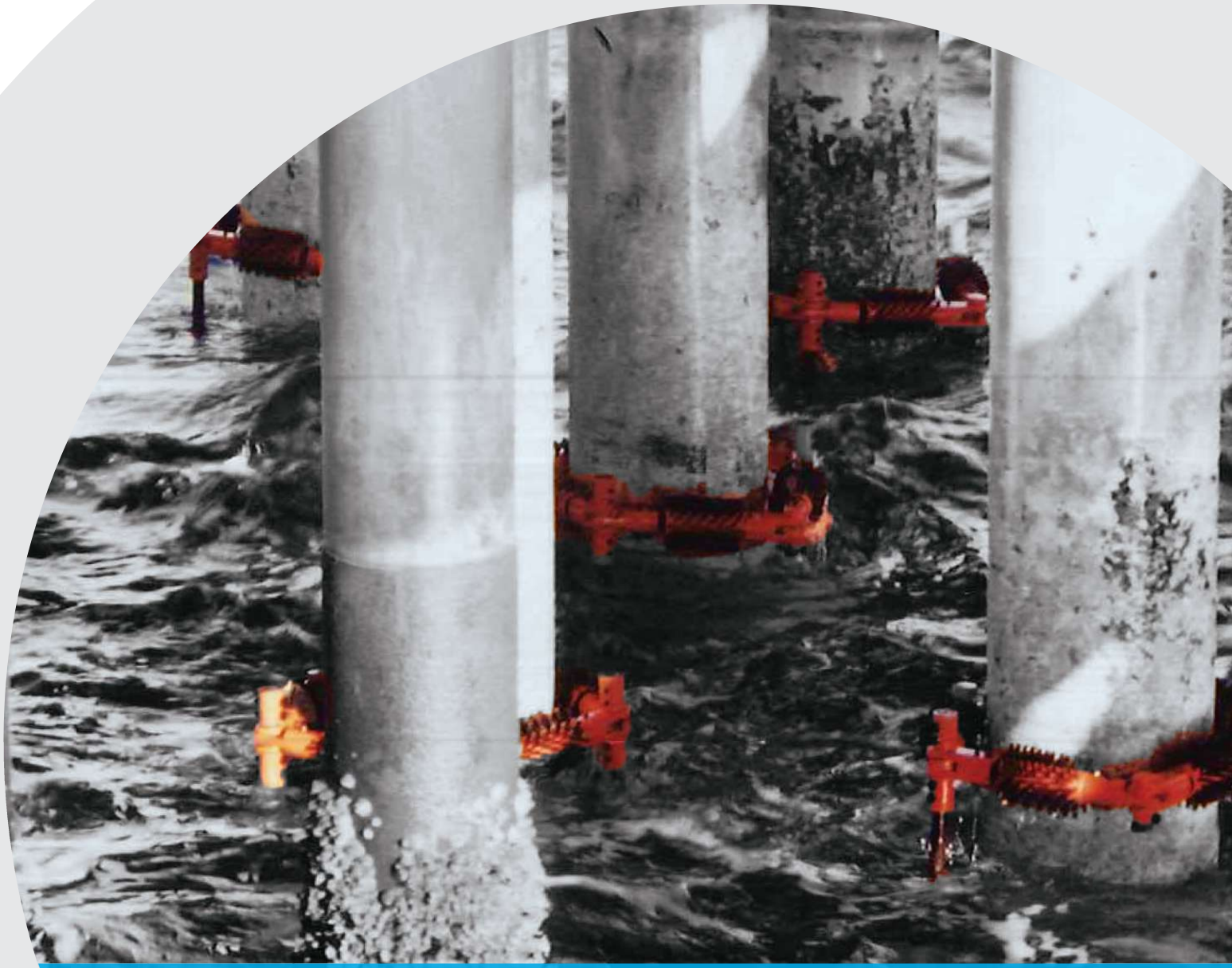
MGP-*i*

creating value with ocean energy

ADD LIFE and STRENGTH to your OFFSHORE ASSETS with the MGP-*i* Solution

- Powered solely by ocean energy
- Highly cost-effective
- Easy to apply and no structural modifications
- Remove and prevent marine growth in a single deployment
- Apply to both new and existing offshore structures
- Designed for all ocean conditions

