Performed tests

1. Laboratory XENO test 1200 for 10.000 hours performed by HOECHST Laboratory in year 1991-1992
2. Laboratory XENO test 1200 for 20.000 hours performed by SERVOCAM Laboratory between 1996 and 1999
3. Laboratory W-O-M test for 20.000 hours performed by SERVOCAM Laboratory between 1996 and 1999
4. Realtime exposure test in the project for 6 years
   Realtime in year 1991-1997
   Performed by HOECHST Laboratory in year 1997
5. Colormetric test of 10 years realtime exposed pipes (1991-2001)

General Informations

Test Methods

Several artificial uv-stability test methods all based on time lapse (time reduction) are possible to use.
For evaluation of the best suitable test norm giving most realistic results, we learned that main difference is the test duration relating to realtime.
High time lapse tests shows results in a short test time but use increased uv-radiation including non-natural spectrum of uv-radiation.
As we assumed this will influence a realistic result, we decided to use the most common test based on lower time lapse but using natural uv-radiation only.

Common tests

- XENO test 1200 according ISO 4892.2 or ASTM or DIN 53387
- W-O-M test

Test correspondances

16 hours XENO test 1200	=	1Kly (kilolangly)
10.000 hours XENO test 1200	=	625 Kly
1 year radiation in Mid Europe	=	60 Kly
1000 test hours	=	1 year realtime exposure in Mid Europe

Test procedures of Xenon-Arc tests

Basic test procedure according DIN 53387 or WOM :
Samples are installed in test equipments and artificial weathered by continous exposure to radiation and with intervalls of wetting (rain) and Dry (sun) with a humidity during the dry interval of 60-80%.

Test result evaluation

Evaluation of tested samples has been performed under microscope (500 magnifications) for color, surface, microfissures, microcracks and general appearance compared to origin.
No specific evaluation norm for HDPE pipes exist.
It is common to basicly use ISO 105 A 02 a norm for textiles / fabrics.
Results are evaluated in grades. Main difficulty using this norm is the fact that the main users as textile industry and automotive industry (with some modifications) do have more strength definitions of color quality but for a much shorter product period.

Definition for HDPE pipe evaluation

Considering the above mentioned difficulties, we define for excellent HDPE pipe quality:

- Pipes do not visible show color changing or fading either partly or circumferencal refering to the specified color inspected from a minimum distance of 0,3 meters.
- Pipes keep smooth pipe surface without roughness
- Pipes do not show visible microfissures (slight changes in the surface texture) on pipe surface and even very little under microscope (500 magnifications). No micro cracks should be observed.
- Pipes keep initial wallthickness.

Evaluation of norm criteria for grade results

Considering with HOECHST and SERVOCAM Laboratory for the evaluation of grade results we concluded following.

Grade	Evaluation	Norm criteria for Evaluation of color changes of textiles	PESTEC and Laboratory criteria after 20.000 test hours for evaluation of HDPE pipes for exposed use
5	Excellent	Perfectly free	perfect
4	Good	A little noticeable but not conspicous	excellent
3	Somewhat Good	A little and clearly noticeable	very good
2	Bad	An important contrast	good
1	Very Bad	A very important contrast	fair

Test Results

1. XENO Test 1200 for 10.000 hours performed by HOECHST Laboratory in year 1991-1992. Test performed according DIN 53387-1-A-X

   The tested sample does not show any changes in color / fading of the outer white coat. The appearance of the surface is optically unchanged. Under the microscope (500 magnifications), microfissures (slight changes in the surface texture) are found up to 100my of depth (maximum 10% of the outer layer only). These microfissures are not detectable with the naked eye. No micro cracks have been observed.
   A reduced mechanical attribute of the pipes cannot be derived from these existing microfissures.
   The mechanical properties might remain at 95% of the initial values.
   The conclusion of the test refering to the mentioned test conditions and the used stabilisation is a fantastic light protection.

2. XENO test 1200 for 20.000 hours performed by Servocam Laboratory between 1996 and 1999.
   Test performed according DIN 53387.1-A-X
   Tested colors :

RAL 3000 red	RAL 9017 black	RAL 9016 white
RAL 9003 white	RAL 9002 grey/white	RAL 9006 silver metallic

   For test results please see attachements.

3. W-O-M test for 19.234 hours performed by Servocam Laboratory started between 1996 and 1999.
   Colors according 3.2
   Test results of different colors attached.

4. Realtime exposure test in a project for 6 years, between 1991 and 1997

   Performed by HOECHST Laboratory in year 1997

   Under the microscope no microfissures are found and no change of the surface was made out. (Rate 0 on scale of 0-6)

   Either visual no changes of color on the outer layer were made out. (refering to tested XENO test sample)

   According to this result of very slow progress in dismantling of the white outer HDPE layer as well as the fact that the mechanical properties are mainly secured from the 10mm black HDPE inner layer we assume a function suitability for this pipe of several decades.

5. Colormetric test of 11 years realtime exposed pipe in a project.

   Test sample was red = RAL 3000, the most difficult color to uv-stabilize.

   Test result was Δ E lab of 4,25 in average.

   Compared with the origin color, the red turned a little bit darker but finally remains the same color.

   For details please take a look at our Technical Information TI 96.

All original test reports are deposited at PES.TEC and for confidentiality reasons they can only be reviewed by independent experts and auditors.

Conclusion

Real time exposure as well as artificial weathering tests show very good uv-stability of our NOCX HDPE pipes complying to the requirements of use in stay cable bridges.

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Essai de vieillissement aux ultraviolets

Tableau de résultats n°29

Réf. Client	Réf. Int.	Cotation Echelle des Gris	Cotation Echelle des Bleus	Observations Aspect
RAL 3000	1	1		PLUS CLAIR
RAL 9017	2	4/5		PLUS CLAIR
RAL 9016	3	3/4		PLUS CLAIR
RAL 9003	4	3/4		PLUS CLAIR- CRAQUELURE
RAL 9002	5	3/4		PLUS CLAIR- CRAQUELURE
RAL 9006	6	4/5		PLUS CLAIR

	Appareil: XENOTEST 1200	ME: RLT D271380/D(06/96)
9937 A	Durée d'exposition: 20000 H	Dernier étalonnage avant essai: 03/02/97

Nota: Compte tenu de la géométrie des pièces, la brillancemétrie et la colorimétrie n'ont pu être effectuées.

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Essai de vieillissement aux ultraviolets

Tableau de résultats n° 26

Réf. Client	Réf. Int.	Cotation Echelle des Gris	Cotation Echelle des Bleus	Observations Aspect
RAL 9017	2	3		plus clair
RAL 9002	5	2/3		plus clair-microcraquelures
RAL 9006	6	3		plus clair

Appareil: WOM ME: RLT D271911(02/95)

9937B Durée d'exposition: 19234 H Dernier étalonnage avant essai: 24/03/97

Nota: Compte tenu de la géométrie des pièces, la brillancemétrie et la colorimétrie n'ont pu être effectuées.