XYPEX INDEPENDENT TESTING SUMMARY
WATER PERMEABILITY

U.S. Army Corps of Engineers (USACE) CRD C48-73 "Permeability of Concrete" Pacific Testing Labs, Seattle, USA *PERM-100*

Two inch (51 mm) thick, 2000 PSI (13.8 MPa) concrete samples were pressure tested for water permeability up to a 405 ft. (124 m) water head (175 psi/1.2 MPa), the limit of the testing apparatus. While untreated samples showed marked leakage, the XYPEX Concentrate treated samples (as a result of the crystallization process) became totally sealed and exhibited no measurable flow through the sample.

U.S. Army Corps of Engineers (USACE) CRD C48-73 "Permeability of Concrete" Warnock Hersey Lab Vancouver, Canada *PERM-101*

Samples measuring 6 x 3 inches (150mm x 74 mm) were cast utilizing 3000 PSI (20.7 MPa) concrete. Following application and curing of the XYPEX Concentrated treatment, the samples were placed into sealed vessels for water permeability testing. The maximum pressure of this particular apparatus of 180 PSI (1.24 MPa) was attained and "it can be concluded that the samples treated with XYPEX did not show any permanence or leakage".

U.S. Army Corps of Engineers (USACE) CRD C48-73 "Permeability of Concrete" Aviles Engineering Corp., Houston, USA *PERM-102*

Two concrete samples containing XYPEX Admix at 3% and 5% respectively, and an untreated control sample, were tested for water permeability. Both the treated and untreated samples were subjected to a pressure of 150 PSI (350 ft. water head). Results showed moisture and permeated water throughout the untreated sample when split in half after 24 hours. However, the XYPEX Admix samples showed no flow through the sample, and water penetration of only 1.5 mm after 120 hours (5 days).

U.S. Army Corps of Engineers (USACE) CRD C48-73 "Permeability of Concrete" Setsco Services, Pte. Ltd., Singapore *PERM-103*

Six XYPEX Admix-treated and six untreated concrete samples were tested for water permeability. Pressure was applied in increments over seven days and then maintained at 7 bars (224 ft. head of water) for 10 days. While the six reference samples showed water flowing through the sample beginning on the fifth day and increasing throughout the test period, the XYPEX Admix samples showed no water permeation at any time during the test.

Texas Construction Company - In House Test Report, Houston, USA
PERM-104

Concrete samples containing the XYPEX Admix were compared to control samples containing no Admix in tests to determine water permeability. Concrete cores 3/4" (19mm) thick were made from 3000 PSI concrete. Pressure utilizing a test apparatus was exerted on all of the samples. The control sample was totally saturated within 24 hours at 43 PSI. The core samples containing the XYPEX Admix were tested at various levels of pressure over time. After 120 hours and a maximum pressure of 172 PSI, the XYPEX samples showed no observable water permeation.

U.S. Army Corps of Engineers (USACE) CRD C48-73 "Permeability of Concrete" - James Neill and Associates Ltd, Vancouver, Canada
PERM-105

Three samples mortar jackets for steel pipes were prepared by Price Brothers in Hattiesburg, MS during their manufacturing process. Samples include one containing XYPEX Admix C-1000 @ 3%, another with XYPEX Admix C-1000 NF (no fines version) @ 1.5% and one that was untreated. The samples were cored to a diameter of 93.5 mm and an average length of 28.8 mm and sealed within the permeability testing apparatus. Each sample was subjected to two separate trials one week apart. The samples were subjected to a maximum pressure of 30 PSI (0.40 MPa). Test duration varied from 5 to 45 minutes. Flow rates for the control samples exceeded 100 ml/min at 27 PSI and only 5 to 7 minute test duration was required to obtain equilibrium flow. The C-1000 NF samples reduced the permeability to approximately 37 to 46% of the control samples. The C-1000 samples have 35 times lower water permeability coefficient than the control samples.

