IRANIAN PETROLEUM STANDARDS

IPS-E-TP-270 (1)

ENGINEERING STANDARDS FOR
PROTECTIVE COatings
FOR
BURIED AND SUBMERGED STEEL STRUCTURES

FIRST REVISION
MARCH 2009

استاندارد مهندسی
برای
پوشش های حفاظتی
برای
سازه های فولادی مدفون در خاک و غوطه ور در آب
ویرایش اول
اسفند 1387

DEPUTY MINISTER
OF
ENGINEERING & LOCAL MANUFACTURING
RESEARCH & STANDARDS

جمهوری اسلامی ایران
وزارت نفت

Iranian Engineering Standards

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Deputy Minister
Of
Engineering & Local Manufacturing
Research & Standards

Islamic Republic of Iran
Ministry of Petroleum
FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS is based on internationally acceptable standards and includes selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein.

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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پیش گفتار

استانداردهای نفت ایران (IPS) (معنیک کننده دیدگاه‌های وزارت نفت ایران است) و برای استفاده در تاسیسات تولید نفت و گاز، پالایشگاههای نفت، واحدهای شیمیایی و پتروشیمی، تاسیسات انتقال و قرارگیری گاز و سایر تاسیسات مشابه نهی شده است.

استانداردهای نفت، براساس استانداردهای قبل قبول بین‌المللی بهره و شیب‌گری‌های از استانداردهای مرجع می‌باشد. همچنین براساس تجربیات صنعتی نفت کشور و قابلیت تأمین کالا از بازار داخلی و نیز مانند نیاز، مواردی بطور تکمیلی و یا اصلاحی در این استاندارد لحاظ شد است. مواردی از گزینه‌های فنی که در متن استانداردها آورده نشده است در داده برگرده به‌صورت شماره گذاری شده برای استفاده مناسب کاربرد ارائه شده است.

استانداردهای نفت، به‌گونه‌ای طراحی شده است که به‌طور کامل اطمینان به‌دست آید و با این حال تعیین نیازمندی‌های پیش‌بینی را پوشش ندهد. در این گونه موارد باید اصلاح‌هایی که تکنیک زمانی قابل توقف آنها را تأمین نمایند و پیش‌بینی نمایند. این اصلاح‌های همراه با تشكل خواهند داد.

استانداردهای نفت نسبتاً در پنج سال یکبار مورد بررسی قرار گرفته و روزار می‌گردد. در این بررسی‌ها ممکن است استانداردهای جدید و یا اصلاح‌هایی به‌آن اضافه شود و بنابراین همراه آخرين و پيروز مکاتب عمل کنند. از کاربران استاندارد، درخواست می‌شود تا نظرها و پیشنهادات اصلاحی و یا هرگونه اصلاح‌هایی که برای موارد خاص تهیه شود، به شماره مستقیم نام‌بندی نظرات و پیشنهادات دریافتی در کمیته‌های فنی مربوط برسی و در صورت تلاش در تجدید نظرهای جدید استاندارد متعکس خواهد شد.

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GENERAL DEFINITIONS:
Throughout this Standard the following definitions shall apply.

COMPANY:
Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER:
Means the "Company" where this standard is a part of direct purchaser order by the "Company", and the "Contractor" where this Standard is a part of contract document

VENDOR AND SUPPLIER:
Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:
Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR:
Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR:
The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work

SHALL:
Is used where a provision is mandatory.

SHOULD:
Is used where a provision is advisory only.

WILL:
Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

MAY:
Is used where a provision is completely discretionary.
ENGINEERING STANDARD

FOR

PROTECTIVE COATINGS

FOR

BURIED AND SUBMERGED STEEL STRUCTURES

FIRST REVISION

MARCH 2009

اسنادار مهندسی

برای

پوشش های حفاظتی

برای

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ویرایش اول

اسفند 1387

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0. INTRODUCTION

The main task of protective coatings is to prevent or control external corrosion of buried or submerged steel structures. The coating isolates metal from contact with surrounding environments. Since a perfect coating cannot be assured, cathodic protection is used in conjunction with the coating system to provide the first line of defense against corrosion. And since a properly selected and applied coating should provide 99% of the protection required, it is of utmost importance to know the advantages and disadvantages of available coatings. The right coating material properly used will make all other aspects of corrosion control relatively easy. The number of coating systems available necessitates careful analysis of the many desired properties for an effective pipe coating. Therefore optimum selection and proper application of protective coatings is of engineering importance.

During extended period of time a protective coating deteriorates as a result of contact with moisture, oxygen, chemicals fluctuating temperatures, abrasion, pressure and many other possible factors proper and timely maintenance is required to get the optimum performance from a protective coating.

Meanwhile, selection and application of maintenance coating is more complicated than for initial construction.

Climatic conditions, chemical exposure, available time, budget, health and safety, grade of surface preparation have serious influence on the planning of optimum design coating. To select the best coating system to fit the environment or oil condition. Knowledge of operating and installation conditions is the beginning of the process. Steel source and job location may limit the coatings available to each project. Selection of a quality applicator is the most important consideration and frequently is the most neglected. Following coating and applicator selection, inspection at the coating mill and especially on the job site during construction will go far in assuring that a high quality pipe coating system has been installed.

Karabed aceli poveshyeha havafisati beray jelokhiero ya kontol xorodgi yesh xarayi saharahasi voleadi di ziray xak ya goulohe wr dar ab miyadesh. Povesh yamhat hasanasai fars dar tamas ba madmini xafe hug yemis, der poveshuni nemvand ha toor kamil va amlami havak yari, dafa havafi kanddi mintahy bar noor an beray jelokhiero az xorodgi yara havafisati ast. Az aqhaha etaxhak va berayi poveshyeha xojoy dar 99 daras dar havafisati ra tamin kand, etaxhak aghaam az mazra va mausub poveshyeha mowjod az havafisati goulohe yep xadiy dar pivaned. Astefade sahih az mowad ba karye rafteh dar poveshyeha mowad yarda kand va tamis. Tedad saman yeha poveshyeha mowjod, prodorot tazhhe va tahlil دقیق خواص مطلوب برای یک پوشش مناسب لوله را ایجاد می‌کند. انتخاب پوشش بهینه و کاربرد صحیح پوشش‌های حفاظتی در مناسب‌ترین دراهم‌های است. در طول دوره زمان یک پوشش حفاظتی در اثر تماس با رطوبت‌ها و خشکی‌ها، مواد شیمیایی، تغییرات درجه حرارت، سایش، فشار و دیگر عوامل اختلال، تخریب شده لازم است که به موقع و اصولی تعییر گردد تا استفاده بهینه از پوشش حفاظتی حاصل شود. ضمناً، اجرای تعمیر پوشش سپس اجرایی از پوشش اولیه است.

شرایط آب و هوای نماس با مواد شیمیایی، زمان کافی، بودجه، ابیسته و بهداشت می‌کارند. دارای چهار آباده سازی سطح، دارای یادگیری جدید بر برنامه ریزی توانایی بهینه پوششی دارند، بهترین پوشش مناسب با محتوای با شرایط نیتی، با باید انتخاب گردد. اگه‌ای از شرایط اجرا و نصب، شروع فرآیند پوشش است. منابع تأمین فولاد و محل کار ممکن است محدود‌سیده‌ای برای اجرای پوشش هر بروز اجادات کند. انتخاب پیمانکار با توجه به اهمیت دارد که بالا را از غفلت می‌گذارد. پس از انتخاب پوشش و پیمانکار، بازرسی از پوشش در کارگاه به ویژه در محل و در حین ساخت این اطلاعات را به ما میده که پوشش لوله با کیفیت خوبی اجرا شده است.
1. SCOPE

1.1 This Engineering Standard covers the minimum requirements for the design and selection of coating systems for external protection of pipes, storage tanks and piling systems to be buried or submerged in water.

1.2 The contents of this Standard define the essential requirements for surface preparation, selection of coating systems and repair of coating defects.

1.3 The standard is intended for corrosion protection of steel structures of oil and gas and petrochemical industries including refineries, chemical and petrochemical plants, gas plants, oil exploration and production units.

1.4 It does not cover pipelines requiring thermal insulation and casing protection.

1.5 Coating of stainless steel, galvanized steel and non-ferrous alloys under external corrosive condition is subject to approval of company design engineer.

1.6 In addition, the internal protection of piping systems for water supply and internal protection of water or chemical storage-tanks are excluded from this standard, and the reference is made to IPS-E-TP-350.

1.7 This Engineering Standard does not supersede cathodic protection application for piping systems and steel structures at burial or submersible conditions.

1.8 Detailed instructions for applying a specific coating are not included, since they are furnished by IPS-C-TP-274.

1.9 Although this Engineering Standard shall submit proper guidelines for selection of proper materials, but decisions on coatings shall not be left to the casual attention of inexperienced personnel.

Note 1:

This standard specification is reviewed and updated by the relevant technical committee on May 2004, as amendment No. 1 by circular No. 232.
Note 2:

This bilingual standard is a revised version of the standard specification by the relevant technical committee on (March 2009), which is issued as revision (1). Revision (0) of the said standard specification is withdrawn.

Note 3:

In case of conflict between Farsi and English languages, English language shall govern.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies, the applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

ASTM D5 "Test Method for Penetration of Bituminous Materials"

ASTM D149 "Standard Test Method for Dialer Break Down Voltage and Dielectric Strength Materials Commercial Power Frequencies"

ASTM D257 "Standard Test Method for DC Resistance or Conductance of Insulating Materials"

ASTM D427 "Test Method for Shrinkage Factors of Soils by the Mercury Method"

ASTM D785 "Test Method for Rockwell Hardness of Plastic and Electrical Insulating"

ASTM D2240 "Test Method for Rubber Property-Durometer Hardness"
ASTM G8 "Test Method for Cathodic Disbonding of Pipeline Coatings"

ASTM G13 "Test Method for Impact Resistance of Pipeline Coating (Limestone Drop Test)"

ASTM G19 "Test Method for Disbonding Characteristics of Pipeline Coatings by Direct Soil Burial"

AWWA (AMERICAN WATER WORKS ASSOCIATION)

AWWA C 203 "Coal-tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot-Applied"

AWWA C 205 "Cement-Mortar Protective Lining and Coating for Steel Water Pipe 4 Inch and Larger-Shop Applied"

AWWA C 213 "Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines"

AWWA C 215 "Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines"
<table>
<thead>
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<tr>
<td>BSI 4147</td>
<td>&quot;Bitumen-Based Hot-Applied Coating Materials for Protecting Iron and Steel, Including Suitable Primers Where Required&quot;</td>
<td>بسته‌بندی بی‌درجه سلولزی استحکامات مواد پوششی برای محافظت از فلزات است.</td>
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<tr>
<td>DIN 30670</td>
<td>&quot;Polyethylene Coatings for Steel Pipes and Fittings&quot;</td>
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</tr>
<tr>
<td>DIN 30672</td>
<td>&quot;Tape and Shrinkable Materials the Production of Buried or under Water Pipelines without Cathodic Protection for Use at Operating Temperatures up to 50 °C&quot;</td>
<td>بسته‌بندی کاغذ و لوله‌های شفاف برای لوله‌های پوششی داخلی و زیر آب است.</td>
</tr>
<tr>
<td>En 10300</td>
<td>&quot;Steel Tubes and Fittings for Onshore and Offshore Pipelines Bituminous hot Applied Materials for External Coating&quot;</td>
<td>بسته‌بندی لوله‌های بی‌درجه سلولزی برای پوشش خارجی برای لوله‌های پرتابل است.</td>
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<tr>
<td>IPS-E-GN-100</td>
<td>&quot;Engineering Standard for Units&quot;</td>
<td>&quot;نیروگاه‌های مهندسی&quot;</td>
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<td>IPS-E-TP-350</td>
<td>&quot;Engineering Standard for Linings&quot;</td>
<td>&quot;نیروگاه‌های مهندسی برای لایه‌های خارجی&quot;</td>
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<td>&quot;Engineering Standard for Cathodic Protection&quot;</td>
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<td>&quot;Material and Equipment Standard for Asphalt Mastic (Cold Applied)&quot;</td>
<td>&quot;نیروگاه تجهیزات و مواد برای مواد لایه‌ای مالات آسفالت قیزی (سرد اجرای)&quot;</td>
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<tr>
<td>IPS-M-TP-275</td>
<td>&quot;Material and Equipment Standard for Fast Drying Synthetic Primer for Use with Hot Applied Coal Tar or Bitumen (Asphalt) Enamels&quot;</td>
<td>استاندارد تجهیزات و مواد برای سریع (گرم اجرا) برای استفاده لعاب قطران با قیر (اسفالت)</td>
</tr>
<tr>
<td>IPS-M-TP-280</td>
<td>&quot;Material and Equipment Standard for Coal Tar Primer (Cold Applied) for Use with Hot Applied Coal Tar Enamel (IPS-M-TP-290)&quot;</td>
<td>استاندارد تجهیزات و مواد برای استری قیرت (سرد اجرا) برای استفاده با لعاب قطران - (ای.PM-TP-290) گرم اجرا</td>
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<td>&quot;Material and Equipment Standard for Bitumen Primer (Cold Applied) for Use with Hot Applied Bitumen Enamel (IPS-M-TP-295)&quot;</td>
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<td>IPS-M-TP-300</td>
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<td>استاندارد تجهیزات و مواد برای حصار الیاف شیشه ای برای لغاف داخلی</td>
</tr>
<tr>
<td>IPS-M-TP-305</td>
<td>&quot;Material and Equipment Standard for Coal Tar Impregnated Glass Fiber Mat for Outer Wrap&quot;</td>
<td>استاندارد تجهیزات و مواد برای آغشته کردن حصار الیاف شیشه با قطران برای لغاف خارجی</td>
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<td>IPS-M-TP-306</td>
<td>&quot;Material and Equipment Standard for Bitumen Impregnated Glass Fiber Mat for Outer Wrap&quot;</td>
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<td>&quot;Material Standard for Cold Applied Laminated Plastic Tape as Inner Layer Tape for Tape Coating System of Buried Steel Pipes&quot;</td>
<td>استاندارد مواد برای کاربرد سرد نوار پلاستیکی لایهای برای لایه داخلی و سامانه پوشش نواری برای لویه‌های فولادی مدفون</td>
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<td>&quot;Material Standard for Plastic Grid (as RockShield) for Pipe Coating&quot;</td>
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<tr>
<td><strong>IPS-M-TP-317</strong></td>
<td>&quot;Material Standard for Hand- Applied Petrolatum Tape &amp; Primer&quot;</td>
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<td><strong>IPS-M-TP-318</strong></td>
<td>&quot;Material Standard for Heat Shrinkable Cross-Linked Polyethylene Coatings (Two Layers)&quot;</td>
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<td><strong>IPS-M-TP-321</strong></td>
<td>&quot;Material standard for Primers (Ditch and Yard) for Use with Cold- Applied Laminated Plastic Tape (IPS-M-T-310) for Tape Coating System of Buried Steel Pipes&quot;</td>
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<td>&quot;Material Standard for Primer for Use with Hand Applied Laminated Tape Suitable for Cold Applied Tape Coating System&quot;</td>
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<td>&quot;Material Standard for Primer for Use with Hand Applied Laminated Tape Suitable for Hot-applied Tape Coating Systems&quot;</td>
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### ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

