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NATIONAL IRANIAN OIL REFINING & DISTRIBUTION COMPANY  
NATIONAL IRANIAN OIL ENGINEERING  
& CONSTRUCTION COMPANY

# NIOEC SP

NIOEC SPECIFICATION  
FOR

## FOAM GENERATING AND PROPORTIONING SYSTEM

SECOND EDITION

JULY, 2009

THIS SPECIFICATION IS THE PROPERTY OF NATIONAL IRANIAN OIL ENGINEERING & CONSTRUCTION COMPANY. IT IS CONFIDENTIAL AND ALL RIGHTS RESERVED TO THE OWNER. NEITHER WHOLE NOR ANY PART OF THIS DOCUMENT MAY BE DISCLOSED TO ANY THIRD PARTY, REPRODUCED, STORED IN ANY RETRIEVAL SYSTEM OR TRANSMITTED IN ANY FORM OR BY ANY MEANS WITHOUT THE PRIOR WRITTEN CONSENT OF THE NATIONAL IRANIAN OIL ENGINEERING & CONSTRUCTION COMPANY.

**IN THE NAME OF GOD****FOREWORD**

By their very nature, technical Specifications are continuously subject to modifications and revisions. To strengthen their merit and usefulness, continuous improvements, addendum, deletion of disparate information and consequently provision of updated revisions are to be made in order to ascertain that such Specifications meet the current requirements, inclusive of Iranian Petroleum Standards (IPS) and the recognized and acceptable national and international Standards, as well as the optimal codes and practices based on the accumulated in-house know-how and plant knowledge and experiences.

However, in reality, due to several reasons, not to mention the complexity of the matter, the ultimate goal of continuous direct embedment of the required changes on the relevant Specifications may be far reaching. Therefore, in the interim periods between the officially issued revisions, the required changes will appear in other documents related to the engineering and design work of the ongoing projects.

In response to the initiative of the Design and Engineering Directorate, and considering that the task of the execution of several important and mega projects for the realization of the new oil refineries, pipelines and oil terminals as well as improvements of the existing facilities, has been assigned to NIOEC, it was decided to update the NIOEC Specifications and to issue new official revisions.

The Design and Engineering Directorate was itself entrusted to carry out this important task, and as such by forming several special technical committees, working in close co-operation and cohesion and sharing their expertise and knowledge, the updated and revised NIOEC Specifications were successfully prepared and complied.

These Specifications are intended to be used for Oil Refineries, Distribution Depots, Oil Terminals, Pipelines and Pump Stations within NIOEC's projects, and have been proven to be of high value for such purposes. It must however be appreciated that these Specifications represent the minimum requirements and should in no way be interpreted as a restriction on the use of better procedures, engineering and design practices or materials.

We encourage and highly appreciate the users and other clear sighted and experts to send their comments on the Specifications to the Design and Engineering Director of NIOEC for evaluation and approval.

## REVISION INDEX

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## NOTES:

- 1) THIS SHEET IS A RECORD OF ALL REVISIONS TO THIS SPECIFICATION.
- 2) WHEN APPROVED, EACH REVISION SHALL BE CONSIDERED AS A PART OF THE ORIGINAL DOCUMENT.
- 3) NUMBER OF PAGES EXCLUDES THIS SHEET AND THE COVER SHEET.

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## INTRODUCTION

To satisfy the requirements of this NIOEC Specification, Iranian Petroleum Standard IPS-E-SF-140 (3) revised on January 2014 with the considerations as specified herein after shall be strictly followed.

Articles 1 through 3 of this document replace entirely the related articles in the referenced IPS Standards.

### 1. SCOPE

This Specification specifies the minimum requirements for foam producing and liquid concentrates employed for fire extinguishment, and gives designs of fixed and semi-fixed systems for applying low, medium and high expansion foam to fires in buildings, industrial plant and storage facilities.

