ISA-TR84.00.07-2018 HAZARD DETECTION REVIEW

HAZARD ASSESSMENT TYPE:

FLAME DETECTION

WASTE MANAGEMENT FACILITY

Client Information

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SITE NAME:	Site
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Report Information

REPORT AUTHOR:	Name
REPORT REFERENCE:	Reference
REVISION:	Revision Number
ECN:	Number
DATE:	05/05/2020

Micropack Consultant Signature

Signature Here

If there are any questions relating to this review, please contact a team member using the contact details below.

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Visual Flame Detection
Multi Spectrum Flame Detection
Fire & Gas Consultancy
3D Fire and Gas mapping software

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Area Description / Hazard Analysis

The waste disposal site receives and sorts waste before sending it on for recycling or landfill.

The principal fire hazard(s) in the building considered during the detector selection and layout design process is/are:

1. Spontaneous ignition of the unsorted or sorted trash pile resulting from the inclusion of inappropriate materials / hazardous waste (i.e., batteries)
2. Mechanical / Electrical Fires (i.e., the trommel and the conveyor system.)

Special risk fuels and fires (i.e., highly pure methanol, MEG, TEG, and hydrogen) will not be present or occur on this site. In the event of a change in hazards on-site, the facility should be re-mapped and appropriate detection technology used.

The hazard analysis and mapping methodology applied is in line with **ISA TR 84.00.07-2018 guidance**. See **Appendix B** for more information.

Summary of Flame Detector Coverage Recommendations

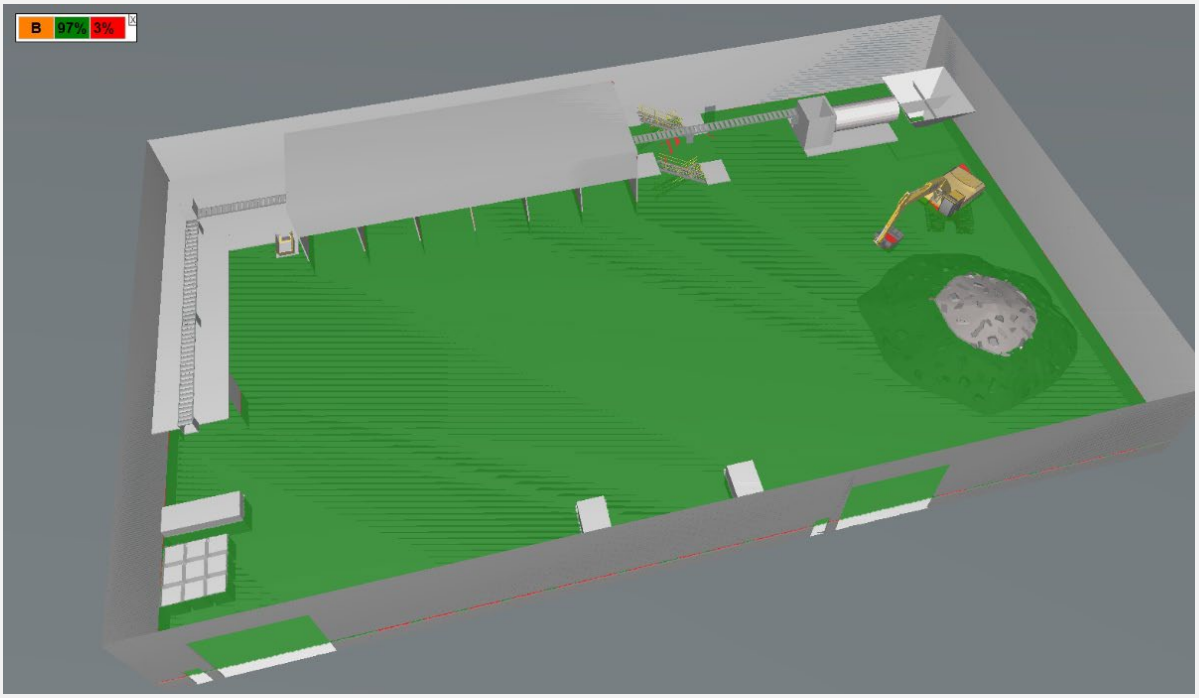
Layout	Detector Count	Full Alarm (1ooN*) Coverage	Delayed Alarm (1ooN) Coverage	No Coverage
Option 1 (FDS300)	5	97%	-	3%

*1ooN: One out of the total number of detectors (N) is required to detect the fire instead of other voting strategies that need multiple concurrent alarm signals.