<table>
<thead>
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<th>ISO Number</th>
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</thead>
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<tr>
<td>ISO 8501/1</td>
<td>&quot;Preparation of Steel Substrates before Application of Paints and Related Products-visual Assessment of Surface Cleanliness-Part 1: Rust Grades and Preparation Grades of Uncoated Steel Substrates and of Steel Substrates after overall Removal of Previous Coatings&quot;</td>
<td>ISO 8501/1</td>
<td>&quot;Iṣfandé Saffoof Foladé Qill Az Aʿumâl Reng̲a wa Fawārd̲eh̲a Maryooteh̲ - Az Zari Boyeş̲e Yâkiqeqi Saffh - Besh̲e Alov: Ḍe̲r̲a̲t̲e Zeng̲a wa Ḍe̲r̲a̲t̲e Amahe Saffoof Foladé Yedon Pous̲h̲ wa Saffoof Foladé B̲e̲d̲e̲ Az B̲u̲d̲a̲nt̲e̲ Kâm̲l̲ Pous̲h̲ha̲y̲ Ceb̲l̲i&quot;</td>
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| ISO 2592   | "Petroleum Product-Determination of Flash and Fire Points"                  | ISO 2592   | "Fawārd̲eh̲a Naf̲ī - Teyeb̲in Naf̲āt Ašṭuwal wa Sow̲a̲nt̲"
| ISO 2431   | "Paint and Varnishes – Determination of Flow Time by Use of Flow Cups"    | ISO 2431   | "Teyeb̲in Zam̲an Ḍer̲an, Reng̲a wa Rogn̲n Jila Ya Ḍer̲a̲h̲a Flos̲h̲ka (Cups"
| ISO 13436  | "Petroleum Products and other Liquids Determination of Flash Point – ABEL Closed Cup Method" | ISO 13436  | "Teyeb̲in Naf̲te Ašṭuwal Fawārd̲eh̲a Naf̲ī wa Dīg̲er Māyib̲a A Ya Ḍer̲a̲h̲a "(Abel Closed Cup"
| ISO 3251   | "Paints, Varnishes and Plastics Determination of Non – Volatile Matter Contents" | ISO 3251   | "Teyeb̲in Maw̲ad Gīf̲ar̲a, Reng̲a, Rogn̲n Jila Ya Bulaisti̲k̲a"
| ISO 21809-1| "Petroleum and National Gas industries – External Coatings for Buried or Submerged Pipe Line Used in Pipe Line Transportation Systems-part1: Polyolefin Coatings (3-Layer PE and 3-Layer PP)" | ISO 21809-1| "M̲a̲s̲a̲b̲ C̲h̲i̲ Naf̲t̲ w̲a̲ Gāz - Pous̲h̲ Xārg̲ī Pīrāy Ḍet̲e̲ L̲o̲ L̲o̲ M̲e̲n̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲̲哲̲ 10
NACE (NATIONAL ASSOCIATION CORROSION ENGINEERS)

NACE RP-0169 "Standard Recommended Practice Control of External Corrosion on Underground or Submerged Metallic Piping Systems"

NACE RP-0375 "Field-Applied Wax Coating Systems for Underground Pipe Lines: Application, Performance, and Quality Control"

NACE RP-0188 "Discontinuity (Holiday) Testing of Protective Coatings"

3. DEFINITIONS AND TERMINOLOGY

For the purposes of this Standard the following definitions apply:

Bitumen

A very viscous liquid or solid, consisting of hydrocarbons and their derivatives, which is soluble in carbon disulphide or trichloroethylene. It is substantially non-volatile and softens gradually when heated. It is black or brown in color and possesses waterproofing and adhesive properties. It is obtained by refinery processes from petroleum.

Bond Strength

For the purposes of this standard, the bond strength is the force required to peel a strip of coating from the pipe under specified conditions.

Cathodic Protection

A technique to reduce the corrosion rate of a metal surface by making it a cathode of an electrochemical cell.

Coating Resistivity

The coating resistivity is the electrical resistance of coatings per unit area.

2- تعريف و اژگان

برای اهداف این استاندارد تعريف زیر به کار می‌رود:

ویژه تاریک نفتی

یک ماده بسیار غلیظ یا جامد، مشتمکل از هیدروکربن‌ها و مشتقات آنها، محلول در دی سولفید کربنی یا در ترکیب گاز یا اثر حرارت به ترتیب ترم می‌شود. در نگاه آن سیاه یا قهوه‌ای به نظر می‌رسد. بازیابی این تهیه از طریق سیستم‌های بازتابگر با دستگاه‌هایی در نظر استخراج می‌گردد.

استقلال جسینگی

قدرت جسینگی عملی از نورهای مورد نیاز برای جدا کردن نوار پوشش از لوله نهت شرایط حساس است.

حفاظت کاتنی

روش کاهش شدت خوردگی سطح فلز با قرار دادن آن به عنوان کاتن در یک پیل الکتروشیمیایی.

مقاومت پوشش

مقاومت پوشش، مقاومت الکتریکی پوشش‌ها بر واحد سطح را گویند.
Consolidate Soil

When a soil is subjected to an increase in pressure due to loading at the ground surface, a re-adjustment in the soil structure occurs. The volume of space between the soil particles decreases and the soil tends to settle or consolidate over time.

Corrosion Protection

Modification of corrosion system so that corrosion damage is mitigated.

Disbondment

The loss of the bond between a coating and the surface coated.

Enamel

The enamel is composed of a specially processed coal tar pitch or bitumen combined with an inert mineral filler.

Engineer

The person, firm, or employee representing the purchaser for adequacy of design and quality assurance.

Environment

The circumstances, acts, or conditions to which a steel pipeline is subjected.

Field Joint

A connection, usually a weldment, between two adjoining members or parts, made on-site at the time of installation.

Hot Applied

Of such a consistency at ambient temperature that heating is required before application.

Inert Filler

Finely divided mineral powder or inorganic fiber which is not substantially hygroscopic, not electrically conducting and does not react with other ingredients of the coating material or with the environment in which it will be used.

Indentation Hardness

The indentation hardness is a measure of the resistance of coating to the penetration of a test cylinder under specified conditions.
Immersed

Is defined as permanent immersion such as submerged structures, offshore drilling rigs, etc.

Impact Strength

The impact strength is defined as the impact energy coating can withstand under specified conditions.

Ionic Transport

Corrosion of a metal is an electrochemical reaction between the metal and its environment, which results in wastage of metal. Thus corrosion is a combination of chemical effect of transported ions of corrosive environment to the metal surface with an associated of electrical energy (corrosion current).

Minimum Coating Thickness

The minimum coating thickness is the required thickness of coating at any point.

Top Coat (Finish)

The final or finish coat of any paint system. This coat provides decoration, durability and resistance properties.

4. UNITS

This standard is based on International System of Units (SI), as per IPS-E-GN-100 except where otherwise specified.

5. FIELD OF APPLICATION

This Engineering Standard deals generally with the following structures to be coated and mainly with buried and submerged steel pipes.

5.1 Types of Pipes to be Coated

The types of pipe to which this Standard is applicable, include both welded and seamless pipes of non-alloy steel used for the conveyance of gas and fluids.

5.2 Types of Fittings to be Coated

The types of fittings to which this Standard is applicable are mainly Bends, Tees Reducers and Collars.

5.3 Valves and Insulating Joints

The standard is applicable to all buried valves and insulating joints.
5.4 Storage Tanks

Any storage tank which shall be externally coated and to be buried underground or submerged in water. In all cases the storage tank shall considered as a pipe which is closed at both ends, requiring external protective coating at overall surfaces.

6. PURPOSE OF COATING

Coatings prevent corrosion of buried and submerged structures ways, as follows:

a) They inhibit corrosion by providing an adhesive film with a high resistance to ionic transport.

b) They reduce the current requirements for cathodic protection by providing an electrically insulating film.

c) They assist in the uniform distribution of cathodic protection current.

Although high costs are involved with the initial coating procedure, the application of coatings will lead to a considerable reduction in cathodic protection power consumption.

Coatings are considered to be an integral part of any cathodic protection system. In most situations, coatings provide the main thrust of any corrosion protection system, with cathodic protection providing back-up corrosion protection of the structure at points where failure of the coating, or damage to the coating, has occurred.

Note:
In compact structures, many combinations of coating systems are used. In-situ repairability should be a significant factor in the selection of the coating system.

7. COATINGS AND CATHODIC PROTECTION

(See also IPS-E-TP-820)
7.1 Influence of Coatings on Cathodic Protection Current Requirements

Although it is technically possible to protect bare (buried or immersed) steel structures and pipelines by applying cathodic protection only, it is seldom desirable to do so because of the cost of providing the large current required and, often the difficulty of arranging anodes so as to give, a uniform current distribution. A good coating of high insulating value greatly reduces the current required to maintain the steel at the required steel-to-soil potential and also provides a more uniform spread of current from the anodes. A protective coating should therefore always be applied to any buried and immersed structure or pipeline which is to be cathodically protected.

7.2 Influence of Cathodic Protection on Coatings

7.2.1 The current required to protect a structure or pipeline is approximately proportional to the area of bare steel (see Table 1). Theoretically, therefore, cathodic protection should be unnecessary when the steelwork is perfectly coated. In practice, coatings are often damaged in transport or during laying, or may contain imperfections such as pinholes. Even in low-corrosivity soils the slightest discontinuity in the protective coating may result in severe local corrosion, so that when corrosive conditions exist even coated structures or pipelines shall be given cathodic protection.

7.2.2 Pipeline coatings of bitumen, coal tar type are never much affected by properly applied cathodic protection. However, a potential more negative than -2.0 V with reference to a copper/copper sulphate electrode may damage the coating by causing hydrogen evolution on the steel surface.

7.2.3 Cathodic protection of painted or metal sprayed and painted structures should be considered carefully because oil-based paints may be saponified by the alkalinity developing at the cathodically protected surface; sprayed aluminum or zinc may be attacked in a similar way. The surface potential shall therefore be maintained as closely as possible to the value needed for protection, and over-protection avoided.

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1-7 تأثیر پوشش‌ها بر شدت جریان مورد نیاز حفاظت

کاندی

از نظر فنی سازه‌های فولادی بدون پوشش (مدفون یا غوطه‌ور) در آب و حالت مورد شدت یک‌واکنش می‌توان در اینجا فاکتور حفاظت کاندی شد. اما با دلیل صده‌ها تأمین شد جریان یک‌واکنش مورد نیاز مشابه آبی‌های این مسئله مورد نیاز نیست. گی‌که پوشش خوب باعث منافع بانک کاهش مقدار زیادی از شدت جریان مورد نیاز یا گام‌سازی لازم در نطفه تمس فولاد با خاک و همچنین همچنین توزیع بکنوهای جریان از آن‌ها به حفظ فولاد می‌باشد. این موضوع با هم‌هشیار در مورد فولاد مصرفی و غوطه‌ور با خط لوله که با حفاظت کاندی شود، رعایت گردد.

۲-7 تأثیر حفاظت کاندی بر پوشش‌ها

2-7-1 حفاظت‌های لازم برای حفاظت یک سازه با خط لوله تقریباً مناسب با سطح فولاد بدون پوشش آن می‌باشد. (جدول شماره ۱) از نظر نظری استفاده از حفاظت کاندی برای سازه‌های فلزی که کاملاً پوشش شده‌اند ضروری نیست. با این حال، پوشش‌ها بیشتر از این جایگاه یا ای کارگاهی صده ویده به دلیل استفاده یا سایر شرایط در هیجان سازه‌ها و رز باشند. حتی در شرایطی که خریدگی‌های کم یا کوچک‌ترین یا شکستگی یا فاش شدن ممکن است باعث خریدگی شدید موضعی گردد، به همین منظور در شرایطی که خریدگی وجود دارد، حتی سازه‌ها و خطوط لوله پوشش شده باید حفاظت کاندی شوند.

2-7-2 پوشش‌های خاک لوله با قبر و قطرات هرگز به اندازه به کارگیری سیاه حفاظت کاندی می‌باشد. پنشال موفقیت آن ۱۲۰-۲۰۰ ولت در برابر است که ممکن است با ایجاد هیدروژن در سطح فلز به تدریج باعث تخریب پوشش شود.

2-7-3 حفاظت کاندی سازه‌های رنگ شده و یا دارای پوشش جایی به روش باشند به دلیل وجود رنگ‌های با پایه رنگی به دقت بررسی شوند. زیرا موارد فلزی باعث صادی شدن سطح حفاظت کاندی می‌شود. پاش آلومنیوم با روی هم ممکن است به شکل مشابه مرد حمله قرار گیرد. بنابراین سطح پنشال باید به شکلی در حد امکان نزدیک به مقدار مورد نیاز به‌طور کامل تأمین کرده و نیاز به حفاظت بیشتر نباشد.
7.2.4 Recommended 'off' - potential limits for underground coatings (to Cu/CuSO₄ half-cell) are:

<table>
<thead>
<tr>
<th>Type of Coatings</th>
<th>Recommended Off-Potential Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fusion-bonded Epoxy</td>
<td>-1.1 V</td>
</tr>
<tr>
<td>Hot applied enamel (coal tar, bitumen and modified bitumen enamel)</td>
<td>-2.0 V</td>
</tr>
<tr>
<td>3 Ply cold applied plastic tape</td>
<td>-1.1 V</td>
</tr>
<tr>
<td>Polyethylene (2 layers)</td>
<td>-1.0 V</td>
</tr>
<tr>
<td>Polyethylene (3 layers)</td>
<td>-1.1 V</td>
</tr>
<tr>
<td>Polypropylene (3 layers) pp</td>
<td>-1.1 V</td>
</tr>
<tr>
<td>Polyurethane pu</td>
<td>-1.1 V</td>
</tr>
<tr>
<td>Cold and hot applied petrolatum and petroleum wax tape</td>
<td>-1.1 V</td>
</tr>
</tbody>
</table>

8. COATING DESIGN

8.1 Desirable Characteristics of a Coating

8.1.1 Effective electrical insulator

Since soil and salt corrosion is an electrochemical process, a pipe coating has to stop the current by isolating the structure from the environment.

8.1.2 Ease of application

The coating material must be suitable and properly applied to be effective. Many excellent pipe coatings require exacting application procedures that are difficult to maintain. Consistent quality may be obtained with a coating system that is least affected by variables. Coating application specifications and good construction practice combined with proper inspection contribute to the quality of the finished coating system.

8.1.3 Applicable to piping with a minimum of coating defects

This characteristic correlates with ease of application. No coating is perfect, and that is why cathodic protection is required.
8.1.4 Adhesion to metal surface

Coating adhesion is important to eliminate water migration between the metal substrate and the pipe coating. The coating adhesion assures permanence and ability to withstand handling during installation without losing effectiveness.

