# LR-4448

# REV. A

# OPERATING & MAINTENANCE INSTRUCTIONS

# FOR

# IN-LINE DEFLAGRATION FLAME ARRESTORS

# DESIGN SERIES FA1-****-***

SUBMITTED BY

G.W. Lisk Company, Inc.

**2 SOUTH STREET**

**CLIFTON SPRINGS, N.Y., USA, 14432**

| PREPARED BY: | DATE: |
|---|---|
| ***Anthony McNeil***<br>Senior Project Engineer, Military/Aerospace Group | ***23 July 2021*** |

| CERTIFIED PRODUCT AUTHORITY: | DATE: |
|---|---|
| ***Brett Arnold***<br>Certified Product Authority | ***29 April 2022*** |

**Certified Product**: no changes permitted without the approval of the certified product authority.

Changes to this document shall be made by cognizant engineer only. All approved changes shall be noted below

**Revisions**

| Revision | Description | Approvals | |
|---|---|---|---|
| | | Engineering | C.P.A |
| - | Initial Release | T. McNeil<br>02 Feb 22 | N/A |
| A | Updates: Formatting Errors, removal of IEC and NEC reference for gas groups per certification authority request.<br>Added Certified Product Authority box and Certified Product note on cover sheet.<br>Added C.P.A. approval to revisions box.<br>Section 5.2:<br>Revised wording to clarify between Flame Arrestor Element and the Flame Arrestor itself.<br>Request from certification authority.<br>Section 5.3:<br>Removed wording that implied the flame arrestor element could be replaced.<br>Request from certification authority.<br>Section 5.4:<br>Removed wording that implied the flame arrestor element could be replaced.<br>Request from certification authority. | L. Ellis<br>27 Apr 22 | B. Arnold<br>29 Apr 22 |

**Table of Contents**

SUBMITTED BY ..... 1
1. INTRODUCTION ..... 4
1.2. Classification ..... 4
1.3. Tags ..... 5
2. Type marking ..... 5
3. Description and Function ..... 7
3.1. Description ..... 7
3.2. Basic Flame Arrestor Characteristic ..... 8
3.3. Limitation of Use ..... 9
4. Mounting of Flame Arrestor, Comissioning ..... 10
5. Maintenance ..... 10
5.1. Maintenance during working conditions – inspection ..... 10
5.2. Revisions and repairs ..... 11
5.3. Maintenance, revision and repair documentation ..... 11
6. Storage ..... 12
7. Warranty Conditions ..... 12
8. Torque Procedure ..... 12
9. Principles and Safety ..... 12

# 1. INTRODUCTION

## 1.1. Applications

LISK In-line deflagration flame Arrestors, the design series FA1- **** - *** (nominal sizes of connection: NPT 1/4“ (DN 8), NPT 1/2” (DN 15), NPT 3/4” (DN 20), NPT 1” (DN 25), NPT 1 1/2” (DN 40), NPT 2” (DN 50), NPT 2 1/2” (DN 65), NPT 3” (DN 80), NPT 4” (DN 100)) are used to prevent a flame transmission at deflagrations of flammable gas and/or vapour/air-mixtures of the explosion group IIA (D) with a maximum experimental safety gap (MESG) > 0.90 mm.

## 1.2. Classification

The DEF series flame Arrestor is defined according to the standard EN ISO 16852:2016 as:

- ***static*** flame Arrestor: flame Arrestor designed to prevent flame transmission by quenching gaps
- ***in-line*** flame Arrestor: flame Arrestor that is fitted with two pipe connections, one on each side of the flame Arrestor
- ***Deflagration*** *Flame Arrestor DEF*: flame Arrestor designed to prevent the transmission of a deflagration
- ***Bi-directional*** Flame Arrestor: flame Arrestor that prevents flame transmission from both sides

**Material Variants:**

The in-line deflagration flame Arrestors design series FA1-****-*** consist essentially of a deflagration-pressure-proof tubular housing with the NPT connections and the built-in flame Arrestor element to prevent a flame transmission. The housing is made from Carbon Steel (A106), ALuminum (2024-T6 or T651), Carbon Steel (A106) or Stainless steel (302, 304 or 316). The Flame Arrestor element is made from Stainless steel (302, 304 or 316). ALuminum housings are anodized while Carbon Steel housings are Black Oxide coated for additional corrosion protection.

**Ex marking:**  **G IIA (D)**

The flame Arrestor design series FA1-****-*** can be used for transported gas medium classified in ZONE 0, and outside in ZONE 1, or ZONE 2.

