctly (visual inspection to verify no leaks, mechanisms are free from obstructions, and discharge piping is clear and fully drained).

### 5.4. Quarterly Maintenance

- Check the condition of the combustion control system (air damper and fuel pressure regulators).
- Lubricate bearings and moving parts.
- Inspect electromechanical components (pumps, fan, limit switches, etc.).
- Check pressure gauges and integrity of control devices (leaks, corrosion, etc.).
- Ensure bolts are properly tightened.

### 5.5. Maintenance During Scheduled Shutdown

The generator must be periodically shut down for inspection and maintenance. The frequency of these activities is defined by experience and must consider facility operating conditions, feedwater quality, and type of fuel burned.

#### 5.5.1. Internal Inspection

After device shutdown, the internal parts of pressurized components must be inspected for salt, oil, corrosion, or other hazardous deposits attributable to feedwater quality. Rust found on internal surfaces of tubes/cylindrical bodies/boiler columns requires immediate feedwater treatment review. Any deposits found inside pressurized parts must be removed by cleaning with water/pressurized air or other methods.

**CAUTION:** BE recommends avoiding boiler cleaning with acids as much as possible.

**Internal Inspection** Internal inspection is also used to verify the condition of auxiliary and accessory components of the boiler to ensure proper operation of the generator. Specifically, internal inspection concerns the ducts and internal parts of the cylindrical body. Special attention must be paid to checking the connections of safety valves, level indicators, and pressure indicators to ensure they are not obstructed by deposits or sediments.

*5.5.1.1. Removal of Superheater*

If required, the superheater can be removed from its housing. The procedure for extraction is attached to this document (Annex “A”). Reinstallation of the superheater must be performed by applying the procedure in reverse order.

#### 5.5.2. External Inspection

Surfaces must be inspected for signs of overheating, leaks, corrosion, and any other possible damage, whether local or extensive, that could compromise the safety of pressure components. The refractory materials of the boiler must be inspected and cleaned. External cleaning can be

performed in several ways: mechanical cleaning of hard deposits, washing with water or steam under pressure, or blowing with compressed air. Cleaning with water injection is the preferred method, as it is faster, more economical, and easier to execute. Generally, water cleaning should be performed without special chemical additives, especially if these could corrode the tubes or metallic parts of the boiler. The water used must be clean, available in large quantities, and at high pressure, thus removing impurities and avoiding mechanical impact phenomena. The ideal time for water cleaning is just before restarting the unit, as the subsequent ignition of the boiler will ensure complete drying of the surfaces.

**DANGER:** In the presence of sludge or sediments, the Operator must absolutely and necessarily clean all affected lines, tubes, and related accessories before restarting the boiler. The presence of such impurities poses serious risks to the integrity of the boiler and its accessories, and also presents a risk to personnel. This can seriously damage the internal parts of valves and instruments.

**NOTE:** When cleaning the external tube surfaces of the boiler with water and steam, water or condensate resulting from cleaning activities must not be discharged directly into waste, but must be collected and treated (neutralized) to eliminate acid contained in deposits on the tubes. All safety and anti-pollution regulations must be strictly observed. [AAA-000-00...cleaned_37]

If the unit must be shut down for a short period and needs to be promptly returned to service, it should be filled with water before being stored. Please refer to the procedures for filling and water storage in the relevant paragraph. Examine all valves (including safety valves) and, if necessary, replace worn gaskets.

### 5.6. Regulatory Inspections

The ministerial decree governing this matter is D.M. December 1, 2004, No. 329, Regulation containing rules for the commissioning and use of pressure equipment and assemblies referred to in Article 19 of Legislative Decree February 25, 2000, No. 93. Refer to this document for all activities required by law to be performed by the operator.

For internal and integrity checks, the boiler is equipped with the following devices:

**Water/Steam Side**

- Cylindrical body: No. 2 manholes 420 x 320 mm
- Lower header: No. 2 nozzles diameter DN 150 (6”)

**Flue Gas Side**

- No. 1 inspection door at the superheater bank: 500 x 500 mm
- No. 1 inspection door at the flue gas outlet duct: 500 x 500 mm
- No. 28 inspection sleeves at each header of the evaporator bundle: DN25

If required, the superheater can be extracted. See the attached procedure referenced in paragraph 5.5.1.1.

