TECHNICAL SPECIFICATION

CONTROL SYSTEM AND INSTRUMENTED PROTECTIVE FUNCTIONS FOR FIRED EQUIPMENT

- System for a single-burner furnace (S 24.024 and S 24.026)

DEP 32.24.20.30-Gen.

July 1997
(DEP Circular 56/97 has been incorporated)

DESIGN AND ENGINEERING PRACTICE

USED BY

COMPANIES OF THE ROYAL DUTCH/SHELL GROUP

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TABLE OF CONTENTS

APPENDICES

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for control systems and instrumented protective functions for a **dual fuel fired, forced draught, single burner furnace/boiler.** This DEP may also be used for single fuel fired equipment; if the heater is fired on gas only, all fuel oil related instrumentation may be disregarded, and vice versa. Similarly, this DEP may also be used for a natural draught furnace, in which case all relevant combustion air controls and trips may be disregarded.

This DEP shall not be used for multi-burner furnaces/boilers, unless specified by the Principal.

This DEP contains a control and IPF narrative and logic diagrams and refers to a standard specific process engineering flow scheme.

This DEP shall be used together with Standard Drawings S 24.024 (dual fuel) or S 24.026 (fuel gas).

This DEP is written for systems which use DCS for control and monitoring and PLC or Solid State / magnetic core type Instrumented Protective Functions. Accordingly, more use has been made of inverted signals than would have been the case for relay type IPFs.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this DEP is confined to companies forming part of or managed by the Royal Dutch/Shell Group, and to Contractors nominated by them (i.e. the distribution code is "C", as defined in DEP 00.00.05.05-Gen.).

This DEP is intended for use in oil refineries, chemical plants, gas plants, onshore and offshore exploration and production facilities, and supply/marketing installations.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS AND ABBREVIATIONS

1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Principal** is the party which initiates, and ultimately pays for, the project. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorised to act for the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Furnace	Includes both furnaces and boilers
Instrumented protective function (IPF)	A function comprising the Initiator function, Logic Solver function and Final Element function for the purpose of preventing or mitigating Hazardous Situations.

NOTE: The term "safeguarding" is not widely used in this DEP because safeguarding relates not only to instrumented protective functions but also to protective equipment of a mechanical nature such as non-return valves, relief valves and bursting disks.

1.3.3 Abbreviations

ARWU	Anti reset wind-up
DCS	Distributed control system
IPF	Instrumented protective function
PEFS	Process engineering flow scheme
PLC	Programmable logic controller
SRF	Standard refinery fuel
TSOV	Tight shut off valve

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced by this DEP are listed in (5).

2. GENERAL

This DEP shall be used as the basis for the control systems, IPFs, narratives, functional logic diagrams and PEFS for the installation for which it has been specified by the Principal.

The Contractor shall prepare installation-specific narratives based on this DEP, and shall add relevant tag numbers, set points, controller configurations, etc. The installation-specific narratives shall not contain general information which is not relevant to the specific installation.

Like this DEP, the narrative shall contain a functional description including operational aspects and a detailed technical description.

3. FUNCTIONAL (OPERATIONAL) DESCRIPTION

3.1 LOAD CONTROL

Flow control is the lowest level of control function for both fuel gas and oil as well as combustion air.

Minimum combustion air flow is ensured by an (adjustable) mechanical minimum stop on the combustion air damper, while the maximum combustion air flow is limited by the capacity of the blower and air register resistance.

Minimum fuel flows are ensured by mechanical minimum stops on the fuel gas and fuel oil control valves.

Maximum burner load is limited by correct control valve sizing.

Note: This does not provide absolute limits to the burner loads because fuel gas density variations exert an influence. This problem can be solved by installing a maximum setpoint limiter on the fuel flow controller.

The furnace load controller (outlet temperature) acts on the fuel and combustion air flow controller set points via a "double-ratio cross-limiting" system. The basic principle is that both fuel and combustion air flows are controlled in parallel, with limits (maximum for fuel, minimum for air) to avoid sub-stoichiometric combustion.

The control system works as follows:
The output signal of the furnace outlet temperature (load) control can be adapted with signals from the furnace inlet temperature and/or the process coil flow in order to add a feed-forward control signal. The resultant signal, which represents the fuel demand, is then passed to the fuel flow controller.

Atomising steam for the fuel oil burner is controlled at a (constant) pressure differential to the burner fuel oil pressure. The furnace load controller (outlet temperature) acts on the fuel and combustion air flow controller set points via a "double-ratio cross-limiting" system. The principle applied is that both fuel and combustion air flows are controlled in parallel, with limits (maximum for fuel, minimum for air) to avoid sub-stoichiometric combustion.

The control system works as follows:

The output signal of the furnace outlet temperature (load) control can be adapted with signals from the furnace inlet temperature, and/or the process coil flow, in order to add a feed-forward control signal. The resultant signal, which represents the total fuel demand, is then passed to the fuel flow controllers as follows:

- the set point of the fuel gas flow controller is the total fuel demand minus the (measured) fuel oil flow.
- the set point of the fuel oil flow controller is the total fuel demand, minus the (measured) fuel gas flow.

NOTE: It is a part of the design philosophy that only ONE fuel is on cascade load control at any time; the other fuel may be either out of operation or on local set point control, operator adjustable).

Depending on the variation in the MW of the fuel gas, the fuel gas flow measurement shall be corrected for changes in gas density (see Section 4.3, Y3). This density compensation compensates for errors in flow measurement and for changes in stoichiometric air requirement.

As the compensated signal also gives a reasonably accurate representation of heat input this signal is also used as input to the fuel flow controller. In this way the fuel gas flow controller indicates a flow in Standard Refinery Fuel (SRF). An additional indication of actual mass flow should be provided for mass balance purposes.

3.2 AIR/FUEL RATIO CONTROL

In parallel to adjusting the fuel flow, the fuel demand signal passes via the air/fuel ratio relay to adjust the setpoint of the combustion air flow controller. The required air/fuel ratio can either be manually set by the panel operator, or automatically set by a closed-loop stack oxygen controller. Limits should be set to the range over which the air/fuel ratio can be adjusted, in order to prevent settings that correspond to sub-stoichiometric combustion.

In addition to the basic parallel control system described above, limits are imposed on the adjustment of the set points of fuel and combustion air, as follows:

- The measured fuel gas flow is being converted to a "fuel equivalent" flow, in terms of air requirement, in order to derive a standardised fuel flow. This fuel flow is multiplied by a factor (typically 90%), and provides a minimum limit (via a high selector) to the fuel demand signal to be sent to the combustion air flow controller setpoint. If the fuel demand decreases, and the actual fuel flow does not react, this signal will limit the decrease to the combustion air flow to prevent sub-stoichiometric combustion. The control system changes from a "parallel" control system to a "fuel-leading" system (fuel decrease leads air decrease) after the high selector has limited the decrease in combustion air flow.

A similar system applies to the fuel flow as follows:

- The measured combustion air flow passes through a "minimum air/fuel ratio" relay (with a setting typically 10% lower than the normal air/fuel ratio, and the signal provides a maximum limit (via a low selector) to the fuel demand signal to be sent to the fuel flow controller setpoint. If the fuel demand increases, and the actual combustion air flow does not follow, this signal will limit the increase in fuel flow demand. The control system changes from a "parallel" control system to an "air leading" system (air increase leads fuel increase) after the low selector has limited the increase in fuel flow.

When only one fuel is in operation small zero errors in the flow transmitter of the fuel not in service can give significant errors to the total fuel signal. For this reason, the fuel measurement is set to a hard zero when the related fuel TSOV is closed (deactivated).

