REVISIONS INDEX

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SUMÁRIO

1. INTRODUCTION

The Flare radiation and gas dispersion study for flare's non-ignition condition is an analysis to evaluate the effects of Flare operation on monitoring points (observers - people, equipment and/or structure) of an Offshore Stationary Production Unit (SPU). In addition to these monitoring points, other aspects considered critical to the safety of the Unit can be evaluated or for equipment integrity, such as those described in the scope of the study and contained in this Technical Specification.

This Technical Specification (ET) guides the development of the implementation of the Study and the preparation of its respective report.

2. OBJETIVES

This technical specification has the following objectives:

- Define scope, methodology and criteria for carrying out the Study for the phases of basic design, Front End Engineering Design (FEED), executive project and assisted operation of the Stationary Offshore Production Unit, hereinafter referred to as installation.
- Guide the dynamics for the planning, development and monitoring of the study by the parties involved and their final approval.
- Define the standardization, content and minimum requirements for submission of the study report.
- This TS can be used optionally as a guide in the operation phase of the Installation due to the need for a review of the study.

3. ABREVIATIONS AND DEFINTIONS

For the purposes of this specification, the following abbreviations and definitions shall be considered:

Abreviations:

CFD – Computational Fluid Dynamics
CSI – Critical Safety Items
TS – Technical Specification
FEED – Front End Engineering Design
MSF – Main Safety Functions
HSE – Health and Safety Executive - Great Britain's independent regulator for work-related health, safety and illness
PFD - Process Flow Diagram
P&ID - Piping and Instrumentation Diagram
SIGEM - Sistema Integrado de Gerenciamento de Empreendimentos
SPU– Stationary Production Unit

Definitions:

Case – It is one of the burning conditions described in the Process Data Sheet considered at the point of interest or representativeness of points in the unit's production curve;

Flare Discharge - Predicted release of high and low pressure Flare gas directly into the atmosphere;

Study Consultant – Is responsible for the execution of the study of radiation and dispersion of gases, and may be a contracted company, either by the Designer or Petrobras, the Designer herself or even an internal workforce of Petrobras;

Radiated fraction – is a factor that allows to represent the fact that not all heat released in a flame can be transferred by radiation and several factors affect the irradiated fraction, such as: gas composition; flame type; air/fuel mixing status; soot, smoke formation;

Main Safety Function (MSF) – Function that a system, device or safety barrier shall fulfill to enable and/or ensure the effectiveness of the strategy of emergency response, escape and abandonment of the Installation during an accidental event. These functions are defined in the Safety Guideline and shall remain available during the period of 1 (one) hour after the start of the event;

Critical Safety Items (CSI) – These are Installation items that shall be kept healthy and functional in a Flare burn condition so that they can fulfill their safety function for a certain period of time. It comprises the Main Ssafety Functions (MSF) and other critical items defined in the Safety Guideline;

Cloud – Three-dimensional representation, in views or cuts, of the simulation of gas discharges with indication of color scale of the gas dilution profile in the atmosphere in a certain contour of interest of gas concentration;

Stationary cloud – Cloud that, in a certain period of time after the start of the discharge, presents stabilization of its composition/concentration, maintaining a constant spatial profile;

Parties Involved – Are the Designer, the Study Consultant and Petrobras involved in the preparation or monitoring of the study of dispersion of gases;

Designer - company responsible for the preparation of the engineering project in phases: conceptual project, basic project, FEED or executive project, which may be Petrobras itself or company contracted to carry out the project.

4. SCOPE

The Flare radiation and gas dispersion study for flare's non-ignition condition shall consider the various discharge and firing cases listed in the flare process data sheet and technical specification for the various operating conditions, including installation start-up.

4.1.Results for the structure

1. The study shall verify the adequacy of the height of the Flare structure to meet the maximum acceptable radiation levels in the various burning conditions described in the Process Data Sheet.

As an acceptance criterion, the maximum permissible levels of radiation to be considered under the various conditions are those defined by Petrobras and described in API-STD-521 with the following values:

- Continuous burning - 1,577 W/m^2

- Emergency burning- 4,737 W/m^2

Note: Always use the values of the most up-to-date version of the API standard mentioned above.

2. The study shall provide the incident radiation profile in the Flare support structure.

3. The study shall provide the temperature profile in the flare support structure in the stationary case (continuous burning), continuous starting condition of the Installation and also in the transient condition (emergency burning) plus the burned flow rate in the low pressure Flare.