Integrity verification must be performed together with the drawings of the pressure parts for comparison of measured thicknesses and dimensions. [AAA-000-00...cleaned_37]

# 6. BOILER STORAGE

Most boiler corrosion problems occur during shutdown and storage periods. During these periods, the benefits of chemical water treatment performed while the boiler is in service can be nullified if adequate monitoring is not applied to protect the internal pressure parts.

For internal pressure components of the boiler, two basic storage methods are possible: "wet storage" and "dry storage." The choice of storage method depends on several factors (technical and economic); for example, it may depend on the following elements:

- The client has planned a boiler shutdown period,
- The complexity of the boiler assembly and ducts,
- Local environmental conditions (with or without risk of freezing),
- Client's request or need to return the generator to service immediately or after a long period,
- Costs associated with storage and subsequent restart,
- Availability of inert gas (usually $N_2$).

In general, if the boiler is to be deactivated for long periods (one month or more) and restart is not required within a short time, or if there is a risk of freezing, "dry storage" is preferable. "Wet storage" is generally suitable for short shutdown periods and when the unit is likely to be restarted quickly.

## 6.1. Wet Storage

Wet storage of the boiler, if necessary, with chemically treated (demineralized) water is a simple method of protecting the boiler during short interruptions. To protect the boiler from corrosion using this method, add a volatile alkaline product and sodium sulfite to the water in proportions that allow a sodium sulfite concentration in the water of about 200 ppm and a pH of 10–11.5. Sodium sulfite acts by eliminating oxygen, while the alkaline product maintains the desired pH. Note that equivalent chemicals may be used, but they must guarantee identical final protection.

**CAUTION:** BE recommends not using sodium hydroxide or potassium hydroxide. [AAA-000-00...cleaned_37]

Fill the boiler with chemically treated or condensed feedwater until the normal level in the cylindrical body is reached; then completely fill the cylindrical body, SH tubes, and downstream piping of the SH with nitrogen, ensuring that the internal pressure is between 0.3 and 0.5 barg. Chemicals must be added to achieve a constant concentration throughout the system. Uniformity of chemical concentration must be ensured for the entire storage period.

## 6.2. Dry Storage with Inert Gas

Dry storage can be adopted as an alternative to wet storage, using an inert gas instead of demineralized water. An adequate protection system must be implemented to introduce an inert gas (typically nitrogen) into the pressure components and establish an internal pressure between 0.3–0.5 barg. Ensure all internal surfaces of the boiler are completely dry before filling with nitrogen. To do this, open all drain valves and check that all water contained in the pressure components of the boiler is properly expelled.

**NOTE:** Risk of pollution due to improper handling of hazardous substances. Comply with applicable requirements and regulations regarding pollution, safety, and international, national, and local standards. Handling and disposal must be performed by qualified personnel.

**CAUTION:** In cold environmental conditions, where there is a risk of freezing, it may be necessary to heat the steam generator (e.g., by inserting into the external hydraulic circuit). In any case, the Operator must carefully check all generator circuits to avoid freezing phenomena, especially in areas where water pockets may form.

**CAUTION:** In case of doubt, ensure that the upstream piping of the manual drain valve is not obstructed by rust, oxides, or other impurities that could compromise water drainage. This is a lengthy task but necessary to avoid damage during subsequent boiler operation and storage due to possible ice formation, especially in cold environmental conditions with possible freezing. [AAA-000-00...cleaned_37]

When the boiler is filled with nitrogen, pressure control must be periodic and scheduled to ensure a constant level of internal pressure, avoiding the risk of air ingress. Alternatively, the inert gas system must be equipped with a regulator and suitable control valves to allow automatic introduction of inert gas into the boiler when boiler pressure drops below the nitrogen regulator setpoint.

