



## FireBus Systems, Inc. Soft Tools

### Fire and Gas Detection Mapping Services

Computer Aided Design to Increase Safety  
and Reduce Cost

Literature No: 09-FCB051-A09

## About FireBus

FireBus Systems, Inc. located in Houston, TX, is focused on the engineering and development of managed IP-based life safety fire detectors and equipment and other enabling technologies to Fire & Gas System users and system integrators. These products broaden their field device choices while reducing restrictions on how they can be integrated in an approved manner

## Notice

Although reasonable effort is made to ensure that the information in this document is complete and accurate at the time of release, changes and/or corrections to the information contained in this document may be incorporated in future versions.

## Technical Support from FireBus Systems, Inc.

North America (281) 277-1777 [Info@FireBusSystems.com](mailto:Info@FireBusSystems.com)

Released by:

FireBus Systems, Inc.  
12818 Century Drive  
Stafford, TX 77477

<http://www.FireBusSystems.com>

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# History & Introduction

# 1

## History

The FireBus Systems Inc. team members have been involved in Industrial Fire & Gas systems in the Oil and Gas industry for over 25 years. The innovative designs and interfaces of FireBus technologies allow Plant and Corporate project teams to use advanced Safety Controllers and PLCs in Fire & Gas systems. As a result of this experience FireBus engineers using a range of Fire and Gas Detection Mapping Tools can provide an estimate of the performance of Fire and Gas Detection coverage taking into account the target hazard types and sizes and effects on detection equipment from the local environment. The combined experience of the FireBus and their team partners offer the industry world-class engineering services with in-country support.

## Introduction

Fire and Gas Detection systems play a crucial role in Loss Prevention on many sites. Formal Safety Assessments such as Quantified Risk Assessments (QRA) often assume that Fire and Gas Detection Systems will reduce risks, yet their design is often a matter of “black art”; it is often difficult to quantify the parameters involved and there is little guidance to define required performance or to relate achieved performance to safety requirements.

Modern fire and Gas detection designs tend towards hazard based approach featuring recognized and quantified hazards, for example ranging from highly sensitive items such as hydrocarbon Gas Compressors through to lower risk items such as Produced Water vessels.

Using highly developed assessment methods together with custom software the FDA (Flame Detection Assessment), GDA (Gas Detection Assessment) and HDA (Heat Detection Assessment) packages FireBus is able to review and assess arrangements from initial designs through construction and onto existing installation. The assessments are used to optimize and validate designs and maybe used in formal safety studies.

This document has been prepared in order to define the methodology used for the completion of a fire & gas review at both onshore and offshore site. The methods will vary dependent on if it is an existing facility or a design review for a new facility.

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## Setting of Performance Targets

Clearly the key to achieving a performance based in Fire and Gas Detection systems design is to start with defining the required system performance. This should be done for all types of Fire and Gas Detection equipment. For example, in terms of fire detection of "flaming fires" parameters such as flame size, in **Radiant Heat Output, (RHO)** should be specified. For gas detection parameters such as gas cloud size and gas concentration should be specified. In both cases voting logic and response time must be clearly specified. The setting of such performance targets will usually require input, or agreement, from the client's operations personnel, normally the control engineer and personnel familiar with the process and safety risks.

### **Typical steps to applying Grades in hydrocarbon risk volumes for flame detection are:**

Assign an "average" Grade of detection coverage throughout all Hydrocarbon Fire Risk volumes **(Grade B)**

Identify any parts of Grade B areas where better detection is required, and assign them **Grade A**

Review all remaining Grade B areas for parts where cover is excessive and assign a lower performance **(Grade C)**.