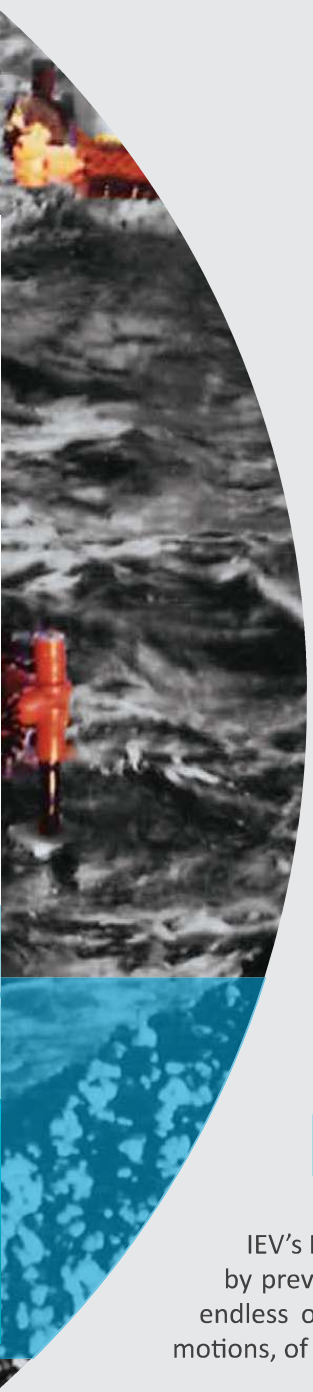


COST $AVING SOLUTION

IEV's Innovative Marine Growth Control Technology

• NO STRUCTURAL MODIFICATION • NO DIVER INTERVENTION •
• MAINTENANCE-FREE •

Early generation of MGPs



A TECHNOLOGY THAT **BUILT A COMPANY**

The “Ocean-Powered” Marine Growth Control Technology is central to the birth of IEV. What began as a prototype design, developed in 1987 from Australia, is now a unique technology applied to over **500** offshore structures worldwide. More than **40,000** Marine Growth Preventers (MGPs) have been deployed on both new and existing offshore oil and gas platforms and jetties to date.

In fact, the MGPs have also been recognised by an international standard, API RP 2SIM – Recommended Practice for Structural Integrity Management of Fixed Offshore Structures, as a measure to reduce hydrodynamic loads.

“Such measures may include installation of sliding marine growth preventers and/ or adding periodic removal to the SIM program for the platform”. (Section 13.3.4.2.3, page 53, API RP 2SIM, First Edition of November 2014 publication).

POWERED BY **ENDLESS OCEAN ENERGY**

IEV’s Marine Growth Control technology focuses on breaking down the marine growth colonization process by preventing the formation of microbial slime, the very first colonizers. This is achieved by harnessing the endless ocean energy, from waves, swells, currents and tidal fluctuation, to power the continuous rolling motions, of specially designed MGPs.

THE TECHNICAL BREAKTHROUGH

Prolific marine growth on offshore structure

Throughout the years, the MGP has undergone several improvements, to cater for various ocean conditions and structural configurations, resulting in increased product durability and cost savings. The most notable breakthrough, however, came through an esteemed client with a unique requirement. The MGP was required to operate under icy-ocean conditions during winter period. Hence, began a journey of extensive research and development, resulting in a new generation of product design with both anti-impact and self-cleaning features. After the success of this pilot project, IEV was awarded a full commercial project at the same site. Subsequently, it became an inspiration to the development and commercialisation of the **MGP-*i*** design in which **"*i*"** symbolises ***i*nnovative**, ***i*mpact-resistant** and ***i*mproved technical specifications** of the MGP.