### 1.3. Tags

D - pipeline diameter

$D_{max}$ - maximum flame Arrestor diameter

$p_0$ - maximum operational pressure

$T_0$ - maximum operational temperature of the flame Arrestor

Lu - pipe length on the unprotected side, maximum allowable run-up length for installation.

MESG - maximum experimental safe gap (safe gap measured in accordance with EN 60079-20-1: 2010)

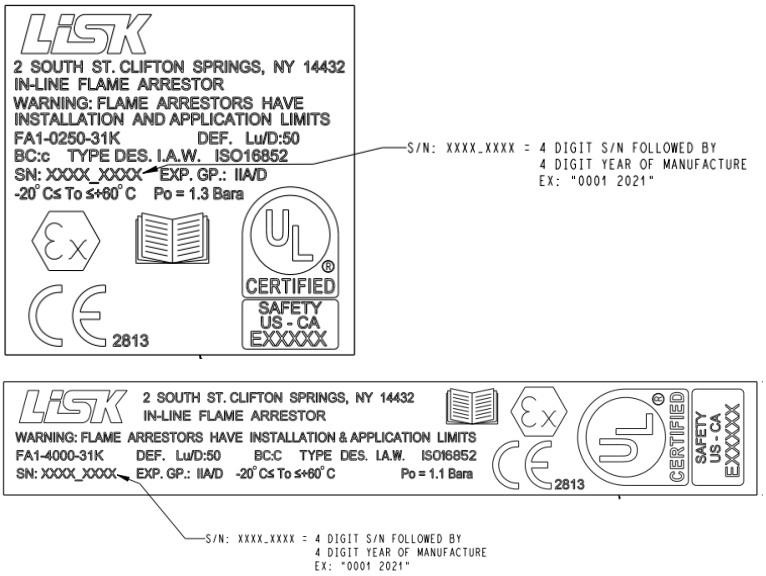
## 2. Type marking

In-line deflagration Flame Arrestors the design series FA1-****-*** type key:

**FA1 –XXXX-XXX**

- Gas group:
  - K = IIA (D)
- Element material:
  - 1 = Stainless steel 302 or 304
  - 2 = Stainless steel 316
- Housing material:
  - 1 = Aluminum 2024-T6 or T651
  - 2 = Stainless steel 303
  - 3 = Stainless steel 304
  - 4 = Stainless steel 316
  - 5 = Carbon Steel A106
- Code marking of size:
  - 0250 = 1/4”
  - 0500 = 1/2”
  - 0750 = 3/4”
  - 1000 = 1”
  - 1500 = 1 1/2”
  - 2000 = 2”
  - 2500 = 2 1/2”
  - 3000 = 3”
  - 4000 = 4”
- Housing style:
  - 1 = NPT (in-line)

**Example of label:**







***NOTE: the technical parameters (To, Po, $L_u$/D) on these examples are reference <u>ONLY</u>. For actual values based on design series, please reference data provided in tables in secton 3.1****

**ABBREVIATIONS:**

DEF (deflagration)

$L_u$: Pipe length on the unprotected side, maximum allowable run-up length for installation

D: Pipeline Diameter

Ex. Gp. (Explosion group):IIA (D)

BC (Stable Burning time): c = no short-time burning proof

$T_0$: Operational Temperature

$P_0$: Operational pressure (absoLute)

Design Code: FA1-4000-31K

EN ISO 16852:2016

**FLOW RATE**:

The rates will be provided by the client.

**TEMPERATURE INTERVALS:**

-20 °C ≤ T ≤ +60 °C

**TYPE:**

In-line deflagration flame Arrestor

**DIRECTION:**

Flame Arrestor that is fitted on pipe connection in any direction

**SIZE OF THE PIPE:**

The size of the connected product, pipe diameter and flange will be in accordance with ASTM, DIN norms as specified by the client. Minimum safe distance is one (1) meter long.

**PRESSURE DROPS ACCORDING TO THE CAPACITY AND SIZE**

Reference LR-4445 (Flow Vs. Pressure Drop Test Report) for Flow and Pressure Drop performance Data

**CONNECTION TYPE:**

The product is manufactured in accordance with the usage field, usage place, ASTM and DIN norms specified by the client.

**HOUSING MATERIAL SELECTION:**

The body can be manufactured from Carbon Steel (A106) Stainless Steel (SS) 303, 304 or 316 or ALuminum 2024-T6 or T651 materials in accordance with the demand of the client. The ALuminum housings are Anodized and the Carbon Steel housings are coated with Black Oxide, to improve corrosion resistance.

