LHCb Detector Safety System

– Inventory of Needs

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Abstract—**After introducing the Scope and Architecture of the Detector Safety System (*DSS*) common to the LHC experiments, this note presents the LHCb environment from a DSS viewpoint and summarizes the so-far recorded LHCb DSS needs and very preliminary requests from the sub-detector groups. It is intended to become a working document to be revised depending on the progress in the inventory of the needs.**

I. INTRODUCTION

The function of the Detector Safety System is to protect the detector equipment by preventing situations from degrading into a full Alarm-of-Level-3. Its development is being carried out as a JCOP sub-project common to the four LHC experiments. The actual needs of the experiments constitute the necessary input to the project design. Some effort has already been invested in discussing them across experiments [1] both to benefit from each other's approach and to come out with a standardized inventory of requirements.

This note presents the first estimate of the DSS needs of the LHCb experiment. Section II describes briefly the scope and architecture of a generic LHC DSS. Section III reviews the LHCb geographical environment and the various sub-systems, proposing a segmentation into well-defined DSS locations. Section IV makes a preliminary inventory of the possible actions to protect the equipment in case of Alarm-of-Level-3 and other alarm conditions detected by monitoring various items and reviews the

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[1] Now at CERN/IT/CO.

corresponding input and output channels necessary for this purpose. Section V is foreseen to contain all the sub-system specific DSS requirements to be collected interactively through questionnaires sent to the sub-system Project Leaders and the regular DSS meetings during LHCb weeks.

The note aims at being a working document regularly updated as the specifications of the experiment needs become more detailed.

II. SCOPE AND ARCHITECTURE OF A LHC DETECTOR SAFETY SYSTEM

The main goals of a Detector Safety System (*DSS*) for the experiments at the LHC are to protect the equipment of the experiment, with that the investment into it, and to avoid situations leading to Alarms-of-Level-3 in order to increase the running time of the experiment. It should complement and not duplicate existing systems, such as the Detector Control System (*DCS*)[2] and the CERN Safety System (*CSS*). The completeness of the ensemble of these three systems for normal operation situations, situations that may lead to damage of equipment, and situations that place people in danger is crucial. On the other hand the Detector Safety System has to be as small as possible to stay reliable and robust. The envisaged system is a balance of these aspects, fulfilling all requirements, and based on several assumptions that are explained in [2].
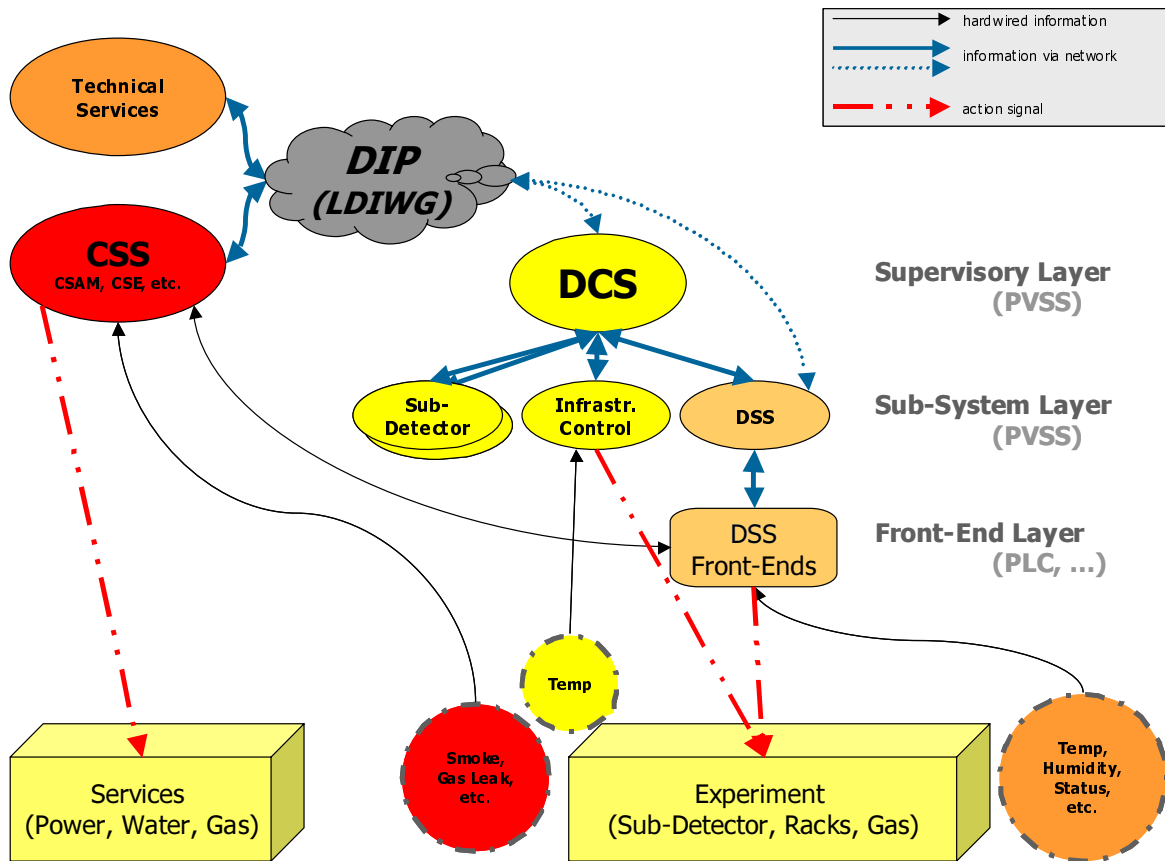

Figure 1: Scope and Architecture Overview for the Common LHC DSS. In this view, primary services are shown on the left-hand side, as they are acted upon only by central services, services under the control of the experiment are shown in the equipment on the right-hand side.

Figure 1 shows the general architecture context of the common system and is meant as a brief reference in order to understand some of the functionality described below. The general functionality is introduced by use-cases in the reference document.

