Nils Marstein:

FIRE PREVENTION IN NORWAY'S LISTED BUILDINGS

Fire is a constant threat to Norway's listed buildings, the majority of which are built in wood. Every year in Norway seven or eight buildings which are of historical or architectural interest are damaged by fire. Let us take a closer look at the various forms of fire prevention which have been applied to listed buildings in Norway.

Fire precautionary measures

The most important thing of course is to prevent fire from breaking out. To this end, we have supplied specific information on fire prevention for each individual building.

In order to prevent grass fires from spreading to buildings, all vegetation is removed in a 1 m. wide zone around the building. Emphasis is placed on the esthetic appearance of this zone in order to retain the relationship between the building and its surroundings.

Statistics show that most fires in Norway are caused by faulty electrical equipment or defective wiring. We therefore ensure that the main cable and fuse-boxes are moved out of the listed building and placed in a separate fireproof room, that new electrical appliances are installed, and that the building is rewired to the optimal capacity.

Most buildings already have some form of lightning conduction, but investigations have shown that the system is often of little benefit, since it has insufficient capacity or has been erected so that it is likely to short-circuit. We replace all lightning conductors with new ones which are properly designed for the job they are supposed to be doing.

To reduce the risk of fire, all attics are cleared, taking care, of course, not to discard any valuable material, which might be there. Vacuum cleaning reduces the risk of dust being ignited by lightning.

Active fire-fighting devices

Hand-held fire extinguishers

These are the simplest, cheapest and probably the best cost-effective means of extinguishing a fire, on the assumption that proper instruction is given in the use of the apparatus. Extinguishers based on powder or water must weigh at least 6 kg,

and preferably 9 kg as smaller extinguishers will have emptied themselves before the best angle of attack has been established.

Automatic fire-protection systems

Hand-held extinguishers presupposes that there is someone around when fire breaks out, as they are of no use against a fire which has got a hold. For this reason automatic extinguishing devices are also necessary. They are expensive, and planning and installing them is a time-consuming process. They also require continual maintenance.

Many of the problems which face us in listed buildings cannot resonably be solved with conventional technology. This applies especially to detecting and extinguishing fires externally. We have therefore made a series of thorough investigations and have carried out relatively extensive projects aimed at finding the best solutions technically and esthetically.

External systems designed to detect and quench fires are greatly affected by climatic conditions. Equipment has not been readily available and it has therefore been necessary to develope new equipment and new techniques for satisfying the requirements imposed by the installation and use of such a system in a listed building. After an extensive examination of various automatic fire detection and extinguishing systems, we have chosen the following model:

The chosen fire-alarm system

The operations control system is situated in a fireproof room either within the building itself or in an adjacent one. All the fire detectors connected with the control unit are individually traceable, so that any detector which has activated the system will be identified and the necessary procedures associated with that particular detector will be automatically put into operation. The message received by the local fire service will also indicate which of the detectors for one reason or another has been activated.

The typical fire detection system will consist of a series of separate detection circuits. When one or more detectors are activated, the appropriate section of the fire extinguishing system is put into operation, while other sections will be placed on the alert. The local fire service is warned simultaneously and a siren is also automatically set off to alarm the local community.

The internal alarm system

Inside the building, heat-sensitive detectors and/or smoke detectors are used.

The heat detectors are activated if a predetermined maximum temperature is reached, or if the rise in temperature is more rapid than determined beforehand.

There are various types of smoke detectors. Ionisation point detectors react to invisible smoke and are in principle similar to the rather more primitive domestic type of smoke detector we all have at home. Optical point detectors react to visible smoke. We therefore usually use a combination of these two types to secure a rapid detection of both kinds of smoke.

Line detectors transmit an infra-red beam across the room, which is either taken up by a receiver on the other side of the room or else reflected back to a receiver built into the transmitter. Any smoke which intercepts the beam will reduce the amount of light received and activate the alarm.

