Fire Alarm and Voice Communication
Design Guidance
October 24, 2018
A world leader

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What we will cover

Design requirements from codes and standards
Designer tools and techniques
General Topics
Design Requirements

After the decision to install a fire alarm system has been made…

OBC – voluntary installations are not required to comply with the OBC [A-1.1.2]

NBCC – voluntary installations are required to comply with the NBCC [A-3]

The provisions in this Part for fire protection features installed in buildings are intended to provide a minimum acceptable level of public safety. It is intended that all fire protection features of a building, whether required or not, will be designed in conformance with good fire protection engineering practice and will meet the appropriate installation requirements in relevant standards. Good design is necessary to ensure that the level of public safety established by the Code requirements will not be reduced by a voluntary installation.

ULC – CAN/ULC-S524 “Standard for installation of Fire Alarm Systems”

ULC – CAN/ULC-S537 “Standard for Verification of Fire Alarm Systems”
Design Requirements – Building Code

Subsection 3.2.4 defines…

› When a fire alarm is required to be installed (based on 14 occupancy conditions)
› Zoning requirements
› Single or two stage
› Detection type and location (manual, automatic)
› Signaling type and performance (audible, visible, voice)
› Monitoring
› Smoke management
› Standards to follow
Design Requirements - High Buildings

All listed in Subsection 3.2.6. of the OBC

› Smoke control for storeys below the lowest exit level
› Smoke control for connected buildings
› Fan shut down
› Elevator recall
› Fan control for venting to aid firefighting
› Central alarm and control facility (CACF)
› Voice communication system
Design Requirements - Standards

ULC 524 defines…
› Design and installation requirements for new fire alarm equipment
› Display and control equipment, power supplies, batteries
› Wiring details and fault tolerance/supervision
› Field device details/coverage
Design Requirements - Standards

ULC 537 defines…

› Testing procedures for the newly installed equipment
  › Panels
  › Isolation modules
  › Detection devices
  › Supporting field devices (monitor or control)
  › Signal devices
  › Emergency phones
  › End of line devices
Design Tools and Techniques – System Operation

Single or Two Stage?

Zone Coded?

Wire and Circuits

› Zones vs. Circuits
› Fault tolerance
Single or Two Stage?

Single stage is required for

› High hazard industrial occupancies (F1)
› Elementary schools except for special needs facilities

Two stage is required for

› Most care and detention occupancies (B)
› All other occupancies are permitted to be either single or two stage

Note: When two stage operation is selected for large buildings there may be a requirement to provide a voice communication system
Zone Coded?

Used mostly for industrial occupancies where occupants have a fire fighting duty or multiple muster locations.

Permitted for two stage systems.

Includes an alert signal with a sound pattern that indicates the zone of alarm.
Zones vs. Circuits 1/2

Zones and circuits are the same thing for a conventional circuit.

Isolation modules required for continued operation of a data communication link (DCL) through a short circuit condition.

ULC-S524 Article 4.3.1.5

“Except as noted in Clause 4.3.1.10, each circuit of a fire alarm system shall be installed such that open circuit faults or ground faults shall not interfere with the operation of other circuits of the fire alarm system, and such faults shall initiate a trouble signal.”
Zones vs. Circuits 2/2

Use of isolation module allows the same pair of wires or circuit serve two or more zones in an addressable fire alarm system.
Fault Tolerance

Large scale system has more than 1000 active and supporting field devices and more than one control unit or transponder

› The implication is the style of communication used which has a performance criteria for fault tolerance

<table>
<thead>
<tr>
<th>ABNORMAL OPERATING CONDITION IN A LINK AT THE SAME LOCATION</th>
<th>DATA COMMUNICATION LINK (DCL) STYLES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DCLA</td>
</tr>
<tr>
<td>Single Open</td>
<td>S</td>
</tr>
<tr>
<td>Single Ground</td>
<td>S</td>
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<tr>
<td>Wire to Wire Short</td>
<td>T</td>
</tr>
<tr>
<td>Wire to Wire Short &amp; Ground</td>
<td>T</td>
</tr>
<tr>
<td>Open and Ground</td>
<td>S</td>
</tr>
<tr>
<td>Loss of Communication</td>
<td>T</td>
</tr>
</tbody>
</table>

LEGEND

T = Trouble indication at the control unit.
S = Trouble indication at the control unit and alarm receipt capability during abnormal operation.
S1 = Trouble indication at the control unit and alarm receipt capability (beyond the isolated fault section of the link) during abnormal operation.
Design Tools and Techniques – System Control Equipment

Annunciation
Controls
Sequence of operations
Equipment Details
Power supplies
Annunciation

Building code uses the term to indicate which areas of a building are to be provided with separate zones.