It also covers:

- Classes of Foam Concentrates.
- Foam Spray Systems
- Total Flooding Systems
- Local Application Systems
- Wetting Agents

Deviations from this specification will only be permitted on obtaining written approval from NIOEC.

Resolution on cases not explicitly stipulated in this Specification, or on cases where conflicts may arise among the requirements of the referenced/relevant IPS and the international standards, shall be made through written consent and approval of NIOEC.

### 2. REFERENCES

The following standards, codes and specifications, to the extent specified hereinafter, shall constitute a part of this NIOEC specification. Latest edition of the undated referenced documents and the cited edition of the dated references shall apply. The applicability of changes made to the dated references, after the cited date shall be mutually agreed upon between NIOEC and the Vendor/ Contractor.

#### BSI (BRITISH STANDARDS INSTITUTION)

5306-Pt-6 "Foam System"

5306 Section 6.1 "Specification for Low Expansion Foams"

#### IPS (IRANIAN PETROLEUM STANDARD)

IPS-E-SF-140 "Foam Generating and Proportioning Systems"

#### NFPA (NATIONAL FIRE PROTECTION ASSOCIATION)

NFPA 11 "Standard for Low-, Medium-, and High-Expansion Foam"

NFPA 18 "Standard on Wetting Agents"

#### NIOEC-SP (NIOEC SPECIFICATIONS)

NIOEC-SP-00-10 "NIOEC Specification for Units"

#### 2.1. Equivalent to IPS Standards

Substitute the following IPS Standards as referred to throughout IPS-G-SF-126 for the relevant NIOEC's Specifications as follows:

| IPS Standard | Relevant NIOEC Specification |
|--------------|------------------------------|
| IPS-E-GN-100 | NIOEC-SP-00-10               |
| IPS-E-SF-140 | NIOEC-SP-47-30               |

|              |                |
|--------------|----------------|
| IPS-E-SF-160 | NIOEC-SP-47-32 |
| IPS-E-SF-200 | NIOEC-SP-47-36 |
| IPS-E-SF-220 | NIOEC-SP-47-28 |
| IPS-E-SF-240 | NIOEC-SP-46-16 |
| IPS-E-SF-280 | NIOEC-SP-70-53 |

### **3. UNITS**

International system of units (SI) shall be used in accordance with NIOEC-SP-00-10, unless otherwise specified.

**ENGINEERING STANDARD**

**FOR**

**FOAM GENERATING AND PROPORTIONING SYSTEMS**

**ORIGINAL EDITION**

**MAY 1993**

This standard specification is reviewed and updated by the relevant technical committee on Dec. 1998(1), July 2006(2) and Jan. 2014(3). The approved modifications are included in the present issue of IPS.

**FOREWORD**

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS is based on internationally acceptable standards and includes selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

Standards and Research department

No.17, Street14, North kheradmand

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Fax: 021-88810462

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**GENERAL DEFINITIONS:**

Throughout this Standard the following definitions shall apply.

**COMPANY:**

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery and Distribution Company.

**PURCHASER:**

Means the "Company" where this standard is a part of direct purchaser order by the "Company", and the "Contractor" where this Standard is a part of contract documents.

**VENDOR AND SUPPLIER:**

Refers to firm or person who will supply and/or fabricate the equipment or material.

**CONTRACTOR:**

Refers to the persons, firm or company whose tender has been accepted by the company.

**EXECUTOR:**

Executor is the party which carries out all or part of construction and/or commissioning for the project.

**INSPECTOR:**

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

**SHALL:**

Is used where a provision is mandatory.

**SHOULD:**

Is used where a provision is advisory only.

**WILL:**

Is normally used in connection with the action by the "Company" rather than by a contractor, supplier or vendor.

**MAY:**

Is used where a provision is completely discretionary.

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## 0. INTRODUCTION

This Engineering Standard specifies various extinguishing systems to be appropriately designed and used for protecting and combating in different classes of fires and provides a degree of protection for life and property.

