

Reliability of Fire Dampers, Smoke Dampers and Smoke Control Systems

by

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ABSTRACT

The purpose of this project is to create awareness of the importance of periodic inspections of fire dampers, smoke dampers, and smoke control systems. A reliability analysis of fire dampers, smoke dampers and smoke control systems will be conducted by collecting data from inspections of such equipment or systems. The analysis will seek to distinguish components that are fully operational, not operational, and operational but not at required performance levels.

1. BACKGROUND

While reliability data exists for some fire protection equipment and systems, such as sprinkler, detection and firestopping systems, no data exists in the public domain for fire life safety (FLS) dampers or smoke control systems.

The International Fire Code adopted in 42 of 50 states recognizes standards that have been developed by committees of the National Fire Protection Association (NFPA). This research project is intended to collect data to provide support to the following NFPA standards committee relative to the specified periodic inspection frequencies:

- **NFPA 80:** Fire dampers shall be inspected 1 year after installation, every 4 years thereafter, except hospitals, which have a 6-year inspection frequency.
- **NFPA 92:** Dedicated smoke control systems shall be inspected at least every six months and non-dedicated smoke control systems shall be inspected at least annually.
- **NFPA 105:** Smoke dampers shall be inspected 1 year after installation, every 4 years thereafter, except hospitals, which have a 6-year inspection frequency.

2. RESEARCH METHODOLOGY

The principal approach for this proposed research included the collection of data from inspections or any post-incident investigations of the performance of fire dampers, smoke dampers and smoke control systems. The survey form included in Appendix A was distributed to contractors, engineering consultants and government agencies who conduct such inspections. The contractors included on the distribution list are those who have been certified through a joint effort by NEMIC and the International Certification Board (ICB). This certification program is recognized by the American National Standards Institute (ANSI) under the ISO/IEC 17024 standard. Any technician or supervisor performing the periodic inspections of fire dampers, smoke dampers, or smoke control systems while employed by these ICB certified ANSI accredited contractors will have completed the required classroom educational requirements and successfully passed the requisite exam(s) required through the ICB certification process.

Engineering consulting companies conduct inspections for building owners or operators to comply with local regulations or in the case of health-care institutions to maintain accreditation by the Joint Commission, a nonprofit organization that accredits more than 22,000 US health care organizations and programs.

3. SURVEY RESULTS

3.1 FLS Damper Results

A total of 39 responses were received to the surveys that were distributed. In these 39 responses, the results from a total of 281 inspection projects in new buildings were reported along with 1,120 inspection projects in existing buildings. The inspection projects in new buildings included inspections of 18,964 fire dampers, smoke dampers, or combination fire/smoke dampers and 151,390 of those components in existing buildings. Hence, the survey results are obtained from conducting a total of 1,401 projects that included inspections of 170,354 FLS dampers.

A summary of the overall responses concerning dampers requiring repair, replacement or other adjustments is included in Table 1. As indicated in the results, the proportion of FLS dampers needing attention in the form of repair, replacement, improved access, or actuator replacement in existing buildings exceed the proportion in new buildings. A more in-depth review of the data is included in the remainder of this section.

Table 1. Summary of All Responses

Topic	New	Existing
1. In the past 36 months, how many FLS damper inspection and testing projects has your company completed?	281	1,120
2. How many FLS dampers (in total) were inspected on these projects?	18,964	151,390
3. Of the inspected FLS Dampers, how many were in need of:		
Repair?	808	80,230
Replacement?	75	3653
Better damper access requiring installation or modification of access (such as doors or other means)?	360	20,550
4. Of the electric or pneumatic actuated FLS dampers that were inspected, how many dampers (in total) required replacement of the actuators?	85	11,377
6. Of the FLS damper inspection projects, how many projects had more than 15% of the components that needed repair or replacement?	16	174

Question 1. In the past 36 months, how many fire and smoke damper inspection and testing projects has your company completed?

Each respondent provided two answers to this question, one relating to projects in new buildings and the other for existing buildings. The responses are depicted in Figure 1. For most of the respondents, the number of inspection projects completed were relatively small. Of the responses obtained, 17 related to inspections in new buildings while 35 were in existing buildings. 48 of 52 responses (or 92% of the non-zero responses) indicated involvement in up to 50 inspection projects during the three years. Only four responses indicated they had done more than 50 inspections in the last three years in either type of building, with a maximum of 705 projects being conducted by a respondent (in an existing building).

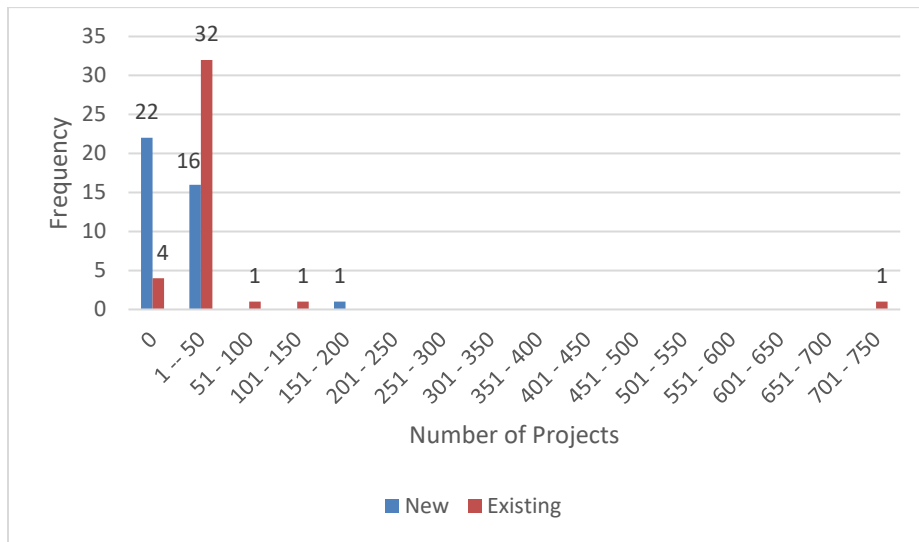


Figure 1. Inspection Projects in the Past 36 Months

Question 2. Total number of Fire Dampers, Smoke Dampers, or Fire/Smoke Dampers Inspected from these projects in the past 36 months

For those respondents who had projects that included FLS damper inspections, 31 of 52 responses (or 60% of the non-zero responses) reported inspecting 500 dampers or less. The maximum numbers of dampers inspected in new and existing buildings were 9,000 and 105,000.