4. Determine the point of the structure (height) where the temperature profile in the Flare supporting structure is 310°C. This point will serve as a reference for determining the length of the structure that shall be protected with "heat shield".

5. Check the location of the Flare (position and height) to minimize the effects of radiation.

4.2. Radiation Results for evaluation of equipment and people

1. Iso-radiation curves shall be drawn on the Unit Arrangement (Plant and Cut planes) to be able to identify the radiation levels at the various points of the Installation. Solar radiation shall be included in calculations (789 W/m2) ref. API 521, different value may be adopted as long as agreed with Petrobras.

2. Maximum radiation levels shall be guaranteed throughout the range of operation of the Flare, simultaneous high and low pressure, and in the various weather conditions described in the Metoceanographic Data ET (METOCEAN DATA).

3. The effect of the wind shall be considered, both in its variation of direction and in the variation of intensity, and its influence on the radiation to which the Installation will be subjected.

4. Determine and report the highest acceptable continuous gas burning flow, within the limits of radiation imposed, for the length of the given Flare structure. For this continuous burning condition, the gas to be considered is the same gas that would be compressed under normal process conditions.

5. The study shall make a sensitivity analysis of variation of the firing parameters (flame emissivity factor and radiation fraction), within acceptable limits for the specified type of equipment, determining the new radiation curves on the Installation. Four (4) monitoring points shall be chosen for the parameters of emissivity and radiated fraction (the choice of the value of this factor shall be recorded and justified).

6. Radiation analysis verifying the impact on platform structures. This analysis aims to determine the temperature that a calculated radiation-prone equipment can reach. As an example, the temperature increase of a pressure vessel and the upper face of a box shall be simulated.

7. It is up to the designer to contact the manufacturers of Flare in order to obtain more data about the burner for modeling.

8. Verification of flare location (position and height) to minimize radiation effects.

4.3. Dispersion results for MSF evaluation

1. To evaluate the impairment of MSF, especially escape routes, by toxic and/or asphyxiating gases - Analysis of gas dispersion in order to evaluate the impairment of MSF by flammable, toxic and asphyxiating gases resulting from the non-ignition condition of flare;

2. In addition to meeting the requirements of the Safety Guideline, the study shall include aspects related to the operation, inspection, maintenance of structures and/or equipment. The analysis of the above aspects shall be presented or referenced in the study report, in order to show that these aspects were properly considered and addressed;

3. Verification of flare location (position and height), to minimize the dispersion effects of toxic and asphyxiating gases.

5. REFERENCE DOCUMENTATION

As inputs for the preparation of the study, the following documents shall be considered, in their most updated version and with status of RELEASED or RELEASED WITH COMMENTS BY PETROBRAS in SIGEM or another electronic document management system defined in contract. The revision of each document to be used shall be clearly indicated in the analysis report.

a) Technical Specification of meteoceanographic data (METOCEAN DATA);

b) Flare technical specification;

c) Process Flow Diagrams (PFDs);

d) Piping and Instrumentation Diagrams (P&IDs);

e) Flare data sheet;

f) Updated Installation 3D model and/or arrangement design (2D);

g) List of equipment.

Additional documents shall be provided for the identification of other relevant aspects.

6. RELEVANT ASPECTS OF THE ANALYSIS

The study shall consider at least the following aspects that influence the analysis:

- The composition of fluids considering the presence and concentration of flammable, combustible, toxic and/or asphyxiating components;
- Congestion of areas by equipment, structures and piping among other items;
- The geometry and physical arrangement of the evaluated region;
- The environmental conditions to be used in the simulations.

7. SOFTWARE REQUIREMENTS

The Flare Radiation Study shall be developed using CFD tools to conduct simulations and shall comply with the requirements of Safety Guideline. Other software, different from those specified in Safety Guideline may be used, provided that previously authorized by Petrobras before being used in simulations.

8. WEATHER CONDITIONS

The weather conditions to be used in the study shall be those of the final lease of the Facility. The use of meteorological data in the study shall comply with the provisions of the Safety Guideline. In the study report, a table shall be presented with wind directions, speeds of each wind direction, as well as

the calm condition and all considerations adopted in relation to the environmental data used in the study.

The most frequent wind speed shall be obtained from the weighted average of the most frequent speed values in each of the eight directions. Weighting is performed by the number of occurrences of each most frequent velocity considered in the calculation. When frequency values or number of occurrences are provided by speed ranges, use the average value of the speed range.

