

消防用設備等に関する ISO 規格の
比較検証事業報告書
(平成 23 年度)

平成 24 年 3 月
消防庁予防課

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はじめに

消防庁予防課においては、消防法に基づく消防用設備等の国内規格を所管するとともに、消防用設備等における国際規格案を審議する専門委員会 ISO/TC21（消防器具）の国内審議に参加している。

本比較検証事業は、国際規格を国内規格に取り込む場合及び国際規格適合品を日本国内に輸入する際における問題点などの抽出・整理を行うために「消防用設備等に関する ISO 規格の比較検証事業」を実施し、文献調査や実験等を通じて国際規格の制定・改正提案を行う際の技術的資料及び知見を得ることを目的としている。

ISO/TC21 の分科委員会 SC6（泡・粉末消火薬剤と泡・粉末消火薬剤を使用する固定式消火設備）の作業部会 WG4（泡消火薬剤）では、既に制定されている国際規格（ISO 7203-1,2,3）の見直しを行い、2011 年 6 月及び 8 月に第 2 版が発行されたところである。

前述の国際規格では、2 つの規格において、消火性能実験の結果を踏まえ、クラス分けにより評価する仕組みとなっている。また、泡消火薬剤として一般的な非水溶性液体可燃物用泡消火薬剤においては、1 つの発泡ノズルを利用して、2 つの放射方式により評価することとしている。しかし、我が国では「泡消火薬剤の技術上の規格を定める省令」においては、消火試験の結果によってクラス分けをするようなことはなく、また、泡消火薬剤の種類により 3 種類の発泡ノズルを利用し、1 つの放射方式で評価することとしている。この点のみでも試験方法に相違点があり、国際規格の試験方法についての国内における知見が不十分であり、課題となっている。

このため、本事業において、国内規格適合品を使用し、国際規格の試験方法に基づき消火実験を行い、試験の妥当性及び結果について比較、検証を行った。

今回の実験結果により、国際規格で規定されている試験に対して、「国際規格の妥当性」及び「国際規格における国内規格適合品への影響」等の知見が得られた。今後は、得られた知見により、国際規格改正案に対する我が国としての提案等を行うなど、国際規格への反映を目指す予定としている。また、我が国において国内規格を見直す際には、その基礎資料として用いることも考えている。

1 . 目的

1. 目的

本報告書は、泡消火薬剤の技術上の規格を定める省令（昭和 50 年 12 月 9 日自治省令第 26 号、以下「規格省令」という。）に適合する個別検定合格品^{※1}を中心に、ISO規格の基準（以下「ISO規格」という。）に従い消火性能実験を実施することにより、国内規格である規格省令と比較し、基準の妥当性及び国内製品に対する影響等について検証することを目的とするものである。

また、実験によって得られた技術的データ及び知見は、

(1) 規格省令のあり方の検討

(2) ISO 規格への改訂意見等提案

を行うための検討資料として活用する。

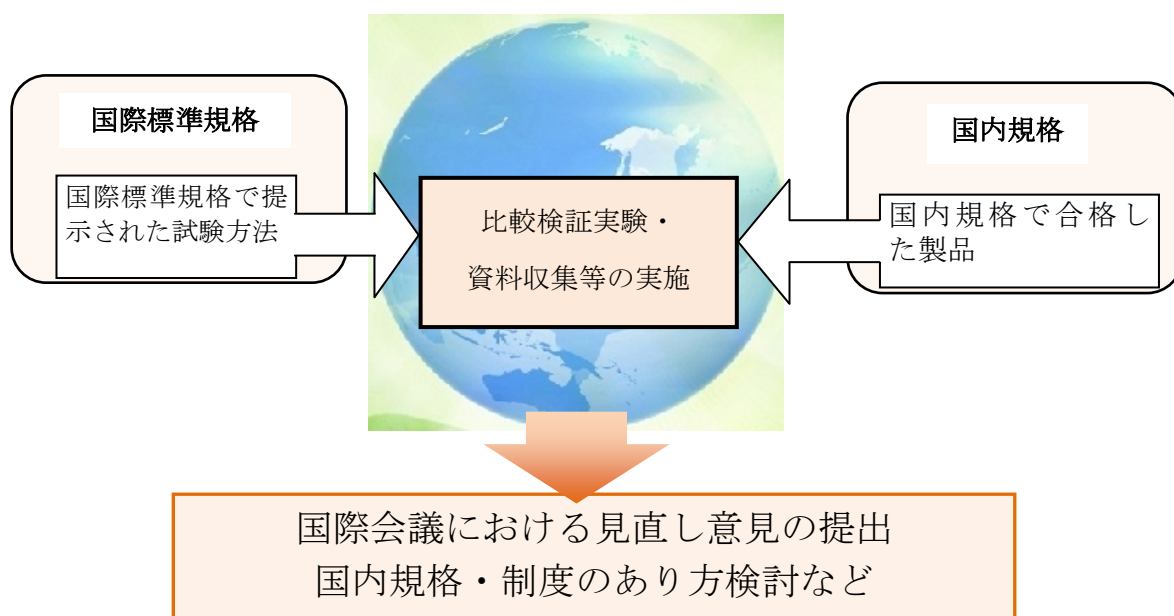
ISO/TC21/SC6（泡と粉末消火薬剤及び泡と粉末消火薬剤を使用する固定式消火設備国際分科会）で検討された泡消火薬剤の ISO 規格は以下に示す 3 規格が制定されている。

ISO7203-1:2011 非水溶性液体可燃物用低発泡泡消火薬剤（以下「ISO①」という。）

ISO7203-2:2011 非水溶性液体可燃物用中・高発泡泡消火薬剤（以下「ISO②」という。）

ISO7203-3:2011 水溶性液体可燃物用低発泡泡消火薬剤（以下「ISO③」という。）

※1：ISO③の試験に使用する水溶性液体可燃物用低発泡泡消火薬剤については、検定対象品目から除外されているため、総務省告示第 559 号基準に適合する泡消火薬剤市販品を選定し、当該実験を行うこととした。



2. 各規格制定の経緯

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2-1. 規格省令

(1) 検定開始

消防法施行令の一部を改正する政令（昭和 46 年政令第 252 号）が昭和 49 年 7 月 1 日に公布になり、新たに検定を受けなければならないものとして泡消火薬剤が加えられた。規格省令が昭和 50 年 12 月 9 日に公布され、昭和 51 年 1 月 1 日に施行された。

(2) 規格原案策定作業経緯

- ①昭和 43 年頃より規格研究委員会を作り審議を開始しており、当初は、昭和 45 年より検定を開始する予定であった。
- ②昭和 39 年自治省消防庁消防研究所において消火設備用空気泡消火薬剤に規定すべき技術基準（案）が作成され、この基準をもとに関係者が集まり、検討が開始された。
- ③昭和 45 年 5 月 15 日、泡原液規格研究委員会が発足し、昭和 49 年 3 月までに 9 回に及ぶ委員会を開催し、消火性能評価試験方法検討のための実験等が行われた。
- ④昭和 48 年 1 月、制定のための技術内容についての原案作成については、日本消防検定協会（以下「協会」という。）がまとめるよう消防庁の要請に基づき規格研究委員会を設置し、各委員の参加を得て審議をすることとなった。
- ⑤「たん白泡消火薬剤」についての規格原案をまとめ、昭和 49 年 5 月末に消防庁に上申した。
- ⑥「たん白泡消火薬剤」の検定をまず開始し、「合成界面活性剤泡消火薬剤」「水成膜泡消火薬剤」の順に各々の規格原案を作成していく手筈であったが、行政上の緊急かつ強い要請が高まり、「合成界面活性剤泡消火薬剤」「水成膜泡消火薬剤」の二つについても、規格原案を作成するため、規格研究委員会委員を追加再編成して、昭和 50 年 1 月から審議を再開した。計 20 回に及ぶ研究会を開催し、昭和 50 年 8 月末「たん白泡消火薬剤」「合成界面活性剤泡消火薬剤」「水成膜泡消火薬剤」について規格制定原案をまとめ、消防庁に上申した。
- ⑦水溶性液体可燃物用泡消火薬剤については、検定対象から除外した。

2-2. ISO 規格

(1) 規格制定の経緯

日本は、1980 年 6 月の SC6/WG4 第 1 回リスボン国際作業部会から規格策定作業に参加している。規格案は 5 つのパートに分けて審議されていたが、1989 年 5 月の SC6（消火薬剤）トロント会議において、タンク底部注入用泡消火薬剤の規格策定作業を中止することが決定され、同時に規格を①非水溶性液体可燃物用低発泡泡消火薬剤、②非水溶性液体可燃物用中・高発泡泡消火薬剤、③水溶性液体可燃物用低発泡泡消火薬剤の 3 つのパートとする再編成が行われた。日本は、防火対象物、実用消火設備との関連性、整合性を無視し、消火試験の結果のみによって、消火性能クラス、耐再燃

性能レベルという消火薬剤の優劣に係る序列をつけることに終始反対してきたが、1991年12月のWG4作業部会のパリ会議をもって実質的な審議は打ち切れ、以後の処理はSC6分科委員会において行われることになり、作業部会WG4（泡消火薬剤）の活動は休止状態となった。

2003年9月のSC6ローマ会議において、SC6の規格策定の作業範囲は、消火薬剤から泡・粉末消火薬剤と泡・粉末消火薬剤を使用する固定式消火設備に変更することについてSC6国際委員長から提案があった。この時、ISO7203-1,2,3のいずれかを国家規格に採用している国を確認したところ、ルーマニアだけが採用しているとの情報であった。2008年9月のSC6分科委員会マンチェスター会議で、ウィーン協定^(※2)に基づき、ISO規格とCEN規格^(※3)との整合性を図る目的で改訂作業を開始する提案がSC6国際事務局よりなされ、改訂作業に「賛成」との結論を得て、ISO/TC21/SC6/WG4の新作業部会再設立に至り、活動が再開された。

我が国日本では、ISO/TC21/SC6/WG4国内作業部会の活動は継続されていたので、国際作業部会の再開に即時対応した。改定作業に対しては、CEN規格との差違および統一性について議論するのではなく、ISO7203シリーズの規格内容そのものを議論すべきであるとの主張を行った。消火性能クラスと耐再燃性能レベルの序列付けについては、審議対象とされなかった。その後、2010年から2011年に新3規格のCD、及びDISが行われ、「DIS投票100%賛成」との結論を得て、FDIS投票省略処置を経て2011年、各規格の改定第2版が発刊された。

① ISO7203-1（非水溶性液体可燃物用低発泡泡消火薬剤）

1995年12月15日に第1版が刊行。その後2回の見直し投票を実施。新規格に関しては、2010年2月にCD投票、同年9月にDIS投票が行われ、2011年6月、第2版が完成した。

② ISO7203-2（非水溶性液体可燃物用中発泡泡消火薬剤及び高発泡泡消火薬剤）

ISO7203-1と同じく1995年12月15日に第1版が刊行。その後2回の見直し投票を実施。新規格に関しては、2010年3月にCD投票、同年9月にDIS投票が行われ、2011年6月、第2版が完成した。

③ ISO7203-3（水溶性液体可燃物用低発泡泡消火薬剤）

1999年3月1日に第1版が刊行。その後1回の見直し投票を実施。新規格に関しては、2010年5月にCD投票、同年11月にDIS投票が行われ、2011年8月、第2版が完成した。

^{※2}：ウィーン協定においては、「欧州が必要とする規格がISOに存在しなかった場合、その開発についてISO側が同意すれば、CENが欧州域内で開発し（これをCENリードという）、その成果を並行投票（CENとISOでの同時投票）によってISO規格にすることが出来る」という内容が決定されている。

^{※3}：EN1568-1（非水溶性液体可燃物用中発泡泡消火薬剤）EN1568-2（非水溶性液体可燃物用高発泡泡消火薬剤）EN1568-3（非水溶性液体可燃物用低発泡泡消火薬剤）EN1568-4（水溶性液体可燃物用低発泡泡消火薬剤）

3. 泡消火薬剤の分類

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3-1. 火災対象別分類

泡消火薬剤は、泡消火設備に設置される機器の構成品の一つであり、泡消火設備の技術上の基準は、消防法施行令第 14 条、同施行規則第 18 条に定められている。また、危険物を対象とした消火設備の基準は、危険物の規制に関する政令第 20 条に定められ、危険物の規制に関する規則第 32 条の 6 に泡消火設備の基準が定められている。

さまざまな防火対象物、あるいは、火災形態に泡消火薬剤が使用されるが、その適応性は泡消火薬剤の消火特性により異なる。現在、国内規格（規格省令及び告示基準についていう。以下同じ。）及び国際規格に係る泡消火薬剤の火災適応性について関連する規格、法令等による用途別分類を表－1. に示す。

表－1. 泡消火薬剤の用途別分類

用途		国内規格	国際規格（参考：EN 規格）
非水溶性液体 可燃物用 （石油類用）	低発泡	規格省令	ISO7203－1（EN1568－3）
	中発泡	—	ISO7203－2（EN1568－1）
	高発泡	規格省令	ISO7203－2（EN1568－2）
水溶性液体 可燃物用 （アルコール類用）	低発泡	告示基準	ISO7203－3（EN1568－4）
	中発泡	—	—
	高発泡	—	—
一般火災用 （木材等固体 可燃物）	低発泡	—	—
	中発泡	—	—
	高発泡	規格省令	—

(1) 非水溶性液体可燃物用泡消火薬剤

国内規格では、原油、ナフサ、ガソリン、灯油等の非水溶性液体可燃物すなわち石油類の火災に主として使用するものである。消防法施行令第 37 条（検定対象機械器具等の範囲）第 3 号に「泡消火薬剤（総務省令で定めるものを除く、別表第 3 において同じ。）」と定められ、規格省令に基づき、総務大臣の型式承認と個別検定が行われ、個別検定に合格した泡消火薬剤のみが国内で販売および販売を目的とした陳列が許されている。

一方、ISO 規格では、Fire extinguishing media－Foam concentrate－Part1、（消火薬剤－泡原液－第一部）として、ISO7203－1：Specification for low expansion foam concentrates for top application to water-immiscible liquids（非水溶性液体可燃物の表面上に放出する低発泡泡原液の仕様）が、加えて Fire extinguishing media－Foam concentrates－Part 2、（消火薬剤－泡原液－第二部）として、ISO7203－2：Specification for medium- and high-expansion foam concentrates for top application to

water-immiscible liquids（非水溶性液体可燃物の表面上に放出する中発泡及び高発泡泡原液の仕様）が定められている。規格範囲は、「非水溶性液体可燃物の火災の制御、消火および再着火防止のための低発泡、中発泡、高発泡を生成するために使用される液体泡原液に不可欠な物理性状および性能要件を規定するものであり、一定の試験火災モデルに対する最低性能を規定する」としている。また、低発泡とは膨張率が 1 から 20 倍と、中発泡とは膨張率が 21 から 200 倍と、高発泡とは膨張率が 201 倍以上と定義している。

(2) 水溶性液体可燃物用泡消火薬剤

アルコール、ケトン、有機酸等水溶性液体の火災に使用するものである。この水溶性液体可燃物用泡消火薬剤は、いわゆる、検定対象機械器具等の範囲から除かれる泡消火薬剤であると総務省令で定められ（消防法施行規則第 34 条の 3）、規格省令に拘束されない。しかし、危険物の規制に関する規則第 38 条の 3 の規定に基づいた技術上の基準の細目を定める告示（総務省告示第 559 号）の第 4 条第 5 号及び第 17 条第 3 項及び第 4 項により、設備等に用いようとする泡消火薬剤の消火性能を確認しなければならない。なお、この告示において、水溶性液体可燃物とは、「第 4 類の危険物（水に溶けないもの以外のもの）」とされている。

ISO 規格では、**Fire extinguishing media—Foam concentrates—Part3、（消火薬剤—泡原液—第三部**とし、**ISO7203 - 3 : Specification for low expansion foam concentrates for top application to water-miscible liquids**（水溶性液体可燃物の表面上に放出する低発泡泡原液の仕様）が制定され、規格範囲は ISO7203 - 1 同様、「水溶性液体可燃物の火災の制御、消火および再着火防止のための低発泡を生成するために使用される泡原液に不可欠な物理性状および性能要件を規定するものであり、一定の試験火災モデルに対する最低性能を規定する」とし、**Alcohol-resistant foam concentrate(AR)**（耐アルコール泡原液）は、アルコールや他の極性溶剤の表面に泡を供給したときに泡の破壊に耐える泡原液と定義されている。また、ISO③の「第 1：範囲（Scope）」では、この規格を満足する泡原液において、ISO①の非水溶性液体可燃物用火災に対しても有効なものもあると記述されている。

国内基準では、対象となる水溶性液体可燃物を定義化しているが、ISO 規格では、水溶性液体可燃物について特に定義されていない。

(3) 一般火災（固体可燃物）用泡消火薬剤

国内規格では、高発泡泡に限定し、木材火災等固体可燃物用泡消火薬剤として規格省令に規定されている。木材火災モデル（A-1 火災模型）を所定時間内に消火し、所定時間以内に再燃しないことが基準となっている。ISO 規格では、一般火災（固体可燃物）用について定義されていないが、今後、クラス A（固定可燃物）泡消火薬剤について規格化が予定され、審議中である。

3-2. 成分構成による分類

規格省令あるいは ISO 規格において、成分構成から分類、定義された泡消火薬剤の種類について、表－2.「泡消火薬剤の種類比較」に示す。

表－2. 泡消火薬剤の種類比較

	規格省令	ISO 規格
たん白泡 消火薬剤	たん白質を加水分解したものを基剤とする泡消火薬剤をいう	たん白泡(P)：加水分解たん白質原料から生成した泡原液
合成界面活性剤泡 消火薬剤	合成界面活性剤を基剤とする泡消火薬剤（次号に掲げるものを除く。）をいう	合成界面活性剤泡(SD)：炭化水素系界面活性剤を混合したものを基材とする泡原液で、フッ素化合物を含むことがある
水成膜泡 消火薬剤	合成界面活性剤を基剤とする泡消火薬剤で、油面上に水成膜を生成するものをいう	水成膜泡(AFFF)：炭化水素系界面活性剤とフッ素系界面活性剤の混合したものを基材とし、炭化水素化合物の表面上に水成膜を形成することができる泡原液である。
フッ素たん白泡 消火薬剤	たん白泡に同じ	フッ素たん白泡(FP)：フッ素系界面活性剤を添加したたん白泡原液
水成膜形成型 フッ素たん白泡 消火薬剤	たん白泡に同じ	水成膜フッ素たん白泡(FFFP)：炭化水素化合物の表面上に水成膜を形成することができるフッ素たん白泡原液
水溶性液体 可燃物用泡 消火薬剤	対応規格なし（総務省告示第 559 号で、泡消火薬剤の水溶性液体に対する消火適合性確認を規定している）	耐アルコール泡原液(AR)：アルコールあるいは極性溶剤の表面に放出したときに破壊に耐える泡原液

3-3. 泡消火薬剤の種類とその解説*

規格省令は、「基剤に泡安定剤その他の薬剤を添加した液状のもので、水（海水を含む。以下第6号において同じ。）と一定の濃度に混合し、空気又は不活性気体を機械的に混入し、泡を発生させ、消火に使用する薬剤をいう。」と定義し、たん白泡消火薬剤、合成界面活性剤泡消火薬剤、水成膜泡消火薬剤の3種を規定しているが、泡消火薬剤の防火対象物用途は規定していない。なお、石油タンクなどの危険物施設に設置される泡消火設備の泡消火薬剤は、たん白泡（フッ素たん白泡を含む。）及び水成膜泡薬剤以外のものを用いることはできないこととされている。

一方、ISO 規格では、(泡) 原液について、「適切な濃度で水と混合された時に泡水溶液となる液体」、また、泡（消火）とは、「泡原液の水溶液から形成される空気に満たされた泡（バブル）の集合体」と定義されている。泡消火薬剤として消火に係る文言は、ISO 規格「第1：範囲（Scope）」に規定されている。泡の消火性能クラスおよび耐再燃性能レベルの泡消火薬剤グレードの表示義務を規定しているが、その泡の使用用途については、ユーザー側に委ねられている。

泡消火薬剤を用いて、発泡装置により泡を生成し、火災拠点に供給する。そのため泡消火設備は、発泡装置と泡消火薬剤との適切な組合せにより、防火対象物に有効となるように設計・設置されている。ここでは、泡消火薬剤の成り立ちや発泡装置により生成される泡の特性などについて、規格省令に定義された3種類に加え ISO 規格でも定義されている泡消火薬剤について概要を記す。

(1) たん白泡消火薬剤（Protein form : P）

たん白泡消火薬剤（以下「たん白泡」という。）は、動物の蹄角などのたん白質原料を細粒に砕いて、アルカリで加水分解した後に、中和、濃縮して、耐火・耐熱強化剤（第一鉄塩等）、凝固点降下剤（グリコール類）、泡安定剤（サポニン等）、粘度調整剤などを加え、溶液としたものである。たん白泡は、今から半世紀前の1950年代半ばに日本に導入された。すなわち、たん白泡は、石油化学産業を中心とした高度成長期に、石油施設の安全に対処してきた古典的な泡消火薬剤といえる。

たん白泡は、合成界面活性剤泡消火薬剤と比較し、油に汚染されにくい泡を形成し、火炎に対する耐火・耐熱性に優れた性能を有している。固い泡を形成するため、泡の流動性が劣り、燃焼油面上への泡の展開が遅いという欠点がある。泡の流動性は、鉄塩などの添加量などで調整できる。

たん白泡は、泡が油面に直接突入するような供給方法では、泡が油に汚染されて性能が低下する場合がある。高度成長初期の石油タンクは小型であったが、やがて直径が50mを超える大型の石油タンクに対処しなければならなくなると、消防隊のタンクへの直接放射では油汚染を避けることができないため、消火の成否は消防隊の熟練度にかかっているともしえる。そのため、欧米では1970年代の半ばから、たん白泡に代

わってたん白泡原液にフッ素系界面活性剤を添加した油に汚染されにくいフッ素たん白泡（次項に記載）が使用されている。しかし、日本では、安価なたん白泡がいまだに主力の泡消火薬剤としてタンクに設置されているのが実情である。

将来、フッ素系界面活性剤も添加しない天然物製品主剤のたん白泡が石油タンク火災の消火に使用する泡消火薬剤として再評価されることも考えられる。

(2) フッ素たん白泡消火薬剤（**Fluoro protein form**：FP）

フッ素たん白泡は、たん白泡の流動性、油汚染性を改善するために、たん白泡に少量のフッ素系界面活性剤を添加したものである。すなわち、動物の蹄角などのたん白質の加水分解物にフッ素系界面活性剤を少量混合したものである。なお、たん白泡の耐火・耐熱強化剤である鉄塩を添加しないものもある。添加するフッ素系界面活性剤の種類によって発泡、消火性、耐火性・耐熱性能や流動展開性等の性能が異なる。

また、フッ素たん白泡には、耐アルコール性が付加されて、極性の大きい水溶性液体の消火にも有効なものもある。

欧米では、たん白泡というとフッ素たん白泡を意味するように、油火災に適した泡として、30年前から石油タンクの泡消火設備に使われている。SSI設備(タンク底部泡供給方式)に一部使われることはあっても、石油タンクの固定式泡消火設備に使用するのが遅れた状況にある。

フッ素たん白泡には、添加するフッ素系界面活性剤の性質によっては、油の表面に水成膜を形成する、「フッ素たん白水成膜泡」というべき泡があり、ISO規格では、これをFFFP(Film forming fluoro protein)と定義している。FFFPは、フッ素たん白泡(FP)よりも更に流動性に優れた泡であるため、水成膜泡に代わって、航空機火災などの流出油火災に消防隊が使用しているが、泡の耐油汚染性がフッ素たん白泡に比べ劣り、水成膜泡と同様、フッ素たん白泡より耐火・耐熱性が劣っている。

(3) 合成界面活性剤泡消火薬剤（**Synthetic detergent**：SD）

合成界面活性剤泡は、炭化水素系界面活性剤に泡安定剤として炭素数が12前後の高級アルコールを少量加えるほか、溶剤(グリコールエーテル類)、凝固点降下剤(グリコール類)を添加したものである。一般に、界面活性剤は低温で高濃度水溶液を得る事が難しいので、水成膜泡消火薬剤と同様、比較的多量の溶剤や凝固点降下剤が添加されている。高級アルコール硫酸エステル塩やエーテル硫酸エステル塩などの陰イオン界面活性剤の混合物が主剤として使用されている。これは、シャンプーや台所用洗剤に使用される界面活性剤と同じ化合物で、生分解性の面で問題が少なく、泡消火薬剤の分野でも使用されている。なお、合成オレフィン系界面活性剤は、環境問題により原料として使用されなくなっている。また、耐油性、耐火性に乏しいという理由から、従来より日本や多くの欧米各国において、石油タンクの消火には使用されてい

ない。

合成界面活性剤泡は、泡による窒息効果による消火を期待するのではなく、泡に含まれる水による冷却効果を期待した消火法と言える。すなわち、合成界面活性剤泡は、水が立体面でもできるだけ燃焼表面に留まれるように、泡の形に変える手段として使うものである。水の表面張力低下による燃焼物への浸透性促進と泡による燃焼表面への付着力向上により、水の持つ消火力効率アップが図られるわけである。

界面活性剤水溶液の良好な発泡性に着目して、低発泡、中発泡、高発泡として、「Hi-EX：高発泡」、「CAFS：圧縮空気式泡」、「Wetting Agent：濡れ水」などの名称で、石油タンク火災用ではなく、クラスAフォームとして一般火災（固定可燃物）用に使われている。

(4) 水成膜泡消火薬剤（Aqueous film forming foam：AFFF）

水成膜泡消火薬剤は、炭化水素系界面活性剤にフッ素系界面活性剤を添加したものである。フッ素系界面活性剤が主成分であるといわれているが、発泡基材として炭化水素系界面活性剤に負っていて、その成分はフッ素系界面活性剤よりも炭化水素系界面活性剤の方が量的に多い。水成膜泡消火薬剤も合成界面活性剤泡消火薬剤同様、低温で高濃度溶液が得にくく、0℃で凍結するので比較的多量の溶剤、凝固点降下剤が添加されている。

水成膜泡消火薬剤は、1960年頃アメリカの海軍研究所で開発されたもので、当時、養成に多額の費用がかかるジェット戦闘機のパイロットを救出する目的で開発され、アメリカの3M社で製品化されたものである。当初は、ドライケミカル粉末と共にジェット機に噴射して、すばやく火災を消火すると共にパイロットを救出する、ピストル型の「ツインエージェントシステム」が開発された。当時のジェット燃料は、灯油とガソリンの混合物であったため、燃料表面に薄い水性の膜を形成するということから、AFFF（Aqueous Film Forming Foam）と呼ばれた。

海軍研究所と3M社は、薄い水性の膜が油面に形成することによって、可燃性蒸気の蒸発を防止し、火災を消火できると水成膜による消火効果の特徴を宣伝したが、水性の薄膜は、軽油や重油などの油面上には形成するが、ガソリンなど沸点の低い油には形成しないことがわかった。加えて、水性の薄膜は、熱によって簡単に蒸発するので、燃えている高温の油面に形成することはないことが知られている。

また、水成膜泡消火薬剤の消火効果は、フッ素系界面活性剤添加による耐熱・耐火強度が向上した泡の窒息効果によるものであることが確認されている。

水成膜泡消火薬剤は、泡の油面流動展開性がよいため、油層の薄い流出油火災に消防隊が対処するに適した泡として、世界各国の飛行場の空港化学車に搭載されている。泡の流動展開性に優れ、迅速な消火を要求される用途に適するが、泡に油の蒸気を包含しやすい特性があり、消火した後、火源があると着火して、泡自体がフレアアップ

プ(大きく燃え上がること)してしまうなどの欠点がある。

3-4. 泡消火薬剤に必要な性質※

油火災を消火する泡には、(1)起泡性、(2)泡の安定性・保水性、(3)油面上の流動展開性、(4)泡の耐熱・耐火性、(5)耐油性・耐油汚染性、(6)消火後の油面封塞性などといった性質をもっていることが必要とされる。

ここでは、これら泡の性質を常温での個々の基本的な測定値、傾向を掲げるが、これらの性質は、実際の消火において、常温の値と異なるのは当然の帰結である。しかも、これら泡の性質が単独で消火に関与するものではなく、互いに相関をなして作用することを念頭に置かなければならない。特にこれらの性質は、油面への泡供給率に関係し、限界供給率においては、厳しい状況になる。

しかし、泡消火は、燃えている油面に放出する泡の供給率と供給方法、発泡器の種類と構造によって変化するが、限界供給率を大きく上回り、経済的供給率をも超えるような大きな供給率で泡を供給する場合は、泡の性質の良否が無視され、あるレベル以上の泡であれば、多少の性能の差があっても消火することができ、結果として消火時間は同じになることも理解しなければならない。

固定設備の場合には、泡消火薬剤、発泡器及び泡供給率は一定のものに決められ、火災時に臨機応変に変えることはできないので、対象物や使用目的に応じた設計をしなければ良い結果は得られない。消防隊によるモニターやノズルは、供給率を変えられることが可能だが、タンク外部からの投入操作を強いられるので、環境条件や消防隊の熟練度に左右される。加えて、泡の投入によって液面に突入して攪拌されるので、通常の消火作業では、泡は油で汚染されるため、泡供給率を大きくする必要がある。

このようなことから、実際には、消火泡の性質について単一の性質とともに、消火の状態における総合的な判断をしなければならない。

(1) 泡の起泡性、発泡倍率

泡の起泡性は、泡消火薬剤の基本的な性質であって、発泡倍率(Expansion ratio: 法令では、膨張率)で表現され、保水性、耐熱性などに関連する。

発泡倍率は、元の泡水溶液から何倍の泡が発生したかということで、その値は、元の泡水溶液の容積と発生した泡の容積の比で表わす。通常は、容積の決められた容器に泡を収集して測定する。大流量の場合は、発生した泡を大きな容器に放出し、発泡器の流量との比で求める。発泡倍率は、発泡器の構造や放出圧力など発泡方法に支配される。石油タンクの消火に用いる低発泡は、発泡倍率が大きいほどよいのではなく、その火災の消火に適した値がある。また、泡消火薬剤の種類によっても異なる。

発泡器の発泡機構には、アスピレート方式とノンアスピレート方式があるが、石油

タンクの消火には、タンクのフォームチャンバー(固定泡放出口)を始め、ほとんどの消火設備がアスピレート方式の発泡器を用いている。ノンアスピレート方式は、一部の大容量泡放水砲に採用されている。

空気を吸引する機構を有するアスピレート方式の低発泡器は、高背圧発泡器を除き、たん白系の泡の発泡倍率が6~8倍になるよう設計してある。たん白系の泡は、少なくとも発泡倍率が6倍以上10倍程度までの泡でないと、十分な泡の安定性、消火性能を有していないからである。

たん白系の泡用に発泡倍率が6~8倍になるよう設計した発泡器で、水成膜泡を発泡すると、起泡性が良いため、発泡倍率は10~12倍以上の泡になる。水成膜泡や合成界面活性剤泡は、ノズルでもフォームチャンバーでも、必要以上に高倍率になる。

一般的に、発泡倍率が大きい泡は、泡量は多くなるが、熱に曝された際は、極端に耐熱性、保水性が悪くなり、泡の消滅が速い。

一方、水成膜泡や合成界面活性剤泡は、起泡性が良いので、空気吸引機構のないノンアスピレート方式が採用できる。この方式は、スプリンクラーヘッドや普通の水ノズルを用いて放出する方法である。これらのノンアスピレートノズルは、泡水溶液が放出された後に水流同士が衝突し、水流中に空気を取り入れられて泡にする方法である。

ノンアスピレート方式は、アスピレート方式に比べ、空気の吸引が十分でないので、発泡倍率は2~3倍であり、還元時間が早く、保水性、安定性の悪い泡しか得られない。しかし、発泡器を使わないため、消防隊が小規模の流出油火災を消火する場合には、便利な方法である。

(2) 泡の安定性、保水性(泡の寿命)

泡の安定性は、泡に含まれている水が排出せずに長く泡の中に保たれていて消滅しないこと(保水性)をいい、すなわち、泡の寿命を表す。タンク火災においては、保水性のよい泡は、油面を展開してタンク壁を冷却し、油表面を被覆して完全消火する。さらに、消火後には、油面を封鎖して油蒸気の発生を防ぎ、再着火を防止する能力を有する。しかし、実際の火災では、泡が供給される時には、火炎に曝され、加熱されて、さらに、油に汚染された状況によってもなお、保水性を有することが必要である。

泡の安定性、保水性は、還元時間(ドレネージ)で表される、通常は、常温においてノズルから発生した泡を容器に採取し、そこから排出する水溶液の量を測定し、元の水溶液の25%量、あるいは50%量が排水される時間をもって、25%還元時間、あるいは50%還元時間という表現をする。

泡の還元時間は、泡水溶液の濃度、温度、発泡方法、発泡器の構造、圧力あるいは周囲温度などに影響される。

通常、還元時間の測定は、常温の発泡直後の泡について行われるから、消火の過程

での泡の性能を表わすものではない。

常温で測定した還元時間は、同じ条件であれば、同種の泡については、その性質を比較できることもある。例えば、還元時間が長い泡は安定性がよいが、長すぎる泡は流動しにくいものとなる。よく攪拌する構造のノズルを高圧で発泡するときは、還元時間の長い泡が発生する。

通常は、その泡消火薬剤に指定されている使用濃度において、最適な発泡倍率、還元時間を示し、濃度が小さければ性能が低下することは理解できるだろうが、使用濃度が高すぎるときにも、空気との攪拌が十分でなく、適正な性能は得られない。発泡倍率は、泡水溶液温度が常温より高い場合には大きくなるが、排水が速く、すぐに収縮するなどの傾向がある。

(3) 泡の展開性、流動性

油火災を早く消火するには、泡が油面上を速やかに流動・展開しなければならない。泡の流動性は、泡の保水性、シアストレス(剪断応力)に関連する。泡のシアストレスは、一般に水成膜泡、合成界面活性剤泡、フッ素たん白泡、たん白泡の順に大きくなる。

シアストレスは、発泡器の構造や放出圧力によって変わる。ノズルでは、一般に細長く、しかも長いパイプの構造のノズルを用いて高圧で放出するときは、シアストレスは大きくなり、stiff(硬い)な、流動性が小さい泡となる。

フォームチャンバーは、シアストレスが小さい、流動性がよい泡を発生するような構造になっていて、あわせて低い放出圧力で発泡するが、泡モニターノズルは、泡を遠くへ飛ばすために放出圧力を高くするので、一般的にはシアストレスの大きな泡となる。

泡の展開性、流動性は、保水性やシアストレスの測定のほか、油面上に泡を展開させて測定することがあるが、この場合でも燃えている油面では泡が破壊され、特に容器の壁面への泡の密着が遅れるので、火災時とは異なる。

泡には自力で展開する力はない。すなわち、泡が油面を展開するときには、泡が油面に投げ出された時の放出圧力と落下速度などの外力によるものであるから、大容量泡放水砲などの泡モニターでは、放射角度(泡の投入角度)も影響する。

発泡器には適正な圧力が必要で、圧力が低い場合は十分な発泡が出来ないが、設計圧力より高い場合は、発泡倍率は低下する。この場合は、不十分な泡になるのではなく、むしろ攪拌が大きすぎるために、細かい密度の高い泡になり、発泡倍率が低下する。この場合、シアストレス(泡のせん断応力)が大きくなるから、硬い泡になり、泡の保水性、耐熱性は大きくなるが、泡の油面への展開性は悪くなるのが一般的な傾向である。

(4) 泡の耐熱性(耐火性)

泡の耐熱性、耐火性は、石油タンクの消火泡としての重要な性質であるが、油で泡が汚染されているかどうかによって大きな差がある。泡の耐熱性、耐火性は、同意語であって、その測定は、容器に入った油の上に泡をのせ、泡層に火炎や電熱を直接あてて、泡が破壊する過程を観察する。昭和 30 年に制定された、損害保険料率算定会の規則（以下「損保規則」）では、この測定結果を「耐火性」と規定していたが、昭和 50 年の規格省令公布以降は、消火試験で総合的に判断するようになって、泡そのものの耐火性は議論しなくなった。

泡の耐熱性(耐火性)は、たん白質系の泡が抜群に良いが、たん白泡は、油汚染した場合には耐火性が低下する。水成膜泡も耐火性が劣る欠点があるが、流動性が優れるため、泡が破壊する前に消火することができ、油火災の初期消火に有効である。

しかし、油汚染された水成膜泡は、泡の耐火性が劣ることと、泡膜に油を含み、泡の中に可燃性蒸気を包含するため、消火した後の油面封鎖時に火源があると大きく一挙に炎上する危険性がある。

(5) 泡の耐油性(耐油汚染性)

泡の耐油性、耐油汚染性は、液体火災を消火するのに重要な要素である。液体可燃物の種類によって耐油性、耐液性は変わるが、泡の油面への突入方法、落下速度が大きく影響する。

損保規則では、ガソリンの上に一定量の容積の泡をのせて、泡が消滅するまでの時間を測定することで、泡の耐油性を表していた。しかし、泡を油面に展開させるときは、多かれ少なかれ油面において泡が油汚染する。よって、油汚染性は(損保規則の方法ではなく)、油面に泡を落下させるなどして油汚染状態を作り、どのくらいの油が泡に包含されたかをガスクロマトグラフや油測定器などで測定し、油汚染度とすることが多い。

油汚染度は、泡の「油ピックアップ率」で表現することがある。この測定方法は、石油タンクの底から泡を投入するタンク底部泡放射法の試験で用いられる。

たん白泡は、古くから油火災の消火用の泡として用いられていたが、泡を油面へ直接放出すると、油にまみれて油汚染されると泡が消滅してしまうので、特に消防隊の泡消火に困難性があった。これは合成界面活性剤泡でも同様である。

フッ素たん白泡は、泡が油で汚染されてもなお泡の安定性、耐熱性、耐火性など、消火に必要な性質を保持している泡である。油に汚染した泡に着火して、泡が燃えている状況でも、泡が消滅する度合いが少ないことが知られている。

水成膜泡は、油汚染されにくい泡であるが、泡の中に油を包み込む性質があり、これに着火すると一瞬に泡が燃えて消滅してしまうことはよく経験することである。

(6) 泡の油面密封性、耐再燃性(耐バーンバック性)

泡が油面を密封して消火し、また、消火後の蒸発を抑制して再着火、再燃(バーンバック)を防止することは、泡の重要な性質で、これには泡の保水性、耐熱性、耐油性、油汚染性が相互関連する。

最近火災抑制の速さだけが重要視され、消火の最後の詰め、すなわち完全消火や、消火後の密封性や耐バーンバック性が軽んじられている傾向がある。密封性、耐バーンバック性は、他の消火薬剤にはない、泡だけが有する性質である。これらの性質は、泡が熱や油に汚染されると極度に低下するので、消火後は常に新しい泡が存在するように、固定設備においても、十分な量の消火薬剤を保有することが重要である。

一般的な傾向としては、油に汚染されない状況では、たん白泡は油面を長い時間カバーしているが、泡が油を含むと早く消滅する。

フッ素たん白泡は、油に汚染されないといわれるが、そうではなく、油に汚染された状況でも、耐火性、耐油性を有していて、油面を密封している。

合成界面活性剤泡は、油に汚染されない状況でも、泡の耐熱性、保水性、耐油性が劣るので、大量放出して消火した場合でも、泡はすぐに破壊されて、油面を封鎖することができない。

水成膜泡は、泡の膜に油を吸収する性質があり、加えて、気泡の中や泡と泡の間に油の蒸気を包み込む性質があるため、消火後に油面を封鎖している場合であっても、泡に火が触れると一挙に炎が燃え上がる(フレイアーアップ)危険がある。

※ [引用文献] 消防研究所研究資料 第73号石油タンク火災の安全確保に関する研究報告書－石油タンク火災に使用される泡消火薬剤の消火特性－

4. 国際規格の試験概要

4. 国際規格の試験概要

4-1. 非水溶性液体可燃物用低発泡消火薬剤 (ISO①関係)

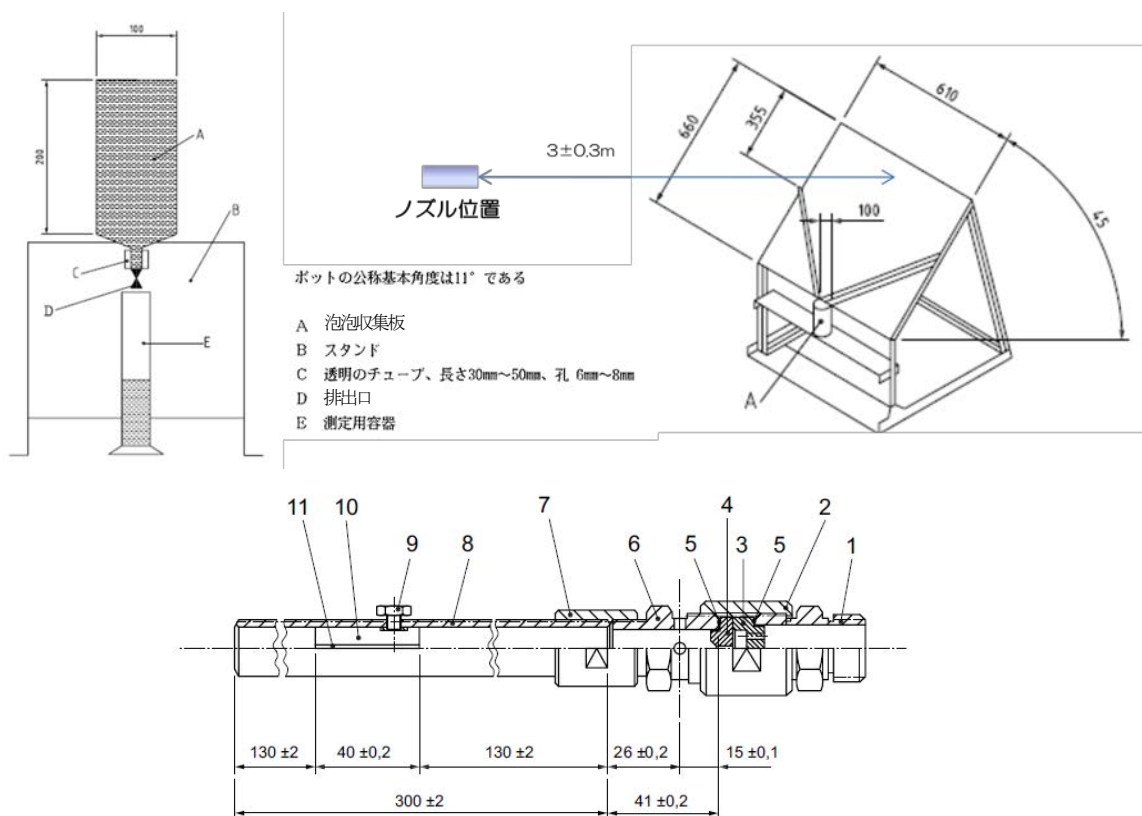
(1) 発泡試験

<試験手順>

- ① 泡水溶液タンクからノズルまでの配管とホースが泡水溶液で完全に満たされていることをチェックする。
- ② ノズル前面を泡収集板の最上端から (3 ± 0.3) m にして、泡収集板の前に直接、水平にノズルを設定する。
- ③ 捕集容器の内部を濡らして秤量する (m_1)。
- ④ 泡生成ノズルを設定しノズル圧力が 0.63MPa ($\pm 0.03\text{MPa}$) のとき、 11.4L/min の流量となるように調整する。
- ⑤ 泡を放出し、放出する泡が泡収集板の中央にあたるようにノズルの高さを調整する。
- ⑥ 泡放出を停止し、泡収集板から全ての泡を洗い流す。
- ⑦ 泡水溶液タンクが充満していることをチェックし、泡の放出を開始。
- ⑧ 30 ± 5 秒後に泡収集板の下に排出口を閉じた捕集容器をおく、容器が一杯になるとすぐに泡収集板から容器を取り出す。
- ⑨ 全容量を秤量する (m_2)。計算式は、右のとおり。
- ⑩ 排出口を開き、25%還元時間を計測する。

$$E = V / (m_2 - m_1)$$

発泡倍率 V: 捕集容器の体積



図ー1. 非水溶性液体可燃物用低発泡消火薬剤の捕集容器、泡収集板及びノズル

(2) 消火試験

<試験手順>(フォースフル方式)

- ①ノズルを油面から 1m (± 0.05 m) の高さにセットし、泡が火災模型の最も遠い端部 (奥) から 1 ± 0.1 m の点で燃料表面の上に直接落下するように、ノズルを配置する。
- ②90L の水及び 144L のノルマルヘプタンを入れた火災模型 (低発泡用) に点火し、点火 1 分後に温度 20°C の泡水溶液を 3 分間連続して発泡し、泡放出させる。
- ③消火に要する時間は、3 分間泡放出し、放出後 3 分以内に消火したとき、消火能力 I と判定し、放出後 4 分以内に消火したとき、消火能力 II と判定する。
- ④発泡を終了してから 5 分後、2L のノルマルヘプタンを入れた耐再燃性能試験用ポットに着火し、火災模型の面積が 25% 持続する炎で覆われるまでの時間が、10 分を超えるものであること。

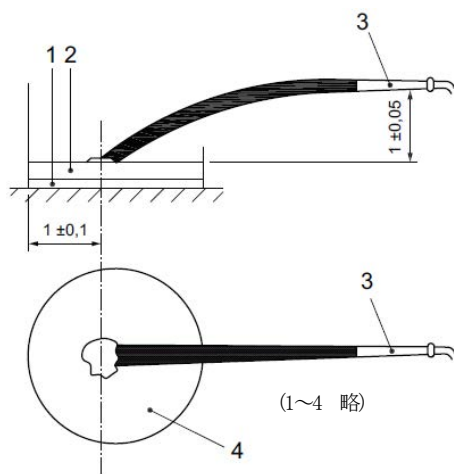


図-2. フォースフル方式

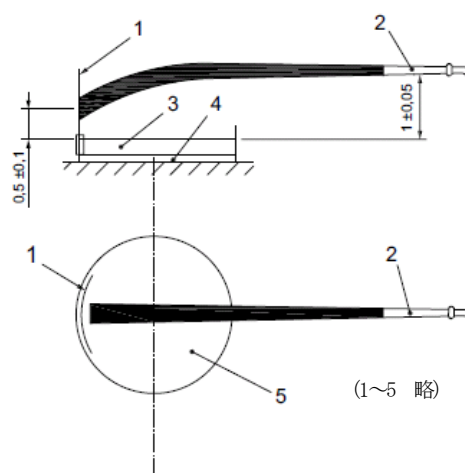


図-3. ジェントル方式

<試験手順>(ジェントル方式)

- ①ノズルを油面から 1m (± 0.05 m) の高さにセットし、泡がバックボードの中央部及び油面からの高さ 0.5 (± 0.1) m の地点へ放出できるように、ノズルを配置する。
- ②90L の水及び 144L のノルマルヘプタンを入れた火災模型 (低発泡用) に点火し、点火 1 分後に温度 20°C の泡水溶液を 5 分間連続して発泡し泡放出させる。
- ③消火に要する時間は、5 分間泡放出し、放出後 5 分以内に消火したとき、消火能力 III と判定する。
- ④放出を終了してから 5 分後、2L のノルマルヘプタンを入れた耐再燃性能試験用ポットに着火し、火災模型の面積が 25% 持続する炎で覆われるまでの時間を測定し、5、10 又は 15 分を超えるものであること。

表-3. 消火性能クラス及び耐再燃性能レベルに関する表

消火 性能クラス	耐再燃 性能レベル	ジェントル方式		フォースフル方式	
		消火時間 (分以内)	25%再燃時間 (分以上)	消火時間 (分以内)	25%再燃時間 (分以上)
Ⅰ	A			3	10
	B	(5)*	15	3	
	C	(5)*	10	3	
	D	(5)*	5	3	
Ⅱ	A			4	10
	B	(5)*	15	4	
	C	(5)*	10	4	
	D	(5)*	5	4	
Ⅲ	B	5	15		
	C	5	10		
	D	5	5		

*ISO①の表に追加補足した

火災模型の内径：(2400 ± 25) mm
 (面積は、約4.52m²)
 深さ：(200 ± 15) mm
 鋼製壁の公称厚さ：2.5 mm
 発泡ノズル：別図のとおり
 耐再燃性能試験用ポット：
 厚さ公称2.5 mm鋼製、直径(300 ± 5) mm、
 高さ(250 ± 5) mm

4-2. 非水溶性液体可燃物用中発泡泡消火薬剤 (ISO2関係)

(1) 発泡試験

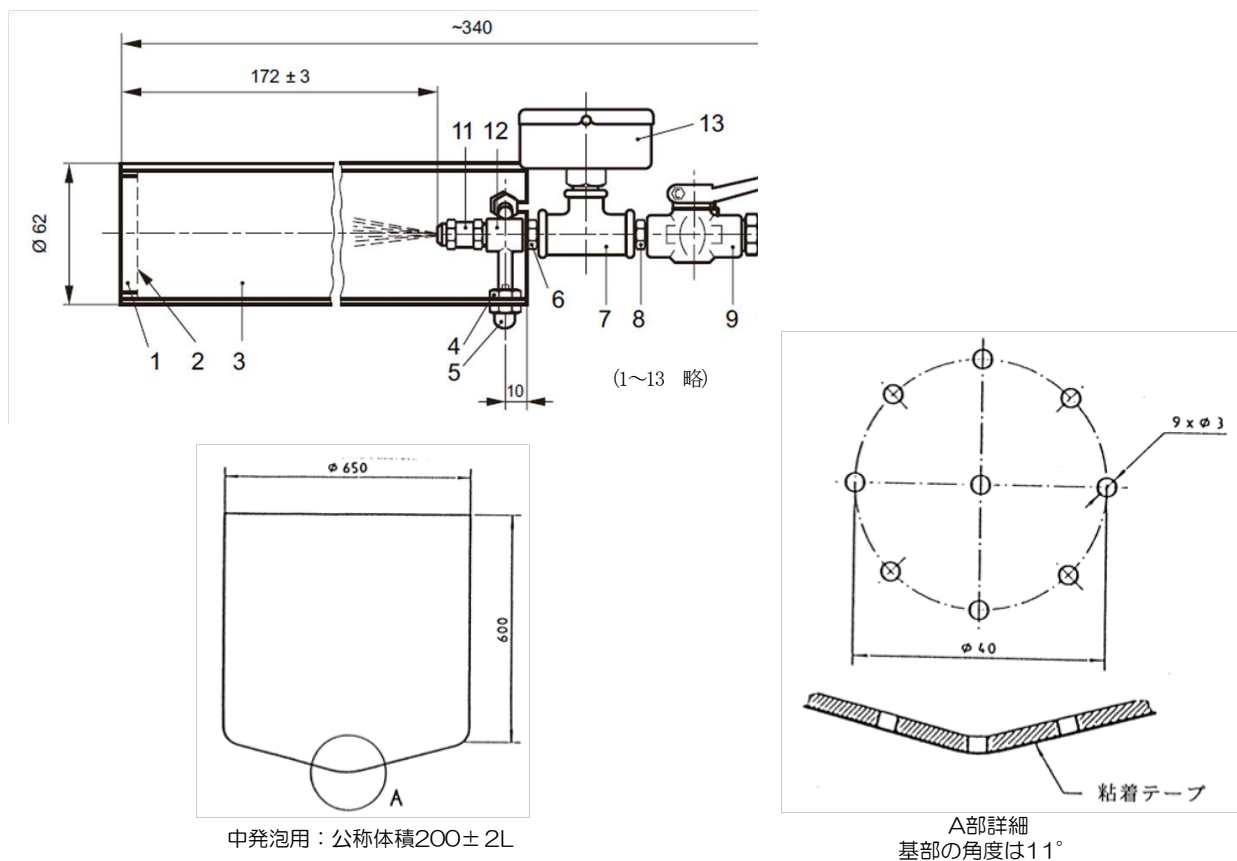
<試験手順>

- ① 泡水溶液タンクからノズルまでの配管とホースが泡水溶液で完全に満たされていることをチェックする。
- ② 捕集容器の内部を濡らして秤量する (m_1)。
- ③ 泡生成ノズルを設定し、ノズル圧力が $0.5\text{MPa}(\pm 0.01\text{MPa})$ のとき、 $3.25 \pm 0.15\text{L/min}$ の流量となるように調整する。
- ④ 泡水溶液タンクが充満していることをチェックし、泡の放出を開始。
- ⑤ 発泡を開始。泡捕集容器に泡を集め、半分満たされたときに計時を開始。
- ⑥ 捕集容器を一杯にした後、全容量を秤量する (m_2)。計算式は下のとおり。
- ⑦ 下穴を開け、25%還元時間及び50%還元時間を計測する。

$$E = V / (m_2 - m_1)$$

発泡倍率

V: 捕集容器の体積



図一4. 非水溶性液体可燃物用中発泡泡消火薬剤の発泡器及び捕集容器

(2) 消火試験

<試験手順>

- ①30Lの水及び55Lのノルマルヘプタンを入れた火災模型（中発泡用）を準備する。
- ②発泡ノズル及び耐再燃性能試験用ポットを設置する。
- ③点火し、点火1分後に温度20℃の泡水溶液を2分間連続して発泡させる。この場合において、発泡開始から2分以内に残炎が認められないこと。
- ④発泡を終了後、0.9Lのノルマルヘプタンを入れた耐再燃性能試験用ポットに着火し、1%再燃時間を計測する。

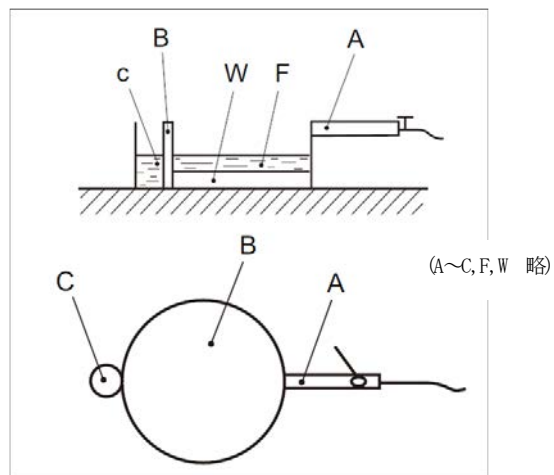


図-5. 非水溶性液体可燃物用中発泡消火薬剤の消火試験

火災模型の内径：(1480 ± 15) mm
(面積は約1.73m²)
深さ：(150 ± 10) mm
鋼製壁の公称厚さ：2.5 mm
発泡ノズル：別図のとおり
耐再燃性能試験用ポット：
厚さ公称2.5 mm鋼製、直径(150 ± 5) mm、
高さ(150 ± 5) mm