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[2] In case of LHCb, the DCS is an integral part of the Experiment Control System.

III. THE LHCB DETECTOR ENVIRONMENT

The LHCb experiment is located at Pt. 8 of the LHC and will reuse as far as possible facilities formerly used by the DELPHI experiment at LEP. The experiment area at Pt. 8 can be subdivided into "locations" depending on the focus. For safety and equipment protection the following locations have been defined (see Figure 2 and Figure 3):

- On the surface,

    o the gas building (Location SG8) with

        ▪ a flammable and
        ▪ a non-flammable gas storage area,
        ▪ a mixer room, and
        ▪ the gas control room, and

    o the experiment hall (Location SX8) with

        ▪ the LHCb Control Room (*LCR*),
        ▪ the computing farm area[3],
        ▪ lab space for the sub-detector-groups, and
        ▪ the large open hall space itself with the trap door to the PX shaft.

- In the underground, represented in the case of LHCb by one single cavern,

    o the counting room area (Location UX85C) with

        ▪ four counting rooms,
        ▪ four gas platforms (which are grouped by two),
        ▪ the barrel of the former DELPHI detector surrounded by an area for visitors, and the entry to the PX shaft, and

    o the detector area (Location UX85D) with

        ▪ the sub-detectors themselves, and
        ▪ some individual racks.

    In the underground locations only non-flammable gases are present, thus the hazard coming from flammable gases is confined to the surface gas building.

Each location is subdivided as seen above and these parts are referred to as "sub-locations". There are twelve sub-systems, each consisting of at least two different entities, generally the sub-detector in UX85D itself and the corresponding set of racks in UX85C. These sub-systems are:

- the VErtex LOcator (VELO),

- the Ring-Imaging-CHerenkov-detector (RICH), consisting of two geographically independent parts (RICH1 and RICH2),

- the inner tracker,

- the outer tracker,

- the calorimeter system, consisting of

    o the PreShower (PS) and Scintillator Pad Detector (SPD),
    o the Electromagnetic Calorimeter (ECal), and
    o the Hadronic Calorimeter (HCal),

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[3] The decision where to place the online computing farm is still pending. In case of a placement in UX85C, the safety and protection needs in SX8 are largely relaxed.

- the muon system,

- the magnet system,

- the trigger system, and

- the online computing system.

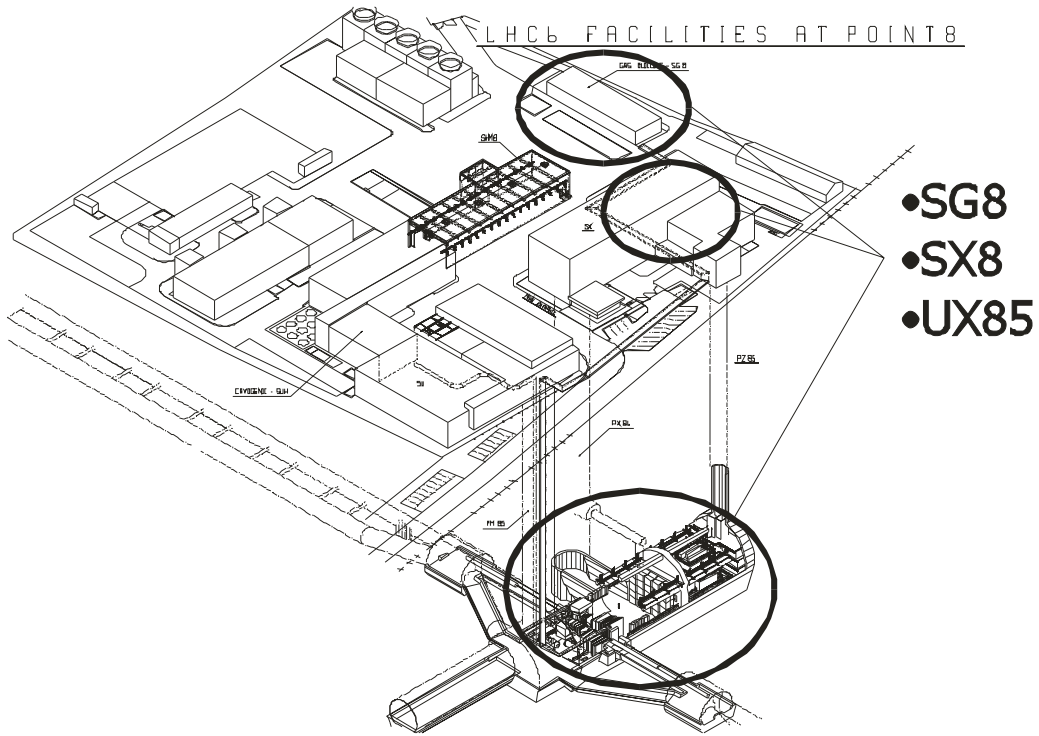Only five sub-systems use various gas mixtures, which are all non-flammable.

