SESSION 2 - SAFETY

EMERGENCY PREPAREDNESS

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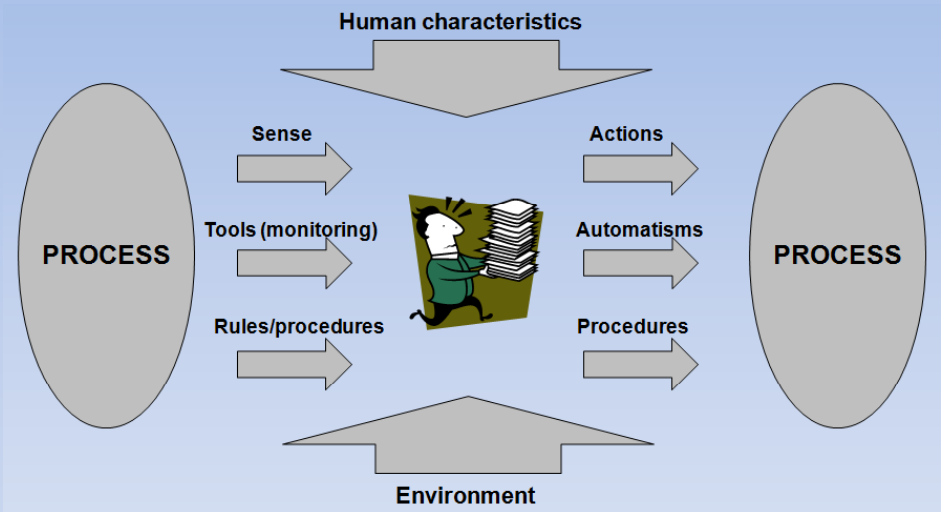
THE CERN STAFF AS INTERFACE OF THE EMERGENCY MANAGEMENT PROCESS … and often it is at the interfaces that the risks come to surface

Human characteristics

- Difficulties to assess the risk and the seriousness during an abnormal event

  The more an event is serious, complex, unknown, non-recurrent, the more the information given to the operator shall be formalised, simple and clear

- Different type of errors
  - Perception errors
  - Decoding errors
  - Operating mode/instruction not respected (deliberately or not)
  - Missing decision in due time
  - Wrong sequence in the actions performed
- Overconfidence bias effect
- Anticipative/Adaptative abilities



Risks at the (Wo)men – process interfaces

- Risks related to the information received from a process
  - ✓ Design of the tools (monitoring)
  - ✓ Pertinence of displayed parameters
- Risks related to the intervention/actions from operators to a process
  - ✓ Is the relation between the action and the expected effect clear enough?
  - ✓ How are managed the different sequences of actions (implicit, explicit procedures, habits …)?
- Communication between people
  - ✓ Correct wording (meaning)
  - ✓ Different languages

RISK MANAGEMENT AND RISK CONTROL

Situations	NORMAL	INCIDENT	ACCIDENT	ACCIDENT Requiring external assistance	MAJOR ACCIDENT	CRISIS
	NORMAL OPERATION - Situation under control - Limited and « short » downtimes		**EMERGENCY MANAGEMENT** - Unexpected and unknown situations, threat for people, environment, equipment - Operation interrupted, long downtimes			

Continuous risk assessment

Preventive/protective improvements

Reviews (audits)

Safety procedures/instructions

Safety training

Equipment and system maintenance

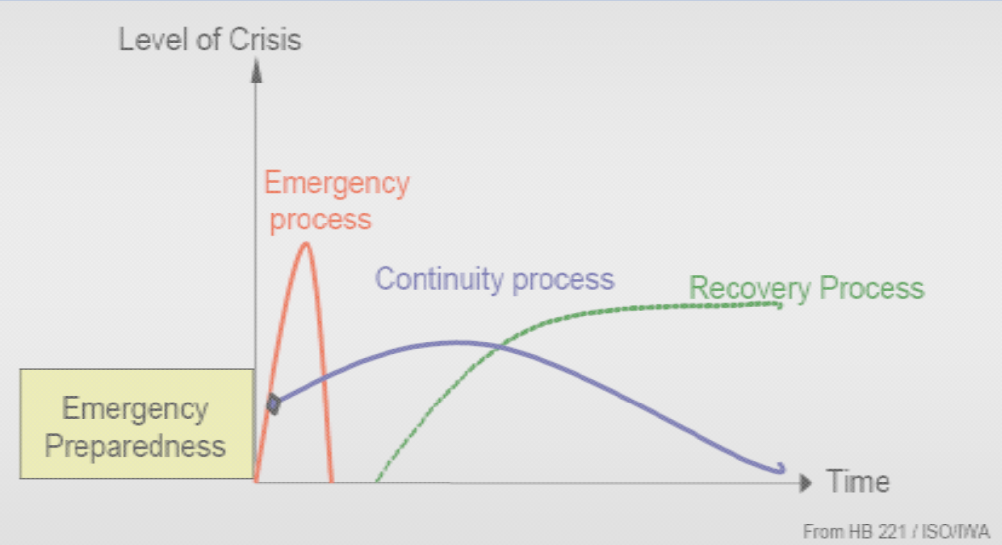
Equipment and system test

Equipment and system monitoring

Management of technical alarms

...

Risk Management



A serious incident/accident/crisis includes three different processes:

- ✓ Emergency response
- ✓ Continuity
- ✓ Recovery

Each must be planned and organised in advance in the emergency preparedness process.