4-3. 非水溶性液体可燃物用高発泡消火薬剤 (ISO②関係)

(1) 発泡試験

<試験手順>

- ① 泡水溶液タンクからノズルまでの配管とホースが泡水溶液で完全に満たされていることをチェックする。
- ② 捕集容器の内部を濡らして秤量する (m_1)。
- ③ 泡生成ノズルを設定し、ノズル圧力が $0.5\text{MPa}(\pm 0.01\text{MPa})$ のとき、 $6.1 \pm 0.1\text{L/min}$ の流量となるように調整する。
- ④ 泡水溶液タンクが充満していることをチェックし、泡の放出を開始。
- ⑤ 捕集容器の下穴を塞ぎ、発泡を開始。捕集容器に泡を集め、半分満たされたときに計時を開始。
- ⑥ 捕集容器を一杯にした後、全容量を秤量する (m_2)。計算式は、下のとおり。
- ⑦ 下穴を開け、25%還元時間及び50%還元時間を計測する。

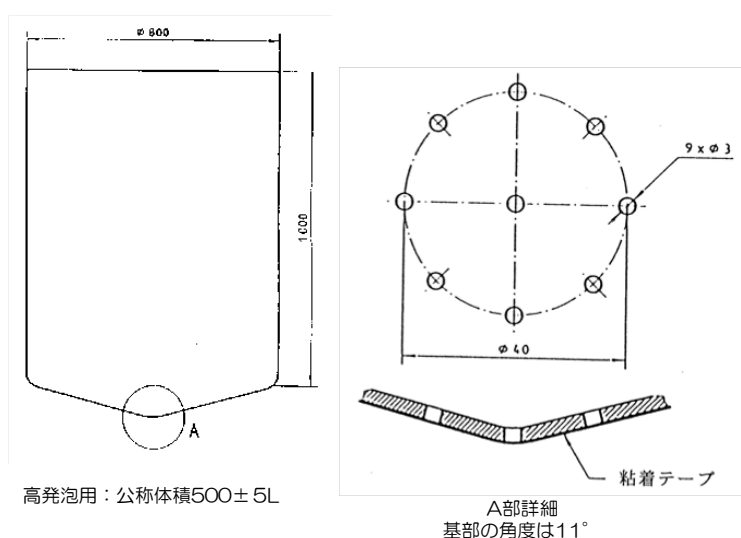
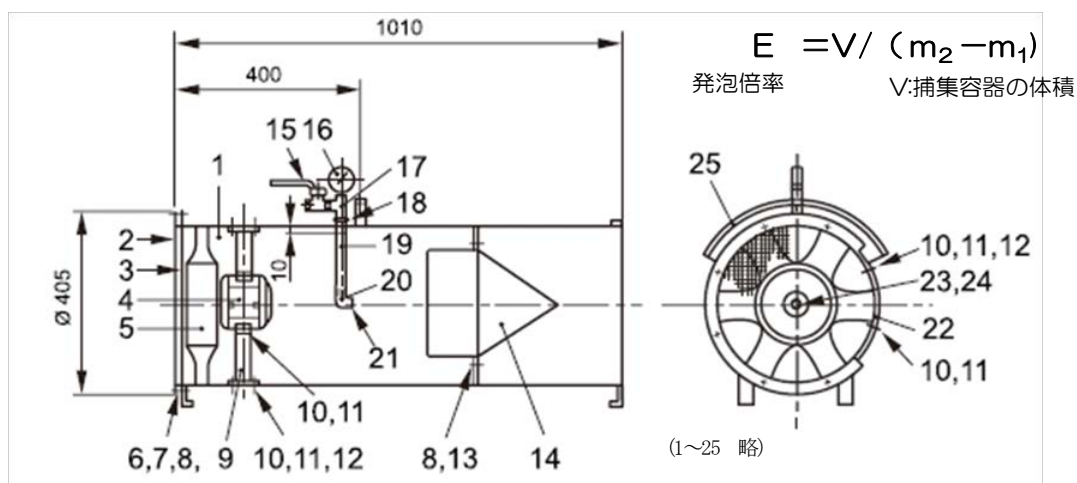


図-6. 非水溶性液体可燃物用高発泡消火薬剤の発泡器及び捕集容器

(2) 消火試験

<試験手順>

- ①30Lの水及び55Lのノルマルヘプタンを入れた火災模型（高発泡用）を準備する。
- ②発泡ノズルを設置する。
- ③点火し、点火1分後に温度20℃の泡水溶液を2分間連続して発泡させる。この場合において、発泡から2分30秒以内に残炎が認められないこと。

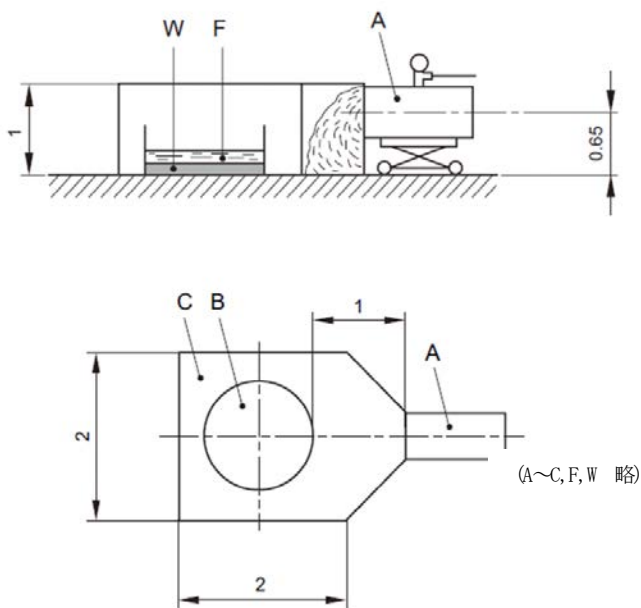


図-7. 非水溶性液体可燃物用高発泡消火薬剤の消火試験

火災模型の内径：(1480 ± 15) mm
(面積は約1.73m²)
深さ：(150 ± 10) mm
鋼製壁の公称厚さ：2.5 mm
発泡ノズル：別図のとおり

4-4. 水溶性液体可燃物用低発泡消火薬剤（ISO③関係）

(1) 発泡試験

<試験手順>

非水溶性低発泡発泡試験と同様。

(2) 消火試験

<試験手順>

- ①火災模型を直接地面に置き、水平になっていることを確かめること。泡放出の中心部が燃料表

面の上にある背板の中心軸(0.5 ± 0.1) mに当たるように、燃料表面の上 (1 ± 0.05) mに発泡ノズルを水平にセットすること。(125 \pm 5) Lの燃料を加えて78 mmの公称フリーボードを確保すること。

②燃料を加えた後、5分以内に点火し、燃料表面に完全に炎が広がった後(120 \pm 5) 秒間燃焼させる。それから泡放出を開始すること。泡放出開始から消火までの時間を消火時間として記録すること。

③ (180 \pm 2) 又は(300 \pm 2)秒間泡放出する、泡放出の間、トレーからの泡のこぼれがあっても無視すること。

④泡放出を停止し、さらに (300 \pm 10) 秒後、(2 \pm 0.1) Lのアセトン又はI.P.Aを入れた耐再燃性能試験用ポットを火災模型の中心に置き、点火する。火災模型の面積の25%が持続する炎で覆われるまでの時間を測定し、5, 10 又は15分を超えるものであること。

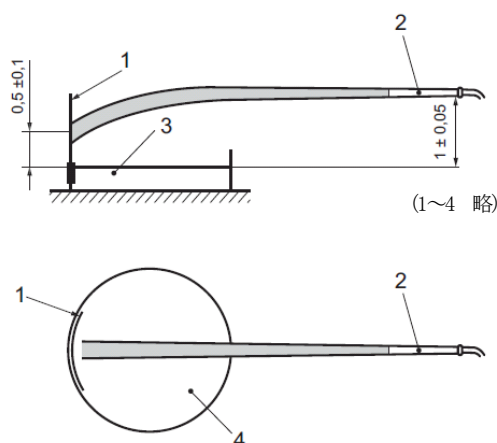


図-8. 水溶性液体可燃物用低発泡消火薬剤の消火試験

燃料 純度99%以上のアセトン及びI.P.Aを使用すること。
火災模型の内径：(1480 \pm 15) mm
(面積は、約1.73m²)
深さ：(150 \pm 10) mm
鋼製壁の公称厚さ：2.5 mm
バックボード：円周壁の上部にできるだけ沿って固定されるか、または壁の延長として形成された、幅(1 \pm 0.05) mで長さ(1 \pm 0.05) mの垂直半円状鋼製背板を取り付けてあること。
発泡ノズル：別図による。
耐再燃性能試験用ポット：厚さ公称2.5 mm鋼製、直径(150 \pm 5) mm、高さ(150 \pm 5) mm

表-4. 消火性能クラス及び耐再燃性能レベルに関する表

消火性能クラス	耐再燃性能レベル	消火時間 (分以内)	25%再燃時間 (分以上)
I	A	3	15
	B	3	10
	C	3	5
II	A	5	15
	B	5	10
	C	5	5

4-5. 泡消火薬剤の消火性能試験等における国内規格と国際規格の比較

国内規格と国際規格を比較すると表-5. から表-8. のとおりとなる。

表-5. 非水溶性液体可燃物用低発泡消火薬剤消火性能試験方法比較

項目	規格省令	ISO 7203-1		
火災模型	角型 4 m ² (2 m×2 m、深さ 0.3 m)	円形 4.52 m ² (直径 2.4 m 深さ 0.2 m)		
使用燃料	自動車用ガソリン、N-ヘプタン	N-ヘプタン		
使用燃料量	200 L	144 L		
使用燃料温度	—	17.5 ± 2.5℃		
敷水	320 L	90 L		
敷水温度	—	17.5 ± 2.5℃		
試験ノズル	たん白泡用、合成界面活性剤泡用、 水成膜泡用の3種類	UNI 86 ノズル		
試験ノズル流量	10 L (+0.5, -0)	11.4 L/分		
試験ノズル圧力	0.69 ± 0.02 MPa	0.63 ± 0.03 MPa		
泡供給方式	I 型 (グーズネック方式)	II 型 (ジェントル方式) III 型 (フォースフル方式)		
泡供給率	2.5 L/分・m ²	2.52 L/分・m ²		
泡水溶液温度	20 ± 2℃	17.5 ± 2.5℃		
周囲空気温度	—	15 ± 5℃ (発泡性能は 20 ± 5℃)		
周囲風速	—	3m/秒以下		
予燃焼時間	1 分間	1 分間		
泡放出時間	5 分間 合成界面泡は 8 分間	フォースフル方式 3 分間 ジェントル方式 5 分間		
消火時間	5 分以内	消火クラスⅠ：フォースフル方式で 3 分以内 消火クラスⅡ：フォースフル方式で 4 分以内 消火クラスⅢ：ジェントル方式で 5 分以内		
密封性試験	耐再燃性能試験開始まで 15 分間 合成界面泡は 12 分間	—		
耐再燃性能試験開始 待機時間	泡放出停止後 15 分 合成界面泡は 12 分	泡放出停止後 5 分		
耐再燃性能試験	15 cm 角に泡を除去後、 着火し 5 分間燃焼し、 泡面の燃焼拡大面積が 900 cm ² 未満	直径 30 cm、深さ 25 cm の ポットに 2 L の N-ヘプタンを入れて 燃焼させ、消火後の泡面が燃焼拡大し、 燃焼部が火災模型の 25 % に至る 時間を計測し、レベルを判定する。		
		耐再燃性能 レベル	消火クラス	再燃時間
		A	Ⅰ	フォースフル方式で 10 分以上
			Ⅱ	
		B	Ⅰ	ジェントル方式で 15 分以上
			Ⅱ	
C	Ⅲ	ジェントル方式で 10 分以上		
	Ⅰ			
	Ⅱ			
D	Ⅲ	ジェントル方式で 5 分以上		
	Ⅰ			
	Ⅱ			
		Ⅲ		

表－6. 非水溶性液体可燃物用中発泡泡消火薬剤消火性能試験方法比較

項目	規格省令	I S O 7 2 0 3 - 2
火災模型	—	円形 1.73 m ² (直径1.48m深さ0.15m)
使用燃料	—	N-ヘプタン
使用燃料量	—	55 L
使用燃料温度	—	17.5 ± 2.5 °C
敷水	—	30 L
敷水温度	—	17.5 ± 2.5 °C
試験発泡装置	—	SKUM社製
試験ノズル流量	—	3.25 ± 0.15 L/分
試験ノズル圧力	—	0.5 ± 0.01 MPa
泡供給方式	—	泡放出口を火災模型の上縁に設置
風量	—	—
泡供給率	—	1.88 L/分・m ²
泡水溶液温度	—	17.5 ± 2.5 °C
周囲空気温度	—	15 ± 5 °C (発泡性能は20 ± 5 °C)
周囲風速	—	3 m/秒以下
予燃焼時間	—	1 分間
泡放出時間	—	2 分間
消火時間	—	2 分以内
密封性試験	—	—
耐再燃性能試験	—	直径15 cm、深さ15 cmのポットに0.9 LのN-ヘプタンを入れ、火災模型の円周に接して置き、泡放出停止後、直ちに着火し、消火後の泡面に30秒間炎が燃え移ってはならない。

表－7. 非水溶性液体可燃物用高発泡泡消火薬剤消火性能試験方法比較

項目	規格省令	I S O 7 2 0 3 - 2
火災模型	円形 1.6 m ² (直径1.43m深さ0.3m)	円形 1.73 m ² (直径1.48m深さ0.15m)
使用燃料	ガソリン	N-ヘプタン
使用燃料量	80 L	55 L
使用燃料温度	—	17.5 ± 2.5 °C
敷水	128 L	30 L
敷水温度	—	17.5 ± 2.5 °C
試験発泡装置	規格省令別図第2に示される標準発泡装置	SKUM社製
試験ノズル流量	6.0 (±0.2) L	6.1 (±0.1) L
試験ノズル圧力	0.1 ± 0.02 MPa	0.5 ± 0.01 MPa
風量	13 m ³ /分	—
泡供給率	3.75 L/分・m ²	3.53 L/分・m ²
泡水溶液温度	20 ± 2 °C	17.5 ± 2.5 °C
周囲空気温度	—	15 ± 5 °C (発泡性能は20 ± 5 °C)
周囲風速	—	3 m/秒以下
予燃焼時間	30 秒間	1 分間
泡放出時間	2分30秒間	2 分間
消火時間	3分以内	2分30秒以内
密封性試験	—	—
耐再燃性能試験	—	—

表－8. 水溶性液体可燃物用低発泡消火剤消火性能試験方法比較

項目	技術上の基準を定める告示第559号	IS07203-3												
火災模型	係数算出のため 4サイズの角型模型を使用 4m ² (2m×2m×0.3m) 3.2m ² (1.789m×1.789m×0.3m) 2.67m ² (1.634m×1.634m×0.3m) 2m ² (1.413m×1.413m×0.3m)	円形1.73m ² (直径1.48m深さ0.15m)												
使用燃料	危険物区分表に示された水溶性液体 類別の代表物質を燃料とする。 1. アルコール類：メチルアルコール 2. ケトン類：アセトン 3. アルデヒド類 (代表物質なし) ：アクリルアルデヒド クロトンアルデヒド パラアルデヒド アセトアルデヒド 4. アミン類：エチレンジアミン 5. ニトリル類：アクリルニトリル 6. 有機酸：酢酸 7. その他の不溶性のもの以外のもの ：プロピレンオキシド エタノール含有ガソリン ※区分表に記載されていない物質に ついてはその物質を燃料とし、 係数を求める試験を実施する。	アセトン と イソプロピルアルコール												
使用燃料量	火災模型に深さ10cmの燃料を入れる。 例えば4m ² では400L	125±5L												
使用燃料温度	—	17.5±2.5℃												
試験ノズル	たん白泡用、合成界面泡用、 水成膜泡用の3種類	UNI86ノズル												
試験ノズル流量	10L (+0.5, -0)	11.4L												
試験ノズル圧力	0.69±0.02MPa	0.63±0.03MPa												
泡供給方式	I型 (グーズネック方式)	II型 (ジェントル方式)												
泡供給率	2.5, 3.125, 3.75, 4L/分・m ²	2.52L/分・m ²												
泡水溶液温度	20±2℃	17.5±2.5℃												
周囲空気温度	—	15±5℃ (発泡性能は20±5℃)												
周囲風速	—	3m/秒以下												
予燃焼時間	1分間	1分間												
泡放出時間	5分間 (合成界面泡は8分間)	ジェントル方式5分間												
消火時間	5分以内	消火クラスⅠ：3分以内消火 消火クラスⅡ：5分以内消火												
密封性試験	耐再燃性能試験開始まで15分間 合成界面泡は12分間	—												
耐再燃性能試験開始 待機時間	泡放出停止後15分 (合成界面泡は12分)	泡放出停止後5分												
耐再燃性能試験	15cm角に泡を除去後、 着火し5分間燃焼し、 泡面の燃焼拡大面積が 900cm ² 未満	直径30cm、深さ25cmの ポットに2Lのアセトンまたは イソプロピルアルコールを入れて 燃焼させ、消火後の泡面が燃焼拡大し、 燃焼部が火災模型の25%に至る 時間を計測し、レベルを判定する。 <table border="1"> <thead> <tr> <th>耐再燃性能 レベル</th><th>消火クラス</th><th>拡大時間</th></tr> </thead> <tbody> <tr> <td>A</td><td>Ⅰ Ⅱ</td><td>15分以上</td></tr> <tr> <td>B</td><td>Ⅰ Ⅱ</td><td>10分以上</td></tr> <tr> <td>C</td><td>Ⅰ Ⅱ</td><td>5分以上</td></tr> </tbody> </table>	耐再燃性能 レベル	消火クラス	拡大時間	A	Ⅰ Ⅱ	15分以上	B	Ⅰ Ⅱ	10分以上	C	Ⅰ Ⅱ	5分以上
耐再燃性能 レベル	消火クラス	拡大時間												
A	Ⅰ Ⅱ	15分以上												
B	Ⅰ Ⅱ	10分以上												
C	Ⅰ Ⅱ	5分以上												

4-6. 今回実施した実験場所及び作業概要等

(1) 試験場所：日本消防検定協会（東京都調布市深大寺東町4-35-16）



日本消防検定協会
中央試験場（外観）



消火散水試験場（外観）



消火散水試験場（内部）

(2) 主要実験機器等



泡水溶液送液装置
(放水量測定時)



低発泡用ノズル及び設置台
(放水量測定時)



低発泡用泡収集板



熱放射計



低発泡用火災模型
(背板は取り外し可能)

＜熱放射計の仕様等＞
(株)チノー製
型式：RE-III(W)型、 フィルター：KRS-6
火災模型からの距離：火災模型の直径の2倍
高さ：油面より1.5m



中・高発泡用火災模型



中発泡器



中発泡捕集容器



高発泡試験用ネット



高発泡器
(放水量測定時)



高発泡捕集容器

(3) 実験方法の概要について

(非水溶性液体可燃物用低発泡消火薬剤の発泡試験及び消火試験)

○放水量の確認

圧力が 0.63MPa ($\pm 0.03\text{MPa}$) の際、ノズルからの放水量が 11.4L/min であることを確認する。



放水量測定時

○泡水溶液の調製

水 97、泡消火薬剤 3 の割合で 100L の泡水溶液を調製する。



泡消火薬剤投入時



泡水溶液を攪拌

○発泡倍率及び還元時間の測定

規定の放水量で泡水溶液を放射し、発泡倍率及び還元時間を測定する。



発泡した泡の捕集



泡水溶液量を測定



25%還元時間を測定

○放射距離の測定

消火実験の際のノズル位置を決定するため、放射距離を測定する。



放射距離を測定



放射距離に基づき
ノズル位置を決定

○消火実験実施

ジェントル方式の場合は、背板にあて、フォースフル方式の場合は、火災模型中央付近に泡を放射し、泡消火薬剤の性能を確認する。



ジェントル方式の消火実験



フォースフル方式の消火実験

(非水溶性液体可燃物用中発泡消火薬剤の発泡実験及び消火実験)

○放水量の確認

圧力が0.50MPa (±0.01MPa) の際、ノズルからの放水量が3.25L/min (±0.15L/min) であることを確認する。

○泡水溶液の作成

低発泡試験と同様。

○発泡倍率及び還元時間の測定

規定の放水量で泡水溶液を放射し、発泡倍率及び還元時間を測定する。



発泡した泡の捕集



25%及び50%還元時間を測定

○消火実験の実施

泡放出口を火災模型の円周上端に設置し、消火を行う。



消火実験の様子

(非水溶性液体可燃物用高発泡消火薬剤の発泡実験及び消火実験)

○放水量の確認

圧力が 0. 50MPa (±0. 01MPa) の際、ノズルからの放水量が 6. 1L/min (±0. 1L/min) であることを確認する。

○泡水溶液の作成

低発泡実験と同様。

○発泡倍率及び還元時間の測定

規定の放水量で泡水溶液を放射し、発泡倍率及び還元時間を測定する。



発泡した泡の捕集



25%及び50%還元時間を測定

○消火実験の実施

5 角形のネットで火災模型の四方を囲み、一方から流し込む方式により実施する。



消火実験の様子

(水溶性液体可燃物用低発泡消火薬剤の発泡実験及び消火実験)

火災模型の大きさや使用燃料等は異なるが、手順としては非水溶性液体可燃物用低発泡実験（ジェントル方式）とほぼ同様の実験内容である。

(4) 実験使用泡消火薬剤一覧
(たん白泡消火薬剤)



A たん白泡消火薬剤 (P1)



B たん白泡消火薬剤 (P2)



C フッ素たん白泡消火薬剤 (FP1)



D フッ素たん白泡消火薬剤 (FP2)



E フッ素たん白泡消火薬剤 (ARFP1)



F フッ素たん白泡消火薬剤 (ARFP2)

(水成膜泡消火薬剤)



G 水成膜泡消火薬剤 (AF1)



H 水成膜泡消火薬剤 (AF2)



I 水成膜泡消火薬剤 (ARAF1)



J 水成膜泡消火薬剤 (ARAF2)

(合成界面活性剤泡消火薬剤)



K 合成界面活性剤泡消火薬剤 (S1)



L 合成界面活性剤泡消火薬剤 (S2)



M 合成界面活性剤泡消火薬剤 (ARS1)

5. 実験日程と実験結果

5. 実験日程と実験結果

今回行った実験及びその日程を表－11. 及び表－12. に、実験結果を表－13. ～表－18. に示す。

<考 察>

(1) ISO①「非水溶性液体可燃物用低発泡泡消火薬剤」

Annex J(informative)に「非水溶性液体可燃物用低発泡泡消火薬剤の予想される消火性能クラスと耐再燃性能レベル」が示されている。この予想例と今回行った実験結果を以下の表にまとめた。

表-9. ISO①における消火試験の予想とその結果

泡消火剤の種類	消火性能クラス			耐再燃性能レベル		
	ISO規格 予想	実験結果		ISO規格 予想	実験結果	
		試料	評価		試料	評価
たん白泡	Ⅲ	A	Ⅲ	B	A	B
		B	Ⅲ		B	B
フッ素たん白泡	Ⅱ	C	Ⅲ	A/B	C	A*
		D	Ⅲ		D	B
水成膜泡	Ⅰ	G	Ⅱ	C	G	B
		H	Ⅲ		H	B
合成界面活性剤泡	Ⅲ	K	不適合	C	K	不適合
		L	Ⅲ		L	C

消火性能クラスと耐再燃性能レベルの予想例と実験結果による評価が合致したのは、たん白泡消火薬剤 2 品目と合成界面活性剤泡消火薬剤 1 品目であった。ジェントル方式及びフォースフル方式による 2 つの泡放出方式の実験結果について併せて評価を行った。

(フッ素たん白泡消火薬剤)

フッ素たん白泡消火薬剤は、消火性能クラスが予想例のクラスⅡを満足せず、クラスⅢとなった。フッ素たん白泡(C)は、泡供給停止後 2 分 27 秒に消火、また、フッ素たん白泡(D)は、泡供給停止後 1 分 02 秒に消火した結果であり、処方の改善により泡供給停止後 1 分以内の消火が可能となりうるものと考ええる。

耐再燃性能レベルは、消火性能クラスが一段階下のクラスⅢに該当する結果となってしまい、自動的に評価はレベルAとはなりえず、レベルBとなった。フッ素たん白泡(C)(D)について、参考のため耐再燃性試験を実施したところ、フッ素たん白泡(C)については、10 分後の燃焼拡大が 5 %未満に留まり、耐再燃性能レベルAの評価に該当する結果となった(上記表中A*と表示)。フッ素たん白泡(C)(D)の消火状況は、泡供給停止数秒後に泡が油面上に落下する位置の炎が消炎し、99%抑圧状態となり、残存する炎は、いわゆるキャンドルファイヤーとゴーストファイヤーの部類と言える状態であった。

ISO①2 版(2011 年)には明文化されていないが、数少ない小さな残炎は無視し、消火と見なすとする記述が 1995 年初版にはあり、この記述に従えば、4 分以内に消火したものといえ、フッ素たん白泡(C)および(D)は消火性能クラスがⅡに該当することとなる。

(水成膜泡消火薬剤)

水成膜泡消火薬剤は、水成膜泡(G)は、消火性能クラスⅡ、水成膜泡(H)は消火性能クラスⅢとなり、予想例の消火性能クラスⅠを満足しない結果となった。

泡の流動展開性については問題はなかったが、油面上に展開される泡の火炎に対する耐火・耐熱性あるいは耐油汚染性強度が弱く、迅速な消火ができなかったものと考えられる。泡膜の耐火・耐熱性あるいは耐油汚染性強度向上の処方改善が期待されるところである。

また、耐再燃性能レベルについては、水成膜泡消火薬剤で問題となる耐再燃性能試験におけるフレアアップ現象が観察されず、15 分間泡面に顕著な燃焼拡大も起きず、レベル B となり、予想例レベル C よりも優れる結果であった。

(合成界面活性剤泡消火薬剤)

合成界面活性剤泡消火薬剤については、合成界面活性剤泡 (L) が消火性能及び耐再燃性能を有しており、表-9. の予想と同様の結果となった。合成界面活性剤泡 (K) は消火不能であった。

(2) ISO②「非水溶性液体可燃物用中・高発泡消火薬剤」

中発泡消火性能実験において、本来、最も中発泡に適すると考えられる合成界面活性剤泡 (L) が消火不能の結果であった。しかし、その他の泡消火薬剤は全て消火および耐再燃性能基準を満足する結果であった。

合成界面活性剤泡 (L) が消火できなかった理由として考えられるのは、規格省令を満たしているが、中発泡において、この泡消火薬剤の消火力そのものが低かったのでは、と考えられる。

高発泡消火性能実験においては、たん白泡消火薬剤及びフッ素たん白泡消火薬剤以外は消火性能基準を満足する結果であった。たん白泡消火薬剤及びフッ素たん白泡消火薬剤は高発泡器の泡放出口から放出された泡の流動性が悪く、ネットスクリーンの囲いに、ある一定以上の泡が展開し積み上がった状態になると泡が前方に展開できず、泡放出口の付近で二次発泡現象を起こし、さらに泡の展開性が悪化し、消火を困難にしてしまう結果であった。

中・高発泡による消火性能試験は、泡消火薬剤が持つ消火力の優劣を評価する手段として有効であると考えられ、泡消火薬剤の小規模火災モデルを使用した消火性能評価試験方法の候補となりうるものと考えられる。

規格省令においては、中発泡という定義がなく、膨張率 100 倍～200 倍程度の高発泡の部類として使用されているのが実態ではないかと考える。加えて、実験における発泡状態を観察したところ、中・高発泡ともに使用される泡消火薬剤は、合成界面活性剤泡消火薬剤に限定されているといえる。なぜなら、発泡メカニズムは発泡スクリーン表面全体に泡水溶液を噴霧し、吸引された空気あるいは吹き込まれた空気を取り込ませて発泡する方式によるものと考えられ、泡水溶液を発泡スクリーンにいかに効率よく噴霧できるかが泡を形成させる生命線となる。合成界面活性剤泡消火薬剤以外の泡消火薬剤は、中・高発泡共に、泡を生成しない噴霧された泡水溶液そのままの状態のものが、発泡スクリーンを突き抜け、泡放出口から流出している現象が観察され、試験発泡機器の発泡メカニズムに適応していないと考えられるからである。

合成界面活性剤泡消火薬剤以外の泡消火薬剤を中・高発泡用泡消火薬剤として適応させるためには、個々の泡水溶液が持つ流動特性に合う適切な噴霧状況を作り出す噴霧ノズルと安定した泡を生成する発泡スクリーンを備えた発泡機器を準備しなければならない。

(3) ISO③「水溶性液体可燃物用低発泡消火薬剤」

ISO③第 2 版 (2011 年) には記載されていないが、1999 年初版の AnnexB (informative) に「水溶性液

体可燃物用低発泡消火薬剤の予想される消火性能クラスと耐再燃性レベル」が示されている。この予想例と今回行った実験結果を以下の表にまとめた。

表-10. ISO③における消火試験の予想とその結果

泡消火薬剤の種類	消火性能クラス				耐再燃性能レベル			
	ISO規格 予想	実験結果			ISO規格 予想	実験結果		
		試料	燃料	評価		試料	燃料	評価
たん白泡	Ⅱ	A	アセトン	不適合	A又はB	A	アセトン	不適合
			I P A	不適合			I P A	不適合
		B	アセトン	不適合		B	アセトン	不適合
			I P A	不適合			I P A	不適合
フッ素たん白泡	Ⅰ又はⅡ	E	アセトン	不適合	A又はB	C	アセトン	不適合
			I P A	不適合			I P A	不適合
		F	アセトン	不適合		D	アセトン	不適合
			I P A	不適合			I P A	不適合
水成膜泡	Ⅰ	I	アセトン	不適合	A又はB	I	アセトン	不適合
			I P A	不適合			I P A	不適合
		J	アセトン	Ⅰ		J	アセトン	C
			I P A	Ⅱ			I P A	C
合成界面活性剤泡	Ⅰ	M	アセトン	Ⅰ	B	M	アセトン	A
			I P A	Ⅱ			I P A	A
		L	アセトン	不適合		L	アセトン	不適合
			I P A	不適合			I P A	不適合

I P A:イソプロピルアルコール

消火性能クラスと耐再燃性能レベルの予想例と実験結果による評価が合致したのは、燃料をアセトンとした消火性能実験において、水成膜泡 1 品目と合成界面活性剤泡消火薬剤 1 品目という結果であった。

今回の実験に使用した泡消火薬剤は、規格省令に適合する個別検定合格品が主であり、水溶性液体可燃物用低発泡消火薬剤の技術上の基準の細目を定める告示基準適合品でないものも含まれていることを申し添える。

上表に示す、たん白泡(A)(B)、水成膜泡(Ⅰ)および合成界面活性剤泡(L)がそれに該当している。したがって、これら 4 種類の泡消火薬剤は、アセトンおよびイソプロピルアルコールに対し、全く消火性能を有しない当然の結果であった。

一方、フッ素たん白泡(E)(F)、水成膜泡(J)および合成界面活性剤泡(M)は、個別検定合格品であり、かつ、告示基準適合品のいわゆる「耐アルコール用泡消火薬剤」として、製造販売業者が販売を行っている製品である。水成膜泡(J)および合成界面活性剤泡(M)は、ISO③の AnnexB に示される予想例と若干の差異があったものの、水溶性液体可燃物用低発泡消火薬剤としての性能が確認できる結果であった。しかし、フッ素たん白泡(E)(F)については、予想に反し、驚きの結果を示したといえる。

告示基準の消火試験方法は、規格省令のグーズネック付の標準泡ノズルを使用し、火災模型に泡を供給する方式であり、国際規格に基づき、バックボードに泡を打ち当てて燃焼面に泡を供給するジェントル方式で実験を行ったことを理由に、消火性能に大きな差を生じるとも考えにくい。

(4) 消火の判定に関連する事項

消火を評価する際の留意点として、以下の 2 点について ISO/TC21/SC6/WG4 国際作業部会（以下「国際作業部会」）に対し、確認をしておく必要がある。

国内では、炎の全く残らない状態を消火とするのが当然の考え方であるが、完全に炎の存在しない状態を消火とするのか、ごく小さな残炎は無視し消火と見なしてしまうのか、各国の感覚に差があるように思われるところであり、消火の定義を明確にしておく必要がある。

また、フォースフル方式による泡供給の方法についても同様に明確な定義をしておく必要がある。3分間の連続泡放出を行っている際、泡が落下する地点は油面が攪拌される状態になり、なかなか消炎に至らない場合が多い。90%抑圧状態以降に、泡の落下位置を少しずらすことにより油面攪拌状態を解消し、消炎を早める処置をすることがないようにしなければならない。

過去に開催された国際作業部会会議の際に実施された消火実験において、ノズルを少し動かして泡落下位置をずらし、消火に至らせた事例が報告されている。国内の試験方法に対する感覚と海外各国の感覚とのズレが無いようにしておかなければ、試験運用段階で混乱を招かないとも限らないだろう。

表－11. 実験No.表

実験No.	使用泡消火薬剤記号	規格	発泡	泡放出方式	使用燃料
1	たん白泡 (A)	7203-1	低発泡	フォースフル方式	N-ヘプタン
2	たん白泡 (B)				
3	フッ素たん白泡 (C)				
4	フッ素たん白泡 (D)				
5	水成膜泡 (G)				
6	水成膜泡 (H)				
7	合成界面活性剤泡 (K)				
8	合成界面活性剤泡 (L)				
9	たん白泡 (A)		低発泡	ジェントル方式	N-ヘプタン
10	たん白泡 (B)				
11	フッ素たん白泡 (C)				
12	フッ素たん白泡 (D)				
13	水成膜泡 (G)				
14	水成膜泡 (H)				
15	合成界面活性剤泡 (K)				
16	合成界面活性剤泡 (L)				
17	たん白泡 (A)	7203-3	低発泡	ジェントル方式	アセトン
18	たん白泡 (B)				
19	フッ素たん白泡 (E)				
20	フッ素たん白泡 (F)				
21	水成膜泡 (I)				
22	水成膜泡 (J)				
23	合成界面活性剤泡 (M)				
24	合成界面活性剤泡 (L)				
25	たん白泡 (A)		低発泡	ジェントル方式	IPA
26	たん白泡 (B)				
27	フッ素たん白泡 (E)				
28	フッ素たん白泡 (F)				
29	水成膜泡 (I)				
30	水成膜泡 (J)				
31	合成界面活性剤泡 (M)				
32	合成界面活性剤泡 (L)				
33	たん白泡 (A)	7203-2	中発泡	火災模型上端部へ 泡放出口を接して 設置し放出	N-ヘプタン
34	たん白泡 (B)				
35	フッ素たん白泡 (C)				
36	フッ素たん白泡 (D)				
37	水成膜泡 (G)				
38	水成膜泡 (H)				
39	合成界面活性剤泡 (K)				
40	合成界面活性剤泡 (L)				
41	たん白泡 (A)	7203-2	高発泡	火災模型を静置した ネットフェンス囲い へ放出	N-ヘプタン
42	たん白泡 (B)				
43	フッ素たん白泡 (C)				
44	フッ素たん白泡 (D)				
45	水成膜泡 (G)				
46	水成膜泡 (H)				
47	合成界面活性剤泡 (K)				
48	合成界面活性剤泡 (L)				

表－12. ISO規格比較検証事業/実験実施日程

2月6日	月	実験No.9	実験No.10	実験No.12	実験No.13	(実施欄の解説) 実験No. ISO規格のパート 泡放出方式 試験燃料 実験使用消火薬剤		
		ISO7203-1 ジェントル方式 ノルマルヘプタン たん白泡 (A)	ISO7203-1 ジェントル方式 ノルマルヘプタン たん白泡 (B)	ISO7203-1 ジェントル方式 ノルマルヘプタン フッ素たん白泡 (D)	ISO7203-1 ジェントル方式 ノルマルヘプタン 水成膜泡 (G)			
2月7日	火	実験No.16	実験No.14	実験No.15	実験No.1	実験No.2		
		ISO7203-1 ジェントル方式 ノルマルヘプタン 合成界面泡 (L)	ISO7203-1 ジェントル方式 ノルマルヘプタン 水成膜泡 (H)	ISO7203-1 ジェントル方式 ノルマルヘプタン 合成界面泡 (K)	ISO7203-1 フォースフル方式 ノルマルヘプタン たん白泡 (A)	ISO7203-1 フォースフル方式 ノルマルヘプタン たん白泡 (B)		
2月8日	水	実験No.4	実験No.5	実験No.6	実験No.7	実験No.8		
		ISO7203-1 フォースフル方式 ノルマルヘプタン フッ素たん白泡 (D)	ISO7203-1 フォースフル方式 ノルマルヘプタン 水成膜泡 (G)	ISO7203-1 フォースフル方式 ノルマルヘプタン 水成膜泡 (H)	ISO7203-1 フォースフル方式 ノルマルヘプタン 合成界面泡 (K)	ISO7203-1 フォースフル方式 ノルマルヘプタン 合成界面泡 (L)		
2月9日	木	実験No.21	実験No.24	実験No.17	実験No.18	実験No.20	実験No.23	
		ISO7203-3 ジェントル方式 アセトン 水成膜泡 (I)	ISO7203-3 ジェントル方式 アセトン 合成界面泡 (L)	ISO7203-3 ジェントル方式 アセトン たん白泡 (A)	ISO7203-3 ジェントル方式 アセトン たん白泡 (B)	ISO7203-3 ジェントル方式 アセトン フッ素たん白泡 (F)	ISO7203-3 ジェントル方式 アセトン 合成界面泡 (M)	
2月14日	火	実験No.19	実験No.22	実験No.3	実験No.11	実験No.25	実験No.26	実験No.32
		ISO7203-3 ジェントル方式 アセトン フッ素たん白泡 (E)	ISO7203-3 ジェントル方式 アセトン 水成膜泡 (J)	ISO7203-1 フォースフル方式 ノルマルヘプタン フッ素たん白泡 (C)	ISO7203-1 ジェントル方式 ノルマルヘプタン フッ素たん白泡 (C)	ISO7203-3 ジェントル方式 I P A たん白泡 (A)	ISO7203-3 ジェントル方式 I P A たん白泡 (B)	ISO7203-3 ジェントル方式 I P A 合成界面泡 (L)
2月15日	水	実験No.30	実験No.29	実験No.28	実験No.27	実験No.31		
		ISO7203-3 ジェントル方式 I P A 水成膜泡 (J)	ISO7203-3 ジェントル方式 I P A 水成膜泡 (I)	ISO7203-3 ジェントル方式 I P A フッ素たん白泡 (F)	ISO7203-3 ジェントル方式 I P A フッ素たん白泡 (E)	ISO7203-3 ジェントル方式 I P A 合成界面泡 (M)		
2月28日	火	実験No.40	実験No.39	実験No.37	実験No.38	実験No.36	実験No.35	実験No.33
		ISO7203-2 中発泡 ノルマルヘプタン 合成界面泡 (L)	ISO7203-2 中発泡 ノルマルヘプタン 合成界面泡 (K)	ISO7203-2 中発泡 ノルマルヘプタン 水成膜泡 (G)	ISO7203-2 中発泡 ノルマルヘプタン 水成膜泡 (H)	ISO7203-2 中発泡 ノルマルヘプタン フッ素たん白泡 (D)	ISO7203-2 中発泡 ノルマルヘプタン フッ素たん白泡 (C)	ISO7203-2 中発泡 ノルマルヘプタン たん白泡 (A)
								実験No.34
2月29日	水	実験No.48	実験No.47	実験No.45	実験No.46	実験No.44	実験No.43	実験No.41
		ISO7203-2 高発泡 ノルマルヘプタン 合成界面泡 (L)	ISO7203-2 高発泡 ノルマルヘプタン 合成界面泡 (K)	ISO7203-2 高発泡 ノルマルヘプタン 水成膜泡 (G)	ISO7203-2 高発泡 ノルマルヘプタン 水成膜泡 (H)	ISO7203-2 高発泡 ノルマルヘプタン フッ素たん白泡 (D)	ISO7203-2 高発泡 ノルマルヘプタン フッ素たん白泡 (C)	ISO7203-2 高発泡 ノルマルヘプタン たん白泡 (A)
								実験No.42

※なお、国際規格では、試験における気温について、15.0℃±5.0℃と規定されているが、本実験の試験温度は、5℃から13.5℃の範囲であった（温度については、6-3-1. (1)においてとりまとめている）。

表－13. ISO 7 2 0 3－1（非水溶性液体可燃物用低発泡泡消火薬剤規格）消火性能実験結果
 【ジェントル方式】火災模型：4.52㎡、燃料：N-ヘプタン144L、UNI86ノズル：流量11.4L/分（0.63MPa）、泡供給率：2.52L/㎡・分

実験No.			9	10	11	12	13	14	15	16
泡消火薬剤			たん白泡 (A)	たん白泡 (B)	フッ素 たん白泡 (C)	フッ素 たん白泡 (D)	水成膜泡 (G)	水成膜泡 (H)	合成界面泡 (K)	合成界面泡 (L)
気温 (℃)			5.0	6.5	8.5	6.5	7.5	10.0	10.5	7.0
湿度			84%	78%	70%	78%	75%	87%	85%	78%
風速			3 m/秒未満							
泡水溶液温度 (℃)			19.8	19.8	19.6	20.0	19.8	19.2	19.1	20.0
発 泡 性 能	発泡倍率	①	6.94	7.41	7.88	7.98	9.33	9.09	10.97	11.40
		②	7.00	7.54	7.88	8.05	9.37	8.93	10.65	10.83
		平均	6.97	7.48	7.88	8.02	9.35	9.01	10.81	11.12
	25%還元量 (ml)	①	58	54	52	50	42	44	36	36
		②	58	54	52	50	42	44	38	38
	25%還元時間	①	6分09秒	5分10秒	5分54秒	5分57秒	3分18秒	3分44秒	8分20秒	10分29秒
		②	6分07秒	4分51秒	5分57秒	5分46秒	3分06秒	3分34秒	8分38秒	11分37秒
		平均	6分08秒	5分01秒	5分56秒	5分52秒	3分12秒	3分39秒	8分29秒	11分03秒
消 火 性 能	敷水温度 (℃)	前	6.3	7.6	8.9	9.1	10.8	10.1	8.9	7.6
		後	14.2	16.6	19.0	25.1	23.0	20.8	18.6	31.2
	燃料温度 (℃)	前	6.3	7.5	8.0	8.2	8.8	9.2	8.9	7.6
		後	28.3	28.4	30.1	29.3	30.6	29.9	27.4	41.8
	消 火	予燃焼時間		1分間						
		泡供給時間		5分間						
		被覆時間		2分30秒	1分20秒	50秒	40秒	40秒	40秒	43秒
		90%抑圧時間		2分32秒	1分43秒	1分30秒	1分22秒	1分03秒	54秒	1分05秒
		99%抑圧時間		3分25秒	2分30秒	2分10秒	2分05秒	1分22秒	1分20秒	1分30秒
		消火時間		4分32秒	3分05秒	2分52秒	3分14秒	2分12秒	2分08秒	消火不能
	耐 再 燃 性	開始までの待機時間		泡供給停止から5分間						
		泡面着火時間		4分40秒	5分13秒	3分28秒	5分11秒	1分27秒	1分35秒	1分40秒
		5分後の燃焼拡大面積		< 1 %	< 1 %	< 1 %	< 1 %	< 1 %	< 1 %	5%
		10分後の燃焼拡大面積		< 1 %	< 1 %	< 1 %	< 1 %	< 1 %	< 1 %	8%
		15分後の燃焼拡大面積		< 1 %	< 1 %	< 1 %	< 1 %	< 1 %	< 5%	—
		25%拡大時間		—	—	—	—	—	—	13分30秒
	消火性能クラス		Ⅲ	Ⅲ	Ⅲ	Ⅲ	Ⅲ	Ⅲ	Ⅲ	Ⅲ
	耐再燃性能レベル		B	B	B	B	B	B	—	C

表-14. ISO 7 2 0 3-1（非水溶性液体可燃物用低発泡消火薬剤規格）消火性能実験結果

【フォースフル方式】火災模型：4.52m²、燃料：N-ヘプタン144L、UNI86ノズル：流量11.4L/分（0.63MPa）、泡供給率：2.52L/m²・分

実験No.			1	2	3	4	5	6	7	8	
泡消火薬剤			たん白泡 (A)	たん白泡 (B)	フッ素 たん白泡 (C)	フッ素 たん白泡 (D)	水成膜泡 (G)	水成膜泡 (H)	合成界面泡 (K)	合成界面泡 (L)	
気温 (℃)			11.5	10.5	5.5	7.0	8.5	9.5	10.0	10.0	
湿度			87%	90%	77%	50%	43%	50%	50%	50%	
風速			3 m/秒未満								
泡水溶液温度 (℃)			19.0	18.9	19.3	18.6	19.2	19.6	19.3	19.5	
発 泡 性 能	発泡倍率	①	7.01	6.72	7.77	7.42	9.41	9.04	11.36	11.15	
		②	6.94	6.77	7.41	7.39	9.25	9.13	10.7	10.67	
		平均	6.98	6.75	7.59	7.41	9.33	9.09	11.03	10.91	
	25%還元量 (ml)	①	58	60	52	54	42	44	36	36	
		②	58	60	54	54	44	44	38	38	
	25%還元時間	①	6分31秒	4分50秒	5分33秒	7分56秒	3分48秒	4分45秒	11分26秒	11分48秒	
		②	6分31秒	4分26秒	5分35秒	7分20秒	3分42秒	4分31秒	11分19秒	12分36秒	
		平均	6分31秒	4分38秒	5分34秒	7分38秒	3分45秒	4分38秒	11分23秒	12分12秒	
	消 火 性 能	敷水温度 (℃)	前	10.1	10.7	9.8	7.3	8.8	8.6	9.2	9.2
後			(23.8)	(24.5)	22.0	19.3	25.6	(19.8)	(25.0)	(27.0)	
燃料温度 (℃)		前	10.1	9.7	7.9	7.5	8.6	8.3	8.9	8.9	
		後	(34.6)	(31.5)	32.5	32.2	27.5	(28.6)	(26.9)	(48.6)	
消 火		予燃焼時間		1分間							
		泡供給時間		3分間							
		被覆時間		45秒	34秒	1分00秒	40秒	37秒	40秒	42秒	44秒
		90%抑圧時間		2分30秒	3分00秒	2分25秒	2分30秒	1分52秒	1分18秒	至らず	至らず
		99%抑圧時間		3分00秒	至らず	3分08秒	3分04秒	2分48秒	1分27秒	—	—
		消火時間		消火不能	消火不能	5分27秒	4分02秒	3分22秒	消火不能	消火不能	消火不能
耐 再 燃 性		開始までの待機時間		泡供給停止から5分間							
		泡面着火時間		実施不能	実施不能	(30秒) ※	20秒	28秒	実施不能	実施不能	実施不能
	10分後の燃焼拡大状況		(< 5 %) ※			—	—				
	25%拡大時間		—			5分50秒	1分15秒				
消火性能クラス			I, II に不適合	I, II に不適合	I, II に不適合	I, II に不適合	II	I, II に不適合	I, II に不適合	I, II に不適合	
耐再燃性レベル			—	—	(A) ※	A に不適合	A に不適合	—	—	—	

※消火時間が5分27秒であり、消火クラスⅠ（3分以内）Ⅱ（4分以内）に不適合であるが、参考実験として耐再燃性能実験を実施した結果。

表－15. ISO 7 2 0 3－2（非水溶性液体可燃物用中発泡泡消火薬剤規格）消火性能実験結果
 火災模型：1.73㎡、燃料：N-ヘプタン55L、SKUM製中発泡器：流量3.25L/分（0.5MPa）、泡供給率：1.88L/㎡・分

実験No.		33	34	35	36	37	38	39	40
泡消火薬剤		たん白泡 (A)	たん白泡 (B)	フッ素 たん白泡 (C)	フッ素 たん白泡 (D)	水成膜泡 (G)	水成膜泡 (H)	合成界面泡 (K)	合成界面泡 (L)
気温 (℃)		9.5	9.0	9.0	8.5	6.0	7.0	5.5	4.0
湿度 (%)		43%	58%	48%	50%	55%	64%	68%	75%
風速		3 m/秒未満							
泡水溶液温度 (℃)		19.7	19.4	20.3	19.5	19.7	20	20	19.8
発 泡 性 能	発泡倍率	①	36.3	25.9	46.4	36.9	54.3	58.9	135.1
		②	36.9	26.5	46.4	36.8	33.5	70.3	149.9
		平均	36.6	26.2	46.4	36.9	43.9	64.6	142.5
	25%還元量 (ml)	①	1379	1930	1078	1355	896	849	370
		②	1280	1885	1079	1360	1491	711	334
	25%還元時間	①	6分37秒	3分21秒	5分51秒	4分46秒	2分37秒	2分43秒	13分17秒
		②	5分59秒	3分37秒	5分57秒	4分34秒	2分20秒	2分48秒	12分54秒
		平均	6分18秒	3分29秒	5分54秒	4分40秒	2分29秒	2分46秒	13分06秒
	50%還元量 (ml)	①	2757	3860	2156	2710	1793	1698	740
		②	2560	3770	2157	2719	2982	1422	667
	50%還元時間	①	14分18秒	8分24秒	11分22秒	10分22秒	4分30秒	4分36秒	23分57秒
		②	12分53秒	8分54秒	11分24秒	10分41秒	4分41秒	4分36秒	25分00秒
		平均	13分36秒	8分39秒	11分23秒	10分32秒	4分36秒	4分36秒	24分29秒
消 火 性 能	敷水温度 (℃)	前	9.4	10.1	9.6	8.4	8.0	7.6	7.6
		後	16.2	17.5	18.1	15.4	16.4	15.4	13.0
	燃料温度 (℃)	前	8.5	8.9	8.6	8.0	7.5	7.0	6.6
		後	26.3	28.4	30.1	30.7	29.0	28.8	34.2
	消 火	予燃焼時間		1分間					
		泡供給時間		2分間					
		被覆時間		1分13秒	43秒	33秒	40秒	1分10秒	38秒
		90%抑圧時間		53秒	1分00秒	44秒	47秒	1分00秒	37秒
		99%抑圧時間		1分13秒	1分15秒	51秒	50秒	1分10秒	44秒
		消火時間		1分55秒	1分43秒	54秒	59秒	1分16秒	49秒
	耐再燃性能 (30秒間観察)		着火せず	着火せず	着火せず	着火せず	着火せず	着火せず	11秒に着火し 4秒後消炎
									実施不能

表－16. ISO 7 2 0 3－2（非水溶性液体可燃物用高発泡消火薬剤規格）消火性能実験結果
 火災模型：1.73m²、燃料：N-ヘプタン55L、SKUM製高発泡器：流量6.1L/分（0.5MPa）、泡供給率：3.53L/m²・分

実験No.			41	42	43	44	45	46	47	48	
泡消火薬剤			たん白泡 (A)	たん白泡 (B)	フッ素 たん白泡 (C)	フッ素 たん白泡 (D)	水成膜泡 (G)	水成膜泡 (H)	合成界面泡 (K)	合成界面泡 (L)	
気温 (℃)			5.5	6.0	4.5	5.5	5.0	4.0	5.0	4.5	
湿度			34%	34%	46%	38%	38%	51%	46%	54%	
風速			3 m/秒未満								
泡水溶液温度 (℃)			19.7	19.5	19.6	19.5	19.8	19.8	20.0	20.0	
発 泡 性 能	発泡倍率	①	286	212	529	395	674	804	1136	1000	
		②	291	243	525	427	663	733	1163	1136	
		平均	289	228	527	411	669	769	1150	1068	
	25%還元量 (ml)	①	438	591	237	317	186	155	110	125	
		②	430	514	238	293	189	170	110	110	
	25%還元時間	①	5分45秒	4分13秒	9分09秒	6分17秒	2分05秒	2分30秒	20分22秒	17分50秒	
		②	6分00秒	4分12秒	—	6分53秒	2分08秒	2分31秒	20分25秒	16分01秒	
		平均	5分53秒	4分13秒	9分09秒	6分35秒	2分07秒	2分31秒	20分24秒	16分76秒	
	50%還元量 (ml)	①	875	1181	473	633	371	311	220	250	
		②	860	1028	476	585	377	341	220	220	
	50%還元時間	①	10分16秒	9分22秒	13分28秒	13分46秒	2分47秒	3分33秒	33分03秒	30分43秒	
		②	10分34秒	9分00秒	13分01秒	13分50秒	2分58秒	3分37秒	33分23秒	27分25秒	
		平均	10分25秒	9分11秒	13分15秒	13分48秒	2分53秒	3分35秒	33分13秒	29分24秒	
消 火 性 能	敷水温度 (℃)	前	9.2	11.4	9.8	10.5	8.2	7.0	8.5	6.6	
		後	(23.5)	—	(21.1)	(22.2)	18.7	17.2	16.5	21.2	
	燃料温度 (℃)	前	8.4	8.7	8.1	8.5	7.0	6.3	7.3	5.7	
		後	(39.7)	—	(40.6)	(46.3)	38.8	35.5	25.7	34.7	
	消 火	予燃焼時間		1分間							
		泡供給時間		2分間							
		90%抑圧時間		70%抑圧には 至る	泡が油面に 展開できず	1分40秒	1分37秒	53秒	50秒	22秒	1分22秒
		99%抑圧時間		至らず	至らず	2分08秒	至らず	—	1分18秒	—	—
		消火時間		消火不能	消火不能	消火不能	消火不能	1分51秒	1分43秒	37秒	2分13秒
		泡供給停止 30秒後の状況						完全消火	完全消火	完全消火	完全消火

表－17. IS07 2 0 3-3（水溶性液体可燃物用低発泡泡消火薬剤規格）消火性能実験結果
 【ジェントル方式】火災模型：1.73㎡、燃料：アセトン125L、UNI86ノズル：流量11.4L/分（0.63MPa）、泡供給率：6.59L/㎡・分

