Sight Glasses

Sight glasses are installed in ports on chemical processing vessels to permit observation of conditions within the vessel. These are generally installed in pairs, one for observation and the other for accommodating a light fixture to illuminate the interior of the vessel.

Part No. B359

Full View Dual Window Sight Glass. P/N B359-1 through -36; B359-8A, -10A, -11A, -22A, -33A. Sizes available between 1 and 12 in. (25 and 305 mm). 150, 300, 450 and 600 psi (1035, 2070, 3105 and 4135 kPa) pressure ratings. Annealed or tempered borosilicate glass, 446° or 500°F (230° or 260°C) max temperature rating, respectively.

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Company Website:	http://clarkreliance.com
New/Updated Product Listing:	No
Listing Country:	United States of America
Certification Type:	FM Approved
Primary Class of Work:	

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DUAL WINDOW SIGHT GLASSES

from

JACOBY-TARBOX CORPORATION
808 NEPPERHAN AVENUE
YONKERS, NEW YORK 10703

I INTRODUCTION

1.1 The Jacoby-Tarbox Corporation requested approval of their dual window Pyrex sight glasses. These glasses are used to view the interiors of pressure vessels and they have the maximum working pressures of from 150 psig up to 600 psig. Refer to Paragraph 2.2 below.

1.2 Two individual glasses are used in each sight glass assembly. The assembly is designed so that if either sight glass is broken, the pressurized fluid will be held inside the pressure vessel by the remaining unshattered glass. As a result, two sight glass failures are necessary before the contents of a pressure vessel can be discharged to the surrounding environment.

1.3 This report description includes the basic dual window assembly described in Section II below. It does not include the various dual-window assembly mounting styles shown on page 5 of the manufacturer's catalog attached to this report.

II DESCRIPTION

2.1 The basic dual window sight glass assembly consists of the components shown in the cross section on the attached Manufacturer's Drawing DW-359A and Catalog Page 5 (glass windows, non-compressible gaskets, sealing gaskets and stainless steel holder). This basic unit may be used in the various style configurations shown on Catalog Page 5. In each instance, the entire dual window unit is bolted between either two flanges or a flange and another seating surface in the same manner that a single or laminated lens is held.

2.2 The glass windows consist of two tempered or two annealed Pyrex borosilicate glass discs manufactured by the Corning Glass Works, Corning, N. Y. This glass has the properties shown in Appendix I attached to this report. These glass windows are available in the sizes shown under the column heading "Disc Size" on attached Drawing No. DW-359A. They are rated for 150, 300 or 600 psig maximum working pressure using either tempered or annealed glass as shown on this drawing, and in Column 5 in Appendix II.

2.3 The manufacturer's instructions specify that the surface of the glass disc must be flush with the face of the stainless steel holder to insure that no leakage will occur. The non-compressible fibre gaskets, which are available in 0.015 and 0.030 in. thicknesses, are used as shims to satisfy this requirement. The sealing gaskets fit between the basic stainless steel holder and sight glass assembly defined in Paragraph 2.1, and the flange or pressure vessel seating surface. Leakage can occur only if the non-compressible gaskets are arranged so that the sealing gasket surfaces of both glass windows are lower than the sealing gasket seating surfaces of the stainless steel holder. Under this condition, there is no longer a tight seal between the glass and the sealing gasket. These sealing gaskets are available in several materials such as Teflon, neoprene, etc. depending on the kind of service that the sight glass is expected to be exposed to.

2.4 The stainless steel holder is available in several sizes as shown on attached Drawing No. DW-359A. Should the flange bolts holding the dual window assembly together be overtightened, the chances of damage to the glass windows are minimized when the assembly is properly installed according to the manufacturer's instructions. This is due to the fact that a large amount of the excessive compressive stresses on that ordinarily would be exerted on these windows will be carried by the stainless steel holders.

III MARKINGS

3.1 The manufacturer's name, part number, glass disc size and pressure rating is stamped on the stainless steel holder.

3.2 A label giving the manufacturer's trademark and the pressure rating is glued to the edge of the glass windows.

IV TESTS

4.1 The manufacturer submitted one No. 5204DW stainless steel holder with four 3-5/8 in. x 5/8 in. annealed glass discs rated at 150 psig, and one No. 910-600 DW stainless steel holder with 4-1/2 in. x 3/4 in. tempered glass discs rated at 600 psig. Also supplied were several sealing and non-compressible gaskets. These two glass disc sample sizes, using the calculations shown in Appendix II, were considered to be representative of those disc sizes having lowest factors of safety in their recommended working pressures.

4.2 The stainless steel holders and two glass windows of each size came installed on a pressure vessel supplied by the manufacturer. Each dual window assembly was held in place using a flange and 8 bolts. The pressure chamber was filled with water at 70°F and the 3-1/2 in. and 4-1/2 in. sight glass assemblies were subjected to pressures of 225 psig and 900 psig respectively for five minutes with no leakage observed.

4.3 The 3-1/2 in. and 4-1/2 in. sight glass assemblies were subjected to hydrostatic test pressures of 450 psig and 1800 psig, respectively, using water at 70°F. These pressures are 300% of the rated maximum operating pressures

of these sight glasses. There was no damage to the sight glass assemblies as a result of these tests.

4.4 With the pressure vessel holding rated 150 psig (3-1/2 in. disc) or 600 psig (4-1/2 in. disc) during two respective test series, a 1.07 Kg weight was dropped from a height of approximately 10 ft. on each of these pressurized sight glass assemblies. In each instance, the outer glass windows struck by the weight was shattered while the inner glass continued to hold the test pressure without leakage as intended in the design of these sight glass assemblies. It was also noted in both of these tests that the outer glass window absorbed the entire impact of this weight. The inner glass windows were not damaged and were able to be used later on other tests.