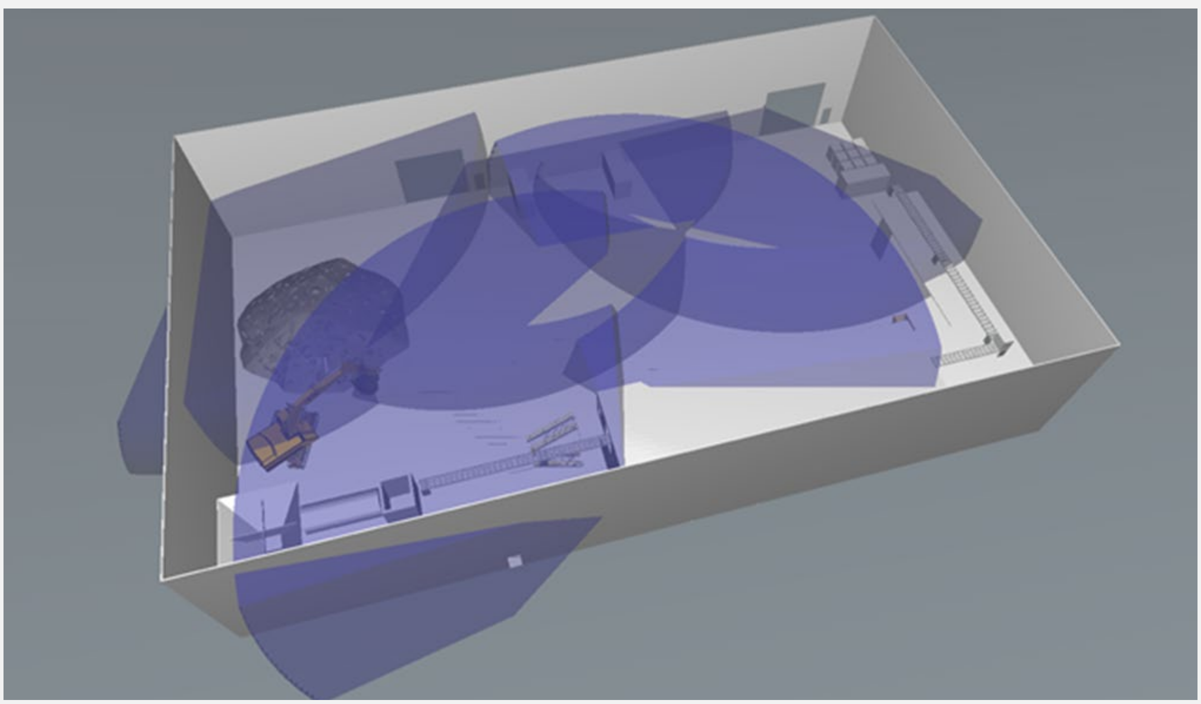
Recommended Flame Detector Layout Details

Tag No	Detector	Technology	Co-ordinates (m)			Pan	Tilt
			X	Y	Z		
De01	Micropack FDS300	iVFD	90.995	41.254	4.00	-170	25
De02			75.253	65.869	4.00	-120	25
De03			63.268	84.438	5.00	-105	25
De04			54.228	46.408	2.00	-15	25
De05			47.428	42.135	2.50	75	25