The intent of the engineering standard is to present the design consideration applicable to these systems. These Standards are divided into the following Titles.

### STANDARD CODES

### TITLES

[IPS-E-SF-120](#)

"Engineering Standard for Off-Shore Installations Fire-Fighting and Fire Protection"

[IPS-E-SF-140](#)

"Engineering Standard for Foam Generating and Proportioning Systems"

[IPS-E-SF-160](#)

"Engineering Standard for CO<sub>2</sub> Gas Fire Extinguishing Systems"

[IPS-E-SF-180](#)

"Engineering Standard for Dry Chemical Fire Extinguishing Systems"

[IPS-E-SF-200](#)

"Engineering Standard for Fire Fighting Sprinkler Systems"

[IPS-E-SF-220](#)

"Engineering Standard for Fire Water Distribution and Storage Facilities"

[IPS-E-SF-260](#)

"Engineering Standard for Automatic Detectors and Fire Alarm Systems"

[IPS-E-SF-300](#)

"Engineering Standard for Application of Breathing Apparatus in Safety and Fire Fighting"

[IPS-E-SF-504](#)

"Engineering Standard for Fire Fighting Vessels"

[IPS-E-SF-340](#)

"Engineering Standard for Fire Fighting Hose Box and/or shelter"

This Standard covers:

### "FOAM GENERATING AND PROPORTIONING SYSTEMS"

## 1. SCOPE

This Standard specifies the requirements for foam producing and liquid concentrates employed for fire extinguishment, and gives designs of fixed and semi-fixed systems for applying low, medium and high expansion foam to fires in buildings, industrial plant and storage facilities.

It also covers:

- Classes of Foam Concentrates
- Foam Spray Systems
- Total Flooding Systems
- Local Application Systems
- Wetting Agents

### Note 1:

This standard specification is reviewed and updated by the relevant technical committee on Dec. 1998. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No. 41 on Dec. 1998. These modifications are included in the present issue of IPS.

### Note 2:

This standard specification is reviewed and updated by the relevant technical committee on July 2006. The approved modifications by T.C. were sent to IPS users as amendment No. 2 by circular No. 302 on July 2006. These modifications are included in the present issue of IPS.

### Note 3:

This standard specification is reviewed and updated by the relevant technical committee on Jan. 2014. The approved modifications by T.C. were sent to IPS users as amendment No. 3 by circular No. 413 on Jan. 2014. These modifications are included in the present issue of IPS.

## 2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

### BSI (BRITISH STANDARD INSTITUTION)

- |                                   |                                                      |
|-----------------------------------|------------------------------------------------------|
| English version of DIN EN 13565-1 | "Fixed Firefighting Systems – Foam Systems"          |
|                                   | Part 1: Requirements and Test Methods for Components |
| BS 13565                          | "Fixed Firefighting Systems- Foam Systems"           |
|                                   | Part 2: Design, Construction and Maintenance         |

### NFPA (NATIONAL FIRE PROTECTION ASSOCIATION)

- |         |                                                       |
|---------|-------------------------------------------------------|
| NFPA 11 | "Standard for Low-, Medium-, and High-Expansion Foam" |
| NFPA 18 | "Standard on Wetting Agents"                          |

### 3. DEFINITIONS AND TERMINOLOGY

#### 3.1 Alcohol-Resistant Foam Concentrate

A concentrate used for fighting fires on water-soluble materials and other fuels destructive to regular, AFFF, or FFFP foams, as well as for fires involving hydrocarbons.

#### 3.2 Aqueous Film-Forming Foam Concentrate (AFFF)

A concentrate based on fluorinated surfactants plus foam stabilizers to produce a fluid aqueous film for suppressing hydrocarbon fuel vapors and usually diluted with water to a 1 percent, 3 percent, or 6 percent solution.

#### 3.3 Combustible Liquid

A liquid that has a closed-cup flash point at or above 37.8°C (100°F).

