IAEA - IWGFR

REPAIRING AN INSTALLATION AND PROCESSING THE RESIDUES

JC. MALET* (CEA) - G. DUVERGER DE CUY* (CEA) - Y. SOPHY* (CEA)
A. CUCINOTTA** (ENEA/CAD)

SUMMARY

After a sodium leak in a locale, producing a fire, the operating first concern is to repair the plant. Since the residual sodium and the products of combustion are chemically aggressive, the personnel will have to perform this operation in an hostile environment. This paper presents answers which can be given at the three questions will however arise :

- When can the intervention begin ?
- How will it be performed ?
- What should be done with the residues of combustion ?

After a sodium leak in a locale, producing a fire the operating staff first concern is to repair the plant. Since the residual sodium and the products of combustion are chemically aggressive, the personnel will have to perform this operation in an hostile environment.

Three questions will however arise :

- When can the intervention begin ?
- How will it be performed ?
- What should be done with the residues of combustion ?

This document aims at presenting the different solutions to this problem, these solutions being derived from experiments carried out in France either in the Esmeralda Program, which is managed jointly by CEA and ENEA, or in the other French programs.

As a general rule, the intervention inside the locale can be made much more easier if :

- it was foreseen right from the beginning of the design (access under the pipes, anchorage for handling, etc...)
- the incident can have be localised thanks to the monitoring of locales, enabling the video recording of the first instants, that is as long as visibility does not fall to zero due to the aerosols from the fire.

1. CHOICE OF THE INTERVENTION TIME AND INSTRUCTIONS FOR INTERVENTION

The operator's first task is to localize the incident inside the locale, in order to study the risks incurred by the operating staff and to set up an intervention and repair procedure. The intervention will depend

upon the specificity of the locale, the operating rules of conduct adopted during the incident, the quantity of sodium released and the locale condition during the incident. Before sending personnel into a damaged locale, it will be necessary to wait until :

- visibility inside the locale is sufficient,

- the sodium temperature has fallen to less than 40°C, the temperature inside the locale is as low as possible,

- the quantity of aerosols deposited on the walls and on the floor is wet enough to be converted into soda. This precaution will have to be taken, especially when the fire is confined or semiconfined and therefore produces sodium peroxide aerosols. When these aerosols react with atmospheric moisture, they produce nascent oxygen which brings about an inflammation of the organic materials present in the locale. This sudden reaction may endanger the operator's life.

The risks incurred by the workers during this operation are the following :

. chemical risk,
. electrical risk,
. mechanical or handling risk.

- The chemical risk :

This is due to the aerosols remaining in suspension in the air and forming a deposit on the vertical walls and on the ceiling. These aerosols can fall onto the workers in soda state or they can be converted into soda through perspiration. If the worker wears permeable clothing, there are risks of chemical burns. In order to a void burn by inhalation of aerosols, the workers have to use smoke helmett.

- The electrical risk :

As much as possible low voltage equipment will be used. In case normal voltage equipment is absolutely necessary, the circuits will be protected.

- The mechanical or handling risk :

The presence of aerosols on the locale floor increases the loss in adherence to the ground, which in turn produces a risk of slipping. Moreover, soda may form a deposit on the gloves. Consequently, lubricated devices are difficult to handle : the hazard resulting for example from the use of circular cross-cut saws is considerably increased. In addition, the difficulty of intervention resulting from the wearing of the special clothing and mask which reduce vision has to be taken into account.

2. INTERVENTION

2.1. Intervention inside the locale

Once the aerosols are removed from around the damaged zone, the first operation consists in removing the sodium and the crusts of residues which may be stuck to the exterior surfaces of the various structures. The technique used to clean the locale may differ, depending on the type of residue to be removed.