Flame Detection Coverage – **HazMap3D** Assessment



Flame Detection Layout – **HazMap3D** Layout



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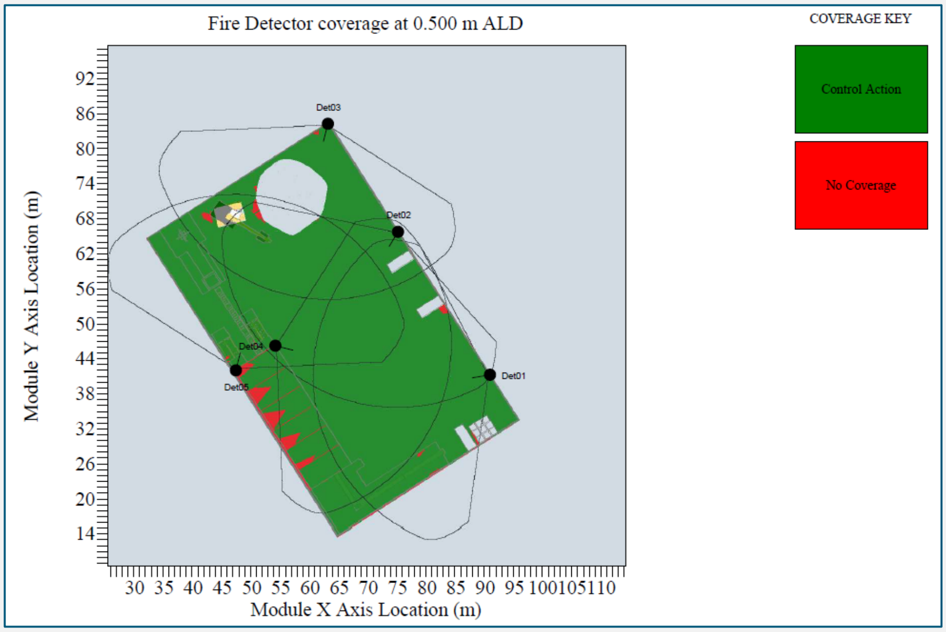
Recommended Flame Detection Layout – 2D Plot Plan



Assessment Colours Guide

<table>
<tr><th colspan="2">Assessment Colors for Flame Detection</th><th colspan="2">Assessment Colors for Gas Detection</th></tr>
<tr><td>Green</td><td>An area where coverage fully meets the graded alarm and control action requirements.</td><td rowspan="2">Green</td><td rowspan="2">An area where the graded alarm and control action requirements are fully met. In methodologies that test only detector spacing, this indicates that the point is close enough to a detector to satisfy the spacing requirement.</td></tr>
<tr><td>Yellow</td><td>Area with sufficient coverage for control action, but alarms will be late/delayed while the fire escalates.</td></tr>
<tr><td>Orange</td><td>Area with alarm coverage from at least one detector but does not have the coverage necessary for control action.</td><td rowspan="2">Orange</td><td rowspan="2">An area with alarm coverage from at least one detector, but the voting target for control action is not achieved. It cannot occur with methodologies in which spacing is the only assessment criterion.</td></tr>
<tr><td>Brown</td><td>Any detector cannot see the area wherein the target fire size, but larger fires can be seen by one device.</td></tr>
<tr><td>Red</td><td>An area with no coverage (based on selected methodology).</td><td>Red</td><td>An area with no coverage (based on selected methodology).</td></tr>
</table>

Consultant Notes

Adding **one additional flame detector** can increase the alarm coverage by X%. Micropack can create a new layout and assessment if desired.

Appendix A: Flame Detector Effective Viewing Distance

The following method is applied to calculate the effective viewing distance of a flame detector (D).

D is the effective viewing distance calculated from parameters X, F1, F2, and F3, as follows:

$$D = X \times F1 \times F2 \times F3$$

1. X = Specified detection distance for a one ft² (0.1 m²) n-heptane pool fire (approximately 40 KW RHO) under ideal FM 3260 conditions at the chosen sensitivity setting, if applicable, and to give the required response time. The surveyor can obtain this distance from the detector specification, manual, or FM 3260 (Ref 25) test report.
2. F1 = Factor is representing a reduction in sensitivity to real flame in the presence of unwanted stimuli. From the detector manual or, otherwise, from the detector manufacturer, obtain the detection distances at the chosen sensitivity setting for the **FM 3260 tests for a one ft² (0.1 m²)** n-heptane pool fire in the presence of the following false alarm sources:

   - **A:** Sunlight (direct, modulated, reflected). ***(Triple Weighted)***
   - **B:** Arc Welding
   - **C:** 6 kW heater, modulated at 24.4m (80 ft) at 3 m (10 ft).
   - **D:** 300 W incandescent lamp, modulated at 0.9 m (3 ft).
   - **E:** 500 W shielded quartz halogen lamp, modulated at 2.4 m (8 ft).
   - **F:** 500 W unshielded quartz halogen lamp, modulated at 2.4 m (8 ft).
   - **G:** 250 W vapor lamp modulated.
   - **H:** Two 34 W fluorescent lamps modulated.