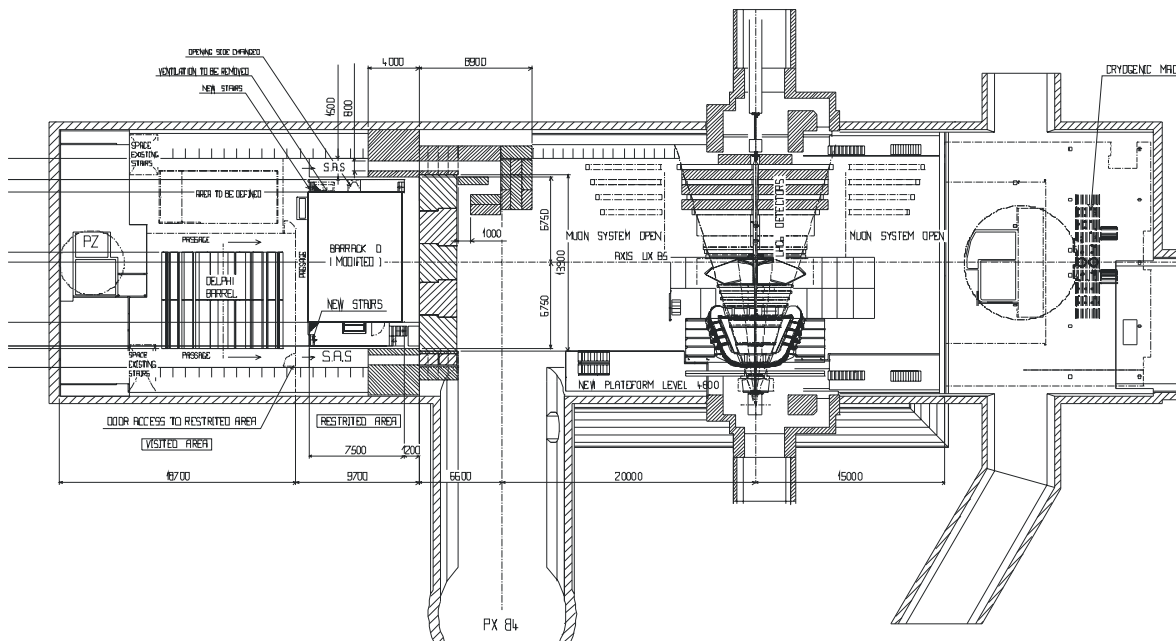Figure 2: Overview of the Facilities at LHC Point 8.

Figure 3: Detailed View of the Underground Installations in UX85C (left of the wall) and UX85D (right of the wall).

IV. GENERAL NEEDS FOR A DETECTOR SAFETY SYSTEM

The following tables are intended to give an overview of possible actions taken by the DSS. Only the levels referred to in Table 1 are predefined, all other alarm levels are subject to definition by the GLIMOS.

A. *In case of an Alarm-of-Level-3*

All actions specified here have to be seen in connection with those actions taken by the CERN Safety System in case of an Alarm-of-Level-3, which in the following will be referred to as "CSS-type alarms".

TABLE 1: FORESEEN DSS ACTIONS IN CASE OF AN ALARM-OF-LEVEL-3

Location	Alarm Type	Level	Possible Experiment Action
SG8	Smoke, Flammable Gas Leak, Oxygen Level	2	One may take first action in sub-locations of the gas building. In case of such alarm in the gas control room, one may cut the power to the mixer room.
		3	One may foresee a power cut in any of the two locations where gas is used (UX85). Furthermore one may consider preventive action on any of the sub-systems, whether they use gas or not.
	Emergency Stop	3	One may foresee a power cut in any of the two locations where gas is used (UX85). Furthermore one may consider preventive action on any of the sub-systems, whether they use gas or not.
SX8	Smoke	2	One may take action on any sub-location, i.e. shutting down the computing farm, cutting power to racks in the labs, …
		3	As all locations depend on the DCS, which is powered in SX8, one may envisage to cut the power to all other locations or take smoother steps, i.e. kill the high voltages, …
	Emergency Stop	3	As all locations depend on the DCS, which is powered in SX8, one may envisage to cut the power to all other locations or take smoother steps, i.e. kill the high voltages, …
UX85C	Smoke, Oxygen Level, Flood, Water Leak	2	One may take preventive action on any counting room and gas platform.
		3	There exist dependencies between the electronics in the counting rooms and the gas platforms and all other locations, so one may think of cutting the power to any of them. If one refrains from such harsh action, one should at least take action on all sub-systems in UX85D.
	Emergency Stop	3	There exist dependencies between the electronics in the counting rooms and the gas platforms and all other locations, so one may think of cutting the power to any of them. If one refrains from such harsh action, one should at least take action on all sub-systems in UX85D.
UX85D	Smoke, Oxygen Level, Flood, Water Leak	2	One may take preventive action on any of the twelve sub-systems in the detector area.
		3	There exist dependencies between the sub-detectors and all other locations, so one may think of cutting the power to any of them. If one refrains from such harsh action, one should at least take action on all sub-systems in the counting rooms.
	Emergency Stop	3	There exist dependencies between the sub-detectors and all other locations, so one may think of cutting the power to any of them. If one refrains from such harsh action, one should at least take action on all sub-system components in the counting rooms.

B. In case of a serious problem not covered by an Alarm-of-Level-3-Procedure

TABLE 2: DSS ACTIONS FORESEEN IN CASE OF NON-CSS-TYPE ALARMS

Location	Type[4]	Level	Possible Experiment Action
SG8	Ambient Temperature	2	In case of a temperature outside limits in any of the four sub-locations one may take action on any of the two sub-locations with electronics.
	Ambient Humidity	2	In case of too high humidity in any sub-location with electronics one may want to take action in any of them.
	Ventilation	2	In case of a stop of ventilation one may consider to take action on any sub-location.
	Normal Power	2	In case of a cut of the normal power one may want to inform CSS.
	Gas Mixture	2	In case of the gas system failing, one may take preventive action on any sub-system.
SX8[5]	Ambient Temperature, Ambient Humidity	2	In case of one of these values outside limits one may take preventive action in any of the four sub-locations.
	Air Conditioning, Ventilation	2	In case of a fault of the air conditioner one may take preventive action in any of the four sub-locations, mainly in the farm and control rooms.
	Chilled Water, Mixed Water	2	In case of the cooling water temperature being outside limits, one may take action in the farm and control rooms.
	Local Water Leak	2	In case of a leak in the farm area one may take action in any of the sub-locations, at least the farm area itself and anything underneath.
	Normal Power	2	In case of a cut of the normal power one may take preventive action in any sub-location and may want to inform CSS.
	Diesel Power, UPS Power	2	In case of problems with these power sources, one may take preventive action in the farm area and the LCR, maybe depending on the status of the normal power.
UX85D[6]	Ambient Temperature, Ambient Humidity	2	In case of one of these values outside limits in the cavern one may take preventive action on several sub-systems and possibly their respective components in UX85C. In case of overheating between sub-detectors, one may want to take action on them and their respective sub-system.
	Ventilation	2	A failure of the ventilation will most probably result in a rising ambient temperature. A preventive action may be considered on several sub-systems and possibly their respective components in UX85C.
	Chilled Water, Mixed Water, Demineralized Water	2	A too high temperature of the cooling water to the cavern will most probably result in a rising ambient temperature. A preventive action may be considered on several sub-systems and possibly their respective components in UX85C.
	Local Water Leak	2	A local water leak around one sub-system may cause damage in this sub-location so one may take preventive action on that sub-system and the respective components in UX85C.
	Normal Power	2	In case of a cut of the normal power one may take preventive action on any sub-system and may want to inform CSS.
	Diesel Power, UPS Power	2	In case of problems with these power sources, one may take preventive action on any of the sub-systems and their respective components in UX85C.