DIN 1048 "Water Impermeability of Concrete" Bautest - Corporation for Research & Testing of Building Materials, Augsburg, German
PERM-200

XYPEX-treated and untreated concrete samples 200 mm thick were pressure tested up to 7 bars (230 ft./70 m water head) for 24 hours to determine water impermeability. While the control samples measured water penetration up to a depth of 92 mm, XYPEX-treated samples measured water penetrations in the samples to an average of 4 mm, with one sample measuring zero.

DIN 1048 "Water Impermeability of Concrete" DICTU S.A. Dept. Of Engineering and Construction Mgt., Santiago, Chile *PERM-201*

XYPEX Admix treated concrete samples and control samples 120 mm thick were tested to determine water permeability. Samples were subjected to pressure for 28 days. It was noted that water had totally permeated through the untreated samples but no water penetration was detected in any of the XYPEX-Admix-treated samples.

Onorm B 3303 "Water Impermeability of Concrete" Technologisches Gerwerbemuseum, Federal Higher Technical Education & Research Institute, Vienna, Austria *PERM-202*

XYPEX-treated concrete samples were pressure tested to a maximum 7 bars (230 ft./70 m water head) for 10 days. Tests revealed that while 25 ml of water had penetrated the untreated concrete samples, no measurable volume had penetrated the XYPEX-treated samples. Test specimens were then broken and showed water penetration to a depth of 15 mm on untreated samples but no measurable water penetration on the XYPEX-treated samples.

CSN 1209/1321 (Modeled on the DIN 1048 Test Procedures) "Impermeability and Resistance to Pressurized Water" Institute of Civil Engineering, Technology and Testing, Bratislava, Slovak Republic
PERM-203

XYPEX-treated and untreated concrete samples were exposed to 1.2 MPa of pressure to determine water permeability. Results showed the XYPEX-treated samples provided effective protection against hydrostatic water pressure. Treated and untreated samples were also subjected to contact with silage juices and various petroleum products (e.g. diesel oil, transformer oil, gasoline) at 14 kPa for 28 days. The XYPEX-treated samples reduced the penetration of these solutions significantly.

Laboratories for Preparation and Methodology (LPM), Luzern, Switzerland
PERM-205

Untreated specimens and XYPEX treated specimens (7 cm thick) were subjected to a water pressure of $2.8x10^4$ Ap dyn/cm^2 for 10 months. The purpose of the testing was to determine the ability of the XYPEX material to make the concrete impermeable. The test results indicate that the XYPEX treated sample was shown to have "very good imperviousness", at $7x10^6$ higher than that of the untreated reference sample.

GOST 12730.5-84 Testing Procedures "Evaluation of Water Tightness", Orgenergostroi, Center of Technology and Quality, Nuclear Power Stations Engineering - Central Construction Laboratory, Moscow, Russia
PERM-206

Concrete cylinders were cast 150 mm x 150 mm with a design water tightness of W2 or 2 atmospheres according to standards of GOST 12730.5-84. Samples were moist cured for 28 days and then treated with 2 coats of XYPEX Modified to a thickness of 1 mm each. Control samples were also moist cured for 28 days. GOST 12730.5-84 test procedures are utilized to determine "water tightness" or ability of a product to make concrete impermeable. The test methodology is similar to the European DIN 1048 procedures. Water pressure was applied to the negative side (opposite surface to the XYPEX treatment) of the cylinder samples and the pressure was increased in increments over time. Test results for the untreated control samples produced the design water tightness index of 2 atmospheres. The samples treated with the XYPEX Modified had the following "water tightness" indices: 3 days - 4 atmospheres, 7 days - 7 atmospheres, 14 days - 8 atmospheres, and 28 days - 8 atmospheres. (Note - 1 atmosphere=14 PSI or 32.4 ft of head pressure).