実験No.			17	18	19	20	21	22	23	24	
泡消火薬剤			たん白泡 (A)	たん白泡 (B)	フッ素 たん白泡 (E)	フッ素 たん白泡 (F)	水成膜泡 (I)	水成膜泡 (J)	合成界面泡 (M)	合成界面泡 (L)	
気温 (℃)			9.0	9.0	6.0	10.0	5.5	6.0	10.0	7.0	
湿度			42%	42%	70%	38%	50%	77%	38%	37%	
風速			3 m/秒未満								
泡水溶液温度 (℃)			18.9	19.0	18.6	18.3	20.2	19.8	18.5	19.4	
発 泡 性 能	発泡倍率	①	6.78	6.96	7.62	5.14	10.26	7.84	9.47	11.03	
		②	6.81	6.99	7.58	5.13	9.70	7.73	9.52	10.74	
		平均	6.80	6.98	7.60	5.14	9.98	7.79	9.50	10.89	
	25%還元量(ml)	①	60	58	54	78	40	52	44	38	
		②	60	58	54	78	42	52	42	38	
	25%還元時間	①	10分28秒	6分23秒	6分01秒	7分41秒	6分10秒	7分09秒	14分44秒	13分58秒	
		②	9分58秒	6分23秒	5分26秒	7分22秒	6分09秒	7分31秒	14分24秒	13分55秒	
		平均	10分13秒	6分23秒	5分44秒	7分31秒	6分10秒	7分20秒	14分34秒	13分57秒	
	消 火 性 能	燃料温度 (℃)		前	5.1	5.4	4.3	6.6	4.0	4.7	6.1
後				(55.9)	(56.6)	(54.8)	(55.5)	(53.8)	31.6	25.2	(55.0)
消 火		予燃焼時間		2 分間							
		泡供給時間		5分00秒	5分00秒	5分00秒	5分00秒	5分00秒	3分00秒	3分00秒	5分00秒
		被覆時間		至らず	至らず	至らず	至らず	至らず	1分40秒	25秒	至らず
		90%抑圧時間		—	—	—	—	—	1分40秒	25秒	—
		99%抑圧時間		—	—	—	—	—	2分00秒	45秒	—
		消火時間		消火不能	消火不能	消火不能	消火不能	消火不能	2分27秒	2分40秒	消火不能
耐 再 燃 性		開始までの待機時間		泡供給停止から5分間							
		泡面着火時間		実施不能	実施不能	実施不能	実施不能	実施不能	45秒	5分40秒	実施不能
		5分後の燃焼拡大状況							< 1 0 %	< 1 %	
		10分後の燃焼拡大状況							6 分 3 0 秒 2 0 %燃焼拡大	< 1 %	
		15分後の燃焼拡大状況							< 1 %		
		25%拡大時間							7分05秒	—	
消火性能クラス		不適合	不適合	不適合	不適合	不適合	I	I	不適合		
耐再燃性能 レベル		不適合	不適合	不適合	不適合	不適合	C	A	不適合		

表－18. ISO 7 2 0 3-3（水溶性液体可燃物用低発泡消火薬剤規格）消火性能実験結果
 【ジェントル方式】火災模型：1.73㎡、燃料：イソプロピルアルコール125L、UNI86ノズル：流量11.4L/分（0.63MPa）、泡供給率：6.59L/㎡・分

実験No.			25	26	27	28	29	30	31	32
泡消火薬剤			たん白泡 (A)	たん白泡 (B)	フッ素 たん白泡 (E)	フッ素 たん白泡 (F)	水成膜泡 (I)	水成膜泡 (J)	合成界面泡 (M)	合成界面泡 (L)
気温 (℃)			8.0	9.0	11.5	10.0	9.0	7.5	13.5	9.0
湿度			72%	87%	61%	74%	80%	90%	60%	80%
風速			3 m/秒未満							
泡水溶液温度 (℃)			19.6	19.3	19.4	19.6	20.0	19.5	19.6	19.5
発 泡 性 能	発泡倍率	①	6.81	7.48	7.62	5.11	10.39	7.77	9.47	11.03
		②	6.81	7.27	7.51	5.11	10.39	7.73	9.88	10.39
		平均	6.81	7.38	7.57	5.11	10.39	7.75	9.68	10.71
	25%還元量 (ml)	①	60	54	54	80	40	52	44	38
		②	60	56	54	80	40	52	42	40
	25%還元時間	①	6分39秒	5分07秒	5分28秒	6分34秒	4分40秒	8分13秒	10分58秒	11分17秒
		②	6分36秒	5分06秒	5分17秒	5分50秒	4分35秒	8分14秒	10分42秒	11分13秒
		平均	6分38秒	5分07秒	5分23秒	6分12秒	4分38秒	8分14秒	10分50秒	11分15秒
	燃料温度 (℃)		前	5.7	7.5	5.8	6.4	6.1	7.3	6.1
消 火 性 能			後	(55.1)	(55.2)	(54.8)	(55.2)	(53.4)	33.2	(52.1)
	消 火	予燃焼時間	2 分間							
		泡供給時間	5分00秒	5分00秒	5分00秒	5分00秒	5分00秒	3分15秒 ^{※1}	5分00秒	5分00秒
		被覆時間	-	-	-	-	-	2分40秒	45秒	-
		90%抑圧時間	-	-	-	-	-	2分30秒	40秒	-
		99%抑圧時間	-	-	-	-	-	2分50秒	48秒	-
		消火時間	消火不能	消火不能	消火不能	消火不能	消火不能	3分15秒	3分22秒	消火不能
	耐 再 燃 性	開始までの待機時間	泡供給停止から5分間							
		泡面着火時間	実施不能	実施不能	実施不能	実施不能	実施不能	45秒	26秒	実施不能
		5分後の燃焼拡大状況						2 0 %燃焼拡大	< 1 %	
		10分後の燃焼拡大状況						—	< 1 0 %	
		15分後の燃焼拡大状況						—	<15%	
		25%拡大時間						5分30秒	至らず	
	消火性能クラス		不適合	不適合	不適合	不適合	不適合	Ⅱ	Ⅱ	不適合
	耐再燃性能レベル		不適合	不適合	不適合	不適合	不適合	C ^{※1}	A	不適合

※泡供給を消火した時点で停止した。消火クラスⅠに該当する3分以内消火が不能であったので、消火クラスⅡに該当する5分泡供給し、耐再燃性能実験を実施すべき事象であった。

5分間泡供給を行った場合の耐再燃性能レベルはBあるいはAを満足する可能性もありうる。

6. 国際規格の消火試験方法等に係る検証

6. 国際規格の消火試験方法等に係る検証

6-1. 試験方法の妥当性

(1) 非水溶性液体可燃物用低発泡消火薬剤試験方法 (ISO①)

非水溶性液体可燃物用低発泡消火薬剤の消火性能試験データ(表-13.ジェントル方式及び表-14.のフォースフル方式)について、各測定項目を解り易く図示化すると、図-9.「ジェントル方式による各種泡消火薬剤の消火性能と耐再燃性能」及び図-10.「フォースフル方式による各種泡消火薬剤の消火性能と耐再燃性能」に示すとおりとなる。

なお、図中の泡消火薬剤別の欄に示した消火性能及び耐再燃性能の項目については、◎(非常に優れている)、○(優れている)、△(普通)及び×(劣る)の4段階で総合的な評価をしている。

ア 総合的評価の考え方

火災に対する消火能力を消火性能及び耐再燃性能並びに観察記録による泡面の燃焼拡大状況を加味して評価することとした。

(ア) 消火性能

消火性能は、消火時間を最も重要な第1ファクターとし、90%及び99%抑制時間を第2のファクター及び被覆時間を第3のファクターとして評価する。

(イ) 耐再燃性能

耐再燃性能は、再燃性能試験用ポットの炎あるいは熱により、ポット周囲の泡面に着火現象を起こした時間(泡面着火時間)をファクターとして評価する。

イ ジェントル方式の評価

(ア) 試験方法の特徴

ジェントル方式は、バックボードに当てた泡を油面上に供給する方式であり、泡が油面に直接衝突又は突入する勢いが、フォースフル方式に比べ緩やかであることから、泡の油汚染が比較的少ないと考えられる。しかし、泡の状態で炎の中を通過することから、その際、火災による泡の破壊があると考えられる。

なお、石油タンク火災などのように消防隊が泡ノズルから直接タンク油面に泡を放出する場合に近いフォースフル方式による消火方法と比較して発泡した泡が壊れにくい方法であるといわれている。

(イ) 実験結果の考察

① たん白泡消火薬剤

たん白泡(A)(B)は、共に、フッ素たん白泡消火薬剤より消火に時間を要しているが、耐再燃性能ではフッ素たん白泡消火薬剤と同等の性能を有していることが確認された。

② フッ素たん白泡消火薬剤

フッ素たん白泡消火薬剤と水成膜泡消火薬剤とを比較すると、水成膜泡消火薬剤のほうが消火時間は早い、耐再燃性能ではフッ素たん白泡消火薬剤のほうが水成膜泡消火薬剤より優れている。

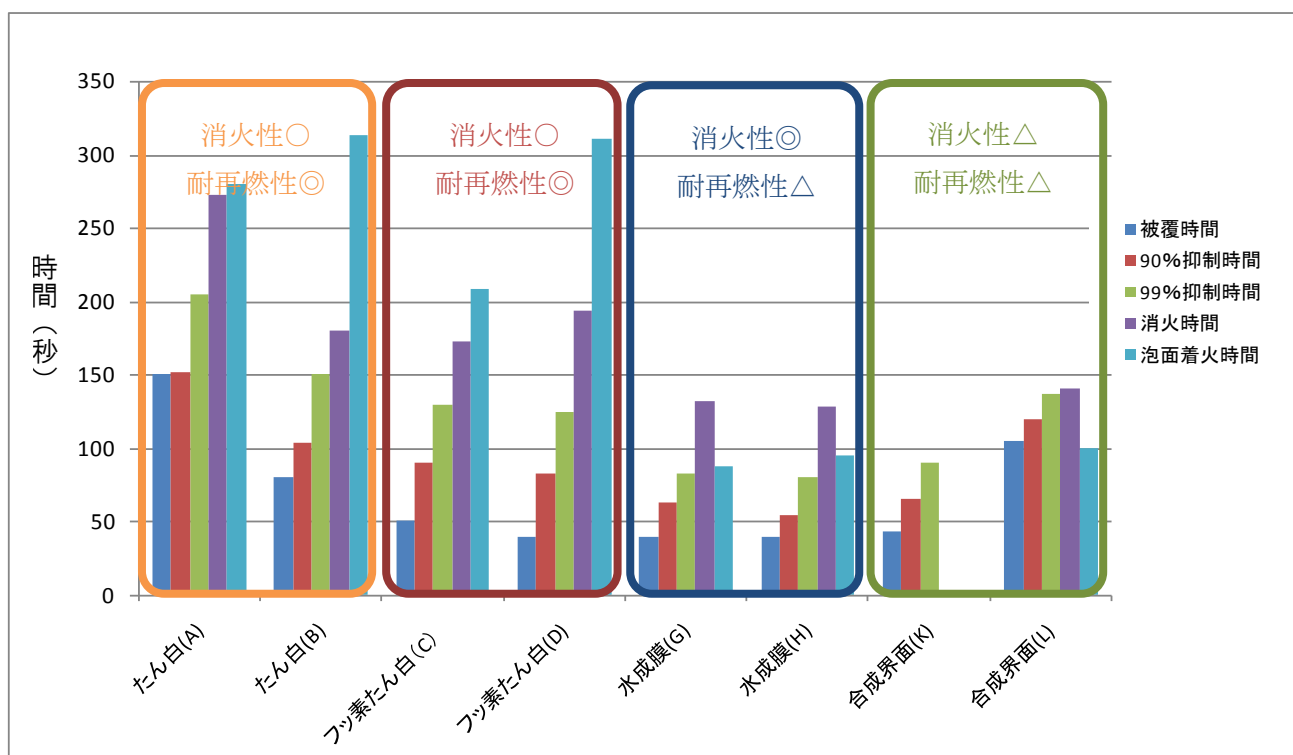
③ 水成膜泡消火薬剤

被覆時間、90%及び99%抑制時間及び消火時間ともに、他の種類の泡に比較し、最も短く消火性能は優れている。一方、耐再燃性能については、泡の油汚染や泡の破壊等の影響から、たん白泡消火薬剤あるいはフッ素たん白泡消火薬剤に比べ劣っている。

④ 合成界面活性剤泡消火薬剤

合成界面活性剤泡(G)は、消火することができなかった。

合成界面活性剤泡(L)は消火できたが、耐再燃性能において、他の泡消火薬剤が15分経過後に燃焼拡大をせず、燃焼拡大が1%未満の結果であったのと違い、13分30秒で燃焼拡大が25%に達し、その後、一気に全面燃焼に至るという結果であった。



図－9. ジェントル方式による各種泡消火薬剤の消火性能と耐再燃性能

ウ フォースフル方式の評価

(ア) 試験方法の特徴

フォースフル方式の消火実験では、泡放出開始直後、供給された全ての泡が直接油面に衝突し、ほとんどの泡が油面下に潜り込んでおり、火炎の熱影響による泡破壊はもちろん、油接触による泡破壊や油汚染した泡の燃焼による破壊などが起こっているものと推定できる。

耐火・耐熱性あるいは耐油汚染性が弱い場合、放出された泡の破壊が進み、燃焼油面上を展開する泡の絶対量が不足し、燃焼抑制することができないまま、燃料が燃え尽きるまで火災が継続してしまう結果を招くことが生じることもある。

(イ) 実験結果の考察

① たん白泡消火薬剤

油面の被覆時間は、概ね 50 秒以内であったが、泡の油汚染により、たん白泡 (A) は、99% 抑制までは達成可能であったが、たん白泡 (B) は、90% 抑制までが限界であった。

たん白泡消火薬剤は、フッ素たん白泡 (C) (D) に比較すると、90% 抑制に長く時間を要する点から、流動展開性の遅れ、あるいは耐油汚染性の弱さを示す結果となっている。

② フッ素たん白泡消火薬剤

フッ素たん白泡は、消火時間が水成膜泡消火薬剤より遅れるものの、耐再燃性では水成膜泡消火薬剤より優れ、特にフッ素たん白泡 (C) は、10 分後の燃焼拡大面積が 5% 未満であり耐火・耐熱性、耐油汚染性が良好であった。

③ 水成膜泡消火薬剤

水成膜泡 (H) は、消火を達成できなかったが、水成膜泡 (G) に注目すれば、流動展開性に優れ、消火を最も迅速に達成できている。

④ 合成界面活性剤泡消火薬剤

合成界面活性泡 (K) (L) は、耐火・耐熱性あるいは耐油汚染性が弱いことから、放出された泡の破壊が進み、燃焼油面上を展開する泡の絶対量が不足し、燃焼抑制することができなかった。

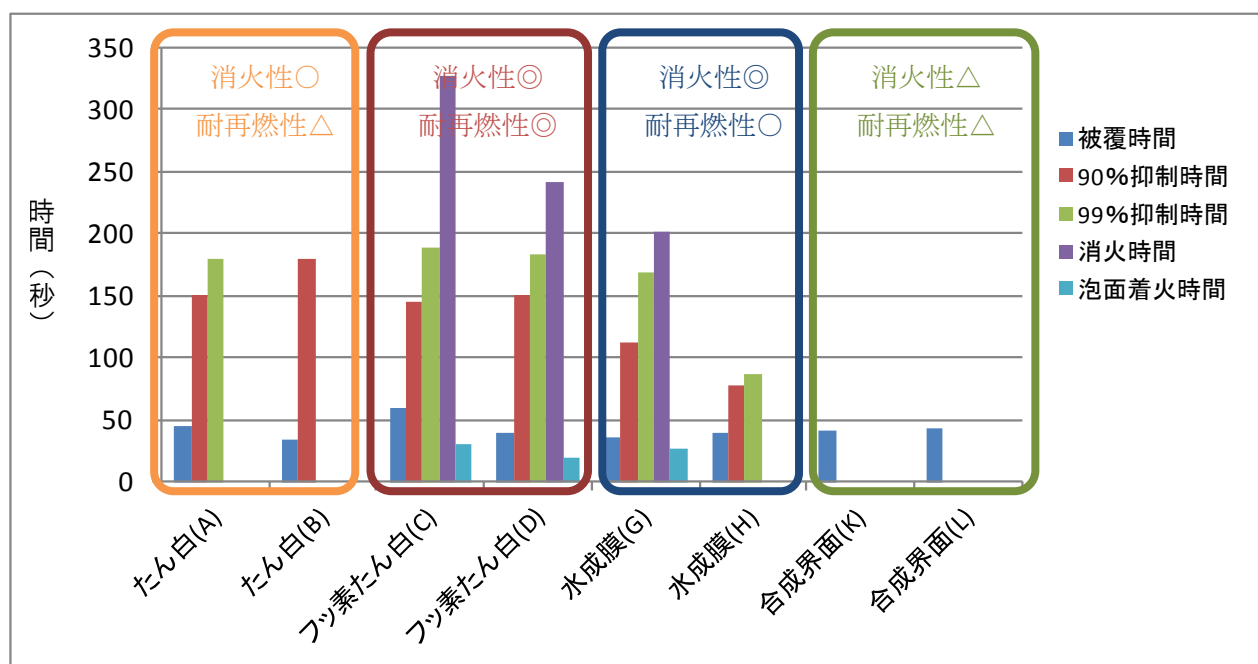


図-10. フォースフル方式による各種泡消火薬剤の消火性能と耐再燃性能

エ 総合的評価

(ア) ジェントル方式及びフォースフル方式による泡消火薬剤の評価

ジェントル方式による試験結果から、泡の消火性能及び耐再燃性能を考慮して、序列をつけると次のとおりとなる。

フッ素たん白泡 > 水成膜泡 ≒ たん白泡 > 合成界面活性剤泡

フォースフル方式による実験結果から、泡の消火性能及び耐再燃性能を考慮し、序列をつけるとすると次のとおりとなる。

フッ素たん白泡 ≧ 水成膜泡 > たん白泡 > 合成界面活性剤泡

フォースフル及びジェントルの2方式による消火性能実験結果から、石油タンク等のプール火災や航空機・自動車事故等による流出油火災を想定した場合、消火性能に序列を付けるとすると、次のとおりとなる。

水成膜泡 > フッ素たん白泡 > たん白泡

また、耐再燃性能について序列をつけるとすると、次のとおりとなる。

フッ素たん白泡 > たん白泡 > 水成膜泡

なお、合成界面活性剤泡消火薬剤については、非水溶性液体可燃物火災用として、低発泡による使用は効果的な消火が期待できないものと考えなければならない。

(イ) 4種類の泡消火薬剤の一般的特徴

従来からの知見をもとに、泡消火薬剤の特徴を整理すると、表－19.「非水溶性液体可燃物用泡消火薬剤の火災適応性」に示すことができる。

表－19. 非水溶性液体可燃物用泡消火薬剤の火災適応性

泡消火薬剤の種類	起泡性	安定性 ・保水性	展開性 ・流動性	耐熱性 (耐火性)	耐油性 (耐油汚染性)	油面 密封性
たん白泡	○	◎	△	○	△	◎
フッ素たん白泡	○	◎	○	◎	◎	◎
水成膜泡	◎	○	◎	○	○	△
合成界面 活性剤泡	◎	○	◎	×	×	×

備考：◎ 非常に優れている ○ 優れている △ 普通 × 劣る

①たん白泡消火薬剤

フォースフル方式により消火を行った場合、燃料油面との衝突により、泡膜表面に油が付着する油汚染が起こりやすく、泡自体の燃焼などの泡破壊が起こりやすくなる。また、泡が固く燃料油面への流動展開性が悪くなり、短時間での消火が難しく長時間の泡供給が必要となってくる。

ジェントル方式により消火を行った場合、流動展開性は劣るが、燃料油との接触も少なく油汚染が起こりにくく、一定の消火能力を保持する。消火後の耐再燃性能においても、熱影響による泡の消滅や泡の膨れ現象が起こりにくく、安定した泡が燃料表面を被覆密封し、再燃防止に寄与することができる。

②フッ素たん白泡消火薬剤

たん白泡消火薬剤の長所を残し、フッ素系界面活性剤を添加することにより、泡膜の油汚染軽減、耐熱性向上、流動展開性改善を図った泡消火薬剤であり、フォースフル方式のような消火を行った場合、たん白泡消火薬剤よりも数段優れる消火能力を発揮することができる。ジェントル方式のような消火では、流動展開性の面で水成膜泡消火薬剤より劣る分、消火に要する時間が長

くなってしまう点は否めない。しかし、耐再燃性能の面では、たん白泡消火薬剤の特徴である泡の安定性とフッ素系界面活性剤添加による泡膜の耐火・耐熱性強度の増強により、燃料油面の被覆密閉性は優れたものとなる。

③水成膜泡消火薬剤

炭化水素系合成界面活性剤とフッ素系界面活性剤を主成分とし、起泡性が良好で流動展開性に優れる特徴があり、泡膜がフッ素系界面活性剤添加により耐火・耐熱性を有しているため、素早く燃焼油面を被覆し、フォースフル方式、ジェントル方式の泡供給方法を問わず、短時間で消火することができる。しかし、泡膜が界面活性剤で生成されているため、燃料蒸気と馴染みやすく、泡膜の膨れ、泡膜中へ燃料蒸気の侵入などによる油汚染が起こりやすい傾向にあり、耐再燃性能試験中に泡表面全体が一気に燃え上がってしまう（フレアーアップ現象）事例がしばしばある。したがって、長時間にわたる燃料油面の被覆密封性を保持することが難しく、スピーディーな消火を実現する能力には優れるが、消火後の安全確保に若干の不安がある。

④合成界面活性剤泡消火薬剤

起泡性が良好で流動展開性に優れ、泡の還元時間も長く泡安定性に優れているので、消火効果が発揮できるものと思慮されるが、環境温度が高いところでは泡の還元時間は極端に短くなってしまうように、泡膜の耐火・耐熱性が弱く、油との接触による油汚染の影響も加味され、泡の破壊や消滅が起こりやすい。したがって、燃焼油面を被覆して消火に至らせるためには多量の泡が必要となる。また、消火後の燃料油面の被覆密封性確保についても多量の泡を供給し続けなければならなくなる。

泡消火薬剤の一般的特長をもとに、泡の種類ごとの総合評価をすると、次のような序列に整理することができる。

フッ素たん白泡 > 水成膜泡 > たん白泡 > 合成界面活性剤泡

（ウ）試験方法の妥当性

フォースフル方式及びジェントル方式による消火性能試験により、得られた消火性能、耐再燃性能をはじめとする特性等を踏まえた総合的評価による消火薬剤の序列、並びに従来からの各泡消火薬剤の種類ごとの一般的特徴を踏まえた総合的評価による消火薬剤の序列をもとに、性能を比較検証すると、ほぼ同様に評価できている。

したがって、ISO①の非水溶性液体火災用低発泡泡消火薬剤の消火性能試験方法基準は、泡消火薬剤の火災適応性を適切に評価できるものであると結論付けることができる。

（2）非水溶性液体可燃物用中・高発泡泡消火薬剤の消火性能試験方法【ISO②】

ア 中・高発泡泡消火薬剤の用途等

中・高発泡泡消火薬剤の泡の成り立ちの歴史的背景と使用用途については、次の通りである。

鉱山火災用に高発泡泡を利用した消火方法が英国で普及し始め、その後、屋内閉鎖空間消火に使用するだけでなく、屋外火災の風の影響下でも泡の放出が効率的となるよう膨張率を低くした中発泡泡消火が普及するようになったといわれている。

一方、国内においては、高発泡用途として、駐車場、一般倉庫やラック倉庫など危険物を含む防火対象物に設置される事例がある。また、LNG タンクなど低温液化ガス貯蔵施設の防液堤などに火災抑性やガス漏洩拡散防止対策として、高発泡泡を使用する事例もある。

海外についても、国内と同様に使用されていることも考えられるが、正確に使用用途が把握できていないので、今後、これらの設置用途、方法などの例について、調査を行う必要がある。

このような背景から、高い膨張率の泡を生成しやすい特性を有する合成界面活性剤泡消火薬剤を中心に、中・高発泡泡消火設備が実用化されていると考えられ、消火性能試験用発泡機器も合成界面活性剤泡消火薬剤を前提としたものと想定される。

イ 中発泡泡消火性能試験

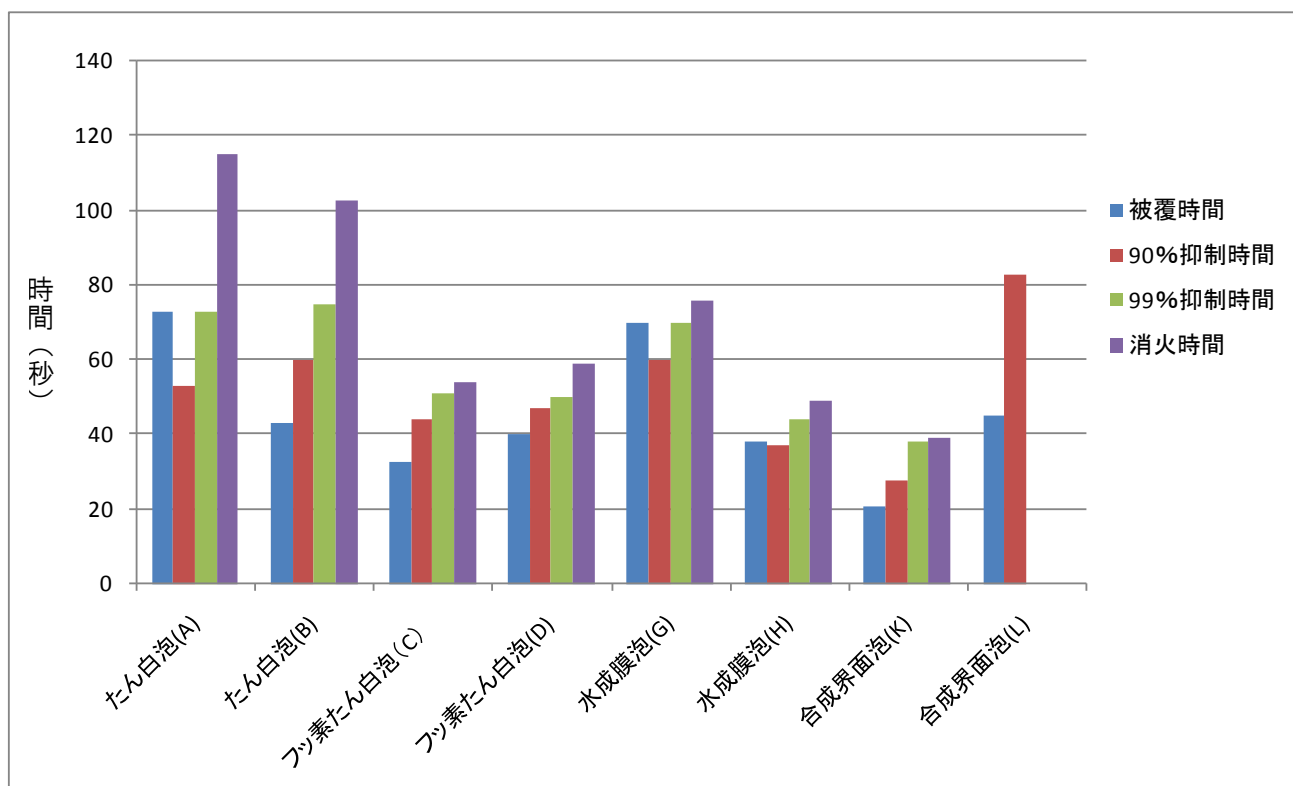
(ア) 試験方法の特徴

発泡ノズルを火災模型の上辺に接触させて泡を投入する方式であり、泡がノズル側から積み重なるように油面を展開する。したがって、泡の耐火・耐熱性能が評価できる。

また、同じ条件で発泡させることから起泡性に優れた泡ほど発泡倍率が高くなる傾向にある。

(イ) 実験結果の概要

非水溶性液体可燃物用中発泡泡消火薬剤の消火性能実験データ(表－15.) について、各測定項目を図示化すると、図－11. 「中発泡泡による各種泡消火薬剤の消火性能と耐再燃性能」に示すようになる。



図－11. 中発泡泡による各種泡消火薬剤の消火性能と耐再燃性能

① 発泡倍率

泡消火薬剤の一般的性状（起泡性、安定性・流動性）のとおり、次の序列となる。

合成界面活性剤泡 > 水成膜泡 > フッ素たん白泡 > たん白泡

② 消火性能と耐再燃性能

消火性能と耐再燃性能については、低発泡泡消火実験の結果と同様な結果であり、次のような序列となる。

フッ素たん白泡 > 水成膜泡 ≒ たん白泡 > 合成界面活性剤泡

(ウ) 試験方法の妥当性

中発泡泡の消火実験の結果は、低発泡泡消火実験の結果に近似しており、泡の性能を評価することに適している試験方法と考える。

ウ 高発泡泡消火性能試験方法

(ア) 試験方法の特徴

ネットフェンスの囲いの中央に置かれた火災模型の前方から泡を流し込む方式であり、火炎により泡が破壊されずに火災模型にいかに早く到達し、火災模型へいかに多量の泡を供給できるかが、消火を可能にするカギとなる。中発泡の試験よりも起泡性、流動展開性、耐火・耐熱性などの泡性状を評価しやすいといえ、より泡消火薬剤の一般的性状（起泡性、安定性・流動性）を評価することができる。一方、起泡性の低い泡消火薬剤については、そもそも高発泡状態とすることが困難な場合がある。

(イ) 実験結果の概要

① 発泡倍率

泡消火薬剤の一般的性状（起泡性、安定性・流動性）のとおり、中発泡と同様、次のような序列となる。

合成界面活性剤泡 > 水成膜泡 > フッ素たん白泡 > たん白泡

② 消火性能と耐再燃性能

消火性能と耐再燃性能については、消火することができなかった、たん白泡及びフッ素たん白泡を除き、高発泡泡に適した泡の順となった。

高発泡の場合は、泡そのものの消火性能や耐再燃性能よりも、大量の泡が短時間のうちに火災模型をいかに覆うかが消火性能に影響している。

合成界面活性剤泡 > 水成膜泡 ×フッ素たん白泡 ×たん白泡

(ウ) 試験方法の妥当性

高発泡泡の消火実験の結果からみて、高発泡に適した泡を評価する手法として適している試験方法と考える。

(3) 水溶性液体可燃物用低発泡泡消火薬剤の消火性能試験方法【ISO③】

ア 水溶性液体可燃物用消火薬剤

国内規格として、水溶性液体可燃物用の泡消火薬剤は、検定対象機械器具等の対象から除外されており、規格省令に定められていない。一方、水溶性液体可燃物用低発泡泡消火薬剤については、専ら危険物施設に用いられることから、消火性能基準は規格省令の試験方法を準用した「製造所等の泡消火設備の技術上の基準の細目を定める告示」（平成23年 総務省告示第559号）が定められており、当該告示により試験を行うよう規定されている。

イ 試験方法

(ア) 試験方法の特徴

ジェントル方式により、UNI86ノズルを使用して非水溶性液体可燃物用低発泡泡消火薬剤の消火方法より放射レート（単位時間・面積あたりの放射量をいう。）を高く（火災模型の大きさが小さい。約2.5倍）設定して消火する方法である。

(イ) 実験結果の概要

実験に使用した泡消火薬剤8種類のうち、水溶性液体可燃物用のものは、試料の調達の関係により、4種類のみとなってしまった。その水溶性液体可燃物用泡消火薬剤4種類のうち、消火性能及び耐再燃性能を有しているものは2種類にとどまった。なお、アセトンとイソプロピルアルコールの燃料の違いがあつたとしても、実験結果は変わらなかった。

(ウ) 試験方法の妥当性

消火実験の結果からみて、水溶性液体可燃物用泡消火薬剤を評価する手法として適している試験方法といえる。ただし、燃料をアセトンとイソプロピルアルコールの2種類に限定しているが、水溶性液体可燃物用泡消火薬剤を評価するものとしてふさわしいか検証の必要がある。

6-2. 国内製品に対する影響

今回行った国際規格に基づく泡消火薬剤の消火試験方法については、消火活動や泡消火設備として使用する場合、泡消火薬剤に求められる展開・流動性、耐熱性、耐油性、油面密封性等の性能を評価できるものとして、概ね妥当であることが確認できた。特に、非水溶性液体可燃物用低発泡泡消火試験については、規格省令と異なり、1つの標準ノズルにより泡の性能を確認できるという点で、当該国際規格が非常にシンプルかつ明快な規格であるといえる。

また、その他の規格についても同様であるが、泡消火薬剤の品質の優劣を明確に判断することができ、また、この規格により判断された泡消火薬剤については消防機関やその他使用者が、今までより安心して使用することが出来るものと考えられる。

一方で、今回の試験に用いた現行の「泡消火薬剤の技術上の規格を定める省令」に適合している泡消火薬剤のうち、国際規格に基づく試験を行った際、不適合となるものがあった。これについては、現行の国内の泡消火薬剤が、規格省令に適合させることを前提に製造されており、必ずしも消火活動や消火設備に使用される環境等を十分に反映していないものとする。

国際的な視点で見ると、EU圏は、国際規格のベースとしてEN規格が採用されており、中華人民共和国は、国際規格について、国内規格への反映が明言されており、かつ、国際幹事国を請け負っているところである。このようなヨーロッパ、アジアにおける主要国の活動を鑑みた場合、我が国に水溶性液体可燃物用泡消火薬剤を皮切りに、国際規格適合品が押し寄せてくることも視野に入れておく必要がある。

今後の国際動向について注視しながらも、国際的に通用する品質として、消火活動や消火設備として使用する環境等を考慮したさらなる開発、技術の発展が必要とされる。

6-3. その他国際規格の留意点について

国際規格に基づく試験を実施した際に、今後、試験の信頼性、再現性等の向上の観点から検討すべき必要がある事項を整理した。

6-3-1. 国際規格の改定の際に見直しを要求すべき事項

国際規格の改定等の際に見直しを要求すべき事項は、次の通りである。

(1) 温度環境に係る事項

消火試験時の温度環境について、国際規格では気温 $15.0^{\circ}\text{C} \pm 5.0^{\circ}\text{C}$ 等という環境条件が規定されている。日本では、自然環境下で消火実験を行うこととしており、夏期や冬期などでは温度条件の範囲外となることが想定される。

また、大規模な試験場にエアコンを導入し、温度環境を調整することは現実的に不可能に近いと考えられる。また、水温などについても同様である。

今後、国際規格の見直しに際しては、許容温度範囲について、地域性や自然環境等を考慮したものとなるよう意見を提出することが肝要だ。

(2) 使用試験機器の詳細な仕様・性能確認方法の決定

今回使用した低発泡用ノズル、中発泡用ノズル及び高発泡機については、国際規格において仕様等が明確でない部分もあり、今後さらに詳細な仕様を決定する必要がある。また、これらの機器が所要性能を有しているか否かの確認方法についても規定が必要である。

(3) 耐再燃性能に関する事項

(ISO①関係)において、耐再燃性能試験用ポットを火災模型中央に設置し耐再燃性能を確認すると規定されているが、耐再燃性能試験ポットの深さ(250mm)が火災模型の深さ(200mm)より高く設定されていることの理由について明確にしておく必要がある。この点については、放出した泡が積み上がりすぎ、ポットに泡が流入してしまうことを想定されるが、例えば、ポット深さを 200mm にした場合、火源をより泡面に近づけることができ、消火後の泡面の耐再燃性強度の評価をより明確にできると考える。

(4) 発泡倍率・還元時間に係る事項

中発泡(200L)及び高発泡(500L)の国際規格で規定された補集容器を用い、発泡倍率及び還元時間を測定したが、2人がかりでなんとか作業が可能というところである。ダウンサイジングした収集容器での測定方法について検証し、効率化や省力化などの視点での提言が必要だ。

6-3-2.国際規格を導入する場合の留意事項

国際規格を泡消火薬剤の規格省令に導入する場合の留意事項等は、次の通りである。

(1) (ISO①及び③関係) クラス分け、レベル分けに関する事項

国際規格においては、消火試験の結果を踏まえて、消火性能クラスと耐再燃性能レベルのランク付けし、その旨を表示すると規定されているが、その消火性能クラスと耐再燃性能レベルに適する防火対象物等の推奨使用用途は示されていない。個々の泡消火薬剤の性能あるいは適応性を考慮し、使用されることが望ましい。

今後、国内で流通する泡消火薬剤については、設置される泡消火設備が有効に機能できる最低限の性能を明確すべきと思料される。この場合において、泡消火設備を構成する多様な発泡機器等についても、生成する泡性状を考慮した性能となるよう併せて検討を行う必要がある。

(2) 海水利用に係る事項

国際規格では、泡水溶液に海水を利用できない場合は、「その旨の表示」をするのみで、国際規格適合品となりえる。国内規格は、淡水及び海水を利用して消火試験を実施することが規定されている。

土地柄にも影響しているが、日本においては、コンビナート地域が海岸沿いに存在することが多いことを鑑みても、海水を利用しても淡水と同様の消火性能を有することが求められる。今回の消火性能実験では、淡水希釈のみ実施したが、海水希釈による試験についても検証の必要がある。

(3) (ISO③関係) 燃料に関する事項

国際規格では、アセトンとイソプロピルアルコールを消火性能試験の燃料として規定し、泡消火薬剤の消火性能クラスと耐再燃性能レベルのランク付けがされているが、これだけで水溶性液体可燃物に適応とするのは少し乱暴である。日本国内においては、エタノールの流通量が最も多い。よって、イソプロピルアルコールを用いた消火試験により確認された泡消火薬剤が、エタノールに対する消火性能の有効性を必ずしも確認できるとは限らない。告示基準が定める水溶性液体可燃物の類別代表物質による係数算出のための消火性能試験による方法のほうが説得力がある。

しかし、水溶性液体可燃物の極性度など化学性状は多岐多様であり、対象となる水溶性液体可燃物の消火性能試験を実施し、泡消火薬剤の有効性確認あるいは設置泡消火薬剤量を算出することが望ましい。

水溶性液体可燃物用泡消火薬剤の消火性能確認については、国内流通量を精査し、評価試験燃料の選定について、さらなる検討が必要がある。

(4) 試料の温度環境試験

国際規格では、試料を 60℃に 7 日間静置するエージング（老化）試験の後に消火試験等を実施する規定があるが、エージング試験後の消火性能試験で適合しない場合は、「その旨の表示」をすることで国際規格適合品となりうる（国際規格第 1 版の規定参照）。

一方、規格省令では、変質試験前後の試料を使い、消火試験を実施した場合、いずれについても適合しない限り、国内規格適合とはならない。

国内規格の方がきびしい規格といえるが、泡消火薬剤は長期間貯蔵して使用されることが前提であり、経年劣化促進試験であるエージング試験後についても一定の基準を満たすことが必要である。

(5) 試験時間に関する事項

中発泡及び高発泡ともに、点火から泡放射、消火の判定まで 3 分 30 秒で完了する。試験の実施時間としては、国内規格と比較し、短時間で試験が終えられることは、試験機関の適合性確認や製造事業者の製品開発において効率的である。

(6) 消火不能の際の措置

消火試験において、危険防止のため消火不能となった際の消火方法等についてあらかじめ、必ず消火可能な手段、方法等を考慮しておく必要がある。

(7) 試験機器の仕様・性能等

発泡用試験ノズルや発泡機については、詳細な寸法等が記載された設計図面や設計資料などがなければ、精密製作が不可能なものとなる。その結果、性能試験において再現性を欠くなど支障をきたすことが考えられる。詳細情報を国際規格に記載するよう意見していく必要がある。

また、これらの機器が所要性能を有しているか否かの確認方法についても規定が必要である。

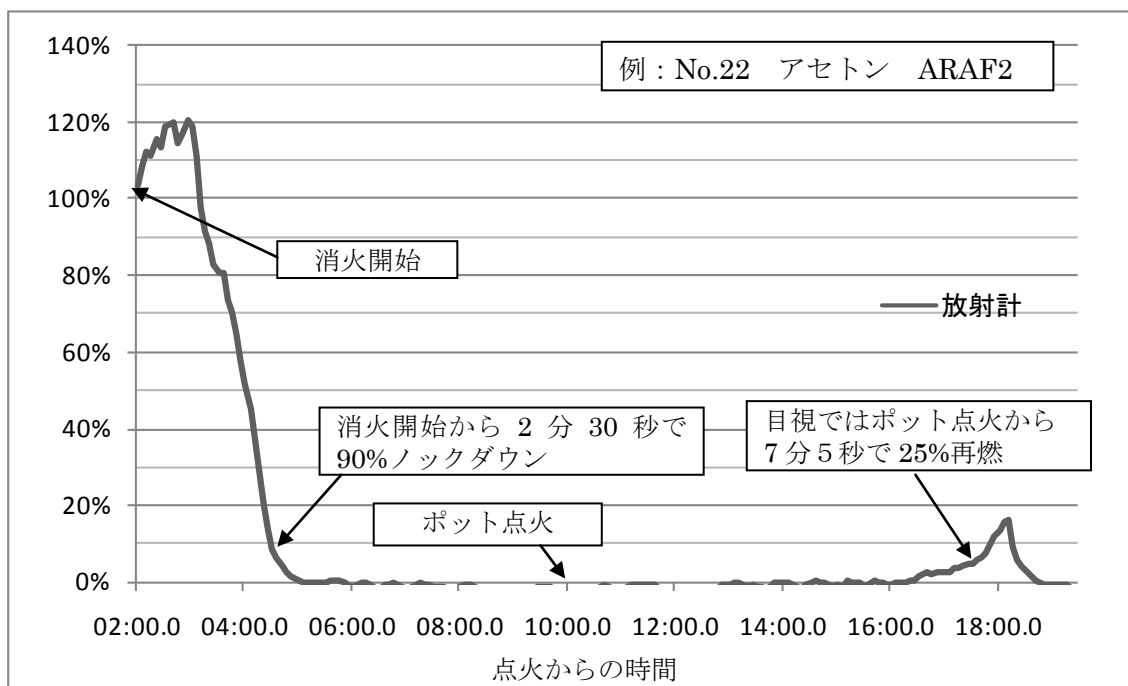
(8) 放射計に関する事項

実験では、放射計を 2 台設置し測定したが、25%燃焼拡大時間の判定において、目視観察記録より放射計測定値からの判定のほうが遅れることが多々あった。ある程度の指標となりうるが、時間的遅れが生じるなど注意が必要であり、放射計記録はあくまで参考としてとどめるべきである。なお、経験豊富な試験立会者による目視での判定のほうが優れていることについては、WG4 国際作業部会においても指摘されているところである。

参 考

(国際規格における放射計測定後のデータ整理方法)

- 1) 消火後 5 秒後から 10 秒後までの 5 秒間における放射熱平均値を利用し、各データ値から差し引く。
- 2) 2 台の放射計の平均値を算出する。
- 3) 泡放出の 30 秒前から 5 秒前までの 25 秒間の平均値を 100%とし、その平均値を各データ値で割り、相対放射熱値を決定する。
- 4) グラフを描く。



6-4.まとめ

泡消火薬剤に係る国際規格のうち、消火試験に特化し、実験を行った結果、特に油火災時において、泡消火薬剤に対して求められる消火能力（展開性・流動性、耐火・耐熱性、耐油性、油密封性等）を適切に評価できるものとして、概ね妥当であることが確認できた。

しかしながら、国際規格に基づいて消火実験を実施した結果を踏まえ、さらに検証することにより、試験方法としての信頼性や再現性の向上を図ることのできる事項も見出すことができた。

これらについては、6-3.においても前述したとおり、国際規格に反映させるべき事項と国内規格として導入する際に検討を要する事項に整理している。今後、これらについては、継続した調査検討が必要である。

一方、今回の消火実験を通じ、現行の泡消火薬剤の技術上の規格を定める省令に適合している泡消火薬剤について、及び、種別ごとの特性や相互間の序列についても、改めて検証することができた。これらについては、今後、国際規格を国内規格に導入する際、内容について改めて検討を行うことが不可欠である。

さらに、今回入手することのできなかつた国際規格適合品については、今後入手し、実験を実施・検証したうえで、国際規格の妥当性等についての検討が必要であろう。

実験を踏まえ、見出された課題、問題点等について引き続き検証等を行い、国内、国際的な知見を蓄積し、我が国の安全・安心のため、技術的な発展を目指すことが望ましい。

最後に、実験に際しご協力いただいた社団法人日本消火装置工業会の関係者の皆様、加えて、短期間において実験及び本報告書を取りまとめいただいた日本消防検定協会の関係者の皆様に感謝申し上げます。

< 参考資料 >

参考 1. 消火実験時の撮影記録

参考 2. ISO7203-1,2,3 における第 1 版(1995 年)と第 2 版(2011 年)
との比較

参考 1. 消火実験時の撮影記録

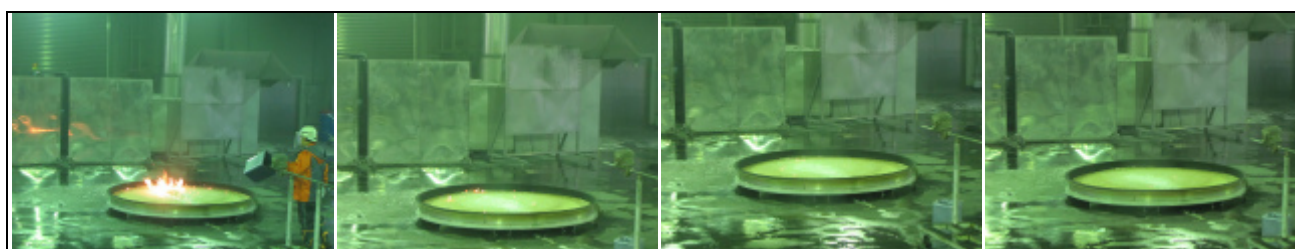
実験 No.1 forceful たん白泡 A (P1) ① 実施日：平成 24 年 2 月 7 日

※点火から 30 秒刻みで撮影

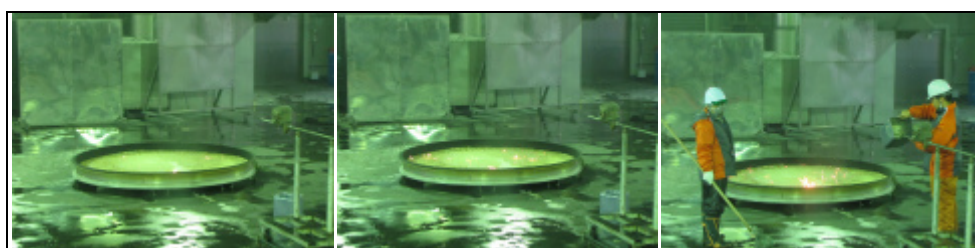
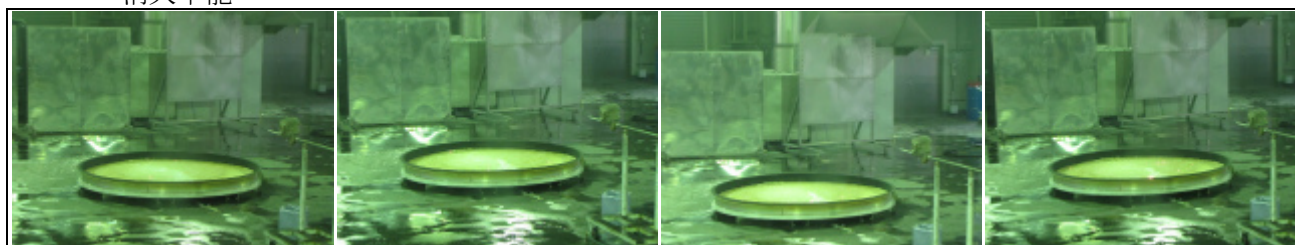


点火

泡放射開始



消火不能



実験 No.2 forceful たん白泡 B (P2) ① 実施日：平成 24 年 2 月 7 日

※点火から 30 秒刻みで撮影



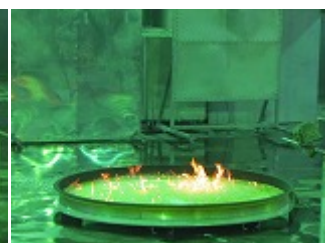
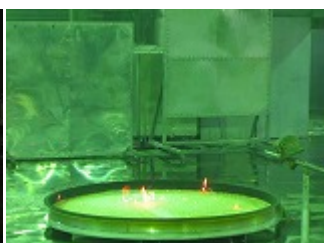
点火



泡放射開始



消火不能



実験 No.3 forceful フッ素たん白泡 C (FP1) ① 実施日：平成 24 年 2 月 14 日
 ※点火から 30 秒刻みで撮影

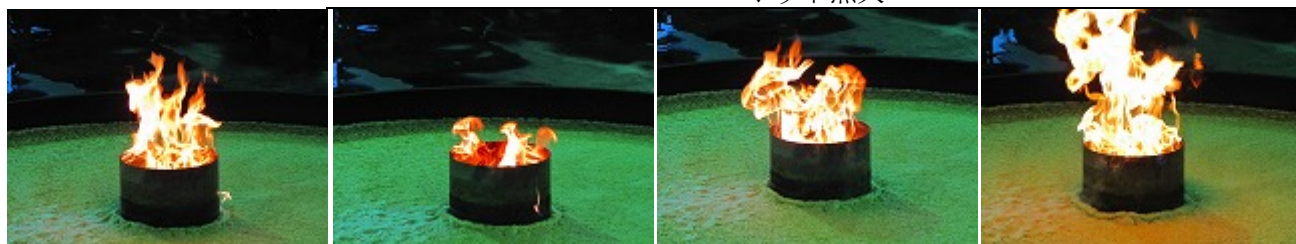


点火

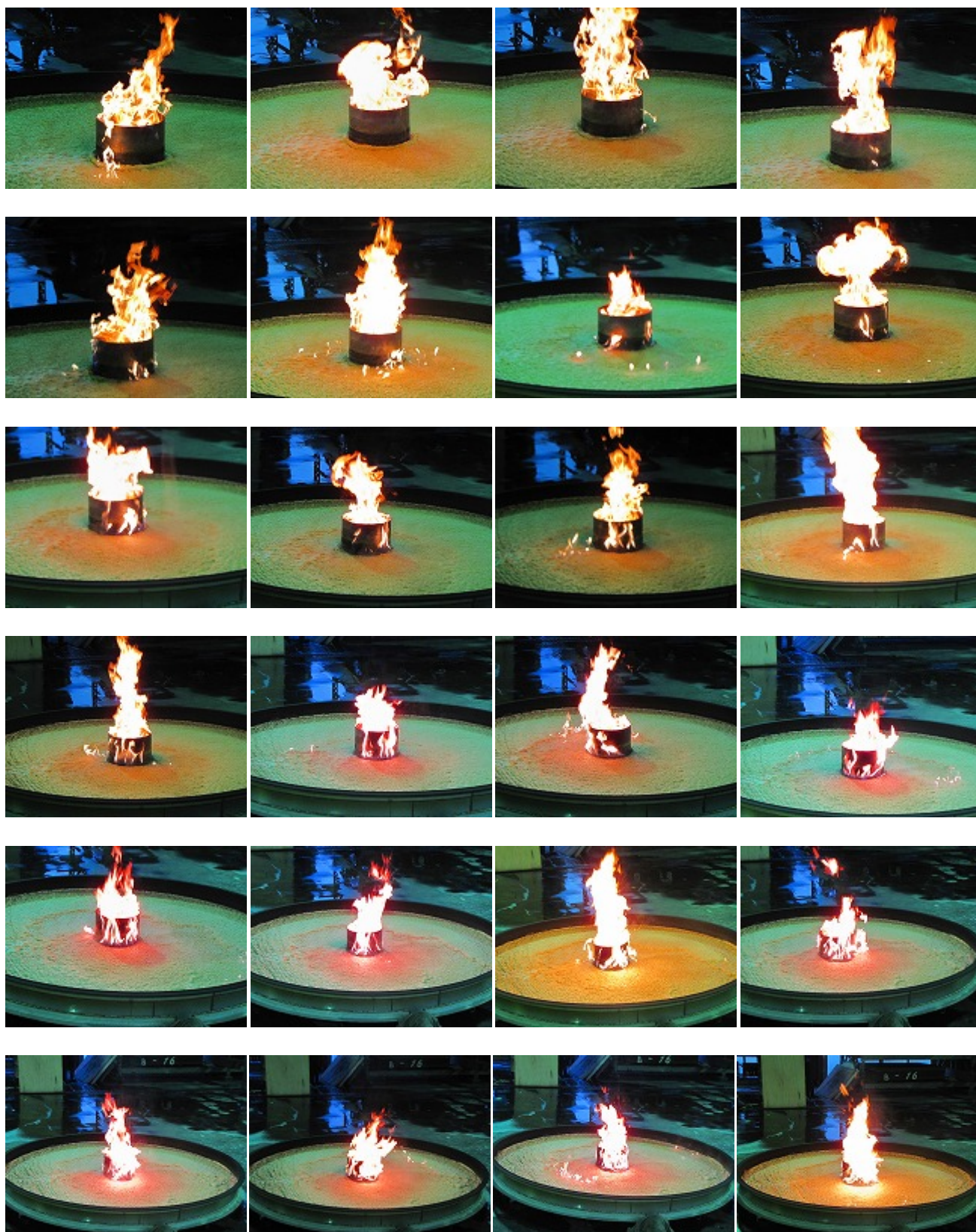
泡放射開始



ポット点火



試験 No.3 forceful フッ素たん白泡 C (FP1) ② 実施日：平成 24 年 2 月 14 日
 ※点火から 30 秒刻みで撮影



実験 No.3 forceful フッ素たん白泡 C (FP1) ③ 実施日：平成 24 年 2 月 14 日
※点火から 30 秒刻みで撮影



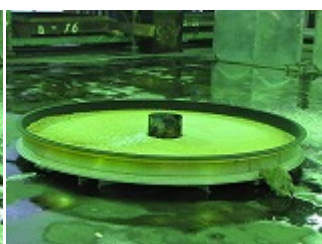
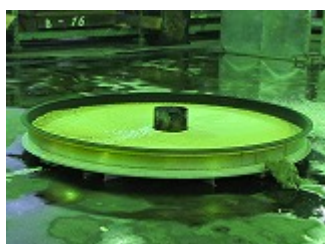
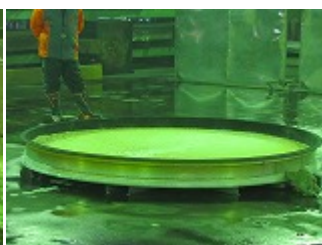
実験 No.4 forceful フッ素たん白泡 D (FP2) ① 実施日：平成 24 年 2 月 8 日
 ※点火から 30 秒刻みで撮影



