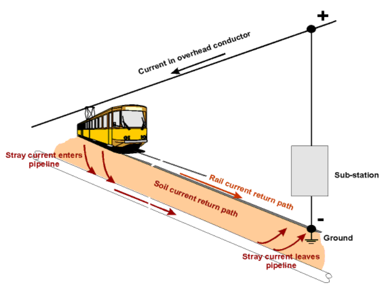
Electrolysis &
Stray Traction Current Report

ONE CARRINGTON STREET
SYDNEY



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Report No: A715-233
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1. INTRODUCTION

Sovereign Wynyard Centre Pty Limited is proposing a major new PCA Premium Grade commercial and retail development over and including the eastern access ways to the Wynyard Station concourse, from George Street through to Carrington Street.

It is a requirement of RailCorp that for all Developments in the vicinity of electrified tracks;

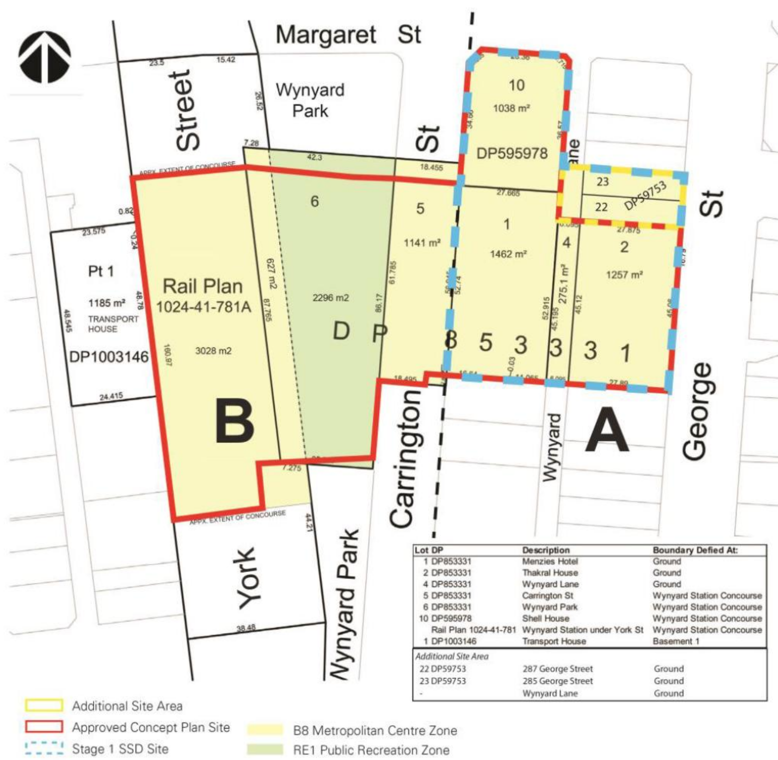
a. The existence of stray traction current in the ground is investigated.

b. A report is developed identifying the extent of the stray traction problem, and what measures should be taken to ensure the stray current does not present a corrosion hazard to the proposed development.

Cathodic Protection Services were commissioned to;

a. Review the development plans and possible exposure to stray traction current.

b. Provide an opinion on whether stray traction current presents a corrosion hazard to the proposed development, and what, if any, remedial or mitigation actions are necessary.



2. CONCLUSIONS

The conclusions of this investigation are;

2.1 Stray traction current can be expected to be present on the site of the Development

2.2 The proposed method of construction, as detailed in Clause 4 of this report will prevent the entry of stray traction current into the structure.

Thus no additional measures are required to protect the building from corrosion hazards due to stray traction current.

2.3 Corrosion of the water service or the electrical earth can be caused by stray traction current. Installation of an insulating fitting in the water service, or the use of a non metallic water meter, or PVC pipe eliminates this hazard.

The above are elaborated on in Clause 8.