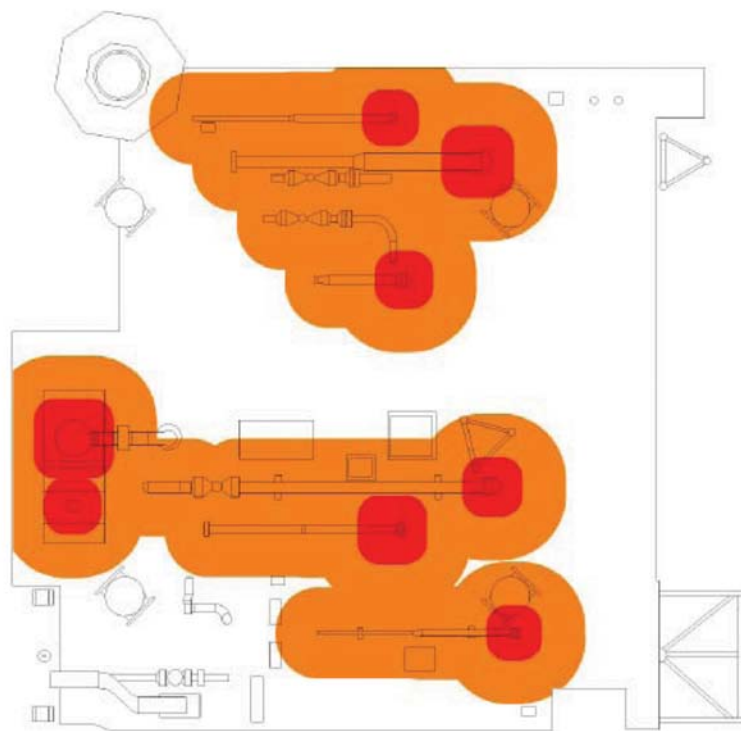
**Grade A** - is used for Hydrocarbon Risks, which are associated with particularly sensitive risks such as small hydrocarbon Condensate Pumps. Such risks will normally have well defined risk reduction measures (control actions), some of which may be active and need to be triggered by automatic fire detection. Grade A zones should extend a minimum of 1m from the plant to which it applies and segregated from Grade C volumes by a further 2m of Grade B

**Grade B** - is the "normal" level of fire detection in hydrocarbon risk areas and is used wherever another Grade is not more appropriate. Typically Grade B equipment will include items that are not sensitive to small fires such as Oil Separation Vessels. Grade B zones should extend a minimum of 2m from any plant which is protected by it, or to the area boundaries if any are within 4m of the plant.

**Grade C** - is used where the Grade B level of detection is excessive, and so a reduced performance Grade is required. Typically Grade C equipment will include items that have little or no flammable inventories such as Produces Water Vessels. Grade C zones should not be within 2m of Grade A volumes (i.e. there must be a Grade B area between A and C), or Hydrocarbon plant from which there is potential source of release, e.g. flanges or compression fittings (which will be Grade A or B).

The Grading described above for flame detection coverage are based on targets used by many Oil & Gas Production companies throughout the world. Typical flame detection performance targets for offshore oil and gas production platforms are expressed in terms of Radiant Heat Output (RHO) are:

