A guide to the proper use of Lysholm scatter radiation grids

Factors that will improve your X-ray image

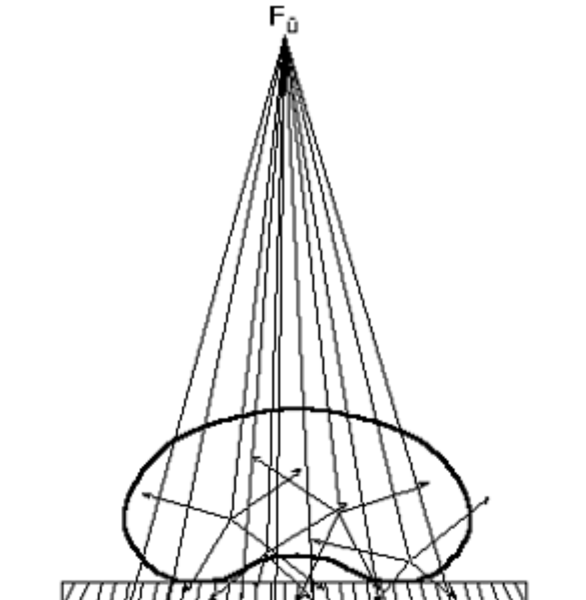
There are primarily five factors that will influence the quality of your X-ray image:

- Scattered radiation
- Collimation
- Compression
- Back scatter prevention
- Film processing

This document will discuss scattered radiation and way of minimizing the negative effects thereof by the utilization of various types of Lysholm X-ray grids.

Technical description
The x-ray grid represents the best-known, most significant, and most effective means of eliminating scattered radiation from the image.
A scattered radiation grid consist of a system of vertical lead lamellae arranged at specific distances from each others. The interposed Lysholm grid medium, aluminium, is highly radio-transparent and thus results in an insignificant attenuation of the image producing radiation.

The secondary radiation, characterized by a path of propagation that in non-paralled to that of the primary radiation is largely absorbed by the lamellae, which are aligned with the path of the primary radiation. In this way the secondary or scattered or scattered radiation is prevented from reaching the X-ray image produced on the receptor film (film, image intensifier or digital medium) behind the grid.



The lamella system is enclosed on all sides by a radio-transparent cover made of 0.2mm aluminium (Al) or 0.25mm carbon fibre (CFR) resin that will ensure high strength (protection against physical damage) and eliminate temperature and atmospheric influences.

Quality

Parameters contributing to the quality of a grid include a well-chosen ratio of the lamella spacing, optimal thickness of the individual lamellae (i. e. lamellae that are not to thin to allow passage of

scattered radiation), the selection of a suitable radio transparent medium as well as its selectivity.
The Lysholm grid satisfies these requirements in every aspect.

Design features of the Lysholm scattered radiation grids

In describing a scattered radiation grid three quantities come into consideration:

- grid radio (r)
- lamella density
- focus-film distance

Technical Specifications related to Lysholm Grids

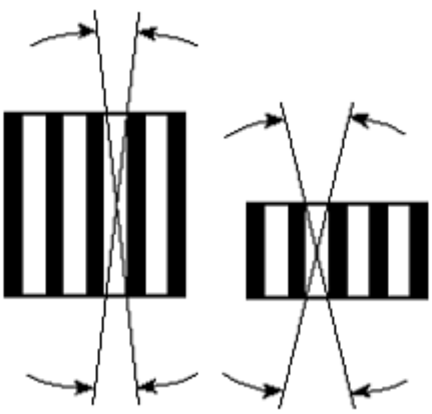
X-ray absorbing material	Lead (Pb)
Inter space material	Aluminium (Al)
Thickness of lead lamellae	N30: 0.050 mm N40: 0.040 mm N70: 0.036 mm
Cover material	0.20 mm Al

Grid ratio:

The grid radio (r) is the ratio of the lamella height to the distance between two adjacent lamellae.

Grid ratio = lamella height / lamella spacing = h/D

A grids "scatter clean up effect" increases with its ratio. In other words, if the lamella height is increasing while the spacing is kept constant, the incident angle for scattered radiation decreases.



This fact contradicts the practical requirements; **a high grid ratio always requires a more precise centering and focusing.**
The result of an out-of-center or out-of-focus condition will appear as loss of primary radiation and peripheral shadowing in the form of a brightening of the radiogram toward the edges.
That the grid ratio in not an absolute measure of the effectiveness of a grid can be demonstrated with the following: If the lamella thickness is increased while the grid ratio is kept constant the distance between adjacent lamellas will narrow. This will result in increased absorption of primary radiation. A reduction in absorption of primary radiation can be achieved by reducing the thickness of the lamellae, which however will increase the transmission of scattered radiation.

Lamella density:
The lamella density is a measure of the number of lamellae/cm (N= lamellae/cm).

Focus-film distance / Source- image distance

The focus-film distance (FFD) or source-image distance (SID) is the distance between the focal point of the X-ray tube and receptor (X-ray film or other radiation receptor).
A grid having the designation 8/40/115 has a grid ratio of r=8:1, a lamella density of N=40/cm, and an FFD (SID) of 115 cm. Since r=8 is the ratio of the lamella height and the distance between two adjacent lamellae, this grid has a lamella height of 1.68 mm.