Risk Control

THE 8 STEPS OF THE EMERGENCY MANAGEMENT PROCESS

1	Threats / Hazard	Generic identification of natural, technical or human caused issues that might cause the organization to fail relative to the given objectives
2	Risk assessment - Probability - Impact/ Consequences	Risk assessment is the overall process of risk identification, risk analysis and risk evaluation. The identified threats / hazards become risks when they have a certain probability and measurable consequences on people or the organization.
3	Prevention Define preventive measures	ces in order to alves, periodical ntive measures are iterative evaluation
4	Residual risk acceptance	In spite of control systems and p ve measures there is always a probability that things go wrong. The residual risk has to i ified, evaluated to be within the legal boundaries and to be accepted by the management.
5	Preparedness	Emergency preparedness and incident response has to cover the residual risk. These measures have to be organized, planned and trained before the emergency occurs. Typical example are not only the preparedness of Fire Brigade and Medical Service, but also is there a high importance of the departmental emergency plans coping with the risks identified in 2,3 and 4.
6	Emergency response mitigation of effects	In this step an incident / emergency has occurred and the situation needs to be brought under control by emergency services. This is done with organization schemes according to the level of seriousness e.g. as described in IS 51.
7	Continuity	Continuity is the capability of an organization to operate under exceptional circumstances and situations in order to continue operations at an acceptable minimum level. e.g. continuity of safety systems, power supply, cooling and ventilation, access system.
8	Recovery	Recovery is the reinstallation of normal operation conditions of the organization. A fully fledged emergency management system sets levels (finance, manpower, delivery time) within which it is expected to recover completely.

EMERGENCY PREPARATION AND RESPONSE

Courtesy of E-P Doebbeling

1. THREATS – CERN'S LEVELS OF SERIOUSNESS

Situations	NORMAL	INCIDENT	ACCIDENT	ACCIDENT Requiring external assistance	MAJOR ACCIDENT	CRISIS
Safety Alarm levels	AL0 / AL1 / AL2	AL3		AL3		
Management	Internal			Internal + External		

Levels of seriousness (IS51)	LEVEL 0	LEVEL 1	LEVEL 2
	Level 0-1: Accidents with negligible injuries or damage which are usually rapidly settled locally. Level 0-2: Minor accidents with injuries or small and limited damage and/or pollution, which can be easily mastered and that only concern the territory of the Organization. Level 0-3: Accidents, fires or environmental hazards with injured person(s) and/or damage which can be mastered by CERN with limited need for coordination by CERN specialists or groups and/or singular outside assis	Serious accidents with major injuries or damage or which require long term or high risk intervention of the CERN Fire Brigade or need for coordination by CERN specialists or groups as well as outside assistance. Accidents, where an impact on CERN's surroundings cannot be excluded	Major accidents with an important impact on the site of the Organization and surroundings. Major accidents outside CERN with threats to CERN areas or installations or extended need of coordination and extended support of Host States' emergency services

LHC Sector 3-4

Conventional accident worst case(*)	Release of cryogenic fluids in the tunnel during *shutdown*
Chemical accident worst case(*)	Accidental release of cyanhydric acid following a chemical reaction
Radiological accident worst cases(*)	Fire in the collimator area in Point 7 of the LHC tunnel during beam operation Fire in radioactive elements storage area (i.e. Bld. 607) with radiological consequences Fire on filters at CNGS air extraction outlets

?

Radiological impact (INES scale)	0 – « Ecart »	1 – Anomaly	2 – Incident	3 – Serious incident	4 – Accident with local consequences	5 – Accident with wider consequences	6 – Serious accident N/A	7 – Major accident N/A

* As defined in the document (Plan d'Urgence Interne) PUI sent to the Host States Safety Authorities

1. THREATS – Sector 3-4 event's levels of seriousness

Situation accidentelle relevant d'un PUI conventionnel

Fiche de l'événement redouté

Rejet des fluides cryogéniques en souterrain pendant la période de *shutdown*	
Local	tunnel LHC
Nature de l'accident	rupture d'une ligne d'hélium liquide
Détection	détecteurs « manque oxygène »
Conséquences	danger d'asphyxie et de brûlure pour le personnel
Matériel de protection	masques à oxygène obligatoires dans le tunnel
Mesures préparatoires d'intervention	procédure d'intervention du SSF

Dans le tunnel LHC (machine), les défaillances suivantes peuvent avoir comme conséquence un rejet massif d'hélium en présence de personnes :

- Rupture d'une ligne d'hélium liquide incorporée dans la ligne de distribution cryogénique séparée (QRL) avec un rejet massif d'hélium liquide dans l'enceinte à vide, augmentation de la pression dans celle-ci, ouverture des vannes de sécurité et rejet d'hélium (froid). Débit maximum d'hélium: 2 kg/s ; quantité maximum d'hélium rejeté: 3300 kg.
- Rupture d'un élément dans la connexion entre la ligne de distribution (QRL) et la chaîne des aimants avec rejet d'hélium. Débit maximum d'hélium : 20 kg/s ; quantité maximum d'hélium rejeté: 4250 kg.
- Rupture d'un élément dans une boîte froide (QRLA) avec rejet d'hélium dans le puits et/ou dans une caverne souterraine. Débit maximum d'hélium : <2 kg/s ; quantité maximum d'hélium rejeté: 180 kg.

* As defined in the document *Plan d'Urgence Interne - PUI*

On 19 September 2008, during powering tests of the main dipole circuit in Sector 3-4 of the LHC, a fault occurred in the electrical bus connection in the region between a dipole and a quadrupole, resulting in mechanical damage and release of helium from the magnet cold mass into the tunnel.