3.3 WASTE GAS FIRING

If the waste gas flow represents more than 15% of the design heat input of the furnace, it shall be taken into account in the load and air/fuel ratio control. I.e. the waste gas flow shall be measured and subtracted from the total fuel demand, before it is fed to the fuel flow controllers. Similarly, the measured waste gas flow shall be added to the fuel flow, which is than used in the air/fuel ratio control scheme.

A fixed heating value and stoichiometric air requirement may be used for the waste gas.

If the waste gas flow represents less than 15% of the design heat input, it may be fed uncontrolled to the furnace, provided the main burner is in operation.

3.4 START-UP AND OPERATIONAL ASPECTS

The system is equipped with an automatic purge sequence. Upon activation of the "purge start" the combustion air damper is opened fully for the period of the purge timer. After the purge time has elapsed and if other conditions are healthy, the burner can be started.

A new purge cycle is only required in case of a combustion air failure. After any other trip a waiting time of one minute suffices, provided the fuel TSOVs are detected closed.

Prior to start-up, the fuel TSOVs are closed, and the fuel flow controllers are automatically set to "manual" with zero output. This will drive the fuel control valves to the mechanical minimum stop setting.

Upon activating the igniter start button the igniter is started. An indefinite number of igniter start trials can be made without purging the furnace.

If the ignition flame is detected, the main burner can be started by activating the main burner start button. If the main burner is not started within 15 minutes, the igniter is stopped again. Although it is possible to start up with fuel oil, start up should be on fuel gas since ignition is easier and timer settings, etc. can be better defined.

Five seconds after starting the main burner, the igniter is automatically stopped. Thereafter the igniter can be restarted at any time (e.g. for testing purposes). After 15 minutes the igniter is automatically stopped again.

Before start-up on oil the atomising steam differential pressure controller should be on automatic, maintaining a slight steam pressure on the burner. As the fuel header pressure increases, the atomising steam pressure will increase to maintain the correct steam/oil differential pressure, aiding a smooth light-off.

If a prompt light-off is not detected the TSOV closes to prevent an accumulation of unburnt fuel in the furnace.

Following the burner light-off (at minimum stop) the fuel flow controller can be commissioned, to increase burner load, and proceed to cascade load control, as required.

It is not necessary to take the combustion air flow controller out of "cascade" control mode during furnace start-up because the combustion air damper is provided with a minimum stop.

Once the load is increased, the setpoint of the combustion air flow controller will increase automatically to take up the load, and increase the combustion air flow above the minimum stop.

4. TECHNICAL DESCRIPTION

4.1 IMPLEMENTATION CONSIDERATIONS

If the fuel gas flow controller FRC-1 or fuel oil flow controller FRC-3 is forced to manual with 0% output (minimum stop) by the PLC the operator shall not be able to change mode and output.

Anti-reset wind-up (ARWU) protection shall be implemented on the master temperature controller TRC-1 and the O_2 controller QRCA-1.

The actual form of the ARWU protection to be implemented will depend on the choice of DCS vendor and the type of controller algorithm used.

If neither fuel is on cascade, the TRC output shall be initialised to the total fuel flow.

If the combustion air is not on cascade, the oxygen QRC output shall be initialised to the (current) air/fuel ratio.

If the chosen DCS / Controller algorithm supports the use of external feedback as ARWU protection then external feedback can be configured from Y10 to QRCA. This external feedback improves the response of the O_2 QRCA during changes in load of the furnace. The principle behind this external feedback is as follows:

If the load of the furnace is reduced and the air flow is reacting more slowly than the fuel flow (due to parallel lead / lag control configuration), the external feed back ensures a minimum overshoot. If there were no external feedback, the QRCA would react to the excess air and further reduce the air, thereby resulting in an overshoot when approaching the final steady state value.

If the control scheme is implemented in a DCS which does not support external feedback (i.e. only ARWU used) the QRCA should be tuned to slow response to minimise the overshoot during transients.

The control scheme is not designed to operate with both fuel flow controllers in cascade mode, due to possible interaction between the two loops. Therefore, when switching over between cascade and automatic modes, both flow controllers should be placed in automatic mode. However, it is recognized that this alone does not ensure a bumpless transfer and therefore the appropriate initialisation techniques shall be configured.

4.2 LOCATIONS OF ALARMS, SWITCHES, ETC.

The system is designed such that remote starting and stopping of the gas burner is possible.

Since oil firing requires local presence of the operator (for checking atomisers, steaming out of oil guns, etc.), the oil burner is started and stopped locally.

To enable the operator to start/stop fuel gas from the control room, and to start/stop fuel oil locally, the igniter start/stop button is duplicated (on a local panel as well as in the control room).

The above philosophy is reflected in Standard Drawings S 24.024 & S 24.026.

If specified by the Principal the fuel gas start/stop button shall be located on the local panel (reasons for this may be to standardize with other furnaces or to comply with local regulations). In this case status indications shall be installed on the local panel as well as in the DCS.

4.3 CALCULATION FORMULAS

The following computing formulae shall be used:

Y1) If the fuel oil TSOV is closed, the oil flow signal to the total fuel flow summer is zero (Y5, Y6).

NOTE: The measured value is still fed to the fuel oil FRC, so that the operator is informed about possible measurement offsets prior to introducing oil.

Y2) If the fuel gas TSOV is closed, the gas flow signal to the total fuel flow summer is zero (Y4, Y6).

NOTE: The measured value is still fed to the fuel oil FRC, so that the operator is informed about possible measurement offsets prior to introducing gas.

Y3) Corrects fuel gas flow measurement for fuel gas density, and (optionally) for pressure and temperature at the transmitter, and converts it into an equivalent flow in SRF.
The actual formula to be used depends on the type of flow meter (vortex orifice type) as well as the type of density meter (line density or Molecular Weight).

In setting up the actual formulae, the following equations shall be used:

$$M_{air\ stoichiometric} = 14.77\left(1 + \frac{2.68}{MW}\right) * M_{fuel\ gas} \qquad [t / d]$$

$$\text{Fuel gas density} = 12.03\ \left(\frac{MW\ *\ P}{T}\right)$$

where:
P = Pressure, bar (abs)

T = Temperature, °C

$$M_{fuel\ SRF} = \frac{M_{air\ stoichiometric}}{13.66} \qquad [tSRF / d]$$

The above formula assumes typical refinery fuel gases, i.e. mixtures of paraffinic hydrocarbons and hydrogen (inerts less than 2%) and is only valid for MW > 5.

It further assumes the stoichiometric air requirement of SRF to be constant at 13.66 kg air/kg SRF.

If the anticipated Molecular Weight (MW) variations are less than ± 20% of the average molecular weight, a fixed (average) value for MW may be used.

Y4) Output = required (total) fuel flow - gas flow - waste gas flow [t/d SRF]
(see Note 1)

Y5) Output = required (total) fuel flow - oil flow - waste gas flow [t/d SRF]
(see Note 1)

Y6) Output = gas flow + oil flow + waste gas flow [t/d SRF]
(see Note 1)

NOTE 1: Waste gas flow shall only be incorporated in calculations if the heat input by waste gas represents more than 15% of the total design heat input.

Y7) Sets a minimum limit for the combustion air flow.
Output = 0.9 * Total fuel flow

Y8) Calculates a maximum allowable fuel flow

Output = M_{air} / (0.9 * 13.66 * [0.8 + 0.8 * QRC]) ;

in which: QRC = Output of oxygen controller [signal 0-1]

M_{air} = Measured air flow [t/d]

The formula limits the air/fuel ratio between 0.8 and 1.6 (times 0.9).

Y9) Calculates the required air flow.