3. CODES AND STANDARDS

This report has been undertaken with reference to the following RIC Standards;

- EP 12 10 00 13 SP 1500 V Traction System Earthing
- EP 12 10 00 20 SP Low Voltage Distribution Earthing
- EP 12 10 00 21 SP Low Voltage Installations Earthing
- EP 12 10 00 22 SP Buildings and Structures Under Overhead Lines
- EP 12 20 00 01 SP Bonding of Overhead Wiring Structures to Rail
- EP 12 30 00 01 SP Electrolysis From Stray DC Current
- ESC 510 Boundary Fences [Civil]
- SPC 511 Boundary fences [Right of Way]
- ESC 380 External Developments

4. DESCRIPTION OF THE PROPOSED DEVELOPMENT

Sovereign Wynyard Centre Pty Limited is proposing a major new PCA Premium Grade commercial and retail development over and including the eastern access ways to the Wynyard Station concourse, from George Street through to Carrington Street. The main commercial tower comprises 27 commercial floors and roof plant above podium level with 4-5 levels below ground. The project also includes the heritage listed Shell House building on the corner of Margaret Street, Carrington Street and Wynyard Lane and heritage listed Beneficial House/Peapes Building at 285 George Street with these heritage listed buildings principally maintained and refurbished for commercial use

Details of the construction are shown on the following

DRAWING NO	REVISION	TITLE
SK-26	0	SECTION 1
SK-7002	PO1	MAKE SCHEME - FOUNDATIONS

Details of the construction, based on the above information are as follow;

1. All underground concrete is specified at 50 to 65 MPa with concrete cover between 50 to 75 mm.

2. Concrete in contact with the ground will be provided with a moisture barrier.

5. THE PROBLEM.

5.1 BACKGROUND

RailCorp use 1500 volt direct current to operate the traction system. The current is delivered by the overhead catenary cables and the return path to the sub station is via the track. The track is not insulated from earth, principally because of the difficultly of achieving insulation and secondly, for safety reasons.

Whilst the steel track is large in cross section, some of the current leaks from the tracks and finds alternate paths back to the sub station. Considerable current can be involved, for instance, a Tangara train requires about 4000 amps to start from rest.

All current obeys Ohms Law and if a low resistance metallic structure exists in the path of the “stray” current this can pick up the stray current which then flows along the structure to a point close to the sub station, where it discharges back to earth, and ultimately returns to the sub station.

Where the “foreign” structure picks up the stray current a small measure of corrosion control or “cathodic protection” is achieved. However, where the current discharges from the foreign structure back to the soil, corrosion of the foreign structure occurs as shown on Sketch CP34.

The problem of stray current corrosion was first identified in the 1930’s. For stray current to be a serious problem the foreign structure has to be electrically continuous. At that time the only organisation which had electrically continuous structures were the PMG (now Telstra) with their lead sheathed cables. They suffered corrosion failures and for many years considered this to be a necessary evil. However an enterprising Engineer decided to plot failures on a map and found they were predominantly grouped around rail lines or tram lines. Further investigation showed that they were also grouped around the sub stations associated with the tracks. He eventually identified the corrosion problem as being caused by stray current. The PMG approached the Railways for compensation and it did appear that the Federal Government would be suing the State Government.

Whilst this was occurring the Engineering staff developed a solution to the problem. This was to connect the foreign structure to the tracks via a simple control system. This provided a low resistance path for the stray current to return to the tracks thus eliminating the corrosion problem. The control bond could be engineered such that a degree of additional corrosion protection could be provided to the foreign structure.

The above led to the formation of the Electrolysis Committee which has representatives of the owners of all underground services, and RailCorp. Cathodic Protection Services represents the interests of the Oil and Chemical Industry on the Committee. Apart from the War Years the committee has met at about monthly intervals since the 1930's to discuss stray current problems and its mitigation with the Railways.

5.2 CORROSION HAZARD FROM STRAY TRACTION CURRENT

Direct current as used by the traction system can cause serious corrosion to underground metallic services and the steel reinforcement of concrete. Stray traction current flowing in the ground can be picked up by the steel reinforcement one side of the development, flow along the steelwork and discharge back to the soil on the opposite side of the building. At the discharge point of the current, corrosion of the reinforcement will occur.

For a building, the most common means of eliminating the corrosion hazard from stray traction current is to increase the electrical resistance of the concrete to the ground. This prevents the flow of stray traction current through the reinforcement.