Grade	Alarm	Control Action
A	10 kW	10 kW
B	10 kW	50 kW
C	100 kW	100 kW



Grade Map Key

Grade A = Red

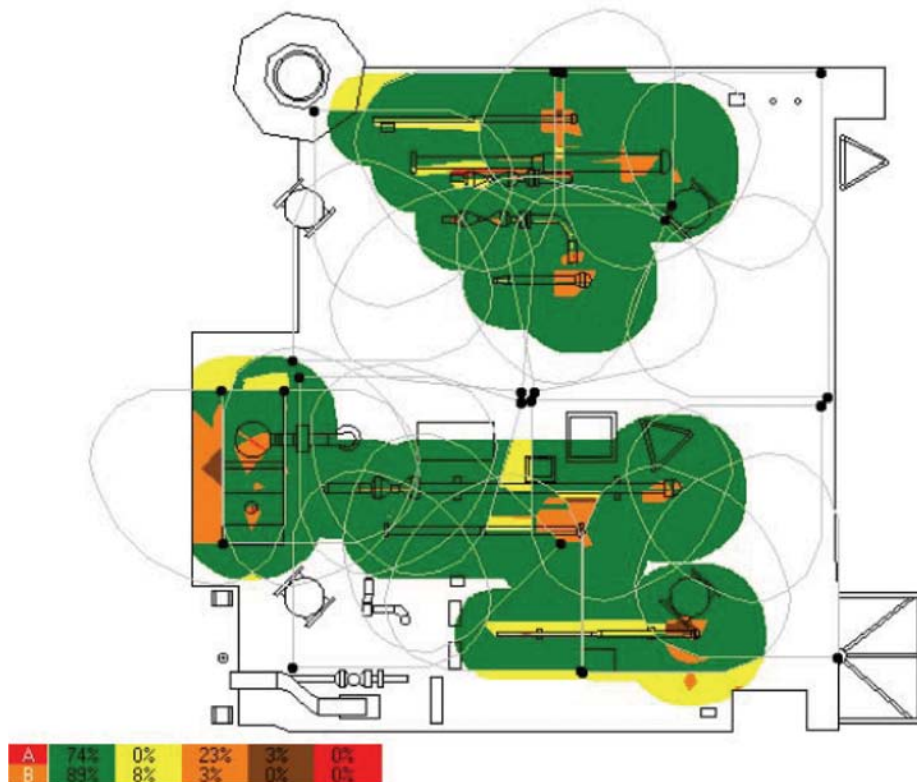
Grade B = Yellow

Grade C = Green

## Flame Detection Coverage Assessment

Flame Detection coverage can be assessed using our proprietary software based mapping tool (FDA). The input requirements for this tool are Performance Targets, detector layouts and details of the detector types all obtained previously. The detectors are represented as 2 dimensional CAD files depicting each detector's field of view. The Performance Targets for each area are set according to their local hazards and escalation risks. This information is stored in a 'Grade map' file. A custom software system then 'overlays' each relevant detector's footprint onto the Grade map and, using a truth table, constructs a graphical image of the coverage afforded by the area's detectors. The finished graphical file is known as the 'assessment' file and provides an objective estimate of that area's flame detection coverage. This analysis shows the typical interaction of flame detector coverage physical obstruction and hazard grading, an interaction that is virtually impossible visualize without computer assistance.

In the example shown below the areas shown in green meet the flame detection coverage targets, those areas in orange and yellow meet restricted targets while those in red have poor coverage and may require revision. The tabular summary provides quantitative data on the hazard coverage.



**Typical steps to applying Grades in hydrocarbon risk volumes for Gas detection are:**

The target gas cloud sizes are selected for each area based on the area's volume, confinement and degree of congestion. Typical gas cloud performance targets are;

- Confined Space (S) - inferring a 4 meter detection limit.
- Partially Enclosed (PE) - inferring a 5 meter detection limit.
- Open (O) - inferring a 10 meter detection limit.

**Geometry of Accumulation**

It is a basic assumption of the methodology used in GDA (in keeping with the philosophy of damaging explosion over-pressures) that the gas cloud can be modeled as a nominal sphere. This assumption (which is conservative because the 'ideal' spherical geometry encourages higher over-pressures than the more realistic plume) permits a rapid and reasonably accurate assessment of detector coverage. The gas cloud sizes considered are specified as 4m, 5m and 10m diameter clouds having volumes of 33m<sup>3</sup>, 65m<sup>3</sup> and 523m<sup>3</sup> respectively.

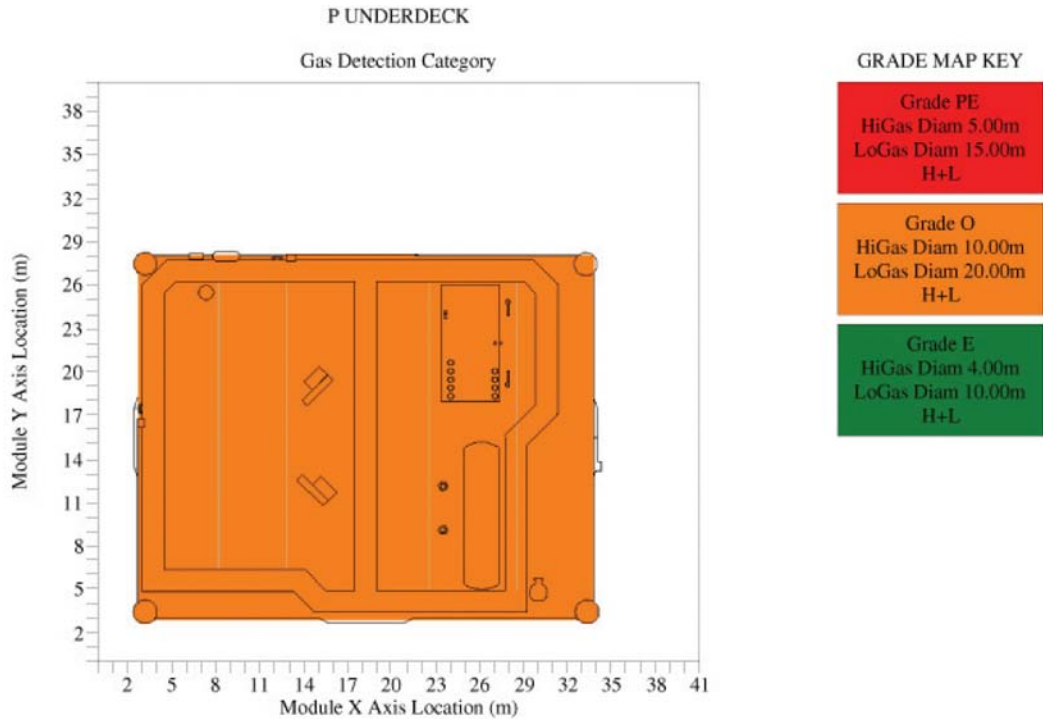
Each area assessed is represented as a regular orthogonal volume specified in terms of its length, width and height (or, using conventional Cartesian coordinates, X, Y and Z dimensions)

