

# Report on the Investigation into the Impact Resistance of Glass Signal Lenses for Railway Signals

# Summary

Glass railway signal lenses are widely believed to be prone to damage to an unacceptable degree, as a result of vandalism.

Nazeing Glassworks has conducted an investigation into the durability and resistance of glass railway signal lenses to impact, specifically high-velocity projectiles such as air gun pellets as specified in RT/E/S/10062 Issue 1. The investigation uses three different types of air gun and three different types of pellet. This report contains the findings of the investigation, along with an analysis of the results.

# Contents

1. Introduction
2. Description of Samples
3. Details of Tests
4. Results of Tests & Conclusions
5. Conclusion

## 1.Introduction

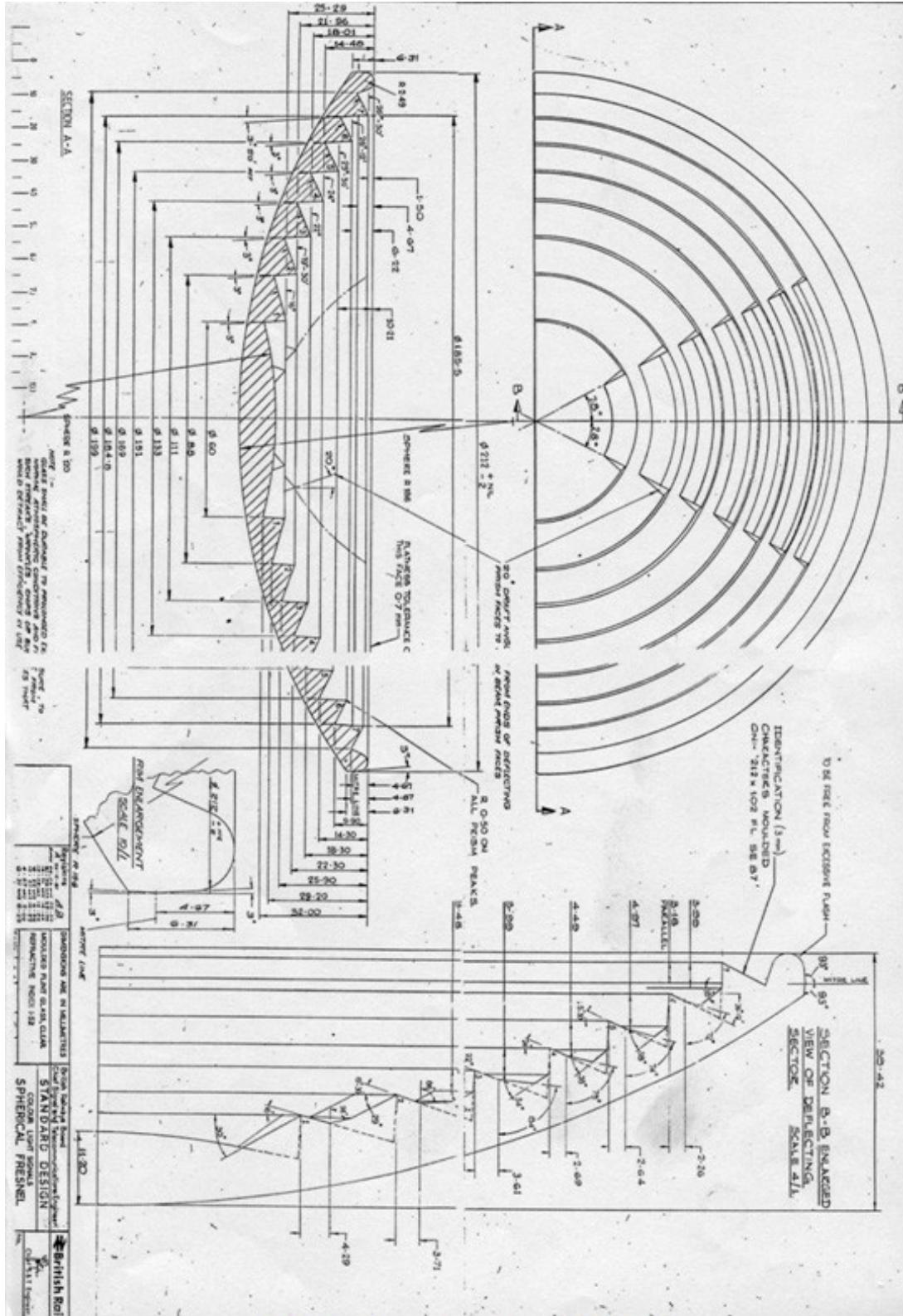
Given the ongoing concerns about trackside vandalism, an investigation has been carried out to determine how resistant existing glass signal lenses are to vandalism as specified in RT/E/S/10062 Issue 1.