Output = Fuel flow * 13.66 * [0.8+0.8 * QRC]

In which the fuel flow is the master signal or (0.9 * total fuel flow), whichever is higher. The formula limits the air/fuel ratio between 0.8 and 1.6.

Y10) Calculates air/fuel ratio for low alarm and trip.

Amended Per Circular 56/97

Output = M_{air} / (13.66 * Total fuel flow) ;

Alarm shall be set at a ratio of 1.0.
Trip to minimum firing shall be set at 0.8.

The total fuel flow shall be given a minimum value to avoid "division by zero", which can give spurious alarms when the furnace is out of operation.

Calculation blocks for (optional) feed-forward:

NOTE: Anti-reset wind up of TRC is always required.

- For feed-forward from process flow through furnace:

Y12) $$\text{Output} = \frac{[\text{fuel flow}]}{[\text{process flow}]}$$

Y13) Output = [process flow] * [TRC output]

- For feed-forward from process flow and furnace inlet temperature:

Y12) $$\text{Output} = \frac{[\text{fuel flow}]}{[\text{process flow}]} + k * [\text{inlet temperature}]$$

Y13) Output = [process flow] * {[TRC output] - k * [inlet temperature]

$$\text{where } k = \frac{[\text{Specific heat process fluid}]}{[\text{fuel LHV}] * [\text{furnace efficiency}]}$$

Y16) Low selector to set a maximum to the signal to the fuel flow controllers.

Y17) High selector to set a minimum to the signal to the air flow controller.

4.4 DESCRIPTION OF INSTRUMENTED PROTECTIVE FUNCTIONS

The instrumented protective functions are described by the functional logic diagrams (Appendix 1) and by the IPF narrative as given below.

The functional logic diagrams are set up in a modular structure. This section follows the same structure. However, it only describes the main modules. Assisting modules such as the "general trips" module are not described separately. Their functionality is described in the modules where they are relevant.

4.4.1 Safe atmosphere module

The function of this module is to continuously check and if necessary re-establish by purging a safe atmosphere for firing the furnace.

If: i. no flame is detected (start condition only); and

ii. both main fuel gas TSOVs and the fuel oil TSOV are closed; and

iii. the combustion air flow is not low; and

iv. the local and panel trip switches are in the healthy position; and

v. the "safe conditions" signal is not present; then

the purge sequence can be started by activating the "start purge" switch. This initiates the full opening of the air damper.

As soon as sufficient air flow for the purging is available, the purge timer starts running and the indication "purge in progress" is given.

If there are no disruptions of the above conditions and after the timer has run out, a purge ready indication is given and the combustion air damper is placed under flow control.

If: i. the purge is completed; and

ii. the combustion air flow is not low; and

iii. the local and panel trip switches are in the healthy positions; then

a "safe conditions" signal is given.

If, during normal operation, any of the above conditions fail, the "safe conditions" signal disappears. Then a complete new purge is required.

4.4.2 Minimum Stop Module

The purpose of this module is to control the set and release of the fuel minimum stops.

If: i. the "not minimum firing" signal from the process (e.g. high temperature trip to minimum firing) is present (where applicable); and

ii. the air/fuel ratio is healthy; and

iii. the module receives a "gas flame on" signal; then

the fuel gas flow controller can be taken into operation by activating the gas minimum firing reset in the control room.

If: i. the "not minimum firing" signal from the process (e.g. high temperature trip to minimum firing) is present (where applicable); and

ii. the air/fuel ratio is healthy; and

iii. the module receives a "oil flame on" signal; then

the fuel oil flow controller can be taken into operation by activating the oil minimum firing reset in the control room.

4.4.3 Igniter Module

The function of this module is to monitor all the conditions required to fire and to control the igniter.

If: i. the module does not receive a "burner start inhibit signal"; and

ii. the igniter stop button is not activated; and

iii. there is no high level in the fuel gas KO drum; and

iv. the safe atmosphere module produces a "safe conditions" signal; and

v. the igniter start button is activated; then

the igniter module produces the following signals:

i. open igniter TSOV

ii. ignition spark signal for a period of 10 seconds.

After the flame stabilisation timer has run out (after 15 seconds) the ignition flame shall be detected by the ionisation rod, and an "ignition flame present" signal is send to the oil and gas burner modules.

If the igniter start trial was unsuccessful, restart is inhibited for a period dictated by the igniter restart inhibit timer (about 30 seconds).

An indefinite number of restarts of the igniter can be attempted without a new purge cycle being required. It is assumed that the capacity of the igniter is sufficiently low to ensure that the overall gas/air mixture is below the lower explosion limit.

After the igniter has been sucessfully started, it will run for a maximum period of 15 minutes. It will be automatically stopped by the main burner module 5 seconds after opening of the oil or gas burner TSOV.

After the main burner has started the igniter can be re-started at any time (for testing purposes). After 15 minutes the igniter is stopped again.

4.4.4 Gas Burner Module

The function of this module is to monitor all the conditions required to open and close the gas burner TSOVs and to control their actions.

There are two parallel TSOVs to allow tightness testing during operation. By means of a selector switch, either gas header A or gas header B can be selected to be in operation.

If: i. the module receives a "safe conditions" signal; and

ii. the other process conditions are healthy (process trips); and

iii. there is no high level in the fuel gas KO drum; and

iv. the "stop gas firing" button is not activated; and

v. the ignition burner is on, or the oil burner is on; and

vi. the "start gas firing" button is activated; then

the module produces the following signals:

a. Open preselected gas burner TSOV. At the same time the output of the gas flow meter is incorporated in the firing and air/fuel ratio control.

b. After the trial for ignition timer has run out (5 seconds after the burner TSOV has opened) the module gives a "stop igniter" pulse.

If: i. either condition i or iv fail; or

ii. the main flame is not detected within 5 seconds; then

the gas burner TSOV closes, and a next start (of the ignition burner) is inhibited for one minute. If the TSOV failed to close, restart of the igniter remains inhibited untill the failure is recovered (or overridden).

If the gas burner TSOV is open and the main flame is detected the gas burner module produces a "gas burner on" signal.

The main flame is detected by means of two flame detectors of which at least one has to detect a flame.

4.4.5 Oil Burner Module

The function of this module is to monitor all the conditions required to open and close the oil burner TSOV and to control its action.

If: i. the module receives a "safe conditions" signal; and

ii. the other process conditions are healthy (process trips); and

iii. the atomising steam pressure is not low; and

iv. the "stop oil firing" button is not activated; and

v. the ignition burner is on, or the gas burner is on; and

vi. the "start oil firing" button is activated; then

the module produces the following signals:

a. Open the oil burner TSOV. At the same time the output of the oil flow meter is incorporated in the firing and air/fuel ratio control.

b. After the trial for ignition timer has run out (5 seconds after the burner TSOV has opened) the module gives a "stop igniter" pulse.

If: i. either condition i or iv fail; or

ii. the main flame is not detected within 5 seconds; then

the oil burner TSOV closes, and a next start (of the ignition burner) is inhibited for one minute. If the TSOV failed to close, restart of the igniter remains inhibited untill the failure is recovered (or overridden).

If the oil burner TSOV is open and the main flame is detected the oil burner module produces a "oil burner on" signal.

The main flame is detected by means of two flame detectors of which at least one has to detect a flame.

4.4.6 Waste gas firing module (optional)

The function of the waste gas firing module is to monitor all conditions required to open and close the waste gas TSOV(s) and to control this (these) valve(s).

If: i. the module receives a "furnace NOT on minimum stop" signal; and

ii. there is no high level in the waste gas KO drum (if applicable); and

iii. the module receives an "main burner in operation" signal; and

iv. the waste gas firing stop button is not activated; then

the waste gas TSOV to the furnace can be opened by activating the waste gas reset button. Usually the waste gas TSOV to the furnace is operated in conjunction with a vent TSOV (i.e. the vent TSOV is automatically opened in case the furnace TSOV is closed).