8.1.5 Resist development of holidays

Once the coating is buried, two areas that may destroy or degrade coatings are soil stress and environmental contaminants. Soil stress, brought about in certain soils that are alternately wet and dry, creates tremendous forces that may split or cause thin areas. Adhesion, cohesion, and tensile strength are important properties to evaluate in order to minimize this problem. The coating’s resistance to chemicals, hydrocarbons, and acidic or alkaline conditions has to be known in order to evaluate performance in known contaminated soils and etc.

8.1.6 Handling, storage and installation

The ability of a coating to withstand damage is a function of its impact, abrasion, and ductile properties. Pipe coatings are subjected to a great deal of handling from application to backfill. While precautionary measures of proper handling, shipping, and stockpiling are recommended, coatings vary in their ability to resist damage. Outside storage requires resistance to ultraviolet rays and temperature changes. These properties must be evaluated to assure proper performance.

8.1.7 Constant electrical resistivity

Since corrosion is an electrochemical reaction, a coating with a high electrical resistance over the life of the system is important. The percentage of initial resistance drop is not as indicative of the pipe coating quality as the overall level of electrical resistivity.

8.1.8 Resistant to disbonding

Since most pipelines are eventually cathodically protected, it is necessary for the coating to withstand cathodic disbondment. The amount of
cathodic protection is directly proportional to the quality and integrity of the coating. Considering interference and stray current problems, this becomes a most important requirement. Cathodic protection does two things.

First, it drives water through a coating that would ordinarily resist penetration. It also may produce hydrogen at the metal surface where current reaches it, and the hydrogen breaks the bond between the coating and metal surface. No coating is completely resistant to damage by cathodic protection, but it is very important to choose a coating that minimizes these effects. The ASTM G8 test for cathodic disbonding of pipeline coatings, commonly known as the salt crack test, measured a coating’s resistance to damage by cathodic protection.

8.1.9 Ease of repair

Recognizing that some damage may occur and that the weld area must be field coated, compatible field materials are required to make repairs and complete the coating after welding. Manufacturers’ recommendations should be followed. Variables in conditions influence selection of materials.

All nine of these characteristics are important when evaluating the selection of a pipe coating. The following factors should also be considered when selecting a pipe coating:

8.1.10 Type of soil or backfill

Soil conditions and backfill influence the coating system selected and thickness specified. Soils are rated by their shrink-swell factor (soil stress). High shrink-swell soils can damage conventional coatings.

Ideally, trenches should be free of projections and rocks, permitting the coating to bear on a smooth surface. When backfilling, rocks and debris should not strike the pipe coating. The following ASTM tests are recommended to measure resistance to penetration of the pipe coating if set on stones in the trench: ASTM D 785, "Method of Test for Rockwell Hardness of Plastics and Electrical Insulating Materials", ASTM D 5, "Method of
The following ASTM tests are recommended to measure the resistance against damage by rock in back fill: ASTM G 13, "Limestone Drop Test" and ASTM G 19, "Test Method for Disbonding Characteristics of Pipe Line Coatings By Direct Soil Burial". Soil stresses on pipe coatings may be evaluated by ASTM D 427, "Method of Test for Shrinkage Factors of Soils".

8.1.11 Accessibility of pipeline

When a pipeline is inaccessible or in a marine environment, the best system should be selected with less emphasis on initial cost. Experience under similar conditions for at least five years or well-designed laboratory tests on new products are the best criteria for coating selection.

8.1.12 Operating temperature of piping

Surface temperature and environmental conditions must be considered, because, once buried, a coating experiences a wet heat condition, which is more detrimental than dry heat and harms coating effectiveness. A modified disbondment test, ASTM G 8 Cathodic Disbonding of Pipeline Coatings, determines resistance to elevated temperatures.

8.1.13 Ambient temperatures during construction and installation

Temperatures during construction and installation are often more critical than operating temperatures.

For instance, some thermoplastic systems such as mastics, tapes, or enamels may become brittle in freezing temperatures (Polyethylene coating systems, however, have been field bent at -40°C). Above recommended operating temperatures, thermoplastic systems may cold flow. Extra care in handling, transport and storage is needed under extreme conditions.
8.1.14 Geographical and physical location

Pipe source and coating plant location often determine the coating or are a cost factor in selection. Severe environments, such as river crossings, pipe inside casings, exceptionally corrosive soils, high soil stress areas and rocky conditions require special consideration. On large projects in remote areas, the economics may favor a railhead or field coating site.

8.1.15 Handling and storage of coated pipe

Handling, shipping and stockpiling are important in the selection process. Some coatings require special handling and padding. All require careful handling. Most underground coatings are not designed for above ground use and are affected by excessive above-ground storage. Coal tar and asphalt enamel and mastic coatings are protected from ultraviolet deterioration by whitewash (see 11.1.2.5.1) or craft paper. In polyethylene, the addition of 2.5 percent carbon black is the most satisfactory deterrent. Stock should be rotated, first-in, first-out, to minimize the potential problem. Long-term storage requirements could determine coating selection.

8.1.16 Costs

Evaluation of pipe coating properties with the above considerations assists in selection. The most misunderstood factor is "costs". In pipe coating economics the end has to justify the means. The added cost of coatings and cathodic protection has to pay for itself through reduced operating costs and longer life. "True" protection costs include not only initial costs of coating and cathodic protection but also installation, joint coatings and repairs. Field engineering and facilities to correct possible damage to other underground facilities may add costs, possibly outweighing initial costs of the pipe coating.

8.1.17 Current density requirements

8.1.17.1 The current density required to protect a buried structure is depend on the type and performance of the coating used. Table 1 gives a minimum design value for new construction projects. The current density values in Table 1 are
to be related to the total pipeline surface area and take into account coating deterioration during the refereed life of the pipeline.

It is assumed that pipeline construction is carried out in a manner to avoid coating damage during construction and operation.

1 مرور به جمع کل مساحت سطح خطوط لوله و در نظر گرفتن تخلیه پوشش در طول عمر پیش بینی شده برای خط لوله است. فرض بر این است که احداث خط لوله در شرایطی انجام شده که در زمان نصب و بهره‌برداری به پوشش صدمه وارد نشده است.

Table 1 - Design current densities for different pipeline coatings

<table>
<thead>
<tr>
<th>Coating Type</th>
<th>Pipeline Life (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 – 5</td>
</tr>
<tr>
<td>Current Density (mA/m²)</td>
<td></td>
</tr>
<tr>
<td>Asphalt bitumen, coal tar, 6 mm</td>
<td>0/200</td>
</tr>
<tr>
<td>Asphalt mastic and Modified</td>
<td>0/200</td>
</tr>
<tr>
<td>Bitumen Enamel</td>
<td></td>
</tr>
<tr>
<td>Fusion bonded epoxy</td>
<td>0/200</td>
</tr>
<tr>
<td>Liquid epoxy</td>
<td>0/200</td>
</tr>
<tr>
<td>Polyurethane</td>
<td>0/5/0</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>0/5/0</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>0/5/0</td>
</tr>
<tr>
<td>3 ply cold applied Plastic tape</td>
<td>0/5/0</td>
</tr>
</tbody>
</table>

Note:
The current densities given in Table 1 already include the current requirements due to the expected coating breakdown during the pipeline life.

8.1.17.2 For protection of pipelines with elevated operating temperatures the minimum design current densities given in Table 1 shall be increased by 25% per 10°C rise in temperature above 30°C.

8.2 General Requirements

8.2.1 Table 2 gives some typical properties of known coating systems.
<table>
<thead>
<tr>
<th>COATING SYSTEM*</th>
<th>COATING SITE</th>
<th>EASE OF ON-SITE APPLICATION</th>
<th>STRUCTURE PRETREATMENT (FOR STEEL)</th>
<th>COATING THICKNESS</th>
<th>SUSCEPTIBILITY TO DAMAGE FROM</th>
<th>IMPACT ATR PROBLEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal tar Enamel</td>
<td>Field (over-the-ditch) yard</td>
<td>Difficult</td>
<td>Wire brush or blast&lt;br&gt;yers</td>
<td>3 to 6</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Extruded Polyethylene/ polypropylene</td>
<td>Shop/factory کارگاه</td>
<td>---</td>
<td>Blast&lt;br&gt;روس بلاست</td>
<td>**</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Fusion Bonded polyethylene</td>
<td>Shop کارگاه</td>
<td>---</td>
<td>Blast&lt;br&gt;روس بلاست</td>
<td>2.5 to 3.5</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Fusion bonded Epoxy</td>
<td>Shop کارگاه</td>
<td>Difficult</td>
<td>Blast&lt;br&gt;روس بلاست</td>
<td>0.5 to 0.76</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Asphalt Enamel</td>
<td>Field and shop &lt;br&gt;منطقه و محوطه</td>
<td>Difficult</td>
<td>Wire brush or blast&lt;br&gt;روس سیمی یا&lt;br&gt;روس بلاست</td>
<td>3 to 6</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Modified Bitumen Enamel</td>
<td>Shop کارگاه</td>
<td>Difficult</td>
<td>Blast&lt;br&gt;روس بلاست</td>
<td>4</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>PVC, polyethylene Backed laminated tape</td>
<td>Field &lt;br&gt;منطقه</td>
<td>Easy</td>
<td>Wire brush or blast&lt;br&gt;روس سیمی یا&lt;br&gt;روس بلاست</td>
<td>1.5 to 3.0</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Petrolatum or wax Tapes</td>
<td>Field and shop &lt;br&gt;منطقه و کارگاه</td>
<td>Easy highly Comfortable</td>
<td>Wire brush&lt;br&gt;روس سیمی</td>
<td>3 to 6</td>
<td>High</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>
Table 2 (continued)

<table>
<thead>
<tr>
<th>COATING SYSTEM*</th>
<th>COATING SITE</th>
<th>EASE OF ON-SITE APPLICATION</th>
<th>STRUCTURE PRETREATMENT (FOR STEEL)</th>
<th>COATING THICKNESS</th>
<th>SUSCEPTIBILITY TO DAMAGE FROM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SOIL STRESSES</td>
</tr>
<tr>
<td>3 Ply Cold Applied Plastic Tape</td>
<td>Field</td>
<td>Easy</td>
<td>Wire</td>
<td>Layered</td>
<td>Low</td>
</tr>
<tr>
<td>Heat Shrink Sleeves</td>
<td>Field and shop</td>
<td>Medium</td>
<td>Blast</td>
<td>Low to Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Polyurethane</td>
<td>Field and shop</td>
<td>Difficult</td>
<td>Blast</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Coal Tar Epoxy</td>
<td>Field and Yard</td>
<td>Medium</td>
<td>Blast</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

* Metalliferous primers should not be used in coating systems for structures requiring cathodic protection.

** Properties resulting from soils which produce stresses, e.g. clay.

γ It is good practice to blast clean surfaces prior to coating application to ensure maximum adhesion. Wire brush pretreatment, which may leave mill scale on a steel surface, may leave the structure in a condition susceptible to stress-corrosion cracking, and is inferior to blast-cleaned surfaces.

§ Used on site welded joints. Difficult to repair.

** (see table 7)

Note:
The properties tabulated above relate only to the basic standard coating for each system. Coating performance can vary substantially from these values, and is dependent on the characteristics of the actual system used.
9. COATING SCHEDULE

9.1 Type of Coatings

With reference to previous considerations only the following types of coatings have been selected for the purpose of this engineering standard. Among which the desired coating system(s) shall be selected in accordance with the following sections for a particular underground and/or submerged structures including offshore risers and piling systems.

9.1.1 Bituminous coatings (see 11.1)

Bituminous coatings include of coal tar and bitumen (asphalt) enamels which are applied in the molten state. These coatings are applied in field or in site.

9.1.2 Three layer polyethylene and polypropylene coatings (see 11.2)

The coating system shall consist of three layers:

1st layer  fusion bonded epoxy primer.
2nd layer adhesive (powder sprayed or extruded)
3rd Layer PE/PP top layer (applied by extrusion)

9.1.3 Fusion bonded epoxy powder coatings (see 11.3)

Fusion bonded epoxy coatings are applied to preheated pipe surfaces of 220 to 260°C with or without primers. These coating shall be applied in factory.

9.1.4 Plastic tape (see 11.4)

Prefabricated, cold applied plastic tapes are normally applied as a three-layer system consisting of liquid adhesive primer, corrosion preventive tape (inner layer), and a mechanical protective tape (outer layer). These coating are generally applied in field.

9.1.5 Polyurethane coatings

Polyurethane coatings shall be applied according to the coating manufacturer’s instruction to the required thickness (See BS-EN-10290 AWWA C222 Standard).

9.2-1 Jodol Poushesh
9.2-2 Poushesh ha

پوشه‌های در ابعاد و تعداد زیر در این استاندارد مهندسی انتخاب شده‌اند. در این میان سامان‌های پوشه مورد نظر باید بر مبنای شرایط زیر به ویژه برای سازه‌های واقع در زیرزمینی یا غوطه ور در آپ شام بلایی مانند (risers) دریایی و پایه سکوها انتخاب شود.
9.1.6 Petrolatum or wax coating tape (See NACE RP 0375)

These coatings covers hot- and cold applied – tapes systems. Traveling machine and hand applied are suggested for hot –applied coating system while cold– applied shall be made by hand or brush with an additional buildup of coating. The tape coating shall be applied after the primer has been applied.

Any reference to wax tape and wax primer in NACE standard also applies to petrolatum tape and petrolatum primer.

9.1.7 Concrete coating (see 11.5)

Cement mortar coatings are usually used for cast-iron pipes and for shielded areas where cathodic protection can not be used effectively. It is relatively expensive but results in a strong, long-lived coating for specialty applications. Concrete coating are used as negative buoyancy and armor protection over ordinary coatings in marine environments. For field joint coating (see 9.4.4).

9.2 Characteristics of Specified Coatings

Followings are the main characteristics of desired coatings special characteristics of these coatings are described in each individual section.

The conventional coating to be used on a line pipe shall be determined regarding the following coating properties.

9.2.1 Bituminous enamel (asphalt and coal tar)

a) Chemically inert.

b) Highly moisture resistant for coal tar but less for bitumen.

c) Very good electrical resistivity.

d) Brittle at low temperatures; sags at high temperatures.

e) Both yard and over the ditch coating possible.

f) Dangerous fumes result from necessary high application temperatures of coal tar.

g) Service temperature range from -10 to 70°C depending on type (see 11.1.4.2).

NACE RP (0375) مراجعة شود

9.1.17 نوشت ژله نفتی (به مومی (به)

ان بیوان ژله نفتی شامل سامانه‌های سرد و گرم اجزاء

می‌باشد. برای اجراهای سامانه‌پوش ژله گرم روش‌های مانند و

دستی پیشنهاد می‌گردد. در حالت که برای پوشش سرد باید از

روش دستی یا بر اساس ایستاده شدن نوع پوششی

یا پوششی. با خاک در نظر گرفته شود.