The spring-loaded relief discs on the vacuum enclosure opened when the pressure exceeded atmospheric, thus releasing helium into the tunnel, but they were unable to contain the pressure rise below the nominal 0.15 MPa in the vacuum enclosure of the central subsector, thus resulting in large pressure forces acting on the vacuum barriers separating the central subsector from the neighbouring subsectors.

** Report on 080919 incident at LHC (DG)

CONVENTIONAL

+

On 19 September 2012?

RADIOLOGICAL

2. RISK ASSESSMENT

- SPS/CNGS and LHC operation's risk assessment
  - ✓ "INB" reports can be considered as the SPS/CNGS and LHC operation' Safety files – RPS I.7 (EDMS 634769)

    Sector 3-4 event → RPS I.7 needs to be updated!!!
  - ✓ Safety studies performed during the design phase of LHC
    Access Safety System
    Beam Dump System
    Machine Protection System
    etc…

    Sector 3-4 event → Safety Design Criteria at the interfaces?
  - ✓ Simulation, prototyping feedback

    Sector 3-4 event → Functional Safety oriented?

◆ **Consequence categories:**

Category	Injury to personnel		Damage to equipment	
	Criteria	N. fatalities (indicative)	SwFr Loss	Downtime
Catastrophic	Events capable of resulting in multiple fatalities	≥ 1	> $5*10^7$	> 6 months
Major	Events capable of resulting in a fatality	0.1 (or 1 over 10 accidents)	10^6 – $5*10^7$	20 days to 6 months
Severe	Events which may lead to serious, but not fatal, injury	0.01 (or 1 over 100 accidents)	10^5 – 10^6	3 to 20 days
Minor	Events which may lead to minor injuries	0.001 (or 1 over 1000 accidents)	0 – 10^5	< 3 days

11/10/2001 F. Balda - AIWG n. 35

- Lessons learned from past experience with incident/accidents
  - ✓ Logging, reporting and analysis

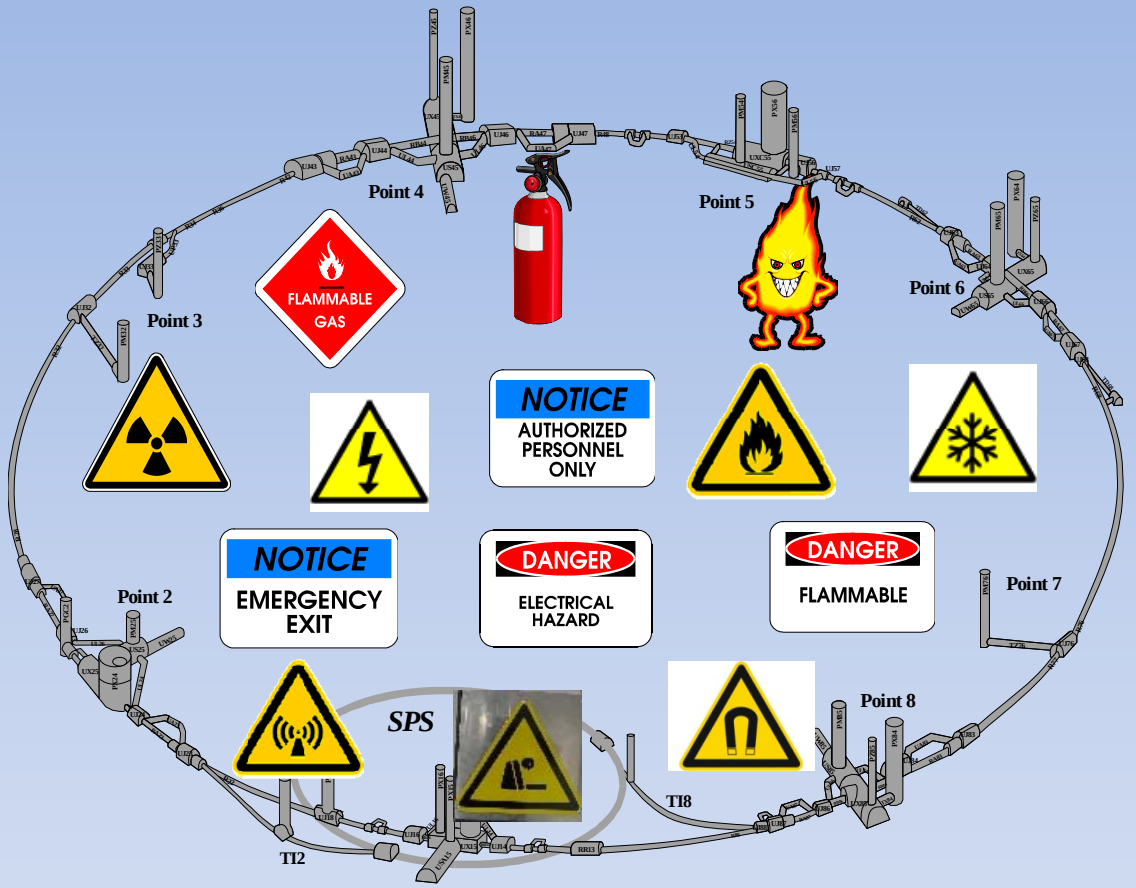
    Sector 3-4 event → Fact finding data/information available? Shared?
- Risk assessment (Safety files) for other existing and new facilities?
  - ✓ LHC Experiments' Safety files
  - ✓ Primary Beam areas (Linac, Booster, PS, AD, nToF, etc)
  - ✓ Secondary Beam areas (PS, SPS Experimental Areas)

Centralised management of all Safety files with relevant information and eventually improvement programs!