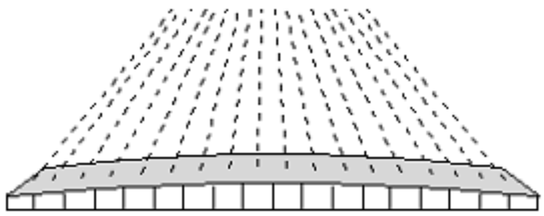
Grid characteristics

The three quantities under chapter Lamella density describe only the technical parameters of a grid but provide really only limited information regarding its quality. A grids effectiveness in reducing scattered radiation is best demonstrated in the relation between transmission of primary radiation to that of scattered radiation.
In the literature this is expressed as **Selectivity** or transmission of primary radiation/transmission of scattered radiation.
This leads to the conclusion that the greater the primary transmission and the more effective the scattered radiation absorption is, the higher is the quality of the grid.
Selectivity will therefore constitute an absolute criterion for evaluating the quality of a grid.

Parallel grids

Parallel grids are relatively insensitive to centering errors and are therefore invaluable for applications such as bedside, surgery and emergency room or any situation where a perfect alignment of the grid to the x-ray tube can not be accomplished.
This suggests that parallel grids give satisfactory results, when the required image size is small enough, and the exposure parameter permits a low ratio grid.

In parallel grids the lamellae are arranged vertically in the grid plane and parallel to each other in contrast to focused grids in which the lamellae converge towards a focal point.
Parallel grids are normally made on the "prismatic section" principle, i.e. the lamellae height taper off towards the edges. This reduces the cut-off of primary radiation which is essential when large film sizes and short FFD/SID are used. Parallel grids are also available where the lamellae height is retained all the way to the edge. These grids are classified as ratio **r**, while the "prismatic" versions are classified as ratio **ro**.

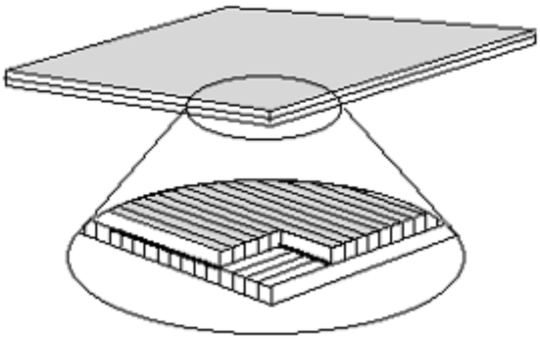


As a general rule, when using parallel grids; a sufficient FFD/SID must be ensured.

We recommend an FFD/SID of at least 100 cm. With shorter distances the peripheral incident radiation is to oblique and is absorbed, resulting in pronounced darkening around the center axis and shadowing in the peripheral zones.
This effect is commonly known as ***grid cut of****.*
The same consideration precludes the use of parallel **wide** grids. It should be noted that since the effect mentioned above does not occur along the longitudinal axis of the lamellae, no restrictions are placed on the length of the grid.
The parallel grid is preferable for all bedside examinations and in all other situations where an absolute perfect alignment of the central beam in relation to the market center line of the grid cannot not be ensured.
A ratio no higher than 10:1 is recommended. With a higher ratio, the alignment again becomes more critical. The answer here may be a cross hatched grid.

Cross hatched grids

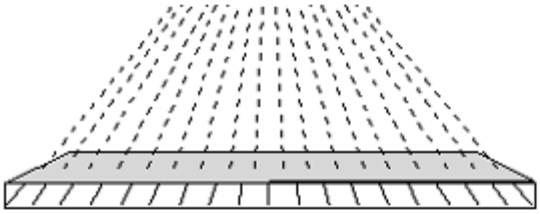
The cross *hatched* grid is two parallel or focused grids assembled in a sandwich fashion, with the lamellae of one grids normally running in a 90 degree angle in relation to the other grid.



The scatter absorption of a cross *hatched* grid is as that of a one component grid of the same ratio. The 2-directional cross hatched grid will however, absorb more scatter originating from the interior of the object being examined than a conventional grid of the same ratio. A cross hatched grid is mainly suitable where a grid with a very high ratio is required.
The cross *hatched* grid *may be the grid of choice when a higher than a 10:1 ratio is needed or* when a deviation from a perpendicular positioning pf the receptor in relation to the beam direction is necessary or *unavoidable*. The reason for the advantage is that the cross *hatched* grid *as opposed the regular grid* only has half the ratio of the linear grid, but in two directions. *This because a cross hatched grid is made up of two 6:1 grids sandwiched together with the lamellae perpendicular to one another, and as described earlier, a lower ratio is more forgiving to misalignment.*

Focused grids

The focused grid is the most effective in reducing scattered radiation. The lamella of a focused grid is arranged parallel to the con-shaped distribution of the primary radiation array.