## 2. Description of Samples

LE-1101-07 (213x102 Outer Doublet Lens +S/Sect, BRSE 87)  
Glass Signal Lenses manufactured by Nazeing Glassworks Ltd.

This particular lens was chosen, as it is the current external lens used in various existing signals for use on the Railway system. The lens is currently produced in flint (soda lime) glass and receives no additional post-processing besides lehr annealing in order to remove stress from the glass.

Chemical Composition of Soda Lime Silicate (Flint) Glass	
Chemical	Percent %
SiO <sub>2</sub>	64.80
Na <sub>2</sub> O	14.65
K <sub>2</sub> O	5.80
CaO	9.30
Fe <sub>2</sub> O <sub>3</sub>	0.02
B <sub>2</sub> O <sub>3</sub>	2.90
BaO	2.50
Density. g/Cm <sup>3</sup>	
	2.48
Coefficient of Thermal Expansion. 50-300°C @ x 10 <sup>-7</sup> /°C.	
	95
Thermal Endurance. °C.	
	120



British Rail issued drawing of LE-1101

### 3.Details of Tests

Impact testing was conducted using two different makes of air gun and an air rifle in order to accommodate the varying impact different makes can subject glass lenses to.

Guns used in impact testing	
Name	Calibre
CO2 Pietro Beretta MOD 92 FS	4.5mm (117)
Gamo 4.5 (177) Air Pistol	4.5mm (117)
Weihrauch HW57 12lb/ft 22 Cal Air Rifle	5.6mm (220)



CO2 Pietro Beretta MOD 92 FS



Weihrauch HW57 12lb/ft 22 Cal Air Rifle

Pellets used for impact testing	
Name	Calibre
Alloy Eley Wasps	4.5mm (117)
Match Kugeln	4.5mm (117)
Alloy Eley Wasps	5.6mm (220)



Variety of pellets used during impact testing

The lenses were placed against a support and subjected to a ballistic impact test from each firearm from various distances. After each shot was fired, the lenses were inspected for any signs of defects or cracking. Where no signs of damage were apparent at any distance, the glass signal lenses were subjected to repeated impacts from the firearm, until any damage was sustained. This has been noted in the results of the experiment.

## 4.Results of Tests & Conclusions

Key:

H = Held  
C = Cracked  
D = Destroyed

### Impact Test 1

Gamo 4.5mm (177) Cal Air Pistol / 4.5mm 177 Eley Wasps				
Distance (Feet)	1 <sup>st</sup> Impact	2 <sup>nd</sup> Impact	No. of impacts required to crack	No. of impacts required to destroy
5 (See Lens A)	H	H	N/A	N/A*
10	H	H	N/A	N/A*

\*No cracking after 30 shots

### Impact Test 2

Pietro CO2 4.5mm 177 Cal Beretta 92 MOD FS / 4.5mm 177 Cal Match Kugeln				
Distance (Feet)	1 <sup>st</sup> Impact	2 <sup>nd</sup> Impact	No. of impacts required to crack	No. of Impacts required to destroy
5 (See Lens B)	H	H	6	N/A*
10	H	H	10	N/A*

\*Although cracked, lens remained intact and usable after 24 shots



## Impact Test 3

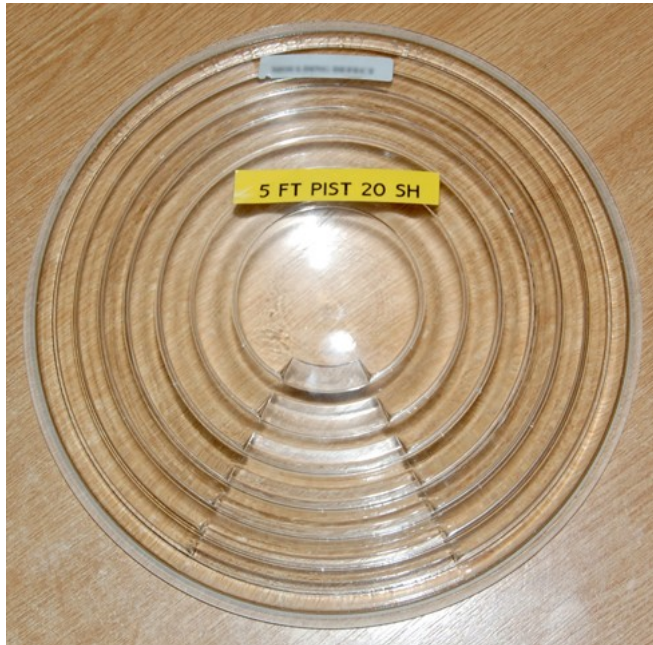
Weihrauch HW57 12lb/ft 22 Cal Air Rifle / 5.6mm 220 Eley Wasps				
Distance (Feet)	1 <sup>st</sup> Impact	2 <sup>nd</sup> Impact	3 <sup>rd</sup> Impact	4 <sup>th</sup> Impact
5	D	H	D	H
10 (See Lens C)	D	H	H	C
15	H	D	H	H
20	H	H	H	H
30	H	H	H	H*