Detectors can create serious esthetic problems. Their size and form means that they are often very visible in a sensitive interior, especially where double detectors are used. It is difficult to find a suitable way of mounting two circular detectors side by side in the interior of a listed building. We have consciously played manufacturers against each other in an attempt to get the size of detectors reduced.

Our special requirements concerning the size and form of the detectors can lead to extra expense in getting them tested for approval by insurance companies. However, we have chosen to design and construct detectors according to our own specifications without the formal approval of insurance companies. Our alterations, in fact, involve only the outer housing, not the electronic parts or the detector chamber. The work is carried on in close collaboration with the manufacturer who guarantees that "our" detectors are of the same quality as standard detectors. As a result we now use double detectors in small specially constructed containers, but as they are not officially approved, they do not qualify for a reduced insurance premium. However, all the extra expenses are covered by government funds, so they are financially viable for the owner of a listed building.

The colour of the detectors also created problems. The standard colour is white and where alternative colours are available, these do not satisfy our requirements. Manufacturers were unwilling to provide other colours suitable to our requirements, but after much discussion, they accepted alternative colours on condition that they could paint them themselves. Today, the staff of the Conservation Department of the Central Office of Historic Monuments are able to paint the detectors a suitable colour on the spot. Problems arise when a detector has to be replaced: a standard detector can be replaced by service personnel, whereas with our specially coloured detectors, only the inside can be replaced, which naturally involves extra work.

Through our active involvement in reducing the size, changing the shape and choosing our own colours for the visible part of the detectors, we have succeeded in obtaining a device which is esthetically and architectonically acceptable in the interiors of our listed buildings.

Exterior alarms

Externally we use heat detecting cables, as well as smoke or heat detectors which are similar to those used inside the building.

Heat sensitive cables fall into two categories. In the conventional kind, overheating causes a circuit to close, thereby setting off the alarm. This is the kind we use today, parallel with a second type developed according to our own specifications for use in buildings situated in areas where there is a wide range in temperature. This consists of a cable with 5x30 mm heat-sensors mounted at regular intervals of 1-1.5 m. The sensors only record the temperature and transmit this information to the control unit, which is able to compare it with the air temperature at a predetermined reference point. If the difference between the temperature by the wall of the building and that at the reference sensor exceeds a predetermined value, for example 30°C, the control unit will activate the alarm.

This system therefore will make compensation for wide variations in the external temperature, and ensure an equal reaction time whatever the season: with an external temperature of minus 30 the alarm will be set off if the temperature by the wall of the church, for example, is zero, whereas with an external temperature of plus 20, the alarm will be given if the temperature at the building reaches 50°C. The detectors are mounted in epoxy and can withstand the effects of the climate without their performance being affected.

Extinguishing fires internally

We looked at a number of possible extinguishing systems at an early stage in our work. Internally, three systems were considered: halon gas, light foam and water sprinklers.

Halon seemed quite promising from the outset. It is a non-aggressive gas, which means that it will not damage wood or decoration. It will suppress a fire if it constitutes more than 5% of the atmosphere, but if it exceeds 12%, the air becomes toxic to humans. A closer investigation showed, however, that the gas is ineffective against smouldering fire or combustion inside solid timber. To be effective, it must be released instantaneously and its concentration must be restricted to between 5 and 12% until the fire-fighting team can take over. A concentration within such narrow limits is impossible to achieve inside the

kind of buildings which we interested in and we have consequently stopped considering the use of halon for our purposes.

Light foam is produced when water containing a foam-producing agent is subjected to a great quantity of air. A litre of water can give up to 1000 litres of foam, which is therefore very dry and will cause minimal damage to even the most susceptible surfaces. The apparatus can often be very large, but the greatest problem is the harm it would cause to humans if released by mistake. It would have to be designed so that the building is filled with foam within five minutes, and if anyone is unable to get out, they would run the risk of becoming asphyxiated once the foam reached head-height. For this reason foam cannot be used for quenching fires in our case.