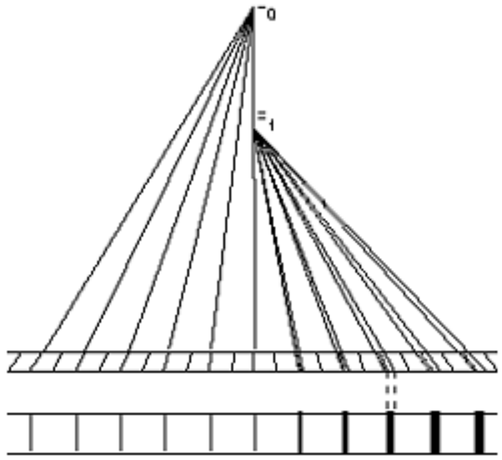
Correct and careful use of focused grids is of outmost importance if their full effectiveness is to be realized.

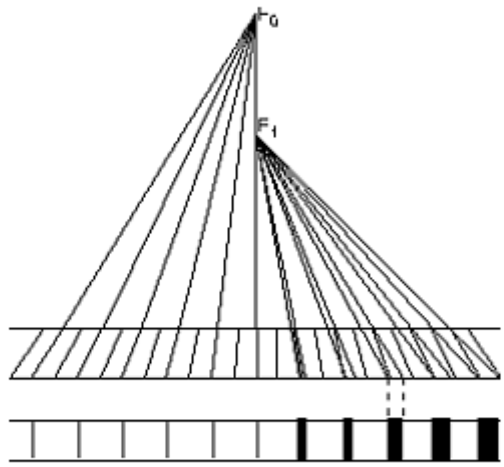
1. The focused grid should be used with the FFD/SID it was designed for. A slight deviation downwards and a somewhat larger deviation upwards are possible.
2. It is of critical importance that the grid is carefully centered during the exposoure.
   A decentered grid position, especially coupled to an incorrect FFD/SID, can result in pronounced shadowing of the radiogram.
3. The grid must be perpendicular in relation to the center beam during exposure

Various artefacts can be explained by the way the grid lamellae have been aligned in relation to the focal spot.

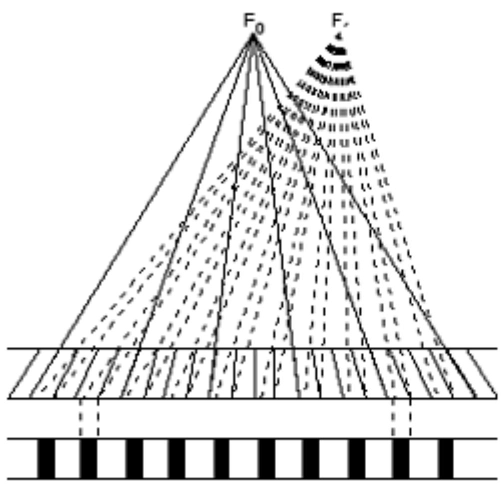
Here are some examples:

1. **When the focus lies above or below the correct focal distance of the grid.**
   As demonstrated in the two figures below an out of focus condition will result in a loss of primary radiation to the receptor. As suggested in the illustration the aborption of primary radiation will, with a short SID, be far greater than in the case where the SID is excessively large. The effect on the radiogram will be a progressive brighening towards the ed ges. Fig 1 and 2 below illustrates the fact that the higher the grid ratio the greater the loss of primary radiation towards the dges of the image.





2. **If the grid is not centered properly in relation to the focal spot,** a uniform loss of primary radiation will result



The table below shows acceptable latitudes in FFD/SID for for different r8, grids when a 40x40 cm film area is exposed:

FFD/SID	**Latitude**
70 cm	64 - 79 cm
115 cm	96 -150 cm
140 cm	111 - 200 cm
150 cm	117 - 212 cm

With smaller film/receptor sizes greater deviations from FFD/SID are possible.

A more detailed table of minimum (f1) and maximum (f2) focus grid distances when 40 % absorption is allowed at the edge at the grid will be found under the chapter Technical Specifications and Data on the last page of this publication.

Grids for use in digital radiography
Digital radiography requires a very high line grid (at least 75 lines /cm) to overcome a problem related to interference between grid line patterns from grids with less lamellae than N75*, the rows of pixels employed in digital detectors* and the lines inherent in a high resolution monitor image. This interference will appear on the monitor screen as a morié pattern that will disturb the viewing.
A grid specifically designed for digital applications with 80 lamellae/cm is available from the Gridline Company under the registered trade name D Grid. This unique grid will eliminate the moiré pattern problem.

High kV technique
A general rule suggests that the higher the kV, the greater the amount of scat ter. This fact necessitates the use of the most efficient grid when kilovoltages above 125 kV is used.
Primary absorption in the grid is of little or no importance here. A grid with a high number of lamellae to the cm should therefore be selected despite the difficuly in getting a correct alignment. Optimum quality is achieved by the use of high definition intensifying screens and a relatively long FFD/SID. This in order to minimize the geometric unsharpness.
The Lysholm focused grid: N70, r12, fo or r16 is recommended.