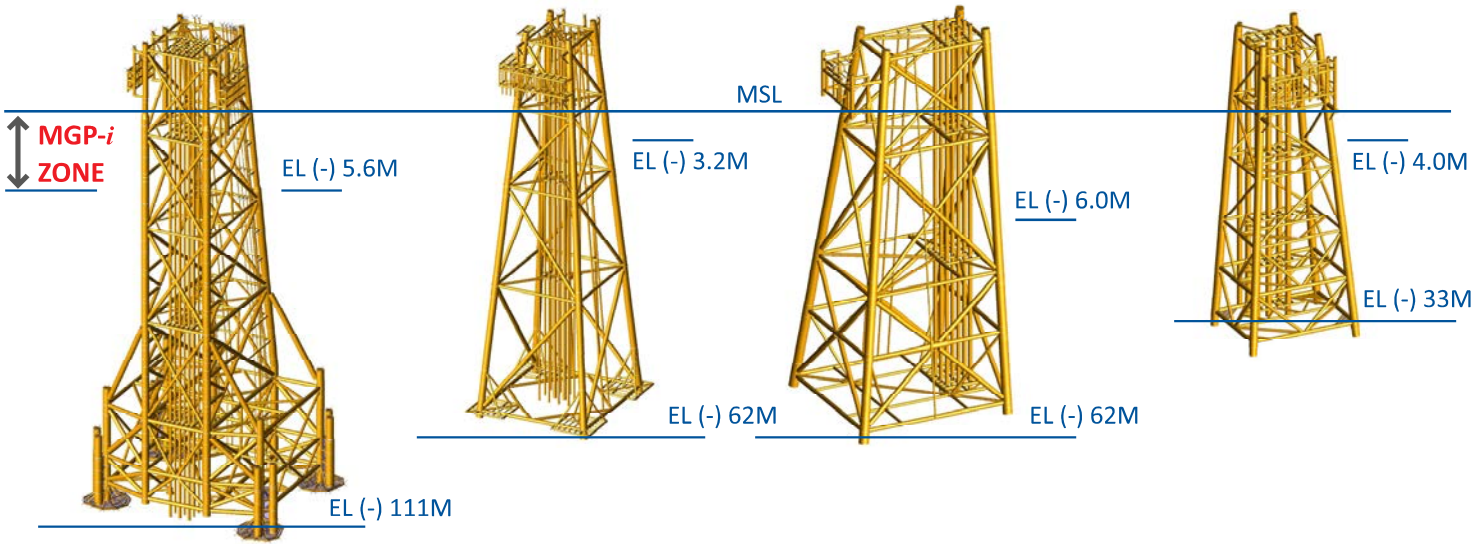
MGP-*i* *in operation under icy ocean conditions*

STRUCTURAL BENEFITS GENERATED BY MGP-*i*

Extensive studies have been conducted to evaluate and quantify the benefits of the **MGP-*i*** application to offshore structures. The results revealed that the majority of loading induced by waves on a fixed offshore structure is generated on the uppermost portion of the structure. Hence, marine growth control is most beneficial in this area.

MARINE GROWTH PREVENTION SENSITIVITY STUDY (MGPSS)

The MGPSS compared the reduction in base shear, over-turning moment and pile axial loading as well as the increase in fatigue life and RSR from the **MGP-*i*** application to a number of offshore platform across Asia and the Middle East.



Offshore Vietnam *Offshore Thailand* *Offshore India* *Offshore Middle East*

***MGP-i zone:** The effective prevention elevation of the **MGP-i** is taken as one third of the maximum operating wave height per annum plus the Lowest Astronomical Tide elevation [(Hmax/3)+ LAT].*

The offshore structures were analysed subject to the following prevailing conditions	Offshore Vietnam	Offshore Thailand	Offshore India	Offshore Middle East
Water Depth (m)	111.42	61.50	62.01	33.17
1 year Operating Hmax (m)	13.80	6.80	11.58	7.30
1 year Operating Associated Wave Period, Tass (s)	11.70	7.20	11.00	8.20
100 Year Storm Hmax (m)	16.00	10.20	17.68	10.40
100 Year Storm Associated Wave Period, Tass (s)	12.90	10.50	14.40	10.10
* The hydrodynamic coefficients in this analysis were increased by 5% for the submerged part of the structures, to account for un-modelled appurtenances e.g. anodes etc.				

REDUCTION in Base Shear, Over-turning Moment and Axial Load

Reduction in base shear, over-turning moment and pile axial load was up to **7.5%**, **9.5%** and **7.5%** respectively.

Results	Offshore Vietnam	Offshore Thailand	Offshore India	Offshore Middle East
Base Shear Reduction (%)	2.1 - 2.4	3.7 - 3.8	5.3 - 7.5	4.8 - 5.3
Over-turning Moment Reduction (%)	3.1 - 3.3	4.8 - 4.9	6.4 - 9.5	6.4 - 6.9
Pile Axial Load Reduction (%)	1.9 - 2.6	2.2 - 2.5	5.2 - 7.5	4.4 - 5.7

IMPROVEMENT IN Fatigue Life and Reserved Strength Ratio

Joint Fatigue Life improvement was up to **3 folds** and Reserved Strength Ratio (RSR) improvement was up to **11.1%** in evaluating **MGP-*i*** benefits for platforms in the Middle East and South East Asia.