点火



泡放射開始



ポット点火



実験 No.4 forceful フッ素たん白泡 D (FP2) ② 実施日：平成 24 年 2 月 8 日
※点火から 30 秒刻みで撮影



25%以上再燃

実験 No.5 forceful 水成膜泡 G (AF1) ① 実施日：平成 24 年 2 月 8 日

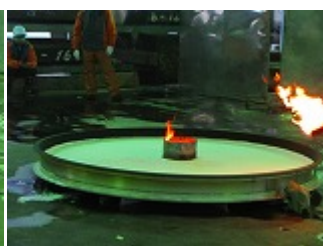
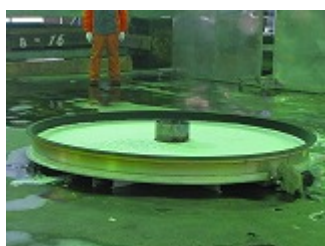
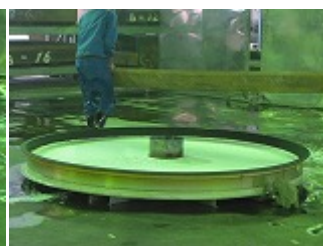
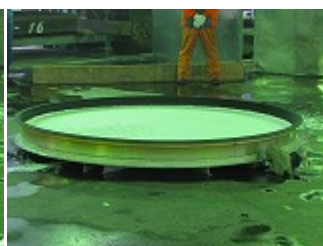
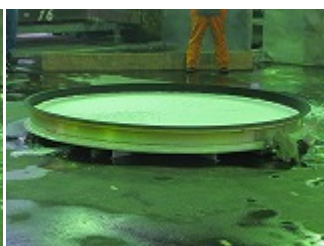
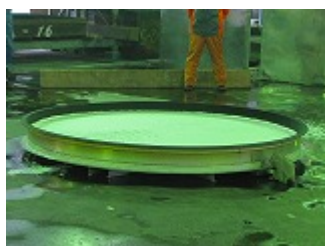
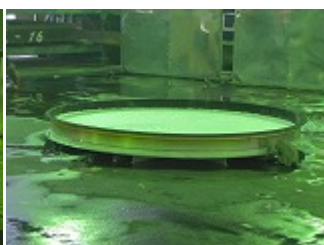
※点火から 30 秒刻みで撮影



点火



泡放射開始



ポット点火



25%以上再燃

実験 No.6 forceful 水成膜泡 H (AF2) ① 実施日：平成 24 年 2 月 8 日

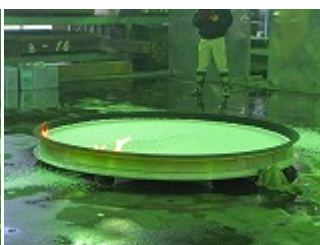
※点火から 30 秒刻みで撮影



点火



泡放射開始



消火不能

実験 No.7 forceful 合成界面泡 K (S1) ① 実施日：平成 24 年 2 月 8 日

※点火から 30 秒刻みで撮影



点火



泡放射開始



消火不能

実験 No.8 forceful 合成界面泡 L (S2) ① 実施日：平成 24 年 2 月 8 日

※点火から 30 秒刻みで撮影



点火



泡放射開始



消火不能

実験 No.9 gentle たん白泡 A (P1) ① 実施日：平成 24 年 2 月 6 日

※点火から 30 秒刻みで撮影



点火



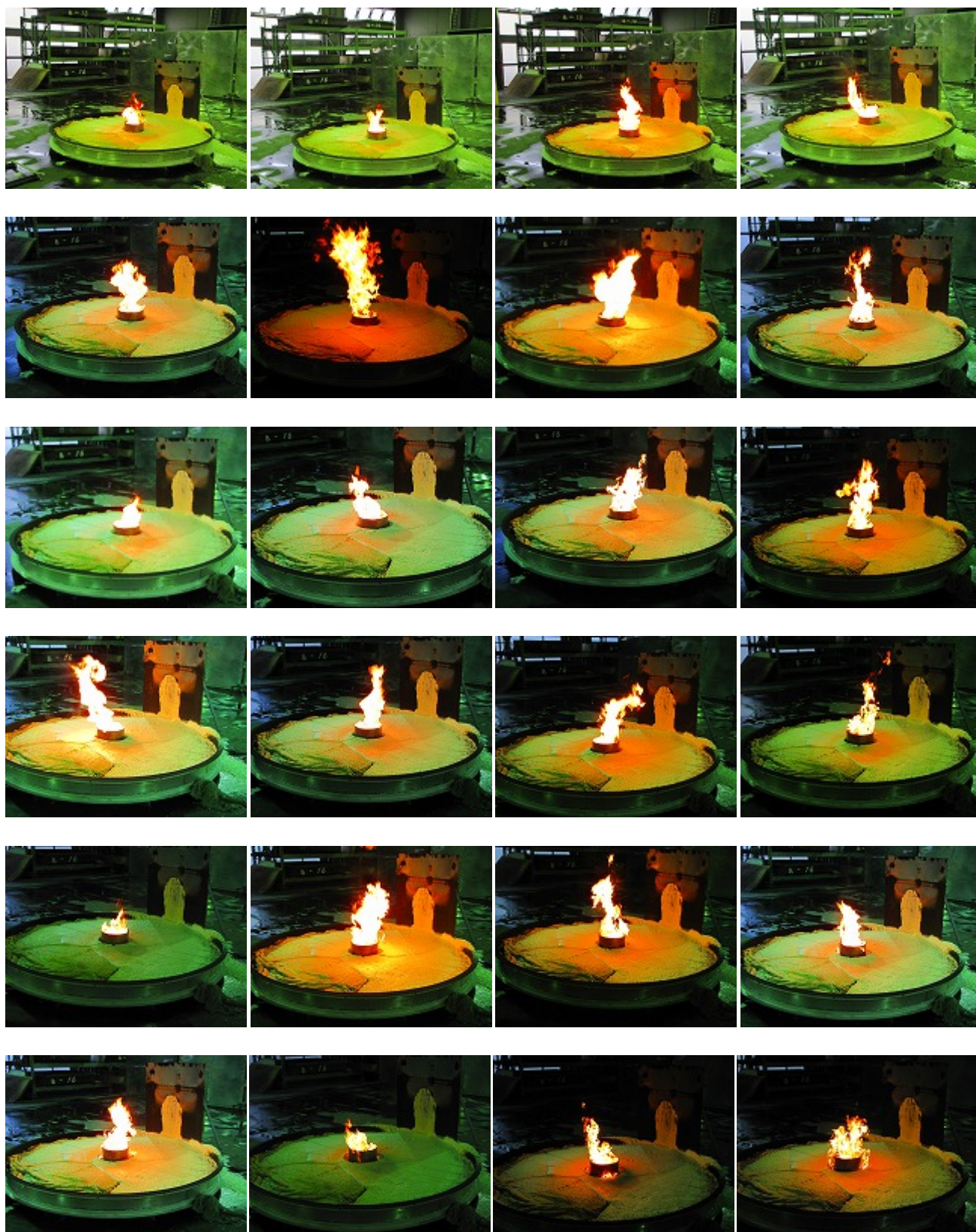
泡放射開始



ポット点火

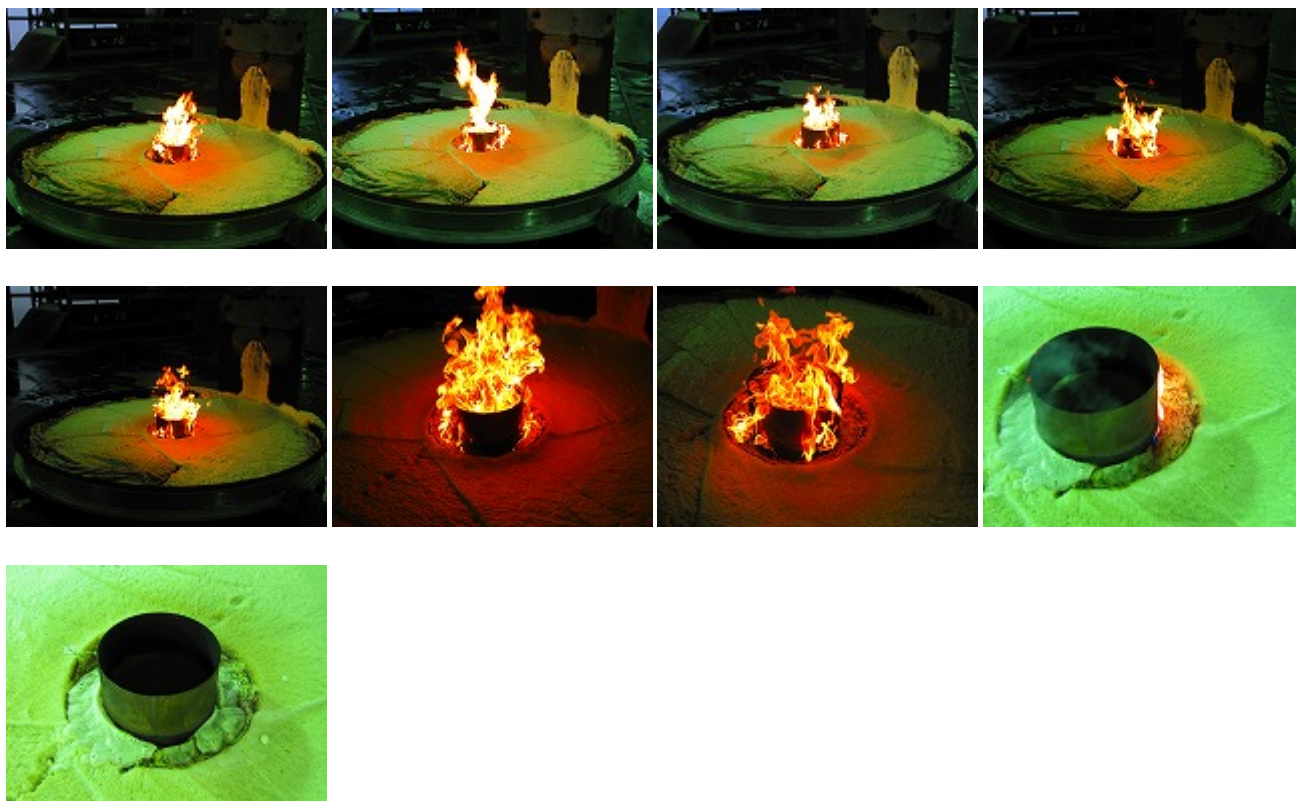
実験 No.9 gentle たん白泡 A (P1) ② 実施日：平成 24 年 2 月 6 日

※点火から 30 秒刻みで撮影



実験 No.9 gentle たん白 A (P1) ③ 実施日：平成 24 年 2 月 6 日

※点火から 30 秒刻みで撮影



実験 No.10 gentle たん白泡 B (P2) ① 実施日：平成 24 年 2 月 6 日

※点火から 30 秒刻みで撮影



点火



泡放射開始



ポット点火

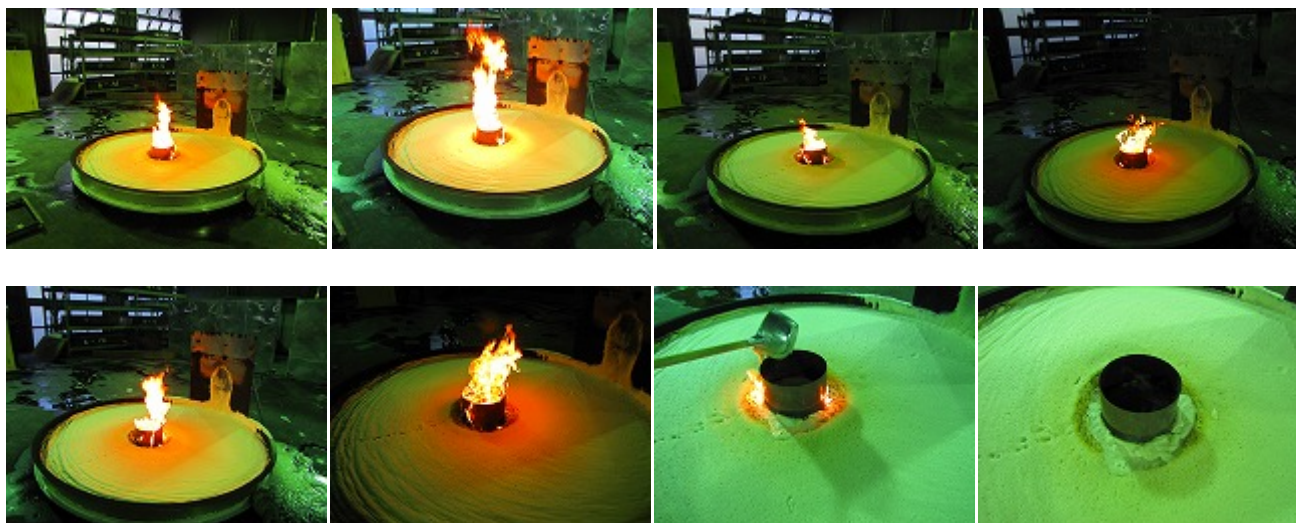
実験 No.10 gentle たん白泡 B (P2) ② 実施日：平成 24 年 2 月 6 日

※点火から 30 秒刻みで撮影



実験 No.10 gentle たん白泡 B (P2) ③ 実施日：平成 24 年 2 月 6 日

※点火から 30 秒刻みで撮影



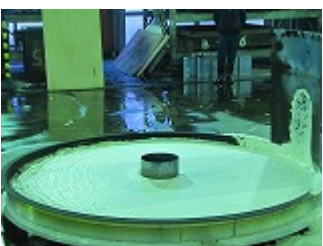
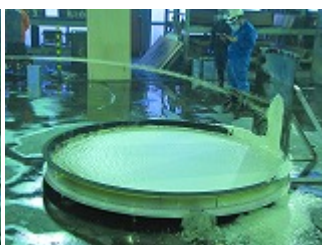
実験 No.11 gentle フッ素たん白泡 C (FP1) ① 実施日：平成 24 年 2 月 14 日
 ※点火から 30 秒刻みで撮影



点火

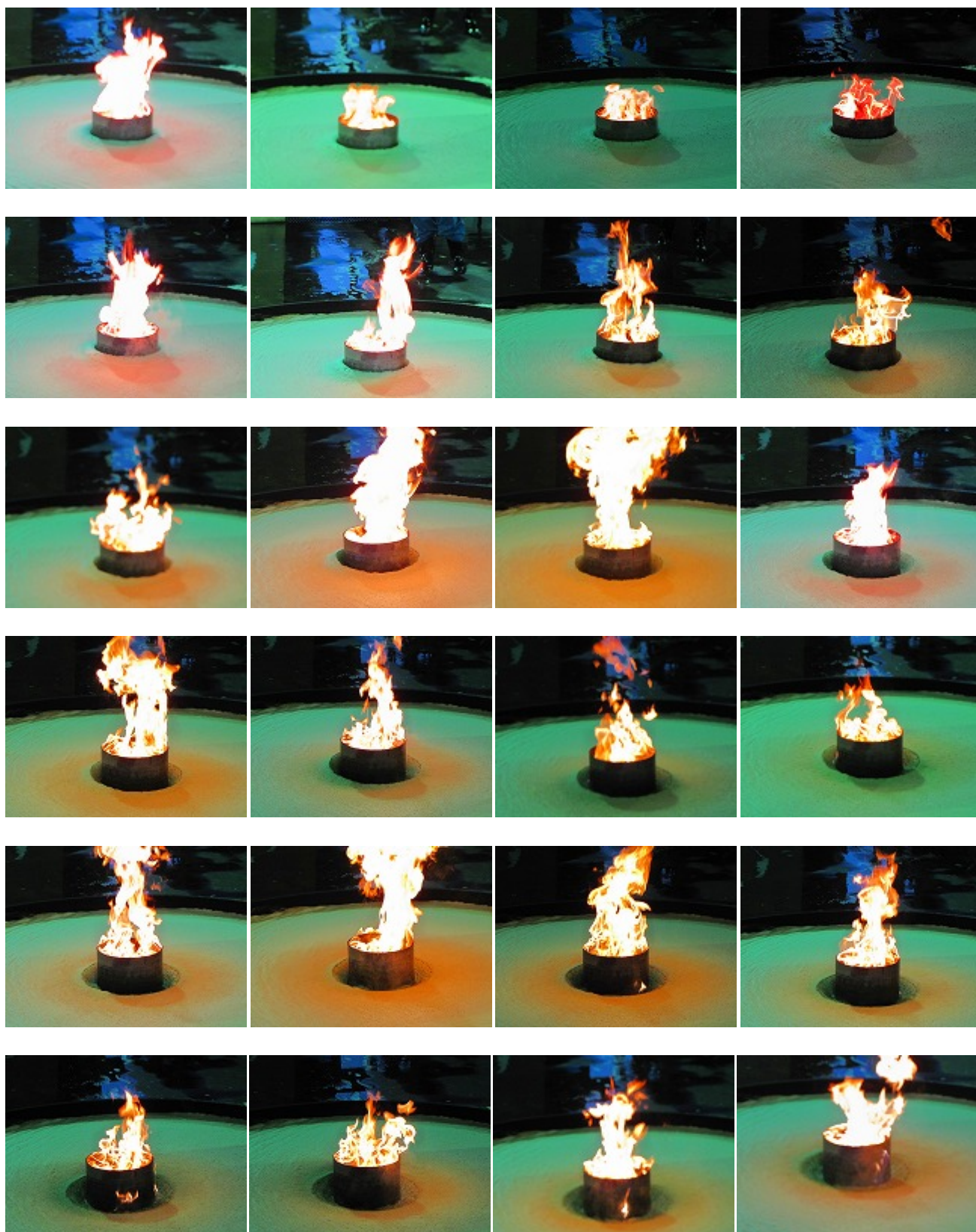


泡放射開始



ポット点火

実験 No.11 gentle フッ素たん白泡 C (FP1) ② 実施日：平成 24 年 2 月 14 日
※点火から 30 秒刻みで撮影



実験 No.11 gentle フッ素たん白泡 C (FP1) ③ 実施日：平成 24 年 2 月 14 日
※点火から 30 秒刻みで撮影



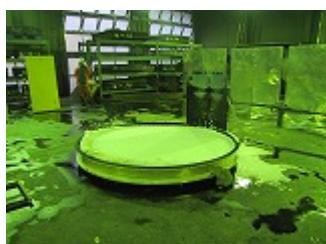
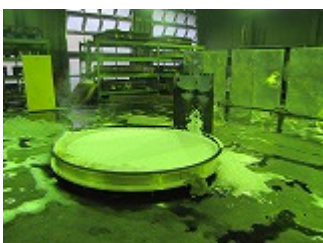
実験 No.12 gentle フッ素たん白泡 D (FP2) ① 実施日：平成 24 年 2 月 6 日
 ※点火から 30 秒刻みで撮影



点火



泡放射開始

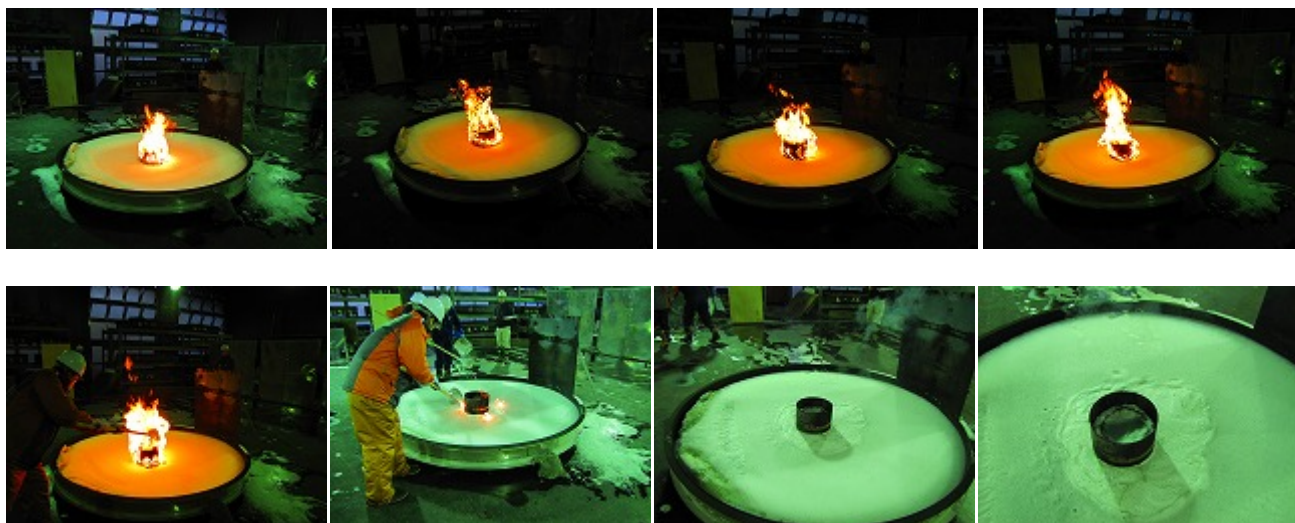


ポット点火

実験 No.12 gentle フッ素たん白泡 D (FP2) ② 実施日：平成 24 年 2 月 6 日
※点火から 30 秒刻みで撮影



実験 No.12 gentle フッ素たん白泡 D (FP2) ③ 実施日：平成 24 年 2 月 6 日
※点火から 30 秒刻みで撮影



実験 No.13 gentle 水成膜泡 G (AF1) ① 実施日：平成 24 年 2 月 6 日

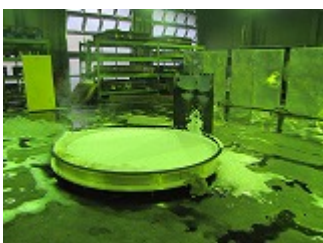
※点火から 30 秒刻みで撮影



点火



泡放射開始



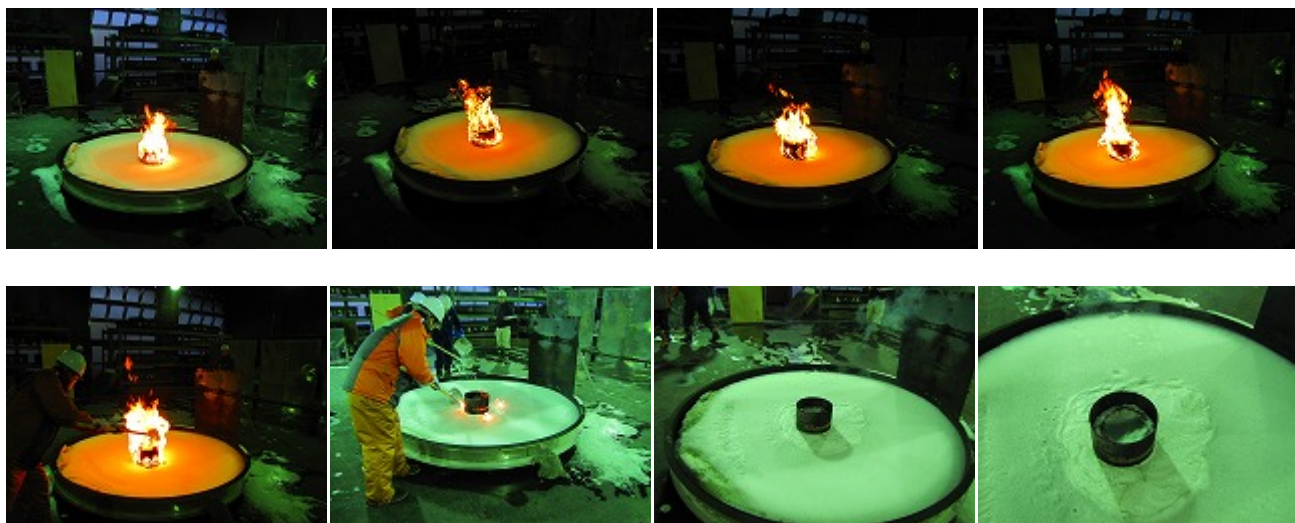
ポット点火

実験 No.13 gentle 水成膜泡 G (AF1) ② 実施日：平成 24 年 2 月 6 日
 ※点火から 30 秒刻みで撮影



実験 No.13 gentle 水成膜泡 G (AF1) ③ 実施日：平成 24 年 2 月 6 日

※点火から 30 秒刻みで撮影



実験 No.14 gentle 水成膜泡 H (AF2) ① 実施日：平成 24 年 2 月 7 日

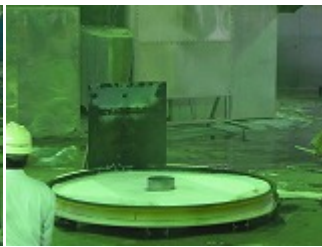
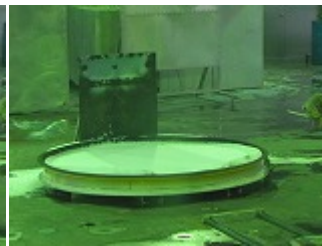
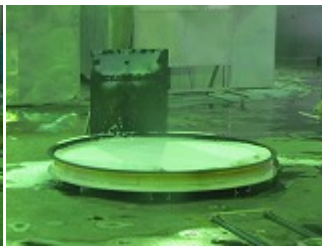
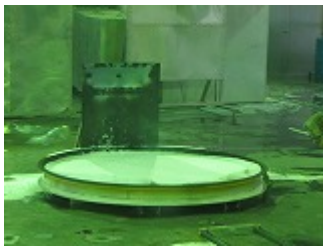
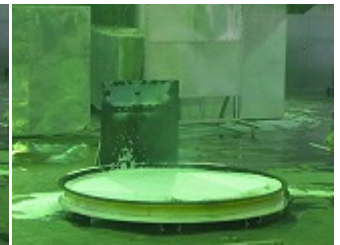
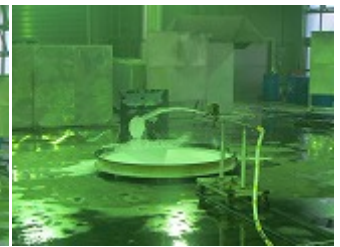
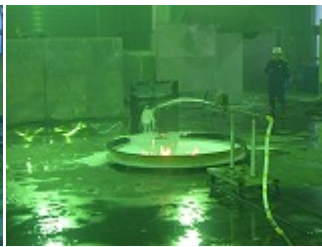
※点火から 30 秒刻みで撮影



点火



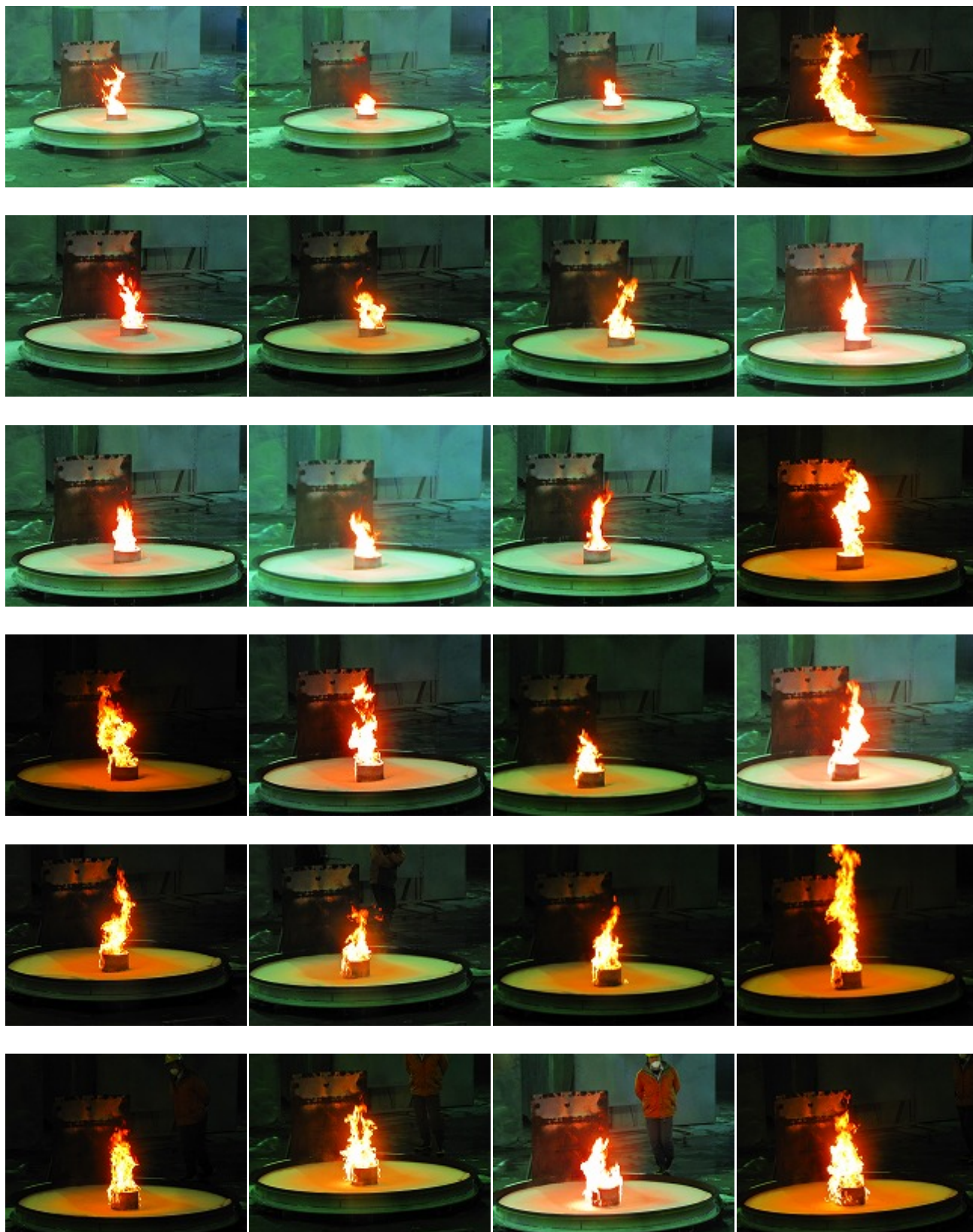
泡放射開始



ポット点火

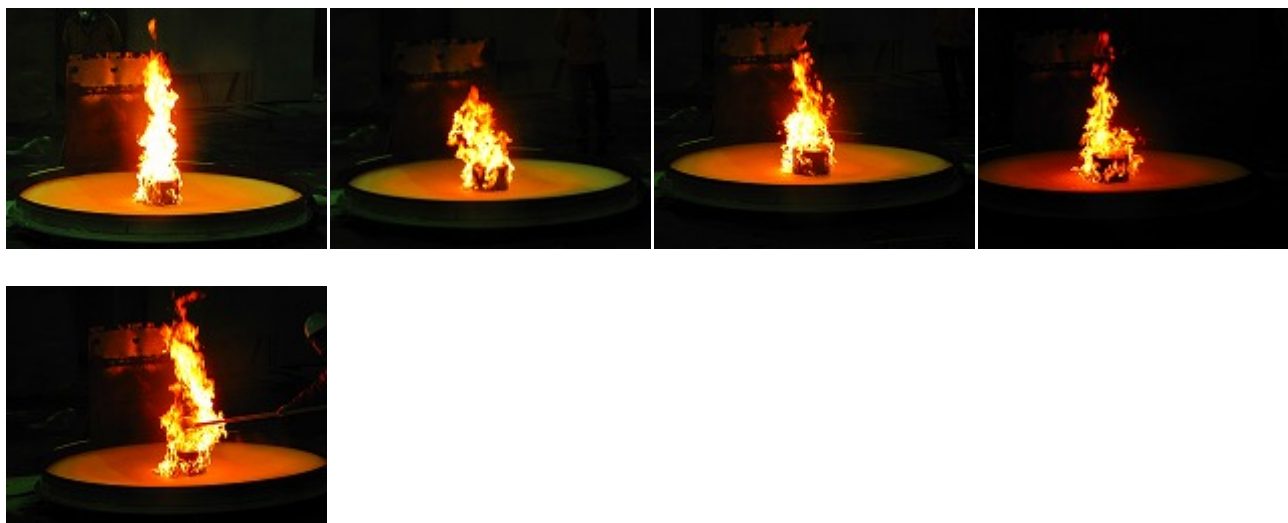
実験 No.14 gentle 水成膜泡 H (AF2) ② 実施日：平成 24 年 2 月 7 日

※点火から 30 秒刻みで撮影



実験 No.14 gentle 水成膜泡 H (AF2) ③ 実施日：平成 24 年 2 月 7 日

※点火から 30 秒刻みで撮影



実験 No.15 gentle 合成界面泡 K (S1) ① 実施日：平成 24 年 2 月 7 日

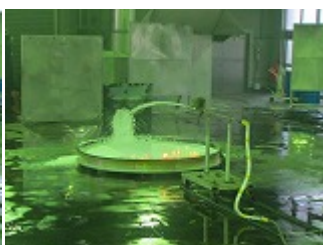
※点火から 30 秒刻みで撮影



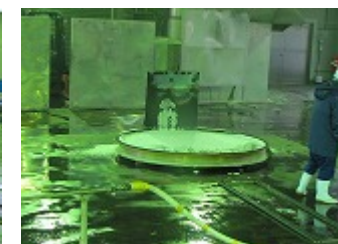
点火



泡放射開始



消火不能



実験 No.16 gentle 合成界面泡 L (S2) ① 実施日：平成 24 年 2 月 7 日

※点火から 30 秒刻みで撮影



点火



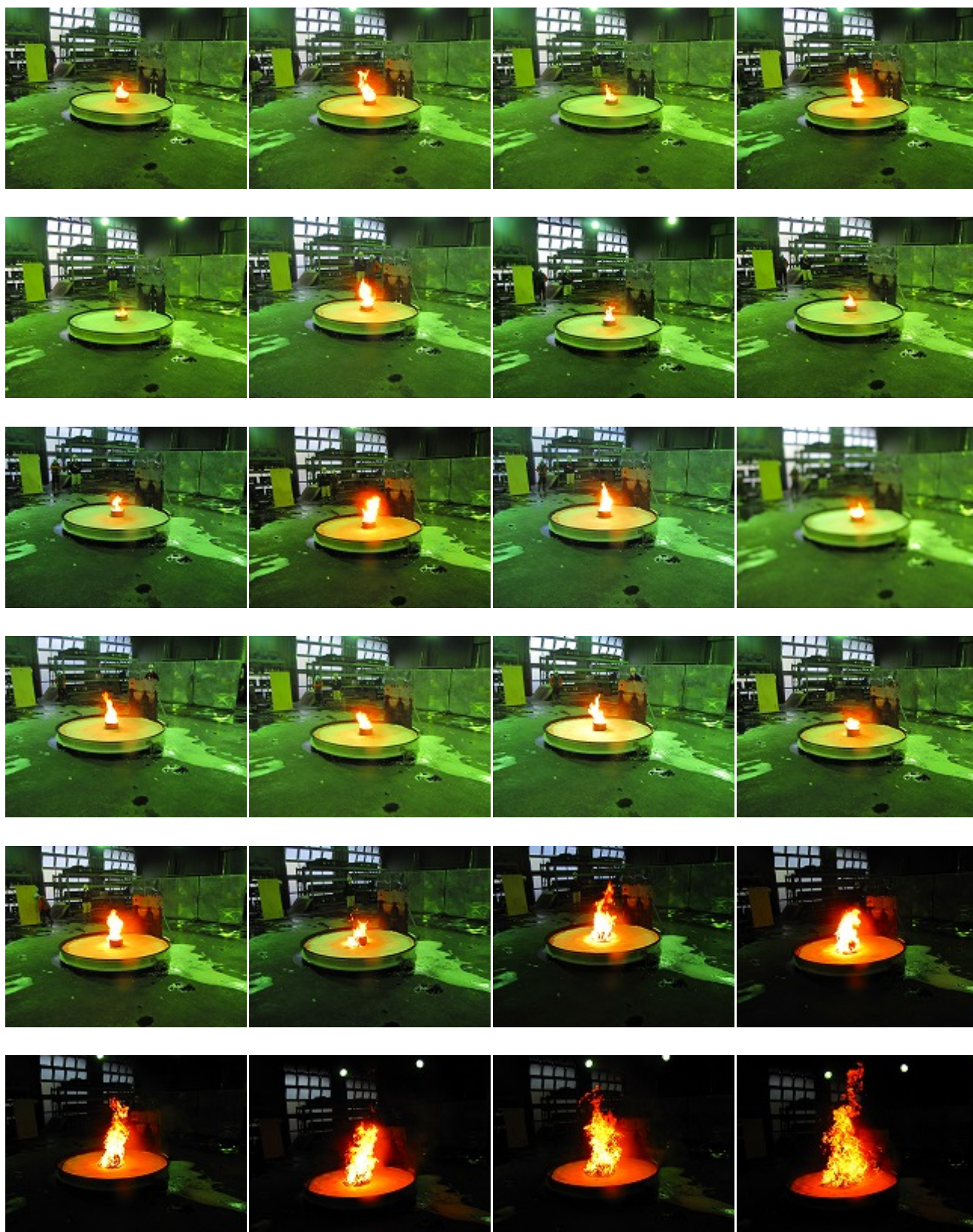
泡放射開始



ポット点火

実験 No.16 gentle 合成界面泡 L (S2) ② 実施日：平成 24 年 2 月 7 日

※点火から 30 秒刻みで撮影



実験 No.16 gentle 合成界面泡 L (S2) ③ 実施日：平成 24 年 2 月 7 日

※点火から 30 秒刻みで撮影



25%以上再燃



実験 No.17 acetone たん白泡 A (P1) ① 実施日：平成 24 年 2 月 9 日

※点火から 30 秒刻みで撮影



点火



泡放射開始



消火不能



実験 No.18 acetone たん白泡 B (P2) ① 実施日：平成 24 年 2 月 9 日

※点火から 30 秒刻みで撮影



点火



泡放射開始



消火不能



実験 No.19 acetone フッ素たん白泡 E (ARFP1) ①実施日：平成 24 年 2 月 14 日
※点火から 30 秒刻みで撮影



点火



泡放射開始



消火不能



実験 No.20 acetone フッ素たん白泡 F (ARFP2) ① 実施日：平成 24 年 2 月 9 日
※点火から 30 秒刻みで撮影



点火



泡放射開始



消火不能



実験 No.21 acetone 水成膜泡 I (ARAF1) ① 実施日：平成 24 年 2 月 9 日

※点火から 30 秒刻みで撮影



点火



泡放射開始



消火不能



実験 No.22 acetone 水成膜泡 J (ARAF2) ① 実施日：平成 24 年 2 月 14 日

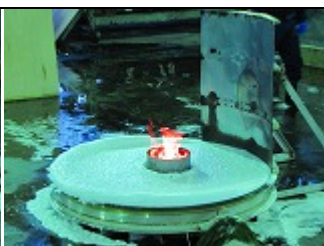
※点火から 30 秒刻みで撮影



点火



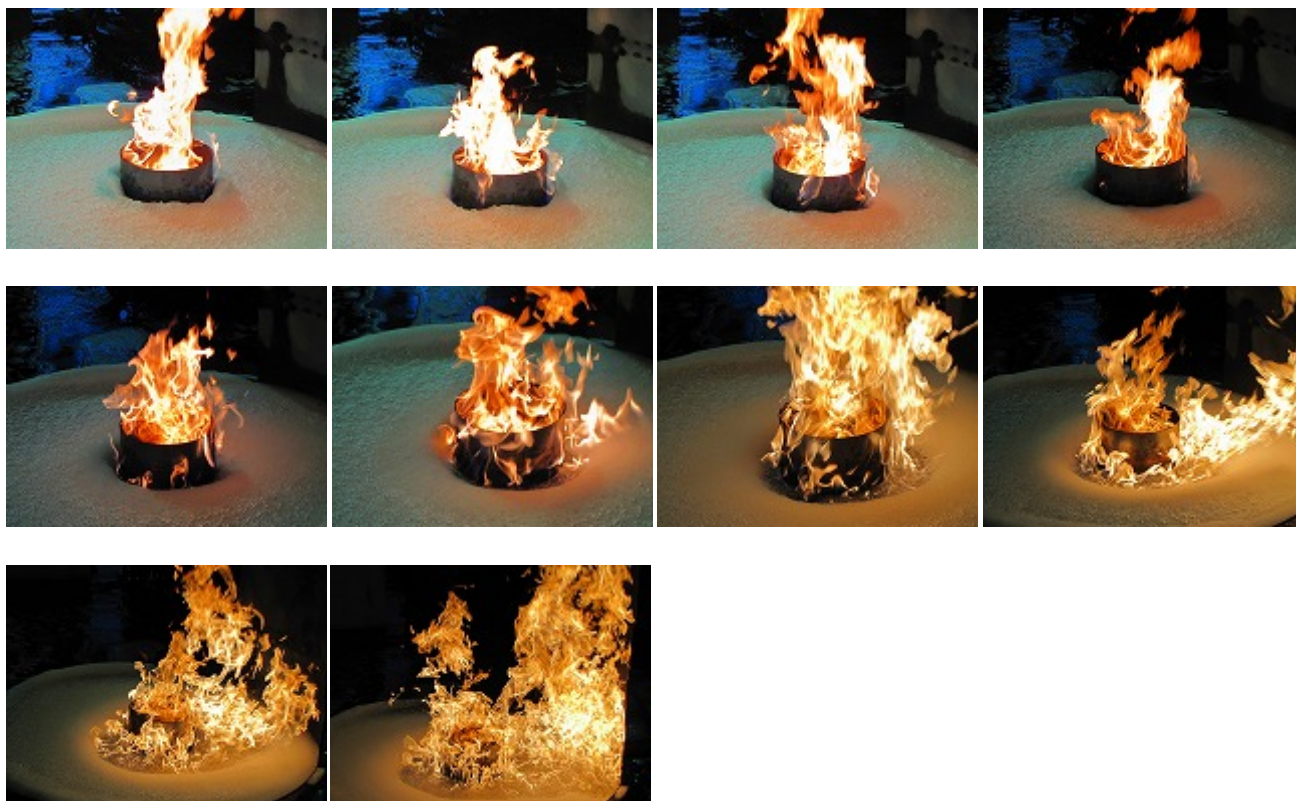
泡放射開始



ポット点火

実験 No.22 acetone 水成膜泡 J (ARAF2) ② 実施日：平成 24 年 2 月 14 日

※点火から 30 秒刻みで撮影



25%以上再燃

実験 No.23 acetone 合成界面泡 M (ARS1) ① 実施日：平成 24 年 2 月 9 日

※点火から 30 秒刻みで撮影



点火

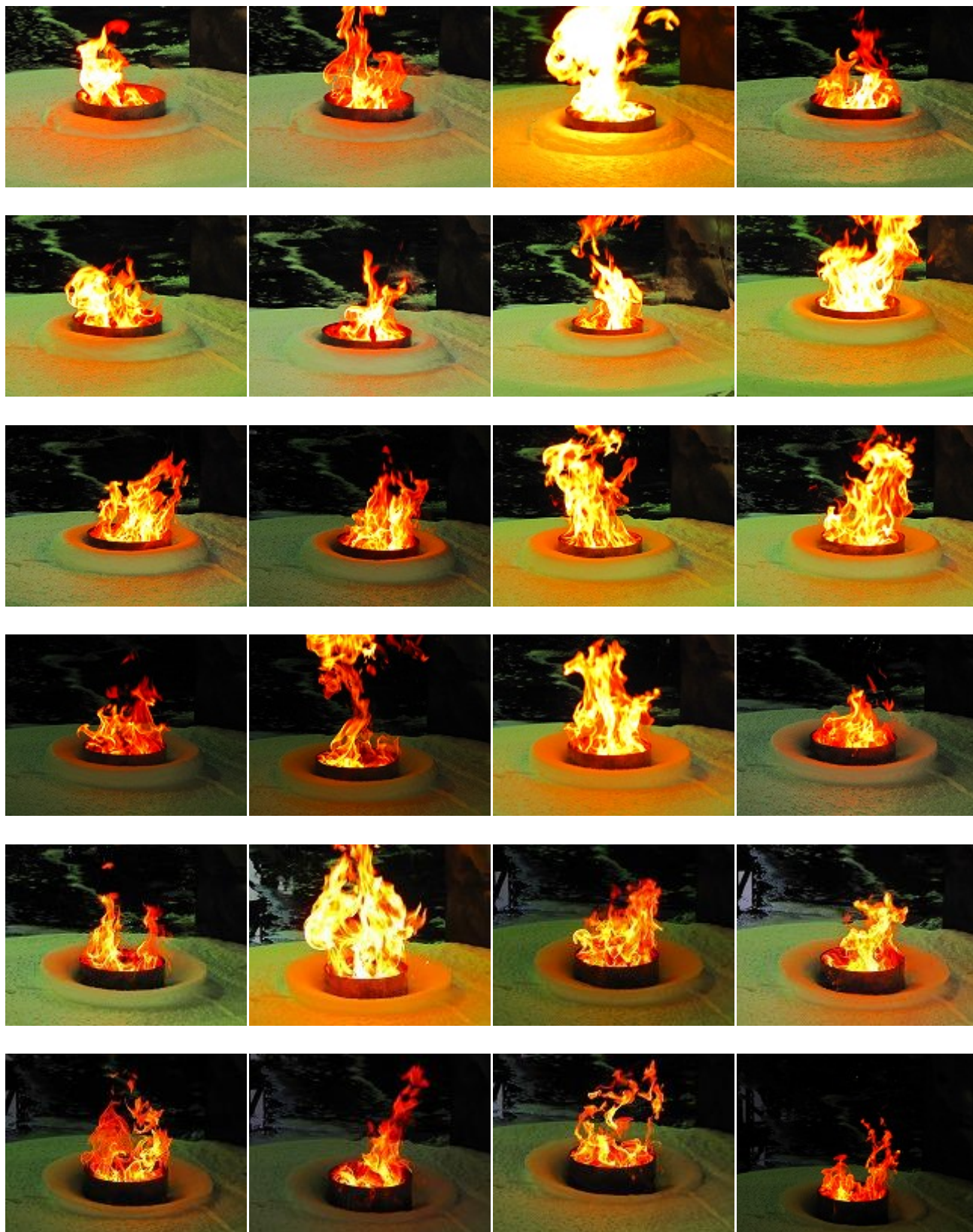


泡放射開始



ポット点火

実験 No.23 acetone 合成界面泡 M (ARS1) ② 実施日：平成 24 年 2 月 9 日
※点火から 30 秒刻みで撮影



実験 No.23 acetone 合成界面泡 M (ARS1) ③ 実施日：平成 24 年 2 月 9 日

※点火から 30 秒刻みで撮影



実験 No.24 acetone 合成界面泡 L (S2) ① 実施日：平成 24 年 2 月 9 日

※点火から 30 秒刻みで撮影



点火



泡放射開始



消火不能



実験 No.25 IPA たん白泡 A (P1) ① 実施日：平成 24 年 2 月 14 日

※点火から 30 秒刻みで撮影



点火



泡放射開始



消火不能



実験 No.26 IPA たん白泡 B (P2) ① 実施日：平成 24 年 2 月 14 日

※点火から 30 秒刻みで撮影



点火



泡放射開始



消火不能



実験 No.27 IPA フッ素たん白泡 E (ARFP1) ① 実施日：平成 24 年 2 月 15 日
※点火から 30 秒刻みで撮影



点火



泡放射開始



消火不能



実験 No.28 IPA フッ素たん白泡 F (ARFP2) ① 実施日：平成 24 年 2 月 15 日
※点火から 30 秒刻みで撮影



点火



泡放射開始



消火不能



実験 No.29 IPA 水成膜泡 I (ARAF1) ① 実施日：平成 24 年 2 月 15 日

※点火から 30 秒刻みで撮影



点火



泡放射開始



消火不能



実験 No.30 IPA 水成膜 J (ARAF2) ① 実施日：平成 24 年 2 月 15 日

※点火から 30 秒刻みで撮影



点火



泡放射開始

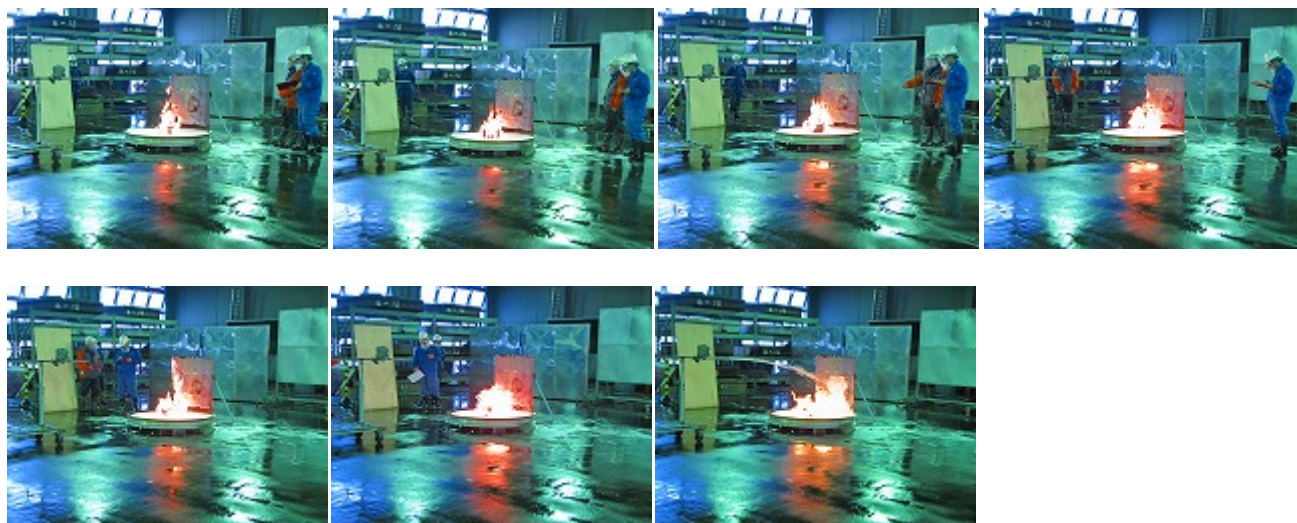


ポット点火



実験 No.30 IPA 水成膜 J (ARAF2) ① 実施日：平成 24 年 2 月 15 日

※点火から 30 秒刻みで撮影



実験 No.31 IPA 合成界面泡 M (ARS1) ① 実施日：平成 24 年 2 月 15 日

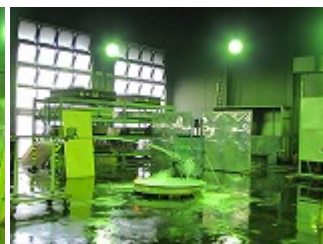
※点火から 30 秒刻みで撮影



点火



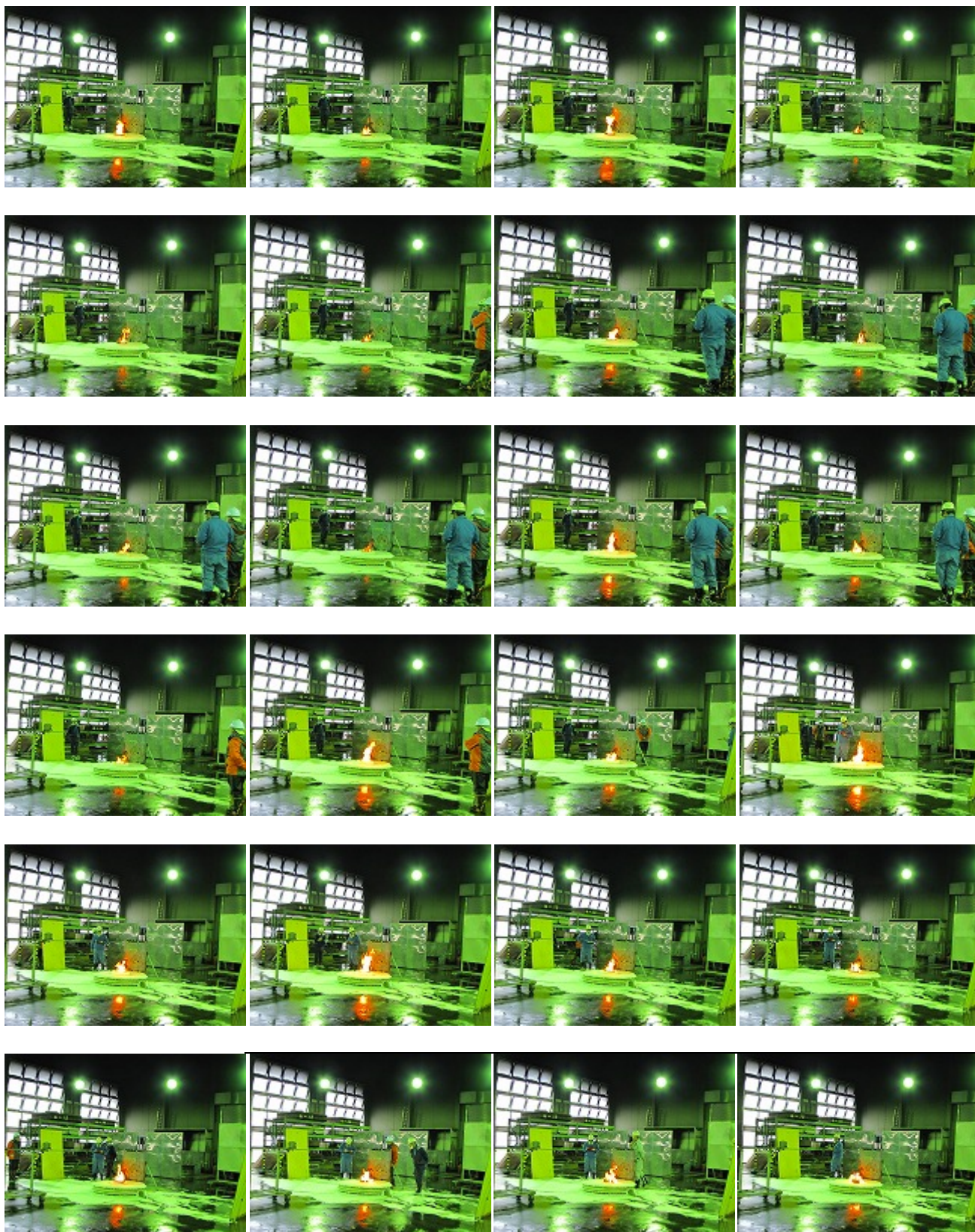
泡放射開始



ポット点火

実験 No.31 IPA 合成界面泡 M (ARS1) ② 実施日：平成 24 年 2 月 15 日

※点火から 30 秒刻みで撮影



実験 No.31 IPA 合成界面泡 M (ARS1) ③ 実施日：平成 24 年 2 月 15 日

※点火から 30 秒刻みで撮影



実験 No.32 IPA 合成界面泡 L (S2) ① 実施日：平成 24 年 2 月 14 日

※点火から 30 秒刻みで撮影



点火



泡放射開始

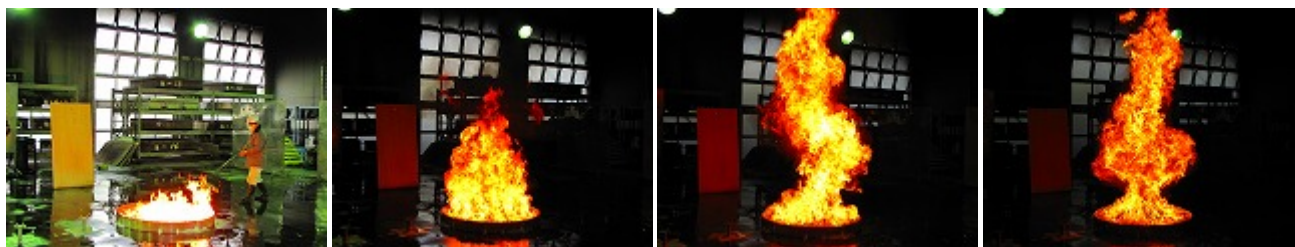


消火不能



実験 No.33 中発泡 たん白泡 A (P1) ① 実施日：平成 24 年 2 月 28 日

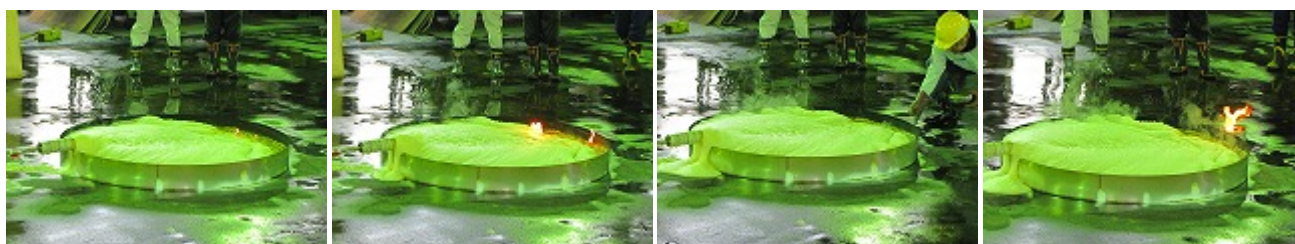
※点火から 10 秒刻みで撮影



点火



泡放射開始



ポット点火



実験 No.34 中発泡 たん白泡 B (P2) ① 実施日：平成 24 年 2 月 28 日

※点火から 10 秒刻みで撮影



点火



泡放射開始



ポット点火



試験 No.35 中発泡 フッ素たん白泡 C (FP1) ① 実施日：平成 24 年 2 月 28 日

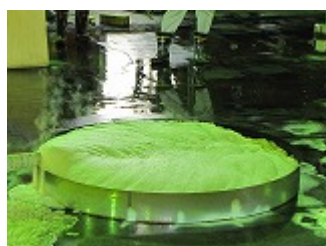
※点火から 10 秒刻みで撮影



点火



泡放射開始



ポット点火



実験 No.36 中発泡 フッ素たん白泡 D (FP2) ① 実施日：平成 24 年 2 月 28 日

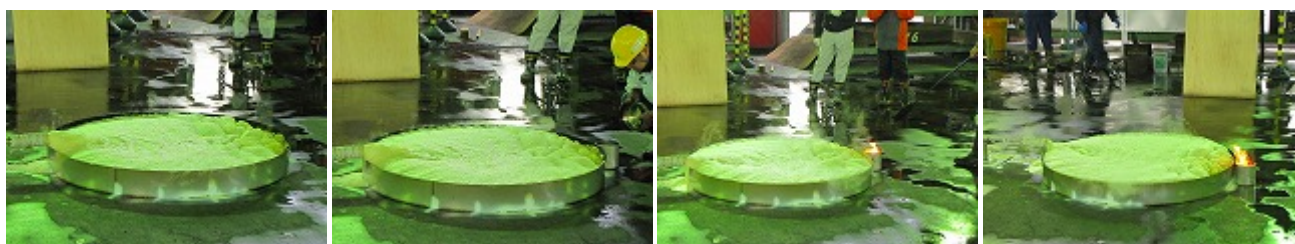
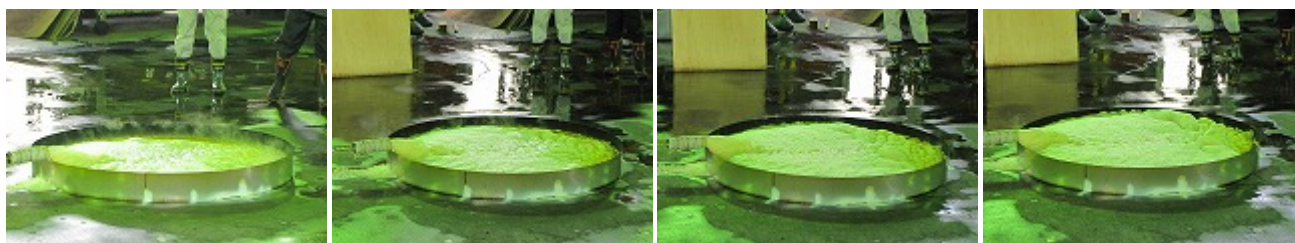
※点火から 10 秒刻みで撮影