Written when fire alarm systems were conventional only. (see zones vs circuits slides).

Separate zones required for

› Each floor and each sprinkler zone (or large floor area within a floor)
› Each area with a fire separation of 2 hr or more
› Each commercial kitchen extinguishing system
› Stair and Elevator shafts
› Air handling equipment equipped with a smoke detector
› Contained use or Impeded egress areas
› Fire compartment serving sleeping areas in hospitals and long term care and retirement home occupancies
Controls

Standard controls for all listed systems
Sequential display or lamps for each zone
Switches for smoke management control
Switches for bypass functions
Switches for voice message zone control
Switches for firefighter telephone zone control
Switches for electromagnetic lock control
Sequence of Operations

For complex sequence

› Use a table to map all inputs to all outputs
› Programming easier
› Testing easier
› Troubleshooting easier
Equipment Details

Follow manufacturer’s guidance
Create rackup sketch
Helps with ordering equipment
Useful shop drawing
Power Supplies

**System Power Requirements**

- **Notifier NF2-3030 Fire Alarm Control Panel**

  - Protected Premises: St. John’s Airport
  - Address: 100 World Parkway, St. John’s
  - City: St. John’s
  - State: NL
  - Zip: 3394

- **Device Current Draw**

  - **Notifier NF2-3030 Fire Alarm Control Panel**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>City</th>
<th>Primary Non-Alarm</th>
<th>Primary Alarm</th>
<th>Secondary Non-Alarm</th>
<th>Secondary Alarm</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td>0.2000 A</td>
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<td></td>
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<td>0.19750</td>
<td>0.19750</td>
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<td>0.2000 A</td>
<td>0.2000 A</td>
<td>0.2000 A</td>
<td>0.2000 A</td>
</tr>
</tbody>
</table>

  - **Total (Amperes):** 1.3214 A
  - **Secondary Alarm Current:** 0.000 A

  - **Total Secondary Alarm:** 1.515 A

**Device Current Draw**

- **Primary Standby Load**
  - Current load on the primary power supply during non-alarm conditions.
  - 1.32 Amps

- **Primary Alarm Load**
  - Current load on the primary power supply during alarm conditions.
  - 1.52 Amps

- **Secondary Standby Load Requirements**
  - 38.57 Amp Hours

**Battery Selection**

- 59 Amp Hours

- **Battery Details**
  - 55 AH BAT-125D Battery (12 volt)
  - Two (two 12/DC sets in parallel)
Heat Detectors

Ceiling height

Beams and pockets

Bottom Line: Construction details required to complete design
Smoke Detectors

Ceiling height

8.3.8.5 Spot type smoke detector spacing is not required to be reduced for ceiling height, but may be affected by beam construction. On ceilings above 3600 mm in room height, spot type smoke detector spacing shall be based on fire type, growth rate, engineering judgement and manufacturer’s published installation instructions.

Beams and pockets

Stairs

\[ \text{\% of rated spacing} \]

\[ \text{CEILING} \]

\[ \text{MORE THAN 100 mm AND LESS THAN 300 mm} \]

\[ \text{25\% 50\% 50\% 25\%} \]

\[ \text{CEILING HEIGHT LESS THAN 3600 mm} \]

\[ \text{\textbullet} - \text{SPOT TYPE SMOKE DETECTOR} \]

\[ \text{IF EXIT STAIR SHAFT MORE THAN 15.0 m IN HEIGHT, ADDITIONAL DETECTORS TO BE PROVIDED EVERY THIRD FLOOR} \]

\[ \text{\textbullet} - \text{SPOT TYPE SMOKE DETECTOR} \]
Audible Signal Devices