Platform Location	No. of Joints Assessed	Fatigue Life Range (Years)		Fatigue Life Improvement
		With marine growth	MGP-*i*	
Middle East	16	13 – 109	26 – 345	2 – 3 folds
S.E. Asia	6	14 – 165	35 - 212	1.2 – 3 folds

Platform Location	Reserved Strength Ratio (RSR)		% RSR Improvement
	With marine growth	MGP-*i*	
Middle East	1.71	1.80	5.3
S.E. Asia	6.20	6.89	11.1

MGP-*i*

*The **MGP-i** is IEV's **latest generation of self-cleaning and anti-impact single-ring product, which can be installed in a single deployment** from above water, to both **remove** existing marine growth and permanently **prevent** their regrowth in the wave zone, where marine growth is most prolific and wave loading is most significant.*

A HIGHLY COST-EFFECTIVE STRUCTURAL INTEGRITY MANAGEMENT AND LIFE EXTENSION SOLUTION

The **MGP-*i*** offers a **simple, reliable and low cost solution** for platform structural integrity management and life extension compared to alternative solutions, which require structural modifications. The employment of **MGP-*i* reduces the dynamic and hydrodynamic loading on the platform, thereby increasing its structural capacity and Reserved Strength Ratio (RSR).** The reduction of cyclic wave loading also improves the fatigue life of joints, hence extends the life of the platform.

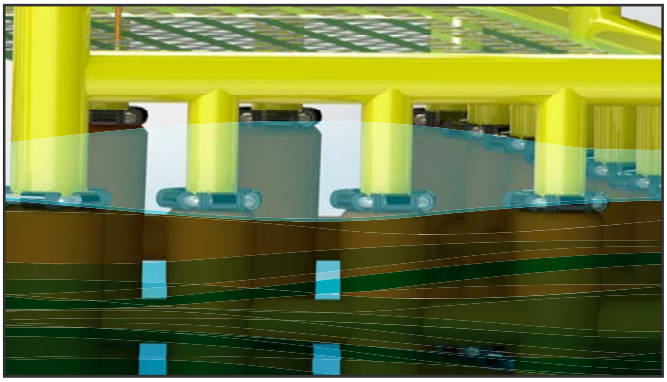
MGP-*i* Vs ALTERNATIVE MARINE GROWTH CONTROL SOLUTIONS

Conventional methods of periodical cleaning of marine fouling by divers or ROVs are costly and risky compared to the employment of **MGP-*i***. In addition, **MGP-*i*** offers a permanent marine growth prevention solution, in which a zero-growth profile is maintained by the products. Whilst adverse weather conditions disrupt underwater activities, they actually enhance the performance of the **MGP-*i*.**

Alternative anti fouling solutions such as the use of copper-nickel panels and anti-fouling paints are either too costly, environmentally unfriendly, time consuming or infeasible to apply in-situ, which requires a highly complex level of supervision to implement, compared to the **MGP-*i*.**

EASY TO APPLY

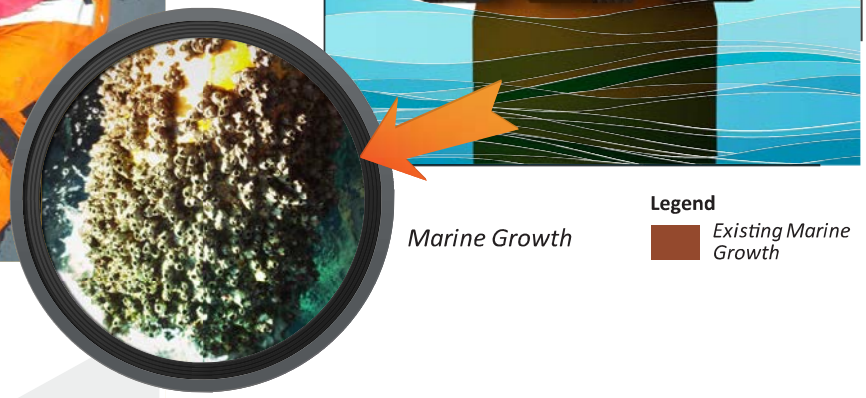
MGP-*i* is typically installed from just below the sea-deck level, by scaffolders or rope access technicians. By following simple instructions, each single ring **MGP-*i*** can be easily assembled, connected around a structural member and dropped to the sea level. Once deployed, the **MGP-*i*** operates instantaneously by ocean waves and no further intervention or reconfiguration is necessary throughout its life.



