Visibility of the distinctive emblem on medical establishments, units, and transports

by Gerald C. Cauderay

1. Visibility: some basic considerations

The Geneva Conventions of 12 August 1949 provide that medical personnel and equipment shall in general be identified by the distinctive emblem of the red cross or red crescent. The Second Geneva Convention, applicable to the victims of conflict at sea, specifies that the exterior surfaces of hospital ships and smaller craft used for medical purposes shall be white and recommends that the parties to the conflict use "the most modern methods" to facilitate identification of medical transports at sea (Art. 43).

It is also recommended that the parties to the conflict provide medical aircraft with "any other markings or means of identification" (First Convention, Art. 36, and Second Convention, Art. 39).

The identification of medical personnel, units and means of transport therefore depends on the distinctive emblem, the use of which is set forth in Chapter VII of the First Convention (Arts. 38 to 44) and Article 18 of Protocol I additional to the 1949 Geneva Conventions. The other technical means of identification described in Chapters III and IV of Annex I to Protocol I are complementary in nature and intended to facilitate identification of protected means of transport.

While the distinctive emblem does not in itself confer protection, there can be no effective protection without it.

Since the distinctive emblem is intended to be the visible manifestation of the right to protection, it must be clearly visible and identifiable when used. This means that it must be recognizable at a distance and in good time. The appropriate distance can vary greatly depending on the type of weapon used: guns, tanks, artillery, sea or air weapons, etc.

For over 125 years, the medical personnel, units and transports protected by the Geneva Conventions have been identified by purely visual means. Yet technological progress has changed the means and methods of modern warfare to such an extent that it no longer suffices to use the red cross or red crescent emblem as the only means of identification.

Modern warfare relies increasingly on the use of sophisticated technology which makes it possible to destroy a target long before it can actually be seen. Moreover, the mechanization of means of combat and the widespread use of electronic means of observation, and even to some extent of automatic firing, especially of sea and air weapons, have considerably increased the range and rapidity with which weapons can be fired and their velocity. As a result it has become well nigh impossible to recognize at a sufficiently early stage personnel and material bearing only the distinctive emblem.

It is therefore indispensable, if the aim is effective protection of medical establishments and means of transport, to considerably improve the visibility of the distinctive emblem.

The emblem's visibility has always been a matter of concern to the International Committee of the Red Cross. The advent of aerial warfare, especially bombing, prompted the institution's leaders already over 50 years ago to test its visibility from the air, in co-operation with the Swiss Army. These tests, which were reported in the *International Review of the Red Cross* in May 1936,[1] demonstrated the limits of the emblem's visibility. The Netherlands Air Force did similar tests during the same period.

Although the technical means of aerial observation have since improved, the conclusions of the 1936 tests are still valid.

In the 1970s, when the Diplomatic Conference on the Reaffirmation and Development of International Humanitarian Law Applicable in Armed Conflicts was being prepared, the visibility of the protective emblem was tested in a number of ways, especially by means of active infrared (IR) electro-optical observation.[2]

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[1] *International Review of the Red Cross,* No. 405, May 1936, pp. 408-412 (in French only).

[2] *Active infrared:* means of night observation comprising traditional white light projectors equipped with filters and infrared lenses for observing objects lit by another source. The system uses near infrared radiation (0.75 — 1.2 microns). An active means of observation, the infrared can be detected using special lenses at distances greater than the range of its source. For this reason, and given how inefficient it is compared to modern means of observation, active infrared is practically no longer used by armed forces.

Following these tests, which were also conducted with the help of the Swiss Army, suggestions were made to improve active IR observation of the red cross emblem. At the time, no tests were carried out using passive IR means of observation,[3] also known as "thermal imaging".

Unlike "active" observation, observation using "passive" electro-optical equipment cannot be detected by the enemy, which explains why armies prefer it.

With a view to the possible revision of Annex I (Regulations concerning identification) to Protocol I additional to the 1949 Geneva Conventions, a meeting of technical experts will be convened by the ICRC in Geneva in August 1990. In preparation for this meeting, the ICRC considered it necessary both to repeat tests on the visibility of the distinctive emblem under varying conditions and using modern technical means of observation, and to improve its knowledge about the characteristics of and inherent limits to the technical means of observation widely used today by the armed forces.

It was not the ICRC's intention to repeat all the tests conducted over the past 40 years, but only certain specific tests using thermal imaging cameras (thermal IR), image-intensifying (II)[4] sight systems and aerial, visual and passive IR means of observing distinctive emblems of different sizes on buildings, various types of vehicles and medical personnel.

In addition to the distinctive emblem, the ICRC also ran a number of tests on the flashing blue lights used to identify medical aircraft (Protocol I, Annex I, Art. 6), which have so far not proven to be entirely satisfactory.

To do these tests, often conducted in conditions approximating real operations, the ICRC used standard red cross and red crescent flags and stickers *(see Annex 1)*.

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[3] *Passive infrared—thermal imaging:* by this means, the natural or artificial electromagnetic energy emitted in the IR band by objects is transformed into electrical signals which are then used to draw a map of the hot points on the landscape, thus forming an image which can be observed through fieldglasses or on a screen or recorded using special apparatus.

[4] *Image intensifiers* (II): Image intensifiers are electro-optical devices which amplify the light levels of objects lit by low light at night. The main component is a light amplification tube which converts a low level polychromatic image (white light) into an electronic image, which is then electronically amplified and transformed into a more intense, usually dull green, monochromatic image. The light levels can be amplified 5,000 to 10,000 times, making it possible to obtain a visible image even on extremely dark nights.

Certain tests were also conducted with specially made red cross and red crescent boards *(Annex 1)* to assess different types of paint and manufacturing processes intended to ensure greater visibility at night, in poor weather or using electro-optical instruments of observation (II sight systems and thermal imaging cameras).

The tests were conducted in the field between June 1989 and April 1990, in weather which was not always good but very representative of real-life situations. As concerns specifically night visibility and passive IR observation, additional laboratory tests were conducted by the Test Section (Radar, Electronics, Optronics) of the Swiss Federal Military Department's Defence Technology and Procurement Group (GDA).

Finally, visibility tests were also conducted at sea with a coastal rescue craft which had a red cross flag on the bridge, two red cross stickers of different sizes on its sides and a flashing blue light at the top of its mast.

Let us now examine these tests and their results.