点火



泡放射開始



ポット点火



実験 No.37 中発泡 水成膜泡 G (AF1) ① 実施日：平成 24 年 2 月 28 日

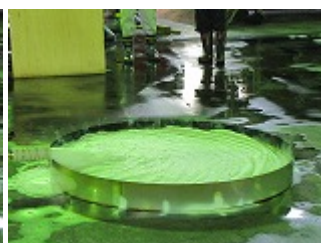
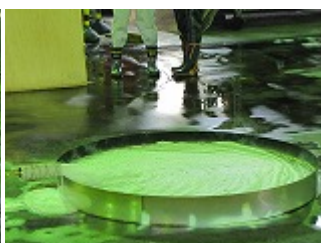
※点火から 10 秒刻みで撮影



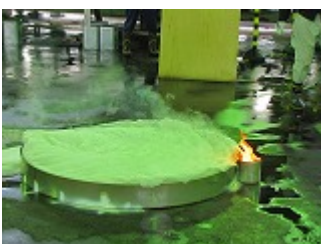
点火



泡放射開始



ポット点火



実験 No.38 中発泡 水成膜泡 H (AF2) ① 実施日：平成 24 年 2 月 28 日

※点火から 10 秒刻みで撮影



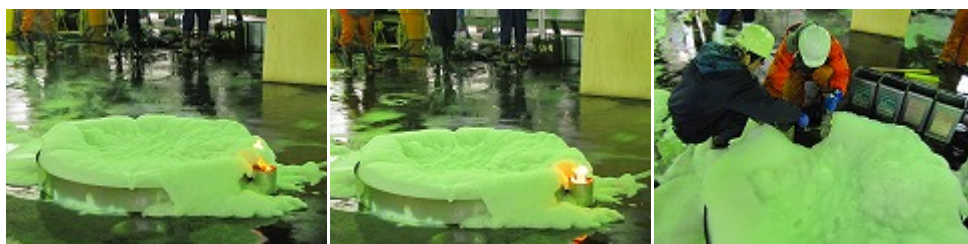
点火



泡放射開始



ポット点火



実験 No.39 中発泡 合成界面泡 K (S1) ① 実施日：平成 24 年 2 月 28 日

※点火から 10 秒刻みで撮影



点火



泡放射開始



消火不能

実験 No.40 中発泡 合成界面泡 L (S2) ① 実施日：平成 24 年 2 月 28 日

※点火から 10 秒刻みで撮影



点火



泡放射開始



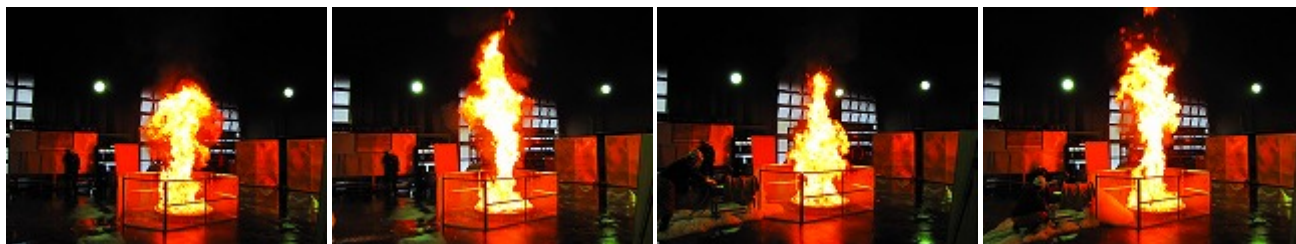
消火不能

実験 No.41 高発泡 たん白泡 A (P1) ① 実施日：平成 24 年 2 月 29 日

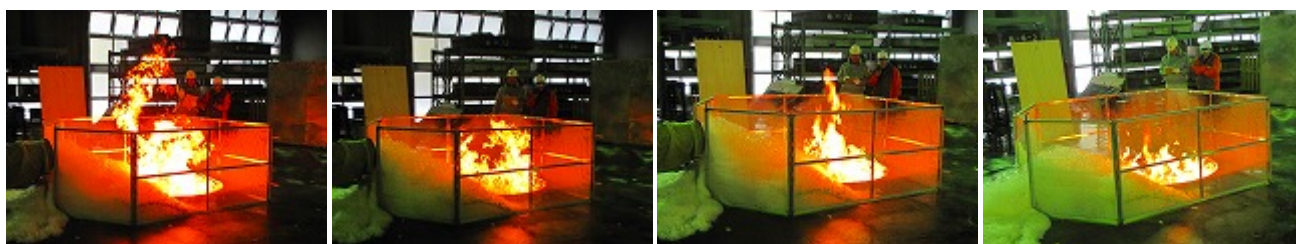
※点火から 10 秒刻みで撮影



点火



泡放射開始



消火不能

実験 No.42 高発泡 たん白泡 B (P2) ① 実施日：平成 24 年 2 月 29 日

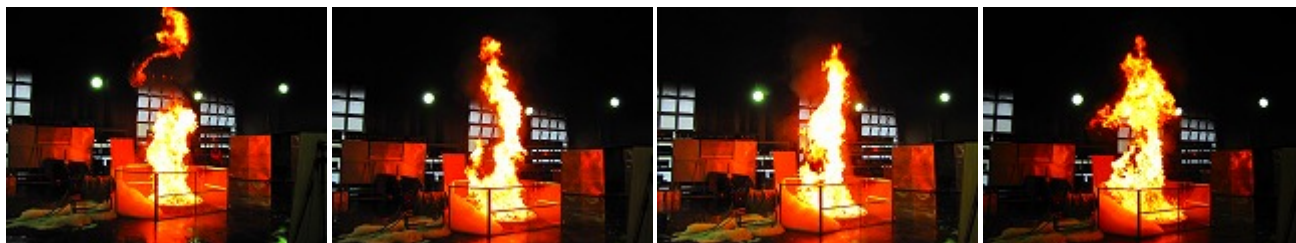
※点火から 10 秒刻みで撮影



点火



泡放射開始



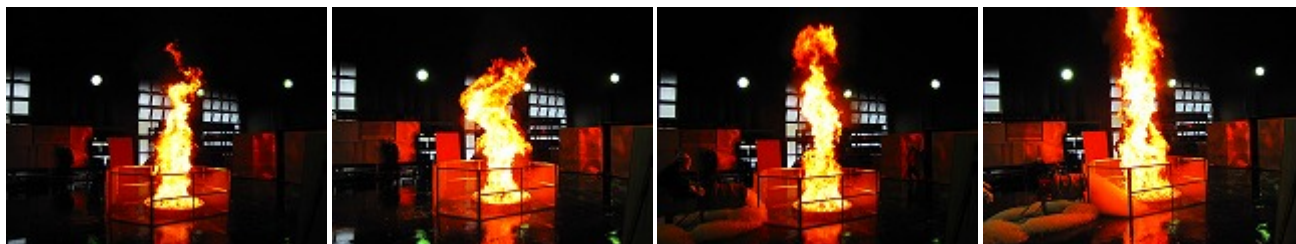
消火不能

実験 No.43 高発泡 フッ素たん白泡 C (FP1) ① 実施日：平成 24 年 2 月 29 日

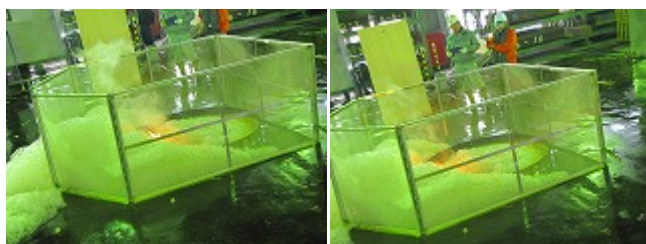
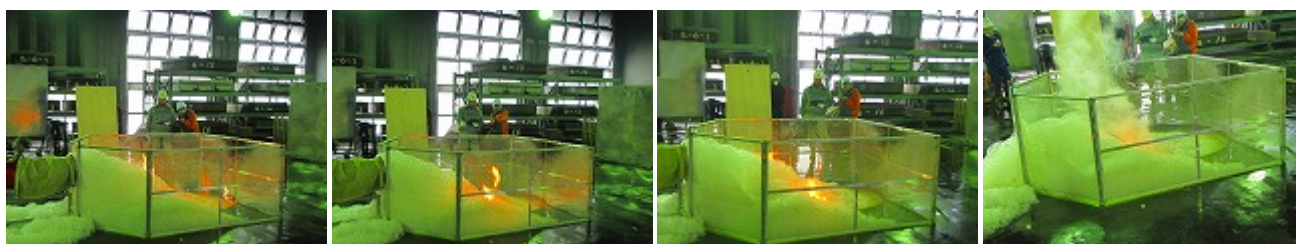
※点火から 10 秒刻みで撮影



点火



泡放射開始



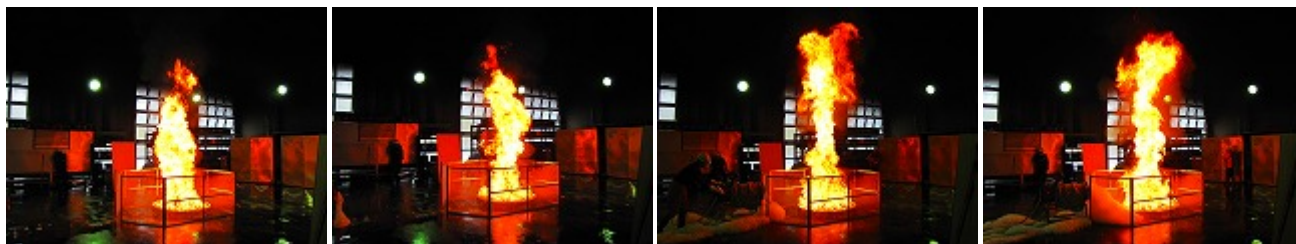
消火不能

実験 No.44 高発泡 フッ素たん白泡 D (FP2) ① 実施日：平成 24 年 2 月 29 日

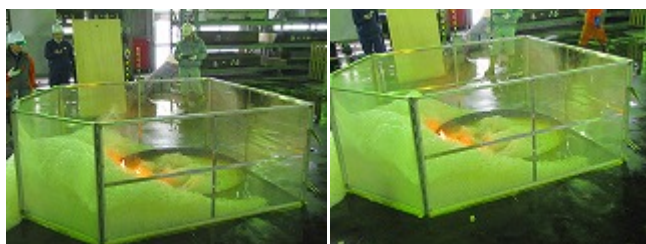
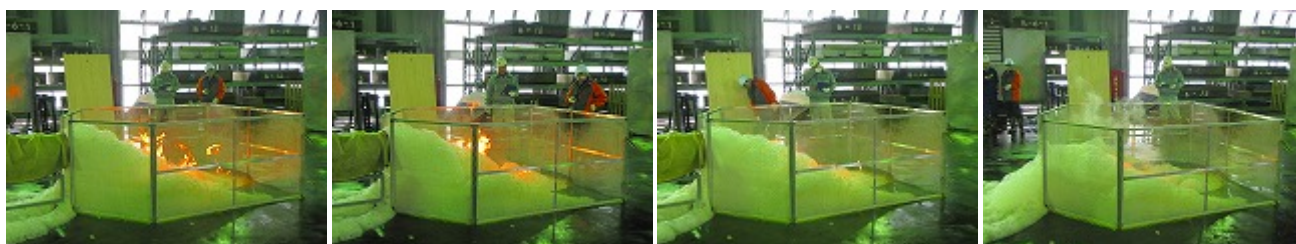
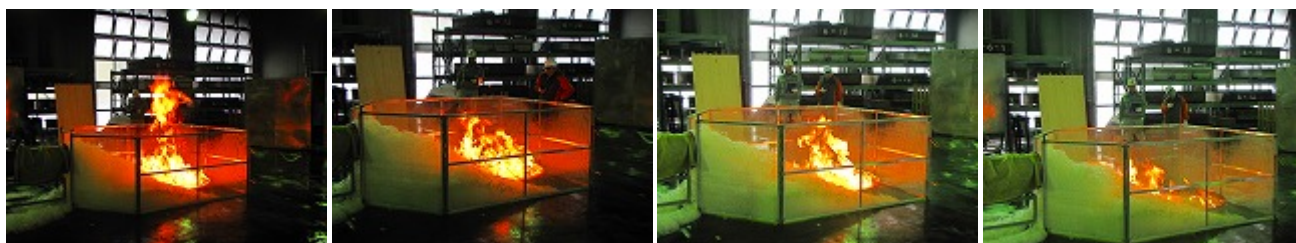
※点火から 10 秒刻みで撮影



点火



泡放射開始



消火不能

実験 No.45 高発泡 水成膜泡 G (AF1) ① 実施日：平成 24 年 2 月 29 日

※点火から 10 秒刻みで撮影



点火



泡放射開始



消火



実験 No.46 高発泡 水成膜泡 H (AF2) ① 実施日：平成 24 年 2 月 29 日

※点火から 10 秒刻みで撮影



点火



泡放射開始

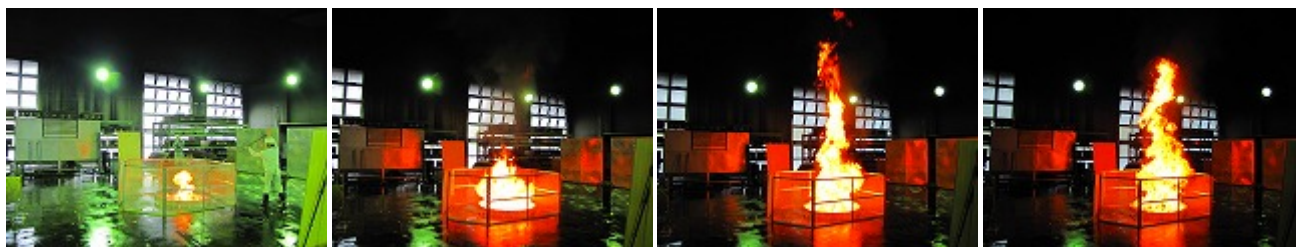


消火

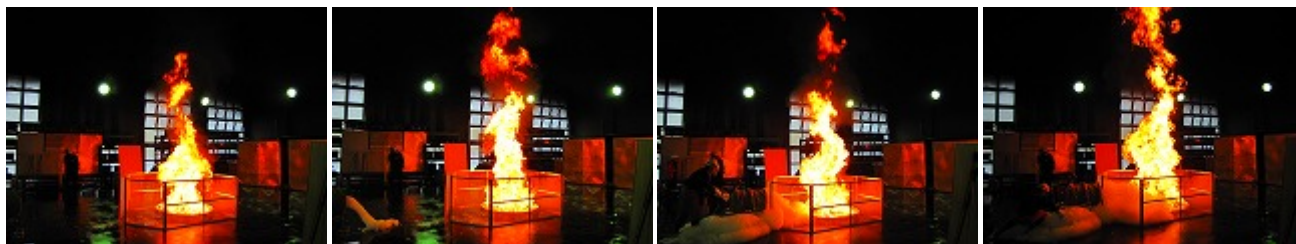


実験 No.47 高発泡 合成界面泡 K (S1) ① 実施日：平成 24 年 2 月 29 日

※点火から 10 秒刻みで撮影



点火



泡放射開始



消火



実験 No.48 高発泡 合成界面泡 L (S2) ① 実施日：平成 24 年 2 月 29 日

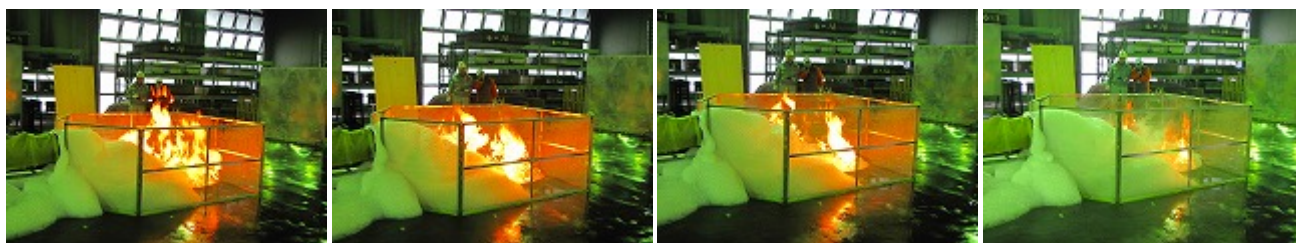
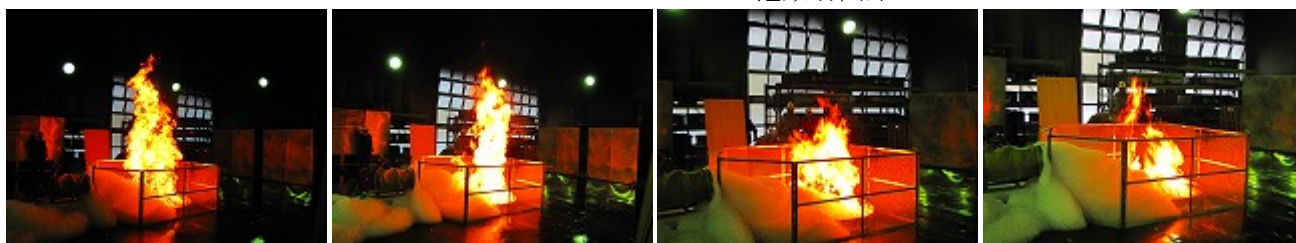
※点火から 10 秒刻みで撮影



点火



泡放射開始



消火



参考 2. ISO7203-1,2,3 における第 1 版(1995)と第 2 版 (2011) との比較表

(参考) ISO 7203-1:1995 (Fire extinguishing media –Foam concentrates-)		(参考) ISO 7203-1:2011 (Fire extinguishing media –Foam concentrates-)	
項目	内容	項目	内容
Foreword	<p>ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.</p> <p>Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.</p> <p>International Standard ISO 7203-1 was prepared by Technical Committee ISO/TC 21, Equipment for fire protection and fire fighting, Subcommittee SC 6, Extinguishing media for fire fighting.</p> <p>ISO 7203 consists of the following parts, under the general title Fire extinguishing media - Foam concentrates:</p> <ul style="list-style-type: none"> -Part 1: Specification for low expansion foam concentrates for top application to water-immiscible liquids - Part 2: Specification for medium and high expansion foam concentrates for top application to water-immiscible liquids - Part 3: Specification for low expansion foam concentrates for top application to water-miscible liquids <p>Annexes A, B, C, D, E, F and G form an integral part of this part of ISO 7203. Annexes H, J and K are for information only.</p>	Foreword	<p>ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.</p> <p>International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.</p> <p>The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.</p> <p>Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.</p> <p>ISO 7203-1 was prepared by Technical Committee ISO/TC 21, Equipment for fire protection and fire fighting, Subcommittee SC 6, Foam and powder media and fixed firefighting systems using foam and powder.</p> <p>This second edition cancels and replaces the first edition (ISO 7203-1:1995), which has been technically revised.</p> <p>ISO 7203 consists of the following parts, under the general title Fire extinguishing media — Foam concentrates:</p> <ul style="list-style-type: none"> - Part 1: Specification for low-expansion foam concentrates for top application to water-immiscible liquids - Part 2: Specification for medium- and high-expansion foam concentrates for top application to water immiscible liquids - Part 3: Specification for low-expansion foam concentrates for top application to water-miscible liquids
Introduction	<p>Firefighting foams are widely used to control and extinguish fires of flammable liquids and for inhibiting reignition. They may also be used to prevent ignition of flammable liquids and, in certain conditions, extinguish fires of solid combustibles.</p> <p>Foams may be used in combination with other extinguishing media, particularly halons, carbon dioxide and powders, which are the subject of</p>	Introduction	<p>Firefighting foams are widely used to control and extinguish fires of flammable liquids and for inhibiting reignition. They can also be used to prevent ignition of flammable liquids and, in certain conditions, extinguish fires of solid combustibles.</p> <p>Foams can be used in combination with other extinguishing media, particularly halons, carbon dioxide and powders, which are the subject</p>

	<p>other International Standards including those listed below:</p> <p>ISO 5923:1989, Fire protection - Fire extinguishing media - Carbon dioxide.</p> <p>ISO 6183:1990, Fire protection equipment - Carbon dioxide extinguishing systems for use on premises - Design and installation.</p> <p>ISO 7201-1 :1989, Fire protection - Fire extinguishing media - Halogenated hydrocarbons - Part 1: Specifications for halon 1211 and halon 1301.</p> <p>ISO 7201-2: 1991, Fire extinguishing media - Halogenated hydrocarbons - Part 2: Code of practice for safe handling and transfer procedures of halon 1211 and halon 1301.</p> <p>ISO 7202:1987, Fire protection - Fire extinguishing media - Powder .</p> <p>A specification for foam systems designed in accordance with this part of ISO 7203 is being prepared and will be published as:</p> <p>ISO 7076: -¹⁾, Fire protection equipment - Automatic extinguishing systems for applying low, medium and high expansion foam.</p> <p>Attention is drawn to annex J which deals with the compatibility of foam concentrates, and the compatibility of foams and powders.</p>		<p>of other International Standards, including ISO 5923, ISO 6183, ISO 7201-1, ISO 7201-2 and ISO 7202. A specification for foam systems (ISO 7076), which is cited in this part of ISO 7203, is under preparation.</p> <p>Attention is drawn to Annex I, which deals with the compatibility of foam concentrates, and the compatibility of foams and powders.</p>
1 Scope	<p>This part of ISO 7203 specifies the essential properties and performance of liquid foam concentrates used to make low expansion foams for the control, extinction and inhibition of reignition of fires of water-immiscible liquids. Minimum performance on certain test fires is specified.</p> <p>The foams are suitable for top application to fires of water-immiscible liquids. Those which will also comply with ISO 7203-3: Fire extinguishing media - Foam concentrates - Part 3: Specifications for low expansion foam concentrates for top application to water-miscible liquids, which is being prepared, will also be suitable for top application to fires of water-miscible liquids.</p> <p>The foam concentrates might be suitable for use in non-aspirating sprayers or for subsurface application to liquid fires, but requirements specific to those applications are not included in this part of ISO 7203.</p>	1 Scope	<p>This part of ISO 7203 specifies the essential properties and performance of liquid foam concentrates used to make low-expansion foams for the control, extinction and inhibition of reignition of fires of water-immiscible liquids. Minimum performance on certain test fires is specified.</p> <p>These foams are suitable for top application to fires of water-immiscible liquids. Those foams that comply with ISO 7203-3 are also suitable for top application to fires of water-miscible liquids.</p> <p>The foam concentrates can be suitable for use in non-aspirating sprayers or for subsurface application to liquid fires, but requirements specific to those applications are not included in this part of ISO 7203.</p>
2 Normative references	<p>The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 7203. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 7203 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.</p> <p>ISO 304:1985, Surface active agents - Determination of surface tension by drawing up liquid films.</p> <p>ISO 3310-1 : 1990, Test sieves - Technical requirements and testing - Part 1: Test sieves of metal wire cloth.</p> <p>ISO 3696: 1987, Water for analytical laboratory use -Specification and test methods.</p>	2 Normative references	<p>The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.</p> <p>ISO 304, Surface active agents - Determination of surface tension by drawing up liquid films</p> <p>ISO 3104, Petroleum products - Transparent and opaque liquids - Determination of kinematic viscosity and calculation of dynamic viscosity</p> <p>ISO 3219, Plastics - Polymers/resins in the liquid state or as emulsions or dispersions - Determination of viscosity using a rotational viscometer with defined shear rate</p> <p>ISO 3310-1, Test sieves - Technical requirements and testing - Part 1:</p>

	ISO 3734:1976, Crude Petroleum and fuel oils - Determination of water and sediment – Centrifuge method. ISO 7203-2:1995, Fire extinguishing media – Foam concentrates - Part 2: Specification for medium and high expansion foam concentrates for top application to water-immiscible liquids. BS 5117:1989, Testing corrosion inhibiting, engine coolant concentrate (antifreeze) - Part 1: Methods of test for determination of physical and chemical properties - Section 1.3: Determination of freezing point.		Test sieves of metal wire cloth ISO 3696:1987, Water for analytical laboratory use - Specification and test methods ISO 3734, Petroleum products - Determination of water and sediment in residual fuel oils – Centrifuge method ISO 7203-2, Fire extinguishing media - Foam concentrates - Part 2: Specification for medium- and high expansion foam concentrates for top application to water-immiscible liquids BS 5117-1.3:1985, Testing corrosion inhibiting, engine coolant concentrate (“antifreeze”). Methods of test for determination of physical and chemical properties. Determination of freezing point
3 Definitions	For the purposes of this part of ISO 7203, the following definitions apply.	3 Terms and definitions	For the purposes of this document, the following terms and definitions apply.
3.1 characteristic values	Values declared by the foam concentrate supplier for the chemical and physical properties and the performances of the foam and foam solution.	3.1 characteristic values	value declared by the foam concentrate supplier for the chemical and physical properties and the performances of the foam, foam solution, and foam concentrate
3.2 25% drainage time	Time for 25 % of the liquid content of a foam to drain out.	3.2 25% drainage time	time for 25 % of the liquid content of a foam to drain out
3.3 50% drainage time	Time for 50 % of the liquid content of a foam to drain out.		
3.4 expansion	Ratio of the volume of foam to the volume of the foam solution from which it was made.	3.3 expansion	ratio of the volume of foam to the volume of the foam solution from which it was made
3.5 low expansion	Applied to foam with expansion in the range 1 to 20, and to associated equipment, systems and concentrates.	3.4 low-expansion	with expansion in the range 1 to 20, as applied to foam and to associated equipment, systems and concentrates
3.6 medium expansion	Applied to foam with expansion in the range 21 to 200 and to associated equipment, systems and concentrates.	3.5 medium-expansion	with expansion in the range 21 to 200, as applied to foam and to associated equipment, systems and concentrates
3.7 high expansion	Applied to foam with expansion greater than 201 and to associated equipment, systems and concentrates.	3.6 high-expansion	with expansion greater than 200, as applied to foam and to associated equipment, systems and concentrates
3.8 foam (firefighting)	Aggregate of air-filled bubbles formed from an aqueous solution of a suitable foam concentrate.	3.7 foam	“firefighting” aggregate of air-filled bubbles formed from an aqueous solution of a suitable foam concentrate
3.9 (foam)	Liquid which, when mixed with water in the appropriate concentration, gives a foam solution.	3.8 foam	liquid which, when mixed with water in the appropriate concentration, gives a foam solution

concentrat e		concentrat e	
3.10 protein foam concentrat e (P)	Foam concentrate derived from hydrolized protein materials.	3.9 protein foam concentrat ion P	foam concentrate derived from hydrolised protein materials
3.11 fluoroprot ein foam concentrat e (FP)	Protein foam concentrate with added fluorinated surface active agents.	3.10 fluoroprotei n foam concentrat e FP	protein foam concentrate with added fluorinated surface-active agents
3.12 synthetic foam concentrat e (S)	Foam concentrate based on a mixture of hydrocarbon surface active agents and which may contain fluorocarbons with additional stabilizers.	3.11 synthetic foam concentrat e S	foam concentrate based on a mixture of hydrocarbon surface-active agents and which can contain fluorocarbons with additional stabilizers
3.13 alcohol-res istant foam concentrat e (AR)	Foam concentrate resistant to breakdown when applied to the surface of alcohol or other polar solvents.	3.12 alcohol-res istant foam concentrat e AR	foam concentrate resistant to breakdown when applied to the surface of alcohol or other water-miscible solvents
3.14 aqueous film-formi ng foam concentrat e (AFFF)	Foam concentrate based on a mixture of hydrocarbon and fluorinated surface active agents with the ability to form an aqueous film on the surface of some hydrocarbons.	3.13 aqueous film-formi ng foam concentrat e AFFF	foam concentrate based on a mixture of hydrocarbon and fluorinated surface-active agents with the ability to form an aqueous film on the surface of some hydrocarbons
3.15 film-formi ng fluoupro tein foam concentrat e (FFFP)	Fluoroprotein foam concentrate which has the ability to form an aqueous film on the surface of some hydrocarbons.	3.14 film-formi ng fluoroprot ein foam concentrat e FFFP	fluoroprotein foam concentrate that has the ability to form an aqueous film on the surface of some hydrocarbons
3.16 foam solution	Solution of foam concentrate and water.	3.15 foam solution	solution of foam concentrate and water
3.17	Application of foam to fall directly onto the surface of a liquid fuel.	3.16	application of foam such that it falls directly onto the surface of a liquid

forceful application		forceful application	fuel
3.18 gentle application	Application of foam indirectly to the surface of a liquid fuel via a backboard, tank wall or other surface.	3.17 gentle application	application of foam indirectly to the surface of a liquid fuel via a backboard, tank wall or other surface
3.19 sediment	Insoluble particles in the foam concentrate.	3.18 sediment	insoluble particles in the foam concentrate
3.20 spreading coefficient	Measure of the ability of one liquid to spontaneously spread across the surface of another.	3.19 spreading coefficient	value calculated from the measured surface and interfacial tensions to indicate the ability of one liquid to spontaneously spread across the surface of another
		3.20 lowest temperature for use	temperature claimed by the manufacturer or supplier to be the lowest temperature at which the foam concentrate can be proportioned correctly using equipment normally available
4	Grades and uses of foam concentrates	4	Grades and uses of foam concentrates
4.1 Grade	The foam concentrate shall be graded - for extinguishing performance as class I, II or III; - for burnback resistance as level A, B, C or D; according to its test fire performance (see clause 13). NOTE 1 Typical anticipated extinguishing performance classes and burnback resistance levels for AFFF, FFFP, FP, P and S foam concentrates are given in annex K.	4.1 Grades	According to its test fire performance (see Clause 13), the foam concentrate shall be graded - as class I, II or III for extinguishing performance; - as level A, B, C or D for burn-back resistance. NOTE Typical anticipated extinguishing performance classes and burn-back resistance levels for AFFF, FFFP, FP, P and S foam concentrates are given in Annex J.
4.2 Use with sea water	If a foam concentrate is marked as suitable for use with sea water, the recommended concentrations for use with fresh water and sea water shall be identical.	4.2 Use with sea water	If a foam concentrate is marked as suitable for use with sea water, the recommended concentrations for use with fresh water and sea water shall be identical.
5 Tolerance of the foam concentrate to freezing and thawing	Before and after temperature conditioning in accordance with A.2, the foam concentrate, if claimed by the supplier not to be adversely affected by freezing and thawing, shall show no visual sign of stratification and non-homogeneity, when tested in accordance with annex B. Foam concentrates complying with this clause shall be tested for compliance with the appropriate requirements given in other clauses of this part of ISO 7203 after freezing and thawing in accordance with A.2.1.	5 Tolerance of the foam concentrate to freezing and thawing	A foam concentrate that the supplier claims not to be adversely affected by freezing and thawing shall show no visual sign of stratification and non-homogeneity before and after temperature conditioning in accordance with A.2, when tested in accordance with Annex B. Foam concentrates complying with this clause shall be tested for compliance with the appropriate requirements given in other clauses of this part of ISO 7203 after freezing and thawing in accordance with A.2.1.
6	Sediment in the foam concentrate	6	Sediment in the foam concentrate
6.1 Sediment before ageing	Any Sediment in the concentrate prepared in accordance with A.1 shall be dispersible through a 180 µm sieve, and the percentage volume of sediment shall be not more than 0.25 %, when tested in accordance with annex C.	6.1 Sediment before ageing	Any sediment in the concentrate prepared in accordance with A.1 shall be dispersible through a 180 µm sieve, and the volume percentage of sediment shall be not more than 0,25 % when tested in accordance with Annex C.
6.2 Sediment	Any Sediment in the concentrate aged in accordance with C.1 shall be dispersible through a 180 µm sieve, and the percentage volume of	6.2 Sediment	Any sediment in the concentrate aged in accordance with C.1 shall be dispersible through a 180 µm sieve, and the volume percentage of

after ageing	sediment shall be not more than 1.0 %, when tested in accordance with annex C.	after ageing	sediment shall be not more than 1,0 % when tested in accordance with Annex C.
7 Comparative fluidity of the foam concentrate	Before and after temperature conditioning in accordance with A.2, the flow rate of the concentrate shall be not less than the flow rate achieved with a reference liquid of kinematic viscosity 200 mm ² /s, when tested in accordance with annex D.	7 Newtonian foam concentrates	Determination of viscosity for pseudo-plastic foam concentrates The viscosity of the foam concentrate at the lowest temperature for use claimed by the manufacturer shall be determined in accordance with ISO 3104. If the viscosity is greater than 200 mm ² /s, the container shall be marked "This concentrate can require special proportioning equipment".
		7.2 Pseudo-plastic foam concentrates	The viscosity of the foam concentrate shall be determined in accordance with Annex D. If the viscosity at the lowest temperature for use is greater than or equal to 120 mPa/s at 375/s, the container shall be marked "Pseudo-plastic foam concentrate. This concentrate can require special proportioning equipment".
8	pH of the foam concentrate	8	pH of the foam concentrate
8.1 pH limits	The pH of the foam concentrate, before and after temperature conditioning in accordance with A.2, shall be not less than 6,0 and not more than 9,5 at (20 ± 2) °C.	8.1 pH limits	The pH of the foam concentrate, before and after temperature conditioning in accordance with A.2, shall be not less than 6,0 and not more than 8,5 at (20 ± 2) °C.
8.2 Sensitivity to temperature	If there is a difference of more than 0,5 pH unit between the two values (before and after temperature conditioning), the foam concentrate shall be designated as temperature sensitive.	8.2 Sensitivity to temperature	The difference in pH between before and after temperature conditioning shall not be greater than 1,0 pH units.
9	Surface tension of the foam solution	9	Surface tension of the foam solution
9.1 Before temperature conditioning	The surface tension of the foam solution prepared from the concentrate, before temperature conditioning in accordance with A.2, at the supplier's recommended concentration, shall be within ± 10 % of the characteristic value when determined in accordance with E.2.	9.1 Before temperature conditioning	The surface tension of the foam solution prepared from the concentrate, before temperature conditioning in accordance with A.2, at the supplier's recommended concentration, shall be within ±10 % of the characteristic value when determined in accordance with E.2.
9.2 Temperature sensitivity	The surface tension of the foam solution prepared from the concentrate, after temperature conditioning in accordance with A.2, at the supplier's recommended concentration, shall be determined in accordance with E.2. If the value obtained after temperature conditioning is less than 0,95 times, or more than 1,05 times, the value obtained before temperature conditioning, the foam concentrate shall be designated as temperature sensitive.	9.2 Temperature sensitivity	The surface tension of the foam solution prepared from the concentrate, after temperature conditioning in accordance with A.2, at the supplier's recommended concentration, shall be determined in accordance with E.2. The value obtained after temperature conditioning shall not be less than 0,95 times, or more than 1,05 times, the value obtained before temperature conditioning.
10	Interfacial tension between the foam solution and cyclohexane	10	Interfacial tension between the foam solution and cyclohexane
10.1 Before temperature	The difference between the interfacial tension between the foam solution prepared from the foam concentrate, before temperature conditioning in accordance with A.2, and cyclohexane (when determined in accordance	10.1 Before temperature	Before temperature conditioning in accordance with A.2, the difference between the interfacial tension between the foam solution prepared from the foam concentrate and cyclohexane (when determined in accordance

re conditioning	with E.3) and the characteristic value, shall not exceed 1,0 mN/m or 10 % of the characteristic value, whichever is the greater.	re conditioning	with E.3) and the characteristic value for interfacial tension shall not exceed 1,0 mN/m or 10 % of the characteristic value, whichever is the greater.
10.2 Temperature sensitivity	The interfacial tension between the foam solution prepared from the foam concentrate, after temperature conditioning in accordance with A.2, and cyclohexane shall be determined in accordance with E.3. If the two values obtained before and after temperature conditioning differ by more than 0,5 mN/m or if the value obtained after temperature conditioning is less than 0,95 times, or more than 1,05 times, the value obtained before temperature conditioning, whichever is the greater, the foam concentrate shall be designated as temperature sensitive.	10.2 Temperature sensitivity	After temperature conditioning in accordance with A.2, the interfacial tension between the foam solution prepared from the foam concentrate and cyclohexane shall be determined in accordance with E.3. The two values obtained before and after temperature conditioning shall not differ by more than 0,5 mN/m.
11 Spreading coefficient of the foam solution on cyclohexane	The spreading coefficient of the foam solution prepared from a concentrate claimed by the supplier to be “film-forming”, before and after temperature conditioning in accordance with A.2, calculated in accordance with E.4, shall be positive. NOTE 2 Foam concentrates complying with this clause are more likely to be of type AFFF or FFFP than of type FP, P or S.	11 Spreading coefficient of the foam solution on cyclohexane	Before and after temperature conditioning in accordance with A.2, the spreading coefficient of the foam solution prepared from a concentrate claimed by the supplier to be “film-forming” shall be positive when calculated in accordance with E.4. NOTE Foam concentrates complying with this clause are more likely to be of type AFFF or FFFP than of type FP, P or S
12	Expansion and drainage of foam	12	Expansion and drainage of foam
12.1	Expansion		
12.1.1 Limits	The foam produced from the foam concentrate, before and after temperature conditioning in accordance with A.2, with potable water and, if appropriate, with the synthetic sea water of G.1.4, shall have an expansion within either ± 20 % of the characteristic value or $\pm 1,0$ of the characteristic value, whichever is the greater, when tested in accordance with annex F.	12.1 Expansion limits	The foam produced from the foam concentrate, before and after temperature conditioning in accordance with A.2, with potable water and, if appropriate, with the synthetic sea water of G.2.4, shall have an expansion within either ± 20 % of the characteristic value or $\pm 1,0$ of the characteristic value, whichever is the greater, when tested in accordance with Annex F
12.1.2 Temperature sensitivity	If any of the values for expansion obtained after temperature conditioning is less than 0,85 times, or more than 1,15 times, the corresponding value obtained before temperature conditioning, the foam concentrate shall be designated as temperature sensitive.		
12.2	Drainage		
12.2.1 Limits	The foam produced from the foam concentrate, before and after temperature conditioning in accordance with A.2, with potable water and, if appropriate, with the synthetic sea water of G.1.4, shall have a 25 % drainage time within ± 20 % of the characteristic value when tested in accordance with annex F.	12.2 Drainage limits	The foam produced from the foam concentrate, before and after temperature conditioning in accordance with A.2, with potable water and, if appropriate, with the synthetic sea water of G.2.4, shall have a 25 % drainage time within ± 20 % of the characteristic value when tested in accordance with Annex F.
12.2.2 Temperature sensitivity	If any of the values for 25 % drainage time obtained after temperature conditioning is less than 0,8 times, or more than 1,2 times, the corresponding value obtained before temperature conditioning, the foam concentrate shall be designated as temperature sensitive.		
13 Test fire	The foam produced from the foam concentrate, before and, if the foam concentrate is designated as temperature sensitive, after temperature	13 Test fire	The foam produced from the foam concentrate with potable water and, if appropriate, with the synthetic sea water of G.2.4, shall have an

performance	conditioning in accordance with A.2 with potable water and, if appropriate, with the synthetic sea water of G.1.4, shall have an extinguishing performance class and burnback resistance level as specified in table 1, when tested in accordance with G.1 and G.2 and/or G.3, as appropriate.	performance	extinguishing performance class and burn-back resistance level as specified in Table 1 when tested in accordance with G.2 and G.3, G.2 and G.4, or G.2 and G.3 plus G.4, as appropriate.
14	Marking, packaging and specification sheet	14	Marking, packaging and specification sheet
14.1	<p>The following information shall be provided by the supplier as a specification sheet either supplied with or marked on the shipping container:</p> <p>a) the designation (identifying name) of the concentrate and the words “low expansion foam concentrate”;</p> <p>b) the class (I, II or III) and level (A, B, C or D) of the foam concentrate and, if the concentrate complies with clause 11, the words “film-forming”;</p> <p>c) recommended usage concentration for use (most commonly 1 %, 3 % or 6 %);</p> <p>d) any tendency of the foam concentrate to cause harmful physiological effects, the methods required to avoid them and the first aid treatment if they should occur;</p> <p>e) recommended storage temperature and temperature of use;</p> <p>f) if the concentrate complies with clause 5, the words “Not affected by freezing and thawing” or, if the foam concentrate does not comply with clause 5, the words “Do not freeze”;</p> <p>g) the nominal quantity in the container;</p> <p>h) the supplier’s name and address;</p> <p>i) the batch number;</p> <p>j) the words “Not suitable for use with sea water” or “Suitable for use with sea water”, as appropriate;</p> <p>k) any corrosiveness of the concentrate, both in storage and in use, which significantly exceeds that of potable water;</p> <p>l) suitable materials for storage containers and equipment, both for the concentrate and the foam solution.</p> <p>WARNING - It is extremely important that the foam concentrate, after dilution with water to the recommended concentration, must not, in normal usage, present a significant toxic hazard to life in relation to the environment.</p> <p>The packaging of the foam concentrate shall ensure that the essential characteristics of the concentrate are preserved when stored and handled in accordance with the supplier’s recommendations.</p> <p>Markings on shipping containers shall be permanent and legible. It is recommended that non-Newtonian concentrates are appropriately identified.</p> <p>Foam concentrates complying with ISO 7203-2 shall also be marked “medium expansion” and/or “high expansion”.</p>	14.1.1	<p>The following information shall be marked on the shipping container:</p> <p>a) designation (identifying name) of the concentrate and the words “low-expansion foam concentrate”;</p> <p>b) class (I, II or III) and level (A, B, C or D) of the foam concentrate and, if the concentrate complies with Clause 11, the words “aqueous film-forming”;</p> <p>c) recommended concentration for use (most commonly 1 %, 3 %, or 6 %);</p> <p>d) any tendency of the foam concentrate to cause harmful physical effects, the methods required to avoid them and the first aid treatment if they occur;</p> <p>e) recommended storage temperature and temperature of use;</p> <p>f) if the concentrate complies with Clause 5, the words; “Not affected by freezing and thawing”; or, if the foam concentrate does not comply with Clause 5, the words “Do not freeze”;</p> <p>g) nominal quantity in the container;</p> <p>h) supplier's name and address;</p> <p>i) batch number;</p> <p>j) words “Not suitable for use with sea water” or “Suitable for use with sea water”, as appropriate.</p> <p>WARNING — It is extremely important that the foam concentrate, after dilution with water to the recommended concentration, shall not, in normal usage, present a significant toxic hazard to life in relation to the environment.</p>

		14.1.2	Markings on shipping containers shall be permanent and legible.
		14.1.3	It is recommended that non-Newtonian concentrates be appropriately identified.
		14.1.4	Foam concentrates complying with ISO 7203-2 shall also be marked “medium-expansion” or “high-expansion” or both.
14.2	If requested by the user, the supplier shall provide a list of the characteristic values.	14.2 Packaging	The packaging of the foam concentrate shall ensure that the essential characteristics of the concentrate are preserved when stored and handled in accordance with the supplier's recommendations.
		14.3	Specification sheet
		14.3.1	If the foam concentrate is Newtonian and the viscosity at the lowest temperature for use is more than 200 mm ² /s when measured in accordance with ISO 3104, the words: “This concentrate can require special proportioning equipment” shall be included on the specification sheet.
		14.3.2	If the foam concentrate is pseudo-plastic and the viscosity at the lowest temperature for use is greater than or equal to 120 mPa/s at 375/s, the words: “Pseudo-plastic foam concentrate. This concentrate can require special proportioning equipment” shall be included on the specification sheet.
		14.3.3	It is recommended that non-Newtonian concentrates be appropriately identified.
Annex A (normative)	Preliminary sampling and conditioning of the foam concentrate	Annex A (normative)	Preliminary sampling and conditioning of the foam concentrate
A.1 Preliminary sampling	The sampling method shall ensure representative samples, whether taken from a bulk container or a number of individual packages. Store samples in fully closed containers. NOTE 3 Containers of capacity 20 litres are suitable.	A.1 Preliminary sampling	The sampling method shall ensure representative samples, whether taken from a bulk container or from a number of individual packages. Store samples in fully closed containers. NOTE Containers with a capacity of 20 l are suitable.
A.2	Conditioning of foam concentrate	A.2	Conditioning of foam concentrate
A.2.1	If the supplier claims that the concentrate is not adversely affected by freezing and thawing, condition the concentrate Sample through four cycles of freezing and thawing, generally as described in B.2, before conditioning in accordance with A.2.2.	A.2.1	If the supplier claims that the concentrate is not adversely affected by freezing and thawing, condition the concentrate sample through four cycles of freezing and thawing, generally as described in B.2, before conditioning in accordance with A.2.2. If the foam concentrate is adversely affected by freezing and thawing, it shall be conditioned according to A.2.2 without prior freezing and thawing.
A.2.2	Condition the concentrate in the sealed container for 7 days at (60 ± 2) °C, followed by 1 day at (20 ± 5) °C.	A.2.2	Condition the concentrate in the sealed container for 7 d at (60 ± 2) °C, followed by 1 d at (20 ± 5) °C.
A.3 Subsequent testing	Test samples prepared in accordance with A.1, or A.1 and A.2 as appropriate. Agitate the sample container before sampling for further tests.	A.3 Subsequent testing	Test samples prepared in accordance with A.1, or A.1 and A.2 as appropriate. Agitate the sample container before sampling for further tests.
Annex B	Determination of tolerance to freezing and thawing (see clause 5)	Annex B	Determination of tolerance to freezing and thawing

(normative)		(normative)	
B.1	Apparatus	B.1 Apparatus	The usual laboratory apparatus and, in particular, the following:
B.1.1	Freezing chamber, capable of achieving the temperatures required in B.2.	B.1.1	Freezing chamber, capable of achieving the temperatures required in B.2.
B.1.2	Polyethylene tube, approximately 10 mm in diameter, 400 mm long and sealed and weighted at one end, with suitable spacers attached. Figure B.1 shows a typical form.	B.1.2	Polyethylene tube, approximately 10 mm in diameter, approximately 400 mm long and sealed and weighted at one end, with suitable spacers attached. Figure B.1 shows a typical form.
B.1.3	Glass measuring cylinder, of capacity 500 ml, approximately 400 mm high and 65 mm in diameter, with a stopper.	B.1.3	Measuring cylinder, glass, of 500 ml capacity, approximately 400 mm high and approximately 65 mm in diameter, with a stopper.
B.2 Procedure	<p>Set the temperature of the freezing chamber (B.1.1) to $(10 \pm 1) ^\circ\text{C}$ below the freezing point of the sample measured in accordance with BS 5117, Section 1.3 (excluding 5.2).</p> <p>To prevent the glass measuring cylinder (B.1.3) from breaking due to expansion of the foam concentrate on freezing, insert the tube (B.1.2) into the measuring cylinder with the sealed end downward, weighted if necessary to avoid flotation, the spacers ensuring it remains approximately on the central axis of the cylinder. Fill the cylinder and fit the stopper.</p> <p>Place the cylinder in the chest, cool it and maintain at the required temperature for 24 h. At the end of this period, thaw the sample for not less than 24 h and not more than 96 h in an ambient temperature of $(20 \pm 5) ^\circ\text{C}$.</p> <p>Repeat three times to give four cycles of freezing and thawing before testing.</p> <p>Examine the sample for stratification and non-homogeneity.</p>	B.2 Procedure	<p>Set the temperature of the freezing chamber (B.1.1) to at least $10 ^\circ\text{C}$ below the freezing point of the sample, measured in accordance with BS 5117-1.3, excluding 5.2.</p> <p>To prevent the glass measuring cylinder (B.1.3) from breaking due to expansion of the foam concentrate on freezing, insert the tube (B.1.2) into the measuring cylinder with the sealed end downward, weighted if necessary to avoid flotation, the spacers ensuring it remains approximately on the central axis of the cylinder.</p> <p>Fill the cylinder and fit the stopper.</p> <p>Place the cylinder in the freezing chamber, cool it and maintain at the required temperature for 24 h. At the end of this period, thaw the sample for not less than 24 h and not more than 96 h in an ambient temperature of $(20 \pm 5) ^\circ\text{C}$.</p> <p>Repeat three times to give four cycles of freezing and thawing before testing.</p> <p>Examine the sample for stratification and non-homogeneity.</p>
Annex C (normative)	Determination of percentage of sediment (see clause 6)	Annex C (normative)	Determination of volume percentage of sediment
C.1 Sample	Use a sample prepared in accordance with A.1. Ensure that any sediment is dispersed by agitating the sample container. Take two samples, testing one immediately and the other after ageing for (24 ± 2) h at $(60 \pm 2) ^\circ\text{C}$ in a filled container without access to air.	C.1 Sampling	Use a sample prepared in accordance with A.1. Ensure that any sediment is dispersed by agitating the sample container. Take two samples, testing one immediately and the other after ageing for (24 ± 2) h at $(60 \pm 2) ^\circ\text{C}$ in a filled container without access to air.
C.2	Apparatus	C.2 Apparatus	The usual laboratory apparatus and, in particular, the following:
C.2.1	Graduated centrifuge tubes.	C.2.1	Centrifuge tubes, graduated. Centrifuge tubes complying with ISO 3734 are suitable.
C.2.2	Centrifuge, operating at $(6,000 \pm 600) \text{ m/s}^2$.	C.2.2	Centrifuge, operating at $(6\,000 \pm 600) \text{ m/s}^2$. A centrifuge complying with ISO 3734 is suitable.
C.2.3	Sieve, of nominal aperture size $180 \mu\text{m}$, complying with ISO 3310-1.	C.2.3	Sieve, of nominal aperture size $180 \mu\text{m}$, complying with ISO 3310-1.
C.2.4	A centrifuge and tubes complying with ISO 3734 are suitable.	C.2.4	Wash bottle, plastic.