A **sprinkler** system, consisting of a network of water pipes with a series of spray-heads which automatically open at a predetermined temperature, was therefore the only system we could use internally, and it has been selected in spite of the fact that if it is set off in one of our decorated stave-churches, any medieval tempera will be washed away in less than thirty seconds. We have agreed that it is better to be left with a medieval stave-church with no decoration than to let the church burn to the ground with its decoration intact.

As the system is based on water, there is a danger of damage from frozen pipes. To avoid this, the pipes contain only air, and are not filled with water until a frost-proof valve has been activated.

Extinguishing fires externally

Outside we have up to now also used sprinklers, usually employing a combination of the dry system where the spray-heads are opened individually as necessary, and the deluge system where all heads release water simultaneously.

In the dry system, the pipes are filled with pressurised air. If the heat from a fire causes a spray-head to open, the pressure will drop and the valve will open, letting water into the system. If the alarm is first given by one of the detectors, the valve will also open, filling the pipes with water in readiness, so that if one of the spray-heads then opens, water will immediately be released over the burning area.

In the deluge system, the alarm will cause the valve to open, filling the pipes with water which will be released from all spray-heads in the relevant section of the system.

It is not always easy to adapt the extensive network of water pipes required by a sprinkler system to the sensitive environment of an antiquarian building. Moreover, the dimen-

sions of the pipes must be suitable for the amount of water which is to pass through them. Nevertheless we have been able to make some allowances in order to arrive at the best possible esthetic solutions. Norwegian insurance companies only approve the use of steel pipes for sprinkler systems. In spite of this and in spite of the extra cost, we use copper piping. There are obvious advantages. Firstly, allowance does not have to be made for internal rusting, which means that we can use a narrower gauge. Secondly, copper piping is more flexible and can be adapted more easily to the details and irregularities in the building. To reduce the dimensions even more, we have developed a method of joining pipes together without the use of visible collars.

At the moment we are experimenting with various additives to increase the wetness of water. By breaking down the surface membrane, the saturation potential will increase radically, which means that the same quenching effect can be achieved with less water, again leading to a reduction in the dimensions of the pipes.

In addition to these technical solutions, we have established a set of esthetic rules concerning the best distance between parallel pipes, the distance between the pipes and the wall or ceiling, the way the pipes should follow the architectonic details, and so on. By following these guide-lines, and by employing skilled, hand-picked plumbers who are particularly interested in antiquarian buildings, it has been possible to have pipes exposed in the sensitive interiors of listed buildings and medieval stave-churches without them affecting the general appearance of the room.

Water spray monitors

In 1987 we are going to install the first external fire-quenching system based on water spray monitors controlled by external alarms. Oscillating jets will be able to cover a wide area and at the same time we will be able to avoid mounting installations on the building.

Miniature fire stations

As a simple and effective alternative to automatic sprinklers we can establish miniature fire stations. A provisional prefabricated station would cost approximately 50,000 *kroner* and would contain a water tank, heated to prevent it from freezing, an electric pump and a couple of hose-reels. The water could also be supplied by connecting the system to the water main or to a reservoir. A c. 5 kilowatt electric supply would be required for the pump and for heating. The miniature fire stations would operate like manual fire-hydrants. At the outbreak of fire, one would switch on the pump and pull out the hoses. The water is automatically turned on when the hoses are unreeled.

SUMMARY

Fire is a constant threat to Norway's listed buildings, the majority of which are built in wood. Fire precautionary measures include establishing a 1-1.5 m wide vegetation-free zone round all listed buildings, checking and renewing the electrical wiring and electrical equipment, moving the main intake and fuse-box to a separate fireproof building where possible, ensuring that lightning conductors are of sufficient capacity and properly mounted so as not to cause short-circuiting, keeping attic rooms tidy and clean, and providing individual fire-precautionary information for each listed building.