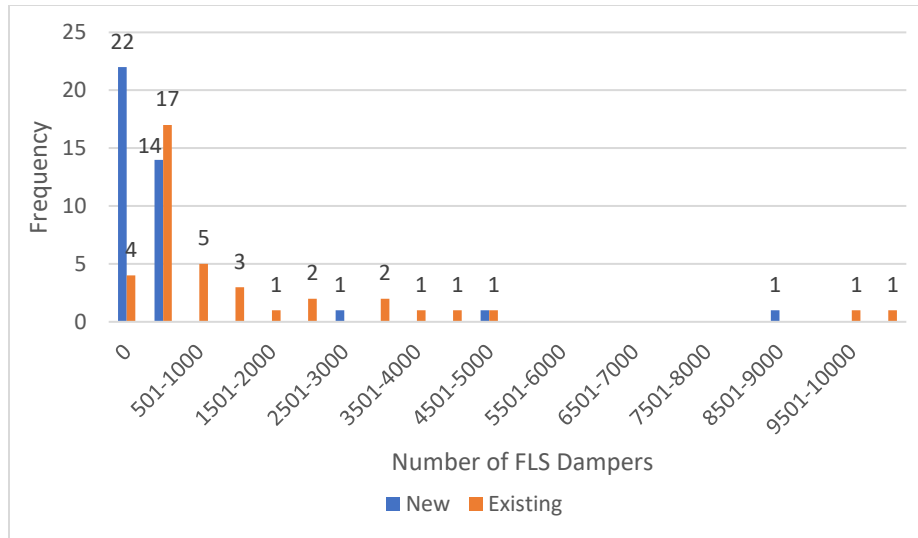


Figure 2. Total number of FLS Dampers Inspected in Past 36 Months

Question 3. Of the inspected Fire Life Safety Dampers, how many were in need of

- a) Repair
- b) Replacement
- c) Better damper access requiring installation or modification of access (such as doors or other means)?

The distribution of responses provided for these three questions are presented in Figures 3-5. For question 3a, only 19 of the 53 responses indicated that repair was not needed to a damper, or 36% of the responses. Of these 19 responses, a substantial majority (16 of 19) were in new buildings. One respondent indicated that they had observed 40,000 dampers as needing repair during the 36 month period. Overall, the dampers needing repair were more often found in existing buildings rather than new buildings.

The responses to questions 3b and 3c follow the same pattern as question 3a. In only 25 of the 53 responses (47%), was no replacement of dampers needed. Of those 25 responses, about two-thirds of them (17 responses) were in new buildings. Only one damper in a new building needed replacement, or 5.6% of the sample, though 77% of responses indicated a need for damper replacement in existing buildings.

For question 3c, 16 of 53 responses indicated that no improvement to access was needed, comprising 30% of the responses. The need for improved access was noted in 91% of the responses for existing buildings.

For questions 3a-3c, most of the responses of dampers needing repair, replacement or access modification were relatively small in number. However, for each question, there were a small number of responses indicating the need for action for a large number of dampers.