The study report shall present a table with wind directions, speeds of each wind direction, as well as calm condition, and all considerations and assumptions adopted for simulations.

9. STUDY METHODOLOGY

The methodology to be adopted in the study of radiation and dispersion of gases shall meet the requirements of the Safety Guideline, complemented by the requirements contained in this TS.

The methodology for the preparation of the study shall follow the steps described in this technical specification. Any deviation from the methodology shall be presented for prior analysis and validation by Petrobras. The following steps shall be performed in the development of the study:

Cases

Consider the cases and flare conditions that will be dimensioning case for this study, listed in the Flare Data Sheet.

9.1.Additional Cases

Cases that have not been previously defined and related in the Flare Process Data Sheet, but identified during the development of the study, and that are categorized as relevant shall also be considered in the study of radiation/dispersion of gases, as well as scenarios caused by design changes, operational changes and unit start-up.

9.2.Process Data

For the determination of the properties of flammable gases or vapours and other data relating to the process variables to be used in the study, only up-to-date project data shall be used. All documents used as a reference for obtaining the data shall be indicated in the reference document item of the report with their revisions.

All simulated cases shall have their information on the physicochemical properties of the fluids (flammable gases/vapors) presented in the report, at least: current composition, pressure, temperature, density, stream code, reference document code (e.g. PFDs, PI&Ds, data sheets, mass and energy balance, line isometrics), mode of operation and other properties to trace the origin and relevance of the information used shall be indicated. These data shall be provided by the Designer and presented for analysis and validation by Petrobras before being used in the simulations. The validation of process data shall be performed by experienced professionals involved in the project.

It is the responsibility of the Designer to provide the reliable input data to be used in the simulations, so any detected inaccuracies that impact the results and require new simulations will be the responsibility of the same. In case of changes in the project formally requested by Petrobras, such as change in composition of the fluids produced or increase / reduction of plant capacity that impact the study, it will be the responsibility of Petrobras.

The Study Consultant shall perform the analysis based on the clouds in stationary condition. Evidence shall be presented to prove that the gas plume used has reached the status of a stationary cloud.

9.3.Requirements for Geometry for CFD Analysis

The geometric model of CFD used in the study shall meet the requirements set out in the Safety Guideline.

The CFD geometric model shall be based on the most up-to-date 3D model available for the Installation or shall be constructed based on the actual geometry of the unit under analysis, when existing.

It is desirable that the degree of confinement and congestion of the CFD model be close to the reality of the unit in the operational condition (as-built). To do this, one shall complete the CFD model based on the items below, in order of priority:

1. Data from the unit itself, if any;

2. Data from other existing units of the same type (FPSO/Semi-submersibles, etc.);

3. Consult professionals of process, mechanics, arrangement and piping of the Designer;

4. Data from other similar detailing projects with more complete models.

Regarding the degree of congestion, it is recommended as good practice to observe the CFD models from different points of view by assessing the degree of congestion to be used in the simulations and comparing it with those observed in photos of the unit (when existing) or photos of the 3D model, adjusting the CFD model when necessary.

Simplifications and use of congestion factors shall be validated with the participation of The Designer and Petrobras.

9.4.CFD modeling

The Study Consultant shall present the details of the modeling options adopted in the CFD software. Mesh definitions, domain, turbulence models, boundary conditions, convergence shall be presented and justified.

A mesh refining study and its impacts on the evaluation of the variables of interest on the monitoring points (mesh independence test) shall be presented, with at least velocity, temperature and kinetic energy turbulence profiles.

9.5. MSF impairment assessment due to non-ignition flare

Evaluate cloud concentration using the impairment criteria defined for each type of gas (see Annex A). Clouds shall be considered that can simultaneously prevent existing main escape routes (escape function), temporary refuge in open area, if any, air outlets and boarding stations.

The study in question shall evaluate whether the cloud of gas released in Flare arrives at the unit and, if it arrives, measures shall be recommended to avoid this impairment, such as increased structure.

Gas cloud simulations shall be made according to the following assumptions:

- **CH_4 simulation:** Cloud interest contour: 20% lower Flammability Limit (LII).

- **CO_2 simulation:** Cloud contour of interest: 3,900 ppm, 30,000 ppm and 40,000ppm.

- **H_2S simulation:** Cloud contour of interest: 8 ppm, 20 ppm and 100 ppm.