Before Cleaning

After Cleaning

MGP-*i* *installation in the North Sea*



Marine Growth

DESIGNED FOR ALL OCEAN CONDITIONS

The use of composite rubber discs in conjunction with "one-piece" rigid connectors provides the **MGP-*i*** with a protective layer to absorb severe impact forces during its cleaning and long-term prevention of marine growth in the wave zone. The new design prevents connectors from being exposed to direct impact against any foreign object or structural obstructions.

MAINTENANCE-FREE

The **MGP-*i*** lifetime is no longer limited by the anti-fouling paint applied to the products as used in previous generations. This is achieved by a system of specially-designed discs that not only offer anti-impact but also self-cleaning features.

REDUCTION in Probability of Failure (PoF)

The reduction in PoF due to fatigue and platform collapse ranges between **4 and 8 folds** from the **MGP-*i*** application to a platform investigated for the Middle East. The PoF figures in the table were derived as per the methodology prescribed in OTC-7755 - Risk Analysis Methodology for Developing Design and Assessment Criteria for Fixed Offshore Structures.

Joint No.	Fatigue PoF		RSR PoF		PoF With marine growth	PoF MGP-*i*	PoF Reduction
	With marine growth	MGP-*i*	With marine growth	MGP-*i*	$P_{f\text{-}acc}$ x $P_{f\text{-}collapse}$	$P_{f\text{-}acc}$ x $P_{f\text{-}collapse}$	
501L	3.04E-1	7.83E-2	1.65E-3	1.09E-3	5.02E-4	8.51E-5	6 folds.
419L	2.32E-1	5.52E-2	1.65E-3	1.09E-3	3.83E-4	6.00E-5	6 folds.
599L	2.02E-1	3.87E-2	1.65E-3	1.09E-3	3.34E-4	4.21E-5	8 folds.
581L	1.42E-1	4.52E-2	1.65E-3	1.09E-3	2.35E-4	4.91E-5	4 folds.
519L	7.70E-2	1.87E-2	1.65E-3	1.09E-3	1.27E-4	2.03E-5	6 folds.

EXTENSION in Platform Inspection Interval

MGP-*i* application will reduce the PoF and lower the risk exposure of the platform. Therefore, it justifies the extension of the interval between underwater inspections as per the platform integrity management philosophy expounded in API RP 2SIM. Fatigue life and PoF assessment results can be used to enhance/support subsea inspection scheduling decisions.

Acceptable PoF Values

Platform Exposure Level	Joint Criticality	PoF Range
L1 (Target PoF = 2×10^{-4})	Low	$< 2 \times 10^{-5}$
	Medium	$2 \times 10^{-5} \leq Pf \leq 2 \times 10^{-5}$
	High	$> 2 \times 10^{-3}$
L3 (Target PoF = 5×10^{-5})	Low	$< 5 \times 10^{-4}$
	Medium	$2 \times 10^{-4} \leq Pf \leq 5 \times 10^{-2}$
	High	$> 5 \times 10^{-2}$

(Source: API Recommended Practice 2A-WSD, Section 17, 21st Edition, Dec 2000)

Risk-based Inspection Program Intervals

Risk Category	Inspection Interval Ranges
Higher	3 years to 5 years
Medium	6 years to 10 years
Lower	11 years to 15 years

(Source: API Recommended Practice 2SIM of Fixed Offshore Platforms 1st Edition, Nov 2014)

IEV GROUP OF COMPANIES

Regional Headquarters:

: Menara PKNS, Block A, Level 5,
No. 17 Jalan Yong Shook Lin,
46050 Petaling Jaya, Selangor

: +6 (03) 7931 9921

: +6 (03) 7931 9964

: info@iev-group.com

: www.iev-group.com

• CONTINUOUS R&D • SKILLED ENGINEERING • OFFSHORE EXPERTISE • AFTER-SALES SUPPORT •