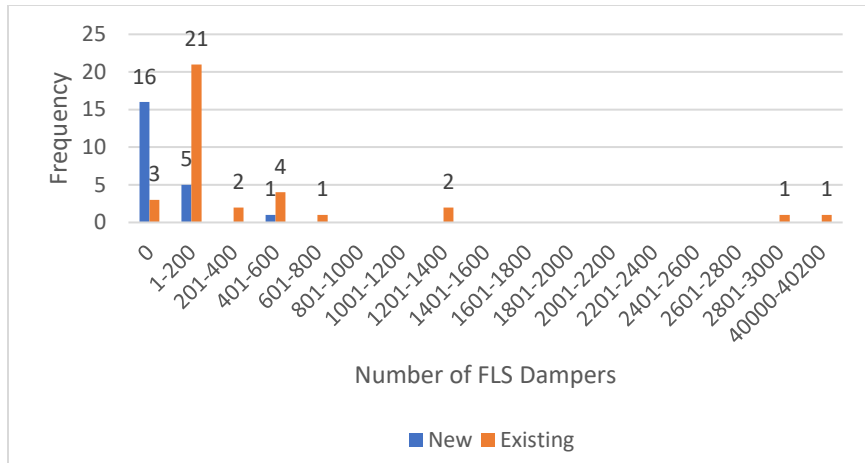


Figure 3. FLS Dampers Needing Repair

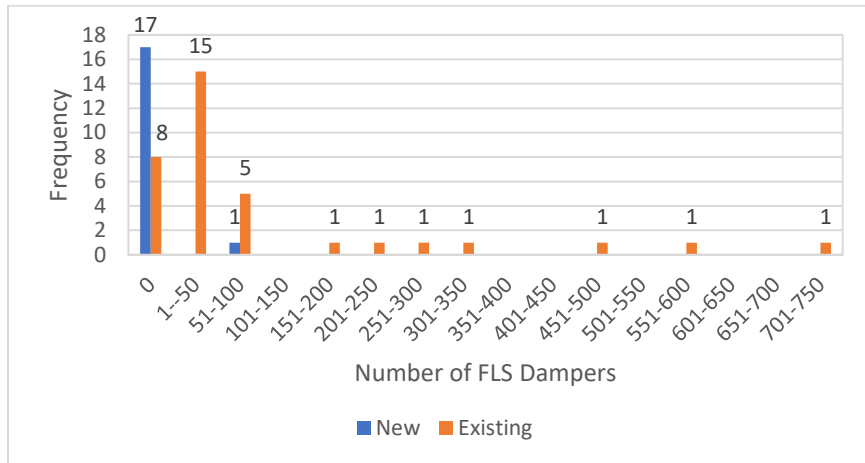


Figure 4. FLS Dampers Needing Replacement

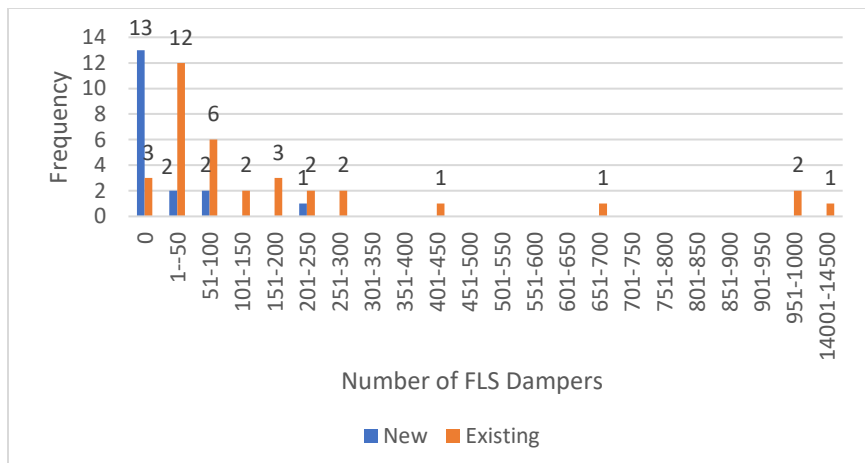


Figure 5. FLS Dampers Needing Better Damper Access Installation or Modification of Access

A comparison of the responses in new versus existing buildings for questions 3-7 are included in Table 2. For each of the responses, it is noteworthy that the issues are substantially greater in existing buildings than new buildings. For every question, a majority of the responses for existing buildings identified the need for service (repair or replacement of dampers, access issues, actuator replacement, reliability and the need to provide immediate attention in order to keep the building open. While the issues are much less prominent in new buildings, the number of issues identified are still substantial, especially given the equipment is new.

Table 2. Responses Indicating Concerns with Dampers or Actuators (%)

Question	New Buildings	Existing Buildings	All Buildings
3a. FLS dampers needing repair	39	91	67
3b. FLS dampers needing replacement	5.6	77	53
3c. FLS dampers needing improved access	28	91	70
4. Actuators needing replacement	17	80	58
5. FLS damper projects with reliability concerns	29	79	38
6. Projects with >15% of components needing repair or replacement	17	71	53
7. FLS dampers needing immediate attention	5.6	63	43

Question 4. Of the electric or pneumatic actuated FLS dampers that were inspected, how many dampers (in total) required replacement of the actuators?

The responses to question 4 are presented in Figure 6. There were 53 responses to this question, with 31 of the responses (58% of the total) indicating a need to replace the actuator.

As in question 3a-3c, the need for replacement of actuators was more prevalent in existing buildings than in new buildings (80% in existing buildings versus 17% in new buildings). A comparison of the response to this question for new versus existing buildings is presented in Table 2. Also similar to the responses to questions 3a-3c is the indication of a very large number of actuators needing replacement in one response.

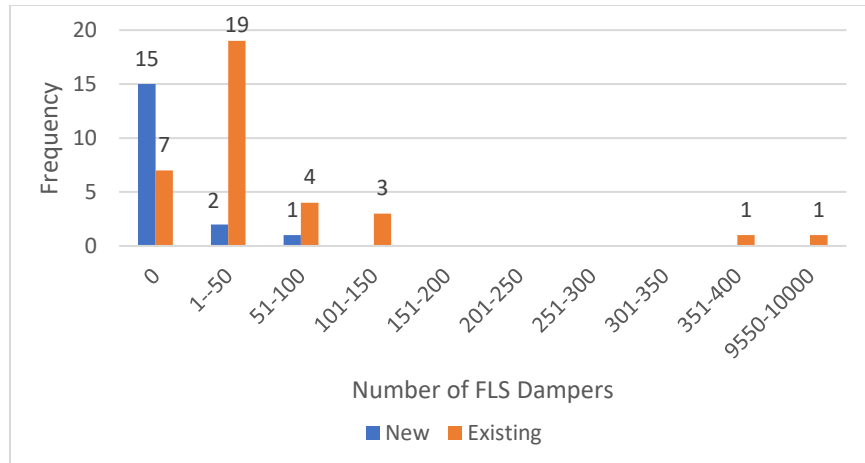


Figure 6. Electrical or Pneumatic FLS Dampers Requiring Replacement of Actuators

Question 5. Of the total number of FLS dampers inspected in the past 24 months, what percentage of fire and smoke damper projects have areas of concern with the reliability of the installed fire, smoke and/or combination dampers?

The frequency distribution of the responses to question 5 are presented in Figure 7. The proportion of FLS damper projects with evidence of reliability concerns was 29% in existing buildings, but 79% in existing buildings. In five of the responses (four of them in existing buildings), reliability was questioned in excess of 90% of the projects. The comparison of the responses for new versus existing buildings is presented in Table 2.

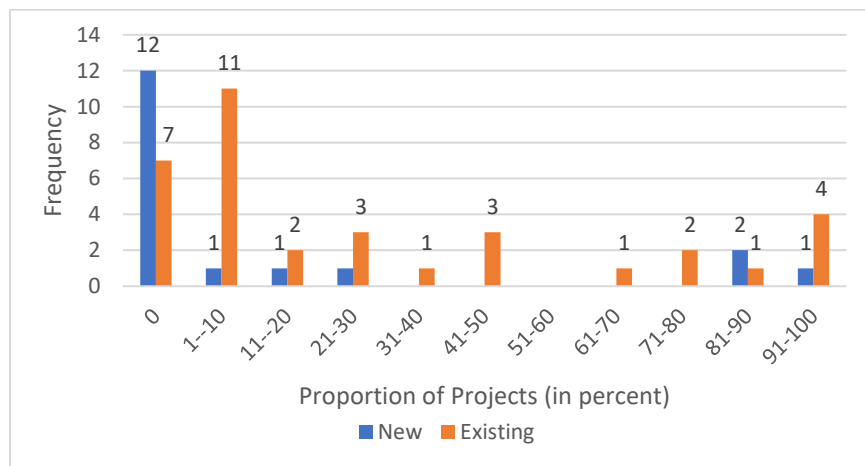


Figure 7. Proportion of FLS Damper Projects with Reliability Concerns

Question 6. Of the FLS damper inspection projects, how many projects had more than 15% of the components that needed repair or replacement?