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[4] This "Type" denotes a monitored value, e.g. ambient temperature, or a system that could fail with different levels of severity, e.g. the normal power distribution.

5 As at least the LCR is closely connected to the rest of the experiment setup, one may take actions on any sub-system or even cutting power to the other locations.

6 In severe cases a power cut of UX85D may be envisaged, which may lead to preventive actions in other locations.

Location	Type[4]	Level	Possible Experiment Action
UX85C[7]	Radiation Level	1	In case of an elevated radiation in the cavern, some sub-systems may be endangered, so one may consider preventive action on them and their components in UX85C.
		2	In case of higher radiation in the cavern, all sub-systems may be endangered, so one may consider a power cut of UX85D, which may lead to preventive actions in other locations.
	Sub-Detector Status	2	In case one sub-system detects an intrinsic problem, one may consider preventive action on this sub-system and/or its neighbors as well as their respective counterparts in UX85C.
	Ambient Temperature, Ambient Humidity	2	In case of one value outside limits in the cavern one may take preventive action on the counting rooms and the gas platforms and possibly the connected components in UX85D.
	Ventilation	2	A failure of the ventilation will most probably result in a rising ambient temperature. A preventive action may be considered on the counting rooms and the gas platforms and possibly the connected components in UX85D.
	Chilled Water, Mixed Water	2	A too high temperature of the cooling water to the cavern will most probably result in a rising ambient temperature. A preventive action may be considered on the counting rooms and the gas platforms and possibly the connected components in UX85D.
	Local Water Leak	2	A local water leak around at least one counting room or gas platform may cause damage in this sub-location so one may take preventive action on that sub-location and the connected components in UX85D.
	Normal Power	2	In case of a cut of the normal power one may take preventive action on any sub-system and may want to inform CSS.
	Diesel Power, UPS Power	2	In case of problems with these power sources, one may take preventive action on any of the sub-systems and their respective components in UX85D.
	UX Water Evacuation Pumps	2	In case of pump failure, one may consider preventive action on some sub-systems, maybe in connection with a pre-alarm water flood.
Counting Rooms[8] [9]	Ambient Temperature	1	In case of temperature outside limits in a counting room, one may take action on the main heat source (e.g. rack row) in this counting room.
		2	In case of a too high temperature in a counting room one may consider a power cut of the counting room.
	Ambient Humidity	2	In case of a too high ambient humidity in a counting room one may take action on parts of the counting room or even a power cut of the full counting room.
	Air Conditioning	2	In case of a fault of the air conditioner one may take preventive action on any of the rack rows or even a power cut of the full counting room.
	Mixed Water	2	In case of the cooling water temperature being outside limits, one may take action on any of the rack rows or even a power cut of the full counting room.
	Local Water Leak	2	A local water leak in a counting room may have serious impact on the electronics inside, so one may take action on any of the rack rows or even a power cut of the full counting room.
	Normal Power	2	In case of a cut of the normal power one may take preventive action on any sub-system and may want to inform CSS.

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[7] In severe cases a power cut of UX85C may be envisaged, which may lead to preventive actions in other locations, mainly UX85D.
[8] A counting room is a sub-location of the counting room area. Nevertheless it has a considerable number of sensors and components.
[9] Any action on a single counting room may trigger preventive actions on any other location or sub-system or even only sub-sets of those.

Location	Type[4]	Level	Possible Experiment Action
	Diesel Power, UPS Power	2	In case of problems with these power sources, one may take preventive action on any of the sub-systems and/or even the full counting room.
	AUL	2	In case of a power cut of the counting room, one may take preventive action on any sub-system.

C. Summary

The following tables show the needed input- and output-channels for all locations of the DSS around LHCb. This accounting results from several assumptions on the locations of detection and transmission equipment for the digital inputs (*DI*), analog inputs (*AI*), and digital outputs (*DO*). The assumed locations are also shown in the tables.

1) Input Channels

Location	Description	from	Type	Nb.
CDInc[10] SG8	Detection of a pre-alarm smoke	CDInc	DI	1
	Detection of an alarm smoke	CDInc	DI	1
CDGas[11] SG8	Detection of a pre-alarm flammable gas	CDGas	DI	1
	Detection of an alarm flammable gas	CDGas	DI	1
	Detection of a pre-alarm oxygen level	CDGas	DI	1
	Detection of an alarm oxygen level	CDGas	DI	1
LSAC[12] SG8?	Evacuation Alarm initiated	?	DI	1
LSAC SG8?	Emergency Stop pushed	?	DI	1
CDInc SX8	Detection of a pre-alarm smoke	CDInc	DI	2
	Detection of an alarm smoke	CDInc	DI	2
LSAC SX8?	Emergency Stop pushed	?	DI	1
CDGas UX85C	Detection of a pre-alarm flammable gas	CDGas	DI	1
	Detection of an alarm flammable gas	CDGas	DI	1
	Detection of a pre-alarm oxygen level	CDGas	DI	1
	Detection of an alarm oxygen level	CDGas	DI	1
LSAC UX85C?	Detection of a pre-alarm water flood	?	DI	1
	Detection of an alarm water flood	?	DI	1
LSAC UX85C?	Detection of a blocked lift	?	DI	1
LSAC UX85C?	Evacuation Alarm initiated	?	DI	1
LSAC UX85C?	Emergency Stop pushed	?	DI	1
CDGas UX85D	Detection of a pre-alarm flammable gas	CDGas	DI	1
	Detection of an alarm flammable gas	CDGas	DI	1
	Detection of a pre-alarm oxygen level	CDGas	DI	1
	Detection of an alarm oxygen level	CDGas	DI	1
LSAC UX85D?	Detection of a pre-alarm water flood	?	DI	1
	Detection of an alarm water flood	?	DI	1
LSAC UX85D?	Evacuation Alarm initiated	?	DI	1
LSAC UX85D?	Emergency Stop pushed	?	DI	1
SG8	Ambient Temperature	DSS	AI	4
	Ambient Humidity	DSS	AI	2
SG8?	Ventilation	ST/CV	DI	1
SG8?	Normal Power Failure	ST/EL	DI	1
SG8?	Gas System Failure	GasSect	DI	5