\*Lens continued to hold after 24 further impacts

The results show that the resistance of the glass lens to impact from an air gun pellet varies depending on the type and make of gun used.

Tests indicate that the glass lens was completely resistant to damage from a regular air pistol from as close as 5 foot, whereas signs of cracking began to emerge after multiple shots from 5 foot from a CO<sub>2</sub> air pistol. However it has to be noted that the likely distance that a vandal will get to a signal installed on the railway system will greatly exceed 5 foot. It should also be noted that long range air rifles, are likely to be used at longer distances than 20 foot.

### LENS A



Glass lens A after 20 shots at 5 foot from a Gamo 4.5mm (177) Cal Air Pistol

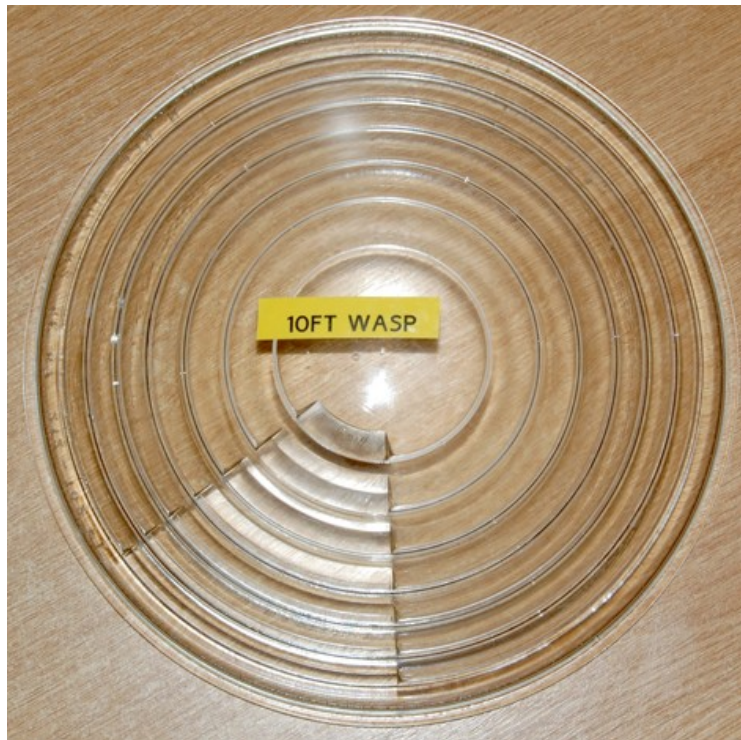
### LENS B



Glass Lens B damage after 24 shots at 5 foot from a Pietro CO2 4.5mm 117 Cal Beretta 92 MOD FS

When subjected to an impact from the 22 cal Air Rifle, the Glass signal lenses were less resistant to impact at distances less than 20 foot. Of the 12 shots fired 5 of the lenses were damaged, indicating that there is at least a 50% chance that the glass signal lens will remain undamaged even when subject to an impact from a powerful air rifle at close range. At distances over 20 foot, the lenses remain unaffected by the impact as shown.

### LENS C



Glass lens after single impact at 10 foot from Weihrauch HW57 12lb/ft 22 Cal Air Rifle, showing virtually no damage

## 5. Conclusion

It is conclusive that the external Glass signal lens (LE-1101) currently in use is more resistant to impact from pellets fired from both air rifles and air pistols than is widely believed.

The lens also appears to be completely resistant to damage from non CO<sub>2</sub> charged air pistols at any distance.

The resistance of the lens to impact increases as the distance between the firearm and the lens increases, to the extent that the lens cannot be damaged from distances in excess of 20 foot, even with a 22 calibre air rifle.