2. Tests of the distinctive emblem's visibility

2.1 Aerial observations

Thanks to the kind and efficient co-operation of the Swiss air force, the ICRC was able to carry out three different tests:

(a) Observations from different heights and distances, in a flat area, of buildings and an ambulance bearing red cross emblems of different sizes.

(b) Observations at night and at low height, in a mountainous region, of buildings and different vehicles bearing red cross emblems of different sizes, using passive IR electro-optical equipment.

The same test was done during the day, but using standard photographic equipment (visible band of the spectrum).

(c) Observations from different heights and distances, in a mountainous area, of buildings and different types of vehicles bearing red cross emblems of different sizes, and of troops wearing red cross armbands, tabards and helmets.

For the first test, conducted in a flat area, red cross flags measuring 10 and 5 m across were put on the roofs of the buildings and on the nearby lawns. One red crescent flag measuring 3 m across was also put on the slope of one of the roofs *(Photo No. 1)*.

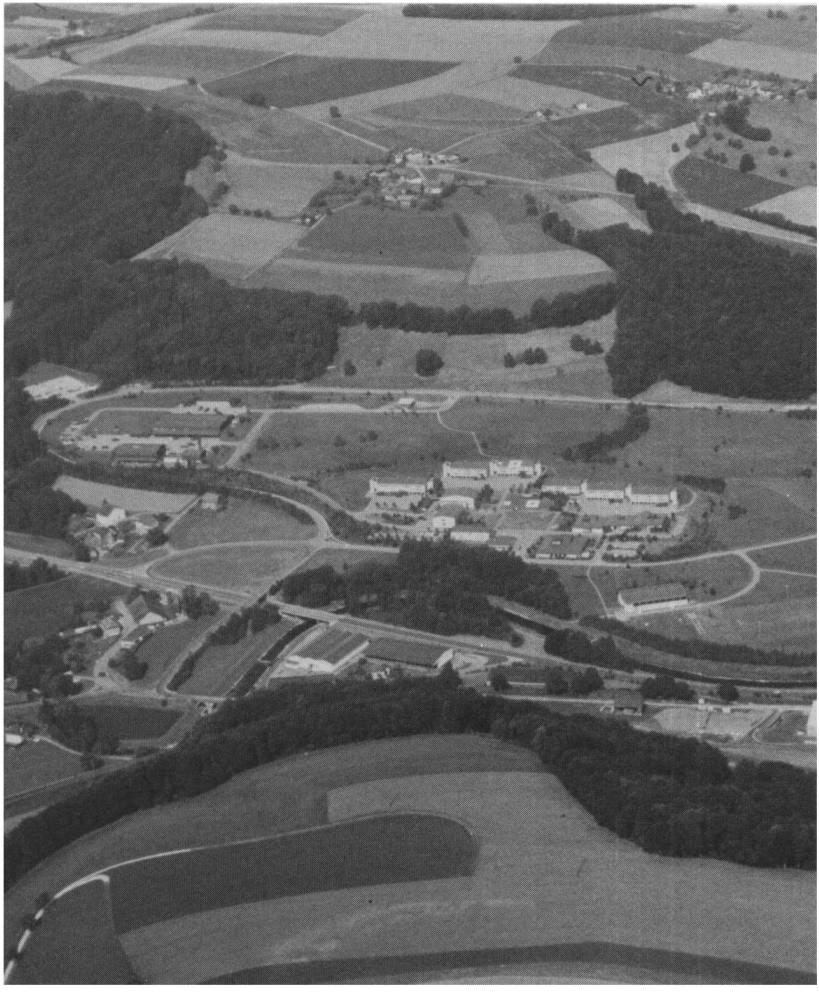


Photo No. 1

Observation from the air.
Altitude 1300 m AMSL, i.e. Above Mean Sea Level
Distance 2 km.

The red cross flags on the roof measure 10 m × 10 m.

CHART No. 1

VISIBILITY TEST OF THE EMBLEM

Observation: from the air
Date: 27 June 1989 Time: 9.30 – 10.30 a.m.
Weather: Fair, light haze

Distinctive emblems

Height/distance	400 m/1000 m	800m /2000 m	1000 m/3000 m	1400 m/4000 m	1800 m/5000 m	
Roof of building Red cross flag	4	4	2	2 1	1	10 m × 10 m
Roof of building Red crescent flag	4	2	1	1	1	3 m × 3 m
Flag alone	4	4	2	2 1	1	10 m × 10 m
Flag alone	4	3	1	1	1	5 m × 5 m
Ambulance on road	1	1	1	1	1	1 m × 1 m

Key (valid for all charts)

1 Barely visible, **NOT** identifiable
2 Discernable but difficult to identify
3 Visible and identifiable
4 Clearly visible

Observations were carried out at an increasing distance and height until the red cross was no longer visible to the naked eye.

As can be seen in *Chart No. 1,* a flag measuring 5 m across is no longer recognizable at a distance of 3000 m (1000 m AGL, i.e. Above Ground Level) and one measuring 10 m across is no longer visible at 5000 m. (1800 m AGL). The 1-m square emblem painted on the ambulance was not even visible at the minimum observation distance of 1000 m. The 3-m square red crescent flag was just barely discernable at 2000 m (800 m AGL).

All the observations were made at an angle of about 20°, which corresponds to normal conditions. The results were somewhat better when the observations were made vertically, but the ICRC considers that these results were not sufficiently representative of real operational conditions.

It should be added that the tests were conducted in ideal weather conditions, which occur on average on only 20% of days in a year.