#### 3.4 Concentration

The percent of foam concentrate contained in a foam solution, usually expressed as a percentage by volume.

#### 3.5 Educator (Inductor)

A device that uses the venture principle to introduce a proportionate quantity of foam concentrate into a water stream. The pressure at the throat is below atmospheric pressure and will draw in liquid from atmospheric storage.

#### 3.6 Expansion

The ratio of air to water in the foam. A measure of the volume of foam produced for each volume of foam solution used.

#### 3.7 Flammable Liquid

A liquid that has a closed-cup flash point that is below 37.8°C (100°F) and a maximum vapor pressure of 2068.6 mm Hg (40 psia) at 37.8°C (100°F).

#### 3.8 Fluoroprotein Foam Concentrate

A concentrate very similar to protein-foam concentrate but with a synthetic fluorinated surfactant additive.

#### 3.9 Foam

A stable aggregation of bubbles of lower density than oil or water.

#### 3.10 Foam Concentrate

A concentrated liquid foaming agent as received from the manufacturer.

#### 3.11 Foam Solution

A homogeneous mixture of water and foam concentrate in the proper proportions.

**3.12 High Expansion Foam**

Foam which has an expansion ratio greater than 200:1

**3.13 Low Expansion Foam**

Foam which has an expansion ratio not greater than 20:1

**3.14 Medium Expansion Foam**

Foam which has an expansion ratio greater than 20:1 but not greater than 200:1

**3.15 Medium- and High-Expansion Foam Concentrate**

A concentrate, usually derived from hydrocarbon surfactants, used in specially designed equipment to produce foams having foam-to-solution volume ratios of 20:1 to approximately 1000:1.

**3.16 Premixed Foam Solution**

Is produced by introducing a measured amount of foam concentrate into a given amount of water in a storage tank.

**3.17 Proportioning**

The continuous introduction of foam concentrate at the recommended ratio into the water stream to form foam solution.

**3.18 Protein Foam Concentrate (Protein)**

Concentrate consisting primarily of products from a protein hydrolysate, plus stabilizing additives and inhibitors to protect against freezing, to prevent corrosion of equipment and containers, to resist bacterial decomposition, to control viscosity, and to otherwise ensure readiness for use under emergency conditions.

**3.19 Surfactant**

Also known as syndet or detergent foam.

**3.20 Wetting Agent**

A chemical compound which when added to water in proper quantities, materially reduces its surface tension, increases its penetrating and spreading abilities and can also provide emulsification and foaming characteristics.

**3.21 Wet Water**

Water to which a compatible wetting agent has been added.

### 3.22 Wet Water Foam

An admixture of wet water with air to form a cellular structure foam which breaks down rapidly into its original liquid state at temperatures below the boiling point of water at a rate directly related to the heat to which it is exposed in order to cool the combustible on which it is applied.

## 4. UNITS

This Standard is based on International System of Units (SI), as per [IPS-E-GN-100](#) except where otherwise specified.

## 5. GENERAL

### 5.1 Abbreviation

|      |                            |
|------|----------------------------|
| AR   | Alcohol Resistant          |
| P    | Protein                    |
| FP   | FluoroProtein              |
| FFFP | Film Forming FluoroProtein |
| AFFF | Aqueous Film Forming Foam  |

### 5.2 Foams

**5.2.1** Extinguishing by the exclusion of air (blanketing) and by its cooling properties, prevention or ignition of ignition or reignition by blanketing. Foam extinguishment is applicable to oils, fats and highly flammable liquids.

**5.2.2** Foam for fire protection is an aggregate of air filled bubbles formed from aqueous solution and is lower in density than lightest flammable liquids. It is principally used to form a coherent floating blanket on flammable and combustible liquids lighter than water and prevents or extinguishes fire by excluding air and cooling the fuel. Reignition is excluded by suppression of flammable vapors. It adheres to surfaces and provides protection from adjacent fires. Foam is supplied by fixed pipe systems or portable foam generating units.