Increasing the electrical resistance of the structure to ground for an onground slab is automatically achieved by the moisture barriers installed to prevent water entry into the structure. The moisture barrier is an electrically insulating membrane.

Where the structure is supported on pad and/or piered footings, increasing the resistance of the structure to ground can be achieved by either;

a. Applying moisture barrier to the excavation into which the pad footings or piers are poured.

b. If installation of moisture barriers into the excavation is impractical, ie for piered footings, these can be insulated from the structure by the application of insulating sleeving to the starter bars where they tie into the building reinforcement.

6. DETECTION OF STRAY TRACTION CURRENT

Stray traction current can be identified by either;

- Measurement of the potential of a metallic structure [such as a water service] to a reference electrode over a 24 hour period.
- Measurement of the potential gradient across the development to earth stakes over 24 hours.

Fluctuations in the potential values indicate the presence of stray traction current.

RailCorp requirement does not include identification of the presence of stray traction current. If the Development is on a corridor reserved for a future rail system, an electrolysis report is still required. The purpose of the Electrolysis Report is to ensure the design of the Developments foundations are such that the foundations are protected from corrosion hazards from stray traction current.

7. MITIGATION OF STRAY CURRENT

There are a number of options to deal with the potential corrosion problems which can result from stray traction current. These include,

a. Prevent or reduce exposure of the structure to stray traction current.
b. Install a mitigation system to offset the problem.

In the case of the latter this is an expensive approach as it requires the establishment of infrastructure necessary for the mitigation of the problem.

7.1. ELIMINATE OF REDUCE EXPOSURE TO STRAY TRACTION CURRENT

The simplest approach is to avoid exposure of the structure to stray traction current. Two approaches, which can be adopted, are;

7.1.1. Reduce Length of Structure in Alignment with Traction Current Path.

As noted in Section 6, the hazard from stray traction current is due to the current flowing onto and then off the metallic structure. Corrosion occurs at the point of discharge of the current back to the soil.

The hazard from the stray traction current increases as the length of the conducting service increases. Stray traction corrosion is a problem because the metallic service presents a lower electrical resistance path to current flow than the alternative path through the earth.

For current to flow onto and discharge from an underground structure, electrochemical reactions need to occur to generate or absorb electrons. Both these reactions require energy, which results in a resistance existing between the structure and the earth. If the structure is short in length, the combined resistance of the pick up and discharge reactions is sufficient to prevent the traction current flowing onto the structure.

Additional to the above, the passage of the stray traction current causes development of potential gradient in the earth. For a short metallic conductor, the potential gradient to which it is exposed to too small to allow the pick up of the current.

Accordingly the shorter the length of the metallic structure the less likely it is to be affected by stray traction current.

7.1.2. Isolate the Structure from Stray Traction Current.

The effects of stray traction current can be avoided by increasing the resistance of the structure to the soils in which stray traction current is flowing. This can be achieved by use of moisture barriers such as FORTICON which provides an electrically insulating membrane which prevents entry of stray traction current. Even if the membrane is damaged, it will still provide sufficient resistance to prevent entry of stray traction current.

7.1.3. Use of High Strength Concrete.

Increasing the strength of the concrete increases the electrical resistance of the concrete. Thus if concrete of 40 mpa is used for the underground components, this has a high resistance, due partly to the reduced water content, and acts as an electrical insulator to the entry of stray traction current.

7.2 STRAY TRACTION CURRENT MITIGATION

Stray traction current mitigation is achieved by providing a low resistance path from the structure to allow discharge of any stray traction current directly back to the rail.

Provision of a mitigation system involves the following;

a. The reinforcement of the concrete has to be made electrically continuous. This involves tack welding all members of the reinforcement cages.

b. Testing has to be undertaken to provide evidence to the Railways that a stray traction current corrosion hazard exists.

c. If the testing identifies a corrosion hazard to the steel reinforcement does exist, installation of a "railway drainage bond" can proceed.

