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15. Supplementary Notes

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16. Abstract (MAXIMUM 200 WORDS)

A furnace test was conducted to investigate a possible cause of premature failures of one-hour fire-rated window assemblies in a previous test series. In the previous series, two of the four A-30 window assemblies and one of the four A-60 window assemblies failed within eight and ten minutes after the beginning of the test exposure. A suspected cause was damage by welding slag from the attachment of the thermocouples to the window frame.

To investigate the suspected cause, the unexposed face of an A-30 window assembly was damaged using welding slag. One damaged window assembly fractured when it was installed in the test bulkhead. A second A-30 window was damaged using welding slag and tested side by side with an undamaged A-30 window. Both windows performed similarly without failure. Thus, damage from welding slag is unlikely to be the cause of the premature failures in the previous test series.

The fire test followed Resolution A.754(18) of the International Maritime Organization with some exceptions. The main exception was termination of the test after 35 minutes.

The window frames in this test were not the same design as those in previous test series due to unavailability.

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EXECUTIVE SUMMARY

This test program is a continuation of the U.S. Coast Guard (USCG) program element 3308.2.74, Fire Resistance of Divisions (Radiation). Previously, the USCG conducted a series of furnace tests of a type of A-0 windows, a type of A-30 windows, and a type of A-60 windows.[1] The A-30 and the A-60 windows were constructed using Contraflam gel sandwiched between glass. The window frame was a design that was approved by Lloyd's Register for A-60 windows. The A-60 windows had been approved by the Canadian Coast Guard. In these tests, an A-30 specimen and an A-60 specimen were mounted side by side in an insulated bulkhead and simultaneously tested. Two out of four A-30 windows and one out of four A-60 windows exhibited early failure. An exact cause of these failures was not determined, and the work effort reported herein was to investigate the potential failure modes.

The postulated failure modes were incorrect installation (i.e., upside down) or damage from welding slag. The first failure mode (improper installation) could not be evaluated. The manufacturer of the window frame assembly used in the previous test series had discontinued this type of window frame. In addition, other window frames available for use were constructed such that the window assembly did not have a specific top or bottom (i.e., could be installed in any manner). Since the exact window frame assembly was not available, a test with improper installation could not be accurately performed, and thus, no further testing or analysis on this failure mode was performed.

The approach to evaluate the second postulated failure mode (i.e., damage) was to perform full-scale fire resistance tests. Two tests were to be conducted. In each test, one damaged and one undamaged A-30 type window assembly would be evaluated. The incorporation of the undamaged window assembly would provide a control in each test. The window assemblies were approved A-30 type windows. In the case of the damaged windows, welding slag was used in an attempt to reproduce the damage noted in the earlier test series.

[1] The A rating indicates that a boundary will resist the passage of flame for one hour. The following number indicates the duration that a boundary will not exceed the limit on temperature rise on the unexposed side. Thus an A-30 window will resist the passage of flame for one hour and not exceed the limit on temperature rise for at least 30 minutes in the standard test.

Initially, one window was selected for damage. The damage consisted of pits into the face of the glazing, and this was accomplished by arc welding on a piece of steel placed above a horizontal window assembly. As this window was being installed, it fractured and was not usable for further testing. A second window assembly was mounted into the test bulkhead and was damaged just prior to the test with the window assembly in the vertical orientation. A subsequent fire resistance test that incorporated both a damaged and an undamaged window assembly was conducted. The test was conducted in accordance with "Recommendation on Fire Test Procedures for 'A,' 'B,' and 'F' Class Divisions (IMO Resolution A.754(18))."

During the test, the exposed layer of glass did fracture and fall from both of the assemblies. The gel did react to the heat, and it formed a char layer. The glass on the unexposed face of both window assemblies did not fracture or fall away. From the temperature data and the observations, both of the test windows met the A-30 requirement of limiting the temperature rise for 30 minutes.

Based on these test results, as well as the lack of a fourth window (i.e., fractured earlier, thus no control window was available), it was decided that a second test would not be performed.

The results of this fire test did not substantiate the theory that welding splatter would cause a premature failure as occurred in the earlier testing. However, the failure of a window assembly during its mounting in a bulkhead indicates that the extent of the damage (i.e., size and depth of pits) may be a significant factor with respect to its performance.

The test also indicates that an A-30 window assembly may perform appropriately even with some damage on the unexposed face of the glass.

Based on this work and since the other postulated failure mode (i.e., incorrect installation) was not evaluated, no definitive conclusion can be drawn concerning the failures observed in the previous testing.