The second series of observations was made at night using a low-flying military aircraft equipped with passive IR electro-optical observation equipment. The purpose of the test was to see how well medical buildings and vehicles bearing a standard distinctive emblem could be identified using modern methods of aerial observation, in particular passive IR equipment. The same test was done during the day with photographs in the visible band of the spectrum. *Photos Nos. 2 and 3* give

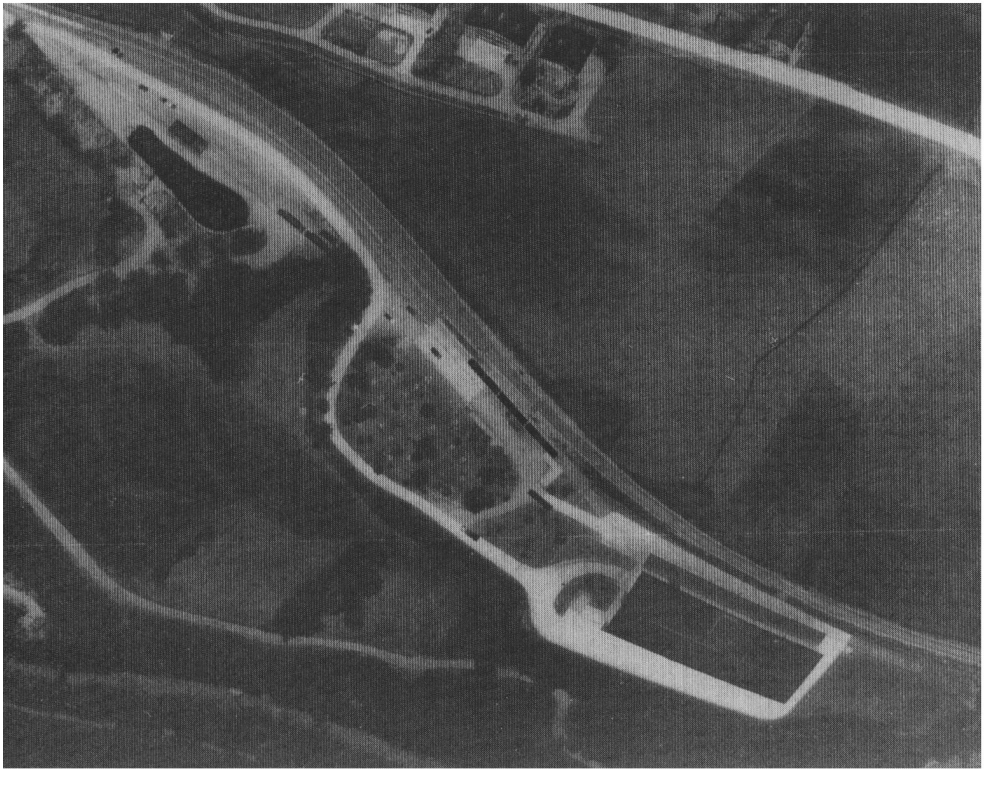


Photo No. 2

Night observation from the air using passive IR.
Height 200 m AGL.

The vehicles can be seen but the red crosses are totally invisible.

Photo No. 3

Observation from the air
(visible band).
Height 100 m AGL.

The different vehicles are clearly visible but not the red crosses. The red cross flags on the building, however, are clearly visible.

a good idea of the results obtained. In the case of night observation, none of the distinctive emblems on the buildings, vehicles or the hospital train is visible, the reason being that there was no difference of temperature between the red of the cross and the white background. On the other hand, the automobiles are clearly visible thanks to the residual heat given off by their engines.

During the daytime tests the distinctive emblems on the flags were clearly visible, whereas the stickers in fluorescent colours were hardly recognizable, even at short distances (about 100 m).

The third series of aerial observations was carried out in the same place as the second, but from a helicopter *(Photo No. 4)*. The idea was to see how well an observer could recognize the different types of distinctive emblems used to identify medical vehicles. The results obtained, which are given in *Chart No. 2,* confirmed those of the first tests carried out in a flat area.

2.2 Ground observations during the day

A series of tests was also made of ground visibility, on rugged terrain, of buildings and moving and stationary vehicles bearing red crosses of different sizes, and of troops wearing red cross armbands and tabards, and helmets with red crosses made out of whatever was at hand, for example cut-outs from fluorescent red and white stickers.

Chart No. 3 gives the results. All the distinctive emblems measuring over 1 m across were still recognizable at 400 m, but anything smaller was barely recognizable at 300 m. The armbands, tabards and helmets could only be recognized with certainty at 100 m. Unfortunately, the test site was such that it was not possible to make observations at greater distances; the visibility of the distinctive emblem beyond 400 m can nevertheless be estimated with relative accuracy from the aerial observations.

2.3 Ground observations at dusk and at night *(Photo No. 5)*

A series of tests was conducted with specially made red cross and red crescent boards 1 m across *(Annex 1)*. The main purpose of the tests was to assess different types of paint and manufacturing processes intended to ensure greater visibility at night, in poor weather, and above all when using electro-optical means of observation such as II sight systems and IR cameras (thermal imaging).

These tests were conducted at dusk and in the evening; it was raining and the night was very dark (residual luminosity: 1-3 μlux). For the sake of comparison, two ambulances bearing the traditional distinctive emblems and fluorescent red cross stickers were also used. The boards and vehicles were observed from a maximum distance of 600 m, first with the naked eye, then using II sight systems and a thermal imaging camera.

