Transitional Attack: White Paper

Background

In 1982 following the loss of two Stockholm firefighters in a flashover, two Swedish fire engineers proposed changes to the tactical approach employed during structural fire attack in an effort to counter the hazards associated with flashover. Mats Rosander, of the Helsingborg Fire Department, and Kris Giselsson had been working on a research project that was aimed at addressing combustion in the gaseous-phase in an effort to optimize the application of water fog for firefighting purposes.

In relation to gas-phase fire suppression and optimal water placement by Lloyd Layman, this approach may not have appeared particularly innovative at the time as earlier research had been undertaken in the USA during the 1940s and 1950s.

Layman's pioneering research into indirect extinguishment and atmospheric displacement was subsequently taken up by Iowa State University when Keith Royer and Floyd Nelson advanced the theories further. The Iowa State University research concentrated on methods and techniques of applying water in finely divided form onto superheated surfaces within a compartment, in an effort to hinder the combustion process and displace the oxygen content within a room, through the creation of large amounts of steam. The principals involved were scientifically proven but the practical applications by firefighters were often misunderstood. The intention was for indirect extinguishing techniques to be used in unoccupied structures, and this form of indirect attack remains an effective and safe tactical attack strategy when correctly applied under a specific range of fire conditions. (Excerpt 3D Fire Fighting, first edition, fpp)

PyroLance UHP Piercing Technology

PyroLance introduces its fine mist of water through a small opening less than 1/8 inches – 3mm. A rapid reduction in temperature occurs without introducing large amounts of oxygen, which greatly reduces the likelihood of flashover or backdraft. Firefighters can manage the thermal layer while remaining outside in a safe, shielded, defensive position.

Actual Size of the Entry Hole

PyroLance makes fire scenes safer by cooling the thermal layer and eliminating the risk of backdraft and flashover.

PyroLance uses pressurized water with a non-metallic aggregate, it is completely non-heat producing and does not generate sparks. This gives PyroLance the ability to quickly breach and/or cut most types of materials without creating any additional heat or sparks. In addition, without the requirement of any other tools, it becomes both a defensive and offensive fire attack tool.

PyroLance as a disruptive technology is a true revolution in firefighting equipment and operational methodology, and the key to achieving a true transitional attack capability.

Transitional Attack

The term 'Transitional Attack' proposes changes in the way firefighters gain entry and approach room and content compartment fires within the confinement of a burning building. It addresses issues such as tactical venting of structures, and proposes alternative means of alleviating worsening conditions in some circumstances. It encourages a risk–based approach to interior firefighting where the concept of personal risk versus gain must be seriously considered. It also proposes the idea that firefighters, prior to entering the structure, must attempt to assert control of the interior fire conditions before entering the involved fire zone or structure.

This new culture of asserting control on the fire prior entering is a key aspect of "Transitional Fire Attack" and the overall strategy toward increased fire fighter safety. The firefighter is encouraged to differentiate between modes of attack and on scene actions that can be described in offensive and defensive terms. While using the Lance, it is possible to be in an offensive mode while maintaining a defensive position.

At the very root of "Transitional Fire Attack" is the safe person concept that views the safety of fire fighters as a priority, while still providing them with tools, techniques, and tactics that allow them to be highly effective in their approach. It is about providing them with a system of work to achieve their objectives in a safe and efficient manner.

The concept of 3D firefighting is an effort to gain the firefighters attention, and direct their minds to the highly hazardous three dimensional volumetric risk of accumulating fire gases that was rarely obvious and never visible until it was too late. This was to teach optimal use of fire suppression and quenching techniques in the gaseous–phase in line with entry, advancement, and tactical venting actions, as an overall strategy that would not conflict in any way but rather serve as a complimentary range of tactics. (Excerpt 3D Fire Fighting, first edition, fpp)

Using the Lance

With the introduction of the PyroLance Ultra High Pressure Water Mist System, the ability to cool the gaseous phase of the fire becomes a real alternative to physically taking the "energy" out of the thermal column, and therefore leaves the fire fighter with a lazy fire that does not threaten