3. PREVENTION

➢ PERSONNEL PROTECTION SYSTEMS

- Access Safety Systems
- Access Control Systems
- Fire Detection Systems
- Flammable Gas Detection Systems
- ODH Detection System
- Emergency Evacuation System
- Flooding Detection Systems
- General Emergency Stops Systems
- Level 3 Alarms Transmission Systems
- Personnel Protection Devices
- Radiation Protection Monitoring
- Environmental Monitoring System



➢ MACHINE PROTECTION SYSTEM

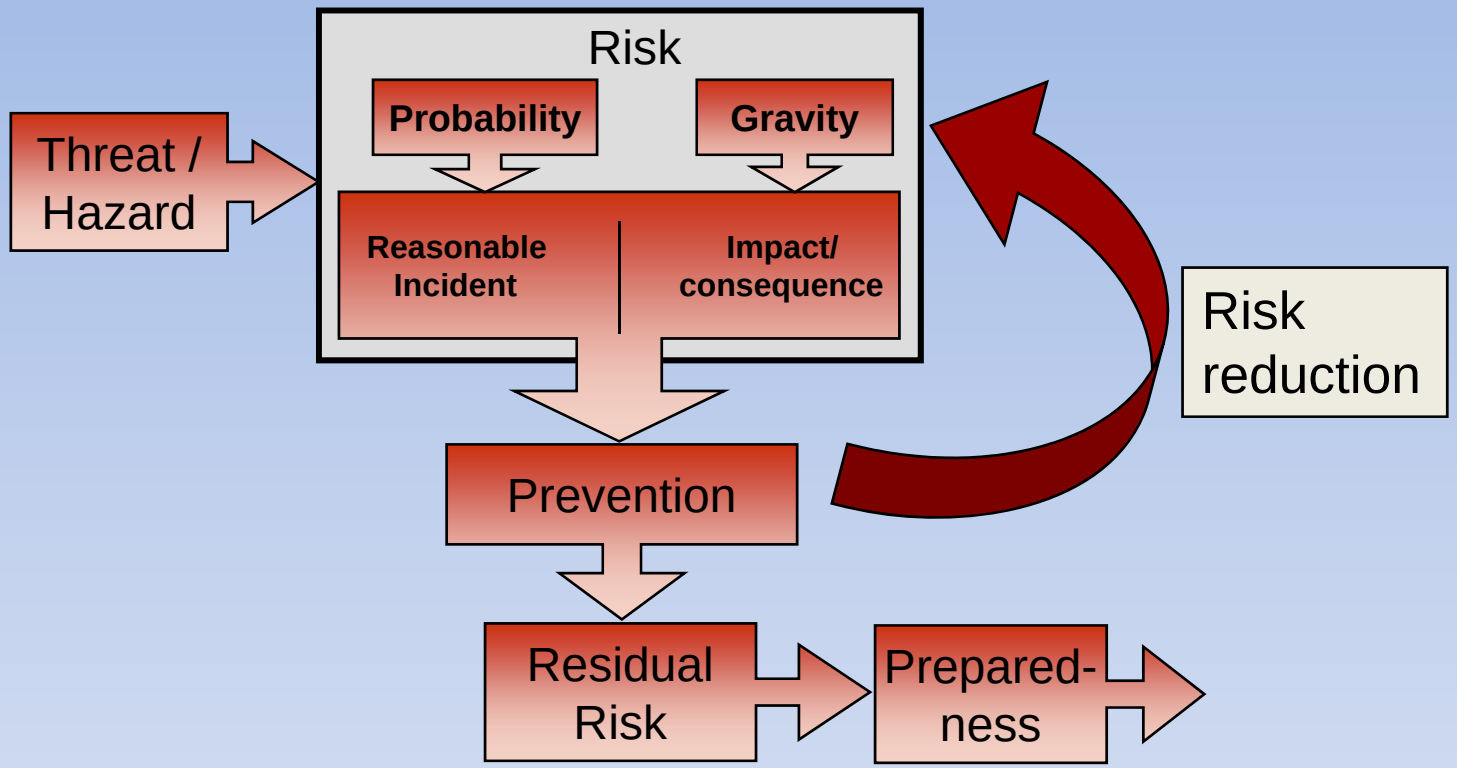
➢ SENSITIVE EQUIPMENT AND SYSTEMS

➢ MONITORING/SURVEILLANCE

Sector 3-4 event ➡ **RELIABILITY / AVAILABILITY / MAINTAINABILITY / SAFETY** | **POLICY** ➡

Maintenance planning
Periodic tests
DSO tests
…

4. RESIDUAL RISK



- Risk reduction by an iterative process of risk analysis and prevention
- The residual risk has to be compared with legal boundaries and accepted by the management

Sector 3-4 event → **ACCEPTABILITY** → **CONSOLIDATION?**

Courtesy of E-P Doebbeling

5. PREPAREDNESS

Preparedness Organisation

- Level 2 Alarms monitoring and follow up
- Near misses analysis
- Procedures/instructions in case of incident/accident
- Education and training of all players (Management, departments, control rooms, emergency services)
- Full exercises as well as table top exercises
- Appropriate Equipment for intervention and Command & Control