The responses to question 6 are presented in Figure 8. In 28 of the 53 responses (53% of the responses), individuals indicated that at least 15% of the components needed repair or replacement. As with the previously discussed questions, a greater proportion of projects in existing buildings had an appreciable number of components (15% or greater) needing repair or replacement than with new buildings. The comparison of the responses for new versus existing buildings is presented in Table 2.

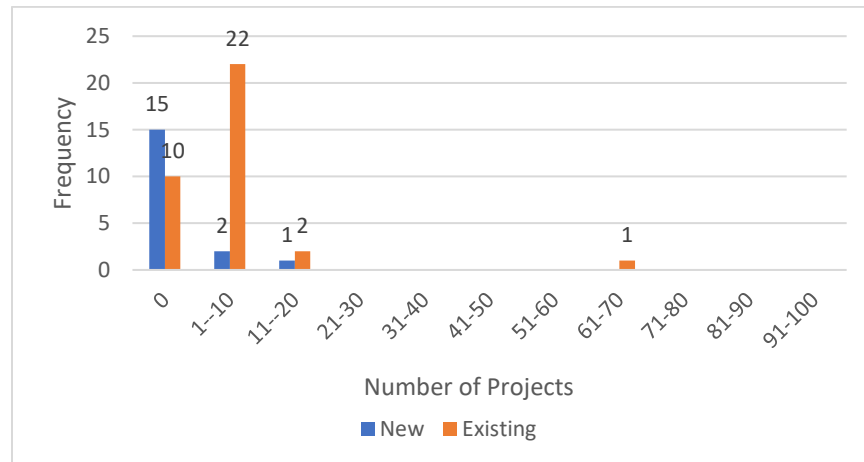


Figure 8. 8 Projects with More than 15% of Components Needing Repair or Replacement

Question 7. Of those requiring attention, in what proportion of FLS dampers was immediate attention required in order to keep the building open as the problem was life threatening?

The responses to question 7 are included in Figure 9. The difference in the responses for new versus existing buildings is noteworthy. Only one response (out of 17) indicated issues needing immediate attention for a new building (or 5.6% of the responses), while for existing buildings the majority of responses (63%) indicated the need for immediate change. One significant observation is the substantial number of responses (10 of 22) that indicated that 90-100% of the dampers needed immediate attention.

Question 8. Of the projects needing repair or replacement, what proportion required the following actions?

8.1 Damper

- a. Adjustment needed
- b. Replacement needed
- c. Other

8.2 Actuation by fire alarm system

- a. Reprogramming needed
- b. Replacement of parts in fire alarm system needed
- c. Other

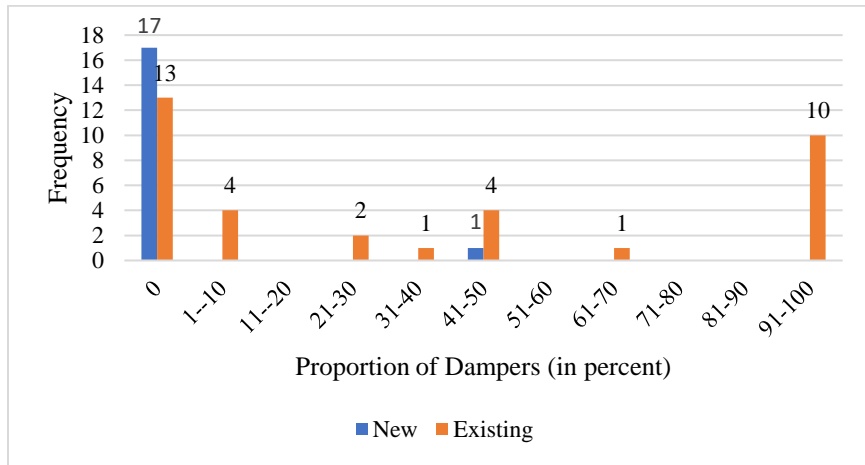


Figure 9. Proportion of FLS Dampers Requiring Immediate Attention

The responses pertaining to actions involving dampers are depicted in Figure 10. As in the case of the previous questions, many more remedial actions were identified for dampers in existing buildings rather than new buildings.

