Who is MTI, and why are we here?

- MTI is a consortium of 52 operating and supplier companies involved in the chemical, pharmaceutical, and pulp & paper industries
- Member companies are knowledgeable and involved in materials engineering issues that apply to the CPI
- MTI wants to ensure that the needs of the CPI are addressed in the existing and proposed API ISI Codes
- MTI members have significant expertise in non-metallic equipment and the fluids contained in this equipment.
- MTI Member Companies use the API Codes and have a significant number of certified API 510/570/653 Inspectors.

What are the needs of these industries?

– Recognized and accepted ISI Codes that apply to equipment handling corrosive and/or toxic materials
– Inclusion of Non-Metallic Materials
  - Thermosetting Plastics (FRP)
  - Thermoplastic Materials (Polyethylene Tanks)
  - Lined and Coated Equipment (rubber, glass, plastics)
– Inclusion of low pressure (non-code) vessels

Why do these needs exist?

- There are virtually no industry standards covering these materials and applications.
  - NBIC 23 covers only Section X Pressure Vessels
  - No other industry code covers:
    - Lined Equipment
    - Process Piping
    - Thermoplastic Structures
    - Low pressure Vessels
- Failure of these equipment items can result in OSHA defined Category A leaks
- States are already pressing for API 510/570 types of compliance for non-metallic materials
- There are tens of thousands of these tanks and vessels in service in chemical plants and refineries in addition to large amounts of piping

Codes covering FRP vs. Metals

	Metals	FRP	MTI Expertise
Tanks New Const.	API 650 API 620	ASME RTP-1	MTI Pub. 50
Tanks ISI	API 653	NBIC 23	Project 165-05
Vessels New Const.	ASME Section VIII	ASME Section X	MTI Pub. 50
Vessels ISI	API 510	NBIC 23	MTI FRP Self-Help Guidelines CD-ROM
Piping New Const.	ASME B31.3	ASME B31.3	Project 165-05
Piping ISI	API 570	???	MTI Manual No. 2 Project 165-05 Project 129-99

Other Non-metallics vs. Metal

	Metals	Non Metallic	MTI Expertise
Lined Tanks New Const.	API 650 API 620	API 650 API 620	
Lined Tanks ISI	API 653	API 652 (Bottoms only)	Project 166-05
Thermoplastics New Const.	API 653	????	Project being bid
Thermoplastics ISI	????	????	Project being bid
Lined Piping New Const.	ASME B31.3	ASME B31.3	Project 166-05
Lined Piping ISI	API 570	API 570	MTI Manual No. 2 Project 166-05

Goals – Short Term

- Participate and ***Contribute*** at API Meetings
- Provide Comments as needed and/or requested by the API Committee Members
- ***Write*** Appendix or Appendices to supply information that we believe needs to be added to the combined ISI Code
- Follow format of API Codes so that users can easily follow and understand any added requirements

Goals – Long Term

- Inclusion of non-metallic materials and low pressure equipment in API ISI Codes as part of an Appendix or Appendices
- MTI will use the expertise and resources of its membership to provide the input required for the new ISI Code

1. Scope

This appendix covers inspection, repair, alteration, and rerating requirements and expectations for FRP piping systems after they have been placed in service.

2.0 OWNER/USER ORGANIZATION RESPONSIBILITIES FOR FRP PIPING SYSTEMS

2.1 Owner/User Organization

An owner/user organization is responsible for developing, documenting, implementing, executing, and assessing pressure equipment, inspection systems and inspection/repair procedures that meet the requirements of this ISI code. These systems and procedures will be contained and maintained in a quality assurance inspection/repair management system and shall include the controls necessary so that only qualified secondary bonders and procedures are used for all repairs and alterations.

2.2 FRP Inspector

The FRP inspector is responsible to the owner/user to assure that the inspection, NDE, and pressure testing activities meet the requirements of this ISI code. The FRP inspector shall be directly involved in the inspection activities, which in most cases will require field activities to ensure that procedures are followed, but may be assisted in performing inspections by other properly trained and qualified individuals, who are not inspectors e.g. examiners and operating personnel. However, all NDE results shall be evaluated and accepted by the FRP inspector.

FRP Inspectors shall be certified in accordance with the provisions of Appendix B of this ISI code.

3.0 INSPECTION PLANS

An inspection plan shall be established for all FRP piping systems within the scope of this code. The inspection plan shall be developed by the FRP inspector and/or engineer. The FRP specialist shall be consulted when needed to clarify potential damage mechanisms and specific locations where degradation may occur.

4.0 INSPECTION FOR TYPES OF DAMAGE, MODES OF DETERIORATION AND FAILURE MECHANISMS

FRP piping is susceptible to various types of damage by several deterioration mechanisms. The list below is a description of the typical damage type mechanisms (internal/external) for FRP piping systems:

4.1 Brittle fracture

a. General and local material loss due to:

1. resin loss
2. veil deterioration
3. mechanical damage (localized impact typically referred as “starcraze”)
4. Organic acid corrosion

5. Erosion / erosion-corrosion
6. Permeation
7. Surface cracking
8. Corrosion barrier imperfections (pitting, air voids, etc.)

b. Subsurface cracking which results in:

1. Blistering
2. Delaminations

c. Thermal degradation which causes:

1. Surface cracking
2. Material Properties Changes
3. Brittle fracture

d. Dimensional changes that result due to:

1. Creep and stress rupture
2. Thermal

Further guidance to the damage mechanisms can be found in MTI-129-99 and NBIC Appendix 9.