Coverage = Rated value - distance loss – Obstruction loss

Range between 65 and 100 dBA and at least 10 dBA above ambient

Use low output devices in small spaces, especially with high reflection surfaces

Almost every room needs a device

\[ \text{dBA}_r = \text{dBA}_R - 20\log \left( \frac{r}{r_R} \right) \]

<table>
<thead>
<tr>
<th>DISTANCE FROM DEVICE</th>
<th>dB(A) LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 m</td>
<td>Rated Value</td>
</tr>
<tr>
<td>6 m</td>
<td>Rated Value – minus 6 dB</td>
</tr>
<tr>
<td>12 m</td>
<td>Rated Value – minus 12 dB</td>
</tr>
<tr>
<td>24 m</td>
<td>Rated Value – minus 18 dB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INTERVENING ITEM</th>
<th>AVERAGE DB(A) LOSS</th>
<th>TYPICAL RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Door</td>
<td>8 dB</td>
<td>4 – 12 dB</td>
</tr>
<tr>
<td>Closed Door, Hollow Core</td>
<td>17 dB</td>
<td>10 – 24 dB</td>
</tr>
<tr>
<td>Closed Door, Solid Core</td>
<td>28 dB</td>
<td>22 – 34 dB</td>
</tr>
<tr>
<td>Single stud wall with gypsum board on both sides</td>
<td>39 dB</td>
<td>32 – 46 dB</td>
</tr>
<tr>
<td>2 rows of studs staggered complete with gypsum board on both sides</td>
<td>40 dB</td>
<td>36 – 47 dB</td>
</tr>
<tr>
<td>200 mm concrete, gypsum board on one side</td>
<td>45 dB</td>
<td>43 – 51 dB</td>
</tr>
<tr>
<td>200 mm hollow concrete block, gypsum board on both sides</td>
<td>40 dB</td>
<td>38 – 47 dB</td>
</tr>
<tr>
<td>300 mm masonry wall with gypsum board on both sides</td>
<td>50 dB</td>
<td>46 – 56 dB</td>
</tr>
</tbody>
</table>
Audible Signal Devices

Signal pattern for the alarm or evacuation signal of a fire alarm system is **Temporal**.


Consists of 3 on-off pulses of 0.5 second duration followed by a 1.5 second pause before it repeats

Signal pattern for the alert signal in a two stage fire alarm system is **Undefined**.

Can range from no sound at all to a steady signal or anything in between that will not be confused with a Temporal pattern

Concept is to select a ‘less urgent’ sound
Visible Signal Devices

Coverage – use tables, or

Opposite Wall

\[ I_o = \frac{I_R}{d_o^2} \]

Adjacent Wall

\[ I_a = \frac{I_R \times OAI}{d_o^2} \]

Minimum 0.404 lx
Voice Communication Signal Devices

Coverage based on Intelligibility

Minimum 0.7 CIS

With low reverberation times, use sound pressure or software (6dB max loss)

With high reverberation times, use software
Voice Communication Signal Devices

\[ T = \frac{0.16V}{-S[\ln(1 - \alpha)]} \]

\[ T = \frac{0.16V}{S\alpha} \]

\( \text{for }\alpha < 0.2, \text{ (Sabine)} \)
\( \text{for }\alpha > 0.2, \text{ (Eyring)} \)

- Where \( T \) (s) is the reverberation time,
- \( V \) (m\(^3\)) is the room volume,
- \( S \) (m\(^2\)) is the total surface area of all room boundaries, and
- \( \alpha \) is the average absorption coefficient

Less than 1.5 seconds in reverberation time indicates that sound pressure level will be the dominant factor in intelligibility.
Miscellaneous

Smoke Control
Elevator Recall
CACF
Emergency Power
Residential Signal Circuits
Smoke Detectors as Smoke Alarms
Visible Signal Operation
Smoke Control 1/2

Smoke control systems need to be controlled by a listed smoke controller (UUKLC) or a fire alarm system

Stair pressurization
› auto/manual start for fans used to pressurize stairs
› required for stairs below grade, optional for stairs above grade
› automatic mode initiated on any alarm

Smoke exhaust
› auto/manual start for smoke exhaust fans (interconnected floor spaces)
› automatic mode initiated from smoke detector within exhausted volume
Smoke Control 2/2