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[10] *C*entrale de *D*etection *Inc*endie: CSS equipment where the information from smoke sensors is concentrated

[11] *C*entrale de *D*etection *Gas*: CSS equipment where the information from gas sensors is concentrated

[12] *L*ocal *S*afety-*A*larm *C*ontroller: CSS equipment where the information on all alarms in a certain zone is concentrated

Location	Description	from	Type	Nb.
SX8	Ambient Temperature	DSS	AI	20
	Ambient Humidity	DSS	AI	16
	Chilled Cooling Water Temperature	DSS	AI	2
	Mixed Cooling Water Temperature	DSS	AI	2
	Local Water Leak	DSS	DI	9
	Trap Door Opening	DSS	DI	1
SX8?	Air Conditioner	ST/CV	DI	10
SX8?	Ventilation	ST/CV	DI	1
SX8?	Chilled Cooling Water Stopped	ST/CV	DI	1
SX8?	Mixed Cooling Water Stopped	ST/CV	DI	1
SX8?	Normal Power Failure	ST/EL	DI	1
SX8?	Diesel Failure	ST/EL	DI	1
SX8?	UPS Failure	ST/EL	DI	1
UX85D	Ambient Temperature	DSS	AI	22
	Ambient Humidity	DSS	AI	3
	Chilled Cooling Water Temperature	DSS	AI	2
	Mixed Cooling Water Temperature	DSS	AI	2
	Demineralized Water Temperature	DSS	AI	2
	Local Water Leak	DSS	DI	12
	Sub-Detector Status	SubDet	DI	12
UX85D?	Air Conditioner	ST/CV	DI	1
UX85D?	Ventilation	ST/CV	DI	1
UX85D?	Chilled Cooling Water Stopped	ST/CV	DI	1
UX85D?	Mixed Cooling Water Stopped	ST/CV	DI	1
UX85D?	Demineralized Cooling Water Stopped	ST/CV	DI	1
UX85D?	Normal Power Failure	ST/EL	DI	1
UX85D?	Diesel Failure	ST/EL	DI	1
UX85D?	UPS Failure	ST/EL	DI	1
UX85D?	Water Evacuation Pumps	EST?	DI	1
UX85D?	Doors	ST/MA	DI	6
UX85C	Ambient Temperature	DSS	AI	2
	Ambient Humidity	DSS	AI	2
	Chilled Cooling Water Temperature	DSS	AI	2
	Mixed Cooling Water Temperature	DSS	AI	2
	Local Water Leak	DSS	DI	2
UX85C?	Air Conditioner	ST/CV	DI	1
UX85C?	Ventilation	ST/CV	DI	1
UX85C?	Chilled Cooling Water Stopped	ST/CV	DI	1
UX85C?	Mixed Cooling Water Stopped	ST/CV	DI	1
UX85C?	Normal Power Failure	ST/EL	DI	1
UX85C?	Diesel Failure	ST/EL	DI	1
UX85C?	UPS Failure	ST/EL	DI	1
UX85C?	Water Evacuation Pumps	EST?	DI	1
Counting Room	Ambient Temperature	DSS	AI	2
	Ambient Humidity	DSS	AI	1
	Mixed Cooling Water Temperature	DSS	AI	2
	Local Water Leak	DSS	DI	3
	AUL	DSS	DI	1
	Door Opening	DSS	DI	1
Counting Room?	Air Conditioner	ST/CV	DI	1
Counting Room?	Mixed Cooling Water Stopped	ST/CV	DI	1
Counting Room?	Normal Power Failure	ST/EL	DI	1
Counting Room?	Diesel Failure	ST/EL	DI	1

Location	Description	from	Type	Nb.
Counting Room?	UPS Failure	ST/EL	DI	1

			Type	Nb.
Sum			DI	122
			AI	90
			Total	**212**

2) Output Channels

Location	Description	to	Type	Nb.
DSU	DSS failure signal	CSS	DO	1
SG8	action on mixer and gas control room	EL.SG8	DO	2
	power cut to location	EL.SG8	DO	1
SX8	action on LCR, farm room, labs, hall	Exp.SX8	DO	4
	power cut to location	EL.SX8	DO	1
UX85C	action on sub-location (counting rooms)	CR.UX85	DO	4
	action on sub-location (gas platforms)	GP.UX85	DO	2
	action on sub-systems (rack groups)	CR.UX85	DO	12
	power cut to location	EL.UX85C	DO	1
UX85D	action on sub-systems	DET.UX85	DO	12
	power cut to location	EL.UX85D	DO	1
Sum			**DO**	**41**

V. SUB-SYSTEM NEEDS FOR A DETECTOR SAFETY SYSTEM

The needs of the various sub-systems have still to be developed by the project leaders together with the LHCb safety team. A first step has been taken and a preliminary inventory is due to be available in the middle of 2002.