It is appreciated that installation of a mitigation system is a particularly expensive option. Cathodic Protection Services recommended a stray traction mitigation system be installed on The Sydney Harbour Tunnel. This structure is 3200m in length and testing indicated the existence of a stray traction current hazard. A stray traction current mitigation system was incorporated to the design of the tunnel

8. ONE CARRINGTON STREET

The elimination of corrosion hazards from stray traction current involves increasing the resistance of the conductive path for stray current which may otherwise be conducted into the underground sections of the structure. If stray current is conducted into the structure, severe corrosion of the concrete reinforcement can result, ultimately resulting in structural failures.

Comments relating to the One Carrington Street project are outlined in the following sections. Electrolysis should not affect the proposed development provided the measures outlined below are adopted.

8.1 LOWER BASEMENT CONCRETE SLAB

The slab will be provided with a moisture barrier which acts as an electrical insulator to the entry of stray traction current. This eliminates any stray traction current hazards to the slab

8.2 FOUNDATIONS AND UNDERGROUND WALLS

All underground concrete is specified as 50 to 65 MPa and concrete cover between 50 and 75 mm Concrete of this strength and cover is considered to have sufficient electrical resistance to resist the conduction of stray traction current.

8.3 INCOMING SERVICES

Stray traction current can affect metallic water, fire and gas services. Should stray traction current be picked up by the services, this can result in a corrosion problem on;

a. The services.

b. The Development's electrical earth system. This is because the earth and the water service have a direct interconnection via the MEN system. Current picked up by the water and/or fire services can discharge back to the earth via the earth system resulting in corrosion of the earth grid or stake.

This problem can be eliminated by installation of an insulating fitting, or non-metallic sections in the services at or close to the boundary of the property as detailed in RIC Standard EP 12 30 00 01 SP "Electrolysis from Stray DC Current", Clause 5.3.

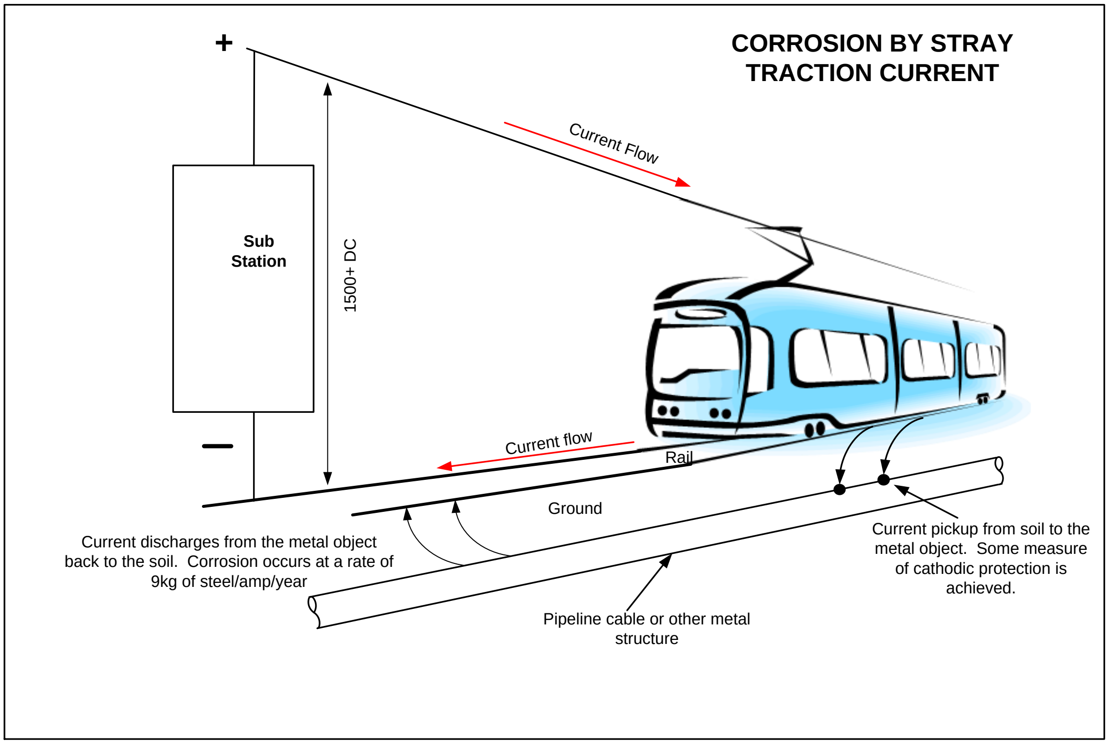
> *"Water and gas pipes servicing buildings on the Railway Corridor and near 1500 V track to have an isolating joint installed at the boundary."*

Suitable insulating fittings are available from Savcor Art, telephone 96632322.