Note: For most of the variables, the radiation source is modulated / "chopped." For sunlight, the value can be modulated OR unmodulated. Modulated sunlight often has a far more severe impact on detector performance than Unmodulated sunlight. In the case of some MSIR detector, unmodulated sunlight degrades performance by 70% (30% effective), while modulated sunlight degrades performance by 85% (15% effective)

3. Take the average detection distance (Dav) from these eight tests with a weighted factor of 3 for the sunlight test. This reduction factor means adding the eight lengths plus twice the sunlight test distance and dividing by ten.

$$D_{av} = \frac{3 * A + B + C + D + E + F + G + H}{10}$$

$$F1 = \frac{(X + D_{av})}{2}$$

Note: There are different approaches in the industry for dealing with missing/unavailable data when performing this calculation. Some operators will remove that false alarm source/variable from the equation when the number is unavailable. Some will substitute a value of 0 for the missing variable - penalizing the detector/manufacturer for not making the information available or not performing the test. If the surveyor uses this punitive approach, and no data is available, Dav will go to zero, and F1 will go to 0.5 - which is the minimum value F1 can assume. Some will substitute values from similar detectors for which data is available.

4. F2 = Factor is representing a reduction in sensitivity due to dirty optics. Determine from the detector specification or instruction manual the fraction of maximum detection distance at which the dirty optics fault alarm occurs. F2 is the midpoint between this fraction and 1. Thus, if the activation of the dirty optics alarm is at 60% of the maximum distance, F2 will be 0.8.

5. F3 = Factor represents a reduction in sensitivity across the claimed field of view from the maximum at the centreline. The surveyor will use a default value of 1.0 unless they can justify a different value from the analysis of the detector field of view diagrams for horizontal and vertical planes.

Micropack FDS300 intelligent Visual Flame Detector

X	60 m
F1	0.95[1]
F2	0.95[2]
F3	1.0[3]
D	60 *0.95*0.95*1.0
D	**54.15 m**
Sensitivity	**90.25%[4]**

Note:

1. Internal and independent testing has shown that the false alarm sources considered in the calculation of F1 do not degrade the performance of the FDS300. It still detects 1 ft by 1 ft n-heptane test fires at 60 m when exposed to these false alarm sources / desensitizing stimuli. However, Micropack still derates the detector by 5% in assessments to be conservative.

2. Independent tests have shown that salt build-up, dirt, grime, and grit build-up on the front optics have minimal, if any, impact on the performance of the FDS300 unless that build-up becomes extremely heavy/severe. However, Micropack still derates the detector by 5% in assessments to be conservative.

3. HazMap3D automatically accounts for F3 by showing the 3D FOV cone, thereby accounting for off-axis sensitivity losses.

4. The sensitivity is 90%, as HazMap3D requires the percentage to be a whole number.

Appendix B: Flame Detection Assessment Methodology

Applying Grades

In areas where we identify a fire risk, we apply a grade to the site, which defines the size of the fire to be covered by the recommended flame detectors.

Viewing Distances & Coverage Factors

Graded areas shall employ the maximum detector viewing distances as detailed below. Performance specifications for each grading define the maximum viewing distances (expressed as D or multiples of D) for flame detectors to cover these hazards/ graded areas. D is the effective viewing distance calculated from specified detection distance to 1 ft^2 n-heptane pool fire incorporating reduction in sensitivity to genuine flame in the presence of desensitizing factors (Refer to Appendix A)

Table 1: Maximum Viewing Distances of Optical Flame Detectors.

Grade	Maximum Viewing Distance for Alarm Coverage	Maximum Viewing Distance for Delayed Alarm Coverage
Fire Grade	1.5D	3.0D

Target Fire Sizes

Alarm: 1.5D (~100 kW RHO or approximately twice the size of the standard 1 square foot heptane test fire)

Delayed Alarm: 3.0D (~400 kW RHO or approximately eight times the size of the standard 1 square foot heptane test fire)

See **Appendix A** for calculation of detector effective viewing distance for the FM3260 test fire, D.