Once the TSOV is opened, the waste gas flow signal is accounted for in the air/fuel ratio control system (only if the anticipated waste gas flow represents more than 15% of the total design heat input of the furnace).

4.5 IPF CLASSIFICATION AND CAUSE AND EFFECT DIAGRAM

The IPFs described in (4.4) have been classified and implemented in accordance with DEP 32.80.10.10-Gen. The classification results are indicated in the cause and effect diagram (Table 1).

Table 1 Cause and effect diagram

Initiators		Actions 1)				
TAG	Service	Abort/Inhibit start sequence	Fuel gas TSOVs close	Fuel oil TSOV close	Trip to minimum firing	Igniter TSOV close
FZA-01-LL	Combustion air	-	III	III	0	0
FZA-02-L	Combustion air (for purging)	III	-	-	-	-
XZA-01-LL	Air/fuel ratio	-	-	-	II	-
XZA-11	Flame detection ignition burner	0	-	-	-	0
XZA-13/14	Flame detection main burner	-	IV	IV	0	-
HZA-01/02	Manual trips	0	IV	IV	0	III
GBSA-02/03	Fuel gas TSOVs closed	III	-	-	-	-
GBSA-01	Fuel oil TSOV closed	III	-	-	-	-
LZA-01-HH	Fuel gas KO drum	-	III	-	0	II
PZA-05	Atomising steam	-	III	II	0	II
Process trips I	General 2)	-	-	-	II	-
Process trips II	General	-	III	III	0	0

NOTES:

1)
- \- = No action
- 0 = Unclassified, but serves purpose in sequence control
- II = IPF class II
- III = IPF class III
- IV = IPF class IV

2) It is assumed that if the trip to minimum firing does not execute, a process trip II is automatically initiated (e.g. if an outlet temperature remains high for too long a period).

5. REFERENCES

In this DEP, reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Classification and implementation of Instrumented Protective Functions	DEP 32.80.10.10-Gen.

STANDARD DRAWING

Control and safeguarding system for a dual fuel fired, single burner furnace/boiler	S 24.024
Control and safeguarding system for a gas fired single burner furnace/boiler	S 24.026

APPENDIX 1 Functional logic diagrams for a single burner furnace.

Amended Per
Circular 56/97

Logics 24 Sheet 0

Furnace safeguarding logics for single burner furnace.

References:

S24.024:
Fuel oil and fuel gas system for a single burner heater or boiler.

S24.026:
Fuel gas system for a single burner heater or boiler.

Note:
When these logics are used for a single fuel system, e.g. gas only, the relevant fuel oil signals must be disregarded / deleted where applicable.

Sheets:

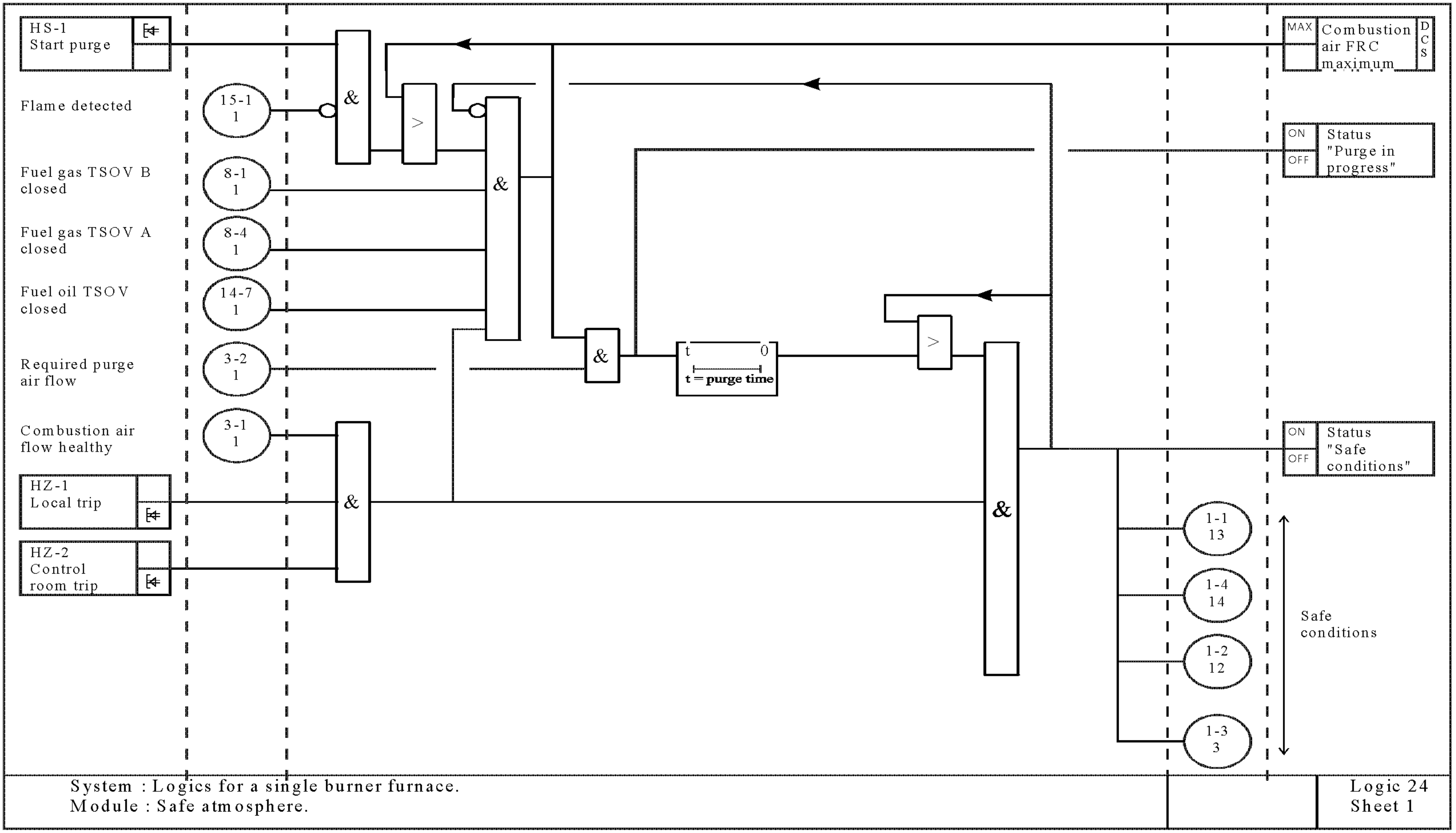
1. Safe atmosphere
3. General trips
4. Minimum stop
8. Fuel gas TSOV selection