هر مرجع مربوط به نوشت و ژلی مومی در استندارد

برای اعمال نوار و آستری پتروپلن نیز به کار می‌رود. NACE

9.1.6 ژله نفتی (به مومی (به 7-9)

پوشش بتنی (به بند 11-5 مراجعة شود)

پوشش ماسیف سیمان پوششی برای لوله‌های جدید و مناطقی که

موقول در راه رسیدن خصاص کاندی موثر وجود دارد به کار

گرفته می‌شود. این پوشش سبب گرما است یا قدرت یافته با

عمر زیاد بوده و برای کارهای ویژه کاربرد دارد. پوشش بتنی به

عنوان عدم شناسایی و زره حفاظی و و می‌باشد. ژلی مومی در

می‌باشد. در نظر گرفته شود. این ژله نفتی با برای

10-9 مشخصات پوشش‌های ژلانه شده

در زیر مشخصات اصلی پوشش‌های مورد نظر و مشخصات ویژه

پوشش‌ها به طور جدایی نیز شده است.

برای استفاده از یک پوشش می‌توان بر روی لوله به خواص

پوششی که در زیر اشاره شده باید توجه کرد:

9.2.1 نوشت لعاب قیفی (آسفالت و قطران)

اکنون پوشش در بالای کانال در محوطه

و بخار خطرات حاصل از دمای بالای اعمال قطران

دماه‌های بیش از 110 تا 120 درجه سانتی‌گراد بسته به

نوع آن دارد (به بند 11-15 1/2 مراجعه شود)

 registro_1387 اسفندرک 1387/2009 IPS-E-TP-270(1)
9.2.2 Three layer polyethylene and polypropylene coatings

- a) Good chemical resistance.
- b) Low water absorption.
- c) Extremely good electrical resistivity.
- d) Flexible.
- e) Shope and factory application only.
- f) Service temperature range in accordance with Table 6.

9.2.3 Three layer cold applied fusion bonded epoxy

- a) Extremely good chemical resistance.
- b) Polyamide-catalyzed epoxies have better water resistance than amide or amine-adduct cured epoxy.
- c) Extremely good electrical resistivity.
- d) Flexible.
- e) Plant application only.
- f) low impact and abrasion strength.
- g) Excellent adhesion to steel.
- h) Electrical deposition method of application. Only sure prevention of pinholes and voids in coating.
- i) Service temperature range from -70 to 120°C.

9.2.4 Three layer cold applied plastic tape

- a) Good chemical resistance.
- b) Good electrical resistivity.
- c) Both yard and over the ditch application possible.
- d) Low impact and abrasion strength.
- e) Subject to pressure deformation from rocky backfill, and damage during transportation from plant to field.
- f) Poor resistance to aromatic hydrocarbons.
- g) Service temperature range from -20 to 60°C depending on type.
Note:

3 Ply cold applied plastic tape (See AWWA C-214) and field joints shall be coated with products as described in AWWA C 203,209 and 216.

9.2.5 Polyurethane coatings (see AWWA-C 222)

a) Abrasion resistance. (ANSI/ASTM D4060)

b) Cut and tear resistance. (ASTMD-624)

c) Excellent elongation and rebound (ISO 37)

d) Chemical resistance and high tensile strength (ANSI/ASTM D5430)

e) Impact resistance (ANSI/ASTM D2794)

f) Low friction (ISO 8295)

g) Excellent adhesion to steel surfaces, fusion bonded epoxy, fiber reinforced plastic and concrete. (ANSI / ASTM D4541).

h) Excellent cathodic disbondment resistant at temperature up to 65°C. (ANSI / ASTM G95).

9.2.6 Petrolatum or wax coatings (see NACE standard RP 0375)

9.2.6.1 Microcrystalline wax shall be as follows

a) Inert, flexible, waterproof and adhesive.

b) Capable of being blended with suitable wetting agents and rust inhibitors.

c) Heated in a clean kettle.

Note:

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9.2.6.1 Microcrystalline wax shall be as follows

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b) Capable of being blended with suitable wetting agents and rust inhibitors.

c) Heated in a clean kettle.
9.2.6.2 Component wrappers shall be as follows

a) Plastic film (Supported or unsupported) that is compatible with the microcrystalline wax coating.

b) Wax over fittings and valves and have the ability to conform to the contours of the surface.

c) Normally applied using a spiral wrap.

9.3 Factors Affecting the Design of Pipeline Coating

Main factors influencing the design of pipeline coatings are as follows:

9.3.1 Diameter and length of pipe

9.3.2 Service temperature of the pipe internal media.

9.3.3 Pressure and frequency of expansions and contractions.

9.3.4 Soil resistivity, soil analysis and soil stress potential.

9.3.5 Statistical condition of pipeline route and right of way.

9.3.6 Availability of materials and cost.

9.3.7 Limitation of access to work.

9.3.8 Repair access and frequency of prospected repair.

9.3.9 Condition of manpower requirement at site.

9.3.10 Transport and handling of the pipe sections.

9.3.11 Availability of electricity beside the pipeline for permanent impressed current-cathodic protection installation.

9.3.12 Provision of access equipment.

9.3.13 Special safety and security regulation which limit the coating design.

9.3.14 Protection condition of adjacent pipeline.
9.4 Selection of Coating to be Used

9.4.1 The coating selected for a specific application ideally shall be that coating which will still have the lowest applied cost per meter of pipe and have the desirable characteristics of good electrical and mechanical strength and long term stability under the environmental conditions and cathodic protection. In order to select optimum coating system following factors shall be considered.

9.4.1.1 Function

a) What is the main function of the structure?

b) What are the second functions of the structure?

9.4.1.2 Life

a) For how long is it required to fulfill this function?

b) What is the life to first maintenance? (It may not be possible to decide these until further questions have been answered?)

9.4.1.3 Environments

a) What is the general environment at the site of the structure?

b) What localized effects exist or are to be expected?

c) Is the structure buried or immersed?

d) Is the structure immersed in sea water or buried in sea bed?

e) Is sulfate reducing bacteria present?

f) Is other type of bacteria present?

g) Is existing soil stress probable?

h) What other factors may affect the structure (e.g. surface temperature and abrasion, service temperature and fluctuation, service pressure and fluctuation)?

9.4.1.4 Special properties

What special properties are required of the coating (e.g. coefficient of friction)?
9.4.1.5 Health and safety

a) Are any problems to be taken into account during initial treatment?

b) Are any problems to be taken into account during maintenance treatment?

9.4.1.6 Tolerance

Does the coating need to be tolerant of?

a) Indifferent surface preparation.

b) Departures from specification.

c) Indifferent application techniques

d) Which facilities shall be required?

9.4.1.7 Coating systems

a) What coating systems are suitable?

b) Are these systems readily available?

c) Are the system elements mutually compatible?

d) Which facilities shall be required?

9.4.1.8 Coating facilities

a) Are the coating facilities readily available?

- for factory application?

- for site application?

- for field application?

b) Do they cover all sizes and shapes of fabrication?

c) Do they permit speedy application?

d) Do the facilities permit work to adequate standards?

9.4.1.9 Compatibility with engineering and metallurgical features

a) Is the design and jointing of the structure compatible with the preferred coating technique?

b) Does surface preparation (blasting) or application of coating affect the mechanical properties of the steel in any way that matters?

c) Is the system compatible with cathodic protection?

9.4.1.9 Compatibility with engineering and metallurgical features

a) Is the design and jointing of the structure compatible with the preferred coating technique?

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b) Does surface preparation (blasting) or application of coating affect the mechanical properties of the steel in any way that matters?

c) Is the system compatible with cathodic protection?
9.4.1.10 Delays
What delays should be allowed between?
   a) Fabrication and first protective coating;
   b) Application of primer and coating;
   c) Application of coating and installation;
   d) Final coating and repair.

9.4.1.11 Transport, storage and handling
How well does the coating withstand?
   a) Excessive or careless handling;
   b) Abrasion and impact;
   c) Early stacking;
   d) Exposure to sea water during transit;
   e) Exposure to sunlight.

9.4.1.12 Experience
   a) What is known of the consistent performance of the coating?

9.4.1.13 Export/Import
   a) What special precautions should be taken when the steelwork is exported or imported?

9.4.1.14 Maintenance
   a) Is the deterioration of the coating rapid and serious if maintenance is delayed?
   b) What access is there going to be for effective maintenance?
   c) What is the possibility of effective maintenance?

9.4.1.15 Costs
   a) What are the approximate costs of?
      1) The basic system;
      2) Any additional items;
      3) Transport;
      4) Access.
   b) What are the approximate costs of maintenance?
9.4.1.16 Cathodic protection

a) Is there specific need for restricting cathodic protection current to absolute minimum? For example, locations where cathodic protection current sources can be installed may be limited and widely spaced necessitating the best practicable current distribution.

b) Is the electricity available beside the structure for impressed current cathodic protection systems to be installed?

c) Is there any restrictions for impressed current systems (e.g. lack of electricity, location, etc.)?

d) Is there any restrictions regarding soil resistivity availability of galvanic anodes, etc.?

9.4.1.17 Access

Will all or part of the structure be installed where not readily accessible (such as river crossings, swampland installations, submarine locations and other similar situations)?

9.4.2 Each coating system considered shall be evaluated carefully in terms of the preceding items. All application and performance characteristics of each coating must be determined, particularly with respect to limitations beyond which good performance cannot be expected.

A relatively simple coating system may be fully adequate if, for instance, a pipeline is to be installed in a rock-free soil not subject to soil stress; if application and installation conditions are to be reasonably dry and not subject to extremes of temperature; if pipeline operating temperature is not to be appreciably above soil temperature; and if pipeline accessibility is reasonable with no unusual limitations on cathodic protection installations. Typically, a single layer standard pipeline enamel with felt wrapper or pipeline plastic tapes could do an excellent job.

On the other hand, a coating as mentioned above might not be satisfactory under adverse conditions. Under rocky conditions, a coating system that will resist impact damage and penetration by steady pressure should be specified. If soil stress is a problem, materials that will resist distortion and "plucking-off" under such conditions should be used. If ambient temperatures are extreme, materials that will not become embrittle and crack
at low temperature should be used. If high temperatures are the problem, a material should be selected that will not soften and be easily damaged during handling. If the pipeline, once installed, will be essentially inaccessible for maintenance work, the best coating available may be essential.

The choice between the use of yard coated pipe and over-the-ditch coating procedures is largely economic. Factors involved include location of the coating plant with respect to the pipeline right-of-way (which will influence shipping costs and whether the pipeline project is large enough to justify the cost of using over-the-ditch coating equipment. The cost of over-the-ditch coating can vary considerably with the type of coating being used as some materials require more equipment and larger crews than others. With some coating materials, establishment of centrally-located "railhead" field coating plants may be justified on large Projects. In any event, the choice is best based on a cost analysis for the particular type of project being planned.

9.4.3 Coating selection criteria

In summing up this subject the following criteria shall be used in selecting the coating system as a minimum:

9.4.3.1 Resistance to deterioration when exposed to corrosive media.

9.4.3.2 High dielectric resistance.

9.4.3.3 Resistance to moisture transfer and penetration.

9.4.3.4 Applicable with a minimum of defects.

9.4.3.5 Resistant to bacteria, microbial growth and vegetable roots.

9.4.3.6 Good adhesion to metallic surfaces.

9.4.3.7 Resistance to mechanical damage during handling, storage, and installation.

9.4.3.8 Resistance to cathodic disbonding.

9.4.3.9 Ease of repair.

9.4.3.10 Retention of physical properties with time.
9.4.3.11 Conditions during shipping, storage construction, and installation.

9.4.3.12 State of the art in the application of coatings.

9.4.3.13 The level of inspection and quality control during coating application.

9.4.3.14 Cost and availability.

9.4.3.15 Service-proven experience.

9.4.3.16 Low water-absorption.

9.4.3.17 Compatibility with the type of cathodic protection to be applied to the system in case of submarine pipes.

9.4.3.18 Compatibility with the system operating temperature.

9.4.3.19 Sufficient ductility to minimize detrimental cracking.

9.4.3.20 Resistance to future deterioration in submerged environment.

9.4.4 Field joint coatings

9.4.4.1 Coated pipe sections connected by welding and/or mechanical coupling by means of valves or other underground appurtenances will be considered field joints. Coating of field joints must be equal to or better than the coating on the pipeline and shall be compatible with main coating.

9.4.4.2 Where materials requiring primer are used, the primer may be hand applied in a uniform coat. Curing or drying time must be in accordance with manufacturer’s specification.

9.4.4.3 Coating materials must be applied substantially free of voids, wrinkles, and air or gas entrapment. This may require the use of materials that will conform to the shape or irregular appurtenances, such as valves. Petrolatum tape coating (IPS-M-TP-317) shall be used for irregular shapes such as bare valves and fittings when applicable.

9.4.4.4 A new coating must overlap and adhere to existing material. The overlap must be sufficient to allow for shrinkage of both new and existing coating (e.g. 10 cm on each side).
9.4.4.5 When hand applied tape (IPS-M-TP-314 or IPS-M-TP-313 as with which is compatible) is selected for field joints it shall be used with 50 percent overlap on its own.

9.4.4.6 Field joints coating systems selected shall be suitable for field application. It shall be fast and easily applicable and shall not require special attention for application and field storage.

9.4.4.7 Types of field joint coatings

With yard-applied coatings, the coating of many field joints has to be carefully selected and applied with sufficient overlap to ensure that the whole length of the pipeline is correctly protected. For the protection of the joint a variety of suitable joint coverings is available. The recommend systems are as in Table 3.

9.4.4.8 Below ground unburied valves shall be coated with asphalt mastic (IPS-M-TP-105) to a minimum thickness of 3.5 mm.
TABLE 3 - LIST OF PREFERRED MATERIALS FOR COATING WELDED JOINTS

<table>
<thead>
<tr>
<th>TYPE</th>
<th>POSSIBLE COMBINATIONS OF DIFFERENT TYPES OF COATING EACH SIDE OF WELD</th>
<th>CHOICE OF COATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Fusion bonded epoxy</td>
<td>Fusion bonded epoxy</td>
</tr>
<tr>
<td></td>
<td>(1st choice for types F and H)</td>
<td>(2nd choice for types F and H)</td>
</tr>
<tr>
<td>B</td>
<td>Two component liquid epoxy (if any)</td>
<td>Two component liquid epoxy</td>
</tr>
<tr>
<td>C</td>
<td>Fusion bonded epoxy</td>
<td>Two component liquid epoxy</td>
</tr>
<tr>
<td></td>
<td>(if any)</td>
<td>(1st choice for types F and H)</td>
</tr>
<tr>
<td></td>
<td>(2nd choice for types F and H)</td>
<td>(2nd choice for types F and H)</td>
</tr>
<tr>
<td>D</td>
<td>Coal tar or bitumen enamel</td>
<td>Overlap sealed with hand applied laminated tape</td>
</tr>
<tr>
<td>E</td>
<td>Coal tar or bitumen enamel</td>
<td>Overlap sealed with hand applied laminated tape</td>
</tr>
<tr>
<td>F</td>
<td>Coal tar or bitumen enamel</td>
<td>Overlap sealed with hand applied laminated tape</td>
</tr>
<tr>
<td>G</td>
<td>Polyethylene plastic tape</td>
<td>Heat shrinkable tape</td>
</tr>
<tr>
<td></td>
<td>(1st choice for types F and H)</td>
<td>(1st choice for types F and H)</td>
</tr>
<tr>
<td>H</td>
<td>Polyethylene plastic tape</td>
<td>Heat shrinkable tape</td>
</tr>
<tr>
<td>I</td>
<td>Polyethylene plastic tape</td>
<td>Heat shrinkable tape</td>
</tr>
<tr>
<td>J</td>
<td>Polyethylene plastic tape</td>
<td>Heat shrinkable tape</td>
</tr>
<tr>
<td>K</td>
<td>Modified Bitumen Enamel</td>
<td>Polymer Modified Bitumen Membrane Tape</td>
</tr>
<tr>
<td>L</td>
<td>Petroleum Tape</td>
<td>Petroleum Tape</td>
</tr>
<tr>
<td>M</td>
<td>3 Ply Cold Applied plastic tape</td>
<td>3 Ply Cold Applied plastic tape</td>
</tr>
<tr>
<td>N</td>
<td>Polyurethane</td>
<td>Liquid Epoxy Coating</td>
</tr>
</tbody>
</table>

Note:

1) Bare or painted pipe or fittings shall be coated with hand applied tape (IPS-M-TP-313) before the relevant butt joint coating is applied.