The percentage coverage required is based on engineering judgment of the area hazards and the benefit of detection. This percentage is the coverage the flame detector provides of the graded areas and includes the loss of view from obstructions and lack of coverage for any other reasons. The designer will consider additional detection if the coverage is not adequate.

Application within Software

Micropack utilized HazMap3D for this project. The 3D model used has been supplied by the client/created by Micropack.

The flame detector's three-dimensional cones, depicting each detector's field of view, are shown with the corresponding obstructions, reducing coverage Figure 1. The footprint of the flame detector is then represented based upon the detector manufacturer's information and equated to the required detection distance for each grade.

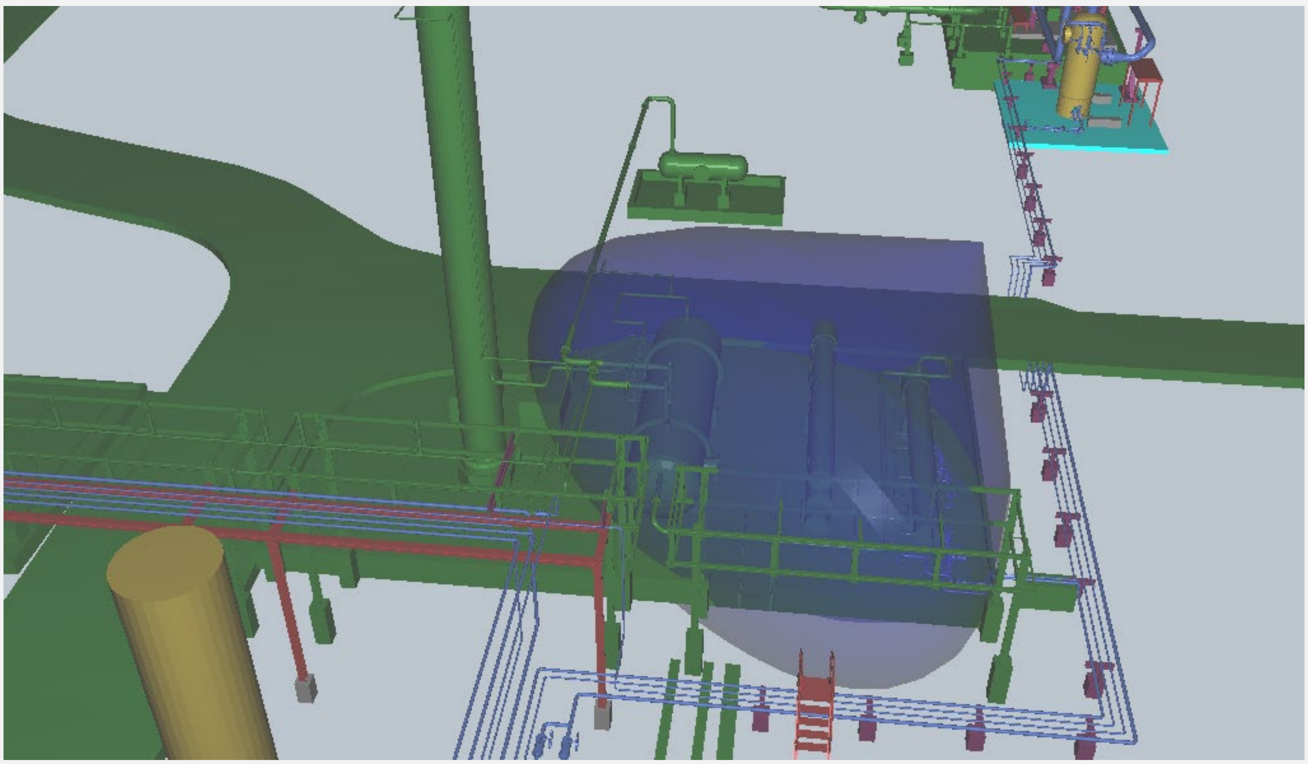


Figure 1: Flame detector footprint.