Emergency Preparedness documentation

- Documentation/procedures/operating modes *("Perfection is not when there is nothing more to add but when there is nothing more to remove"?)*
  - ✓ In line with the rules and regulations in force
  - ✓ Clear responsibilities
  - ✓ Available where needed
  - ✓ Adapted to the circumstances (from normal situation up to crisis situation)
  - ✓ Simple wording
  - ✓ Pictograms
  - ✓ Documentation Management System
  - ✓ Harmonised templates
  - ✓ Grows in effectiveness and efficiency by real life experience and exercises

Information during Emergency management

- Provide only useful, exact, pertinent, simple and unambiguous information to all stakeholders

5. PREPAREDNESS DOCUMENTATION STRUCTURE

Safety Documentation Structure (Recommended)

Situations	NORMAL	INCIDENT	ACCIDENT	ACCIDENT Requiring external assistance	MAJOR ACCIDENT	CRISIS
Documents Plans (required)	Safety Documents/Plans		Internal Emergency Plan	External Emergency Plan		
			Recovery Plan			
	Risk Management		Risk Control			

CERN Safety Documentation Structure (January 2009)

CERN Safety Rules	Adapted? Applicable? Valid?		
CERN	Departmental Safety Plans	Plan d'Urgence Interne	« Héphaïstos » Project
SPS/CNGS/LHC operation	Règle… …t LHC	Under revision	In work
LHC experiments	Prede… incide… exper… ATLA… …d	Fire Brigade procedures/training/exercises ✓	
CPS Exp. areas	Secu…		
LHC experiments	Safety procedures/instruction/organisation	CERN Recovery Plan	?

Only paper?
Applicable?
Up to date?
Coherent?
Shared?
Managed?

6. EMERGENCY RESPONSE AND MITIGATION

Situations	NORMAL	INCIDENT	ACCIDENT	ACCIDENT Requiring external assistance	MAJOR ACCIDENT	CRISIS
Management	Internal			Internal + External		
Safety Alarm levels	AL0	AL1	AL2	AL3	AL3	
Warning Safety alarm transmission		Monitoring systems **warning** responsibles **and/through** the CCC		CSAM **and/or** phone call to SCR (74444) **warning** the CERN Fire Brigade Host States' services **alerted/informed** following the level of seriousness		
Intervention		Technical services On duty services		CERN Fire Brigade **in collaboration** with the technical services and/or on duty services	CERN Fire Brigade Swiss Fire Brigade (SIS GE) French Fire Brigade (SDIS 01)	
Levels of seriousness (IS51)			LEVEL 0	LEVEL 1	LEVEL 2	
Levels of seriousness (Host States' definition*)			A	A+	B1/B1 bis	B2
Poste de commandement de l'intervention (PCI*)			PCI CERN	PCI CERN **supported by** PCI SIS GE **or** PCI SDIS 01	PCI SIS GE **or** PCI SDIS 01 **supported by** PCI CERN	PCI SIS GE **and** PCI SDIS 01 **supported by** PCI CERN
Etat Major des Opération (EMO*)					EMO GE **or/and** EMO 01 **eventually** EMO leader designated	PCI SIS GE **and** PCI SDIS 01 **supported by** PCI CERN
Cellule de Crise Stratégique (CCS*)					DG CERN Préfet **or/and** Conseiller GE	DG CERN Préfet/Conseiller GE Désignation de l'EMO leader

* Hephaïstos project

7. CONTINUITY

- Identify equipment, supplies, and supply chain interactions that support the critical activities
- Develop strategies to secure operation of safety systems, maintenance and research facilities
- Re-establish critical operations already during incident response
- Maintain operations and services

Energy-Gas sector e.g.
Electrical power
Emergency power supply capacity
Emergency power distribution capacity
Gas, heating, hot water
Compressors
Helium, Argon, Nitrogen

Infrastructure sector e.g.
Access system availability
Safety system availability
Construction safety (Buildings, Installations)
Traffic circulation on CERN sites
Ventilation and cooling
Safe access to underground for maintenance
Information network

Human resources sector e.g.
Delay of CERN stand by services
Delay of contractors' services
Availability of CERN, users' and contractors' specialists
Emergency epidemic plan

Courtesy of E-P Doebbeling

8. RECOVERY

The recovery plan should identify and consider:

- An estimation about the time table for restoration of operation according to the identified main risks
- Identification of installations and operations that cannot be restored with reasonable delay
- Total or partial suspension of operations not urgently needed
- Decisions on keeping on stock a minimum number of critical spare parts
- Additional technical and human resources required from outside
- Co-operation agreements with partners to contribute to the recovery
- Procedures for financial consideration (insurances, provisions, stakeholders)
- Pre-emptive planning based on lessons learned