毅阿豆:

1) لوه و انصالات رنگ شده و نشده رو پايد قبل از پوشش جوش به در با دست نوار پيچي کرد (IPS-M-TP-313)
2) When the butt weld to be coated is on a pipeline that will operate at less than 30% SMYS (specified minimum yield strength) and less than 20°C, the use of joint coatings other than those detailed in this Table may be considered.

3) Polyethylene is referred to both 2 and 3 layers polyethylene coatings.

4) The special heat shrinkable tape the multi component liquid epoxy primer shall be used. Materials specification shall be approved by company and the field application of materials shall be in accordance with manufacturer instructions.

10. COATING APPLICATION

10.1 The external coating shall be applied according to IPS-C-TP-274.

The procedure is normally to include:
- Handling and treatment of coating materials.
- Surface preparation.
- Temperatures, air humidity and time lags between steps in the coating process.
- Testing methods, with reference to IPS-C-TP-274.
- Acceptance criteria.
- Repair procedure following attachment of cathodic protection cables, pad eye, etc.
- Handling, transport of coated pipes.
- Quality control and inspection.
- Coating repair.
- Reporting procedure.
10.2 Status of Coating

The quality control reports shall include the followings:

- Acceptance criteria according to the coating specification.
- Surface preparation data.
- Temperature and humidity measurements.
- Number of coats and total dry film thickness.
- Adhesion data.
- Holiday detection.
- Information on the location of reinforcement in the coating.

A preproduction test is to be carried out at the coating yard in order to demonstrate that the coating can be adequately applied under the prevailing conditions.

10.3 Field Joint Coating

Field joint coating should be applied according to an approved procedure of similar nature as described in IPS-C-TP-274.

The field joint coating should be compatible with the pipe coating. (See 9.4.4.1).

10.4 Repair & Rejection

Criteria for acceptance, repair and rejection of coating before burial or submersion of pipe are to be stated. Repair methods for damaged coating under field conditions are described in IPS C-TP-274.

10.5 Surface Preparation

The steel surface to be coated shall, at the time of application of the coating, be dry and free from all contaminants (such as previous coatings, paint, loose dirt, grease, oil, salt, etc.) which could be harmful to the surface preparation or to the adhesion of the coating to the steel.

The surface of steel shall be prepared in accordance with IPS-C-TP-101. The prepared surface shall be Sa 2½ to ISO 8501/1 for all the coating systems specified in this Engineering Standard.

Note:

Surface preparation for coating of field joints and repair shall be in accordance with IPS-C-TP-274.
11. DESCRIPTION OF COATING SYSTEMS

11.1 Bituminous and Coal Tar Coatings

11.1.1 General

11.1.1.1 Enamels are formulated from coal tar pitches or petroleum asphalts hot applied (blown bitumen) and have been widely used as protective coatings for many years. Coal tar and asphalt enamels are available in various grades. These enamels are the corrosion coating, combined with glass wool to obtain mechanical strength for handling. These materials shall meet requirements of relevant IPS-M-TP-290 and 295 Enamel Coatings have been the workhorse coatings of the industry and provide efficient long life corrosion protection.

11.1.1.2 Bituminous coating systems may be used within a service temperature range of -10 to 70°C (see 11.1.1.8). When temperatures fall below 4°C, precautions should be taken to prevent cracking and disbonding during field installation. Enamels are affected by ultraviolet rays and should be protected by craft paper or whitewash (see 11.1.2.5.1). Enamels also are affected by hydrocarbons. A barrier coat is recommended when contamination exists. This coating can be used on all sizes of pipe.

11.1.1.3 Enamel coatings are low-cost coatings whose protective properties depend on film thickness.

11.1.1.4 Enamel coatings have good resistance to dilute acids and alkalis, salt solutions and water, but are not resistant to vegetable oils, hydrocarbons and other solvents. They may become brittle in cold weather and soften in hot weather. Enamelled coated articles shall not be stacked (see also Table 4).

11.1.1.5 Enamel coatings are not suitable for above ground structure and piping and shall only be used for underground and subsea structures and pipelines.

11.1.1.6 Enamels are formulated from coal tar or petroleum asphalts hot applied (blown bitumen) and have been widely used as protective coatings for many years. Coal tar and asphalt enamels are available in various grades. These enamels are the corrosion coating, combined with glass wool to obtain mechanical strength for handling. These materials shall meet requirements of relevant IPS-M-TP-290 and 295 Enamel Coatings have been the workhorse coatings of the industry and provide efficient long life corrosion protection.
11.1.1.6 The coatings may be applied in a coating yard or over-the-ditch as appropriate by the job. The designer shall specify the method of application. Coating at a yard is likely to produce the best results, assuming that proper control is exercised and that subsequent transport, handling and joint coating are carried out with care.

11.1.1.7 The cost of materials for hot-applied coatings is usually relatively low, whereas the cost of application is relatively high.

11.1.1.8 These coatings should in general not be used for buried pipelines and structures if the operating temperature is above 60°C, or above 70°C in case of subsea pipeline unless special enamel coating is specified (see 11.1.4).

11.1.1.9 Recently modified bitumen enamel used for buried pipes which is suitable for service temperature of -30 to +90°C. This specification is based on the EN 10300.

11.1.1.10 Enamel coatings are widely used for submarine pipelines alone or under the concrete weight coating. (enamel coating thickness shall be 6 mm minimum).

11.1.1.11 Bituminous enamel glass fiber reinforced coatings shall be used for coating line pipes and networks buried in normal soil, except when the soil is contaminated with hydrocarbons or other solvents (see Table 4), or when the temperature of the pipeline contents exceeds 50°C when the pipeline is buried in consolidated fill.

11.1.1.12 Recently, coal tar enamel use for buried pipes and structures has declined for the following reasons:

- Reduced suppliers.
- Environmental and health hazard regulations.
- Increased acceptance of other coatings such as extruded polyethylene and fusion bonded epoxy coatings.

11.1.2 Description of bituminous coating system

The bituminous coating system consists of:

- Bitumen enamels
- Glass fiber mesh
- Epoxy resins
- Polyethylene extrudable coatings
- Fusion bonded coatings
- Coatings of other types

11.1.1.13 The designer shall specify the method of application. Coating at a yard is likely to produce the best results, assuming that proper control is exercised and that subsequent transport, handling and joint coating are carried out with care.

11.1.1.14 The cost of materials for hot-applied coatings is usually relatively low, whereas the cost of application is relatively high.

11.1.1.15 These coatings should in general not be used for buried pipelines and structures if the operating temperature is above 60°C, or above 70°C in case of subsea pipeline unless special enamel coating is specified (see 11.1.4).

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11.1.1.18 Bituminous enamel glass fiber reinforced coatings shall be used for coating line pipes and networks buried in normal soil, except when the soil is contaminated with hydrocarbons or other solvents (see Table 4), or when the temperature of the pipeline contents exceeds 50°C when the pipeline is buried in consolidated fill.

11.1.1.19 Recently, coal tar enamel use for buried pipes and structures has declined for the following reasons:

- Reduced suppliers.
- Environmental and health hazard regulations.
- Increased acceptance of other coatings such as extruded polyethylene and fusion bonded epoxy coatings.
11.1.2.1 A cold applied primer coat which shall be selected in conjunction with the bitumen or coal tar derived coating material with which it shall be compatible. Coal tar primer (IPS-M-TP-280) or bitumen primer (IPS-M-TP-285) shall be used with coal tar enamel or bitumen enamel respectively and is only suitable for site or yard application. Fast-drying synthetic primer (IPS-M-TP-275) can be used both with coal tar and bitumen enamel and is suitable for site application as well as for field or ditch application. The primer shall apply at the thickness specified by the manufacturer with reference to relevant IPS standard for each primer.

11.1.2.2 One or more coats of bituminous coal tar enamel (IPS-M-TP-290) or bitumen enamel (IPS-M-TP-295) build up to form the thickness required for the type of protection. (see 11.1.2.7.2)*.

11.1.2.3 One or more reinforcements of glass fiber mat (IPS-M-TP-300) as inner wrap, embedded in each protective layer.

11.1.2.4 One protective layer of coal tar or bitumen saturated fiber glass mat (IPS-M-TP-305 or M-TP-306) with which it is compatible) as outer wrap.

11.1.2.5 One solar protective layer, in case of coal tar enamel, with following formula as white wash to prevent excessive heating of the coating by solar radiation:

11.1.2.5.1 White wash formula

All white wash to be used shall be mixed as follows:

- **Ingredients**

White wash ingredients shall include 190 liters water, 3.8 liters boiled linseed oil, 68 kg processed quicklime, and 4.5 kg salt.

- **Mixture**

Add salt to water, then add quicklime and linseed oil slowly and simultaneously, and mix thoroughly, allow mixture to stand for not less than three days before it is used.
11.1.2.6 In certain special cases (for example, nature of backfill, rocky area, environmental temperature or working temperature (about +50°C) an additional mechanical protections as rockshield (IPS-M-TP-316 or IPS-M-TP-315) under the concrete weight coating and concrete slabs or rockshield may be specified by the designer with reference to the job requirements.

11.1.2.7 Type of coating system

Two types of coating system are generally specified for Bituminous coating as follows:

* For each 4 mm enamel thickness only one layer of inner wrap shall be specified.

11.1.2.7.1 Single coat system consists of:
- One coat of primer.
- One coat of Bituminous enamel.
- One wrap of glass fiber inner wrap.
- One wrap of glass fiber outer wrap.

11.1.2.7.2 Double coat system consists of:
- One coat of primer.
- One coat of Bituminous enamel.
- One wrap of glass fiber inner wrap.
- One coat of Bituminous enamel.
- One wrap of glass fiber outer wrap.

11.1.2.8 Single coat system usually used for field (over-the-ditch) coating application and double coat system for yard application.

11.1.3 Characteristic of coal tar and bitumen enamels

11.1.3.1 Table 4 gives a comparison of Bitumen Enamel (Asphalt) characteristics with coal tar Enamel.
TABLE 4 - COMPARISON OF BITUMEN ENAMEL (ASPHALT) CHARACTERISTICS WITH COAL TAR ENAMEL

<table>
<thead>
<tr>
<th>Bitumen Enamel (Hot Applied)</th>
<th>Coal Tar Enamel (Hot Applied)</th>
<th>Use Of Resistant Coatings</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Lab Applied)</td>
<td>(Lab Applied)</td>
<td></td>
</tr>
<tr>
<td>(گرم اجرا)</td>
<td>(گرم اجرا)</td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>Poor</td>
<td>Temperature resistance</td>
</tr>
<tr>
<td>ضعیف</td>
<td>ضعیف</td>
<td>ممقاومت در برای حرارت</td>
</tr>
<tr>
<td>Fair</td>
<td>Fair</td>
<td>Abrasion resistance</td>
</tr>
<tr>
<td>نسبتاً خوب</td>
<td>نسبتاً خوب</td>
<td>مقاومت در برای سایش</td>
</tr>
<tr>
<td>Poor</td>
<td>Good</td>
<td>Bacteria &amp; fungus resistance</td>
</tr>
<tr>
<td>ضعیف</td>
<td>Good</td>
<td>مقاومت در برای بکتری و فارگیا</td>
</tr>
<tr>
<td>Good</td>
<td>Poor</td>
<td>Chemical resistance</td>
</tr>
<tr>
<td>خوب</td>
<td>نسبتاً خوب</td>
<td>مقاومت در برای مواد شیمیایی</td>
</tr>
<tr>
<td>Poor</td>
<td>NR</td>
<td>Hardness</td>
</tr>
<tr>
<td>ضعیف</td>
<td>غیر مقاوم</td>
<td>اسید اکسید کندنه</td>
</tr>
<tr>
<td>Good</td>
<td>غیر مقاوم</td>
<td>غیر اکسید کندنه</td>
</tr>
<tr>
<td>NR</td>
<td>غیر مقاوم</td>
<td>Nonoxidizing</td>
</tr>
<tr>
<td>غیر مقاوم</td>
<td>غیر مقاوم</td>
<td>Organic</td>
</tr>
<tr>
<td>Sea water OK</td>
<td>Sea water OK</td>
<td>Alkali</td>
</tr>
<tr>
<td>آب دریا بالانع</td>
<td>آب دریا بالانع</td>
<td>سلز: اکسید</td>
</tr>
<tr>
<td>NR</td>
<td>غیر مقاوم</td>
<td>غیر اکسید کندنه ها</td>
</tr>
<tr>
<td>غیر مقاوم</td>
<td>غیر مقاوم</td>
<td>Nonoxidizing</td>
</tr>
<tr>
<td>Good</td>
<td>غیر مقاوم</td>
<td>سولوتن: آلیفیک</td>
</tr>
<tr>
<td>غیر مقاوم</td>
<td>غیر مقاوم</td>
<td>هلال: خفی</td>
</tr>
<tr>
<td>NR</td>
<td>غیر مقاوم</td>
<td>- حلقوی</td>
</tr>
<tr>
<td>غیر مقاوم</td>
<td>غیر مقاوم</td>
<td>- اسپیزیون</td>
</tr>
<tr>
<td>Good</td>
<td>غیر مقاوم</td>
<td>آب:</td>
</tr>
<tr>
<td>غیر مقاوم</td>
<td>غیر مقاوم</td>
<td>- دراز رطوبیت</td>
</tr>
<tr>
<td>NR</td>
<td>غیر مقاوم</td>
<td>- پترولیم</td>
</tr>
<tr>
<td>غیر مقاوم</td>
<td>غیر مقاوم</td>
<td>- مشتقات فنی</td>
</tr>
<tr>
<td>Good</td>
<td>غیر مقاوم</td>
<td>انعطاف پذیر</td>
</tr>
<tr>
<td>غیر مقاوم</td>
<td>غیر مقاوم</td>
<td>رشد ریشه</td>
</tr>
<tr>
<td>Poor</td>
<td>غیر مقاوم</td>
<td>مقاومت در برای خاک</td>
</tr>
<tr>
<td>ضعیف</td>
<td>غیر مقاوم</td>
<td>مقاومت در برای هوا و پوست غربینشی</td>
</tr>
<tr>
<td>Excellent</td>
<td>غیر مقاوم</td>
<td>مودار خشخاش کاربرد</td>
</tr>
<tr>
<td>عالی</td>
<td>غیر مقاوم</td>
<td>- NR</td>
</tr>
<tr>
<td>غیر مقاوم</td>
<td>Coal tar fumes</td>
<td>- NR</td>
</tr>
</tbody>
</table>

11.1.3.2 The hardness of the coal tar is better than asphalt enamel, but weather-ability of the asphalt is better than the coal tar, however, proper asphalt enamel can be used for underground waterlines and gas pipelines, but coal tar for oil processing areas and oil and gas pipelines.
11.1.3.3 Despite of bitumen, coal tar enamel due to poly-nuclear carcinogen hydrocarbon compound is toxic to vegetable and sea animals therefore, it is good coating for pipelines in seabed and forest environment and wooden right of way.