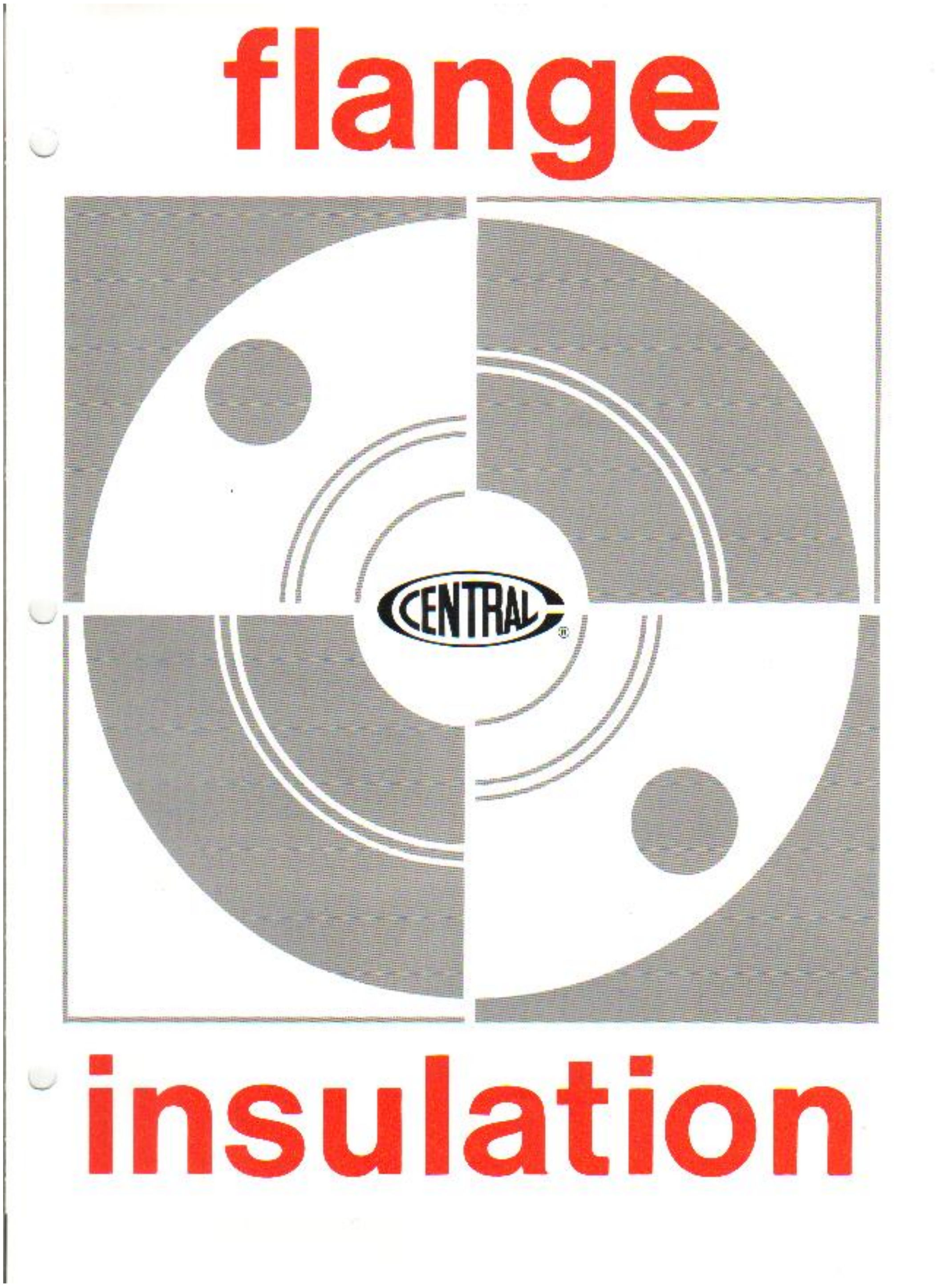
If the water service, or the water meter is constructed from non metallic materials, no other insulation is necessary.