- If combustion is almost complete, the crumbly residue can be removed with a shovel and then placed into casks which are not hermetically

sealed, these casks are then placed into containers (see § 3),

- If combustion is incomplete, either because the sodium has fallen into smothering tanks or because the available oxygen is not sufficient or because the fire has been extinguished with powder, the tank containing the residue has to be cut into pieces. They may then be placed into transport containers to be avacuated to a sodium destruction installation. In this case, it is necessary to cut the sodium before cutting the sheet metal of the tank (examples : smothering tanks, funneling floors).

  The sodium can be cut by means of :

  . an hydraulically boosted blade,
  . a sodium-adapted chain saw,
  . a pick hammer.

  In the case the sheet metal of the tank has to be removed, two techniques can be used to cut it :

  . a detonating fuse : in this case, the operator must be qualified for handling explosive substances ; moreover, since the detonation may result in the formation of burning sodium particles, it is necessary to have extinguishing powder at hand, either in extinguishers or in bulk.

  . the electron torch, provided that the sodium is not touched.

The intervention team operating in a locale must be in permanent contact with a technical support team outside the locale. This team will be responsible for the supply of the intervention equipment and for waste disposal. Any intervention requires beforehand :

. specific handling equipment, for the locale is not always designed for this purpose,

. intervention equipment,

. special clothing in sufficient number in order to make the intervention possible, taking into consideration the cleaning and drying of the clothes (workers must always wear clean clothes for each intervention),

. the neighbouring premises must be equipped with a minimum number of lockers, as well as with water for rinsing out the special clothes and preliminary treating of burns.

If the structures filled with sodium or residues still containing sodium have to be stored in an annex locale before the eliminating of their contents, it is necessary to cover the surfaces either with sheet metal or with extinguishing powder.

Once the equipement and the structures are evacuated, the floor and the locale walls are washed down with water.

2.2. The protection of persons

The individual protection of the operators is ensured by clothes adapted to the tasks to be performed. The problem is to combine resistance to sodium and high temperature with lightweight materials and ease of use.

Several types of special clothes, meeting different requirements, have been developed in France : ETNA 100, ETNA 1000 and PARNA.

If workers are burnt by soda or sodium, fast intervention is essential. It is the reason why it is recommended to have washing facilities (intervention showers) next to premises where there is a sodium risk. For soda burns, we advise running water onto the wound and then applying a low acid content neutralising solution. For sodium burns and in the case it is impossible to remove the metal rapidly, we advise immersing the injured part in a great quantity of water even if this intervention produces a risk of a localized sodium-water reaction.

3. PROCESSING OF RESIDUES

3.1. Storage and Transport

A sodium leak due to large-scale fires produces important quantities of residues, which in turn brings about a problem of storage and transport to the processing plant.

The composition of these residues is qualitatively known. They contain non-burned sodium (or sodium metal), sodium monoxide and peroxide, and in certain cases, MARCALINA powder (sodium fire extinguishing powder composed of alkaline carbonates and graphite). On the other hand, the proportion of each product varies according to the fire conditions.

Since the containers available in France are not adequate, the CEA and the ENEA within the framework of the ESMERALDA program, have developed a type of container for sodium residues which meets the requirements of the current legislation concerning the transport of dangerous substances.

3.2. The processing of residues

The residues are processed by water thus producing soda. This exothermal reaction releases hydrogen which may combine locally with oxygen in detonating proportions. The destruction can be controlled by :

- regulating the water aspersion rate,
- using dynamic confinement, involving forced ventilation and effective trapping of the aerosols in order to reduce soda release into the environment.

A prototype locale for the destruction of residues has proved the validity of this method, by processing a ton of sodium per day.

4. CONCLUSION

Thanks to studies carried out on a medium scale (PLUTON 400 m^3) and on a large scale (ESMERALDA), it was possible to identify the problems an operator may face in the case of a sodium leak. The results brought about the development of techniques that not only will make the operator's task easier but have brought to light the problems he may encounter. This research has made it possible to work out elementary rules that can be used as a basis for defining obligatory instructions in the case of any intervention following a sodium fire.