Plastics wash bottle			
C.3 Procedure	Centrifuge each sample of the solution for (10 ± 1) min. Determine the volume of the sediment and record it as a percentage of volume of the centrifuged sample volume. Wash the contents of the centrifuge tube (C.2.1) onto the sieve (C.2.3) and check that the sediment can or cannot be dispersed through the sieve by the jet from the plastics wash bottle (C.2.4).	C.3 procedure	Centrifuge each sample of the concentrate for (10 ± 1) min. Determine the volume of the sediment and record it as a percentage of volume of the centrifuged sample volume. Wash the contents of the centrifuge tube (C.2.1) onto the sieve (C.2.3) and check whether or not the sediment can be dispersed through the sieve by the jet from the plastic wash bottle (C.2.4).
Annex D (normative)	Determination of comparative fluidity (see clause 7) NOTE 4 The kinematic viscosity of Newtonian concentrates can be measured in accordance with ISO 3104:1994, Petroleum products - Transparent and opaque liquids - Determination of kinematic viscosity and calculation of dynamic viscosity. The dynamic viscosity of non-Newtonian foam concentrates can be measured using a Brookfield LVT viscometer ²⁾ with a No. 4 spindle at a rotational speed of 60 r/min, taking readings (60 ± 5) s after the spindle begins to rotate. In both cases, a temperature tolerance of $\pm 0,1$ °C may be applied.	Annex D (normative)	Determination of viscosity for pseudo-plastic foam concentrates
D.1	Apparatus and materials (see figure D.1)	D.1 General	This annex specifies the procedure for determining the viscosity for pseudo-plastic foam concentrates. The procedure is described in ISO 3219. NOTE Pseudo-plastic foam concentrates are a particular class of non-Newtonian foam concentrate and have a viscosity that decreases with increasing shear rate at constant temperature.
D.1.1	Stainless steel pipe, 1 m long, of internal diameter 8,5 mm to 8,8 mm, sharply cut at both ends, where two external nipples are welded or screwed.		
D.1.2	Tank, of minimum capacity 10 litres, in which the sample can be kept cold at the minimum temperature for use, pressurized by a regulated gas supply.		
D.1.3	Tubing, of internal diameter $20 \text{ mm} \pm 2 \text{ mm}$, equipped with a valve connecting the pipe and tank with a pressure gauge with a full scale reading of 1,5 bar or 2,0 bar, at the supply end of the pipe, and an elbow at the outlet end of the pipe.		
D.1.4	Container, to collect the discharged liquid.		
D.1.5	Insulation material, covering the pipe and tubing such that the difference between the temperature of the contents of the tank and the temperature of the discharged liquid does not exceed 1 °C. NOTE 5 10 mm thick insulation is suitable.		
D.1.6	Reference liquid, for calibrating the apparatus, of known density and of viscosity $200 \text{ mm}^2/\text{s}$ at a temperature close to ambient. NOTE 6 A water/glycerol mixture at 21 °C with 90 % (m/m) of glycerol		

	($d_{15}^{15}=1,2395$) is suitable		
D.1.7	Thermometers, to measure the temperatures of liquids.		
D.2 Calibration	<p>Fill the tank (D.1.2) with the reference Newtonian liquid (D.1.6). Adjust the pressure in the tank so that the gauge shows a constant pressure of $(0,5 \pm 0,02)$ bar. Collect the liquid from the pipe (D.1.1) in a container (D.1.4) for a period of about 60 s and record the temperature, collection time and mass. Calculate the flow rate in l/min.</p> <p>Carry out two further tests and take the average of the three tests as the viscosity tube calibration value.</p> <p>NOTE 7 Usually the flow rate is approximately 1,8 l/min (2,25 kg/min) when the tube diameter is close to 8,6 mm and when using the glycerol mixture described in note 6.</p>	D.2	Viscosity determination
		D.2.1 Apparatus	The usual laboratory apparatus and the following:
		D.2.1.1	<p>Rotational viscometer, in accordance with ISO 3219, with the following parameters:</p> <ul style="list-style-type: none"> - maximum shear stress of ≥ 75 Pa; - maximum shear rate of ≥ 600/s. <p>The viscometer shall be fitted with a temperature control unit that can maintain the sample temperature within ± 1 °C of the required temperature.</p>
		D.2.2 Test temperatures	The viscosity of the foam concentrate shall be measured from 20 °C down to, and including, the lowest temperature for use claimed by the manufacturer, in increments of 10 °C. Use a fresh sample for each temperature.
		D.2.3 Viscosity measurement	<p>If the sample contains suspended air bubbles, the sample shall be centrifuged for 10 min using the apparatus specified in C.2.1 and C.2.2 before the sample is placed in the apparatus.</p> <p>The test should be performed according to the following test procedure.</p> <ol style="list-style-type: none"> Adjust the temperature control unit. Set the gap. Apply the sample. Wait a minimum of 10 min (with no shear) to reach temperature equilibrium. Pre-shear for 1 min at 600/s. Wait 1 min without shearing. Measure the shear stress for 10 s at each shear rate, starting at the lowest shear rate (preferably at 75/s). <p>Measure the shear stress at a minimum of eight different shear rates over the range 0/s to 600/s, e.g. 75/s, 150/s, 225/s, 300/s, 375/s, 450/s, 525/s and 600/s. Calculate the apparent viscosity, η, expressed in millipascal-seconds, as given in Equation (D.1):</p>

			$\nu = 1000 \times \frac{s_1}{s_2}$ <p>where s_1 is the shear stress, expressed in pascals; s_2 is the shear rate, expressed in reciprocal seconds.</p>
		D.2.4 Results	Report the results as a table including test temperature, expressed in degrees Celsius, the shear rate, expressed in reciprocal seconds, the shear stress, expressed in reciprocal seconds, and apparent viscosity, expressed in millipascal-seconds.
D.3 Procedure	Fill the tank (D.1.2) with foam concentrate and cool to a temperature between 1 °C and 3 °C specified by the supplier. Control the temperature to $\pm 0,1$ °C. Perform at least two tests, generally as described in D.2. Plot a graph of readings between 1 °C and 3 °C above the L.U.T. and project the plot to the L.U.T. to obtain the reading.		
Annex E (normative)	Determination of surface tension, interfacial tension and spreading coefficient (see clauses 9, 10 and 11)	Annex E (normative)	Determination of surface tension, interfacial tension and spreading coefficient
E.1	Materials	E.1	Reagents and materials
E.1.1	Solution of foam concentrate, at the recommended concentration for use in freshly made analytical water complying with grade 3 of ISO 3696 and surface tension not less than 70 mN/m. NOTE 8 The solution may be made up in a 100 ml volumetric flask using a pipette to measure the foam concentrate.	E.1.1	Solution of foam concentrate, at the recommended concentration for use in freshly made analytical water complying with grade 3 of ISO 3696:1987 and with surface tension not less than 70 mN/m. NOTE The solution can be made up in a 100 ml volumetric flask, using a pipette to measure the foam concentrate.
E.1.2	Cyclohexane, of purity not less than 99 %, for interfacial tension and spreading coefficient only.	E.1.2	Cyclohexane, of purity not less than 99 %, for interfacial tension and spreading coefficient only.
E.2 Procedure for surface tension	Determine the surface tension of the solution (E.1.1) at a temperature of (20 ± 1) °C using the ring method of ISO 304.	E.2 Procedure for surface tension	Determine the surface tension of the solution (E.1.1) at a temperature of (20 ± 1) °C, using the ring method in accordance with ISO 304.
E.3 Procedure for interfacial tension	After measuring the surface tension in accordance with E.2, introduce a layer of cyclohexane (E.1.2) at (20 ± 1) °C onto the foam solution (E.1.1), being careful to avoid contact between the ring and the cyclohexane. Wait (6 ± 1) min and then measure the interfacial tension.	E.3 Procedure for interfacial tension	After measuring the surface tension in accordance with E.2, introduce a layer of cyclohexane (E.1.2) at (20 ± 1) °C onto the foam solution (E.1.1), being careful to avoid contact between the ring and the cyclohexane. Wait (6 ± 1) min and then measure the interfacial tension.
E.4 Spreading coefficient	Calculate the spreading coefficient between the solution (E.1.1) and cyclohexane (E.1.2) from the equation $S = \gamma_c - \gamma_f - \gamma_i$ <p>Where S is the spreading coefficient, in millinewtons per metre; γ_c is the surface tension of the cyclohexane, in millinewtons per metre; γ_f is the surface tension of the foam solution, in millinewtons per metre;</p>	E.4 Spreading coefficient	Calculate the spreading coefficient, S , expressed in millinewtons per metre, between the solution (E.1.1) and cyclohexane (E.1.2) from Equation (E.1): $S = \gamma_c - \gamma_f - \gamma_i \quad (\text{E.1})$ <p>where γ_c is the surface tension of the cyclohexane, expressed in millinewtons per metre;</p>

	v_i is the interfacial tension between the foam solution and cyclohexane, in millinewtons per metre.		Y_f is the surface tension of the foam solution, expressed in millinewtons per metre; Y_i is the interfacial tension between the foam solution and cyclohexane, expressed in millinewtons per metre.
Annex F (normative)	Determination of expansion and drainage time (see clause 12)	Annex F (normative)	Determination of expansion and drainage time
F.1	Apparatus	F.1 Apparatus	The usual laboratory apparatus and, in particular, the following:
F.1.1	Plastics collecting vessel, of volume known to $\pm 1\%$, equipped with a bottom discharge facility, as shown in figure F.1.	F.1.1	Collecting vessel, plastic, cylindrical, of volume known to $\pm 1\%$, equipped with a bottom discharge facility, as shown in Figure F.1.
F.1.2	Foam collector, for expansion and drainage measurement, as shown in figure F.2. Stainless steel, aluminium, brass and plastics are suitable materials for the collection surface.	F.1.2	Foam collector, for expansion and drainage measurement, as shown in Figure F.2. Stainless steel, aluminium, brass and plastics are suitable materials for the collection surface.
F.1.3	Foam-making nozzle, as shown in figure F.3 which, when tested with water, has a flow rate of 11,4 l/min at a nozzle pressure of $(6,3 \pm 0,3)$ bar	F.1.3	Foam-making nozzle, as shown in Figure F.3, that, when tested with water, has a flow rate of 11,4 l/min at a nozzle pressure of (630 ± 30) kPa $[(6,3 \pm 0,3)$ bar].
F.1.4	Foam solution tank, connected to the nozzle.	F.1.4	Foam solution tank, connected to the nozzle.
F.2 Temperature conditions	Carry out the tests under the following temperature conditions: Air temperature: $(15 \pm 5)^\circ\text{C}$ Foam solution temperature: $(17,5 \pm 2,5)^\circ\text{C}$	F.2 Temperature conditions	Carry out the tests under the following temperature conditions: - air temperature $(20 \pm 5)^\circ\text{C}$; - foam solution temperature $(17,5 \pm 2,5)^\circ\text{C}$.
F.3 Procedure	Check that the pipework and hose from the foam solution tank (F.1.4) to the nozzle (F.1.3) is completely full of solution. Set up the nozzle horizontally, directly in front of the foam collector (F.1.2), with the front of the nozzle $(3 \pm 0,3)$ m from the top edge of the collector. Wet the collecting vessel (F.1.1) internally and weigh it (m_1). Set up the foam-making nozzle and adjust the nozzle pressure to give a flow rate of 11,4 l/m. Discharge foam and adjust the height of the nozzle so that the discharge strikes the collector centrally. Keep the nozzle horizontal. Stop foam discharge and rinse all the foam from the collector. Check that the foam solution tank is full. Start discharging foam and, after (30 ± 5) s to allow the discharge to stabilize, place the collecting vessel, with the discharge outlet closed, below the collector. As soon as the vessel is full, remove it from the collector, strike the foam surface level with the rim and start the clock. Weigh the full vessel (m_2). Calculate the expansion E from the equation $E = \frac{V}{m_2 - m_1}$ Where V is the volume, in litres, of the collecting vessel (F.1.1); m_1 is the mass, in kilograms, of the empty vessel; m_2 is the mass, in kilograms, of the full vessel.	F.3 Procedure	Check that the pipework and hose from the foam solution tank (F.1.4) to the nozzle (F.1.3) is completely full of solution. Set up the nozzle horizontally, directly in front of the foam collector (F.1.2), with the front of the nozzle $(3 \pm 0,3)$ m from the top edge of the collector. Wet the collecting vessel (F.1.1) internally and weigh it; record the mass as m_1 . Set up the foam-making nozzle and adjust the nozzle pressure to give a flow rate of 11,4 l/min. Discharge foam and adjust the height of the nozzle so that the discharge strikes the collector centrally. Keep the nozzle horizontal. Stop foam discharge and rinse all the foam from the collector. Check that the foam solution tank is full. Start discharging foam and, after (30 ± 5) s to allow the discharge to stabilize, place the collecting vessel, with the discharge outlet closed, below the collector. As soon as the vessel is full, remove it from the collector, strike the foam surface level with the rim and start the clock. Weigh the full vessel; record the mass as m_2 . Calculate the expansion, E, as given in Equation (F.1): $E = \frac{V}{m_2 - m_1}$ where V is the volume, expressed in litres, of the collecting vessel (F.1.1); m_1 is the mass, expressed in kilograms, of the empty vessel;

	Assume that the density of the foam solution is 1,0 kg/l. Open the drainage facility (see F.1.1) and collect the foam solution in the measuring cylinder to measure the 25 % drainage time. Adjust the drainage facility such that the drained foam solution may flow out whilst preventing the passage of foam. NOTE 9 This may be achieved by controlling the level of the liquid/foam interface in the plastics tube at the outlet.		m ₂ is the mass, expressed in kilograms, of the full vessel. Assume that the density of the foam solution is 1,0 kg/l. Open the drainage facility (see F.1.1) and collect the foam solution in a graduated measuring cylinder to measure the 25 % drainage time. Adjust the drainage facility such that the drained foam solution can flow out but the passage of foam is prevented. NOTE This can be achieved by controlling the level of the liquid/foam interface in the plastic tube at the outlet.
		Annex G (normative)	Determination of test fire performance
Annex G (normative) Determination of test fire performance (see clause 13)	The tests described in this annex are more expensive and time consuming than the other tests of this part of ISO 7203. It is recommended that they are carried out at the end of the test programme, so as to avoid the expense of unnecessary testing of foam concentrates which do not comply in other respects.	G.1 General	This annex specifies the procedure for determining the test fire performance for low-expansion foam concentrates. The tests described in this annex are more expensive and time-consuming than the other tests described in this part of ISO 7203. It is recommended that they be carried out at the end of the test programme, so as to avoid the expense of unnecessary testing. Testing at temperatures above the range required by this part of ISO 7203 can result in poor performance, and does not result in conformity to this part of ISO 7203.
G.1	General conditions		
G.1.1	Test series	G.2	General conditions
G.1.1.1	A test is successful only if all the appropriate requirements of clause 13 are met.	G.2.1	Test series and criteria for success
G.1.1.2	For foam concentrates not compatible with sea water, carry out two or three tests (the third test is not necessary if the first two are both successful or if both are not successful). The concentrate complies with clause 13 if two tests are successful.	G.2.1.1 Foam concentrates not compatible with sea water	Conduct two or three tests (the third test is not necessary if the first two are both successful or if neither are successful). The concentrate conforms to Clause 13 if two tests are successful.
G.1.1.3	For foam concentrates compatible with sea water, carry out one of the first two tests with potable water and the other with the synthetic sea water of G.1.4. If both are successful or if both are not successful, terminate the test series. If only one of the tests is not successful, repeat that test. If this repeat test is successful, carry out a second repeat test, otherwise terminate the test series. The concentrate complies with clause 13 either a) if the first two tests are successful; or b) if one of the first two tests and both repeat tests are successful.	G.2.1.2 Foam concentrates compatible with sea water	Conduct one of the first two tests with potable water and the other with simulated sea water of the composition given in G.5. If both are successful, repeat the test with the greater of the two extinction times. If the extinction times are identical, repeat the sea water test. If the repeat test is successful, terminate the test series. If the repeat test is unsuccessful, carry out a second repeat test. If one of the first two tests is not successful, repeat that test. If this repeat test is successful, conduct a second repeat test; otherwise terminate the test series. The concentrate conforms to Clause 13 if three tests are successful.
G.1.2 Temperature and	Carry out the tests under the following conditions: Air temperature: (15 ± 5) °C Fuel temperature: (17,5 ± 2,5) °C	G.2.2 Temperature and	Carry out the tests under the following conditions: - air temperature (15 ± 5) °C; - fuel temperature (17,5 ± 2,5) °C;

wind speed	Water temperature: (17,5 ± 2,5) °C Foam Solution temperature: (17,5± 2,5) °C Maximum wind Speed: 3 m/s in the proximity of the test pan NOTE 10 If necessary, some form of wind-screen may be used.	wind speed	- water temperature (17,5 ± 2,5) °C; - foam solution temperature (17,5 ± 2,5) °C; - maximum wind speed in the proximity of the fire tray 3 m/s. NOTE If necessary, some form of wind-screen can be used.												
G.1.3 Records	During the fire test, record the following: - indoor or outdoor test; - air temperature, - fuel temperature, - water temperature, - foam-Solution temperature, - wind speed, - extinction time, - 25 % burnback time (where appropriate). For quality control purposes, it is recommended that 90 % and 99 % control times are recorded. Control times may either be determined visually by an experienced person or be determined from thermal radiation measurements. Annex H gives details of one method suitable for low and medium expansion foams.	G.2.3 Records	During the fire test, record the following: a) location; b) air temperature; c) fuel temperature; d) water temperature; e) foam solution temperature; f) wind speed; g) 90 % control time; h) 99 % control time; i) extinction time; j) 25 % burn-back time. NOTE 90 % control time and burn-back time can be determined either visually by an experienced person or from thermal radiation measurements. Annex H gives details of a method suitable for low-expansion foams.												
G.1.4 Foam solution	Prepare a foam solution following the recommendations from the supplier for the concentration, maximum premix time, compatibility with the test equipment, avoidance of contamination by other types of foam, etc. Use potable water to make up the foam solution and, if the manufacturer claims that the concentrate is suitable for sea water, also make a foam solution using simulated sea water made up by dissolving the following components. <table><tr><td>Component</td><td>Content % (m/m)</td></tr><tr><td>Sodium chloride (NaCl)</td><td>2,50</td></tr><tr><td>Magnesium chloride (MgCl₂.6H₂O)</td><td>1,10</td></tr><tr><td>Calcium chloride dihydrate (CaCl₂.2H₂O)</td><td>0,16</td></tr><tr><td>Sodium sulfate (Na₂SO₄)</td><td>0,40</td></tr><tr><td>Potable water</td><td>95,84</td></tr></table>	Component	Content % (m/m)	Sodium chloride (NaCl)	2,50	Magnesium chloride (MgCl ₂ .6H ₂ O)	1,10	Calcium chloride dihydrate (CaCl ₂ .2H ₂ O)	0,16	Sodium sulfate (Na ₂ SO ₄)	0,40	Potable water	95,84	G.2.4 Foam solution	Prepare a foam solution following the recommendations from the supplier for concentration, maximum premix time, compatibility with the test equipment, avoiding contamination by other types of foam, etc. Use potable water to prepare the foam solution and, if the supplier claims that the concentrate is suitable for use in sea water, make a second foam solution at the same concentration using simulated sea water in accordance with G.5.
Component	Content % (m/m)														
Sodium chloride (NaCl)	2,50														
Magnesium chloride (MgCl ₂ .6H ₂ O)	1,10														
Calcium chloride dihydrate (CaCl ₂ .2H ₂ O)	0,16														
Sodium sulfate (Na ₂ SO ₄)	0,40														
Potable water	95,84														
G.1.5 Fuel	Use an aliphatic hydrocarbon mixture having physical properties according to the following specification: Distillation range: 84 °C to 105°C Maximum difference between initial and final boiling Points: 10 °C Maximum aromatic content: 1 % Density at 15 °C: NOTE 11 Typical fuels meeting this specification are n-heptane and	G.2.5 Fuel	Use an aliphatic hydrocarbon mixture having physical properties according to the following specification: a) distillation range: 84 °C to 105 °C; b) maximum difference between initial and final boiling points: 10 °C; c) maximum aromatic content: 1 % mass fraction; d) density at 15 °C: (700 ± 20) kg/m³. NOTE 1 The normal value of surface tension of the aliphatic hydrocarbon mixture measured in accordance with G.2.1 is 21 mN/m to												

	certain solvent fractions sometimes referred to as commercial heptane. The surface tension of η -heptane measured in accordance with E.2 is approximately 20 mN/m.		22 mN/m. NOTE 2 Typical fuels meeting this specification are certain solvent fractions sometimes referred to as commercial heptane.
G.2 Gentle applicatio n	See table 1.	G.4	Gentle application fire test
G.2.1	Apparatus	G.4.1 Apparatus	The usual laboratory apparatus and, in particular, the following.
G.2.1.1	Circular fire tray, made of steel with a vertical steel backboard ($1 \pm 0,05$) m high and ($1 \pm 0,05$) m long, fitted as closely as possible along the curved top of the curved wall, or formed by an extension of the wall. The dimensions of the tray are as follows: Internal diameter at rim: (2400 \pm 25) mm Depth: (200 \pm 15) mm Nominal thickness of steel wall: 2,5 mm Area: approximately 4,25 m ²	G.4.1.1	Circular fire tray, stainless steel grade 314, with dimensions as follows: - internal diameter at rim (2400 \pm 25) mm; - depth (200 \pm 15) mm; - nominal thickness of steel wall 2,5 mm.
		G.4.1.2	Backboard, vertical, stainless steel, ($1 \pm 0,05$) m high and ($1 \pm 0,05$) m long and 2,5 mm thick, fitted as closely as possible along the top of the tray wall, or formed by an extension of the tray wall. NOTE The tray has an area of approximately 4,52 m ² .
G.2.1.2	Foam-making nozzle, in accordance with F.1.3.	G.4.1.3	Foam-making equipment, as described in F.1.3.
G.2.1.3	Burnback pot, made of steel with nominal thickness 2,5 mm, (300 \pm 5) mm in diameter and (250 \pm 5) mm high.	G.4.1.4	Burn-back pot, stainless steel, of nominal thickness 2,5 mm, diameter (300 \pm 5) mm and height (250 \pm 5) mm.
G.2.2 Procedure	Place the tray (G.2.1.1) downwind from the nozzle (G.2.1.2) directly on the ground and ensure that it is level. Add approximately 90 litres of potable water and check that the base of the tray is completely covered. Set up the foam-making nozzle horizontally, ($1 \pm 0,05$) m above the fuel level, in a position where the central part of the foam discharge will strike the centre axis of the backboard ($0,5 \pm 0,1$) m above the fuel level (see figure G.1). Add (144 \pm 5) litres of fuel, to give a nominal freeboard of 150 mm. Ignite the tray not more than 5 min after adding the fuel, and allow it to burn for (60 \pm 5) s after the surface of the fuel is fully ablaze. Then start applying foam. Record the extinction time as the period between the start of foam application and extinction. For the purposes of this test, extinction is considered to have occurred when the entire fuel surface is covered by foam and when: a) for class III foams, all the flames have disappeared; b) for class II and I foams, the only remaining flames are reduced to only one or more flickers within 0,1 m of the rim of the tray, are not more than 0,15 m higher than the rim, with an aggregate flame front (i.e. disregarding any space between flickers not more than 0,5 m measured	G.4.2 Test procedure	Place the tray directly on the ground and ensure that it is level. Set up the foam nozzle horizontally, ($1 \pm 0,05$) m above the fuel level, in a position where the central part of the foam discharge strikes the centre axis of the backboard ($0,5 \pm 0,1$) m above the fuel level (see Figure G.2). Clean the tray. Add approximately 90 l of water and check that the base is completely covered. Add (144 \pm 5) l of fuel, to give approximately 150 mm between the fuel surface and the top of the tray wall. Ignite the fuel not less than 3 min, and not more than 5 min, after adding it. Start foam application (60 \pm 2) s after full involvement of the surface of the fuel. Readjust the nozzle to ensure that the jet continues to hit the centre of the backboard. Apply foam for (300 \pm 2) s. If the fire is extinguished, record the extinction time as the period from the start of foam application and until the time when all flames are extinguished. NOTE 1 If a foam has achieved a burn-back resistance level A at extinguishing performance class I or II on the forceful application test, it is not necessary to test it using gentle application. NOTE 2 Extinction is not required for foams that have successfully extinguished the forceful application test of G.3 without achieving burn-back resistance level A.

	around the rim) and which do not increase in intensity during the period before burnback. Apply foam for (300 ± 2) s. Stop applying foam and, after a further (300 ± 10) s, place the burnback pot (G.2.1.3) containing $(2 \pm 0,1)$ litres of fuel in the centre of the tray and ignite. Record the time when 25 % of the tray is covered with sustained flames, ignoring any faint blue or barely visible transient flames.		NOTE 3 Foams that do not extinguish the gentle application test of this clause can have a reduced burn-back resistance level because of flames remaining after foam application. If the fire is not extinguished within (300 ± 2) s and the foam has not achieved extinguishing performance class I or II, terminate the test. After an additional (300 ± 10) s, place the burn-back pot, containing $(2 \pm 0,1)$ l of fuel, in the centre of the tray and ignite. Record the 25 % burn-back time.
G.3 Forceful applicatio n	See table 1.	G.3	Forceful application fire test
G.3.1 Apparatus	As in G.2.1, except that the tray does not have a backboard.	G.3.1 Apparatus	The usual laboratory apparatus and the apparatus listed in G.4.1, except that the tray does not have a backboard.
G.3.2 Procedure	Place the tray (see G.3.1) downwind from the nozzle (G.2.1.2), generally in accordance with G.2.2, but position the nozzle so that the central part of the foam discharge will fall directly onto the fuel surface, at a point $(1 \pm 0,1)$ m from the edge of the tray furthest from the nozzle (see figure G.2). Ignite the fuel within 5 min of adding it and allow it to burn for (60 ± 5) s after the surface of the fuel is fully ablaze. Apply foam for (180 ± 2) s and, if the fire is extinguished, record the extinction time. Stop applying foam and, if the fire is not extinguished, wait to see if any remaining flames are extinguished and record the extinction time. After a further (300 ± 10) s, place the burnback pot (G.2.1.3) containing $(2 \pm 0,1)$ litres of fuel in the centre of the tray and ignite. Record the time when 25 % of the tray is covered with sustained flames, ignoring any faint blue or barely visible transient flames.	G.3.2 Procedure	Set up the tray and nozzle generally in accordance with G.4.2 but position the nozzle so that the central part of the foam discharge falls directly on the fuel surface at a point $(1 \pm 0,1)$ m from the edge of the tray furthest from the nozzle (see Figure G.1). Ignite the fuel not more than 300 s after adding it and allow to burn for (60 ± 2) s after full involvement of the surface of the fuel. Apply foam for (180 ± 2) s. If the fire is extinguished prior to the end of foam application, record the extinction time as the period from the start of foam application until the time when all flames are extinguished. Stop applying foam and, if the fire is not extinguished, wait to see if any remaining flickers of flame are extinguished and record the extinction time. (300 ± 10) s after stopping foam application, place the burn-back pot containing $(2 \pm 0,1)$ l of fuel in the centre of the tray and ignite. Visually estimate when 25 % of the tray is covered by sustained flames or by “flare up” flames (see Note), ignoring any faint, barely visible, or transient flames. Record the time elapsed since ignition of the burn-back pot as the 25 % burn-back time. NOTE During the burn-back test, a “flare up” can occur, in which large flames can be sustained for periods typically ranging from 30 s to 3 min before decreasing in intensity.
		G.5 Simulated sea water	Prepare the simulated sea water by dissolving the components as given in Table G.1.
Annex H (informati ve)	Description of a radiation measurement method	Annex H (informati ve)	Description of a radiation measurement method
H.1 Evaluatio n	Radiation measurement is a convenient and objective way to monitor the performance of a foam during the fire performance test. It reduces the need for visual observations (except for flame flickers and time necessary	H.1 Evaluatio n	Radiation measurement is a convenient and objective way to monitor the performance of a foam during the fire performance test. It reduces the requirement for visual observations (except for flame flickers and

	<p>for complete extinction).</p> <p>This annex describes the equipment and procedure³⁾ used in a series of tests in one testing laboratory, and the methods used to interpret and present the results.</p> <p>The method is suitable for low and medium expansion foams but not for high expansion foams.</p>		<p>the time necessary for complete extinction).</p> <p>This annex describes the equipment and procedure used in a series of tests in one testing laboratory, and the methods used to interpret and present the results. See Reference [8] for additional details. The method is suitable for low- and medium-expansion foams but not for high-expansion foams.</p>
H.2 General arrangement of test	<p>Radiometers should be placed diametrically in relation to the tray as shown in figure H.1. The distance between the meters and the rim of the tray should be not less than twice the diameter (D) of the tray and the height above the rim not less than 1,5 m.</p> <p>NOTE 12 The maximum distance is limited by the sensitivity of the radiometers.</p> <p>Radiation levels should be recorded continuously or with intervals not exceeding 1 s.</p>	H.2 General arrangement of test	<p>Radiometers should be placed diametrically in relation to the tray, as shown in Figure H.1. The distance between the meters and the rim of the tray should be not less than twice the diameter, D, of the tray; the height above the rim should be not less than 1,5 m.</p> <p>NOTE The maximum distance is limited by the sensitivity of the radiometers.</p> <p>Radiation levels should be recorded continuously or with intervals not exceeding 1 s.</p>
H.3 Technical data for radiometers ⁴⁾	<p>Two radiometers of type Gordon or Schmidt-Boelter should be used. The meters should be cooled with water. The temperature of the cooling water should be $(30 \pm 10)^\circ\text{C}$, held constant during the measurements.</p> <p>The radiometers absorb at least 90 % of the incoming radiation within the range of wavelengths 0,6 μm to 15,0 μm.</p> <p>For a fully developed fire, the radiometer reading should be not less than 0,6 times full scale.</p> <p>The radiometers should have maximum non-linearity of ± 3 % of nominal range of measurement, and a maximum response time of 2 s (up to 63 % of full response).</p> <p>NOTE 13 A radiometer with protective glass could be used, provided that the requirements on spectral sensitivity are satisfied. If it is assumed to be necessary, the utilization of the range of measurement specified above could be changed, if the radiometers have a better linearity. Less than 40 % utilization is not advisable, as the influence of background radiation might cause an effect that is too high.</p>	H.3 Technical data for radiometers	<p>Two radiometers¹⁾ of the Gordon or Schmidt-Boelter type should be used. The meters should be cooled with water. The temperature of the cooling water should be $(30 \pm 10)^\circ\text{C}$, held constant during the measurements. The radiometers absorb at least 90 % of the incoming radiation within the range of wavelengths 0,6 μm to 15 μm.</p> <p>For a fully developed fire, the radiometer reading should be not less than 0,6 times the full scale.</p> <p>The radiometers should have maximum non-linearity of ± 3 % of nominal range of measurement, and a maximum response time of 2 s (up to 63 % of full response).</p> <p>A radiometer with a protective glass may be used, provided that the requirements on spectral sensitivity are satisfied. If it is considered necessary, the utilization of the range of measurement specified above may be changed if the radiometers have a better linearity. Less than 40 % utilization is not advisable, as the influence of background radiation can have too great an effect.</p> <p>¹⁾ The Medtherm Series 64 supplied by Medtherm Corp., PO Box 412, Huntsville, AL, USA is an example of suitable apparatus available commercially. This information is given for the convenience of users of this part of ISO 7203 and does not constitute an endorsement by ISO of this apparatus.</p>
H.4 Procedure	<p>Correct the output from the two radiometers by deducting the background radiation recorded from 5 s to 10 s after the moment of complete extinction.</p> <p>Determine the average value of the two radiometers.</p> <p>Determine the average value of time of recorded radiation during the 25 s period from 30 s to 5 s before the start of the foam application (see figure H.2).</p> <p>Determine the relative radiation by dividing the output by the average value obtained in accordance with the preceding paragraph.</p>	H.4 Procedure	<p>Correct the output from the two radiometers by deducting the background radiation recorded from 5 s to 10 s after the moment of complete extinction.</p> <p>Determine the average value of the two radiometers.</p> <p>Determine the average value of time of recorded radiation during the 25 s period beginning at 30 s before the start of the foam application and ending 5 s before the start of the foam application (see Figure H.2).</p> <p>Determine the relative radiation by dividing the output by the average value obtained in accordance with the preceding paragraph.</p>

	<p>The instantaneous radiation values are subject to random fluctuation. A smoother curve, which facilitates interpretation, can be obtained by plotting radiation values averaged over a period of ± 5 s for each time value.</p> <p>The adjusted relative radiation is shown for the extinguishing test in figure H.3 and for the burnback test in figure H.4. A control of 90 % is equivalent to the relative radiation 0,1.</p> <p>The description above implies that computer-controlled measuring practice should be applied.</p>		<p>The instantaneous radiation values are subject to random fluctuation. A smoother curve, which facilitates interpretation, can be obtained by plotting radiation values averaged over a period of ± 5 s for each time value.</p> <p>The adjusted relative radiation is shown for the extinguishing test in Figure H.3 and for the burn-back test in Figure H.4. A control of 90 % is equivalent to the relative radiation 0,1.</p> <p>The description above implies that computer-controlled measuring practices should be applied.</p>
Annex J (informative)	Compatibility	Annex I (informative)	Compatibility
J.1 Compatibility between foam concentrates and fire extinguishing powders	Where foam and powder might be applied simultaneously or successively, users should ensure that any unfavourable interaction does not cause an unacceptable loss of efficiency.	I.1 Compatibility between foam concentrates and fire extinguishing powders	<p>Where foam and powder can be applied simultaneously or successively, users should ensure that any unfavourable interaction does not cause an unacceptable loss of efficiency.</p> <p>The small-scale fire-test detailed in Annex K may be used to evaluate the compatibility of foam concentrates and powders. This test is carried out on the foam in question, and then repeated after the fuel has been covered in powder.</p> <p>If the increase in extinction time is equal to or greater than 25 % compared to the result without powder, then the combination of powder and foam may be considered to lead to an unacceptable loss in efficiency. Likewise, a reduction in burn-back time by 25 % or more when powder is used would indicate that the foam and powder are incompatible. (500 \pm 1) g powder is weighed into a 180 μm sieve placed on a sheet of paper or cardboard. The sieve is held over the fuel, and the cardboard or paper removed. The powder is then evenly distributed over the surface of the fuel from a height of (150 \pm 10) mm. The fuel is lit not more than 60 s after the powder has been spread over the surface of the fuel.</p>
J.2 Compatibility between foam concentrates	Foam concentrates of different manufacture, grade or class are frequently incompatible and should not be mixed unless it has first been established that an unacceptable loss of efficiency does not result.	I.2 Compatibility between foam concentrates	Foam concentrates of different manufacture, grade or class are frequently incompatible and should not be mixed, unless it has first been established that an unacceptable loss of efficiency does not result.
Annex K (informative)	Typical anticipated performance for various types of foam concentrate	Annex J (informative)	Typical anticipated performance for various types of foam concentrate
		Annex K (informative)	Small-scale fire test
		K.1 General	Annex G describes large-scale fire tests for type approval. This annex describes a small-scale fire test which can be suitable for quality control

			<p>purposes.</p> <p>The test should not be run outdoors as the results are very sensitive to any kind of air flow.</p> <p>To analyse the compatibility between foams and dry chemical powder, this test should be repeated according to the procedure given in K.3.</p>
		K.2	Apparatus
		K.2.1	<p>Fire tray, circular, brass, as shown in Figure K.1, with a turned-over rim and a drain point with valve at the centre of the conical base, with dimensions as follows:</p> <ul style="list-style-type: none"> – internal diameter at rim (565 ± 5) mm; – height of vertical wall (150 ± 5) mm; – height of conical base (30 ± 5) mm; – thickness of vertical wall ($1,2 \pm 0,2$) mm. <p>NOTE The tray has an area of approximately 0,25 m².</p> <p>The fire tray is supported approximately 1 m above the ground on a steel frame with four legs. The tray is normally placed beneath a suitable fume extraction hood that can extract the smoke without interfering with the fire.</p>
		K.2.2	<p>Burn-back pot, brass, with a turned-over rim, fitted with four studs at the base to give an overall height of (96 ± 2) mm, with dimensions as follows:</p> <ul style="list-style-type: none"> – internal diameter at rim (120 ± 2) mm; – internal depth (80 ± 2) mm; – thickness of wall ($1,2 \pm 0,2$) mm. <p>A chain fitted to the rim allows lifting of the burn-back pot using a metal rod.</p>
		K.2.3	<p>Foam-making nozzle, as shown in Figure K.2, which has a nominal flow rate of 5,0 l/min at 700 kPa (7 bar) when tested with water.</p> <p>It is fitted with an adjustable collar to allow ejection of the foam from the side of the nozzle and, thus, variation of the foam flow rate through the outlet. The foam flow rate can also be controlled by adjusting the pressure applied to the foam solution.</p>
		K.2.4	<p>Fuel, consisting of an aliphatic hydrocarbon mixture as specified in G.2.5.</p>
		K.3	Test procedure
		K.3.1 Test conditions	<p>Carry out the test under the following conditions:</p> <ul style="list-style-type: none"> – air temperature (15 ± 5) °C; – fuel temperature ($17,5 \pm 2,5$) °C; – foam solution temperature ($17,5 \pm 2,5$) °C.
		K.3.2 Set-up	<p>Position the foam nozzle horizontally with the by-pass holes in the adjustable collar facing downwards at a height of (150 ± 5) mm above the rim of the fire tray (see Figure K.1).</p> <p>Prepare the foam solution following the recommendations of the</p>

			<p>supplier for concentration, maximum premix time, compatibility with test equipment, avoiding contamination by other types of foam, etc. Set the nozzle pressure to 700 kPa (7 bar) and the foam flow rate to $(0,75 \pm 0,025)$ kg/min by adjusting the collar and, if necessary, reducing the nozzle pressure. It is convenient to collect the foam in a tared vessel for 6 s and to weigh it to calculate the flow rate.</p> <p>Position the nozzle while keeping it horizontal so that the foam strikes the centre of the fire tray. Shut off the foam discharge. Clean the tray and close the drain valve.</p>
		K.3.3 Fire test	<p>Place $(9 \pm 0,1)$ l of fuel in the tray, and $(0,3 \pm 0,01)$ l of fuel in the burn-back pot.</p> <p>(120 ± 2) s after fuelling, ignite the fuel and allow to burn for (60 ± 2) s before starting foam application. Apply foam for (120 ± 2) s to the centre of the tray and record the times from the start of foam application to 90 % control, 99 % control, and complete extinction.</p> <p>At the end of foam application, ignite the fuel in the burn-back pot, and (60 ± 2) s after the end of foam application, lower the pot into the centre of the tray with a metal rod, taking care not to allow foam to enter the pot. Record as the burn-back time the time taken from positioning of the burn-back pot to permanent full reinvolverment of the fire tray surface in flames.</p>

(参考) ISO 7203-2:1995 (Fire extinguishing media -Foam concentrates-)		(参考) ISO 7203-2:2011 (Fire extinguishing media -Foam concentrates-)	
項目	内容	項目	内容
Foreword	<p>ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.</p> <p>Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.</p> <p>International Standard ISO 7203-2 was prepared by Technical Committee ISO/TC 21, Equipment for fire protection and fire fighting, Subcommittee SC 6, Extinguishing media for fire fighting.</p> <p>ISO 7203 consists of the following parts, under the general title Fire extinguishing media - Foam concentrates:</p> <ul style="list-style-type: none"> - Part 1: Specification for low expansion foam concentrates for top application to water-immiscible liquids - Part 2: Specification for medium and high expansion foam concentrates for top application to water-immiscible liquids - Part 3: Specification for low expansion foam concentrates for top application to water-miscible liquids <p>Annexes A, B, C, D, E, F and G form an integral part of this part of ISO 7203. Annexes H and J are for information only.</p>	Foreword	<p>ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.</p> <p>International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.</p> <p>The main task of technical committees is to prepare International Standards.</p> <p>Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.</p> <p>Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.</p> <p>ISO 7203-2 was prepared by Technical Committee ISO/TC 21, Equipment for fire protection and fire fighting, Subcommittee SC 6, Foam and powder media and fixed firefighting systems using foam and powder.</p> <p>This second edition cancels and replaces the first edition (ISO 7203-2:1995), which has been technically revised.</p> <p>ISO 7203 consists of the following parts, under the general title Fire extinguishing media — Foam concentrates:</p> <ul style="list-style-type: none"> – Part 1: Specification for low-expansion foam concentrates for top application to water-immiscible liquids – Part 2: Specification for medium- and high-expansion foam concentrates for top application to waterimmiscible liquids – Part 3: Specification for low-expansion foam concentrates for top application to water-miscible liquids
Introduction	<p>Firefighting foams are widely used to control and extinguish fires of flammable liquids and for inhibiting reignition. They may also be used to prevent ignition of flammable liquids and, in certain conditions, extinguish fires of solid combustibles.</p> <p>Foams may be used in combination with other extinguishing media, particularly halons, carbon dioxide and powders, which are the subject of other International Standards including those listed below:</p>	Introduction	<p>Firefighting foams are widely used to control and extinguish fires of flammable liquids and for inhibiting reignition. They can also be used to prevent ignition of flammable liquids and, in certain conditions, extinguish fires of solid combustibles.</p> <p>Foams can be used in combination with other extinguishing media, particularly halons, carbon dioxide and powders, which are the subject of other International Standards including ISO 5923, ISO 6183, ISO 7201-1,</p>

	<p>ISO 5923: 1989, Fire protection - Fire extinguishing media - Carbon dioxide.</p> <p>ISO 6183: 1990, Fire protection equipment - Carbon dioxide extinguishing Systems for use on premises - Design and installation.</p> <p>ISO 7201-1 :1989, Fire protection - Fire extinguishing media - Halogenated hydrocarbons - Part 1: Specifications for halon 1217 and halon 1301.</p> <p>ISO 7201-2: 1991, Fire extinguishing media - Halogenated hydrocarbons - Part 2: Code of practice for safe handling and transfer procedures of halon 1211 and halon 1301.</p> <p>ISO 7202:1987, Fire protection - Fire extinguishing media - Powder.</p> <p>A specification for foam Systems designed in accordance with this part of ISO 7203 is being prepared and will be published as:</p> <p>ISO 7076: -1), Fire protection equipment - Automatic extinguishing systems for applying low, medium and high expansion foam.</p> <p>Attention is drawn to annex J which deals with the compatibility of foam concentrates, and the compatibility of foams and powders.</p>		<p>ISO 7201-2 and ISO 7202. A specification for foam systems (ISO 7076), which is cited in this part of ISO 7203, is under preparation.</p> <p>Attention is drawn to Annex K, which deals with the compatibility of foam concentrates, and the compatibility of foams and powders.</p> <p>Attention is drawn to Annex K, which deals with the compatibility of foam concentrates, and the compatibility of foams and powders.</p>
1 Scope	<p>This part of ISO 7203 specifies the essential properties and performance of liquid foam concentrates used to make medium and/or high expansion foams for the control, extinction and inhibition of reignition of fires of water-immiscible liquids. Minimum performance on certain test fires is specified.</p>	1 Scope	<p>This part of ISO 7203 specifies the essential properties and performance of liquid foam concentrates used to make medium- or high-expansion foams or both for the control, extinction and inhibition of reignition of fires of water-immiscible liquids. Minimum performance on certain test fires is specified.</p> <p>These foams are suitable for top application to fires of water-immiscible liquid. Those foams that comply with ISO 7203-1 are also suitable for top application to fires of water-immiscible liquids.</p>
2 Normative references	<p>The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 7203. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 7203 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.</p> <p>ISO 304:1985, Surface active agents - Determination of surface tension by drawing up liquid films.</p> <p>ISO 3310-1 : 1990, Test sieves - Technical requirements and testing - Part 1: Test sieves of metal wire cloth.</p> <p>ISO 3696: 1987, Water for analytical laboratory use - Specification and test methods.</p> <p>ISO 3734:1976, Crude Petroleum and fuel oils – Determination of water and sediment – Centrifuge method.</p> <p>ISO 7203-1 :1995, Fire extinguishing media - Foam concentrates - Part 1: Specification for low expansion foam concentrates for top application to water-immiscible liquids.</p> <p>BS 5117:1989, Testing corrosion inhibiting, engine coolant concentrate</p>	2 Normative references	<p>The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.</p> <p>ISO 304, Surface active agents — Determination of surface tension by drawing up liquid films</p> <p>ISO 3104, Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity</p> <p>ISO 3219, Plastics — Polymers/resins in the liquid state or as emulsions or dispersions — Determination of viscosity using a rotational viscometer with defined shear rate</p> <p>ISO 3310-1, Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth</p> <p>ISO 3696:1987, Water for analytical laboratory use — Specification and test methods</p> <p>ISO 3734, Petroleum products — Determination of water and sediment in residual fuel oils – Centrifuge method</p> <p>ISO 7203-1, Fire extinguishing media — Foam concentrates — Part 1: Specifications for low-expansion foam concentrates for top application to</p>

	(antifreeze) - Part 1: Methods of test for determination of physical and chemical properties - Section 1.3: Determination of freezing point.		water-immiscible liquids BS 5117-1.3:1985, Testing corrosion inhibiting, engine coolant concentrate (“antifreeze”). Methods of test for determination of physical and chemical properties. Determination of freezing point
3 Definitions	For the purposes of this part of ISO 7203, the following definitions apply.	3 Terms and definitions	For the purposes of this document, the following terms and definitions apply.
3.1 characteristic values	Values declared by the foam concentrate supplier for the chemical and physical properties and the performances of the foam and foam solution.	3.1 characteristic value	value declared by the foam concentrate supplier for the chemical and physical properties and the performances of the foam, foam solution, and foam concentrate
3.2 25% drainage time	Time for 25 % of the liquid content of a foam to drain out.	3.2 25% drainage time	time for 25 % of the liquid content of a foam to drain out
3.3 50% drainage time	Time for 50 % of the liquid content of a foam to drain out.	3.3 50% drainage time	time for 50 % of the liquid content of a foam to drain out
3.4 expansion	Ratio of the volume of foam to the volume of the foam solution from which it was made.	3.4 expansion	ratio of the volume of foam to the volume of the foam solution from which it was made
3.5 low expansion	Applied to foam with expansion in the range 1 to 20, and to associated equipment, systems and concentrates.	3.5 low-expansion	with expansion in the range 1 to 20, as applied to foam and to associated equipment, systems and concentrates
3.6 medium expansion	Applied to foam with expansion in the range 21 to 200 and to associated equipment, systems and concentrates.	3.6 medium-expansion	with expansion in the range 21 to 200, as applied to foam and to associated equipment, systems and concentrates
3.7 high expansion	Applied to foam with expansion greater than 201 and to associated equipment, systems and concentrates.	3.7 high-expansion	with expansion greater than or equal to 200, as applied to foam and to associated equipment, systems and concentrates
3.8 foam (firefighting)	Aggregate of air-filled bubbles formed from an aqueous Solution of a suitable foam concentrate.	3.8 foam	(firefighting) aggregate of air-filled bubbles formed from an aqueous solution of a suitable foam concentrate
3.9 (foam) concentrate	Liquid which, when mixed with water in the appropriate concentration, gives a foam solution.	3.9 foam concentrate	liquid which, when mixed with water in the appropriate concentration, gives a foam solution
3.10 protein foam concentrate	Foam concentrate derived from hydrolyzed protein materials.	3.10 protein foam concentrator	foam concentrate derived from hydrolysed protein materials

e (P)		tion P	
3.11 fluoroprotein foam concentrate (FP)	Protein foam concentrate with added fluorinated surface active agents.	3.11 fluoroprotein foam concentrate FP	protein foam concentrate with added fluorinated surface-active agents
3.12 synthetic foam concentrate (S)	Foam concentrate based on a mixture of hydrocarbon surface active agents and which may contain fluorocarbons with additional stabilizers.	3.12 Synthetic foam concentrate S	foam concentrate based on a mixture of hydrocarbon surface-active agents and which can contain fluorocarbons with additional stabilizers
3.13 alcohol-resistant foam concentrate (AR)	Foam concentrate resistant to breakdown when applied to the surface of alcohol or other polar solvents.	3.13 alcohol-resistant foam concentrate AR	foam concentrate resistant to breakdown when applied to the surface of alcohol or other water-miscible solvents
3.14 aqueous film-forming foam concentrate (AFFF)	Foam concentrate based on a mixture of hydrocarbon and fluorinated surface active agents with the ability to form an aqueous film on the surface of some hydrocarbons.	3.14 aqueous film-forming foam concentrate AFFF	foam concentrate based on a mixture of hydrocarbon and fluorinated surface-active agents with the ability to form an aqueous film on the surface of some hydrocarbons
3.15 film-forming fluoroprotein foam concentrate (FFFP)	Fluoroprotein foam concentrate which has the ability to form an aqueous film on the surface of some hydrocarbons.	3.15 film-forming fluoroprotein foam concentrate FFFP	fluoroprotein foam concentrate that has the ability to form an aqueous film on the surface of some hydrocarbons
3.16 foam solution	solution of foam concentrate and water.	3.16 foam solution	Solution of foam concentrate and water
3.17 forceful application	Application of foam to fall directly onto the surface of a liquid fuel.	3.17 forceful application	application of foam such that it falls directly onto the surface of a liquid fuel
3.18 gentle application	Application of foam indirectly to the surface of a liquid fuel via a backboard, tank wall or other surface.	3.18 gentle application	application of foam indirectly to the surface of a liquid fuel via a backboard, tank wall or other surface

3.19 sediment	Insoluble particles in the foam concentrate.	3.19 sediment	Insoluble particles in the foam concentrate
3.20 spreading coefficient	Measure of the ability of one liquid to spontaneously spread across the surface of another.	3.20 spreading coefficient	value calculated from the measured surface and interfacial tensions to indicate the ability of one liquid to spontaneously spread across the surface of another
4	Classification and uses of foam concentrates	4	Classification and uses of foam concentrates
4.1 Classificat ion	The foam concentrate shall be classified as medium and/or high expansion and shall comply with the appropriate requirements.	4.1 Classificat ion	The foam concentrate shall be classified as medium- or high-expansion or both and shall comply with the appropriate requirements.
4.2 Use with sea water	If a foam concentrate is marked as suitable for use with sea water, the recommended concentrations for use with fresh water and sea water shall be identical.	4.2 Use with sea water	If a foam concentrate is marked as suitable for use with sea water, the recommended concentrations for use with fresh water and sea water shall be identical.
5 Tolerance of the foam concentrat e to freezing and thawing	Before and after temperature conditioning in accordance with A.2, the foam concentrate, if claimed by the supplier not to be adversely affected by freezing and thawing, shall show no visual sign of stratification and non-homogeneity, when tested in accordance with annex B. Foam concentrates complying with this clause shall be tested for compliance with the appropriate requirements given in other clauses of this part of ISO 7203 after freezing and thawing in accordance with A.2.1.	5 Tolerance of the foam concentrat e to freezing and thawing	Before and after temperature conditioning in accordance with A.2, the foam concentrate, if claimed by the supplier not to be adversely affected by freezing and thawing, shall show no visual sign of stratification and non-homogeneity, when tested in accordance with Annex B. Foam concentrates complying with this clause shall be tested for compliance with the appropriate requirements given in other clauses of this part of ISO 7203 after freezing and thawing in accordance with A.2.1.
6	Sediment in the foam concentrate	6	Sediment in the foam concentrate
6.1 Sediment before ageing	Any Sediment in the concentrate prepared in accordance with A.1 shall be dispersible through a 180 µm sieve, and the percentage volume of sediment shall be not more than 0.25 %, when tested in accordance with annex C.	6.1 Sediment before ageing	Any sediment in the concentrate prepared in accordance with A.1 shall be dispersible through a 180 µm sieve, and the volume percentage of sediment shall be not more than 0,25 % when tested in accordance with Annex C.
6.2 Sediment after ageing	Any Sediment in the concentrate aged in accordance with C.1 shall be dispersible through a 180µm sieve, and the percentage volume of sediment shall be not more than 1.0 %, when tested in accordance with annex C.	6.2 Sediment after ageing	Any sediment in the concentrate aged in accordance with C.1 shall be dispersible through a 180 µm sieve, and the volume percentage of sediment shall be not more than 1,0 % when tested in accordance with Annex C.
7 Comparati ve fluidity of the foam concentrat e	Before and after temperature conditioning in accordance with A.2, the flow rate of the concentrate shall be not less than the flow rate achieved with a reference liquid of kinematic viscosity 200 mm ² /s, when tested in accordance with annex D.	7	Determination of viscosity for pseudo-plastic foam concentrates
		7.1 Newtonian foam concentrat e	The viscosity of the foam concentrate at the lowest temperature for use claimed by the manufacturer shall be determined in accordance with ISO 3104. If the viscosity is greater than 200 mm/s, the container shall be marked "This concentrate can require special proportioning equipment".
		7.2	The viscosity of the foam concentrate shall be determined in accordance

		Pseudo-plastic foam concentrates	with Annex D. If the viscosity at the lowest temperature for use is greater than or equal to 120 mPa/s at 375/s, the container shall be marked "Pseudo-plastic foam concentrate. This concentrate can require special proportioning equipment".
8	pH of the foam concentrate	8	pH of the foam concentrate
8.1 pH limits	The pH of the foam concentrate, before and after temperature conditioning in accordance with A.2, shall be not less than 6.0 and not more than 9.5 at (20±2) °C.	8.1 pH limits	The pH of the foam concentrate, before and after temperature conditioning in accordance with A.2, shall be not less than 6,0 and not more than 8.5 at (20 ± 2) °C.
8.2 Sensitivity to temperature	If there is a difference of more than 0.5 pH unit between the two values (before and after temperature conditioning), the foam concentrate shall be designated as temperature sensitive.	8.2 Sensitivity to temperature	The difference in pH between before and after temperature conditioning shall not be greater than 1.0 pH units.
9	Surface tension of the foam solution	9	Surface tension of the foam solution
9.1 Before temperature conditioning	The surface tension of the foam solution prepared from the concentrate, before temperature conditioning in accordance with A.2, at the supplier's recommended concentration, shall be within ±10% of the characteristic value when determined in accordance with E.2.	9.1 Before temperature conditioning	The surface tension of the foam solution prepared from the concentrate, before temperature conditioning in accordance with A.2, at the supplier's recommended concentration, shall be within ±10 % of the characteristic value when determined in accordance with E.2.
9.2 Temperature sensitivity	The surface tension of the foam Solution prepared from the concentrate, after temperature conditioning in accordance with A.2, at the supplier's recommended concentration, shall be determined in accordance with E.2. If the value obtained after temperature conditioning is less than 0.95 times, or more than 1.05 times, the value obtained before temperature conditioning, the foam concentrate shall be designated as temperature sensitive.	9.2 Temperature sensitivity	The surface tension of the foam solution prepared from the concentrate, after temperature conditioning in accordance with A.2, at the supplier's recommended concentration, shall be determined in accordance with E.2. The value obtained after temperature conditioning shall not be less than 0,95 times, or more than 1,05 times, the value obtained before temperature conditioning.
10	Interfacial tension between the foam solution and cyclohexane	10	Interfacial tension between the foam solution and cyclohexane
10.1 Before temperature conditioning	The difference between the interfacial tension between the foam solution prepared from the foam concentrate, before temperature conditioning in accordance with A.2, and cyclohexane (when determined in accordance with E.3) and the characteristic value, shall not exceed 1.0 mN/m or 10 % of the characteristic value, whichever is the greater.	10.1 Before temperature conditioning	Before temperature conditioning in accordance with A.2, the difference between the interfacial tension between the foam solution prepared from the foam concentrate and cyclohexane (when determined in accordance with E.3) and the characteristic value for interfacial tension shall not exceed 1,0 mN/m or 10 % of the characteristic value, whichever is the greater.
10.2 Temperature sensitivity	The interfacial tension between the foam solution prepared from the foam concentrate, after temperature conditioning in accordance with A.2, and cyclohexane shall be determined in accordance with E.3. If the two values obtained before and after temperature conditioning differ by more than 0.5 mN/m or if the value obtained after temperature conditioning is less than 0.95 times, or more than 1.05 times, the value obtained before temperature conditioning, whichever is the greater, the foam concentrate shall be designated as temperature sensitive.	10.2 Temperature sensitivity	After temperature conditioning in accordance with A.2, the interfacial tension between the foam solution prepared from the foam concentrate and cyclohexane shall be determined in accordance with E.3. The two values obtained before and after temperature conditioning shall not differ by more than 0,5 mN/m.