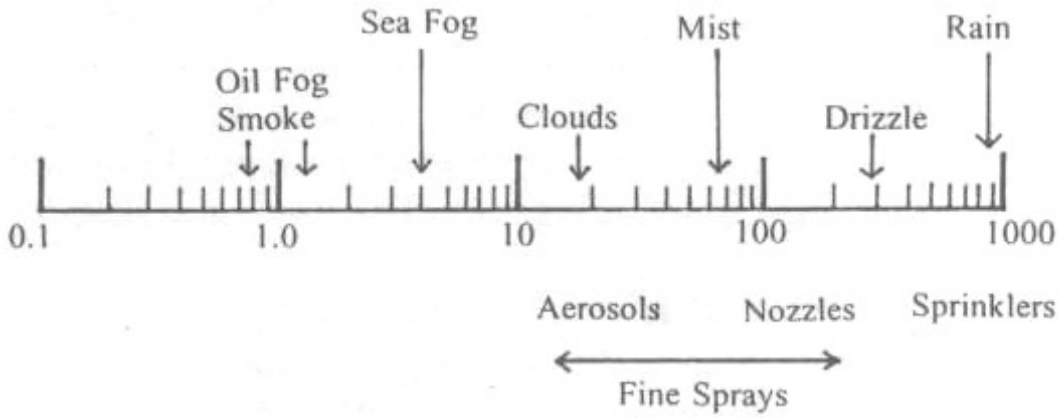
his safety nor allows the possibility of lateral spread. The major benefit is that all this can be achieved by penetrating from the outside of the structure prior to entering.

By using the Lance to penetrate through the outer structure in very quick time and allowing the ultra-high pressure water mist to flow directly into the thermal column, the "gas cooling" effect will bring the interior temperatures down to well below flashover conditions.

By introducing ultra-high pressure water mist to the fire service, the efficiency factor just quantum leaps due to four very simple scientific reasons:

- Droplet size
- Droplet speed
- Hang time - suspension of water droplets in the atmosphere
- Increasing humidity

When discussing water mist systems, often the immediate interest is in the size of the water particles being produced. This factor greatly effects how the spray will interact with the fire and which of the extinguishment mechanisms listed above will play significant roles. Figure 4 shows the spectrum of drop sizes from 0.1 μm to 1,000 μm in relation to everyday occurrences.



- The size of water particles plays an important part in the characteristics and interaction with a fire. In the case of heat extraction, smaller particles result in a higher surface area and hence faster heat extraction for a given volume.

- Additional to this is the falling rate, considered hang time, of a particle as it passes through the plume. As a particle becomes smaller the drag force created across its surface becomes larger in relation to its mass and hence the gravitational force on it.

A large particle will fall quickly to the floor while a small particle will fall at a much slower rate. If this rate is lower than the velocity within the plume, then the particle will be lifted within the plume and circulated within the compartment.

- The speed of the droplet greatly affluences the ability of the water mist to absorb the heat. Traditional nozzle technology is seeing droplet velocities of approximately 40mph (64km/h) compared to UHP technology which can attain droplet velocities approaching 150mph (241 km/h) or even 240mph (386km/h).

- Increasing the humidity inside the structure interrupts the flame chain reaction thereby inhibiting the process of pyrolysis.

Transitional Attack – Ventilation Profiles

One of the most difficult decisions a fire commander or firefighter must surely make while on scene during the early stages of a fire is whether to ventilate or not. Is the best option to pop that window? Cut into that roof? Open the skylights? The strategy of venting buildings has been approached from many angles. In the USA it has long been accepted that the most viable approach for firefighters is to open the building at an early stage of fire operations, in an attempt to relieve conditions for firefighters and trapped occupants. This is also seen as a method of preventing various forms of extreme fire behavior, flashover, backdraft, etc. as well as controlling vertical fire spread from mushrooming and involving adjacent horizontal routes such as attics, voids and cocklofts.

Any venting action demands some forethought based on an intention – what is the objective?

- Venting for life
- Venting for fire
- Venting for safety

“Tactical venting is the venting or containment action by on scene firefighters, used to gain tactical advantage during interior structural firefighting operations.

The most dangerous opening a firefighter can make on the fire ground is at the point of entry (controlling the door).

This opening is often seen as necessary to gain access to the structure and is not considered as part of the venting plan. However the airflow provided (gravity current) at this point of entry may serve to intensify the fire and may indeed allow it to escalate beyond the capability of initial attack hose-lines.” (Excerpt 3D Fire Fighting, first edition, fpp)

By using the Lance to penetrate and cool the thermal layer, the need for an initial door opening is eliminated and the risk of gravity currently feeding the fire is totally alleviated.