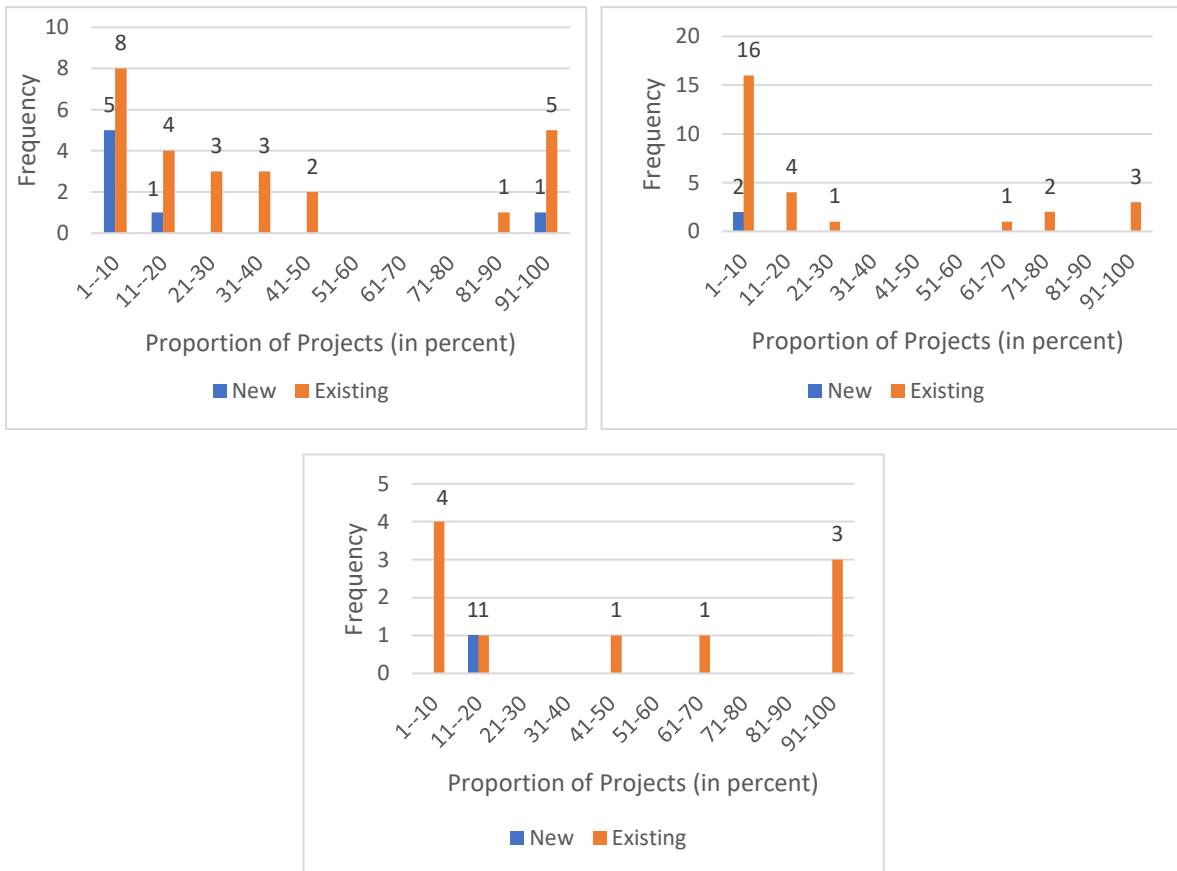


Figure 10. Remedial Actions for Dampers
(upper left: 8.1a, upper right: 8.1b, bottom: 8.1c)

The responses pertaining to actions involving actuation of dampers are depicted in Figure 11. As in the case of the previous questions, many more remedial actions were identified for actuation components in existing buildings rather than new buildings.

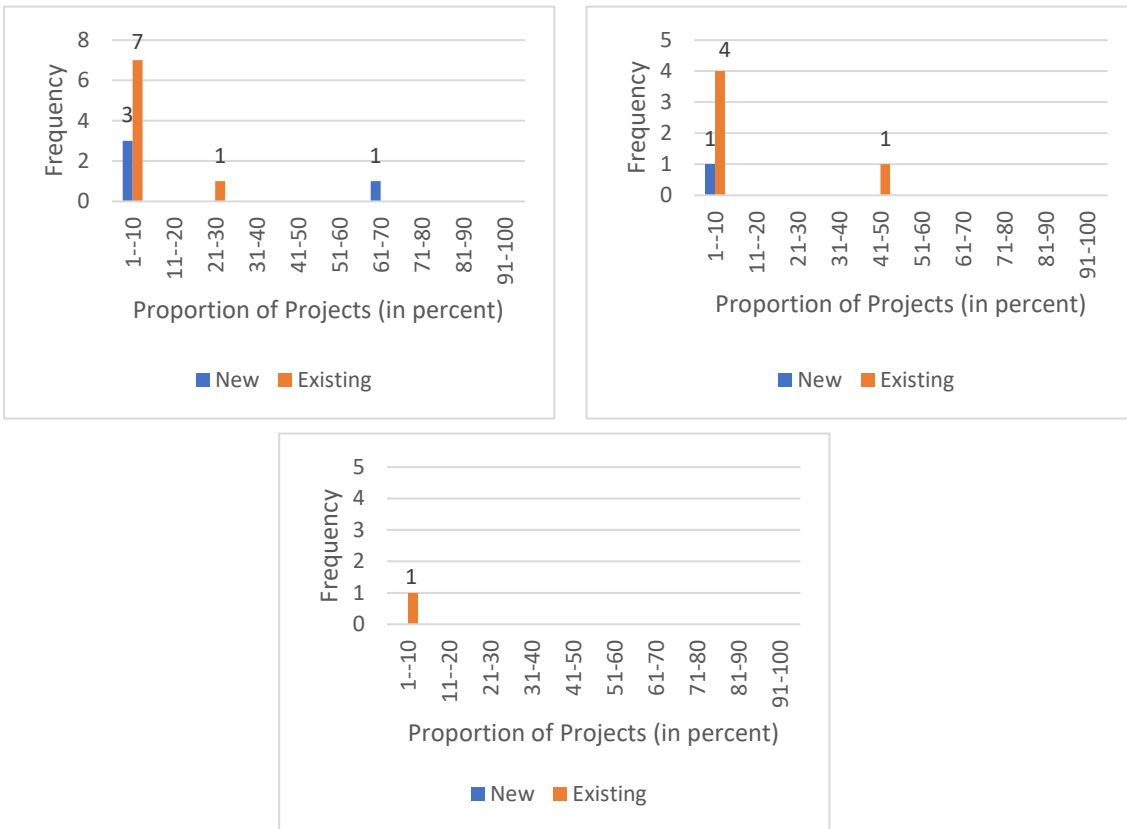


Figure 11. Remedial Actions for Dampers
(upper left: 8.2a, upper right: 8.2b, bottom: 8.2c)

3.2 Smoke Control System Results

The responses pertaining to inspections of smoke control systems varied by the type of system and are generally less than the number obtained for fire dampers (described in the previous section).

Question 9. How many inspection projects has your company completed in the past 36 months?

The number of responses to question 9 from those companies who had conducted at least one inspection of a smoke control system is summarized in Table 3.