Courtesy of E-P Doebbeling

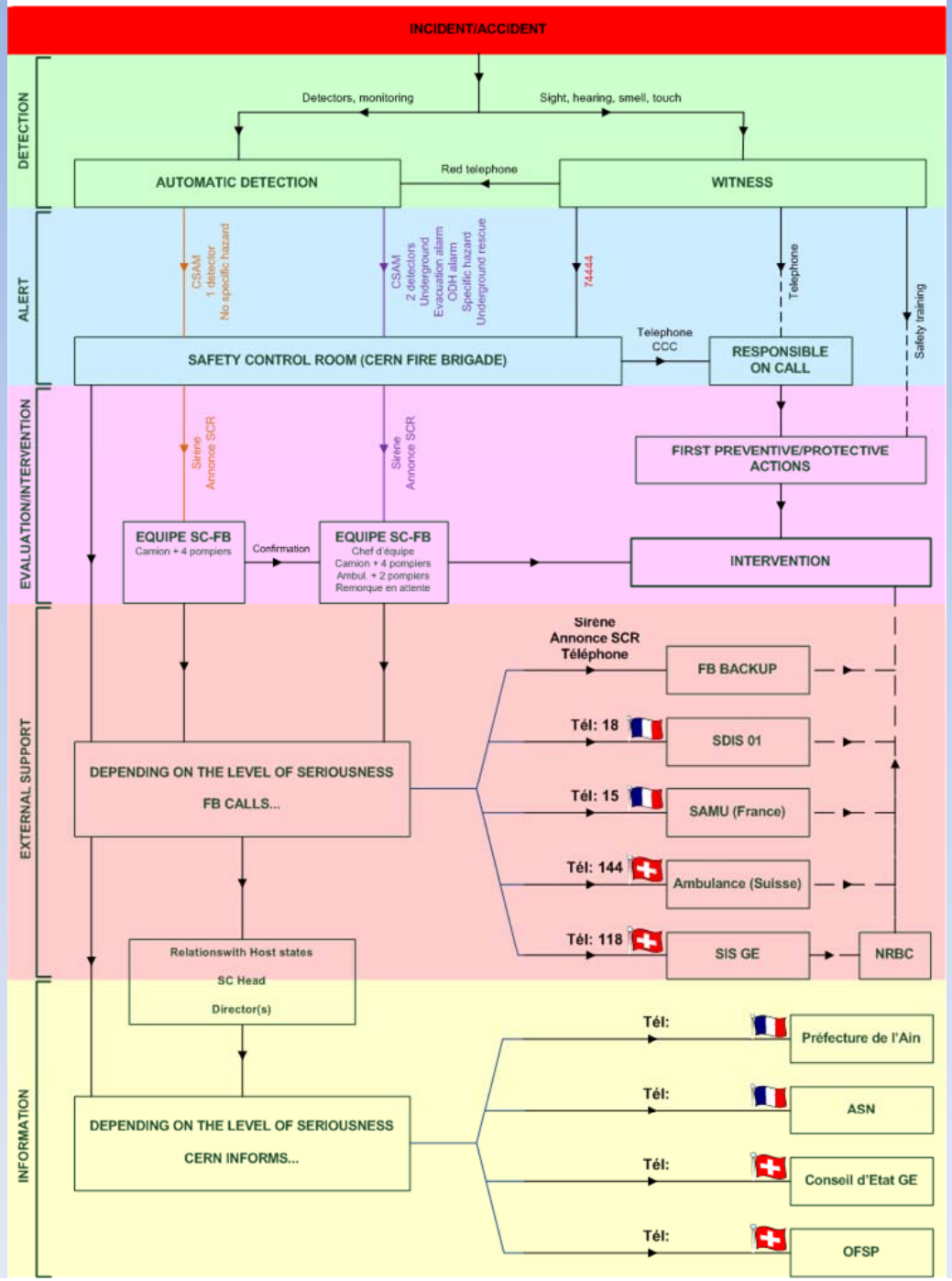
SUMMARY – MAIN POSSIBLE ACTIONS/IMPROVEMENTS