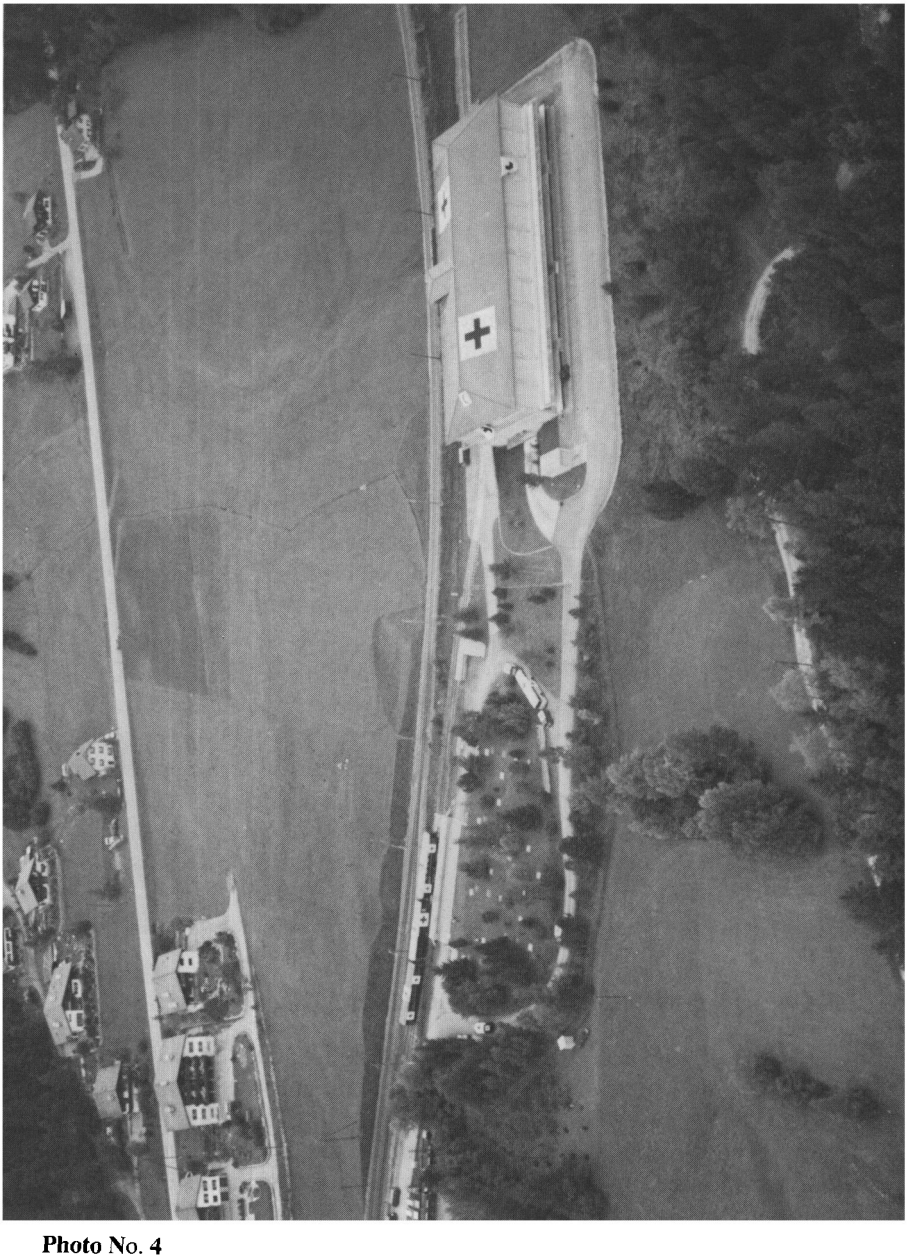


Photo No. 4

Observation from the air.
Height 500 m AGL.

Only the distinctive emblems more than 2 m across are clearly visible and identifiable.

CHART No. 2

VISIBILITY TEST OF THE EMBLEM

Observation: from the air, with the naked eye
Date: 27 September 1989 Time: 10.30 – 11.30 a.m.
Weather: Overcast (approx. 7 octas at 2000 m AGL)

Medical vehicles

Height (AGL)	500 m	1000 m	1500 m			
Hospital train	④	④	④			3 m × 3 m
Ambulance No. 1	④	③	②			1 m × 1 m
Ambulance No. 2	④	③	②			1 m × 1 m
Bus	④	④	③			3 m × 3 m
	④	③	②			2 m × 2 m
Truck	④	④	③			3 m × 3 m

Buildings

Red cross flag	④	④	④			10 m × 10 m
Red cross flag	④	④	③			5 m × 5 m
Red crescent flag	③	②	②			3 m × 3 m

Troops

Tabards	①	—	—			
Armbands	—	—	—			
Helmets	①	—	—			

CHART No. 3

VISIBILITY TEST OF THE EMBLEM

Observation: from the ground, with the naked eye, of stationary or moving vehicles
Date: 27 September 1989 Time: 11 a.m.
Weather: Overcast (approx. 7 octas at 2000 m)

Medical vehicles

Distance	50 m	100 m	200 m	300 m	400 m	
Hospital train	④	④	④	④	④	3 m × 3 m 2 m × 2 m
Ambulance No. 1	④	④	④	④	④	1 m × 1 m
	④	④	③	③		0,50 m × 0,50 m
Ambulance No. 2	④	④	④	③	③	2 m × 2 m
	④	④	③	②	②	0,50 m × 0,50 m
Medical bus	④	④	④	④	④	3 m × 3 m 2 m × 2 m
Medical truck	④	④	④	③	③	2 m × 2 m

Buildings

Red cross flag	④	④	④	④	④	10 m × 10 m
Red cross flag	④	④	④	④	④	5 m × 5 m
Red crescent flag	④	④	④	—	—	3 m × 3 m