4.2 Freeze damage

At subfreezing temperatures, water and aqueous solutions in piping systems may freeze and cause failure because of the expansion of these materials. Because of the brittle nature of FRP piping systems, they should be thoroughly inspected for external cracking if freezing has occurred.

4.3 Deposits

The FRP inspector, in consultation with the FRP specialist, should determine when it is necessary to remove deposits to perform adequate inspections in FRP piping systems. The FRP inspector, in consultation with the FRP specialist, should determine when it is necessary to remove deposits to perform adequate inspections. Whenever operating deposits, such as chlorine butter, are normally permitted to remain on the equipment surface, it is important to determine whether these deposits adequately protect the equipment or do not cause additional deterioration of the surface. Spot examinations at selected areas, using a cut out may be required to determine the equipment condition.

In the case of FRP piping, particular attention should be given to the external overlays and flanges. Look for small cracks at the interface of the overlays and at the flange hub area.

5.0 CONDITION MONITORING METHODS

5.1 Examination Technique Selection

In selecting the technique(s) to use during FRP piping inspection, the possible types of damage for that equipment should be taken into consideration. The FRP inspector should consult with the FRP specialist or an engineer to help define the type of damage, the NDE technique and extent of examination. Examples of such techniques include:

5.1.1 Acoustic emission examination: for detecting structurally significant defects. ASME Section V Non Destructive Examination Article 11 provides guidance on performing acoustic emission examination.

5.1.2 Destructive Testing: In order to further ascertain the condition of FRP piping, some situations may require destructive testing. This is typically done by using cutouts from the exposed pipe and inspecting the rate of corrosion/permeation that has occurred. The FRP specialist should be consulted to evaluate the condition of the corrosion barrier and the laminate structure

5.1.3 Pneumatic Pressure Tests

Pneumatic tests are not recommended for FRP piping systems. Any low pressure pneumatic test that is to be considered for FRP piping shall be reviewed and approved by the FRP specialist.

5.2 INSPECTION OF FRP FLANGED JOINTS

FRP flanges will exhibit a small crack at the flange to hub interface. Excessive stress due to pipe loads, excessive torque or uneven flange faces can cause this type of failure.

5.3 PIPING INSPECTION INTERVALS

The following criteria should be considered for determining the interval between FRP piping inspections.

a. Corrosion rate and remaining life calculations.

b. Piping service classification (section 6.5).

c. Applicable jurisdictional requirements.

d. Judgment of the FRP inspector, the piping engineer, the piping engineer supervisor, or an FRP specialist, based on operating conditions, previous inspection history, current inspection results, and conditions that may warrant supplemental inspections. The owner/user or the inspector shall establish inspection intervals for thickness measurements and external visual inspections and, where applicable, for internal and supplemental inspections.

5.4 VISUAL EXTERNAL INSPECTIONS

In the case of FRP piping, particular attention should be given to the external overlays and flanges.   Look for small cracks at the interface of the overlays and at the flange hub area.

FRP piping systems should be inspected for delaminations and/or small cracks. Ultraviolet degradation is a common problem for FRP piping that has been exposed to sun light for many years. This phenomena causes resin loss on the outer layer. The FRP inspector with the support of the FRP specialist should determine the condition of the piping system and decide if any repairs are necessary.

5.5 INTERNAL CORROSION RATE DETERMINATION

The corrosion rate of FRP piping depends largely on the service, pressure and temperature conditions. The FRP specialist must review the results to determine the appropriate corrosion rate of each piping circuit.

5.6 MAXIMUM ALLOWABLE WORKING PRESSURE DETERMINATION

The MAWP for FRP piping circuits must be evaluated and approved by the FRP specialist.

5.7 REQUIRED THICKNESS DETERMINATION FOR PIPE

FRP structural calculations are largely dependent on the type of fabrication. The FRP specialist should be consulted for the appropriate values to be used in the calculations.

5.8 REPAIRS AND ALTERATIONS

FRP piping repairs or alterations approved by the inspector shall also be reviewed and approved by the FRP specialist.

5.8.1 Material: FRP repairs require a laminate that has similar properties and resin system as the original joints that were used in the code of construction. The FRP inspector shall verify that the resin, catalyst and laminate strength required for any repair or alterations in a piping circuit complies with the original code of construction. If required, the FRP specialist can be contacted for proper application procedures. Further guidance can be found in MTI-129-99.

5.8.1.2 Defect Repairs: Repairs to defects found in FRP piping components may be made by several techniques often dependent upon the size and nature of the defect, the materials of construction, and the design requirements. Repair techniques can be classified as permanent or temporary depending upon their design and conformance to the applicable construction code.

These repairs require the approval of the FRP specialist. The procedure for these repairs shall also be provided by the FRP specialist. Guidance for FRP repairs can be found in NBIC App. 9, section 9-4000 and ASME RTP-1 Mandatory App. M7.