The transparent purple cone is the field of view of a detector 1.0D, calculated in Appendix A in response to a 40kW n-heptane pool fire. Surrounding this core are other cones that correspond to the required detection distance and fire size (kW); however, these are invisible within the model UI to decrease the processing time and produce a manageable amount of information on the screen. Two or more flame detectors need to have overlapped transparent cones of the appropriate size to achieve voted control action coverage.

Note: The typical detection distance of the field of view cones shown within the 3D model is 1.0D. Therefore, the field of view visible on the assessments should not be assumed to be the entire range of the detector.

As determined using the performance target specification procedure, we will grade the area according to its local hazards and escalation risks. HazMap3D will store information in a 'Grade map' file. This Grade map is essentially the area that requires to be seen by the flame detector, Figure 2. A custom software system then 'overlays' each relevant detector's footprint onto the Grade map. Using a truth table, HazMap3D constructs a graphical image of the coverage afforded by the area's detectors.

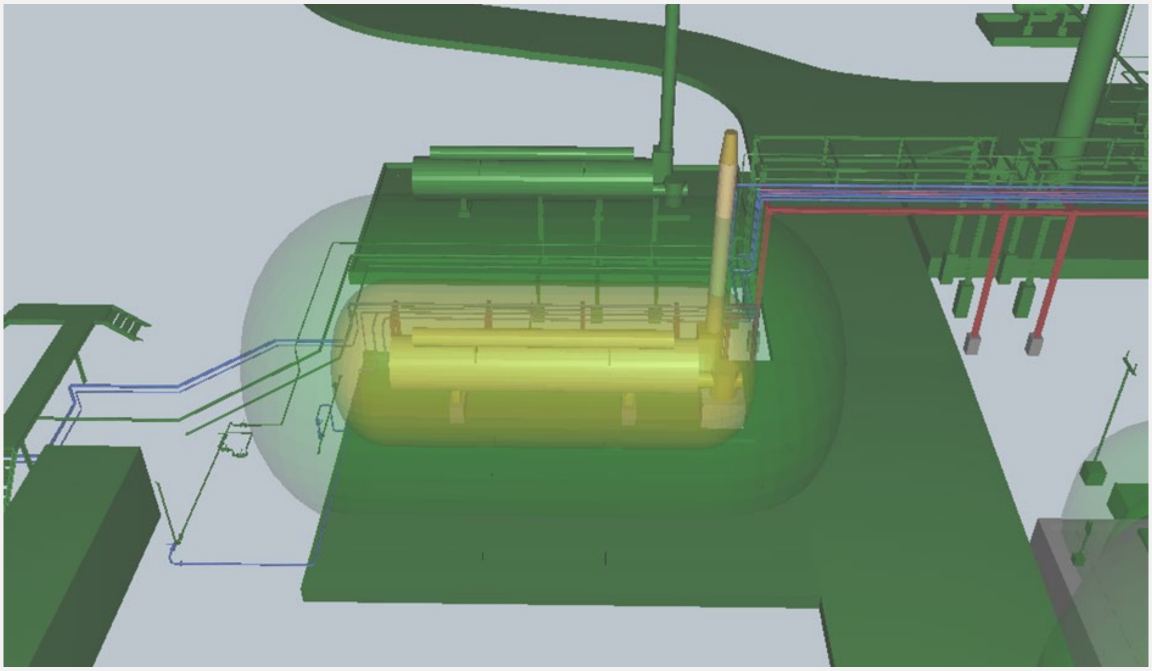


Figure 2: Picture depicting the fire grade map within the software.

The finished graphical file is known as the 'assessment' file (Micropack will present this in the review) and provides an objective estimate of that area's flame detection coverage. If the coverage is adequate, no additional detection is required, and Micropack will review whether detectors can be optimized or removed. If the assessment does not meet the coverage target, then we must relocate or add more devices. Note, however, that adequacy (or otherwise) of an area's detection still requires engineering judgment. The surveyor will assess the results of the mapping assessment through the use of site knowledge and best judgment.

Voting Configuration

Different voting strategies are used on other sites depending on risk level, the likelihood of spurious alarm, and desired executive actions.

1ooN: One out of the total number of detectors (N) is required to detect the fire instead of other voting strategies requiring multiple concurrent alarm signals.

2ooN: At least two out of the total number of detectors (N) are required to detect the fire simultaneously.