11.1.4 Temperature limitation (the application and service temperatures)

11.1.4.1 Application temperature

For application of enamel coatings by flooding or other means, the temperature of the coating material shall be such that the viscosity is controlled to give the thickness of coating required, and not so high as to cause excessive fuming. No grade of material should be heated above the maximum application temperature given in Table 5.

11.1.4.2 Service temperature

In general, materials of higher softening point or lower penetration are intended for use under higher temperature conditions coal tar service (operating) temperature requirements are achieved by modifying the combined materials with various plasticizers. Grade 105/15 or bitumen grade a at normal and lower than normal ambient temperatures in temperature climates. Coal tar grade 105/8 and bitumen grade b are suitable at ambient temperatures in both low temperate and hotter climates coal tar grade 120/5 shall be designed for use at elevated service temperatures up to 70°C, or up to 115°C in the case of off-shore pipelines when an additional concrete anti-buoyancy coating material is used. Under these conditions a degree of hardening will occur early in use. The manufacturer of the product should be consulted as to its suitability under particular conditions.

<table>
<thead>
<tr>
<th>TABLE 5 - APPLICATION TEMPERATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade Of Coating Material</td>
</tr>
<tr>
<td>Coal Tar</td>
</tr>
<tr>
<td>Bitumen</td>
</tr>
<tr>
<td>Enameled</td>
</tr>
<tr>
<td>Bitumen</td>
</tr>
<tr>
<td>105/15</td>
</tr>
<tr>
<td>105/8</td>
</tr>
<tr>
<td>120/5</td>
</tr>
</tbody>
</table>
Notes:

1) For service temperature-higher and lower than normal (0-35°C) only synthetic primer (IPS-M-TP-275) shall be used.

2) Bitumen enamel grade C can be used for service temperature zero to 60°C and coal tar enamel grade 120/5 can be used for service temperature zero up to 70°C for buried structures or up to 115°C in the case of offshore pipelines when an additional concrete weigh coating is used.

11.1.5 Application and inspection procedure

11.1.5.1 Surface preparation shall be blast cleaned to ISO 8501/1 grade Sa 2½ near white metal proceeds by removal of surface contamination. The surface preparation shall be in accordance with IPS-C-TP-101.

11.1.5.2 The prepared surface shall be primed with appropriate primer (for field coating application only synthetic primers shall be used). The primer shall be applied at the rate recommended by the manufacturer, with reference to relevant IPS standard for specified primer, and shall be subject to his recommended maximum and minimum rates. It shall be allowed to dry to a uniform film free from bubbles and discontinuities.

11.1.5.3 The primed surface shall be enamel coated only within the time limits recommended by the manufacturer and shall be free from dust, moisture and other contaminants before flood coating.

11.1.5.4 The flood coating of enamel shall be applied in an approved machine, also equipped for spiral wrapping of the inner and outer wrap.

11.1.5.5 The first flood coat of enamel shall have the inner wrap pulled in so that it does not touch the surface of the steel pipe and is embedded in the middle 50% of the enamel thickness; the second flood coat shall have the outer wrap pulled on and securely bonded, without wrinkles, to the enamel. The two flood coats may be combined if approved by the Company. Each wrap shall overlap by not less than 25 mm (1 inch).
11.1.5.6 The enamel shall be applied at a temperature not exceeding that specified in 11.1.4. It shall be melted in a boiler fitted with mechanical agitators and shall be continuously stirred. All other aspects of enamel handling, melting and application shall be as specified in IPS-C-TP-274.

11.1.5.7 The coating shall terminate 250 mm (10 inch) or cut back 100 mm up to size DN 500 mm and 150 mm for sizes over DN 500 mm from each end of each length of pipe and be neatly trimmed to a 45° bevel.

11.1.5.8 The finished thickness of the coating shall average 5 mm (3/16 inch) with a minimum of 4 mm (5/32 inch) and a maximum of 6 mm (¼ inch). The minimum thickness over seam or spiral welds may be relaxed to 3 mm (1/8 inch) provided that the coating satisfies holiday detection requirements.

11.1.5.9 After inspection and repair of defects, the coating shall be covered with weather-resistant whitewash (11.1.2.5.1) or similar approved solar protection coating if the coating is applied at site.

11.1.5.10 Coated pipe shall be suitably marked to identify the grade of enamel employed.

11.1.5.11 For either field or yard application of coating the procedures outlined in 11.4.4 shall be followed.

11.1.5.12 Inspection shall include the following points (see also IPS-C-TP-274):

a) Monitoring the particle size, cleanliness and mix of the blast cleaning media.

b) Visual checks in good light, after blast cleaning, of the pipe surface for steel defects and occluded grit.

c) Control of temperature and freedom from moisture of the pipe surface before priming and before flood coating.

d) The enamel melting and application temperatures.
e) The location of the inner wrap in the thickness of the enamel.

f) The adhesion of the coating to the pipe and to the outer wrap.

g) Overall holiday detection, including testing of repairs, as required in IPS-C-TP-274.

h) The adhesion or bond test shall be as required in IPS-C-TP-274.

11.1.6 Handling and stacking

11.1.6.1 All coated pipe shall be handled and transported according to IPS-C-TP-274. The contractor shall ensure that pipe is not handled under unsuitable temperature conditions.

11.1.6.2 Stacking of coated pipe shall be limited to such a height that neither flattening nor indentation of the coating occurs (see IPS-C-TP-274).

11.1.7 Field repair, joints and fittings

- Field coating repair and coating of joints, fittings and specials sections shall be performed by using hand applied laminated tape IPS-M-TP-314 and it’s primer IPS-M-TP-323. The tape shall be wrapped with 50% overlap.

- For irregular shapes such as valves and fittings which are buried petrolatum tape (IPS-M-TP-317) shall be used.

For below ground unburied valves shall be coated with asphalt mastic (IPS-M-TP-105) to a minimum thickness of 3.5 mm.

11.1.8 Standard coating materials

The standard coating materials used shall be as follows:

11.1.8.1 Primer

- Synthetic primer IPS-M-TP-275.
- Bitumen primer IPS-M-TP-285.
- Coal tar primer IPS-M-TP-280.

11.1.8.2 Enamel

- Hot-applied bitumen enamel IPS-M-TP-295.
- Hot-applied coal tar enamel IPS-M-TP-290.
11.1.8.3 Inner wrap IPS-M-TP-300
11.1.8.4 Outer wrap IPS-M-TP-305
11.1.8.5 Rock shield IPS-M-TP-316

11.1.8.6 Hand applied tape coating:
- Hand applied plastic tape IPS-M-TP-314.
- Primer IPS-M-TP-323.

11.1.9 Cathodic protection characteristics

11.1.9.1 Bituminous coatings have good electrical resistance and need rather low cathodic protection current (see Table 1). Recommend design current density for 15-30 years service life is 200 microamperes per square meter of external pipe surface. The later utilizes multiple extruders in a proprietary method, which obtains maximum bond with minimum stress.

11.2 Three Layer Polyethylene and Polypropylene (PE/PP) Coatings

11.2.1 General

11.2.1.1 There are two systems available for coating of line pipes. One is an extruded polyethylene or Polypropylene sleeve, shrunk over a primed pipe by cross head extruded method. The other is a dual extrusion (side extrusion method) where a butyl adhesive (soft primer) or polyethylene copolymer (hard primer) is extruded onto the blast-cleaned pipe followed by multiple fused layers of polyethylene or Polypropylene. The later utilizes multiple extruders in a proprietary method, which obtains maximum bond with minimum stress.

11.2.1.2 In both methods the pipe shall be uniformly heated in accordance with the manufacturer's Specified temperature limits but shall not exceed 270°C.
11.2.1.3 The sleeve type is available on 130 mm through 610 mm (5 inch through 24 inch) pipe, while the dual extrusion is presently available on 63.5 mm through 260 mm (2½ inch through 10.3 inch) pipe. The accepted standard to which pipe is coated with these types of polyethylene coatings is DIN 30670.

11.2.1.4 Coatings system qualification. (amendments IPS-G-TP-335).

- Each coating system shall be qualified by the applicator to meet the requirements of table 5.

- The applicator shall apply coating materials qualified in accordance with the requirements of 1.2. (table 5 and item 1.2 reference to the above amendments).

11.2.2 Characteristic of polyethylene and polypropylene coatings

11.2.2.1 Polyethylene and Polypropylene coatings are durable and their penetration and impact resistance are better than the resistance of hot applied (asphalt or coal tar enamel) coatings are therefore less prone to mechanical damage during transport, handling, storage and laying. They also exhibit a high electrical resistance which allows of low cathodic protection current requirements throughout long years of service (see Table 1).

11.2.2.2 Pigmenting the material with carbon black has eliminated earlier ultra-violet degradation problems resulting from long exposure to sunlight.

11.2.2.3 The coating classes shall be capable of withstanding the service temperature range required As shown in table 6.

<table>
<thead>
<tr>
<th>Coating class</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top layer material</td>
<td>MDPE/HDPE</td>
<td>PP</td>
</tr>
<tr>
<td>Design temperature</td>
<td>-20 to +80</td>
<td>-30 to +110</td>
</tr>
</tbody>
</table>

11.2.2.4 Coatings system qualification (amendments IPS-G-TP-335).

- Each coating system shall be qualified by the applicator to meet the requirements of table 5.

- The applicator shall apply coating materials qualified in accordance with the requirements of 1.2. (table 5 and item 1.2 reference to the above amendments).

11.2.2.5 The accepted standard to which pipe is coated with these types of polyethylene coatings is DIN 30670.

TABLE 6 - COATING CLASSES AND DESIGN TEMPERATURES

<table>
<thead>
<tr>
<th>Coating class</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top layer material</td>
<td>MDPE/HDPE</td>
<td>PP</td>
</tr>
<tr>
<td>Design temperature</td>
<td>-20 to +80</td>
<td>-30 to +110</td>
</tr>
</tbody>
</table>

11.2.2.6 Pigmenting the material with carbon black has eliminated earlier ultra-violet degradation problems resulting from long exposure to sunlight.

11.2.2.7 The coating classes shall be capable of withstanding the service temperature range required As shown in table 6.
11.2.2.4 Polyethylene and Polypropylene coatings are not recommended for pipelines operating above 80°C and 110°C respectively. 

11.2.2.5 Polyethylene and polypropylene coatings have a field’s good bend ability (1.9° per pipe diameter length at -40°C).* 

* Pipe diameter length: any length along the pipe access equal to the specified outside diameter of the pipe. 

11.2.2.6 Swelling may occur in hydrocarbon environments. 

11.2.2.7 These coatings are applied only in the shop or factory at a thickness which depends on nominal pipe diameter as specified in tables 4 and 7 Amendment. 

<table>
<thead>
<tr>
<th>Pipe Diameter (mm (in))</th>
<th>Powder Epoxy Resin (1st layer) mm (μm)</th>
<th>Adhesive (2nd layer) mm (μm)</th>
<th>Total Thickness, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to DN 500 (20)</td>
<td>0.2(200)</td>
<td>0.15(200)</td>
<td>3LPE 2.5</td>
</tr>
<tr>
<td>DN 500 (20) up to DN 900 (36)</td>
<td>0.2(200)</td>
<td>0.15(200)</td>
<td>3LPP 2.5</td>
</tr>
<tr>
<td>&gt; DN 900 (36)</td>
<td>0.2(200)</td>
<td>0.15(200)</td>
<td>3.5</td>
</tr>
</tbody>
</table>

11.2.3 Application procedure Specification application methods and tests (see IPS-G-TP-335, Amendments, Attachment No.3 Item 1.2, 2 and 4) 

11.2.4 Handling and stacking 

All coated pipes shall be handled and stored at coating factory in accordance with IPS-G-TP-335 and handled, transported and stored for installation according to IPS-C-TP-274 and IPS-G-TP-335.
11.2.5 Field joints and specials

11.2.5.1 Field joints and specials shall be coated either by polyethylene shrink tape or sleeve (IPS-M-TP-318) with own epoxy primer according to the vendor specification or cold applied tape (IPS-M-TP-313) to be applied with 50% overlap over it’s primer (IPS-M-TP-322).

11.2.5.2 Polyethylene shrink tapes and sleeves have the advantages and disadvantages over conventional cold-applied tape. Their advantages are self-tensioning, and resistant to direct sunlight. Their disadvantages are:

- They require a source of heat (a flame torch) for application which is major disadvantage.
- Field construction crews must be skilled to apply the heat shrink tape and sleeve properly.
- Their application is slow and time consuming.
- They are more expensive.

11.2.5.3 For irregular shapes such as valves and fittings which are buried petrolatum tape (IPS-M-TP-317) shall be used.

11.2.6 Cathodic protection characteristic

11.2.6.1 Due to high electrical resistance the coatings need low cathodic protection current throughout long years of service.

11.2.6.2 Recommended design current density for 15-30 years service life is 10 micro amperes per square meter of external pipe surface.

11.2.6.3 Recommended "off"-potential limits for underground coatings (to Cu/CuSO₄ half-cell) is -1.1 Volt.

11.3 Fusion Bonded Epoxy Coating (FBE)

11.3.1 General

11.3.1.1 This coating is a thin-film coating and can be applied on various type of diameter pipes.

11.3.1.2 The fusion-bonded powder epoxy coating has good mechanical and physical properties and may be used above or below ground. On above-ground installations, to eliminate chalking and to maximize service life, topcoat with a urethane paint system. Of all the pipe coating systems the fusion-bonded epoxy resin system is the most resistant to hydrocarbons, acids, and alkalis.

(IPS-E-TP-270(1))

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IPS
11.3.1.3 The number of holidays that occur is a function of the surface condition and thickness of the coating increasing the thickness of the applied coating will minimize the holidays.

11.3.1.4 This coating is widely used for land-based pipelines operating at elevated temperatures.

11.3.2 Characteristic of coating

11.3.2.1 Despite its low film thickness (500-760 μm) the fusion-bonded epoxy coating displays many desirable characteristics or properties not fully found in any of the traditional pipe coating systems. For example, this system is tough, has great flexibility and provides good adhesion to the steel pipe along with extremely good chemical resistance.

11.3.2.2 In view of its high dielectric strength, very small quantities of current for complete cathodic protection are required (see 11.3.7.2).