12. Igniter
13. Fuel gas burner
14. Fuel oil burner
15. Flame detection

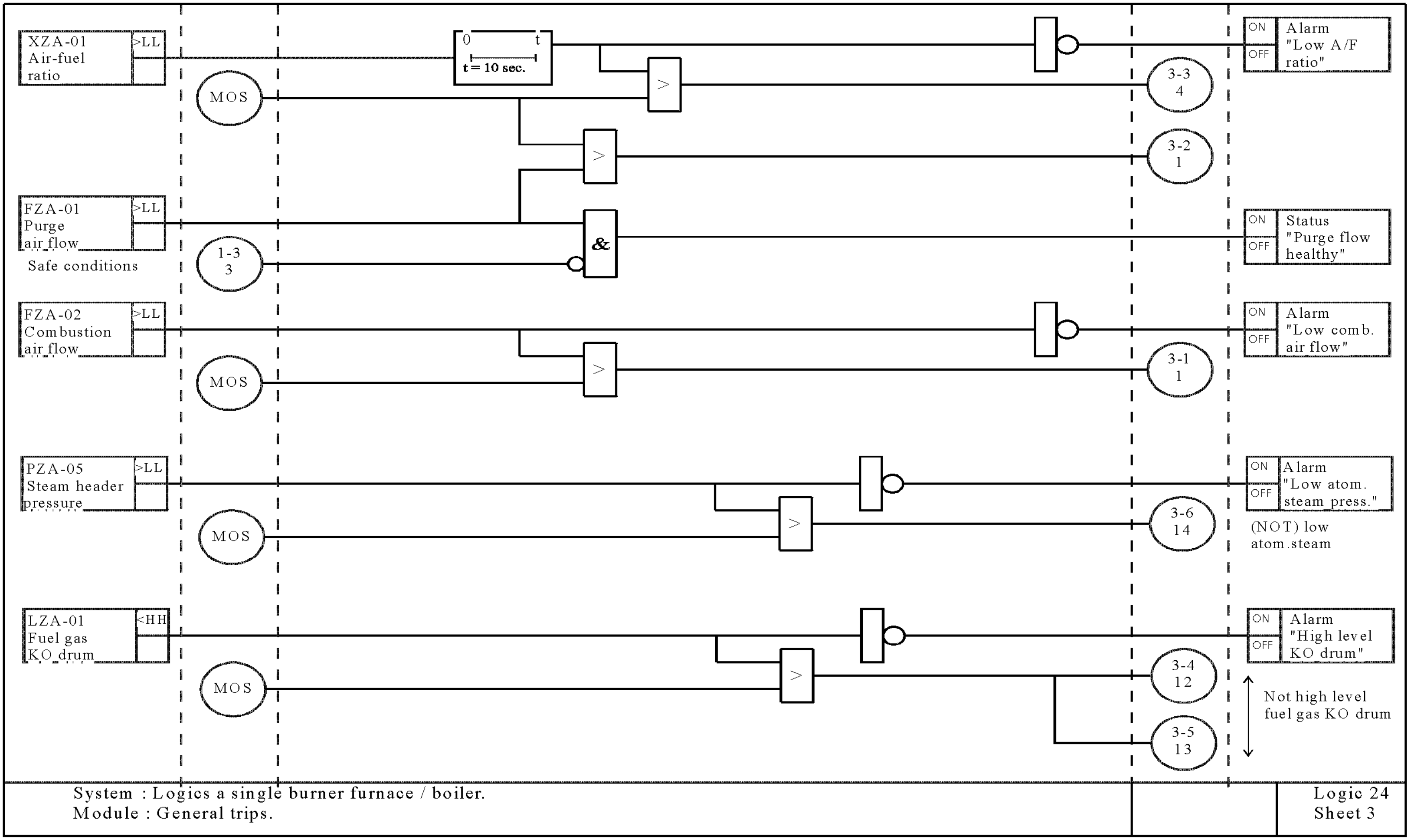
99. Status indications, alarms, switches