4.5 Both size discs were mounted in their appropriate stainless steel holders and were alternately subjected to hot (140°F) and cold (80°F) water at 125 psig, 3000 times. The rate of temperature change for this test was 10°F per second. In addition, the 3-1/2 in. discs were installed on a pressure vessel filled with water that contained a heating element and a thermostat that could be preset for the desired high temperature. When this temperature was reached, a timing control was set in motion which opened valves to the pressure vessel and allowed water at 60°F to be flushed through it for 30 seconds. In this second test, the sight glass assembly was exposed to a maximum 360°F and 150 psig pressure and then cooled to 100°F at approximately 50 psig in approximately 10 seconds for 80 cycles. This represents a temperature change of 260°F (144°C) or approximately 14°C per second. A pressure switch connected to the pressure vessel vented any pressure increase above 150 psig due to water expansion. No damage was observed in the glass windows throughout these tests.

4.6 The Corning Glass Works submitted data giving the upper working temperatures shown in Appendix I. This data supplemented the results obtained from the tests described in Paragraph 4.5.

4.7 The results of these tests, which were intended to confirm the ratings of the glass windows, are satisfactory.

V CONCLUSION

These dual window sight glasses meet Factory Mutual approved requirements. Approval is effective when the Manufacturer's Agreement is signed and returned to Factory Mutual.

TEST AND REPORT BY : D. E. Skinner

ORIGINAL DATA : Test Notebook 234

ATTACHED : Appendix I
Appendix II
Page 5 from Manufacturer's Catalog 71 and
Manufacturer's Drawing No. DW-359A

GLASS PROPERTIES

The Corning Glass Works submitted data showing that the borosilicate Pyrex glass used in these dual window sight glasses has the following properties:

Color: clear
Thermal expansion, 0-300°C : 33×10^{-7} in./in./°C

Upper working temperatures (mechanical considerations only) for normal service (freedom from excessive thermal shock is assumed):

Annealed glass : 230°C
Tempered glass : 260°C

Thermal shock resistance (approximate resistance to sudden changes in temperature based on plunging sample into cold water after oven heating) for annealed glass:

1/8" thick : 180°C
1/4" thick : 150°C
1/2" thick : 100°C
3/4" thick : 50°C

Tempered samples have over twice the thermal shock resistance of annealed glass.

Thermal stress resistance : 53°C. This is the temperature differential between the two surfaces of the glass that will cause a tensile stress of 1000 psi on the cooler surface.

Other physical characteristics are:

Density : 2.23 grams/c.c.
Young's Modulus : 9.1×10^6 psi
Poisson's Ratio : 0.20

The Corning Glass Works submitted a chart showing the relationship between the recommended working pressure, the thickness and the unsupported diameter for a circular glass. Using this data, the results below were calculated:

1	2	3	4	5	6
Glass Disc Specification	Unsupported Diameter	Thickness Ratio	Recommended Pressures, Psig. Corning	Jacoby - Tarbox	Factor of Safety
A-1" x 3/16"	3/4"	0.25	220	150	1.47
A-1 1/2" x 1/4"	1 1/8"	0.22	180	150	1.20
A-1 3/4" x 3/8"	1 3/8"	0.26	235	150	1.57
A-2 5/8" x 1/2"	2"	0.25	220	150	1.47
A-3 1/4" x 5/8"	2 3/4"	0.23	190	150	1.27
A-3 5/8" x 5/8"	3"	0.21	165	150	1.10
T-4 1/2" x 1/2"	3 1/2"	0.14	235	150	1.57
T-5 1/2" x 5/8"	4 1/2"	0.14	235	150	1.57
T-6" x 3/4"	5"	0.15	270	150	1.80
T-7 7/8" x 3/4"	6 7/8"	0.11	150	150	1.00
T-9 1/4" x 1"	8 1/4"	0.12	180	150	1.20
T-12 1/8" x 1 1/4"	11 3/8"	0.11	150	150	1.00
T-1 1/2" x 1/4"	1 1/8"	0.22	515	300	1.72
T-1 3/4" x 1/4"	1 3/8"	0.18	375	300	1.25
T-2 5/8" x 3/8"	2"	0.19	415	300	1.38
T-4 1/2" x 5/8"	3 3/16"	0.20	450	300	1.5
T-5 1/2" x 3/4"	4 1/4"	0.18	375	300	1.25
T-1 1/2" x 3/8"	1 1/8"	0.33	980	600	1.63
T-1 3/4" x 3/8"	1 3/8"	0.26	700	600	1.17
T-2 5/8" x 1/2"	2"	0.25	650	600	1.08
T-4 1/2" x 3/4"	3 3/16"	0.245	640	600	1.07
T-5 1/2" x 1"	4 1/4"	0.245	640	600	1.07

Manufacturer's Note: Column 6 F/S is in addition to that already included in Corning's recommended pressure.

A-Annealed T-Tempered

Column 1 data is taken from the columns headed "Disc Size" and "Mat'l Pyrex" on attached Drawing No. DW-359A. An A-1"x3/16" glass disc is an annealed glass disc that is 1 in. in diameter and 3/16" thick.

Column 2 data is taken from the "D" column on DW-359A.

Column 3 data are the glass disc thicknesses shown in column 1 divided by their respective Column 2 entries.

Chart submitted by Corning converts the Column 3 entries into the recommended pressures shown in Column 4.

Column 5 data is taken from "P.S.I." column on DW-359A.

Column 6 data are the Column 4 entries divided by the Column 5 entires.