11.3.2.3 An extra benefit from epoxy pipe coating not easily achieved with other coating systems is the ability to withstand a relatively high temperature of approximately 100°C for an extended length of time without damage, provided the environment is dry. Some epoxy thin-film systems can even withstand wet environments at this elevated temperature.

It is current group practice to specify this type of coating for land-based pipelines operating at temperatures 65°C.

11.3.2.4 A short coming of the coating system is its increased sensitivity to sharp impact damage, which requires careful attention during transportation, field handling and pipe laying. Fortunately, impact damage does not normally cause disbonding outside of the damage area and can be readily repaired by hot-melt or with liquid epoxy resins.

11.3.2.5 Experience has shown that proper surface preparation prior to the application of the epoxy resin powder is of extreme importance with this coating. To obtain a satisfactory coating it is furthermore absolutely necessary that good quality control during the application process is strictly adhered to.
11.3.2.6 Fusion bonded epoxy coating should only be ordered against detailed specifications covering both the epoxy resin materials and their application.

11.3.2.7 Fusion bonded epoxy coating shall be in accordance with NACE RP 0394, 0402.

11.3.2.8 The coating shall be applied with in temperature range (65°C to 95°C) to a minimum thickness of 500 microns and a maximum of 760 microns. Coating applied outside these limits shall be rejected and reprocessed.

11.3.2.9 For other characteristics of this coating system see 9.2.3.

11.3.3 Application and inspection procedure

11.3.3.1 The coating is plant-applied by applying epoxy resin powder by means of multiple electrostatics guns on to a blast cleaned (ISO 8501-1 grade to Sa 2½). The preheated pipe shall be in accordance with the coating manufactures recommendations (Approximately 220-240°C) but not exceed 260 °C.

11.3.3.2 The pipe surface shall be free from protective oil, lacquer or mill primer. The pipe surface shall also be as free as possible from scab, silvers, laminations and similar defects.

11.3.3.3 The pipe surface shall be blast cleaned. The cleaning media shall be selected to achieve a surface profile of 40-80 microns. The appropriate blend of shot and grit to achieve this profile is necessary. The surface preparation shall be in accordance with IPS-C-TP-101.

11.3.3.4 The application and inspection procedure shall be according to IPS-C-TP-274.

11.3.4 Coating materials

The powder epoxy used shall be in accordance with NACE RP 0394.

11.3.5 Handling and stacking

11.3.5.1 All coated pipes shall be handled and stored of coating factory in accordance with IPS-C-TP-274 and NACE RP 0185.
11.3.5.2 A short coming of the coating system is its increased sensitivity to sharp impact damage, which requires careful attention during transportation, field handling and pipe laying.

11.3.5.3 Transportation, field handling and storing for installation shall be in accordance with IPS-C-TP-274, NACE RP 0185.

11.3.6 Field joints and fittings

11.3.6.1 Pipe joints and fittings shall be coated by hot-melt or with liquid epoxy resins. The materials shall be in accordance with AWWA C213.

11.3.6.2 Field joint coating and repair shall be in accordance with IPS-C-TP-274.

11.3.7 Cathodic protection characteristics

11.3.7.1 Due to high electrical resistance the coating needs rather low cathodic protection current throughout long years of service.

11.3.7.2 Recommended design current density for 15-30 years service life is 50 µA/m² of external pipe surface.

11.3.7.3 Recommended "off" potential limits for underground coating (to Cu/CuSO₄ half-cell) is -1.1 Volts.

11.4 Plastic Tape Coating System

11.4.1 General

11.4.1.1 Cold-applied plastic tape coating system are applied as a three-layer system consisting of primer liquid adhesive, corrosion preventive tape (inner layer) and a mechanical protective tape (outer layer). This system is recommended for maximum service of potable water temperatures. The coating systems will perform at higher temperatures which are not covered in this Standard. The manufacturer should be consulted for recommendations suitable to the purchaser's needs.

11.4.1.2 The primer’s function is to provide a bonding medium between the pipe surface and the adhesive or sealant on the inner layer. For standard specification of primer see IPS-M-TP-321-322.
11.4.1.3 The inner layer tape consists of a plastic backing and adhesive. This layer protects against corrosion, so it has to provide a high electrical resistivity and low moisture absorption and permeability, along with an effective bond to the primed steel. For standard specification see IPS-M-TP-310-313.

11.4.1.4 The outer layer tape consists of a plastic film and an adhesive of the same types of materials used in the inner layer tape. The purpose of the outer layer tape is to provide mechanical protection to the inner layer tape, and also to be resistant to the elements during outdoor storage. For standard specification see IPS-M-TP-311.

11.4.2 Characteristic of coating system

11.4.2.1 Three-layer coating system is applied for normal construction conditions. This coating system is applied cold to a prepared pipe surface.

11.4.2.2 The coating can be applied by hand to small diameter pipes and small pipe sections, but it shall normally be applied by machine.

11.4.2.3 The coating can be easily applied in field.

11.4.2.4 The coating is suitable for operation temperature from -20 to 60 °C.

11.4.2.5 For other characteristic of the coating systems see 9.2.4.

11.4.3 Description of coating system

The coating system consists of:

11.4.3.1 One primer coat which shall be properly applied. The material specification shall be in accordance with IPS-M-TP-321-322.

11.4.3.2 One protective layer (inner wrap) which shall be applied to the primed steel pipe. Material specification shall be in accordance with IPS-M-TP-310-313.
11.4.3.3 One mechanical protective layer (outer wrap) to be applied over protective layer. Material specification shall be in accordance with IPS-M-TP-311. The spiral overlap of each layer shall be one inch (See Table 8).

<table>
<thead>
<tr>
<th>No</th>
<th>Type of coating tapes</th>
<th>Overlap at joints</th>
<th>Overlap on pipes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>On itself</td>
</tr>
<tr>
<td>1</td>
<td>Cold applied plastic</td>
<td></td>
<td>1”</td>
</tr>
<tr>
<td></td>
<td>AWWA C 214</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Bituminous coating</td>
<td></td>
<td>½”</td>
</tr>
<tr>
<td></td>
<td>BS EN 10300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Fusion bonded epoxy</td>
<td></td>
<td>2”</td>
</tr>
<tr>
<td></td>
<td>AWWA C 0402</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Petroleum</td>
<td></td>
<td>1”</td>
</tr>
<tr>
<td></td>
<td>AWWA C 222</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Polyurethane</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

* RECOMMENDED BY MANUFACTURES

11.4.4 Application and inspection procedure

11.4.4.1 Surface preparation

Prior to application of primer the pipe shall be prepared to Sa 2½ according to ISO8501/1 by blast cleaning. Surface preparation shall be in accordance with IPS-C-TP-101.

11.4.4.2 Field application of coating

In this procedure the pipe is welded together beside the canal then the surface preparation, priming and wrapping is performed continuously over the ditch. The coating is inspected simultaneously and the approved coated pipeline will be buried.

11.4.4.3 Yard and field application of coating

In this procedure the pipes are surface cleaned and primed at yard. The primed pipes are transported to the field, jointed, cleaned from contaminations, reprimed wrapped, inspected and buried as in 11.4.4.2. The application and inspection procedures of coating shall be in accordance with IPS-C-TP-274.
11.4.4 Field repair and fittings

Field coating repairs and coating of fittings and special sections shall be performed using hand applied laminated tape IPS-M-TP-313 and its primer IPS-M-TP-322. The tape shall be wrapped with 50% overlap.

11.4.5 Cathodic protection characteristics

11.4.5.1 Due to good electrical resistance the coating needs rather low cathodic protection current (see Table 1).

Recommended design current density for 15-30 years service life is 200 micro amperes per square meter of external pipe surface.

11.4.5.2 Although plastic tape coatings have certain advantages and are relatively easy to apply, many problems have arisen with this system in practice. One major drawback of tapes is their sensitivity to disbonding, particularly at the overlaps. As a result of which cathodic protection currents are easily shielded, rendering the cathodic protection system ineffective so that corrosion can proceed unabated. As a consequence, the use of tape coatings shall be limited to the special cases where other coatings can not be selected for the reason(s) stated in (11.4.1.1).

11.4.5.3 Recommended "off" potential limits for underground coating (to Cu/CuSO₄ half-cell) is /1.1 Volts.

11.5 Polyurethane Coating Systems Solvent Free

11.5.1 General

Polyurethane coating is recommended for shop- and close - applied and used for onshore and offshore structures, buried and submerged steel pipelines. Special section, welded joints, connections and fittings. The coating system shall consist of thermoset, aromatic polyurethane plastic polymer that is the reaction product of biphenyl – methane disiocyanate (MDI) resin and polyl resin as polyamine resin as a mixture of polyl and polyamine resins. Typically, these systems are solvent free. Unless recommended by the product manufacturer.

11.5.2 Characteristic of polyurethane (See 9.2.5)
11.5.3 Application and inspection procedure (see BS EN 10290)

11.5.3.1 Coatings shall be applied according to the coating manufacturer’s instruction to the required thickness. Surface profile 50-100 µm. (See AWWA – C – 222 and BS EN 10290)

11.5.3.2 Prior to abrasive blast cleaning surface to be coated shall be inspected and, if required, cleared in accordance to SSPC-SP-1 to remove any oil, grease, or other soluble contaminants. For coated inspection requirements following points shall be considered.

- Cure , test (manufacturer’s recommendation)
- Coating appearance (visual)
- Dry film thickness ( SSPC-PA 2 )
- Electrical continuity (NACE RP – 0188 )* 
- V- cut Adhesion
- Pull-off adhesion (ASTM D 4541)*

* Tests marked to be performed at the option of the purchaser.

11.5.3.3 Handling and stacking

All coated pipe shall be packed, handled and stored in a manner that will minimize damage. (See AWWA- C-222)

11.5.3.4 Field repair, joints and fittings

Pipe joints and Fitting shall be coated by joint material as approved by manufacturer. Areas that are less than the specified minimum dry film thickness shall be recoated as specified by (AWWA - C - 222).

11.6 Petrolatum or Wax Coating System

11.6.1 General

Wax and component wrappers and wax-tape covers hot-and cold-applied coating systems for the protection of underground pipe, fittings , and valves. It outlines material requirement for hot-applied waxes, cold-applied waxes, component wrappers, and wax tapes as well as proper methods of surface preparation, coating application, and handling of the coated pipe.

BS EN 10290

11.6.1.1 General

V- cut Adhesion
- Pull-off adhesion (ASTM D 4541)*
- Coating appearance (visual)
- Electrical continuity (NACE RP – 0188 )* 
- SSFPA 2-

* Tests marked to be performed at the option of the purchaser.

11.6.1.2 Handling and stacking

All coated pipe shall be packed, handled and stored in a manner that will minimize damage. (See AWWA- C-222)

11.6.1.3 Field repair, joints and fittings

Pipe joints and Fitting shall be coated by joint material as approved by manufacturer. Areas that are less than the specified minimum dry film thickness shall be recoated as specified by (AWWA - C - 222).
11.6.2 Characteristic of coating system

11.6.2.1 Hot applied wax coating systems consist of microcrystalline wax and component wrappers with specific characteristics in accordance with standard NACE RP 0375.

11.6.2.2 Cold applied wax coating consist of wax coating that is hand applied to the surface with and without primer and over wrapped with a component wrapper, characteristics are in accordance standards IPS-M-TP-317, AWWA-C-217 And NACE RP 0375.

11.6.2.3 Application and inspection procedure.

11.6.2.3.1 Traveling machine application
a) One coat of hot-applied wax coating
b) One wrap of component wrapper: and
c) One wrap of suitable outer wrap (if specified)

11.6.2.3.2 Hand application
a) One coat of hot-applied wax coating
b) One wrap of component wrapper: and
c) An additional over coat of hot-applied wax (if specified)

11.6.2.3.3 Surface shall be cleaned for hot and cold applied in accordance SSPC (SP-1 & SP-2 RESPECTIVELY)

11.6.2.3.4 Handling and Stacking (See NACE RP 0375)

11.6.2.3.5 Inspection and Repair (See NACE RP 0375)

11.6.2.3.6 Cathodic protection
If required, cathodic protection shall be installed in accordance with NACE standard RP 0169.
11.7 Concrete

11.7.1 General

11.7.1.1 Mortar lining and coating has the longest history of protecting steel or wrought iron coating and cast iron from corrosion. When steel is encased in concrete, a protective iron oxide film and cast iron from corrosion. When steel is history of protecting steel or wrought iron coating of asphalt or coal-tar enamel. This design has demonstrated good short and long-term characteristics. Combined with properly selected tensioners on a lay barge this design has also been successfully installed offshore in many areas.

11.7.2 Concrete weight coatings

11.7.2.1 Concrete weight coatings are normally applied to offshore pipelines, river crossings and marsh lines to maintain the lateral and vertical stability of the pipeline. The amount of concrete is determined by the calculated required submerged weight of the pipeline, also called negative buoyancy.

11.7.2.2 Most frequently the concrete is applied by the impingement method over an anti-corrosion coating of asphalt or coal-tar enamel. This design has demonstrated good short and long-term characteristics. Combined with properly selected tensioners on a lay barge this design has also been successfully installed offshore in many areas.
11.7.2.3 There must not be any electrical contact between the pipe and the reinforcement, as this may make subsequent cathodic protection of the pipe difficult or even impossible.

11.7.2.4 Application methods for concrete coatings other than by impingement are being developed to resolve problems resulting from weight coating application over FBE anticorrosion coating. Current experience with these applications is limited.

12. COATING OF SUBSEA PIPELINES

12.1 Subsea pipelines are defined as those lines which are laid in or on the seabed. It covers requirements for coating against corrosion the external surfaces of pipelines that are welded and joint coated on a lay barge, followed by pipe laying over the stringer.

It also covers pipelines laid by reel barge or by pulling into the sea or across creeks, estuaries, rivers or canals.

12.2 The coatings that may be used on subsea pipelines are specified in Section 11.0. All coatings on such subsea pipelines shall be compatible with concrete or bituminous weight coating and with normal levels of cathodic protection, with the protective potential no more negative than minus 1.30 Volts measured against a silver/silver chloride half cell.

12.3 For weight coating see 12.5.

12.4 Hot-applied coal tar enamel glass fiber reinforced (see 11.1) shall be used for coating subsea pipelines which may or may not be weight coated. It shall not be used when:

a) The temperature of the pipeline contents exceeds 70°C (160°F) (see 12.5).

b) The pipeline is to be laid from a reel (see 12.5).

c) The pipeline is to be laid by pulling or placing and is not to be concrete weight coated. See 13.6.
12.5 Epoxy powder coating shall be used when one or both of the following conditions apply:

a) The temperature of the pipeline contents is too high for coal tar enamel but does not exceed 95°C (200°F).

This includes pipeline risers.

b) The pipeline is to be laid from a reel.

12.6 Pipelines which are laid by pulling or placing and are not concrete weight coated (this includes prefabricated spool pieces), shall be coated with epoxy powder.

12.7 Plastic tape coating shall not be used for subsea pipelines.

12.8 When designing coating for subsea pipelines the following important factors shall be considered:

12.8.1 Concrete slippage

For submarine applications some coatings, e.g. fusion bonded epoxy, polyethylene, polypropylene will normally need an intermediate coating to provide increased friction to avoid slippage between concrete and coating during pipe laying.