Venting to aid firefighting

› Building exhaust system is most popular
  › Sprinklered buildings only
  › Makes use of HVAC system but requires control
  › Manual control but not really
Elevator Recall

› Automatic recall enforced for all elevator renovations by TSSA
› Smoke detectors within 21 ft (6.4 m) of elevator doors
› Relays to match output requirements

<table>
<thead>
<tr>
<th>DETECTOR LOCATION</th>
<th>ELEVATOR RECALL FLOOR</th>
<th>IN CAR FIRE INDICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>General fire alarm from detector at a typical level</td>
<td>Main floor</td>
<td>Illuminates solid</td>
</tr>
<tr>
<td>Main floor</td>
<td>Floor above main floor (or can remain as main floor if the main is sprinklered)</td>
<td>Illuminates solid</td>
</tr>
<tr>
<td>Machine room (located above main floor)</td>
<td>Main floor</td>
<td>Illuminates flashing</td>
</tr>
<tr>
<td>Machine room (located at or below main floor)</td>
<td>Floor above main floor</td>
<td>Illuminates flashing</td>
</tr>
<tr>
<td>Top of hoistway*</td>
<td>Main floor</td>
<td>Illuminates flashing</td>
</tr>
<tr>
<td>Pit*</td>
<td>Floor above main floor</td>
<td>Illuminates flashing</td>
</tr>
</tbody>
</table>

* If a common group of elevators has fire separated hoistways, these signals should only trigger the appropriate action for the elevators within that hoistway.
Central Alarm and Control Facility

Laundry list of requirements

› Acoustically isolated (no speakers in the room)
› All Call, Floor by Floor and Stair by Stair paging
› Fire alarm annunciator
› Alarm transmitter
› Magnetic hold open release
› Manual alarm activation zone by zone
› Separate sprinkler/standpipe alarms, supervisory and trouble signals
Emergency Power

Fire alarm systems have separate requirements from other systems used during emergencies (pumps, elevators, fans etc.)

High Rise building fire alarms require emergency power to provide 24 hours of supervisory power followed by 2 hours of full load power

Full load power following supervisory period for other building types

› Buildings with group B and C type occupancies require 1 hour even when they are not high rise
› Other non high rise buildings require 30 minutes
› Buildings with only one zone require 5 minutes
Residential Signal Circuits

Signal isolation and signal silence requirements are unique for buildings with Group C type occupancies.

Two signal circuits for each floor with suites (suites vs other areas)

Suite circuit operates through a single open at an individual device.

- Class C (Operates like DCLC),
- Separate circuit for each suite, or
- Suite signal isolators

Individually silenceable signals or automatically silenced signals
Smoke detector as a smoke alarm

Smoke alarms are required for dwelling units and sleeping rooms not within dwelling units (some exceptions)

Where this requirement exists, smoke detectors that are part of the building fire alarm system are allowed instead in suites of residential occupancy so long as a local sounder is provided which is activated by the smoke detector

Need not cause a fire alarm or alert signal to sound in the building
Visible signal operation

Strobes are to be silenced/activated at the same time as audible signal devices…ULC 524

› 4.1.12 Visible signal devices that supplement audible signal devices to advise occupants that a fire emergency exists, shall be turned off automatically when audible signals are silenced and shall be turned on automatically when audible signals are reactivated.

Fire do not enter and directional exit signs are not to be silenced

› 9.7.4 Circuits for “Fire Do Not Enter” signs shall not be affected by signal silence.
› 9.8.4 Circuits for “Directional Signs for Evacuation” shall not be affected by signal silence.
Our values keep us anchored and on track. They speak to how we run our business, how we express ourselves as a group, and how we engage with our stakeholders and inspire their trust.

**Teamwork & excellence**
We’re innovative, collaborative, competent and visionary.

**Customer focus**
Our business exists to serve and add long-term value to our customers’ organizations.

**Strong investor return**
We seek to reward our investors’ trust by delivering competitive returns.

**Health & safety, security and environment**
We have a responsibility to protect everyone who comes into contact with our organization and the environment we work in.

**Ethics & compliance**
We’re committed to ethical business.

** Respect**
Our actions consistently demonstrate respect toward our stakeholders.