10. REQUIREMENTS FOR FOLLOW-UP MEETINGS

The follow-up meetings of the study shall follow the guidelines below.

10.1. General Considerations

The monitoring of the development of the study shall be carried out by the team of the Designer with Petrobras participation in the cases mentioned in this specification.

The follow-up meetings shall be held at the Study Consultant's premises, with the exception of the project documentation planning and analysis meeting, which shall be held at the Designer's premises. The place of meetings may be amended in agreement between the parties concerned. Petrobras, at its discretion, may participate in the meetings by videoconference.

The meeting minutes shall be prepared by the Designer and made available as a project document or included as an annex to the report in its final review.

All validation decisions (assumptions, data, geometry, among others) shall be included in the final report of the study in the form of an annex. Validations shall be signed by the persons responsible for each party involved.

10.2. Planning Meeting

Meeting aimed at the summary presentation of the project, the clarification of aspects related to the objectives and scope of the study, delivery of the project documentation, evaluation and necessary adjustments in the work schedule and the resources necessary to carry out the study, where the minimum agenda shall be:

- Safety Briefing - (Designer);
- Presentation of the Project to the study Consultant - (Designer);
- Clarifications on objectives, scope of analysis and requirements of the study (Designer and Petrobras);
- Delivery of the project documentation as provided for this TS (Designer), including the 3D model of the Installation;
- Dimensioning of the teams of the Designer and Performer of the study that will participate in the preparation and follow-up of the study, with the definition of the matrix of responsibilities;
- Presentation of the focal points of each party involved and identification of the responsible of each discipline of each party involved who will participate in the follow-up meetings and validations required in this TS;
- Presentation of the schedule foreseen for the execution of the study in accordance with the project schedule (Study Consultant and Designer);
- Definition of the locations, resources needed and duration of the follow-up meetings (Project designer and Study Consultant).

Participants of the planning meeting: The focal points of the parties involved, the professionals of the Study Consultant involved and the leaders of the Designer's disciplines responsible for monitoring the study shall participate.

Note: The schedule shall include the deadline of twenty working days for comments of the reports (partial and final) by Petrobras, as well as the deadline for implementation of the comments made.

10.3. Documentation Analysis Meeting

Meeting for the analysis and validation of the project documentation necessary for the development of the Study and preparation of backlog, if any. The objective is to avoid errors and rework in the studies due to possible failures or omissions of information in the documentation, which will serve as an input database for the study.

The meeting shall also cover the evaluation and validation of the 3D model of the Installation as to its suitability for the purposes of exporting or developing the CFD model.

From the analysis of the list of project documents and the documents provided, the study consultant may request clarifications and answer doubts about the information contained in the documents. In the case of identification of pending documents or need to provide other documents, the Designer shall inform the time required to remedy the pending and/or to send the documents, so that it does not affect the schedule provided for the study.

At the end of the meeting, the study performer shall sign a term of acceptance of the documentation which shall contain the pending items, if any.

Note: The Designer, as responsible for managing project changes, must inform the other parties involved of any changes in the project that impact the study. The documents altered as a result of the changes, which affect the study, shall be sent to the Study Consultant.

The study consultant shall evaluate the changes and report their impacts on the development of the analysis and the expected schedule. This information shall be formally sent to the Designer and communicated to Petrobras.

Participants of the documentation analysis: The professionals of the study executed involved and the discipline leaders of the Designer responsible for monitoring the study shall participate. This meeting is optional for Petrobras.

10.4. Meeting of Premises and Methodology

Meeting aimed at the presentation and definition of premises to be used in the study, clarification of the methodology and confirmation of basic data of the Installation.

The study consultant shall present the proposed premises for the development of the study and its doubts regarding the methodology proposed in this TS. The doubts shall be clarified by the Designer with the participation of Petrobras.

This meeting aims to validate the cases to be simulated, consolidate the premises defined in this TS and other additional ones not covered by this TS, and shall include at least the following:

- Wind directions: the variability and applicability of dispersions to be simulated shall be evaluated. Some very similar cases can be extrapolated, while others can simply disperse out of the unit and be disregarded;

- Eliminated scenarios: agree and document deleted scenarios;

- In the event of toxic/asphyxiating gases include in the impediment analyses of the main safety functions, as listed in the table in ANNEX A.

The premises shall be defined in agreement between the parties concerned and shall be included in the study report.