Sector 3-4 accident → **Sector 3-4 opportunity?**

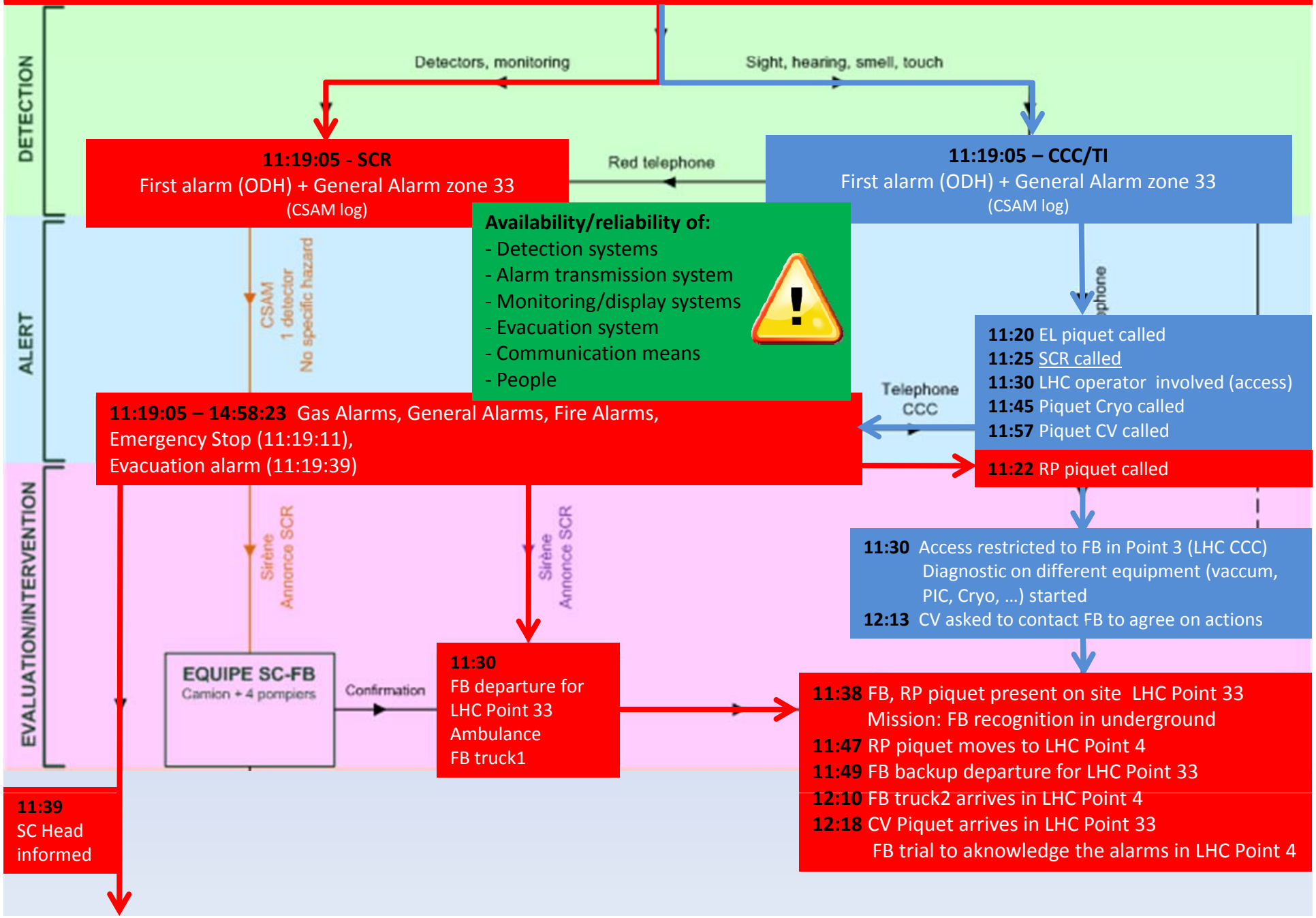
Threats / Hazard Identification	✓ **exhaustive?**	➢ Re-assess the risks of damage to equipment
Risk assessment - Probability - Impact/ Consequences	✓ **incomplete?**	➢ Check the risk assessment at the interfaces ➢ Tackle the Safety File production process ➢ Elaborate a centralised accident logging and analysis tool ➢ Compare CERNs current situation on Emergency management with ISO 31000 and ISO PAS 22399
Prevention Define preventive measures	✓ **availability/reliability to be assured**	➢ Define a list of critical/sensitive systems ➢ Implement a quality assurance plan for these systems ➢ Evaluate the residual risk impact also on downtimes
Residual risk acceptance	✓ **awareness of the residual risk**	➢ Define the consequences related to the residual risk ➢ Search for potential improvements
Preparedness	✓ **(Fire Brigade)** ≈ **Organisation/documentation**	➢ Review/clarify Safety Rules on Emergency Management ➢ Update Safety Plans/Procedures, Internal Emergency Plan ➢ Ask/help for the elaboration of an External Emergency Plan
Emergency response mitigation of effects	✓ **external support?**	➢ Elaborate “modus operandi” with external Emergency services ➢ Perform regular training and exercises
Continuity Recovery	✓ **immediate response** ≈ **framework**	➢ Define a Emergency Management Method ➢ Elaborate Continuity/Recovery Plans (guidelines)

CERN EMERGENCY WARNING OUTLINE

ec/alerte.vsd/Novembre2008



The first evidence was the appearance of a voltage of 300 mV detected in the circuit above the noise level: the time was **11:18:36** CEST (*Report on 080919 incident at LHC - DG*)



SCR

CCC

12:25 CCC informs SCR: Helium leak (~1 ton) at 19R3 up to 22R3 location

12:35 CCC informs SCR: location not fully identified, 6 magnets concerned

12:37 FB recognition mission in LHC Point 33 aborted

12:46 FB intervention team moves to LHC Point 4

12:52 Info AT-CGR: No more leak

12:54 FB intervention team moves to LHC Point 4

Situation on the other LHC site?
- Information
- Instructions
- Evacuation

nforms: location of the problem is between
and 7906

forms: L4 purge: air pulse in the direction

13:15 FB starts intervention in Point 4 underground
Mission: Collecting information: Oxygen Deficiency, Temperature, radiological situation, etc
FB support team and AT-CGR piquet in stand-by

13:32 FB intervention enters R39 tunnel

13:32 CV informs: FB asked for hotest air supply (presently 32°)

13:43 FB informs: progression in direction of Point 3

14:00 Crisis meeting with DG

14:09 FB intervention message: Temperature 20°, Oxygen 13% (1 km from IP4)

14:12 FB informs: Temperature 20°, Oxygen 13% (1 km from IP4)

SCR

14:20 FB intervention aborted due to lack of radio communication

15:20 FB intervention 1st toll:
Recognition up to 1600m from IP4
Frost-covered magnets
Air Temperature 5°
Dipoles temperature -20°
In RE42: 16% O_2, beyond: 11%
Visible Helium cloud
AT-CGR requested to give feedback on QRL
Ventilation air flow: 50'000 m^3/h
PM32 pit (top): Helium present, T = 11°

16:00 New FB intervention with new communication means and instructions

16:35 Intervention request for TIM team. Agreed

16:44 FB intervention on going

17:10 FB intervention team informs: 1600m from Point 3: Temperature = 12°, O2 = 18%, Dipole Temp = -16°

CCC

14:45 FB informs: intervention aborted, Temperature 20°, Oxygen 13% (1 km from IP4)

15:40 FB request received: information on tunnel vault pressure?

15:50 Civil Engineering called: information on tunnel vault pressure?