VI. APPENDIX

A. Standardized Needs Inventory

DSS needs catalog v1.5

ZONE: Surface					LOCATION: Gas Building SG8															
ALARM (IS37, up to L3)				**DESTINATION**			**ACTION BY**					**DSS**							**EXPERIMENT ACTION**	**COMMENT**
Type	Level	Detection	Trans. Expt.	Others	to Expt.	Other	CSS aut.	DCS aut.	DCS man.	DSS aut.	DSS man.	Ana.	Dig.	out1	out2	out3	out4	out5		
Smoke	1	ST/AA	N	TCR	DCS	TCR	x													L1 is not foreseen in CSS
	2	ST/AA	H1,N	TCR	DCS DSS	TCR		x	x	x			1		2				see explanations	
	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x	x	x	x			1				2	24	see explanations	
Flammable gas leak	1	ST/AA	N	TCR	DCS	TCR	x													L1 is not foreseen in CSS
	2	ST/AA	H1,N	TCR	DCS DSS	TCR		x	x	x			1		2				see explanations	
	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x	x	x	x			1				2	24	see explanations	
Oxygen level	1	ST/AA	N	TCR	DCS	TCR	x													L1 is not foreseen in CSS
	2	ST/AA	H1,N	TCR	DCS DSS	TCR		x	x	x			1		2				see explanations	
	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x	x	x	x			1				2	24	see explanations	
Flood Water leak	1	ST/CV	N		DCS	TCR														L1 is not foreseen in CSS
	2	ST/CV	H1,N		DCS DSS	TCR														
	3	ST/CV	H1,N	TCR,FB	DCS DSS	FB	x													
Blocked lift	3	ST/HM	H1,N	TCR,FB	DCS DSS	FB	x													
Evacuation	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x						1							monitored value
Emergency stop	3	ST/EL	H1,N	TCR,FB	DCS DSS	FB	x						1				2	24	see explanations	
Emerg. telephone	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x													
"deadman" device	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x													

Total Zone

Inputs		Outputs				
Ana.	Dig.	out1	out2	out3	out4	out5
0	8	0	2	0	2	24

DSS needs catalog v1.5

ZONE: Surface					LOCATION: Experiment Building SX8															
ALARM (IS37, up to L3)				**DESTINATION**			**ACTION BY**					**DSS**							**EXPERIMENT ACTION**	**COMMENT**
Type	Level	Detection	Trans. Expt.	Others	to Expt.	Other	CSS aut.	DCS aut.	DCS man.	DSS aut.	DSS man.	Ana.	Dig.	out1	out2	out3	out4	out5		
Smoke	1	ST/AA	N	TCR	DCS	TCR	x													L1 is not foreseen in CSS
	2	ST/AA	H1,N	TCR	DCS DSS	TCR		x	x	x			2		3				see explanations	
	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x	x	x	x			2				3	24	see explanations	
Flammable gas leak	1	ST/AA	N	TCR	DCS	TCR														L1 is not foreseen in CSS
	2	ST/AA	H1,N	TCR	DCS DSS	TCR														
	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x													
Oxygen level	1	ST/AA	N	TCR	DCS	TCR														L1 is not foreseen in CSS
	2	ST/AA	H1,N	TCR	DCS DSS	TCR														
	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x													
Flood Water leak	1	ST/CV	N		DCS	TCR														L1 is not foreseen in CSS
	2	ST/CV	H1,N		DCS DSS	TCR														
	3	ST/CV	H1,N	TCR,FB	DCS DSS	FB	x													
Blocked lift	3	ST/HM	H1,N	TCR,FB	DCS DSS	FB	x													
Evacuation	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x													
Emergency stop	3	ST/EL	H1,N	TCR,FB	DCS DSS	FB	x						1				3	24	see explanations	
Emerg. telephone	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x													
"deadman" device	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x													

Total Zone

Inputs		Outputs				
Ana.	Dig.	out1	out2	out3	out4	out5
0	5	0	3	0	3	24

DSS needs catalog v1.5

ZONE: Underground					LOCATION: Counting Room Area in UX85 (UX85C)															
ALARM (IS37, up to L3)				**DESTINATION**			**ACTION BY**					**DSS**							**EXPERIMENT ACTION**	**COMMENT**
Type	Level	Detection	Trans. Expt.	Others	to Expt.	Other	CSS aut.	DCS aut.	DCS man.	DSS aut.	DSS man.	Ana.	Dig.	out1	out2	out3	out4	out5		
Smoke	1	ST/AA	N	TCR	DCS	TCR	x													L1 is not foreseen in CSS
	2	ST/AA	H1,N	TCR	DCS DSS	TCR		x	x	x			1		6				see explanations	
	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x	x	x	x			1				3	12	see explanations	
Flammable gas leak	1	ST/AA	N	TCR	DCS	TCR														L1 is not foreseen in CSS
	2	ST/AA	H1,N	TCR	DCS DSS	TCR														
	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x													
Oxygen level	1	ST/AA	N	TCR	DCS	TCR														L1 is not foreseen in CSS
	2	ST/AA	H1,N	TCR	DCS DSS	TCR		x	x	x			1		6				see explanations	
	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x	x	x	x			1				3	12	see explanations	
Flood Water leak	1	ST/CV	N		DCS	TCR														L1 is not foreseen in CSS
	2	ST/CV	H1,N		DCS DSS	TCR		x	x	x			1		6				see explanations	
	3	ST/CV	H1,N	TCR,FB	DCS DSS	FB	x	x	x	x			1				3	12	see explanations	
Blocked lift	3	ST/HM	H1,N	TCR,FB	DCS DSS	FB	x	x					1							monitored value
Evacuation	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x	x	x	x			1							monitored value
Emergency stop	3	ST/EL	H1,N	TCR,FB	DCS DSS	FB	x			x			1				3	12	see explanations	
Emerg. telephone	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x													
"deadman" device	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x													