For lay barges with a single tensioner, precautions may be needed to avoid breakage and slippage of the concrete at the ends of the pipe. This might be achieved with temporary infill blocks or could involve stronger longitudinal reinforcing wire. (Any dimensional irregularities at the end of the coating, e.g. "bell ends", will exacerbate this problem.) The exposed end portion of anti-corrosion coating may become too short or even disappear if slippage does occur.

12.8.2 Anti-corrosion coating damage

An intermediate "barrier" layer may be needed to prevent damage from the concrete impingement process.

12.8.3 Choice of anti-corrosion coating

There are normally many factors involved in the choice of coating for a particular pipeline. The above two potential problem areas may need to be taken into account in this choice.
12.8.4 Pipe dimensions and stiffness

Pipes with large diameter/wall thickness (D/t) ratios have a tendency to become oval when loaded externally and may also buckle at the field joint area when the concrete coated pipes are installed. Large concrete thicknesses can be the cause of ovalization.
APPENDICES

APPENDIX A

A.1 Technical Specification of Modified Bitumen Enamel Coating System for Line Pipe

A.1.1 Scope

This specification covers the minimum equipments for the materials, performance, properties, application, inspection and testing, repair, handling and storage of modified bitumen enamel coating system for corrosion protection of external surface of buried steel pipes. Modified bitumen enamel shall be suitable for service temperature of -29 to +60°C.

This specification is based on the EN 10300 (NOV. 2005)

A.1.2 Requirements

A.1.2.1 Coating system description

The modified bitumen enamel coating system shall consist of following materials and application:

- Specific primer.
- Modified bitumen enamel.
- Outer wrap.
- Anti u.v. coating.

A.1.2.2 Materials

A.1.2.2.1 Primer

The primer shall be fast drying. It shall be compatible with the modified bitumen enamel and to be supplied by the same manufacturer of modified bitumen enamel.

The primer shall comply with the requirements in table 1 when tested by the methods specified and, when dry, shall provide a suitable bond between the metal and subsequent coating.

Note: The primer shall be supplied in bulk or in sealed new steel containers.
A.1.2.2.2 Modified bitumen enamel

The modified bitumen enamel shall consist of modified bitumen with inert filler. The modified bitumen enamel shall comply with the requirements given in table 2 when tested by the methods specified. The modified bitumen enamel in conjunction with an appropriate primer shall comply with the requirements given in table 3 when tested by the methods specified.

Inert filler

The inert filler shall be physically and chemically stable at the maximum application temperature of the coating material. Powdered slate and talc are typical examples of suitable filler types.

The fillers graded in accordance with ISO 2591-1, sub clause 7.3, shall meet the following requirements:

- Passing 90 µm: more than 93% by weight
- Passing 250 µm: more than 99% by weight

Note: The modified bitumen enamel shall be supplied hot in bulk.

The hot bulk shall be accompanied by a delivery note clearly marked with the manufacture’s name, material designation, date of manufacture and batch number.

A.1.2.2.3 Outerwrap (sheet)

The outer wrap shall consist of a continuous sheet of glass fiber / polyester composite fabric impregnated by a suitable bituminous material.

The outer wrap shall have a uniform porosity to allow air and fumes to escape.

The outer wrap shall have a uniform appearance, free from holes, slits and other visible faults.

The outer wrap shall comply with the requirements given in table 4.

A.1.2.2.4 Anti U.V. coating (solar protection)

The anti U.V. coating shall be whitewash or water emulsion latex paint or Kraft paper as described in AWWA C 203-97

A.1.2.3 Coating thickness

The minimum thickness of the coating system over the weld seam and pipe body shall be 4 mm.
الف-1-4 فاقد پوشش
انتهای درجه پایه به میزان (150 ± 15 میلی‌متر) بدن پوشش باشد؛ مگر آن که به نحو دیگر توسعه متفقین مشخص شده باشد.

الف-1-3 مشخصات فنی روش ساخت (M.P.S.):
پیمانکار مشخصات ملی روش ساخت خود را جهت بررسی و تایید به کارفرما ارائه کند.

الف-1-2 پرونده کنترل کیفیت (Q.C.P.):
الف-1-2-1 پیمانکار پوشش باید پرونده کنترل کیفیت خود را جهت بررسی و تایید به کارفرما ارائه کند.
الف-1-2-2 پیمانکار پوشش باید استاندارد زیر از سازنده مواد پوشش دریافت و به کارفرما ارائه کند:
- لعاب قبر اصلاح شده و لفاف پیوستی ارائه شده باید با مشخصات فنی مندرج در استاندارد و روشن های تعیین شده مطابقت داشته باشد.

الف-1-5 بارزسی و آزمایش
الف-1-5-1 بارزسی پوشش باید توسط پیمانکار پوشش در حضور بارزس فنی انجام شود.
الف-1-5-2 بارزسی فنی باید به طور آزاد و درست به کارگاه‌ها، محوطه‌های ابزار و آزمایشگاه پیمانکار پوشش را داشته و امکانات لازم برای انجام مصوبه این مهارت توسط پیمانکار باید بارزس فنی فراهم شود.
الف-1-5-3 با محض حضور در کارگاه، پیمانکار پوشش باید استانداردهای شده توسط سازنده پوشش را که با مشخصات فنی مندرج در این استاندارد مطابقت دارد را ارائه نماید.
الف-1-5-4 بارزسی باید مشخصا با بارزس فنی امضاء شود، گواهی بارزسی پوشش لوله شامل نتایج آزمایش‌ها و اسناد مربوط به آن است.
A.1.6 Coating repair instruction

The coating applicator shall submit detailed procedures for coating repairs to the company, for review and approval.

These procedures shall contain:
- Repair of surface damage.
- Repair of holidays and small damage.
- Repair of damage due to site quality check.
- Removal of rejected coating and cleaning the pipe to the required standard for recoating.
- Testing to prove the effectiveness of the repairs.

A.1.7 Documentation

The coating applicator shall keep accurate records of all relevant data of the coating process, materials and coating performance.

This documentation shall include:
- Copies of the coating materials 'data including manufacturer's name, material designation, date of manufacture and batch number.
- Serial numbers of rejected pipes and the reason for rejection.
- The results of all quality control testing.
- Repair records.

This documentation shall be submitted to the company after completion of each individual order together with the calibration certificates of the testing and inspection instruments.

A.1.8 Handling, storage and transport of bare and coated pipe

A.1.8.1 The coating applicator shall take receipt of the pipes, and keep a record of the serial numbers of the delivered pipes. Upon receipt, the pipes shall be inspected for transport damage or other defects. Damaged pipes shall be separately stored and reported to the company.

A.1.8.2 The coating applicator shall ensure that coated pipes are handled without causing damage to the ends of the pipes or to the coating. The use of steel ropes, steel slings or any lifting equipment, which could damage the coating and the pipe ends, shall be prohibited.
Pipes shall be handled by means of end hooks or by flat slings, which cradle the pipe, and other lifting equipment such as spreader bars, beams, hoists and cranes.

Lifting trucks or front-end loader shall have soft padded forks or grips to prevent damage to the pipes during handling.

### TABLE A-1-9-1- PROPERTIES OF PRIMER

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Unit</th>
<th>Requirement</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow time (flow cup No : 4 at 23°C)</td>
<td>Second</td>
<td>35-60</td>
<td>EN-ISO 2431</td>
</tr>
<tr>
<td>Flash point (Abel close cup),(min)</td>
<td>°C</td>
<td>23</td>
<td>EN-ISO 13736</td>
</tr>
<tr>
<td>Residual non-volatile matter At 105-110°C for 3 hours (min.)</td>
<td>%mass</td>
<td>25</td>
<td>ISO 3251</td>
</tr>
</tbody>
</table>

### TABLE A-1-9-2- PROPERTIES OF MODIFIED BITUMEN ENAMEL

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Unit</th>
<th>Requirement</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filler content by ignition</td>
<td>%by wt</td>
<td>25-35</td>
<td>BS EN 10300</td>
</tr>
<tr>
<td>Density at 25°C</td>
<td>g/cm³</td>
<td>1.2-1.4</td>
<td>BS EN 10300</td>
</tr>
<tr>
<td>Softening point (Ring &amp; Ball)</td>
<td>°C</td>
<td>130-160</td>
<td>EN 1426</td>
</tr>
<tr>
<td>Penetration at 25°C</td>
<td>0.1 mm</td>
<td>5-15</td>
<td>EN 1426</td>
</tr>
<tr>
<td>Flash point (Cleveland open cup), min.</td>
<td>°C</td>
<td>260</td>
<td>ISO 2592</td>
</tr>
</tbody>
</table>
### TABLE A. 1-9-3- PROPERTIES OF MODIFIED BITUMEN ENAMEL COATING SYSTEM

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Unit</th>
<th>Requirement</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sag test 90 C, 24hr , (Max)</td>
<td>mm</td>
<td>1.5 Note(1)</td>
<td>BS – 4147 Appendix E</td>
</tr>
<tr>
<td>Impact max disbonded area, حداکثر سطح جدایب‌سازی در اثر ضربه</td>
<td>Refer to Note (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peel initial and delayed, كرکس اولیه و ناخنی</td>
<td>mm</td>
<td>80</td>
<td>BS EN 10300</td>
</tr>
<tr>
<td>Bend (min)</td>
<td>mm</td>
<td>15</td>
<td>BS – 4147 Appendix F</td>
</tr>
<tr>
<td>Cathodic disbonding</td>
<td>mm</td>
<td>7</td>
<td>ASTM G8</td>
</tr>
<tr>
<td>Pin Hole Test (max)</td>
<td>KV</td>
<td>20</td>
<td>AWWA – C 203</td>
</tr>
</tbody>
</table>

**NOTES:**
1- Modified bitumen applied on primed steel.
2- The impact energy shall be equal to $5\phi$ Jule per mm. Of coating thickness with a tolerance of 5% (refer to sub-clause 5.3.4 of DIN - 30670).

### TABLE A-1-9-4 - PROPERTIES OF OUTER WRAP

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>UNIT</th>
<th>REQUIREMENT</th>
<th>TEST METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (min.)</td>
<td>G</td>
<td>450</td>
<td>BS EN 10300 (Type F)</td>
</tr>
<tr>
<td>Thickness (min.)</td>
<td>mm</td>
<td>0.6</td>
<td>BS EN 10300 (Type F)</td>
</tr>
<tr>
<td>Longitudinal Tensile Strength (min.)</td>
<td>N/50 mm</td>
<td>800</td>
<td>BS EN 10300 (Type F)</td>
</tr>
<tr>
<td>Transversal Flexibility (23±2°C)</td>
<td>No Cracking</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Yadarooyeh:**
1- اجرای قیمر اصلاح شده روی فولاد آستری شده
2- ضخامت یوشک به روازداری 5 درصد باشد. (به زیربند DIN-30670) 5-3-4 استاندارد AWWA – C 203
A.2 Technical Specification of Polymer Modified Bitumen Coated Tape

A.2.1 Scope

A.2.1.1 This specification provides min. requirements for coating material of field weld joints with polymer modified bitumen coated tape as an external anti-corrosion joint coating for pipes coated with bitumen enamel …

The coating performance test method and inspection shall be all in accordance with DIN 30672, part(1) 1991 edition and manufacturer’s recommendations.

A.2.1.2 Supplier shall provide safety instruction and data sheets to be followed for application and handling of material.

A.2.3 Coating material general characteristic

The coating system consists of a primer and a coated tape with following general description:

A.2.3.1 Primer

It shall be fast drying (5-15 MIN at 23°C); synthetic and special formulated to be used with the relevant polymer modified coated tape.

A.2.3.2 Coated tape

It shall consist of a special glass fiber, impregnated and coated with polymer modified bitumen.

A.2.3.3. Polymer modified bitumen

It shall consist of a uniform mixture of bitumen modified with thermoplastic rubbers and 25% to 35% inert filler.

A.2.3.4 The coated tape & primer shall be supplied by the same manufacturer.

A.2.3.5 The tape properties and the coating system performance shall meet the requirements of table 1.
### Table 5

<table>
<thead>
<tr>
<th>Properties</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>min. 4.0 mm (DIN 30672)</td>
</tr>
<tr>
<td>Weight</td>
<td>≥5000g/m² (DIN 30672)</td>
</tr>
<tr>
<td>Tensile</td>
<td></td>
</tr>
<tr>
<td>LONGITUDINAL</td>
<td>≥15 kg/cm² (DIN 30672)</td>
</tr>
<tr>
<td>TRANSVERSAL</td>
<td>≥25 kg/cm² (DIN 30672)</td>
</tr>
<tr>
<td>Adhesion</td>
<td></td>
</tr>
<tr>
<td>To: (steel, bituminous Coated system)</td>
<td>≥10 kg/cm² (DIN 30672)</td>
</tr>
<tr>
<td>Impact (23°C)</td>
<td>Class C (DIN 30672)</td>
</tr>
<tr>
<td>Dielectric strength</td>
<td>≥25 kV (ASTM D149)</td>
</tr>
<tr>
<td>Volume resistivity</td>
<td>≥10¹² OHM-CM (ASTM D257)</td>
</tr>
<tr>
<td>Water absorption</td>
<td>≤0.7 gr/m² (ISO 5256)</td>
</tr>
<tr>
<td>Cathodic disbondment</td>
<td>≤5.0 mm (ASTM G8)</td>
</tr>
</tbody>
</table>

(To be Continued)
### A.2.5 Packaging

#### A.2.5.1 Coated tape

The tapes shall be delivered in roll form and the surface shall be used with fine sand to prevent sticking during storage.

Each roll shall be individually put in plastic bag and then up to 6 in of with inclusive in a carton box. Rolls & boxes shall be suitability palletized and packed with plastic cover.

#### A.2.5.2 The primer shall be delivered in max. 20 lit. New steel container.

### Table 5 (Continued)

<table>
<thead>
<tr>
<th>Properties (خواص)</th>
<th>Requirements (الزامات)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indentation hardness (سختی (تومفتکی))</td>
<td>≥1.5 mm (DIN 30672, CLASS B)</td>
</tr>
<tr>
<td>Application temperature (دما اجرای)</td>
<td>ACC. To manufacturer’s recommendation</td>
</tr>
<tr>
<td>Service temperature (دما عملیات)</td>
<td>-10°C to 60°C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimension of roll (اندازه توب)</th>
<th>Width (عرض) (in)</th>
<th>Length (طول) (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe size اندازه لوله (in)</td>
<td>Estimates tape Length per weld joint (تحمین طول نوار برای هر اتصال جوش (in))</td>
<td></td>
</tr>
<tr>
<td>12,18 in TO BE Specified by Company اینج توسط نوسان کرده برای</td>
<td>3 4 5 6 8 10 12</td>
<td>4 8.5 15 21 27.5 34 40.5</td>
</tr>
<tr>
<td>Tensile strength اندازه بهکنش و توسط</td>
<td>Larger size اندازه بزرگتر</td>
<td>To be specified By manufacturer for different pipe dia. And to be approved by Company</td>
</tr>
</tbody>
</table>