Table 3. Respondents Conducting Inspections of Smoke Control Systems

Type of System	New Building	Existing System	Total
Stairwell Pressurization	10	10	20
Zoned Smoke Control	8	6	14
Atrium Smoke Management	6	7	13

The number of inspections conducted by any respondent varied appreciably. The range in the number of inspections conducted is presented in Figures 12-14 for the three types of systems. The total number of systems that the responding companies inspected is summarized in Table 4.

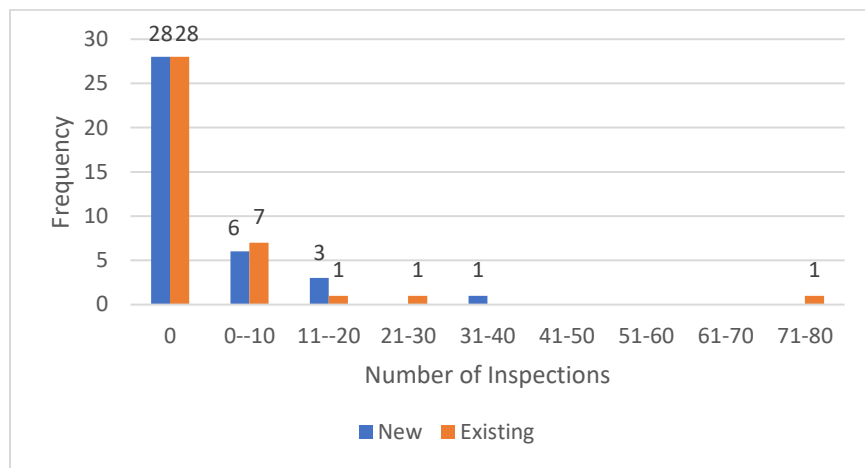


Figure 12. Inspections of Stairwell Pressurization Systems

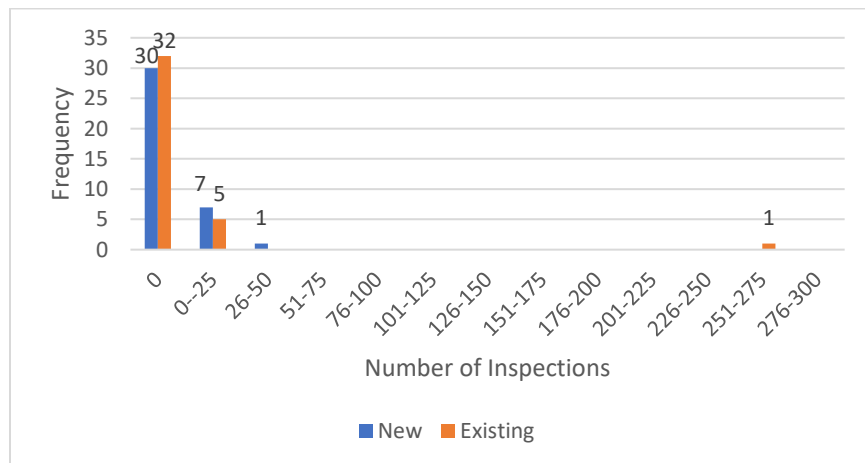


Figure 13. Inspections of Zoned Smoke Control Systems

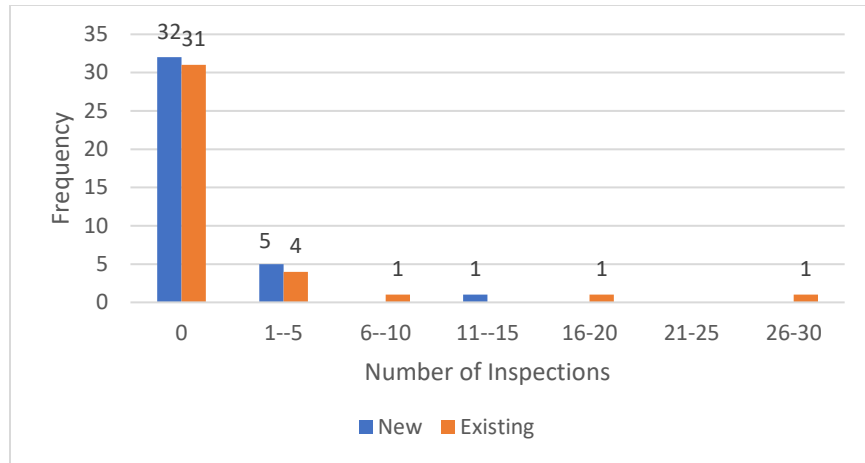


Figure 14. Inspections of Atrium Smoke Management Systems

Table 4. Responses on Smoke Control Systems

Question	Stairwell	Zoned	Atrium
9. How many inspection projects has your company completed in the past 36 months?			
New construction	118	84	27
Existing building	149	297	65
10. How many projects required repairs, adjusting, and/or balancing of the system, including associated dampers?			
New construction	100	72	22
Existing building	61	37	14
11. How many projects required that more than 15% of the components needed adjustments, repairs or replacements?			
New construction	82	66	20
Existing building	29	22	7

Question 10. How many projects required repairs, adjusting, and/or balancing of the system, including associated dampers?

The responses to question 10 for the three types of smoke control systems are included in Figures 15-17. The proportion of smoke control projects requiring repair, adjustment or balancing in new and existing buildings is indicated in Table 5. The proportion of inspection projects that identified the need for service, i.e. repair, adjustment or balancing, were similar for the three types. The proportion of systems needing service were much greater in new versus existing buildings.