Troops

Tabards	④	④	②	—		
Armbands	④	③	①	—		
Helmets	④	③	①	—		

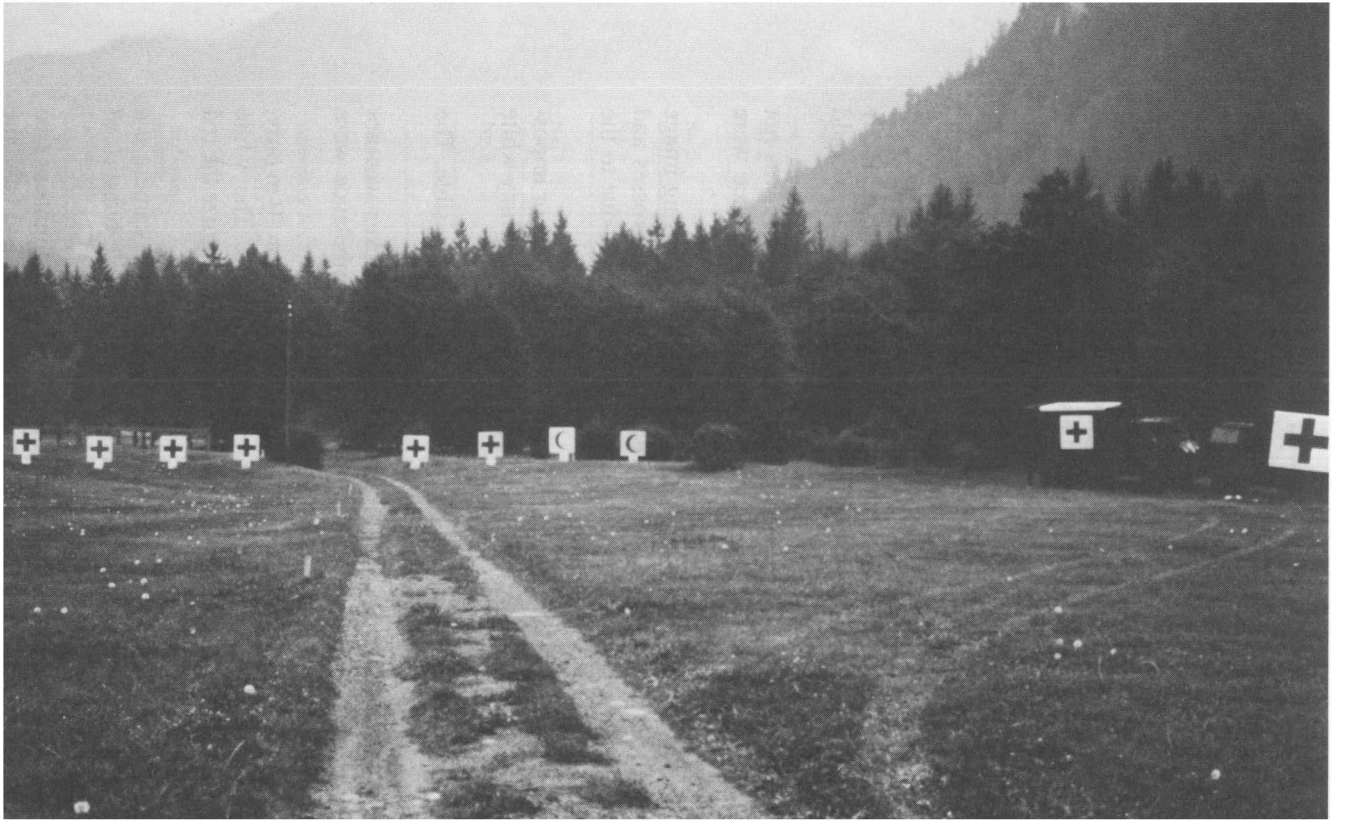


Photo No. 5

Observation of red cross and red crescent boards (1 m × 1 m) at dusk.
Distance 100 m.

At dusk all the boards were visible and easily recognizable by the naked eye at up to 500 m. The results of the tests made at night using the II sight systems are given in *Chart No. 4*. Most of the boards were clearly visible and recognizable at up to 200 m, with the exception of Boards Nos. 2, 6 and 7.

When observed from different distances using the IR camera (passive observation), none of the distinctive emblems on the eight boards (red crosses made of different types of material and using different kinds of paint) was either visible or recognizable. The red crosses on the vehicles were obscured by the heat given off by the engines.

On the other hand, the observations made using II sight systems revealed major differences in the characteristics of visibility depending on the type of paint or materials used to manufacture the red crosses. For example, the crosses on Boards Nos. 1, 3, 4 and 5 were perfectly visible and recognizable, while those on Boards Nos. 6, 7 and 8 could hardly be discerned.

On one ambulance, the sticker with a fluorescent red cross was not visible, whereas the red crosses painted on the other ambulance were clearly visible.

When observed at close quarters (200 and 100 m), still using image intensifiers, all the boards were clearly visible and the red crosses and crescents relatively easy to recognize, with slight differences due to the type or the combination of paints used.

Only the emblems on Boards Nos. 2, 6 and 7 were difficult or impossible to discern. For example, Board No. 2 appeared only as a shiny white surface.

The red cross sticker on one of the ambulances was not visible. The red crosses painted on the ambulance were barely visible.

Even at a distance of 50 m, the red cross on the sticker was not visible, whereas the red crosses painted on the other ambulance were perfectly visible and clearly recognizable.

The tabards worn by the soldiers became visible at 100 or 50 m only, but the red crosses were not always clearly identifiable. The white helmets were clearly visible but again it was not easy to recognize the red crosses.

The tests conducted using a thermal imaging (passive IR) camera at a distance of 50 m were inconclusive: the boards were visible but the red crosses could not be seen.

Tests were also made with the boards lit up by the headlights of two vehicles, a short distance away in an attempt to heat them and have the

CHART No. 4

VISIBILITY TEST OF THE EMBLEM

Observation: from the ground, image intensifying sight system
Date: 27 September 1989 Time: 8.15 p.m.
Weather: Rain
Residual luminosity: 1-3 µlux

Boards 1 m × 1 m

see Annex 1

Distance	50 m	100 m	200 m	300 m		
No. 1	④	④	④	③		
No. 2	②	②	①	①		
No. 3	④	④	③	③		
No. 4	④	④	③	③		
No. 5	④	④	③	③		
No. 6	④	③	②	②		
No. 7	④	③	②	②		
No. 8	④	③	③	②		

Vehicles

Ambulance No. 1	*	*	*	*		
Ambulance No. 2	④	③	②	*		

* Brilliant white ground, red cross (crescent) not visible, but visible to the naked eye

Troops

Red cross tabards	③	②	—	—		
Red cross armbands	—	—	—	—		
Red cross helmets	②	②	②	—		

red crosses give off IR radiation, even at a very low level. The only result was increased brilliance at the spot lit by the headlights; none of the red crosses could be recognized.

Finally, observations were made at varying distances (50 and 150 m) using II sight systems and IR lighting of the boards. At both distances, all the boards were clearly visible and recognizable, with the exception of Board No. 3.

Use of a thermal imaging camera gave no better results: the red crosses and crescents remained invisible.

Boards No. 3, 6 and 8 were clearly visible when lit by IR and observed using image intensifiers but the red crosses on the ambulances remained invisible under the same conditions.

2.4 GDA tests using electro-optical methods

These tests consisted essentially in observing the red cross emblem using electro-optical means, such as II sight systems and thermal IR, for example thermal imaging.

The report drawn up by the GDA contains the principal results of the tests conducted in the laboratory and in field conditions and their interpretation in terms of physics. This article is not the appropriate place to comment on the technical details. Suffice it to say that the laboratory tests confirmed the field observations and made it possible to assess a number of means for improving the visibility of the red cross emblems when observed using electro-optical means.

For the low light visibility tests, II sight systems equipped with second and third generation II tubes were used (the typical light sensitivity of the tubes is given in *Annex II).*

These systems can be used with light levels of only a few μlux, whereas cameras fitted with image intensifiers can detect light levels as low as 10^{-4} lux. Tests under these light conditions were made at night in the field and in controlled laboratory conditions.

The result obtained showed that with II sight systems visibility can be improved by using red crosses manufactured with paint containing reflective materials.

Infrared observations were made in two specific "windows", determined by the atmospheric transmission conditions *(see Annex II),* between 3 and 5 μm, and 8 and 12 μm for far IR, or thermal IR. It should be mentioned that, making an object visible in near IR, in which II sight systems operate, is quite a different matter from making it visible in far IR.