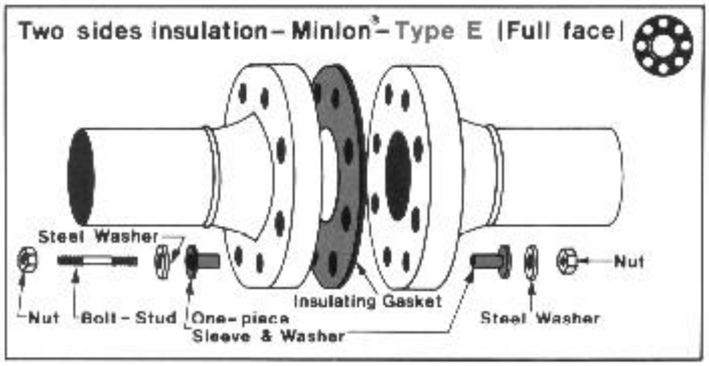
Gas services do not require any additional insulation. If the incoming service is steel construction, this will be fitted with a cathodic protection system incorporating an insulating joint at the meter. If the service is low pressure, this will be run in non-metallic pipe.

APPENDIX A

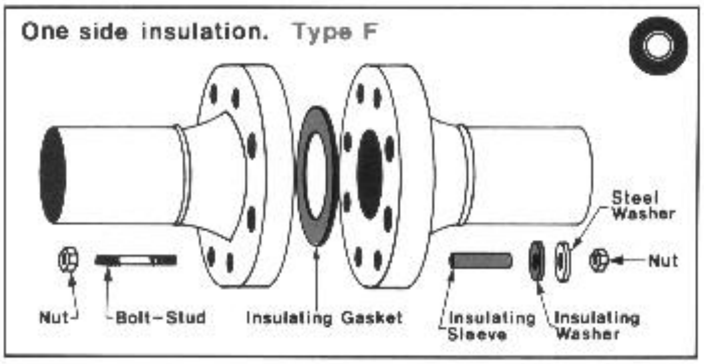

CORROSION BY STRAY TRACTION CURRENT
+
—
Sub Station
1500+ DC
Current Flow
Current flow
Rail
Ground
Current discharges from the metal object back to the soil. Corrosion occurs at a rate of 9kg of steel/amp/year
Current pickup from soil to the metal object. Some measure of cathodic protection is achieved.
Pipeline cable or other metal structure

APPENDIX B



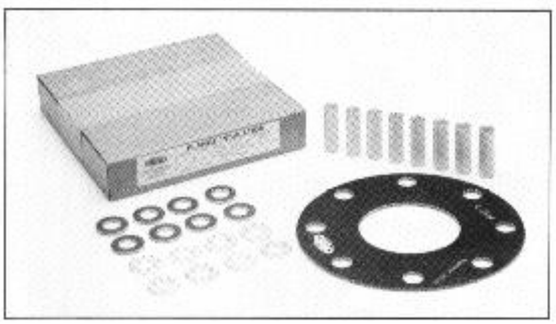


Type "E" gaskets perfectly center on precisely located bolt holes. Since their outside diameters are the same, foreign material is prevented from "shorting" the flange insulation



Type "F" gaskets are made without bolt holes, to fit tightly inside the overall bolt hole circle of the flange faces. The outside diameter of the gasket fits tightly in place assuring a well centered position.