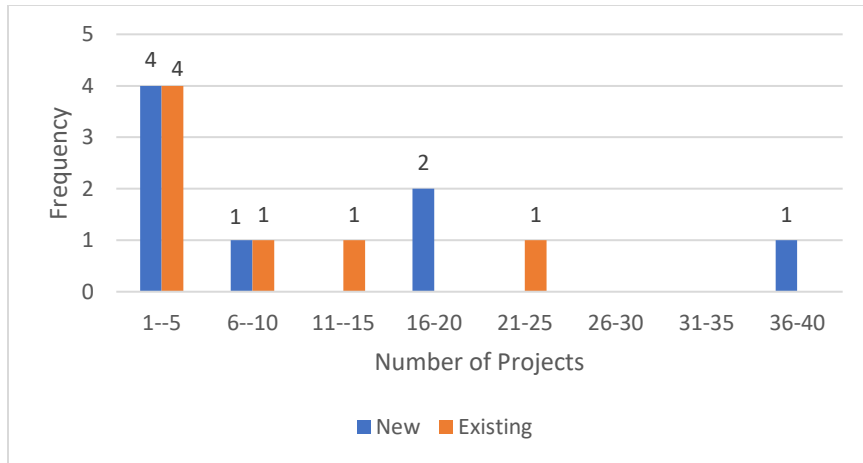


Figure 15. Inspection Projects of Stairwell Pressurization Systems Identifying Need for Repair, Adjustment or Balancing

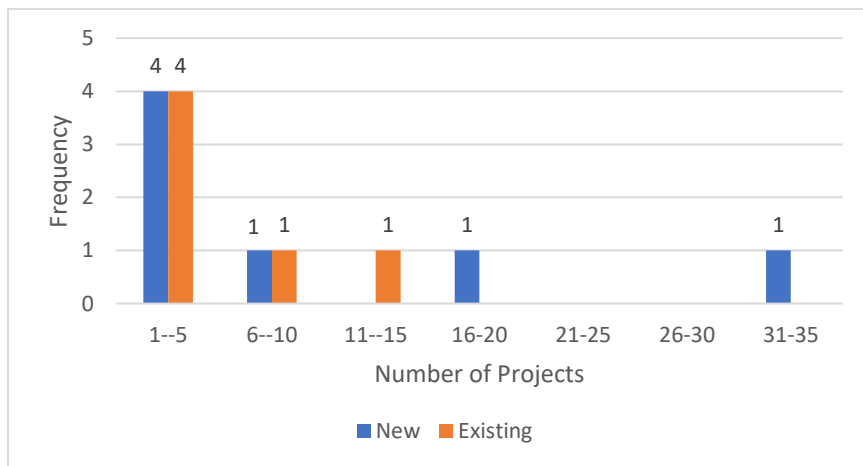


Figure 16. Inspection Projects of Zoned Smoke Control Systems Identifying Need for Repair, Adjustment or Balancing

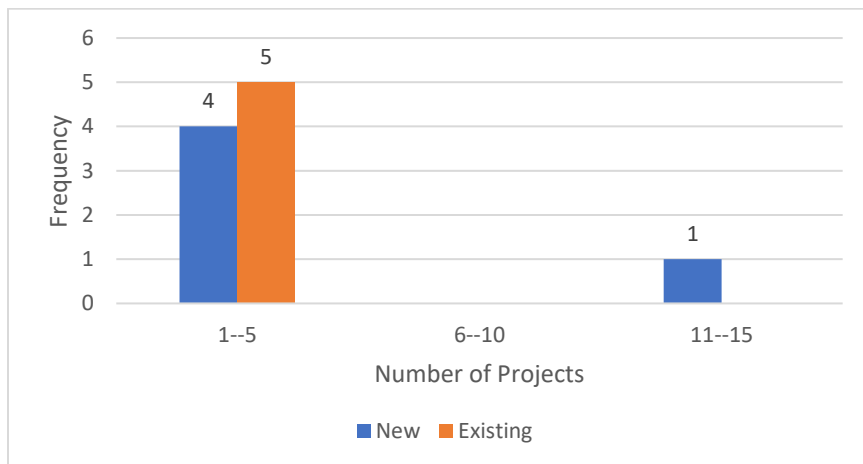


Figure 17. Inspection Projects of Atrium Smoke Management Systems Identifying Need for Repair, Adjustment or Balancing

Table 5. Smoke Control Systems Requiring Repairs, Adjustment or Balancing (%)

Building	Stairwell	Zoned	Atrium
New	85	86	81
Existing	41	12	22

Question 11. How many projects required that more than 15% of the components needed adjustments, repairs or replacements?

The responses to question 11 for the three types of smoke control systems are included in Figures 18-20. The proportion of smoke control projects with a substantial number (i.e. more than 15%) of the components needing adjustment, repair or replacement is summarized in Table 6. As indicated in the proportion of systems needing attention being greater in new buildings as compared to existing buildings, the proportion of systems with a substantial number of components needing attention is also greater in new buildings as compared to existing buildings.

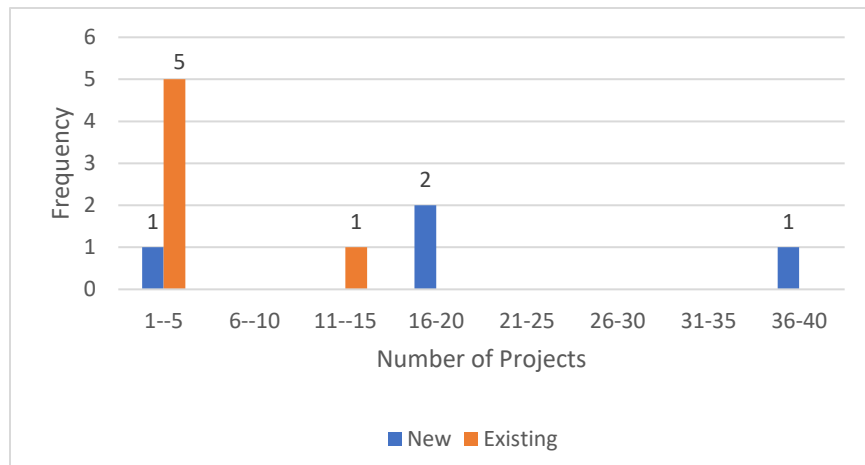


Figure 18. Proportion of Stairwell Pressurization System Inspection Projects with More Than 15% of the Components Needing Adjustments, Repairs or Replacements