Total Zone

Inputs		Outputs				
Ana.	Dig.	out1	out2	out3	out4	out5
0	9	0	6	0	3	12

DSS needs catalog v1.5

ZONE: Underground					LOCATION: Detector Area in UX85 (UX85D)															
ALARM (IS37, up to L3)				**DESTINATION**			**ACTION BY**					**DSS**							**EXPERIMENT ACTION**	**COMMENT**
Type	Level	Detection	Trans. Expt.	Others	to Expt.	Other	CSS aut.	DCS aut.	DCS man.	DSS aut.	DSS man.	Ana.	Dig.	out1	out2	out3	out4	out5		
Smoke	1	ST/AA	N	TCR	DCS	TCR	x													L1 is not foreseen in CSS
	2	ST/AA	H1,N	TCR	DCS DSS	TCR		x	x	x			1		12				see explanations	
	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x	x	x	x			1				3	12	see explanations	
Flammable gas leak	1	ST/AA	N	TCR	DCS	TCR														L1 is not foreseen in CSS
	2	ST/AA	H1,N	TCR	DCS DSS	TCR														
	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x													
Oxygen level	1	ST/AA	N	TCR	DCS	TCR	x													L1 is not foreseen in CSS
	2	ST/AA	H1,N	TCR	DCS DSS	TCR		x	x	x			1		12				see explanations	
	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x	x	x	x			1				3	12	see explanations	
Flood Water leak	1	ST/CV	N		DCS	TCR														L1 is not foreseen in CSS
	2	ST/CV	H1,N		DCS DSS	TCR							1		12				see explanations	
	3	ST/CV	H1,N	TCR,FB	DCS DSS	FB	x						1				3	12	see explanations	
Blocked lift	3	ST/HM	H1,N	TCR,FB	DCS DSS	FB	x													
Evacuation	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x	x	x	x			1							monitored value
Emergency stop	3	ST/EL	H1,N	TCR,FB	DCS DSS	FB	x			x			1				3	12	see explanations	
Emerg. telephone	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x													
"deadman" device	3	ST/AA	H1,N	TCR,FB	DCS DSS	FB	x													

Total Zone

Inputs		Outputs				
Ana.	Dig.	out1	out2	out3	out4	out5
0	8	0	12	0	3	12

Figure 4: Standardized DSS Needs tables for Alarms-of-Level-3.

Transmis. > Expt.	H1	CSS *(CSE)* -> DSU
	H2	DSS sensor to DSU
	N	Network *(DIP)*

Action by	Other: action by TCR (piquet) or FB
	DCS aut: Automatic action by DCS
	DCS man: Manual action by operator directly on equipment
	DSS aut: Automatic action by DSS
	DSS man: Manual action of operator on DSU

DSS Outputs	out1	Cut the power to location
	out2	Action on part of the location (e.g. set of racks)
	out3	DSU -> CSS
	out4	Cut of power to another location
	out5	Action on part of another location (e.g. set of racks)
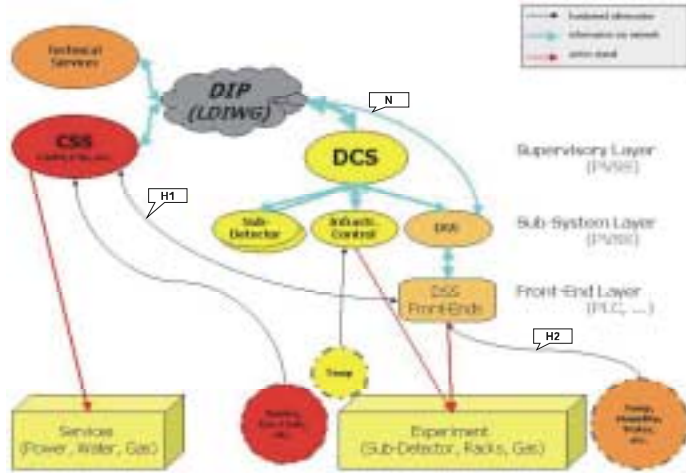
Figure 5: General explanations for the standardized needs tables.

DSS needs catalog v1.5 — ZONE: Surface — LOCATION: SG8

Type	Level	Detection	Trans. Expt.	Others	to Expt.	Other	Ana.	Dig.	out1	out2	out3	out4	out5	COMMENT
Ambient temperature	1	DSS	H2		DCS DSS									
	2	DSS	H2		DCS DSS		4		2					
Ambient humidity	1	DSS	H2		DCS DSS									
	2	DSS	H2		DCS DSS		2		2					
Air-conditioning	1	ST/CV	N	TCR	DCS	TCR								
	2	ST/CV	N	TCR	DCS DSS	TCR								
Ventilation	1	ST/CV	N	TCR	DCS	TCR								
	2	ST/CV	N	TCR	DCS DSS	TCR	1		2					
Chilled cooling water	1	ST/CV	N	TCR	DCS	TCR								
	2	ST/CV	N	TCR	DCS DSS	TCR								
	2	DSS	H2		DCS DSS									
Mixed cooling water	1	ST/CV	N	TCR	DCS	TCR								
	2	ST/CV	N	TCR	DCS DSS	TCR								
	2	DSS	H2		DCS DSS									
Local water leak	1	DSS	H2		DCS DSS									
	2	DSS	H2		DCS DSS									
Rack control	1	RackCtrl	N		DCS									
	2	RackCtrl	N		DCS DSS									
Normal Power	2	ST/EL	N	TCR	DCS DSS	TCR	1		2	1				
Diesel Power	2	ST/EL	N	TCR	DCS DSS	TCR								in case of problems trigger a procedure
UPS power	2	ST/EL	N	TCR	DCS DSS	TCR								
Radiation level	1	TIS/RP	N	PCR	DCS									
	2	TIS/RP	N/H	PCR	DCS DSS									
Sub-detector status	1	DSS	H2		DCS DSS									
	2	DSS	H2		DCS DSS									
Access control	2	ST/AA	N	TCR	DCS DSS	TCR								
UX water evacuation pumps	1	ST/CV		TCR	DCS DSS	TCR								
	2	ST/CV		TCR	DCS DSS	TCR								
SG Gas mixture	1	Gas control	H2		DCS									
	2	Gas control	H2		DCS DSS		5				5		24	
DSS internal monitoring	1	DSS	N/H		DCS									
	2	DSS	N/H		DCS DSS									

Figure 6: Standardized DSS Needs table for non-CSS-type alarms in SG8.