FURNACE SAFEGUARDING LOGICS		Logics 24 Sheet 0

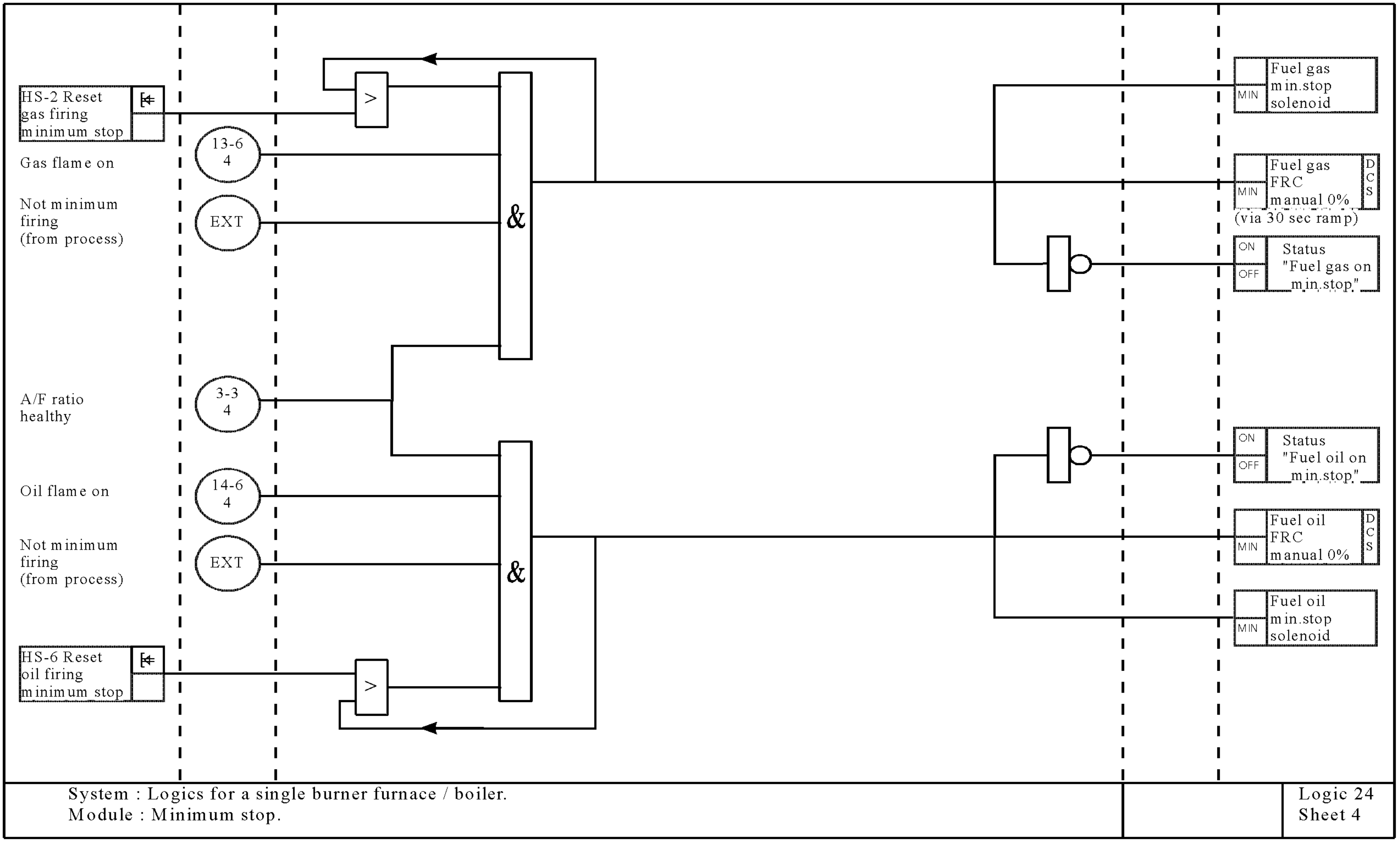
Logics 24 Sheet 1



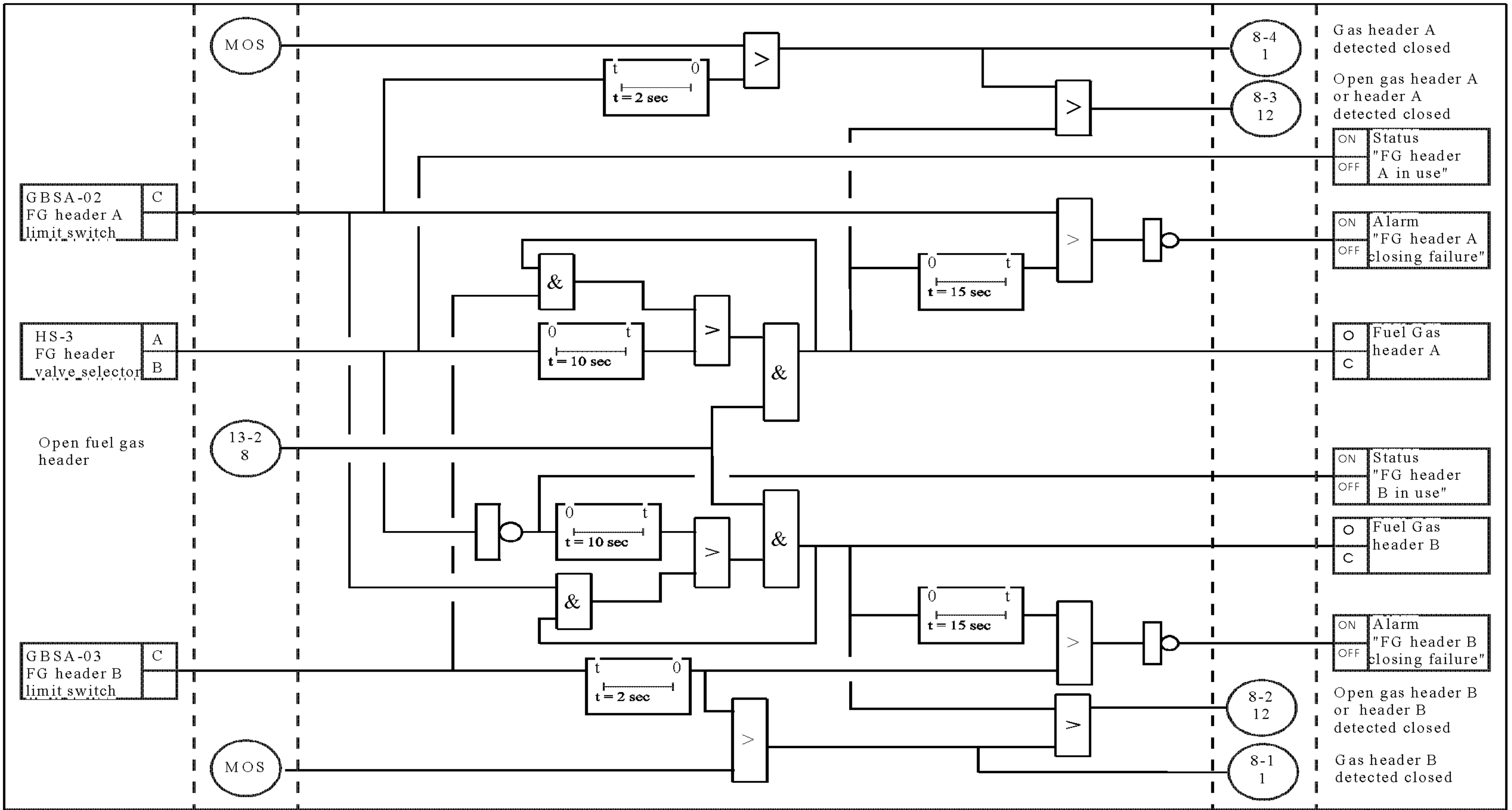
Logics 24 Sheet 3



Logics 24 Sheet 4