11 Spreading coefficient of the foam solution on cyclohexan e	The spreading coefficient of the foam solution prepared from a concentrate claimed by the supplier to be “film-forming”, before and after temperature conditioning in accordance with A.2, calculated in accordance with E.4, shall be positive. NOTE 1 Foam concentrates complying with this clause are more likely to be of type AFFF or FFFP than of type FP, P or S.	11 Spreading coefficient of the foam solution on cyclohexan e	Before and after temperature conditioning in accordance with A.2, the spreading coefficient of the foam solution prepared from a concentrate claimed by the supplier to be “film-forming” shall be positive when calculated in accordance with E.4. NOTE Foam concentrates complying with this clause are more likely to be of type AFFF or FFFP than of type FP, P or S.
12	Expansion and drainage of foam	12	Expansion and drainage of foam
12.1	Medium expansion foam concentrates		
12.1.1	Limits		
12.1.1.1	The foam produced from the foam concentrate, before and after temperature conditioning in accordance with A.2, with potable water and, if appropriate, with the synthetic sea water of G.1.4, shall have an expansion of not less than 50, and 25 % and 50 % drainage times within ± 20 % of the characteristic values, when tested in accordance with F.1.	12.1 Medium-e xpansion foam concentrat es — Limits	The foam produced from the foam concentrate, before and after temperature conditioning in accordance with A.2, with potable water and, if appropriate, with the synthetic sea water of H.2.4, shall have an expansion of not less than 50 when tested in accordance with Annex F.
12.1.1.2	If the foam concentrate is marked as suitable for use with sea water [see 14.1 j)], the foam produced from the foam concentrate with the synthetic sea water of G.1.4, when tested in accordance with F.1, shall have an expansion as follows: a) if the characteristic value is less than 100, within ± 10 of the expansion value obtained from the same sample of foam concentrate tested with potable water (see 12.1.1.1); or b) if the characteristic value is not less than 100, not less than 0.9 times and not more than 1.1 times the expansion value obtained from the same sample of foam concentrate tested with potable water (see 12.1.1.1). NOTE 2 Expansion is a function of the foam concentrate and the branch pipe (see figure F.2). The test branch pipe of F.1 tends to give expansions higher than some other equipment, so the minimum expansion is greater than that given in the definition for medium expansion (see 3.6).		
12.1.2Tem perature sensitivity	If the value for expansion, and/or 25 % drainage time and/or 50 % drainage time, obtained after temperature conditioning is less than 0.8 times, or more than 1,2 times, the corresponding value obtained before temperature conditioning, the foam concentrate shall be designated as temperature sensitive.		
12.2	High expansion foam concentrates		
12.2.1	Limits		
12.2.1.1	The foam produced from the foam concentrate, before and after temperature conditioning in accordance with A.2, with potable water shall have an expansion of not less than 201, and a 50 % drainage time of not less than 10 min within ± 20 % of the characteristic value, when tested in accordance with F.2.	12.2 High-expa nsion foam concentrat e — Limits	The foam produced from the foam concentrate, before and after temperature conditioning in accordance with A.2, with potable water and, if appropriate, with the synthetic sea water of I.2.4, shall have an expansion of not less than 201 when tested in accordance with Annex G.

12.2.1.2	If the foam concentrate is marked as suitable for use with sea water [see 14.1 j)], the foam produced from the foam concentrate with sea water shall have an expansion not less than 0,9 times and not more than 1,1 times the expansion value obtained from the same sample of foam concentrate tested with potable water (see 12.2.1.1), when tested in accordance with F.2.		
12.2.2 Temperature sensitivity	If the value for expansion, and/or 50 % drainage time, obtained using temperature-conditioned foam concentrate is less than 0,8 times, or more than 1,2 times, the corresponding value obtained using foam concentrate that is not temperature conditioned, the foam concentrate shall be designated as temperature sensitive.		
13	Test fire performance		
13.1 Medium expansion foam concentrates	The foam produced from the foam concentrate, before and, if the concentrate is designated as temperature sensitive, after temperature conditioning in accordance with A.2, with potable water and, if appropriate, with the synthetic sea water of G.1.4, shall have an extinction time not greater than the value given in table 1 and a burnback time not less than the value given in table 1, when tested in accordance with G.1 and G.2.	13 Test fire performance	The foam produced from the foam concentrate with potable water, and if appropriate, with the synthetic sea water of H.2.4 and/or I.2.4, shall have an extinguishing performance class and burn-back resistance level as specified in Table 1 when tested in accordance with Annex H or Annex I, or both, as appropriate.
13.2 High expansion foam concentrates	The foam produced from the foam concentrate, before and, if the concentrate is designated as temperature sensitive, after temperature conditioning in accordance with A.2, with potable water and, if appropriate, with the synthetic sea water of G.1.4, shall have an extinction time not greater than the value given in table 1, when tested in accordance with G.1 and G.3.		
14	Marking, packaging and specification sheet	14	Marking, packaging and specification sheet
		14.1	Marking
14.1	The following information shall be provided by the supplier as a specification sheet either supplied with or marked on the shipping Container: a) the designation (identifying name) of the concentrate and, as appropriate, the words “medium”, or “high”, or “medium and high” and “expansion foam concentrate”; b) if the concentrate complies with clause 11, the words “film-forming”; c) recommended concentration for use (most commonly 1 %, 3 % or 6 %); d) any tendency of the foam concentrate to cause harmful physiological effects, the methods required to avoid them and the first aid treatment if they should occur; e) recommended storage temperature and temperature of use; f) if the concentrate complies with clause 5, the words “Not affected by freezing and thawing” or, if the foam concentrate does not comply with clause 5, the words “Do not freeze”; g) the nominal quantity in the container; h) the supplier’s name and address;	14.1.1	The following information shall be marked on the shipping container: a) designation (identifying name) of the concentrate and, as appropriate, the words “medium” or “high”, or “medium and high” and “expansion foam concentrate”; b) if the concentrate complies with Clause 11, the words “aqueous film-forming”; c) recommended concentration for use (most commonly 1 %, 3 % or 6 %); d) any tendency of the foam concentrate to cause harmful physical effects, the methods required to avoid them and the first aid treatment if they should occur; e) recommended storage temperature and temperature of use; f) if the concentrate complies with Clause 5, the words “Not affected by freezing and thawing” or, if the foam concentrate does not comply with Clause 5, the words “Do not freeze”; g) nominal quantity in the container; h) supplier’s name and address; i) batch number;

	<p>i) the batch number;</p> <p>j) the words “Not suitable for use with sea water” or “Suitable for use with sea water”, as appropriate;</p> <p>k) any corrosiveness of the concentrate, both in storage and in use, which significantly exceeds that of potable water;</p> <p>l) suitable materials for storage containers and equipment, both for the concentrate and the foam solution.</p> <p>WARNING - It is extremely important that the foam concentrate, after dilution with water to the recommended concentration, must not, in normal usage, present a significant toxic hazard to life in relation to the environment.</p> <p>The packaging of the foam concentrate shall ensure that the essential characteristics of the concentrate are preserved when stored and handled in accordance with the supplier's recommendations</p> <p>Markings on shipping containers shall be permanent and legible.</p> <p>It is recommended that non-Newtonian concentrates are appropriately identified.</p> <p>Foam concentrates complying with ISO 7203-1 shall also be marked “low expansion”.</p>		<p>j) words “Not suitable for use with sea water” or “Suitable for use with sea water”, as appropriate.</p> <p>WARNING — It is extremely important that the foam concentrate, after dilution with water to the recommended concentration, shall not, in normal usage, present a significant toxic hazard to life in relation to the environment.</p>
		14.1.2	Markings on shipping containers shall be permanent and legible.
		14.1.3	It is recommended that non-Newtonian concentrates be appropriately identified.
		14.1.4	Foam concentrates complying with ISO 7203-1 shall also be marked “low-expansion”
14.2	If requested by the user, the supplier shall provide a list of the characteristic values.	14.2 Packaging	The packaging of the foam concentrate shall ensure that the essential characteristics of the concentrate are preserved when stored and handled in accordance with the supplier's recommendations.
		14.3	Specification sheet
		14.3.1	If the foam concentrate is Newtonian and the viscosity at the lowest temperature for use is more than 200 mm ² /s when measured in accordance with ISO 3104, the words “This concentrate can require special proportioning equipment” shall be included on the specification sheet.
		14.3.2	If the foam concentrate is pseudo-plastic and the viscosity at the lowest temperature for use is greater than or equal to 120 mPa/s at 375/s, the words “Pseudo-plastic foam concentrate. This concentrate can require special proportioning equipment” shall be included on the specification sheet.
		14.3.3	It is recommended that non-Newtonian concentrates be appropriately identified.
Aneex A (normative)	Preliminary sampling and conditioning of the foam concentrate	Annex A (normative)	Preliminary sampling and conditioning of the foam concentrate A.

A.1 Preliminary sampling	The sampling method shall ensure representative samples, whether taken from a bulk Container or a number of individual packages. Store samples in full closed Containers. NOTE 3 Containers of capacity 20 litres are suitable.	A.1 Preliminary sampling	The sampling method shall ensure representative samples, whether taken from a bulk container or a number of individual packages. Store samples in fully closed containers. NOTE Containers with a capacity of 20 l are suitable.
A.2	Conditioning of foam concentrate	A.2	Conditioning of foam concentrate
A.2.1	If the supplier claims that the concentrate is not adversely affected by freezing and thawing, condition the concentrate sample through four cycles of freezing and thawing, generally as described in B.2, before conditioning in accordance with A.2.2.	A.2.1	If the supplier claims that the concentrate is not adversely affected by freezing and thawing, condition the concentrate sample through four cycles of freezing and thawing, generally as described in B.2, before conditioning in accordance with A.2.2. If the foam concentrate is adversely affected by freezing and thawing, it shall be conditioned according to A.2.2 without prior freezing and thawing.
A.2.2	Condition the concentrate in the sealed container for 7 days at $(60 \pm 2)^\circ\text{C}$ followed by 1 day at $(20 \pm 5)^\circ\text{C}$.	A.2.2	Condition the concentrate in the sealed container for 7 d at $(60 \pm 2)^\circ\text{C}$, followed by 1 d at $(20 \pm 5)^\circ\text{C}$.
A.3 Subsequent testing	Test samples prepared in accordance with A.1, or A.1 and A.2 as appropriate. Agitate the sample container before sampling for further tests.	A.3 Subsequent testing	Test samples prepared in accordance with A.1, or A.1 and A.2 as appropriate. Agitate the sample container before sampling for further tests.
Annex B (normative)	Determination of tolerance to freezing and thawing (see clause 5)	Annex B (normative)	Determination of tolerance to freezing and thawing
B.1	Apparatus	B.1 Apparatus	The usual laboratory apparatus and, in particular, the following.
B.1.1	Freezing chamber, capable of achieving the temperatures required in B.2.	B.1.1	Freezing chamber, capable of achieving the temperatures required in B.2.
B.1.2	Polyethylene tube, approximately 10 mm in diameter, 400 mm long and sealed and weighted at one end, with suitable spacers attached. Figure B.1 shows a typical form.	B.1.2	Polyethylene tube, approximately 10 mm in diameter, approximately 400 mm long and sealed and weighted at one end, with suitable spacers attached. Figure B.1 shows a typical form.
B.1.3	Glass measuring cylinder, of capacity 500 ml, approximately 400 mm high and 65 mm in diameter, with a stopper.	B.1.3	Measuring cylinder, glass, of 500 ml capacity, approximately 400 mm high and approximately 65 mm in diameter, with a stopper.
B.2 Procedure	Set the temperature of the freezing chamber (B.1.1) to $(10 \pm 1)^\circ\text{C}$ below the freezing point of the sample measured in accordance with BS 5117, Section 1.3 (excluding 5.2). To prevent the glass measuring cylinder (B.1.3) from breaking due to expansion of the foam concentrate on freezing, insert the tube (B.1.2) into the measuring cylinder with the sealed end downward, weighted if necessary to avoid flotation, the spacers ensuring it remains approximately on the central axis of the cylinder. Fill the cylinder and fit the stopper. Place the cylinder in the chest , cool it and maintain at the required temperature for 24 h. At the end of this period, thaw the sample for not less than 24 h and not more than 96 h in an ambient temperature of $(20 \pm 5)^\circ\text{C}$. Repeat three times to give four cycles of freezing and thawing before testing.	B.2 Procedure	Set the temperature of the freezing chamber (B.1.1) to at least 10°C below the freezing point of the sample, measured in accordance with BS 5117-1.3, excluding 5.2. To prevent the glass measuring cylinder (B.1.3) from breaking due to expansion of the foam concentrate on freezing, insert the tube (B.1.2) into the measuring cylinder with the sealed end downward, weighted if necessary to avoid flotation, the spacers ensuring it remains approximately on the central axis of the cylinder. Fill the cylinder and fit the stopper. Place the cylinder in the freezing chamber , cool it and maintain at the required temperature for 24 h. At the end of this period, thaw the sample for not less than 24 h and not more than 96 h in an ambient temperature of $(20 \pm 5)^\circ\text{C}$. Repeat three times to give four cycles of freezing and thawing before testing.

	Examine the sample for stratification and nonhomogeneity.		Examine the sample for stratification and non-homogeneity.
Annex C (normative)	Determination of percentage of sediment (see clause 6)	Annex C (normative)	Determination of volume percentage of sediment
C.1 Sampling	Use a Sample prepared in accordance with A.1. Ensure that any Sediment is dispersed by agitating the sample container. Take two samples, testing one immediately and the other after ageing for (24 ± 2) h at (60 ± 2) °C in a filled container	C.1 Sampling	Use a sample prepared in accordance with A.1. Ensure that any sediment is dispersed by agitating the sample container. Take two samples, testing one immediately and the other after ageing for (24 ± 2) h at (60 ± 2) °C in a filled container without access to air.
C.2	Apparatus	C.2 Apparatus	The usual laboratory apparatus and, in particular, the following.
C.2.1	Graduated centrifuge tubes.	C.2.1	Centrifuge tubes, graduated. Centrifuge tubes complying with ISO 3734 are suitable.
C.2.2	Centrifuge, operating at (6000 ± 600) m/s ² .	C.2.2	Centrifuge, operating at (6000 ± 600) m/s ² . A centrifuge complying with ISO 3734 is suitable.
C.2.3	Sieve, of nominal aperture size 180 µm, complying with ISO 3310-1.	C.2.3	Sieve, of nominal aperture size 180 µm, complying with ISO 3310-1.
C.2.4 Plastics wash bottle.	A centrifuge and tubes complying with ISO 3734 are suitable.	C.2.4	Wash bottle, plastic.
C.3 Procedure	Centrifuge each sample of the solution for (10 ± 1) min. Determine the volume of the sediment and record it as a percentage of volume of the centrifuged sample volume. Wash the contents of the centrifuge tube (C.2.1) onto the sieve (C.2.3) and check that the sediment can or cannot be dispersed through the sieve by the jet from the plastics wash bottle (C.2.4).	C.3 Procedure	Centrifuge each sample of the concentrate for (10 ± 1) min. Determine the volume of the sediment and record it as a percentage of volume of the centrifuged sample volume. Wash the contents of the centrifuge tube (C.2.1) onto the sieve (C.2.3) and check whether the sediment can or cannot be dispersed through the sieve by the jet from the plastic wash bottle (C.2.4).
Annex D (normative)	Determination of comparative fluidity (see clause 7) NOTE 4 The kinematic viscosity of Newtonian concentrates can be measured in accordance with ISO 3104:1994. Petroleum products - Transparent and opaque liquids - Determination of kinematic viscosity and calculation of dynamic viscosity. The dynamic viscosity of non-Newtonian foam concentrates can be measured using a Brookfield LVT viscometer ²⁾ with a No. 4 spindle at a rotational speed of 60 r/min, taking readings (60 ± 5) s after the spindle begins to rotate. In both cases, a temperature tolerance of ± 0.1 °C may be applied.	Annex D (normative)	Determination of viscosity for pseudo-plastic foam concentrates
D.1	Apparatus and materials (see figure D.1)	D.1 General	This annex gives the procedure for determining the viscosity for pseudo-plastic foam concentrates. The procedure is described in ISO 3219. NOTE Pseudo-plastic foam concentrates are a particular class of non-Newtonian foam concentrate and have a viscosity which decreases with increasing shear rate at constant temperature.
D.1.1	Stainless steel Pipe, 1 m long, of internal diameter 8.5 mm to 8.8 mm, sharply cut at both ends, where two external nipples are welded or screwed.		

D.1.2	Tank, of minimum capacity 10 litres, in which the sample can be kept cold at the minimum temperature for use, pressurized by a regulated gas supply.		
D.1.3	Tubing, of internal diameter 20 mm \pm 2 mm, equipped with a valve connecting the pipe and tank with a pressure gauge with a full scale reading of 1.5 bar or 2.0 bar, at the supply end of the pipe, and an elbow at the outlet end of the pipe.		
D.1.4	Container, to collect the discharged liquid.		
D.1.5	Insulation material, covering the pipe and tubing such that the difference between the temperature of the contents of the tank and the temperature of the discharged liquid does not exceed 1 °C. NOTE 5 10 mm thick insulation is suitable.		
D.1.6	Reference liquid, for calibrating the apparatus, of known density and of viscosity 200 mm ² /s at a temperature close to ambient. NOTE 6 A water/glycerol mixture at 21 °C with 90 % (m/m) of glycerol($d_{15}^{15} = 1,2395$) is suitable.		
D.1.7	Thermometers, to measure the temperatures of liquids.		
D.2 Calibration	Fill the tank (D.1.2) with the reference Newtonian liquid (D.1.6). Adjust the pressure in the tank so that the gauge shows a constant pressure of (0.5 \pm 0.02) bar. Collect the liquid from the pipe (D.1.1) in a container (D.1.4) for a period of about 60 s and record the temperature, collection time and mass. Calculate the flow rate in l/min. Carry out two further tests and take the average of the three tests as the viscosity tube calibration value. NOTE 7 Usually the flow rate is approximately 1,8 l/min (2.25 kg/min) when the tube diameter is close to 8.6 mm and when using the glycerol mixture described in note 6.	D.2	Viscosity determination
		D.2.1 Apparatus	The usual laboratory apparatus and a rotational viscometer in accordance with ISO 3219 with the following parameters: – maximum shear stress of ≥ 75 Pa; – maximum shear rate of ≥ 600 /s. The viscometer shall be fitted with a temperature control unit which can maintain the sample temperature within ± 1 °C of the required temperature.
		D.2.2 Test temperature	The viscosity of the foam concentrate shall be measured from 20 °C down to, and including, the lowest temperature for use claimed by the manufacturer, in increments of 10 °C. Use a fresh sample for each temperature.
		D.2.3 Viscosity measurement	If the sample contains suspended air bubbles, the sample shall be centrifuged for 10 min using the apparatus specified in C.2.1 and C.2.2 before the sample is placed in the apparatus.

		ent	<p>The test should be performed according to the following test procedure:</p> <p>a) Adjust the temperature control unit.</p> <p>b) Set the gap.</p> <p>c) Apply the sample.</p> <p>d) Wait a minimum of 10 min (with no shear) to reach temperature equilibrium.</p> <p>e) Pre-shear for 1 min at 600/s.</p> <p>f) Wait 1 min without shearing.</p> <p>g) Measure the shear stress for 10 s at each shear rate, starting at the lowest shear rate (preferably at 75/s).</p> <p>Measure the shear stress at a minimum of eight different shear rates over the range (0/s to 600/s), e.g. 75/s, 150/s, 225/s, 300/s, 375/s, 450/s, 525/s, 600/s. Calculate the apparent viscosity, η, expressed in millipascal-seconds, as given in Equation (D.1)</p> $\eta = 1000 \times \frac{s_1}{s_2} \quad (\text{D.1})$ <p>where</p> <p>s_1 is the shear stress, expressed in pascals;</p> <p>s_2 is the shear rate, expressed in reciprocal seconds.</p>
		D.2.4 Results	Report the results as a table including test temperature, expressed in degrees Celsius, the shear rate, expressed in reciprocal seconds, the shear stress, expressed in reciprocal seconds, and the apparent viscosity, expressed in millipascal-seconds.
D.3 Procedure	Fill the tank (D.1.2) with foam concentrate and cool to a temperature between 1 °C and 3 °C specified by the supplier. Control the temperature to ± 0.1 °C. Perform at least two tests, generally as described in D.2. Plot a graph of readings between 1 °C and 3 °C above the L.U.T. and project the plot to the L.U.T. to obtain the reading.		
Annex E (normative)	Determination of surface tension, interfacial tension and spreading coefficient (see clauses 9, 10 and 11)	Annex E (normative)	Determination of surface tension, interfacial tension and spreading coefficient
E.1	Materials	E.1	Reagents and materials
E.1.1	Solution of foam concentrate, at the recommended concentration for use in freshly made analytical water complying with grade 3 of ISO 3696 and surface tension not less than 70 mN/m. NOTE 8 The Solution may be made up in a 100 ml volumetric flask using a pipette to measure the foam concentrate.	E.1.1	Solution of foam concentrate, at the recommended concentration for use in freshly made analytical water complying with grade 3 of ISO 3696:1987 and with surface tension not less than 70 mN/m. NOTE The solution can be made up in a 100 ml volumetric flask, using a pipette to measure the foam concentrate.
E.1.2	Cyclohexane, of purity not less than 99 %, for interfacial tension and spreading coefficient only.	E.1.2	Cyclohexane, of purity not less than 99 %, for interfacial tension and spreading coefficient only.
E.2 Procedure for surface	Determine the surface tension of the Solution (E.1 .1) at a temperature of (20 ± 1) °C using the ring method of ISO 304.	E.2 Procedure for surface	Determine the surface tension of the solution (E.1.1) at a temperature of (20 ± 1) °C, using the ring method in accordance with ISO 304.

tension		tension	
E.3 Procedure for interfacial tension	After measuring the surface tension in accordance with E.2, introduce a layer of cyclohexane (E.1.2) at $(20 \pm 1) ^\circ\text{C}$ being careful to avoid contact between the ring and the cyclohexane. Wait (6 ± 1) min and then measure the interfacial tension.	E.3 Peocedure for interfacial tension	After measuring the surface tension in accordance with E.2, introduce a layer of cyclohexane (E.1.2) at $(20 \pm 1) ^\circ\text{C}$ onto the foam solution (E.1.1), being careful to avoid contact between the ring and the cyclohexane. Wait (6 ± 1) min and then measure the interfacial tension.
E.4 Spreading coefficient	Calculate the spreading coefficient between the solution (E.1.1) and cyclohexane (E.1.2) from the equation $S = Y_c - Y_f - Y_i$ Where S is the spreading coefficient, in millinewtons per metre; Y_c is the surface tension of the cyclohexane, in millinewtons per metre; Y_f is the surface tension of the foam solution, in millinewtons per metre; Y_i is the interfacial tension between the foam solution and cyclohexane, in millinewtons per metre.	E.4 Spreading coefficient	Calculate the spreading coefficient, S, expressed in millinewtons per metre, between the solution (E.1.1) and cyclohexane (E.1.2) from Equation (E.1): $S = Y_c - Y_f - Y_i \quad (\text{E.1})$ where Y_c is the surface tension of the cyclohexane, expressed in millinewtons per metre; Y_f is the surface tension of the foam solution, expressed in millinewtons per metre; Y_i is the interfacial tension between the foam solution and cyclohexane, expressed in millinewtons per metre.
Annex F (normative)	Determination of expansion and drainage time (see clause 12)	Annex F (normative)	Determination of expansion and drainage time for medium-expansion foam concentrates
F.1 Medeium expansion foam	See 12.1.		
F.1.1	Apparatus	F.1 Apparatus	The usual laboratory apparatus and, in particular, the following.
F.1.1.1	Plastics collecting vessel, of volume approximately 200 litres and accurately known to ± 2 litres, equipped with a bottom discharge facility, as shown in figure F.1 a).	F.1.1	Collecting vessel, plastic, cylindrical, of volume known to $\pm 1\%$, equipped with a bottom discharge facility, as shown in Figure F.1.
F.1.1.2	Foam-making nozzle, as shown in figure F.2 which, when tested with water, has a flow rate of $(3.25 \pm 0.15) \text{ l/min}$ at a nozzle pressure of (5.0 ± 0.1) bar.	F1.2	Foam-making equipment, with nozzle as shown in Figures F.2 and F.3 that, when tested with water, has a flow rate of between 3.1 l/min and 3.4 l/min at a nozzle pressure of $(500 \pm 10) \text{ kPa}$ [$(5.0 \pm 0.1) \text{ bar}$].
		F.1.3	Stop watch, or other timing device.
F.1.2 Temperatu re conditions	Carry out the tests under the following conditions: Air temperature: $(15 \pm 5) ^\circ\text{C}$ Foam Solution temperature: $(17.5 \pm 2.5) ^\circ\text{C}$	F.2 Temperatu re conditions	Carry out the tests under the following temperature conditions: – air temperature $(20 \pm 5) ^\circ\text{C}$; – foam solution temperature $(17.5 \pm 2.5) ^\circ\text{C}$.
		F.3	Procedure
		F.3.1	Prepare two samples of foam concentrate in accordance with Annex A. Condition one in accordance with Annex A.
		F.3.2	Carry out the remainder of the procedure for each sample on the same day. Prepare a foam solution of each sample following the supplier's recommendations for concentration, maximum premix time, compatibility

			with the test equipment, avoiding contamination by other types of foam, etc. Use potable water to make up the foam solutions and, if the supplier claims that the concentrate is suitable for sea water, also make foam solutions at the same concentration using the simulated sea water prepared in accordance with F.4. The concentration used in simulated sea water shall be the same as the concentration used in potable water.
F.1.3 Procedure	<p>Wet the collecting vessel (F.1.1.1) internally and weigh it (m_1). Set up the foam-making nozzle (F.1.1.2) and adjust the nozzle pressure to give a flow rate of 3.25 l/min. With the discharge facility closed, collect foam in the vessel, starting the clock when half full. As soon as the vessel is full, stop collecting foam and strike the foam surface level with the rim. Weigh the vessel (m_2).</p> <p>Calculate the expansion E from the equation</p> $E = \frac{V}{m_2 - m_1}$ <p>Where</p> <p>V is the volume, in litres, of the vessel (F.1.1.1);</p> <p>m_1 is the mass, in kilograms, of the empty vessel;</p> <p>m_2 is the mass, in kilograms, of the full vessel.</p> <p>Assume that the density of the foam solution is 1.0 kg/l.</p> <p>Open the drainage facility (see F.1.1.1) and measure the 25 % and 50 % drainage times.</p> <p>Determine the drainage either by placing the vessel on a balance and recording the loss in mass, or by collecting the drained foam Solution in a measuring cylinder.</p> <p>Care should be taken to ensure that there are no voids in the foam collected in the vessel.</p> <p>During the filling operation, keep the discharge facility in the bottom of the vessel closed until the total mass of the foam is determined. In the vessel shown in figure F.1, the holes can be covered by a piece of adhesive tape, for example.</p>	F.3.3	<p>Wet the vessel internally and weigh it. Record the mass as m_1. Set up the foam equipment and adjust the nozzle pressure to within the range (500 ± 10) kPa $[(5.0 \pm 0.1)$ bar] to give a flow rate between 3,1 l/min and 3,4 l/min. With discharge facility closed, collect foam, taking care that voids are not formed in the vessel, and start the timing device when the vessel is half full. As soon as the vessel is full, stop collecting foam and strike the foam surface level with the rim, and clean the exterior surface of the vessel of foam. Weigh the vessel and record the mass as m_2.</p> <p>Calculate the expansion, E, from Equation (F.1):</p> $E = \frac{V}{m_2 - m_1} \quad (F.1)$ <p>where</p> <p>V is the vessel volume, expressed in litres;</p> <p>m_1 is the mass, expressed in kilograms, of the empty vessel;</p> <p>m_2 is the mass, expressed in kilograms, of the full vessel.</p> <p>Assume that the density of the foam solution is 1,0 kg/l.</p> <p>Open the drainage facility and measure the 25 % and 50 % drainage time. Determine the drainage either by placing the vessel on a set of scales and recording the mass loss or by collecting the drained foam solution in a measuring cylinder. Adjust the drainage facility such that the drained foam solution can flow out but the passage of foam is prevented. For each sample carry out the test three times.</p>
		F.3.4	For each sample, calculate the mean values of the three tests for the expansion and 25 % and 50 % drainage time.
		F.4 Simulated sea water	Prepare the simulated sea water by dissolving the components as given in Table F.1.
F.2 High expansion foam	See 12.2.	Annex G (normative)	Determination of expansion and drainage time for high-expansion foam concentrates
F.2.1	Apparatus	G.1 Apparatus	The usual laboratory apparatus and, in particular, the following.
F.2.1.1	Plastics collecting vessel, of volume approximately 500 litres and	G.1.1	Collecting vessel (see Figure G.1), of volume, V, of approximately 500 l

	accurately known to ± 5 litres, as shown in figure F.1 b).		and that is accurately known to ±5 l, equipped with a drain at the base.
F.2.1.2	High expansion foam generator, as shown in figure F.3, with a flow rate of (6,1 ± 0,1) l/min at a nozzle pressure of (5,0 ± 0,1) bar.	G.1.2	High-expansion foam generator, with nozzle as shown in Figures G.2, G.3 and G.4 that, when tested with water, has a flow rate of between 6,0 l/min and 6,2 l/min at a nozzle pressure of (500 ± 10) kPa [(5,0 ± 0,1) bar].
F.2.2	Carry out the tests under the following temperature conditions: Air temperature: (15 ± 5) °C Foam Solution temperature: (17,5 ± 2,5) °C	G.1.3	Stop watch, or other timing device
Temperatu re conditions		G.2	Carry out the tests under the following temperature conditions: – air temperature (20 ± 5) °C; – foam solution temperature (17,5 ± 2,5) °C.
		G.3	Procedure
		G.3.1	Prepare two samples of foam concentrate in accordance with Annex A. Condition one in accordance with Annex A.
		G.3.2	Carry out the remainder of the procedure for each sample on the same day. Prepare a foam solution of each sample following the supplier's recommendations for concentration, maximum premix time, compatibility with the test equipment, avoiding contamination by other types of foam, etc. Use potable water to make up the foam solutions and, if the supplier claims that the concentrate is suitable for sea water, also make foam solutions at the same concentration using the simulated sea water prepared in accordance with G.4. The concentration used in simulated sea water shall be the same as the concentration used in potable water.
F.2.3 Procedure	Wet the collecting vessel (F.2.1.1) internally and weigh it (m ₁). Set up the foam generator (F.2.1.2) and adjust to give a flow rate of 6,1 l/min. With the discharge facility closed, collect foam in the vessel, starting the clock when half full. As soon as the vessel is full, stop collecting foam and strike the foam surface level with the rim. Weigh the vessel (m ₂). Calculate the expansion E from the equation $E = \frac{V}{m_2 - m_1}$ where V is the volume, in litres, of the vessel (F.2.1.1); m ₁ is the mass, in kilograms, of the empty vessel; m ₂ is the mass, in kilograms, of the full vessel. Assume that the density of the foam solution is 1,0 kg/l. Open the drainage facility and measure the 50 % drainage time. Determine the drainage either by placing the vessel on a balance and recording the loss in mass, or by collecting the drained foam solution in a measuring cylinder. Care should be taken to ensure that there are no voids in the foam collected in the vessel. During the filling operation, keep the discharge facility in the bottom of the vessel closed until the total mass of the foam is determined. In the vessel shown in figure F.1, the holes can be covered by a piece of adhesive tape, for example.	G.3.3	Wet the vessel internally and weigh it. Record the mass as m ₁ . Set up the foam equipment and adjust the nozzle pressure within the range (500 ± 10) kPa [(5,0 ± 0,1) bar] to give a flow rate of between 6,0 l/min and 6,2 l/min. With the drain at the base closed, collect foam, taking care that voids are not formed in the vessel. Start the timing device when the vessel is half full. As soon as the vessel is full, stop collecting foam, strike the foam surface level with the rim, and clean the exterior surface of the vessel of foam. Weigh the vessel and record the mass as m ₂ . Calculate the expansion, E, from Equation (G.1): $E = \frac{V}{m_2 - m_1} \quad (G.1)$ where V is the vessel volume, expressed in litres; m ₁ is the mass, expressed in kilograms, of the empty vessel; m ₂ is the mass, expressed in kilograms, of the full vessel. Assume that the density of the foam solution is 1,0 kg/l. Open the drainage facility and measure the 25 % and 50 % drainage time. Determine the drainage either by placing the vessel on a set of scales and recording the mass loss or by collecting the drained foam solution in a measuring cylinder. Adjust the drainage facility such that the drained foam solution can flow out but the passage of foam is prevented. For each sample, carry out the test three times. G.3.4 For each sample, calculate the mean values of the three tests for the

			expansion and the 25 % and 50 % drainage time.
		G.4 Simulated sea water	Prepare the simulated sea water by dissolving the components as given in Table G.1.
		Annex H (normative)	Determination of test fire performance for medium-expansion foam concentrates
Annex G (normative)	Determination of test fire performance (see clause 13) The tests described in this annex are more expensive and time consuming than the other tests of this part of ISO 7203. It is recommended that they are carried out at the end of the test programme, so as to avoid the expense of unnecessary testing of foam concentrates which do not comply in other respects.	H.1 General	This annex specifies the procedure for determining the test fire performance for medium-expansion foam concentrates. The tests described in this annex are more expensive and time-consuming than the other tests described in this part of ISO 7203. It is recommended that they be carried out at the end of the test programme, so as to avoid the expense of unnecessary testing. Testing at temperatures above the range required by this part of ISO 7203 may result in poor performance, and will not result in conformity to this part of ISO 7203.
G.1	General conditions	H.2	General conditions
G.1.1	Test series	H.2.1	Test series and criteria for success
G.1.1.1	A test is successful only if all the appropriate requirements of clause 13 are met.		
G.1.1.2	For foam concentrates not compatible with sea water, carry out two or three tests (the third test is not necessary if the first two are both successful or if both are not successful). The concentrate complies with clause 13 if two tests are successful.	H.2.1.1 Foam concentrat es not compatible with sea water	Carry out two or three tests (the third test is not necessary if the first two are both successful or if neither are successful). The concentrate conforms to Clause 13 if two tests are successful.
G.1.1.3	For foam concentrates compatible with sea water, carry out one of the first two tests with potable water and the other with the synthetic sea water of G.1.4. If both are successful or if both are not successful, terminate the test series. If only one of the tests is not successful, repeat that test. If this repeat test is successful, carry out a second repeat test, otherwise terminate the test series. The concentrate complies with clause 13 either a) if the first two tests are successful; or b) if one of the first two tests and both repeat tests are successful.	H.2.1.2 Foam concentrat es compatible with sea water	Carry out one of the first two tests with potable water and the other with the simulated sea water of the composition given in F.4. If both are successful, repeat the test with the greater of the two extinction times. If the extinction times are identical, repeat the sea water test. If the repeat test is successful, terminate the test series. If the repeat test is unsuccessful, carry out a second repeat test. If one of the first tests is not successful, repeat the test. If this repeat test is successful, carry out a second repeat test; otherwise terminate the test series. The concentrate conforms to Clause 13 if three tests are successful.
G.1.2 Temperatu re and wind speed	Carry out the tests under the following conditions: Air temperature: $(15 \pm 5) ^\circ\text{C}$ Fuel temperature: $(17,5 \pm 2,5) ^\circ\text{C}$ Water temperature: $(17,5 \pm 2,5) ^\circ\text{C}$ Foam solution temperature: $(17,5 \pm 2,5) ^\circ\text{C}$ Maximum wind speed: 3 m/s in the proximity of test pan NOTE 9 If necessary, some form of wind-screen may be used.	H.2.2 Temperatu re and wind speed	Carry out the tests under the following conditions: – air temperature $(15 \pm 5) ^\circ\text{C}$; – fuel temperature $(17,5 \pm 2,5) ^\circ\text{C}$; – water temperature $(17,5 \pm 2,5) ^\circ\text{C}$; – foam solution temperature $(17,5 \pm 2,5) ^\circ\text{C}$; – maximum wind speed in the proximity of the fire tray 3 m/s. NOTE If necessary, some form of wind-screen can be used.

G.1.3 Records	<p>During the fire test, record the following:</p> <ul style="list-style-type: none">- indoor or outdoor test;- air temperature;- fuel temperature;- water temperature,- foam-solution temperature;- wind speed;- extinction time;- 1 % burnback time (for medium expansion only). <p>For quality control purposes, it is recommended that 90 % and 99 % control times and 25 % burnback times are recorded. Control times may either be determined visually by an experienced person or be determined from thermal radiation measurements.</p> <p>Annex H gives details of one method suitable for low and medium expansion foams.</p>	H.2.3 Records	<p>During the fire test, record the following:</p> <ul style="list-style-type: none">a) location;b) air temperature;c) fuel temperature;d) water temperature;e) foam solution temperature;f) wind speed;g) 90 % control time;h) 99 % control time;i) extinction time;j) 1 % burn-back time. <p>It is recommended that the time is recorded at 1 % burn-back. Control times and burn-back time can be determined either visually by an experienced person or from thermal radiation measurements. Annex J gives details of a method suitable for medium-expansion foams.</p>												
G.1.4 Foam solution	<p>Prepare a foam Solution following the recommendations from the supplier for the concentration, maximum premix time, compatibility with the test equipment, avoidance of contamination by other types of foam, etc.</p> <p>Use potable water to make up the foam solution and, if the manufacturer claims that the concentrate is suitable for sea water, also make a foam solution using simulated sea water made up by dissolving the following components.</p> <table><tr><td>Component</td><td>Content % (m/m)</td></tr><tr><td>Sodium chloride (NaCl)</td><td>2,50</td></tr><tr><td>Magnesium chloride hexahydrate (MgCl₂·6H₂O)</td><td>1,10</td></tr><tr><td>Calcium chloride dihydrate (CaCl₂·2H₂O)</td><td>0,16</td></tr><tr><td>Sodium sulfate (Na₂SO₄)</td><td>0,40</td></tr><tr><td>Potable water</td><td>95,84</td></tr></table>	Component	Content % (m/m)	Sodium chloride (NaCl)	2,50	Magnesium chloride hexahydrate (MgCl ₂ ·6H ₂ O)	1,10	Calcium chloride dihydrate (CaCl ₂ ·2H ₂ O)	0,16	Sodium sulfate (Na ₂ SO ₄)	0,40	Potable water	95,84	H.2.4 Foam solution	<p>Prepare a foam solution following the recommendations from the supplier for concentration, maximum premix time, compatibility with the test equipment, avoiding contamination by other types of foam, etc.</p> <p>Use potable water to prepare the foam solution and, if the supplier claims that the concentrate is suitable for use in sea water, make a second foam solution at the same concentration using simulated sea water in accordance with F.4.</p>
Component	Content % (m/m)														
Sodium chloride (NaCl)	2,50														
Magnesium chloride hexahydrate (MgCl ₂ ·6H ₂ O)	1,10														
Calcium chloride dihydrate (CaCl ₂ ·2H ₂ O)	0,16														
Sodium sulfate (Na ₂ SO ₄)	0,40														
Potable water	95,84														
G.1.5 Fuel	<p>Use an aliphatic hydrocarbon mixture having physical properties according to the following specification:</p> <p>Distillation range: 84 °C to 105 °C</p> <p>Maximum difference between initial and final boiling Points: 10 °C</p> <p>Maximum aromatic content: 1 %</p> <p>Density at 15 °C: (700 ± 20) kg/m³</p> <p>NOTE 10 Typical fuels meeting this specification are η-heptane and certain solvent fractions sometimes referred to as commercial heptane. The surface tension of η-heptane measured in accordance with E.2 is approximately 20 mN/m.</p>	H.2.5 Fuel	<p>Use an aliphatic hydrocarbon mixture having physical properties according to the following specification:</p> <ul style="list-style-type: none">a) distillation range: 84 °C to 105 °C;b) maximum difference between initial and final boiling points: 10 °C;c) maximum aromatic content: 1 % mass fraction;d) density at 15 °C: (700 ± 20) kg/m³. <p>NOTE 1 The normal value of surface tension of the aliphatic hydrocarbon mixture measured in accordance with H.2.1 is 21 mN/m to 22 mN/m.</p> <p>NOTE 2 Typical fuels meeting this specification are certain solvent fractions sometimes referred to as commercial heptane.</p>												
G.2 Medium	See 13.1.	H.3	Fire test												

expansion foam			
G.2.1	Apparatus	H.3.1 Apparatus	The usual laboratory apparatus and, in particular, the following.
G.2.1.1	Circular fire tray, made of steel, with dimensions as follows: Internal diameter at rim: (1480 ± 15)mm Depth: (150 ± 10)mm Nominal thickness of steel wall: 2,5mm Area: approximately 1,73m ²	H.3.1.1	Circular fire tray, stainless steel grade 314, with dimensions as follows: – internal diameter at rim (1480 ± 15) mm; – depth (150 ± 10) mm; – nominal thickness of steel wall 2,5 mm. NOTE The tray has an area of approximately 1,73 m ² .
G.2.1.2	Foam-making nozzle, in accordance with F.1.1.2.	H.3.1.2	Foam-making equipment, as described in F.1.2.
G.2.1.3	Burnback pot, made of steel with nominal thickness 2.5mm (150 ± 5) mm in diameter and (150 ± 5) mm high, with a bracket so that it can be suspended directly on the rim of the fire tray.	H.3.1.3	Burn-back pot, stainless steel, of nominal thickness 2,5 mm, diameter (150 ± 5) mm and height (150 ± 5) mm, with a bracket so that it can be suspended directly on the rim of the fire tray. The upper rim of the burn-back pot shall be level with, and in contact with, the upper rim of the fire tray.
G.2.2 Procedure	Place the tray (G.2.1.1) directly on the ground and ensure that it is level. Add approximately 30 litres of potable water and (55 ± 2) litres of fuel, to give a nominal freeboard of 100 mm. Suspend the burnback pot (G.2.1.3) containing (0,9 ± 0,1) litre of fuel on the lee side of the fire tray. Ignite the tray not more than 5 min (5 分以上) after adding the fuel, and allow it to burn for not less than 45 s after the surface of the fuel is fully ablaze. Then mount the foam-making nozzle (G.2.1.2) horizontally on the rim of the tray, as shown in figure G.1. Start applying foam (60 ± 5) s after the surface is fully ablaze. Record the extinction time as the period between the start of foam application and extinction. Apply foam for (120 ± 2) s. Following foam application, allow the fire in the burnback pot to burn until persistent flames appear in the fire tray above the foam blanket. Record this time as the 1 % burnback time. If the burnback pot is extinguished due to overflow of foam during foam application, re-ignite it immediately.	H.3.2 Test procedure	Place the tray directly on the ground and ensure that it is level. Add approximately 30 l of water and (55 ± 2) l of fuel to give a nominal 50 mm fuel depth, with approximately 100 mm between the fuel surface and the upper rim of the tray wall. Suspend the burn-back pot containing (0,9 ± 0,1) l of fuel on the sheltered side of the fire tray. Ignite the fuel not less than 3 min and not more than 5 min after adding it. Not less than 45 s after full involvement of the surface of the fuel, mount the medium-expansion nozzle horizontally on the rim of the tray, as shown in Figure H.1. Start foam application (60 ± 2) s after full involvement. Apply foam for (120 ± 2) s. Record the extinction time as the time after the start of foam application at which all flames in the fire tray are extinguished. Following foam application, allow the fire in the burn-back pot to burn until sustained flames appear above the foam blanket. Record this time as the 1 % burn-back time. If the burn-back pot is extinguished due to overflow of foam during foam application, re-ignite it immediately.
		Annex I (normative)	Determination of test fire performance for high-expansion foam concentrates
		I.1 General	This annex specifies the procedure for determining the test fire performance for high-expansion foam concentrates. The tests described in this annex are more expensive and time-consuming than the other tests described in this part of ISO 7203. It is recommended that they be carried out at the end of the test programme, so as to avoid the expense of unnecessary testing. Testing at temperatures above the range required by this part of ISO 7203

			may result in poor performance, and will not result in conformity to this part of ISO 7203.
		I.2	General conditions
		I.2.1	Test series and criteria for success
		I.2.1.1 Foam concentrat es not compatible with sea water	Carry out two or three tests (the third test is not necessary if the first two are both successful or if neither are successful). The concentrate conforms to Clause 13 if two tests are successful.
		I.2.1.2 Foam concentrat es compatible with sea water	Carry out one of the first two tests with potable water and the other with simulated sea water of the composition given in G.4. If both are successful, repeat the test with the greater of the two extinction times. If the extinction times are identical, repeat the sea water test. If the repeat test is successful, terminate the test series. If the repeat test is unsuccessful, carry out a second repeat test. If one of the first tests is not successful, repeat that test. If this repeat test is successful, carry out a second repeat test; otherwise terminate the test series. The concentrate conforms to Clause 13 if three tests are successful.
		I.2.2 Temperatu re and wind speed	Carry out the tests under the following conditions: – air temperature (15 ± 5) °C; – fuel temperature (17,5 ± 2,5) °C; – water temperature (17,5 ± 2,5) °C; – foam solution temperature (17,5 ± 2,5) °C; – maximum wind speed in the proximity of the fire tray 3 m/s. NOTE If necessary, some form of wind-screen can be used.
		I.2.3 Records	During the fire test, record the following: a) location; b) air temperature; c) fuel temperature; d) water temperature; e) foam solution temperature; f) wind speed; g) 90 % control time; h) 99 % control time; i) extinction time. NOTE Control times can be determined visually by an experienced person.
		I.2.4 Foam solution	Prepare a foam solution following the recommendations from the supplier for concentration, maximum premix time, compatibility with the test equipment, avoiding contamination by other types of foam, etc. Use potable water to prepare the foam solution and, if the supplier claims that the concentrate is suitable for use in sea water, make a second foam

			solution at the same concentration using simulated sea water in accordance with G.4.
		I.2.5 Fuel	Use an aliphatic hydrocarbon mixture having physical properties according to the following specification: a) distillation range: 84 °C to 105 °C; b) maximum difference between initial and final boiling points: 10 °C; c) maximum aromatic content: 1 % mass fraction; d) density at 15 °C: (700 ± 20) kg/m ³ . NOTE 1 The normal value of surface tension of the aliphatic hydrocarbon mixture measured in accordance with I.2.1 is 21 mN/m to 22 mN/m. NOTE 2 Typical fuels meeting this specification are certain solvent fractions sometimes referred to as commercial heptane.
G.3 High expansion foam	See 13.2.	I.3	Fire test
G.3.1	Apparatus	I.3.1 Apparatus	The usual laboratory apparatus and, in particular, the following.
G.3.1.1	Fire tray, in accordance with G.2.1.1	I.3.1.1	Circular fire tray, stainless steel grade 314, with dimensions as follows: – internal diameter at rim (1480 ± 15) mm; – depth (150 ± 10) mm; – nominal thickness of steel wall 2,5 mm. NOTE The tray has an area of approximately 1,73m ² .
G.3.1.2	High expansion foam generator, in accordance with F.2.1.2.	I.3.1.2	High-expansion foam generator, as described in G.1.2, mounted horizontally (650 ± 50) mm above the ground.
G.3.1.3	Fire screens, of nominal 5 mm square metal mesh, to form the arrangement shown in figure G.2.	I.3.1.3	Fire screens, of nominal 5 mm square metal mesh, to form the nominal arrangement shown in Figure I.1.
G.3.2 Procedure	Place the tray (G.2.1.1) directly on the ground and ensure that it is level. Add approximately 30 litres of potable water and (55 ± 5) litres of fuel, to give a nominal freeboard of 100 mm. Place the mesh screens (G.3.1.3) around the fire tray as shown in figure G.2. Within 5 min, ignite the fuel and allow it to burn for a period of not less than 45 s. Commence foam generation with the foam generator (F.2.1.2) some distance from the fire. (60 ± 5) s after the surface is fully ablaze, move the foam generator to the opening in the net screen and apply foam to the fire for (120 ± 2) s. Record the extinction time as the period between the start of foam application and extinction.	I.3.2 Test procedure	Place the tray directly on the ground and ensure that it is level. Add approximately 30 l of water and (55 ± 2) l of fuel to give a nominal 50 mm fuel depth, with approximately 100 mm between the fuel surface and the upper rim of the tray wall. Place the net screens around the fire tray as shown in Figure I.1. Ignite the fuel not less than 3 min and not more than 5 min after adding it. Not less than 45 s after full involvement of the surface of the fuel, commence foam generation with the foam generator no nearer than 3 m to the tray. Wait (60 ± 2) s after full involvement, then move the foam generator to the opening in the net screen and apply foam to the fire. Apply foam for (120 ± 2) s. Record the extinction time as the period from the start of foam application to extinction.
Annex H (informative)	Description of a radiation measurement method	Annex J (normative)	Determination of radiation measurement method
H.1 Evaluation	Radiation measurement is a convenient and objective way to monitor the performance of a foam during the fire Performance test. It reduces the	J.1 Evaluation	Radiation measurement is a convenient and objective way to monitor the performance of a foam during the fire performance test. It reduces the

n	need for visual observations (except for flame flickers and time necessary for complete extinction). This annex describes the equipment and procedure ³⁾ used in a series of tests in one testing laboratory, and the methods used to interpret and present the results. The method is suitable for low and medium expansion foams but not for high expansion foams.	n	need for visual observations (except for flame flickers and time necessary for complete extinction). This annex describes the equipment and procedure used in a series of tests in one testing laboratory, and the methods used to interpret and present the results. See Reference [7] for details. The method is suitable for low-and medium-expansion foams, but not for high-expansion foams.
H.2 General arrangement of test	Radiometers should be placed diametrically in relation to the tray as shown in figure H.1. The distance between the meters and the rim of the tray should be not less than twice the diameter (D) of the tray and the height above the rim not less than 1,5 m. NOTE 11 The maximum distance is limited by the sensitivity of the radiometers. Radiation levels should be recorded continuously or with intervals not exceeding 1 s.	J.2 General arrangement of test	Radiometers should be placed diametrically in relation to the tray, as shown in Figure J.1. The distance between the meters and the rim of the tray should be not less than twice the diameter, D, of the tray; the height above the rim should be not less than 1,5 m. NOTE The maximum distance is limited by the sensitivity of the radiometers. Radiation levels should be recorded continuously or with intervals not exceeding 1 s.
H.3 Technical data for radiometers ⁴⁾	Two radiometers of type Gordon or Schmidt-Beelter should be used. The meters should be cooled with water. The temperature of the cooling water should be (30 ± 10) °C, held constant during the measurements. The radiometers absorb at least 90 % of the incoming radiation within the range of wavelengths 0,6 µm to 15,0 µm. For a fully developed fire, the radiometer reading should be not less than 0,6 times full scale. The radiometers should have maximum non-linearity of ± 3 % of nominal range of measurement, and a maximum response time of 2 s (up to 63 % of full response). NOTE 12 A radiometer with protective glass could be used, provided that the requirements on spectral sensitivity are satisfied. If it is assumed to be necessary, the utilization of the range of measurement specified above could be changed, if the radiometers have a better linearity. Less than 40 % utilization is not advisable, as the influence of background radiation might Cause an effect that is too high.	J.3 Technical data for radiometers	Two radiometers ³⁾ of type Gordon or Schmidt-Boelter should be used. The meters should be cooled with water. The temperature of the cooling water should be (30 ± 10) °C, held constant during the measurements. The radiometers absorb at least 90 % of the incoming radiation within the range of wavelengths 0,6 µm to 15 µm. For a fully developed fire, the radiometer reading should be not less than 0,6 times the full scale. The radiometers should have maximum non-linearity of ± 3 % of nominal range of measurement, and a maximum response time of 2 s (up to 63 % of full response). A radiometer with protective glass may be used, provided that the requirements on spectral sensitivity are satisfied. If it is considered necessary, the utilization of the range of measurement specified above may be changed, if the radiometers have a better linearity. Less than 40 % utilization is not advisable, as the influence of background radiation can have too great an effect. ³⁾ The Medtherm Series 64 supplied by Medtherm Corp., PO Box 412, Huntsville, AL, USA is an example of suitable apparatus available commercially. This information is given for the convenience of users of this part of ISO 7203 and does not constitute an endorsement by ISO of this apparatus.
H.4 Procedure	Correct the output from the two radiometers by deducting the background radiation recorded from 5 s to 10 s after the moment of complete extinction. Determine the average value of the two radiometers. Determine the average value of time of recorded radiation during the 25 s period from 30 s to 5 s before the start of the foam application (see figure H.2). Determine the relative radiation by dividing the output by the average value obtained in accordance with the preceding	J.4 Procedure	Correct the output from the two radiometers by deducting the background radiation recorded from 5 s to 10 s after the moment of complete extinction. Determine the average value of the two radiometers. Determine the average value of time of recorded radiation during the 25 s period beginning at 30 s before the start of the foam application and ending 5 s before the start of foam application (see Figure J.2). Determine the relative radiation by dividing the output by the average value obtained in accordance with the preceding paragraph.