To supplement conventional fire quenching appliances, extensive investigations have been made into automatic fire warning systems and fire fighting equipment. The system we have chosen consists of a control unit receiving information from smoke and heat detectors both inside and outside the building. When activated, the sprinkler system is put into operation, the alarm is sent to the local fire service and the local community is warned by a siren. Both optical and ionisation smoke detectors are used, often in special esthetically designed and coloured casing suitable to the sensitive interior of a listed building. For fire quenching, both halon gas and foam were considered but rejected for various reasons. In order to prevent the risk of frozen and burst water pipes, these normally contain only air, and water from a warmed, pressurized tank is only admitted into the system after the alarm is activated. Different circuits enable controlled use of dowsing, and the control unit will ensure that adjacent circuits are placed on the alert for instantaneous reaction if necessary. Because of the wide range in outdoor temperatures, from 20° or more below zero in winter, an absolute predetermined temperature cannot be used for activating the alarm. Instead, the control unit compares the temperature at the wall of the building with the air temperature some way away and will react to a pretermined difference.

Great attention is placed on the esthetic appearance of the sprinkler system, copper piping being preferred for its flexibility. Guidelines have been drawn up for positioning the pipes so that they will not obtrude on the visual experience of the interior. The design and colour of detectors has already been mentioned.

Current experiments involve attempts to increase the wetness of water, thereby improving its quenching capabilities. With less water required, we will be able to use less obtrusive installations. Externally, water-cannons with oscillating jets placed well away from the building are now being tried, thus avoiding the necessity of mounting installations on the building itself.

Résumé

L'incendie menace constament les monuments historiques de Norvège qui pour la plupart sont en bois. Les mesures préventives en vigueur sont les suivantes: établissement d'une zone libre de toute végétation sur 1m-1,50 de largeur autour du monument, contrôle et renouvellement des installations électriques, déplacement du compteur et des fusibles dans un bâtiment à part si possible, contrôle de la capacité et du montage des fils conducteurs afin d'éviter les cours-circuits, entretien des parties sous les combles, enfin rédaction d'une fiche d'informations pratiques pour chaque monument.

Pour suppléer aux installations d'extinction conventionnelles on a fait des recherches poussées dans le domaine des alarmes et des extincteurs automatiques. Le système que nous avons choisi consiste en une unité de contrôle recevant des informations fournies par des détecteurs de fumée et de chaleur placés à l'intérieur et à l'extérieur du bâtiment. Celui-ci met en marche automatiquement le système d'aspersion tout en donnant l'alarme au service d'incendie le plus proche et en avertissant la communauté locale par une sirène. On utilise aussi bien des détecteurs de fumée par système optique ou par ionisation, souvent dessinés spécialement et dont la couleur s'harmonise le plus possible à l intérieur du monument. Quant au système d'extinction, ni le gaz halogène ni la mousse n'ont été retenus pour diverses raisons.
Pour prévenir le risque de gel qui ferait éclater les conduites, celles ci sont en général remplies d'air et de l'eau chaude sous pression provenant d'un tank ne les rempli qu'au déclanchement de l'alarme. Différents circuits facilitent le dosage et l'unité de contrôle assure que les circuits adjacents sont mis en marche dès que cela devient nécessaire. A cause des grandes différences de température extérieure , qui peuvent descendre au dessous de 20° en hiver, il est impossible d'utiliser une température de base pour déclancher l'alarme .L'unité de contrôle est pourvue d'un système qui réagit à un écart de température déterminé entre les murs et l'air ambiant.

On a accordé une attention toute spéciale à l'aspect du système d'aspersion, des tuyeau en cuivre ont été choisis de préférence à cause de leur flexibilité. L'emplacement des tuyeaux est soumis à certaines règles afin d'éviter des installations inesthétiques. Le dessin et la couleur des détecteurs a déjà été ementionné.

Des essais sont en cours pour augmenter l'humidité de l'eau afin d'augmenter ses propriétés d'extinction. En diminuant la quantité d'eau nécessaire on peut ainsi réduire les installations inesthétiques. A l'extérieur des jets à oscilliation placés à bonne distance du bâtiment sont à l'essai, ce qui pourrait éviter les installations à l'intérieur dans l'avenir.