**FLAME ARRESTOR ELEMENT MATERIAL:**

Flame Arrestor element can be manufactured from Stainless Steel (SS) 302, 304 or 316

**STRUCTURE:**

Connections must be controlled due to the static load on the tank.

**GROUNDING:**

As there are no additional grounding screws/bolts used on this design., grounding is provided via metal to metal contact at the threaded connection of the Flame Arrestor and the adjacent pipe system.

## 3. Description and Function

### 3.1. Description

In-line deflagration Flame Arrestors design series FA1- **** - *** (nominal sizes of connection: NPT 1/4“ (DN 8), NPT 1/2” (DN 15), NPT 3/4” (DN 20), NPT 1” (DN 25), NPT 1 1/2” (DN 40), NPT 2” (DN 50), NPT 2 1/2” (DN 65) , NPT 3” (DN 80), NPT 4” (DN 100)) are used to prevent a flame transmission at deflagrations of flammable gas and/or vapour/air-mixtures of the explosion group IIA (D) with a maximum experimental safety gap (MESG) > 0.90 mm. Maximum operational pressure $p_o$, maximum operational temperature of the flame Arrestor $T_0$ and ratio Lu/D are written in the tables below.

The in-line deflagration Flame Arrestors design series FA1- **** - *** are designed as the bi-directional without burning time BC: c.

The in-line deflagration Flame Arrestor design series FA1-****-*** consist essentially of a deflagration-pressure-proof tubular housing with the NPT connections and the built-in flame Arrestor element to prevent a flame transmission. The housing is made from Carbon Steel (A106), Aluminum (2024-T6 or T651) or Stainless steel (302, 304 or 316). The flame Arrestor element is made from Stainless steel (302,

304 or 316). The Aluminum housings are Anodized and the Carbon Steel housings are coated with Black Oxide to provide additional corrosion protection. The flame Arrestor element consists of a quenching gaps with triangular channels with gap (high of crimped tape) ≤ 0.73 mm. Through these triangular channels the flammable gas and/or vapour/air-mixtures can flow, however, a flame transmission is prevented.

Technical parameters:

| Nominal size of design series FA1- **** - *** NPT Size [in.] | Operational temperature $T_0$ [°C] | Operational pressure $p_o$ [bar abs] | $L_u/D$ |
|---|---|---|---|
| 1/4“ | -20 … +60 | 1.3 | 50 |

| Nominal size of design series FA1- **** - *** NPT Size [in.] | Operational temperature $T_0$ [°C] | Operational pressure $p_o$ [bar abs] | $L_u/D$ |
|---|---|---|---|
| 1/2“ | -20 … +60 | 1.3 | 50 |
| 3/4“ | | | |
| 1“ | | | |
| 1 1/2“ | | | |

| Nominal size of design series FA1- **** - *** NPT Size [in.] | Operational temperature $T_0$ [°C] | Operational pressure $p_o$ [bar abs] | $L_u/D$ |
|---|---|---|---|
| 2“ | -20 … +60 | 1.1 | 50 |
| 2 1/2“ | | | |
| 3“ | | | |
| 4“ | | | |

### 3.2. Basic Flame Arrestor Characteristic

| **Design series** | **FA1- **** - ***** |
|---|---|
| Explosion Group | IIA (D) ( MSEG > 0,90 mm) |
| Number of flame Arrestor elements | 1 |
| Max. operational pressure $p_0$ | 1.3 bar abs (1/4” to 1 ½”)<br>1.1 bar abs (2” to 4”) |
| Max. operating temperature $T_0$ | -20°C ≤ $T_0$ ≤ +60 °C |

| | |
|---|---|
| Max. ratio $L_u/D$ | 50 |
| Short-time burning "BC" | C = no short time burn proof |
| Classification according to EN ISO 16852:2016 | Bc: c - without short time burning both sides |

### 3.3. Limitation of Use

In-line deflagration Flame Arrestors design series FA1-****-*** were not tested on safety against a flame transmission at a stabilized burning on the flame Arrestor element (short-time burning and endurance burning). Therefore, the in-line deflagration Flame Arrestors must not be used if a burning on the flame Arrestor element is expected due to the plant and process conditions.