**5.2.3** All fixed foam installations should be designed to reduce time lag in charging service lines to a minimum, and provision made for draining all services after use.

**5.2.4** Subsurface foam injection facilities shall be provided for fixed roof tanks.

### 5.3 Expansion

Foams are classified by their expansion ratio (expansion), the ratio of the volume of the made foam to the volume of the solution from which it is made, as follows.

- a)** Low expansion foams, with expansions between 1 and 20, are intended primarily for application to the surface of flammable liquid fires.
- b)** Medium expansion foams, with expansions between 21 and 200, are intended for surface application or for application to fires which require a certain depth of foam to obtain coverage, e.g. up to depths of 4 m.
- c)** High expansion foams, with expansions between 201 and 1000, are intended for filling enclosures within which a number of fires are burning at different levels up to 10 m.

## 5.4 Foam-Solution

**5.4.1** Protein foams are made from concentrates based on proteinaceous products alone and with the addition of fluorinated additives to give fluoro protein foams. Another development is a mixture of hydrocarbon and fluorinated surfactant materials with stabilizers to form aqueous filmforming foam (AFFF) type concentrates. These are used for the extinction of fires in hydrocarbons and other water immiscible flammable liquids.

**5.4.2** Modifications of fluoroprotein and AFFF foams have been developed that are suitable for use on fires in watermiscible flammable liquids, e.g. alcohols and ketones. These are the alcohol resistant (AR) foams or general purpose foams. Medium expansion foams can be made from low expansion foam concentrates, but it is more usual to make them from a surfactant concentrate based on ammonium lauryl ether sulphate. High expansion foams are also made from this concentrate.

**5.4.3** The use of low expansion foams is restricted largely to the extinction of flammable liquid fires, but there is no reason why they should not be applied to solid fuels also, provided adequate coverage can be obtained to exclude air as much as possible. In practice, low expansion foams may either be applied to the surface of a burning liquid (surface application), or beneath the surface so that the foam stream floats to the surface and spreads to form a protective layer or blanket upon it (sub-surface application). The first method is the more common, and can be used against spill fires, fires in banded areas, fuel tanks, etc., using the appropriate equipment.

**5.4.4** Medium expansion foams are generally applied to the surface of flammable liquid fires, either by hand-held foam-making branches, or from fixed foam makers. This medium can also be used effectively on solid fuel fires, or 'mixed' fires of solid and liquid combustibles. Typical examples would be on a fire in a gas turbine driven generating set, a fuel fire in the engine room of a ship, heat-treatment baths, or places where fuel spillages can occur, e.g. in pit areas, in garages or in overhaul shops. High expansion foams are similar in action to medium expansion foams, but they require generators in which air is supplied by a fan, in order to achieve the rate of flow necessary for their production. They work by blanketing or smothering a fire, but the degree of cooling available is much less than for medium expansion foams, due to their lower water content. They can, however produce much greater foam depths of at least 10m, and can therefore smother a fire in goods stored on high racks. For this, the depth of the foam needs to increase rapidly in order to match, or overtake, the upward rate of development of the fire.

## 6. LOW EXPANSION FOAM-TYPES AND REQUIREMENTS

### 6.1 System Description

**6.1.1** A system consists of an adequate water supply, a supply of foam concentrate, suitable proportioning equipment, a proper piping system, foam makers, and discharge devices designed to adequately distribute the foam over the hazard. Some systems may include detection devices.

**6.1.2** These systems are of the open outlet type in which foam discharges from all outlets at the same time, covering the entire hazard within the confines of the system.

**6.1.3** Self-contained systems are those in which all components and ingredients, including water, are contained within the system. Such systems usually have a water supply or premix solution supply tank pressurized by air or inert gas. The release of this pressure places the system into operation.

**6.1.4** There are four basic types of systems:

- a) Fixed
- b) Semifixed
- c) Mobile
- d) Portable