With this storage method, it is advisable to use a heat tracing source (electric, hot water, or steam) for all small components that certainly contain water and for which freezing is likely to occur.

### 6.3. Dry Storage with Corrosion Inhibitor

Dry storage with corrosion inhibitor can be adopted as an alternative to dry storage with inert gas, using a corrosion inhibitor instead of inert gas. Corrosion inhibitors are designed to protect ferrous metals from corrosion in places inaccessible by conventional methods, such as cavities. They are useful for protecting equipment that is deactivated for both short and medium terms (up to 24 months). The corrosion inhibitor will form a protective film on the surfaces, so no addition is necessary during the storage period. If the protective film is partially removed by moisture or by opening an inspection door, protection remains uninterrupted and normally no product addition is required. The inhibitor is usually applied in solid form. After spraying, ensure all accesses are well closed. A metal indicator is installed in the boiler to periodically check corrosion. If corrosion of the metal indicator occurs, check that all accesses are well closed and add the product. Removal of the corrosion inhibitor before returning the boiler to service is not normally necessary. However, if deemed necessary during dry storage, the material can be removed after rinsing with water.

**DANGER – IMPORTANT WARNING:** It is absolutely forbidden to heat empty or nearly empty tubes (bypassing all safety regulations) by keeping vents open to completely evaporate water contained in pressure components. This poses enormous risk and could cause severe damage to empty boiler tubes, destruction of cylindrical bodies, and risk to personnel safety. THIS DANGEROUS OPERATION MUST NOT BE PERFORMED UNDER ANY CIRCUMSTANCES. BE declines all responsibility if this dangerous operation is performed. All warranties of proper operation and material conformity will be immediately voided. [AAA-000-00...cleaned_37]

### 6.4. External Protection

The boiler and convection zones must be protected against ambient moisture penetration by hermetic seals at the intake and outlet of the system.

Periodic checks must also be performed to verify the presence of condensation or corrosion on surfaces. In extreme cases, it may be necessary to ignite the burner (with the precautions mentioned above) or flush the generator with hot air to maintain a temperature above the condensation point.

During long periods of inactivity, all valves and instruments must be closed and wrapped in plastic bags containing silica gel sachets or similar, after applying a protective grease, oil, or similar product.

Periodically, the effectiveness of instrumentation and equipment must be checked (e.g., opening/closing all valves, etc.).

## 7. PERIODIC BOILER INSPECTIONS

The generator may only be started if the operator has successfully completed the verification of all safety systems and the required checks. If one or more safety systems are not fully operational, do not proceed with startup and restore proper functionality.

The generator must be equipped with adequate safety systems to prevent exceeding permissible limits for pressure, temperature, water level, and the formation of explosive mixtures.

For pressure control, in addition to the regulatory spring-type safety valves, the generator must be equipped with a redundant pressure control system that intervenes to shut down the combustion system if the operating pressure reaches the maximum set value. Reset is then required via the RESET button on the HMI.

For water level control, the generator must be equipped with a redundant level control system that intervenes to shut down the combustion system if the water level drops below a minimum threshold, indicating risk of water shortage. Similarly, the same redundant system protects the boiler from high-level phenomena above a predetermined limit. In both cases, reset is required via the RESET button on the HMI.

To prevent the formation of explosive mixtures, the generator must be protected by a burner flame detection system and continuous fuel/air ratio control, which intervenes to shut down the combustion system. Manual reset via the RESET button on the HMI is required for restart.

In the event of loss of electrical power to one or more safety accessories, the protection system must initiate a safe shutdown of the generator.

Periodic boiler inspections must be aimed at maintaining the SIL (Safety Integrity Level) of safety functions; the timing of these inspections is defined in the SIL verification calculation for safety chains. Any shorter periodic inspection requirement defined by the SIL calculation takes precedence.

The definition of safety chains, SIL assessment, and verification of SIL safety chains is not within the scope of supply of ACME INC.

Personnel appointed by the user (licensed operator or specialized company) must be experienced and possess the necessary technical skills.