16:10 Civil Engineering informs: latest data 8.5 bar dated August 6th. FB informed

SCR

17:17 Civil Engineering request: verification of any tunnel vault collapse

17:49 FB intervention team informs: magnets moved from their position, ventilation door repared

18:01 FB intervention in point 3 to control ventilation doors

18:34 All intervention aborted on Project Leader request

18:48 Head of SC confirms the abort instruction

18:58 FB deputy Head evacuation instruction to all FB intervention teams

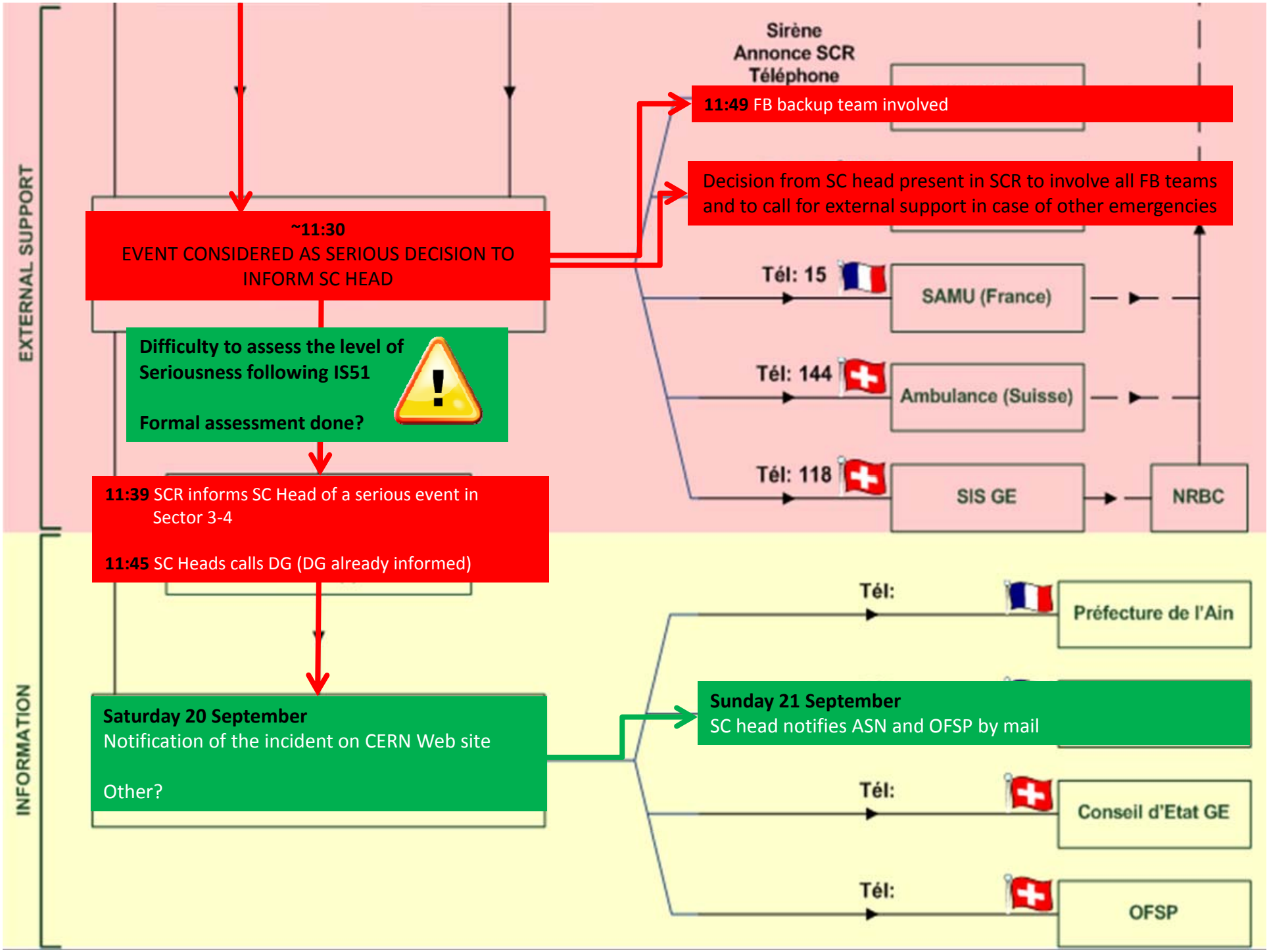
19:04 All intervention teams exits via PZ45

CCC

18:00 Access instruction: No access in sector 3-4 except emergency

18:40 CV informs: they leave the site, ventilation left as it is (50'000 m^3/h, Air temp = 32°)

19:30 FB informs: all interventions ended


EXTERNAL SUPPORT
Sirène
Annonce SCR
Téléphone
11:49 FB backup team involved
~11:30
EVENT CONSIDERED AS SERIOUS DECISION TO INFORM SC HEAD
Decision from SC head present in SCR to involve all FB teams and to call for external support in case of other emergencies
Tél: 15
SAMU (France)
Difficulty to assess the level of Seriousness following IS51
Formal assessment done?
Tél: 144
Ambulance (Suisse)
Tél: 118
SIS GE
NRBC
11:39 SCR informs SC Head of a serious event in Sector 3-4
11:45 SC Heads calls DG (DG already informed)
INFORMATION
Tél:
Préfecture de l'Ain
Saturday 20 September
Notification of the incident on CERN Web site
Other?
Sunday 21 September
SC head notifies ASN and OFSP by mail
Tél:
Conseil d'Etat GE
Tél:
OFSP