**Definition of Gas Detection Grade in terms of cloud size**

Grade	High Gas	Low Gas
PE	5 Meter	15 Meter
O	10 Meter	20 Meter
E	4 Meter	14 Meter

For the setting of both fire and gas performance targets a full list of existing detection equipment and detector location drawings will be required. From these, preliminary fire and gas detection grade maps and a survey execution plan will be produced.

Below is an example of gas grade maps, indicating the performance targets, and coverage assessments.



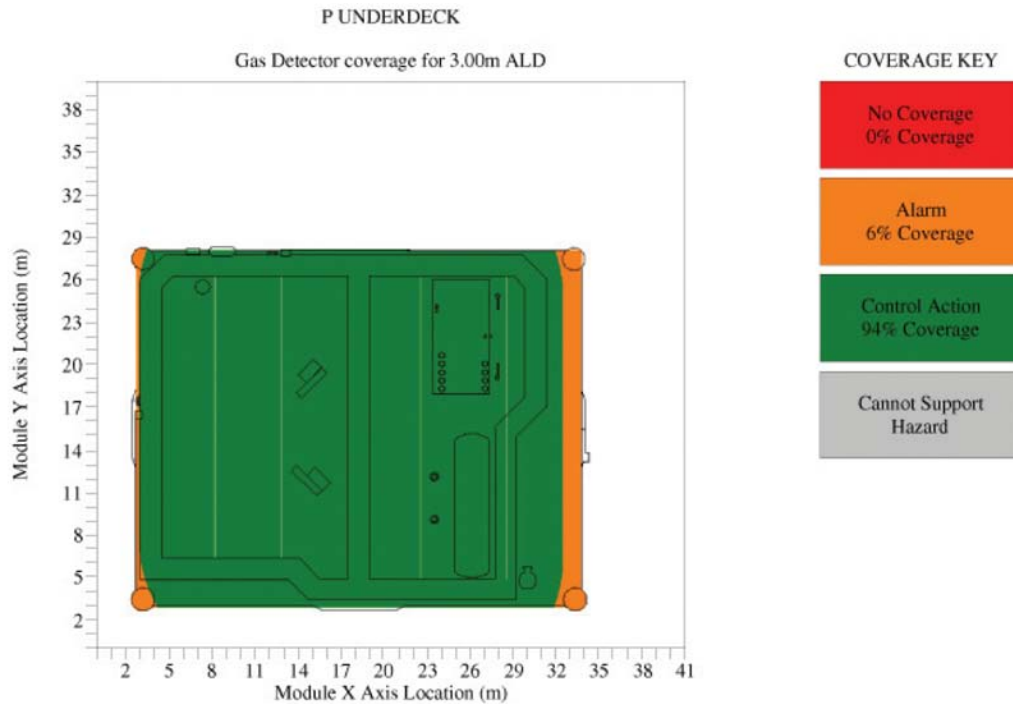
## Gas Detection Coverage Assessment

The gas detection coverage to the target gas cloud sizes can be assessed using our proprietary Gas Detection Assessment (**GDA**) software assessment tool. The target gas cloud sizes will be proposed for each area based on the area's volume, confinement and degree of congestion as agreed previously.