The GDA report also emphasizes that widely varying factors influence thermal imaging, in particular certain adjustments of the instruments used for observation. In practice, all the instruments can give a complementary image, meaning that the "hot" parts appear in black instead of white, and vice versa. Depending on the instrument's settings (offset, contrast, amplification), very different details can be highlighted of the same image.

According to the experts, it nevertheless seems that it might be possible to make the distinctive emblem visible by thermal IR, but additional research would have to be conducted. The GDA obtained some encouraging results in tests using a red cross emblem with special thermal IR characteristics.

3. Tests with flashing blue lights and the distinctive emblem

3.1 Tests of flashing blue lights on medical aircraft

These tests were conducted in accordance with a programme drawn up by agreement between the GDA's special section for test flights and the ICRC. Seven flights were made between 10 a.m. and 9 p.m. and two types of flashing lights were tested in different meteorological and visibility conditions.

At dusk and at night the lights were clearly visible and recognizable up to 10 km, but during the day visibility in normal light did not exceed 1.5 km.

For these tests a HELLA KG system (type 2LA 003 322) of flashing blue lights, lent by the manufacturer and mounted on an Alouette III helicopter *(Photo No. 6)*, was used. Two strobe lights were made available, one with a blue dome and the other with a clear dome and a blue filter, meaning that the latter could be used as a white anti-collision strobe light or a blue medical light. The strobe light with the blue dome was a prototype, while the strobe light with the built-in switchable blue filter was in mass production.

Each test consisted of two flights, one at a height of 1000 m AGL, the other at 200 m AGL. The helicopter approached the airfield (approximate direction NE-SW) from a maximum distance of 8 km during the day and 15 km at dusk and at night. The observations were made from the control tower at intervals of 1 km (500 m at the end of the approach). During the first two flights, made between 10.45 and 11.15 a.m., the helicopter was

Photo No. 6

Swiss Army Alouette III helicopter used to test the visibility of the flashing blue light.

equipped with the strobe light with a blue dome (200 eff.cd. power), the prototype. The weather conditions were as follows:

General visibility:	15 km
Weather:	fair, cloud cover 6 octas
Luminosity:	2700 lux
Height:	1000 m AGL (first flight)
	200 m AGL (second flight).

In these conditions, the helicopter was just barely visible at 5 km; it became vaguely recognizable at 4 km and was clearly identifiable only at 3 km. The blue light could be seen only at 1.5 km but appeared to be white; it could be identified without error only at 1 km.

During the second flight, made at 200 m AGL, the weather conditions were identical. The results were slightly better because the helicopter could be clearly seen although not really identified at 6 km. It could be recognized distinctly only at 3 km. The blue light could be seen but only vaguely at 2 km, but was perfectly visible and recognizable at 1.5 km.

For flights 3 and 4 (between 2.15 and 2.45 p.m.), the light with the blue dome was replaced by the standard strobe light (100 eff. cd. power), fitted with a blue filter, making it possible to have a flashing blue or white light. The weather and visibility were the same as for the first two flights, except the luminosity was 3200 lux. Flight 3 was made at 1000 m AGL, flight 4 at 200 m AGL.

At both altitudes the results were basically the same as for the first two flights. The helicopter was perfectly visible and recognizable at 4 km; the blue light became visible but was not yet recognizable at 2 km. The flashing blue light became visible but was only barely identifiable (the white predominated) at 1.5 km; it was perfectly visible only at 1 km and less. This light tended to go from blue to white as the distance increased.

Flights 5 and 6 were made at dusk (between 7.35 and 7.47 p.m.), again at heights of 1000 and 200 m AGL respectively. Visibility was still 15 km and cloud cover 6 octas, while luminosity was rapidly falling from 190 to 60 lux.

At 1000 m AGL, the following observations were made.

The helicopter was not identifiable beyond 5 km; however, the blue light was already visible at 6 km but appeared white. It turned blue at 4 km and was clearly recognizable at 3.5 km. When passing overhead the blue light was clearly visible.

At 200 m AGL, the following observations were made.

The helicopter could be recognized only at 4 km, but the blue light was already visible at 6 km, appearing mainly white. It became clearly visible and recognizable as a blue light at 4 km.

The final flight was made at night at 1000 m AGL. Visibility was still about 15 km but there were some light fog patches beneath a cloud cover of 6 octas.

At a distance of 15 km from the observation point, the helicopter indicated its position by switching on its landing lights; at that point the flashing blue light was already visible but looked white. From 12 km the flashing light was clearly blue and became increasingly visible as the helicopter approached.

The results of these different tests reveal that the strobe light with the blue dome remained blue over a slightly greater distance than the standard light.

By day, neither of the lights was recognizable beyond 1.5 km. At dusk and at night, visibility was excellent and the blue light could unerringly be identified up to 10 km.

The helicopter used had only one flashing blue light. A plane fitted with two lights, one on the tail and the other on the under surface of the fuselage, could perhaps be more easily identified, but not necessarily at a greater distance. It will in any case not be possible, with the strobe lights currently available, to attain the desired distance of 3 nautical miles (about 5.2 km). To be seen at that distance, the radiated light power would have to be increased, with all that entails: increased weight and power consumption and more complex installation.

Moreover, at present no manufacturer of aeronautical navigational lights has plans to produce a blue light meeting these requirements. Regrettably, too, with the exception of HELLA KG, which has made a considerable effort in this respect, no other manufacturer to our knowledge has undertaken development work on such a light, the market being probably much too small.

3.2 Visibility tests of the distinctive emblem and the flashing blue light at sea

The British Royal National Lifeboat Institution did a number of visibility tests on the emblem and the flashing blue light at sea. The

tests were conducted in August and October 1989 at Weymouth. Red cross stickers measuring 1 and 2 m across were put on an Arun-class lifeboat and a 2-m square flag was mounted on the bridge *(Photo No. 7)*. The boat was fitted with a standard flashing blue light (55 watts, 120 flashes/minute).

The tests took place in variable weather conditions, meaning both on clear and sunny days and on overcast (8 octas) and rainy days. Observations were made from the air and sea at different angles. The test results were as follows:

From the air, the 2x2 m red cross emblems were visible and recognizable up to about 700 m. They were no longer recognizable beyond 900 m (1000 yards). The observations at sea level gave the same results.