Firefighting training manuals frequently promote a wide range of benefits that may be derived through operational venting actions. These actions include:

- Reduction in compartment/structural temperatures
- Improved visibility
- Clearance of smoke and toxic gases
- Reduction in the potential for flashover or backdraft events
- Prevention of fire spread

However, on occasion the act of creating an opening to vent combustion products may even cause the following:

- Increase in temperature
- Reduction in visibility
- Cause a flashover or backdraft
- Create rapid fire growth

The decision to vent must be based on a balance of probabilities, taking previous practical experience and theoretical appreciation of basic fire dynamics into consideration.

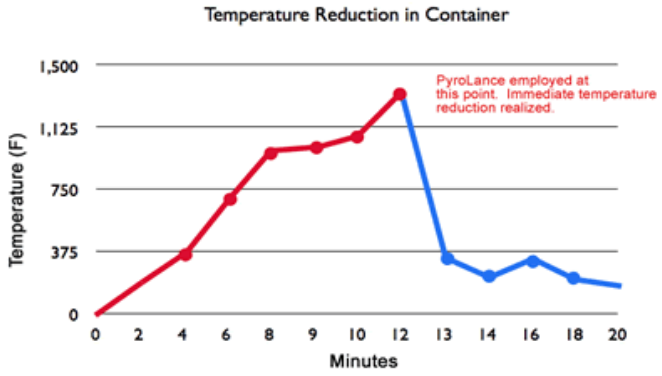
Transitional Fire Attack Profile (Conceptual)

The transitional attack principle of utilizing gas cooling along with surface cooling has a profound effect in that minimal water is required due to the ultra-high pressure water mist technology involved. The unique feature of being able to penetrate using the Lance from the outside in very quick time allows fast control of the interior fire conditions from a defensive exterior position, without the risk of fire fighter exposure. Once the interior fire conditions have been brought under control, enter the fire zone with the Blitz attack line to suppress and overhaul the fire using UHP fog in a fast moving attack with high mobility and fierce knockdown power. By entering the involved structure after the thermal layer has been cooled and employing the PyroBlitz hand line flowing 20gpm@1450psi (75lpm@10 000kPa), the residual fire is quickly extinguished using only minimal amount of water; The attack hose is only ¾" (19mm) and therefore allows rapid entering and high mobility to the interior crew thus the name "Blitz" (putting the wet stuff on the red stuff).

Tenets upon which "Transitional Attack" is based using PyroLance Technology:

- A risk versus gain procedure that hugely increases the safety margin for the Firefighter
- Interrupts the flame chain reaction, reducing the process of pyrolysis and inhibit radiant heat flux thereby impeding fire spread
- Cools gases to below ignition temperature and reduces the volumetric flame
- Inactivating the atmosphere by raising the humidity level
- Interrelates the ventilation profile with ongoing fire conditions

When utilizing a combination of high-pressure water and a non-sparking abrasive aggregate material, the PyroLance has the ability to pierce any material in a matter of seconds and then blanket the thermal layer inside with a fog of atomized water; Test results indicate the ability to penetrate a mild steel plate with a one inch thickness, in less than 55 seconds. After penetrating with the water and aggregate mixture, PyroLance then utilizes the high pressure water mist, without the aggregate, to quickly cool the atmosphere and contain the fire.



1100 Degree Fahrenheit =
593 Degree Celsius

1500 Degree Fahrenheit =
815 Degree Celsius

375 Degree Fahrenheit =
190 Degree Celsius

Again, PyroLance as a disruptive technology is a true revolution in firefighting equipment and operational methodology and the key to achieving a true Transitional Attack capability.

Works Cited

1. Layman L: Fire Fighting Tactics. NFPA: Boston, 1953.
2. Layman L: Attacking and Extinguishing Interior Fires. NFPA: Boston, 1955.
3. Handell A: Utvärdering av dimstrålrörs effektivitet vid brandgaskylning. Lund University: Lund, Sweden, 2000.
4. Giselsson K and Rosander M: The Fundamentals of Fire. Norrköping, Sweden, year unknown.
5. Grimwood P, Hartin E, McDonough J, Shan Raffel et al: 3D Fire Fighting: Training, Techniques and Tactics. Fire Protection Publications: Stillwater, Okla., 2005.
6. Menchini C et al: The Development and Design of a Prototype Ultra-High Pressure P-19 Firefighting Vehicle. USAF: Tyndal AFB, 2006.
7. Clark W: Firefighting Principles and Practices. PennWell: Saddle Brook, N.J., 1991.
8. Royer and Nelson: “Water for Firefighting—Rate of Flow Formula.” Iowa State University Bulletin #18. Ames, Iowa: Iowa State University, 1959.
9. CCS Cobra, Sweden