The F&G plot plans will usually be used to establish their proposed location on the installation, elevations will be required. These coordinates will be input into a software package, GDA (Gas Detection Assessment) for analysis and assessment. This package objectively assesses the coverage of the existing gas detection system against the proposed Performance Target.

GDA uses a number of simplifying assumptions in order to make it possible to assess sites. It is assumed that all gas detectors are either "point" or "open path" gas detectors, and that gas is detected if the accumulation envelopes a detector or intersects the track of an open path detector. Other types of inferential gas detector technologies including ultrasonic gas detection measures are not presently modeled by GDA, primarily because they effectively respond to release rates rather than gas concentrations.

Each area assessed is represented as a regular orthogonal volume specified in terms of its length, width and height (or, using conventional Cartesian coordinates, X, Y and Z dimensions). The assessment result is, by definition a three dimensional structure which cannot easily be rendered on two dimensional paper, and the results of the assessment are available both as a numerical summary and as a series of horizontal 'slices' through the volume. These slices are available at various intervals and, for clarity; one representative slice for each area will be reproduced in this study.



# Typical Study Scope of Work

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## Typical Study Scope of Work

**If an existing facility is to be assessed A Firebus team member will visit the facility and will conduct the following work:**

### Hazardous Areas

Establish existing detection arrangements by conducting the following activities:

- a) Record location, elevation and maintenance accessibility of existing optical flame detectors.
- b) Record field of view photographs of existing optical flame detectors.
- c) Record field of view of proposed additional flame detectors.
- d) Record location and elevation of flammable gas detectors.
- e) Record location and elevation of proposed additional gas detectors.

### Non Hazardous Areas

- a) Record location & elevation of existing smoke and heat detectors with respect to local hazards.
- b) Estimate (using smoke tracer) local air movements where they are likely to influence the performance of smoke and heat detectors. This will involve the use of a “smoke pencil”, and is based upon a chemical reaction which takes place inside a glass tube once a seal has been broken and air is passed through the tube using a dropper.

### Non Hazardous Area Air Intakes

- a) Record existing smoke and gas detection arrangements.
- b) Conduct scent tracer air transit time tests. Using essential oil, or peppermint scent, the tracer is introduced into the air intake. This is communicated to a second person located at the nearest vent outlet via radio. The second person can then determine the time it takes the scent to travel through the ducting.

## If the facility is at the design stage .....

The Fire and Gas Detection Review shall cover all Hazardous Areas and non-Hazardous Areas as defined on the Equipment Layout drawings. This information will be used to assess the Fire and Gas detection against the site performance targets.

## Review Preparation

A full set of the following documentation is required:

- Process Flow Diagrams.
- Equipment layout drawings
- Fire and Gas Detection Layout drawings
- Hazardous area drawings

This information will be used to set the site performance targets. One of our experienced site surveyors will use his knowledge and experience of similar sites to set the performance targets and agreed them with the client.

## Typical Deliverables

Typical deliverables include one draft report (for client review/comment) and one final issue that will include the following:

- Site Performance Targets.
- Fire and Gas Detection Study including;
  - a) Narrative covering the review process and major findings.
  - b) Graphical Assessments of Fire and Gas detector coverage.
  - c) Proposals, including sketches, detailing recommended improvements for flame, gas, smoke, and heat detection improvements where required.

The report will present the survey/design data together with commentary on the suitability of the systems with respect to hazards and site performance targets. Flame and Gas detection coverage will be assessed using FDA and GDA assessment software and graphical assessments will be presented of both the present arrangements and of any proposed improvements in coverage.

## Summary

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The use of fire and gas mapping clearly defines the risk and the precautions needed to be able to detect fires and gas releases. The methods used allow the designer to optimize the design and achieve the best possible balance between safety and economy. This practice improves safety and reduces operating costs by ensuring that the number of devices used is minimized while the required level of safety is maintained. All end-users should require this level of information as part of any new or upgrade to their facility regardless of fire and gas detector manufacturer selected for the project supply and/or installation.

### **Review Notes:**



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FireBus Systems Inc.  
P.O. Box 460269  
Houston, Texas 77056-8269 USA

Tel +1(281)277-1777  
Fax +1(281)277-1909  
[www.FireBusSystems.com](http://www.FireBusSystems.com)