Below is the table of standard inspections indicated in EN 12952. Specific inspections must be defined based on the SIL analysis performed by the system integrator. Functional tests may also have different frequencies based on the evidence from the SIL analysis. [AAA-000-00...cleaned_43]

**Table: Standard Boiler Inspections (EN 12952)**

| Pos | Component/Function | Ref. EN 12952 | 3 days | 1 month | 3 months | 6 months | 12 months | Effort (man hours) | Notes/Suggestions for T |
|---|---|---|---|---|---|---|---|---|---|
| A | Safety devices against overpressure (safety valves) | 4.1 | O | | | T | | 8 | Detailed inspection every 6 months (verify discharge and drain line clearance); consider legal requirements for calibration verification; trip test method to be defined with the competent inspector |
| B | Boiler level indicators | 5.4 | T | | | | | 2 | Comparative verification or measuring devices |
| C | Discharge devices, continuous and intermittent blowdown | 5.2 | T | | | | | 4 | |
| D | Valves | 4.6, 5.2 | O | | | T | | 2 | As per manufacturer's instructions |
| E | Feedwater regulation | 5.1, 7.5.3.1 | O | | | T | | 1 | |
| F | Low-level limiter | 5.5, 7.5.2.2, 7.5.3.2 | O | T | | | | 2 | Modify threshold values as needed |
| G | Steam pressure and temperature | 5.6, 5.7 | O | | | | | 2 | Comparative verification or measuring devices |
| H | Pressure limiter | 4.1, 5.6.2, 7.5.1.2 | O | T | | | | 2 | Modify threshold values as needed |
| I | Temperature limiter | 5.5.1, 5.7.3, 7.5.1.3 | O | T | | | | 2 | Modify threshold values as needed |
| J | Water quality devices | 4.8, 7.4 | O | | | T | | 4 | Verification with reliable measurement system; (2) Performed by qualified personnel |
| K | Safety system | 4.5 | O | | | T | | 4 | Electrical and mechanical checks must be performed by qualified personnel |
| L | Pressure parts and accessories (tubes, manholes, flanges, gaskets, etc.) | | O | | | | | 8 | |
| M | Steam pressure and temperature regulators | 5.7.2, 7.5.1.1 | O | | | T | | 4 | |
| N | Feedwater system | 5.1 | O | | T | | | 2 | |
| O | Feedwater and boiler water quality | 4.8, 7.4 | T | | | | | 4 | See EN 12952-12 and relevant manual section |
| P | Combustion system | 4.2, 7.2 | O | | | | T | 4 | Checks must be performed by qualified personnel according to the manufacturer's manual |

**Legend:**
O: Monitoring during operation
T: Inspections and functional tests of the element

## 8. DISPOSAL – END OF LIFE

ACME INC., in accordance with its environmental policy, is committed to reducing the environmental impacts generated by its activities and products, both directly and through raising awareness and involving its customers and suppliers. Therefore, it reminds that, just as utmost attention was paid to the use of natural resources in the construction of the boiler, avoiding waste, at the end of the generator's life it is mandatory to follow rules for disposing of its various constituent materials.

Materials used for boiler construction include: carbon steel, stainless steel, refractories, and others in smaller quantities (gaskets, instruments).

Once the boiler is decommissioned and cooled, it must be drained of fluids used during normal operation (water, lubricants, liquid fuels), which must be collected and stored separately. At this point, the various "solid" materials should also be separated and stored separately. After separation, disposal must be carried out through companies qualified for these services.

All materials must be separated and disposed of in accordance with applicable local regulations.