Participants of the meeting of premises and methodology: The professionals of the study executed involved and the discipline leaders of the Designer and Petrobras responsible for monitoring the study shall participate.

10.5. Follow-up and Validation Meetings

Meetings aimed at monitoring the study by the Designer with Petrobras participation where the items provided for in the methodology shall be addressed.

The Designer in agreement with the Study Consultant, and considering the schedule foreseen for the study, shall present the agenda of meetings to monitor the development of the study. The meetings shall include the stages of study provided for in item 9 (Methodology) of this TS. Follow-up and validation meetings indicated in Table 1 below shall be provided for:

Table 1: Follow-up and validation meetings

Item	Scope	Ref.
R1	**Geometry validation:** Presentation of the CFD model for dispersion study - geometry evaluation.	9.4 e 9.5
R2	**Presentation of the Partial Report:** Presentation, discussion and validation of the results of radiation/dispersion simulations and compliance with recommendations.	10.5

Table 1 is based on Petrobras' experience, and the number of meetings can be changed, by agreement between the parties involved, provided that all items that compose the methodology and require validation are addressed, as well as the analysis of the results and recommendations are discussed and evaluated as to their applicability to the project.

Participants of the follow-up and validation meetings: Professionals of the study consultant involved and the discipline leaders of the Designer and Petrobras responsible for monitoring the study shall participate in the meetings.

10.6. Final Report Presentation Meeting - Preliminary Version

Meeting for the presentation of the final report (preliminary version) before its issuance to Petrobras. The final report is the responsibility of the Designer and shall be issued by the designer. The final report shall include the report of the Study Consultant plus the treatment of the study recommendations to be implemented in the project by the Designer. The codification of the report and its stamp shall identify the Designer as originating from the document. The coding shall be in accordance with Petrobras n-1710 and the format according to N-381.

The presentation shall focus on the main events, the main results, the conclusions and recommendations of the study. The treatment given to each of the study's recommendations shall be addressed.

Participants of the study report presentation meeting:

The focal points of the parties involved, the professionals of the study executed involved and the discipline leaders of the Designer and Petrobras responsible for monitoring the study shall participate.

In this meeting it is recommended the participation of professionals operating and maintaining the Installation.

11. STUDY REPORTS

The final report shall be issued in Portuguese and English. The report shall meet the content specified in this document.

All the hypotheses of simplification and assumptions adopted shall be presented and explained in the corresponding part of the report. In addition, the minutes of the meetings shall be presented in the annex, especially those that have validation of stages of the methodology. The graphs and figures of the reports shall be presented with the respective scales, legends and with the rose of the winds and predominant wind direction. For the elaboration of tables, graphs and figures, the units of the International System (IS) shall be applied.

All graphs and figures supporting the study's findings and recommendations shall be presented in the final report.

11.1. Partial Report

At least one partial report shall be submitted by the Study Consultant to Petrobras, for acceptance of the study, before the final report is issued.

The Partial Report shall contain at least the requirements:

- Assumptions
- Software used
- Hardware equipment used
- 3D model and geometry
- Mesh and simulation domain
- Process data
- Cases to be examined
- Results of simulations
- Indication of incident radiation at monitoring points
- P&ID and PFD attached

11.2. Final Report

The Final Report corresponds to the issue of the report under review 0. It shall contain all the requirements of item 11.1, take into account the comments made to the Partial Report, and additionally contain:

- Attached minutes of meeting (item 10);

– LV attached (item 14);

Additional revisions shall be provided for cases where there are changes in the project that affect the study or if errors in the final issue are identified.

The minimum content of the report must be in accordance with the requirements of the Petrobras Safety Engineering Guideline.

12. DEADLINES

According to the complexity of the project, the scope of the study and the deadlines established in the contract, the project designer shall define in agreement with the study consultant the deadlines required for the study and issuance of partial and final reports. These deadlines shall be included in the schedule cited in item 10.2 of this TS.

13. QUALIFICATION TO CARRY OUT THE STUDY

Due to the complexity involved in the methodology and use of CFD software applicable to the study of dispersion of gases and radiation, and also due to the importance of this study for the safety of the Installation, the preparation of the same shall be carried out by a qualified company, belonging to the register of suppliers of goods and services of Petrobras.