DSS needs catalog v1.5 — ZONE: Surface — LOCATION: SX8

Type	Level	Detection	Trans. Expt.	Others	to Expt.	Other	Ana.	Dig.	out1	out2	out3	out4	out5	COMMENT
Ambient temperature	1	DSS	H2		DCS DSS									6 ground floor, rest computing farm area
	2	DSS	H2		DCS DSS		20		4			3	24	
Ambient humidity	1	DSS	H2		DCS DSS									
	2	DSS	H2		DCS DSS		18		4			3	24	
Air-conditioning	1	ST/CV	N	TCR	DCS	TCR								
	2	ST/CV	N	TCR	DCS DSS	TCR	10		4			3	24	
Ventilation	1	ST/CV	N	TCR	DCS	TCR								
	2	ST/CV	N	TCR	DCS DSS	TCR	1		4			3	24	
Chilled cooling water	1	ST/CV	N	TCR	DCS	TCR								
	2	ST/CV	N	TCR	DCS DSS	TCR								
	2	DSS	H2		DCS DSS		2		2			3	24	Computer Room
Mixed cooling water	1	ST/CV	N	TCR	DCS	TCR								
	2	ST/CV	N	TCR	DCS DSS	TCR								
	2	DSS	H2		DCS DSS		2		2			3	24	Computer Room
Local water leak	1	DSS	H2		DCS DSS									
	2	DSS	H2		DCS DSS		9		2			3	24	computing farm area
Rack control	1	RackCtrl	N		DCS									
	2	RackCtrl	N		DCS DSS									
Normal Power	2	ST/EL	N	TCR	DCS DSS	TCR	1	1	4	1			24	
Diesel Power	2	ST/EL	N	TCR	DCS DSS	TCR	1	1	4					
UPS power	2	ST/EL	N	TCR	DCS DSS	TCR	1	1	4					
Radiation level	1	TIS/RP	N	PCR	DCS									
	2	TIS/RP	N/H	PCR	DCS									
Sub-detector status	1	DSS	H2		DCS DSS									
	2	DSS	H2		DCS DSS									
Access control	2	ST/AA	N	TCR	DCS DSS	TCR								
UX water evacuation pumps	1	ST/CV		TCR	DCS DSS	TCR								
	2	ST/CV		TCR	DCS DSS	TCR								
SG Gas mixture	1	Gas control	H2		DCS									
	2	Gas control	H2		DCS DSS									
DSS internal monitoring	1	DSS	N/H		DCS									
	2	DSS	N/H		DCS DSS				1					
P8 trap door open	2	DSS	H2		DCS DSS									

Figure 7: Standardized DSS Needs table for non-CSS-type alarms in SX8.

Figure 8: Standardized DSS Needs table for non-CSS-type alarms in UX85D.

Figure 9: Standardized DSS Needs table for non-CSS-type alarms in UX85C.

Figure 10: Standardized DSS Needs table for non-CSS-type alarms in a counting room.

VII. GLOSSARY

The following table is meant as an overview of terms used in the DSS Working Group in general and in this document in particular. Furthermore some definitions are given in the table. Unless stated otherwise these definitions are taken from the relevant CERN safety documents [3][4].

TABLE 3: GLOSSARY OF TERMS.

Term	Definition	Description
AL1	Alarm-of-Level-1	Equipment or installation fault. Action by the technical service concerned.
AL2	Alarm-of-Level-2	Incorrect operation of equipment or abnormal situation. Immediate action by the technical service concerned.
AL3	Alarm-of-Level-3 (here also:" CSS-type Alarm")	Accident or serious abnormal situation, especially where people's lives are or may be in danger. Immediate action by the Fire and Rescue Group.
AUG	Arret d'Urgence General	General Emergency Stop, general cut-offs issuing a Level 3 Alarm.
AUL	Arret d'Urgence Local	Local Emergency Stop, cut-offs to premises without issuing a Level 3 Alarm
CSAC	CERN Safety Alarm Controller	
CSAM	CERN Safety Alarm Monitoring	
CSE	CERN Safety Equipment	
CSS[13]	CERN Safety System	Entity comprising all parts of the CERN safety system, like CSAM, CSAC, CSE.
DCS	Detector Controls System	
DIP	Data Interchange Protocol	Protocol provided for data interchange. Defined by the LDIWG (cf. [5]).
DSU	Detector Safety Unit	Autonomous unit in the DSS Frontend system.
GasSect	Gas Section	Section in EP/TA1 responsible for the experiment gas systems.
GLIMOS	Group Leader In Matters Of Safety	
JCOP	Joint COntrols Project	
LDIWG	LHC Data Interchange Working Group	
Safety Action	Legally binding action in case of an Alarm-of-Level 3	In accordance with [6].
SAPOCO	SAfety POlicy COmmittee	
SCR	Safety Control Room	Control room of the fire brigade.
SLIMOS	Shift Leader In Matters Of Safety	
TCR	Technical Control Room	
TIS	Technical Inspection and Safety commission	
TS	Technical Services	Entity consisting of all technical services provided to the experiment (e.g. by ST/EL, ST/CV, ...). Contact for the services operation will be TCR.
XCR	Experiment Control Room	In case of LHCb it is called LCR.

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[13] Definition by the DSS Working Group to group several entities without individual impact on the DSS.

VIII. ACKNOWLEDGMENT

The work of the LHC-wide working group on a common DSS for the detectors at the LHC forms the basis of this document. Only through a common effort a system as complex as needed but also as simple as possible could be achieved.

IX. REFERENCES

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