CENTRAL FLANGE INSULATION KIT



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- POLYETHYLENE
- MYLAR®
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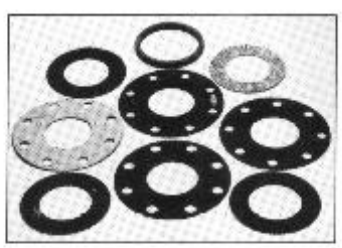
- OTHERS

INSULATING WASHERS
- PHENOLIC
- EPOXY GLASS
- OTHERS



INSULATING GASKETS
- TYPE E – FULL FACE
- TYPE F – RING
- TYPE D – RTJ, BX
- Jack-O-RING

NEOPRENE FACED PHENOLIC
PHENOLIC
J.M. 71® ASBESTOS
EPOXY GLASS
OTHERS

SEAL RING
- NITRILE, BUNA-N
- VITON
- OTHERS

MOLDED ONE-PIECE SLEEVE & WASHER
- MINLON®

(Standard Gasket Width-1/8")

FOR BEST RESULTS
CENTRAL RECOMMENDS

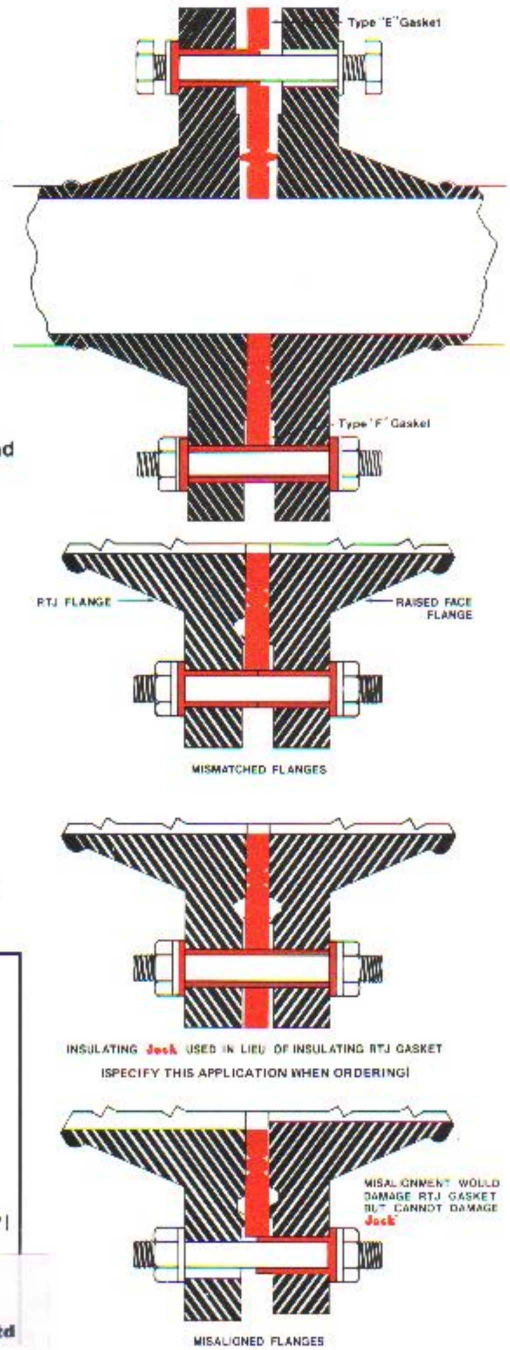
Jock™ O-RING GASKETS

BEFORE: The flange face contacts the crown of the elastomer seal ring. As the bolts are tightened the flange face deforms the seal crown into the molded voids.

AFTER: The flange faces are in complete contact with the seal retainer, thus encapsulating the seal elements in conjunction with the retainer grooves. The elastomer, because of it's resiliency and pressure from the line fluid, attempts to return to it's original shape and effects a positive o-ring type seal.

PROBLEMS SOLVED.............

- Fewer Service Calls due to leaking and "shorting" flanges.
- Positive Sealing through a wide range of fluctuating temperatures.
- Maintenance Versatility and Positive Sealing in difficult situations. (see examples)
- Longest Fire Life of any insulating gasket.
- Positive Seals and Zero Environmental Leakage.



HOW?

TO ORDER FLANGE INSULATION KIT PLEASE INDICATE THE FOLLOWING:

1. Quantity
2. Pipe Size (Nominal)
3. Pressure Rating (ANSI,DIN,API)
4. Gasket Type
5. Retainer Material
6. Sealing Element
7. Single or Double Washer Sets (SW or DW)
8. Sleeve Material

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