	<p>Paragraph.</p> <p>The instantaneous radiation values are subject to random fluctuation. A smoother curve, which facilitates interpretation, can be obtained by plotting radiation values averaged over a period of ± 5 s for each time value.</p> <p>The adjusted relative radiation is shown for the extinguishing test in figure H.3 and for the burnback test in figure H.4. A control of 90 % is equivalent to the relative radiation 0,1.</p> <p>The description above implies that computer-controlled measuring practice should be applied.</p>		<p>The instantaneous radiation values are subject to random fluctuation. A smoother curve, which facilitates interpretation, can be obtained by plotting radiation values averaged over a period of ± 5 s for each time value.</p> <p>The adjusted relative radiation is shown for the extinguishing test in Figure J.3 and for the burn-back test in Figure J.4. A control of 90 % is equivalent to the relative radiation 0,1.</p> <p>The description above implies that computer-controlled measuring practices should be applied.</p>
Annex J (informati ve)	Compatibility	Annex K (informati ve)	Compatibility
J.1 Compatibi lity between foam concentrat es and fire extinguish ing powders	Where foam and powder might be applied simultaneously or successively, users should ensure that any unfavourable interaction does not cause an unacceptable loss of efficiency.	K.1 Compatibi lity between foam concentrat es and fire extinguish ing powders	Where foam and powder can be applied simultaneously or successively, users should ensure that any unfavourable interaction does not cause an unacceptable loss of efficiency.
J.2 Compatibi lity between foam concentrat es	Foam concentrates of different manufacture, grade or class are frequently incompatible and should not be mixed, unless it has first been established that an unacceptable loss of efficiency does not result.	K.2 Compatibi lity between foam concentrat es	Foam concentrates of different manufacture, grade or class are frequently incompatible and should not be mixed, unless it has first been established that an unacceptable loss of efficiency does not result.

(参考) ISO 7203-3:1995 (Fire extinguishing media -Foam concentrates-)		(参考) ISO 7203-3:2011 (Fire extinguishing media -Foam concentrates-)	
項目	内容	項目	内容
Foreword	<p>ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.</p> <p>Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.</p> <p>International Standard ISO 7203-3 was prepared by Technical Committee ISO/TC 21, Equipment for fire protection and fire fighting, Subcommittee SC 6, Extinguishing media for fire fighting.</p> <p>ISO 7203 consists of the following parts, under the general title Fire extinguishing media — Foam concentrates:</p> <ul style="list-style-type: none"> - Part 1: Specification for low expansion foam concentrates for top application to water-immiscible liquids - Part 2: Specification for medium and high expansion foam concentrates for top application to water-immiscible liquids - Part 3: Specification for low expansion foam concentrates for top application to water-miscible liquids <p>Annex A forms an integral part of this part of ISO 7203. Annexes B to D are for information only.</p>	Foreword	<p>ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.</p> <p>International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.</p> <p>The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.</p> <p>Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.</p> <p>ISO 7203-3 was prepared by Technical Committee ISO/TC 21, Equipment for fire protection and fire fighting, Subcommittee SC 6, Foam and powder media and fixed firefighting system using foam and powder.</p> <p>This second edition cancels and replaces the first edition (ISO 7203-3:1999), which has been technically revised.</p> <p>ISO 7203 consists of the following parts, under the general title Fire extinguishing media — Foam concentrates:</p> <p>ISO 7203 consists of the following parts, under the general title Fire extinguishing media — Foam concentrates:</p> <ul style="list-style-type: none"> -Part 1: Specifications for low-expansion foam concentrates for top application to water-immiscible liquids -Part 2: Specification for medium- and high-expansion foam concentrates for top application to water-immiscible liquids -Part 3: Specification for low-expansion foam concentrates for top application to water-miscible liquids
Intoroduct ion	<p>Firefighting foams are widely used to control and extinguish fires of flammable liquids and for inhibiting re-ignition. They may also be used to prevent ignition of flammable liquids and, under certain conditions, extinguish fires of solid combustibles.</p> <p>Foams may be used in combination with other extinguishing media, particularly halons, carbon dioxide and powders, which are the subject of</p>	Introducti on	<p>Firefighting foams are widely used to control and extinguish fires of flammable liquids and for inhibiting reignition. They can also be used to prevent the ignition of flammable liquids and, in certain conditions, extinguish fires of solid combustibles.</p> <p>Foams can be used in combination with other extinguishing media, particularly halons, carbon dioxide and powders, which are the subject of</p>

	other International Standards including those listed in annex D. A specification for foam systems designed in accordance with this part of ISO 7203 is being prepared and will be published as ISO 7076.		other International Standards including ISO 5923, ISO 6183, ISO 7201-1, ISO 7201-2 and ISO 7202 (ISO 5923, ISO 6183, ISO 7201-1, ISO 7201-2, ISO 7202 を含む) A specification for foam systems [ISO 7076 (all parts)1)] designed in accordance with this part of ISO 7203 is being prepared and will be published as ISO 7076 (all parts). Attention is drawn to Annex J, which deals with the compatibility of foam concentrates, and the compatibility of foams and powders.
1 Scope	This part of ISO 7203 is applicable to low expansion foam concentrates which conform to ISO 7203-1. It specifies additional requirements to assess their suitability for use on water-miscible fuels. In this part of ISO 7203, the fire performance is tested using acetone as fuel, which also forms the basis for the performance classification. However, there are a large number of water-miscible liquids which have more or less different properties compared to acetone. It has been shown by tests using other fuels that the performances of various foams differ considerably. See clause 6.	1 Scope	This part of ISO 7203 specifies the essential properties and performance of liquid foam concentrates used to make low-expansion foams for the control, extinction and inhibition of reignition of fires of water-miscible liquids. Minimum performance on certain test fires is specified. These foams are suitable for top application to fires of water-miscible liquids. Those foams that also comply with ISO 7203-1 are also suitable for top application to fires of water-immiscible liquids. The foam concentrates can be suitable for use in non-aspirating sprayers or for subsurface application to liquid fires, but requirements specific to those applications are not included in this part of ISO 7203.
2 Normative reference	The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 7203. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 7203 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards. ISO 7203-1: 1995, Fire protection — Fire extinguishing media — Foam concentrates — Part 1: Low expansion foam concentrates for top application to water-immiscible liquids.	2 Normative references	The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. ISO 304, Surface active agents - Determination of surface tension by drawing up liquid films ISO 3104, Petroleum products - Transparent and opaque liquids - Determination of kinematic viscosity and calculation of dynamic viscosity ISO 3219, Plastics - Polymers/resins in the liquid state or as emulsions or dispersions - Determination of viscosity using a rotational viscometer with defined shear rate ISO 3310-1, Test sieves - Technical requirements and testing - Part 1: Test sieves of metal wire cloth ISO 3696:1987, Water for analytical laboratory use - Specification and test methods ISO 3734, Petroleum products - Determination of water and sediment in residual fuel oils - Centrifuge method ISO 7203-2, Fire extinguishing media - Foam concentrates - Part 2: Specification for medium- and high-expansion foam concentrates for top application to water-immiscible liquids BS 5117-1.3, Testing corrosion inhibiting, engine coolant concentrate ('antifreeze'). Methods of test for determination of physical and chemical properties. Determination of freezing point
3 Definitions	For the purposes of this part of ISO 7203, the definitions given in ISO 7203-1 apply.	3 Term and definitions	For the purposes of this document, the following terms and definitions apply.

4 General requirements	The foam concentrate shall conform to ISO 7203-1.	3.1 characteristic value	value declared by the foam concentrate supplier for the chemical and physical properties and the performances of the foam, foam solution, and foam concentrate
5	Grades and uses of alcohol-resistant foam concentrates	3.2 25 % drainage time	time for 25 % of the liquid content of a foam to drain out
5.1 Grade	The foam concentrate shall be graded for - extinguishing performance as grade AR I or AR II, - burnback resistance as level A, B or C, according to its fire test performance (see clause 6). NOTE Typical anticipated extinguishing performance and burnback resistance are given in annex B.	3.3 expansion	ratio of the volume of foam to the volume of the foam solution from which it was made
5.2 Use with sea water	If a foam concentrate is marked as suitable for use with sea water, the recommended concentrations for use with fresh water and sea water shall be identical.	3.4 low-expansion	with expansion in the range 1 to 20, as applied to foam and to associated equipment, systems and concentrates
6	Test fire performance (water-miscible liquids)	3.5 medium-expansion	with expansion in the range 21 to 200, as applied to foam and to associated equipment, systems and concentrates
6.1	The foam produced from the foam concentrate before and, if the foam concentrate is designated temperature sensitive, after conditioning in accordance with A.2 of ISO 7203-1:1995, with potable water and if appropriate with the synthetic sea water of G.1.4 of ISO 7203-1:1995, shall have an extinguishing performance class and burnback resistance level as specified in table 1 when tested in accordance with annex A.	3.6 high-expansion	with expansion greater than 200, as applied to foam and to associated equipment, systems and concentrates
6.2	In this part of ISO 7203, the fire performance is tested using acetone as fuel, which also forms the basis for the performance classification. However, there are a large number of water-miscible liquids which have more or less different properties compared to acetone. It has been shown by tests using other fuels that the performances of various foams differ considerably. Examples of such fuels are isopropyl alcohol (IPA) and methyl ethyl ketone (MEK). CAUTION: It is therefore essential that the user check for any unfavourable or unacceptable loss of efficiency when the foam is used against fires in water-miscible liquids other than acetone. The fire test conditions and procedure described in annex A might be used in order to achieve results comparative with acetone and related requirements. Other fuels might also require the use of other application rates, both lower and higher, to achieve relevant test data. Other trays might then be used correcting the amount of fuel to achieve the same fuel depth as specified in annex A. It is also essential for the user to note that other fuel depths and methods of application compared to those specified in annex A can cause	3.7 foam	<firefighting> aggregate of air-filled bubbles formed from an aqueous solution of a suitable foam concentrate

	considerable loss in efficiency. These matters should be carefully considered by the user when assessing the suitability for particular applications.		
7 Marking, packaging and specificati on sheet	In addition to the information specified in 14.1 of ISO 7203-1:1995, the following information shall be provided in the same format: a) additional to the designation of 14.1 a) of ISO 7203-1:1995, the words “suitable for use on water-miscible liquids”; b) additional to the grade and level of 14.1 of ISO 7203-1:1995, the words “(on water-immiscible liquids)”; c) the grade (AR I or AR and the words “on water-miscible liquids (ACETONE)”; d) if appropriate, the minimum and/or maximum transit time (between proportioning and foam-making) recommended by the manufacturer.	3.8 concentrat e	<foam> liquid that, when mixed with water in the appropriate concentration, gives a foam solution
Annex A (normative)	Determination of fire test performance	3.9 Protein foam concentrat ion P	foam concentrate derived from hydrolized protein materials
A.1 General	See clause 6. NOTE Where appropriate, it is recommended that the tests of this part of ISO 7203 are carried out after those of ISO 7203-1 so as to avoid the expense of unnecessary testing of foam concentrates which do not comply in other respects.	3.10 fluoroprot ein foam concentrat e FP	protein foam concentrate with added fluorinated surface active agents
A.2	Test series	3.11 synthetic foam concentrat e S	foam concentrate based on a mixture of hydrocarbon surface-active agents and which can contain fluorocarbons with additional stabilizers
A.2.1	A test is successful only if all the appropriate requirements of clause 6 are met.	3.12 alcohol-res istant foam concentrat e AR	foam concentrate resistant to breakdown when applied to the surface of alcohol or other water-miscible solvents
A.2.2	For foam concentrates not compatible with sea water, carry out two or three tests (the third test is not necessary if the first two are both successful or if both are not successful). The concentrate complies with clause 6 if two tests are successful.	3.13 aqueous film-formi ng foam concentrat	foam concentrate based on a mixture of hydrocarbon and fluorinated surface-active agents with the ability to form an aqueous film on the surface of some hydrocarbons

		e AFFF	
A.2.3	For foam concentrates compatible with sea water, carry out one of the first two tests with potable water the other with the synthetic sea water of A.3.3. If both are successful, or if both are not successful terminate the test series. If only one of the tests is not successful repeat that test. If this repeat test is successful carry out a second repeat test, otherwise terminate the test series. The concentrate complies with the clause 6 either: a) if the first two tests are successful; or b) if one of the first two tests and both repeat tests are successful.	3.14 film-forming fluoroprotein foam concentrate FFFP	fluoroprotein foam concentrate that has the ability to form an aqueous film on the surface of some hydrocarbons
A.3	Test conditions	3.15 Foam solution	solution of foam concentrate and water
A.3.1 Temperature and wind speed	Carry out the tests under the following conditions: Air temperature $(15 \pm 5) ^\circ\text{C}$ Fuel temperature $(17,5 \pm 2,5) ^\circ\text{C}$ Foam solution temperature $(17,5 \pm 2,5) ^\circ\text{C}$ Maximum wind speed 3 m/s in the proximity of the test pan NOTE If necessary, some form of windscreen may be used.	3.16 Forceful application	application of foam such that it falls directly onto the surface of a liquid fuel
A.3.2 Records	During the fire test record the following: - indoor or outdoor test; - air temperature; - fuel temperature; - foam solution temperature; - wind speed; - extinction time; - 25 % burnback time. NOTE For quality control purposes, it is recommended that 90 % and 99 % control times are recorded. Control times may either be determined visually by an experienced person or may be determined from thermal radiation measurements. Annex H in ISO 7203-1:1995 gives details of one method suitable for low- and medium-expansion foams.	3.17 Gentle application	application of foam indirectly to the surface of a liquid fuel via a backboard, tank wall or other surface
A.3.3 Foam solution	Prepare a foam solution following the recommendations from the supplier for concentration, maximum premix (transit) time, compatibility with the test equipment, avoiding contamination by other types of foam, etc. Use potable water to make up the foam solution and, if the manufacturer claims the concentrate to be suitable for sea water, also make a foam solution using simulated sea water made up by dissolving the following components: Mass fraction (%) Component 2,50 Sodium chloride (NaCl) 1,10 Magnesium chloride ($\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$)	3.18 sediment	Insoluble particles in the foam concentrate

	0,16 Calcium chloride ($\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$) 0,40 Sodium sulfate (Na_2SO_4) 95,84 Potable water		
A.3.4 Fuel	Use acetone of not less than 99 % purity.	3.19 Spreading coefficient	value calculated from the measured surface and interfacial tensions to indicate the ability of one liquid to spontaneously spread across the surface of another
A.4 Fire test	See clause 6.	3.20 lowest temperatu re for use	temperature claimed by the manufacturer or supplier to be the lowest temperature at which the foam concentrate can be proportioned correctly using equipment normally available
A.4.1	Apparatus	4	Grades and uses of foam concentrates
A.4.1.1	Circular fire tray, made of steel, with dimensions as follows: diameter at rim: (1480 ± 15) mm depth: (150 ± 10) mm nominal thickness of steel wall: 2,5 mm with a vertical steel backboard (1 ± 0,05) m wide and (1 ± 0,05) m long, fitted as closely as possible along the curved top of the curved wall, or formed by an extension of the wall. The tray should have an area of approximately 1,73 m ²	4.1 Grades	Based on the test fire performance of the foam concentrate (see Clause 13), it shall be graded -as class I or II for extinguishing performance; -as level A, B or C for burn-back resistance.
A.4.1.2	Foam making equipment, in accordance with F.1.3 of ISO 7203-1:1995.	4.2 Use with sea water	If a foam concentrate is marked as suitable for use with sea water, the recommended concentrations for use with fresh water and sea water shall be identical.
A.4.1.3	Burnback pot, of nominal 2,5 mm steel, of diameter (300 ± 5) mm and of height (250 ± 5) mm.	5 Tolerance of the foam concentrat e to freezing and thawing	Before and after temperature conditioning in accordance with A.2, the foam concentrate, if claimed by the supplier not to be adversely affected by freezing and thawing, shall show no visual sign of stratification and non-homogeneity when tested in accordance with Annex B. Foam concentrates complying with Annex B shall be tested for compliance with the appropriate requirements given in other clauses and subclauses of this part of ISO 7203 after freezing and thawing in accordance with A.2.1.
A.4.2 Test procedre	Place the tray directly on the ground and ensure that it is level. Set up the foam nozzle horizontally (1 ± 0,05) m above the fuel level in a position where the central part of the foam discharge will strike the centre axis of the backboard (0,5 ± 0,1) m above the fuel level (see figure A.1). Add (125 ± 5) l of fuel, to give a nominal freeboard of 78 mm. Ignite the tray not more than 5 min after adding the fuel and allow it to burn for a period of (120 ± 5) s after full involvement of the surface of the fuel then start foam application. Record the extinction time as the period between the start of foam application and extinction. Apply foam for (180 ± 2) s for extinction class extinction class application. Stop foam application and after a further (300 ± 10) s place the burnback pot, containing (2 ± 0,1)	6	Sediment in the foam concentrate

	and ignite. Record the time when 25 % of the tray is covered with sustained flames.		
Annex B (informative) Anticipated performance	Typical anticipated performances for various types of alcohol resistant foams on acetone are given in table B.1. NOTE Other fuels might influence the performance of a foam considerably, see 6.2.	6.1 Sediment before ageing	Any sediment in the concentrate prepared in accordance with A.1 shall be dispersible through a 180 µm sieve, and the percentage volume of the sediment shall be not more than 0,25 % when tested in accordance with Annex C.
Annex C (informative)	Small-scale fire test for quality control purposes	6.2 Sediment after ageing	Any sediment in the concentrate aged in accordance with C.1 shall be dispersible through a 180 µm sieve, and the percentage volume of sediment shall be not more than 1,0 % when tested in accordance with Annex C.
C.1 General	Annex A describes large-scale fire tests for type approval. This annex describes a small-scale fire test which might be suitable for quality control purposes. It should be noted that the foam quality produced with the nozzle specified in this informative annex does not give the same foam properties as the foam nozzle used in the normative part of this part of ISO 7203. Expansion and drainage are therefore not directly comparable using the two nozzles.	7	Viscosity of the foam concentrate
C.2	Test conditions	7.1 Newtonian foam concentrates	The viscosity of the foam concentrate at the lowest temperature for use claimed by the manufacturer shall be determined in accordance with ISO 3104. If the viscosity is $> 200 \text{ mm}^2\text{s}^{-1}$, the container shall be marked: "This concentrate can require special proportioning equipment".
C.2.1 Temperature and wind speed	Carry out the tests under the following conditions: Air temperature $(15 \pm 5) ^\circ\text{C}$ Fuel temperature $(17,5 \pm 2,5) ^\circ\text{C}$ Foam solution temperature $(17,5 \pm 2,5) ^\circ\text{C}$ Maximum wind speed indoors in a draught-free room	7.2 Pseudo-plastic foam concentrates	The viscosity of the foam concentrate shall be determined in accordance with Annex D. If the viscosity at the lowest temperature for use is greater than or equal to $120 \text{ mPa} \cdot \text{s}$ at 375 s^{-1} , the container shall be marked: "Pseudo-plastic foam concentrate. This concentrate can require special proportioning equipment".
C.2.2 Records	During the fire test record the following: - air temperature - fuel temperature - foam solution temperature - wind speed - 90 % control - 99 % control - extinction - 100 % burnback time NOTE Control and burnback times may either be determined visually by an experienced person or may be determined from thermal radiation measurements. Annex H of ISO 7203-1:1995 gives details of one method suitable for low- and medium- expansion foams.	8	pH of the foam concentrate

C.2.3 Foam solution	Prepare a foam solution following the recommendations from the supplier for concentration, maximum premix time, compatibility with the test equipment, avoiding contamination by other types of foam, etc. Use potable water to make up the foam solution and, if the manufacturer claims the concentrate to be suitable for sea water, also make a foam solution using simulated sea water according to the composition given in annex A.	8.1 pH limits	The pH of the foam concentrate, before and after temperature conditioning in accordance with A.2, shall be not less than 6,0 and not more than 8,5 at $(20 \pm 2) ^\circ\text{C}$.
C.2.4 Fuel	Use acetone of not less than 99 % purity. NOTE Other fuels may be used for comparative purposes.	8.2 Sensitivity to temperature	The difference in pH between before and after temperature conditioning shall not be greater than 1,0 pH units.
C.3	Fire test	9	Surface tension of the foam solution
C.3.1	Apparatus	9.1 Before temperature conditioning	The surface tension of the foam solution prepared from the concentrate, before temperature conditioning in accordance with A.2 at the supplier's recommended concentration, shall be within $\pm 10\%$ of the characteristic value when determined in accordance with E.2.
C.3.1.1	Circular fire tray, made of brass, with a turned-over rim and central drain point and valve, with dimensions as follows: internal diameter at rim: $(565 \pm 5) \text{ mm}$ depth: $(150 \pm 5) \text{ mm}$ conical base: $(30 \pm 5) \text{ mm}$ nominal thickness of brass wall: $(1,2 \pm 0,2) \text{ mm}$ with a curved steel backboard $(0,3 \pm 0,05) \text{ m}$ high, $(0,6 \pm 0,05) \text{ m}$ long and of 2 mm nominal thickness, fitted inside and along the fire tray side located opposite the nozzle, as shown in figure C.1. The tray should have an area of approximately 0,25 m ² .	9.2 Temperature sensitivity	The surface tension of the foam solution prepared from the concentrate, after temperature conditioning in accordance with A.2 at the supplier's recommended concentration, shall be determined in accordance with E.2. The value obtained after temperature conditioning shall not be less than 0,95 times, or more than 1,05 times the value obtained before temperature conditioning.
C.3.1.2	Foam-making equipment, consisting of a branch pipe having a maximum flow rate of 5 l/min. It is fitted with a collar which can be positioned to allow foam to be projected from the branch pipe before reaching the nozzle, so the flow rate from the nozzle can be controlled (see figure C.2).	10	Interfacial tension between the foam solution and cyclohexane
C.3.1.3	Burnback pot, of $(1,2 \pm 0,2) \text{ mm}$ brass, of diameter $(120 \pm 2) \text{ mm}$ and $(80 \pm 2) \text{ mm}$ internal height, with four studs on the base to give an overall height of $(96 \pm 2) \text{ mm}$. The pot shall have a turned-over rim and a chain fitted to the rim to allow the pot to be lifted using a metal rod and lowered into the tray when required.	10.1 Before temperature conditioning	The difference between the interfacial tension between the foam solution prepared from the foam concentrate, before temperature conditioning in accordance with A.2, and cyclohexane (when determined in accordance with E.3) and the characteristic value, shall not exceed 1,0 mN/m or 10 % of the characteristic value, whichever is the greater.
C.3.2 Test procedure	Place the tray approximately 1 m above the floor in a steel frame with four legs and ensure that it is level. Carry out the tests beneath an extraction hood which will just exhaust the smoke without interfering with the fire.	10.2 Temperature sensitivity	The interfacial tension between the foam solution prepared from the foam concentrate, after temperature conditioning in accordance with A.2, and cyclohexane shall be determined in accordance with E.3. The two values obtained before and after temperature conditioning shall

	<p>Pressurize the premix to 7 bar and adjust the branch pipe flowrate to $(1\ 625 \pm 75)$ g/min. It is convenient to collect the foam in a tared vessel for 6 s and weigh to calculate the flowrate.</p> <p>Set up the foam nozzle horizontally with the by-pass holes directed downwards (150 ± 5) mm above the rim of the tray in a position where the central part of the foam discharge will strike the centre of the backboard (see figure C.1). Drain, clean and dry the tray and close the drain valve. Add $(9 \pm 0,1)$ l of acetone to the tray.</p> <p>Ignite the tray 120 s after adding the acetone and allow it to burn for a period of (120 ± 5) s after full involvement of the surface of the fuel, then start foam application. Record the extinction time as the period between the start of foam application and extinction of the fire.</p> <p>Apply foam for (120 ± 2) s or, if the fire still is not extinguished, for (240 ± 2) s. Stop foam application and, after a further (60 ± 5) s, ignite and lower the burnback pot, containing $(0,3 \pm 0,01)$ l of acetone into the centre of the tray.</p> <p>Care shall be taken not to allow foam to enter the pot. Record the time when 100 % of the tray is covered with sustained flames.</p>		not differ by more than 0,5 mN/m.
Annex D (informative) Bibliography	<p>ISO 5923:1989, Fire protection — Fire extinguishing media — Carbon dioxide.</p> <p>ISO 6183:1990, Fire protection equipment — Carbon dioxide extinguishing systems for use on premises — Design and installation.</p> <p>ISO 7076:—¹⁾, Fire protection equipment — Automatic extinguishing systems for applying low, medium and high expansion foams.</p> <p>ISO 7201-1:1989, Fire protection — Fire extinguishing media — Halogenated hydrocarbons — Part 1: Specifications for halon 1211 and halon 1301.</p> <p>ISO 7201-2:1991, Fire extinguishing media — Halogenated hydrocarbons — Part 2: Code of practice for safe handling and transfer procedures of halon 1211 and halon 1301.</p> <p>ISO 7202:1987, Fire protection — Fire extinguishing media — Powder.</p> <p>ISO 14520-1:—¹⁾, Gaseous fire-extinguishing systems — Physical properties and system design — Part 1: General requirements.</p> <p>ISO 14520-2:—¹⁾, Gaseous fire-extinguishing systems — Physical properties and system design — Part 2: CF₃I extinguishant.</p> <p>ISO 14520-3:—¹⁾, Gaseous fire-extinguishing systems — Physical properties and system design — Part 3: FC-2-1-8 extinguishant.</p> <p>ISO 14520-4:—¹⁾, Gaseous fire-extinguishing systems — Physical properties and system design — Part 4: FC-3-1-10 extinguishant.</p> <p>ISO 14520-5:—¹⁾, Gaseous fire-extinguishing systems — Physical properties and system design — Part 5: FC-5-1-14 extinguishant.</p>	11 Spreading coefficient of the foam solution on cyclohexane	<p>The spreading coefficient of the foam solution prepared from a concentrate claimed by the supplier to be “film-forming” before and after temperature conditioning in accordance with A.2, calculated in accordance with E.4, shall be positive.</p> <p>NOTE Foam concentrates complying with Clause 11 are more likely to be of types AFFF or FFFP than of types FP, P or S.</p>

	ISO 14520-6:— ¹⁾ , Gaseous fire-extinguishing systems — Physical properties and system design — Part 6: HCFC Blend A extinguishant. ISO 14520-7:— ¹⁾ , Gaseous fire-extinguishing systems — Physical properties and system design — Part 7: HCFC 124 extinguishant. ISO 14520-8:— ¹⁾ , Gaseous fire-extinguishing systems — Physical properties and system design — Part 8: HFC 125 extinguishant. ISO 14520-9:— ¹⁾ , Gaseous fire-extinguishing systems — Physical properties and system design — Part 9: HFC 227ea extinguishant. ISO 14520-10:— ¹⁾ , Gaseous fire-extinguishing systems — Physical properties and system design — Part 10: HFC 23 extinguishant. ISO 14520-11:— ¹⁾ , Gaseous fire-extinguishing systems — Physical properties and system design — Part 11: HFC 236fa extinguishant. ISO 14520-12:— ¹⁾ , Gaseous fire-extinguishing systems — Physical properties and system design — Part 12: IG-01 extinguishant. ISO 14520-13:— ¹⁾ , Gaseous fire-extinguishing systems — Physical properties and system design — Part 13: IG-100 extinguishant. ISO 14520-14:— ¹⁾ , Gaseous fire-extinguishing systems — Physical properties and system design — Part 14: IG-55 extinguishant. ISO 14520-15:— ¹⁾ , Gaseous fire-extinguishing systems — Physical properties and system design — Part 15: IG 541 extinguishant.		
		12	Expansion and drainage of foam
		12.1	Expansion
		12.1.1 Limits	The difference between the expansion of the foam produced from the foam concentrate, before and after temperature conditioning in accordance with A.2, with potable water and, if appropriate, with the synthetic sea water of G.2.4, and the characteristic value shall be within either $\pm 20\%$ of the characteristic value or $\pm 1,0$ of the characteristic value, whichever is the greater, when tested in accordance with Annex F.
		12.2	Drainage
		12.2.1 Limits	The difference between the drainage time of the foam produced from the foam concentrate, before and after temperature conditioning in accordance with A.2, with potable water and, if appropriate, with the synthetic sea water of G.2.4, and the characteristic value shall be within $\pm 20\%$ of the characteristic value when tested in accordance with Annex F.
		13 Test fire performance	The foam produced from the solution prepared using the foam concentrate sampled in accordance with Annex B at the supplier's recommended concentration with potable water, and if appropriate at the same concentration with the synthetic sea water in accordance with F.4, shall have an extinguishing performance class and burn-back resistance level as specified in Table 1, when tested in accordance with G.1 and G.2.
		14	Marking, packaging and specification sheet
		14.1	Marking

		14.1.1	<p>The following information shall be marked on the shipping container:</p> <ul style="list-style-type: none"> a) designation (identifying name) of the concentrate and the words “low-expansion foam concentrate”; b) class (I or II) and level (A, B, or C) of the foam concentrate and, if the concentrate complies with Clause 11, the words “aqueous film-forming”; c) recommended usage concentration for use (most commonly 1 %, 3 % or 6 %); d) any tendency of the foam concentrate to cause harmful physical effects, the methods required to avoid them and the first aid treatment if they occur; e) recommended storage temperature and temperature of use; f) if the concentrate complies with Clause 5, the words “Not affected by freezing and thawing” or, if the foam concentrate does not comply with Clause 5, the words “Do not freeze”; g) nominal quantity in the container; h) supplier's name and address; i) batch number; j) words “Not suitable for use with sea water” or “Suitable for use with sea water”, as appropriate. <p>WARNING — It is extremely important that the foam concentrate, after dilution with water to the recommended concentration and in normal usage, not present a significant toxic hazard to life in relation to the environment.</p> <p>The packaging of the foam concentrate shall ensure that the essential characteristics of the concentrate are preserved when stored and handled in accordance with the supplier's recommendations.</p>
		14.1.2	Markings on shipping containers shall be permanent and legible.
		14.1.3	It is recommended that non-Newtonian concentrates be appropriately identified.
		14.1.4	Foam concentrates in accordance with ISO 7203-2 shall also be marked “medium-expansion” or “high-expansion” or both.
		14.1.5	Foam concentrates in accordance with ISO 7203-3 shall also be marked “alcohol resistant”.
		14.2	Packaging
		14.2.1	If requested by the user, the supplier shall provide a list of the characteristic values.
		14.3	Specification sheet
		14.3.1	If the foam concentrate is Newtonian and the viscosity at the lowest temperature for use is more than 200 mm ² /s when measured in accordance with ISO 3104, the words “This concentrate can require special proportioning equipment” shall be marked.
		14.3.2	If the foam concentrate is pseudo-plastic and the viscosity at the lowest temperature for use is greater than or equal to 120 mPa·s at 375/s, the words “Pseudo-plastic foam concentrate. This concentrate can require

			special proportioning equipment” shall be marked.
		14.3.3	It is recommended that non-Newtonian concentrates be appropriately identified.
		Annex A (normative)	Preliminary sampling and conditioning of the foam concentrate
		A.1 Preliminary sampling	The sampling method shall ensure representative samples, whether taken from a bulk container or a number of individual packages. Store samples in tightly closed containers. NOTE Containers of capacity 20 l are suitable.
		A.2	Conditioning of foam concentrate
		A.2.1	If the supplier claims that the concentrate is not adversely affected by freezing and thawing, condition the concentrate sample through four cycles of freezing and thawing, generally as described in B.2, before conditioning in accordance with A.2.2. If the foam concentrate is adversely effected by freezing and thawing, it is conditioned in accordance with A.2.2 without prior freezing and thawing.
		A.2.2	Condition the concentrate in the sealed container for 7 d at $(60 \pm 2) ^\circ\text{C}$, followed by 1 d at $(20 \pm 5) ^\circ\text{C}$.
		A.3 Subsequent testing	Test samples shall be prepared in accordance with A.1, or A.2.1 and A.2.2 as appropriate. Agitate the sample container before sampling for further tests.
		Annex B (normative)	Determination of tolerance to freezing and thawing
		B.1 Apparatus	The usual laboratory apparatus and, in particular, the following.
		B.1.1	Freezing chamber, capable of achieving the temperatures required in B.2.
		B.1.2	Tube, polyethylene, approximately 10 mm in diameter, approximately 400 mm long and sealed and weighted at one end, with suitable spacers attached; see Figure B.1 for a typical form.
		B.1.3	Measuring cylinder, glass, of capacity 500 ml, approximately 400 mm high and approximately 65 mm in diameter, with a stopper.
		B.2 Procedure	Set the temperature of the freezing chamber (B.1.1) to at least $10 ^\circ\text{C}$ below the freezing point of the sample measured in accordance with BS 5117, Section 1.3 (excluding 5.2). To prevent the glass measuring cylinder (B.1.3) from breaking due to expansion of the foam concentrate on freezing, insert the tube (B.1.2) into the measuring cylinder with the sealed end downward, weighted if necessary to avoid flotation, with the spacers to ensure that it remains approximately on the central axis of the cylinder. Fill the cylinder and fit the stopper.

			Place the cylinder in the freezing chamber, cool it and maintain at the required temperature for 24 h. At the end of this period, thaw the sample for not less than 24 h and not more than 96 h in an ambient temperature of $(20 \pm 5) ^\circ\text{C}$. Repeat three times to give four cycles of freezing and thawing before testing. Examine the sample for stratification and non-homogeneity.
		Annex C (normative)	Determination of percentage of sediment
		C.1 Sampling	Use a sample prepared in accordance with A.1. Ensure that any sediment is dispersed by agitating the sample container. Take two samples, testing one immediately and the other after ageing for (24 ± 2) h at $(60 \pm 2) ^\circ\text{C}$ in a filled container without access to air.
		C.2 Apparatus	The usual laboratory apparatus and, in particular, the following.
		C.2.1	Centrifuge tubes, graduated.
		C.2.2	Centrifuge, operating at (6000 ± 600) m/s ² . NOTE A centrifuge and tubes in accordance with ISO 3734 are suitable.
		C.2.3	Sieve, of nominal aperture size 180 μm , in accordance with ISO 3310-1.
		C.2.4	Wash bottle, plastic.
		C.3 Procedure	Centrifuge each sample of the concentrate for (10 ± 1) min. Determine the volume of the sediment and record it as a percentage of volume of the centrifuged sample volume. Wash the contents of the centrifuge tube (C.2.1) onto the sieve (C.2.3) and check whether or not the sediment can be dispersed through the sieve by the jet from the plastic wash bottle (C.2.4).
		Annex D (normative)	Determination of viscosity for pseudo-plastic foam concentrates
		D.1 General	This annex gives the procedure for determining the viscosity for pseudo-plastic foam concentrates. The procedure is described in ISO 3219. NOTE Pseudo-plastic foam concentrates are a particular class of non-Newtonian foam concentrate and have a viscosity that decreases with increasing shear rate at constant temperature.
		D.2	Viscosity determination
		D.2.1 Apparatus	The usual laboratory apparatus and, in particular, the following.
		D.2.1.1	Viscometer, rotational, fitted with a temperature control unit that can maintain the sample temperature within $\pm 1 ^\circ\text{C}$ of the required temperature, in accordance with ISO 3219 with the following parameters: -maximum shear stress: $\square\square 75$ Pa; -maximum shear rate: $\square\square 600/\text{s}$.

		D.2.2 Test temperatu re	The viscosity of the foam concentrate shall be measured at temperatures from 20 °C to and including the lowest temperature for use claimed by the manufacturer in steps of 10 °C. Use a fresh sample for each temperature.
		D.2.3 Viscosity measurem ent	<p>If the sample contains suspended air bubbles, the sample shall be centrifuged for 10 min using the apparatus specified in C.2.1 and C.2.2 before the sample is applied in the apparatus.</p> <p>The test should be performed in accordance with the following test procedure.</p> <p>a)Adjust the temperature control unit.</p> <p>b)Set the gap.</p> <p>c)Apply the sample.</p> <p>d)Wait a minimum of 10 min (period of no shear) to reach temperature equilibrium.</p> <p>e)Pre-shear for 1 min at 600/s.</p> <p>f)Wait 1 min without shearing.</p> <p>g)Measure the shear stress for 10 s at each shear rate, starting at the lowest shear rate (preferably at 75/s).</p> <p>Measure the shear stress at least at eight different shear rates over the range 0/s to 600/s, e.g. 75/s, 150/s, 225/s, 300/s, 375/s 450/s, 525/s, 600 s/s. Calculate the apparent viscosity, η, expressed in millipascal-seconds, from Equation (D.1):</p> $\eta = 1000 \frac{s_1}{s_2} \quad (D.1)$ <p>where</p> <p>s_1 is the shear stress, expressed in pascals;</p> <p>s_2 is the shear rate, expressed in reciprocal seconds.</p>
		D.2.4 Results	Report the results as a table, including the test temperature (°C), shear rate (1/s), shear stress (Pa), and apparent viscosity (mPa·s).
		Annex E (normative)	Determination of surface tension, interfacial tension and spreading coefficient
		E.1	Reagents
		E.1.1	<p>Foam concentrate solution, at the recommended concentration for use in freshly made analytical water complying with grade 3 of ISO 3696:1987 and surface tension not less than 70 mN/m.</p> <p>NOTE The solution can be made up in a 100 ml volumetric flask using a pipette to measure the foam concentrate.</p>
		E.1.2	Cyclohexane, of purity not less than 99 %, for interfacial tension and spreading coefficient only.
		E.2 Procedure for surface	Determine the surface tension of the solution (E.1.1) at a temperature of (20 ± 1) °C using the ring method in accordance with ISO 304.

		tension	
		E.3 Procedure for interfacial tension	After measuring the surface tension in accordance with E.2, introduce a layer of cyclohexane (E.1.2) at $(20 \pm 1) ^\circ\text{C}$ onto the foam solution (E.1.1), being careful to avoid contact between the ring and the cyclohexane. Wait (6 ± 1) min and then measure the interfacial tension.
		E.4 Spreading coefficient	Calculate the spreading coefficient, S, expressed in millinewtons per metre, between the solution (E.1.1) and cyclohexane (E.1.2) from Equation (E.1): $S = Y_c - Y_f - Y_i$ (E.1) where Y_c is the surface tension of the cyclohexane, expressed in millinewtons per metre; Y_f is the surface tension of the foam solution, expressed in millinewtons per metre; Y_i is the interfacial tension between the foam solution and cyclohexane, expressed in millinewtons per metre.
		Annex F (normative)	Determination of expansion and drainage time
		F.1 Apparatus	The usual laboratory apparatus and, in particular, the following.
		F.1.1	Collecting vessel, plastic cylindrical, of volume known to $\pm 1\%$, equipped with a bottom discharge facility, as shown in Figure F.1.
		F.1.2	Foam collector, for expansion and drainage measurement; stainless steel, aluminium, brass and plastics are suitable materials for the collection surface; see Figure F.2.
		F.1.3	Foam-making nozzle, that, when tested with water, has a flow rate of 11,4 l/min at a nozzle pressure of (630 ± 30) kPa $[(6,3 \pm 0,3)$ bar]; see Figure F.3.
		F.1.4	Foam solution tank, connected to the nozzle.
		F.2 Temperatu re conditions	Carry out the tests under the following temperature conditions: -air $(20 \pm 5) ^\circ\text{C}$; -foam solution $(17,5 \pm 2,5) ^\circ\text{C}$.
		F.3 Procedure	Check that the pipework and hose from the foam solution tank (F.1.4) to the nozzle (F.1.3) is completely full of solution. Set up the nozzle horizontally, directly in front of the foam collector (F.1.2), with the front of the nozzle $(3 \pm 0,3)$ m from the top edge of the collector. Wet the vessel internally and weigh it. Record the mass as m_1 . Set up the foam equipment and adjust the nozzle pressure within the range (630 ± 30) kPa $[(6,3 \pm 0,3)$ bar] to give a flow rate of 11,4 l/min. With the drain at the base closed, collect foam, taking care that voids are not formed in the vessel.

			<p>Start the timing device when the vessel is half full. As soon as the vessel is full, stop collecting foam and strike the foam surface level with the rim. Weigh the vessel and record the mass m_2. Calculate the expansion, E, from Equation (E.1):</p> $E = \frac{V}{m_2 - m_1} \quad (\text{F.1})$ <p>where</p> <p>V is the volume, expressed in litres, of the collecting vessel (F.1.1);</p> <p>m_1 is the mass, expressed in kilograms, of the empty vessel;</p> <p>m_2 is the mass, expressed in kilograms, of the full vessel.</p> <p>Assume that the density of the foam solution is 1,0 kg/l.</p> <p>Open the drainage facility (see F.1.1) and collect the foam solution in the graduated measuring cylinder to measure the 25 % drainage time. Adjust the drainage facility such that the drained foam solution can flow out whilst preventing the passage of foam.</p> <p>NOTE This can be achieved by controlling the level of the liquid/foam interface in the plastics tube at the outlet.</p>
		F.4 Simulated sea water	Prepare the simulated sea water by dissolving the components listed in Table F.1.
		Annex G (normative)	Determination of test fire performance
		G.1 General	<p>This annex specifies the procedure for determining the test fire performance for low expansion foam concentrates. The tests described in this annex are more expensive and time-consuming than the other tests described in this part of ISO 7203. It is recommended that they be carried out at the end of the test program to avoid the expense of unnecessary testing.</p> <p>Testing at temperatures above the range required by this part of ISO 7203 can result in poor performance, and precludes conformity with this part of ISO 7203.</p>
		G.2	General conditions
		G.2.1	Test series and criteria for success
		G.2.1.1 Foam concentrat es not compatible with sea water	Conduct one test with potable water on propan-2-one (acetone) and one test with potable water on propan-2-ol (isopropanol, isopropyl alcohol, IPA). If both tests are successful, or if both tests are unsuccessful, terminate the test series. If one test is unsuccessful, repeat that test. The concentrate conforms to Clause 13 if the first two tests are successful, or if one of the first two tests is successful, and the repeat test is successful.
		G.2.1.2 Foam concentrat	Conduct one test with potable water on propan-2-one (acetone), and one test with potable water on propan-2-ol (isopropanol, isopropyl alcohol, IPA). If both tests are successful, carry out one test with the simulated sea

		es compatible with sea water	water in accordance with F.4 on propan-2-one (acetone), and one test with the simulated sea water in accordance with F.4 on propan-2-ol (isopropanol, isopropyl alcohol, IPA). If all tests are successful, terminate the test series. If one of the potable water tests is not successful, repeat that test. If one of the simulated sea water tests is not successful, repeat that test. The concentrate conforms to Clause 13 if all four tests have been successful or, in the case of one or two unsuccessful results, the repeat or repeats has or have been successful.
		G.2.2 Temperature and wind speed	Carry out the tests under the following conditions: -air temperature (15 ± 5) °C; -fuel temperature ($17,5 \pm 2,5$) °C; -foam solution temperature ($17,5 \pm 2,5$) °C; -maximum wind speed in the proximity of the fire tray 3 m/s. NOTE If necessary, some form of wind-screen can be used.
		G.2.3 Records	During the fire test record the following: a)location; b)air temperature; c)fuel temperature; d)foam solution temperature; e)wind speed; f)90 % control time; g)99 % control time; h)extinction time; i)25 % burn-back time. NOTE 90 % control time and burn-back time can be determined either visually by an experienced person or from thermal radiation measurements. Annex I gives details of a method suitable for low-expansion foams.
		G.2.4 Foam solution	Prepare a foam solution following the recommendations from the supplier for concentration, maximum premix time, compatibility with the test equipment, avoiding contamination by other types of foam, etc. Use potable water to prepare the foam solution and, if the supplier claims that the concentrate is suitable for use in sea water, make a second foam solution at the same concentration using the simulated sea water in accordance with G.4.
		G.2.5 Fuel	Use propan-2-one (acetone) of not less than 99 % purity. Use propan-2-ol (isopropanol, isopropyl alcohol, IPA) of not less than 99 % purity.
		G.3	Fire test
		G.3.1 Apparatus	The usual laboratory apparatus and, in particular, the following
		G.3.1.1	Fire tray, circular, of stainless steel grade 314 with dimensions as follows: -internal diameter at rim ($1\ 480 \pm 15$) mm; -depth (150 ± 10) mm;

			-foam solution temperature ($17,5 \pm 2,5$) mm; -nominal thickness of steel wall 2,5 mm. The tray shall have a vertical stainless steel backboard ($1 \pm 0,05$) m high and ($1 \pm 0,05$) m long fitted as closely as possible along the curved top of the curved wall, or formed by an extension of the wall. NOTE The tray has an area of approximately 1,73 m ² .
		G.3.1.2	Foam making equipment, as described in F.1.3.
		G.3.1.3	Burn-back pot, stainless steel, of nominal thickness 2,5 mm, diameter (300 ± 5) mm and height (250 ± 5) mm.
		G.3.2 Test procedure	Place the tray directly on the ground and ensure that it is level. Set up the foam nozzle horizontally ($1 \pm 0,05$) m above the fuel level in a position where the central part of the foam discharge will strike the centre axis of the backboard ($0,5 \pm 0,1$) m above the fuel level (see Figure G.1). Clean the tray. Add (125 ± 5) l of fuel. Ignite the fuel, not less than 3 min and not more than 5 min after adding it. Start foam application (120 ± 2) s after full involvement of the surface of the fuel. Readjust nozzle to ensure that the jet continues to hit the centre of the backboard. If the foam concentrate is claimed to be class 1, apply foam for (180 ± 2) s. If the foam concentrate is claimed to be class 2, apply foam for (300 ± 2) s. If the fire within the fire tray is extinguished prior to the end of foam application, record the extinction time as the period from the start of foam application until the time all flames are extinguished within the fire tray. If a fire remains only on the outside of the tray after foam application, this fire shall be manually extinguished before starting the burn-back test. After a further (300 ± 10) s, place a burn-back pot, containing ($2 \pm 0,1$) l of fuel in the centre of the tray and ignite. Record the 25 % burn-back time. NOTE During foam application, some foam can overflow from the fire tray, possibly carrying burning fuel. It is advisable to mount the test fire tray within a non-combustible bunded or dyked area to contain any foam overflow.
		Annex H (informative)	Small-scale fire test
		H.1 General	Annex G describes large-scale fire tests for type approval. This annex describes a small-scale fire test that can be suitable for quality control purposes. This test should not be run outdoors as the results are very sensitive to any kind of air flow. To analyse the compatibility between foams and dry chemical powder, this test should be repeated according to the procedure in H.3.
		H.2 Apparatus	The usual laboratory apparatus and, in particular, the following.
		H.2.1	Fire tray, circular, of brass, with a turned over rim, and a drain point with

			<p>valve at the centre of the conical base, with dimensions as follows; see Figure H.1:</p> <ul style="list-style-type: none"> -internal diameter at rim (565 ± 5) mm; -height of vertical wall (150 ± 5) mm; -height of conical base (30 ± 5) mm; -thickness of vertical wall ($1,2 \pm 0,2$) mm. <p>The fire tray shall have a vertical backboard 2,5 mm thickness, 600 mm long and 300 mm high formed by an extension of the wall opposite to the nozzle.</p> <p>NOTE The tray has an area of approximately 0,25 m².</p> <p>The fire tray is supported approximately 1 m above the ground on a steel frame with four legs. The tray is normally placed beneath a suitable fume extraction hood which extracts the smoke without interfering with the fire.</p>
		H.2.2	<p>Burn-back pot, brass, with a turned over rim, and fitted with four studs at the base to give an overall height of (96 ± 2) mm. with dimensions as follows:</p> <ul style="list-style-type: none"> -internal diameter at rim (120 ± 2) mm; -internal depth (80 ± 2) mm; -thickness of wall ($1,2 \pm 0,2$) mm. <p>A chain fitted to the rim allows lifting the burn-back pot using a metal rod.</p>
		H.2.3	<p>Foam making nozzle, with a nominal flow rate of 5,0 l/min at 700 kPa (7 bar) when tested with water; see Figure H.2. It is fitted with an adjustable collar to allow ejecting foam from the side of the nozzle and, thus, vary the foam flow rate through the outlet. The foam flow rate can also be controlled by adjusting the pressure applied to the foam solution.</p>
		H.2.4	<p>Fuel, consisting of propan-2-one (acetone) or propan-2-ol (isopropanol, isopropyl alcohol, IPA) of not less than 99 % purity.</p>
		H.3	Test procedure
		H.3.1.1 Test conditions	<p>Carry out the test under the following conditions:</p> <ul style="list-style-type: none"> -air temperature (15 ± 5) °C; -fuel temperature ($17,5 \pm 2,5$) °C; -foam solution temperature ($17,5 \pm 2,5$) °C.
		H.3.1.2 Set-up	<p>Position the foam nozzle horizontally with the by-pass holes in the adjustable collar facing downwards at a height of (150 ± 5) mm above the rim of the fire tray (see Figure H.2).</p> <p>Prepare the foam solution following the recommendations of the supplier for concentration, maximum premix time, compatibility with test equipment, avoiding contamination by other types of foam, etc.</p> <p>Set the nozzle pressure to 700 kPa (7 bar) and the foam flow rate to ($1,625 \pm 0,025$) kg/min by adjusting the collar and, if necessary, reducing the nozzle pressure. It is convenient to collect the foam in a tared vessel for 6 s and to weigh it to calculate the flow rate.</p>

			Position the nozzle while keeping it horizontal so that the foam strikes the centre of the fire tray. Shut off the foam discharge. Clean the tray and close the drain valve.
		H.3.1.3 Fire test	Place $(9 \pm 0,1)$ l of fuel in the tray and $(0,3 \pm 0,01)$ l of fuel in the burn-back pot. (120 ± 2) s after fuelling, ignite the fuel and allow to burn for (120 ± 2) s before starting foam application. Apply foam for (120 ± 2) s to the centre of the backboard and record the times from the start of foam application to 90 % control, 99 % control and complete extinction. If complete extinction is not obtained within (120 ± 2) s, apply the foam for a further (120 ± 2) s. At the end of foam application, ignite the fuel in the burn-back pot, and (60 ± 2) s after the end of foam application, lower the pot into the centre of the tray with a metal rod, taking care not to allow foam to enter the pot. Record the time taken from positioning of the burn-back pot to permanent, full re-involvement of the fire tray surface in flames as the burn-back time.
		Annex I (informative)	Description of a radiation measurement method
		I.1 Evaluation	Radiation measurement is a convenient and objective way to monitor the performance of a foam during the fire performance test. It reduces the requirement for visual observations (except for flame flickers and time necessary for complete extinction). This annex describes the equipment and procedure used in a series of tests in one testing laboratory, and the methods used to interpret and present the results; see Reference [8] for details. The method is suitable for low- and medium-expansion foams but not for high-expansion foams.
		I.2 General arrangement of test	Radiometers should be placed diametrically in relation to the tray as shown in Figure I.1. The distance between the meters and the rim of the tray should be not less than twice the diameter, D, of the tray and the height above the rim, not less than 1,5 m. NOTE The maximum distance is limited by the sensitivity of the radiometers. Radiation levels should be recorded continuously or with intervals not exceeding 1 s.
		I.3 Technical data for radiometers	Two radiometers ²⁾ of type Gordon or Schmidt-Boelter should be used. The meters should be cooled with water. The temperature of the cooling water should be (30 ± 10) °C, held constant during the measurements. The radiometers absorb at least 90 % of the incoming radiation within the range of wavelengths 0,6 µm to 15 µm. For a fully developed fire, the radiometer reading should be not less than 0,6 times full scale. The radiometers should have maximum non-linearity of ± 3 % of nominal range of measurement, and a maximum response time of 2 s (up to 63 % of

			<p>full response).</p> <p>NOTE A radiometer with protective glass can be used, provided that the requirements on spectral sensitivity are satisfied. If it is considered necessary, utilization of the range of measurement specified above can be changed, if the radiometers have a better linearity. Less than 40 % utilization is not advisable, as the influence of background radiation can cause an effect that is too high.</p> <p>²⁾ The Medtherm Series 64 supplied by Medtherm Corp., P.O.Box 412, Huntsville, AL. USA is an example of a suitable apparatus available commercially. This information is given for the convenience of users of this part of ISO 7203 and does not constitute an endorsement by ISO of this apparatus.</p>
		I.4 Procedure	<p>Correct the output from the two radiometers by deducting the background radiation recorded from 5 s to 10 s after the moment from complete extinction.</p> <p>Determine the average value of the two radiometers.</p> <p>Determine the average value of time of recorded radiation during the 25 s period from 30 s to 5 s before the start of the foam application (see Figure I.2).</p> <p>Determine the relative radiation by dividing the output by the average value obtained in accordance with the preceding paragraph.</p> <p>The instantaneous radiation values are subject to random fluctuation. A smoother curve, which facilitates interpretation, can be obtained by plotting radiation values averaged over a period of ± 5 s for each time value.</p> <p>The adjusted relative radiation is shown for the extinguishing test in Figure I.3 and for the burn-back test in Figure I.4. A control of 90 % is equivalent to the relative radiation 0,1.</p> <p>The description above implies that a computer-controlled measuring practice should be applied.</p>
		Annex J (informative)	Compatibility
		J.1 Compatibility between foam concentrates and fire extinguishing powders	<p>Where foam and powder might be applied simultaneously or successively, users should ensure that any unfavourable interaction does not cause an unacceptable loss of efficiency.</p> <p>The small-scale fire-test detailed in Annex H may be used to evaluate the compatibility of foam concentrates and powders.</p> <p>This test is carried out on the foam in question, and then repeated after the fuel has been covered in powder as follows.</p> <p>a) (500 ± 1) g powder is weighed into a 180 μm sieve, placed on a sheet of paper or cardboard.</p> <p>b) The sieve is held over the fuel, and the cardboard or paper removed.</p> <p>c) The powder is then evenly distributed over the surface of the fuel from a</p>

			<p>height of (150 ± 10) mm.</p> <p>d)The fuel is lit not more than 60 s after the powder has been spread over the surface of the fuel.</p> <p>If the increase in extinction time is equal to or greater than 25 % longer than the result without powder, then the combination of powder and foam may be considered to lead to an unacceptable loss in efficiency.</p> <p>Likewise, a reduction in burn-back time by 25 % or more when powder is used indicates that the foam and powder are incompatible.</p>
		J.2 Compati bility between foam concentrat es	<p>Foam concentrates of different manufacture, grade or class are frequently incompatible and should not be mixed, unless it has first been established that an unacceptable loss of efficiency does not result.</p>

* 変更部分については、 で色づけし、項目が変更になっている部分については、 で色づけした。