These results were obviously greatly influenced by the general conditions of visibility, which deteriorated sharply in overcast or rainy weather.

The tests on the blue light were conducted in the rain; visibility of the flashing blue light did not exceed 900 m.

4. Comments and conclusions

These visibility tests of the emblem and flashing blue lights demonstrated yet again that identification using only the distinctive emblem is limited both by distance and by the technical means of observation used, mainly opto-electronic.

Given the means of modern warfare, one can reasonably wonder whether it still suffices to use only the distinctive emblem to mark medical facilities, transports and units. The different visibility tests described above show that this is no longer the case. We therefore feel that a way must be found as a matter of urgency to enable medical facilities and transports to identify themselves by technical means in addition to using the distinctive emblem.

Annex I to Protocol I additional to the 1949 Geneva Conventions already takes a step in that direction and contains a number of provisions on the use of technical means of identification.

As concerns the emblem as such, it must obviously be as large as possible if it is to be recognizable at a great distance. However, beyond 3 km a 5-m flag is no longer recognizable even if visibility is good. The

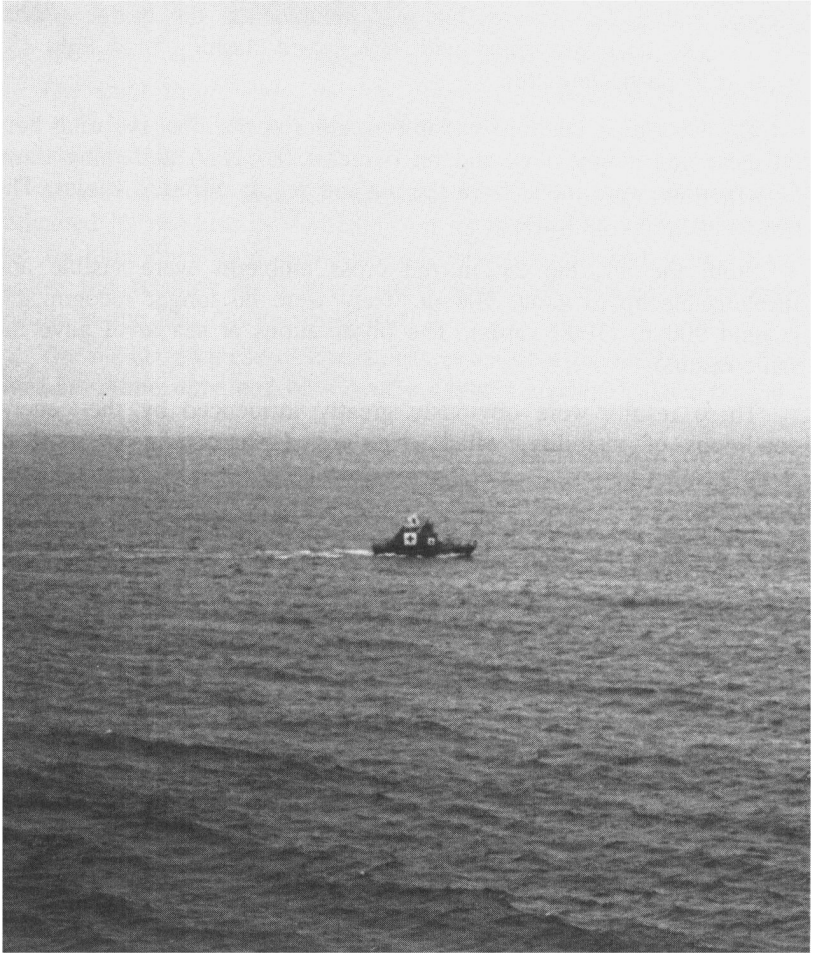


Photo No. 7

Observation at sea.
Rescue craft with red crosses.
Distance: 1/4 nautical mile.

tests showed that the red crescent emblem, all other things being equal (size, distance, lighting, etc.), was much less easily recognizable than the red cross.

In poor visibility, at dusk or even at night, II sight systems should make it possible to identify a painted red cross emblem or a red cross flag, but the same is not true of passive IR observation (thermal imaging). Solutions could be found, but at the cost of major research and development work, perhaps involving new technology and materials. A number of ideas have already been put forward in this context. Although they merit serious consideration, it would be premature to go into them in this article.

Another source of concern is the range of the flashing blue light used to identify medical aircraft.

In a follow-up to Resolution 17 of the 1974-1977 Diplomatic Conference, the International Civil Aviation Organization (ICAO) introduced in its Airworthiness Technical Manual (Doc. 9051) rules for the use of the flashing blue light to identify medical aircraft protected under Articles 36 of the First Geneva Convention and 39 of the Second Convention, and Articles 8(m) and 18 of Additional Protocol I. These provisions recommend that the lights be bright enough to be visible at a distance of 3 nautical miles (about 5.2 km). This same distance is recommended in Chapter XIV, para. 4.2, of the International Code of Signals of the International Maritime Organization (IMO).

The results of the tests demonstrate that while the flashing blue lights were indeed visible and recognizable at up to 10 km at night and at dusk, by day their visibility did not exceed 1.5 km in normal light. There is a long way to go before reaching the visibility recommended by the ICAO and the IMO. If medical aircraft are indeed to be identified at that distance, the range of the lights will have to be increased. This implies greater weight and power consumption, a more complex installation, and probably a new type approval requirement for the aircraft concerned. The operating cost of using the material would probably increase.

As mentioned previously, there is at present no flashing blue light for medical aircraft on the market, except for the one used in the tests, which was developed and manufactured by HELLA KG. To our knowledge, no other manufacturer has done any development work on this.

These tests of the visibility of the distinctive emblem and the flashing blue lights made it possible to assess the current situation using the new technical means of observation widely employed by the world's armed forces. The results not only established more clearly the characteristics of visibility and identification of the emblems used to mark medical units, means of transport and facilities, but also confirmed their limitations.

Improvements must be made in the marking of medical facilities, transports and troops if the protection to which they are entitled under the 1949 Geneva Conventions and Additional Protocol I is to be effective. Serious progress will have to be made and the combined efforts of all interested parties will be required to obtain satisfactory results.