**According to the standard EN ISO 16852:2016 the using of the Flame Arrestor is limited by:**

- operational temperature -20°C ≤ $T_0$ ≤ +60 °C (for flame Arrestor tested with atmospheric conditions)
- maximum operational pressure $p_0$ for which was the flame Arrestor tested
- for gas/air mixtures with MESG equal or higher than that for which the flame Arrestor was tested
- the pipe diameter on the protected side shall be no less than the pipe diameter on the unprotected side
- the pipe diameter on the unprotected side shall be no greater than the flame Arrestor connection
- the length of the pipe (between the potential source of ignition and the flame Arrestor) and the diameter of the pipe must not exceed the ratio $L_u/D$
- the pipe branches and valves on the unprotected side shall be installed as close as possible to the in-line deflegration flame Arrestor
- burn rating, the sign "BC" pLus the classification "c" (as is specified in the chapter 3.2)
- in the source of ignition must be free at least 10% of the pipe cross-section

**Please note the following when designing and using of a flame Arrestor:**

- The flame velocity and the pressures of flammable mixtures can be increased by back turbulence, which can be caused by bends, valves, or any change in pipe cross-section. For an explosion-proof flame Arrestor, the pipe on the unprotected side, e.g. the pipe between the ignition source and the flame Arrestor, must be as straight and clear as possible.
- All metal parts must be properly grounded.
- Flame Arrestor cannot be placed near hot equipment unless the flame Arrestor is certified for elevated temperatures, as heat transfer to the flame Arrestor will reduce its performance and may cause it to fail.
- If it is known that the process can contain particles or substances that could block the Flame Arrestor elements and increase the pressure in the system, it is recommended that pressure losses be continuously monitored.
- Installation of the flame Arrestor must be in accordance with the oerating instructions and the flame Arrestor must be regularly maintained, depending on the operating conditions. If it is found that the device has been exposed to flame (deflegration) or stabilized burning, the entire flame Arrestor needs to be checked and if necessary, replaced.

- The flame Arrestor must be placed as close as possible (≥ $L_u$/D) to the locations of the supposed deflegration so that the explosive voLume and thus the pressure are as low as possible.
- The FA1-****-*** Design Series Flame Arrestor is not intended for use in systems where short term burning is a concern, however, when operating the Flame Arrestor - short-term burning - there may be a significant increase in surface temperature on the flame Arrestor and part of the connected pipe on the unprotected side can cause potential for risk of burns.
- The temperature sensors must be connected to the control system which ensure safety in case of faiLure and power faiLure.
- In the event of a temperature sensor temperature rise - the flame Arrestor system can only be restarted after the cause has been detected and rectified.
- During designing of the Flame Arrestor, the connection technology must be considered with the effects of explosion pressures and short-term combustion.

## 4. Mounting of Flame Arrestor, Comissioning

The flame Arrestor must not be subjected to any forces from the connected piping or other parts of the equipment it is part of. Flame Arrestors may only be assembled by authorized personnel for installation and/or repair.

## 5. Maintenance

The maintenance of the flame Arrestor is divided into:

- Normal maintenance during operation - inspection
- Revisions and repairs

The flame Arrestor maintenance schedule must be part of the local operating safety regulations of the equipment or system of which the flame Arrestor is part.

Flame Arrestor maintenance may only be carried out by personnel authorized to install and/or repair.

### 5.1. Maintenance during working conditions – inspection

It is a visual check of the flame Arrestor body and a check of tightening of the screw connections and the temperature sensor body. Furthermore, it is advisable to monitor the surface temperature of the flame Arrestor and the pressure drop. The results of inspections and measurements should be recorded in the operating documentation. The period and extent of these checks depend on the operating conditions of the flame Arrestor. This is recommended to consult with the manufacturer.

### 5.2. Periodic Maintenance Progress

Control of tightness materials. Visually inspect the filter element within the flame Arrestor. If there's blockage, remove the Flame Arrestor, clean with pressurized air and reinstall the Flame Arrestor.

- Record the all operations on the maintenance form.
- Check visually the flame elements, if there is contamination or damage, replace the flame arrestor
- Elements may be cleaned with any suitable solvent followed by a blow through with compressed air. Steam cleaning may also be effective.
- If the flame arrestor cannot be cleaned satisfactorily, the flame arrestor must be replaced.
- Reinstall the cleaned flame arrestor into the system.
- Record all the operation in its maintenance form.
- To ensure a gas tight seal, thread sealant should be replaced every time a flame arrestor is loosened or removed for maintenance and must be replaced exactly as originally fitted.
- **Annual periodic maintenance is necessary for safe operation.**
- **Never use any sharp objects to clear the element openings of debris, this could result in damage to the element openings!**

### 5.3. Revisions and repairs

Inspection and repair work may only be carried out by the manufacturer or by an authorized service partner. Revision and all assembly work is only performed if the equipment is at rest and without pressure.