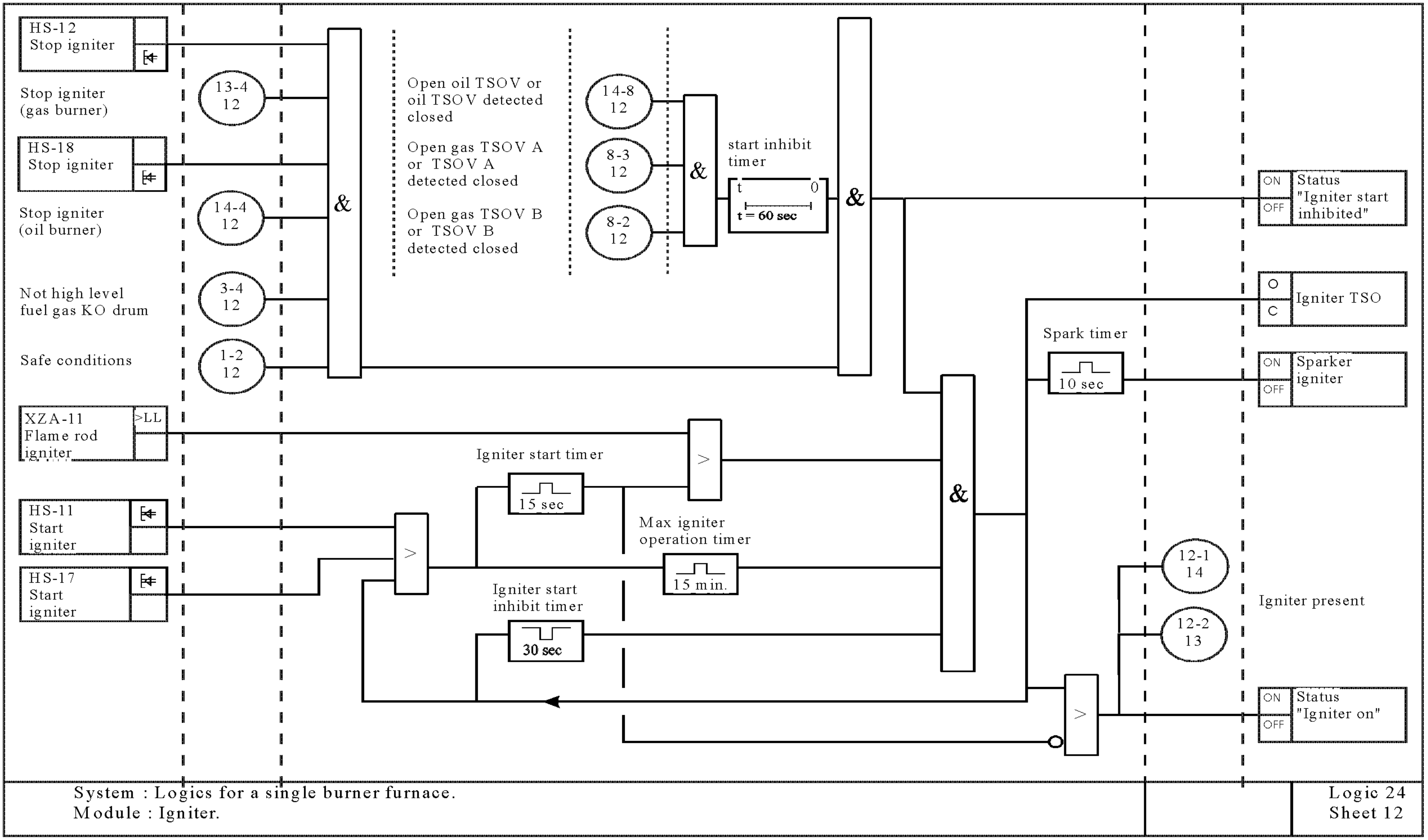
Logics 21 Sheet 8



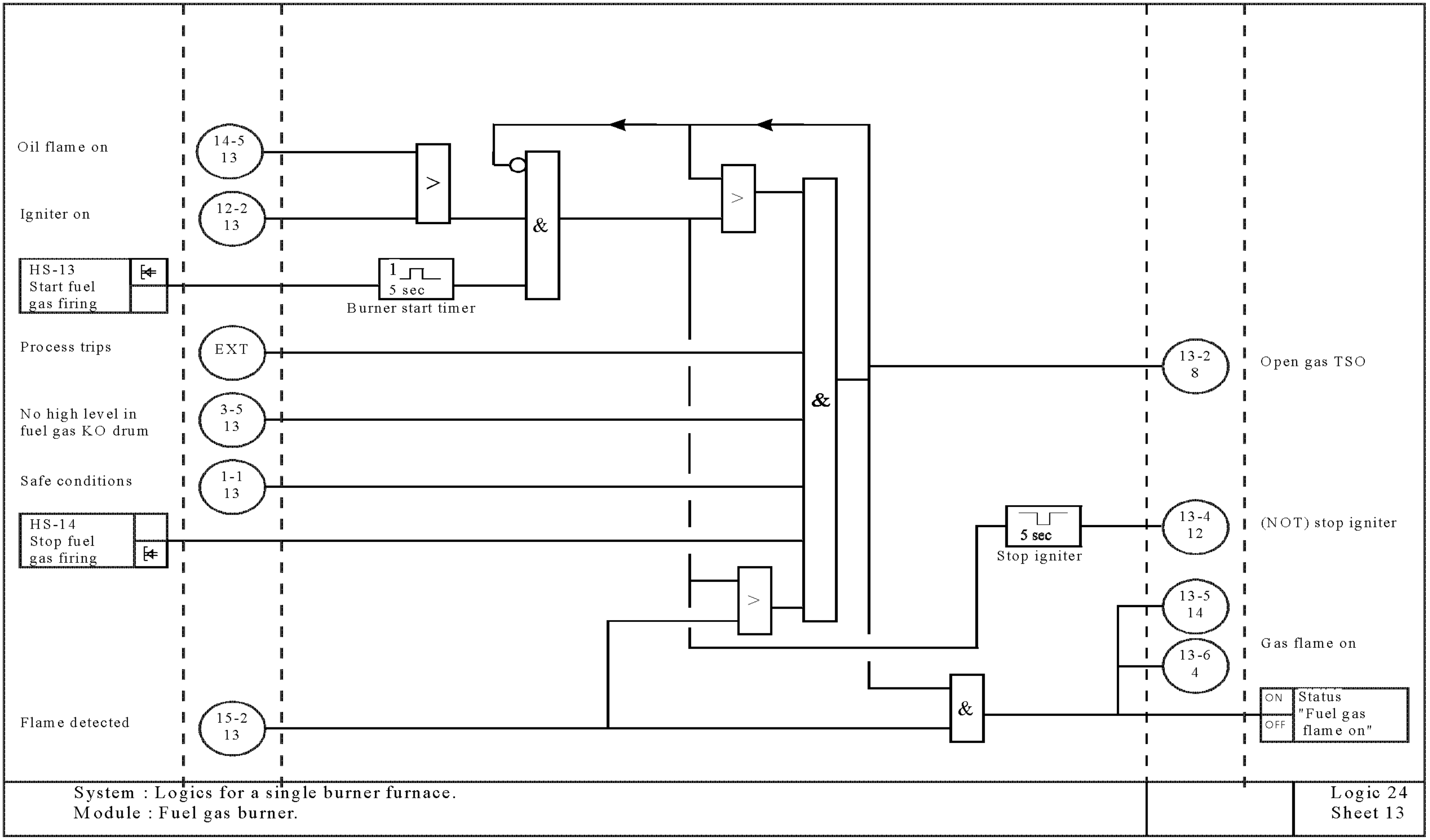
System : Logics for a manually started, multi burner furnace / boiler.
Module : Fuel gas header valve selection.