Gerald C. Cauderay

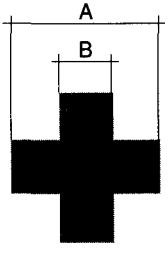
Gerald C. Cauderay trained and worked for several years as a merchant navy radio and radar officer. He later held a number of senior positions in the electronics industry, in particular in the fields of telecommunications and marine and aeronautical radionavigation, before being appointed Industrial and Scientific Counsellor to the Swiss Embassy in Moscow. At the ICRC, Mr. Cauderay is in charge of matters related to the marking and identification of protected medical transports and units and to telecommunications.

We wish to express our gratitude to the different services of the Swiss Army and the Swiss Federal Military Department for their support and co-operation in the conduct of the visibility tests. We should like to thank in particular the Chief of the General Staff, the Swiss Army Surgeon General and his staff, and the Command Air Force personnel for their efficient logistical and technical help, without which the tests could not have been done. Our thanks also go the Royal National Lifeboat Institution, in Poole, Dorset, UK, which conducted the tests at sea.

ANNEX I

LIST OF MATERIALS USED FOR THE VISIBILITY TESTS

1) Red cross and red crescent flags and stickers



a) red cross flag (to mark a hospital)

dimensions:	white square:	1000 cm × 1000 cm
	red cross:	A 730 cm
		B 200 cm

b) red cross flag (to mark a building used as a hospital)

dimensions:	white square:	500 cm × 500 cm
	red cross:	A 335 cm
		B 50 cm

c) red cross flag or sticker (to mark vehicles, trucks or trains)

dimensions:	white square:	300 cm × 300 cm
	red cross:	A 200 cm
		B 60 cm

d) red cross flag or sticker (to mark ambulances)

dimensions:	white square:	200 cm × 200 cm
	red cross:	A 130 cm
		B 40 cm

e) red crescent flag (to mark vehicles, trucks or trains)

dimensions:	white square:	300 cm × 300 cm
	red crescent max. height:	220 cm

2) Red cross and red crescent boards

dimensions:	of the board:		100 cm × 100 cm
	of the red cross:	A	80 cm
		B	20 cm
	of the red crescent:		approx. 80 cm (max. height)

Manufacturing process: FOREX (polystyrene foam) backboard with ordinary and/or special paints.

Technical details:

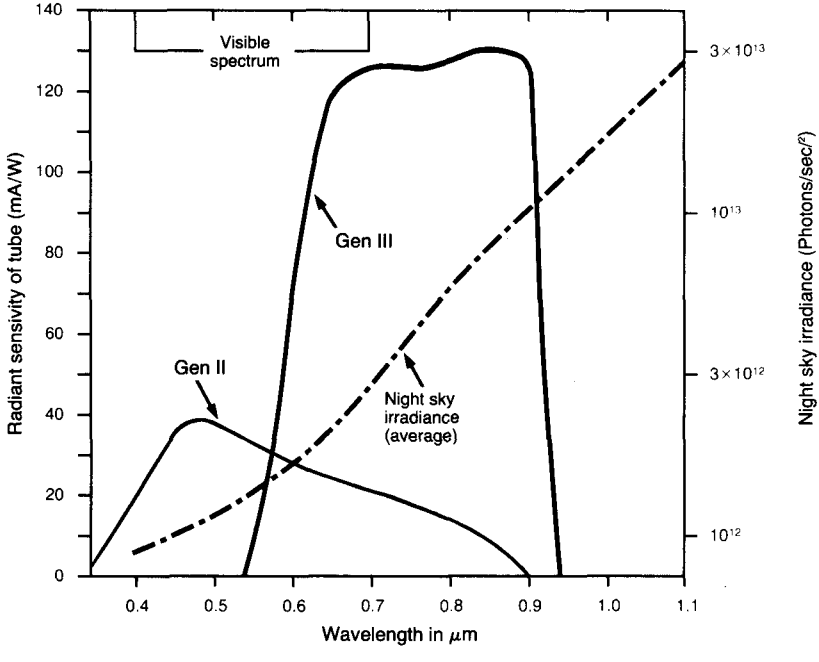
No. 1	white ground	= opaque white "Vinaprint" * 110
	red cross	= PVC MG 8 red
No. 2	white ground	= opaque white "Vinaprint" * 110
	red cross	= MG 65 fluorescent
No. 3	white ground	= opaque white "Vinaprint" * 110
	red cross	= reflective red, "Scotchlite" **
No. 4	white ground	= opaque white "Vinaprint" * 110
	red cross	= Q 8 synthetic red painted on PVC MG 28, black
No. 5	white ground	= opaque white "Vinaprint" * 110
	red cross	= PVC Q 8 red on silver MG ground (with aluminium pigments)
No. 6	white ground	= reflective white "Scotchlite" **
	red cross	= PVC Q 8 red on silver MG ground (with aluminium pigments)
No. 7	white ground	= reflective white "Scotchlite" **
	red crescent	= PVC MG 8 red
No. 8	white ground	= white "Scotchlite" **
	red crescent	= PVC Q 8 red on silver MG ground (with aluminium pigments)

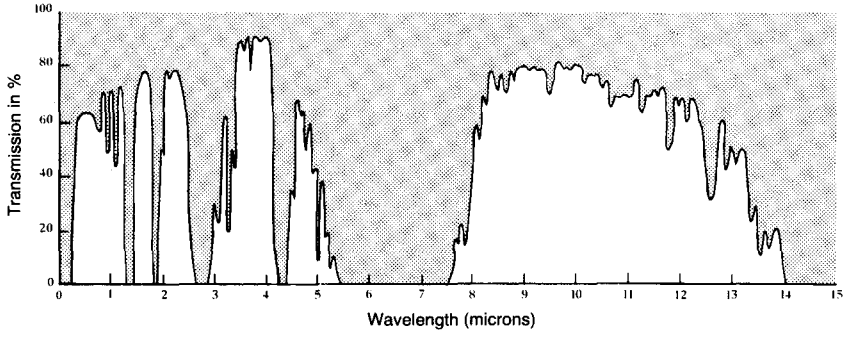
* "Vinaprint", a brand name of N.V. Unico S.A., 1740 Ternat, Belgium.

** "Scotchlite", trademark of 3M, St. Paul, Minnesota, USA.

ANNEX II

TYPICAL SPECTRAL RESPONSE CURVES OF 2nd AND 3rd GENERATION IMAGE INTENSIFIER TUBES





SPECTRAL TRANSMISSION OF ATMOSPHERE