GOST 12730.5-84 Testing Procedures "Evaluation of Water Tightness", Orgenergostroi, Center of Technology and Quality, Nuclear Power Stations Engineering - Central Construction Laboratory, Moscow, Russia
PERM-207

Concrete cylinders were cast 150 mm x 150 mm with a design water tightness of W2 or 2 atmospheres according to GOST 12730. XYPEX Concentrate was applied to the samples at the rate of 1 kg per m^2. The samples were cured and the negative side (opposite surface to the XYPEX treatment) surface of the cylinder was subjected to hydrostatic pressure for 14 days. The XYPEX treated samples withheld a pressure of 12 atmospheres (168 PSI or 389 ft. head pressure). The XYPEX treatment demonstrated a sharp rise in the concrete's impermeability to water at all stages and that the effect increases with time. Tests were also conducted on sample cylinders where a second coat of XYPEX Modified was applied on top of the hardened Concentrate coat. It was shown that an additional "waterproofing" effect can be achieved by utilizing this two-coat system.

Testing was also performed on a XYPEX Patch 'n Plug installation. Concrete cylinders were cast 150 mm x 150 mm with a design water tightness of W2 or 2 atmospheres according to GOST 12730.5. A hole measuring 15 mm wide by 3 mm deep was cored into the surface of the cylinder. XYPEX Patch 'n Plug was placed into this hole and firmly packed until hardened. The hole that was filled with XYPEX Patch 'n Plug was then subjected to hydrostatic pressure as per GOST 12730.5-84. Test result confirmed that XYPEX Patch 'n Plug repair material withstood 14 atmospheres of pressure (196 PSI or 454 ft. head pressure).

DIN 1048 Test Procedures "Evaluating Depth of Water Penetration Under Pressure", Klokner Institute of the Czech Technical University, Prague, Czech Republic*PERM-208*

Six concrete block samples 200 mm long x 100 mm high with a compressive strength of 23.2 MPa were utilized for the permeability testing. Three were treated with a coating of XYPEX Concentrate followed by a coating of XYPEX Modified and then cured. Three untreated concrete block samples were similarly cured. Water pressure was applied to the positive side (surface of the XYPEX treatment) of the concrete block samples and the pressure was increased in increments over time (100 kPa for 48 hours, 300 kPa for 24 hours, and then 700 kPa for 24 hours). All samples were then broken transversely to expose the depth of water penetration. The XYPEX samples showed an average measurement for the depth of water penetration as 17 mm, while the untreated samples all allowed the water to penetrate the entire thickness of the samples (100 mm).

STN 73 1321 Test Procedures "Evaluating Water Tightness and

Measurement of Water Penetration under Pressure", Technical Testing Institute of Civil Engineering, Bratislava, Slovak Republic *PERM-209*

Concrete samples measuring 150 mm thick were prepared at an independent lab. Two separate batches of concrete were utilized in the testing. Only the brand of cement utilized to make the concrete was varied. Three samples from each batch included the XYPEX Admix and similarly three samples from each batch contained no Admix. Water pressure was applied to the concrete samples and the pressure was increased in increments (similar to the DIN 1048 methodology) over time. All the samples were then broken transversely to expose the depth of water penetration. The samples containing the XYPEX Admix showed an average 30 mm for the depth of water penetration. The non-treated samples showed an average penetration of 85 mm.

Valenta Test Procedures *"Evaluation of Permeability"* (Singapore Custom's House) Kajima Construction Company In-House Test, Singapore PERM-302

This test involved preparing three different samples, including: Xypex Admix, Xypex Admix + Cormix super-plasticizer and a control mix + Cormix super-plasticizer. The specimens were tapered cylinders measuring 100 mm (diameter) & 180 mm (long). The permeability coefficient was determined using both the Valenta technique (based on the depth of water penetration) and a quasi-steady state in-flow to calculate permeability. The samples were exposed for 14 - 17 days to 6.9 MPa (1000 psi) which is equivalent to or 690 m (2,265 ft.) head of water.

In determining the Valenta permeability co-efficient, the Xypex treated samples reduced permeability by 28% compared to the control sample which utilized a super-plasticizer. Testing, which compared the Xypex + superplasticizer sample to the control (superplasticizer only), showed that Xypex reduced the Valenta permeability figure by 55%. Using the coefficient of permeability from the quasi-steady state in-flow test the Xypex sample was 63% lower that the control sample.