Logic 21
Sheet 8

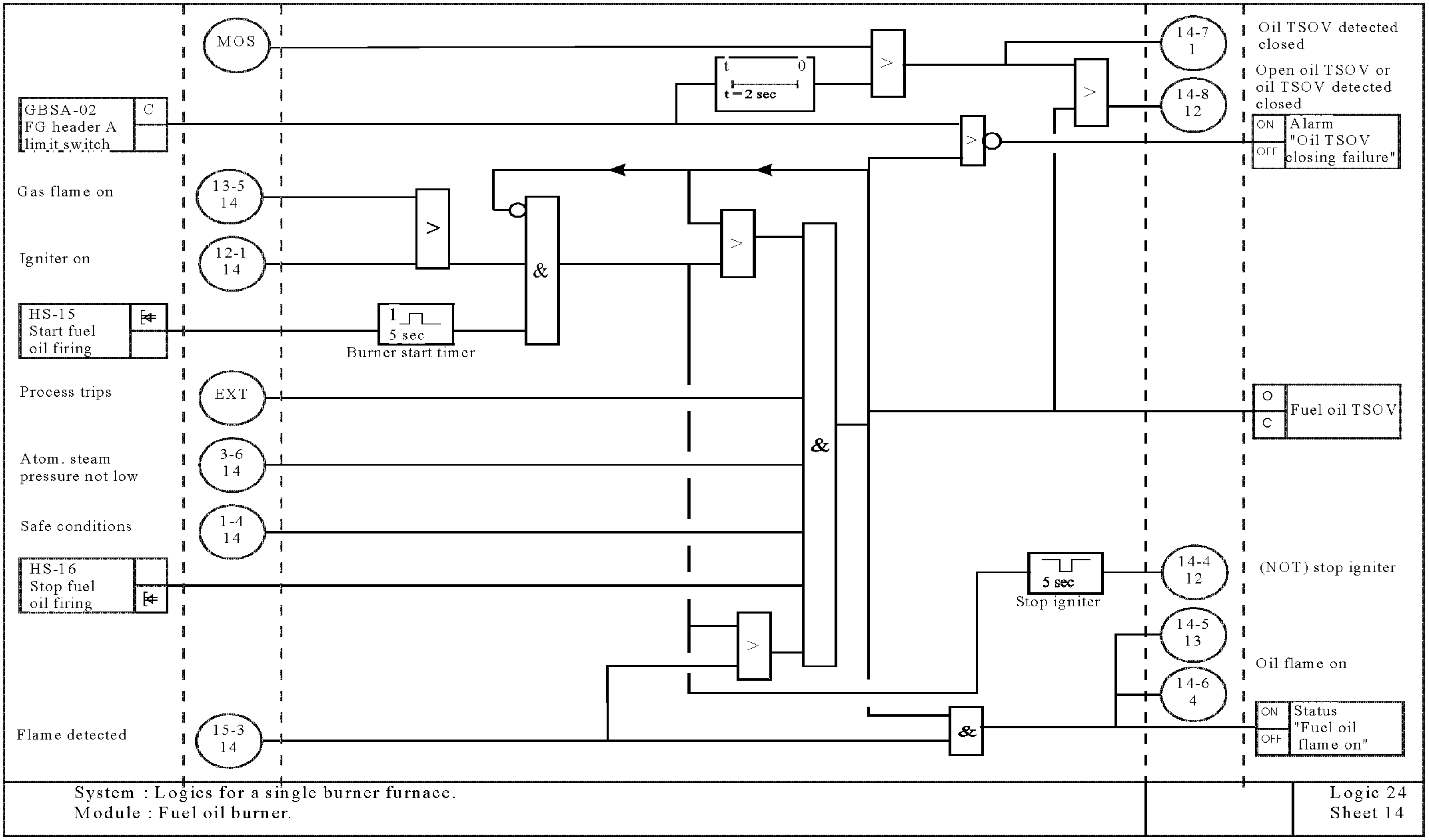
Logics 24 Sheet 12



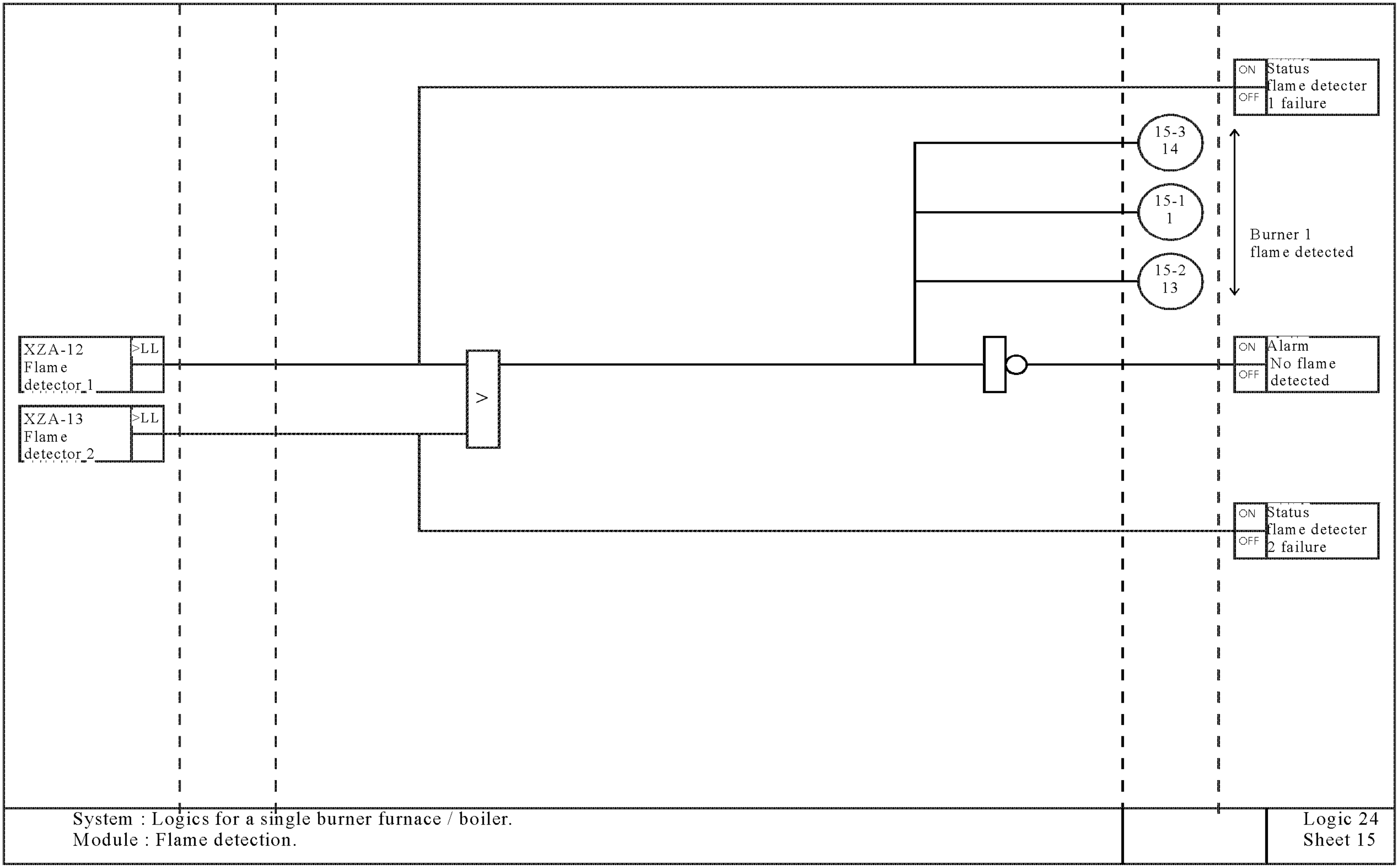
Logics 24 Sheet 13



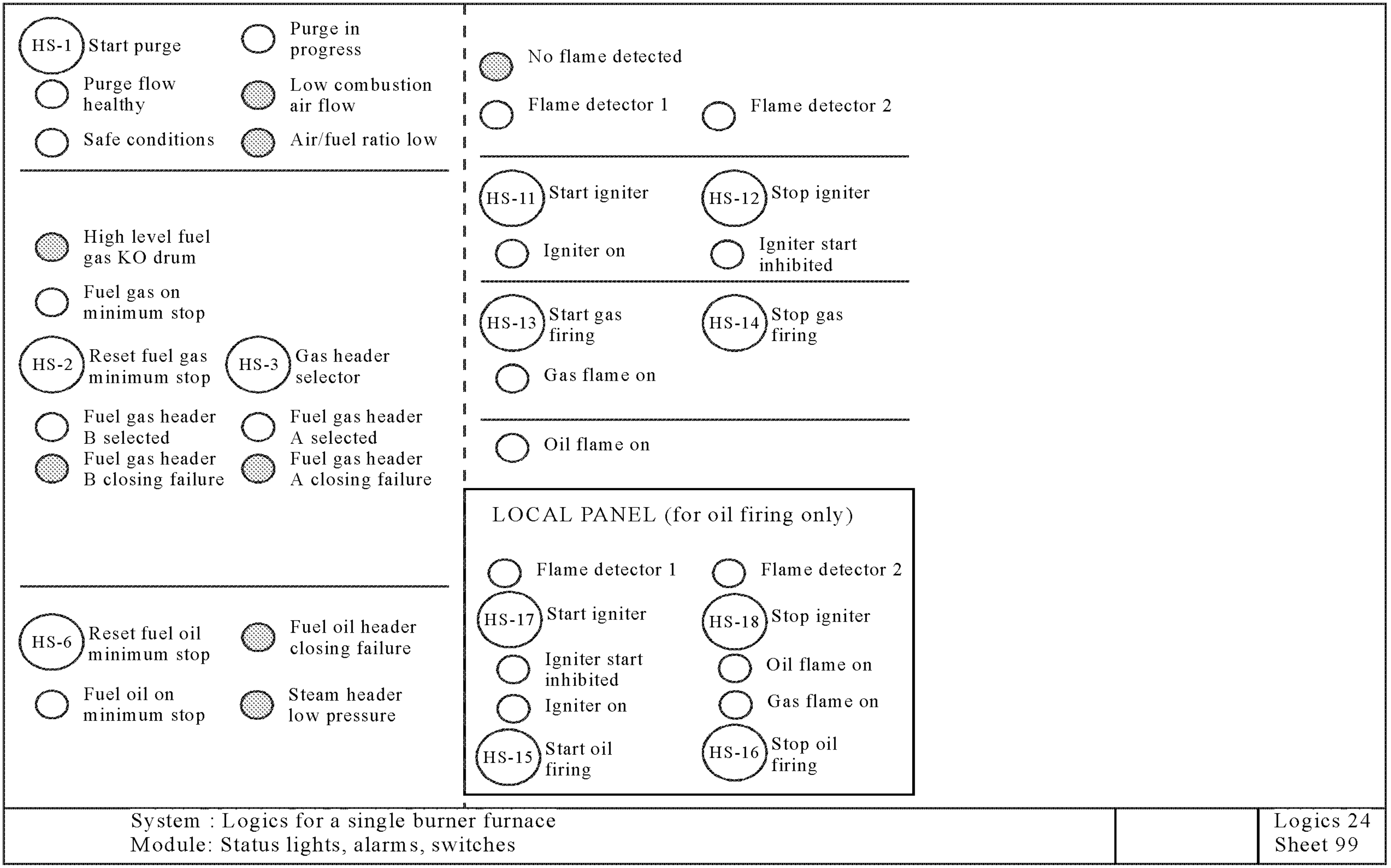
Logics 24 Sheet 14



Logics 24 Sheet 15



Logics 24 Sheet 99



Last page of this DEP