All health and safety requirements must be met before starting work.

The period of revision depends mainly on the degree of pollution of the transported medium. The recommended revision period is 6 months, but not more than 12 months.

Replacement of the flame Arrestor must also be carried out after deflagration.

Restoration of the flame Arrestor is carried out by the manufacturer or an authorized service partner.

### 5.4. Maintenance, revision and repair documentation

Operational maintenance, inspections, faults and repairs must be recorded in the local operating safety regulations of the equipment or system of which the flame Arrestor is located. Must state:

- date and time of the action
- description of the action
- flame Arrestor operating parameters (temperature, pressure, pressure loss) during inspection or
- in case of repair description of damage (e.g. photo documentation with description)
- the way the fault is eliminated
- duration of repair
- the name of the service organization and the names of the workers
- Serial numbers of original and new flame Arrestor(s) when replaced.
- Periodic maintenance of flame Arrestor is carried out once in six months.
    - These periodic maintenances will be carried out by our technical team.

**RECOMMEND!**
**Before maintenance, purge the line or tank with an inert gas, if it is possible!**

## 6. Storage

Flame Arrestors are recommended to be stored in such a way as to protect them from the weather. It is always necessary to protect the threaded ends and other opening with suitable caps to protect against the ingress of dirt and damage to the flame Arrestor elements.

## 7. Warranty Conditions

The in-line deflagration flame Arrestors the design series FA1-****-***are designed as a protective system. Any tampering, use or modification to the Flame Arrestor Element or housing not approved by manufacturer may affect the function of the flame Arrestor. In such cases, the manufacturer is not responsible for any consequential damages.

Please Check:

- Remove any protective material and unpack the product.
- If there is any damage or missing parts, customer should inform the manufacturer within a week after delivery!
- Install the flame arrestor by tightning according to user industry standard.
  - Be sure not to over tighten as it may lead to damage to the flame arrestor housing
  - Be sure not to cross thread the flame arrestor during installation, this may lead to leaks in the assembly.
- If applicable, carefully install the sensor(s).

**Notification-1: PLEASE REMOVE THE CAPS BEFORE ASSEMBLY.**

## 8. Torque Procedure

As a general rule, pipe fittings with tapered threads should not be assembled to a specific torque because the torque required for a reliable joint varies with thread quality, port and fitting materials, sealant used, and other factors. Install per customer industry standard.

## 9. Principles and Safety

Inline deflegration flame Arrestor functions by absorbing the heat from a flame front traveling at sub-sonic velocities, thus dropping the burning gas/air mixture below its auto-ignition temperature: consequently, the flame cannot survive. The heat is absorbed through channels (passages) designed into an element. These channels are chosen and measured as the mesg (maximum Experimental Safe Gap - MESG) of the

gas for a particular installation. These passages can be regular, like crimped metal ribbon or wire mesh or a sheet metal plate with punched holes, or irregular, such as those in random packing. The required size of the channels needed to stop the flame front can vary significantly, depending on the flammability of the fuel mixture. The large openings on a chain link fence are capable of slowing the spread of a small, slow-burning grass fire, but fast-burning grass fires will penetrate the fence unless the holes are very small. In a coal mine containing highly explosive coal dust or methane, the wire mesh of a Davy lamp must be very tightly spaced.

In-line deflegration Flame Arrestor used as a safety device, the mesh must be protected from damage due being dropped or struck by another object, and the mesh must be capable of rigidly retaining its shape during the propagation of a flame front. Any shifting of the individual wires that make up the mesh can create an opening large enough to allow the flame to penetrate and spread beyond the barrier.

**SAFETY**; Flame Arrestors should be used only in the gas group and conditions they have been designed and tested for. Since the depth on an Arrestor is specified for certain conditions, changes in the temperature, pressure, or composition of the gases entering the Arrestor can cause the flame spatial velocity to increase, making the design of the Arrestor insufficient to stop the flame front ("propagation"). The deflegration may continue downstream of the Arrestor

On a fuel storage vent, flame Arrestors also serve a secondary purpose of allowing air pressure to equalize inside the tank when fuel is added or removed, while also preventing insects from flying or crawling into the vent piping and fouling the fuel in the tanks and pipes.