14. CHECKLIST APPLICATION (LV)

The Designer shall present as evidence of monitoring the activities of the Study Consultant a checklist (LV), which shall be included as an annex to the report. LV shall contain the requirements contained in the Safety Guideline and those contained in this TS. The verification of each requirement shall have the identification and signature of the person responsible for the verification.

The verification of the part relating to the adequacy of flare height as to the aspects of interference with persons, structures and equipment shall be included in the project documentation or as an annex to the report. In case this documentation shall not be included in the study report in a specific item, with a clear indication of how and where the study recommendations were met.

15. INFORMATION SECURITY

In addition to the provisions of the Safety Guideline, the Designer and the Study Consultant shall have a data security system that guarantees the integrity, reliability, traceability, confidentiality and inviolability of the data contained in the study and the data provided by Petrobras. All information shall be preserved against accidental events or information security for at least five years..

16. ANEXES

ANNEX A - GAS IMPAIRMENT CRITERIA

Critical Safety Item - CSI	Description	Impairment Criterion			
		Parameter to be checked	CO (ppm)	CO_2 (ppm) (note 1)	H_2S (ppm)
Boarding Stations	FWD Boarding Stations	Ability to remain of persons for evacuation.	100 (note 2)	30.000	20 (note 6)
			100 (note 2)	30.000	20 (note 6)
Escape Routes (note 4)	Starboard Escape Route	Impossibility of escape due to the impairment of main escape routes at the same time, considering: Asphyxia and toxicity..	1.200	40.000	100 (note 6)
	Portside Escape Route		1.200	40.000	100 (note 6)
	Central Escape Route		1.200	40.000	100 (note 6)
Boarding Stations	Air outlets in rooms near FLARE	Gas contamination (hydrocarbons, toxic and asphyxiating) (note 3))	100 (nota 2)	30.000	8 (note 5)

Notas:

1. 1. Reference: NIOSH. The value of 30,000 ppm corresponds to the Short Term Exposure Limit (STEL) and the value of 40,000 ppm corresponds to the Immediately Dangerous for Life and Healthy (IDLH).
2. Considered 50% of the maximum value of NIOSH - National Institute for Occupational Safety and Health - (200 ppm).
3. Gas monitoring in the air outlets.
4. According to NIOSH IDLH definition:: "*The purpose for establishing an IDLH value in the Standards Completion Program was to determine the airborne concentration from which a worker could escape without injury or irreversible health effects from an IDLH exposure in the event of the failure of respiratory protection equipment. The IDLH was considered a maximum concentration above which only a highly reliable breathing apparatus providing maximum worker protection shall be permitted. In determining IDLH values, NIOSH considered the ability of a worker to escape without loss of life or irreversible health effects along with certain transient effects, such as severe eye or respiratory irritation, disorientation, and incoordination, which could prevent escape*."
5. Reference: Safety Engineering Guideline.
6. Reference: API RP 55 - Recommended Practice for Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide.

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ANNEX B - RADIATION IMPAIRMENT CRITERIA.

Use the values of Table 12 (Recommended Design Thermal Radiation for Personnel Table 12 - Recommended Design Thermal Radiation for Personnel) of API 521, always use the value of the most up-to-date version of the standard.

Table 12—Recommended Design Thermal Radiation for Personnel

Permissible Design Level K kW/m^2 (Btu/h·ft^2)	Conditions
9.46 (3000)	Maximum radiant heat intensity at any location where urgent emergency action by personnel is required. When personnel enter or work in an area with the potential for radiant heat intensity greater than 6.31 kW/m^2 (2000 Btu/h·ft^2), radiation shielding and/or special protective apparel (e.g. a fire approach suit) should be considered. **Safety Precaution—It is important to recognize that personnel with appropriate clothing [a] cannot tolerate thermal radiation at 9.46 kW/m^2 (3000 Btu/h·ft^2) for more than a few seconds.**
6.31 (2000)	Maximum radiant heat intensity in areas where emergency actions lasting up to 30 s can be required by personnel without shielding but with appropriate clothing. [a]
4.73 (1500)	Maximum radiant heat intensity in areas where emergency actions lasting 2 min to 3 min can be required by personnel without shielding but with appropriate clothing. [a]
1.58 (500)	Maximum radiant heat intensity at any location where personnel with appropriate clothing a can be continuously exposed.

[a] Appropriate clothing consists of hard hat, long-sleeved shirts with cuffs buttoned, work gloves, long-legged pants, and work shoes. Appropriate clothing minimizes direct skin exposure to thermal radiation.