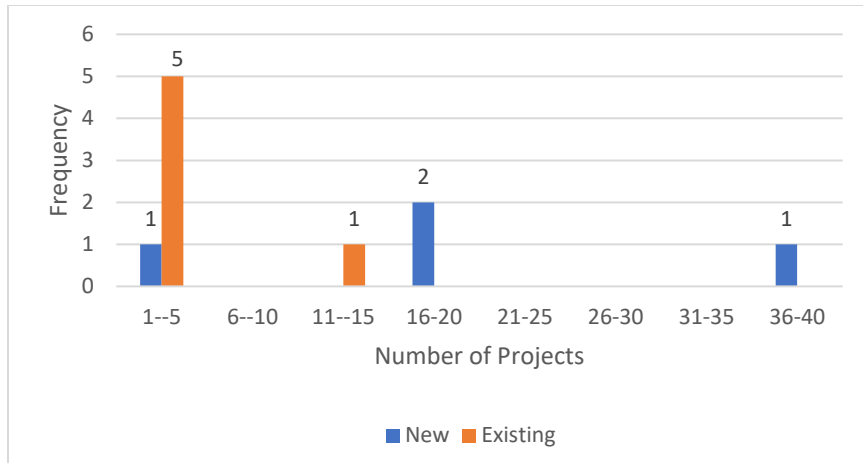


Figure 19. Proportion of Zoned Smoke Control System Inspection Projects with More Than 15% of the Components Needing Adjustments, Repairs or Replacements

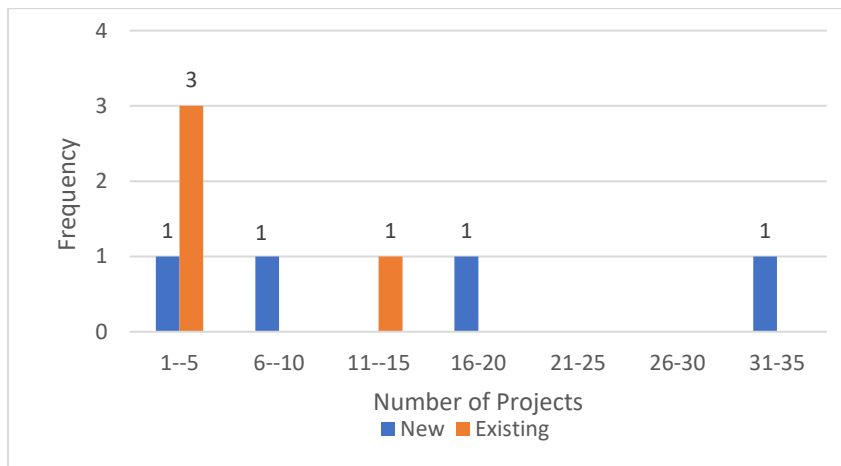


Figure 20. Proportion of Atrium Smoke Management System Inspection Projects with More Than 15% of the Components Needing Adjustments, Repairs or Replacements

Table 6. Smoke Control System Projects with More Than 15% of Components Requiring Repairs, Adjustment or Balancing (%)

Building	Stairwell	Zoned	Atrium
New	69	79	74
Existing	19	7	11

4. SUMMARY

The results of the survey indicate that inspections of FLS dampers and smoke control systems are identifying a substantial number of issues concerning these components or systems.

The trends in the results for new versus existing buildings is opposite for FLS dampers than smoke control systems. Issues with FLS dampers were far more prominent in existing buildings, while issues with smoke control systems were observed more often in new buildings.

The issues for FLS dampers in existing buildings were pervasive, with a majority of the responses to each question expressing concern. Even so, FLS dampers in new buildings were not immune from showing evidence of problems.

The issues for smoke control systems were more prominent in new buildings than existing buildings, which is expected given design practice. Because smoke control system design includes some key design assumptions, testing of the system typically identifies adjustments needed in fan capacities or damper settings in order to create acceptable pressure differences within the building.

Appendix A. Survey Form



Survey of Fire Life Safety Systems

General

In what state or region of the U.S. does your company provide inspection services of FLS Dampers or Smoke Control Systems? _____

Fire Life Safety Dampers

	New Construction	Existing Building
1. In the past 36 months, how many fire and smoke damper inspection and testing projects has your company completed?		
2. How many fire dampers, smoke dampers, or combination fire/smoke dampers (in total) were inspected on these projects?		
3. Of the inspected Fire Life Safety Dampers, how many were in need of:		
a. Repair?		
b. Replacement?		
c. Better damper access requiring installation or modification of access (such as doors or other means)?		
4. Of the electric or pneumatic actuated FLS dampers that were inspected, how many dampers (in total) required replacement of the actuators?		
5. Of the total number of FLS dampers inspected in the past 24 months, what percentage of fire and smoke damper projects have areas of concern with the reliability of the installed fire, smoke and/or combination dampers?		
6. Of the FLS damper inspection projects, how many projects had more than 15% of the components that needed repair or replacement		
7. Of those requiring attention, in what proportion was immediate attention required in order to keep the building open as the problem was life threatening		

8. Of the projects needing repair or replacement, what proportion required the following actions		
8.1 Damper		
a. Adjustment needed		
b. Replacement needed		
c. Other		
8.2 Actuation by fire alarm system		
a. Reprogramming needed		
b. Replacement of parts in fire alarm system needed		
c. Other		

Smoke Control Systems

Answer each of the following questions for each type of smoke control system inspected.			
	Stairwell Pressurization System	Zoned Smoke Control	Atrium Smoke Management ¹
9. How many inspection projects has your company completed in the past 36 months?			
New construction			
Existing building			
10. How many projects required repairs, adjusting, and/or balancing of the system, including associated dampers?			
New construction			
Existing building			
11. How many projects required that more than 15% of the components needed adjustments, repairs or replacements?			
New construction			
Existing building			

¹ “Atrium Smoke Management” is meant to refer to a system with smoke exhaust in a large, uncompartmented space such as an atrium, covered mall, arena, airport terminal, etc.