# 9. ANNEXES

## 9.1. . Superheater Extraction – Annex “A”

**Annex “A” – Superheater Extraction Procedure (Instruction Manual)**

**Step 1:**
Remove insulation and unbolt the SH (superheater) casing.

**Step 2:**
Lift the SH casing using the designated lifting lugs.

- Casing weight: 90 kg

**Step 3:**
Remove the ceramic fiber.

**Step 4:**
Unscrew the bolts of the lower casing.

**Step 5:**
Extract the SH using the designated lifting lugs.

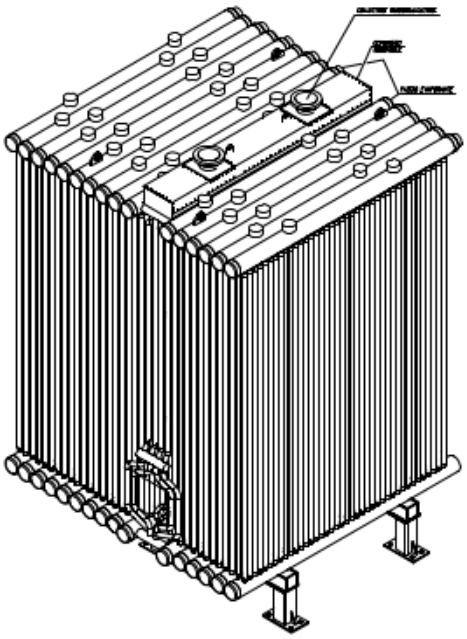
- Superheater weight: 2100 kg
- Minimum sling length: 3500 mm

**Additional Notes:**

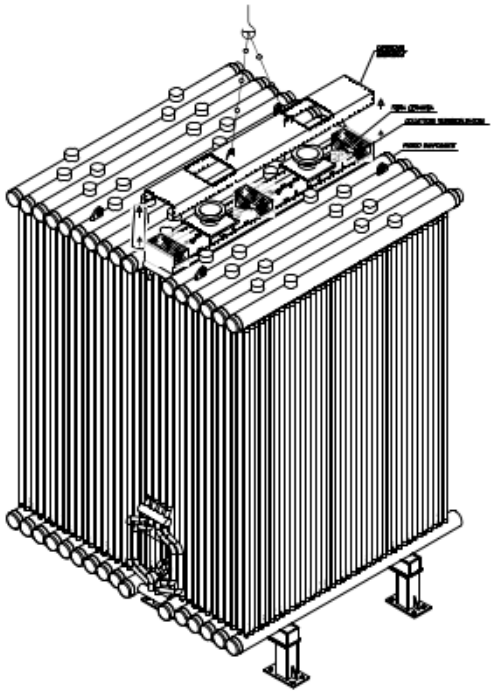
- Ensure all lifting operations use the appropriate lifting lugs.
- The ceramic fiber and removable covers must be handled as indicated.
- The evaporator bundle, refractory cement casting, and collectors are referenced in the diagrams.

# PROCEDURA ESTRAZIONE SH - ALLEGATO "A" MANUALE DISTRUZIONI
## DOC. A94501-000-000-M-1841-KOM-0001 - 11BB 2

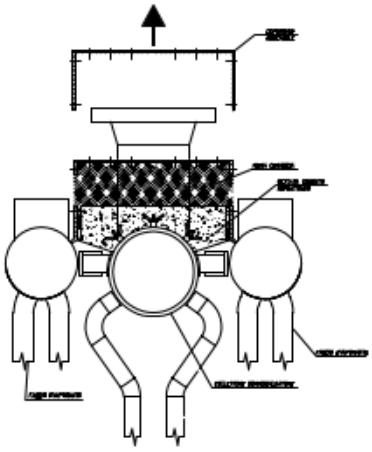
**1ª FASE:**
RIMUOVERE LA COIBENTAZIONE E SOLLEVARE CASSONETTO SH



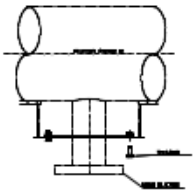
**2ª FASE:**
SOLLEVARE CASSONETTO SH USANDO LE APPOSITE ORECCHIE DI SOLLEVAMENTO
PESO CASSONETTO = 90kg



**3ª FASE:**
ASPORTARE LA FIBRA CERAMICA



**4ª FASE:**
SVITARE LE VITI DEL CASSONETTO INFERIORE



**5ª FASE:**
ESTRARRE SH UTILIZZANDO LE APPOSITE ORECCHIE DI SOLLEVAMENTO
PESO SURRISCALDATORE: 2100kg